Utah Groundwater Discharge Permit Application for Crystal Peak Minerals Sevier Playa Potash Project

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Executive Summary

Peak Minerals Inc., DBA Crystal Peak Minerals (CPM) is developing a mining operation on the Sevier Playa. This operation will consist of trenches and wells for extraction of the brines from the playa sediments; recharge canals, collectors, and trenches to provide recharge from the Sevier River and ephemeral drainages surrounding the playa; preconcentration ponds and production ponds for evaporation, concentration, and deposition of salts from the brines; a facility area for processing of the salt to produce sulfate of potash; and a waste storage facility for storage of process tailings and purge brine. This document is provided to the Utah Division of Water Quality (DWQ) for the ground water discharge application for these facilities.

As part of site history, three rounds of water quality baseline data collection of the surface and ground water hydrology of the proposed site area has been conducted during the period from 2011 to 2013. Additional data from the 2015 -2016 CPM studies on the playa were collected. The Fresh Water Baseline Study (CPM, 2018), is on-going and is being conducted with the approval of the US Bureau of Land Management, the major land management agency. From these data, CPM has developed a conceptual hydrogeologic model which describes the groundwater flow within the site area (CPM, 2018). This model is discussed within the application and an accompanying technical memorandum (CPM, 2018) included as an appendix.

Based on this conceptual model, the Sevier Playa consists of a series of interbedded clays, silts, and fine sand layers that are contained within a down-dropped depression (graben). These sediments are connected to and recharged by the local aquifers that overlay the adjacent mountain slopes. These sediments overlay the underlying eastern area quartzite and western area carbonate bedrock. The bedrock formations are considered part of the Great Basin Carbonate Aquifer system. Shallow groundwater flows from the local mountain slope aquifers toward the playa. Additionally, surface water from the Sevier River, during wet cycle years, when runoff exceeds upstream uses, flows onto the playa and provides recharge to the playa aquifers. These waters mix with the existing playa waters and discharged via evaporation. Due to the fine-grained nature of the sediments, much of this groundwater is held within the playa sediments by matrix forces. A small portion of the local groundwater, which are not able to migrate into the tighter playa sediments, drains vertically into the underlying bedrock aquifer. The groundwater within the bedrock flows from the Cricket Mountains on the east toward the House Range/Black Hills on the west. Then the groundwater enters the more permeable, fractured carbonate formations and flows north.

The preliminary baseline data shows that the brines within the playa sediments meet the Utah standard of a Class IV water. Groundwaters surrounding the playa naturally decrease in quality the closer they are to the playa. At the top of the surrounding mountains, the waters meet the standards of a Class I water. As the distance to the playa decreases, the waters sequentially meet the standard of both Class II and Class III waters.

CPM anticipates that the potential for any discharges from the proposed facilities is quite low. This is due to the presence of a very low permeability clay that covers the surface. As the facilities will be underlain by, essentially, earthen liners, CPM has approached the permitting as if there is a potential for some minor discharge from the areas that would pond waters. These consist of the preconcentration ponds, the production ponds, and the tailings and purge brine storage areas. Leakage simulations were conducted for these areas and a horizontal velocity of the potential leakage was determined to be very low at 3.4 feet per year. Flux rates for these potential leakage flows are such that mounding under the facilities and migration along the gradient to the edge of the playa is unlikely to occur within the 30-year planned life of the operation. Once the operation ceased, the purge brine and tailings would be drained, and the source of the potential leakage would be removed. This would result in any mounding and leakage flow dissipating and minimizing the potential for the leakage to continue to migrate.

To assess whether such leakage will occur, CPM has incorporated a compliance monitoring plan into this application which will be used to identify any potential discharges from the facilities. This monitoring plan includes 16 existing and 10 proposed wells completed in playa and unconsolidated sediments and bedrock. These wells will be used to comply with the U.S. Bureau of Land Management (BLM) stipulation to monitor the groundwater hydrology and identify any off-lease impacts that might result from the proposed operations. Additionally, CPM is proposing a series of well points immediately adjacent to the main potential source, the tailings and purge brine storage areas. These well points will serve as an early warning if there are any leakage from these facilities. If leakage is identified, CPM will work with the agency to document the movement, direction, rate, and quality of the leakage, to determine if there is potential for the leakage to move off-site.

Abbreviations

ac-ft/yr	acre-feet per year
amsl	above mean sea level
bgs	below ground surface
BLM	U.S. Bureau of Land Management
btoc	below top of casing
cm/s	centimeters per second
CPM	Crystal Peak Minerals, Inc.
CPM Canada	Crystal Peak Minerals, Inc. (CPM Canada, or the Company), formally known as EPM Mining Ventures Inc.
CPMC	Crystal Peak Minerals Corporation
DAQ	Division of Air Quality
DOI	U.S. Department of the Interior
DWQ	Division of Water Quality
EA	Environmental Assessment
EIS	Environmental Impact Statement
Emerald Peak	Emerald Peak Minerals LLC
EPA	Environmental Protection Agency
Exploration EA	DOI-BLM-UT-W020-2011-015-EA
ft/d	feet per day
ft/ft	feet per foot
FONSI	Finding of No Significant Impact
gal/hr	gallons per hour
gal/ton	gallons per ton
gal/yr	gallons per year
GBCASS	Great Basin Carbonate and Alluvial Aquifer System

gpm	gallons per minute
GWDP	Ground Water Discharge Permit
GWQS	Utah Groundwater Quality Standards
in/yr	inches per year (in/yr)
Leasing EA	DOI-BLM-UT-W020-2010-014-EA
LUMA	LUMA Minerals LLC
mg/l	milligrams per liter
mm/yr	millimeters per year
MCZ	Marl Clay Zone
pcf	Pounds per cubic feet
Project	Sevier Playa Potash Project
RCRA	Resource Conservation and Recovery Act
ROW	right-of-way
Salada	Salada Minerals LLC
SCZ	Siliceous Clay Zone
SITLA	Utah School and Institutional Trust Lands Administration
SOP, or potassium sulfate (K_2SO_4)	sulfate of potash
SPCC	Spill Prevention, Control and Countermeasures
SR	State Route
SWPPPs	Storm Water Pollution Prevention Plans
TDS	Total Dissolved Solids
tons/yr	tons per year
UAC	Utah Administrative Code
UDOGM	Utah Division of Oil Gas and Mining
UPDES	Utah Pollutant Discharge Elimination System
USGS	United States Geological Survey
WMP	Water Monitoring Plan

1.0 INTRODUCTION AND BACKGROUND

Peak Minerals Inc., DBA Crystal Peak Minerals (CPM) is proposing to construct and operate the Sevier Playa Potash Project (Project) on federal, state, and private lands in Millard County, Utah. The Project would be designed to produce an average of approximately 328,500 tons per year of potash in the form of potassium sulfate (K_2SO4), also known as sulfate of potash (SOP), as well as other associated mineral products. CPM owns as lessee, or through agreement has the right to develop and operate, potassium mineral leases on approximately 118,000 acres of land administered by the U.S. Bureau of Land Management (BLM) as well as potash mineral leases on an additional approximately 6,400 acres of state lands managed by the State of Utah School and Institutional Trust Lands Administration (SITLA) for a total of approximately 124,400 acres. The primary on-lease Project components would include evaporation and production ponds, extraction and recharge trenches, extraction wells, and the Processing Facility. To support the Project, additional components to be constructed outside of the lease boundary (off-lease lands) on state, private, and BLM-administered lands would include power and communication lines, communication towers, a Natural Gas Pipeline, a Rail Spur and Loadout Facility, multiple water wells and pipelines, and access roads.

The leases within the Project are held by three entities:

- CPM
- LUMA Minerals LLC (LUMA)
- Emerald Peak Minerals LLC (Emerald Peak)

CPM has agreements with Luma and Emerald Peak to control permitting and mining activities and is the entity applying for this groundwater discharge permit from the Utah Division of Water Quality (DWQ).

1.1 HISTORY OF MINERAL EXPLORATION AND DEVELOPMENT ON THE SEVIER PLAYA

In the 1800s various descriptions of the Sevier Playa region were put forth; however, specific details on the location of the Sevier Lake were not confirmed. In 1869, the U.S. Army Corps of Engineers determined the true position of the lake/playa (Gwynn 2006). Between 1869 and 1977, most mapping work in the region focused on improving topographical and surface geology information, with scientific studies undertaken in the 1960s to assess the Sevier Playa mineralogy and brine chemistry. These studies served as the basis for more detailed exploration and bulk sampling by Crystal Peak Minerals Corporation (CPMC), starting in 1977. There is no relationship between the historical CPMC company and the current CPM company.

In 1987, the BLM completed an Environmental Assessment (EA) of the leaseholds under the National Environmental Policy Act. The CPMC development and operations plans were reviewed, and the leasehold area was surveyed for environmental concerns, including wildlife habitat, threatened and endangered species, cultural and archaeological resources, and impacts to recreational opportunities. The BLM issued a “Finding of No Significant Impact” (FONSI) in October 1987. Salada Minerals LLC (Salada) assembled approximately 15,360 acres of federal sodium leases in 1997, covering the south end of the playa. Salada also held approximately 1,280 acres of potash leases in five separate sections from the state of Utah, School and Institutional Trust Land Administration (SITLA). Salada’s leases and plans were also evaluated under the EA process, culminating in a FONSI decision by the BLM in June 1997 and a right-of-way (ROW) grant in February 1998.

More recently, two additional EAs have been developed by the BLM for the area. In February 2011, the BLM published an EA (DOI-BLM-UT-W020-2010-014-EA) (Leasing EA), disclosing and analyzing the environmental consequences of its Sevier Lake Competitive Potash Leasing Proposal (BLM 2011a). The Leasing EA was not limited to the assessment of leasing and included analysis of the effects of reasonable scenarios for potash extraction based on known available processes and technology.

The BLM's Decision Record and FONSI for the Leasing EA allowed a competitive Sevier Playa potassium lease sale to move forward. The BLM published the Sevier Lake Potash Lease Sale notice for the lands under consideration on March 2, 2011. CPM was the high bidder and was awarded federal leases totaling 95,801.76 acres on June 2, 2011.

As a follow-up to the Leasing EA, the BLM completed a second EA (DOI-BLM-UT-W020-2011-015-EA) (Exploration EA) to assess the impacts of CPM's proposed exploration on Sevier Playa (BLM 2011b). The BLM issued a Decision Record and FONSI for the Exploration EA in August 2011. After the Decision Record was signed, the first phase of the exploration program was successfully initiated and completed in 2011–2012. A second phase of exploration was successfully initiated and completed in 2013. A third exploration phase was initiated in 2015 and was completed in 2017. A fourth phase was initiated in 2018.

Potassium and potash leases, collectively referred to as potash leases, grant the lessee the exclusive right and privilege to explore for, drill for, mine, extract, remove, beneficiate, concentrate, or otherwise process and dispose of the potassium deposits and other associated minerals. The extraction and development of that resource are only allowed in accordance with lease stipulations and under an approved mining plan, as well as being subject to other required state and federal approvals.

1.2 PROJECT OBJECTIVE

The purpose of the Project is to support economic recovery of potash resources from federal and state (SITLA) lands by commercial production. Such development has the potential to supplement the global supply of potash, a highly desirable and necessary potassium fertilizer, and to contribute to local, regional, and state economies.

CPM is proposing to construct and operate the Project, which would be designed to produce an average of approximately 328,500 tons per year (tons/yr) of potash in the form of sulfate of potash (SOP, or potassium sulfate [K_2SO_4]). Under the Project, brines extracted from Sevier Playa (dry lakebed) sediments would be concentrated by solar evaporation within the preconcentration ponds. The potassium-rich potash salts conveyed to and precipitated in production ponds would be harvested and processed in a modern crystallization plant to produce a saleable SOP product, as well as other associated minerals. The Project would feature recharge and extraction canals at the surface of the mineral extraction area as a method of recovery of the potassium-rich salts. Also, shallow extraction wells would be used to extract salts from local underground aquifers within the playa. Recharge waters would be collected from natural precipitation and the Sevier River. Evaporation ponds would be used for recovery of the crude salts. The salts would be harvested using mobile equipment and sent to the nearby Processing Facility for beneficiation to produce SOP. Waste brines and tailings from the processing would be stored in the Waste Storage Area.

2.0 PART A GENERAL FACILITY INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Facility Name: Sevier Playa Potash Project

2.1.1 Mailing Address

Crystal Peak Minerals

2150 South 1300 East, Suite 550

Salt Lake City, UT 84104

United States of America

2.1.2 Property Location and Access

The Project property, located in southwestern Utah's central Millard County, is defined essentially by the geographical boundaries of the Sevier Playa, centered approximately at latitude 38°56'50.21" N and longitude 113°08'25.75" W. The playa covers an area of about 130,000 acres and is approximately 26 miles long by an average of 8 miles wide, at an elevation of about 4,514 feet above mean sea level (amsl).

The Project property is situated approximately 140 miles southwest of Salt Lake City, Utah, generally between the towns of Delta, 30 miles to the northeast, and Milford, 25 miles to the south-southeast, as illustrated in Figure A1-1. From Delta, the northern margin of the playa is accessed by traveling 11 miles southwest along U.S. Routes 6 and 50. The southern end of the Project can be accessed from Milford by traveling 23 miles north on Utah State Route (SR) 257 to the historic Town of Black Rock and then traveling the remaining 13 miles west on Crystal Peak Road, a secondary improved gravel road, and Crystal Peak Spur Road, a Class B county maintained road, which leads to the south end of the playa, as shown in Figure A1-2.

Two secondary north-south-trending roads run along the west and east sides of the property. On the west, the Steamboat Pass Road is a graded native surface (dirt) road, which is a Class B, county-maintained road. On the east of the playa, a rough two-track road runs from SR 257 Cutoff Road to Crystal Peak Road. Numerous unimproved roads and trails suitable for four-wheel drive vehicles lead from these north-south-trending routes to the edge of the playa.

The ability to travel on the playa varies seasonally, depending on the amount of moisture on the saltpan. The margins of the playa can support a pickup truck, in places, but use of normal vehicles is risky due to their ground pressure and the likelihood of becoming mired in the relatively soft playa sediments. Playa travel is best approached with all-terrain vehicles. This has been creatively addressed by CPM using snow cats with extra-wide treads. Recent exploration activities, performed during a period of unusually wet playa conditions, have used marsh buggies commonly employed in the bayous of the southern United States as rig platforms, as well as air-propelled boats for personnel and equipment transport.

The planned facilities are shown in Figure A1-3. The approximate center locations of the major facilities are presented in Table A1-1.

Table A1-1 Location of Center of Site Facilities

Facility ID	Public Land Survey System	Latitude, Longitude
Preconcentration Ponds	Township 11W, Range 20S, Section 35	39.023486, -113.068758
Production Ponds	Township 12W, Range 24S, Section 3	38.755169, -113.184346
Purge Brine Storage Pond	Township 12W, Range 24S, Section 5	38.748822, -113.218740
Tailing Storage Area	Township 12W, Range 24S, Section 8	38.735238, -113.224953
Processing Facilities	Township 12W, Range 24S, Section 16	38.722068, -113.199777

The Project leases are held by the following three entities:

- CPM, through its 2011 federal potassium leases

  Contact: Woods Silleroy
  2180 South 1300 East, Suite 200
  Salt Lake City, UT 84106
  Telephone: (801) 485-0225
  email: woods@crystalpeakminerals.com

- LUMA, through its 2011 federal potassium leases

  Contact: Denise Dragoo
  Snell & Wilmer L.L.P.
  15 West South Temple, Suite 1200
  Salt Lake City, UT 84101
  Telephone: (801) 257-1998
  email: ddragoo@swlaw.com

- Emerald Peak, through its 2008 state (SITLA) potash leases

  Contact: John Mansanti
  2180 South 1300 East, Suite 200
  Salt Lake City, UT 84106
  Telephone: (801) 485-0225
  email: jgmansanti@crystalpeakminerals.com

2.1.3 Property Contact

Comments and documentation regarding this permit application should be directed to:

- Crystal Peak Minerals
  John Mansanti, CEO
  Telephone: (801) 485-0223
  Fax: (801) 467-2521
  email: jgmansanti@crystalpeakminerals.com

2.2 OWNER/OPERATOR INFORMATION

- Owner:

  Crystal Peak Minerals
  2180 South 1300 East, Suite 200
  Salt Lake City, Utah 84104

- Operator:

  Crystal Peak Minerals
  2180 South 1300 East, Suite 200
  Salt Lake City, Utah 84104

- Official Representative:

  John Mansanti, CEO
  Telephone: (801) 485-0223
  Fax: (801) 467-2521
  email: jgmansanti@crystalpeakminerals.com

2.3 FACILITY CLASSIFICATION

This Project is a new facility.

2.4 TYPE OF FACILITY

The Project is a mining and processing operation.

2.5 SIC/NAICS CODE

The Project is classified under SIC Code: 1474, Potash, Soda, and Borate Minerals and NAICS CODE: 212391, Potash, Soda, and Borate Mineral Mining.

2.6 PROJECTED FACILITY LIFE

Mining is anticipated to occur for 30 years with ore processing anticipated to occur for 32 years. As the operation progresses additional reserves may be discovered which could extend the life of the Project.

2.7 MINE OPERATING AND PROCESSING DESCRIPTION

An overall description of the Project mining and processing activities are presented in the Project summary presented in Appendix A. Playa brine will be extracted in a combination of trenches and wells and fed to the first of several preconcentration ponds. The purpose of the preconcentration ponds is to bring the playa brine to near saturation with respect to certain potassium minerals, where the brine can then be fed to the production ponds. During the preconcentration process, the minerals halite ($NaCl$), gypsum ($CaSO_4+2H_2O$), bloedite ($Na_2SO_4+MgSO_4+4H_2O$), and polyhalite (K_2SO_4+$MgSO_4$+2$CaSO_4$+2H_2O) are expected to precipitate. The preconcentration ponds will be constructed on the playa surface.

After the playa brine has reached near potassium mineral saturation in the preconcentration ponds, it will be fed to the production (i.e., harvest pond) circuit. These ponds will be constructed on the playa surface at the south end of the playa. The brine will be evaporated in the production pond circuit until the magnesium chloride concentration is roughly 30% by weight. During this concentration process, halite, schoenite (K_2SO_4+$MgSO_4$+6H_2O), epsomite ($MgSO_4$+7H_2O), sylvite (KCl), and carnallite (KCl+$MgCl_2$+6H_2O) are expected to precipitate in the production ponds. The 30% $MgCl_2$ brine that exits the production ponds will be sent to a purge brine storage pond. This pond will be constructed on the playa surface west, southwest of the production ponds.

The mixed salts from the production ponds will be harvested and fed to the processing plant. The first unit operation within the processing plant is called the conversion reactor. The chemistry in the conversion reactor is controlled so that only schoenite, epsomite, and halite exit. This slurry is then fed to a flotation circuit that targets the flotation of schoenite. The flotation concentrate is fed to the schoenite leach step where any remaining halite or epsomite are removed, and the flotation tailings are fed to the tails leach where any remaining schoenite is removed. Schoenite from the schoenite leach is fed to the potassium sulfate crystallizer and mixed with water and sylvite. The purpose of the sylvite in the crystallizer is to convert some of the $MgSO_4$ from the schoenite into $MgCl_2$ and K_2SO_4.

Three streams will exit the Processing Facility. The first stream consists of the solids that are removed in the flotation circuit and will consist primarily of halite and epsomite. These solids will be trucked and stacked in the tailings waste storage area. The second stream that exits the Processing Facility will be the process recycle stream. This stream is a liquid that is piped back to the production ponds and is retreated because of its high potassium concentration. The soluble potassium in this stream will contribute to the production solids precipitated in the production pond circuit. The third stream is the SOP product which leaves the process facility as finished product for shipment.

2.8 ISSUED AND PENDING PERMITS

2.8.1 Permit History

Currently, CPM has approval from both the BLM and Utah Division of Oil Gas and Mining (UDOGM) for mineral exploration activities on the playa. Exploration activities within the lease area are completed under exploration UDOGM permits E/027/0078, E/027/0080, E/027/0084, E/027/0094, and E/027/0095.

Exploration activities on federal leases for the BLM are done through compliance with the Sevier Dry Lake Exploratory Testing EA issued in October 2011 (BLM 2011a).

2.8.2 Pending Permits

Development of CPM’s leases requires both state and federal approvals. For the federal approvals, CPM is working toward compliance with the National Environmental Policy Act. Due to the size of the Project area, BLM has determined that an Environmental Impact Statement (EIS) will be required for the proposed Project. Development of the EIS has been initiated and a third-party contractor has been selected to support BLM’s preparation of the Project EIS. A Draft EIS is currently being prepared and will be released for public review following an announcement of its availability.

In addition, development of CPM's federal leases requires approval of a mining plan in accordance with the requirements specified in 43 CFR 3590, Solid Minerals (Other than Coal) Exploration and Mining Operations, through 43 CFR 3596 as applicable. The Project must also file a Notice of Intent to Commence Large Mining Operations and must obtain approval from the UDOGM prior to beginning operations in accordance with the Mined Land Reclamation Act. The BLM and UDOGM have agreed that the Mining Plan will be a joint document that will meet the requirements of both agencies.

CPM is also working with the DWQ regarding permits for storm water runoff under the state's Utah Pollutant Discharge Elimination System (UPDES). Due to the site conditions, DWQ is unclear on how the UPDES permit would apply as Sevier Playa is a terminal basin. A review of the information associated with the Project will be conducted and determination made as to applicability. In the meantime, CPM will develop Storm Water Pollution Prevention Plans (SWPPP)s for construction and industrial activities and will keep these plans current. Plans will be available on site prior to commencement of construction or mining activities. CPM is considering submitting the SWPPP to DWQ for a review prior to operations.

A Spill Prevention, Control and Countermeasures (SPCC) Plan will be developed for the Project.

No concentrated animal feed operations will occur as part of the proposed operations.

No underground injection of fluids will occur as part of the Project.

No Resource Conservation and Recovery Act (RCRA) hazardous wastes will be generated as part of the proposed operations. CPM is also working with the Utah Division of Air Quality (DAQ) to submit a minor source permit application for construction and operation activities. CPM is in the process of preparing that permit application.

Also, a Ground Water Discharge Permit (GWDP) is required from the DWQ. It is CPM's understanding that the GWDP is normally a single permit covering the hydrogeologic site conditions and proposed process and discharge descriptions along with construction plans for dealing with the proposed processing and discharge streams. For this project, CPM proposes adjusting to a two-part permit – part 1 is the hydrogeologic permit and part 2 the construction permit. CPM is utilizing a design build approach so final construction plans are not available for inclusion in the application at this time. This application covers the hydrogeologic portion of that requirement along with preliminary plans and a general description of the proposed process and discharge handling facilities. CPM requests that DWQ review the hydrogeologic portion and grant approval with stipulation that once final details for the preconcentration ponds, production ponds, and purge brine and tailings storage areas are developed, CPM will be submitting plans for the construction permit. Further, CPM proposes that no construction on the ponds be undertaken until plans are reviewed and approved by DWQ.

Solid wastes generated will be hauled to regulated landfills by third-party services on a regular basis, therefore, no on-site landfills or incinerators will be required.

CPM will obtain all the necessary permits to properly store, transport, and dispose of chemicals and wastes prior to project start-up in coordination with local and state agencies.

CPM anticipates that a drinking water treatment plant permit will be required prior to project start-up. CPM will work with the Utah Division of Drinking Water to obtain this permit.

Prior to project start-up, CPM will obtain a county conditional use permit from Millard County, along with other ancillary county approvals required.

2.9 WATER SOURCES

The Project area has been studied by several groups. Whetstone Associates, Inc. (2017) (referred to hereafter as Whetstone) prepared a summary of studies and data up to 2013. CPM prepared a technical memorandum to supplement the Whetstone report with additional data collected from 2014 to 2016.

2.9.1 Well and Spring Identification

United States Geological Survey (USGS) 7.5-minute topographic maps, Utah water rights records, the National Hydrography Dataset and water quality databases maintained by Environmental Protection Agency (EPA) and USGS were reviewed to determine the locations of wells and springs in the area of the proposed project. It was assumed for the sake of this document that the potential point of discharge from the site would be the edge of the playa sediments.

The DWQ groundwater discharge permit application requests information on water sources within one mile of the point of discharge. Only one spring appears to be located close to one-mile from the edge of the playa. This spring (Anderson Spring) is located in the Sevier River drainage north of the playa in the SW1/4 of Section 4, T20S, R10W (see Figure A9-1). Water Right 68-46, which is associated with Anderson Spring, allows the use of this spring for stock watering. Other springs in the general vicinity are located at a greater distance than one mile from the playa edge and are at elevations significantly above the playa surface. Thus, these additional springs are not expected to be impacted by Project operations.

Numerous wells were completed by CPM within the playa as part of an exploration project to assess the brine resources. In addition to the brine-exploration wells, 16 wells exist outside the playa boundary but within one mile of the playa edge as shown in Figure A9-1. Information regarding these wells, which are completed in playa sediments, alluvial/colluvial sediments, and bedrock zones, is provided in Table A9-1. Information regarding 17 additional wells shown in Figure A9-1 farther than one mile from the playa edge is presented in Table A9-2.

Table A9-1 Wells Within One Mile of Playa Edge

Well ID	Owner	Status	Use	Lithology	Nothing (Meters)	Easting (Meters)	Elevation (ft amsl)	Depth (ft btoc)	Casing Type	Screened Interval (ft btoc)
Wishing Well	USGS	Existing	Monitoring	Silt, Clay, Sand	4,289,219.151	304,245.258	4,561.09	145	2-In. Sch 40 PVC	127 - 145
Lakeview	BLM	Existing	Stock Well	Lava	4,287,710.967	309,518.781	4,590.11	532	6-In. Steel	420 - 500
Black Hills	BLM	Existing	Stock Well	Notch Peak	4,300,942.405	304,812.365	4,638.12	560	6-In. Steel	No Record
PVC Shoal	No Record	Existing	Monitoring	No Record	4,300,949.310	306,592.104	4,524.32	11	2-In. Sch. 40 PVC	3 - 8
Amasa	USGS	Existing	Monitoring	Clay, Interbedded Silt	4,330,790.927	314,446.233	4,548.74	145	2-In. Sch 40 PVC	127 - 145
Erehwon	USGS	Existing	Monitoring	Clay	4,300,282.807	314,512.213	4,534.76	203	2-In. Sch 40 PVC	200 - 203
Glass Ocean	USGS	Existing	Monitoring	Clay	4,322,908.649	308,230.983	4,527.98	101	2-In. Sch 40 PVC	98 - 101
Glitter Gulch	USGS	Existing	Monitoring	Clay	4,322,831.142	307,775.286	4,561.92	201	2-In. Sch 40 PVC	198 - 201
Headlight Gap	USGS	Existing	Monitoring	Clay	4,300,037.028	314,749.932	4,549.94	207	2-In. Sch 40 PVC	204 - 207
Laceration	USGS	Existing	Monitoring	Clay	4,300,966.513	306,447.386	4,532.10	203	2-In. Sch 40 PVC	200 - 203
Machine Gun	USGS	Existing	Monitoring	Clay	4,300,952.613	306,456.082	4,531.54	102	2-In. Sch 40 PVC	99 - 102
Mudflat	USGS	Existing	Monitoring	Clay and Sand	4,327,924.446	310,866.439	4,528.56	203	2-In. Sch 40 PVC	200 - 203
Nautilus	USGS	Existing	Monitoring	No Record	4,300,298.142	314,490.957	4,531.34	24.8	2-In. Sch 40 PVC	21.2 - 22.6
Red Boat	USGS	Existing	Monitoring	Clay	4,301,261.474	305,817.285	4,560.63	200	2-In. Sch 40 PVC	197 - 200
Dike Access	CPM	Existing	Monitoring	Silty Clay	4,288,743.245	309,902.889	4,544.74	380	4-In. Sch 40 PVC	349.5 - 380
Provo	CPM	Existing	Monitoring	Sandy Silty Clay	4,299,963.801	315,326.771	4,575.75	460	4-In. Sch 40 PVC	260 – 460

Note: Table data summarized from Whetstone Report.

Table A9-2 Wells Outside One Mile of Playa Edge

Well ID	Owner	Status	Use	Lithology	Nothing (Meters)	Easting (Meters)	Elevation (ft amsl)	Depth (ft btoc)	Casing Type	Screened Interval (ft btoc)
Black Rock	BLM	Existing	Stock Well	Sand and Clay	4,287,177.960	328,084.442	4,851.05	91.0	6-In. Steel	50 - 84
Mudhole	BLM	Existing	Stock Well	Sand and Clay	4,332,972.796	336,261.267	4,559.56	503	6-In. Steel	338-365 480-503
UDOT-2	UDOT	Existing	--	No Record	4,338,769.621	325,704.378	4,690.94	778	8-In. Steel	523 - 778
UDOT-3	UDOT	Existing	--	No Record	4,333,764.304	318,701.653	4,660.87	507	8-In. Steel	No Record
Crystal Peak Road	USGS	Existing	Monitoring	Silt, Sand, Gravel	4,286,415.294	301,248.194	4,623.94	195	2-In. Sch. 40 PVC	177.5 - 195.5
Wah Wah	BLM	Existing	Stock Well	Gravel	4,283,585.813	299,460.852	4,657.58	294	8/6-In. Steel	236 - 294
Ibex	BLM	Existing	Stock Well	Clay, Sand, Gravel	4,311,515.288	293,920.794	4,783.36	493	6.25-In Steel	No Record
Tule 1 MX	BLM	Existing	Stock Well	Silt and Sand	4,330,147.975	287,464.237	4,512.86	620	10.75-In Steel	500 - 600
Coyote	CPM	Existing	Monitoring	Notch Peak Fm.	4,303,123.819	303,565.770	4784.27	765	5-In. Sch. 80 PVC	560-760
Monument Point	CPM	Existing	Monitoring	Prospect Mtn Qtz.	4,297,920.869	319,183.604	4,891.30	1,215	5-In. Sch. 80 PVC	1,030-1,210
Nighthawk	CPM	Existing	Monitoring	Notch Peak Fm.	4,322,356.885	304,601.819	4,804.36	780	5-In. Sch. 80 PVC	580-780
North Cricket	CPM	Existing	Monitoring	Prospect Mtn. Qtz.	4,318,516.348	327,907.318	5,083.78	780	5-In. Sch. 80 PVC	580 - 780
CWTW-1	CPM	Existing	Water Supply	Undifferentiated Qtz.	4,284,182.747	306,994.141	≈4,960	750	Open Hole	Open
Guzzler	CPM	Existing	Monitoring	Sand, Gravel Cobbles w/ Clay	4,314,342.754	324,861.882	4,966.81	425	4-in Sch. 40 PVC	325-425
Miller Canyon Res.	CPM	Existing	Monitoring	Bedded Clay Sand and Gravel	4,322,849.859	306,412.000	4,699.22	315	4-in Sch. 40 PVC	245-315

Note: Table data summarized from Whetstone Report.

2.9.2 Surface Water Drainage Identification

The Sevier Playa is a terminal surface water basin with no outlet. Sevier River is the main surface water source to the Sevier Playa. The river drains an area of about 11,574 square miles and flows approximately 279 miles north then southwest through a series of reservoirs from its headwaters in Kane County to its terminus at Sevier Playa. Gunnison Bend Reservoir is the closest water storage facility, located about 30 miles upstream of the playa. About 21 miles upstream of the playa a diversion structure, Conks Dam, diverts the major portion of the remaining Sevier River flow for irrigation purposes. The USGS does not recognize the reaches of the Sevier River below Conks Dam as a perennial stream, due to this diversion. During normal and low flow years the Sevier River is completely depleted by upstream uses and does not flow in the main channel below Conks Dam. However, CPM anticipates purchasing water rights in the region and using the lower reach of the river channel (below Conks Dam) to convey recharge water on an as-needed basis during the life of the operation.

Other than the Sevier River, the geographic area surrounding and including the playa is dissected by numerous ephemeral drainages typical of high-desert landscapes and does not contain any perennial surface water sources. Fourteen primary ephemeral drainages flow toward the playa from both the Cricket Mountains, on the east, and the Black Hills/House Range, on the west. These ephemeral drainages only flow in response to rapid snow melt and high-intensity rainfall events. Under most circumstances flow from these drainages does not reach the playa boundary. Transmission losses consume most of these flows into the alluvial/colluvial deposits around the fringe of the playa.

No other bodies of surface water have been identified within one-mile of the edge of the playa.

2.9.3 Well-head Protection Area Identification

No drinking water supply wells exist within a one-mile radius of the Project. Therefore, no well-head protection areas have been identified.

2.9.4 Drinking Water Source Identification

No protection zones or drinking water sources subject to the protection of Utah Administrative Code (UAC) 309-600 have been identified within a one-mile radius of the Project.

2.9.5 Man Made Structures

CPM currently operates a maintenance shop and laydown yard at the south end of the Playa. The shop is located in T24S, R12W, Section 16, S/2 (LAT 38.722347, LONG -113.196010).

During operations, the proposed process facility will be located within one mile of the edge of the playa at the south end of the playa. The Proposed facilities are to be located in T24S, R12W, Section 16, S/2 (LAT 38.720347, LONG -113.196010).

A water tank and well head associated with the Lake View Well are located about 1.1 miles from the Playa edge. This structure is located in T24S, R12W, Section 22, NW/4 (LAT 38.717545, LONG -113.190971). No other man-made structures are within a one-mile radius of the Project.

2.9.6 Well Logs

As described in Section 9.1 above, several monitoring wells have been installed by CPM and its predecessors, by the USGS, and by the BLM within the playa and the area surrounding the Project area. Information regarding these wells is summarized in Tables A9-1 and A9-2. Well logs are not available for all wells. Available logs are included in Appendix B.

3.0 PART B GENERAL DISCHARGE INFORMATION

3.1 DISCHARGE POINT LOCATIONS

As indicated in Part A, Sections 2.1 and 2.7, the mine/processing operation will consist of a series of Preconcentration and Production ponds where solar evaporation will occur, a Processing Facility, and a waste storage area. No specific discharge is intentionally planned. However, due to the earthen lined ponds being used and the extensive area of these ponds, discharges due to pond leakage may occur beneath the Preconcentration and Production ponds and waste storage areas. Locations of these areas are shown in Figure A1-3. Any discharge from the preconcentration ponds will be upgradient of the brine extraction and recharge operations. Therefore, discharge from this set of ponds will be recaptured by the mining operations.

As shown in Figure A1-3, the preconcentration ponds will be located in the north end of the playa and the production ponds and waste storage areas will be located in the south end of the playa. Potential leakage from the preconcentration and production ponds and the waste storage area represent discharges that could enter the playa groundwater system. As further described in Section 3.8 of this Part B, groundwater in the alluvial/colluvial sediments surrounding the playa flows toward the playa, thereby limiting the potential for off-playa movement of groundwater from the playa sediments. Furthermore, the playa sediments below the production zone include a thick sequence of hard, dry clays that separates the production zone from the underlying playa sediments and regional bedrock groundwater system. This will preclude pond leakage from migrating vertically to the regional bedrock groundwater system.

Given these conditions, it is anticipated that discharges to groundwater from the Project (if any) will remain primarily within the currently-saturated playa sediments and not impact the adjacent alluvial/colluvial or regional bedrock groundwater systems. Furthermore, as noted above, a large majority of potential leakage from the Project ponds will be recaptured by the mining operations. A groundwater monitoring program is proposed herein to provide early detection of impacts if they occur.

No uncontrolled discharges are planned from the Project.

3.2 TYPE OF PLANNED AND POTENTIAL DISCHARGE

The mine operations will use water for dust control and, therefore, will be applying water to the ground surface. However, as the water will be used at a controlled rate for dust control, this will ensure that the applied water will evaporate and will not be considered a discharge to the groundwater system.

The mining method consists of the extraction of brine from the playa sediments through a network of extraction trenches and wells. Brine will be conveyed to a series of Preconcentration and Production ponds to concentrate the produced salts. Potassium salts from the Production ponds will then be transferred to the Processing Facility. Process filter cake brine will be stockpiled in the waste storage area shown in Figure A1-3.

3.2.1 Planned Discharge

As discussed above, discharges to the playa groundwater system may occur due to brine leakage from the production ponds, preconcentration ponds, and waste storage area. While there may be leakage from the preconcentration ponds, such discharges will be very similar to the brines that exist within the playa sediments. Furthermore, the preconcentration ponds are upgradient of the brine extraction and recharge operations. Thus, leakage from these ponds would be recaptured by the mining operations.

As noted in Section 3.8 of this Part B, a thick sequence of hard, dry clay exists at a depth of approximately 85 to 100 feet below ground surface (bgs) in the playa sediments beneath the brine production zone. This layer effectively separates the saturated playa sediments from the underlying playa sediments and regional bedrock groundwater system. Therefore, if leakage occurs from the Project ponds and waste storage area, this leakage will not migrate vertically to the regional bedrock groundwater system. In the event leakage from the Project ponds and waste storage areas migrates horizontally off playa to the surrounding alluvial/colluvial sediments, such event would be identified/monitored by the proposed compliance monitoring network. In addition, the potential impact of this lateral brine movement will be further minimized by the fact that pre-Project Total Dissolved Solids (TDS) concentrations of groundwater in these adjacent sediments are generally greater than the Utah Class IV TDS standard of 10,000 milligrams per liter (mg/l), as further discussed in Section 3.8 of this Part B.

3.2.2 Potential Discharges

Potential discharges other than those described in Section 3.2.1 above are limited to incidental spills of process chemicals, runoff from process area, overflow of containment structures due to major storm events (i.e., storms with a return period of more than 10 years), and material failure of pipelines and structures at the process area. However, all project facilities lie either within or next to the playa. Therefore, these potential discharges would be captured within the playa area.

The following chemicals will be used during production of the SOP:

- Flotation collector: Clariant Flotigam 8122 (primary amine) will be injected to the flotation feed with a dosage of up to 272 gal/ton of the dry solids feed. The dry mass flotation feed is 1,975,030 tons/yr, which translates into 592 tons/yr of collector.
- Flotation Extender Oil: Kerosene will be injected to the flotation feed with a dosage of up to 73 gallons per ton (gal/ton) of the dry solids feed. The dry mass flotation feed is 1,975,030 tons/yr, which translates into 159 tons/yr of extender.
- Flotation frother: Methyl isobutyl carbinol will be injected to the dry flotation feed, with a dosage of approximately 18 gal/ton of the dry solids feed. The dry mass flotation feed is 2,177,097 tons/yr, which translates into 39 tons/yr of frother.
- Anti-dusting agent: Anti-dusting oil will be added to the product at the truck/train loadout to prevent dust formation during transport and handling. The anti-dusting agent is a mineral oil (the same or equivalent to RHT22-85, supplied by the Commercial Oil Company). The dosage of oil is 0.1% oil for all SOP produced, which yields a consumption rate of 84 pounds per hour, which would be applied throughout the 7,880 operating hours of the Processing Facility. Based on this application rate, 331 tons/yr of anti-dusting agent will be required.
- Potable water treatment: Sodium hypochlorite will be required to chlorinate the potable water supply. It is currently anticipated that the quantity of chlorination solution required will be approximately 10 gallons per hour (gal/hr) or 78,800 gallons per year (gal/yr).

- Methanol use in the process laboratory: Methanol will be used to wash brine from various mineral samples prior to analysis. The waste methanol will be collected and stored for disposal. It is estimated that the yearly usage of methanol will not exceed 55 gallons.

The majority of these chemicals will be stored and used in buildings with concrete floors, thereby essentially precluding potential discharges to groundwater. The primary exception will be the anti-dusting agent. This agent will be stored and handled in accordance with a Spill Prevention, Control, and Countermeasure Plan that will be prepared in accordance with EPA requirements, thereby also minimizing the potential that this agent would discharge to groundwater.

3.3 ACTUAL DISCHARGE VOLUMES

As this is a proposed operation, there are no actual discharges at the present time.

3.4 POTENTIAL DISCHARGE VOLUMES

Potential discharges may come in the form of pond infiltration/seepage, seepage from pond overflow due to major precipitation events, material failure, and incidental precipitation contact with product.

Seepage from Project facilities that lie either within or next to the playa up-gradient of mining operations will be captured by mining operations. As discussed in Part B, Section 3.8, the upper 12 feet of the playa sediments consists of low permeability fat clay which limits potential seepage through this layer. However, the potential exists that seepage from Project ponds and the waste storage area may migrate into the Utah Class IV groundwater in the alluvial/colluvial sediments surrounding the playa.

Norwest (2017) estimated the potential leakage from Project ponds using the software SEEP/W 2012, a two-dimensional finite element model developed by GeoSlope International. Additional information regarding this modeling effort is provided in Section 3.9.2 of this Part B. This analysis was conducted assuming a hydraulic conductivity of $1x10^{-7}$ centimeters per second (cm/s) for the fat clay that lies near the surface of the playa. This hydraulic conductivity represents the geometric mean of values determined from eight constant-head permeability tests conducted on undisturbed samples of the fat clay collected at a depth of 1.2 to 4.0 meters (3.9 to 13 feet) below ground surface. The Norwest (2017) evaluation conservatively did not account for the potential decrease in permeability due to accumulation of halite on the floor of the Project ponds (see Tang et al., 2017).

The results of the seepage evaluation are provided in Appendix C. It is estimated that seepage rates will decline as the upper, unsaturated portion of the fat clay saturates. Steady-state seepage from ponds constructed on the low-permeability fat clay is estimated to be 0.055 inches per year (in/yr), with 96% of this seepage occurring through the floor of the ponds and 4% occurring through the pond embankments. Table B4-1 presents estimates of the seepage volume, based on Project pond areas provided by Brebner et al. (2018). As noted, it is estimated that leakage from the ponds will reach a steady state rate of 2 to 80 acre-feet/year, depending on the pond area. As indicated previously, the vast majority of this leakage from preconcentration ponds will discharge to the playa groundwater system and be recaptured by the mining operations.

Table B4-1 Estimated Seepage Rates from Project Ponds

Pond	Area (ac)	Leakage Rate (in/yr)	Leakage Volume	
			(ac-ft/yr)	(gal/day)
Preconcentration ponds	17,563	0.055	80	71,860
Production ponds	2,539	0.055	12	10,390
Purge brine storage pond	746	0.055	3	3,050
Tailings storage facility	543	0.055	2	2,220

The risk of a discharge occurring to groundwater due to overtopping of pond embankments during major storm events is extremely low. All ponds have been designed with freeboard that will contain direct precipitation. The potential for groundwater to be impacted by runoff from product areas is also extremely low since these stockpiles will be covered or surrounded by containment berms. Therefore, it is anticipated that potential discharges from these sources to groundwater will be de minimis.

Failure of Project brine pipelines may result in inadvertent discharges to groundwater. Since such a failure would represent the loss of a valuable product, CPM is committed to minimizing that potential and mitigating that loss rapidly. Given the location of these pipeline, within and adjacent to the playa area, such a discharge would be recaptured by brine recovery operations and would not affect groundwater resources outside the playa.

3.5 MEANS OF DISCHARGE OR POTENTIAL DISCHARGE

The most likely means of discharges to groundwater from the Project will be by way of infiltration/seepage from the preconcentration ponds, production ponds, and the waste storage area.

3.6 FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGY

The proposed layout of the mine facilities is shown in Figure A1-3. In general, the mine design consists of the following four major components:

- Brine extraction system consisting of canals, trenches and wells;
- Recharge system consisting of canals, collectors and trenches;
- Preconcentration and Production ponds; and
- Waste storage area.

Extraction and recharge trenches will be installed throughout the playa, with spacing and direction depending primarily on the hydraulic conductivity of the playa sediments and concentration of the brine. The Playa is divided into several mining units, each of which consists of extraction trenches, recharge trenches, recharge collectors, and extraction wells.

Brine will be extracted using trenches and wells, which will be connected to extraction canals to facilitate direct flow to a lift station where brines will be pumped to the preconcentration ponds.

The recharge system will consist of a structure to divert water from the Sevier River to a distribution point that will direct the flow into both east and west recharge canals. The recharge water will then be introduced to each mining unit through a series of recharge trenches and recharge collectors. Flows from the recharge canals to the recharge collector trenches will be controlled by valves or gates.

Preconcentration and Production ponds are designed to contain the produced brine and capture the precipitated salts. For the preconcentration ponds in the north, the deposited non-production salts will be stored in place and the berms will be raised over time to match the deposition of the salts. Production ponds in the south end of the playa will remain at their initial elevation for the life of mine since precipitated products will be periodically harvested and trucked to the Processing Plant for beneficiation.

Processing waste will be stored in three main areas. Salts predominantly halite develop as chemical precipitation will be deposited through the evaporation process. These will be stored in the preconcentration ponds. Bitterns or purge brine and tailings from the processing plant flotation circuit will be stored in two bermed areas in the southwestern portion of the Playa.

A simplified block diagram of the mine process is provided in Figure B6-1. The volume of water/brine that is planned for flow through the extraction/recharge process is approximately 30,000 gallons per minute (gpm) (48,340 acre-feet per year (ac-ft/yr)). Comparison with Table B4-1 indicates that only a small portion of this water will be lost to leakage from the ponds, with the vast majority lost to evaporation. Furthermore, as indicated previously in this permit application, the majority of the water lost to leakage from Project ponds will be recaptured in the brine extraction system.

Water lost via evaporation will be made up by recharge water supplied from rainfall, the Sevier River, and runoff from the surrounding mountain ranges. Project operations will also consume approximately 1,500 (ac-ft/yr) or 922 gpm of fresh water from proposed freshwater wells to be located south of the playa. This fresh water will be consumed for dust suppression, SOP production at the Processing Facility, potable use, and general service use at the Processing Facility and Rail Loadout Facility.

3.7 DISCHARGE EFFLUENT CHARACTERISTICS

The results of analyses of water quality samples collected from existing wells sampled in 2011-2013 within the playa sediments and 23 monitoring wells completed and sampled in 2015-2016 across the playa from both shallow and deep sediments are summarized in Tables B7-1A & B. These data, which are considered representative of concentrations at the upstream end of the preconcentration ponds, indicate that groundwater in playa sediments is a sodium-chloride brine (TDS concentrations ranging from 13,000 to 230,000 mg/l, averaging 161,000 mg/l) with circum-neutral pH (averaging 7.2 s.u.).

The in-situ brine is classified as a Class IV Saline Groundwater based on its TDS concentration greater than 10,000 mg/l and numerical groundwater standards are not applicable.

Evaporation of the brine will increase the concentration of many constituents while chemical precipitation and harvesting of the resource will decrease the concentration of others. Based on the results of detailed geochemical modeling, laboratory and field pilot tests, and mine projections, concentrations of total dissolved solids and major cations and anions have been estimated for the purge bine pond (i.e., the point of surface discharge from the final harvest pond) and the tailings storage area. These concentrations are presented in Table B7-2. This table also provides comparisons with the average concentrations presented in Table B7-1B together with the resulting concentrating factors. The indicated concentrating factors for the cations vary widely, as would be expected since these ions are the target of the chemical precipitation and harvesting process. The estimated minimum and maximum concentrating factors for chloride, which is generally considered to be a chemically conservative ion (i.e., chemically stable and persistent), are 1.6 and 3.5, respectively. The estimated concentrating factors for TDS range narrowly from 2.8 to 2.9.

Table B7-1a Summary of Project Specific and Publicly Available Water Quality Data for Wells Completed in Playa Sediments

Parameters	Units	Utah Groundwater Standards Class IV	2011-2013 Project Specific Water Quality Data for Wells in Playa Deposits [1] [2]							Publicly Available Water Quality Data for Wells in Playa Deposits [3] [4]						
			Average	Std. Dev.	Meridian	Range	Count	%ND	%>WQ Standard	Average	Std. Dev.	Meridian	Range	Count	%ND	% >WQ Standard
Major Ions and Solution Parameters																
Bicarbonate	mg/l $CaCO_3$	-	182	155	111	65.5 – 706	17	0%	-	150	119.7	118	59 - 581	16	0%	-
Carbonate	mg/l $CaCO_3$	-	NC	NC	NC	<10 - <20	17	100%	-	-	-	-	-	-	-	-
Hardness, Ca+Mg	mg/l	-	1,445	1,089	1,070	223 - 4,310	17	0%	-	7,915	3,347.9	8,420	2,480 - 14,600	15	0%	-
Calcium	mg/l	-	8,941.9	7,997	6,474.5	1,546.8 - 37,121	17	0%	-	813	385.2	715	240 - 1,660	16	0%	-
Magnesium	mg/l	-	1,207	1,683	717	146 - 7,780	17	0%	-	1,494	731.4	1,650	390 - 3,100	16	0%	-
Potassium	mg/l	-	530	782	186	19.3 - 2,560	17	0%	-	246.1	289.8	120.5	2.7 - 1,100	16	0%	-
Sodium	mg/l	-	23,861	18,041	18,800	4,190 - 70,900	17	0%	-	23,013	10,136.4	20,500	6,700 - 43,000	16	0%	-
Chloride	mg/l	-	34,494	30,317	23,200	5,590 - 116,000	17	0%	-	36,569	17,297.1	32,550	10,000 - 66,000	16	0%	-
Fluoride	mg/l	-	0.474	0.367	0.337	<0.1 - <1	17	53%	0%	0.4	0.32	0.3	0.1 - 1.4	15	7%	0%
Silicon	mg/l	-	9.4	3.88	8.49	3.59 - 19.9	17	0%	-	9,591	4,540.4	7,700	4,450 - 20,000	16	0%	-
Sulfate	mg/l	-	9,362	4,800	8,440	1,860 - 19,900	17	0%	-	15	11.1	12	5.8 - 50	15	0%	-
Total Dissolved Solids	mg/l	-	84,629	50,003	76,000	13,800 - 194,000	17	0%	-	72,169	29,948.2	66,300	23,900 - 123,000	16	0%	-
Nutrients																
Nitrate+Nitrite	mg/l N	-	-	-	-	-	-	-	-	8.3	24.66	<0.1	<0.1 - 100	15	53%	7%
Nitrate	mg/l N	-	4.14	10.17	<0.02	<0.01 - 39.8	15	60%	13%	NC	NC	NC	31.2	1	0%	100%
Total Orthophosphate	mg/l	-	0.65	2.12	<0.05	<0.05 - 8.59	15	67%	-	NC	NC	NC	0.118	1	0%	-
Dissolved Solids																
Aluminum	mg/l	-	0.3	0.2	<0.2	<0.1 - <1	17	24%	-	NC	NC	NC	4.66	1	0%	-
Arsenic	mg/l	-	0.1467	0.1782	0.0729	<0.002 - 0.771	17	12%	82%	0.1035	0.0195	0.1035	0.084 - 0.123	2	0%	100%
Beryllium	mg/l	-	NC	NC	NC	<0.002 - <0.015	17	100%	0%	-	-	-	-	-	-	-
Boron	mg/l	-	8.18	7.88	4.28	1.55 - 33.7	17	0%	-	10.67	6.925	7.98	3.7 - 25.	7	0%	-
Cadmium	mg/l	-	0.0017	0.0008	<0.0018	<0.0005 - <0.0045	17	82%	0%	-	-	-	-	-	-	-
Chromium	mg/l	-	0.01	0.01	<0.01	<0.002 - 0.0305	17	82%	0%	-	-	-	-	-	-	-
Copper	mg/l	-	0.0614	0.0587	0.0418	<0.002 - 0.202	17	18%	0%	NC	NC	NC	0.107	1	0%	0%
Iron	mg/l	-	1.625	5.082	0.246	<0.1 - 21.9	17	29%	-	1.585	1.315	1.585	0.27 - 2.9	2	0%	-
Lead	mg/l	-	0.013	0.028	<0.004	<0.002 - 0.123	17	59%	12%	NC	NC	NC	0.0084	1	0%	0%
Manganese	mg/l	-	0.51	0.745	0.156	0.0562 - 2.88	17	0%	-	0.332	0.118	0.332	0.214 - 0.45	2	0%	-
Mercury	mg/l	-	NC	NC	NC	<0.00015 - <0.00015	17	100%	0%	-	-	-	-	-	-	-
Selenium	mg/l	-	0.01034	0.0161	0.00701	<0.002 - 0.0727	17	88%	6%	0.0268	0.02672	0.0225	<0.001 - 0.0815	6	17%	17%
Silver	mg/l	-	NC	NC	NC	<0.002 - <0.01	17	100%	0%	-	-	-	-	-	-	-
Zinc	mg/l	-	1.559	1.933	0.906	<0.05 - 7.75	17	29%	6%	NC	NC	NC	0.0973	1	0%	0%
Field Parameters																
Temperature	°C	-	12.86	4.14	13.91	0.88 - 19.6	15	0%	-	16	1.7	16	13 - 19.5	15	0%	-
pH [5]	s.u.	-	7.3	0.4	7.4	6.19 - 7.9	15	0%	7%	7.5	0.2	7.4 7	7.2 - 7.8	15	0%	0%
Specific Conductance [5]	μS/cm	-	81,396	45,508	71,330	21,590 - 177,600	15	0%	-	75,227	25,486.3	74,600	34,800 - 126,000	15	0%	-
Turbidity	NTU	-	190.5	199.6	155.5	1 - 709.	10	0%	-	-	-	-	-	-	-	-
Dissolved Oxygen	mg/l	-	3.08	4.35	1.16	0.1 - 16.5	15	0%	-	-	-	-		-	-	-
ORP	mV	-	5.1	98.2	33.9	-177 - 148.8	15	0%	-	-	-	-	-	-	-	-

Notes:
[1] Compiled data for Playa Sediments represent one sample each from 16 wells in 2012 and 2013: Amasa, Dike Access, Glass Ocean, Glitter Gulch, Headlight Gap, Laceration, Machine Gun, Mudflat, Nautilus, Provo, PVC Shoal, Red Boat, RR7-1, RR7-4, S13, SN-11-400-4, and Wishing Well. Water quality data from SN-11-400-1 were rejected due to anomalous pH related to insufficient well development.
[2] Statistics were calculated by substituting the reported detection limit for non-detect data.
[3] Data source: NWIS and STORET databases, accessed at http://www.waterqualitydata.us, 2/16/2017; and BLM, 1989. Compiled data represent nine samples collected from seven wells by USGS and DEQ between 1970 and 1987.
[4] Statistics calculated by substituting the reported detection limit for non-detect data and may include total and dissolved concentrations for any analyte.
[5] Statistics for pH and specific conductance may include field and laboratory measurements for publicly available data.
U = Analysis reported as being below the detection limit, but the detection limit was not reported.
NC = Statistic not calculated. Either all data were below the detection limit or there was only one sample.
%ND = Percent of samples reported as below the detection limit.
% > WQ Standard = percent of samples reported above the groundwater quality standard. Non-detect data with MDLs greater than the standard are not compared to the standard.

Table B7-1b Playa Groundwater System

Parameter	Units	Utah Groundwater Standards	2015-2016 Project-Specific Water Quality Data for Wells in Playa Deposits [1]						
			Average	Std. Dev.	Meridian	Range	Count	%ND	%>WQ Standard
Major Cations and Anions									
Bicarbonate	Mg/l $CaCO_3$	-	354	133	380	54 - 830	61	0%	-
Carbonate	Mg/l $CaCO_3$	-	75	28	84	32 - 100	61	0%	-
Hydroxide	Mg/l $CaCO_3$		<6	-	-	<6 - <6	61	0%	-
Total Alkalinity	Mg/l $CaCO_3$		360	127	380	86 - 830	61	0%	-
Calcium	mg/l	-	543.2	283.8	530.0	63 – 1,400	61	0%	-
Magnesium	mg/l	-	3,427	1,804	2,700	220 – 6,970	61	0%	-
Potassium	mg/l	-	2,801	1,114	2,500	430 – 4,670	61	0%	-
Sodium	mg/l	-	40,710	10,812	40,800	5,300 – 77,000	61	0%	-
Chloride	mg/l	-	88,502	33,712	82,000	7,600 -150,000	61	0%	-
Sulfate	mg/l	-	10,784	2,840	11,000	2,000 - 16,000	61	0%	-
Total Dissolved Solids	mg/l	-	160,623	47,654	160,000	13,000 – 230,000	61	0%	100%
Nutrients									
Nitrate+ Nitrite	mg/l N	10	0.20	0.16	0.20	<0.015 – 0.310	61	0%	-
Total Phosphorus	mg/l	-	5.65	0.07	5.65	<0.15 – 5.70	61	0%	-
Dissolved Metals									
Aluminum	mg/l	-	-	-	-	<0.006 - <1.5	61	100%	-
Antimony	mg/l		-	-	-	<0.0015 - <0.380	61	100%	-
Arsenic	mg/l	0.05	0.270	0.000	0.270	<0.003 - 0.270	61	98%	2%
Barium	mg/l		0.044	0.004	0.044	<0.015 – 0.047	61	97%	-
Beryllium	mg/l	0.004	-	-	-	<0.0015 - <0.038	61	100%	0%
Bismuth	mg/l		-	-	-	<0.006 - <0.15	61	100%	-
Boron	mg/l	-	23.816	11.479	25.000	3.1 – 58	61	0%	-
Cadmium	mg/l	0.005	-	-	-	<0.0015 - <0.038	61	100%	0%
Chromium	mg/l	0.1	-	-	-	<0.003 - <0.075	61	100%	0%
Cobalt	mg/l		-	-	-	<0.006 - <0.15	61	100%	-
Copper	mg/l	1.3	0.775	0.884	0.775	<0.15 – 1.4	61	98%	0%
Iron	mg/l	-	4.887	2.820	6.100	0.12 – 7.6	61	90%	-
Lead	mg/l	0.015	0.025	0.000	0.025	<0.003 - 0.025	61	98%	2%
Lithium	mg/l		28.007	9.234	28.000	3.4 – 46.0	61	0%	-
Manganese	mg/l	-	2.224	1.534	2.200	<0.003 – 4.90	61	31%	-
Mercury	mg/l	0.002	-	-	-	<0.00032 - <0.00032	61	100%	0%
Molybdenum	mg/l		0.045	0.000	0.045	<0.006 – 0.045	61	98%	-
Nickel	mg/l		0.150	0.000	0.150	<0.012 – 0.150	61	98%	-
Selenium	mg/l	0.05	-	-	-	<0.006 - <0.015	61	100%	0%
Silver	mg/l	0.1	-	-	-	<0.003 - <0.075	61	100%	0%
Strontium	mg/l		16.423	8.713	15.000	2.5 – 40.0	61	0%	-
Thallium	mg/l		-	-	-	<0.006 - <0.015	61	100%	-
Tin	mg/l		-	-	-	<0.006 - <0.015	61	100%	-
Titanium	mg/l		-	-	-	<0.006 - <0.015	61	100%	-
Uranium	mg/l	0.030	0.140	0.028	0.140	0.12 - <0.75	61	0%	25%
Vanadium	mg/l		-	-	-	<0.006 - <0.015	61	100%	-
Zinc	mg/l	5	0.953	0.772	0.770	0.29 – 1.80	61	95%	0%
Zirconium	mg/l		0.000	0.000	0.000	<0.006 - <0.015	61	100%	-
Field Parameters									
pH	s.u.	6.5 - 8.5	7.177	0.635	7.000	6.50 - 9.20	61	0%	%
Specific Conductance	µS/cm	-	183,442	40,895	180,000	25,000 - 230,000	61	0%	-
Specific Gravity		-	1.107	0.064	1.113	0.999 – 1.193	61	0%	-

[1] Average of 61 samples for 24 wells in playa sediments.

Table B7-2 Estimated Concentrations of TDS and Major Constituents in the Brine Purge Pond and the Tailings Storage Area

Constituent	Baseline Concentration (mg/l)	Purge Brine Pond		Tailings Storage Area	
		Concentration (mg/l)	Concentrating Factor	Concentration (mg/l)	Concentrating Factor
Chloride	88,502	309,552	3.50	140,679	1.59
Magnesium	3,427	111,651	32.58	57,167	16.68
Potassium	2,801	1,438	0.51	27,449	9.80
Sodium	40,710	2,991	0.07	50,850	1.25
Sulfate	10,784	34,237	3.17	175,448	16.27
TDS	160,623	460,511	2.87	451,620	2.81

An accurate estimate of the concentration of each water-quality constituent that may discharge to groundwater via leakage from the Project ponds would require additional, extensive geochemical modeling and would still be constrained by substantial uncertainty. Therefore, based on a review of the chloride and TDS data provided in Table B7-2, an estimate of the potential range of constituent concentrations that may discharge to groundwater was made using concentrating factors of 2 and 4. The results of these calculations are presented in Table B7-3. It is of note that, although the Utah groundwater protection standards do not apply to Class IV groundwater, it is estimated that five constituent concentrations (arsenic, copper, lead, total dissolved solids, and uranium) exceed the protection standard. Of these constituents, four (arsenic, lead, total dissolved solids, and uranium) exceeded the standard under baseline conditions and only one (copper) may exceed that standard in the pond leakage.

Table B7-3 Estimated Range of Potential Concentrations of Purge Brine and Tailings Fluids

Analyte Name	Units	Utah GW Prot Std (mg/l ex pH, SG, & EC)	Average Conc. * (mg/l ex pH, Sg, & Ec)	Range of Potential Concentration (mg/l)	
				CD=2	CF=4
Aluminum	mg/l	-	-	-	-
Antimony	mg/l	0.006	-	-	-
Arsenic	mg/l	0.050	0.270	0.540	1.080
Barium	mg/l	2.0	0.044	0.088	0.176
Beryllium	mg/l	0.004	-	-	-
Bicarbonate Alkalinity	mg/l	-	354	708	1,417
Bismuth	mg/l	-	-	-	-
Boron	mg/l	-	23.82	47.63	95.27
Cadmium	mg/l	0.005	-	-	-
Calcium	mg/l	-	543.2	1086.4	2172.8
Carbonate Alkalinity	mg/L	-	75	150	301
Chloride	mg/L	-	88,502	177,003	354,007
Chromium	mg/l	0.1	-	-	-
Cobalt	mg/l	-	-	-	-
Conductivity	µmhos/cm	-	183,443	366,885	733,770

Analyte Name	Units	Utah GW Prot Std (mg/l ex pH, SG, & EC)	Average Conc. * (mg/l ex pH, Sg, & Ec)	Range of Potential Concentration (mg/l)	
				CD=2	CF=4
Copper	mg/l	1.3	0.78	1.55	3.10
Hydroxide Alkalinity	mg/l	-	-	-	-
Iron	mg/l	-	4.89	9.77	19.55
Lead	mg/l	0.015	0.025	0.050	0.100
Lithium	mg/l	-	28.01	56.01	112.03
Magnesium	mg/l	-	3,427	6,854	13,708
Manganese	mg/l	-	2.22	4.45	8.89
Mercury	mg/l	0.002	-	-	-
Molybdenum	mg/l	-	0.045	0.09	0.18
Nickel	mg/l	-	0.15	0.3	0.6
Nitrate-Nitrite as N	mg/l	10.0	0.20	0.39	0.79
pH	pH	6.5-8.5	7.2	-	-
Phosphorus	mg/l	-	0.52	1.03	2.07
Potassium	mg/l	-	2,801	5,603	11,206
Selenium	mg/l	0.05	-	-	-
Silver	mg/l	0.1	-	-	-
Sodium	mg/l	-	40,710	81,420	162,839
Specific Gravity		-	1.107	-	-
Strontium	mg/l	-	16.42	32.85	65.69
Sulfate	mg/l	-	10,784	21,567	43,134
Thallium	mg/l	0.002	-	-	-
Tin	mg/l	-	-	-	-
Titanium	mg/l	-	-	-	-
Total Alkalinity	mg/l	-	360	721	1,441
Total Dissolved Solids	mg/l	10,000	160,623	321,246	642,492
Total Phosphorus	mg/l	-	5.65	11.30	22.60
Uranium	mg/l	0.030	0.14	0.28	0.56
Vanadium	mg/l	-	-	-	-
Zinc	mg/l	5.0	0.95	1.91	3.81
Zirconium	mg/l	-	-	-	-

Note: Concentrations in shaded cells exceed the Utah groundwater quality protection standard. These are provided as a point of comparison only, since these standards do not apply to Class IV groundwater.
*Average of 61 samples from 23 wells in the playa sediments.

3.8 HYDROGEOLOGIC REPORT

CPM has collected water quality and water level and flow data for both surface and groundwater in the playa area for the period from 2011 through 2016. Investigations during this period included extensive studies of groundwater within the playa sediments, alluvial/colluvial sediments, and regional bedrock systems as well as surface water in drainages contributing to the playa (i.e., the Sevier River and the ephemeral mountain drainages from the Cricket and House

Ranges). The results of these investigations are summarized in a technical memorandum prepared for CPM that is presented in Appendix C and summarized below.

3.8.1 Surface Water Hydrologic Setting and Watershed Management Units

The Project is primarily located within the Escalante Desert-Sevier Lake Basin of the Great Basin Region (Seaber et al., 1987). The Escalante Desert-Sevier Lake Basin is subdivided by the USGS into nine sub-basins, four of which would contain facilities for the proposed Project. The proposed on-lease facilities would be located completely within the Sevier Lake Sub-Basin. The proposed off-lease facilities would be located in the Sevier Lake, Lower Sevier, Lower Beaver, and Beaver Bottoms-Upper Beaver sub-basins (Figure B8-1).

3.8.1.1 Surface Water Hydrology

Surface water inflows to the Sevier Playa area consist of the Sevier River, Amasa Creek, and local ephemeral streams from the Cricket and House Ranges surrounding the playa that flow in response to snowmelt or rainfall (see Figure B8-2). Flows from the Sevier River comprise the majority of inflow to the playa. The use of surface water by upstream water users or storage in retention facilities limits the volume of water that enters the Sevier Playa. Currently, during normal and low-precipitation years, little surface water reaches the playa.

Satellite imagery acquired from August 1999 through August 2002 (Gwynn 2006) and from 2003 through 2017 indicates water on the surface of Sevier Playa occurs typically during November through April. Based on the extent of the inundated areas and the playa topography, these inundated areas normally amount to only several inches in depth. This water generally is the result of snowmelt or rainfall in the watersheds that drains to the playa. During the remainder of the year (May through October), the majority of the playa's surface is dry. However, periodic unusually wet climatic conditions create substantial flow in the Sevier River drainage which exceed the upstream storage capacity and the excess water flows onto the Sevier Playa. For example, from 1983 to 1987, runoff of about 2.27 million ac-ft in the Sevier River flooded the playa and re-established Sevier Lake, which reached a maximum lake level of 4,527 feet amsl (approximately 25 feet deep at the deepest point) in June 1985. In late 2011 and early 2012, Sevier Lake received an estimated 250,000 ac-ft of water, resulting in widespread inundation of the playa and up to 4.5 feet of standing water in the deeper locations. The historical record of surface water is limited, but periods of abnormally wet climatic conditions that flood the playa appear to occur with a frequency of at least once per two decades.

3.8.2 Hydrogeologic Setting

A general stratigraphic column, surficial geologic units, and geologic cross sections of the Sevier Playa area are presented in Figures B8-3, B8-4, and B8-5, respectively. Groundwater in the area of interest is part of the Great Basin Carbonate and Alluvial Aquifer System (GBCAAS) described by Heilweil and Brooks (2011). The GBCAAS covers an area of approximately 110,000 square miles, mostly in eastern Nevada and western Utah (see Figure B8-6), and generally consists of unconsolidated alluvium and volcanic rocks in valleys that are bound by carbonate and clastic sedimentary rocks in the adjacent ranges.

Groundwater within the GBCAAS typically flows at local, intermediate, and regional scales (see Figure B8-7). Local-scale systems have short flow paths that transmit limited volumes of groundwater from areas of recharge to areas of discharge within the same drainage. Intermediate-scale systems are characterized by longer flow paths that often cross surficial drainage divides and transmit appreciable amounts of groundwater to discharge areas in adjacent valleys. Regional-scale systems involve inter-basin transfers of groundwater and are characterized by long flow paths that discharge at large springs having nearly constant annual flows (Tóth 1963).

Natural groundwater recharge in the GBCAAS occurs by infiltration of precipitation, mostly in the form of melting winter snowpack that accumulates at higher elevations. Limited recharge can also occur by infiltration of runoff near mountain fronts and by infiltration of surface water from losing stream segments. Little or no recharge is thought to occur to groundwater by precipitation that falls on valley floors (Harrill and Prudic, 1998; Flint and Flint, 2011). In addition to natural sources, recharge to groundwater may also occur by the infiltration of unconsumed irrigation and public supply water. This type of recharge is associated with reservoirs, canals, and irrigated land.

Patterns of groundwater flow near Sevier Playa have been evaluated by the USGS and are controlled by the locations of recharge and discharge areas (Harrill and Prudic 1998; Gardner et al. 2011; Heilweil and Brooks 2011). The Project area is part of the regional-scale Sevier Desert groundwater flow system which is a sub-system within the GBCAAS that has an approximate area of 3,969 square miles (see Figure B8-6). Heilweil and Brooks (2011) estimated that natural recharge to the Sevier Desert groundwater flow system is about 41,000 ac-ft/yr, which is less than 40% of the estimated groundwater discharge in that hydrogeologic area (110,000 ac-ft/yr). They estimated that over half (59,000 ac-ft/yr) of the groundwater discharge in the area was due to evapotranspiration.

The direction of regional groundwater flow near Sevier Playa is primarily to the west-northwest toward the House Range where flow crosses into the Great Salt Lake Desert System and turns north toward the surface discharge area at Fish Springs Flat (see Figure B8-8). Fish Springs Flat is located about 60 miles north of Sevier Playa and has a surface elevation of about 4,280 feet amsl. The discharge from this spring is estimated to be about 34,000 ac-ft/yr (Heilweil and Brooks 2011).

Groundwater flow at Sevier Playa has also been assessed by Wilberg (1991), who described local-scale groundwater flow systems in the basin-fill sediments adjacent to the playa. His conceptual model of local groundwater flow in the area is similar to that found throughout the Basin and Range physiographic province where groundwater in the local-scale systems is recharged along the upper alluvial slopes of the surrounding ranges and flows laterally toward the playa following topography as it infiltrates downward to the regional system.

3.8.3 Conceptual Model of Groundwater Flow at Sevier Playa

CPM developed a conceptual model of the groundwater systems in the playa area which is presented in Appendix D. This conceptual model is summarized below. Figures B8-9 and B8-10 show cross-sections of the geologic structure of the Sevier Playa and adjacent areas as well as the interpreted lithology. These figures also show the three groundwater systems.

3.8.3.1 Alluvial/Colluvial System

For both the Cricket Mountains and the Black Hills watersheds surrounding the playa, alluvial/colluvial sediments are quite variable in thickness. In some areas, this layer consists of a thin veneer or blanket of in-place sands, silts, and clays draped over bedrock slopes while in others, primarily at the mouths of drainages that form at the base of the mountains, this system consists of reworked alluvial fans and stream deposits that are thick and relatively coarse grained. As is typical of alluvial/colluvial sediments in the Intermountain West, these sediments tend to be interbedded due to the variable nature of the geologic forces of erosion and mass wasting that occurred intermittently over time. Aquifer tests conducted by CH2M (2012) indicated that the hydraulic conductivity of the alluvial/colluvial strata ranges from 0.06 to 51 feet per day (ft/d), with the most reliable test results falling within the range of 0.6 to 0.9 ft/d.

3.8.3.2 Playa System

The majority of playa sediments consist of very fine-grained clays that occur relatively consistently over the playa area. These clays are interbedded with silts and fine sands that are discontinuous and variable in thickness. These generally occur in areas where ephemeral channels historically flow into the lake. Sediments generally grade from coarser grained at the edge of the playa to finer grained into the playa. Based on data collected from a gravity survey of the area, Case and Cook (1979) estimated that the playa sediments may reach a thickness of 4,600 feet beneath the east edge of the playa.

Figure B8-11 presents a typical stratigraphic column of the sediments in the upper 100 feet of the playa sediments. The upper 10 to 12 feet consists of a plastic (fat) clay, with low hydraulic conductivity. This dense grey clay is capped by a thin salt crust that is typically several inches thick over most of the Playa; but can range up to 18 inches thick in certain areas, according to CPM auger logs (Gwynn, 2006). This zone is referred to as the Fat Clay Zone (FCZ) and is generally not considered part of the production zone.

The FCZ is underlain by a grey, bedded, granular clay averaging 20.2 feet in thickness and extending to a depth of 32 to 35 feet. These sediments have a granular texture which arises from what is observed to be silt-size granules of smaller clay particles loosely bound by a soft calcareous or gypsiferous matrix. This zone is referred to as the Marl Clay Zone (MCZ) which is part of the upper production zone.

The MCZ is underlain by the Siliceous Clay Zone (SCZ) or lower production zone. This zone contains an olive grey, quartz-rich clay with a relatively low carbonate content, averaging approximately 30% carbonate content, noticeably lower than the overlying MCZ. The SCZ averages 58.6 feet in thickness. Four sand and gravel beds have been identified within the SCZ from drill hole records; but are not consistent throughout the Playa. This zone is underlain by a hard, dry clay that is consistently found in all bore holes at a depth of 85 to 100 feet bgs. This zone was used as a target bed to know when the bottom of the SCZ was reached. The thickness was not determined, but each borehole penetrated between 3 and 5 feet into the clay layer.

Based on logs for the various wells surrounding the playa, the playa sediments depicted in Figures B8-9 and B8-10 are shown only below the flat area which represents the traditional playa surface. According to the Glossary of Geology (Bates and Jackson, 1980), a playa is “a dry, vegetation free, flat area at the lowest part of an undrained desert basin”. Therefore, while clayey sediments may exist on the slopes contributing to the basin, the playa sediments are shown as deposits below the relatively flat surface and do not extend up the hill sides. These circumstances are observed at the Sevier Playa.

Consistent with the stratigraphic column presented in Figure B8-11 and the borehole logs from Gwynn (2006) and Wilberg (1991), discontinuous stringers of coarse alluvial/colluvial sediments are shown extending laterally into the playa sediments. The production zone for the Project is generally considered to the be the upper 75 feet of playa sediments. Below this depth, Playa sediments consist predominantly of clay, interbedded with silt and sand layers. The clay at depth is generally hard and dry with occasional soft, wet lenses. Silt and sand lenses are interbedded with the clay and do not appear to be continuous across the basin. The waters found within these interbedded lenses are described as slightly salty to salty, indicating they are not fresh water. This deposition pattern is similar to that found in other Intermountain basin fills (Wilberg, 1991). Aquifer testing of the playa sediments indicates that the hydraulic conductivity ranged from 0.01 to 24.2 ft/d. The higher values were from wells that encountered a number of sand and silt layers. Other wells were completed predominately in the silts and clays of the typical playa sediments had hydraulic conductivity values ranging from 0.01 to 1.08 ft/d.

3.8.3.3 Regional Bedrock Groundwater System

Bedrock formations in the vicinity of the playa consist of the Prospect Mountain Quartzite in the Cricket Mountains east of the playa, the Notch Peak Limestone in the House Range/Black Hills west of the playa, and either the Prospect Mountain Quartzite or Mutual Formation south of the playa. Some areas of volcanic flows are also draped over these formations along the southern portion of the site area. Structurally, the playa area consists of down dropped faulting to create the depression (graben) where the sediments collected. Aquifer tests conducted in wells completed in bedrock south of the playa indicated hydraulic conductivities ranging from 0.9 to 133 ft/d.

3.8.3.4 Interaction Between Aquifers

Upward vertical hydraulic gradients are evident in the Playa groundwater system below a depth of about 40 feet, implying a hydraulic connection to surrounding formations. It was initially proposed by Whetstone (2017) that the connection might be to the Regional Bedrock groundwater system. However, borehole logs of SN2-11-400 (drilled to a depth of 497 feet) and SN3-12-RR-7 (drilled to a depth of 240 feet) indicate that playa sediments below the SCZ are generally hard and dry below a depth of about 70 feet. Exceptions to this generality occur where thin (typically < 2 feet) sand, silty sand, or silty clay layers were encountered. Additionally, the bores for SDL-2, SDL-3, SDL3a, and SDL-4 also indicate that deeper zones within the playa sediments contain thin sand layers interbedded with silts and clays with the clays generally consisting of dry, hard layers similar to that below the SCZ. These deeper clay layers range in thickness from several inches to in excess of 20 feet depending on the depositional sequence. This lack of continuous, vertically saturated layers at depth in the playa sediments indicates that the near-surface, saturated layers of the playa (i.e., the layers to be mined by the Project) are not hydraulically connected to the Regional Bedrock groundwater system.

The fact that thick sequences of dry, hard clay exist above and below the occasional thin, discontinuous sandy or silty layers that occur at depth within the playa at depth below the SCZ indicates that the upward hydraulic pressure in the playa sediments is not caused by interaction with groundwater in the underlying Reginal Bedrock groundwater system. Rather, as is typical of valley fill in the Basin and Range province (Wilberg, 1991), groundwater in these layers of coarser sediments likely originates and is recharged from the Alluvial/Colluvial groundwater system. No evidence has been found to indicate that these coarser layers are laterally continuous between the Cricket Mountains and the Black Hills. In fact, if lateral continuity existed from east to west across the playa, a substantial loss of hydraulic head from east to west within the Playa groundwater system would be expected. However, this is not the case and water level data from the playa wells indicate a relatively flat potentiometric surface. This indicates that the vertical pressure in each discontinuous, coarser layer within the playa sediments is a function of the elevation at which that layer connects hydraulically with the adjacent Alluvial/Colluvial system.

Figures B8-9 and B8-10 show cross-sections of the playa area with the potentiometric surface for the various groundwater systems. Groundwater flows from the Alluvial/Colluvial groundwater system toward the Playa groundwater system on both the east and west sides of the playa (see Figures B8-9 and B8-10). This is consistent with hydrogeologic conditions throughout the Basin and Range province, where groundwater in unconsolidated sediments is regularly shown to flow from alluvial/colluvial sediments on mountain sides toward the intervening valleys (see, for example, Thomas et al., 1986).

Figures B8-9 and B8-10 show that groundwater levels in the playa sediments are higher than those in the alluvial/colluvial sediments immediately east and west of the playa, indicating the presence of a groundwater mound within the playa. The higher groundwater levels in the Playa groundwater system relative to the adjacent Alluvial/Colluvial groundwater system appear to be caused by many factors:

- Being at the terminal end of a large basin, surface water inflow to the playa is substantially greater than that which occurs from the ephemeral slopes of the Cricket Mountains and the Black Hills located east and west of the playa, respectively. A review of satellite photographs (each with the December date) indicates that the playa was essentially fully inundated from 1984 (the earliest available image date) through 1988. Partial ponding on the playa surface was also evident in the month of December during seven additional years between 1989 and 2013. CH2M (2017) estimated that surface water inflow to the playa from the Sevier River occurred 13 times during the 31-year period from 1985 through 2015. They further estimated that the average annual (but highly variable) inflow to the playa from the Sevier River is 90,625 acre-feet. Although a large portion of the surface water that reaches the playa likely evaporates directly from the ponded surface, substantial infiltration into the playa sediments has undoubtedly also occurred, especially during prolonged periods of inundation. Given the fine-grained nature of the playa sediments, matric forces likely retain a considerable portion of the water that infiltrates prior to ultimate evaporation. Due to the low hydraulic conductivity of the playa sediments, the majority of this infiltrated water is retained in the playa sediments rather than flowing laterally outward, thereby contributing to a groundwater mound within the playa sediments.
- Elevated groundwater levels in the playa sediments relative to the immediately adjacent alluvial/colluvial sediments indicate that some groundwater probably flows outward from the playa. This hydraulic pathway is also evidenced by the higher salinity of groundwater in the alluvial sediments adjacent to the playa relative to groundwater in Alluvial/Colluvial sediments at greater distance from the playa. For instance, the TDS concentration of groundwater at the Nautilus Well, located immediately adjacent to the playa edge, is 109,000 mg/l while that in the Provo Well (33,000 mg/l, located about 0.7 mile east of the playa edge) and that obtained from the Bonneville Well (1,060 mg/l, located about 2.4 miles from the playa edge) are substantially lower. However, given the high salinity of the playa groundwater relative to the alluvial/colluvial groundwater together with the high clay content of both groundwater systems, groundwater also undoubtedly also flows from the Alluvial/Colluvial groundwater system to the Playa groundwater system via osmosis. This osmotic flow raises the water table in the playa sediments relative to the alluvial sediments.
- Given the high clay content of the playa sediments, matric forces cause groundwater to rise toward the surface of the playa via capillarity until it is discharged from the playa surface via evaporation. Xiaopeng et al. (2013) report that capillary matric forces are sufficient to pull water from depths in excess of 6 meters (nearly 20 feet) in clay. This upward force creates a negative pressure that pulls groundwater from the Alluvial/Colluvial groundwater system, via the discontinuous sand lenses noted in Figures B8-9 through B8-11, thereby creating a groundwater mound in the playa sediments.

Some interaction between the Regional groundwater system and the playa sediments undoubtedly occurs at depth near the physical boundary between playa sediments and the underlying fractured bedrock. CPM data indicate that groundwater sampled from monitoring wells completed in quartzite on the east side of the playa contains TDS concentrations of 400 to 480 mg/l while TDS concentrations in groundwater sampled from monitoring wells completed in limestone on the west side of the playa ranges from 528 to 744 mg/l, indicating an increase in TDS concentrations in the downgradient direction. A detailed geochemical analysis would be required to determine the extent to which this increase in TDS concentration was due to flow through approximately 10 miles of limestone versus interaction with playa sediments. However, concentrations of chloride generally decrease, and carbonate/bicarbonate generally increase from east to west. On the other hand, the brines in the playa sediments generally contain very high concentrations of chlorides and sulfates relative to carbonate/bicarbonates. These data indicate that the increase in TDS concentrations from east to west is likely more a function of limestone dissolution than interaction with the playa sediments. Thus, the degree to which groundwater from the Regional Bedrock system interacts with the playa sediments is likely minimal. These observations, together with the hard, dry clay layers that extend vertically to great depths beneath the brine-production zone, also indicate that the playa is not a point of evaporative discharge from the Regional Bedrock groundwater system.

3.8.4 Groundwater Chemistry

Groundwater samples were collected in 2012 and 2013 from wells completed in the Playa, Alluvial/Colluvial, and Regional Bedrock groundwater systems and analyzed for major cations, major anions, TDS, nitrate, total orthophosphate, dissolved metals, and field parameters.

The results of analyses of water samples collected from wells completed in the Regional Bedrock groundwater system are summarized in **Tables B8-1** and **B8-2**. The groundwaters in the bedrock systems meet the Utah state standards for Class I and II waters. Water-quality data collected from wells completed in the Alluvial/Colluvial groundwater system are summarized in **Table B8-3**. The groundwaters in the alluvial/colluvial systems meet the Utah state standards for Class II and III waters.

Table B8-1a Summary of Project Specific Water Quality Data for Wells Completed in Bedrock

Parameter	Units	Utah Groundwater Standards	Undifferentiated Lower Cambrian and Precambrian Quartzite [1] [2]										Notch Peak Formation [1][3]						
			Monitoring Well Data							CWTW-1 Airlift Samples									
			Average	Std. Dev.	Meridian	Range	Count	%ND	%>WQ Standard	553 Feet Depth	579 Feet Depth	734 Feet Depth	Average	Std. Dev.	Meridian	Range	Count	%ND	% >WQ Standard
Major Ions and Solution Parameters																			
Bicarbonate	Mg/l $CaCO_3$	-	142.	3.	144.	138. - 145.	3	0%	-	94.6	140	142	189.8	25	176.5	173 - 233	4	0%	-
Carbonate	Mg/l $CaCO_3$	-	NC	NC	NC	<10 - <20	3	100%	-	34.6	<20	<20	NC	NC	NC	<20 - <40	4	100%	-
Hardness, Ca+Mg	mg/l	-	232.3	34.7	246.4	184.5 - 265.9	3	0%	-	-	-	-	186.35	18.97	193.95	154.4 - 203.1	4	0%	-
Calcium	mg/l	-	42.2	7.9	37.8	35.6 - 53.3	3	0%	-	27.1	41.5	43.9	35.5	5.23	38.05	26.5 - 39.4	4	0%	-
Magnesium	mg/l	-	30.9	7.9	27.6	23.3 - 41.8	3	0%	-	22.8	28.3	30.5	23.8	1.5	24.1	21.5 - 25.5	4	0%	-
Potassium	mg/l	-	9.58	5.74	5.54	5.5 - 17.7	3	0%	-	7.57	6.84	6.63	11.2	0.1	11.2	11.0 - 11.3	4	0%	-
Sodium	mg/l	-	195.1	149.8	91.5	86.9 - 407	3	0%	-	56.4	43	43.8	143	42	123	110 - 214	4	0%	-
Chloride	mg/l	-	151.	11.	146.	141 - 166	3	0%	-	113	112	116	118	23.7	105.5	102 - 159	4	0%	-
Fluoride	mg/l	4	0.28	0.02	0.281	0.254 - 0.304	3	0%	0%	0.289	0.27	0.275	1.036	0.259	0.913	0.836 - 1.48	4	0%	0%
Silicon	mg/l	-	6.85	1.04	6.15	6.07 - 8.32	3	0%	-	<0.5	7.63	8.92	10.72	1.9	11.65	7.48 - 12.1	4	0%	-
Sulfate	mg/l	-	58.6	5.4	62.2	50.9 - 62.7	3	0%	-	31.5	34.7	35.8	132	7	134	120 - 139	4	0%	-
Total Dissolved Solids	mg/l	-	425.	37.	476.	400 - 480	3	0%	-	352	396	388	586	91	536	528 - 744	4	0%	-
Nutrients																			
Nitrate	mg/l N	10	NC	NC	NC	0.868	1	0%	0%	-	-	-	0.6128	0.0277	0.6005	0.59 - 0.66	4	0%	0%
Total Orthophosphate	mg/l P	-	NC	NC	NC	<0.05	1	100%	-	-	-	-	NC	NC	NC	<0.05 - <0.05	4	100%	-
Metals																			
Aluminum	mg/l	-	NC	NC	NC	<0.1 - <0.1	3	100%	-	<0.1	<0.1	<0.1	NC	NC	NC	<0.1 - <0.1	4	100%	-
Arsenic	mg/l	0.05	0.00539	0.00216	0.00558	0.00266 - 0.00793	3	0%	0%	<0.003	<0.0006	0.013	0.02683	0.00375	0.02805	0.0206 - 0.0306	4	0%	0%
Beryllium	mg/l	0.004	NC	NC	NC	<0.0003 - <0.002	3	100%	0%	<0.003	<0.0006	<0.0006	NC	NC	NC	<0.0006 - <0.006	4	100%	0%
Boron	mg/l	-	NC	NC	NC	<0.5 - <0.5	3	100%	-	<0.5	<0.5	<0.5	0.5	0.038	<0.5	<0.5 - 0.587	4	75%	-
Cadmium	mg/l	0.005	NC	NC	NC	<0.00009 - <0.0005	3	100%	0%	<0.0009	<0.00018	<0.00018	NC	NC	NC	<0.00018 - <0.0009	4	100%	0%
Chromium	mg/l	0.1	NC	NC	NC	<0.002 - <0.01	3	100%	0%	<0.01	<0.01	<0.01	NC	NC	NC	<0.01 - <0.01	4	100%	0%
Copper	mg/l	1.3	0.002	0.0003	<0.002	0.0015 - <0.00229	3	67%	0%	<0.0040	0.000801	0.00119	0.144168	0.24356	<0.004745	0.00118 - 0.566	4	25%	0%
Iron	mg/l	-	NC	NC	NC	<0.1 - <0.428	3	100%	-	<0.1	<0.1	<0.1	0.1258	0.0268	0.1205	<0.1 - 0.162	4	50%	-
Lead	mg/l	0.015	NC	NC	NC	<0.0002 - <0.002	3	100%	0%	<0.002	<0.0004	<0.0004	NC	NC	NC	<0.0004 - <0.002	4	100%	0%
Manganese	mg/l	-	0.0208	0.01	0.0263	<0.00675 - <0.0293	3	67%	-	0.0655	0.0833	0.0135	0.01613	0.00445	0.01495	<0.012 - 0.0226	4	50%	-
Mercury	mg/l	0.002	NC	NC	NC	<0.00015 - <0.00015	3	100%	0%	<0.00015	<0.00015	<0.00015	NC	NC	NC	<0.00015 - <0.00015	4	100%	0%
Selenium	mg/l	0.05	0.002	0.0003	<0.002	0.00137 - <0.002	3	67%	0%	<0.004	0.000851	0.0012	NC	NC	NC	<0.0008 - <0.004	4	100%	0%
Silver	mg/l	0.1	NC	NC	NC	<0.0002 - <0.002	3	100%	0%	<0.002	<0.0004	<0.0004	NC	NC	NC	<0.0004 - <0.002	4	100%	0%
Zinc	mg/l	5	0.064	0.071	0.019	<0.00828 - <0.164	3	67%	0%	<0.025	<0.005	<0.005	0.1103	0.0156	0.1165	0.0841 - 0.124	4	0%	0%
Field Parameters																			
Temperature	°C	-	21.90	1.440	21.90	20.46 - 23.33	2	0%	-	-	19.6	18.4	23.82	2.48	24.09	20.65 - 26.71	3	0%	-
pH	s.u.	6.5 - 8.5	7.97	0.27	7.97	7.70 - 8.24	2	0%	0%	-	8.5	8.4	7.3	0.3	7.5	6.89 - 7.52	3	0%	0%
Specific Conductance	µS/cm	-	931	21	93	910 - 952	2	0%	-	-	700	720	964	79	932	887 - 1,072	3	0%	-
Turbidity	NTU	-	70	70	70	U - 140	2	0%	-	-	21.4	U	-	-	-	-	-	-	-
Dissolved Oxygen	mg/l	-	9.59	0.63	9.59	8.96 - 10.22	2	0%	-	-	-	-	5.48	0.75	5.92	4.43 - 6.1	3	0%	-
ORP	mV	-	112.5	87.5	112.5	25 - 200	2	0%	-	-	-	-	-79.1	50.8	-107.9	-121.7 - -7.8	3	0%	-

Notes:
[1] Statistics were calculated by substituting the reported detection limit for non-detect data
[2] Statistics for undifferentiated lower Cambrian and Precambrian quartzite represent data from two samples collected from Monument Point well in 2012 and 2013 and one sample from North Cricket well in 2013. Data from the Clean Water Test Well (CWTW-1) are not included in the statistics. The CWTW-1 samples were collected by air-lifting from an open borehole and are not considered to be comparable to samples from monitoring wells that were collected using standard environmental monitoring protocols
[3] Compiled data for Notch Peak Formation represent two samples collected from Black Hills well in 2012 and one each sample from Coyote and Nighthawk wells in 2012
NC = statistic not calculated, either all data were below the detection limit or there was only one sample
%ND = percent of samples reported as below the detection limit
% > WQ Standard = percent of samples reported above the Utah numerical groundwater quality standard. Non-detect data with MDLs greater than the standard are not compared to the standard
U = Analysis reported as being below the detection limit, but the detection limit was not reported
(R) = Data rejected as not being representative of sampled water
ORP = Oxidation-Reduction Potential

Table B8-1b Summary of Publicly Available Water Quality Data for Wells Completed in Bedrock

Parameter	Units	Utah Groundwater Standards	Notch Peak Formation [1] [2] (Black Hills Well)							Volcanic Bedrock [1] [2] (Lakeview Well)						
			Average	Std. Dev.	Meridian	Range	Count	%ND	%>WQ Standard	Average	Std. Dev.	Median	Range	Count	%ND	%>WQ Standard
Major Ions and Solution Parameters																
Bicarbonate	Mg/l $CaCO_3$	-	70.	53.3	82	U - 129	3	0%	-	55	55	55	U - 110	2	0%	-
Carbonate	Mg/l $CaCO_3$	-	0.005	0.005	<0.005	U - <0.01	2	50%	-	NC	NC	NC	U	1	0%	-
Hardness, Ca+Mg	mg/l	-	145	41.5	154	90.2 - 190.7	3	0%	-	197.45	3.45	197.45	194 - 200.9	2	0%	-
Calcium	mg/l	-	29	8.1	32	18 - 37.2	3	0%	-	37.9	0.1	37.9	37.8 - 38	2	0%	-
Magnesium	mg/l	-	18.	5.2	18	11 - 23.8	3	0%	-	24.95	0.95	24.95	24. - 25.9	2	0%	-
Potassium	mg/l	-	13.7	3.72	11.2	11 - 19	3	0%	-	9.365	0.065	9.365	9.3 - 9.43	2	0%	-
Sodium	mg/l	-	128	23.2	116	107 - 160	3	0%	-	77.1	8.9	77.1	68.2 - 86	2	0%	-
Chloride	mg/l	-	151.8	56.69	127.8	97.5 - 230	3	0%	-	141	9	141	132 - 150	2	0%	-
Fluoride	mg/l	4	0.7885	0.0115	0.7885	0.777 - 0.8	2	0%	0%	NC	NC	NC	0.5	1	0%	0%
Silicon	mg/l	-	119	3.7	120	114 - 123	3	0%	-	57.35	12.65	57.35	44.7 - 70	2	0%	-
Sulfate	mg/l	-	NC	NC	NC	5.3	1	0%	-	NC	NC	NC	41	1	0%	-
Total Dissolved Solids	mg/l	-	536	62.3	548	454 - 605	3	0%	-	468	26	468	442 - 494	2	0%	-
Nutrients																
Nitrate+ Nitrite	mg/l N	10	0.415	0.315	0.415	<0.1 - 0.73	2	50%	0%	2.51	0.105	2.51	2.4 - 2.61	2	0%	0%
Nitrate	mg/l N	10	NC	NC	NC	0.96	1	0%	0%	-	-	-	-	-	-	-
Phosphate	mg/l	-	NC	NC	NC	0.06	1	0%	-	NC	NC	NC	0.25	1	0%	-
Dissolved Metals																
Aluminum	mg/l	-	NC	NC	NC	U	1	100%	-	NC	NC	NC	U	1	100%	0
Arsenic	mg/l	0.05	0.0289	0.0061	0.0289	0.0228 - 0.035	2	0%	0%	NC	NC	NC	0.0167	1	0%	0%
Barium	mg/l	2.0	NC	NC	NC	0.0391	1	0%	0%	NC	NC	NC	0.0663	1	0%	0%
Boron	mg/l	-	NC	NC	NC	2.18	1	0%	-	-	-	-	-	0	-	-
Cadmium	mg/l	0.005	NC	NC	NC	U - 0.018	2	50%	50%	NC	NC	NC	U	1	100%	0%
Chromium	mg/l	0.1	NC	NC	NC	U - 0.002	2	50%	0%	-	-	-	0.0051	1	0%	0%
Copper	mg/l	1.3	NC	NC	NC	U	1	100%	0%	NC	NC	NC	U	1	100%	0%
Iron	mg/l	-	NC	NC	NC	U - 13.04	2	50%	-	NC	NC	NC	U	1	100%	-
Lead	mg/l	0.015	NC	NC	NC	U - 1<0.01	2	100%	0%	NC	NC	NC	0.0036	1	0%	0%
Manganese	mg/l	-	NC	NC	NC	U	1	100%	-	NC	NC	NC	U	1	100%	-
Mercury	mg/l	0.002	NC	NC	NC	U - 0.001	2	50%	0%	NC	NC	NC	U	1	100%	0%
Selenium	mg/l	0.05	0.0011	0.0001	0.0011	0.001 - 0.0012	2	0%	0%	NC	NC	NC	0.0018	1	0%	0%
Silver	mg/l	0.1	NC	NC	NC	U	1	100%	0%	NC	NC	NC	U	1	100%	0%
Zinc	mg/l	5	NC	NC	NC	0.0439	1	0%	0%	NC	NC	NC	U	1	100%	0%
Field Parameters																
Temperature	°C	-	NC	NC	NC	19.	1	0%	-	NC	NC	NC	23.5	1	0%	-
pH[3]	s.u.	6.5 - 8.5	8.18	0.22	8.18	7.96 - 8.4	2	0%	0%	7.885	0.015	7.885	7.87 - 7.9	2	0%	0%
Specific Conductance[3]	µS/cm	-	935	35	935	900 - 970	2	0%	-	772	23	772	749 - 795	2	0%	-
Turbidity (laboratory)	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	mV	-	NC	NC	NC	0.093	1	0%	-	NC	NC	NC	0.044	1	0%	-

Notes:
[1] Data source: NWIS and STORET databases, accessed at http://www.waterqualitydata.us, 2/16/2017
[2] Statistics were calculated by substituting the reported detection limit for non-detect data and may include total and dissolved concentrations for any analyte
[3] Statistics for pH and conductivity may include field and laboratory measurements
U = Analysis reported as being below the detection limit, but the detection limit was not reported
NC = Statistic not calculated. Either all data were below the detection limit or there was only one sample
%ND = Percent of samples reported as below the detection limit
% > WQ Standard = percent of samples reported above the groundwater quality standard. Non-detect data with MDLs greater than the standard are not compared to the standard

Table B8-2 Summary of Water Quality Data from Wells Completed in the Alluvial/Colluvial Groundwater System

Parameter	Units	Utah Groundwater Standards	Project-Specific Water Quality Data for Wells in Unconsolidated Deposits (1) (2)							Publicly Available Water Quality Data for Wells in Unconsolidated Deposits (3) (4)						
			Average	Std. Dev.	Meridian	Range	Count	%ND	%>WQ Standard	Average	Std. Dev.	Median	Range	Count	%ND	%>WQ Standard
Major Ions and Solution Parameters																
Bicarbonate	Mg/l $CaCO_3$	-	232	102	209	111 - 399	11	0%	-	197	92.8	161	107 - 461	11	0%	-
Carbonate	Mg/l $CaCO_3$	-	23	8	<20	<10 - <40	11	82%	-	18	36.3	0	U - 91	5	20%	-
Hardness, Ca+Mg	mg/l	-	403.8	791.4	35.3	4.61 - 2,430	11	0%	-	455	344.3	325	11 - 1,200	12	0%	-
Calcium	mg/l	-	2,097	3,918	249	37.9 - 11,688	11	0%	-	118	124.7	69	2 - 447	12	0%	-
Magnesium	mg/l	-	176.5	282.2	47.1	<7.6 - 845	11	36%	-	57	45.7	46	0.586 - 130	12	0%	-
Potassium	mg/l	-	82.8	142.8	16.3	5.22 - 397	11	0%	-	26	21.7	21	1.2 - 72	11	0%	-
Sodium	mg/l	-	4,003	7,618	598	69.2 - 23,900	11	0%	-	694	500.2	600	30 - 1,700	11	0%	-
Chloride	mg/l	-	6,247	11,840	889	144 - 33,000	11	0%	-	1,034	848.8	780	29.9 - 2,600	11	0%	-
Fluoride	mg/l	4	1.469	1.672	0.635	0.219 - 6.36	11	0%	9%	1.2	1	0.9	0.3 - 3.9	11	0%	0
Silicon	mg/l	-	13.6	8.4	12.9	<0.651 - 33.1	11	9%	-	375.3	287.69	216.5	43 - 1,000	12	0%	-
Sulfate	mg/l	-	3,069	5,745	458	35.5 - 16,400	11	0%	-	35.8	16.08	38.5	1 - 61	12	0%	-
Total Dissolved Solids	mg/l	-	16,328	30,857	2,000	472 - 82,700	11	0%	-	2,385	1,551	2,070	334 - 5,280	12	0%	-
Nutrients																
Nitrate+ Nitrite	mg/l N	10	-	-	-	-	-	-	-	0.833	1.0418	0.365	<0.1 - 3.2	8	38%	-
Nitrate	mg/l N	10	0.65	1.15	<0.01	<0.01 - 2.93	5	60%	0%	1.35	1.2932	1.063	0.113 - 3.16	4	0%	0%
Total Orthophosphate	mg/l	-	0.08	0.04	<0.05	<0.05 - 0.136	5	60%	-	0.12	0.079	0.12	<0.02 - 0.21	4	25%	-
Dissolved Metals																
Aluminum	mg/l	-	0.3	0.4	<0.1	<0.1 - <1.44	11	91%	-	NC	NC	NC	0.1325	1	0%	-
Arsenic	mg/l	0.05	0.1353	0.1869	0.0421	<0.002 - 0.652	11	18%	45%	0.262	0.3311	0.036	0.0196 - 0.73	3	0%	33%
Beryllium	mg/l	0.004	NC	NC	NC	<0.0006 - <0.01	11	100%	0%	-	-	-	-	-	-	-
Boron	mg/l	-	2.94	3.31	2.06	<0.5 - 11	11	27%	-	1.8	1.34	2.1	0.1 - 3.7	10	0%	-
Cadmium	mg/l	0.005	NC	NC	NC	<0.00018 - <0.0025	11	100%	0%	-	-	-	-	-	-	-
Chromium	mg/l	0.1	NC	NC	NC	<0.002 - <0.01	11	100%	0%	-	-	-	-	-	-	-
Copper	mg/l	1.3	NC	NC	NC	<0.0008 - <0.01	11	100%	0%	NC	NC	NC	<0.01	1	100%	0%
Iron	mg/l	-	0.807	1.665	0.122	<0.1 - 6.01	11	64%	-	0.81	0.974	0.12	0.12 - 2.186	3	0%	-
Lead	mg/l	0.015	0.003	0.003	<0.002	<0.0004 - <0.01	11	73%	0%	NC	NC	NC	<0.01	1	100%	0%
Manganese	mg/l	-	0.2599	0.4507	<0.0407	<0.0012 - 1.54	11	55%	-	0.019	0.0169	0.016	U - 0.041	3	0%	-
Mercury	mg/l	0.002	NC	NC	NC	<0.00015 - <0.00015	11	100%	0%	NC	NC	NC	<0.001	1	100%	0%
Selenium	mg/l	0.05	0.003	0.003	<0.002	<0.0008 - <0.01	11	91%	0%	0.004	0.0047	<0.001	<0.001 - 0.013	5	80%	0%
Silver	mg/l	0.1	NC	NC	NC	<0.0004 - <0.01	11	100%	0%	-	-	-	-	-	-	
Zinc	mg/l	5	0.0819	0.0914	<0.0352	<0.005 - 0.323	11	73%	0%	-	-	-	-	-	-	-
Field Parameters																
Temperature	°C	-	16.53	2.85	15.67	12.24 - 20.66	10	0%	-	16	2.2	16	12 - 20	15	0%	-
pH(5)	s.u.	6.5 - 8.5	7.89	0.843	7.625	6.68 - 9.3	10	0%	30%	7.8	0.31	7.9	7.5 - 8.6	9	0%	11%
Specific Conductance(5)	µS/cm	-	12,545	29,152	3,010	790 - 99,900	10	0%	-	3,399	2,365.5	2,380	477 - 8,960	17	0%	-
Turbidity	NTU	-	514	697	203	23 - 2,146	7	0%	-	NC	NC	NC	25	1	0%	-
Dissolved Oxygen	mg/l	-	5.721	4.774	6.315	U - 11.55	10	0%	-	-	-	-	-	-	-	-
ORP	mV	-	-53.4	123.8	-92.2	-182 - 180.2	10	0%	-	-	-	-	-	-	-	-

Notes:
(1) Compiled data for Unconsolidated Basin Margin Deposits represent two samples collected from 257 Cutoff Well 2012 and 2013 and one sample from each of nine wells in 2012 and 2013: 257-Cutoff, Black Rock, Bonneville, Crystal Peak Road, Guzzler, Lakeview, Miller Canyon Reservoir, Mudhole, UDOT-2, and UDOT-3
(2) Statistics were calculated by substituting the reported detection limit for non-detect data
(3) Data source: NWIS and STORET databases, accessed at http://www.waterqualitydata.us, 2/16/2017; and BLM, 1989. Compiled data represent 18 samples collected from 10 wells by USGS and DEQ between 1923 and 2001
(4) Statistics calculated by substituting the reported detection limit for non-detect data and may include total and dissolved concentrations for any analyte
(5) Statistics for pH and specific conductance may include field and laboratory measurements for publicly available data
U = Analysis reported as being below the detection limit, but the detection limit was not reported
NC = Statistic not calculated. Either all data were below the detection limit or there was only one sample
%ND = Percent of samples reported as below the detection limit
% > WQ Standard = percent of samples reported above the groundwater quality standard. Non-detect data with MDLs greater than the standard are not compared to the standard
(R) = Data rejected as not being representative of sampled water

3.8.4.1 Lower Cambrian and Precambrian Quartzite

Analytical results from the Monument Point and North Cricket wells indicate that groundwater in the quartzite east of the playa is a sodium-chloride water with alkaline pH (7.70–8.24) and TDS ranging from 400 to 480 mg/L. Groundwater samples obtained from the CWTW-1 water supply exploration borehole south of the playa has calcium-bicarbonate to calcium-chloride composition with alkaline pH (8.4–8.5) and TDS ranging from 352 to 396 mg/L. The analytical results from the quartzite bedrock were all reported at concentrations below the Utah Groundwater Quality Standards (GWQS).

3.8.4.2 Notch Peak Formation

Analytical results from the Black Hills, Coyote, and Nighthawk wells west of the playa indicate the groundwater in this area is a sodium-chloride to sodium-sulfate water with circum-neutral pH (6.89–7.52) and somewhat elevated TDS (528–744 mg/L). The analytical results from the limestone/dolomite bedrock were all reported at concentrations below the Utah GWQS.

3.8.4.3 Volcanic Bedrock

An analytical result from the Lakeview well screened in volcanic rock near the south end of the playa indicates that groundwater in this area is a sodium-chloride composition with circum-neutral to alkaline pH (7.77) and moderate TDS (420 mg/L). The analytical results from the volcanic bedrock were all reported at concentrations below the Utah GWQS.

3.8.4.4 Alluvial/Colluvial Deposits

A total of 10 wells were sampled that represent the alluvial/colluvial deposits on the flanks of the basin overlying bedrock. These wells are Black Rock, Bonneville, Crystal Peak Road, Guzzler, Miller Canyon Reservoir, Mudhole, UDOT-2, UDOT-3, 257 Cutoff, and Wah Wah. Analytical results from these aforementioned wells indicate that the groundwater in the alluvial/colluvial sediments is a sodium-chloride to sodium-sulfate type water with circum-neutral to alkaline pH (6.68–9.30) and variable TDS ranging from 472 to 3,410 mg/L. The exception is the 257 Cutoff well that is screened shallower than the other wells and yields a sodium chloride brine composition, with TDS ranging from 80,800 to 82,700 mg/L.

Fluoride, arsenic and pH results were above GWQS in some wells. Arsenic was detected once in wells Crystal Peak Road, Miller Canyon, and UDOT-2, and twice in 257 Cutoff at concentrations ranging from 0.0519 to 0.652 (GWQS of 0.05 mg/L). Fluoride was detected once in Bonneville well at 6.36 mg/L above the GWQS of 0.359 mg/L. The field parameter pH was above the GWQS of 7.77 in Bonneville well at 8.82, in UDOT-2 well at 9.14 and in UDOT-3 well at 9.30. The remaining analytical results from the alluvial/colluvial wells were reported at concentrations below the Utah GWQS.

3.8.4.5 Playa Sediments

Water quality data summarized in Table B7-1 indicate that groundwater in playa sediments is sodium-chloride brine (TDS of 13,800–194,000 mg/L) with circum-neutral pH (6.19–7.90). The brine is classified as a Class IV Saline

Groundwater based on its TDS concentration greater than 10,000 mg/L. Utah GWQS for Class IV groundwater have not been established.

3.8.4.6 Springs

Numerous springs are located in the mountains surrounding the Sevier Playa. The elevations of most of these springs are well above the regional groundwater level. Whetstone (2017) shows a total of 62 springs (see Figure B8-12) in the area; 12 springs are interpreted to be from discharge from the regional groundwater system.

The locations of the 12 springs that are interpreted to be from discharge of regional groundwater are presented in Figure B8-12. The springs are Alkali Spring, Big Spring, Cottage Spring, Coyote Spring, House Spring, Kaufman Seep, South Coyote Spring, Tie House Spring and Unnamed Spring in the Black Rock Area; and Anderson Spring, Jensen Spring and Rocky Knoll Spring in the Sevier River area. These springs are used for stock watering, irrigation, and domestic use. Some of these springs will be monitored for flow and water chemistry to detect potential effects to in the regional groundwater system associated with the Project, however unlikely.

3.8.4.7 Agricultural Description

No agricultural crops will be grown in the legal boundaries of the proposed site.

3.9 GROUNDWATER DISCHARGE CONTROL PLAN

The anticipated points of discharge include the preconcentration, production, and purge brine ponds and the tailings storage area. These points of discharge will be controlled through the use of earthen liners. These ponds will be constructed on the playa and with FCZ materials and underlain by the FCZ layer of the playa sediments, which consists of 8 to 12 feet of clay that has a geometric mean hydraulic conductivity of $1x10^{-7}$ cm/s. As a point of comparison, the U.S. EPA requires that hazardous and non-hazardous waste landfills be lined with 3 and 2 feet, respectively, of soil having a hydraulic conductivity no greater than $1x10^{-7}$ cm/s (see 40 CFR 264.301(c)(1)(i)(B) and 40 CFR 258.40(b), respectively). CPM is assessing the need to compact this layer to provide a better seal for the pond bottoms.

CPM is approaching Sevier Playa Potash Project as a design build project. At the current time, the designs are at the 30% stage and are not to the level that the UDWQ has asked for the construction plans and specifications. As part of the current application package, CPM is providing the current planned construction schedule and the currently anticipated cross-sections of the various pond structures in Appendices E and F. CPM will provide DWQ with construction plans and specifications for these ponds once final designs are completed. It is anticipated that these plans will be available at least 3 months prior to the start of construction. As shown on the cross-sections, these ponds will be constructed on the playa with elevated berms above the playa surface using materials from the FCZ. The upper 6 inches of materials on the playa will be scraped and separated, then the underlining 2 to 4 feet of FCZ will be used to construct the embankments. Any run-off from the pond berms will flow onto the playa surface. Run-on to the playa will be retained/diverted around the outside of the pond berms.

3.9.1 Release Mechanisms

Based on the evaluations conducted and summarized in previous sections, the potential release mechanisms for fluids to groundwater include seepage from Project ponds, the tailings storage area, and inadvertent discharges from the Processing Facility. As noted previously, potential discharges from the Processing Facility and preconcentration ponds would be captured by mine operations. Strata receiving potential discharges from the Project ponds and tailings storage area have low permeability and water quality of potential receptors is greater than the Utah Class IV classification of 10,000 mg/l TDS. Over time, these released fluids could build up a mound in the subsurface and move toward the edge of the playa. It is anticipated that this movement would be very slow due to the low hydraulic conductivity of the aquifers underlying the playa.

3.9.2 Seepage Evaluation

This section summarizes the leakage analysis carried out to quantify potential seepage rates from ponds.

The leakage analysis was completed using the software SEEP/W 2012 (version 8.14) from GeoSlope International Ltd, a two-dimensional finite element modeling software. Both steady-state and transient analysis were completed to gain a better understanding of how potential leakage will impact the ponds over time. Hydraulic conductivity values of the materials used in the analysis are presented in Table B9-1.

Table B9-1 Material Parameters Used in Leakage Analysis

Unit	Depth (feet)	Unit Weight (pcf)	Effective Friction Angle (°)	Cohesion (psf)	Hydraulic Conductivity (inch/s) [cm/s]
Desiccated Soils	0.0 - 1.5	124.1	25	210	3.9E-6 [1E-5]
Fat Clay	1.5 - 13	124.1	25	210	3.9E-8 [1E-7]
Marl Clay	13 - 33	124.1	25	310	3.9E-6 [1E-5]
Embankment Fill	N/A	124.1	30	0	3.9E-6 [1E-5]
Clay Fill	N/A	124.1	30	0	3.9E-8 [1E-7]

The transient analysis was based on an initial ground water level 3 feet (1 meter) below the surface of the playa. Multiple time steps were modeled to evaluate how the wetting front develops with time. The upper 50 feet (15 meters) of the playa sediment was modeled, with an impermeable (model) boundary assumed at that depth. The leakage analyses were completed using an embankment section with a low permeability clay fill upstream blanket cover with a seepage cut-off trench through the upper 1.5 feet (0.5 meter) of desiccated soils.

Table B9-2 presents the results of the leakage analysis. The analysis shows that pond leakage is governed almost entirely by the area of the pond base and perimeter effects at the embankments are minimal with leakage through the embankment making up less than 5% of the modeled seepage. Therefore, the results of this analysis may be applied to ponds of various geometries and layouts, generally independent of type (preconcentration, production, tailings).

Pond leakage analysis results are dependent on two (2) driving factors:

- The hydraulic properties of the foundation and construction materials; and
- The design cross-section of the dykes, specifically the presence of a seepage cut off and low permeability upstream blanket.

Table B9-2 Leakage Analysis Results

Item	Unit	Transient Analysis Time Step						Steady State Analysis
		30 Days	90 Days	180 Days	1 Year	2 Years	3 Years	
Leakage Rate Through Embankment	mm/yr	5.3E-3	1.2E-2	1.7E-2	2.1E-2	2.2E-2	3.1E-2	5.4E-2
	in/yr	2.1E-4	4.7E-4	6.7E-4	8.5E-4	8.7E-4	1.2E-3	2.1E-3
Leakage Rate Through the Foundation	mm/yr	52.7	14.7	10.6	6.8	4.1	2.8	1.3
	in/yr	2.07	0.58	0.42	0.27	0.16	0.11	0.053
TOTAL LEAKAGE	**mm/yr**	**52.7**	**14.7**	**10.6**	**6.9**	**4.1**	**2.8**	**1.4**
	in/yr	**2.07**	**0.58**	**0.42**	**0.27**	**0.16**	**0.11**	**0.055**
% Through Embankment	%	0%	0%	0%	0%	1%	1%	4%
% Through Foundation	%	100%	100%	100%	100%	100%	99%	96%

The calculated steady-state leakage rate is 0.055 inch/year (1.4 millimeters per year [mm/yr]). During the initial period of wetting (first 180 days), leakage modeling indicated higher rates, but these rates will rapidly decrease within the first year based on the modeled results. This initial high rate is due to the saturating of the FCZ and MCZ zone. Once these zones are fully saturated, the leakage rate will decrease. The steady-state analysis considered a freeboard of 5 feet (1.5 meters). While not a freeboard limit, such freeboard amounts are regularly used in other evaporation operations.

3.9.3 Evaluation of Groundwater Velocity

As noted elsewhere in this document, potential discharges from the Process Facilities and the preconcentration ponds will be captured by mining operations. Discharges from the production ponds and the waste storage area in the south end of the playa have the potential to migrate downgradient from the playa sediments into the surrounding alluvium/colluvium. Downgradient average linear groundwater velocity, q, can be estimated using Darcy's Law,

$q = ki/\varphi$

k = hydraulic conductivity,

i = groundwater gradient, and

φ = porosity.

Whetstone (2017) reports a hydraulic conductivity range for the colluvial sediments of 0.02 ft/d to 77 ft/d with a geometric mean of 1.1 ft/d. The boring log from the nearest alluvial/colluvial well downgradient from the production ponds and waste storage area, USGS Wishing Well, indicates the colluvium in this area consists of clays, silts, and sand suggesting that the hydraulic conductivity of the colluvium in this area would be on low to middle end of this range. Using the above equation and assuming the geometric mean hydraulic conductivity of 1.1 ft/d, a groundwater gradient of 0.0025 feet per foot (ft/ft) (based on average east-to west gradients from Figures B8-9 and B8-10), and a porosity of 0.3 results in an average linear groundwater velocity of 3.4 ft/yr in this area indicating that any potential discharge from the production ponds and waste storage area is not likely to have impacts outside the Utah Class IV in the colluvium surrounding the playa over the 30-year life of mine. CPM will monitor this potential discharge as part of the compliance monitoring program and evaluate mitigation of local impacts in this area, if required, as part of reclamation.

3.10 COMPLIANCE MONITORING PLAN

CPM will be monitoring the wells, springs, and drainages that surround the playa through the construction, operations, and reclamation periods. Details of the water monitoring plan are presented in Appendix G. The monitoring network will include monitoring of the Playa, Alluvial/Colluvial, and Regional Bedrock groundwater systems as well as surface water inflows to the playa from the Sevier River. The monitoring wells will cover both the uppermost aquifer that underlies the discharge points and the deeper/adjacent alluvial/colluvial and bedrock aquifers. CPM is planning to use 16 existing wells and install 16 new wells and a series of 10 well points around the purge brine and tailings storage areas at the locations shown in Figures B10-1 and B10-2 to monitor for potential migration of brines into the surrounding aquifers.

To date, CPM has collected water quality and water level and flow data for a portion of baseline information for both surface and groundwater in the playa area over the period from 2011 through 2016. Although this dataset does not currently contain two years of quarterly data, the data do provide a good understanding of the water quality and flows of surface water and water levels of groundwater in the area of the playa.

Special Stipulation 13 of the BLM lease states:

> "Hydrologic Analysis: Sufficient base line data shall be established prior to conducting any surface disturbing activity which shall be determined necessary by the AO. In order to accomplish this, the lessee shall submit for review and approval by the AO a plan to analyze ground and surface water interactions as part of any operations or exploration on the leases. The plan shall be submitted prior to or concurrent with a Mining or Exploration plan under 43 CFR 3592.1. The plan shall include, but not be limited to the following items, and shall describe how the lessee proposes to; (1) develop sufficient baseline groundwater information to document existing hydrogeology associated with Sevier Lake basin fill and underlying carbonates, encompassing a reasonable area of potential resources, springs, and the alluvial and bedrock aquifers. This shall include items such as the location, size, and depth of any hole that will encounter water and/or brine as well as any information that will be collected on each hole. (2) Determine the potential impacts to existing water right holders, wells, wetlands, and surface and groundwater throughout their operations. Water chemistry (including stable isotopes as necessary), estimated flow and water quantity (water balance) shall be addressed. (3) Monitor the actual impacts to groundwater resources throughout and surrounding the operation including but not limited to changes in meteoric precipitation and springs, wells (base conditions, water levels, and chemistry conditions prior to construction and monitoring after construction), wetlands, and ditches. Wells, wetlands, and springs (at sites determined to be relevant based upon the groundwater study that would be conducted prior to development) shall be monitored during operations in order to minimize potential impacts to groundwater resources by allowing an early identification. Further, the plan shall contain sufficient detail to allow it to be independently assessed and include such things as the type of groundwater model that would be used (and/or other methods of analysis), phasing of the analysis and proposed iterative studies. The plan shall also contain a list of people and their qualifications to accomplish the work and a list of deliverables with

> a timing schedule. The lessee shall be responsible for any cost incurred for the plan and the accomplishing of the work."

In accordance with these requirements, the following information has been collected and plans will continue to be developed and updated:

- Baseline data summary of water monitoring conducted by CPM and affiliated groups for 2011 through 2016.
- Evaluation of the surface and groundwater chemistry for the existing wells and water rights locations surrounding the playa.
- Implementation of the water monitoring plan presented in Appendix G to add additional data for surface and groundwater data and better assess the seasonal fluctuations within the hydrologic regime by monitoring meteoric precipitation, wells, springs, and streams for potential impacts to groundwater resources.

The existing and proposed data collection locations discussed in Appendix G were selected to provide a better understanding of pre-mining hydrologic conditions and to assess whether there are any discharges that move off playa. This network and monitoring plan have been developed in accordance with DWQ requirements as well as to address CPM's federal lease requirements.

As the piezometric surface of the Playa groundwater system is very near or above the playa surface and the preconcentration, production, purge brine, and tailings ponds are constructed on the playa surface, there is no vadose zone. Therefore, no vadose zone monitoring is planned.

Leak detection monitoring will be assessed by a combination of analytical seepage analyses and monitoring of areas adjacent to the ponds to determine if the movement of seepage is occurring as predicted and at what rates. This will be accomplished by use of multiple wells at differing distances from the edge of the playa and well points surrounding the ponds to assess movement of brines. Locations of these wells and well points are presented in Figures B10-1 and B10-2.

Surface water inflows to the Sevier Playa would be from storm water runoff, precipitation, and flow from the Sevier River. CPM will be monitoring the inflows from the Sevier River as the major inflow source to the playa.

As the Sevier Playa is a terminal basin there are no surface water outflows from the playa; therefore, impacts to surface water from equipment used on the playa or in the Processing Facility present a low risk. Even so, an SPCC Plan will be developed and implemented before construction activities begin. The SPCC Plan will include measures to minimize and contain potential spills, cleanup measures, and reporting requirements. Fueling stations will be equipped with secondary containment structures to contain spills. Maintenance and processing chemicals will be confined to specific use areas or storage in the facility of use, and secondary containment systems would be used as needed.

3.11 RECLAMATION AND CLOSURE EVALUATION

Following the completion of mining and processing activities, the operation will be reclaimed per the requirements of UDOGM. The overall objective of final reclamation is to return lands disturbed during the Project to an ecologically functional state, reduce visual modifications to the landscape, and minimize environmental degradation that may occur as a result of Project activities. Final reclamation will generally consist of removing structures, plugging wells, filling in trenches and holes, grading berms, re-contouring soils, installing erosion controls if needed, re-contouring roads that are to be abandoned, seeding off-playa disturbed areas, and controlling noxious weed species. Reclamation strategies are designed to comply with reasonably accepted post-mining land uses.

Following is a summary of the reclamation plan.

3.11.1 Evaporation Ponds

3.11.1.1 Preconcentration Ponds

The following measures will be taken to reclaim the preconcentration ponds:

- Remove all pumps, weirs, pipelines, and electrical equipment and reuse or recycle it, or take it to a permitted landfill for disposal.
- Release any remaining brine located in the ponds to the playa by breaching berms.
- Remove the freeboard on all ponds by using equipment to push the portions of the exterior berms that are above the accumulated salts away from the interior of the ponds.
- Regrade/breach the interior berms (those berms that provide a physical separation between two adjacent preconcentration ponds) to reduce berm height and to provide positive drainage.
- Use equipment to recontour and grade the surface of the accumulated salts and remaining berms to provide positive drainage; take other actions, such as ripping drainage channels, as needed to ensure a self-draining system with positive drainage away from pond centers.
- Bury the imported gravel and erosion-control rock to at least 2 feet below ground surface during recontouring.
- Abandon in place the residual salts and remaining preconcentration pond berms (after freeboard has been removed).
- No topsoil placement or revegetation will occur on-playa.

3.11.1.2 Production Ponds

Leading up to reclamation, CPM will harvest as much of the potash salts from the production ponds as possible. The following measures will be used to reclaim these features:

- Remove all pumps, weirs, pipelines, and electrical equipment and reuse or recycle them, or take them to permitted landfill for disposal.
- When the ponds are free of liquid, remove the berms by pushing berm material out away from pond centers, and regrade the area to restore the surface to its former condition as far as reasonably possible.
- Leave any remaining potash salts in place; abandon in place the halite layer and other non-potash salts.
- Bury the imported gravel and erosion-control rock at least 2 feet below grade during regrading.
- No topsoil placement or revegetation on-playa.

3.11.2 Extraction Trenches and Canal

Extraction trenches will be reclaimed to restore the playa surface to former conditions as far as reasonably possible. At the end of production, the estimated 25 million cubic yards of material stored in spoils piles near the trenches and canals will be backfilled into the trenches/canals and left mounded, to allow for the material to settle. No topsoil placement or revegetation on-playa areas will occur.

3.11.3 Extraction Wells

During reclamation, the extraction wells will be plugged and abandoned as reflected in the procedures listed below:

- Remove and reuse or recycle pump and power supply components and piping or take them to a permitted landfill for disposal.
- Plug and abandon the extraction wells by setting a nonmetallic permanent plug at a minimum of 5 feet below ground surface, installing natural clay material from that depth to existing grade, and severing the casing at least 2 feet below grade.

3.11.4 Sevier River Drop Structure, Diversion Berm, and Canal

The Sevier River Drop Structure will be left in place at the end of the Project. The diversion berm and canal will be reclaimed as follows:

- Remove the diversion berm, remove all fill and place it in the diversion canal, and restore channel contours to approximate pre-disturbance condition.
- Remove any riprap (if used) and reuse it in channel re-establishment or bury it in the diversion canal or at least 2 feet below grade or recycle all riprap and imported materials.
- Backfill the canal with spoils (including those used to construct the diversion berm); due to swell of excavated material, backfilled material would naturally be mounded over the canal and would settle over time.
- Remove and reuse or recycle the sump and head gates, transfer pipe, and attached energy dissipation fabric, or take them to a permitted landfill for disposal.
- Remove and reuse or recycle the box culvert or take it to a permitted landfill for disposal during reclamation of Perimeter Road.
- Grade off-playa areas to blend with surrounding topography.
- Spread suitable topsoil and seed off-playa areas with suitable seed mix approved by the applicable landowner or land manager.

3.11.5 Recharge Trenches, Canals, and Collectors

To reclaim these on-playa conveyance features, the following general process would be used:

- Shut off the water supply to recharge trenches, canals, and collectors when no longer needed for recharge.
- Remove and reuse or recycle the culverts or take them to permitted landfill for disposal.
- Backfill the trenches with spoils; due to swell of excavated material, backfilled material would naturally be mounded over the trench and would settle over time.
- Remove all pumps, power supply components, transfer pipes, and ditch gates and reuse or recycle them, or take them to a permitted landfill for disposal.
- Remove erosion-control fabric to the extent possible and take it to a permitted landfill for disposal.
- Bury the gravel a minimum of 2 feet below grade.
- No topsoil placement or revegetation on-playa.

3.11.6 Control Structures, Pipes, and Pumps

The control structures, pipes, and pumps will be reclaimed as follows:

- Remove all surface pipelines and reuse or recycle them or take them to permitted landfill for disposal.
- Fill in the trenches with trench spoils if removing a buried pipeline.

- Remove all above-ground pipeline portions down to 2 feet below grade. Cap and leave in place all pipelines buried more than 2 feet below grade.
- Remove and reuse or recycle all equipment and control structures or take them to a permitted landfill for disposal.

3.11.7 Brine Transfer Canal and Pipeline

The Brine Transfer Canal and Pipeline will be reclaimed as follows:

- Backfill the canal with spoils; due to swell of excavated material, backfilled material would naturally be mounded over the canal and would settle over time.
- Remove and reuse or recycle all solar power supply equipment or take it to a permitted landfill for disposal.
- Remove and reuse or recycle culverts or take them to a permitted landfill for disposal.

3.11.8 Waste Storage Area Reclamation

3.11.8.1 Purge Brine Pipeline and Storage Pond(s)

Release of brine onto the playa from the Purge Brine Storage Ponds could help with salt crusting and playa dust control. The following general measures would be taken to reclaim the Purge Brine Storage Ponds and pipeline:

- Remove all pumps and equipment and reuse or recycle them or take them to a permitted landfill for disposal.
- Remove all surface pipelines and reuse or recycle them or take them to a permitted landfill for disposal.
- Fill in the pipeline trench with trench spoils and recontour it (if pipeline is buried).
- Remove residual purge brine onto the playa via controlled release unless economics allow for sale of $MgCl_2$.
- Ensure that the released purge brine is contained on-playa.
- Remove and recontour the berms; ensure that positive drainage exists to avoid ponding.
- Bury imported gravel and erosion-control rock to at least 2 feet below grade during recontouring.
- No topsoil placement or revegetation on-playa.

3.11.8.2 Tailings Storage Area

The 450-acre Tailings Storage Area will remain in place, with reclamation actions as described below to provide for positive drainage.

- Remove all equipment and reuse, recycle, or take it to permitted landfill for disposal.
- If tailings have not reached the top of the berm, breach the berms at multiple locations so that water is not impounded within the pond footprint. Outer berms would be breached, and channels constructed to enhance flow onto the playa.
- Ensure that the released fluid would be contained on-playa.
- Use equipment to recontour and grade the surface of the tailings to provide for positive drainage and to limit the potential for ponding.
- Abandon in place the accumulated tailings and tailings pond berms (after any existing freeboard has been removed).
- No topsoil placement or revegetation on-playa.

3.11.9 Processing Facility

Any inventories at the Processing Facility will be removed once operations have concluded. The various components of the Processing Facility will be decommissioned and demolished. Demolished materials will be disposed of at an appropriate off-site landfill or would be recycled.

The following general measures will be taken to reclaim the Processing Facility:

- Clean and flush any tanks or pipelines according to required procedures.
- Remove all above-ground pipeline portions down to 2 feet below grade. Cap and leave in place all pipelines buried more than 2 feet below grade.
- Bury gravel at least 2 feet below grade or remove gravel and reuse or recycle it or take it to a permitted landfill for disposal in coordination with the applicable landowner or land manager.
- Decommission and remove all buildings, equipment, and fencing and reuse or recycle them or take them to a permitted landfill for disposal.
- Remove concrete foundations and concrete slabs and take them to a permitted landfill for disposal or break slabs apart and bury them at least two below grade in accordance with landowner requirement.
- Grade the area to blend with surrounding topography.
- Spread suitable topsoil and seed the area with a suitable seed mix approved by the applicable landowner or land manager.

3.11.10 Water Supply Facilities

When the Project is no longer operational, water rights for the water supply wells will be transferred to other entities or relinquished to the state of Utah. Any wells not transferred to another entity will be plugged in accordance with UAC R655-4. In addition, the following general reclamation actions will be taken:

- Abandon the wells in coordination with the BLM and according to UAC 655-4-14 or the most current approved regulation.
- Dismantle each well house and reuse or recycle all structures and equipment and fencing or take them to a permitted landfill for disposal.
- Bury gravel at least 2 feet below grade or remove gravel and reuse or recycle or take to a permitted landfill for disposal.
- Remove the concrete slabs and take them to a permitted landfill for disposal or break slabs apart and bury them at least 2 below grade as per landowner requirement.
- Grade the area to blend with surrounding topography.
- Spread suitable topsoil and seed the area with suitable seed mix approved by the applicable landowner or land manager.

3.11.11 Monitoring Wells

Monitoring wells no longer needed for continued monitoring of site conditions during or after reclamation will be reclaimed according to state of Utah regulations unless transferred to other ownership. Prior to decommissioning monitoring wells, BLM, the state of Utah, and United States Geologic Survey will be contacted to determine if any of these agencies wish to assume ownership and maintenance responsibilities of the wells. Monitoring wells destined for abandonment and deeper than 30 feet and located outside of the playa would be plugged in accordance with UAC Rule R655-4. The abandonment will be accomplished by a currently licensed water well driller. General reclamation procedures will include the following:

- Remove and reuse or recycle the pump and power supply or take them to a permitted landfill for disposal.
- Plug (abandon) monitoring wells located on or off the Sevier Playa according to state of Utah rules.
- Reapply topsoil and revegetate the area as required by the applicable landowner or land manager.
- Replace the cadastral survey monuments as necessary per the lease stipulations.

3.12 CONTINGENCY AND CORRECTIVE ACTION PLAN

Once mining operations start and following collection of additional pre-mining hydrologic data, the water monitoring plan will be modified to determine if there are actual impacts to surface water and groundwater resources throughout and surrounding the mine area during operations. These modifications will be determined based on the baseline data collected. During operations, if impacts are identified, CPM will work with DWQ and BLM in order to minimize potential impacts to groundwater resources. The water monitoring plan will allow early determination of whether water resources that contain <10,000 mg/L TDS are affected.

As noted previously, potential discharge from the production ponds and waste storage area is not likely to have impacts outside the Utah Class IV groundwater in the alluvium/colluvium surrounding the playa over the 30-year life of mine. In the event that compliance monitoring identifies exceedances above the upper limits of the target parameter, CPM will work with the DWQ to develop a corrective action plan for the issue identified. Initially, the focus of the efforts is identification of how the exceedance is occurring and what steps can be taken to correct the issue. A program will then be prepared to control and correct the problem.

CPM’s federal lease, Special Stipulation 8 states:

“Water Replacement: The Lessee at his expense, will be responsible to replace any water resources (that contain in a baseline analysis of <10,000 mg/1 Total Dissolved Solids (TDS)), that are lost or adversely affected (quality or quantity) by their mining operations. These shall include (1) developed ground water sources existing at lease issuance or new sources that may be developed during the term of the lease, and (2) other surface and/or ground water sources that may be identified by the BLM for protection as part of the conditions for any mining plan approvals. If replacement is required, the lessee shall replace the sources with an alternate source in the same quantity and quality to maintain existing uses. The existing uses shall include but not limited to riparian habitat, fishery habitat, livestock, wildlife, domestic, agricultural, or other land uses. The lessee/operator shall obtain sufficient base line data and monitoring in order to establish parameters to show whether water resources are affected.”

Therefore, in the event that one of the BLM wells that surround the playa is impacted by elevated TDS concentrations greater than 10,000 mg/l, then CPM will work with the BLM to replace the well. The target will be to provide a water supply that has the same flow potential and TDS concentration of less than 10,000 mg/l.

Once mining activities are completed and reclamation commences, CPM will evaluate the need for additional monitoring. As part of the monitoring program, annual reports will be prepared and submitted to the DWQ and BLM. The data collected will be summarized and plotted in time series plots to show the relationship of the target constituents and ensure that trends of indicator parameters do not indicate changes in the surrounding groundwater systems. Additionally, statistical analyses will be conducted to assess whether there are any indications of long-term trends of projected impacts to the surrounding groundwater systems.

If there are no indications of trends of impacts, then CPM will propose a cessation of monitoring activities. If trends are identified, then CPM will work with the DWQ and BLM to determine if such trends are resulting from the mining activities and if so to develop plans to address the concerns.

3.13 CERTIFICATION

Certification is shown on the following page.

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Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

John G. Mansanti, President and CEO	801-485-0223
NAME & OFFICIAL TITLE (type or print)	PHONE NO. (area code & no.)
	August 30, 2018
SIGNATURE	DATE SIGNED

Certification

I certify under penalty of law that the Hydrogeologic Report, Groundwater Discharge Control Plan, Compliance Monitoring Plan, Closure and Post-Closure Plan, and Contingency and Corrective Action Plans in this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thomas J. Suchoski, Senior Hydrologist
NAME & OFFICIAL TITLE (type or print)

801-539-0044
PHONE NO. (area code & no.)

SIGNATURE

06/05/19
DATE SIGNED

LICENSED PROFESSIONAL GEOLOGIST
NO. 176754
THOMAS J. SUCHOSKI
STATE OF UTAH

4.0 REFERENCES

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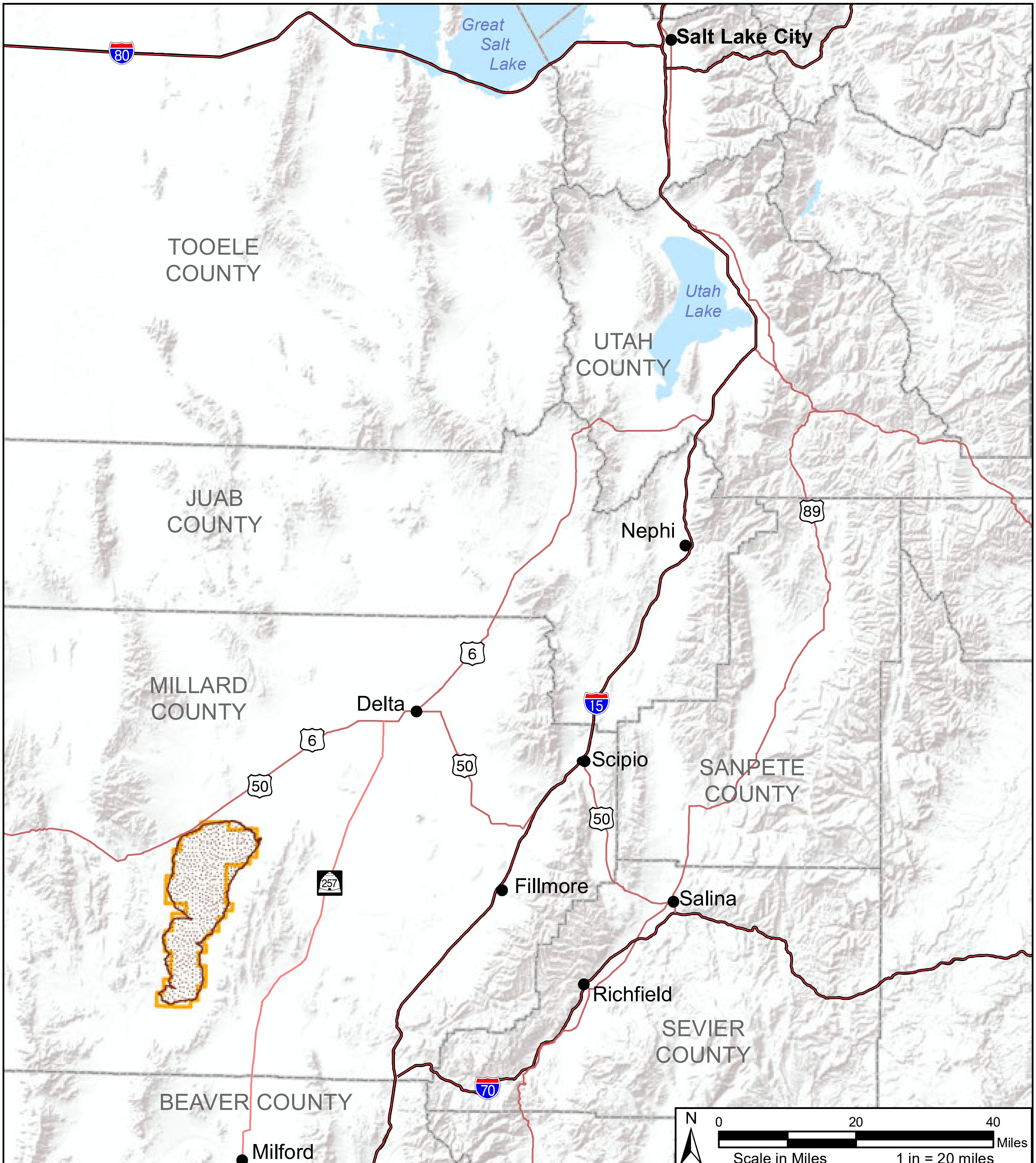
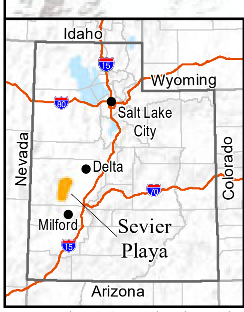




Sevier Playa Boundary

BLM and SITLA Lease Boundary

NO.	DATE	REVISION	BY	APVD
2	7/20/2018	Revised based on comments		
1	1/5/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN	DR	CHK	APVD

FIGURE A1-1

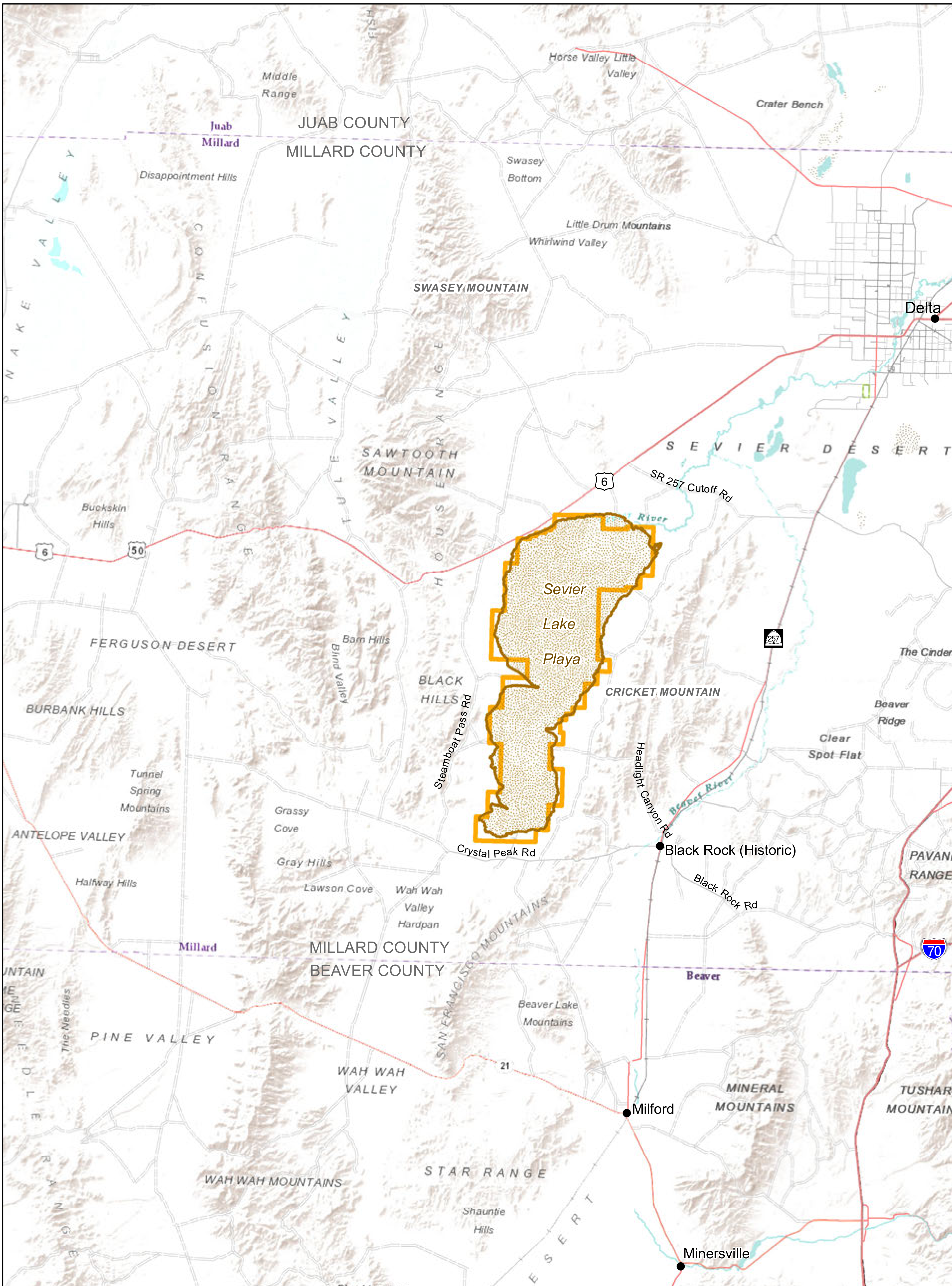
Sevier Playa Potash Project
Regional Vicinity

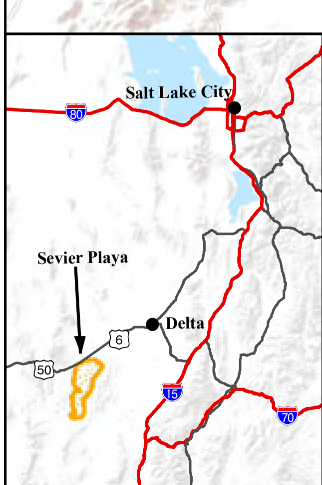
GROUNDWATER DISCHARGE APPLICATION

DATE: 7/20/2018 SCALE: 1:1,267,200

CRYSTAL PEAK MINERALS INC.

GWDA Fig A1-1 - Regional Location Map 180720 7/20/2018 11:46:38 AM





Project Features

- Sevier Playa Boundary
- BLM and SITLA Lease Boundary

N

0 5 10 20 Miles

1 in = 8 miles

Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

NO.	DATE	REVISION	BY	APVD
2	7/20/2018	Revised based on comments		
1	1/5/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN | DR | CHK | APVD

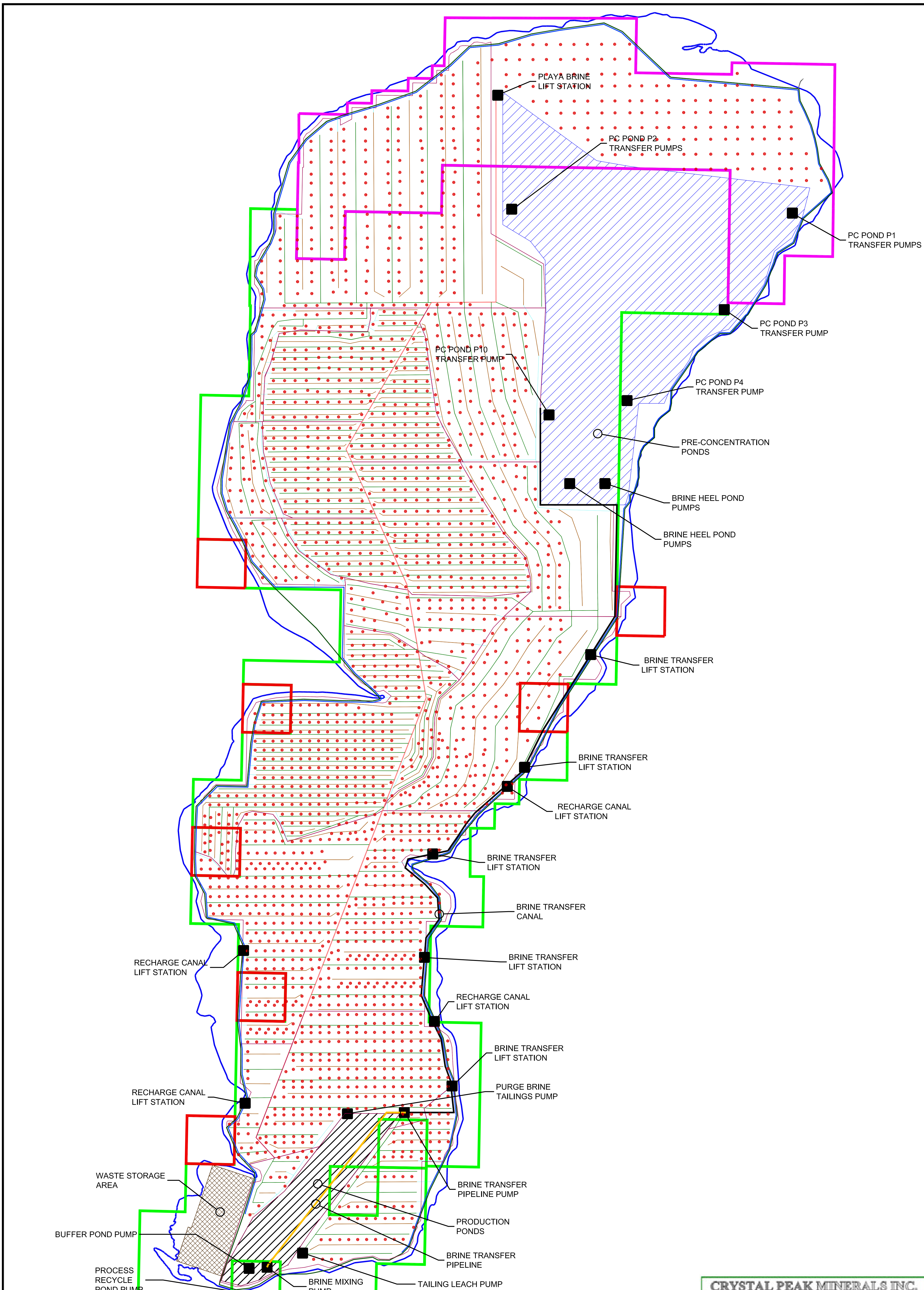
FIGURE A1-2

Sevier Playa Potash Project
Local Vicinity Map

GROUNDWATER DISCHARGE APPLICATION

DATE: 7/20/2018 SCALE: 1:500,000

CRYSTAL PEAK MINERALS INC.



LEGEND

Extraction Trench	Production Pond Area	LUMA Lease
Recharge Trench	Pre-Concentration Area	Federal Lease
Recharge Collector	Waste Storage Area	State Lease
Transfer Trench	BMU Boundary	BMU Boundary
Transfer Pipeline	Main Canal	Pump Station
Perimeter Road	Playa Boundary	
Recharge Canal	Extraction Well	
Extraction Trench		
Recharge Trench		

N

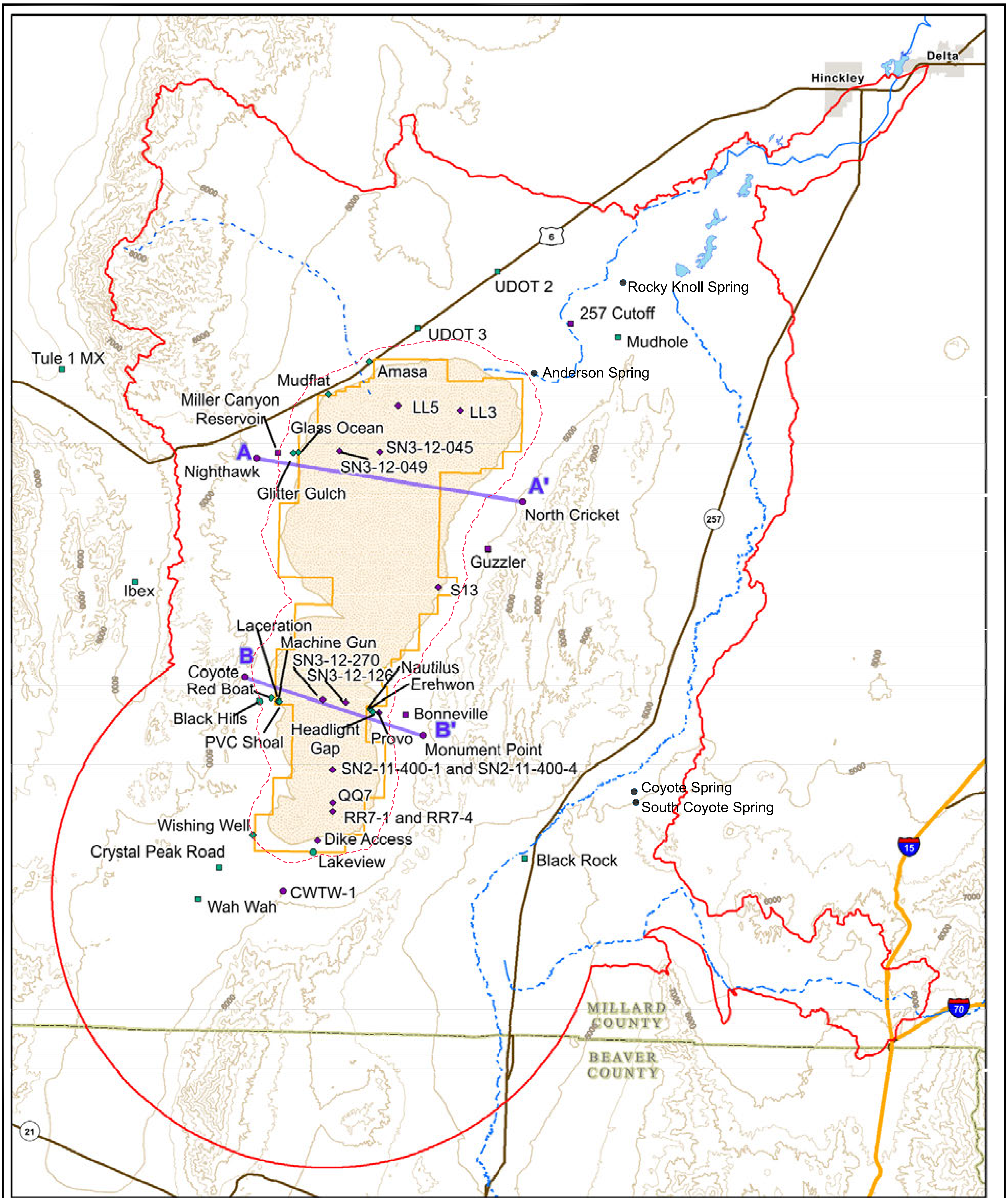
0 5,000 10,000 15,000
Feet

FIGURE A1-3

Sevier Playa Potash Project
Groundwater Discharge Application
General Arrangement of
Playa Features

NORWEST CORPORATION now Stantec

DATE: 08/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE A1-3 General Arrangement.dwg



Explanation

- Sevier Playa Potash Project Water Resources Analysis Area
- Sevier Playa Potash Project Lease Area
- Sevier Playa
- Interstate Highway
- Major Highway
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir
- County Boundary
- 6000 Reference Contour
- Intermediate Contour

A — A' Location of Hydrogeologic Cross Section Shown on Figure 31

B — B' Location of Hydrogeologic Cross Section Shown on Figure 32

One Mile Boundary From Playa

Goundwater Monitoring Locations

- CPM Well in Playa Sediments
- CPM Well in Unconsolidated Deposits
- CPM Well in Bedrock
- Other Well in Playa Sediments
- Other Well in Unconsolidated Deposits
- Other Well in Bedrock

0 2 4 6 8 Miles

Contour Interval: 500 ft

Projection: NAD83 UTM Zone 12N Meters

N

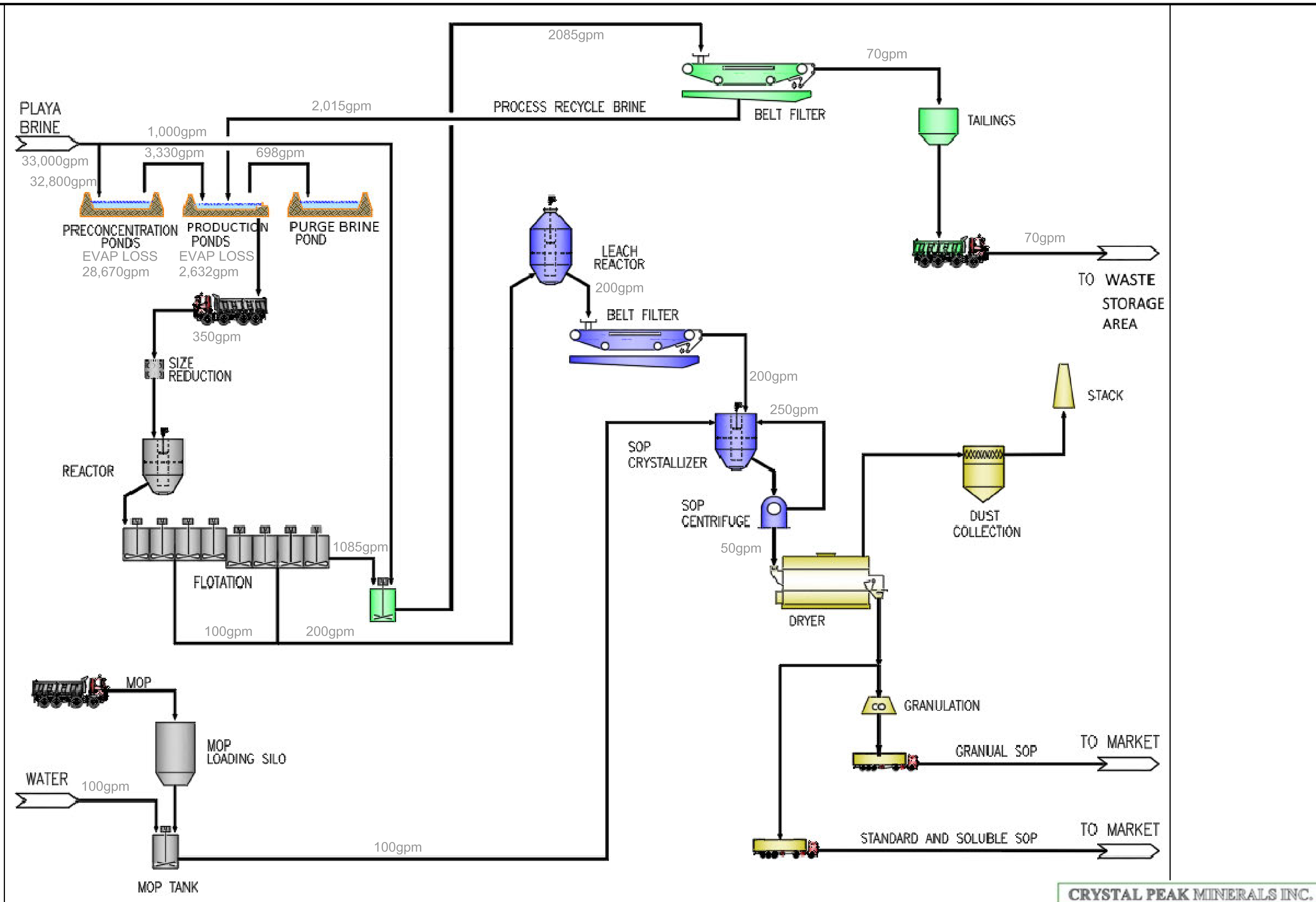
CRYSTAL PEAK MINERALS INC.

FIGURE A9-1

Sevier Playa Potash Project
Groundwater Discharge Application
Project Area Springs
(Whetstone 2017)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018	PROJECT: 89-12	SCALE: NTS
FILE: FIGURE A9-1 CPM Wells.dwg		



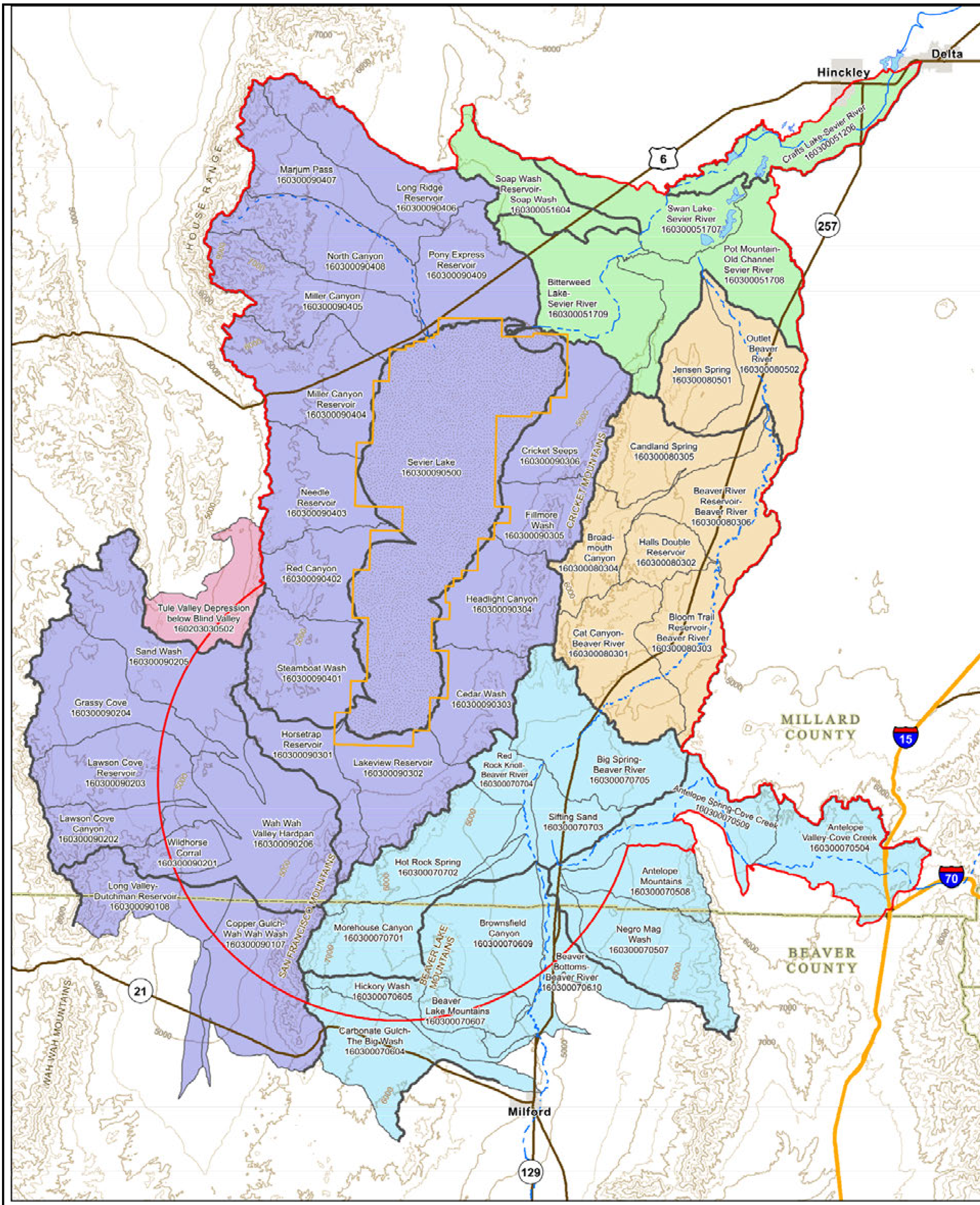
Source: Novopro

FIGURE B6-1

Sevier Playa Potash Project
Groundwater Discharge Application
Process Block Diagram

NORWEST CORPORATION now Stantec

DATE: 08/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE B6-1 Process Block Diagram.dwg



Explanation

- Sevier Playa Potash Project Water Resources Analysis Area
- Sevier Playa Potash Project Lease Area
- Sevier Playa
- Interstate Highway
- Major Highway
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir
- County Boundary
- Reference Contour
- Intermediate Contour

Watershed Boundaries

- HUC-12 Boundary
- HUC-10 Boundary

Watershed Cataloging Unit (HUC-8) Areas

- Sevier Lake
- Lower Sevier
- Lower Beaver
- Beaver Bottoms - Upper Beaver
- Tule Valley

0 2.5 5 7.5 10 Mile

Contour Interval: 500 ft
Projection: NAD83 UTM Zone 12N Meters

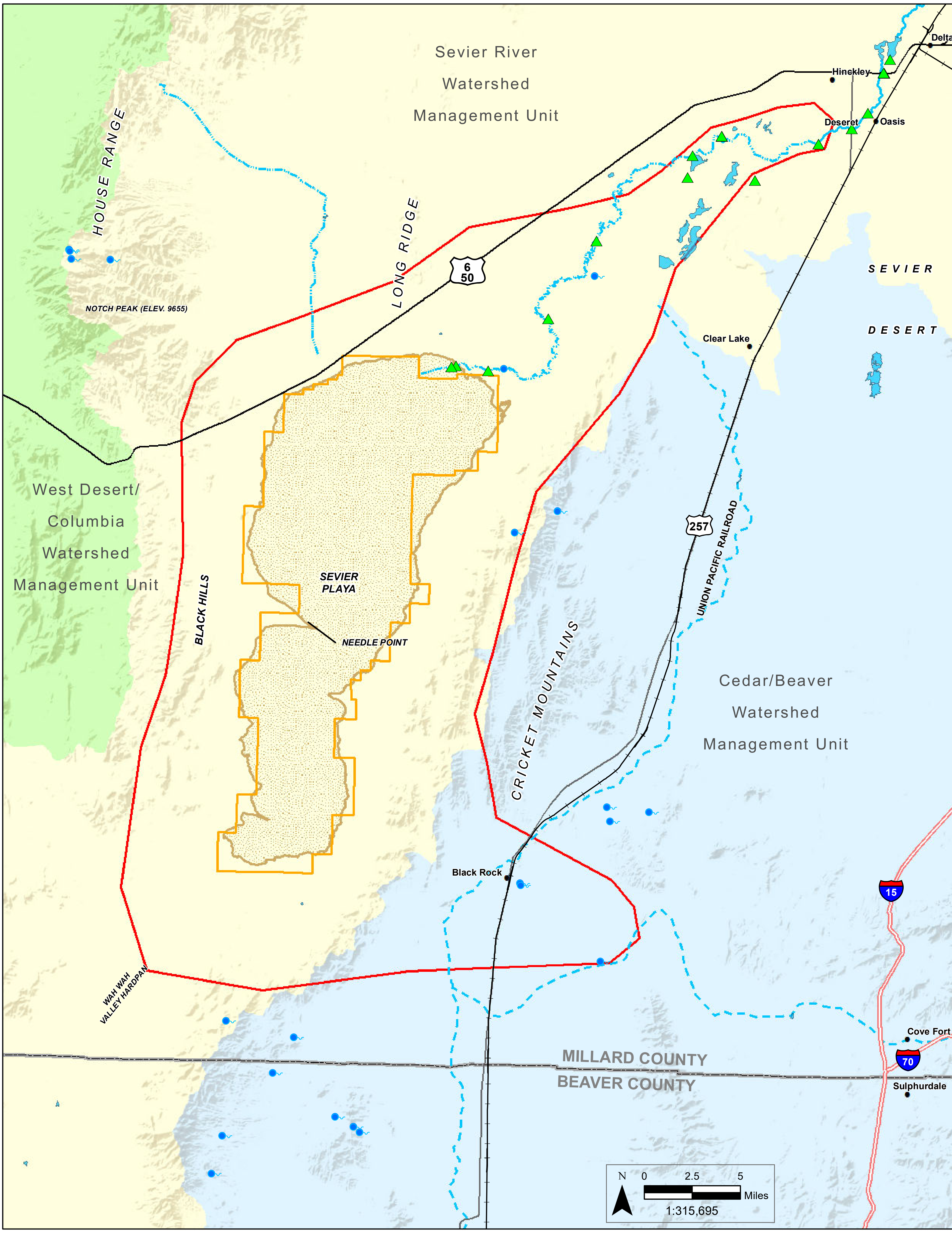
CRYSTAL PEAK MINERALS INC.

FIGURE B8-1

Sevier Playa Potash Project
Groundwater Discharge Application
Surface Water Drainage Areas
(Whetstone 2017)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 PROJECT: 89-12 SCALE: NTS
FILE: FIGURE B8-1 SW Drainage Areas.dwg



Explanation

- Spring
- SW Station
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir
- Sevier Playa
- Sevier Playa Study Area
- BLM/SITLA Lease Boundary
- Interstate Highway
- U.S. or State Highway
- Existing Railroad

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018;
Sevier Playa Study Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Watershed Management Areas, Utah AGRC, 2018:
Streams and Water Bodies, NHD, 2017:
Springs and SW Stations, Norwest, 2018;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;

NO.	DATE	REVISION	BY	APVD
2	7/20/2018	Revised based on comments		
1	1/5/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN	DR	CHK	APVD

FIGURE B8-2

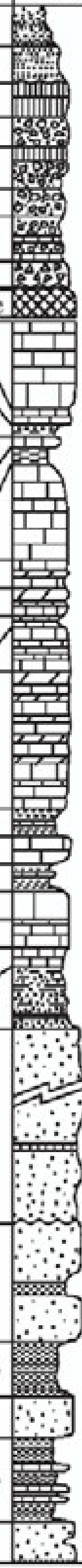
Sevier Playa Potash Project
Surface Water and Spring Locations

GROUNDWATER DISCHARGE
APPLICATION

DATE: 7/20/2018 SCALE: 1:315,695

CRYSTAL PEAK MINERALS INC.

CRICKET AND NORTHERN SAN FRANCISCO MOUNTAINS



AGE	MAP SYMBOL	ROCK UNIT		THICKNESS FEET	THICKNESS METERS	FOSSILS, ISOTOPIC AGES, AND OTHER INFORMATION	REFERENCES
Q	various	Alluvial, lacustrine, and eolian deposits		0-600±	0-200±		Oviatt, 1989, 1991a
TERTIARY	QTf,QTln	Lacustrine deposits of Sevier Desert		1,000 est.	300 est.	Bishop ash **760,000 yr B.P.** Huckleberry Ridge ash **2.02 Ma**	Oviatt, 1989, 1991a
	Thb	Basalt of High Rock		0-150	0-50		
	Tsr	Skull Rock Pass Conglomerate		--	--	Correlation uncertain	Lemmon and Morris, 1984; this bulletin
	Ths	Horn Silver Andesite		0-1,600+	0-500+	Flows and pyroclastic rocks **31.6 & 35.0 Ma K-Ar**	
	Thr	Conglomerate of High Rock Pass		0-300	0-90	Oligocene	
	Tf	Flagstaff Formation		300-585	90-190	Paleocene? Cg of Red Pass and Ls of Fillmore Canyon	Hintze, 1984; this bulletin
	Tbr	Breccia of Cat Canyon		0-165	0-50	MAJOR UNCONFORMITY	Hintze, 1984; Hintze & others, 1984; this bulletin
CRET?	TKbr	Tectonic breccia in San Francisco Mtns.		1,600 wide	500 wide	Age uncertain	
CAMBRIAN	OЄn	Notch Peak Formation		100+	30+	Top not preserved; regional thickness about 1,600 ft (500 m)	
	Єou	Orr Fm	Sneakover Limestone Mbr	100	30		
			Corset Spring Shale Mbr	40	12		
			Johns Wash Limestone Mbr	100	30		
			Candland Shale Mbr	165	50	*Dunderbergia** Bioclastic limestone	
	Єob		Big Horse Limestone Mbr	656	200	*Crepicephalus**	
	Єwt	Wah Wah Summit Fm	White Marker Mbr	165-230	50-70		
			Ledgy member	410	125		
		Trippe Limestone	Fish Springs Mbr	100	30	*Eldoradia**	
			Lower member	660-760	200-230	White algal boundstone	
	Єcm	Limestone of Cricket Mountains		1,970	600	Unfossiliferous; Bioturbated limestone, dolomite and light gray laminated boundstone	Hintze, 1984; this bulletin
	Єw	Whirlwind Formation		200-265	60-80	*Ehmaniella**	
	Єdh	Dome Limestone		230-330	70-100	Cement quarry rock	
		Chisholm Formation		165-265	50-80	*Glossopleura**	
		Howell Limestone	Upper member	100-165	30-50	Light gray	
			Millard Member	200-250	60-75	Dark gray	
	Єp	Pioche Formation	Tatow Member	82-115	25-35	*Paraalbertella**	
			Lower member	660-760	200-230	*Olenellus** Hematite bed	
	Єpm	Prospect Mountain Quartzite		4,000+	1,200+	Pink vitreous quartzite; **Basalt flow 15 to 50 ft (5-15 m)** thick, 1,650 ft (500 m) above bottom	Lemmon and Morris, 1984
LATE PRECAMBRIAN	pЄm	Mutual Formation		2,100	635	Purple conglomerate quartzite; Maroon slate; Reddish-purple pebbly quartzite	Woodward, 1968, 1972; Christie-Blick, 1982; Lemmon and Morris, 1984
	pЄi	Inkom Formation		460-530	140-160	Red and green phyllitic argillite	
	pЄc	Caddy Canyon Quartzite		265-330	80-100	Light-colored quartzite	
	pЄb	Black Rock Canyon Limestone		600-990	180-300	Argillite, metasiltstone, quartzite and marble	
	pЄp	Pocatello Formation		970	300	Light gray quartzite	

Diagram is schematic-- no fixed scale

*Trilobites

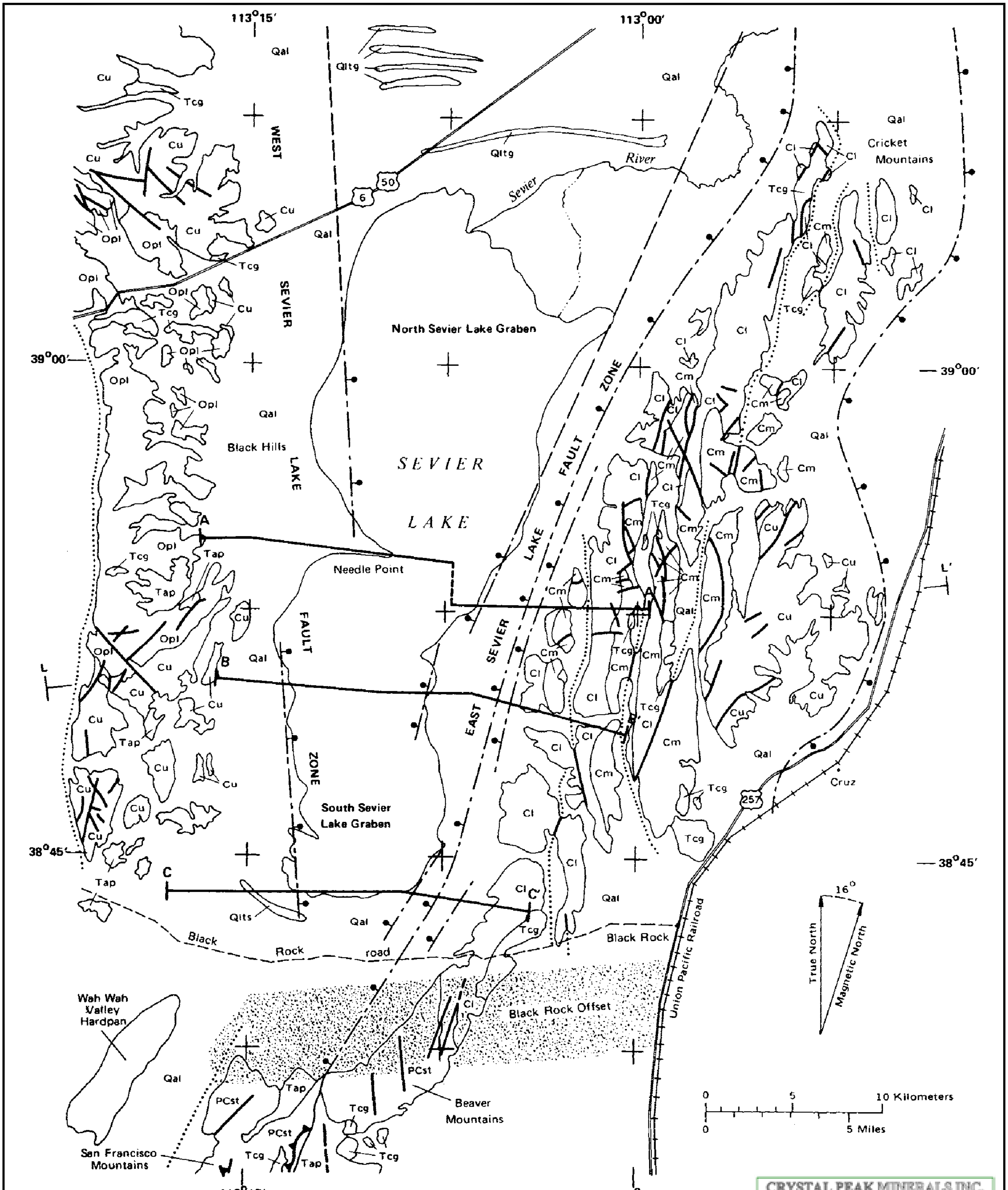
CRYSTAL PEAK MINERALS INC.

FIGURE B8-3

Sevier Playa Potash Project
Groundwater Discharge Application
Project Area Stratiagraphic Column
(Hintze and Davis, 2003)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE B8-3 Strat Column.dwg



LEGEND

Quaternary

Symbol	Description
Qltg	Constructional lake shore features
Qal	Alluvium

Tertiary

Symbol	Description
Tap	Volcanic flows
Tcg	Conglomerate

Ordovian

Symbol	Description
Opl	Chiefly Limestone and intraformational conglomerate. Lower Ordovician

Cambrian

Symbol	Description
Cu	Chiefly limestone and dolomite Lower Cambrian
Cm	Chiefly Limestone and some shale. Middle Cambrian
Cl	Chiefly Quartzite and some Phyllite. Lower Cambrian

Precambrian

Symbol	Description
PCst	Metasedimentary rocks

Concealed fault, inferred by gravity, dots on downthrown side

Thrust fault, teeth on upper plate

Fault, dashed where inferred by geology

Concealed fault, inferred by geology

Contact

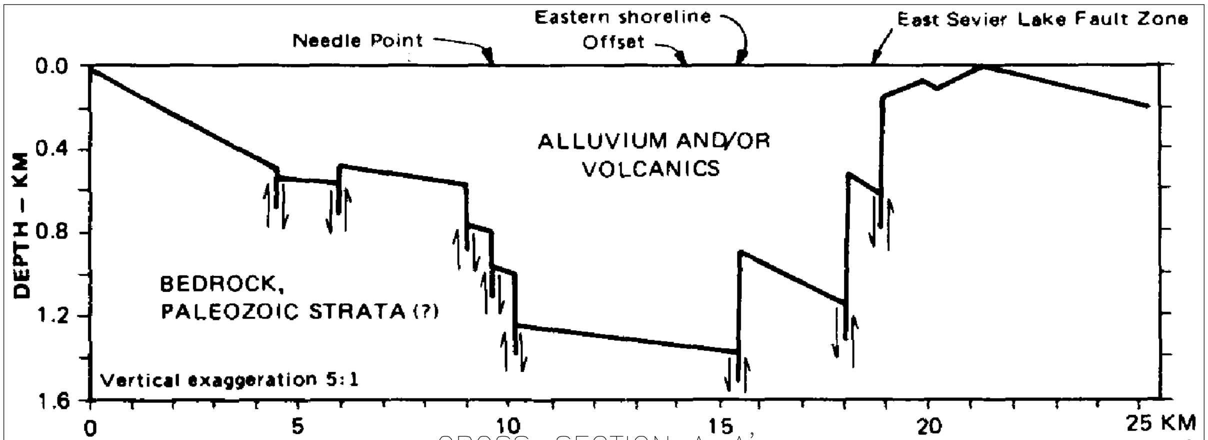
A A' Gravity profile

FIGURE B8-4

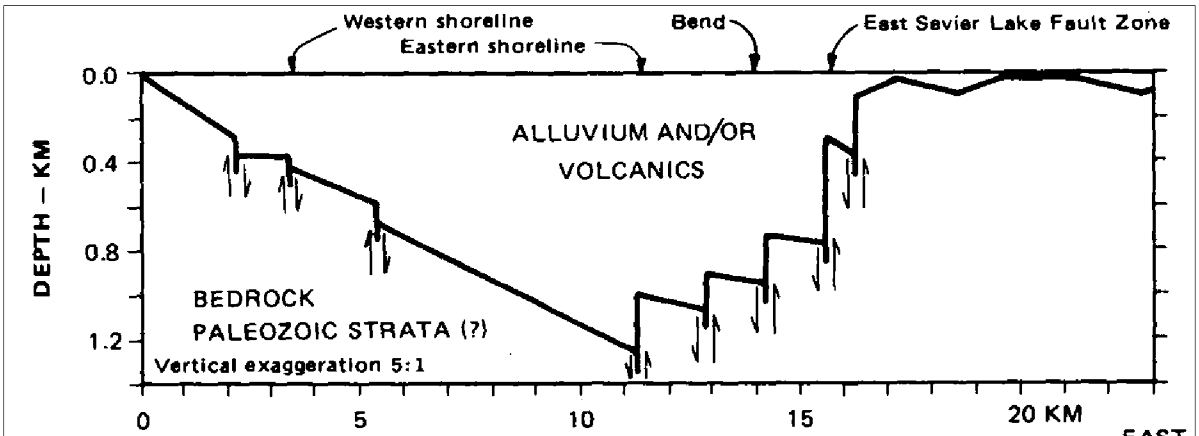
Sevier Playa Potash Project
Groundwater Discharge Application
Project Area Geology
(Case and Cook, 1979)

NORWEST CORPORATION now Stantec

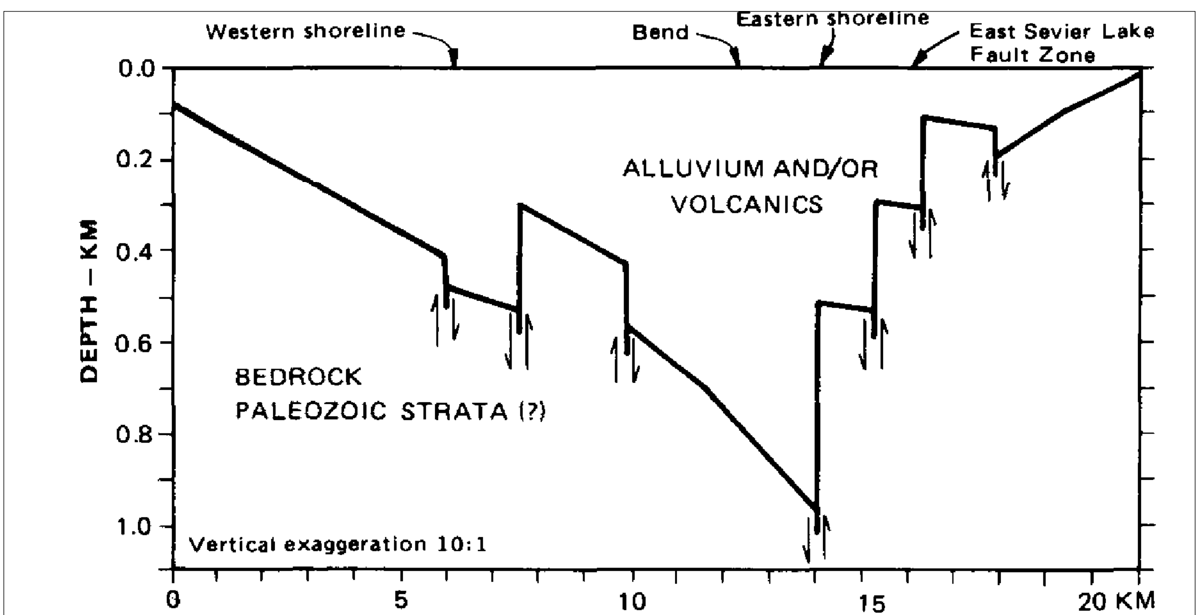
DATE: 07/31/2018	PROJECT: 89-12	SCALE: NTS
FILE: FIGURE B8-4 Geology.dwg		



CROSS–SECTION A–A'



CROSS–SECTION B–B'



CROSS–SECTION C–C'

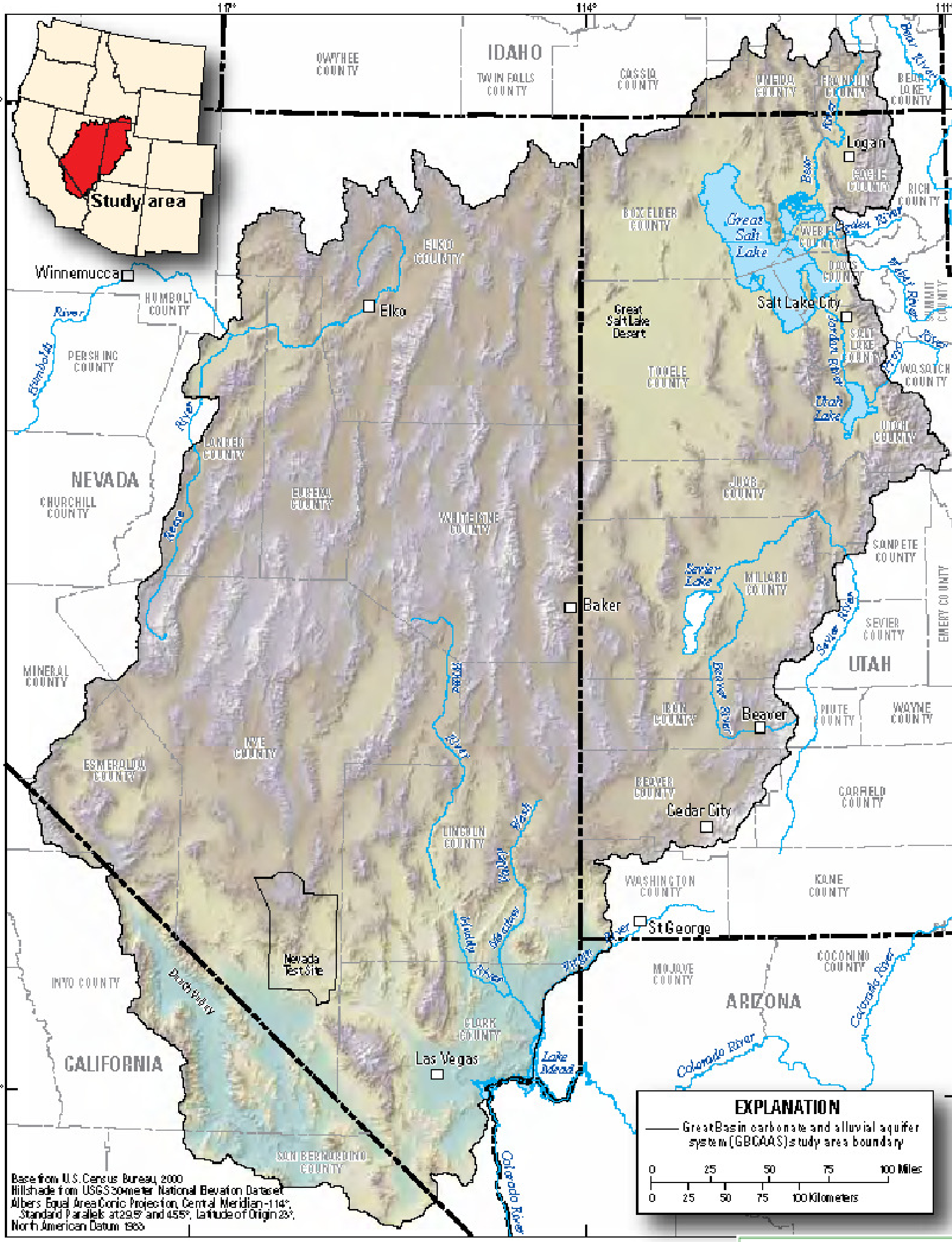
CRYSTAL PEAK MINERALS INC.

FIGURE B8-5

Sevier Playa Potash Project
Groundwater Discharge Application
Project Area Gravity Cross-sections
(Case and Cook, 1979)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018	PROJECT: 89–12	SCALE: NTS
FILE: FIGURE B8–5 Gravity Cross–sections.dwg		



CRYSTAL PEAK MINERALS INC.

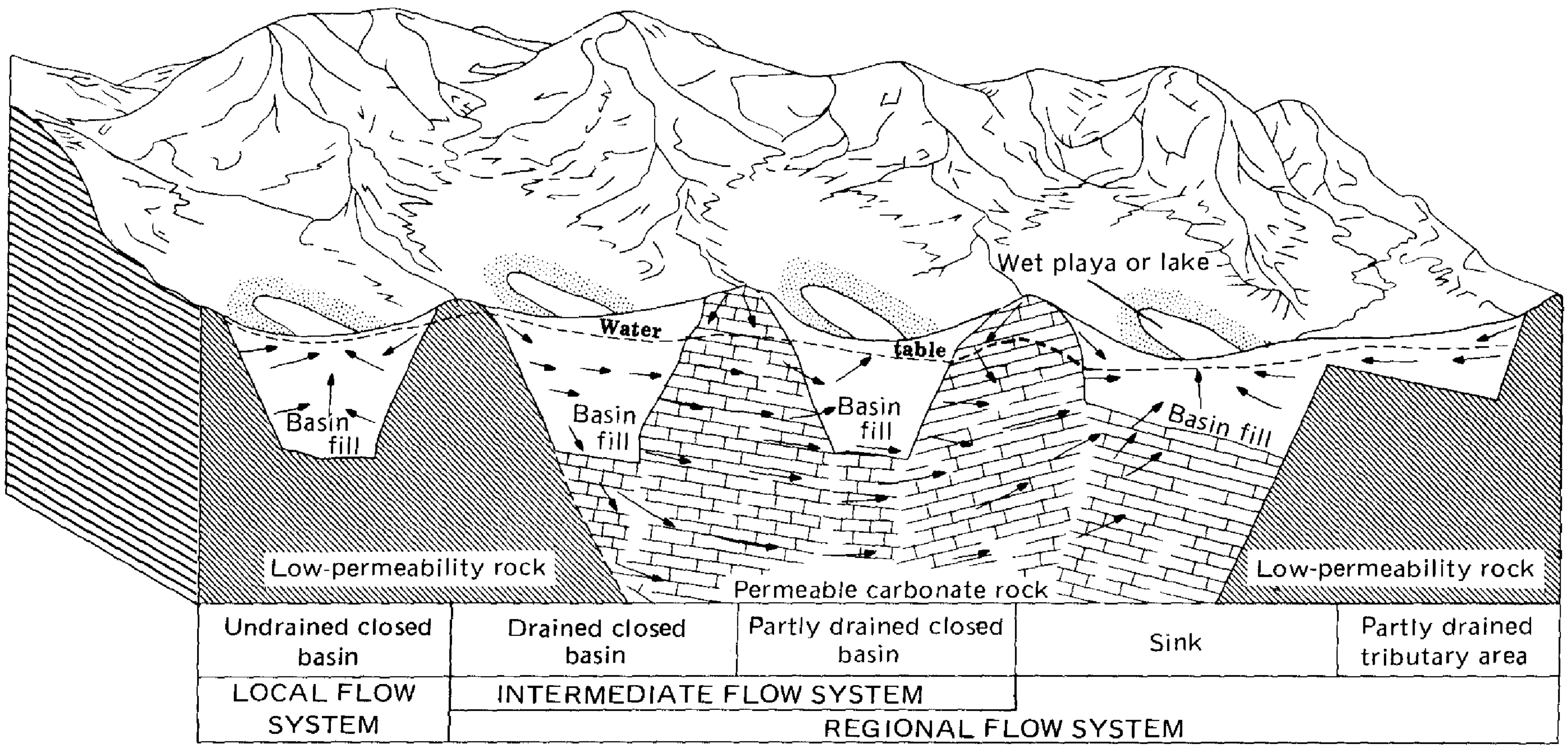
Figure from Heilweil and Brooks, 2011

FIGURE B8-6

Sevier Playa Potash Project
Groundwater Discharge Application
Great Basin Carbonate and
Alluvial Aquifer System

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE B8-6 GBCAAS.dwg



CRYSTAL PEAK MINERALS INC.

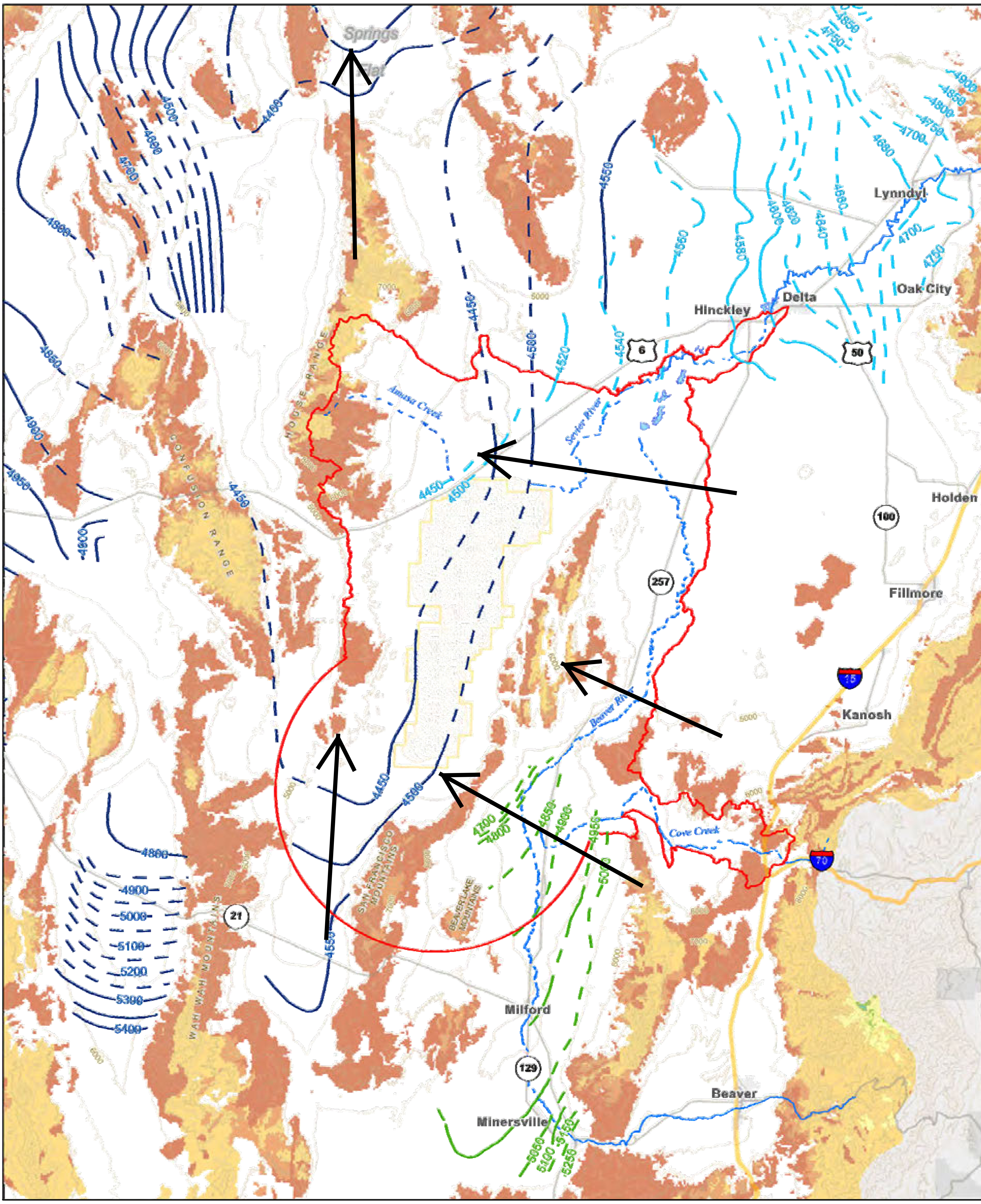
FILE From Wilberg, 1991

FIGURE B8-7

Sevier Playa Potash Project
Groundwater Discharge Application
Local, Intermediate, and Regional Flow System Block Diagram

DATE: 07/31/2018
FILE: Figure B8-7 Flow Block Diagram.dwg
SCALE: NONE

NORWEST CORPORATION



Explanation

- Sevier Playa Potash Project Water Resources Analysis Area
- Sevier Playa Potash Project Lease Area
- Sevier Playa
- Interstate Highway
- Major Highway
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir
- 6000 Reference Contour
- Intermediate Contour

Regional Aquifer Potentiometric Surface Contours

Gardener et al., 2011
potentiometric surface, circa 2007 - 2010
- Potentiometric Surface Contour
- Inferred Contour

Mason, 1998
potentiometric surface, circa 1983
- Potentiometric Surface Contour
- Inferred Contour

Holmes, 1984
potentiometric surface in unconsolidated deposits, circa 1981
- Potentiometric Surface Contour
- Inferred Contour

Estimated Average Annual In-Place Recharge (feet)

Source: Flint and Flint, 2011

- No Data
- 0
- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3+

0 4 8 12 16 Miles

Elevation Contour Interval: 500 ft
Projection: NAD83 UTM Zone 12N Meters

N

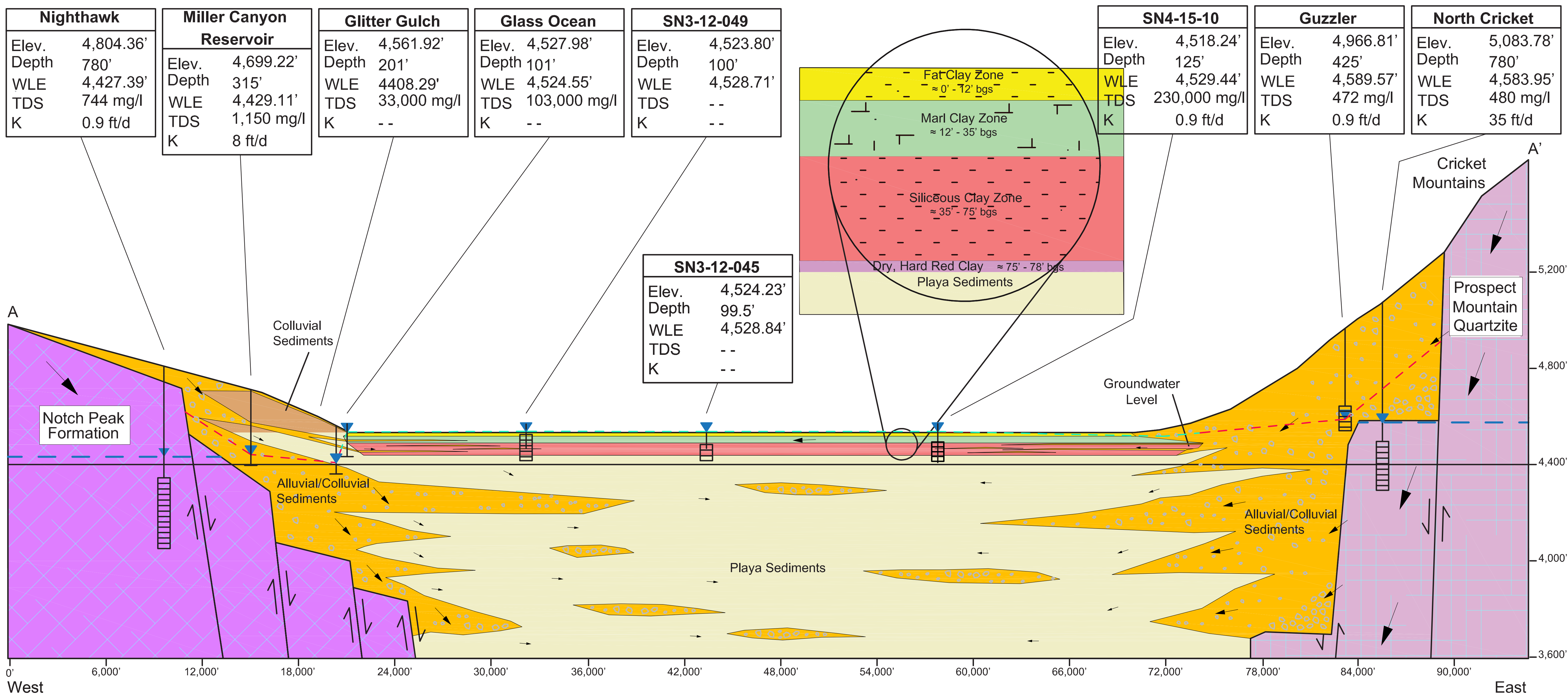
CRYSTAL PEAK MINERALS INC.

FIGURE B8-8

Sevier Playa Potash Project
Groundwater Discharge Application
Regional Potentiometric Surface
(Whetstone 2017)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018	PROJECT: 89-12	SCALE: NTS
FILE: FIGURE B8-8 Regional Potentiometric.dwg		



Cross Section A-A'
(Vertical Exageration 15:1)

CRYSTAL PEAK MINERALS INC.

EXPLANATION

Well Showing Screened Interval and Water Level Elevation (WLE July 2015)

Groundwater Potentiometric Surfaces
- Regional Bedrock
- Alluvial/Colluvial
- Playa

Fault Showing Direction of Movement

Key	
Elev.	Collar Elevation
Depth	Well Depth
WLE	Water Level Elevation
TDS	Total Dissolved Solids
K	Hydraulic Conductivity

NO.	DATE	REVISION	BY	APVD
0	04/04/18	INITIAL SUBMISSION	TJS	GG

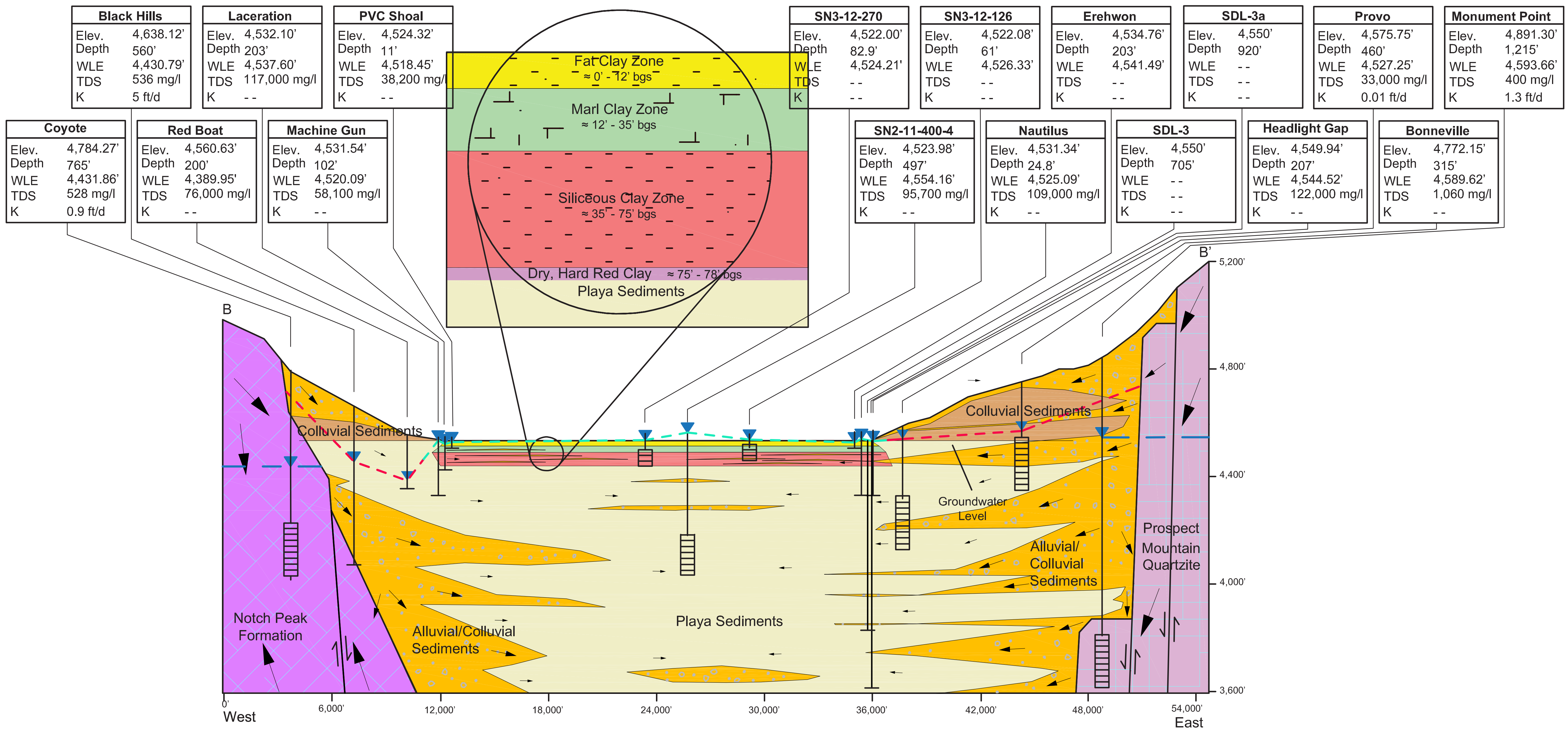
DSGN	DR	CHK	APVD
TJS	TJS	GG	GG

FIGURE B8-9

Sevier Playa Potash Project
Groundwater Discharge Application
Hydrogeologic Cross-section
A-A'

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 PROJECT: 89-12 SCALE: 1"=6000'
FILE: FIGURE B8-9 Cross-section A-A'.dwg



Cross Section B-B'
(Vertical Exageration 15:1)

CRYSTAL PEAK MINERALS INC.

EXPLANATION

- Well Showing Screened Interval and Water Level Elevation (WLE July 2015)
- Groundwater Potentiometric Surfaces
  - Regional Bedrock
  - Alluvial/Colluvial
  - Playa
- Fault Showing Direction of Movement

Key	
Elev.	Collar Elevation
Depth	Well Depth
WLE	Water Level Elevation
TDS	Total Dissolved Solids
K	Hydraulic Conductivity

NO.	DATE	REVISION	BY	APVD
0	04/04/18	INITIAL SUBMISSION	TJS	GG

DSGN	DR	CHK	APVD
TJS	TJS	GG	GG

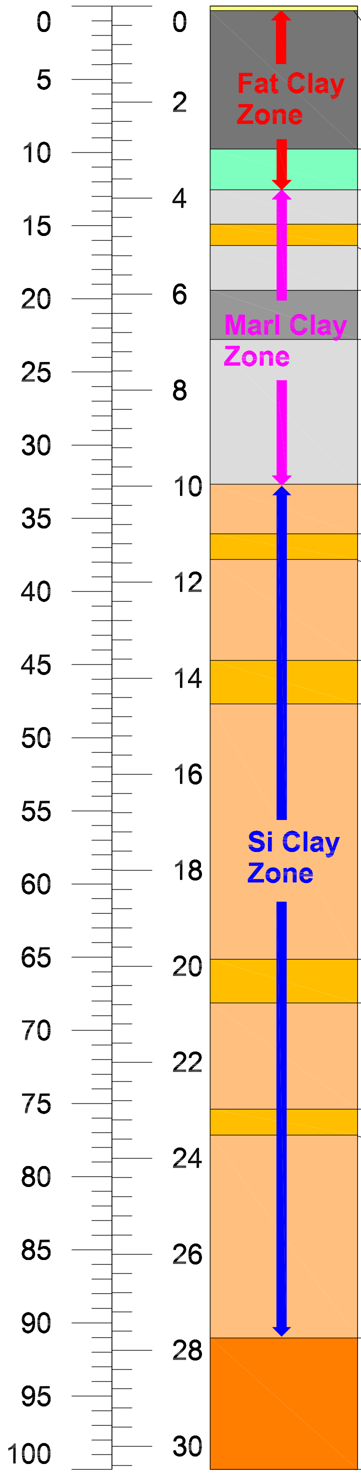
FIGURE B8-10

Sevier Playa Potash Project
Groundwater Discharge Application
Hydrogeologic Cross-section
B-B'

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 PROJECT: 89-12 SCALE: 1"=6000'
FILE: FIGURE B8-10 Cross-section B-B'.dwg

Depth (ft)|(m)



Thickness (m)(ft)	Carbonate (%)	Penetrometer (t/ft^2)
0-0.5m (0-1.5ft)	38.6	0 - 0.25
2.9m (9.5ft)	38.6	0 - 0.5
0.9m (2.8ft)	46.2	0 - 0.5
0.7m (2.4ft)	46.5	0 - 0.5
0.4m (1.5ft)	46.9	0 - 0.5
0.9m (3.1ft)	47.3	0 - 0.5
1.0m (3.4ft)	48.5	1.5-3.0
3.0m (9.9ft)	47.7	0.75-1.25
1.0m (3.4ft)	29.6	0.75-1.25
0.5m (1.8ft)	32.2	0.75-1.25
2.1m (6.9ft)	34.4	0.75-1.25
0.9m (3.0ft)	31.1	0.75-1.25
5.3m (17.5ft)	32.2	1.0-1.5
0.9m (3.0ft)	28	1.0-1.5
2.2m (7.3ft)	33.6	1.0-1.5
0.5m (1.8ft)	34	1.0-1.5
4.2m (13.9ft)	31.1	1.0-1.5
>1.5m (>5ft)	-	>5

CRYSTAL PEAK MINERALS INC.

LEGEND

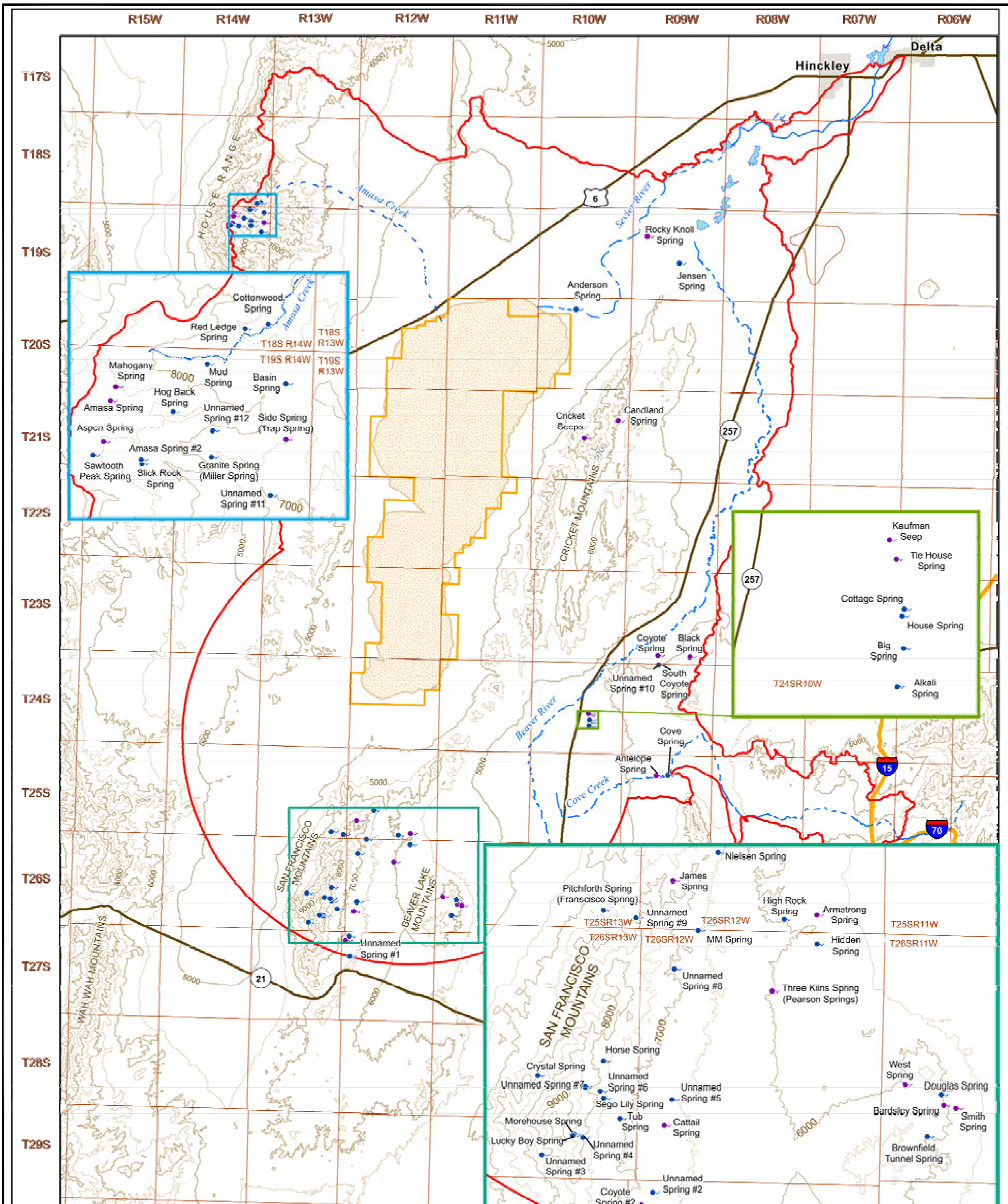
- Salt Crust
- Fat Clay with organics
- Fat (plastic) Clay
- Stiff Marl Clay
- Marl Clay
- Sand and Gravel
- Siliceous Clay
- Hard Dry Clay

FIGURE B8-11

Sevier Playa Potash Project
Groundwater Discharge Application
Typical Brine Aquifer
Stratigraphy

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE B8-11 Brine Aquifer Stratigraphy.dwg



Explanation

- Sevier Playa Potash Project Water Resources Analysis Area
- Sevier Playa Potash Project Lease Area
- Sevier Playa
- Interstate Highway
- Major Highway
- County Boundary
- Reference Contour
- Intermediate Contour
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir

Springs

- Spring with Water Quality Data
- Spring without Water Quality Data

0 2.5 5 7.5 10 Miles

Contour Interval: 500 ft
Projection: NAD83 UTM Zone 12N Meters

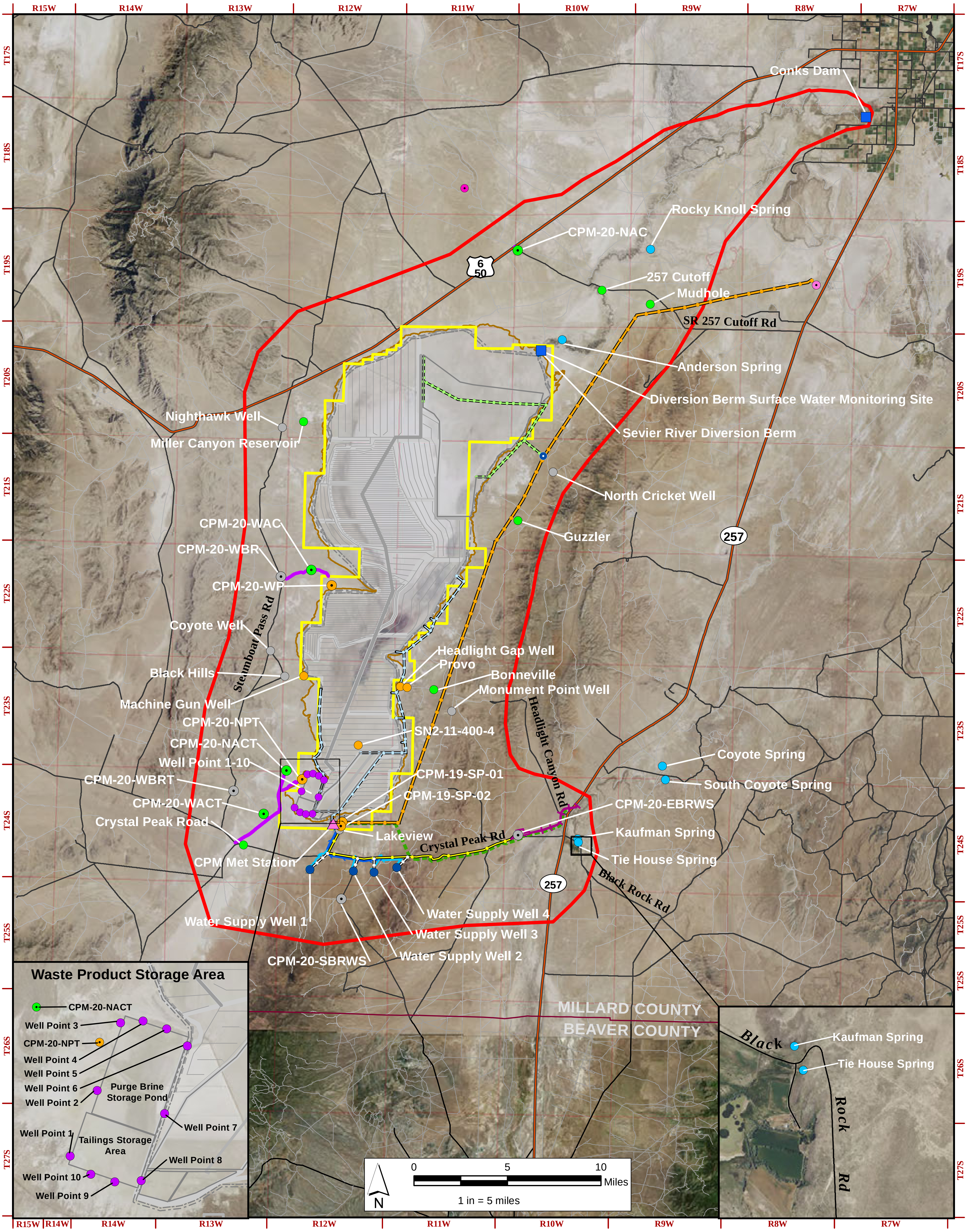
CRYSTAL PEAK MINERALS INC.

FIGURE B8-12

Sevier Playa Potash Project
Groundwater Discharge Application
Project Area Springs
(Whetstone 2017)

NORWEST CORPORATION now Stantec

DATE: 07/31/2018 | PROJECT: 89-12 | SCALE: NTS
FILE: FIGURE B8-12 Project Area Springs.dwg



Existing and Proposed Proposed Project Features

- Existing Playa Aquifer Well
- Proposed Playa Aquifer Well
- Existing Alluvial/Colluvial Aquifer Well
- Proposed Alluvial/Colluvial Aquifer Well
- Existing Bedrock Aquifer Well
- Proposed Bedrock Aquifer Well
- Proposed Well Point Location
- Proposed Water Supply Well
- Surface Water Monitoring Site
- Spring
- Proposed Sevier River Diversion Berm
- Sevier Playa Potash Project Water Resources Area of Interest
- BLM/SITLA Lease Boundary
- Access Road - Off-Lease
- Proposed 69-kV Power and Communication Line
- Proposed 25-kV Power Line
- Proposed 12.47-kV Power Line
- Proposed 12.47-kV Power and Communication Line
- Proposed 12.47-kV Power Line Spur
- Proposed Rail Spur and Access Corridor
- Proposed Rail Loadout Facility
- Proposed Natural Gas Pipeline
- Proposed Communication Tower
- Proposed Substation
- Meteorological Station
- Proposed Water Supply Pipeline
- Proposed Water Supply Pipeline Spur

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018, 2019;
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2018

4	2/15/2019	Revised based on comments		
3	10/15/2018	Revised based on comments		
2	7/18/2018	Revised based on comments		
1	6/19/2018	Revised based on comments		
0	10/25/2017	Initial Submission		
NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD

FIGURE B10-1

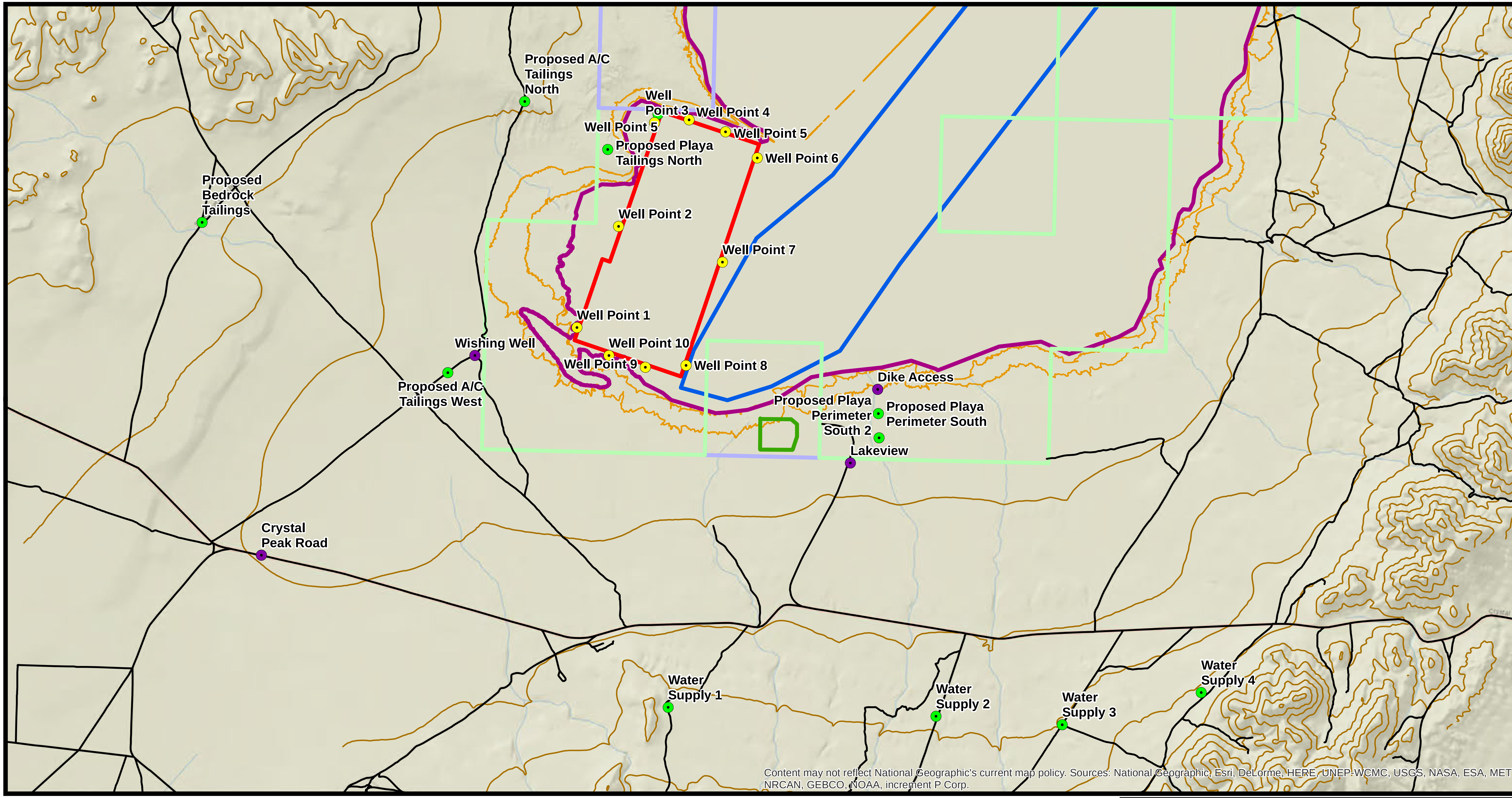
Sevier Playa Potash Project
Surface and Groundwater
Monitoring Network

GROUNDWATER DISCHARGE APPLICATION

DATE: 6/6/2019 SCALE: 1:318,859

CRYSTAL PEAK MINERALS INC.

D:\GIS\Peak Minerals\Operational Monitoring Plan\GWDA Fig B10-1 - Surface and Ground Water Monitoring Network 1.mxd6/6/2019 12:38:23 PM



0 650 1,300 2,600
Meters
1:52,000

N

- Proposed Well Points
- Existing Wells
- Proposed Monitoring Wells
- Roads
- Boundary Federal Lease 2016
- Boundary Playa
- BoundaryState Lease 2016
- Boundary Tailing Area
- Countor Line 8 ft
- Contour Line 25 ft
- Plant Site
- Production Ponds

CRYSTAL PEAK MINERALS INC.

Sevier Lake Waste StorageTailings and Purge Brine Ponds

Figure B10-2

Date: Jul 17, 2018	Coordinate System: NAD 1983 UTM Zone 12N	Project # 89-14	Revision 1
Drawn By: SKB / Chkd By: TJS			

Document Path: N:\4-0023 4757 GNPD\101-17 Phase III\MXD\Sevier_Lake_Waste_Monitoring_1_10_WellPts.mxd

APPENDIX A

Project Summary

(Included as Attachment)

	Revision Number:	4
	Date:	July 30, 2018

Crystal Peak Minerals Inc. (CPM) proposes to construct and operate the Sevier Playa Potash Project, which would be designed to produce approximately 372,000 tons per year of sulfate of potash (SOP), as well as other associated minerals from salts present in the brines of the Sevier Playa. The proposed action is made up of two primary components.

I. Mining Project: Facilities that would be constructed and activities that would take place as part of full commercial development of the potash resource on leases owned or controlled by CPM
II. Rights-of-Way (ROWs): Facilities that would be constructed and activities that would take place outside of leases owned or controlled by CPM on Bureau of Land Management (BLM) administered land on ROWs issued by the BLM to support full development of the potash resource

The purpose of this document is to provide an overall Project summary. Through the Feasibility Study (FS) efforts in 2016 and 2017, CPM updated the Mining Plan design originally presented in CPM's Prefeasibility Study (PFS). Similar to the PFS Mining Plan, the updated, proposed FS mining method (for production of SOP and associated minerals) would consist of collecting naturally occurring brine from the Sevier Playa and diverting the brine into a series of solar evaporation preconcentration and production ponds. The ponds would be constructed on the surface of the playa. Potash salts would be precipitated in production ponds where the salts would be harvested using mobile equipment. The harvested salts would be sent to the Processing Facility for beneficiation and production of SOP with the addition of muriate of potash (MOP) to the process.

I. Mining Project

In general, the mine design consists of the following three major components: 1) a brine extraction system consisting of canals, trenches, and wells; 2) a recharge system consisting of canals and trenches; and 3) a series of evaporation ponds. The proposed layout of the Project facilities is shown in **Figure 1**. Detailed Mining Project descriptions are available in the *Mining Plan for the Sevier Playa Potash Project* (CPM 2018a) and the *Plan of Development for Off-Lease Facilities for the Sevier Playa Potash Project* (CPM 2018b). The individual components of the Mining Project are summarized below.

Brine Extraction System

Extraction would focus on two shallow brine-bearing horizons of the playa: the Marl Clay Zone (MCZ) and the Siliceous Clay Zone (SCZ). The MCZ is a marl with high carbonate content, which generally consists of agglomerated clay particles held by weak bonds that have a silt-sized texture if undisturbed. The MCZ extends from the surface to approximately 20 to 40 feet below ground surface.

The SCZ consists of a clay aquifer with layers of clayey silts, sands, and gravels. While the SCZ clay zones have low permeability, the main permeable zones are the silts, sands, and gravels layers or lenses. The bottom of the SCZ extends to an average depth of approximately 70 feet. The combined MCZ and SCZ horizons vary from 40 to 100 feet deep and are limited at the base by another low-permeability, stiff clay horizon exhibiting relatively low moisture content.

Brine from the MCZ would be collected via extraction trenches that allow for gravity drainage of the brine to the trenches. Approximately 306 miles of extraction trenches would be excavated throughout the playa generally running east to west across the playa (north to south in some areas). These trenches drain into the extraction canal, which is pumped into the preconcentration ponds. In accordance with federal regulations, extraction trenches would not be constructed within 500 feet of the lease boundary. Extraction trenches would be spaced throughout the playa from 900 feet to 4,900 feet apart with recharge trenches midway between them. Extraction trenches would be approximately 20 feet deep (See Typical Extraction Trench and Canal in **Figure 2**). The side walls of the trenches would be vertical and would be separated by benches with a top width of 32 feet and a bottom width of 8 feet. Spoils from the extraction trenches would be placed on the playa surface at a minimum of 10 feet from the edge of the trench and would be approximately 10 feet in height and 38 feet in width at the base. No imported materials are planned for use in or near the extraction trenches. The extraction trenches would be backfilled using materials in the adjacent spoils piles during the decommissioning phase of the Project.

Extraction wells with pumps would be used to extract brine from the lower portions of the MCZ and the SCZ. These wells would be equipped with piping that would drain extracted brine into the nearest extraction trench. The extraction wells north of the preconcentration ponds would be connected via a manifold piping system, which would pipe extracted brine to the extraction canal. Extraction wells would be drilled throughout the playa in rows approximately 400 feet to 2,600 feet apart and at an approximate distance of between 130 and 1,300 feet from the extraction trenches. A typical drawing of the layout of the extraction wells and piping in relation to the extraction and recharge trenches is shown in **Figure 3**. Over the life of the Project, 2,366 6-inch-diameter wells would be required to provide adequate brine flow to the preconcentration ponds. The average depth of wells would be approximately 77 feet, but well depths may vary from 50 to 100 feet based on the depth of the brine resource. A typical drawing of an extraction well, conveyance piping, and associated features is shown in **Figure 4**. Power would be supplied to the extraction wells from solar panels. Each extraction well would be equipped with a solar system (panels, batteries, and wiring) sufficient to operate the pump at the necessary capacity. A typical solar system connection to an extraction well is shown in **Figure 5**.

Brine from the extraction trenches would be discharged into a main north–south extraction canal, approximately 26 miles long, in the middle of the playa, which would convey the brine by gravity flow to a pump lift station at the north end of the preconcentration ponds located on the north end of the playa.

The extraction system would be constructed in phases throughout the life of the Project as necessary to meet production requirements. Approximately half of the extraction trenches and most of the extraction canal would be constructed during initial Project construction (first 3 to 4 years). The remaining extraction trenches and the complete extraction canal would be constructed throughout the life of the Project when needed. A construction schedule showing the initial construction (approximately the first 3 to 4 years), operation and maintenance (that occur throughout the life of the Project), and production is included in **Table 1**.

Recharge System

Hydraulic head would be required to maintain a reasonable extraction rate because brine seeps very slowly through the low-permeability playa sediments. Recharge of the brine aquifer would be necessary to ensure that enough fluid is available over the life of the Project to maintain target extraction rates and to extract most of the resource. Recharge would help drive the brine into the extraction trenches by maintaining hydraulic head in the playa sediments.

Recharge water for the brine aquifer would come from infiltration of precipitation and water from the Sevier River that flows onto the playa. The Project is designed to extract brine at a rate of 48,339 acre-feet per year (ac-ft/yr) (29,946 gallons per minute). Extracted brine would need to be replaced at a 1:1 ratio by recharge water; therefore, 48,339 ac-ft/yr is also the required volume of recharge water needed to be delivered to the Sevier Playa. After accounting for anticipated transmission losses, it is anticipated that CPM would need to lease or purchase and convey an average volume of 50,234 ac-ft/yr from upstream sources.

The Sevier Playa area has no perennial streams, and water that collects on the playa comes from precipitation, runoff, and the Sevier River. To manage and control recharge of the brine aquifer, flows from the Sevier River would be diverted into a new (constructed) canal near the location where the river enters the Sevier Playa. The intent of this diversion is not to impound water within the Sevier River floodplain but to redirect river water into the diversion canal and the recharge system. The diversion canal would be constructed to mimic the overall natural gradient of the existing river channel with the purpose of retaining natural flow rates and maximizing the amount of water available for the recharge system.

The diversion canal would empty into a diversion sump. The sump would be excavated into natural materials using on-site materials. Headgates would be used to allow water to be discharged into either the west or east recharge canal or both simultaneously.

The recharge canal would be constructed around the outside perimeter of the playa, approximately 69 miles, to provide water to the recharge trenches. The recharge canal would follow the western and eastern edges of the playa. The canal would be constructed from north to south along both edges. In addition to conveying water from the Sevier River, the recharge canal would also capture any runoff entering the playa from the surrounding landscape. Because of the topography on the south end of the playa, lift stations would be required in order to pump water into the southern portions of the playa. Both the east and west recharge canals would require pump lift stations: two stations at the west recharge canal and four stations at the east recharge canal. Diesel generators would be used to power lift station pumps until a solar system (panels, batteries, and wiring) is installed at each pump.

Figure 2 includes a typical configuration for the upper recharge canal and a typical configuration for the lower recharge canal. The upper recharge canal would be constructed on the north end of the playa. As construction of the recharge canal advances toward the south end of the playa, topography would require construction per the typical lower recharge canal configuration.

Most recharge trenches would be fed from recharge collectors (indicated as turquoise lines in **Figure 6**), which would branch off the east and west recharge canals. Recharge collectors essentially convey recharge water to the recharge trench, but they have a different configuration (shown on **Figure 2**) that requires less material to be excavated. No imported materials are planned for use in or near the recharge collectors.

The recharge trench system would introduce water into the MCZ to maintain continuous brine extraction over time. The recharge trenches would be located throughout the playa, midway between the extraction trenches totaling approximately 276 miles. Recharge trenches would be approximately 12 feet deep (See Typical Recharge Trench in **Figure 2**). Spoils from the recharge trenches would be placed on the playa surface a minimum of 8 feet from the edge of the trench and would be approximately 7 feet in height and 28 feet in width at the base. No imported materials are planned for use in or near the recharge trenches.

The recharge system would be constructed in phases throughout the life of the Project as necessary to meet production requirements. Approximately half of the recharge trenches and collectors and most of the recharge canal would be constructed during initial Project construction (approximately the first 3 to 4 years). The remaining recharge trenches and collectors and the remainder of the recharge canals would be constructed when needed. A construction schedule showing the initial construction (approximately the first 3 to 4 years), operation and maintenance (that occurs throughout the life of the Project), and production is included in **Table 1**.

Brine Mining Units

Based on the output from the modeling efforts completed for the FS, it became apparent that a continuum of trench and well development was required over the life of the Project to support recovery. To better understand the operation of the extraction and recharge trenches, the playa area has been divided into mining units called Brine Mining Units (BMU). Each BMU consists of portions of the extraction and recharge systems, including extraction trenches, recharge trenches, and recharge collectors, which were combined into select BMUs. FS groundwater modeling determined the order of

BMU construction to meet production targets given the variances in permeability of resource zones across the playa. The BMUs would be operated in series and would be oriented parallel to ensure that adequate brine volume and concentration are supplied to the preconcentration ponds. There are 21 BMUs; BMU1 to BMU11 and BMU13 to BMU22. The BMUs that would be constructed during initial construction are BMU1 to BMU5, BMU9, and BMU14 to BMU22.

After initial construction, additional BMUs would be constructed, as necessary, throughout the life of the Project. **Figure 7** shows the general construction timing of each BMU, which includes a typical BMU construction time frame of 2 years. Some BMUs would take longer than 2 years to construct; this is not indicated in **Figure 7**. As the BMUs cycle through the production process, individual BMUs would be turned on or off as shown in Table 1 to provide brine flow that meets flow and grade requirements.

Perimeter Road and On-Playa Transportation

The Perimeter Road would extend around the playa boundary for a total distance of approximately 74 miles, as shown in **Figure 6**. The road would typically be located on the periphery of the recharge canals. Portions of the Perimeter Road would be routed outside of the lease boundaries and would require a BLM and SITLA ROWs.

The Perimeter Road would be constructed of materials adjacent to the road alignment. Select portions of the Perimeter Road may require off-site aggregate materials (gravel). The portion of the Perimeter Road utilized by haul trucks would also include the use of off-site materials. Culverts would be placed where required to convey drainage from local runoff into the recharge canal. Culvert locations would be provided in the as-built drawings provided as part of the Mining Plan (2018a). The Perimeter Road turnouts would be constructed approximately one every mile. **Figure 8** includes a cross section of Perimeter Road.

Access to the playa from Perimeter Road would require crossing the recharge canal. These crossings would occur as necessary and would include either two parallel corrugated metal pipes or a concrete box culvert depending on the flow in the canal. This information would be provided in the as-built drawings provided to the BLM.

The ability to travel on the Playa varies seasonally depending on the amount of moisture on the saltpan. The margins of the Playa can support pickup trucks in places, but due to their weight their use on the playa is risky increasing the likelihood of becoming mired in the relatively soft playa sediments. All-terrain vehicles, including snow cats or similar low ground bearing pressure equipment, would transport personnel where necessary across the playa to access project components. The Project anticipates that all travel on the playa, off the Perimeter Road and other designated roads, would be overland. Canal and trench crossings would be placed, as necessary, throughout the playa using either corrugated metal piping or concrete box culverts, depending on the specific crossing conditions and the trench/canal flow rate.

Two parallel Haul Roads would be constructed from the Processing Facility to the Perimeter Road. Salts harvested from the production ponds would be transported to the Processing Facility using Haul Roads constructed on the pond berms, to a Haul Road Spur road that connects to Perimeter Road, and the Processing Facility Haul Roads. Filter cake tailings generated from the Processing Facility would be transported as a filtered solid from the Processing Facility to the Tailings Storage Area using the Processing Facility Haul Roads, Perimeter Road, a Haul Road Spur road off Perimeter Road that connects to the berms of the Tailings Storage Area.

Evaporation Ponds

Two sets of evaporation ponds would be constructed: 1) preconcentration ponds near the north end of the playa and 2) production ponds at the south end of the playa. Additional details on these two sets of ponds are provided in the remainder of this section.

Preconcentration Ponds

Preconcentration ponds would be constructed near the north end of the playa (**Figure 9**) to allow for the progressive concentration of extracted brine to near saturation with respect to sulfate salts. The total pond area of the ponds is 17,563 acres which represents the evaporative area of the ponds, not the footprint acreage of the ponds with the berms.

Brine collected from the extraction system would gravity flow through the extraction canal to a lift station to be pumped through pipelines into Preconcentration Pond 1 (P-1). Ten preconcentration ponds (P-1 through P-10) would be actively used for evaporation. Pond-to-pond brine transfer would be achieved by using pumps or weirs depending on the pond. During this process, the preconcentration ponds would bring potassium up to its saturation concentration in the brine but would not allow potassium to precipitate in the preconcentration ponds. Preconcentration ponds would also reduce the amount of gangue minerals (commercially valueless material) precipitated in the production ponds by having them precipitate in the preconcentration ponds.

Initially, each of the preconcentration pond berms would be constructed to accommodate a shallow (1.6 feet) brine layer, the salts that would precipitate over the first 5 years of the Project, and an additional 3.3 feet of freeboard between the brine and the top of the berms. Each of the preconcentration pond berms would range in height from 6 to 9 feet at initial construction, depending on the topography of the playa and the requirements of the individual ponds. The berms would be 18 feet wide at the top and have a bottom width of 72 feet, again depending on the topography of the playa and the requirements of the individual ponds. Material to construct the initial berms would be sourced from inside the footprint of the ponds.

In subsequent years, berm lifts would be constructed to approximate the annual deposition of halite and other salts. Clay material from the playa, adjacent to the preconcentration ponds referred to as borrow areas would be used to construct the berm lifts.

Recovering all the brine entrained in the preconcentration pond is subject to many operational and technical difficulties. This is particularly true for Ponds P-1 through P-4. Because of their size, these ponds contain large amounts of heel brine volume, also referred to as entrained brine. The heel brine is the volume of brine constituted by the supernatant brine (above the deposited salt layer). Therefore, draining and filling these ponds are challenging operations. In addition, the amount of SOP equivalent lost in P-1 through P-4 is small given the size of these ponds.

Ponds P-5 through P-10 are considerably smaller and, for this reason, have a more manageable heel brine volume when compared to P-1 through P-4. Additionally, these ponds contain considerably more entrained equivalent SOP per area, since they contain more concentrated brines. It is assumed that about 40% of the entrained brine in these ponds can be recovered, based on the operation of similar ponds at regional operations. To complete the heel brine recovery process, Ponds P-5 through P-10 would be drained one pond at a time. A mobile pump would be placed on the berm of a pond to transfer brine into a non-evaporative pond referred to as the Heel Brine Pond. The salts within that pond being drained would be windrowed using bulldozers and graders to allow the entrained brine within the salts to be recovered. The windrowed salts would then be pushed to the side and contained within the confines of the pond berms for the life of the Project. The heel brine that was pumped into the Heel Brine Pond would then be pumped back into the windrowed pond and combined with the brine recovered from the windrowed salts. Run on a 3-year cycle, this procedure would only occur during the winter period and would start 3 years after startup of the preconcentration ponds.

A pump station located in Pond P-10 would pump preconcentrated brine into the brine transfer canal to be conveyed to the production ponds. Mobile diesel generators would provide power to preconcentration pond pumps until the North Playa Substation and 25-kilovolt (kV) Power Line are completed and connected to each pump.

The brine transfer canal would be located adjacent to the Perimeter Road on the east side of the playa from the preconcentration ponds to the production ponds. Because of the topography on the south end of the playa, five lift stations are required to pump the preconcentrated brine to the production ponds. Mobile diesel generators would be used to power these pumps until long-term power is constructed. At four of the pumps, long-term power would consist of a solar system (panels, batteries, and wiring) installed at each pump. The pump closest to the production pond would be connected to the 12.47-kV Power Line. Where the canal reaches the toe of the production pond embankment, the flow is lifted again via pump and conveyed by a 14-inch-diameter brine transfer pipeline, approximately 5.5 miles along the production pond berm and into a Brine Mixing Sump located within the production ponds.

Production Ponds

The production ponds would be located at the south end of the playa to minimize haul distance to the Processing Facility. The production ponds would continue the evaporation process, increase potash salt saturation in the brine, and subsequently allow collection of potash salts for transport to the Processing Facility. The design specifications for the production ponds would be the same as those for the preconcentration ponds except the production ponds would be smaller and would not require subsequent berm lifts. The berms for the production ponds would be shorter than the preconcentration ponds, ranging from 6 to 9 feet, which would provide 1.6 feet of freeboard. The total area of the production ponds is about 2,539 acres which represents the evaporative area of the ponds and not the actual footprint of the ponds with the berms.

The production ponds would be set up as four parallel ponds, each divided into four cells for a total of 16 cells, as shown in Figure 10. Preconcentrated brine transferred from the preconcentration ponds would be mixed in the Brine Mixing Sump with process recycle brine from the Processing Facility and then pumped into the brine feed canal where it flows via weirs in the first production ponds (H1). The brine would transfer between the four parallel production ponds (**Figures 10 and 11**) through weirs, ending at pond H4. Each pond, H1 through H4, would collect a salt compound. One production pond train, consisting of four cells (for example, H1-A, H2-A, H3-A and H4-A) would be drained at a time and all four cells would be harvested simultaneously. Dividing the production ponds into parallel trains provides operational flexibility by allowing flow to be shut off in one pond train while the precipitated potassium minerals are removed for processing. All precipitate from these ponds would be harvested and transported to the Processing Facility. Precipitated salts would be harvested and would not accumulate within the ponds; therefore, the production pond berms would not require berm raises. The residual bitterns or purge brine would be pumped to the purge brine storage pond, discussed below. Mobile, diesel generators would provide power to production pond pumps until the Processing Facility Substation and 12.47-kV Power Line are completed and connected to each pump.

The preconcentration ponds and the production ponds would be constructed during initial Project construction (approximately the first 3 to 4 years).

Processing Facility

The Processing Facility would be located at the south end of the playa on a parcel leased from the state of Utah School and Institutional Trust Lands Administration (SITLA) by CPM for mineral development. The Processing Facility (**Figure 12**) would include three main processing buildings: a wet plant, a dry plant, and a compaction and bagging plant. There would be other support buildings and support areas/facilities within the Processing Facility. This includes a propane storage tank, a 634,000-gallon freshwater tank (40 feet wide × 32 feet high) of which 330,000 gallons are dedicated to firewater, a bulk fuel storage tank, and a warehouse. A single-level administration building with adjoining employee parking would provide office space. The Processing Facility communication tower would be connected to the administration building and would support telephone and data communication during construction of the Project. Water for processing and other uses would be supplied by the freshwater wells and pipeline.

Propane gas would be used for the drying units at the Processing Facility and to provide heat at the Processing Facility and Rail Loadout Facility until construction of the Natural Gas Pipeline is complete. Project gas consumption is estimated at approximately 2,730 gallons per day of propane. The primary components of the propane supply and storage system would be as follows:

- A 60,000-gallon aboveground propane gas storage tank located within the perimeter security fence at the Processing Facility. The capacity of this tank would be sufficient to supply a minimum 2-week period during the higher-usage winter months.
- An approximately 0.25-mile, 8-inch-diameter buried propane gas pipeline connecting the propane gas storage tank to the wet plant building at the Processing Facility.
- A 500-gallon aboveground propane storage tank located within the perimeter security fence at the Rail Loadout Facility.

Propane would be transported by truck to the Processing Facility and Rail Loadout Facility, using either a highway transport truck or a smaller bulk delivery truck. Approximately eight shipments of propane per month would be required to meet Project requirements. Propane shipments would occur during daylight hours on weekdays only from a local gas supply company. Trucks would travel either south from Delta on State Route (SR) 257 or north from Beaver or Milford on SR 21 and/or SR 257 to Crystal Peak Road. From Crystal Peak Road, the trucks would access the Rail Loadout Facility directly or would continue down the Rail Spur Road to the Processing Facility. No road improvements or additional ROWs would be required for propane storage, use, or delivery.

CPM would construct an 8-inch-diameter pipeline to replace propane with natural gas. Once the natural gas pipeline is operational, CPM would discontinue the use of propane gas at both the Processing Facility and Rail Loadout Facility.

Collectively, the three main processing buildings, support buildings, and other support facilities/areas would occupy an area up to approximately 50 acres. The tallest structures at the Processing Facility would be the main processing buildings and product loadout silos, which would not exceed a maximum height of 100 feet. The Processing Facility would be fenced (using non-reflective materials) to provide security and protect public safety. A security guard house and gate would be located at the entrance to the Processing Facility.

Potash salts that accumulate in the production ponds would be harvested year-round. One production pond train (four cells) would be drained at a time, and the cells would be harvested simultaneously. The harvested salts would be trucked to the Processing Facility. Road graders would be used to windrow the potash salts for pickup and delivery to the crude salt unloading area, located at the Processing Facility, using a loader and haul trucks. The purge brine would be pumped from the production ponds to the purge brine storage ponds via the purge brine pipeline.

Once the raw potash salts enter the Processing Facility, they would be subjected to a series of processes designed to separate and produce SOP, as outlined below. The Processing Facility would use or produce the following chemicals, which would be stored in the Processing Facility:

- Flotation collector: Flotigam 8122 - Amine collector
- Flotation extender: Kerosene flotation frother - methyl isobutyl carbinol
- Anti-dusting agent: mineral oil, equivalent to RHT22-85 supplied by the Commercial Oil Company
- Potable water decontamination: Sodium hypochlorite

A schematic diagram of the processing system is shown in **Figure 13** and is detailed below.

- Process Feed: The raw salts from the ponds would be deposited into a hopper-feeder which would convey salts into a crusher where salts are reduced in size for conversion.
- Conversion Reactor: The crushed salts would be fed directly, without a slurrying step, to the conversion circuit. A high-sulfate brine from the halite leach step would cause the mixed potassium pond salts to form schoenite. Along with schoenite, halite and magnesium sulfate are expected to be present.
- Conditioning and Flotation: Insolubles, such as gypsum, clays, and silicates originating from lake mud and natural-occurring windblown dust, would be removed and conveyed to the Tailings Storage Facility. These insolubles are known as filter cake tailings. Schoenite would be separated from other salts and slimes. Flotation reagents and oils would be added to the potash salt slurry. Concentrates from the flotation circuit would be conveyed to a solid-liquid separation step to be separated into a substantially brine-free cake, which would be conveyed to the halite leach step.
- Tailings leach: To ensure no schoenite is lost to tailings, the tailing slurry would be pumped to two leach tanks where its mixed with playa brine. After leaching the process recycle brine is sent back to the production ponds while the remaining halite and epsomite would be sent to the Tailing Storage Area.
- SOP crystallization: Schoenite would be converted to SOP. Water and muriate of potash (MOP) would be added to the schoenite crystals to dissolve the magnesium sulfate and produce SOP. The SOP crystals would be recovered from the brine by a combination of cyclones and centrifuges to concentrate the solids and recover them from the thickened slurry. Potassium chloride reacts with the magnesium sulfate in solution to form additional SOP and magnesium chloride.
- Product drying, handling and shipping: The SOP exiting the crystallization circuit would be dried and screened to produce the desired products. The dryer off-gas would be processed through a dust cyclone and scrubber unit. Some of the fines would be collected as dry solids and added to the product. The dried product would be cooled and sent to product sizing and storage through a series of conveyors. The fertilizer-grade SOP would be produced as standard, soluble, and granular grades. The sizing area would separate the SOP into oversize product, coarse product,

fine product, and fines. The oversize product would be sent to an impact crusher. The fines would be conveyed to a compactor to be converted into larger particles. Compacted fines and the oversize product would pass through a cage mill to reduce it to an acceptable product size before being returned to the three-deck vibrating screen. The coarse and fine products would be sent to product storage silos by a combination of bucket elevators and screw conveyors. The solids in the silos would be loaded into trucks for direct delivery or for transport to the Rail Loadout Facility (discussed further below). When needed, some of the oversize material would be crushed into soluble SOP and sent to the bagging plant.

Addition of Muriate of Potash

The FS process of natural SOP also produces an excess of residual brine containing magnesium sulfate. To capitalize on the excess magnesium sulfate, the process design includes reacting magnesium sulfate with imported MOP. The chemical reaction is governed by the following equation: $MgSO_4 + 2KCl \rightarrow MgCl_2 + K_2SO_4$

The addition of the reactive SOP to natural SOP provides a production rate of 372,000 short tons of SOP per year.

MOP would be added to the crystallizer vessel directly in the form of MOP brine. MOP delivered to the Processing Facility would be dissolved in a heated process water tank. MOP would be delivered to the Rail Loadout Facility and stored in the train cars it is delivered in until it is needed at the Processing Facility.

Waste Product Storage Area

Two types of waste products would be created from the Mining Project: 1) purge brine from the production ponds, and 2) filter cake tailings produced from the Processing Facility. **Figures 6 and 7** show the configuration of the waste product storage area at its projected, full footprint.

Purge Brine Storage Ponds

Purge brine from the final production ponds would flow via weirs into the purge brine canal where it would be pumped to the purge brine storage ponds located on the playa, west of the production ponds. These waste products would generally contain salts and other materials with no current commercial value. The purge brine stream is anticipated to contain high concentrations of dissolved magnesium chloride and low levels of potassium. Purge brine would be used as a dust suppressant, on roads and other on-playa, disturbed areas because of its high concentration of magnesium chloride. Purge brine may be used off playa pending CPM testing and approval by the BLM.

Purge brine production is estimated at 466.2 ac-ft/yr. As noted above, some of the purge brine will be used for dust suppression; however, most would be sent to the Purge Brine Storage Pond. The purge brine would be pumped approximately 3.7 miles through an 8-inch-diameter pipeline from the final production pond to the Purge Brine Storage Pond. As the height of purge brine rises to fill the storage ponds as the operational years proceed, the storage pond berms would be lifted. Material used to construct the initial berms would be sourced the interior of the ponds. Material for subsequent berm lifts would be sourced adjacent to the ponds from the borrow area. The Purge Brine Storage Pond design incorporates a 5-foot-minimum freeboard during all stages of operation. The final footprint of the Purge Brine Storage Pond is 746 acres.

Tailings Storage Area

Filter cake tailings would contain halite, epsomite, and schoenite, as well as other impurities. Filter cake tailings would be trucked as a filtered solids material from the Processing Facility flotation circuit to the Tailings Storage Area. This material is anticipated to contain 20% moisture as delivered to the storage area.

The initial construction of the Tailings Storage Area would provide 2 years of storage. Subsequent pond expansions have been designed throughout the life of the Project to provide necessary storage capacity. The pond would have an initial berm height of 5 feet constructed with playa materials sourced within the footprint of the area. As water continues to evaporate and the tailings material dries, the berms, made up of compacted tailings would be raised to approximately 17 feet.

The final footprint area of the Tailings Storage Facility is approximately 450 acres.

Fuel Storage

A bulk fuel-storage site would be located within the perimeter security fence at the Processing Facility. The fueling station would service light-duty vehicles and would also be used to fill 1,500-gallon or smaller mobile tanks mounted on trucks, which would transport fuel to heavy equipment and generators that would be refueled in place during construction and operation activities. The fueling station would consist of two petroleum fuel tanks, 25,000 gallons each, located within secondary containment near the truck shop. Delivery of fuel would likely be contracted with a local supplier. The *Spill Prevention, Control and Countermeasures Plan* (CPM 2018c) for the Project would ensure protection of surface water and groundwater resources, prevent spills of petroleum products, and identify response procedures.

II. Rights-of-Way

To support development of the Mining Project, utilities and infrastructure would be required on BLM-administered lands outside of the potash lease boundary (off-lease lands). **Figure 14** shows the Project facilities that would be located off-lease, the Mining Project BLM and SITLA lease areas, and existing and planned access roads that would be used for Mining Project construction and operation and maintenance. Off-lease Project facilities and supporting components are provided in the following sections.

Power and Communication Lines

Power for the Project would be needed at the Processing Facility, Rail Loadout Facility, water supply wells, and pumps at the preconcentration and production ponds. Communication lines would be needed at the Processing Facility and Rail Loadout Facility. The principal components of the power and communication line infrastructure would consist of the following:

- 69-kV Power and Communication Line
- Power Line Access Road
- Overland power access routes
- North Playa Substation
- 25-kV Power Line (provides power to preconcentration pond pumps)
- 25-kV Power Line Access Road
- Processing Facility Substation
- 12.47-kV Power and Communication Line (provides power and communication for Processing Facility and Rail Loadout Facility)
- Rail Loadout Facility Substation
- 12.47-kV Power Line (provides power to production pond pumps)

The 69-kV Power and Communication Line alignment is 43.3 miles. **Figure 15** shows the planned locations of the 25-kV, 12.47-kV, and 69-kV Power and Communication Lines.

Communication Towers

Communication tower facilities would consist of the following:

- Long Ridge Communication Tower
- Long Ridge Access Road
- Black Rock Communication Tower
- Black Rock Substation Access Road
- Processing Facility communication tower/microwave station

Propane and Natural Gas Supply

CPM would truck propane gas from a local supplier to storage tanks at the Processing Facility and Rail Loadout Facility. Following construction of the Natural Gas Pipeline, CPM would discontinue the use of propane gas and switch the operational fuel source to natural gas. The propane and natural gas fuel supply components are described below.

Propane Supply

- An aboveground propane gas storage tank located at the Processing Facility
- A buried propane gas pipeline connecting the propane storage tank to the concentrator building at the Processing Facility
- An aboveground propane storage tank located at the Rail Loadout Facility

Natural Gas Pipeline

- Natural Gas Pipeline
- Natural Gas Pipeline Spur
- Natural Gas Pipeline Access Roads 1A, 1B, 2, 3, 4, 5A, 5B, 6, 7, and 8
- Valve connection at the Processing Facility

Existing dirt track roads (Natural Gas Pipeline Access Roads 1A, 1B, 2, 3, 4, 5A, 5B, 6, 7, and 8) would provide construction, maintenance, and decommissioning access to the Natural Gas Pipeline. Natural Gas Pipeline Access Road 4 is a county-maintained Class B road. Improvements to all other roads would be done as necessary.

Rail Facilities

The principal components of the rail facilities would consist of the following:

- Rail Loadout Facility, including product storage, two refueling stations, a propane tank and pipeline, a water storage tank, train loadout, and truck loadout
- Yard tracks
- Rail Spur
- Rail Spur Access Corridor
- Rail Loadout Facility Access Roads 1 and 2

Figure 16 shows the layout of the Rail Loadout Facility. The Rail Loadout Facility footprint covers 110.0 acres. Each refueling station would include one 6,000-gallon diesel fuel tank located within secondary containment. The propane tank would be 500 gallons, and the water storage tank would be 500,000 gallons (32 feet wide × 36 feet high).

MOP would be delivered and staged on a dedicated spur line while waiting for unloading at the Rail Loadout Facility. MOP would then be transferred to the Processing Facility using the same trucks and trailers used for SOP delivery. This would result in no increase for mobile fleet traffic between the Rail Loadout Facility and Processing Facility. SOP and MOP hauling to and from the Rail Loadout Facility would be done with two-trailer tandem dump trucks. SOP and MOP would be unloaded from the bottom of the trailers.

Water Supply Wells and Distribution

Water supply and distribution facilities would consist of the following:

- Water Supply Wells 1, 2, 3, and 4, west to east
- Water Supply Pipeline
- Water Supply Pipeline Spurs 1, 2, 3, and 4
- 12.47-kV Power Line Spurs 1, 2, 3, and 4
- Water Supply Well Access Roads 1, 2, 3, and 4 (Roads 1, 3, and 4 are existing two-track roads. Water Supply Well Access Road 2 is an existing class B road.)

Access Road Network

The principal components of the access road network would consist of the following:

- Existing Playa Access Road Segments A, B, C1 and C2, D1 and D2, E, F, and G
- Perimeter Road Segments 1 through 11
- Off-lease Perimeter Road Turnouts

These access roads are identified on **Figure 17**.

Preconcentration Ponds and Heel Brine Holding Pond

Between Perimeter Road Spurs 2 and 3, portions of Preconcentration Ponds P-3, P-4, and P-5 and portions of the Heel Brine Holding Pond would be located off-lease. A 1,986-acre ROW would be required for the portions of P-3, P-4, P-5, and the Heel Brine Holding Pond that are off-lease. This ROW would accommodate construction of berms both within the ponds and at the pond boundary, installation and operation of pumping stations, and brine movement.

Three pumps would be located off-lease: one between P-3 and P-4, one between P-4 and P-5, and one between P-5 and the Heel Brine Holding Pond. A diesel generator would be used to power these pumps until construction of the 25-kV Power Line is complete and electrical power is connected.

Brine Transfer Canal Segments

The brine transfer canal would follow the Perimeter Road alignment. The brine transfer canal allows conveyance of concentrated brine from the preconcentration ponds at the north end of the playa to the production ponds at the south. Portions of this canal (Brine Transfer Canal Segments 1 through 3, **Figure 18**) would be located off-lease.

Recharge Canal and Recharge Collectors

The recharge canal would follow the Perimeter Road alignment. The canal provides recharge water to each of the recharge trenches via recharge collectors. Portions of the canal (Recharge Canal Segments 1 through9, **Figure 18**) and some of the recharge collectors (Recharge Collectors A, B, and C, **Figure 18**) would be located off-lease.

Aggregate Materials

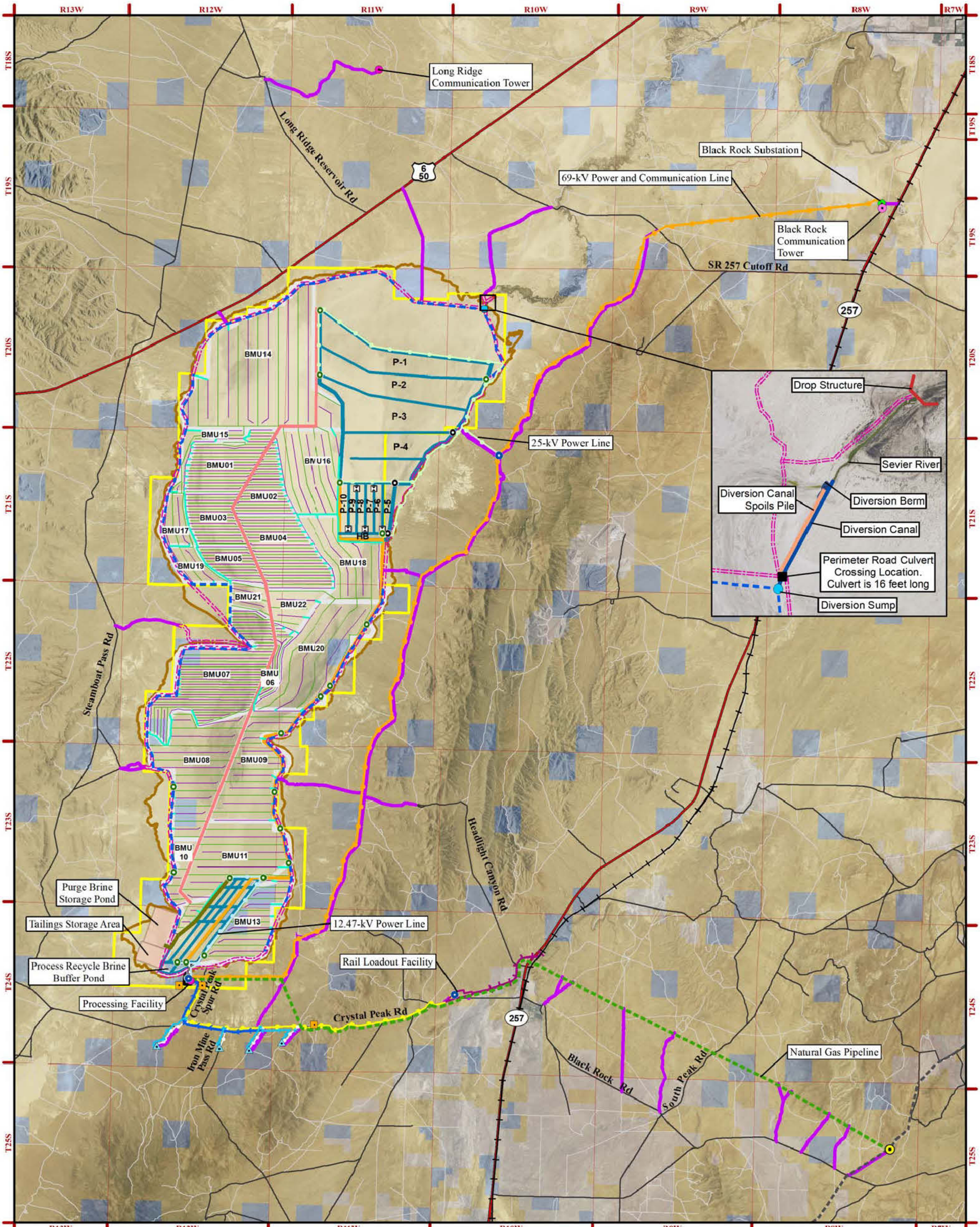
Aggregate materials would be needed for the construction of a variety of Project components, including haul roads constructed on the production pond berms and the Processing Facility. These aggregates would be provided by three proposed source areas: two on BLM-administered land and one on SITLA-managed land (**Figures 1 and 14)**. A mineral materials-negotiated sale as well as other necessary permits and approvals would be approved by the BLM and SITLA before construction and use.

References Cited

Crystal Peak Minerals Inc. (CPM). 2018a. *Mining Plan for the Sevier Playa Potash Project*. BLM Case File Number UTU-88387. Salt Lake City, Utah: Crystal Peak Minerals Inc. and Norwest Corporation.

———. 2018b. *Plan of Development for Off-Lease Facilities for the Sevier Playa Potash Project*. Prepared for the Bureau of Land Management.

———. 2018c. *Spill Prevention, Control, and Countermeasures Plan*. Salt Lake City, Utah: Crystal Peak Minerals Inc.



Proposed Project Features

- 69-kV Power and Communication Line
- 25-kV Power Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line
- 12.47-kV Power Line Spur
- Access Road - Off-Lease
- Perimeter Road and Spurs - On-Lease
- Rail Spur and Access Corridor
- Recharge Trench
- Extraction Trench
- Recharge Collector
- Recharge Canal
- Extraction Canal
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Preconcentration and Production Ponds
- Pump Station - Off-Lease
- Pump Station - On-Lease
- Gravel Pit
- Preconcentration Pond Weir
- Water Supply Pipeline
- Water Supply Pipeline Spur
- Water Supply Well
- Communication Tower
- Substation
- Sevier River Diversion
- Brine Mining Unit Boundary
- Natural Gas Pipeline

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- Kern River Natural Gas Pipeline
- Kern River Valve Station
- Black Rock Substation
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

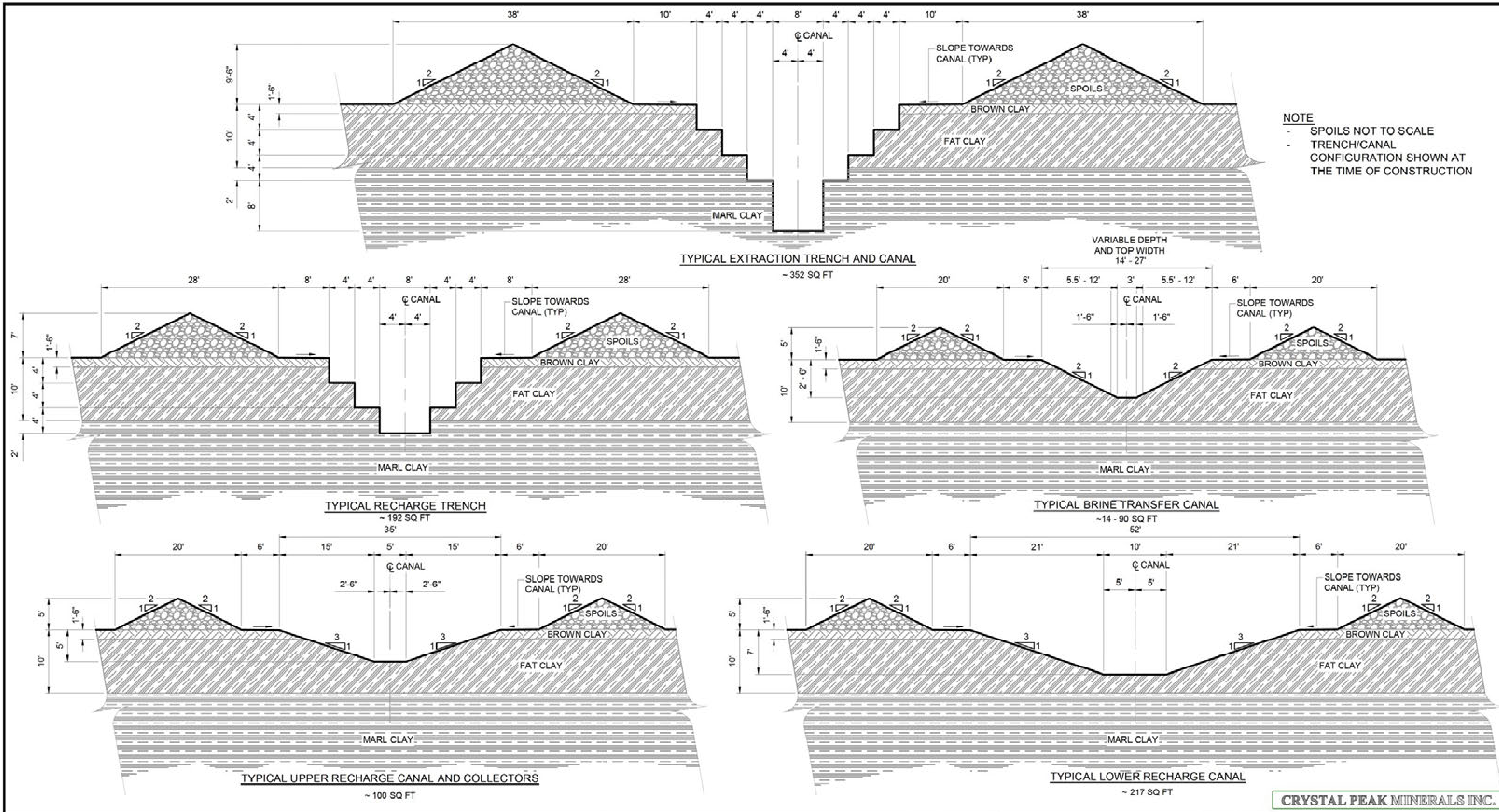
N 0 2 4 Miles
1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015-2018;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagy, USDA/APFO 2016

Note:
• The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

FIGURE 1
Project Facilities Overview
MINING PLAN SUMMARY
SEVIER PLAYA POTASH PROJECT

Source: POD Fig 1-4 - Project Facilities Overview 180214 2/16/2018 9:47:41 AM
CPM revised Figure No. and Doc. Title 3/7/18 by BU



15 0 15 30

FEET

NO.	DATE	REVISION	BY	APVD
1	01-05-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

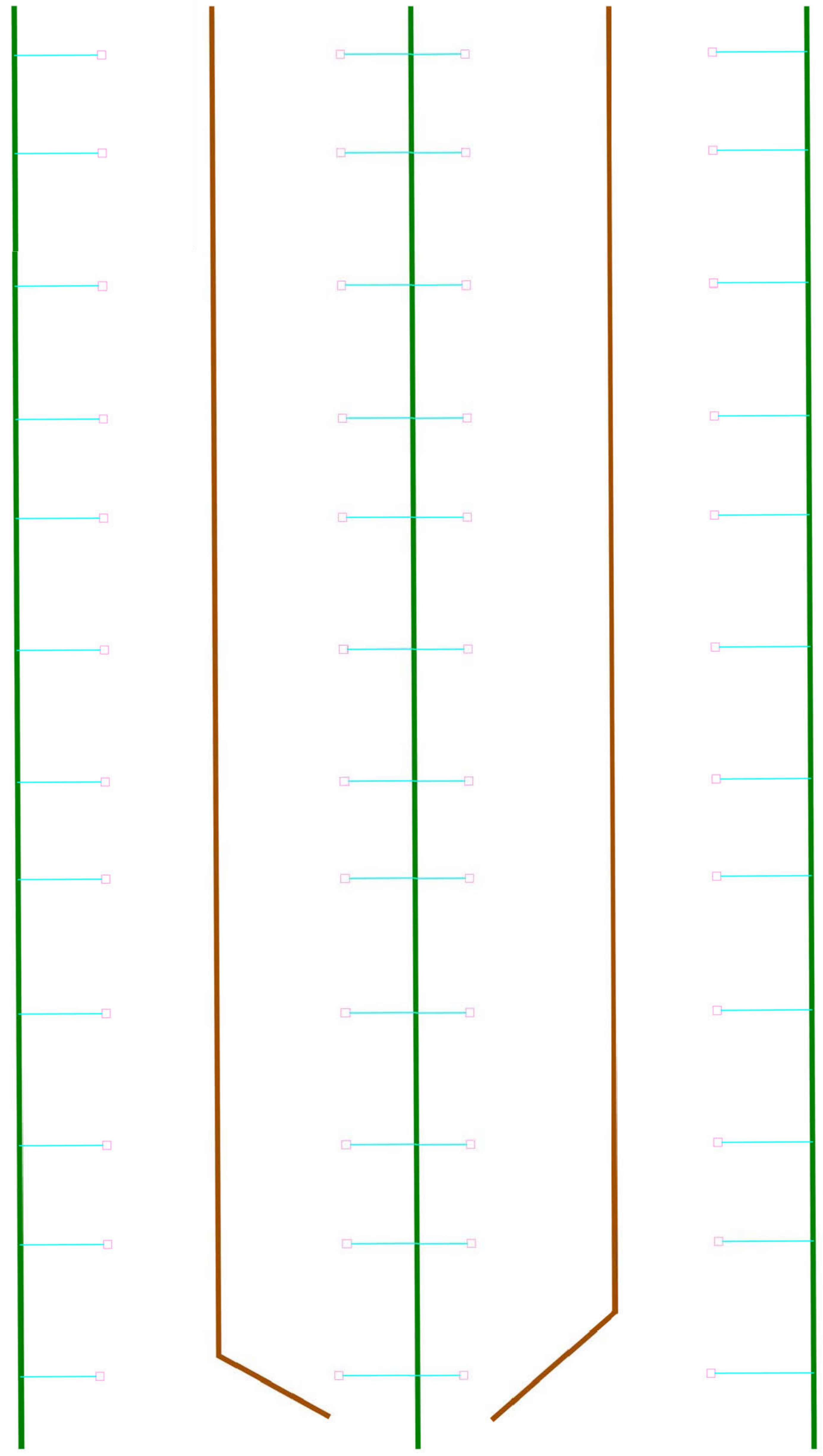
FIGURE 2

Sevier Playa Potash Project
Typical Constructed Extraction
Trench/Collector/Canal

DATE: 09/21/2017
FILE: Figure 6-3 Typical Trench-Collector-Canal Rev
SCALE: As Shown

NORWEST CORPORATION

CONFIDENTIAL



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CRYSTAL PEAK MINERALS INC.

LEGEND

- Extraction Trench
- Recharge Trench
- Extraction Well
- Piping

N

1200 0 600 1200 2400

FEET

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

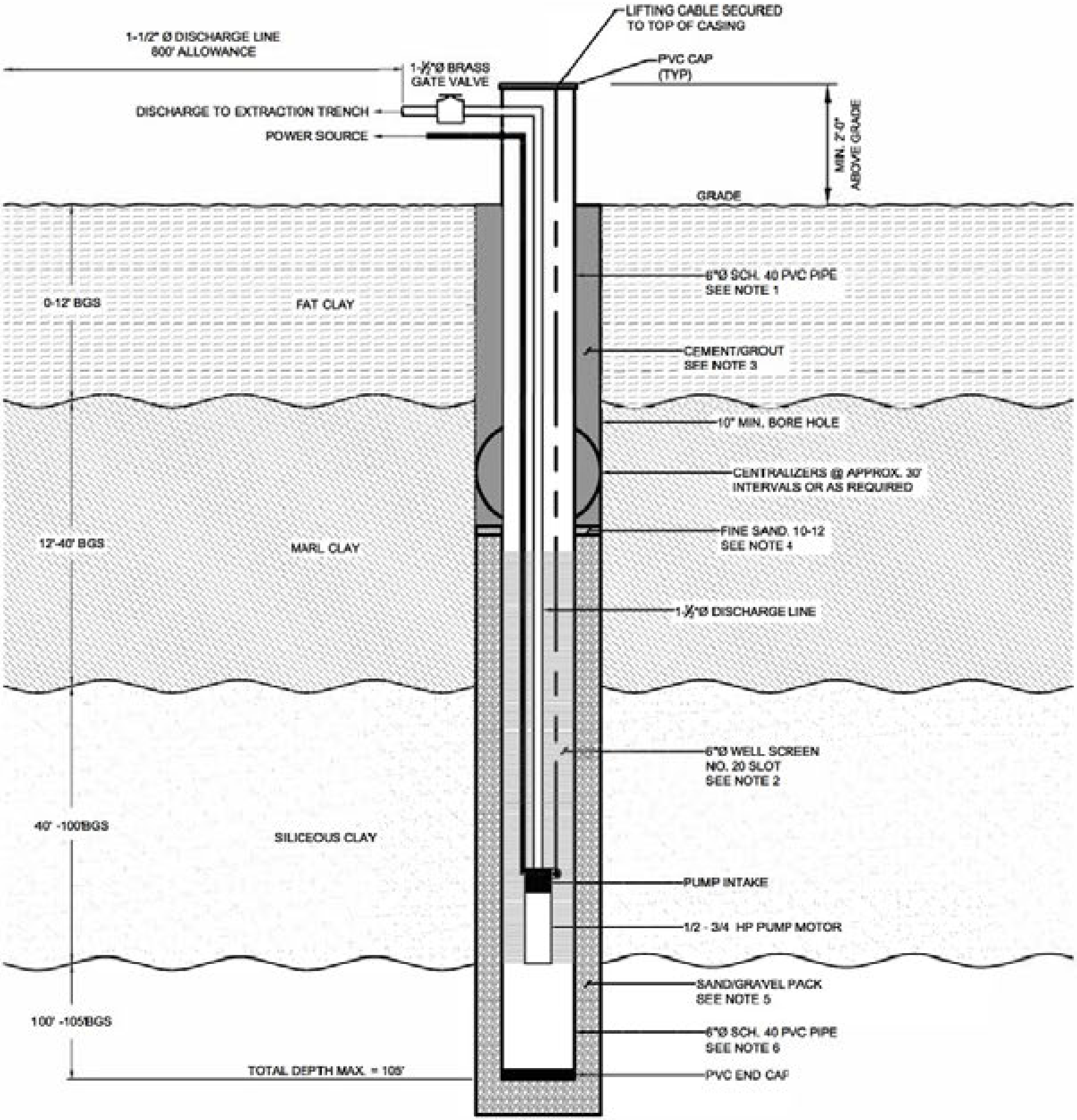
DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE 3

Sevier Playa Potash Project
Typical Trenches and Wells
Layout

DATE: 09/14/2017
FILE: Figure 6-4 Typical Trenches and Wells Layout
SCALE: As Shown

NORWEST CORPORATION



EXTRACTION WELL TYPICAL SECTION

WELL TOTAL DEPTH VARIES BY LOCATION
MINIMUM DEPTH = 61 FEET
MAXIMUM DEPTH = 111 FEET
AVERAGE DEPTH = 77 FEET

ABBREVIATIONS:

AGS - ABOVE GRADE SURFACE
BGS - BELOW GRADE SURFACE
TD - TOTAL DEPTH

NOTES:

1) 2' AGS TO 33' BGS
2) 33' BGS TO TD
3) GRADE TO 30' BGS
4) 30' BGS TO 31' BGS
5) 31' BGS TO 100' BGS
6) 100' BGS TO 105' BGS

CRYSTAL PEAK MINERALS INC.

N

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

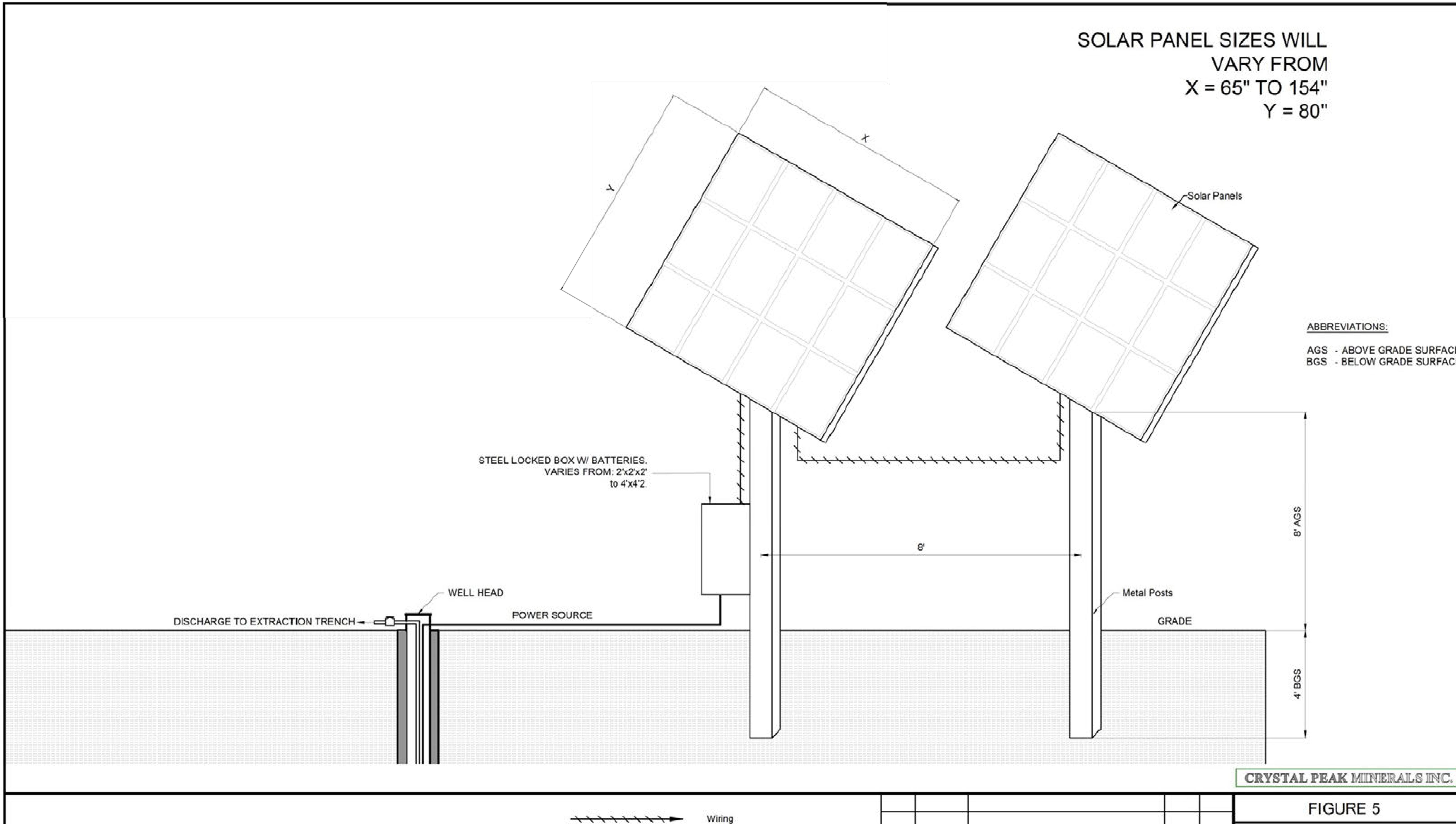
DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE 4

Sevier Playa Potash Project
Extraction Well
Typical Section

DATE: 09/14/2017
FILE: Figure 6-5 Typical Extraction Well Typical S
SCALE: NTS
NORWEST CORPORATION

CONFIDENTIAL



CRYSTAL PEAK MINERALS INC.

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE 5

Sevier Playa Potash Project
Extraction Well Power
Schematic

DATE: 09/25/2017
FILE: Figure 6-6 Extraction Well Power.dwg
SCALE: NONE

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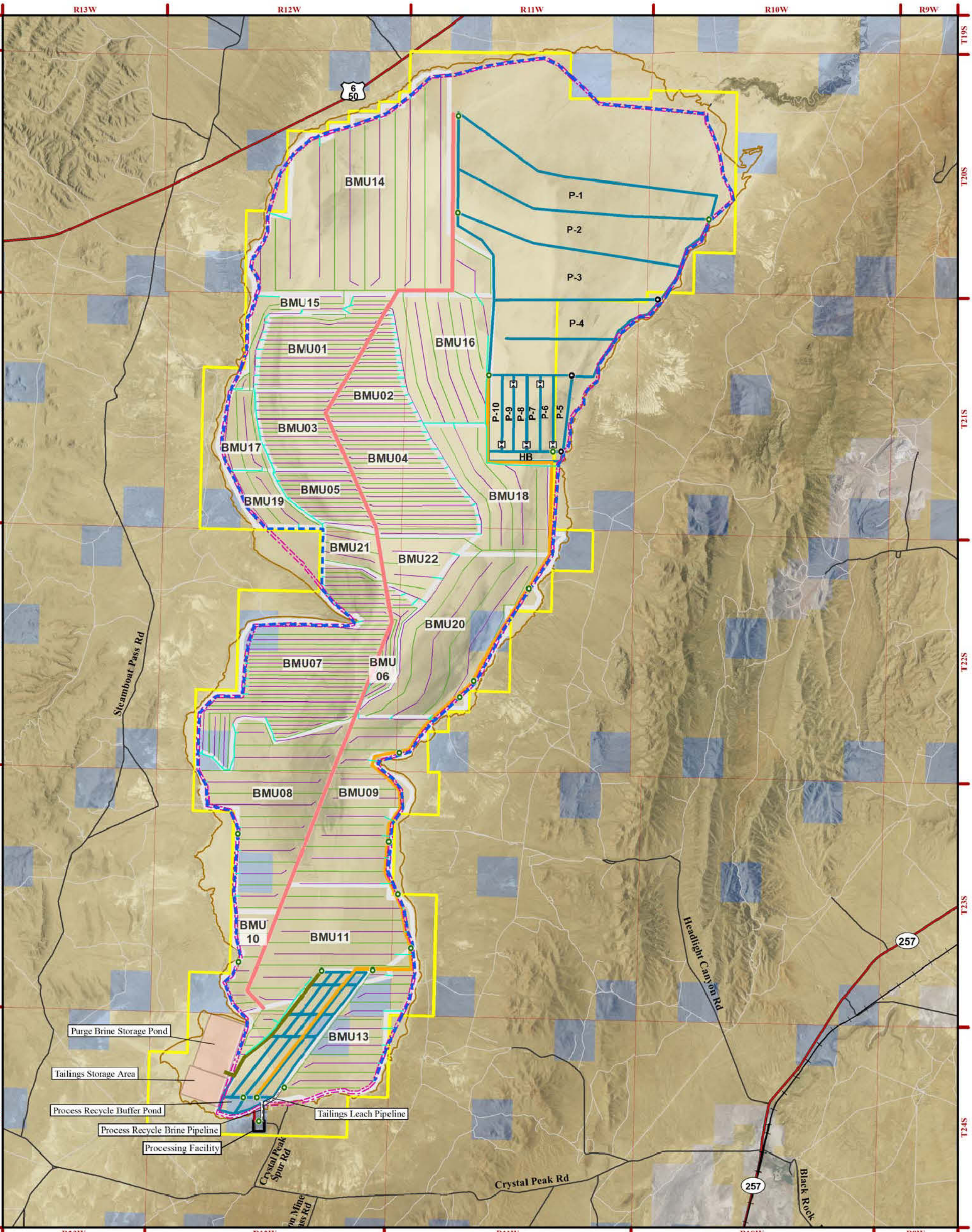

Proposed Project Features

- Recharge Trench
- Recharge Collector
- Extraction Trench
- Recharge Canal
- Extraction Canal
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Process Recycle Brine Pipeline and Tailings Leach Pipeline
- Preconcentration and Production Ponds
- Preconcentration Pond Weir
- Pump Station - On Lease
- Pump Station - Off Lease
- Sevier River Diversion
- Brine Mining Unit Boundary
- Perimeter Road
- Haul Roads

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

N

0 1 2 4 Miles

1 in = 2 miles

Sources:
Project features, Crystal Peak Minerals, 2015, 2016, 2017;
Public land survey system, BLM 2013;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagy, USDA/APFO 2016

Notes:
• The utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.
• Some features have been graphically offset to improve map legibility.

NO.	DATE	REVISION	BY	APVD
1	1/18/2018	Revised per Mining Plan Update		
DSGN	DR	CHK	APVD	

FIGURE 6

Sevier Playa Potash Project
Mine Plan Trench Layout

MINING PLAN SUMMARY

DATE: 1/18/2018 SCALE: 1:150,000

CRYSTAL PEAK MINERALS INC.

Source: MP_Fig 6-2 - Trench Layout 180111 1/18/2018 3:38:34 PM
CPM revised Figure No. and Document Title 3/7/18 by BU

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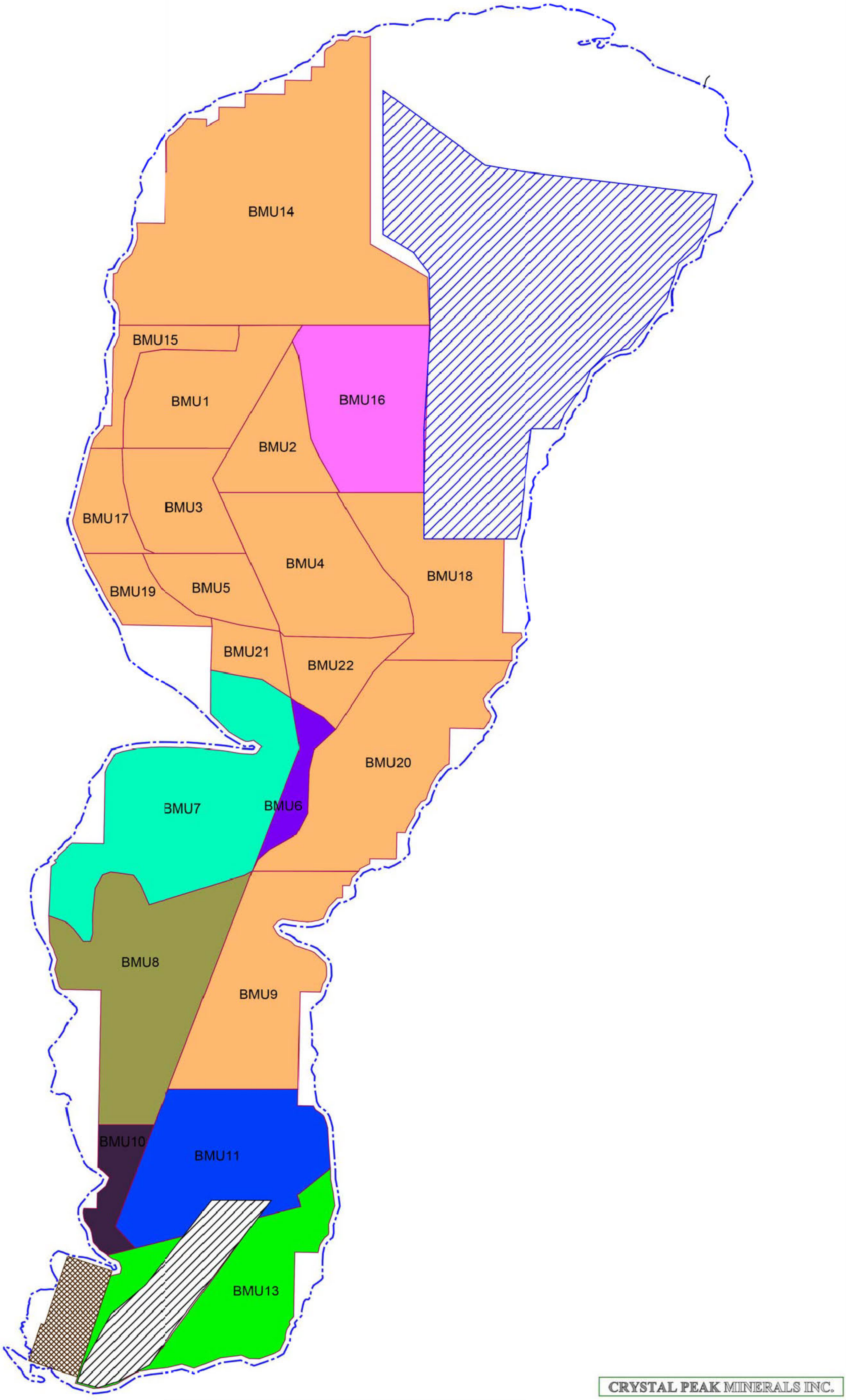

LEGEND

- Production Ponds
- Preconcentration Ponds
- Waste Product Storage Area
- BMU Boundary
- Sevier Playa Boundary

BMU CONSTRUCTION TIMING

- Year 1 to 4
- Year 4 to 5
- Year 5 to 7
- Year 8 to 9
- Year 9 to 11
- Year 14 to 16
- Year 21 to 23
- Year 23 to 25

N

10,000 0 10,000 20,000

1"=10,000'

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE 7

Sevier Playa Potash Project
Construction Timing
BMU

DATE: 09/25/2017
FILE: Figure 6-34 Timing & Sequence Map Trenches_M117
SCALE: As Shown

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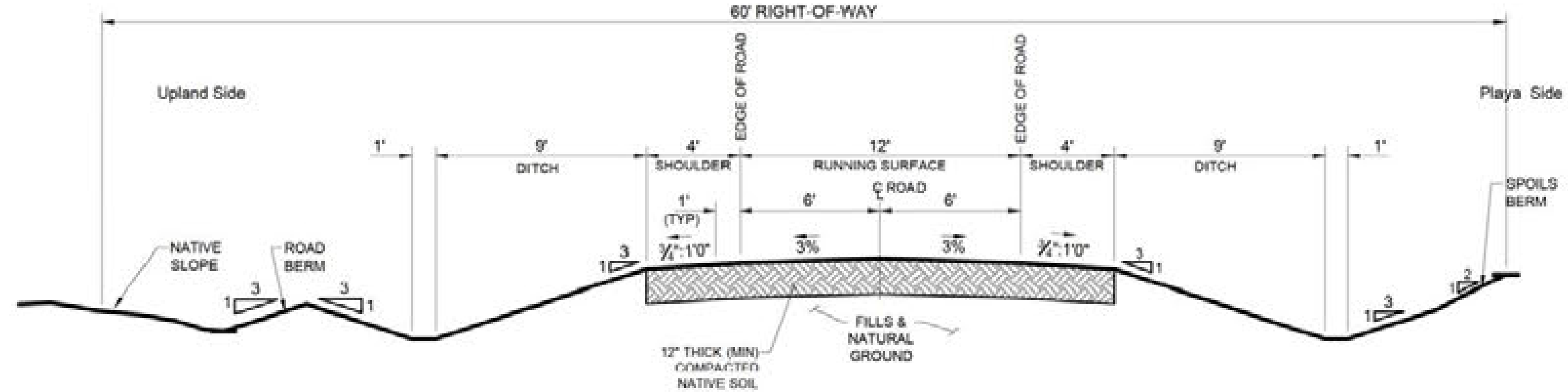
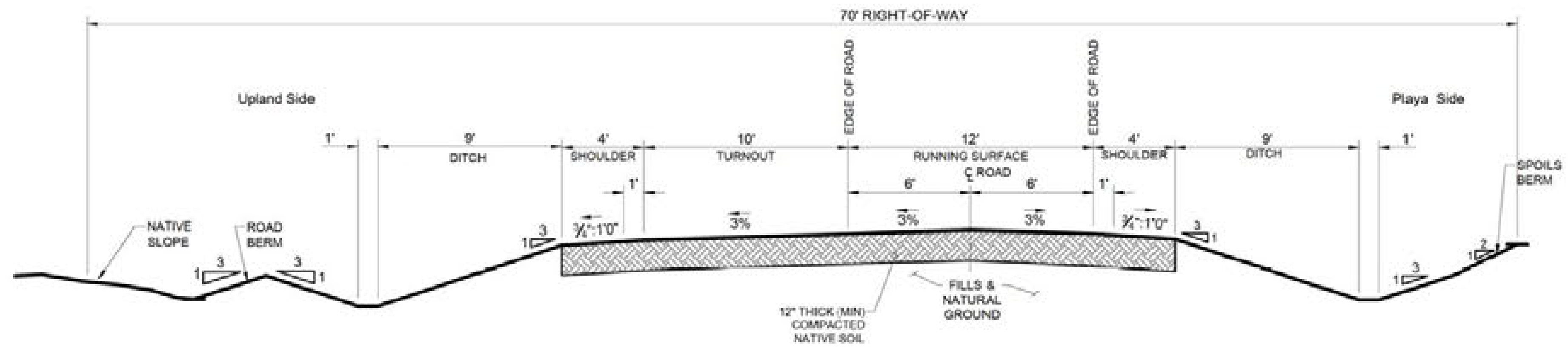


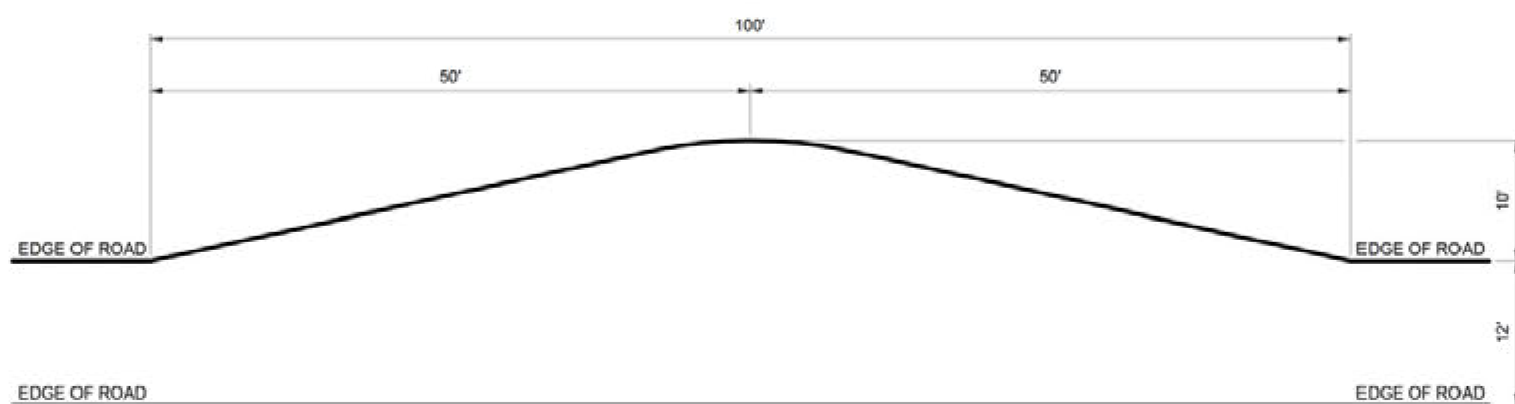
TYPICAL PERIMETER ROAD SECTION

SCALE: 1/8" = 1'0"



TYPICAL PERIMETER ROAD SECTION W/ TURNOUT

SCALE: 1/8" = 1'0"



TYPICAL TURNOUT - PLAN VIEW

SCALE: 1/16" = 1'0"

CRYSTAL PEAK MINERALS INC.

8 0 8 16

1"=8'

CONFIDENTIAL

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE 8

Sevier Playa Potash Project

Perimeter Road

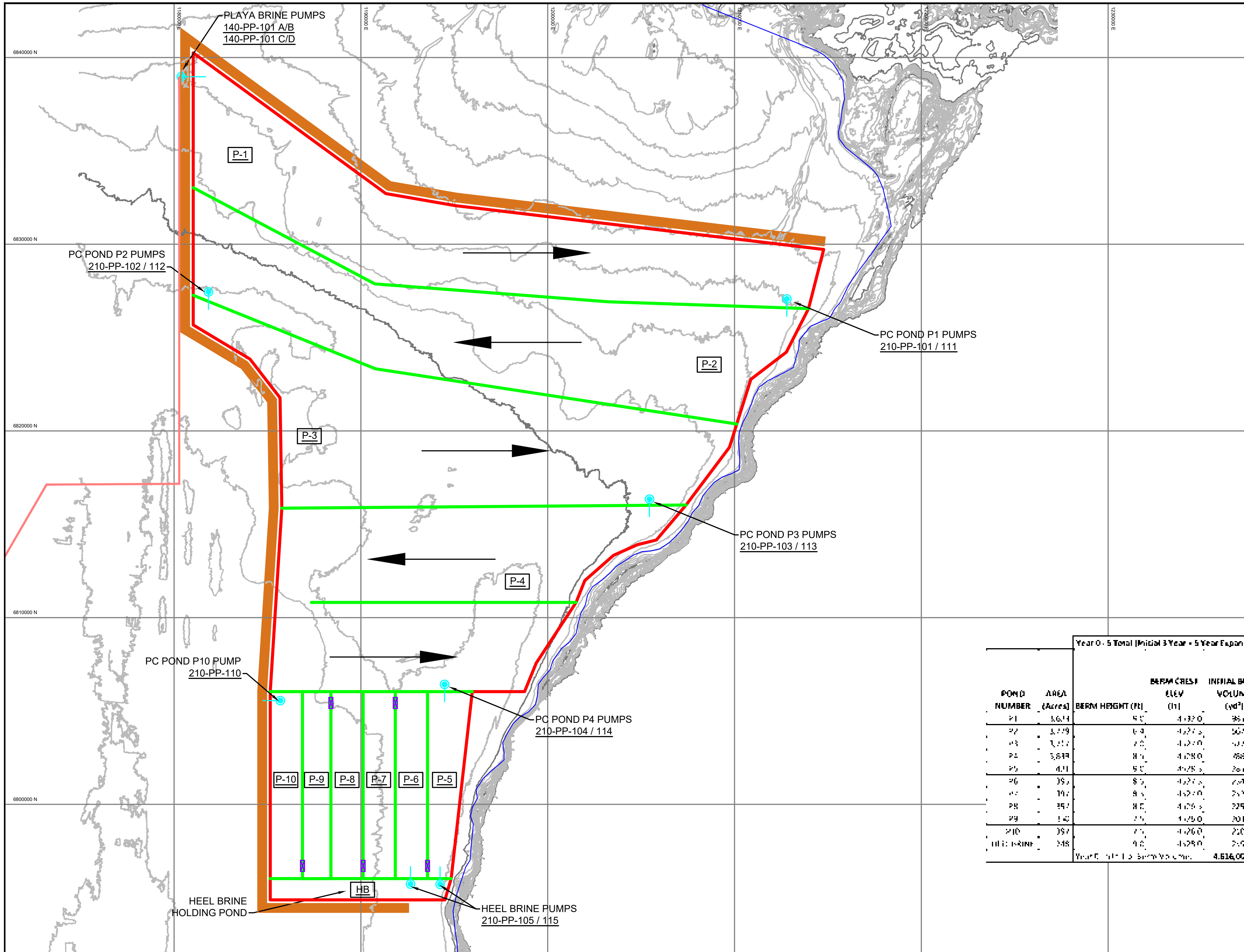
Typical Sections and Turnouts

DATE: 09/22/2017

FILE: Figure 6-32 Perimeter Road Typical Sections RevC

SCALE: As Shown

NORWEST CORPORATION



PRECONCENTRATION PONDS: YEAR 0 - 5

POND NUMBER	BERM HEIGHT (ft)	BRINE HEIGHT (ft)	AREA (Acres)	BRINE VOLUME (ft³)	INTERIOR BERM LENGTH (miles)	EXTERIOR BERM LENGTH (miles)
P1	9	6	3,021	30,242,000	6.49	8.98
P2	5.5	3.5	3,779	21,337,000	5.70	2.52
P3	7	4	3,717	25,809,000	4.10	3.57
P4	8.5	5.5	3,839	35,952,000	4.75	5.00
P5	9	6	421	4,340,000	2.14	1.91
P6	8.5	5.5	395	5,733,000	2.22	0.00
P7	8.5	5.5	397	5,518,000	2.22	0.00
P8	8	5	397	4,474,000	2.22	0.00
P9	7.5	4.5	350	2,702,000	2.19	0.00
P10	7.5	4.5	397	3,074,000	0.33	1.90
HEEL BRINE	9	6	248	2,522,000	0.00	2.21
Total			17,560	142,703,000	32.3	26.0

		Year 0 - 5 Total (Initial 3 Year + 5 Year Expansion)			Year 5 - 15 Total (Expansions every year)				Year 15 - 30 Total (Expansions every year)			
POND NUMBER	AREA (Acres)	BERM HEIGHT (ft)	BERM CREST ELEV (ft)	INITIAL BERM VOLUME (yd³)	ADDITIONAL BERM HEIGHT (ft)	TOTAL BERM HEIGHT (ft)	BERM CREST ELEV (ft)	ADDITIONAL BERM VOLUME (yd³)	ADDITIONAL BERM HEIGHT (ft)	TOTAL BERM HEIGHT (ft)	BERM CREST ELEV (ft)	ADDITIONAL BERM VOLUME (yd³)
P1	3,621	9.0	[illegible]	[illegible]	-	9.0	[illegible]	-	-	9.0	4,532.0	-
P2	3,779	6.4	[illegible]	567,937	-	6.4	[illegible]	-	-	6.4	[illegible]	-
P3	3,717	7.0	[illegible]	[illegible]	1.0	8.0	[illegible]	[illegible]	1.3	9.3	[illegible]	147,310
P4	3,839	8.5	4,528.0	488,830	6.5	15.0	[illegible]	523,306	7.7	22.7	[illegible]	881,570
P5	421	9.0	[illegible]	[illegible]	5.0	14.0	[illegible]	[illegible]	5.5	19.5	4,539.0	299,745
P6	395	8.5	[illegible]	[illegible]	5.0	13.5	[illegible]	211,072	5.7	19.2	[illegible]	192,310
P7	397	8.5	[illegible]	[illegible]	4.5	11.0	[illegible]	158,912	5.5	16.5	[illegible]	149,275
P8	357	8.0	[illegible]	225,342	5.0	13.0	[illegible]	158,170	5.5	18.5	4,537.0	[illegible]
P9	350	7.5	4,525.0	201,823	5.0	12.5	[illegible]	150,409	5.7	18.2	[illegible]	[illegible]
P10	397	7.5	4,526.0	210,197	4.5	12.0	[illegible]	145,004	5.4	17.4	[illegible]	190,874
HEEL BRINE	248	9.0	4,529.0	[illegible]	-	9.0	4,529.0	-	-	9.0	4,529.0	-
		Year 0 - 5 Total Berm Volume		4,616,000 yd³	Year 5 - 15 Raise Additional Berm Volume			2,291,000 yd³	Year 15 - 30 Raise Additional Berm Volume			2,173,000 yd³

CRYSTAL PEAK MINERALS INC.

LEGEND

- Type R1 Exterior Berm
- Type R1 Interior Berm
- Extraction Canal
- Sevier Playa Boundary
- Pump Station
- Weir
- Borrow Area

NOTES:

1. THE PONDS WERE DESIGNED IN CHRONOLOGICAL ORDER. INTERIOR SEPARATING BERMS ARE ALLOCATED TO THE POND UTILIZING THEM WITH THE LOWEST POND NUMBER. (EXAMPLE: P1 IS ALLOCATED THE LENGTH AND VOLUME OF THE INTERIOR BERM BETWEEN P1 AND P2)
2. INDIVIDUAL BERM VOLUMES ARE ESTIMATED BASED ON AVERAGE CROSS SECTIONAL AREA FOR THE TOTAL POND AND ARE ALLOCATED TO EACH POND BASED UPON INDIVIDUAL BERM LENGTHS.
3. TOTAL BERM VOLUME FOR ALL OF THE PRECONCENTRATION PONDS REMAINS ACCURATE.
4. THE AREA DELINEATED FOR THE BORROW AREA ACCOUNTS FOR AN OFFSET OF 500FT FROM WELLS, TRENCHES AND CANALS (NOT SHOWN). TO ACCOUNT FOR THIS DELINEATION, THE BORROW AREA FOOTPRINT HAS BEEN INCREASED BY 20 PERCENT.
5. DEPTH OF BORROW AREAS APPROXIMATELY 2 FEET.

0 2500 5000 7500
FEET

NO.	DATE	REVISION	BY	APVD
1	12/18/17	UPDATED BERM VOLUMES	JDS	GG
0	9/20/17	INITIAL SUBMISSION	TJS	GG

DSGN	DR	CHK	APVD
JDS	JDS	GG	GG

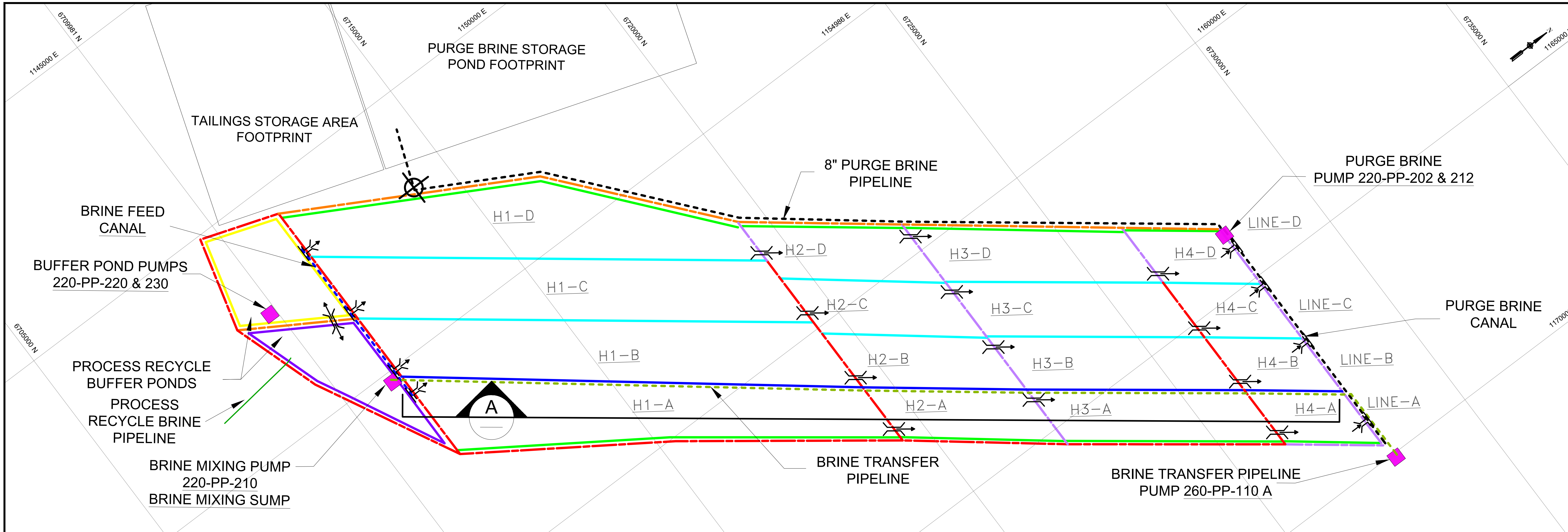
FIGURE 9

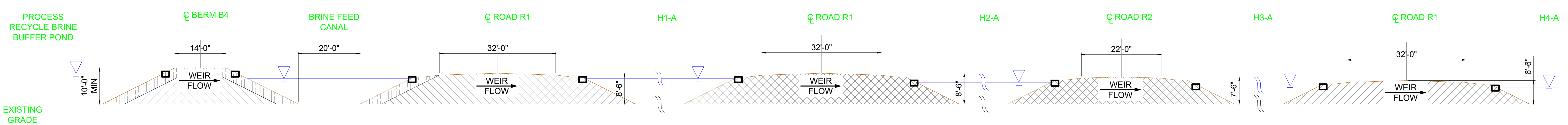
Sevier Playa Potash Project
Preconcentration Ponds
Plan-View

DATE: 12/18/2017
FILE: Figure 6-14 PRECONCENTRATION PLAN VIEW.dwg
SCALE: 1":6000'

NORWEST CORPORATION

CONFIDENTIAL





SECTION A, LOOKING WEST

(NOT TO SCALE)

CRYSTAL PEAK MINERALS INC.

LEGEND

- Road Type R1 (Main Haul Road - 32')
- Road Type R2 (Secondary Road - 22')
- Road Type R3 (Construction / Maintenance Road)
- Berm Type B1 (Berm - 6' width)
- Berm Type B2 (Berm - 14' width)
- Berm Type B3 (Berm - 14' width w/ pipe ledge)
- Berm Type B4 (Berm - 14' width)
- Berm Type B5 (Berm - 6' width)
- Brine Brine Canal
- Brine Transfer Pipeline
- Purge Brine Pipeline
- Process Recycle Pipeline
- Purge Brine Fill Station Dust Suppression
- Pump Station
- Weir (Pond to Pond)
- Weir (Canal to Pond)
- Weir (Pond to Canal)

0 2000 4000 6000

FEET

NO.	DATE	REVISION	BY	APVD
1	1-5-18	MADE REQUESTED CHANGES	JB	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	JB	AB	AB

FIGURE 10

Sevier Playa Potash Project

Production Pond Plan-View

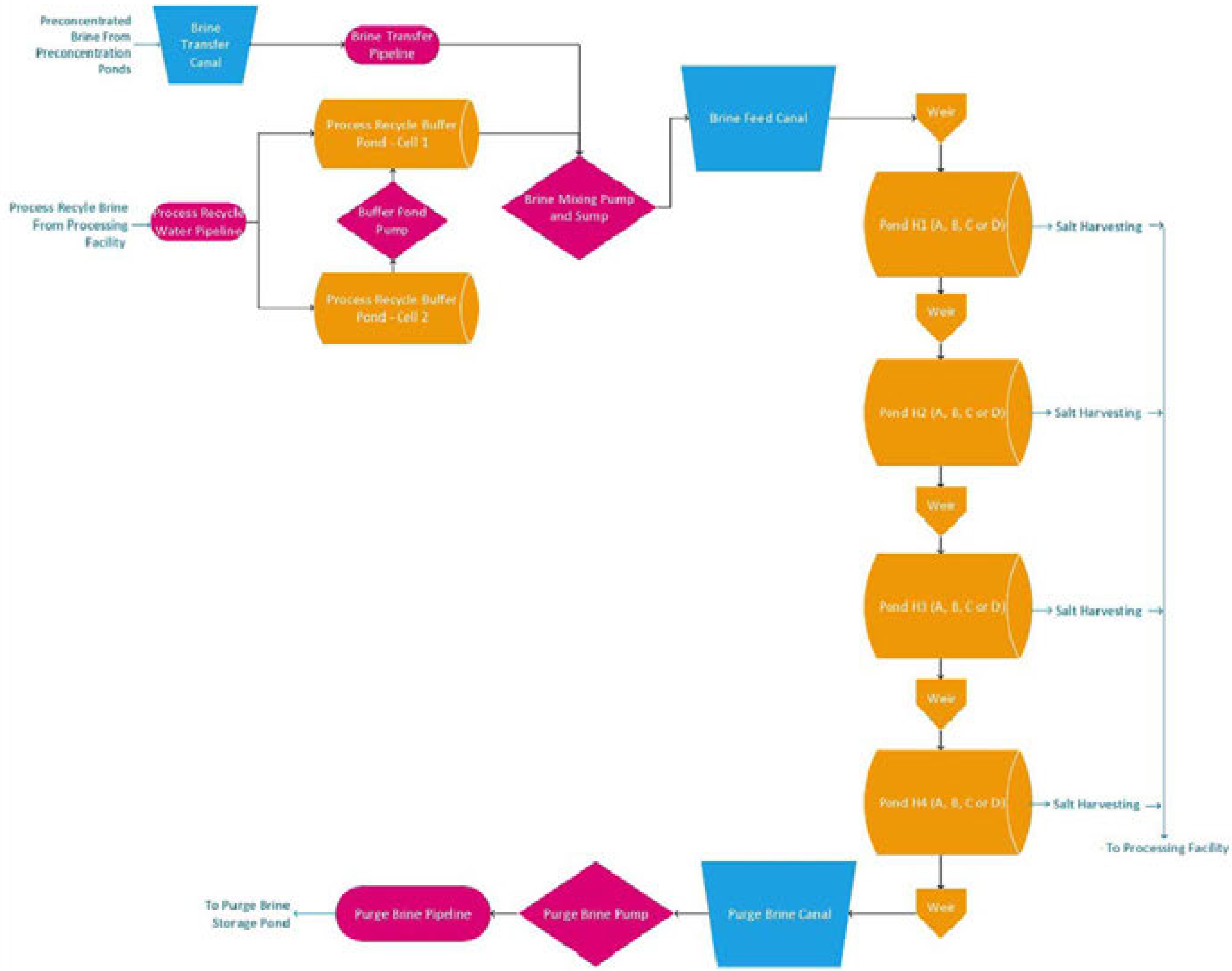
DATE: 12/18/2017

FILE: Figure 6-16 Production Plan View.dwg

SCALE: As Shown

NORWEST CORPORATION

CONFIDENTIAL



CRYSTAL PEAK MINERALS INC.

FIGURE 11

Sevier Playa Potash Project
Production Pond Flow

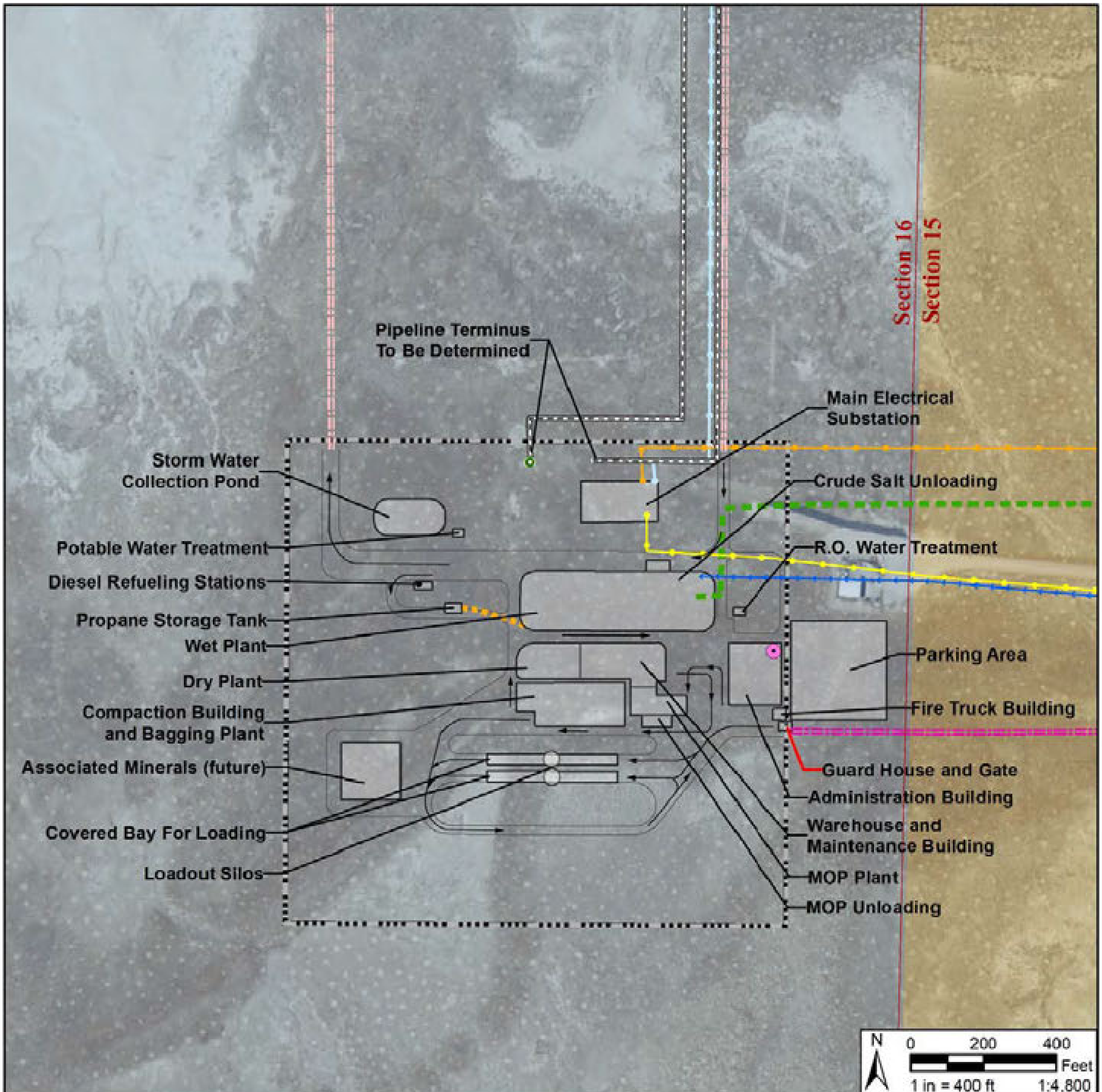
NO.	DATE	REVISION	BY	APVD
0	10-25-17	INITIAL SUBMITTAL	DL	AB

DSGN	DR	CHK	APVD
DL	DL	AB	AB

DATE: 10/03/2017
FILE: Figure 11 Production Pond Flow.dwg
SCALE: As Shown

NORWEST CORPORATION

CONFIDENTIAL



Proposed Project Features

- 69-kV Power and Communication Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line
- Water Supply Pipeline
- Natural Gas Pipeline
- Propane Pipeline
- Process Recycle Brine Pipeline and Tailings Leach Pipeline
- Process Recycle Brine Pump
- Perimeter Security Fence
- Communication Tower
- Access Road
- Haul Road

Land Ownership

- BLM
- State Lands

Sources:
Project features, Crystal Peak Minerals, 2015, 2016, 2017;
Public land survey system, BLM 2013;
Roads, Millard County, 2013;
Aerial Imagy, NAIP 2016

Notes:
- Some project facilities not drawn to exact scale to improve legibility of figure.
- The project facilities shown on this map are draft and may be revised and/or refined throughout the development of the project.

NO.	DATE	REVISION	BY	APVD
1	1/17/2018	Revised per Mining Plan Update		

DSGN	DR	CHK	APVD

FIGURE 12

Sevier Playa Potash Project
Processing Facility Site Plan

MINING PLAN SUMMARY

DATE: 1/17/2018 | SCALE: 1:4,800

CRYSTAL PEAK MINERALS INC.

Source: MP_Fig 6-24_Processing_Plant 180111 1/17/2018 12:37:54 PM
CPM revised Figure No. and Document Title 3/7/18 by BU

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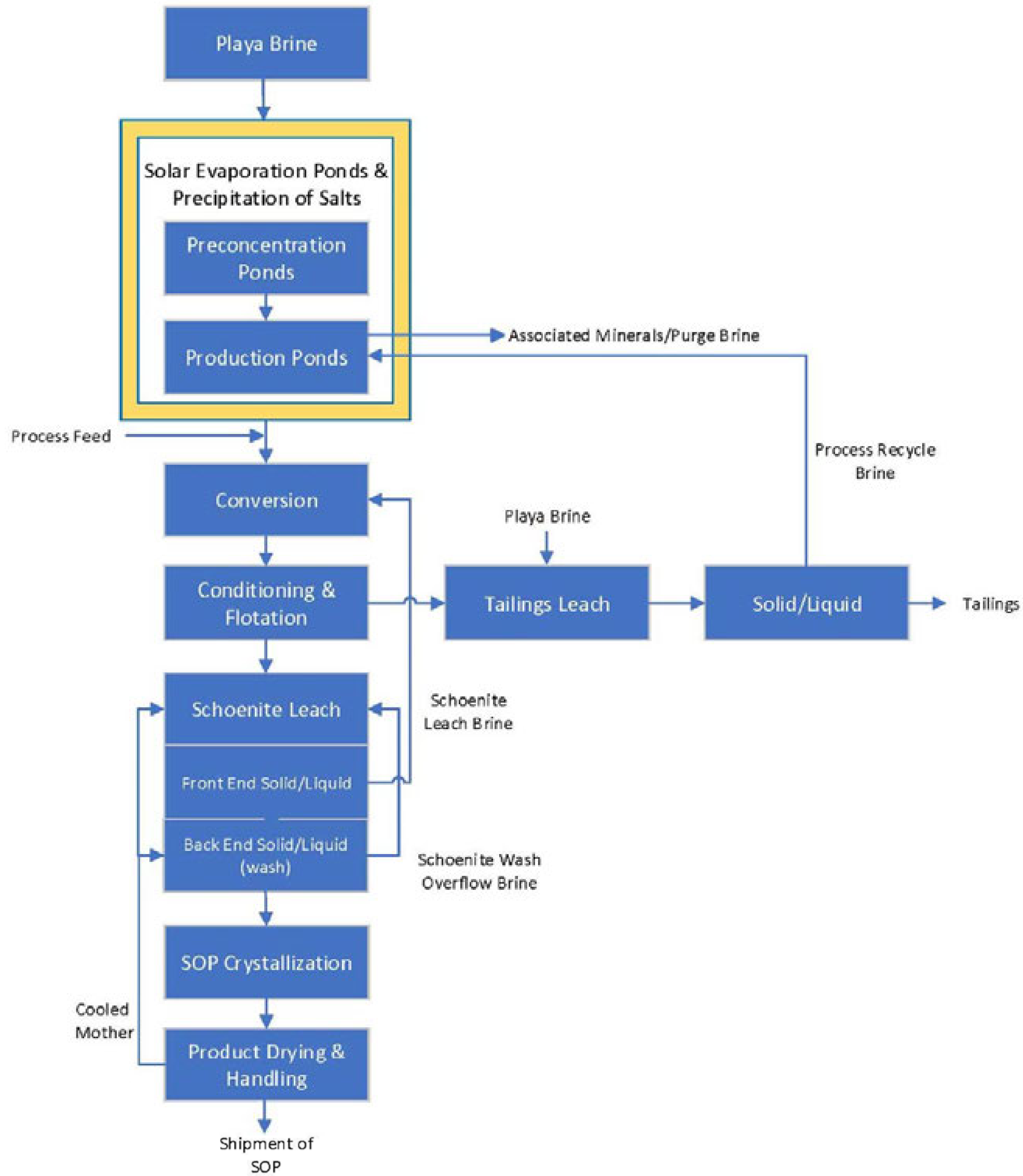


CRYSTAL PEAK MINERALS INC.

NO.	DATE	REVISION	BY	APVD
1	8-30-18	REVISED PROCESS OVERVIEW	TS	AB
0	10-25-17	INITIAL SUBMITTAL	DL	AB

DSGN	DR	CHK	APVD
DL	DL	AB	AB

FIGURE 13

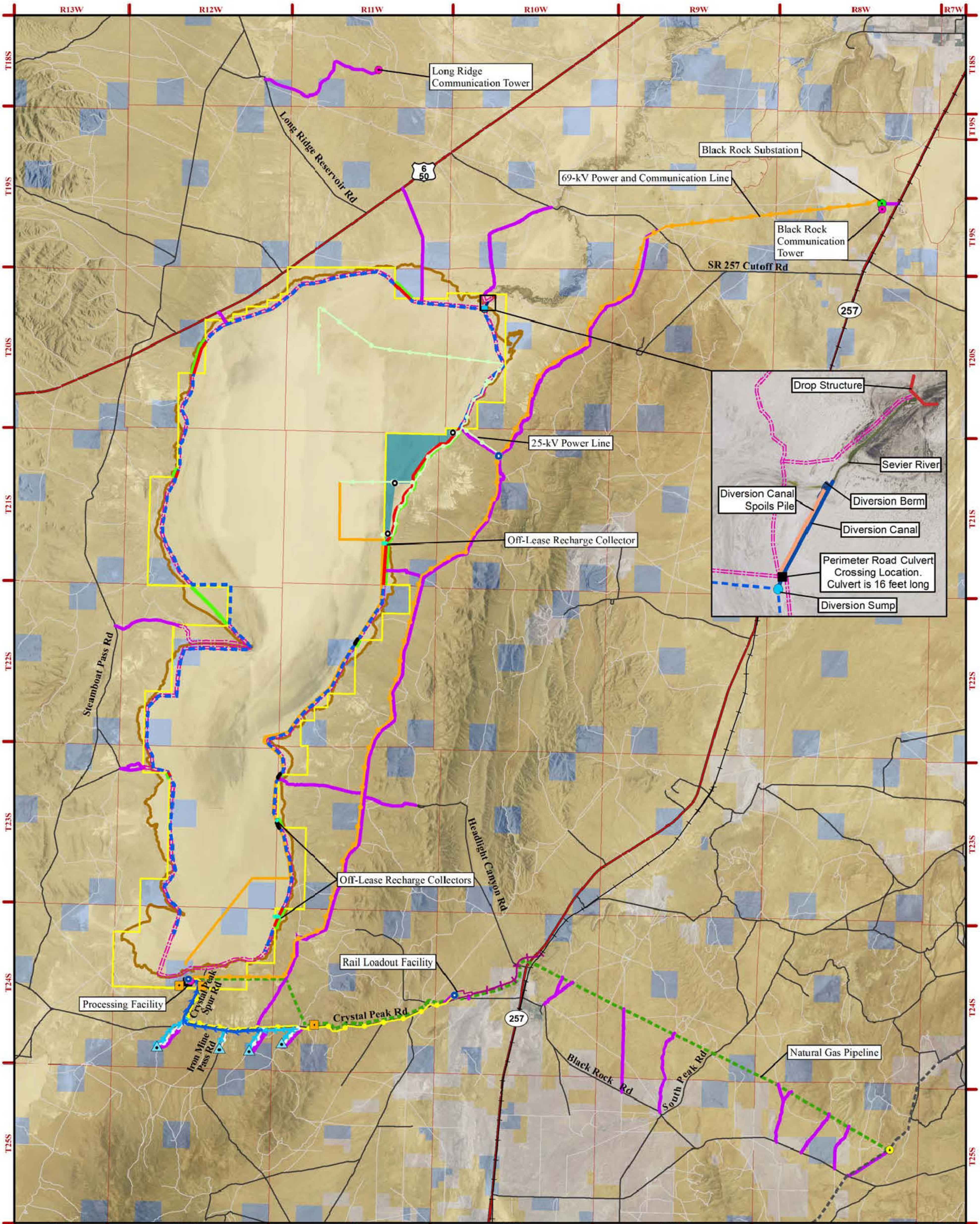
Sevier Playa Potash Project
Process Overview

DATE: 10/03/2017
FILE: Figure 13 Process Overview.dwg
SCALE: As Shown

NORWEST CORPORATION

N

CONFIDENTIAL



Proposed Project Features

- 69-kV Power and Communication Line
- 25-kV Power Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Access Road - Off-Lease
- Perimeter Road and Spurs - On-Lease
- Perimeter Road Segment - Off-Lease
- Preconcentration Ponds - Off-Lease
- Recharge Canal - On-Lease
- Recharge Canal - Off-Lease
- Brine Transfer Canal/Pipeline - On-Lease
- Brine Transfer Canal - Off-Lease
- Recharge Collector - Off-Lease
- Natural Gas Pipeline
- Sevier River Diversion
- Rail Spur and Access Corridor
- Rail Loadout Facility
- Gravel Pit
- Water Supply Pipeline
- Water Supply Pipeline Spur
- Water Supply Well
- Communication Tower
- Substation
- Pump Station - Off-Lease
- Diversion Sump
- Processing Facility

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- Kern River Natural Gas Pipeline
- Kern River Valve Station
- Black Rock Substation
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

N

0 2 4 Miles

1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015-2018;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagy, USDA/APFO 2016

Note:
• The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

FIGURE 14

Project Off-Lease Facilities Overview

MINING PLAN SUMMARY

SEVIER PLAYA POTASH PROJECT

Source:POD_Fig_1-2_Project_Facilities_Overview 180214 2/16/2018 9:47:13 AM
CPM revised Figure No. and Doc. Title 3/7/18 by BU

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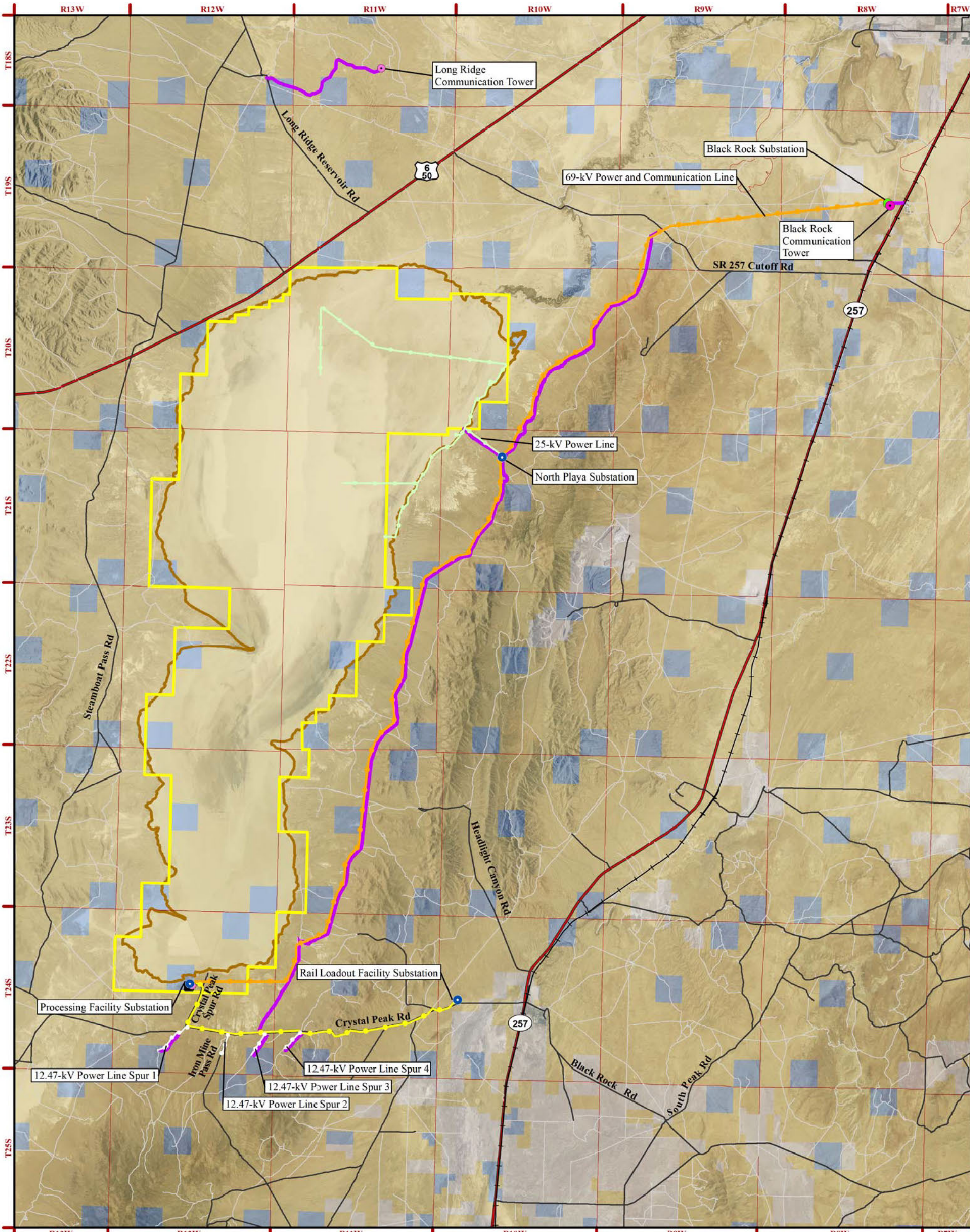

Proposed Project Features

- 69-kV Power and Communication Line
- 25-kV Power Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Access Road
- Substation
- Communication Tower
- Processing Facility

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad
- Black Rock Substation

Land Ownership

- BLM
- State Lands
- Private

N 0 2 4 Miles
1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015;
Public land survey system, Land jurisdiction BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2014

Note:
• The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

FIGURE 15
Power and Communication Line Overview
MINING PLAN SUMMARY
SEVIER PLAYA POTASH PROJECT

Source: POD_Fig_2-1_Power Line and Communication Line Overview 180112 1/23/2018 5:45:34 PM
CPM revised Figure No. and Doc. Title 3/7/18 by BU

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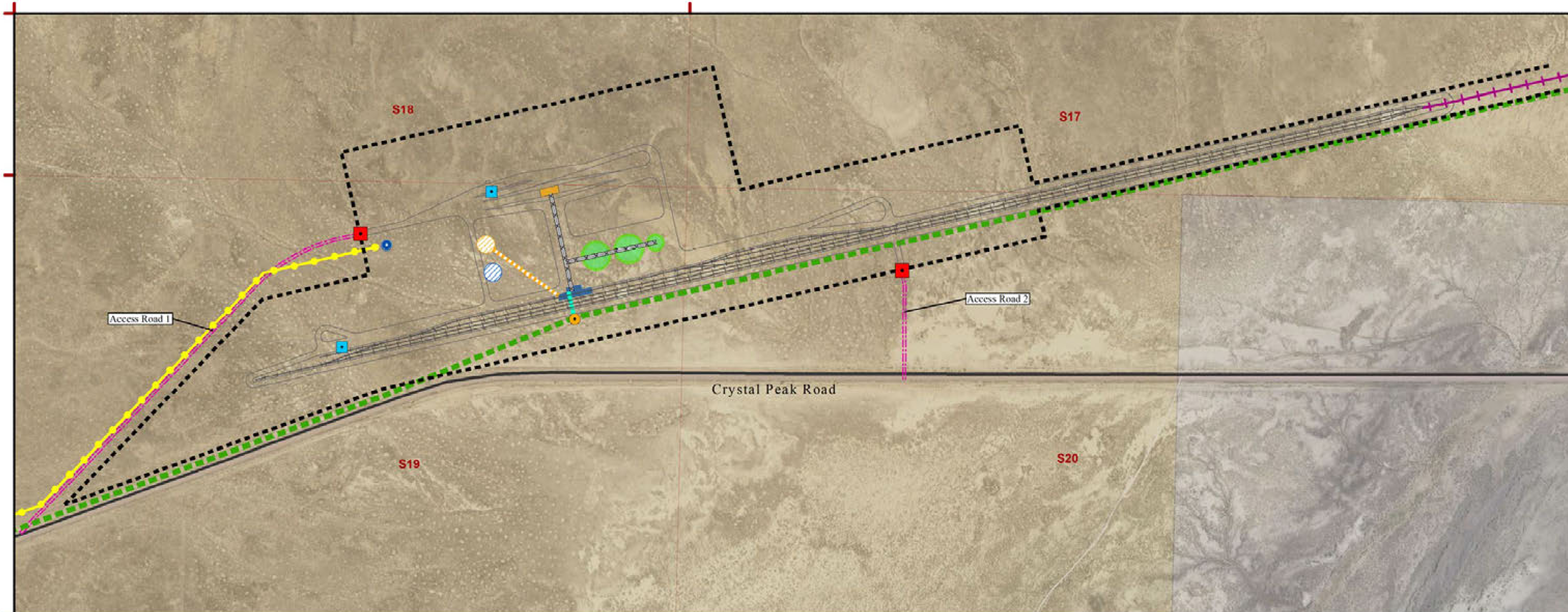


Proposed Project Features

- Rail Spur
- Rail Car Staging Tracks
- Substation
- 12.47-kV Power and Communication Line
- Rail Loadout Facility Access Road
- Rail Loadout Facility Access Road Gate
- Truck Loadout
- Train Loadout
- Storage Dome
- Conveyor Belt
- Rail Loadout Facility Boundary Fence and Gravel Yard
- Natural Gas Spur Valve
- Propane Storage Tank
- Propane Pipeline
- Refueling Station
- Water Storage Tank
- Natural Gas Pipeline Spur
- Natural Gas Pipeline

General Reference

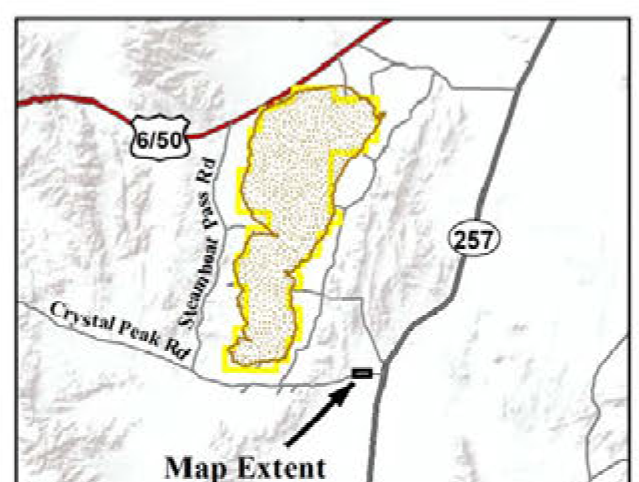
Land Ownership

- BLM
- Private
- Class B Road

N

0 250 500 1,000 Feet

1 inch = 533 feet



Note:
• The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of t he project.

Source: MP Fig 6-33 Rail Loadout Detail 180108 1/11/2018 2:21:06 PM

CPM revised Figure No. and Doc. Title 3/7/18 by BU

NO.	DATE	REVISION	BY	APVD
1	1/5/2018	Revised per Mining Plan Updates		

DSGN	DR	CHK	APVD

FIGURE 16

Sevier Playa Potash Project
Rail Loadout
Facility Overview

MINING PLAN SUMMARY

DATE: 1/11/2018 SCALE: 1:6,400

CRYSTAL PEAK MINERALS INC.

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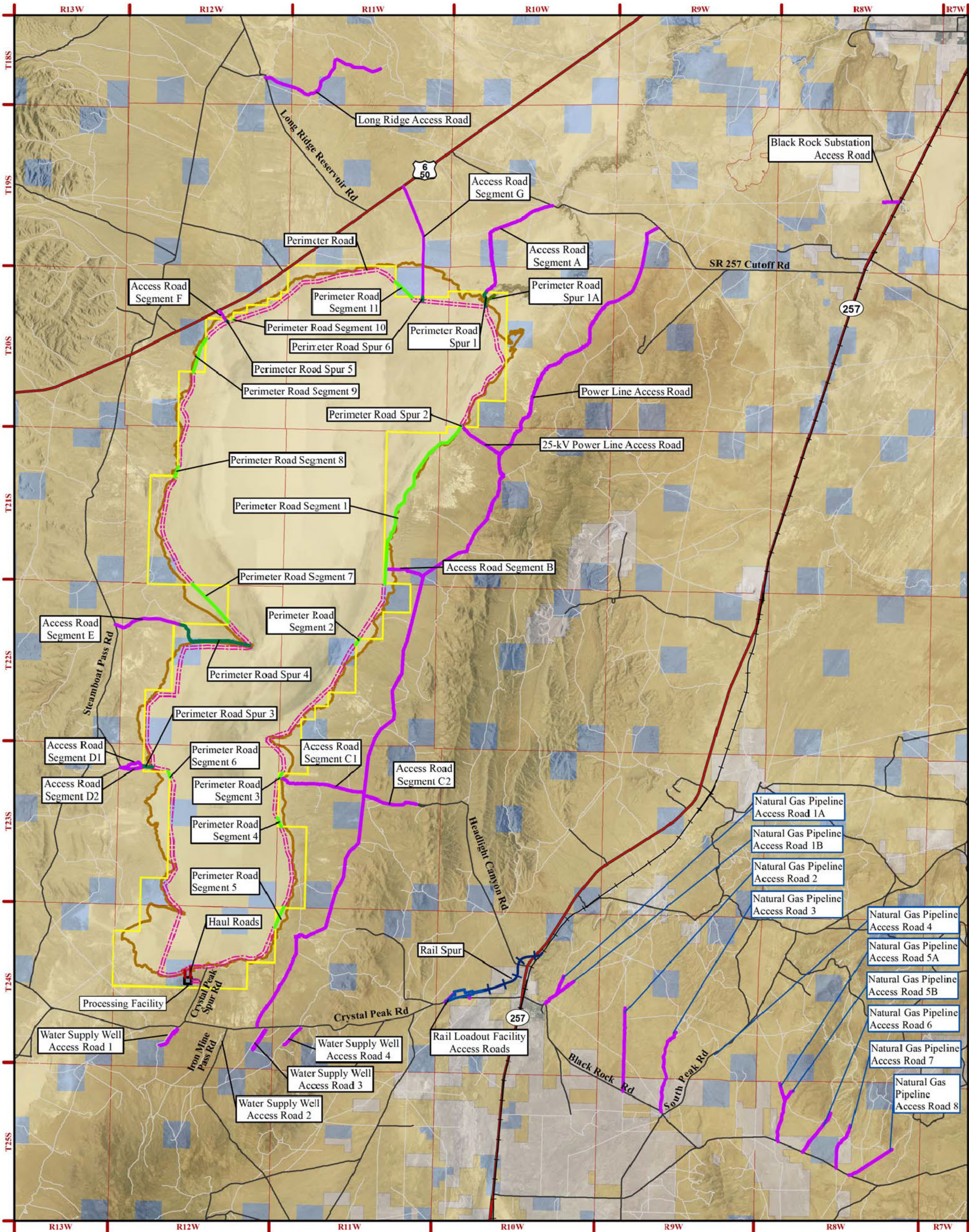


Proposed Project Features

- Access Road - Off-Lease
- Access Road - On-Lease
- Perimeter Road - On-Lease
- Perimeter Road Segment - Off-Lease
- Haul Roads
- Rail Spur

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Existing Railroad

Land Ownership

- BLM
- State Lands
- Private

N

0 2 4 Miles

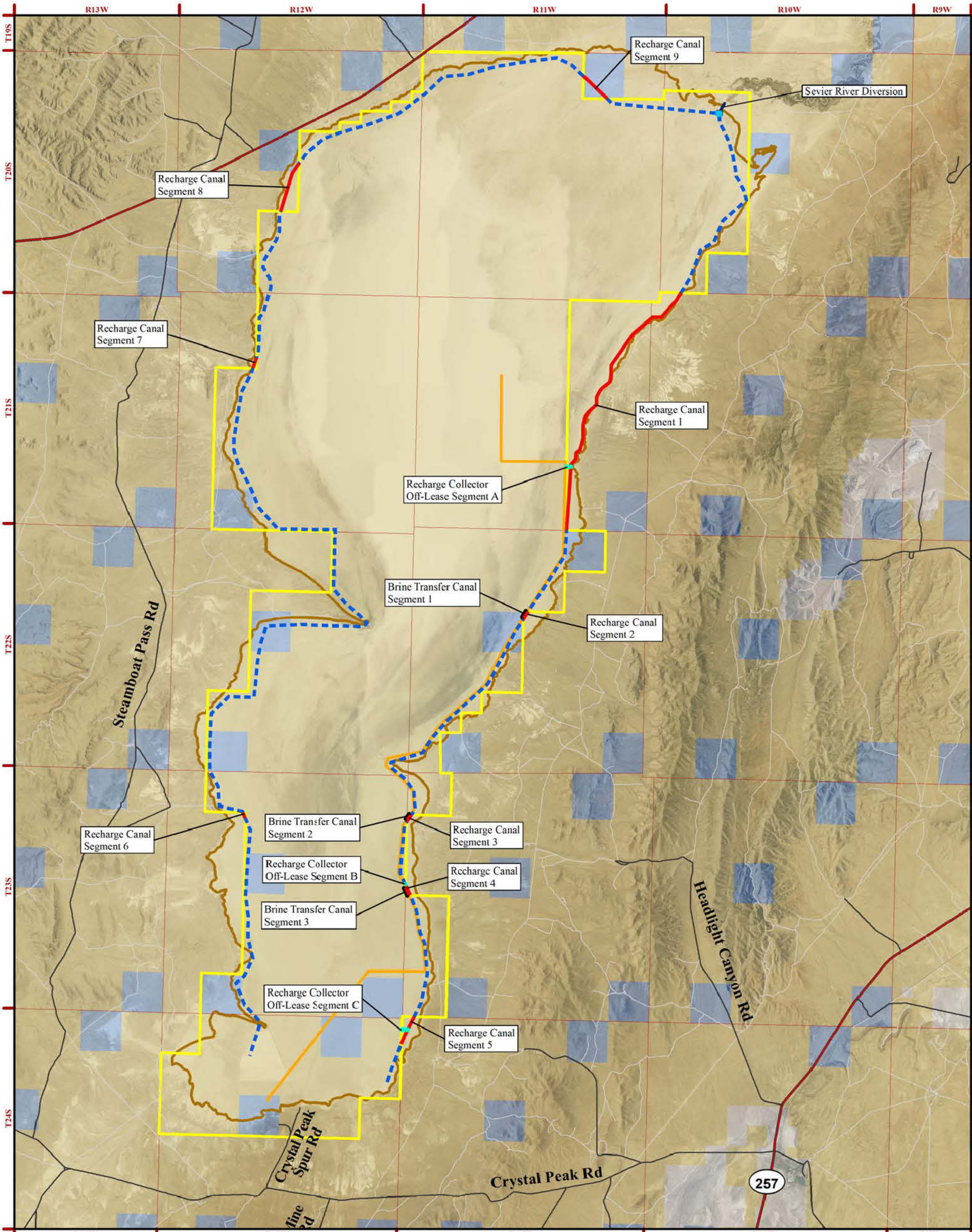
1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015, 2016, 2017;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2016

Note:
• The proposed project features shown on this map are draft and may be revised and/or refined throughout the development of the project.

FIGURE 17
Project Access Roads and Playa Perimeter Road
MINING PLAN SUMMARY
SEVIER PLAYA POTASH PROJECT

Source: POD_Fig_2-15 Playa Access Road And Perimeter Road_Overview 180112 1/22/2018 6:04:03 PM
CPM revised Figure No. and Doc. Title 3/7/18 by BU



Proposed Project Features

- Recharge Canal - On-Lease
- Recharge Canal - Off-Lease
- Brine Transfer Canal/Pipeline - On-Lease
- Brine Transfer Canal - Off-Lease
- Recharge Collector - Off-Lease
- Sevier River Diversion
- Diversion Sump

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

N 0 2 4 Miles
1 in = 2 miles 1:150,000

Sources:
Project features, Crystal Peak Minerals, 2015, 2016, 2017;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagy, USDA/APFO 2016

Note:
• The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

FIGURE 18
Recharge Canal / Collectors / Brine Transfer Canal - Off-Lease Segments
MINING PLAN SUMMARY
SEVIER PLAYA POTASH PROJECT

Source: POD_Fig_2-18_Recharge Canal Off Lease 180112 1/23/2018 6:07:31 PM
CPM revised Figure No. and Doc. Title 3/7/18 by BU

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APPENDIX B

Well Logs

Pre-existing Wells

(Included as Attachment)

WALTS WELL

(C-20-12) 1aacf-1

390623113084101

FUGRO NATIONAL, INC.
Consulting Engineers and Geologists

LOG OF OBSERVATION WELL NUMBER WW-O-1 (L9)

PAGE 1 OF 1

PROJECT NUMBER 78-280-61

LOGGED BY Ron Whitler DATE 10-2-79

PROJECT NAME MX-SITING INVESTIGATION

CHECKED BY V. SHUPE DATE 10.6.79

DRILLING COMPANY Tex Jones

NO. OF SAMPLES 19

DRILL SIZE; METHOD 4 7/8" tricone, rotary wash

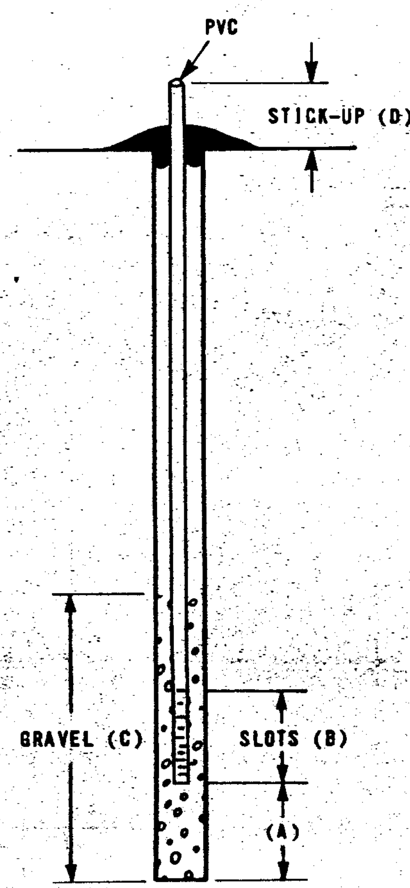
DRILLER: Frank Frantz

116 9003 M00

WIN# 435352

Details of Observation Well:

1. Total Depth 150 feet
2. Date started 10-2-79
3. Date Completed 10-3-79
4. Drilling Mud Used Revert - 1/2 bag
5. Diameter of PVC 2"
6. Distance from PVC Tip to Bottom of Hole (A) 5 feet
7. Length of PVC with Slots (B) 18 feet
8. Height of Gravel-pack (C) 35 feet
9. PVC Stick-up (D) 2 1/2 feet
10. Backfill above Gravel none
11. Remarks: Used 5 sacks of pea Gravel, used 900 gallons of water; 600 gallons from Fugro Reservoir, 300 gallons from Blue tanker (Gau) Smooth drilling!



AF-28 7/79

3:27

FUGRO NATIONAL, INC.

PROJECT NUMBER 78-280- 61	FIELD LOG OF WELL NUMBER WW-0-1 (L9)
PROJECT NAME MX SITING INVESTIGATION	SITE Whirlwind (L9)
EQUIPMENT USED 4 7/8" tricone	LOGGED BY Ron Whitler DATE 10-2-79
	CHECKED BY V. Shupe DATE 10-6-79
COMPANY Tex Jones	OPERATOR Frank Frantz

NUMBER WW-0-1 (L9)

TIME *6:30 SET UP 10:00 START 16:30 STOP

*Note: Rig mobilized from Delta to site ~5:30-6:30 (Repaired & waited for cable) Kelly cable 6:30-10:00

SAMPLE NUMBER	SAMPLE DEPTH	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
b-1	0.0	D	MD	lt. br	SM	0	75	25	SILTY SAND, fine-med, poorly graded, subang-subr sand, non-plastic silt, strong HCl
b-2	2.0	SM	D	lt. br	GM	55	15	30	SILTY GRAVEL, fine, poorly graded, subang-subr gra., some non plastic silt, fine-coarse subang-subr sand; strong HCl
									little
b-3 10→	9.0	M	S	lt. br.	CL	0	10	90	SILTY CLAY, slight-med. plasticity, some silt, fine subang-subr sa; weak HCl trace *drill rate 10FT in 13min
									drill rate 10 FT in 17 min (10-20FT) *
b-4 20→	19.0	SM	V.S	lt. br.	CL	0	4	96	CLAY, med-high plasticity; tr fine subang sand, strong HCl. ?
									drill rate 10FT in 17 min, 30 PSI → * 20-30FT
b-5	29	M	V.S.	br.	CL	0	4	96	CLAY, med-high plasticity; tr fine subang sand; weak HCl ?
									30 PSI drill rate 10FT in 13 min (30-40FT) *
b-6 40→	39	SM	V.S	br.	CL	0	6	94	CLAY, med plasticity, fine subang-subr sand; weak HCl. trace

FUGRO NATIONAL, INC.

FIELD LOG OF WELL NUMBER WW-O-1 (L9)

PROJECT NUMBER 78-280- 61

SITE Whirlwind L9

PROJECT NAME MX SITING INVESTIGATION

LOGGED BY Ron Whitler DATE 10-2-79

EQUIPMENT USED 4 7/8" tricone

CHECKED BY V. Shupe DATE 10.6.79

COMPANY Tex Jones

OPERATOR Frank Frantz

NUMBER WW-O-1 (L9)

TIME 6:30 SET UP 10:00 START 16:30 STOP

SAMPLE NUMBER	SAMPLE DEPTH	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION	
43→										
									(40-50 FT) drill rate 10FT in 14 min, 30 PSI	*
6-7	49	M	V.S.	br.	CL	0	5	95	CLAY, med plasticity; fine subang - subr. sand; weak HCl. trace	
									drill rate 50-60 FT 18 min 100PSI	* 12:30
6-8	59	SM	V.S.	br.	CH	0	2	98	CLAY, high plasticity; trace fine subang - subr. sand; strong HCl.	
									100 PSI 60-70FT, drillrate 10FT in 12 min	*
6-9	69	M	V.S.	lt. br.	CL	0	5	95	CLAY, med. plasticity, trace fine subang - subr. sand; weak HCl.	
									drill rate 70-80FT 16 min, 30 PSI	*
6-10	79	M	V.S.	br.	CL	0	5	95	CLAY, med. plasticity, trace fine subang - subr. sand; weak HCl.	

FUGRO NATIONAL, INC.

FIELD LOG OF WELL NUMBER WW-0-1 (L9)

PROJECT NUMBER 78-280- 61

SITE Whirlwind L9

PROJECT NAME MX SITING INVESTIGATION

LOGGED BY Ron Whitler DATE 10-2-79

EQUIPMENT USED 4 7/8" tricone

CHECKED BY V. SHUPE DATE 10-6-79

COMPANY Tex Jones

OPERATOR F. FRANTZ

NUMBER WW-0-1 (L9)

TIME 6:30 (SET UP) 10:00 (START) 16:30 (STOP)

SAMPLE NUMBER	SAMPLE DEPTH	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
6-11 86→	86	M	S	lt. br.	CL	0	6	94	SILTY CLAY, slight-med. plasticity; trace fine subang-subr. sand; weak HCl.
									drill rate 80-90FT 16min, 50 PSI * 1:45
6-12	90	M	S	lt. br.	CL	0	6	94	SILTY CLAY, slight-med. plasticity; trace fine subang-subr. sand; weak HCl
6-13	96	M	S	lt. br	ML	30	15	55	GRAVELLY SILT; nonplastic silt; some fine ang gravel; little fine-coarse ang sa; weak HCl.
									drill rate 10 FT in 20 min, 50 PSI *
6-14	100	SM	V.S.	br.	CL	0	5	95	CLAY, med plasticity; trace fine subang-subr. sand; weak HCl
									drill rate 10 FT in 16 min. *
6-15	110	M	S	lt. br.	CL ML	0	4	96	INTERBEDD CLAY and SILT, slight-med plasticity; trace fine subang-subr. sand
									drill rate 10 FT. in 16 min, *
6-16	120	M	S	br.	CL	0	5	95	CLAY, slight-med. plasticity; trace fine subang-subr. sand, weak HCl.

FUGRO NATIONAL, INC.

FIELD LOG OF WELL NUMBER WW-0-1 (L9)

PROJECT NUMBER 78-280- 61
SITE Whirlwind L9
PROJECT NAME MX SITING INVESTIGATION
LOGGED BY Ron Whitler DATE 10-2-79
EQUIPMENT USED 4 7/8" tricone
CHECKED BY V. SHUPE DATE 10.6.79
COMPANY Tex Jones
OPERATOR Frank Frantz

NUMBER WW-0-1 (L9)
TIME 6:30 SET UP 10:00 START 1630 STOP

SAMPLE NUMBER	SAMPLE DEPTH	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
									drill rate 10FT in 15 min, 30 PSI *
b-17	130	M	S	lt. br.	CL	0	4	96	CLAY, slight-med plasticity; some silt; fine subang-subr. sand; weak HCl.
									drill rate 10FT in 16 min, 30 PSI. *
b-18	140	M	S	lt. br.	CL	0	4	96	CLAY, slight-med plasticity; some silt; fine subang-subr. sa; weak HCl.
									drill rate 10FT in 10 min, 20 PSI *
b-19	150	M	VS	br.	CL	0	6	94	CLAY, med plasticity; trace fine sub-ang sand; weak HCl

Time breakdown:

5:30-6:30 rig mobilized to reservoir
6:30 - 8:30 rig crew performed rig maint. while waiting for kelly cable to be delivered
8:30 - 9:30 repaired kelly cable.
9:30 - 10:00 moved from reservoir to drill site. 10:00 - 4:30 rig drilled 150 FT. 4:30 - 5:00 travel time back to Delta.

STATE OF UTAH -- DIVISION OF WATER RIGHTS -- DATA PRINT OUT for 69-21(A16972)

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 07/06/2016 Page 1

WATER RIGHT: 69-21 APPLICATION/CLAIM NO.: A16972 CERT. NO.: 3470

```
==========================================================================================================================================
OWNERSHIP*********************************************************************************************************************************
==========================================================================================================================================

NAME: USA Bureau of Land Management
ADDR: 2370 South 2300 West
      Salt Lake City UT 84119
INTEREST: 100%

==========================================================================================================================================
DATES, ETC.*******************************************************************************************************************************
==========================================================================================================================================

LAND OWNED BY APPLICANT?                    COUNTY TAX ID#:
FILED:     10/09/1945|PRIORITY:  10/09/1945|PUB BEGAN:          |PUB ENDED:          |NEWSPAPER:
ProtestEnd:          |PROTESTED: [No      ]|HEARNG HLD:         |SE ACTION: [Approved]|ActionDate:06/26/1946|PROOF DUE:
EXTENSION:           |ELEC/PROOF:[        ]|ELEC/PROOF:         |CERT/WUC:  03/23/1948|LAP, ETC:             |LAPS LETTER:
RUSH LETTR:          |RENOVATE:            |RECON REQ:          |TYPE: [             ]

PD BOOK: [  69-     ]|MAP:  [             ]|PUB DATE:

Type of Right: Application to Appropriate     Source of Info: Certificate                  Status: Certificate

==========================================================================================================================================
LOCATION OF WATER RIGHT*******************************************************************************************************************
==========================================================================================================================================

FLOW: 0.05 cfs

SOURCE: Underground Water Well

COUNTY: Millard      COMMON DESCRIPTION:


POINT OF DIVERSION -- UNDERGROUND:
(1)  N  561 ft E  450 ft from SW cor, Sec 06, T 23S, R 12W, SLBM
DIAMETER OF WELL:  6 ins. DEPTH:  560 to      ft. YEAR DRILLED:      WELL LOG? No   WELL ID#: 21100

==========================================================================================================================================
USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family
                  (The Beneficial Use Amount is the quantity of Use that this Water Right contributes to the Group Total.)
==========================================================================================================================================
SUPPLEMENTAL GROUP NO. 435952.
..........................................................................................................................................
  STOCKWATER: 3500.0000 Stock Units                                                                      PERIOD OF USE: 01/01 TO 12/31

==========================================================================================================================================
PLACE OF USE for STOCKWATERING************************************************************************************************************
==========================================================================================================================================
                               NORTH-WEST≈       NORTH-EAST≈       SOUTH-WEST≈       SOUTH-EAST≈
                               NW NE SW SE       NW NE SW SE       NW NE SW SE       NW NE SW SE
Sec 06 T 23S R 12W SLBM       *  :  :  :  *     *  :  :  :  *     *  :  : X:  *     *  :  :  :  *
******************************************************************************************************************************************
*******************************************************E N D   O F   D A T A**************************************************************
******************************************************************************************************************************************
```

EXPLANATORY

Note.—The second space provided in Paragraph 3 on page 1 must not be used except when storage is contemplated; in such case Paragraph 4 (first line) should indicate the time in each year during which the water will be released and used. The lands to be inundated by the reservoir must be described in the space below this note as nearly as may be and by government subdivisions if upon surveyed land, and the area of the reservoir when at full stage should be given in acres.

If the Reservoir is Located on the Channel of the Source from which the water is to be appropriated, it should be so stated in the space below, and—

1. The location of the center of the impounding dam should be described in Paragraph 7.
2. The point where the released storage will be rediverted from the natural stream should be described in the space below in accordance with the note under Paragraph 7.

When Water is Not Stored in the Natural Channel of the Source from which it is to be appropriated, it should be so stated in the space below, and—

1. The point of diversion from the supplying source should be described in Paragraph 7.
2. The center of the impounding dam and the point where the released storage will be rediverted from a natural channel should be described below in accordance with the note under Paragraph 7.

In all cases Paragraphs 8 to 18, inclusive, should describe the entire diverting works, exclusive of natural channels and laterals, even if already constructed in whole or in part.

If Application is Made for the Water of a Number of Springs, or other sources collected at a common point, said point should be described as the point of diversion in Paragraph 7 and the point of diversion from each source should also be described below, in accordance with the note in Paragraph 7. The quantity of water sought from each source should be indicated below ,the total equaling the quantity specified in Paragraph 3. Where the source of supply is in reality a spring area, the point of diversion is the point where the water is collected; in such case the exterior boundary of the spring area must be described below by metes and bounds and located with reference to a point as outlined by the note under Paragraph 7.

The following additional facts are set forth in order to define more clearly the full purpose of the proposed appropriation:

The purpose of the water proposed for appropriation in this application is to provide a stock watering facility in a large area of Federal range land, grazed by 15,000 sheep and 500 cattle.

The quantity of water sought to be appropriated will be limited to that which can be beneficially used for the purposes herein described.

It is the principal intent of the Grazing Service, in seeking to perfect title to the water from this well, to protect and insure the availability of this important stock-watering resource for future public use.

United States of America - U.S. Grazing Service
/s/ By: M. W. Peterson
Acting Regional Grazier
*Signature of Applicant**

*If applicant is a corporation or other organization, signature must be in the name of such corporation or organization by its proper officer. If a corporation, the affidavit below need not be filled in. If there are more than one applicant, a power of attorney, authorizing one to act for all should accompany the Application.

STATE OF UTAH, } ss.
County of Salt Lake

On the 24th day of September, 1945, personally appeared before me, a notary public for the State of Utah, the above applicant who, on oath, declared that he is a citizen of the United States.

/s/ Helen U. Tuddenham
Notary Public.

My commission expires (SEAL) 2/23/47

(Seal)

In view of the President's Reorganization Plan No. 3 of 1946 and Departmental Order No. 2225 of July 15, 1946, the words "Grazing Service" and "Director of Grazing" should be construed to mean respec...y "Bureau of Land Management" and "Director, Bureau of Land Management."

Form F—3-10-44—1000

Grazing District #3
Proj #2-C-141

Application No. 16972

Application to Appropiate Water for Stock Watering

STATE OF UTAH

69-21

Do not fill out this blank until you have read carefully and thoroughly understand the Rules and Regulations on the back hereof and all the notes in the body of it.

For the purpose of ~~acquiring~~ the right to use a portion of the unappropriated water of the State of Utah, for stock watering purposes, Application is hereby made to the State Engineer, based upon the following showing of facts, submitted in accordance with the requirements of the Laws of Utah.

Note.—The information given in the following blanks should be free from explanatory matter, but when necessary a complete supplementary statement should be made on the following page under the heading "Explanatory."

1. *The name of the applicant is* United States ~~of America - U.S. Grazing Service~~ Bureau of Land Management
2. *The post-office address of the applicant is* P.O. Box ~~1046~~ #659, Salt Lake City 10, Utah
3. *The quantity of water to be appropriated is* .05 *second-feet or* ______ *acre-feet* (See note on following page)
4. *The water is to be used each year from* Jan. 1 (Month) (Day) *to* Dec. 31 (Month) (Day) *incl.,*

   and stored each year (if stored) from ______ (Month) (Day) *to* ______ (Month) (Day) *incl.*
5. *The drainage area to which the direct source of supply belongs is* Sevier River (Leave blank)
6. *The direct source of supply is*† Underground water (Name of stream or other source)

   which is tributary to ______, *tributary to* ______

†Note.—Where water is to be diverted from a well or a tunnel, the source should be designated as "Underground Water" in the first space and the remaining spaces should be left blank. If the source is a stream, a spring, a spring area, or a drain, so indicate in the first space, giving its name, if named, and in the remaining spaces, designate the stream channels to which it is tributary, even though the water may sink, evaporate, or be diverted before reaching said channels. If water from a spring flows in a natural surface channel before being diverted, the direct source should be designated as a stream and not a spring.

7. *The point of diversion from ~~stream, spring, spring area, drain~~, well (~~flowing or~~ pump), ~~tunnel~~,* (Strike words not needed)

   or ______ *is in* Millard *county, situated at a point**

   N38°45' E. 719' from the SW Cor. of Sec. 6, T23S, R12W., SLB&M.

*Note—The point of diversion must be located definitely and described with reference to a regularly established United States land corner or United States mineral monument, by rectangular co-ordinates, i.e., by giving the distance north or south and east or west, or by one course and distance therefrom if within a distance of six miles of either; otherwise to a prominent and permanent natural object. (Also see note at top of following page.)

No Application will be received in which the point of diversion is not described definitely. Any change made in this description after Application is received and before approved will bring down priority of Application to date when amendment is made of record in the State Engineer's office, if made after approval it must be by change application.

8. *The diverting and carrying works will consist of* cased well, depth 560', motor operated pump, ~~5,000~~ *5280 gallon metal storage tank, 100 lin. ft. metal trough together with ~~1½"~~ 3" connecting pipelines.
9. *The cross section of the diverting channel ~~will be~~ is* —⊔—⟍—⟋— O (Strike ones not needed)
10. *The diverting works and diverting channel ~~will be~~ are constructed of ~~earth, wood~~, iron, concrete.* (Strike words not needed)
11. *The length of the diverting channel, exclusive of laterals, ~~will be~~ is* ~~560~~ *590 *feet*
12. *The top width of the diverting channel will be (if a ditch)* ---- *feet*
13. *The bottom width of the diverting channel will be (if a ditch)* ----- *feet*
14. *The depth of water in the diverting channel will be (if a ditch)* ------- *feet*
15. *The width of the diverting channel will be (if a flume)* ------ *feet*
16. *The depth of water in the diverting channel will be (if a flume)* ------ *feet*
17. *The diameter of the diverting channel will be (if a pipe)* casing - 6¼" 3½" 2" *inches*
18. *The grade of the diverting channel will be* vertical & horizontal *feet per thousand*
19. *The number and kind of stock to be watered are as follows:* 15,000 sheep, 500 cattle

* See written proof

FORM C-1-A 2000

DUPLICATE

CERTIFICATE OF APPROPRIATION OF WATER
STATE OF UTAH

APPLICATION NO. 16972 **CERTIFICATE NO.** 3470

NAME AND ADDRESS OF APPROPRIATOR UNITED STATES OF AMERICA, BUREAU OF LAND MANAGEMENT, P. O. BOX 659, SALT LAKE CITY, UTAH

SOURCE OF SUPPLY UNDERGROUND WATER **IN** MILLARD **COUNTY, UTAH;** SEVIER RIVER **DRAINAGE AREA**

QUANTITY OF WATER FIVE/ONE HUNDREDTHS (0.05) SECOND-FOOT **PRIORITY OF RIGHT** OCTOBER 9, 1945

PERIOD AND NATURE OF USE FROM JANUARY 1 TO DECEMBER 31 INCLUSIVE OF EACH YEAR FOR STOCK-WATERING PURPOSES

Whereas, It has been made to appear to the satisfaction of the undersigned that the appropriation of water has been perfected in accordance with the Laws of Utah; Therefore, Be it known that I, ED. H. WATSON *the duly appointed, qualified and acting State Engineer, by authority of the Laws of Utah, do hereby certify that said appropriator is entitled to the use of water as herein set out, subject to prior rights, if any, for diversion and use as follows, to wit:*

The water appropriated is yielded by a pump well fully cased with 6¼-in. iron pipe, driven to a depth of 560 ft. below ground surface, situated N38°45'E 719 ft. from SW Cor. Sec. 6 T23S R12W SLB&M. The water is diverted by means of a gas operated pump, located directly over the well, discharging Northerly 10 ft. through 10 ft. of 2-in. galvanized iron pipe into a 5280 gallon circular metal storage tank. The water appropriated is, at the tank, intermittently released and conveyed by gravity Northerly 20 ft. through 3-in. galvanized iron pipe to a wood frame supported semicircular metal trough, 21-in. in diameter and 100 ft. long, where it is, during the entire year, used to water 15,000 head of sheep and 500 head of cattle.

The diverting and distributing works are to be operated and maintained in such manner and condition as will prevent waste of water.

In Witness Whereof, I have hereunto set my hand and affixed the seal of my office this 23rd *day of* March - - , 1948.

Ed. H. Watson,
STATE ENGINEER

Form L23 2M Star Printing, Ogden

THE STATE OF UTAH

OFFICE OF STATE ENGINEER

SALT LAKE CITY

March 23, 1948.

CERTIFICATE

U. S. Bureau of Land Management
P. O. Box 659
Salt Lake City, 1, Utah.

Gentlemen: REL: CERTIFICATE APPLICATION NO. 16972.

Enclosed is Certificate No. 3470 - - - issued by the State Engineer as the final step in completing the appropriation relating to Application No. 16972.

Under the law this Certificate must be recorded in the office of the County Recorder in the County where the water is diverted, within 30 days from the receipt hereof. You should attend to this matter at once.

Yours very truly,

ADDRESS ALL COMMUNICATIONS TO:

ba
enc.

STATE ENGINEER
STATE CAPITOL
SALT LAKE CITY 1, UTAH

BLACK HILLS WELL
UTAH DIST. 3

PROOF OF APPROPRIATION OF WATER
STOCK-WATERING WELLS

Application No. 16972

1. *The name of the appropriator is* United States of America - U.S. Grazing Service
2. *The post-office address of the appropriator is* P.O. Box 1046, Salt Lake City 10, Utah
3. *The quantity of water appropriated is* ~~.06~~ .05 *second-feet or* ~~27~~ *G.P.M.*
4. *The water is used each year from* Jan. 1 (Month) (Day) *to* Dec. 31 (Month) (Day) *incl.*
5. *The drainage area to which the direct source of supply belongs is* (Leave Blank)
6. *The direct source of supply is underground water in* Millard *County*
7. *The point of diversion from the well (~~flowing~~ pump) is** N 38°45' E, 719' from SW cor. of Sec. 6, T 23 S, R 12 W, of SLB&M.

*NOTE—Give the location of the well with reference to a United States land survey corner or mineral monument.

8. *The diverting works including well and distribution system consist of* drilled well, 560' deep, $6\frac{1}{4}$" cased, motor operated pump, pump house, 5280 gal. metal tank, 100' metal trough.
9. *Well depth* 560 *ft., diameter* $6\frac{1}{4}$ *inches, length of distributing system* Trough - 100' Pipe, 30 *ft. dia. of pipes* 2 & 3 *in., pump make* Myers, *diam. intake* 3 *in., diam. disch* 3 *in.*
10. *Hydrostatic level, at well is* 4236 *ft., at the outlet* 4442 *ft.*†

†NOTE—Use sea level datum where reference is on or near well, otherwise refer to distance above or below ground surface and a permanently established bench mark described under General Remarks.

11. *Elevation of ground surface at well* 4440 *ft.*
12. *Kind and number of each class of livestock watered* 15,000 sheep; 500 cattle
13. *The place where the water is used is*‡ $SW\frac{1}{4}SW\frac{1}{4}$ Sec. 6, T 23 S, R 12 W, SLB&M.

‡NOTE—Give place of use by legal subdivisions of section, township and range of United States land survey.

14. *Construction of well was commenced* 4-1, 19 44, *and completed* 11-13, 19 45
15. *Water from the well was first used* 11-13 19 45
16. *Water was measured by* O.P. DeJulio ~~M.P. Greaves~~ *Date* Feb. 14 19 46 *By vessel,* ~~*weir, meter or*~~ ** (Strike words not needed)

EXPLANATORY

In cases where water is drunk by the livestock in troughs or other drinking facilities at the well no maps or drawings need be submitted.

In cases where water is conveyed away from the well before being drunk, maps and drawings of the entire scheme must be submitted. They shall be on tracing linen sheets cut to the same size as the proof, attached thereto and mailed without folding. If maps are submitted they shall contain the certificate of the engineer in accordance with rules and regulations.

In any event a detail written description of the works and use of water beginning at and including the well, proceeding therefrom to each place of use must be submitted under "General Remarks," or if necessary, on a separate sheet the same size as the proof and attached thereto as a part of "General Remarks." Give length, dimensions and purpose of each type of diverting channel. If all works necessary to apply the water to use were constructed prior to the time of approval of the application herein described, so indicate and give a history of the development work. The log of the well, also description, including location of permanent bench mark, shall be given under "General Remarks".

**Sufficient data as to the measurement of water must be submitted in order to enable one to compute therefrom the actual flow of water appropriated, if by vessel the diameter and height to which filled and time elapsed, or if by current meter the discharge notes and meter rating table, if by weir, orifice, etc., the size, kind and height of opening, also head, must be submitted in detail.

Give details of pumping plant, including motor, under "General Remarks".

Read rules and regulations before preparing proof.

GENERAL REMARKS

The diverting works at the Black Hills Well consist of a drilled and cased well, $6\frac{1}{4}$ inches in diameter (I.D.) and 560 ft. in depth. Pumping equipment installations consist of 269 ft. of $3\frac{1}{2}$" (I.D.) column pipe and 6 ft. brass working barrel (Double Action) providing a total drawdown of 75 ft. The pump is a Myers sealed and self-oiling unit located directly over the well — ORD. operating on a 12-inch stroke and powered with an International 30 H.P. gas engine, by means of ~~x~~ 4 V-belts on grooved pulleys. The discharged water is delivered in a northerly direction through 10 ft. of 2-inch G.I.P. line to a circular metal storage tank 10' in diameter and 9' in height, with a capacity of 5280 gallons.

App. [illegible] .05 cfs

CERTIFICATE OF APPROPRIATOR

(Fill in blank spaces but do not sign until proof has been submitted to the State Engineer and accepted as sufficient.)

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

I, CHESLEY P. SEELY *being first duly sworn, do hereby certify that I am the* ~~xxxxxxxxxxxxxxxxx~~ Regional Chief, Division of Grazing, of the Bureau of Land ~~xx~~ Management ~~xxxx~~ *which made an Application to appropriate water from the underground supply in* Millard *county for stock-watering purposes; that said Application is filed in the State Engineer's office as No.* 16972 *; that the works necessary to accomplish the diversion and perfect the appropriation of water in accordance with the said Application have been completed; that the foregoing statement of facts ~~and the maps and drawings attached hereto~~ are submitted in proof of the completion of said works and the appropriation of said water; that I made the said statement and that each and all of the items contained therein are true to the best of my knowledge and belief.*

UNITED STATES OF AMERICA, Bureau of Land Management
By: Chesley P. Seely
Chesley P. Seely
Regional Chief, Division of Grazing. *Signature of Appropriator.*

Subscribed and sworn to before me this 19 *day of* Feb, 1948
(Seal)
My commission expires 5-13, 1950

Allen S Crow
Notary Public.

CERTIFICATE OF DISINTERESTED WITNESSES (One is to be the Engineer)

(Fill in blank spaces but do not sign until proof has been submitted to the State Engineer and accepted by him as sufficient.)

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

Howard G. Beehler *and* O. P. DeJulio *having both been duly sworn, each for himself says that he is personally acquainted with the works constructed by* United States of America *for the diversion and appropriation of water from the underground supply in* Millard *county for stock-watering purposes; that said works have been fully completed and used to the extent and in the manner particularly set forth in the foregoing statement of facts ~~and on the maps and drawings attached hereto~~; that he has read said statement and that each and all of the items therein contained are true to the best of his knowledge and belief.*

Howard G Beehler
Signature of Witness.

O P DeJulio
Signature of Witness.

Subscribed and sworn to before me this 19 *day of* Feb. 1948
(Seal)
My commission expires 5-13, 1950

Allen S Crow
Notary Public.

STATE ENGINEER'S ENDORSEMENTS

Dates

1. Oct. 9, 1945 *Application received in State Engineer's office; Approved* Jan 26 1946
2. Jan. 30, 1948 *Proof of Appropriation due in State Engineer's office.*
3. July 18 1946 *Proof received in State Engineers office by* [illegible]
4. Feb. 18, 1948 *Proof returned for correction by* FHC
5. Feb 24 1948 *Corrected proof resubmitted, received by* [illegible]
6.
7. Feb. 3, 1948 *Corrected proof examined and Certificate written by* [illegible]
8. Mar. 23, 1948 *Certificate of Appropriation issued (No.* 3470 *)*
9. not required *Fee for filing proof $1.00, received by .... Receipt No.*
10. *Fee for examining maps, if submitted, $5.00, received by .... Receipt No.*
11. *Fee for issuing Certificate $1.00, received by .... Receipt No.*

This proof complies with the requirements of the laws of Utah, and the same is hereby approved.

Mar 23, 1948 [illegible signature]
State Engineer.

Proof of Appropriation on Application No. 16972

1000 6-43

CERTIFICATE OF APPROPRIATOR

(Fill in blank spaces but do not sign until proof has been submitted to the State Engineer and accepted as sufficient.)

STATE OF UTAH, } ss.
COUNTY OF Salt Lake

I, CHESLEY P. SEELY *being first duly sworn, do hereby certify that I am the* ~~xxxxxxxxxxxxxxxx~~ Regional Chief, Division of Grazing, of the Bureau of Land ~~xx~~ Management ~~xxxx~~ *which made an Application to appropriate water from the underground supply in* Millard *county for stock-watering purposes; that said Application is filed in the State Engineer's office as No.* 16972 *; that the works necessary to accomplish the diversion and perfect the appropriation of water in accordance with the said Application have been completed; that the foregoing statement of facts ~~and the maps and drawings attached hereto~~ are submitted in proof of the completion of said works and the appropriation of said water; that I made the said statement and that each and all of the items contained therein are true to the best of my knowledge and belief.*

UNITED STATES OF AMERICA, Bureau of Land Management
By: Chesley P. Seely
Chesley P. Seely
Regional Chief, Division of Grazing.
Signature of Appropriator.

Subscribed and sworn to before me this 19 *day of* Feb. *, 19*48
(Seal)
My commission expires 5-13 *, 19* 50

Allen S. Crow
Notary Public.

CERTIFICATE OF DISINTERESTED WITNESSES (One is to be the Engineer)

(Fill in blank spaces but do not sign until proof has been submitted to the State Engineer and accepted by him as sufficient.)

STATE OF UTAH, } ss.
COUNTY OF Salt Lake

Howard G. Beehler *and* O. P. DeJulio *having both been duly sworn, each for himself says that he is personally acquainted with the works constructed by* United States of America *for the diversion and appropriation of water from the underground supply in* Millard *county for stock-watering purposes; that said works have been fully completed and used to the extent and in the manner particularly set forth in the foregoing statement of facts ~~and on the maps and drawings attached hereto~~; that he has read said statement and that each and all of the items therein contained are true to the best of his knowledge and belief.*

Howard G. Beehler
Signature of Witness.

O. P. DeJulio
Signature of Witness.

Subscribed and sworn to before me this 19 *day of* Feb. *, 19*48
(Seal)
My commission expires 5-13 *, 19*50

Allen S. Crow
Notary Public.

STATE ENGINEER'S ENDORSEMENTS

Dates

1. Oct. 9, 1945 *Application received in State Engineer's office; Approved* Jan. 26 *19*46
2. Jan. 30, 1948 *Proof of Appropriation due in State Engineer's office.*
3. July 18, 1946 *Proof received in State Engineers office by* [illegible]
4. Feb. 18, 1948 *Proof returned for correction by* [illegible]
5. Feb. 2, 1948 *Corrected proof resubmitted, received by* [illegible]
6.
7. Feb. 3, 1948 *Corrected proof examined and Certificate written by* [illegible]
8. Mar. 23, 1948 *Certificate of Appropriation issued (No.* 3470 *)*
9. not required *Fee for filing proof $1.00, received by .... Receipt No.*
10. *Fee for examining maps, if submitted, $5.00, received by .... Receipt No.*
11. *Fee for issuing Certificate $1.00, received by .... Receipt No.*

This proof complies with the requirements of the laws of Utah, and the same is hereby approved.

Mar. 23 , 19 48 [illegible signature]
State Engineer.

Proof of Appropriation on Application No. 16972

1000 6-43

From the tank the water is delivered by gravity in a northerly direction through 20 ft. of 3" G.I.P. line to 100 lin. ft. of semi-circular metal trough, 21 inches in diameter and a capacity of 900 gallons. The flow from the storage tank is controlled by a gate valve where the line leaves the tank. The trough system is suspended on a timber framework and the pumping system is housed in a 10' x 10' galv. corrugated metal building, set on a 12" concrete slab.

The diverted water is used to water 15,000 sheep and 500 cattle intermittently throughout the year.

The water measurement was made at the pump discharge by means of a metal vessel $9\frac{1}{4}$" square and $13\frac{1}{2}$" (I.D.) in depth. Four tests were taken after the pumping system had been in operation at maximum speed of 32 strokes per minute for 20 minutes, and flow was stabilized.

The results from four trails are as follows:

First filling ---	11 sec.
Second filling --	11 sec.
Third filling ---	11 sec.
Fourth filling --	11 sec.
Mean --	11 sec.

$$\frac{(9.25^2) \times (13.50)}{231} \times \frac{60}{11} = 27 \text{ G.P.M.}$$

$$\frac{27}{450} = .06 \text{ C.F.S.}$$

9.25
9.25
4625
1850
8325
85.5625
13.5
42780
25668
8556
231)1155.0 60 min (5,000 gls.
1155
.060

$\frac{5}{7.48 \times 11(83.25)}$ =
748
748
82.28)5.00,00(.0607 = .06 CFS.
49368
63200

ENGINEERS CERTIFICATE

(Proof covering Application No. 16972)

O.P. DeCluwo being first duly sworn, certifies that he supervised the compilation of information required for proof of appropriation under application 16972 : that the accompanying ~~map, consisting of one sheet~~, TIES AND ENGINEERING DATA ~~has been correctly drawn to the designated scales~~ ARE TAKEN from field notes of a survey made by HIM on FEB. 14-46, ~~and on~~ ______________ : that this ~~map, when combined with the~~ written proof, correctly and fully represents the location, extent, and nature of the works used to divert water under application No. 16972 and shows such other related information as fully and correctly delineates the work done to appropriate the water as required by law.

[illegible signature]

Subscribed and sworn to before me

this 11th day of March 1948.

[illegible signature]
Notary Public

My Commission Expires: July 1, 1951

MAY 13 1946
State Engineer's
Office

RE: No.* ____
Well Driller* ____

State Engineer:

(Date) May 10, 1946

On or about May 10, 1946 I will commence drilling [X], cleaning [ ], repairing [ ], or deepening [ ], a
(By check ✓ note the work you propose to do)
6" inch ~~well~~, covered by Application or ~~Claim No.~~ A16972
for Bat Alred [illegible] located approx 6 miles South East of Black Rock Utah

Vernon Dimick
Well Driller

*Leave blank

Report No. 4911

Listed on well record
Listed by counties
Copied gh 4-22-47
Exam. & Recorded M.K. 4-21-47
Exam. for filing
Final Copy checked gh 4-25-47
Platted & No. Assigned
Indexed gh 4-22-47
Engr. filed well
Engr. on DH
Well No.

Report No. 4313
Filed Jan 10, 1946
Rec. By counter
Ret'd USH

PAGE
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Report of Well and Tunnel Driller

STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel~~
(Strike words not needed)
Gerald Cazier, Nephi, Utah, Driller.

2. Name and address of owner of well ~~or tunnel~~ U. S. Grazing Service, (Fillmore, Ut.)
(Strike words not needed)
P.O.Box 1046, S.L.C.-10-

3. Source of supply is in Millard County;
drainage area; artesian basin
(Leave blank) (Leave blank)

4. The number of approved application to appropriate water is ~~One~~ 16972

5. Location of well ~~or mouth of tunnel~~ is situated at a point
T. 23S., R. 12W. Sec. 6; N.38°45" E. 719' of SW corner
Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy descripton from well owner's approved applcation)

6. Date on which work on well ~~or tunnel~~ was begun April 23 1945
(Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ July 11, 1945
(Strike words not needed)

8. Maximum quantity of water measured as ~~flowing~~, pumped or on completion of
(Strike words not needed)
well ~~or tunnel in sec. ft.~~; or in gals. per minute about 12 Date

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ pump well. Temperature of water °F.
(Strike words not needed)

(a) Total depth of well is 560 ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

(c) If pump well, give depth from ground surface to water surface before pumping 210 ft.; during pumping 210 ft

(d) Size and kind of casing 6 in
(If only partially cased, give details)

(e) Depth to water bearing stratum 1 ft.
(If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations

(g) Log of well 559 feet through heavy greasy white clay then one foot of water to bed rock.

(h) Well was equipped with ~~cap, valve~~, or to control flow.
(Strike words not needed)

(Over)

10. **TUNNEL:** It is timbered, tiled, piped, open, bulkheaded, covered or
(Strike words not needed)

(a) Dimensions; total length; temperature of water °F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel

(c) Log of tunnel

11. **GENERAL REMARKS:** (Note any general or detailed information not covered above.)

STATE OF UTAH,
COUNTY OF Juab } ss.

I, Gerald Cazier, being first duly sworn, do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Gerald Cazier
Driller

~~Subscribed and sworn to before me this~~ Witnessed 7 day of Jan, 1946

N A K Hansen
~~Notary Public~~
Bert Cazier

(SEAL)

My Commission Expires:

JAN 10 1946
State Engineer's Office

Listed on well record
Listed by counties
Copied rgh 2-12-47
Exam. & Recorded M.V. 12-23-46
Exam. for filing
Final Copy checked rgh 2-20-47
Platted & No. Assigned
Indexed rgh 2-17-47
Engr. tied well
Engr. set BM
Well No. C-23-12) 6 ccc-1

Report No. 4911
Filed October 19, 1946
Rec. By McKim
Ret'd

PAGE
(Leave Blank)

8.12 186

Report of Well and Tunnel Driller

STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel.~~ (Strike words not needed)
Vernon Rinick Monti Utah

2. Name and address of owner of well ~~or tunnel~~ (Strike words not needed) U.S. (Government) Grazing Service Federal Bldg (Black Rock) Utah

3. Source of supply is in Millard County;
drainage area; (Leave blank) artesian basin (Leave blank)

4. The number of approved application to appropriate water is 16972

5. Location of well ~~or mouth of tunnel~~ is situated at a point
N. 38°45' E.719' from SW Cor. Sec.6 T23 S. R12 W., SLB&M

Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy descripton from well owner's approved applcation)

6. Date on which work on well ~~or tunnel~~ was begun May 11 - 1946 (Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ 5/17/46 (Strike words not needed)

8. Maximum quantity of water measured ~~as flowing,~~ pumped or .... on completion of well ~~or tunnel in sec. ft.~~ ....; or in gals. per minute 5 Date 5/17/46 (Strike words not needed)

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ pump well. Temperature of water 49 °F. (Strike words not needed)

(a) Total depth of well is 60' ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface .... ft.

(c) If pump well, give depth from ground surface to water surface before pumping 27'; during pumping 50'

(d) Size and kind of casing 6" New Standard Pipe (If only partially cased, give details)

(e) Depth to water bearing stratum 51' (If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations 50 to 59

(g) Log of well 0-20 Top soil with fine gravel 20-48 Try colored Clay 48-51 Hard gravely formation 51-60 fine Gravel & Water

(h) Well was equipped with cap, valve, or .... to control flow. (Strike words not needed)

(Over)

10. **TUNNEL:** It is timbered, tiled, piped, open, bulkheaded, covered or
(Strike words not needed)

(a) Dimensions ; total length ; temperature of water °F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel

(c) Log of tunnel

11. **GENERAL REMARKS:** (Note any general or detailed information not covered above.)

RECEIVED
OCT 19 1946
State Engineer's
Office

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

I, Vernon L. Dimick, being first duly sworn,
do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Vernon L. Dimick
Driller

Subscribed and sworn to before me this 19 day of October, 1946.

Laurence C. Monson
Notary Public

(SEAL)

My Commission Expires:
July 18 1948

October 15, 1945

RE: APPLICATION NO. 16972 (S-16, p.186)

Memorandum for Office Study Only, by J. A. WARD

APPLICANT: United States of America - U. S. Grazing Service, P. O. Box 1046, Salt Lake City 10, Utah

SOURCE: Underground Water - Millard County

AMOUNT & USE: 0.05 sec. ft. - Stock Watering

RECEIVED: October 9, 1945

COMMENT: In Application No. 16972 it is proposed to divert 0.05 sec. ft. of water for 15,000 head of sheep and 500 head of cattle, from a well 6¼ inches in diameter and 560 feet deep, located at (C-23-12)6ccc-1, the tie being N.38°45' E, 719 ft. from SW Cor. Sec. 6, T23S, R12W, SLB&M.

Water will be pumped from the well into a 5,000 gallon metal storage tank and 100 lineal feet of metal troughs.

This well is to be known as the "Black Hills Well", Grazing District #3.

This well was completed during the summer of 1945 and was originally covered by Application No. 15551, which was approved July 26, 1944. However, due to the change in the location of the well it is requested by the applicant that the original Application No. 15551 be withdrawn upon approval of the revised Application No. 16972, which contains the final corrected location of the diversion point.

+The application is recommended for advertisement.

JAW/mv J.A.W.

6/17/46

NOTICE TO WATERS PUBLISHED in Millard County Chronicle, Delta, Utah, from Feb. 21 to March 21, 1946. Protesting Period ended April 20, 1946, with no protests filed.

R.E.R.

RER/le

(C-24-13) 23ccc-1
FRISCO PK.
ccd-1(JRS)
384215113165701

WA-B-7
~~SL-B-2~~ (N
~~FL-B-~~14

FUGRO NATIONAL, INC.
Consulting Engineers and Geologists

LOG OF OBSERVATION WELL NUMBER ~~FL-B-~~14
PAGE 1 OF 1

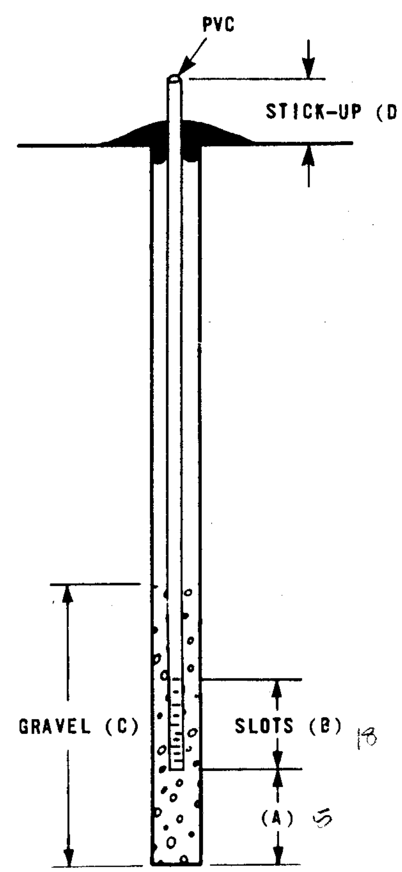
PROJECT NUMBER 78-280-61
LOGGED BY Ron Whitler DATE 10-10-79
PROJECT NAME MX-SITING INVESTIGATION
CHECKED BY V.SHUPE DATE 10.21.79
DRILLING COMPANY Tex Jones
NO. OF SAMPLES 23
DRILL SIZE; METHOD 4 7/8", rotary wash
DRILLER: Frank Frantz

1169003M00

WIN#
435375

Details of Observation Well:

1. Total Depth 200.5 feet
2. Date started 10-8-79
3. Date Completed 10-10-79
4. Drilling Mud Used Revert - 1 bag
5. Diameter of PVC 2"
6. Distance from PVC Tip to Bottom of Hole (A) 5 feet
7. Length of PVC with Slots (B) 18 feet
8. Height of Gravel-pack (C) 35 feet
9. PVC Stick-up (D) 2 1/2 feet
10. Backfill above Gravel none
11. Remarks: Used 1200 gallons of water from Wah-Wah Well; used 5 sacks of Pea gravel.



AF-28 7/79

FUGRO NATIO[illegible]AL
Consulting Engineers and Geologists

FIELD LOG OF [illegible]ING NUMBER ~~SC-B-2~~ ~~TL-B-14~~ (N)
WA-B-7 (N)
PAGE 1 OF 11

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28"-30"

LOGGED BY Ron Whitler DATE 10-8-79
CHECKED BY V. Shupe DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME 15:00 (SET UP) 15:30 (START) 18:00 (STOP)

Sample	FT	Bulk	Core	Tip Depth	Recovery	Blowcount	Moisture	Consistency	Color	USCS Symbol	GR	SA	FINES	Description
D-1	1–2.5		■	2.5	0.5 ~~1.5~~ 1.5	7 8 13	D	Soft	White	MH MH Silt	0 0	4 2	96 95	CLAYEY SILT, ~~slight~~ high plasticity, tr. fine subang-subr sand; strong HCl. High % of $CaCO_3$ + evaporites. LL=57, PI=14
D-2	3.5–5		■	5.0	0.65 ~~1.5~~ 1.5	4 5 6	SM	Soft	Grey	CL	0	9	91	CLAY, med. plasticity; fine subang-subr. sand; strong HCl. Voids-dessication cracks.
change D-3	5–6.5		■	6.5	0.5 ~~1.5~~ 1.5	5 9 14	M	MD	br.	SP	8	90	2	SAND, fine-coarse, poorly graded, subang-subr. fine subang-subr. gravel; tr. silt; strong HCl.
D-4	8–9.5		■	9.5	0.5 ~~1.5~~ 1.5	13 17 24	SM	MD	br.	SP SP	9 3	89 94	2 3	SAND, fine-coarse, poorly graded, subang-subr; fine subang-subr. gravel; tr. nonplastic silt; strong HCl
D-5	10–11.5		■	11.5	0.5 ~~1.5~~ 1.5	13 16 8	SM	MD	br.	SM	8	52	40	SILTY SAND, fine-coarse, subang-subr., non-slightly plastic silt; fine subang-subr. gravel; strong HCl; caliche stage II. Composition of each rings is highly variable.
P-6	15–17.5		■	17.5	1.2 2.5	100 PSI	SM	S	Grey	CL [illegible] Clay	0 [illegible]	6	94 [illegible]	CLAY, med. plasticity; fine subang-subr. sand; strong HCl. LL=53, PI=34

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER ~~WA-B-7~~ ~~FL-B-14~~ WA-B-14 (N)

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 AVERAGE DROP 28"-30"

LOGGED BY Ron Whitler DATE 10-9-79
CHECKED BY V. Shupe DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP — START 6:15 — STOP 19:00

10-9-79 drillers left Delta 5:00 arrived at site 6:15 left site ~19:00. Arrived Delta - 20:30

FT		SAMPLES: BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	GR	SA	FINES	DESCRIPTION
20														
1	P-7		▮	~~22.5~~	1.3 / 2.5	100 PSI	M	VS	Green	CL	0	7	93	CLAY, med. plasticity; fine subang- subr. sand; weak HCl.
2				22.5										↓
3														
4														
25	P-8		▮		1.8 / 2.5	100 PSI	M	S	Green	CL	0	8	92	CLAY, med plasticity; fine subang.- subr sand; weak HCl. Gypsum near top of sample.
6														
7				26.8										↓
8														
9														
30	P-9		▮		2.6 / 2.5	100 PSI	M	VS	Green	CL	0	6	94	CLAY, med plasticity; fine subang.- subr sand; weak HCl.
1														
2				32.6										↓
3														
4														
35	P-10		▮		2.4 / 2.5	100 PSI	M	VS	Green	CL	0	6	94	CLAY, med plasticity, fine subang- subr. sand; weak HCl.
6														
7				37.4										↓
8														
9														
40														

REMARKS:

AF/01 3-77

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID —
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD
DRIVING WEIGHT 335 AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-9-79
CHECKED BY V. SHUPE DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP ___ START 6:15 STOP 19:00

FT	SAMPLES BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
40													↓
45				0	100 PSI	M	VS	Grey	CL	0	6	94	No recovery - fell out of Tube - this box of tubes has been poorly crafted, we are loosing portions of all of the Pitcher Tube samples
47			47.5										
48 (b-11)	X					M	VS	Grey	CL	0	5	95	CLAY, med. plasticity; fine subang-subr sand; strong HCl.
50													↓
55 (P-12)		■		2.5 / 2.5	100 PSI	M	S	br.	CL	0	7	93	CLAY, slight-med plasticity; fine subang-subr sand; strong HCl.
57			57.5										
60													↓

REMARKS:

FUGRO NATIO[illegible]AL
Consulting Engineers and Geologists

FIELD LOG OF [illegible]RING NUMBER TL-B-14 (N)

PAGE 4 OF 11

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-9-79
CHECKED BY V. Shupe DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP ______ START 6:15 STOP 19:00

	FT	SAMPLES BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
	60													
	1													
	2													
	3													
	4													
	65				2.5/2.5	150 PSI	M	VS	Grey	CL	0	6	94	CLAY, med. plasticity; fine subang-subr. sand;
P-13	6													
	7			67.5										
	8													
	9													
	70													
	1													
	2													
	3													
	4													
	75					150 PSI	VSM	VS	Grey	CL	0	6	94	CLAY, med. plasticity; fine subang-subr. sand; strong HCl.
P-14	6				2.4/2.5									
	7			77.4										
	8													
	9													
	80													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PAGE 5 OF 11

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" tricone; rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-9-79
CHECKED BY V. SHUPE DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP ___ START 6:15 STOP 19:00

FT	SAMPLES: BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
80													
85 (P-15)				2.3 / 2.5	150 PSI	SM	VS	Grey	CL	0	12	88	SANDY CLAY, slight plasticity; some silt; fine subang-subr. sand; strong HCl.
87			87.5										
90													
95													
96 (P-16)				0 / 2.5	150 PSI								No recovery - sample slipped out of tube - will take drive sample at 100' to insure recovery.
97			97.5										
100													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID

DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-9-79
CHECKED BY N. SHUPE DATE 10.21.79

DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP START 6:15 STOP 19:00

	FT	BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
	10 0						SM	VS	br.	CL	0	8	92	CLAY, slight-med. plasticity; fine subang-subr. sand; strong HCl.
P-16	1					150 PSI								
	2			1025	2.4/2.5									
	3													
	4													
	5													
	6													
	7													
	8													
	9													
	11 0					300 PSI	SM	S	br.	CL	0	7	93	CLAY, med plasticity; fine subang-subr. sand; strong HCl. A portion of the sample slipped out of the tube.
P-17	1				1.4/2.5									
	2			1125										
	3													
	4													
	5													
	6													
	7													
	8													
	9													
	0													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PAGE 7 OF 11

PROJECT NUMBER 78-280- 61

PROJECT NAME MX-SITING INVESTIGATION

U.T.M. GRID -

DRILLING COMPANY Tex Jones

DRILL SIZE; METHOD 4 7/8" rotary wash

DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-9-79

CHECKED BY V. SHUPE DATE 10.21.79

DATE (S) ______ ELEVATION ______

DATUM ______

WATER LEVEL ______ AFTER ______ HOURS

TIME ______ (SET UP) 6:15 (START) 19:00 (STOP)

FT	SAMPLES: BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
12 0													
P-18 1				1.3 / 2.5	300 PSI	M	VS.	br.	CL	0	6	94	CLAY, med plasticity; fine subang-subr. sand; strong HCl.
2			122.5										
3													
4													
5													
6													
7													
8													
9													
13 0				0.7 ~~1.5~~	25	SM	VS	Grey	CL CH	0 0	12 7	88 90	CLAY, med. plasticity; fine subang- subr. sand; HCl.
D-19 1			131.5	1.5	50 75								LL=53 PI=29
2													
3													
4													
5													
6													
7													
8													
9													
0													

REMARKS:

AF/01 3-77

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PROJECT NUMBER 78-280-61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID -
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-10-79
CHECKED BY V. Shupe DATE 10.21.79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME: SET UP left delta; START 6:00; STOP 16:00, 4:45

start drilling - 6:00 (@160FT.
Completed hole 16:00 - mobed to Baker to repair rig.

FT	BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
140													
1													
2													
3													
4													
145				1.3	25	SM	VS	br.	CL	0	7	93	CLAY, med plasticity;
D-20 6		■		1.5	45								fine subang - subr. sand;
			146.5		30-3"								strong HCl.
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
160													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)
PAGE 9 OF 11

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary
DRIVING WEIGHT ____ AVERAGE DROP ____

LOGGED BY Ron Whitler DATE 10-10-79
CHECKED BY V. SHUPE DATE 10.21.79
DATE (S) ____ ELEVATION ____
DATUM ____
WATER LEVEL ____ AFTER ____ HOURS
TIME ____ (SET UP) 6:00 (START) 16:00 (STOP)

FT	BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	GR	SA	FINES	DESCRIPTION
16 0				0.5/	30	SM	VS	br.	CL	0	6	94	CLAY, med. plasticity;
				1.5	60								fine subang- subr. sand;
D-2 1			161.5		30-30"								strong HCl.
2													
3													
4													
5													
6													
7													
8													
9													
17 0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
18 0													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PAGE 10 **OF** 11

PROJECT NUMBER 78-280- 61

PROJECT NAME MX-SITING INVESTIGATION

U.T.M. GRID

DRILLING COMPANY Tex Jones

DRILL SIZE; METHOD 4 7/8" rotary wash

DRIVING WEIGHT 335 AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-10-79

CHECKED BY Y. SHUPE DATE 10·21·79

DATE (S) ELEVATION

DATUM

WATER LEVEL AFTER HOURS

TIME SET UP START STOP

FT	BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	PERCENT GR	SA	FINES	DESCRIPTION
17 0													
1													
2													
3													
4													
5													
6													
7													
8													Change at 180.5'
9													
18 0				.8	60	M	S	Grey	CL	0	11	89	SILTY CLAY, Slight PI,
)-22 1			180.8	1.0	43-3"				SM	20	58	22	SILTY SAND, fine-med. nonplastic silty fine
					R								subang-subr. gravel; weak HCl. Composition of
2													rings vary.
3													
4													
5													
6													
7													
8													
9													
19 0													

REMARKS:

FUGRO NATIONAL
Consulting Engineers and Geologists

FIELD LOG OF BORING NUMBER TL-B-14 (N)

PROJECT NUMBER 78-280- 61
PROJECT NAME MX-SITING INVESTIGATION
U.T.M. GRID
DRILLING COMPANY Tex Jones
DRILL SIZE; METHOD 4 7/8" rotary wash
DRIVING WEIGHT 335 lbs AVERAGE DROP 28-30"

LOGGED BY Ron Whitler DATE 10-10-79
CHECKED BY V. SHUPE DATE 10·21·79
DATE (S) ELEVATION
DATUM
WATER LEVEL AFTER HOURS
TIME SET UP START STOP 11:00

FT	BULK	CORE	TIP DEPTH	RECOVERY	BLOWCOUNT	MOISTURE	CONSISTENCY	COLOR	USCS SYMBOL	GR	SA	FINES	DESCRIPTION
190													
1													
2													
3													
4													
5													
6													
7													
8													
9													
200		■		~~.8~~ 0.5	60	M	VD	br.	SM	0	75	25	SILTY SAND, fine, some med, poorly graded, subang-subrd, nonplastic silt, weak HCl.
1 (D-23)			200.0	1.0	45 3"								
2													
3			T.D. 200.5 FT.										
4													Finished drilling at 8:30, rig left at 10:00, finished cleanup, getting load of water, moving water truck to next site 11:00. Water truck driver left for Baker 11:00. 13:00 - rig arrived in Baker - left rig to have tub + table ram welded
5													
6													
7													
8													
9													Used 1200 gallons of water from Wah-Wah Well.
0													

REMARKS:

AF/01 3-77

RECEIVED

MAY 21 1979

WATER RIGHTS

FORM 40

STATE OF UTAH

PROOF OF APPROPRIATION OF WATER

Do not fill out this blank until you have read carefully the Instructions in the body and on the back hereof.

Application No. 52186 71-3440

1. Irrigation ☐ Domestic ☐ Stockwatering ☒ Municipal ☐ Power ☐ Mining ☐ Other Uses ☐
2. The name of the appropriator is United States of America, Bureau of Land Management
3. The post-office address of the appropriator is Box 768, Richfield, Utah 84701
4. The quantity of water appropriated is .015 second-feet or .... acre-feet
5. The water is used each year for stockwatering from October 15 to May 1
   other use period for wildlife watering from January 1 to December 31
   and stored each year (if stored) .... from .... to .... (MONTH/DAY) (MONTH/DAY)
6. The drainage area to which the direct source of supply belongs is: .... (LEAVE BLANK)
7. The direct source of supply is† underground water (mudhole well) (NAME OF STREAM OR OTHER SOURCE)
   which is tributary to ...., tributary to ....

†Note—When diverted from underground sources list as "underground water" and show the means by which it is diverted such as well, underground drain, or tunnel. If the water is to be taken from a stream, spring, spring area, or surface drain, so indicate, giving its name, and the stream channels to which it is tributary.

8. The point of diversion from ~~stream, spring, spring area, drain,~~ well (~~flowing or~~ pump), ~~tunnel, or~~ (STRIKE WORDS NOT NEEDED) is in Millard county, situated at a point* 1252 Feet South and 570 Feet East of the West ¼ Corner of Section 29, T. 19 S, R. 9 W., Salt Lake Base and Meridian (Approximately 14 miles west of Clear Lake)

*NOTE—Locate the point at which water is first diverted from its source or channel with reference to the same tie corner used in the approved application. In case of storage on the natural channel, or diversion by means of dam, describe the point of intersection of stream bed with the center line of the impounding or diverting dam. If a spring area, describe the point at which water is collected and diverted therefrom, and under General Remarks give a description of closed traverse by metes and bounds of said area.

9. The diverting and carrying works consist of 6" steel cased well with water pumped by a 3/4 h.p. submersible pump into a 16 foot diameter 24 in. deep galv. steel tank.
10. If water is used for irrigation purposes, give legal subdivisions of land irrigated N/A
    ....Total area irrigated is .... acres.
11. If water is used for power purposes, describe the type of power plant used N/A
12. If water is used for mining purposes, give the name of the mine, the mining district, and the uses made of the water N/A
13. If water is used for stockwatering purposes, give the number and kind of stock watered 1,800 cattle and 6,000 sheep
14. If water is used for domestic purposes, give number of families served N/A
15. If water is used for municipal purposes (a) give name of municipality N/A
    .... (b) If municipality serves areas outside of corporate limits, describe legal subdivision served and uses made of water ....
16. If water is used for other purposes, give a general description of such uses Water for resident 25 head antelope herd (year round) and local birds and small mammals.
17. Give place of use by legal subdivisions for all uses described in paragraphs 11 to 16 inclusive NW¼, SW¼, Section 29, T. 19S, R9W, SLB&M
18. The point where the water is returned to the natural channel, if returned, is situated N/A
19. The water is used supplementally to the following rights None
20. Construction of works was commenced* April 30 1979, and completed May 5 1979
    *Date of first work subsequent to aproval of application.
21. Works were first used to convey water May 5, 1979
22. Water was measured by Lynn J. Bernhard (NAME OF HYDROGRAPHER) Date ...., 19....
23. Water was measured by ~~vessel, weir, reservoir capacity, or by~~ .... (STRIKE WORDS NOT NEEDED)

‡(Give sufficient data under "General Remarks" to enable State Engineer to check the water measurements. It is necessary that the results of a series of such measurements be given.)

RETURNED FOR CORRECTION

MICROFILMED

GENERAL REMARKS

(See Instructions on page 4)

Water flow was measured using 5 gallon capacity bucket with stopwatch.

The well was allowed to pump for 30 minutes and then the measurements were taken:

Trial	Time to Fill Bucket	Flow Rate (g.p.m.)
1	46.2 Sec.	6.5
2	45.0 Sec.	6.6
3	46.0 Sec.	6.5
4	45.8 Sec.	6.5

Average Flow = 6.5 gallons per minute

Average Flow = 0.0145 cubic feet per second

Submission of proof attested by:

X Applicant or his agent: Donald L. Reutteltow Date 5/16/79

Engineer: Lynn Jeffrey Bernhard PE Lynn J. Bernhard PE Date May 11, 1979

P.O. Address of Engineer: Box 768, Richfield, Utah 84701

License Number: 4161

Form 113—5M—12-6

Examined ....
Recorded: B. C. .... T. B. ....
Inspection Sheet ....
Copied ....

71-2453
3440

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. C 81977
Claim No. ....
Coordinate No. ....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name U.S. Department of the Interior
Address Bur. of Land Management Fillmore Utah

(2) LOCATION OF WELL:
County Millard Ground Water Basin .... (leave blank)
North/South ? feet, East/West ? feet from SW/4 Corner of Section 29, T 19 S, R 9 W USM (strike out words not needed)

(3) NATURE OF WORK (check):
New Well ☐ Replacement Well ☒ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: ....

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☒
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE:
Threaded ☐ Welded ☒
6" Diam. from 0 feet to 503 feet Gage 281
.... " Diam. from .... feet to .... feet Gage ....
.... " Diam. from .... feet to .... feet Gage ....
New ☒ Reject ☐ Used ☐

(7) PERFORATIONS:
Perforated? Yes ☒ No ☐
Type of perforator used Mills
Size of perforations .... inches by .... inches
60 perforations from 338 feet to 365 feet
30 perforations from 480 feet to 503 feet
.... perforations from .... feet to .... feet
.... perforations from .... feet to .... feet
.... perforations from .... feet to .... feet

(8) SCREENS:
Well screen installed? Yes ☐ No ☒
Manufacturer's Name ....
Type .... Model No. ....
Diam. .... Slot size .... Set from .... ft. to ....
Diam. .... Slot size .... Set from .... ft. to ....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☐ Size of gravel: ....
Gravel placed from .... feet to .... feet
Was a surface seal provided? Yes ☐ No ☐
To what depth? .... feet
Material used in seal: ....
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: .... Depth of strata ....
Method of sealing strata off: ....

Was surface casing used? Yes ☐ No ☒
Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:
Static level 20' feet below land surface Date May 20
Artesian pressure .... feet above land surface Date ....

LOG RECEIVED:

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:
Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☒ If so, by whom? ....
Yield: .... gal./min. with .... feet drawdown after .... hours
" .... " .... " .... "
" .... " .... " .... "
Bailer test 30 gal./min. with 20 feet drawdown after 8 hours
Artesian flow .... g.p.m. Date ....
Temperature of water .... Was a chemical analysis made? No ☒ Yes ☐

(13) WELL LOG:
Diameter of well 6" inches
Depth drilled 503 feet. Depth of completed well 503 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

From	To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	14	X	X									Grey. (water 14 ft)
14	60	X	X	X								Mostly clay
60	110	X	X	X								L. Brown
110	140	X	X	X								Grey
140	168	X	X	X								Rock color.
168	240	X	X	X								L. Grey
240	268	X	X	X								L. Brown
268	300	X										Grey.
300	338	X		X								L. Br & L. Grey clay
338	360	X	X	X								Black clay water showing
360	375	X		X								Grey - Fine sand
375	412	X		X								" sand showing
412	420	X										Grey
420	435	X	X	X								Grey clay fine sand
435	450	X		X								Clay
450	475	X	X	X								Grey
475	495	X										Grey clay
495	503	X		X								Grey.

Work started May 4, 1972 Completed May 20, 1972

(14) PUMP:
Manufacturer's Name ....
Type: .... H. P. ....
Depth to pump or bowles .... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Scott Stephenson Drilling Co.
(Person, firm, or corporation) (Type or print)
Address Box 141 Fillmore Utah 84631
(Signed) Scott Stephenson
(Well Driller)
License No. 106 Date May 22, 1972

USE OTHER SIDE FOR ADDITIONAL REMARKS

MICROFILMED

(Wah Wah Well)
Utah District 3.

Form F—7-46 7,000

Application No. 20214

Application to Appropriate Water for Stock Watering

STATE OF UTAH

69-75

Do not fill out this blank until you have read carefully and thoroughly understand the Rules and Regulations on the back hereof and all the notes in the body of it, as well as the Rules and Regulations in pamphlet form promulgated by the State Engineer.

For the purpose of acquiring the right to use a portion of the unappropriated water of the State of Utah, for stock watering purposes, Application is hereby made to the State Engineer, based upon the following showing of facts, submitted in accordance with the requirements of the Laws of Utah.

Note.—The information given in the following blanks should be free from explanatory matter, but when necessary a complete supplementary statement should be made on the following page under the heading "Explanatory."

1. *The name of the applicant is* United States of America, Bureau of Land Management

2. *The post-office address of the applicant is* P. O. Box 659, Salt Lake City, Utah.

3. *The quantity of water to be appropriated is* ~~.05~~ * 0.0467 *second-feet or* .... *acre-feet* (See note on following page)

4. *The water is to be used each year from* January 1 (Month) (Day) *to* December 31 (Month) (Day) *incl.*, *and stored each year (if stored) from* .... (Month) (Day) *to* .... (Month) (Day) *incl.*

5. *The drainage area to which the direct source of supply belongs is* Sevier River (Leave blank)

6. *The direct source of supply is*† Underground water (Name of stream or other source) *which is tributary to* ~~Sevier Lake~~, *tributary to* ....

†**Note.**—Where water is to be diverted from a well, a tunnel, or a drain, the source should be designated as "Underground Water" in the first space and the remaining spaces should be left blank. If the source is a stream, a spring, a spring area, or a drain, so indicate in the first space, giving its name, if named, and in the remaining spaces, designate the stream channels to which it is tributary, **even though the water may sink, evaporate, or be diverted before reaching said channels.** If water from a spring flows in a natural surface channel before being diverted, the direct source should be designated as a stream and not a spring.

7. *The point of diversion from* ~~*stream, spring, spring area, drain,*~~ *well* ~~*(flowing or*~~ *pump),* ~~*tunnel, or*~~ (Strike words not needed) *is in* Millard *county, situated at a point** North 1233.3 ft., east 185 ft. from S.W. Corner Sec. 34, T. 24 S., R. 13 W., of S. L. B. & M.

***Note.**—The point of diversion must be located definitely by course and distance or by giving the distance north or south, and east or west, and described with reference to some United States land survey corner or United States mineral monument, if within a distance of six miles of either or if at a greater distance, to some prominent and permanent natural object. (Also see note on page 4.)

No Application will be received in which the point of diversion is not described definitely. Any change made in this description after Application is received and before approved will bring down priority of Application to date when amendment is made of record in the State Engineer's office, if made after approval it must be by change application.

8. *The diverting and carrying works* ~~*will*~~ *consist of* Drilled well, 294' deep, 6-1/4" dia., fully cased and equipped with motor, pump, 5000 gal. storage tank, and 94' metal trough.

9. *The cross section of the diverting channel* ~~*will be*~~ is are (Strike ones not needed)

10. *The diverting works and diverting channel* ~~*will be*~~ *constructed of* ~~*earth,*~~ *wood, iron, concrete.* (Strike words not needed)

11. *The length of the diverting channel, exclusive of laterals,* ~~*will be*~~ is 147 *feet*

12. *The top width of the diverting channel will be (if a ditch)* ---------- *feet*

13. *The bottom width of the diverting channel will be (if a ditch)* ---------- *feet*

14. *The depth of water in the diverting channel will be (if a ditch)* ---------- *feet*

15. *The width of the diverting channel will be (if a flume)* ---------- *feet*

16. *The depth of water in the diverting channel will be (if a flume)* ---------- *feet*

17. *The diameter of the diverting channel* ~~*will be*~~ is *(if a pipe)* 3½" - 3" - 6" *inches*

18. *The grade of the diverting channel* ~~*will be*~~ is vertical *feet per thousand*

19. *The number and kind of stock to be watered are as follows:* 11,000 sedentary sheep watered directly at well site, 6,000 transitory sheep in outlying range areas are watered by haulage from this well.

* See written proof.

EXPLANATORY

The following additional facts are set forth in order to define more clearly the full purpose of the proposed appropriation. If additional space is required under this paragraph, sheets cut the same size as this form folded should be added identified as "Explanatory Continued."

F.E.R.A. Well No. 4, also locally known as Wah-Wah Well, was drilled and equipped during the winter of 1934-35 under the Federal Emergency Relief Administration Program. In accordance with the provisions of that program, the facility was subsequently transferred to the former Grazing Service for future control and maintenance. Since its completion, this well has received heavy usage in supplying water for 11,000 sedentery sheep which graze in the North Wah-Wah Valley area in addition to providing water for sheep herds aggregating some 6000 transitory sheep in number which graze in the Crystal Peak and Black Hills areas, the supply for the latter being hauled by tank wagon from this facility.

The purpose of the appropriation as herein proposed is to protect and insure the future availability of this all important public range resource for the use of stockmen who are licensed by the Bureau of Land Management to graze livestock on the aforementioned areas of Federal range.

Although the amount of livestock to be watered at this facility may vary from time to time, the total quantity of water to be appropriated will not exceed that which can be beneficially used for the purposes herein described.

UNITED STATES OF AMERICA, Bureau of Land Management
By: /s/ H. Byron Mock
H. Byron Mock *Signature of Applicant**
Regional Administrator.

*If applicant is a corporation or other organization, signature must be in the name of such corporation or organization by its proper officer. If a corporation, the affidavit below need not be filled in. If there are more than one applicant, a power of attorney, authorizing one to act for all should accompany the Application.

STATE OF UTAH,
County of Salt Lake } ss.

On the 30 day of September, 1948, personally appeared before me, a notary public for the State of Utah, the above applicant who, on oath, declared that he is a citizen of the United States.

My commission expires May 13, 1950 /s/ Allen S. Crow
(SEAL) *Notary Public.*

(seal)

(This page is not to be filled in by applicant)

12:30 P.M.

State Engineer's Endorsements

1. Oct. 1, 1948 *Application received* ~~*over counter*~~ *by mail in State Engineer's office by* LJ
2. *Priority of Application brought down to, on account of*
3. no fee required *Fee for filing Application, $......, received by ...... Rec. No......*
4. Oct. 5, 1948 *Application copied in book* S-18, *page* 572, *and indexed by* BGB GP
5. Oct. 4, 1948 *Application platted by* ACT(c-24-13)34ccb-1 Band Made & Tabbed
6. Oct. 19, 1948 *Application examined by* C.N.H.
7. *Application returned, with letter, to ...... for correction*
8. *Corrected Application resubmitted over counter by mail to State Engineer's office.*
9. *Fee for publishing notice requested.*
10. Jan. 8, 1949 *Fee for publishing notice, $* 7.00, *received by* LJ NN *Rec. No.* 20404
11. Oct. 19, 1948 *Application approved for advertisement by* J.A.W. C.N.H.
12. Nov. 4, 1948 *Notice to water users prepared by* C.N.H.
13. Nov. 11, 1948 *Publication began; was completed* Dec. 9, 1948
    Notice published in Millard County Chronicle, Delta, Ut.
14. Nov. 12, 1948 *Proof slips checked by* C.N.H. & LE
15. *Application protested by*
16. April 1, 1949 *Application designated for approval* ~~*rejection*~~ *by* J.A.W. C.N.H.
17. *Fee for approving Application requested*
18. No fee required *Fee for approving Application, $2.50 received by ...... Rec. No......*
19. May 5, 1949 *Application proofread by* LE ECA
20. May 5, 1949 *Application approved* ~~*rejected*~~ *and returned to applicant*

This Application is approved, subject to prior rights, if any, on the following conditions:

1. *Actual contruction work shall be diligently prosecuted to completion.*
2. *Proof of Appropriation shall be submitted to the State Engineer's office by* Sept. 20, 1951.
3.

H.A. Linke
Harold A. Linke *State Engineer.*

21. *Time for making Proof of Appropriation extended to*
22. June 25, 1951 *Proof of Appropriation submitted.*
23. No *Fee for filing Proof of Appropriation, $1.00, received by ...... Rec. No......*
24. Fees *Fee for examining maps, profiles and drawings, $5.00, received by ...... Rec. No......*
25. Required *Fee for issuing Certif. of Appropriation, $1.00, received by ...... Rec. No......*
26. Apr. 30, 1952 *Certificate of Appropriation, No.* 4476 *, issued*

I Hereby Certify that the foregoing is a true copy of the Application by ...... to appropriate water and of the endorsements therein as shown by the records of my office on the date given below.

Salt Lake City, Utah, ..., 19......

State Engineer.

Application No. 20214

PROOF OF APPROPRIATION OF WATER
STOCK-WATERING WELLS

Application No. 20214

1. *The name of the appropriator is* UNITED STATES OF AMERICA, Bureau of Land Management
2. *The post-office address of the appropriator is* P. O. Box No. 659, Salt Lake City, Utah
3. *The quantity of water appropriated is* ~~.05~~ .0464 *second-feet or* ~~....~~ *G.P.M.*
4. *The water is used each year from* January 1 (Month) (Day) *to* December 31 (Month) (Day) *incl.*
5. *The drainage area to which the direct source of supply belongs is* Sevier River (Leave Blank)
6. *The direct source of supply is underground water in* Millard *County*
7. *The point of diversion from the well (~~flowing~~ pump) is** N. 1233.3 ft., E. 185 ft. from SW Corner Sec. 34, T. 24 S., R. 13 W. of S. L. B. & M.

*NOTE—Give the location of the well with reference to a United States land survey corner or mineral monument.

8. *The diverting works including well and distribution system consist of* drilled well, 294' deep, 6-1/4" dia., fully cased, and equipped with motor, pump, 5,000 gal. storage tank, and 94' metal trough.
9. *Well depth* 294 *ft., diameter* 6-1/4 *inches, length of distributing system* 147 *ft.*

   dia. of pipes 6 *in., pump make* Stover, *diam. intake* $3\frac{1}{2}$ *in., diam. disch* 3 *in.*
10. *Hydrostatic level, at well is* 4278 *ft., at the outlet* 4503 *ft.*†

†NOTE—Use sea level datum where reference is on or near well, otherwise refer to distance above or below ground surface and a permanently established bench mark described under General Remarks.

11. *Elevation of ground surface at well* 4500 *ft.*
12. *Kind and number of each class of livestock watered* 11,000 sedentary sheep & 6000 transitory sheep.
13. *The place where the water is used is*‡ $SW\frac{1}{4}SW\frac{1}{4}$ Sec. 34, T. 24 S., R. 13 W. of S.L.B.&M.

‡NOTE—Give place of use by legal subdivisions of section, township and range of United States land survey.

14. *Construction of well was commenced* Dec., 19 34, *and completed* January, 19 35.
15. *Water from the well was first used* February, 19 35.
16. *Water was measured by* O.P.DeJulio *Date* September 24, 19 48 *By* ~~xxxxx~~ ~~xxxxxxxx xx~~ (5000 gal. tank) **

(Strike words not needed)

EXPLANATORY

In cases where water is drunk by the livestock in troughs or other drinking facilities at the well no maps or drawings need be submitted.

In cases where water is conveyed away from the well before being drunk, maps and drawings of the entire scheme must be submitted. They shall be on tracing linen sheets cut to the same size as the proof, attached thereto and mailed without folding. If maps are submitted they shall contain the certificate of the engineer in accordance with rules and regulations.

In any event a detail written description of the works and use of water beginning at and including the well, proceeding therefrom to each place of use must be submitted under "General Remarks," or if necessary, on a separate sheet the same size as the proof and attached thereto as a part of "General Remarks." Give length, dimensions and purpose of each type of diverting channel. If all works necessary to apply the water to use were constructed prior to the time of approval of the application herein described, so indicate and give a history of the development work. The log of the well, also description, including location of permanent bench mark, shall be given under "General Remarks".

**Sufficient data as to the measurement of water must be submitted in order to enable one to compute therefrom the actual flow of water appropriated, if by vessel the diameter and height to which filled and time elapsed, or if by current meter the discharge notes and meter rating table, if by weir, orifice, etc., the size, kind and height of opening, also head, must be submitted in detail.

Give details of pumping plant, including motor, under "General Remarks".

Read rules and regulations before preparing proof.

GENERAL REMARKS

The water appropriated is yielded by a pump well $6\frac{1}{4}$" in diameter and 294 ft. in depth, cased with 294 ft. of 6" (I.D.) steel casing and located at a point described under paragraph 7 of the foregoing. The well is equipped with a pumping system consisting of a Stover No. $6\frac{1}{2}$ plunger type pump jack, situated directly over the well and connected to a column pipe of $3\frac{1}{2}$ inch diameter extending 238 ft. below ground level. The pump is powered by a 35 h.p. Waukesha, water cooled, gas motor and the entire pumping unit is resting on a concrete floor slab and housed by an 8' x 8', steel pumphouse. The water is pumped into a 5000 gal. metal storage tank 9' dia. x 10.5' high, 8 feet southeast of the pump by means of a 3" galvanized iron pipe. The tank is equipped with 16 ft. of 2" G.I.P. for supply to mobile water tanks as necessary, and with a 6" gate valve and a 6" C.I.P. running 35 ft. S. 85° E. to the south end of a metal trough 10" x 21" extending N. 28° E. ~~xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx~~ for a distance of 94 ft., having a storage capacity of 800 gallons.

CERTIFICATE OF APPROPRIATOR

(Fill in blank spaces but do not sign until proof has been submitted to the State Engineer and accepted as sufficient.)

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

I, Kelso P. Newman being first duly sworn, do hereby certify that I am the agent ~~person, manager or the~~ of the Bureau of Land Management ~~whose~~ which made an Application to appropriate water from the underground supply in Millard county for stock-watering purposes; that said Application is filed in the State Engineer's office as No. 20214; that the works necessary to accomplish the diversion and perfect the appropriation of water in accordance with the said Application have been completed; that the foregoing statement of facts ~~and the maps and drawings attached hereto~~ are submitted in proof of the completion of said works and the appropriation of said water; that I made the said statement and that each and all of the items contained therein are true to the best of my knowledge and belief.

UNITED STATES OF AMERICA, Bureau of Land Management
By: Kelso P. Newman ~~Kelso P. Newman~~
Reg. Chief, Div. of Range Management. Signature of Appropriator.

Subscribed and sworn to before me this 30 day of November, 1951

(Seal)
My commission expires May 13, 1954 Allen S Crow
Notary Public.

... until proof has been submitted to the State Engineer and accepted by him as sufficient.)

STATE OF UTAH
COUNTY OF Salt Lake } ss.

Alden N. Brewer having been duly sworn, certifies that he is the engineer who prepared the within proof; that he is personally acquainted with the works constructed by United States of America, Bureau of Land Management for the diversion and appropriation of water from Underground water in Millard county, under Application No. 20214 for stock-watering purposes; that said works have been fully completed and used to the extent and in the manner particularly set forth in the foregoing statement of facts; that he has read said statement and that each and all of the items therein contained are true to the best of his knowledge and belief.

Alden N Brewer
Proof Engineer

Subscribed and sworn to before me this 30 day of November, 1951

(Seal)
My commission expires May 13, 1954 Allen S Crow
Notary Public

STATE ENGINEER'S ENDORSEMENTS

Dates

1. Oct. 1, 1948 Application received in State Engineer's office; Approved May 5 1949
2. Sept. 20, 1951 Proof of Appropriation due in State Engineer's office.
3. June 25, 1951 Proof received in State Engineers office by TH
4. Nov. 20, 1951 Proof returned for correction by H.W.S.
5. Jan. 3, 1952 Corrected proof resubmitted, received by TH
6.
7. April 15, 1952 Corrected proof examined and Certificate written by H.W.S.
8. Apr. 30, 1952 Certificate of Appropriation issued (No. 4476)
9. No Fee for filing proof $1.00, received by Receipt No.
10. fees Fee for examining maps, if submitted, $5.00, received by Receipt No. no map
11. required Fee for issuing Certificate $1.00, received by Receipt No.

This proof complies with the requirements of the laws of Utah, and the same is hereby approved.

4-30, 1952 Joseph M Tracy
State Engineer.

Proof of Appropriation
on Application No. 20214

1000 6-48

DIVISION OF WATER RIGHTS

MAR 24 2006

RICHFIELD AREA

Utah Water Well 69-25

MILLARD COUNTY

Grazing District No. 3

Well No. 4 Cost - $3,109.94

General Location - Twelve miles north of Newhouse

Exact Location - 1233 ft. north and 185 ft. east of southwest cor. of Sec. 34, T. 24 S; R 13 W

Date Drilled - December 28, 1934 **Driller** - H. L. Hall & H. M. Robinson

Depth - 294 feet **Depth to Water** - 222 feet

Water Developed - 30 gallons per minute **Quality of Water** - Slightly brackish

Column Pipe - 241 feet of 3½-inch **Casing** - 174' of 8¼" & 236' of 6¼"

Equipment Installed - ~~4-9 H.P. gas engine, pump, countercharges~~, 8 ft. x 8 ft. steel house, 94 feet of steel trough, and 5000-gallon steel tank.

LOG OF WELL

Depth in feet	Formation
0 - 35	Light colored clay
35 - 100	Light brown clay
100 - 141	Brown clay
141 - 150	Gray clay with gypsum
150 - 230	Brown clay
230 - 234	Fine sand - Water
234 - 270	Hard porphyritic gravel
270 - 290	Gravel - Water

WATER ANALYSIS

	Parts per Million
Total dissolved mineral solids -	2640.0
Calcium Oxide -	90.7
Magnesia Oxide -	91.5
Sulphates -	315.5
Chlorides -	846.0
Corresponding to NaCl -	1395.9
Silica - SiO_2 -	26.0
Alkalinity as $CaCO_3$ -	.8
Sodium Sulphate -	130.0

REMARKS - Ample water. Pumps no sand.

Listed on well record
Listed by counties
Copied ygh 4-22-47
Exam. & Recorded M.K. 4-21-47
Exam. for filing
Final Copy checked ygh 4-25-47
Platted & No. Assigned
Indexed ygh 4-22-47
Engr. filed well
Engr. ext. DM
Well No.

Report No. 4313
Filed Jan 10, 1946
Rec. By counter
Ret'd UGH

PAGE
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Report of Well and Tunnel Driller

STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel.~~ (Strike words not needed)

   Gerald Cazier, Nephi, Utah, Driller.

2. Name and address of owner of well ~~or tunnel~~ (Strike words not needed) U. S. Grazing Service, (Fillmore, Ut.)

   P.O.Box 1046, S.L.C.-10-

3. Source of supply is in Millard County;

   (Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is ~~One~~ 16972

5. Location of well ~~or mouth of tunnel~~ is situated at a point

   T. 23S., R. 12W. Sec. 6; N.38°45" E. 719' of SW corner

   Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy descripton from well owner's approved application)

6. Date on which work on well ~~or tunnel~~ was begun (Strike words not needed) April 23 1945

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ (Strike words not needed) July 11, 1945

8. Maximum quantity of water measured as ~~flowing~~, pumped or (Strike words not needed) on completion of well ~~or tunnel in sec. ft.~~; or in gals. per minute about 12 Date

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ pump well. (Strike words not needed) Temperature of water °F.

   (a) Total depth of well is 560 ft. below ground surface.

   (b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

   (c) If pump well, give depth from ground surface to water surface before pumping 210 ft.; during pumping 210 ft

   (d) Size and kind of casing 6 in (If only partially cased, give details)

   (e) Depth to water bearing stratum 1 ft. (If more than one stratum, give depth to each)

   (f) If casing is perforated, give depth from ground surface to perforations

   (g) Log of well 559 feet through heavy greasy white clay then one foot of water to bed rock.

   (h) Well was equipped with ~~cap, valve~~, or to control flow. (Strike words not needed)

(Over)

10. **TUNNEL**: It is timbered, tiled, piped, open, bulkheaded, covered or
(Strike words not needed)

(a) Dimensions; total length; temperature of water °F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel

(c) Log of tunnel

11. **GENERAL REMARKS:** (Note any general or detailed information not covered above.)

STATE OF UTAH,
COUNTY OF Juab } ss.

I, Gerald Cazier, being first duly sworn, do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Gerald Cazier
Driller

~~Subscribed and sworn to before me this~~ Witnessed 9 day of Jan, 1946

(SEAL) N A K Hansen
~~Notary Public~~
Dist Cazier

My Commission Expires:

JAN 10 1946
State Engineer's Office

Listed on well record
Listed by counties
Copied rgh 2-12-47
Exam. & Recorded M.H. 12-23-46
Exam. for filing
Final Copy checked rgh 2-20-47
Platted & No. Assigned
Indexed rgh 2-17-47
Engr. tied well
Engr. set BM
Well No. C-23-12)6 ccc-1

Report No. 4911
Filed October 19, 1946
Rec. By McKim
Ret'd

PAGE
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8.16 186

Report of Well and Tunnel Driller

STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel.~~ (Strike words not needed)
Vernon Rinick Monti Utah

2. Name and address of owner of well ~~or tunnel~~ (Strike words not needed) U.S. (Government) Grazing Service Federal Bldg (Black Rock) Utah

3. Source of supply is in Millard County;
(Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is 16972

5. Location of well ~~or mouth of tunnel~~ is situated at a point
N. 38°45' E.719' from SW Cor. Sec.6 T23 S. R12 W., SLB&M

Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy descripton from well owner's approved applcation)

6. Date on which work on well ~~or tunnel~~ was begun May 11 - 1946 (Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ 5/17/46 (Strike words not needed)

8. Maximum quantity of water measured ~~as flowing,~~ pumped or .... on completion of (Strike words not needed) well ~~or tunnel in sec. ft.~~ ......; or in gals. per minute 5 Date 5/17/46

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ pump well. Temperature of water 49 °F. (Strike words not needed)

(a) Total depth of well is 60' ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface .... ft.

(c) If pump well, give depth from ground surface to water surface before pumping 27'; during pumping 50'

(d) Size and kind of casing 6" New Standard Pipe (If only partially cased, give details)

(e) Depth to water bearing stratum 51' (If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations 50 to 59

(g) Log of well 0-20 Top soil with fine gravel 20-48 Tan colored Clay 48-51 Hard gravely formation 51-60 fine Gravel & water

(h) Well was equipped with cap, valve, or .... to control flow. (Strike words not needed)

(Over)

10. **TUNNEL:** It is timbered, tiled, piped, open, bulkheaded, covered or.........................
(Strike words not needed)

(a) Dimensions.............; total length.........................; temperature of water..............°F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel..............

....

....

(c) Log of tunnel...

....

....

....

11. **GENERAL REMARKS:** (Note any general or detailed information not covered above.)

RECEIVED
OCT 19 1946
State Engineer's
Office

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

I, Vernon L. Eimick, being first duly sworn,

do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Vernon L. Eimick
Driller

Subscribed and sworn to before me this 19 day of October, 1946.

Laurence C. Monson
Notary Public

(SEAL)

My Commission Expires:
July 18 1948

Table 7.—*Drillers' lithologic logs of selected wells*—Continued

Site number	Location and material	Thickness	Depth
15	(C-20-12) 1aac- 1. Log by Fugro National, Inc. Alt. 4,543.8 feet		
Amasa	Sand, silty, poorly sorted...	2	2
	Gravel, silty, poorly graded, strong effervescence	7	9
	Clay, silty, weak effervescence....................	10	19
Playa Hjin	Clay, strong effervescence...	10	29
	Clay, medium plasticity, weak effervescence..........	30	59
	Clay, high plasticity, strong effervescence........	10	69
	Clay, medium plasticity, weak effervescence..........	27	96
	Silt, nonplastic, gravel, fine, angular, weak effervescence..............	4	100
	Clay, slight to medium plasticity, silt interbeds..	50	150
17	(C-20-12)10dcd- 2 Alt. 4,524.5 feet		
	Clay, tan, and gravel, unsorted....................	5	5
	Clay, tan....................	25	30
	Clay, reddish-brown	71.5	101.5
18	(C-20-12)10dcd- 3 Alt. 4,525 feet		
Mud Flat	Clay, tan, and gravel, unsorted....................	5	5
Playa Hjin	Clay, tan....................	30	35
	Clay, gray-green............	2	37
	Clay, red-brown, some gypsum crystals present............	53	90
	Clay, gray-green, with some interbedded red-brown clay containing some gypsum......	40	130
	Clay, red-brown, sand, coarse	73	203
19	(C-20-12)32aaa- 1 Alt. 4,525 feet		
Glitter Gulch	Sand, gravel, clay, unsorted....................	1	1
	Clay, tan....................	4	5
Playa HSU	Clay, red-brown.............	40	45
	Clay, red-brown, high plasticity.................	5	50
	Clay, red, tan, intermittent gray-green clay layers......	10	60
	Clay, red....................	2	62
	Clay, red-brown.............	39	101
20	(C-20-12)32aaa- 2 Alt. 4,525 feet		
Glass Ocean	Sand, gravel clay, unsorted....................	1	1
Playa HSU	Clay, tan, gypsum present....	7	8
	Clay, red, with intermittent gray-green clay layers......	195.5	203.5
21	(C-20-12)32abd- 1 Alt. 4,550 feet		
	Sand, thin soil layer on top.	8	8
	Clay, red, low plasticity ...	17	25
	Clay, red-brown, thin layer of gray-green clay at 40 feet........................	125	150
	Clay, alternating red-brown and gray-green.............	52	202
25	(C-22-12)14a - 1. Log by M. C. Godbe, III Alt. 4,528 feet		
TD 975 SDL-4 (Gwynn, 2006) Needle Pt.	Limestone, dark gray to black, minor quartzite pebble gravel, quartz sand and grit, tan and light brown, grades downward with silt and clay, gray, interbedded with sand, salty taste.....................	30	30
	Clay, silty, dark, carbonaceous.....................	10	40
	Clay, silty, green-gray, silt and sand, fine, silty clay zone partially cemented with gypsum and selenite crystals....................	20	60
	Sand, dark brown to gray, thin beds, grading to clay, salty.......................	20	80
	Clay, gray-green, sandy zones, slight salt taste....	20	100
	Clay, gray-green, and silty clay, brown, mottled, silty-sand zones, some carbon, salty.......................	100	200
	Clay, brown, mottled, silt and sand, gray-green, slightly salty..............	20	220
	Clay, gray-green and brown, mottled, hard, dense, slightly salty..............	20	240
	Clay, gray-green and brown, alternating, mottled, moderately hard, dense.........	80	320
	Clay, sandy-silty, green-gray and brown, some gypsum cementing...................	40	360
	Clay, silty, gray-green and brown, occasionally mottled, slightly salty, dense, hard, zones of carbonaceous material from 430-490............	158	518
	Sand, fine, dark gray-brown, clay bits, gray............	7	525
	Sand and silt, brown and red-brown, scattered gypsum in clay........................	50	575
	Silt, gray-brown.............	5	580

Site number	Location and material	Thickness	Depth
	(C-22-12)14a - 1.--Continued		
	Clay, silty, gray-green and brown, occasional carbon, little salty taste..........	140	720
	Clay, gray-green and brown, not salty....................	60	780
	Silt and silty clay, gray-brown.......................	60	840
	Sand, fine-grained, dark gray brown, lime and quartz grains......................	10	850
	Sand, silt, and clay interbeds, gray-green and gray-brown, occasional carbonaceous clay.................	125	975
26	(C-22-12)36acc- 1. Log by M. C. Godbe III		
	Alt. 4,517 feet		
	Clay, cream-colored, pebble gravel with limestone and quartzite clasts, sand, medium coarse, salt encrustation at top inch...........	21	21
	Clay, blue-gray.............	7	28
	Clay, blue to green-gray, scattered salt seams........	10	38
	Sand, medium grain, gray.....	2	40
	Clay, light gray, scattered salt seams..................	16	56
	Sand, medium grain, gray.....	2	58
	Clay, sandy, light gray......	30	88
	Clay, light gray to green-gray with brown-black seams.	52	140
	Clay, dense, light gray, euhedral salt (gypsum?) crystals...................	30	170
	Clay, dense, light green-gray	25	195
	Clay, dense, light brown.....	5	200
	Clay, light green-gray.......	15	215
	Clay, silty, light green-gray, with sand, fine- to medium-grained lenses, some carbonaceous pieces and streaks...	27	242
	Clay, dense, gray............	8	250
	Clay, dense, gray-green, abundant carbonaceous streaks...	20	270
	Clay, silty, dry, green-gray.	10	280
	Clay, moderately compact, gray-green..................	40	320
	Clay, brown..................	5	325
	Clay, moderately compact, gray to light gray..........	35	360
	Clay, moderately hard, alternating gray-green and brown.	28	388
	Clay, green-gray.............	8	396
	Clay, moderately dry, alternating gray-green and brown.	34	430
	Clay, wet, slightly salty taste, green-gray...........	20	450
	Clay with silt and sand interbeds, dry, salty taste, alternating gray-green and red-brown..................	78	528
	(C-22-12)36acc- 1.--Continued		
	Unit similar to above but wetter and less salty taste....	27	555
	Unit similar to above but with decreasing sand content.....	5	560
	Clay, silty, dry, hard, carbonaceous, gray and gray-green, occasional sand grains......	36	596
	Clay, wet, gray to green, sand, medium- to coarse-grained, scattered, salty taste.......................	54	650
	Clay, brown..................	5	655
	Clay, sandy-silty, alternating wet and dry, gray-green and gray.....................	121	776
	Clay, silty-sandy, gray to gray-green with some brown, slightly salty taste........	64	840
29	(C-23-11) 7bbc- 2		
	Alt. 4,530 feet		
	Clay, sandy..................	3	3
	Sand, gravel, clay, unsorted, wet.........................	2	5
	Clay, tan, sandy.............	2	7
	Clay, tan....................	11	18
	Clay, gray...................	22	40
	Clay, black..................	5	45
	Clay, gray-green.............	80	125
	Clay, gray-green, high plasticity.................	78	203
30	(C-23-11) 7bdb- 1		
	Alt. 4,550 feet		
	Sand, fine with clay.........	1	1
	Sand, angular, and gravel, rounded, unsorted...........	12	13
	Clay, tan, gypsum crystals present.....................	12	25
	Clay, gray-green, gypsum crystals present, high plasticity.................	30	55
	Clay, gray-green, high plasticity.................	105	160
	Clay, gray-green alternating with brown.................	18	178
	Clay, gray-green alternating with dark gray to black, high plasticity.............	7	185
	Clay, gray-green alternating with brown, high plasticity.................	9	194
	Clay, gray-green, high plasticity.................	13	207
31	(C-23-11) 8cda- 1. Log by Stephenson Drilling Inc.		
	Alt. 4,685 feet		
	Top soil.....................	2	2
	Clay, blue...................	538	540

SDL-2 (in Gwynn 2006)

TD 840

Erehwon

Playa HSU

Headlight Gap

Playa HSU

Table 7.--*Drillers' lithologic logs of selected wells*--Continued

TD 705

SDL-3 (Gywnn 2006)

Site number	Location and material	Thickness	Depth
32	(C-23-11)31a -1. Log by M. C. Godbe III Alt. 4,520 feet		
	Pebble gravel, quartzite.....	3	3
	Sand, coarse, quartz, with clay beds, light green to gray, salty................	7	10
	Clay, light green to gray, moderately dense............	12	22
	Clay, brown, scattered with sand, medium coarse, quartz.	8	30
	Clay, gray-green, dense, some salt crystals..........	8	38
	Clay, dark gray-green, dry, carbonaceous, salty, sand seams......................	22	60
	Clay, gray-green, wet, some brown zones, salty taste....	40	100
	Clay, light to dark gray-green, silty, some vegetal remains....................	20	120
	Clay, gray-green, some brown, wet, dense.................	12	132
	Clay, gray-green, silt, some brown streaks, wet..........	103	235
	Clay, dark gray-green, slightly silty, carbonaceous	20	255
	Clay, interbedded brown and gray-green, some salt and gypsum, silty in places.....	235	490
	Silt, brown and gray, with abundant sand..............	8	498
	Gypsum crystals and clay, gray.......................	10	508
	Clay, mottled gray-green and brown, dense, some silt, salty......................	172	680
	Gypsum, some silt...........	5	685
	Clay, green-gray, mottled with brown, hard, dense.....	20	705
33	(C-23-11)31a -2. Log by M. C. Godbe III Alt. 4,520 feet		
	No samples..................	35	35
	Clay, green-gray to gray-green, occasional silty zones vegetal material, salt and gypsum in vugs.....	39	74
	Clay, dark gray-blue to gray, carbonaceous zones, silty...	41	115
	Silty.......................	45	160
	Clay, gray-green mottled with brown, hard, silty, little salt........................	55	215
	Clay, gray-green, moderately hard, wet, silty, gypsum crystals in vugs...........	50	265
	Clay, brown and gray-green, mottled....................	25	290
	Clay, gray-green, wet, scatterred sand grains..........	5	295
	Clay, brown and gray-green, mottled....................	30	325
	(C-23-11)31a -2.--Continued		
	Clay, gray-green, hard, dense, silty zones, carbonaceous specks......................	35	360
	Clay, brown and gray-green, mottled, silty zones........	130	390
	Gypsum, euhedral crystals....	5	395
	Clay, gray-green, occasional brown mottling, slightly silty, moderately dense.....	45	540
	Clay, gray-green, some mottling, silty, some wet areas, slightly salty taste........	30	570
	Silt, moderate...............	10	580
	Clay, gray-green, some mottling, silt.................	25	605
	Silt........................	5	610
	Clay, gray-green............	70	680
	Silt, moderate, slight salt..	5	685
	Clay, alternating gray-green and brown, hard, dense, carbonaceous spots..........	102	787
	Silt........................	3	790
	Carbonaceous and vegetal material...................	5	795
	Clay, gray-green and brown mottled, silt zones, hard, dense, slightly salty.......	75	870
	Clay, blue-gray to dark gray, carboneceous in spots.......	50	920
35	(C-23-12) 5cdd- 2 Alt. 4,525 feet		
	Sand........................	2	2
	Clay, gray-green............	6	8
	Clay, gray-green, darker than above......................	27	35
	Clay, reddish-tan, with intermittent gray-green layers.....................	67	102
36	(C-23-12) 5cdd- 3 Alt. 4,525.4 feet		
	Sand........................	2	2
	Clay, light gray-green.......	10	12
	Clay, red-brown..............	3	15
	Clay, dark gray-green........	15	30
	Clay, brown..................	2	32
	Clay, dark gray-green with alternating brown layers....	40	72
	Clay, gray-green, low plasticity, alternating thin-layered, clay, red-brown, higher plasticity....	101	173
	Clay, gray-green, high plasticity.................	30	203
37	(C-23-12) 6ccd- 1. Log by Gerald Cazier, Driller Alt. 4,632 feet		
	Clay, white, greasy, heavy...	559	559
	Bedrock with water...........	1	560

TD 920

SDL-3A (Gywnn, 2006)

Machine Gun Playa HSU

Exploration

Playa HSU

Black Hills Well

Black Hills

APPENDIX B

Well Logs

Unconsolidated Wells

(Included as Attachment)

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-022 257 Cut Off	SHEET 1 OF 4

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah	LOCATION : 257 Cut Off Rd. (39.1 N, -112.9 E)
ELEVATION : 4574.0 ft	DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter	
WATER LEVELS : 21.3 ft below ground surface START : 3/12/2013	END : 3/14/2013 LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0				Lean Clay (LL); 10yr 4/3 Brown w/ white stringers; stiff, moist; Gravel (0%), Sand (5%), Clay/Silt (95%)	*Construction Notes*: Grout=6.5 bags portland cement; Gravel pack=12 bags of 20/40 sand
		7.5				Reacts to HCL; Medium Plasticity
5						
	7.5					
					Lean Clay (LL); 10yr 4/3 Brown w/ white stringers; stiff, moist; Gravel (0%), Sand (5%), Clay/Silt (95%)	
10						
		10.0				
15						
	17.5					
20						
					Lean Clay (LL); Color change to 10yr 7/3, Very Pale Brown;; stiff, moist; Gravel (0%), Sand (5%), Clay/Silt (95%)	
		10.0				
					Thin (~4') sandy clay layer, wet;Gravel (0%), Sand (25%), Clay/Silt (75%)	Small (~1") layer of very small intact shells
25						

PROJECT NUMBER:	BORING NUMBER:	SHEET 2 OF 4
465077	SEV-12-022 257 Cut Off	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : 257 Cut Off Rd. (39.1 N, -112.9 E)

ELEVATION : 4574.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 21.3 ft below ground surface — START : 3/12/2013 — END : 3/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Very stiff, slightly moist; high plasticity; Color change to Gley 5/1 greenish grey; Gravel (0%), Sand (5%), Clay/Silt (95%)	
	27.5					
30					Silty Clay (CL) Gley 5/1 greenish grey, moist-very moist; medium low plasticity;Gravel (0%), Sand (5%), Clay/Silt (95%)	
		10.0			Clay (CL) Gley 5/1 greenish grey; very stiff, moist-slightly moist, very high plasticity;Gravel (0%), Sand (5%), Clay/Silt (95%)	
35						
	37.5					
40						
		10.0				
45						
	47.5					
50					Silty Sand (SM); 2a5y 3/1 Very dark grey; Medium dense, wet ; Gravel (0%), Sand (6%), Clay/Silt (35%)	Driller states that he has hit water

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-022 257 Cut Off	SHEET 3 OF 4

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : 257 Cut Off Rd. (39.1 N, -112.9 E)

ELEVATION : 4574.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 21.3 ft below ground surface

START : 3/12/2013

END : 3/14/2013

LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		5.0				
					Silty Sand (SM); 2a5y 3/1 Very dark grey; Medium dense, wet; poorly graded with fine sands; Sand (6%), Clay/Silt (35%)	
	52.5					
55						
		10.0				
					Sandy Clay (CL); Wet, brown, firm moist; Gravel (0%), Sand (40%), Clay/Silt (60%)	
					Well graded sand w/silt (SW); 10yr 4/3 Brown, wet ; stiff, moist; Gravel (0%), Sand (80%), Clay/Silt (20%)	
60						
					Lean Clay with sand (CL); 10yr 4/3 Brown, stiff, moist; not saturated, med. plasticity; Gravel (0%), Sand (20%), Clay/Silt (80%)	
	62.5					
65						
		11.5				
					Sandy Clay (CL); 5y 5/1 stiff, moist, medium plasticity; Gravel (0%), Sand (35%), Clay/Silt (65%)	
70						
	74.0					
75						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-022 257 Cut Off	SHEET 4 OF 4

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : 257 Cut Off Rd. (39.1 N, -112.9 E)

ELEVATION : 4574.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 21.3 ft below ground surface — START : 3/12/2013 — END : 3/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Lean Clay (CL) Brown 10yr 4/3, moist, very stiff, high plasticity, small (<2") sand layer; Gravel (0%), Sand (5%), Clay/Silt (95%)	
80		13.5				
85						
	87.5					
90		10.0				
95						
	97.5					
					Bottom of Hole at 60.0 ft below ground surface 3/14/2013	
100						

CH2MHILL

SUBJECT CS / Cut Off (SEV-12-022)
Well Construction

BY

SHEET NO. ______ of ______ DATE

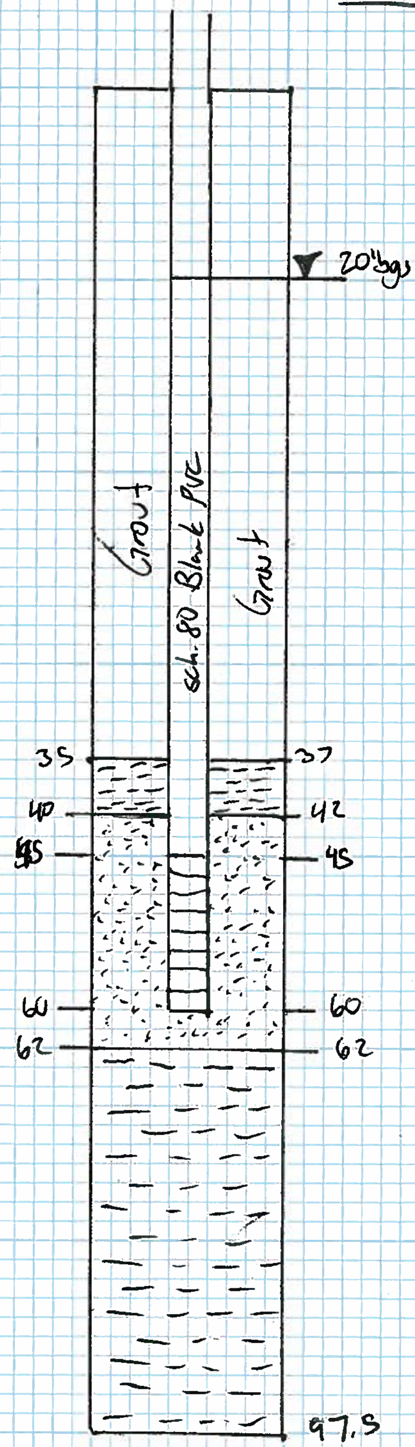
PROJECT NO.

Actual Planned

Grout
6½ bags Portland cement
½ bag quick gel

12 bags of
20/40 Sand

3/8" Bentonite Chips
17+2 bags



Centralizers: 45', 1' above ground

Monitoring Point/Location: 257-Cutoff Date: 4-13-13 Sampler: Ryan Hamilton

Weather: Cloudy Visitors:

Boring Dia. 8" Casing Dia. 4" DTW: 21.28 TOC TD: 60 Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume ______ Tubing Leng. (ft) X ______ Tubing Dia. Factor + ______ Pump Volume X 2 = ______ Purge Volume (mL) = ______ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume ______ TD (ft) - ______ DTW (ft) = ______ Water Column (ft) - ______ Scr. Leng. (ft) = ______ Casing Leng. X ______ Casing Factor X 3 = ______ Casing Vol. = ______ Purge Volume (gal) (0.0)

(Casing Volume Above Screen)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1000	1st bailer		2.5 gal	silty	water				10' bailer		~3 ft of muck	at bottom	
1002	2nd bailer		2.5	gal	silty water								
1004	3rd bailer		2.5	gal	silty water								
1007	4th bailer		2.5	gal	very silty water			/ coarse sand	with 8 mm pebbles			1/4 gall sand	
1012	5th bailer		2.5	gal	"		"	/ more sand	than last bail		"	1/2 gallon	sand
1015	6th bailer		1.5	gal	"		"	"					
1020	7th bailer		2.5	gal	"		"	"				"	
1022	8th bailer		2.5	gal	"		"	1/2 gallon coarse sand				~~less sand~~ RH	
1025	9th bailer		2.5	gal	"		"	"			"		
1027	10th bailer		2.5	gal	"		"	"			"		
1031	11th bailer		2.5	gal	silty water			fine sand		~~1/2~~ 1/8 gal			
1034	12th bailer		2.5	gal	silty water			"			"		
1036	13th bailer		2.5	gal	silty water			"			"		
1037	14th bailer		2.5	gal	silty water			"			"		
1039	15th bailer		2.5	gal	silty water			"			"		
1040	16th bailer		2.5	gal	silty water			"			"		
1043	17th bailer		2.5	gal	silty water			"			"		
1045	18th bailer		2.5	gal	silty water			"			"		
1046	19th bailer		2.5	gal	silty water			"			"		
1048	20th bailer		2.5	gal	silty water			"			"		
1051	21st bailer		2.5	gal	silty water			"			"		

Purge Flow Rate (mL (0) or gal per min (0.0))

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)
1053	22nd	bailer		silty	water		1/4 gal	fine	sand	10%		pebbles
1055	23rd	bailer		silty	water		"					"
1058	24th	bailer		silty	water		"					"
1140	25th	bailer		silty	water		"					"
1142	26th	bailer		silty	water		"					"
1144	27th	bailer		silty	water							"
1146	28th	bailer		silty	water		"					"
Field parameters stable?		Y N	Y N	Y N	Y N	Y N	Y N					

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal					
Duplicate					
MS/SD					
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter:

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH								
Turbidity								
ORP								
Spec Cond								
DO								
Ammonia								
Chloride								
Nitrate								

General Notes:

Monitoring Point/Location: 257-cutoff / Provo Date: 4-13-13 Sampler: Ryan Hamblin

Weather: Visitors:

Boring Dia. 8" Casing Dia. 4" DTW: TD: 40 Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume ______ X ______ + ______ X 2 = ______ = ______
Tubing Leng. (ft) | Tubing Dia. Factor | Pump Volume | Purge Volume (mL) | Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Casing Volume Above Screen

Standard Method: Calculated Purge Volume ______ - ______ = ______ - ______ = ______ X ______ X 3 = ______ = ______
TD (ft) | DTW (ft) | Water Column (ft) | Scr. Leng. (ft) | Casing Leng. | Casing Factor | Casing Vol. | Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1149	29th	bailer		silty water		1/2 gal fine sand		with		10% cobbles		→ >5mm dia	
1151	30th	bailer		"			"				"		
Provo								WL = 70.18 ft to TOC					
1533	1st bailer		2.5 gal	very silty/mud				Bottom tagged at 460 ft. to TOC ~3ft of muck					
1537	2nd bailer		2.5 gal	very silty mud									
1541	3rd bailer		2.5 gal	very silty water									
1543	4th bailer		2.5 gal	very silty water									
1549	5th bailer		2.5 gal	very silty water									
1552	6th bailer		2.5 gal	very silty water									
1556	7th bailer		2.5 gal	very silty water									
1600	8th bailer		2.5 gal				"	clearing					
1605	9th bailer		2.5 gal	silty water				Developer states that bottom is clear of fines					
1618	10th bailer		2.5 gal	silty water				bucket has very little fines in bottom.					
													Purge Flow Rate (mL (0) or gal per min (0.0))

PROJECT NUMBER:	BORING NUMBER:	SHEET 1 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface START : 2/14/2013 END : 2/14/2013 LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0	7.5			Silty gravel with sand (GM) 7.5YR 5/4 Brown, moist to slightly moist; medium dense; occasional cobble; Gravel (50%), Sand (25%), Clay/Silt (25%).	
5						
	7.5	10.0				
10						
15						
	17.5	10.0				
20					Clay (CH) 2.5Y 7/2 light grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Some $CaCO_3$ that react violently with HCL
25						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 2 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	27.5					
30						
		10.0				
35						
	37.5					
40						
		8.5				
45						
	46.0					
		1.0				
	47.0					
50						

PROJECT NUMBER:	BORING NUMBER:	SHEET 3 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CH) 2.5Y 7/2 light grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%). % change at 70'bgs to Gravel (0%), Sand (15%), Clay/Silt (85%).	Clay reacts violently with HCL; rust streaks possibly silt or sand streak between 57 and 67' bgs; higher concentration of rust streaks on fine sand between 67 and 74' bgs. 2-4" silty sand hangers 69-71' bgs Sizeable mud cracks.
55						
	57.0					
60						
		10.0				
65						
	67.0					
70						
		7.0				
	74.0					
75						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 4 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CH) 5Y 6/2 light olive grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Occasional sand layer; Reacts violently with HCL
80		13.0				
85	87.0					
90		9.0				
95	96.0					
					Clay (CH) GLEY 6/5GY greenish grey, moist, very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Reacts violently with HCL
100						

PROJECT NUMBER:	BORING NUMBER:	SHEET 5 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		11.0			Clay (CH) GLEY 6/1 greenish grey, moist, very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Reacts violently with HCL
105						
	107.0					
110		10.0				
115						
	117.0				Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey with black marbling; very moist, very stiff, very high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts violently with HCL; possible pyrite forming in thin organic layers
120		8.0				
125						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	125.0				Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey with black marbling; moist, stiff, average-high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	
130		9.5				
	134.5					
135					Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey; moist, stiff, average-high plasticity; Gravel (0%), Sand (15%), Clay/Silt (85%)with % change at 150' to; Gravel (0%), Sand (20%), Clay/Silt (80%)	Abundannt sand layers up to 4" at 150' bgs No black marbling
	137.0					
140						
		17.5				
145						
150						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 7 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	152.0					
155					Silty Sand (SM) GLEY1 5/1 greenish grey;slightly moist, loose, average-high plasticity; Gravel (0%), Sand (80%), Clay/Silt (20%)	
		12.0			Fat clay (CH) GLEY 5/1 greenish grey; moist, very stiff, average-high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts violently with HCL; some shells at 195' bgs ~4" organic rich layer at 200' bgs.
160						
	164.0					
165		12.0				
170		13.0 17.0				
175						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 8 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
180						
	181.0					
185						
		13.0				
190						
	194.0					
195						
200						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
205						
	207.0				Fat clay (CH) GLEY 5/1 greenish grey; moist-slightly moist,stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Water level measured at 222' bgs.
210						
215		15.0				
220						
	222.0					
225						

PROJECT NUMBER:	BORING NUMBER:	SHEET 10 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL-CH) GLEY 5/1 greenish grey; moist,very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
230		15.0				
235						
	237.0					
240						
		10.0				
245						
	247.0					
250						

PROJECT NUMBER:	BORING NUMBER:	SHEET 11 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CL-CH) GLEY 5/1 greenish grey; moist,very stiff, high plasticity; Gravel (0%), Sand (7%), Clay/Silt (93%) with % change at 260' bgs to Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL
255						
	257.0					
260						
		10.0				
265						
	267.0					
270						
		15.0				
275						

PROJECT NUMBER:	BORING NUMBER: SHEET 12 OF 13
465077	SEV-12-026 Bonneville

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL-CH) GLEY 6/1 greenish grey; moist,very stiff, high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL
280						
	282.0					
285						
					Poorly sorted Sand with silt 10YR 4/6 Dark Grayish Brown, wet, loose, medium grained;Gravel (0%), Sand (90%), Clay/Silt (10%)	
					Clay (CL-CH) GLEY 6/1 greenish grey; moist,very stiff, high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL Driller states that there was flowing sands. Measured water table at ~200' Drillers have used 300 gallons of water.
290						
		18.0				
295						
300						

PROJECT NUMBER:	BORING NUMBER:	SHEET 13 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah   LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

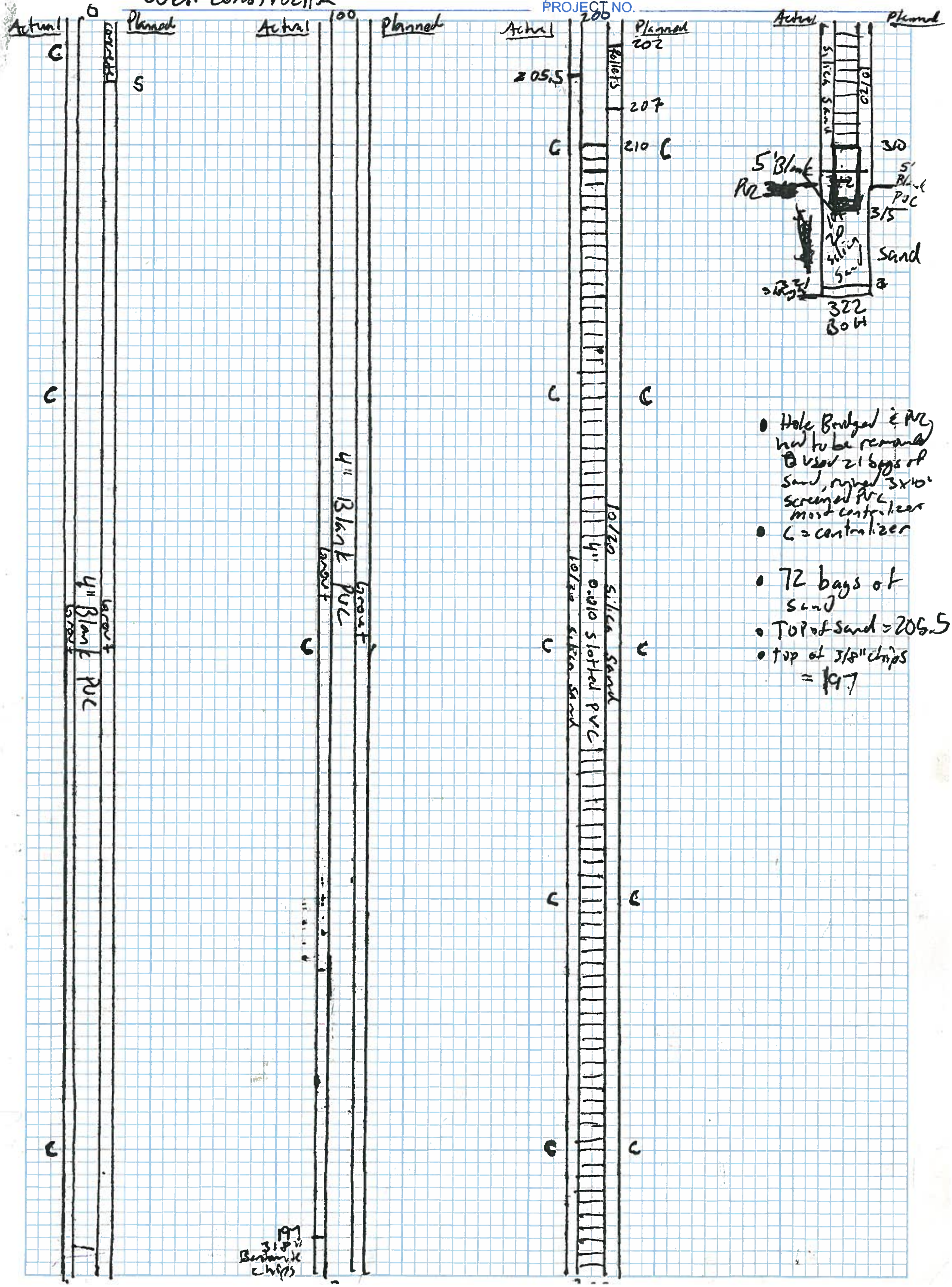
WATER LEVELS : 180.5 ft below ground surface   START : 2/14/2013   END : 2/14/2013   LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
305, 310	300.0–312.0	12.0			Clay (CL-CH) GLEY 6/1 greenish grey; moist,very stiff, high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Called bottom of hole. Driller ran an extra 10 feet in order to have solids for clean trip out.
315, 320	312.0–322.0	10.0				Extra run as stated above.
325					Bottom of Hole at 315.0 ft below ground surface 2/14/2013	

CH2MHILL

SUBJECT Peak Minerals
SEV-12-026
Well construction

BY
SHEET NO. ____ of ____ DATE ____
PROJECT NO. ____



- Hole Bridged & PVC had to be removed. Used 21 bags of sand, ruined 3x10' screened PVC, most centralizer
- C = centralizer
- 72 bags of sand
- Top of Sand = 205.5
- top of 3/8" chips = 197

Monitoring Point/Location: Bonneville SEV-12-026 Date: 3-2-13 Sampler: Ryan Hamilton

Weather: Clear Sunny Visitors:

Boring Dia. 8" Casing Dia. 4" DTW: 180.49 TOC TD: 315 bgs Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume ______ Tubing Leng. (ft) X ______ Tubing Dia. Factor + ______ Pump Volume X 2 = ______ Purge Volume (mL) = ______ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume ______ TD (ft) - ______ DTW (ft) = ______ Water Column (ft) - ______ Scr. Leng. (ft) = ______ Casing Leng. X ______ Casing Factor X 3 = ______ Casing Vol. = ______ Purge Volume (gal) (0.0)

(Casing Volume Above Screen)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
0742	Arrive at Bonneville well												
0802	Water level measured at 180.49 to TOC												
0809	Bottom tagged at 314.5 to TOC												
0815	1st	bailer			1.5	gal	silty	mud					
0823	2nd	bailer			1.5	gal	silty	mud					
0826	3rd	bailer			1.5	gal	silty	mud (clearing)					
0829	4th	bailer			1.5	gal	silty	water					
0834	5th	bailer			1.5	gal	silty	water					
0839	6th	bailer			1.5	gal	silty	water					
0844	7th	bailer			1.5	gal	silty	water	some	sand			
0858	8th	bailer			1.5	gal	silty	water	some	sand			
0903	9th	bailer			1.5	gal	silty	water	some	sand			
0908	Commenced Surging												
0925	Stopped Surging												
0931	10th	bailer			1.5	gal	silty	water	some	sand			
0935	11th	bailer			~~1.5~~ RH	gal	silty	water	some	sand			
0938	12th	bailer			1.5	gal	silty	water	some	sand			
0943	Depth to water 203.2 ft TOC												
	Bottom tagged at ~ 317 ft TOC												
0955	Cut bolts on cable U clamp so no chance of pinching wire												
1029	Started dropping pump 10 SQE-200 smaller pump Transducer ~~1ft~~ 2ft above TOP												Purge Flow Rate (mL (0) or gal per min (0.0))

\\Snowbird\proj\AFCEE\341561 AFCEE TO 409\Work Plans\Field Log_Development and Sampling.xls

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)
1118	Pump down			27" above ground			BOP is 312.75'			bgs	(has check valve)	
1126	Transducer depth below water is 127.50											
1141	Start of pumping					1.096	gpm					
1328	93.0	19.63	7.01	1.78	—	9.53	-38					
1605	153.0	19.50	8.68	1.64	950	9.82	-43					
1705	180.0	18.76	8.77	1.76	—	9.38	-47					
-3-13 0856	~~340~~	16.27	8.79	1.78	—	9.89	-161					
Field parameters stable? 190		Y N	Y N	Y N	Y N	Y N	Y N					

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal					
Duplicate					
MS/SD					
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter:

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH								
Turbidity								
ORP								
Spec Cond								
DO								
Ammonia								
Chloride								
Nitrate								

General Notes:

Monitoring Point/Location: Bonneville Date: ______ Sampler: Ryan Hampton

Weather: Cloudy / windy Visitors: ______

Boring Dia. 8" / Casing Dia. 4" DTW: ______ TD: ______ Pump Intake Depth: ______ Pump Top Depth: ______

Purge/Sampling Method: ______ Vial pH: ______ Depth to Water @Sampling: ______

Low Flow:
Calculated Purge Volume ______ (Tubing Leng. (ft)) X ______ (Tubing Dia. Factor) + ______ (Pump Volume) X 2 = ______ (Purge Volume (mL)) = ______ (Rounded Purge Volume (Rounded up to nearest 100 mL))

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Casing Volume Above Screen

Standard Method:
Calculated Purge Volume ______ (TD (ft)) - ______ (DTW (ft)) = ______ (Water Colume (ft)) - ______ (Scr. Leng. (ft)) = ______ (Casing Leng.) X ______ (Casing Factor) X 3 = ______ (Casing Vol.) = ______ (Purge Volume (gal) (0.0))

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)		Nitrate mg/L	Phosphate mg/L	GW Level (ft below MP)	Comments (Color/Odor)	
PH ~~1418~~	~~Pw~~			~~2.02~~	~~302.0~~	~~9.11~~	~~-184~~	RH					
0935	250.3	16.60	8.88	2.02	302.0	9.11	-184						
1018	270.0	15.43	8.82	1.98	515.0	9.27	-151	pump off letting well recover					
1230	Water level has recharged to 89.11							pump on begin sampling after water clears					
1250	Done sampling / fill out COC / do colorimeter test												
1313	Pipe out of hole								0.0	0.04			
1331	Water level measured at					234.38		TOC					
	Total purged volume 280 gals												
1340	Left site Bonneville well												

Purge Flow Rate (mL (0) or gal per min (0.0))

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification

Non-Production Well: 1369001M00 WIN: 436431

Owner *Note any changes*

CH2M HILL FOR PEAK MINERALS INC.
C/O STEPHEN HILL
215 S. STATE STREET, STE. 1000
SALT LAKE CITY, UT 84111

Contact Person/Engineer: Stephen Hill / CH2mHill

Well Location *Note any changes*

N 223 E 225 from the W4 corner of section 09, Township 23S, Range 11W, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation,local well #) SEV-12-026

Drillers Activity Start Date: 01-15-13 Completion Date: 04-05-13

Check all that apply: ☒ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use: Monitor Well

If a replacement well, provide location of new well. ________ feet north/south and ________ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	322	9	Sonic	N/A

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE High	PERMEABLE Low	CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTION AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture,degree of weathering, hardness, water quality, etc.)
0	207			X	X	X	X	X					Brown	
207	322	X	X		X	X	X						"	

RECEIVED
APR 29 2013 JH
WATER RIGHTS
SALT LAKE

Static Water Level

Date 02-27-13 Water Level 207 feet Flowing? ☐ Yes ☒ No

Method of Water Level Measurement WLI If Flowing, Capped Pressure N/A PSI

Point to Which Water Level Measurement was Referenced ground level Elevation N/A

Height of Water Level reference point above ground surface N/A feet Temperature N/A degrees ☐C ☐F

Well Log

Construction Information

DEPTH (feet) FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	210	4" Sch. 80 PVC	80	4	210	310	.010	4	Factory Slot

☒ SCREEN ☐ PERFORATIONS ☐ OPEN BOTTOM

Well Head Configuration: Above grade Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: Flush Thread Perforator Used: N\A

Was a Surface Seal Installed? ☒ Yes ☐ No Depth of Surface Seal: 205 feet Drive Shoe? ☒ Yes ☐ No

Surface Seal Material Placement Method: Tremie Bentonite and Cement

Was a temporary surface casing used? ☒ Yes ☐ No If yes, depth of casing: 322 feet diameter: 9 inches

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	197	Cement Bentonite	53 bags	50 lbs each
197	205	Bentonite chips	6 bags	" "
205	322	20-40 Sand	72 bags	" "

Well Development and Well Yield Test Information

DATE	METHOD	YIELD	Units Check One: GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
	N\A					

Pump (Permanent)

Pump Description: N\A Horsepower:____ Pump Intake Depth:____ feet

Approximate Maximum Pumping Rate:____ Well Disinfected upon Completion? ☐ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary Circumstances, abandonment procedures. *Use additional well data form for more space.*

N\A

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name BOART LONGYEAR License No. 626

(Person, Firm, or Corporation, Print or Type)

Signature ____ Date 04-25-13

(Licensed Well Driller)

PROJECT NUMBER:	BORING NUMBER:	SHEET 1 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0			Silty sand (SM), 10YR 5/6 yellow brown, moist-dry, loose; Gravel (5%), Sand (75%), Clay/Silt (20%)	Trace fine gravel
		5.0			
5	5.0			SP/GP 10 YR 5/6 yelow brown, moist, loose; Gravel (40%), Sand (40%), Clay/Silt (20%)	SP/GM
				Silty gravel with sand (GM) 7.5 YR 5/4 Brown; moist, loose; ; Gravel (55%), Sand (25%), Clay/Silt (20%)	Quartz dominant clasts; coarse sand Does effervesce with HCL (%carbonate)
10		10.0			
				Lean clay (CL) 7.5 YR 5/4 brown, moist, stiff, medium plasticity; ; Gravel (0%), Sand (5%), Clay/Silt (95%)	
15	15.0			Silty Gravel with sand (GM) 10 YR 5/4 brown, moist, loose; ; Gravel (50%), Sand (30%), Clay/Silt (20%)	
				Silty clay (CL) 2.5Y 7/2, light grey, dry, medium stiff-stiff, crunbles, low plasticity; ; Gravel (0%), Sand (10%), Clay/Silt (90%)	
20		10.0			
				Silty clay (CL) 2.5Y 7/2, light grey, dry,stiff-very stiff, crunbles, low plasticity; ; Gravel (0%), Sand (10%), Clay/Silt (90%)	
25					

PROJECT NUMBER:	BORING NUMBER:	SHEET 2 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	25.0				Silty clay (CL) 5y 6/2 light olive green with 10YR 5/4 brown ribbons, moist, very stiff;Gravel (0%), Sand (5%), Clay/Silt (95%)	5-10% gypsum crystals in clay Had to use a hammer to pound putty knife in
30		10.0				
35	35.0				Silty clay (CL) 7.5 YR 5/4 brown, moist, stiff-medium stiff, medium to high plasticity, roll and re-roll 4-5 times;Gravel (0%), Sand (5%), Clay/Silt (95%)	5-10% salt crystals in clay
40		12.0				
45						
	47.0					
50						

PROJECT NUMBER:	BORING NUMBER:	SHEET 3 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface START : 1/17/2013 END : 1/24/2013 LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		8.0			Lean clay (CL) GLEY 6/5G Pale Green, moist, stiff-medium stiff, medium plasticity;Gravel (0%), Sand (5%), Clay/Silt (95%)	No observed salt crystal fomation
					Silty clay (CL) 7.5 YR 5/4 brown, moist, medium stiff-stiff, low plasticity and slightly crumbly;Gravel (0%), Sand (10%), Clay/Silt (90%)	
55	55.0					
		10.0			Sandy clay with silt (CL), GLEY 1 6/106y Greenish grey, moist, medium stiff-stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	Slightly crumbly, dry, increase in % sand 5-10% salt crystal fomation
60						
65	65.0					
		10.0			(CL) Silty clay with sand mixed GLEY1 6/10GY greenish grey with 7.5 YR 5/4 brown, moist,stiff, low plasticity and slightly crumbly;Gravel (0%), Sand (10%), Clay/Silt (90%)	Drill rig working hard on clay. Comes up hot, seems baked and crumbles easily with lenses of stiff borrings 15-30% crystals.
70						
75						

PROJECT NUMBER:	BORING NUMBER:	SHEET 4 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface START : 1/17/2013 END : 1/24/2013 LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	75.0				(CL), GLEY 1 6/106y Greenish grey, moist-dry, loose medium stiff chunks w/ ~30% crystals; Gravel (0%), Sand (10%), Clay/Silt (90%)	non-plastic
80		10.0			(CL), GLEY 1 6/106y Greenish grey, moist, stiff, crumbles between fingers; Gravel (0%), Sand (10%), Clay/Silt (90%)	non-low plastic
85	85.0				Silty clay w/salt, (CL), GLEY1 6/10GY and 1.5YR 5/4 brown greenish grey, moist, medium stiff; Gravel (0%), Sand (10%), Clay/Silt (90%)	crumbles easily; 15-25% salt crystals, formed in clay, non-low plasticity, white salt rimmed on core.
90		10.0				
					Silty clay, (CL), 7.5YR 5/4 brown, moist, stiff; medium plasticity;Gravel (0%), Sand (10%), Clay/Silt (90%)	Significant % decrease in salt crystal formation (5-10%)
95	95.0				Silty clay, (CL) 7.5 YR 5/4 brown w/ GLEY1 6/5G greenish grey, moist, medium stiff to stiff, medium to low plasticity;Gravel (0%), Sand (10%), Clay/Silt (90%)	5-15% salt crystal growth in clay
100						

PROJECT NUMBER: 465077	BORING NUMBER: Sev-12-027 Dike Access	SHEET 5 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
105	107.0	12.0			Silty clay, (CL) 7.5 YR 5/4 brown w/ GLEY1 6/5G from 100-102' bgs greenish grey, moist, medium stiff to stiff, medium to low plasticity;Gravel (0%), Sand (10%), Clay/Silt (90%)	
110					Silty clay, (CL) 7.5 YR 5/4 brown , moist, medium stiff, crumbly, low plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	5-10% salt crystals
115	117.0	10.0			Silty clay, (CL) 7.5 YR 5/4 brown w/ GLEY 6/56 greenish grey , moist, medium stiff-stiff, crumbly, low plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	5-10% salt crystals
120		10.0			Silty clay, (CL) GLEY 6/56 greenish grey , moist-dry, medium stiff-stiff, crumbly, low plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	<5 salt crystals
125						

PROJECT NUMBER:	BORING NUMBER:	SHEET 6 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	127.0	10.0			Silty clay, (CL) 7.5 YR 5/4 brown , moist,stiff, crumbly, low plasticity; Gravel (0%), Sand (20%), Clay/Silt (80%)	% increase in sand
130						
135						
	137.0	10.0			Silty clay w/sand, (CL) 7.5 YR 5/4 brownm w/ GLEY 6/56 greenish grey , moist, medium stiff-stiff, crumbly, low plasticity; Gravel (0%), Sand (25%), Clay/Silt (75%)	Abundant salt crystals give sandy texture; easily crumbles; low plasticity (rolls)
140						
145					Silty clay, (CL) GLEY1 5/56 greenish grey , moist, stiff-very stiff, low plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Trace salt crystals <5%
	147.0				Silty clay, (CL) GLEY1 6/56 greenish grey , moist, medium stiff- stiff, low plasticity; Gravel (0%), Sand (20%), Clay/Silt (80%)	Increase in % sand; crumbly clay
150						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
155	157.0	10.0				
160		10.0			Silty clay, (CL) 7.5 YR 5/4 brown w/ GLEY 6/5G greenish grey , moist,stiff-very stiff, crumbly, low plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	5-10% crystal formation
					Silty clay w/sand, (CL) 7.5 YR 5/4 brown , wet, soft-medium stiff, crumbly; Gravel (0%), Sand (30%), Clay/Silt (70%)	162.5-163' bgs dry rolled clay clast act like gravels; Produces water in 6" band
165	167.0				Silty clay w/sand, (CL) 7.5 YR 5/4 brown , moist-dry, medium stiff, crumbly; Gravel (0%), Sand (25%), Clay/Silt (75%)	15-20% crystal formation; barely moist appears dry
170		10.0			Silty clay w/salt crystals, (CL) 7.5 YR 5/4 brown , moist-dry, medium stiff, crumbly loose; Gravel (0%), Sand (15%), Clay/Silt (85%)	15-20% salt crystal formation; salt crystals seem to act like sand to provide the grain > no. 200 sieve
175						

PROJECT NUMBER: **465077**

BORING NUMBER: **Sev-12-027 Dike Access**

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	177.0					
					Silty clay w/salt crystals, (CL) 7.5 YR 5/4 brown , moist-dry, medium stiff, crumbly loose, medium plasticity; Gravel (0%), Sand (20%), Clay/Silt (80%)	
180					Silty clay, (CL) GLEY1 6/10GY greenish grey , moist, stiff-medium stiff; Gravel (0%), Sand (20%), Clay/Silt (80%)	Some salt crystal formation ~25-40% euhedral gypsum
		10.0				
					Silty clay w/salt crystals, (CL) 7.5 YR 5/4 brown , moist, stiff, medium plasticity; Gravel (0%), Sand (20%), Clay/Silt (80%)	
185						
	187.0				Silty clay w/sand, (CL) 7.5 YR 5/4 brown , moist-dry, stiff, very crumbly; Gravel (0%), Sand (25%), Clay/Silt (75%)	10-20% salt crystal formation, crystals are like grains of sand in clay (small); Coarse sandy clay seems packed/compressed together in cubes.
190						
		10.0				
195						
	197.0				Silty clay, (CL) 7.5 YR 5/4 brown, moist-dry,stiff, crumbly; Gravel (0%), Sand (15%), Clay/Silt (85%)	5-10% salt crystals
200						

PROJECT NUMBER:	BORING NUMBER:	SHEET 9 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0				
					Silty clay, (CL) 7.5 YR 5/4 brown w/ GLEY 6/5G greenish grey , moist-dry, crumbly; Gravel (0%), Sand (15%), Clay/Silt (85%)	10-20% salt crystals
205					(CL) 7.5 YR 5/4 brown w/ GLEY 6/5G greenish grey,stiff, crumbly; Gravel (0%), Sand (10%), Clay/Silt (90%)	
	207.0				Silty clay, (CL) 7.5 YR 5/4 brown, moist-dry, crumbly; Gravel (0%), Sand (10%), Clay/Silt (90%)	<5% salt crystal formation 213-215' bgs very stiff. Cuts like batter with knife.
210						
		10.0				
215						
	217.0				(CL) Silty clay with sand GLEY1 5/10GY greenish grey, moist-dry,medium stiff,crumbly, low plasticity;Gravel (0%), Sand (15%), Clay/Silt (85%)	10-15% gypsum
220					(CL) Silty clay with sand GLEY1 6/10GY greenish grey, moist-dry,medium stiff,crumbly, low plasticity and slightly crumbly;Gravel (0%), Sand (15%), Clay/Silt (85%)	15-% gypsum crystal growth crumbly clay with low plasticity
		10.0				
225						

PROJECT NUMBER: 465077	BORING NUMBER: Sev-12-027 Dike Access	SHEET 10 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	227.0				(CL) Silty clay with sand GLEY1 6/10GY greenish grey w/ 7.5 YR 5/4 brown, moist-dry,medium stiff-stiff,crumbly, low plasticity;Gravel (0%), Sand (15%), Clay/Silt (85%)	15-20% gypsum crystal growth ; Clay dry and comes out loose w/ 6-8" competent sections not disentegrated.
230						
		10.0				
235						
	237.0					
240						
		10.0				
245					(CL) Silty clay with sand GLEY1 6/5G greenish grey, moist, stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	Less crumbly than previous interval, some moisture, more cohesive, medium plasticity, (rolls easily)
	247.0					
250		5.0				

PROJECT NUMBER:	BORING NUMBER:	SHEET 11 OF 16
465077	Sev-12-027 Dike Access	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface START : 1/17/2013 END : 1/24/2013 LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	252.0					
255					(CL) Silty clay GLEY1 6/5G greenish grey, moist, stiff-medium stiff, medium plasticity;Gravel (0%), Sand (10%), Clay/Silt (90%)	10-15% salt crystal growth <5mm
260		15.0				
265						
	267.0					
270					(CL) Silty clay GLEY1 6/5G greenish grey, moist, stiff-medium stiff, medium plasticity;Gravel (0%), Sand (15%), Clay/Silt (85%)	Percent change 15-20% gypsum growth <2mm Small black sand pocket
275		10.0				

PROJECT NUMBER: **465077**

BORING NUMBER: **Sev-12-027 Dike Access**

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface

START : 1/17/2013

END : 1/24/2013

LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	277.0				(CL) Silty clay with sand GLEY1 6/5G greenish grey, moist, stiff-very stiff;Gravel (0%), Sand (10%), Clay/Silt (90%)	No gypsum Sand pocket @ 276' bgs w/ black silts (organic?) Batter clay
280		10.0			(CL) Silty clay GLEY1 6/5G greenish grey, dry-moist, stiff-very stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	<5% gypsum growth or really small
285	287.0				(CL) Silty clay 7.5YR 5/4 brown, dry-moist, very stiff, crumbly;Gravel (0%), Sand (15%), Clay/Silt (85%)	<5% gypsum growth Small laminations of greenish grey from285-287' bgs One piece of degraded limestone @ 285'bgs.
290 295	297.0	10.0			(CL) Silty clay GLEY1 6/5G greenish grey w/ 7.5YR 5/4 brown, , dry-moist, very stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	<5% gypsum growth Very stiff but crumbly Low plasticity
					(CL) Silty clay GLEY1 6/5G greenish grey w/ 7.5YR 5/4 brown, dry-moist, very stiff;Gravel (0%), Sand (10%), Clay/Silt (90%)	Percent change
300					(CL) Silty clay GLEY1 6/5G greenish grey, moist, very stiff;Gravel (0%), Sand (10%), Clay/Silt (90%)	30-45% black silt laminations No observed gypsum

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0				
305						
	307.0					
					(CL) Silty clay GLEY1 6/5G greenish grey w/ alternating zones of 7.5 YR 5/4 brown, moist, very stiff;Gravel (0%), Sand (10%), Clay/Silt (90%)	
310						
		10.0				
315						
	317.0					
					(CL) Silty clay GLEY1 6/5G greenish grey w/ 7.5 YR 5/4 brown, dry-moist, crumbly, stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	4" organic laminations @ 320' bgs
320						
		10.0				
325						

PROJECT NUMBER: 465077	BORING NUMBER: Sev-12-027 Dike Access	SHEET 14 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : East of South Yard (38.7 N, -113.2 E)
ELEVATION : 4574.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
WATER LEVELS : 205.7 ft below ground surface
START : 1/17/2013
END : 1/24/2013
LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	327.0	10.0		(CL) Silty clay GLEY1 6/5G greenish grey w/ 7.5 YR 5/4 brown, dry-moist, crumbly, stiff;Gravel (0%), Sand (25%), Clay/Silt (75%)	Percent change
				Clayey silt w/ fine sand, (ML) 7.5 YR 5/4 brown, loose;Gravel (0%), Sand (35%), Clay/Silt (65%	
330				(CL) Silty clay with sand GLEY1 6/5GY greenish grey, dry-moist, medium stiff- stiff;Gravel (0%), Sand (20%), Clay/Silt (80%)	
335					
	337.0	10.0		(CL) Silty clay with sand GLEY1 6/5GY greenish grey, dry-moist, medium stiff- stiff;Gravel (0%), Sand (15%), Clay/Silt (85%)	Percent Change
340					
345					
	347.0			(CL) Silty clay with sand GLEY1 6/5GY greenish grey, dry-moist, stiff;Gravel (0%), Sand (20%), Clay/Silt (80%)	Crumbly No gypsum
350					

PROJECT NUMBER: 465077	BORING NUMBER: Sev-12-027 Dike Access

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : East of South Yard (38.7 N, -113.2 E)

ELEVATION : 4574.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter

WATER LEVELS : 205.7 ft below ground surface — START : 1/17/2013 — END : 1/24/2013 — LOGGER : A. Cantrell

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
355		15.0				
360	362.0					
365	367.0	5.0			(CL) Silty clay with sand GLEY1 6/5GY greenish grey, wet, medium stiff;Gravel (0%), Sand (20%), Clay/Silt (80%)	Desicated blocks of stiff clay stacked like gravels, driller reported gravel but CL blocks act as clasts up to 2"/ will see if next 10' run is the same.
370	372.0	5.0			(CL) Silty clay with sand GLEY1 6/5GY greenish grey, wet, medium stiff;Gravel (0%), Sand (20%), Clay/Silt (80%)	Stiff lenses of clay in soft matrix Contact @ 372.5' bgs w/ very stiff (CL) and black speckled silt described below.
375		5.0			(CL) Silty clay with sand GLEY1 6/5GY greenish grey, wet, very stiff, moist-dry;Gravel (0%), Sand (10%), Clay/Silt (90%)	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
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DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8"casing diameter
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DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	377.0			(SM) very fine sand, greenish grey, dense, dry-moist;Gravel (0%), Sand (65%), Clay/Silt (35%)	Trace organic w/ black silt
				Silty Clay (CL), GLEY 1 6/5G greenish grey, moist, stiff to very stiff;Gravel (0%), Sand (10%), Clay/Silt (90%)	
380					
		10.0			
385					
	387.0			Silty Clay (CL), GLEY 1 6/5G greenish grey, dry-moist, medium stiff;Gravel (0%), Sand (20%), Clay/Silt (80%)	crumbly and loose
390					
		10.0			
395				Silty Clay (CL), GLEY 1 6/5G greenish grey, dry-moist, medium stiff;Gravel (0%), Sand (5%), Clay/Silt (95%)	Bottom called
	397.0			Bottom of Hole at 380.0 ft below ground surface 1/24/2013	
400					

Monitoring Point/Location: Dike Access　Date: Feb 26 2013　Sampler: Ryan Hamilton / Steve Hill

Weather: Sunny, temp: 20°F　Visitors: Bryan (Peak), Rick Nye (Peak)

Boring Dia. 8"　Casing Dia. 4"　DTW: ____　TD: 397　Pump Intake Depth: ____　Pump Top Depth: ____

Purge/Sampling Method: ____　Vial pH: ____　Depth to Water @Sampling: ____

Low Flow: Calculated Purge Volume　____ Tubing Leng. (ft) X ____ Tubing Dia. Factor + ____ Pump Volume X 2 = ____ Purge Volume (mL) = ____ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft　1/2"= 38 mL/ft　5/8"= 60 mL/ft

Casing Volume Above Screen

Standard Method: Calculated Purge Volume　____ TD (ft) - ____ DTW (ft) = ____ Water Colume (ft) - ____ Scr. Leng. (ft) = ____ Casing Leng. X ____ Casing Factor X 3 = ____ Casing Vol. = ____ Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95　Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ____　PPE Disposal: ____　Disposition of Purge Water: ____　90% Recharge Level: ____ ft　Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)
Screened		interval =		350- 380'	bgs							
900											33.86	TOC North
910	Verified		Surge	Stick		has	been	reclaimed		with	developer	
	~~Begin~~		~~working~~		~~3"~~	~~x 5'~~	~~bailer,~~	~~tag~~	SH 7.2413			
915	tag	depth	to	silt	at	380.3'	⇒	will	have	to	bail	
	~ 17											
930	1st	bailer	out	~	1.5	gallons		very	silty	mud		
936	2nd	bailer		~	1.5	gallons		very	silty	mud		
948	3rd	bailer		out ~	1.5	gallons		very	silty	mud		
953	4th	bailer		out	"							
959	5th	bailer			1.5	gallons	noticeably,		less	mud		
1004	6th	bailer		out	1.5	gallons		silty	water			
1011	7th	bailer			"			"				
1016	8th	bailer			1.5	gallons	--	continued	thinning	of	silt/	mud
1021	9th	bailer			1.5	gallons		"		"		
1024	10th	bailer			1.5	gallons		"		"	63.91	a little sand
1033	11				1.5	gallons		"		"		
1039	12th				1.5	gallons						
1044	13th				1.5	gallons						" "
1050	14th				1.5	gallons						getting lighter
1100	15th				1.5	gallons						

Purge Flow Rate (mL (0) or gal per min (0.0))

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)			total purge Vol (gal) ~~Total Purge Volume~~	GW Level (ft below MP)	Comments (Color/Odor)	
1106	16th	bailer	out.		1.5	gallons	silty	water		24			
1107 ~~1110~~	17th									23.5		silty water	
1116	18th		"							27.0		silty/looks to	be
1120	19th									28.5		clearing	
1122	20th									30			
Have removed about 0.5ft of silt off of the bottom. Will try swabbing													
continued next page													
Field parameters stable?		Y N	Y N	Y N	Y N	Y N	Y N						

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal					
Duplicate					
MS/SD			SH	2/26/13	
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter:

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH								
Turbidity								
ORP								
Spec Cond								
DO								
Ammonia								
Chloride								
Nitrate								

General Notes:

Monitoring Point/Location: Dike Access Development (Continued) Date: ______ Sampler: ______

Weather: ______ Visitors: ______

Boring Dia. ______ Casing Dia. ______ DTW: ______ TD: ______ Pump Intake Depth: 370' Pump Top Depth: 367'

Purge/Sampling Method: ______ Vial pH: ______ Depth to Water @Sampling: ______

Low Flow: Calculated Purge Volume ______ Tubing Leng. (ft) X ______ Tubing Dia. Factor + ______ Pump Volume X 2 = ______ Purge Volume (mL) = ______ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Casing Volume Above Screen

Standard Method: Calculated Purge Volume ______ TD (ft) - ______ DTW (ft) = ______ Water Column (ft) - ______ Scr. Leng. (ft) = ______ Casing Leng. X ______ Casing Factor X 3 = ______ Casing Vol. = ______ Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1130	30	Begin		surgin	well		to try	to	stir	up	silt	at bottom	
1200	36	Begin		Bailing	again								
1220	31.5 21	st			1.5	gal				silty	water		
1224	33 22	nd			1.5	gal				silty	water		
1230	34.5 23	rd			1.5	Gal				silty	water		
1235	36 24	th			1.5	gal				silty	water		
1243	37.5 25	th			1.5	gal				silty	water		
1255											167.67	End Bailing	
1342											106.58		
1452	Pump	and		transducer		deployed.	to	Bottom	of	pump	at	370'	
	transducer			at	~ 365'								
1515	pump	on		7.5	gpm								
1525	112.5 75 5th	14.60	6.59	2.06	0.5	11.01	22.1					cloudy, turbidity suspect	
1534												sinking → might be above range	
1535	187.5 50										0	stopped pumping.	
1620	resumed		pumping		at 6.0 gpm					depth over transducer ↔	50.85	let recover	
1625	5th 180 28									depth of transducer ↔	0.3	stopped pumping	
2/27 1730	"										325.17		
1000	Autocalibrated			the		Horiba	after	having	some	problems.	I believe	the	
	high	conductivity		water	from	the	well	yesterday	may have	created	some	issues	
1105	224	14.96	~~5.13~~ 7.07	19.3	813	9.43	14						Purge Flow Rate (mL (0) or gal per min (0.0))

7.07 (44g/L TDS)

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)	(mg/L) nitrate	phosphate mg/L		GW Level (ft below MP)	Comments (Color/Odor)
1117	233	15.52	~~7.48~~ 7.48	79.7	275	8.66	-51					
1135	247	15.32	7.58	71.8	671	7.77	-20					Pump off
1330	247	15.63	7.27	59.8	709	9.87	50	1.0	0.16			sampled
Field parameters stable?		Y N	Y N	Y N	Y N	Y N	Y N					

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal	Dike Access	1350	2/27/13	metals, TDS, anions, C-14, stable O and H isotopes	
Duplicate					
MS/SD					
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter: Horiba U-22

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH	✓		2/26/13	13:30	4	3.99	4.00	✓
Turbidity	✓			13:30	0	~5-10 (unstable)	0.0	✓
ORP								
Spec Cond	✓			1330	4.49 mS/cm	4.44 mS/cm	4.49 mS/cm	✓
DO								
Ammonia								
Chloride								
Nitrate								

General Notes: Nitrate and phosphate analyzed by colorimetry in field

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification

Non-Production Well: 1369001M00 WIN: 436428

Owner *Note any changes*

CH2M HILL FOR PEAK MINERALS INC.
C/O STEPHEN HILL
215 S. STATE STREET, STE. 1000
SALT LAKE CITY, UT 84111

Contact Person/Engineer: Stephen Hill / CH2mHill

Well Location *Note any changes*

S 2080 W 84 from the N4 corner of section 15, Township 24S, Range 12W, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation,local well #) SEV-12-027

Drillers Activity Start Date: 01-15-13 Completion Date: 04-05-13

Check all that apply: ☒New ☐Repair ☐Deepen ☐Clean ☐Replace ☐Public Nature of Use: Monitor Well

If a replacement well, provide location of new well. ______ feet north/south and ______ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	397	10	Sonic	N/A

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE High	PERMEABLE Low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTION AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture,degree of weathering, hardness, water quality, etc.)
0	263			X	X	X	X						Brown	
263	397	X	X		X	X	X						"	

RECEIVED
APR 29 2013 JH
WATER RIGHTS
SALT LAKE

Static Water Level

Date 01-30-13 Water Level 263 feet Flowing? ☐Yes ☒No

Method of Water Level Measurement WLI If Flowing, Capped Pressure N/A PSI

Point to Which Water Level Measurement was Referenced ground level Elevation N/A

Height of Water Level reference point above ground surface N/A feet Temperature N/A degrees ☐C ☐F

√

Construction Information

DEPTH (feet) FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	☒SCREEN ☐PERFORATIONS ☐OPEN BOTTOM SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	350	4" Sch. 80 PVC	80	4	350	380	.010	4	Factory Slot

Well Head Configuration: Above grade   Access Port Provided? ☒Yes ☐No

Casing Joint Type: Flush Thread   Perforator Used: N/A

Was a Surface Seal Installed? ☒Yes ☐No   Depth of Surface Seal: 345 feet   Drive Shoe? ☒Yes ☐No

Surface Seal Material Placement Method: Tremie Bentonite And Cement

Was a temporary surface casing used? ☒Yes ☐No If yes, depth of casing: 397 feet diameter: 9 inches

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	335	Cement Bentonite	80 bags	50 lbs each
335	345	Bentonite chips	6 bags	" "
345	380	20-40 Sand	26 bags	" "
380	397	Bentonite chips	5 bags	" "

Well Development and Well Yield Test Information

DATE	METHOD	YIELD	Units Check One: GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
	N/A					

Pump (Permanent)

Pump Description: N/A   Horsepower: ____   Pump Intake Depth: ____ feet

Approximate Maximum Pumping Rate: ____   Well Disinfected upon Completion? ☐Yes ☐No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary Circumstances, abandonment procedures. *Use additional well data form for more space.*

N/A

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name BOART LONGYEAR   License No. 626

(Person, Firm, or Corporation) (Print or Type)

Signature ____   Date 04-25-13

(Licensed Well Driller)

PROJECT NUMBER:	BORING NUMBER:	SHEET 1 OF 18
465077	SEV-12-023 Guzzler	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
END : 2/16/2013
LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0	7.0			(GP), poorly-graded alluvial gravel, rounded clasts, pebble-cobble sized; 10yr 6/4; very loose, dry; Gravel (80%), Sand (15%), Clay (5%)	Carbonite and quartzite clast; coarse gravel to cobble
5						
	7.0	10.0			Same as above; Gravel (80%), Sand (15%), Clay (5%)	
10					Same as above; w/smaller clast size and more sand; Gravel (60%), Sand (35%), Clay (5%)	
					Poorly graded alluvial gravel, (GP), sub-rounded pebble-cobble size, loose, dry; 10yr 7/3 very pale brown; coarse gravel to cobble; carbonate and quartzite clasts; Gravel (80%), Sand (15%), Clay (5%)	clast size and gravel content increase with depth
15						
	17.0	10.0			Same as above with increasing clast size and gravel content; Gravel (60%), Sand (15%), Clay (25%)	
20						
25						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface

START : 2/2/2013

END : 2/16/2013

LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
				Poorly graded silty alluvial silty gravel; (GP) 10yr 7/2 light grey; very loose and dry, coarse to cobble sized, sub-round, sub-angular, increased silt content with depth;Gravel (60%), Sand (15%), Clay (25%)	sub-round to subangular carbonate and quartzite clasts
	27.0				
				Poorly graded silty alluvial gravel (GP); 10yr 7/3 very pale brown, loose and dry with coarse to cobble-sized clasts; Gravel (60%), Sand (25%), Clay (15%)	
30					
		10.0			
35				Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose and dry; Gravel (15%), Sand (5%), Clay (80%)	
				Poorly graded silty gravel (GM), 10yr7/3 very pale brown, very loose and dry coarse subangular-subround gravel;Gravel (40%), Sand (10%), Clay (50%)	core lost from 37-42'
	37.0				
40					
		5.0			
				Poorly graded silty sandy gravel (GM); 10 yr 7/3 very pale brown; very loose and dry; coarse subangular-subround gravel; carbonate and quartzite clasts; Gravel (35%), Sand (30%), Clay (35%)	carbonate and quartzite clasts; Host rock-conglomerate with silt matrix consistent with alluvial wash environment; high energy, near source, poorly sorted, poorly lithified
45					
	47.0				
50					

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 3 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
END : 2/16/2013
LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		5.0				
	54.0					
55		3.0				
	57.0					
60		10.0				
65					Very fine sandy silt (ML); few coarse gravel clasts, one large cobble; 10yr 7/3 very pale brown; very loose; dry; Gravel (10%), Sand (20%), Clay (70%)	
	67.0					
					Poorly graded silty sandy gravel (GM); 10 yr 7/3 very pale brown; very loose and dry; coarse subangular-subround gravel; carbonate and quartzite clasts; Gravel (35%), Sand (15%), Clay (50%)	3% change with depth
70		10.0				
75						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah	LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft	DRILLING CONTRACTOR : Boart Longyear
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WATER LEVELS : 233.0 ft below ground surface; START : 2/2/2013; END : 2/16/2013	LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	77.0				
80		10.0			
85					
	87.0				
				Poorly graded silty gravel (GM); 10yr 7/3 very pale brown; very loose and dry; Gravel (30%), Sand (10%), Clay (60%)	coarse gravel to cobble clasts; subround-subangular; carbonate and quartzite
90		10.0			
95					
	97.0				
100					

PROJECT NUMBER:	BORING NUMBER:	SHEET 5 OF 18
465077	SEV-12-023 Guzzler	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
END : 2/16/2013
LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0				
105						
	107.0					
110		5.0				
					Clayey silt (ML); 10yr 4/6 dark yellowish brown; soft, low plasticity; moist, Gravel (5%), Sand (10%), Clay (85%)	
	112.0				Poorly graded silty gravel (GM); 10yr 7/3 very pale brown; very loose and dry; Gravel (30%), Sand (10%), Clay (60%)	coarse gravel to cobble; some cobbles up to 6"- quartzite; subround-subangular
115		5.0				
	117.0					
120						
		10.0				
125						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
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DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	127.0				Poorly graded silty gravel (GM); 10yr 7/3 very pale brown; very loose and dry; Gravel (25%), Sand (5%), Clay (70%)	subangular-subround, coarse-fine gravel, some cobbles up to 4"
130						
		10.0				
135						
	137.0					
140						
		10.0				
145						
	147.0					
150						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
END : 2/16/2013
LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
155	157.0	10.0			
				Poorly graded clayey silty gravel (GC); 10yr 5/6 yellowish brown, loose, moist-dry; Gravel (30%), Sand (5%), Clay (65%)	
160		10.0		Poorly graded clayey silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	
165	167.0			Poorly graded clayey silty gravel (GC); 10yr 5/6 yellowish brown, loose, moist-dry; Gravel (30%), Sand (5%), Clay (65%)	clasts of coarse gravel to cobble (~6"), subangular-subround; predominantly quartzite
170		10.0		Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	coarse gravel to cobble; some cobbles up to ~3"; subround-subangular; from 172.5'-173.5' clasts are coarse grave, no cobbles, round-subround
175					

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 8 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface | START : 2/2/2013 | END : 2/16/2013 | LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	177.0			Poorly graded clayey silty gravel (GC); 10yr 5/6 yellowish brown, very loose, dry; Medium plasticity Gravel (30%), Sand (5%), Clay (65%)	coarse gravel, subround-subangular
180		10.0		Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	subangular-subround, coarse-fine gravel, some cobbles up to 4"; 2" compact silt lense 186' bgs
185	187.0				
190		10.0		Poorly graded clayey silty gravel (GC); 10yr 5/6 yellowish brown, loose, wet; Gravel (15%), Sand (20%), Clay (65%)	water first observed at 193' bgs' 2' interval
195				Poorly graded clayey sandy, silty, gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	coarse gravel and cobbles, subround-subangular
200	197.0				

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
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DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
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START : 2/2/2013
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DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			
205					
	207.0			Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	coarse gravel and cobbles, subround-subangular; 1" compact silt lense 203' bgs
210				Poorly graded clayey silty gravel (GC); 10yr 5/6 yellowish brown, loose, wet; Gravel (25%), Sand (5%), Clay (70%)	coarse gravel; few cobbles
		10.0			
215					
	217.0				
220					
		10.0			
225					

PROJECT NUMBER:	BORING NUMBER:	SHEET 10 OF 18
465077	SEV-12-023 Guzzler	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface — START : 2/2/2013 — END : 2/16/2013 — LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	227.0				
230		10.0		Poorly graded silty sandy gravel (GM); 10yr 5/6 yellowish brown, loose, moist; Gravel (30%), Sand (50%), Clay (20%)	**Water encountered @ 233 ft** coarse gravel and cobbles, medium sand, moist-wet at 233'bgs
235					
	237.0			Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (25%), Sand (5%), Clay (70%)	coarse gravel-cobbles up to (~5"), subangular-subround
240		6.0			
	243.0			Poorly graded sandy silty gravel (GM); 10yr 5/6 yellowish brown, loose, moist-wet; Gravel (30%), Sand (50%), Clay (20%)	@ 247' bgs core is wet (6"interval), @ 249' bgs core dry to 251'bgs
245					
250		12.0			

PROJECT NUMBER:	BORING NUMBER: SHEET 11 OF 18
465077	SEV-12-023 Guzzler

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
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DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
255	255.0					
		7.0			Poorly graded sandy gravel (GP); 10yr 6/6 brownish yellow, very loose, dry; Gravel (30%), Sand (40%), Clay (30%)	medium-coarse sand; fine gravel; angular-subangular
260					Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (30%), Sand (25%), Clay (45%)	2" silt lens @260' bgs
	262.0				Poorly graded silty gravel (GM); 10yr 5/6 yellowish brown, loose, moist-dry; Gravel (30%), Sand (20%), Clay (50%)	Clay rich intervals, medium plastictiy, coarse gravel angular-subround
265		10.0			Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (30%), Sand (10%), Clay (60%)	coarse to fine gravel and cobbles (>3"), andgular to subround
270						
	272.0					
					Poorly graded clayey silty sandy gravel (GC); 10yr 5/6 yellowish brown, very loose, moist to dry; Gravel (30%), Sand (30%), Clay (40%)	
275						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 12 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface — START : 2/2/2013 — END : 2/16/2013 — LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			
280					
	282.0				
285		5.0			
	287.0				
				Poorly graded silty gravel (GM); 10yr 7/2 very pale brown, very loose, dry; Gravel (10%), Sand (0%), Clay (90%)	high silt content with loess, very fine-glacial fllow, very large cobbles (~6")
290					
		8.0		Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (10%), Sand (0%), Clay (90%)	coarse gravels-cobbles, subround-subangular, trace clay lenses @299'bgs
295	295.0				
300		9.0			

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 13 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah   LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface   START : 2/2/2013   END : 2/16/2013   LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	304.0					
305					Poorly graded clayey silty gravel (GM); 10yr 5/6 yellowish brown, soft, moist; Medium plasticity Gravel (30%), Sand (5%), Clay (65%)	coarse gravel-cobbles, moisture may be water added to saturate upper sed./first run of the day
		10.0				
310					Poorly graded silty gravel (GM); 10yr 7/3 very pale brown, very loose, dry; Gravel (40%), Sand (5%), Clay (55%)	fragment of lithified conglomerate with silt matrix, coarse gravel to cobbles, subangular-subround; 319'-321' bgs increased clay and moisture content 326'-327' bgs, more clay, black carbonate rock and different quartzite, than previously observed; Clay is stiff, med. plasticity, matrix of gravel conglomerate; 6" clay at 329' -333'bgs.
	314.0					
315						
320						
		13.0				
325						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER: SHEET 14 OF 18
465077	SEV-12-023 Guzzler

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface START : 2/2/2013 END : 2/16/2013 LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	327.0				
330		8.0			
335	335.0				
		4.0		Clayey gravel with sand (GC) Dense, very moist, medium coarse gravel to cobbles, 7.5yr 4/4 Brown, low -medium plasticity, predominantly quartzite with some black carbonates;Gravel (60%), Sand (20%), Clay (20%)	
	339.0				
340				Silty gravel with sand (GM) 7.5 yr 4/4 brow, loose, wet, well graded gravels/cobbles, well graded sands, angular-subangular; Gravel (50%), Sand (30%), Clay (20%)	
		2.0			
345					
	349.0				
350				Silty sand (SM) 10yr 4/5 Brtown, loose, wet	Cobbles up to 4", water level measured at 323.2' bgs

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 15 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface — START : 2/2/2013 — END : 2/16/2013 — LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		5.0			
355	355.0			Silty gravel with sand (GM) 7.5 yr 4/4 yellowish brown, loose, wet, well graded gravels/cobbles, well graded sands, angular-subangular; Gravel (50%), Sand (30%), Clay (20%)	No cobbles
360		8.0		Clayey gravel with sand (GC) 10yr 4/4 Dark yellowish brown, dense, wet, well graded, fine to medium gravel, no cobbles; Gravel (70%), Sand (10%), Clay (20%)	
	364.0			Same as above but no longer saturated.	Water level measured at 275.7' bgs
365				Same as above with occasional cobbles.	
		8.0			
370	372.0			Sandy clay with gravel (CL) 10yr 4/4 Dk yellow brown, very moist, stiff, well graded sands; Gravel (30%), Sand (35%), Clay (45%)	
375					

PROJECT NUMBER:	BORING NUMBER:	SHEET 16 OF 18
465077	SEV-12-023 Guzzler	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface

START : 2/2/2013

END : 2/16/2013

LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		6.0				
	378.0					
380		9.0			Well graded gravel (GW), Limestone shale, poss. sandstone, Dense clast, loose unit, wet or washed, subangular to subrounded, well graded cobbled; Gravel (95%), Sand (5%), Clay (0%)	Driller noted that 200 gal of water used to get through zone WL measured at 249.4' bgs, Trace calcite precip on limestone, predominately quartz
					Clayey sand with gravel (SM), 7.5 yr 5/4 brown, moist/wet, medium dense, medium dense; Gravel (15%), Sand (60%), Clay (25%)	medium high plasticity, fines-coarse, well graded
385					Clayey gravel (GC) 7.5 yr 5/4 brown, moist, medium high plasticity; Gravel (50%), Sand (20%), Clay (30%)	well graded, subangular-subrounded
	387.0					
390		1.0			Same as above, clay is supersaturated like cake frosting, fine-coarse gravel, sub-angularto sub-rounded competent clasts	9' of core lost, soft
395						
	397.0					
400					Clayey, silty gravel with sand (GC) 7.5 yr4/4 brown, moist, medium stiff, medium plasticity, fines with well graded gravel and coarse sand; Gravel (50%), Sand (25%), Clay (25%)	some cobbles up to 6", compaction/ cementation with weathering and ~40% oxidation, trace ribbons of yellow clay

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 17 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North of Headlight Gap (38.9 N, -113.0 E)

ELEVATION : 4965.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter

WATER LEVELS : 233.0 ft below ground surface — START : 2/2/2013 — END : 2/16/2013 — LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
405	407.0	10.0			
410	417.0	10.0		Clayey gravel with sand (GC) 10 yr 4/6 yellow brown, moist, loose, medium dense, low plasticity, lower moisture content; Gravel (65%), Sand (20%), Clay (15%)	5-10% oxidation staining with medium weathering (~80%) competent clasts with trace degraded LS, large boulder @ 410'
415, 420	423.0	6.0		Clayey gravel with sand (GC) 7.5 yr 4/4 brown, very moist, medium stiff; Gravel (50%), Sand (15%), Clay (35%)	High plasticity, fines, fine-coarse gravels, sub-angular to sub rounded, predominantly quartzite with traces of degraded LS
425				Same as above but very dry.Gravel (55%), Sand (15%), Clay (30%)	Cemented, highly compacted, very stiff

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-023 Guzzler	SHEET 18 OF 18

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap (38.9 N, -113.0 E)
ELEVATION : 4965.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto sonic; 8" casing diameter
WATER LEVELS : 233.0 ft below ground surface
START : 2/2/2013
END : 2/16/2013
LOGGER : A. Cantrell; J. Olsen; G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	427.0	4.0				
					Bottom of Hole at 425.0 ft below ground surface 2/16/2013	
430						
435						
440						
445						
450						

CH2MHILL

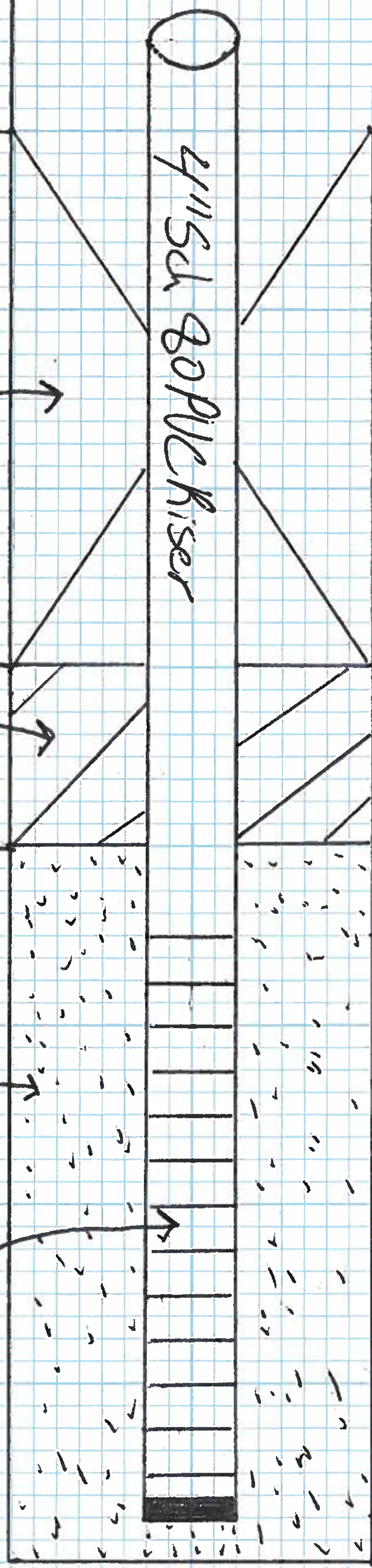
SUBJECT ~~BP~~ SEU-12-023 GUZZLER

BY A. Cantrell

SHEET NO. 1 of 1 DATE 2-16-13

PROJECT ~~NO.~~ PEAK ALLUVIAL

Material Tracking Log	As Built Depth	Design Depths
2-19-13 48 x 94lbs bags Cement w/3 bags gel 2-18-13 16 x 94lbs bag cement 1 bag gel 3 x 94lb bags 2-20-13	Cement Bentonite Grout	0'
6 → 3 Bags Chips (50#) w/50 gal water	312 ~~316~~ Bentonite Chips	315' Min. thickness 5-feet
58 bags of #20/40 Sand (50#) w/ ≈500 gal water	322 ~~326~~ 329 #20/40 Silica Sand Sch 80 PVC 0.010 Slot screen	320' 325' Top of Screen 425' Bottom of Screen/Shoe 427'



2 tag lines lost @377 and 371 Copper and Galvanized Steel

1 - 3' x 1/2" SS Rod w/ 16' fiberglass tape @417' bgs

10 pieces Screen
33 pieces Riser
10 centralizers
1 - foot/ 1 - plug

TD 427' bgs

* Not To Scale *

REV 12/01 FORM 18C

PEAK MINERALS ALLIVIAL DRILLING	PROJECT NUMBER 465077	BORING NUMBER SEV-12-023	SHEET 1 OF 17

SOIL BORING LOG

PROJECT : SevierLake Alluvial Drilling - HydroBaseline LOCATION : SEV-12-023 (GUZZLER)
ELEVATION : DRILLING CONTRACTOR : Boart Longyear (BLY)
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : Sonic
WATER LEVELS : START : 2/2/13 END : 2/16/13 LOGGER : G. TANALOS / J. Olsen / K. Cardwell

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	SAMPLE NUMBER AND TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
0–5		☒	7/7	RUN 1	GP, poorly-graded alluvial gravel, rounded clasts; pebble-cobble sized, ~~7.5YR 6/4~~ 10YR 7/3 v. pale brown, v. loose dry. -carbonate and quartzite clast -coarse gravel to cobble		80	15	5
7					S.A.A.		80	15	5
10					SAA, w/ smaller clast size and more sand		60	35	5
11		☒	10/10	RUN 2	poorly graded alluvial gravel, GP, ~~rounded~~ subrounded, pebble - cobble size, v. loose, dry, 10YR 7/3 v. pale brown ~~7.5YR 6/4 light brown~~ -Coarse gravel to cobble -carbonate + quartzite clast	Clast size increases with depth	80	15	5
15						gravel content increases	85	10	5
17–20		☒	10/10	RUN 3					
24–25					poorly graded alluvial silty gravel, GM, 10YR 7/2 ~~pale brown~~ light grey v. loose, dry • coarse to cobble sized • subround to ~~subang~~ subangular • higher silt content		60	15	25

☒ Bulk Composite Sample of Interval/Run

PEAK MINERALS ALLIVIAL DRILLING	PROJECT NUMBER 465077	BORING NUMBER SHEET 2 OF
	SOIL BORING LOG	

PROJECT : Alluvial Hydro - Drilling
LOCATION : SEV 12.023 GUZZLER
ELEVATION :
DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS :
START : 2/2/13
END :
LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
25									
26 - 27		☒	10/10	RUN 3	S.A.A. poorly graded silty alluvial gravel GM; 10YR 7/3 very pale brown v. loose, dry • coarse to cobble-size clasts	• subround to subangular • carbonate + quartzite clasts	~~70~~ 60	~~10~~ 25	~~20~~ 15
30		☒	10/10	Run 4					
34					poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose; dry		~~80~~ 15	~~20~~ 5	~~0~~ 80
35									
36 - 37					poorly-graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose, dry • coarse gravel, subangular - subround		40	10	50
40					• core lost from 37'-42'				
42		☒		RUN 5					
43			5/10		poorly graded silty sandy gravel; GM; 10YR 7/3 v. pale brown; v. loose; dry • coarse subangular - subround gravel • carbonate + quartzite clasts		35	30	35
45									
47		☒	5/5	RUN 6					
50									

PEAK MINERALS ALLIVIAL DRILLING	PROJECT NUMBER 465077	BORING NUMBER SHEET 3 OF
	SOIL BORING LOG	

PROJECT : Alluvial Hydro Drilling LOCATION : SEV-12-023 [GUZZLER]
ELEVATION : DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
50									
51		☒	5/5	RUN 6	% change poorly-graded silty gravel, GM 10YR 7/3 v. pale brown; v. loose, dry	• sub angular - subrounded clasts • carbonate & quartzite clasts	15	25	60
53					% change	HOST ROCK → • conglomerate w/ silt matrix, consistant w/ alluvial wash environment. • high-energy, near-source - sub angular to subround - poorly sorted. • silt cementation; poorly lithified	35	30	35
54									
55		☒	3/3	RUN 7					
57									
60									
61		☒	10/10	RUN 8	% change; silt content higher		20	10	70
65					very fine sandy silt, ML; few coarse gravel clasts; one large cobble; 10YR 7/3 v. pale brown; v. loose; dry		10	20	70
67									
68					poorly-graded silty sandy gravel; GM; 10YR 7/3 v. pale brown; v. loose; dry · coarse gravel to cobble clast · sub-rounded to subangular	• carbonate + quartzite clasts	~~35~~ 35	~~30~~ 15	~~35~~ 60 50
70		☒	10/10	RUN 9					
75									

PEAK MINERALS ALLIVIAL DRILLING	PROJECT NUMBER 465077	BORING NUMBER SHEET 4 OF
	SOIL BORING LOG	

PROJECT : Alluvial Hydro Drilling LOCATION : SEV-12-023 (GUZZLER)
ELEVATION : DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	VISUAL (%) SAND	VISUAL (%) CLAY/SILT
75		☒	10/10	RUN 9	S.A.A. ≈ poorly graded silty sandy gravel; GM, 10YR7/3 v. pale brown; v. loose, dry	• subround to subangular • coarse gravel to cobble	35	15	50
78					S.A.A w/ % change		35	30	35
80		☒	10/10	RUN 10					
83					S.A.A w/ % change		35	15	50
85					S.A.A w/ % change		40	20	40
87									
88					poorly graded silty gravel, GM, 10YR7/3 v. pale brown; v. loose, dry	• coarse gravel to cobble clasts • subround to subangular	30	10	60
90		☒	10/10	RUN 11					
95									
97		☒	10/10	RUN 12					
100									

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 5 OF
ALLIVIAL DRILLING	SOIL BORING LOG		

PROJECT : Alluvial Hydro Drilling LOCATION : SEV-12-023 · GUZZLER
ELEVATION : DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS : START : 2/2/13 END : LOGGER : Tangalos

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
100–105		☒	10/10	RUN 12	S.A.A. poorly graded silty gravel; GM; 10YR 7/3 v. pale brown; v. loose; dry	· coarse gravel to cobbles (softball-size) · Subround to subangular clasts · carbonate and quartzite	30	10	60
107–110		☒	5/5	Run 13					
110–112		☒			clayey silt, ML; 10YR 4/6 dark yellowish brown; soft; low plasticity; moist		5	10	85
112–117		☒	5/5	RUN 14	poorly graded silty gravel; GM; 10YR 7/3 v. pale brown; v. loose; dry	· coarse gravel to cobble; some cobbles up to 6". Quartzite. · Subround to subangular	30	10	60
117–124		☒	10/10	RUN 15					
124–125					see next page		15	5	80

PEAK MINERALS	PROJECT NUMBER	BORING NUMBER
ALLIVIAL DRILLING	465077	SHEET 6 OF

SOIL BORING LOG

PROJECT : Alluvial Hydro Drilling
LOCATION : SEV-12-023 GUZZLER
ELEVATION :
DRILLING CONTRACTOR :
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS :
START : 2/2/13
END :
LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%): GRAVEL	VISUAL (%): SAND	VISUAL (%): CLAY/SILT
125		☒	10/10	Run 15	clayey silty gravel; GC; 10YR4/6 dark yellowish brown, coarse to cobble clasts; loose; moist to dry; poorly graded	• quartzite in dominant clast type • clast subangular to sub rounded.	15	5	80
127									
							25	5	70
130		☒	10/10	Run 16	poorly graded silty gravel; GM; 10YR7/3 v. pale brown; v.loose, dry	• clasts subangular to sub round • coarse to fine gravel; some cobbles.			
135									
138					SAA % change	cobbles up to 4"	30	5	65
140									
141		☒	10/10	Run 17	SAA % change	cobble up to 4"	25	5	70
145									
		☒	10/10	Run 18					
150									

PEAK MINERALS ALLIVIAL DRILLING	PROJECT NUMBER 465077	BORING NUMBER	SHEET 7 OF
	SOIL BORING LOG		

PROJECT : Alluvial Hydro Drilling   LOCATION : SEV 12 023 GUZZLER
ELEVATION :   DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS :   START : 2/2/13   END :   LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
150–157 (2/2/13 ↑)		☒	10/10	RUN 18	S.A.A. poorly graded silty gravel; GM; 10YR7/3 v. pale brown; v. loose; dry	• clast size coarse gravel to cobble • subangular to subround • predominately quartzite	25	5	70
157–159 (↓ 2/3/13)					poorly graded clayey silty gravel, GC; 10YR5/6 yellowish brown; loose; moist to dry		30	5	65
159–166		☒	10/10	RUN 19	poorly graded silty gravel, GM; 10YR7/3 v. pale brown; v. loose, dry	• clasts coarse gravel to cobbles (~6") • subangular to subround	25	5	70
166–168					poorly graded clayey silty gravel, GC; 10YR5/6 yellowish brown; loose; moist to dry		30	5	65
168–175		☒	10/10	RUN 20	poorly graded silty gravel, GM; 10YR7/3 v. pale brown, v. loose, dry 172.5'-173.5': clasts are coarse gravel, no cobbles; round to subround	• coarse gravel to cobble (~3") • subangular to subround	25	5	70

Depth marks: 150, 155, 160, 165, 166, 167, 168, 170, 175

PEAK MINERALS

ALLIVIAL DRILLING

PROJECT NUMBER: 465077

BORING NUMBER:

SHEET 8 OF

SOIL BORING LOG

PROJECT: Alluvial Hydro Drilling

LOCATION: SEV-12-023 GUZZLER

ELEVATION:

DRILLING CONTRACTOR: BLY

WEATHER CONDITIONS:

DRILLING METHOD AND EQUIPMENT USED: SONIC

WATER LEVELS:

START: 2/2/13

END:

LOGGER: TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%): GRAVEL	VISUAL (%): SAND	VISUAL (%): CLAY/SILT
175–176		☒	10/10	RUN 20	poorly graded clayey silty gravel, GC 10YR 5/6 yellowish brown; loose; moist	clay has med. plasticity	25	5	70
176–180					poorly graded clayey silty gravel; GC GP, 10YR 5/6 yellowish brown, loose; moist to dry • med. plasticity	• coarse gravel • subround to subangular	30	5	65
180–192		☒	10/10	Run 21	poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose; dry.	• coarse gravel to cobbles (~4") • subround to subangular 2" compact silt lense @ 186' bgs	25	5	70
192–194		☒	10/10	RUN 22	poorly graded clayey silty sandy gravel, GC; 10YR 5/6 yellowish brown; loose; wet	Water 1st observed @ 193' bgs; 2' interval.	15	20	65
194–200		☒	10/10	RUN 23	poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose, dry	coarse gravel and cobbles subround to subangular	25	5	70

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 9 OF
ALLIVIAL DRILLING	SOIL BORING LOG		

PROJECT : Alluvial Hydro Drilling
LOCATION : SEV-12-023 GUZZLER
ELEVATION :
DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS :
START : 2/2/13
END :
LOGGER : Tangalos

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
200 – 207		☒ (203)	10/10	RUN 23	S.A.A. poorly graded silty gravel, GM; 10YR7/3 v. pale brown; v. loose; dry	· coarse gravel to cobbles · subround to subangular 1" silt lense, compacted @ 203' bgs	25	5	70
207 – 210					poorly graded clayey, sandy silty gravel; 10YR5/6 yellowish brown; loose; moist - GC	coarse gravel; few cobbles	~~25~~	15	60
210 – 217		☒	10/10	RUN 24	poorly graded silty gravel, GM; 10YR7/3 v. pale brown; v. loose; dry	· coarse gravel to cobbles ~~(2.5")~~ (4") · subround to subangular	25	5	70
217 – 225		☒	10/10	RUN 25					

Depth marks: 200, 203, 205, 207, 210, 215, 220, 225

PEAK MINERALS

ALLIVIAL DRILLING

PROJECT NUMBER: **465077**

BORING NUMBER

SHEET 10 OF

SOIL BORING LOG

PROJECT: Alluvial Hydro. Drilling

LOCATION: SEV 12 023 GUZZLER

ELEVATION:

DRILLING CONTRACTOR: BLY

WEATHER CONDITIONS:

DRILLING METHOD AND EQUIPMENT USED: SONIC

WATER LEVELS:

START: 2/2/13

END:

LOGGER: TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
225–227		☒	10/10	RUN 25	SAA. poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose; dry	• coarse gravel to cobble (5" diameter) • subangular to subround • primarily quartzite	25	5	70
227–236 (230, 233)		☒	10/10	RUN 26	poorly graded silty sandy gravel, GM; 10YR 5/6 yellowish brown; v. loose, moist	• coarse gravel & cobbles • medium sand • moist to wet @ 233'	30	50	20
236–243 (237, 240)		☒	6/6	RUN 27	poorly graded silty gravel; GM; 10YR 7/3 v. pale brown; v. loose; dry	• coarse gravel to cobbles (up to 5") • subangular to subround	25	5	70
243–250 (245, 247)		☒	12/12	RUN 28	poorly graded sandy silty gravel; GM; 10YR 5/6 yellowish brown; loose; moist to wet.	@ 247, core wet / producing water 6" interval. @ 249, core dry to 251	30	50	20

SOIL BORING LOG

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER
ALLIVIAL DRILLING	SOIL BORING LOG	SHEET 11 OF

PROJECT : Alluvial Hydro. Drilling LOCATION : SEV 12-023 GUZZLER

ELEVATION : DRILLING CONTRACTOR : BLY

WEATHER CONDITIONS:

DRILLING METHOD AND EQUIPMENT USED : SONIC

WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

2/3/13

2/4/13

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
250		☒	12/12	RUN 28	SAA poorly graded sandy silty gravel, GM; 10YR5/6 yellowish brown; loose; moist to wet	253-255: core wet/producing water	30	50	20
255									
258		☒	7/7	RUN 29	poorly graded sandy gravel; GP; 10YR6/6 brownish yellow; v. loose; dry	~~med~~ med. to coarse sand; fine gravel • angular to subangular	30	40	30
260					poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose; dry	• 2" silt lense @ 260'	30	25	45
261					poorly graded sandy silty clayey gravel, GM; 10YR5/6 yellowish brown; loose; moist to dry	• clay-rich parts med. plasticity • coarse gravel • angular to subround	30	20	50
262									
265		☒	10/10	RUN 30	poorly graded silty gravel, GM; 10YR 7/3 v. pale brown; v. loose; dry	• coarse to fine gravel and cobbles (>3") • angular to subround	30	10	60
269									
270						% change	15	5	80
271						% change	30	10	60
272									
273		☒	10/10	RUN31	poorly graded silty sandy clayey gravel; GC; 10YR5/6 yellowish brown; v. loose; moist to dry		30	30	40
275									

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 12 OF
ALLIVIAL DRILLING	SOIL BORING LOG		

PROJECT : Alluvial Hydro. Drilling LOCATION : SEV-12-023 GUZZLER
ELEVATION : DRILLING CONTRACTOR : BLY
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
275–282		☒	10/10'	RUN 31	poorly graded silty gravel, GM; 10YR 7/2 v. pale brown; v. loose; dry	• coarse gravel to cobbles (>6") • subangular to subround • some clay lenses	30	5	65
282–287 (285)		☒	5/5'	RUN 32					
287–288		☒*							
288–290		☒	8/8'	RUN 33	poorly graded silty gravel, GM 10YR 7/2 v. pale brown; v. loose, dry	• high silt content - wind-blown dust (loess?) • very fine - glacial flour? • very large cobbles (6")	10	0	90
290–295		☒ ☒*			poorly graded silty gravel, GM; 10YR 7/2 v. pale brown, v. loose; dry	• coarse gravels to cobbles • subround to subangular • trace clay lenses (299' bgs)	30	5	65
295–300		☒	9/9'	RUN 34					

*☒ = composite sample of entire interval [287'-295']

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 13 OF
ALLIVIAL DRILLING	SOIL BORING LOG		

PROJECT : Alluvial Hydro. Drilling LOCATION : SEV-12-023 GUZZLER

ELEVATION : DRILLING CONTRACTOR : BOART LONGYEAR

WEATHER CONDITIONS:

DRILLING METHOD AND EQUIPMENT USED : SONIC

WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	VISUAL (%) SAND	VISUAL (%) CLAY/SILT
300 (2/4/13)	2-15-13	☒	9/9	run34	S.A.A. poorly graded silty gravel, GM, 10YR7/3 v. pale brown; v. loose; dry	• coarse gravels to cobbles • subangular to subround • trace 1-3" clay lenses w/ gravel (moist)	30	5	65
304 (2/6/13) 305		☒	10/10	Run35	poorly graded silty gravel, GM; 10YR5/6 yellowish brown; soft; med. plasticity; moist	• coarse gravel to cobbles • moisture may be b/c water added saturated upper sediments • first run of day.	30	5	65
310					poorly graded silty gravel, GM; 10YR7/3 v. pale brown; v. loose; dry	• fragment of lithified conglomerate w/ silt matrix • coarse gravel to cobbles • subangular to subround	40	5	55
314 315 320 325		☒	14/14	Run36	319-321' bgs increased clay and moisture content				

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 14 OF
ALLIVIAL DRILLING	**SOIL BORING LOG**		

PROJECT : Alluvial Hydro-Drilling LOCATION : SEV-12-023 GUZZLER
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : SONIC
WATER LEVELS : START : 2/2/13 END : LOGGER : TANGALOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	VISUAL (%) SAND	VISUAL (%) CLAY/SILT
325		☒	14/14	Run 36	poorly graded silty gravel; GM; 10YR 7/2 v. pale brown; loose to v. loose; moist to dry - med. to coarse gravel to cobbles (~4") - sub round to subangular	@ 326 - 327 ft. bgs, more clay; black carbonate rock and different quartzite than previously observed • clay is stiff, med. plasticity - matrix of gravel conglomerate	30	5	65
327									
330		☒	8/8	Run 37		• 6" clay @ 329' bgs + 333' bgs; moist			
334						→ 334' bgs % change	40	5	55
335		☒	4/4	Run 38	Clayey gravel w/ sand (GC) ~~Dense~~ very moist/wet med ~~to~~ coarse gravel to cobbles, possibly boulders 7.5YR 4/4 Brown	Start 2/12 can roll threads • low to med plasticity • Quartzite dominant some black carbonate	60	20	20
340		☒	2/10	Run 39	Silty gravel w/ sand (GM) 7.5YR 4/4 Brown, loose wet. - well graded gravels, cobbles - well graded sands - subrounded to angular	Boulder (Quartzite) ☆ Driller stated mostly gravel/cobble			
345							50	30	20
350					Silty sand (SM) Brown - med loose 10YR 4/3				

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER 15	SHEET	OF
ALLIVIAL DRILLING	SOIL BORING LOG			

PROJECT : Alluvial Hydro Drilling LOCATION : SEV-12-023 Guzzler
ELEVATION : DRILLING CONTRACTOR : BL
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED : Sonic
WATER LEVELS : START : 2/2/13 END : LOGGER : Olson /Cantrell

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
350					silty sand (SM) Brown, wet	Took water level @ 323.2'	10	70	20
		☒	5/6	Run 40	clayey gravel w/sand (GC) 10YR 4/4 dk. Yellow Brown Dense, wet • cobbles up to 4"				
355							40	25	35
					silty gravel w/sand (GM) 10YR 4/4 Dk Yellowish Brown Loose, wet No cobble Well graded	Drove casing to 347'	70	10	20
360		☒	8/9	Run 41	clayey gravel w/sand (GC) 10 YR 4/4 Dk Yellowish Brown Dense, wet, well graded fines to med-gravel no cobbles		40	25	35
365					Same as above except becomes moist, no longer saturated	Took water reading ~ 275.7	50	20	30
		☒	8/8	Run 42	Same as above with occassional cobbles				
370							50	20	30
						Took water level ~ 332 and falling			
		☒	6/6	Run 43	Sandy clay w/gravel (CL) 10YR 4/4 Dk Yellow Brown very moist ~~to moist~~, ~~Dense~~ Stiff well graded sands	added casing to 357'	30	35	45
375									

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER 16 SHEET OF
ALLIVIAL DRILLING	SOIL BORING LOG	

PROJECT : 5 LOCATION :
ELEVATION : DRILLING CONTRACTOR : BLY / Chavez
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED :
WATER LEVELS : START : END : LOGGER : A. Cantrell on 2-15-13

2-13-13
2-15-13

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL / SAND / CLAY/SILT
~~375~~ 375					Same as above Quartzite boulder	End 2/13	as above
378 – 383 (380)		☒	9/9		Wellgraded gravel, GW, Multi color w/ qtz, L.S. Shale(?)/SS.(?) Dense clast; loose unit, wet or crushed. Subangular to sub rounded fine to cobble, wellgraded.	- Driller noted that 200 gal water used to get through this Zone. I WL: @ 249.4 bgs WL 5 min @ 249.4; WL 10 min @ 253.1 - Trace calcite precip only on L.S. qtz dominant.	95/5/0
383					Clayey Sand w/ gravel, SC/SM, 7.5YR 5/4 Brown, moist/wet, med dense/med stiff	- med-high plastic fines retain water. fine to coarse, well graded	15 60 25
385		☒			Clayey gravel, GC, 7.5YR 5/4 Brown moist, med-high plasticity	- wellgraded Subang - to Sub Round	50 20 30
387 – 397 (390, 395)		☒	1/10		Same as above. clay super saturated. Like cake frosting. - fine to coarse gravel, sub angular to sub rounded, competent clast	- 9' lost. Soft, may have pushed through - too much moisture to tell plasticity	50 20 30
397 – 400		↓	10/10		Clayey/Silty gravel w/ Sand, GC/GM, ~~10YR~~ 7.5YR 4/4 Brown, moist, med stiff, med plasticity fines w/ wellgraded gravels and coarse sand	- Few cobbles up to 6" - Compaction/cementation w/ weathering and <10% oxidation trace ribbons of red yellow clay (7.5YR 6/8)	50 25 25

253.1
249.4
3.6'
Δh 3.6/hr
~~or 0.36'/hr~~
or 0.72

PEAK MINERALS	PROJECT NUMBER 465077	BORING NUMBER	SHEET 17 OF 17
ALLIVIAL DRILLING	**SOIL BORING LOG**		

PROJECT : 5 LOCATION : SEU-12-023
ELEVATION : DRILLING CONTRACTOR : BLY / Chavez
WEATHER CONDITIONS:
DRILLING METHOD AND EQUIPMENT USED :
WATER LEVELS : START : END : LOGGER : ACantrell 02-15-13

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole	VISUAL (%) GRAVEL	SAND	CLAY/SILT
405, 407		X	10/10		Same as above	- Still lots of water in borehole WL@ 320' bgs, added by driller earlier today. - 6" Sand @ 403.5' bgs Coarse, poorly graded.	50	25	25
410, 415, 417		X	10/10		Clayey gravel w/ Sand GC/GM, 10YR 4/6 Yellow brown, moist Loose/med dense.	- Low plasticity, lower moisture content - 5-10% oxidation Staining w/ low-mod weathering; mostly (≈80%) competent clast w/ trace degraded L.S. - Large boulder @ 410' Recvd core ≈8" long. Moist on top dry below.	65	20	15
420, 423		X	5/5 6/6		Clayey gravel w/ Sand, GC, 7.5YR 4/4 Brown, V. moist, med stiff	- High plasticity fines - fine to Coarse gravels Subangular to Sub rounded - Dominant qtz w/ Trace degraded limestone	50	15	35
425, 427		X	4/4		S.A.A but dusty dry. and % change	- cemented or highly compacted. V. Stiff - Dry Very stiff GC. add water and Similar to above.	~~50~~ 55	~~15~~ 15	30

2-15-13
2-16-13

T.D. Called @ 427' bgs.
2-16-13 @ 12:51
AC

Monitoring Point/Location: Guzzler SEV-12-023 Date: 2/28/13 Sampler: Ryan Hamilton

Weather: Clear Sunny Visitors:

Boring Dia. 8" Casing Dia. 4" DTW: 374.15 TD: 425' Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume: ____ Tubing Leng. (ft) X ____ Tubing Dia. Factor + ____ Pump Volume X 2 = ____ Purge Volume (mL) = ____ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: Casing Volume Above Screen [____ TD (ft) - ____ DTW (ft) = ____ Water Column (ft) - ____ Scr. Leng. (ft) = ____ Casing Leng.] X ____ Casing Factor X 3 = ____ Casing Vol. = ____ Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ____ PPE Disposal: ____ Disposition of Purge Water: ____ 90% Recharge Level: ____ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1144	Initial		water	depth	376.15			screened interval			325	-425'	
1201	Tagged	silt		at	423								
1211	1st	bailer		dropped	~	1.5 gal		clay mud	3"	x 5'	bailer		
1225	2nd	bailer			~	1.5 gal		clay mud					
1231	3rd	bailer				1.5 gal		clayey water					
1239	Switched	to	10' x 3"		and	~~dropped~~		cap would	not go	on	possible	bad	threads
1248	Took	extension		off	and	dropped		bailer					
1251	4th	bailer				1.5 gal		clayey water					
1256	5th	bailer				1.5 gal		clayey water					
1300	6th	bailer				1.5 gal		clayey sand	water				
1305	7th	bailer				1.5 gal		clayey sand	water				
1311	8th	bailer				1.5 gal		clayey water					
1317	9th	bailer				1.5 gal		clayey water					
1322	10th	bailer				1.5 gal		clayey water					
1328	11th	bailer				1.5 gal		clayey water					
1334	12th	bailer				1.5 gal		clayey water					
1343	13th	bailer				1.5 gal		clayey water					
1350	14th	bailer				1.5 gal		clayey water					
1355	15th	bailer				1.5 gal		clayey water					
1400	16th	bailer				1.5 gal		clayey water					Purge Flow Rate (mL (0) or gal per min (0.0))
1412	17th	bailer				1.5 gal		clayey water					

Monitoring Point/Location: Guzzler   Date: 2/28/13–3/1/13   Sampler: Ryan Hamilton

Weather: Clear Sunny   Visitors:

Boring Dia. 8   Casing Dia.   DTW: 376.22   TD: 425 bgl   Pump Intake Depth: 424'   Pump Top Depth: 419'

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume: ____ Tubing Leng. (ft) X ____ Tubing Dia. Factor + ____ Pump Volume X 2 = ____ Purge Volume (mL) = ____ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: ____ TD (ft) - ____ DTW (ft) = ____ Water Colume (ft) - ____ Scr. Leng. (ft) = ____ Casing Leng. X ____ Casing Factor X 3 = ____ Casing Vol. = ____ Purge Volume (gal) (0.0)

(Casing Volume Above Screen)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95   Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: PPE Disposal: Disposition of Purge Water: 90% Recharge Level: ____ ft   Sampling Flow Rate < 1,000 mL/min?

2/28/13

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
14:16	18th	bailer				1.5	gal	clayey	water				
14:21	19th	bailer				1.5	gal	clayey	water				
14:25	Water	level taken			377.59		TOC						
	Attached	swab											
1432	Begin	surging											
1502	Stopped	surging			& attached		bailer						
1514	19th	bailer				1.5	gal	clayey	water				
1519	20th	bailer				1.5	gal	clayey	water				
1525	21st	bailer				1.5	gal	clayey	water				
1530	22nd	bailer			0.75	~~1.5~~	gal	clayey	water				
1535	23rd	bailer				1.5	gal	clayey	water				
1542	24th	bailer				1.5	gal	clayey	water				
1551	25th	bailer				1.5	gal	clayey	water				
1557	26th	bailer				1.5	gal	clayey	water				
1601	Water	level		374.76'									
1618	Leave	well	head back										
3/1/13													
0841	Water	level		@ 376.22		TOC							
	clayey	mud	tagged at			~428'		TOC					
0906	Pump	attached	(with			stop	valve)	Transducer		attached			
1010	Pump	installed	420'	of	pipe	5'	pump ~	1 ft	of pipe	>TOC		BOP at 424 to TOC	

Purge Flow Rate (mL (0) or gal per min (0.0))

Monitoring Point/Location: Guzzler Date: 3-1-13 Sampler: Ryan Hamilton

Weather: Sunny Clear Visitors:

Boring Dia. 8" Casing Dia. DTW: TD: 425' Pump Intake Depth: 424' TOC Pump Top Depth: 419' TOC

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume: ____ Tubing Leng. (ft) X ____ Tubing Dia. Factor + ____ Pump Volume X 2 = ____ Purge Volume (mL) = ____ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: ____ TD (ft) - ____ DTW (ft) = ____ Water Column (ft) - [Casing Volume Above Screen: ____ Scr. Leng. (ft) = ____ Casing Leng. X ____ Casing Factor] X 3 = ____ Casing Vol. = ____ Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ____ PPE Disposal: ____ Disposition of Purge Water: ____ 90% Recharge Level: ____ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1025	Transducer	Depth			43.65'		Start	logging					
1028	Turned	pump on											
1032	water	out		3.16 GPM									
1034				2.02	GPM								
1035				2.20	GPM								
1039	RH			2.17	GPM (stabilizing)								
1043	~~15.4~~ 19.5 gal			2.28	gpm								
1100	~~46.88~~ 34.22 gal			2.28	gpm		Increasing to 3 gpm						
1106	TCB			3.01	gpm		stabilizing						
1123	~~180.77~~ 103.45 gal			3.16	gpm								
1205	~~321.49~~ 234.07 gal			3.11	gpm								
1222	~~1222~~		Reset flow meter to get a reading of volume & increased flow to 3.5 gpm										
Baseline	~~374.3~~ 286.9 gal			3.16									
1245	Turned Horiba on to calibrate receive Error 2 (Sensor probe batt voltage drop) poss. bad sensor batt.												
	Instrument seems to have calibrated properly												
1256	~~494.~~ 406.94	+ 170 gal at 3.42 gpm											
1300	420.62	19.15	7.19	1.002	182.0	8.73	11						
1317	Increased pumping rate to 4 gpm												
1330	532.44			+254 VS									
	53	20.38	7.30	0.99	496.0	9.92	15						
1400	660.94	20.65	7.25	1.001	119.0	9.95	15						Purge Flow Rate (mL (0) or gal per min (0.0))

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)	mg/L Nitrate	phosphate mg/L		GW Level (ft below MP)	Comments (Color/Odor)
1410	494.94	20.66	7.28	0.97	203	9.92	14					
	All stabilization parameters are within range except for Turbidity which is suspect due to its bouncing around so much (poss bad sensor)											
1417	72.94	— Sampling										
1435	794.94	Pump off Samples Taken					Allowing well to recharge until samples labeled & colorimeter					
1457								0.40	0.00			
1515	Recharge Stabalized at ~ 43.24' Transducer Depth / pipe pulled											
Field parameters stable?		Y N	Y N	Y N	Y N	Y N	Y N					

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal					
Duplicate					
MS/SD					
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter:

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH								
Turbidity								
ORP								
Spec Cond								
DO								
Ammonia								
Chloride								
Nitrate								

General Notes: Tried getting an end of day depth to water reading but tape kept sticking to the side of casing (possibly because side walls of casing are coated with muddy water.

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification

Non-Production Well: 1369001M00 WIN: 436429

Owner *Note any changes*

CH2M HILL FOR PEAK MINERALS INC.
C/O STEPHEN HILL
215 S. STATE STREET, STE. 1000
SALT LAKE CITY, UT 84111

Contact Person/Engineer: Stephen Hill / CH2mHill

Well Location *Note any changes*

N 12 E 1230 from the W4 corner of section 36, Township 21S, Range 11W, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation,local well #) SEV-12-023

Drillers Activity Start Date: 01-15-13 Completion Date: 04-05-13

Check all that apply: ☒ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use: Monitor well

If a replacement well, provide location of new well. ______ feet north/south and ______ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	427	9	Sonic	N/A

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE High	PERMEABLE Low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTION AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture,degree of weathering, hardness, water quality, etc.)
0	320			X	X	X	X	X					Brown	
320	427	X	X		X	X	X						"	

RECEIVED
APR 29 2013 JH
WATER RIGHTS
SALT LAKE

Static Water Level

Date 02-20-13 Water Level 320 feet Flowing? ☐ Yes ☒ No

Method of Water Level Measurement WLI If Flowing, Capped Pressure N/A PSI

Point to Which Water Level Measurement was Referenced ground level Elevation N/A

Height of Water Level reference point above ground surface N/A feet Temperature N/A degrees ☐ C ☐ F

Construction Information

DEPTH (feet) FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	☒ SCREEN ☐ PERFORATIONS ☐ OPEN BOTTOM: SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	325	4" Sch. 80 pvc	80	4	325	425	.010	4	Factory Slot

Well Head Configuration: Above grade

Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: Flush Thread

Perforator Used: N/A

Was a Surface Seal Installed? ☒ Yes ☐ No

Depth of Surface Seal: 320 feet

Drive Shoe? ☒ Yes ☐ No

Surface Seal Material Placement Method: Tremie Bentonite and Cement

Was a temporary surface casing used? ☒ Yes ☐ No If yes, depth of casing: 427 feet diameter: 9 inches

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	315	Cement Bentonite	87 bags	50 lbs each
315	320	Bentonite chips	6 bags	" "
320	427	20-40 Silica Sand	58 bags	" "

Well Development and Well Yield Test Information

DATE	METHOD	YIELD	Units Check One: GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
	N/A					

Pump (Permanent)

Pump Description: N/A

Horsepower: _____ Pump Intake Depth: _____ feet

Approximate Maximum Pumping Rate: _____

Well Disinfected upon Completion? ☐ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary Circumstances, abandonment procedures. *Use additional well data form for more space.*

N/A

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name BOART LONGYEAR (Person, Firm, or Corporation - Print or Type)

License No. 626

Signature [signature] (Licensed Well Driller)

Date 04-25-13

NORWEST
Norwest Corporation

Drill Hole Lithology Log

START TIME 1545
Feb 14

Hole: LL #13 (Lone TP3)
Page: 1 of 2
Date: 14 / 02 / 13
Name: B. Auger

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E 0314044 N 4325941
Elev: Datum: WGS84 UTM
Start: 14 / Feb / 2013 TD: 63'
End: 15 / Feb / 2013 Photos: Yes / No (No circled)

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description (SCREEN 12' TO 37')
0	Run 1					(0-4) Unconsolidated wet clay, salt crust on top, no samples
5	Run 2	LLH3 S1				
		LLH3 S2				
		S3				
10		S4				
		S5				
15	Run 3	S6				~ Transition to firmer clays ~ 13-15' BGS
		S7				
		S8				
20		S9				
		S10				
25	Run 4	S11				
		S12				
		S13				
30		S14				
		S15				
		S16	34			
35	Run 5	S17	35.5			End of Day 1 Drilling 16:50 @ 37'
		S18	37			Begin Day 2 - Rig won't start due to cold. Starts @ 10:45
40	Run 6	S19				
		S20				
		S21				
45	~~XX~~ Run	~~X~~				Some core loss, likely due to expansion in 50-51 zone
		S22				
50	Run 7	S23				

NORWEST
Norwest Corporation

Drill Hole Lithology Log

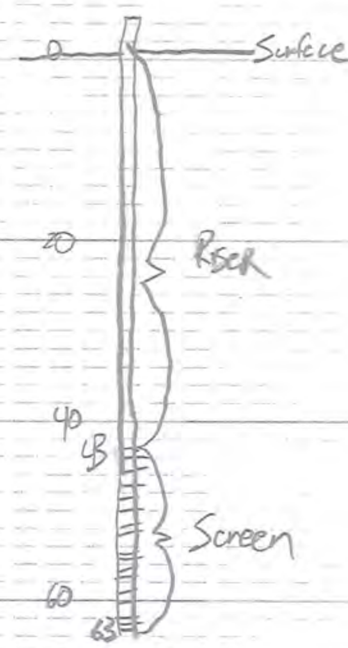
Hole: LLH3 (Luna TT3)
Page: 2 of 2
Date: 15/02/13
Name: B. ACGER

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ______ N ______
Elev ______ Datum ______
Start: 14/02/13 TD: 63'
End: 15/02/13 Photos: Yes / No (No circled)

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 7	LLHB S24				(51-52) SAND & GRAVEL ZONE, WET
		S25				(53-54) Clay becoming very STIFF
55	Run 8	S26				(54-63) Dry-Zone Clay, minimal moisture, TD called @ 63' because of dry clay
		S27				
		S28				
60	Run 9	S29				Well will be set with screen 48-63' TO capture wet zone and tight clays above
		S30				
65		Drilling Completed @ 1300 15/Feb				
70						
75						
80						
85						
90						
95						
100						



DETAILED LOG DONE POST DRILLING

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole: LLH3
Page: 1 of 3
Date: 18/Feb/13
Name: B. ALGER

Core Number	Top	Base	Cut	Recovered
RUN	INFO	ON	SUMMARY	SHEET

Well Completion Data

Coordinates: E ___ N ___
Elev ___ Datum ___
Start: __/__/__ TD: 64
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
0		No Sample				0-10 (No Samples) - Surface clays
2						
4						
6						
8						
10		LLH3 10-20				(10-11) Surface clays) (11-12) saturated angular sands
12						(12=20') med to light olive Gray Clay, saturated, STANDARD SHALLOW ZONE CLAYS
14						
16						
18						
20						

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole: LLH3
Page: 2 of 4
Date: 18/02/13
Name: B. Alger

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ____ N ____
Elev ____ Datum ____
Start: __/__/__ TD: ____
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
20						Cly (20-30) med olv GRAY moist to saturated, standard shallow clay
22		LLH3 20-30				
24						
26						
28						Abundant Gypsum crystals
30						Cly (30-38) SAME AS ABOVE
32						
34		LLH3 30-40				
36						
38						(36-38.5) saturated fine sand zone (38.5-40) med olv gray clay, moist
40						

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole LLH3
Page 3 of 3
Date 18/Feb/13
Name B. Alger

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ____ N ____
Elev ____ Datum ____
Start: __/__/__ TD: ____
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
40		LLH3 40-50				(40-50) Clay continued
42						
44						
46						
48						
50		LLH3 50-60				(50-51.0) cont.
						(51.0-52.5) sandy zone, pebbles, rounded, saturated, good resource
52						(52.5-64) stiff dry red clay
54						Dry zone
						(54-54.5) some pebbles, subrounded, moisture exists, but not in large quantity
56						Screen set from 44-64'
58						
60						

64 — TD @ 64' (No photos 60'-64') just stiff clay

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole: LLH5
Page: 1 of 2
Date: 16/Feb/13
Name: B. Acsen

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E 0316970 N 4326978
Elev: Datum: WGS84 UTM
Start: 16/02/13 TD: 69'
End: 16/Feb/13 Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
0	Run 1					0-4 wet clay, poor samples, not kept
05	Run 2	LLH5 S1, S2, S3, S4, S5				4-14 med olive clay, moist/saturated becoming slightly more dense in (12-14) zone
10						
15	Run 3	LLH5 S6, S7, S8, S9, S10				14-24 - No Change
20						
25	Run 4	S11, S12, S13, S14, S15				24-34 - No major changes still med frm olv gray clay
30						
35	Run 5	S16, S17, S18, S19, S20				34-44 No Change
40						
45	Run 6	S21, S22, S23				(44-54) Lithologic change to reddish brown clay, tacky, moist to saturated, different from "shallow zone" clays
50						

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Drill Hole Lithology Log

Hole LL45
Page 2 of 2
Date 16/Feb/13
Name B. Alger

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E 0316970 N 4326978
Elev Datum WGS84 UTM
Start: 16/Feb/13 TD: 69'
End: 16/Feb/13 Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	Run 6	LL45 S24				44-54 Clay - Reddish brown, still moist, contains resource
		S25				
55		S26				(54-56.5) Same AS ABOVE, some larger particles, sand?
		S27				(56.5-64.0) Reddish brown mottled with red olv GRAY clay, very stiff, dry, Top of DRY ZONE Clay @ 56.5
	Run 7	S28				
60		S29				
		S30				
		S31				(64.0-69.0) SAA
65	Run 8	S32				
		S33				
70						TD @ 69' AFTER 13' OF STIFF "DRY ZONE" CLAYS.
75						Well WILL BE CONSTRUCTED TO CAPTURE CHANGE IN LITHOLOGY @ 44' TO TD
80		Well Construction				Riser = Surface TO 44' Screen = 44' TO 69' Pea GRAVEL 44-69 Sand 42-44 GROUT 0-44
85						
90						
95						
100						

LOG IS POST DRILLING

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole LLH5
Page 1 of 4
Date __/__/__
Name B. ALGER

Core Number	Top	Base	Cut	Recovered
DETAILED	LOG	ON	SUMMARY	SHEET

Well Completion Data

Coordinates: E ______ N ______
Elev ______ Datum ______
Start: __/__/__ TD: ______
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities: Type	Discontinuities: Graphic	Discontinuities: Description	Lithologic Description
0–2						HOLE LOGGED TWO DAYS AFTER ~~COMPLETED~~ CORING
2						
4						
6						
8						
10		LLH5 10-20				Cly (10.0 - 14.0) med olv GRAY / some gypsum crystals
12						
14						Cly (14-20) NO CHANGE
16						
18						
20						

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Norwest Corporation

Drill Hole Lithology Log

Hole LLHS
Page 2 of 4
Date 17 / Feb / 13
Name B. ALGER

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ______ N ______
Elev ______ Datum ______
Start: __/__/__ TD: 69
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
20						(20-24) ~~Bn~~ light GRAY CLY MORE SATURATED
22		LLHS 20-30				
24						(24-30) med olv GRY cly ~~STIFF~~ USUAL STUFF
26						
28						
30						(30-34) SAA
32		LLHS 30-40				
34						(34.0-34.3) ~~[illegible]~~ wet SANDY ZONE vf sand (34.3-40) med olv GRN clay, becoming MORE STIFF,
36						
38						
40						

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Norwest Corporation

Drill Hole Lithology Log

Hole LLH5
Page 3 of 4
Date __/__/__
Name B. Ager

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ____ N ____
Elev ____ Datum ____
Start: __/__/__ TD: ____
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
40		LLH5 40-50				Cly (40-45) SAA
42						
44						
46						SAND (45-50) some pebbles, some rounded cobbles, likely a flood event or paleo channel, saturated, reddish brown, GOOD RESOURCE TARGET
48						
50		LLH5 50-60				Sand cont. (50-56)
52						
54						
56						(56-60) dry, stiff cly little moisture, start of dry ZONE
58						
60						

NORWEST
Norwest Corporation

Drill Hole Lithology Log

Hole LLHS
Page 4 of 4
Date 17/2/13
Name B. Algor

Core Number	Top	Base	Cut	Recovered

Well Completion Data

Coordinates: E ______ N ______
Elev ______ Datum ______
Start: __/__/__ TD: ______
End: __/__/__ Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
		LLHS 60-69				Cly (60-69) Same as above Dry zone CONTINUED
69						
70						TD @ 69' AFTER 12.5' OF DRY ZONE Screen 44-69

CH2MHILL

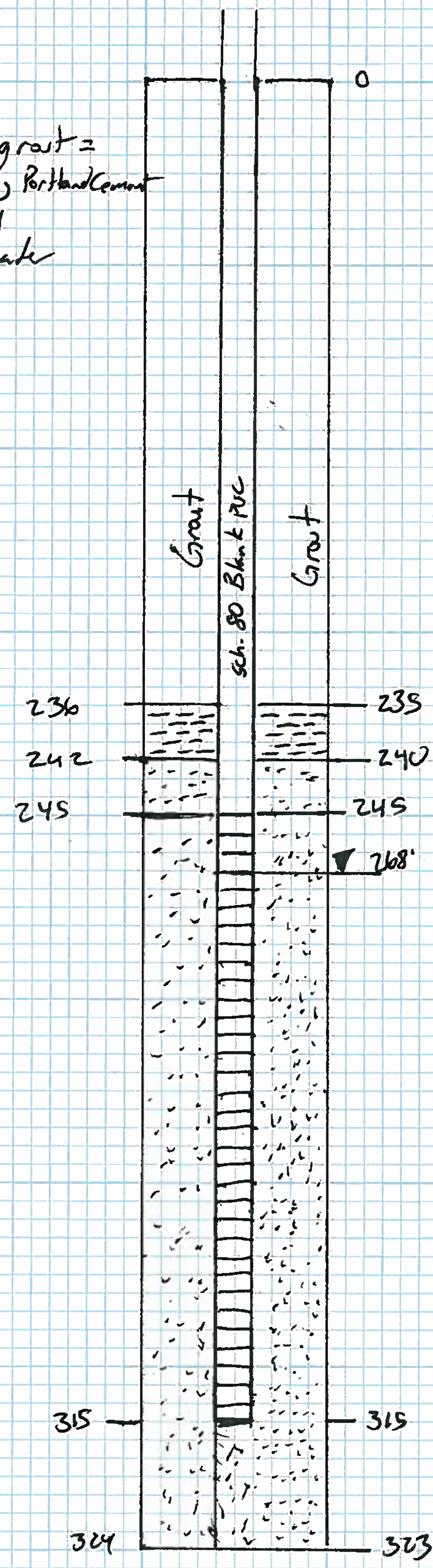
SUBJECT Miller Canyon (SEV-12-J31)
Well Construction

BY

SHEET NO. ___ of ___ DATE

PROJECT NO.

Actual Planned



3/20
7 batches of grout
17 bags Portland cement
4 bags gel

1 batch of grout =
2½ (94lb) bag Portland Cement
⅓ bag quick gel
~35 gallons water

3/21
4½ batches of grout
14 bags portland cement
2 bags quickgel

2 bags 3/8" bentonite chips
chips were allowed to hydrate 1 hr before adding grout

58 bags 20/40 sand

Centralizers every 20' on screen
every 50' on blank

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 1 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft) INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
0.0 – 7.0	7.0			Sandy clay (CL) 10 YR 4/3 brown, moist, medium plasticity, firm, reacts to HCL; Gravel (0%), Sand (25%), Clay/Silt (75%)	Reacts with HCL
				Silty gravel w/sand (GM) 10 YR 4/3 brown, dry, loose, mostly 3/4"; Gravel (45%), Sand (25%), Clay/Silt (30%)	Reacts with HCL
7.0 – 17.0	10.0			Clay (CL) 10 YR 4/3 brown, firm, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
17.0 –	10.0				

Depth scale: 5, 10, 15, 20, 25

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 2 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface — START : 3/14/2013 — END : 3/18/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	27.0				Clay (CL) 2.5 6/3 light yellowish brown, stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
30		10.0			Clay w/ many sand lenses 5Y 7/4 pale yellow, stiff, dry, medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL
35	37.0					
40		10.0			Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry, dessication cracks; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
45	47.0					
50						

PROJECT NUMBER:	BORING NUMBER:	SHEET 3 OF 13
465077	SEV-12-031 Miller Canyon	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0				
					Clay (CL) 5Y 7/2 light grey, hard, medium plasticity, dry, possible calcite; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
55						
	57.0				Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
60						
		10.0				
65						
	67.0					
70						
		10.0				
75						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL) 10 YR 5/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL dessication cracks
	77.0					
80						
		10.0				
85						
	87.0					
90						
					Clay (CL) 5 Y 6/3 pale olive, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	No longer has dessication cracks
		10.0				
95						
	97.0					
100						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CL) 10 YR 4/3 brown alternating to olive, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Dessication cracks Reacts with HCL Thin ~1/2" sand layer @ 121'bgs.
105						
	107.0					
110						
		10.0				
115						
	117.0					
120						
		10.0				
125						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 6 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface START : 3/14/2013 END : 3/18/2013 LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	127.0					
					Sandy Clay (CL) 5Y 5/3 olive, very stiff, low plasticity, dry; Gravel (0%), Sand (30%), Clay/Silt (70%)	Reacts to HCL
130					Clay (CL) 5 Y 5/3 olive, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
		10.0				
135						
					Sandy Clay (CL) 5Y 5/3 olive, very stiff, low plasticity, dry; Gravel (0%), Sand (30%), Clay/Silt (70%)	Reacts to HCL
	137.0					
					Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
140						
		10.0				
					Silty sand w/ gravel (SM) 5Y 5/3 olive, very stiff, dry, low plasticity; Gravel (15%), Sand (55%), Clay/Silt (30%)	Reacts to HCL
145						
	147.0					
					Sandy Clay (CL) 5Y 5/3 Olive, stiff, dry; Gravel (0%), Sand (30%), Clay/Silt (70%)	
150						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 7 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
155	157.0					
					Sandy Clay (CL) 5Y 5/3 Olive, stiff, dry; Gravel (0%), Sand (30%), Clay/Silt (70%)	
					Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (10%), Sand (20%), Clay/Silt (70%)	Reacts to HCL Thin ~2" gravelly clay layer @164' bgs
160		10.0				
165	167.0					
					Silty Sand w/gravel, brown; Gravel (15%), Sand (55%), Clay/Silt (30%)	
					Silty Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
170		10.0				
					Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
175						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 8 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface — START : 3/14/2013 — END : 3/18/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL) 10 YR 4/3 brown, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL ~3" sandy clay layer @176' bgs
	177.0					
180						
		10.0				
185						
	187.0					
190						
		10.0				
195						
	197.0					
200						

PROJECT NUMBER:	BORING NUMBER:	SHEET 9 OF 13
465077	SEV-12-031 Miller Canyon	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface — START : 3/14/2013 — END : 3/18/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CL) 10 YR 4/3 brown w/ color change at 212' bgs to 5Y 5/3 olive, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
205						
	207.0					
210		8.0				
215	215.0				Clayey Gravel with sand (GC) 5Y 5/3 olive, very stiff, well graded, subrounded to rounded ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Predominantly LS and quartzite
					Clayey Sand (SC) 5Y 5/3 Olive, dense, poorly graded find sand, medium plasticity ; Gravel (5%), Sand (55%), Clay/Silt (40%)	
220		11.0			Clay (CL) 5 Y 5/3 olive, very stiff, medium plasticity, dry; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts to HCL
225						Gravels consist of LS, quartzite, and obsidian

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 10 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)
ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	226.0				Clayey Gravel with sand (GC) 5Y 5/3 olive, moist, very dense, well graded, subround to subangular, gravels, medium plasticity ; Gravel (50%), Sand (25%), Clay/Silt (25%)	Gravels consist of LS, quartzite, and obsidian Driller ran to 236' lost core while tripping out. Tried to recover core but could not get past 231'. Tripped out and then went back down to 237' bgs Changed to 6" core barrel at 237, bgs Ocassional cobbles at 241'bgs
					Clayey Gravel with sand (GC) 5Y 5/3 olive, moist, very dense, well graded, subround to subangular, gravels, medium plasticity ; Gravel (55%), Sand (20%), Clay/Silt (25%)	
230						
		11.0				
235						
	237.0					
240						
		10.0				
245						
	247.0					
250		5.0				

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-031 Miller Canyon	SHEET 11 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface — START : 3/14/2013 — END : 3/18/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	252.0			Clayey Sand (SC) 10YR 4/3 brown, very dense, moist, poorly graded find sand, medium plasticity ; Gravel (25%), Sand (50%), Clay/Silt (25%)	Well graded fine to coarse gravel
255		5.0		Clayey Gravel with sand (GC) 5Y 5/3 olive, moist, very coarse, well graded, subround to subangular, gravels ; Gravel (50%), Sand (30%), Clay/Silt (20%)	Gravels fine to coarse/ possibly cemented Reacts to HCL
	257.0			Clay (CL) 10 YR 4/3 brown, moist very stiff, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	
260		7.0		Clayey Gravel with sand (GC) 5Y 5/3 olive, dry, very dense, slightly cemented, well graded, subround to subangular, gravels ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Fine to corse gravels predominantly quartzite, LS, and obsidian
	264.0			Sandy Clay (CL) 10 YR 6/4 Light yellow brown, dry, very stiff, medium plasticity; Gravel (0%), Sand (35%), Clay/Silt (65%)	
265	267.0	3.0		Clayey Gravel with sand (GC) 5Y 5/3 olive, dry, very dense, well graded, subround to subangular, gravels ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Gravels consist of LS, quartzite, and obsidian
270		7.0		Sandy Clay w/gravel (CL) 10 YR 6/4 Light yellow brown, dry, very stiff, medium plasticity; Gravel (10%), Sand (30%), Clay/Silt (60%)	Reacts to HCL
275	274.0			Clayey Gravel with sand (GC) 10YR 6/2 brownish grey, dry, very dense ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Occasional cobbles

PROJECT NUMBER:	BORING NUMBER:	SHEET 12 OF 13
465077	SEV-12-031 Miller Canyon	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft
DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface
START : 3/14/2013
END : 3/18/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clayey Gravel with sand (GC) 10YR 6/2 brownish grey, moist-dry, very dense, well graded, subround gravels ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Gravels consist of LS, quartzite, and obsidian Some cobbles (increasing with depth) Reacts to HCL Likely water bearing zone 8" clay later @ 295' bgs Wet zone 299-303' bgs
280		13.0				
285						
	287.0					
290		5.0				
	292.0					
295		5.0				
	297.0					
300						

PROJECT NUMBER:	BORING NUMBER:	SHEET 13 OF 13
465077	SEV-12-031 Miller Canyon	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : North East Landing Rd (39.0 N, -113.2 E)

ELEVATION : 4703.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 268.9 ft below ground surface START : 3/14/2013 END : 3/18/2013 LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
305	307.0	10.0			Clayey Gravel with sand (GC) 10YR 6/2 brownish grey, wet-dry, very dense, well graded, subround gravels ; Gravel (50%), Sand (20%), Clay/Silt (30%)	Gravels consist of LS, quartzite, and obsidian Reacts to HCL Some cobbles Alternating wet and dry layers between 313.5 and 322, bgs
310	312.0	5.0				
	313.5	1.5				
315, 320	322.0	9.5				
	323.0	1.0			Sand clay (CL) brown, dry, stiff	
325					Bottom of Hole at 315.0 ft below ground surface 3/18/2013	

CH2MHILL

SUBJECT Miller Canyon (SEV-12-J31) BY

Well Construction SHEET NO. ____ of ____ DATE

PROJECT NO.

Actual Planned

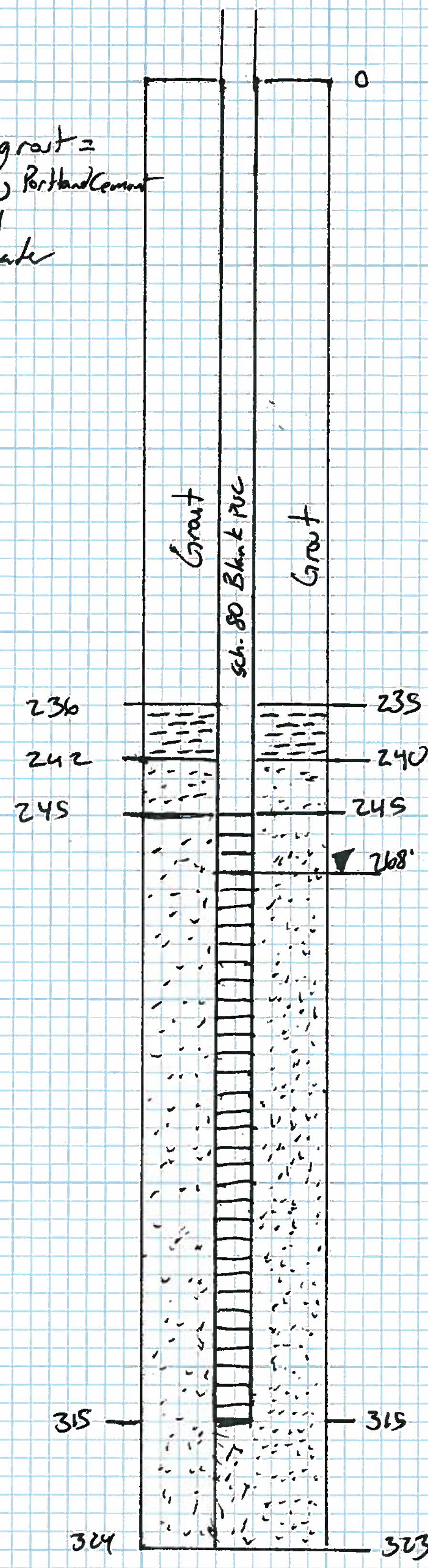
3/20
7 batches
of grout
17 bags Portland
cement
4 bags gel

1 batch of grout =
2 1/2 (94lb) bag Portland Cement
1/3 bag quick gel
~35 gallons water

3/21
4 1/2 batches
of grout
14 bags Portland cement
2 bags quick gel

2 bags 3/8" bentonite chips
chips were allowed to hydrate
1 hr before adding grout

58 bags 20/40 sand



Centralizers every 20'
on screen
every 50' on blank

Monitoring Point/Location: Sev-12-031 Miller Canyon Date: ______ Sampler: Ryan Hon[illegible]

Weather: Sunny Visitors: ______

Boring Dia. 10" Casing Dia. ~~8"~~ 4" DTW: 268.86 TOC TD: 315 bgs Pump Intake Depth: ______ Pump Top Depth: ______

Purge/Sampling Method: ______ Vial pH: ______ Depth to Water @Sampling: ______

Low Flow: Calculated Purge Volume: ______ Tubing Leng. (ft) X ______ Tubing Dia. Factor + ______ Pump Volume X 2 = ______ Purge Volume (mL) = ______ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: ______ TD (ft) - ______ DTW (ft) = ______ Water Colume (ft) - ______ Scr. Leng. (ft) = ______ Casing Leng. [Casing Volume Above Screen] X ______ Casing Factor X 3 = ______ Casing Vol. = ______ Purge Volume (gal) (0.0)

SC = ± 10%
Temp = ± 20°C
Turb = < 10 NTU
PH ± 10%

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)	Sal	TDS		GW Level (ft below MP)	Comments (Color/Odor)	
1042	1st bailer		2.5	gal	silty	water		Bottom	tagged	at	~~31?~~.4	To TOC ~315 bgs	
1045	2nd bailer		2.5	gal	silty	water			Screened	interval	245	- 315	
1048	3rd bailer		2.5	gal	silty	water							
1050	4th bailer		2.5	gal	silty	water							
1101	Start	surging											
1130	Stop	surging											
1135	5th bailer		2.5	gal	silty	water				Colorin			
1138	6th bailer		2.5	gal	silty	water							
1141	7th bailer		2.5	gal	silty	water							
1144	8th bailer		2.5	gal									
1147	9th bailer		2.5	gal	silty	water							
1150	10th bailer		2.5	gal	silty	water							
1431	265.64	16.71	6.85	1.91	-5.0	9.59	152	0.09	1.24				
1500	654.31	18.72	6.80	2.19	142	14.79	124	0.11	1.42				
1547	1055.0	17.45	6.89	2.06	45.2	14.10	134	0.10	1.35				
1622	1423.0	16.40	~~3.20~~ 6.91	2.09	32.2	11.14	104	0.10	1.34				
1635	1566	15.67	6.68	2.10	25.2	11.02	128	0.10	1.35			Sampling	Purge Flow Rate (mL (0) or gal per min (0.0))

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification

Non-Production Well: 1369001M00 WIN: 436427

Owner *Note any changes*

CH2M HILL FOR PEAK MINERALS INC.
C/O STEPHEN HILL
215 S. STATE STREET, STE. 1000
SALT LAKE CITY, UT 84111

Contact Person/Engineer: Stephen Hill / CH2MHill

Well Location *Note any changes*

S 701 W 847 from the NE corner of section 31, Township 20S, Range 12W, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation,local well #) SEV-12-031

Drillers Activity Start Date: 01-15-13 Completion Date: 04-25-13

Check all that apply: ☒ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use: monitor well

If a replacement well, provide location of new well. ______ feet north/south and ______ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	323	9	Sonic	N/A

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE High	PERMEABLE Low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTION AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture,degree of weathering, hardness, water quality, etc.)
0	245			X	X	X	X	X					Brown	
245	323	X	X		X	X	X						"	

RECEIVED
APR 29 2013 JH
WATER RIGHTS
SALT LAKE

Static Water Level

Date 03-26-13 Water Level 245 feet Flowing? ☐ Yes ☒ No

Method of Water Level Measurement WLI If Flowing, Capped Pressure N/A PSI

Point to Which Water Level Measurement was Referenced ground level Elevation N/A

Height of Water Level reference point above ground surface N/A feet Temperature N/A degrees ☐ C ☐ F

Well Log

Construction Information

DEPTH (feet) FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	☒SCREEN ☐PERFORATIONS ☐OPEN BOTTOM — SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	245	4" Sch. 80 pvc	80	4	245	315	.010	4	Factory Slot

Well Head Configuration: Above grade Access Port Provided? ☒Yes ☐No

Casing Joint Type: Flush Thread Perforator Used: N/A

Was a Surface Seal Installed? ☒Yes ☐No Depth of Surface Seal: 240 feet Drive Shoe? ☒Yes ☐No

Surface Seal Material Placement Method: Tremie Bentonite and Cement

Was a temporary surface casing used? ☒Yes ☐No If yes, depth of casing: 323 feet diameter: 9 inches

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION — SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	235	Cement Bentonite	45 bags	50 lbs each
235	240	Bentonite chips	4 bags	" "
240	323	20-40 Sand	58 bags	" "

Well Development and Well Yield Test Information

DATE	METHOD	YIELD	Units Check One GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
	N/A					

Pump (Permanent)

Pump Description: N/A Horsepower: ____ Pump Intake Depth: ____ feet

Approximate Maximum Pumping Rate: ____ Well Disinfected upon Completion? ☐Yes ☐No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary Circumstances, abandonment procedures. *Use additional well data form for more space.*

N/A

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name BOART LONGYEAR (Person, Firm, or Corporation Print or Type) License No. 626

Signature [signature] (Licensed Well Driller) Date 04-25-13

PROJECT NUMBER:	BORING NUMBER:	SHEET 1 OF 19
465077	SEV-12-025 Provo	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface — START : 2/27/2013 — END : 3/3/2013 — LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0 – 7.0	7.0			Fine to very fine silt (ML); 10yr 7/3 very pale brown; very loose, dry. Some wind blown silt, few rounded cobbles+gravel@ 6' bgs; Gravel (0%), Sand (10%), Clay/Silt (90%) changing to Gravel (5%), Sand (15%), Clay/Silt (80%) at 6' bgs.	
5						
	7.0 – 17.0	10.0				
10					Fine sandy clayey silt (ML); 10yr 5/8 yellowish brown; loose, dry; few medium dense clay lenses+trace subrounded gravel; Gravel (5%), Sand (30%), Clay/Silt (65%)	trace organics at 15' bgs
15						
	17.0	10.0				
					Clay, (CH) 10YR5/8 yellowish brown, very stiff, moist to dry, medium plasticity. Disseminated gypsum prevalent, some gypsum crystals;Gravel (0%), Sand (5%), Clay/Silt (95%)	high conc. of gypsum in 2" interval @ 21 and 23' bgs; Some vertical cracks/fissures/pockets @ 43-45' bgs + mm thick bands'stringers of sand @ 46.5' bgs 10YR 5/8 yellowish brown, oxidized.
20						
25						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	27.0				Clay, (CL) 10YR5/8 yellowish brown, very stiff, moist to dry, medium plasticity. Disseminated gypsum prevalent, some gypsum crystals; Gravel (0%), Sand (5%), Clay/Silt (95%)	high conc. of gypsum in 2" interval @ 21, 23 and 31' bgs; Some vertical cracks/fissures/pockets @ 43-45' bgs + mm thick bands'stringers of sand @ 46.5' bgs 10YR 5/8 yellowish brown, oxidized.
30		10.0				
35	37.0					
40		10.0				
45	47.0					
50						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface | START : 2/27/2013 | END : 3/3/2013 | LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0				
55						
	57.0					
60		5.0			Silty, sandy clay (CL); GLEY 5/1 greenish grey, stiff, moist; Gravel (0%), Sand (15%), Clay/Silt (85%)	Black organic silt is absent
	62.0					
65						
		10.0				
70						
	72.0				Clay, (CL); GLEY 5/1 greenish grey; very stiff, moist, medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	silty mm-scale interbeds, no gypsum or black organic silt
75		5.0				

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 4 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface START : 2/27/2013 END : 3/3/2013 LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	77.0				Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity;Gravel (0%), Sand (10%), Clay/Silt (90%) - Gravel (0%), Sand (10%), Clay/Silt (90%)	@76.5' black silty organci pocket with associated gypsum @ 80' black silty wet pocket, clay, very sticky trace gypsum throughout mm-scale black silty bed @ 96'
80		10.0				
85	87.0					
90						
95		18.0				
100						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 5 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Trace amounts of black organic silt, no mm-scale laminations, no gypsum
105	105.0					
110		10.0				
115	115.0					
120		12.0				
125						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	127.0				Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Trace amounts of black organic silt, no mm-scale laminations, gypsum crystals @ 127' bgs, % increase of black silt, < micro scale laminations, black organic silt pocket ~3" thick @ 141' bgs.
130						
135		18.0				
140						
145	145.0					
150						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 7 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	% increase of gypsum crystals from 153'-159' bgs with peak concentration at 156' bgs; black silt microlamination from 164-164.5' bgs; clay nodule/spherical @ 166'bgs; possible fluvial deposit.
155		20.0				
160						
165	165.0					
170		12.0				
175						

PROJECT NUMBER:	BORING NUMBER:	SHEET 8 OF 19
465077	SEV-12-025 Provo	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface | START : 2/27/2013 | END : 3/3/2013 | LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	177.0				Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Trace microlaminations of black organic silt; trace disseminated gypsum @178'bgs, 6" section of higher % black silt microlaminations. @197' black silt % increases @ 200' bgs are spherical nodules which streak black across sediment. These are likely sulfide concentrations such as iron sulfide (pyrite) from microbial sulfide reduction. Sample collected. Metalic Pyrite interior.
180						
185		15.0				
190						
	192.0					
195						
200		13.0				

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 9 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface — START : 2/27/2013 — END : 3/3/2013 — LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL); GLEY 5/1 greenish grey, very stiff, moist, medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	No gypsum; high % of micro scale black silt lamination; @ 201' and 204', 1" black silt beds; @ 200' sulfide nodules as seen in previous interval. @206' 1/2 " thick silt layer @209' % change; Gravel (0%), Sand (10%), Clay/Silt (90%) @211' % change; Gravel (0%), Sand (5%), Clay/Silt (95%)
205	205.0					
210		12.0				
215	217.0					
					Sandy silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (15%), Clay/Silt (85%)	Main difference is % change; more fine grain sand @ 224.5' bgs a brownish black organic 1/4" layer; appears woody, stringy @ 228.5 - 229' bgs trace black silt Not a water bearing zone despite slightly more sand @ 230' % change; Gravel (0%), Sand (20%), Clay/Silt (80%) @231' bgs % change; Gravel (0%), Sand (15%), Clay/Silt (85%)
220						
225		15.0				

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
230					
	232.0				
235				Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	@242' bgs, 1/4" gypsum bed with few crystals between 242' and 244.5', 6" gypsum bed.
240		15.0			
245					
	247.0				
250					

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 11 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface | START : 2/27/2013 | END : 3/3/2013 | LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Large gypsum crystals @ 250.5' bgs. Microlamination/smearing of black silt throughout section. 1/2" layer of black metallic silt. Between 259' and 263' bgs are four 4" intervals of metallic black silt, no associated gypsum. Small isolated gypsum crystals present between 273 and 275 ' bgs.
255		20.0				
260						
265	267.0					
270						
275		15.0				

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL) 10YR4/3 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Dessiminated and large crystals of gypsum from 279'-282' bgs 3" gypsum pocket at 280' bgs. 1" layer of black silt at 291' bgs. <1% trace black silt 1" gypsum crystals at 304' bgs.
280						
	282.0					
285						
		14.0				
290						
295						
	296.0					
300						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface | START : 2/27/2013 | END : 3/3/2013 | LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		12.0				
305						
	308.0				Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Trace black silt, gypsum absent, no sand/water. @324.5' 1" gypsum crystal
310						
315						
320						
325						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 14 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		17.0			Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	@ 330' 6" interval of 15" thick by 7" long lenses of clay Traces of black silt (microlaminations which are likely streaking of sulfide mineral while drilling/splitting core from 334'-342' bgs. No sand/ No water Organic-rich brown and lack lens @ 339; ~1 1/2" thick.
330						
335						
340						
	342.0					
345						
350						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-025 Provo	SHEET 15 OF 19

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		16.0			Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	@ 355.5' bgs 1/4" pyrite nodule-black exterior, metallic interior.
355						
					Fine grain silty, clayey sand (SM) 10YR 7/4 very pale brown, moist, medium dense; Gravel (0%), Sand (55%), Clay/Silt (45%)	
	358.0				Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Gypsum crystals at 367.5' bgs.
360						
					Silty clay (CL) GLEY 4/1 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	
365						
		16.0				
370					Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Some bands of gypsum crystals.
					Silty clay (CL) GLEY 4/1 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	
	374.0					
375						

PROJECT NUMBER:	BORING NUMBER:	SHEET 16 OF 19
465077	SEV-12-025 Provo	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4611.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter

WATER LEVELS : 70.2 ft below ground surface — START : 2/27/2013 — END : 3/3/2013 — LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Silty clay (CL) GLEY 4/1 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Gypsum and pyrite absent to 391' bgs.
380						
		16.0				
385						
390						
	391.0					
					Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	
395						
		11.0			Silty clay (CL) CL 10YR 4/1 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Gypsum crystals @ 399'
400						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
				Silty clay (CL) CL 10YR GLEY 4/1 brown; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Gypsum crystals @ 402, 403, 405, and 407.5' bgs. Some gypsum between 409-410' bgs. 410.5-411.0'; 4" sand lenses; wet, but not producing.
	402.0				
405		6.0			
	408.0				
410					
		12.0		Silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Gypsum absent
415					
				Sandy silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (15%), Clay/Silt (85%)	Gypsum absent
420	420.0				
425					

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

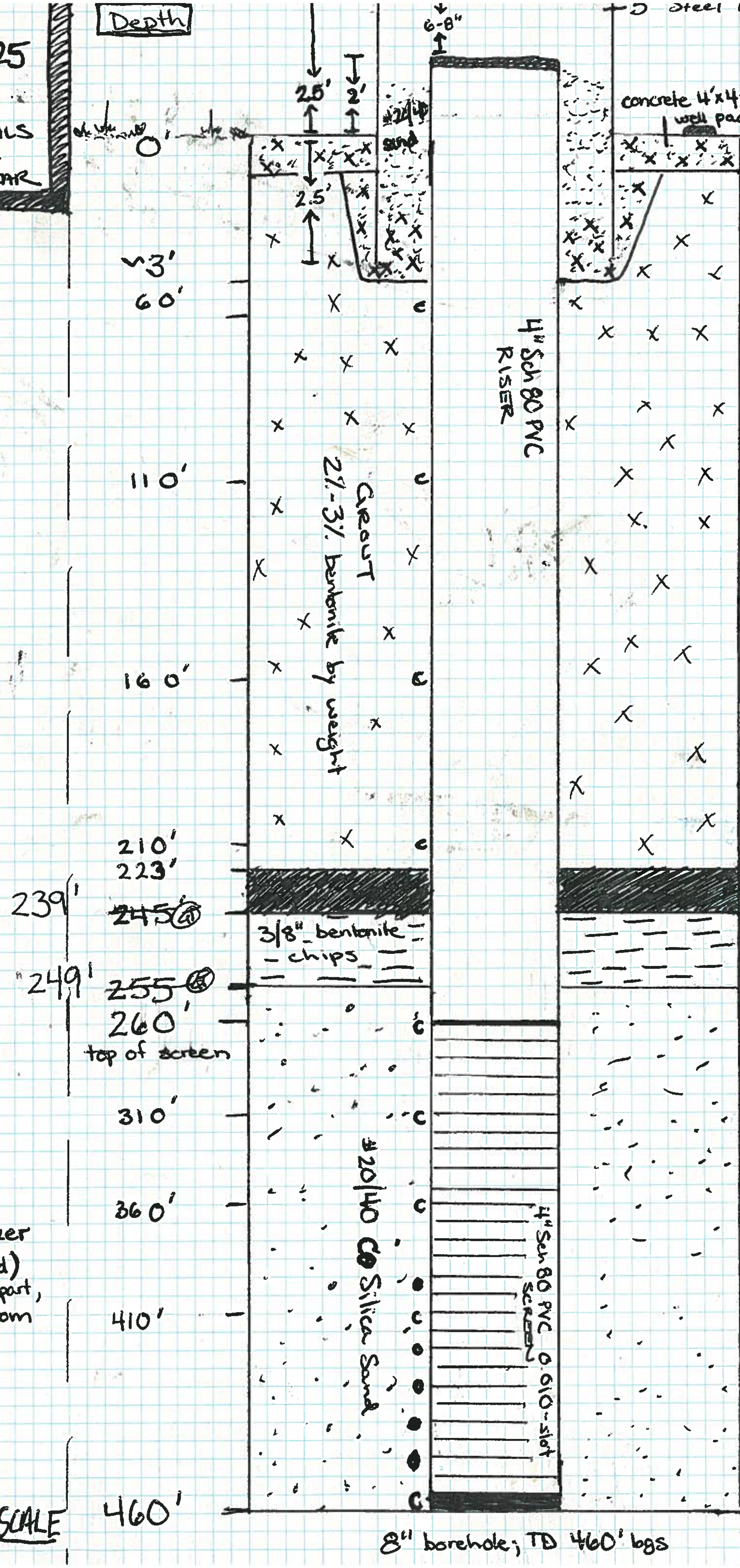
DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		15.0			Sandy silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (15%), Clay/Silt (85%) Below water 448'-450', color fluctuates between GLEY 5/1 greenish grey and 10YR4/1 brown.	@ 427.5-429.5' abundant black silt; 3% gypsum crystals @ 432'-435' 15% gypsum crystals @ 434'-434.4' 6" bed containing mollusca shell fragments(clam bed); chells are well-sorted, mm-size fragments, broken/far from source. @ 435'-437' 30% fossil mollusca and gastrapod (snail) @ 437' black organic flakers (coal) Black silt and gypsum present between 435-439' bgs; gypsum present between 444.5-447.0'
430						
435	435.0					
440						
445		25.0				
450						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4611.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing daimeter
WATER LEVELS : 70.2 ft below ground surface
START : 2/27/2013
END : 3/3/2013
LOGGER : G. Tangalos

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
455					Sandy silty clay (CL) GLEY 5/1 greenish grey; very stiff; moist; medium plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%) Color fluctuates between GLEY 5/1 greenish grey and 10YR4/1 brown.	Between 454' and 456' up to 1/2"gypsum crystals present; large twinned crystal @ 458' bgs
460	460.0					
465					Bottom of Hole at 460.0 ft below ground surface 3/3/2013	
470						
475						

PROVO
SEV-12-025
/27/13 -
EAK MINERALS
H2M HILL
OART LONGYEAR



C = Centralizer (9 required) 50-feet apart, from bottom

NOT TO SCALE

Calculated Volume/Quantity

Actual Volume/Quantity

GROUT
245 feet

8" boring w/ 4" well
= 0.266 ft³/ft
= 1.9 gal/ft
50-gal grout = 10 ft³
= 1 batch

245 ft x 0.266 ft³/ft
= 65.17 ft³
= 6.5 batches
(this is low)

or

245 ft x 1.95 gal/ft
= 478 gal
= 9.5 batchs
(seems low)

• 3/7/13: 5 batches: 115' inside 8" casing

@ Bonneville
13 batch = 200 ft.
@ Dike Access
9 batch = 315 ft.

est. based on Bonneville = 16 batches

Formation collapse

10 ft. chips
20 lbs/ft.
= 200 lbs / 50 lbs
= 4 bags

3 bags

205 ft. filterpack
ex: Bonneville = 1.6'/bag
ex: Dike Access 1.6'/bag
(1) Boart table
26 lbs/ft
= 106.6 50 lbs bags
= 1.4 palette
(2) examples
1.6'/bag
= 128 50 lbs bags
= 2.3 palette
[56 x 50 lbs/palette]

102 bags

PVC (Sch80)
20 x 10' SCREEN
26 x 10' RISER
1 x 5' RISER

Monitoring Point/Location: 257-cutoff / Provo Date: 4-13-13 Sampler: Ryan Hamblin

Weather: Visitors:

Boring Dia. 8" Casing Dia. 4" DTW: TD: 40 Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume: ______ Tubing Leng. (ft) X ______ Tubing Dia. Factor + ______ Pump Volume X 2 = ______ Purge Volume (mL) = ______ Rounded Purge Volume (Rounded up to nearest 100 mL)

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: ______ TD (ft) - ______ DTW (ft) = ______ Water Column (ft) - ______ Scr. Leng. (ft) = ______ Casing Leng. X ______ Casing Factor X 3 = ______ Casing Vol. = ______ Purge Volume (gal) (0.0)

(Casing Volume Above Screen)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: ______ PPE Disposal: ______ Disposition of Purge Water: ______ 90% Recharge Level: ______ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
1149	29th	bailer		silty water		Tiny fine		sand	with	10% cobbles		→ >5 mm dia	
1151	30th	bailer		"		"		"			"		
Provo								WL = 70.18 ft to TOC					
1533	1st bailer	2.5 gal	very silty / mud					Bottom tagged at 460 ft. to TOC ~3 ft of muck					
1537	2nd bailer	2.5 gal	very silty mud										
1541	3rd bailer	2.5 gal	very silty water										
1543	4th bailer	2.5 gal	very silty water										
1549	5th bailer	2.5 gal	very silty water										
1552	6th bailer	2.5 gal	very silty water										
1556	7th bailer	2.5 gal	very silty water										
1600	8th bailer	2.5 gal	"				"	clearing					
1605	9th bailer	2.5 gal	silty water					Developer states that bottom is clear of fines					
1618	10th bailer	2.5 gal	silty water					bucket has very little fines in bottom!!					

Purge Flow Rate (mL (0) or gal per min (0.0))

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification

Non-Production Well: 1369001M00

WIN: 436430

Owner *Note any changes*

CH2M HILL FOR PEAK MINERALS INC.
C/O STEPHEN HILL
215 S. STATE STREET, STE. 1000
SALT LAKE CITY, UT 84111

Contact Person/Engineer: Stephen Hill / CH2mHill

Well Location *Note any changes*

S 2036 E 571 from the N4 corner of section 07, Township 23S, Range 11W, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation,local well #) SEV-12-025

Drillers Activity Start Date: 01-15-13 Completion Date: 04-05-13

Check all that apply: ☒ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use: monitor Well

If a replacement well, provide location of new well. ______ feet north/south and ______ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	460	9	Sonic	N/A

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE High	PERMEABLE Low	CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	ROCK TYPE (CONSOLIDATED)	COLOR	DESCRIPTION AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture,degree of weathering, hardness, water quality, etc.)
0	205			X	X	X	X						Bown	
205	460	X	X		X	X	X						"	

RECEIVED
APR 29 2013 JH
WATER RIGHTS
SALT LAKE

Static Water Level

Date 03-07-13 Water Level 205 feet Flowing? ☐ Yes ☒ No

Method of Water Level Measurement WLI If Flowing, Capped Pressure N/A PSI

Point to Which Water Level Measurement was Referenced ground Level Elevation N/A

Height of Water Level reference point above ground surface N/A feet Temperature N/A degrees ☐ C ☐ F

Well Log

Construction Information

DEPTH (feet) FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	200	4" Sch. 80 pvc	80	4	200	260	.010	4	Factory Slot

☒ SCREEN ☐ PERFORATIONS ☐ OPEN BOTTOM

Well Head Configuration: Above grade

Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: Flush Thread

Perforator Used: N/A

Was a Surface Seal Installed? ☒ Yes ☐ No

Depth of Surface Seal: 190 feet

Drive Shoe? ☒ Yes ☐ No

Surface Seal Material Placement Method: Tremie Bentonite Cement

Was a temporary surface casing used? ☒ Yes ☐ No If yes, depth of casing: 460 feet diameter: 9 inches

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	**Quantity** of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	190	Cement Bentonite	63 bags	50 lbs each
190	200	Bentonite chips	4 bags	" "
200	460	20-40 Sand	102 bags	" "

Well Development and Well Yield Test Information

DATE	METHOD	YIELD	Units Check One: GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
	N/A					

Pump (Permanent)

Pump Description: N/A Horsepower: ____ Pump Intake Depth: ____ feet

Approximate Maximum Pumping Rate: ____ Well Disinfected upon Completion? ☐ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary Circumstances, abandonment procedures. *Use additional well data form for more space.*

N/A

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name BOART LONGYEAR (Person, Firm, or Corporation—Print or Type)

License No. 626

Signature [signature] (Licensed Well Driller)

Date 04-25-13

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	5.0				
2	5.0	10.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic
Name A. Garhart
Date Sept/5/2011
Page 1 of 10
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
0							Cly & Sand (0.0 - 1.5) pl ylw brn - md gry, Intbded, Clay - soft, wet, massive, Sand - vf grn, mod srted, silty, soft, wet
1	Run 1						Cly (1.5 - 5.7) md gry - grysh brn, silty, minor vf sand, massive, soft, wet strong sulfur odor
2							
3							
4							
5	5.0						
6	Run 2						Silt (5.7 - 9.4) md gry - pl olv gry, clayey, some fn sand, thickly bedded, occ gypsum, soft, damp - wet
7							
8							
9							Cly (9.4 - 10.0) reddish brn - med gry, thickly bedded, soft - mod stiff, damp
10	10.0						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	10.0	12.0	2.0	2.0				
4	12.0	20.0	8.0	8.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A Garhart

Date Sept/15/2011

Page 2 of 10

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
		Shelby Tube SHQQ7-SONIC 10-12 10.0-12.0'					Shelby Tube sample collected 10.0-12.0'
							Sample # SHQQ7-SONIC 10-12
11	Run 3						
12	12.0	12.0					Cly (12.0 – 14.3) SAA, oolitic @ bottom
13							
14	Run 4						
							Silt (14.3 – 20.0) md gry - pl olv gry, clayey, some vf sand, massive, soft, damp-dry occ organics (black)
15							
16							
17							
18							
19							
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
5	20.0	30.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A. Gachart

Date Sept 15 / 2011

Page 3 of 10

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
						Cly (20.0-30.0) lt greenish gry - med dk gry, silty, mottled, deformed lams - massive, med stiff, damp
21						
22						
23						
24						
25						
26	Run 3					
27						
28						
29						
30	30.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	30.0	40.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic
Name A. Garhart
Date Sept/15/2011
Page 4 of 10
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							Cly (30.0-31.2) lt greenish gry - black, silty organic rch, med stiff, damp
31							Cly (31.2-40.0) lt greenish gry, occ med dk gry minor silt, massive, med stiff, damp, gypsum and barite throughout
32							
33							
34							
35	Run 6						
36							
37							
38							
39							
40	40.0						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
7	40.0	50.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A.Gerhart

Date Sept 15, 2011

Page 5 of 10

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							Cly (40.0-55.0) pl olv gry - lt greenish gry, silty, silt intbds up to 4mm, md stiff-stiff, damp, occ lg barite xtals, occ gypsum
41							
42							
43							
44							
45	Run X						
46							
47							
48							
49							
50	50.0						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	50.0	55.0	5.0	5.0				
9	55.0	60.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A. Gorhart

Date Sept / 15 / 2011

Page 6 of 10

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							SAA (50.0 - 55.0)
51							
52							
53	Run 8						
54							
55	55.0						Cly (55.0 - 60.0) reddish brown occ pl olv gry intbds, massive, homogeneous, abnt gypsum & barite mineralization, very stiff - hard, dry
56							
57				+++ +++ +++	abnt gypsum xtls		
58	Run 9						
59							
60	60.0						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	60.0	67.5	7.5	7.5				
11	67.5	72.5	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A. Gearhart

Date Sept 15, 2011

Page 7 of 10

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							Cly (60.0-72.5) Reddish brown, occ pl dk gry intbds, mottld in places, massive homogeneous very dense, occ barite/gypsum, dry, hard
61				++ +	Lg barite/gypsum		
62				+++	barite/gypsum		
63							
64	Run 10						
65							
66							
67	67.5						
68							
69	Run 11						
70							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	72.5	77.5	5.0	5.0				
13	77.5	90.0	12.5	12.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic
Name A. Gearhart
Date Sept 15, 2011
Page 8 of 10 Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							SAA (70.0-72.5)
71	Run 11						
72							Cly (72.5-90.0) Intbded reddish brown & pl olv gry, mottled in places, thickly bedded, little mineralization, dry, hard, very dense, occ gypsum, occ FeO?
	72.5						
73							
74	Run 12						
75							
76							
77							
	77.5						
78							
79	Run 13						
80							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic
Name A.Gorhart
Date Sept 15 /2011
Page 9 of
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
						SAA (80.0-90.0)
81						
82						
83						
84						
85						
86						
87						
88	Run 13					
89						
90	90.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	90.0	100.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole QQ7-Sonic

Name A.Garhart

Date Sept 15, 2011

Page 10 of 10

Photos (Yes) / No

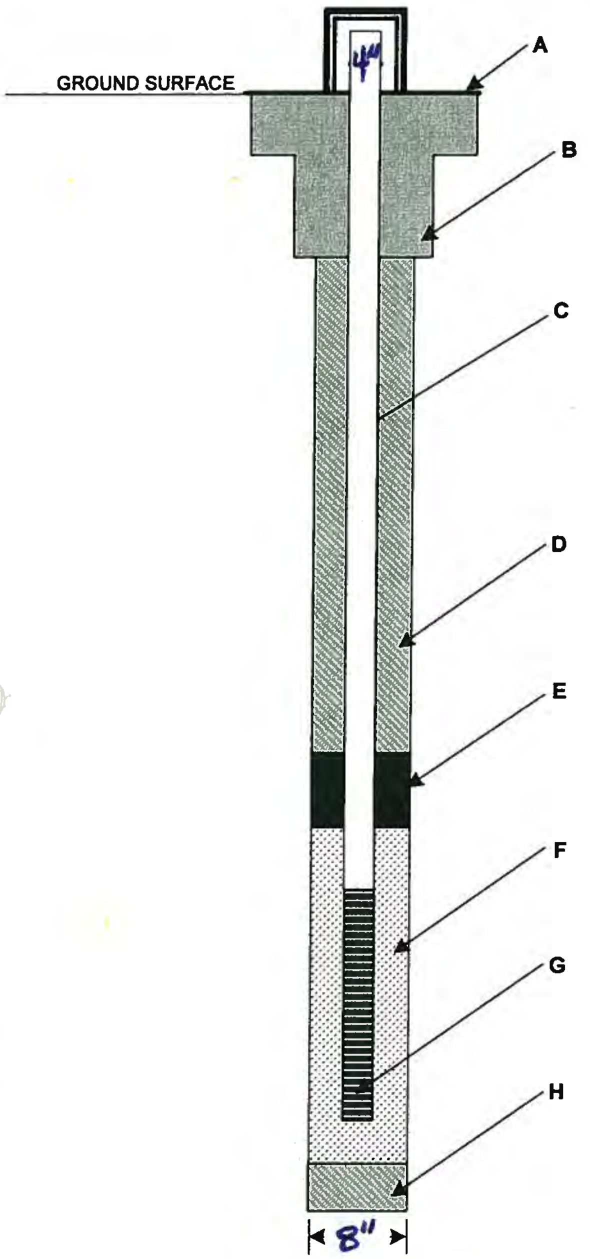
Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
						SAA (90.0 – 100.0)
91						
92						
93						
94						
95						
96						
	Run 14					
97						
98						
99						
100	100.0					100.0 = TD

MONITORING WELL / PIEZOMETER CONSTRUCTION LOG

WELL NO: BW241202QQ7SONIC
PROJECT: 421350.PO.EX.03.02
SITE: SEVIER LAKE

PROJECT NO: Brine Exploration Drilling
CONSTRUCTED BY: Boart Longyear
~~CITY~~: 9/7/2011

NORTHING:
EASTING:
GROUND SURFACE ELEVATION:
MEASURING POINT ELEVATION:



A. SURFACE COMPLETION

COMPOSITION: Cement
SIZE:
MATERIALS USED: 4X80lbs. bags Quikrete

B. SURFACE SEAL

MATERIAL: N/A
INTERVAL:

C. RISER PIPE

TYPE: Sch. 40 PVC 4"
INTERVAL: 9'-0'
HEIGHT ABOVE GROUND SURFACE: ~2.5'

D. GROUT

COMPOSITION:
INTERVAL: N/A
CALCULATED MATERIALS NEEDED:
MATERIALS USED:

E. SEAL

TYPE: Cement
INTERVAL:
CALCULATED MATERIALS NEEDED:
MATERIALS USED:

F. FILTER PACK

TYPE: Pea Gravel 3/8" washed
INTERVAL: 100.3' –
CALCULATED MATERIALS NEEDED:
MATERIALS USED:

G. SCREEN

DIAMETER: 4"
TYPE: Sch. 40 PVC
SLOT SIZE: 0.010"
INTERVAL: 99'-9'

H. BACKFILL

TYPE: Pea gravel 3/8" washed
INTERVAL: 100.3-99'
CALCULATED MATERIALS NEEDED:
MATERIALS USED:

TOTAL DEPTH: 100.3' (FEET BELOW GROUND SURFACE)

______ (FEET BELOW TOP OF CASING)

Centralizers @ 98'
80'
60'
40'
20'

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	5.0				
2	5.0	7.0	2.0	2.0				
3	7.0	10.0	3.0	3.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
Name A. Gorhart
Date Aug. /30 /2011
Page 1 of 24
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Code (From – To) Lithologic Description Color Grain Size Sorting
							Cly. (0.0-5.0) md lt gry - lt brn gry, minor silt, massive, occ gypsum infills, soft, damp - moist, occ organic (eg roots)
1.0							
2.0							
3.0	Run 1	Box 1		+++	gypsum		
4.0				x++	gypsum		
5.0		5.0					
							Shelby tube # 33SH5-7 (5'-7')
6.0	Run 2	Shelby Tube #33SH5-7					
7.0		7.0					Cly (7.0-10.0) SAA, occ lg barite xtals, sulfur odor
8.0							
9.0	Run 3	Box 2		+++	barite		
				+++	barite		
10.0							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	10.0	12.0	2.0	2.0				
5	12.0	15.0	3.0	3.0				
6	15.0	20.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

Date Aug /30 / 2011

Page 2 of 24

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
	Run 4	Shelby tube #33SH 10-12				Shelby tube sample #33SH 10-12
11.0						
12.0		12.0				Silt, clayey (12.0-15.0) minor fn sand, lt brn gry, massive, oolitic in places, soft, wet & saturated, occ lg barite xtals
13.0	Run 5	Box 3				
14.0						
15.0		15.0				Cly (15.0-20.0) minor silt, med lt gry - md gry, massive, minor barite, med stiff, damp
16.0						
17.0	Run 6	Box 4				
18.0						
19.0						
20.0		20.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
7	20.0	25.0	5.0	5.0				
8	25.0	30.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
Name A. Garhart
Date Aug/30/2011
Page 3 of 24
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							Cly (20.0-30.0) lt olv gry, minor silt, massive, occ gypsum xtals & Mn? (black xtals) med stiff - stiff, damp, rare gravel (meta-sandstone?), artificial moisture from drilling, occ silty intbds
21.0							
22.0	Run 7	Box 5					
23.0							
24.0							
25.0		25.0					
26.0							
27.0							
28.0	Run 8	Box 6					
29.0							
30.0		30.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	30.0	32.0	2.0	2.0				
10	32.0	35.0	3.0	3.0				
11	35.0	42.5	7.5	7.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

Date Aug /30 /2011

Page 4 of 24

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
30.0–32.0	Run 9	Shelby tube # 33S#30-32; 32.0					Shelby tube sample 30.0 -32.0 # 33S#30-32
32.0–35.0	Run 10	Box 7					Cly (32.0 - 38.5) pl olv gry, massive, homogeneous, occ lg barite xtals, med stiff - stiff, damp
35.0–40.0	Run 11	Box 8; 40.0					Cly (38.5 - 44.0) silty, pl olv gry - olv gry, Intbd silt & clay, thickly bedded in places, stiff, damp, occ barite xtals

Depth scale: 31.0, 32.0, 33.0, 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	42.5	50.0	7.5	7.5				
1								

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

Date Aug/30/2011

Page 5 of 24 Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
41.0	Run 11					
42.0		Box 9				
	42.5					
43.0						
44.0						Silt (44.0 - 45.0) clayey, minor fn sand, dk gry - pl olv gry soft - med stiff, damp
45.0	Run 12	45.0				Sand (45.0 - 47.5) Int bded w/ clay, silt & minor gravels, f-crs grn, mod sort, sub ang, abnt baritie in clay, med stiff, damp - dry gravels up to 2cm in diameter, meta SS & qtz
46.0						
47.0		Box 10				Sand (47.5 - 50.0) pl olv gry - dk reddish brn, md grn, mod well srt, mass, sub rnd - sub ang, soft - med stiff, damp - wet
48.0						
49.0						
50.0	50.0	50.0				RR7-1 Sample taken @ 50'

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
13	50.0	52.5	2.5	2.5				
14	52.5	60.0	7.5	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-6	Code (From - To) Lithologic Description Color Grain Size Sorting
	50'<	RR7-1 RR7-2				Cly (50.0-57.5) reddish brn; massive, homogeneous, stiff, damp - dry
51.0	Run 13	Box 11				Note: a large amount of gravel slough was removed from the top of Run 13. Gravel up to 2", subrnd-subang, metaSS, SS, Qtz, minor mafics
52.0						*Sample # RR7-2 taken from gravel slough ~50'
53.0						
54.0						
55.0		55.0				
56.0	Run 14					
57.0		Box 12				Core loss 57.5 - 60.0
58.0						
59.0						
60.0						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
15	60.0	66.0	6.0	6.0				
16	66.0	72.5	6.5	6.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

Date Aug/31/2011

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
	Run 15	Box 12				Cly (50.0-66.0) lt greenish gry, massive, occ gypsum xtals, very stiff, damp
61.0						
62.0		62.5				
63.0		Box 13				
64.0						
65.0		66.0				
66.0	Run 16	Box 14				Cly (66.0-73.0) weak red-reddish brn, massive, occ gypsum & barite xtals, homogeneous, very stiff-hard, damp-dry
67.0						
68.0						
69.0						
70.0		70.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	72.5	77.5	5.0	5.0				
18	77.5	85.0	7.5	7.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
71.0	Run 16	Box 15				
72.0	72.5					
73.0						Cly (73.0 – 74.0) pl olv gry, massive, mottled w/ reddish brn, occ barite & gypsum xtals very stiff, dry
74.0	Run 17					Cly (74.0 – 77.5) weak red – reddish brn, mottled w/ pl olv gry at top, massive, very stiff, dry
75.0		75.0				
76.0						
77.0	77.5	Box 16				Cly (77.5 – 86.0) pl olv gry, massive, occ barite xtals, minor silt, very stiff – hard, dry
78.0	Run 18					
79.0						
80.0		80				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
19	85.0	95.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H Ri-5	Code (From – To) Lithologic Description Color Grain Size Sorting
81.0							
82.0		Box 17					
83.0	Run 18						
84.0							
85.0	85.0	85.0					
86.0							Cly (86.0–95.0) Pl olv gry / reddish brn, mottled, massive, occ barite xtals, hard, dry
87.0		Box 18					
88.0	Run 19						
89.0							
90.0		90.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
20	95.0	105.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garbart

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
91.0						
92.0						
93.0		Box 19				
94.0	Run 19					
95.0	95.0	95.0				SAA (95.0 - 97.5)
96.0	Run 20					
97.0						Cly (97.5-105.0) Intbd pl olv gry & reddish brn, massive, abnt gypsum in places, very stiff, dry
98.0		Box 20				
99.0						
100.0		100.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
21	105.0	114.0	9.0	9.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
101.0						
102.0						
103.0	Run 20					
104.0		Box 21				
105.0	105.0	105.0				SAA (105.0–110.0)
106.0						
107.0		Box 22				
108.0	Run 21					
109.0						
110.0		110.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
22	114.0	125.0	11.0	11.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
Name A. Garhart
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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
						Cly (110.0 - 114.0) pl olv gry - lt greenish gry, massive, homogeneous, occ gypsum/barite xtals, dry, very stiff - hard
111						
112	Run 21	Box 23				
113						
114	114.0					Cly (114.0 - 120.8) reddish brown, massive, homogeneous, occ gypsum, very stiff - hard, dry
115		115.0				
116	Run 22					
117		Box 24				
118						
119						
120		120.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
Run23	125.0	135.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A.Garheib

Date Aug/31/2011

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Photos (Yes)/ No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
						Cly (120.8-135.0) pl olv gry massive, very stiff-hard, dry, occ mottled w/ reddish brn, occ gypsum/barite
121						
122		Box 25				
123	Run 22					
124						
125	125.0	125.0				
126						
127	Run 23	Box 26				
128						
129						
130						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
24	135.0	146.0	11.0					

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RD7

Name A Garhart

Date Aug /31/2011

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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
131							
132							
133	Run 23	Box 27					
134							
135	135.0	135.0					SAA (135.0–145.1)
136							
137	Run 24	Box 28					
138							
139							
140							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
25	146.0	160.0	14.0	14.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A.Garhart

Date Aug 31 /2011

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
141						
142						
143	Run 24	Box 29				
144						
145		145.0				Sand (145.1 - 145.6) pl olv gry - lt green gry, fn grn, minor silt, mod. well srt, subrnd, qtz rich, massive, soft, damp
146	146.0					Cly (145.6 - 147.5) pl olv gry, massive, occ gypsum/barite, stiff - very stiff, damp - dry
147						Sand (147.5 - 149.5) reddish brown, vf - fn grn, minor silt, well srt, massive, qtz rich, subrnd, soft, wet - saturated
148	Run 25	Box 30				
149		Sample# RR7-3				Cly (149.5 - 160.0) pl olv gry w/ motled reddish brown, massive, occ barite/gypsum, stiff - very stiff, damp - dry
150						Sample RR7-3 collected @ 149.0'

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
25	146.0	160.0	14.0	14.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
						SAA (150.0 - 160.0)
151						
152						
153		Box 31				
154						
155	Run 25					
156						
157		Box 32				
158						
159						
160						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
26	160.0	170.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A.Gorhart

Date Sept 1, 2011

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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
160	Run 26	Box 33				Cly (160.0 – 170.0) Reddish brown w/occ ltolv gry intbds, massive, very stiff – hard, dry – damp, mottled in places, no mineralization
161						
162						
163						
164						
165						
166		Box 34				
167						
168						
169						
170	170.0	170.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
27	170.0	180.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Garhart

Date Sept / 1 / 2011

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Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							Cly (170.0 - 180.0) Int bd pl olv gry & reddish brn, mottled in places, occ gypsum, massive, very stiff - hard, dry, charcoal @ 72.5 occ organics & pyrite
171							
172							
173		Box 35					
174	Run 27						
175		175.0					
176							
177		Box 36					
178							178.0 - Organics w/ pyrite
							178.5 Black organic lense
179							
180	180.0	180.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
28	180.0	190.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
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Date Sept/1/2011
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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-6	Code (From – To) Lithologic Description Color Grain Size Sorting
						SAA (180.0 – 192.7)
181						
182		Box 37				
183						
184	Run 28					
185		185.0				
186						
187		Box 38				
188						
189						
190	190.0					190' = End of 7" core & begin 6" core

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
29	190.0	195.0	5.0	5.0				
30	195.0	210.0	15.0	15.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Gearhart

Date Sept 1, 2011

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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
191							
192	Run 29						
		Box 39					Cly (192.7-210.0) reddish brown, occ pl dk grn intbds, massive, very stiff - hard, dry
193							
194							
195		195.0					
196							
197	Run30	Box 40					
198							
199							
200		200.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
30	195.0	210.0	15.0	15.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							SAA
201							
202							
203		Box 41					
204							
205	Run 30	205.0					
206							
207							
208		Box 42					
209							
210	210.0	210.0					

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
31	210.0	215.0	15.0	15.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7

Name A. Gorhart

Date Sept, 1, 2011

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Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
210							Cly (210.0 – 221.0) pl olv gry lt grnish gry, massive, homogeneous, very stiff & hard, dry, occ gypsum
211							
212							
213		Box 43					
214				+++	gypsum Xtals		
215	Run 31	215.0					
216							
217							
218		Box 44					
219							
220							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
32	225.0	240.0	15.0	15.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
Name A. Gerhart
Date Sept/1/2011
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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
221							Cly (221.0-240.0) reddish brown, massive, abnt gypsum, very stiff-hard, dry Intbd w/ pl olv gry cly as above
222				+++ ++	gypsum		
223	Run 31	Box 45		++ ++ +	gypsum		
224							
225	225.0	225.0		+++	gypsum		
226							
227							
228	Run 32	Box 46					
229							
230							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole RR7
Name A. Gerhard
Date Sept / 1 / 2011
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Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H Rt-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							SAA
231							
232							
		Box 47					
233							
234							
		235.0					
235							
236	Run 32						
237							
		Box 48					
238							
239							
	240.0	240.0					240.0 = TD
240							

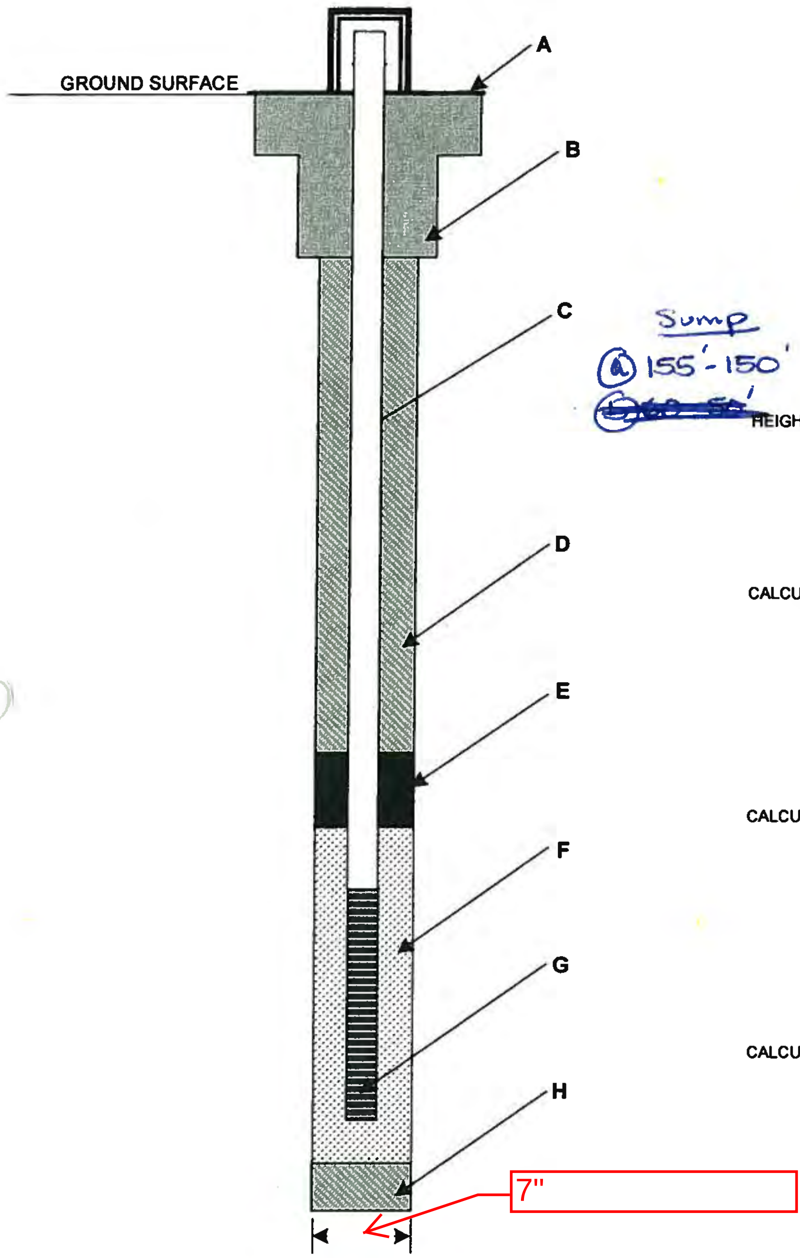
G. Tangalos / CH2M HILL

MONITORING WELL / PIEZOMETER CONSTRUCTION LOG

WELL NO: BW241202RR7 (#33) PROJECT: SEVIER LAKE BRINE EXPL. SITE: SITLA : Sevier Lake

PROJECT NO: 421350.PO.EX.03.02 CONSTRUCTED BY: BOART LONGYEAR ~~CITY:~~ ~~[illegible]~~ 9-2→9-5

NORTHING: EASTING: GROUND SURFACE ELEVATION: MEASURING POINT ELEVATION:



Sump
(a) 155' - 150'
~~(b) [illegible]~~

TOTAL DEPTH: 240' (FEET BELOW GROUND SURFACE)
242.5' (FEET BELOW TOP OF CASING)

A. SURFACE COMPLETION

COMPOSITION: Concrete
SIZE: 36" x 36"
MATERIALS USED: ~~[illegible]~~ Quikrete Ready Mix

B. SURFACE SEAL

MATERIAL: #100 sand
INTERVAL: 3' - 7.5'

C. RISER PIPE

TYPE: (a) 1" Sch. 40 (b) 4" sch. 40
INTERVAL: (a) 140' ~~[illegible]~~ (b) 10' ~~[illegible]~~
HEIGHT ABOVE GROUND SURFACE: (a) 2.5' (b) 2.5'

D. GROUT

COMPOSITION: 1 bag Portland + 1 bag #100 sand
INTERVAL: 135.5 - 84'
CALCULATED MATERIALS NEEDED: 150 gal.
MATERIALS USED: 230 gal.

E. SEAL

TYPE: (a) #100 sand (b) #100
INTERVAL: (a) 132.5 - 135.5 (b)
CALCULATED MATERIALS NEEDED:
MATERIALS USED: (a) 3 bags (b)

F. FILTER PACK

TYPE: (a) 20/40 (b) 20/40
INTERVAL: (a) 158 - 135.5' (b) 84' - 7.5'
CALCULATED MATERIALS NEEDED:
MATERIALS USED: (a) 17 bags (b) 55 bags

G. SCREEN

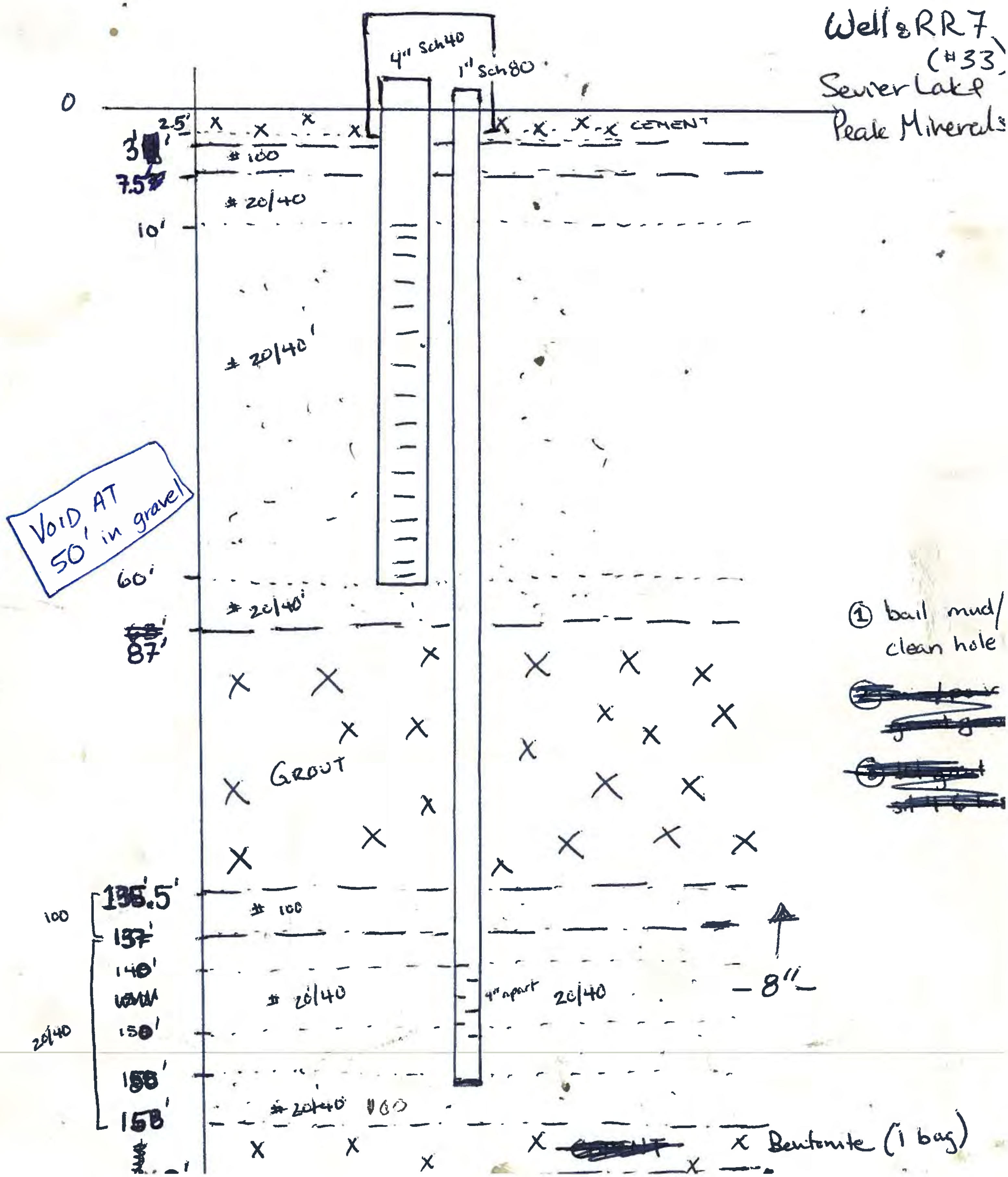
(a) 1" Sch40 PVC
(b) 4" Sch40 PVC

DIAMETER: (a) 1" (b) 4"
TYPE: (a) Sch. 40 (b) sch. 40
SLOT SIZE: (a) hand-cut (b) 0.010" w/ filter sock
INTERVAL: (a) 150' - 140' (b) 60' - 10'

H. BACKFILL

TYPE: Road gravel
INTERVAL: 240 - 160'
CALCULATED MATERIALS NEEDED: 12 5-gal. buckets 2.4 yd^3
MATERIALS USED: 37.5 5-gal buckets

9/2/11
G. Tangalos
CH2MHILL



Monitoring Point/Location: RR7-4 Date: 2-13-12 Sampler: M. Spencer, S. Larsen

Weather: Cloudy, 35° F Visitors:

Boring Dia. N/A Casing Dia. 4" DTW: 4.43 TD: 60.00 Pump Intake Depth: Pump Top Depth:

Purge/Sampling Method: STANDARD Vial pH: Depth to Water @Sampling:

Low Flow: Calculated Purge Volume: N/A (Tubing Leng. (ft)) X (Tubing Dia. Factor) + (Pump Volume) X 2 = (Purge Volume (mL)) = (Rounded Purge Volume (Rounded up to nearest 100 mL))

Tubing Diameter Factors: 3/8"= 22 mL/ft 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Standard Method: Calculated Purge Volume: 60 (TD (ft)) - 4.43 (DTW (ft)) = 55.57 (Water Colume (ft)) - 50 (Scr. Leng. (ft)) = 5.57 (Casing Leng.) X 0.66 (Casing Factor) X 3 = 11.03 (Casing Vol.) = 12 GAL'S (Purge Volume (gal) (0.0))

Casing Volume Above Screen

Casing Volume Factors (gal/ft): 2"= 0.17 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: PPE Disposal: Disposition of Purge Water: 90% Recharge Level: ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
0900	Arrived @ Well. Set up to purge & sample. Dropped Grundfos pump down casing. HW Ground Fault.												
	Pulled pump. Electrical cable is damaged. Sam driving back to Lakeview shop to repair pump.												
1030	Began purging well with bailer.												
1045	3 GAL	12.07	6.42	149.1	50.3	1.49	-45.2				5.40	Lt. gray to clear, no odor	
1105	12 GALLONS Purged. Will return tomorrow with pump to Sample												
													Purge Flow Rate (mL (0) or gal per min (0.0))

\\Snowbird\proj\AFCEE\341561 AFCEE TO 409\Work Plans\B2_ Field Log.xls

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)	
Field parameters stable?		Y N	Y N	Y N	Y N	Y N	Y N						

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal					
Duplicate					
MS/SD					
Trip Blank					
Equipment Blank					

Flow-through Cell Calibration Meter:

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH			2/13/12	757	7 pH / 10 pH	7.20 / 9.55	7.18 / 9.96	✓
Turbidity			2/13/12	818	0.0 /	-2.5 / 118.2	-3.3 / 133.9	✓
ORP			2/13/12	826	240 mV	255.0	258.2	✓
Spec Cond			2/13/12	749	1.413 ms/cm	1.181	1.188	✓
DO				832		9.46	13.11	
Ammonia								
Chloride								
Nitrate								

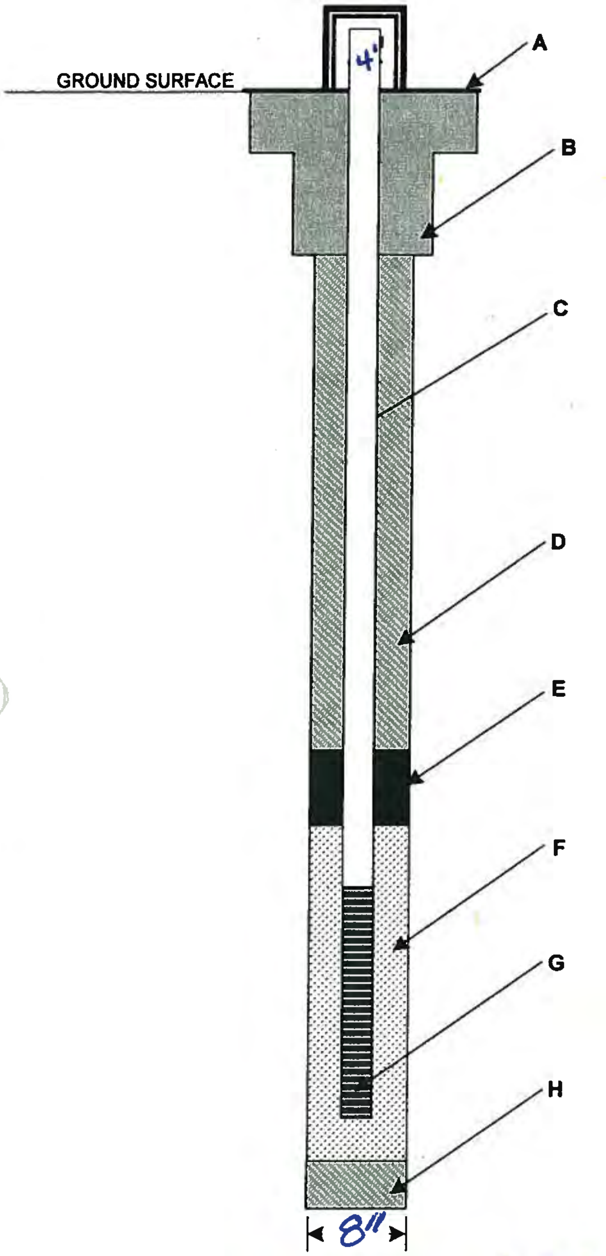
General Notes:

MONITORING WELL / PIEZOMETER CONSTRUCTION LOG

WELL NO: BW221102S13 (#2) PROJECT: ~~421350~~ Brine Exploration SITE: Sevier Lake east (Sec. 2)

PROJECT NO: 421350.PO.EX.03.02 CONSTRUCTED BY: Cone Tec ~~CITY:~~ Date: 10/5/11

~~NORTHING~~: 38.92972° N ~~EASTING~~: -113.07059° W GROUND SURFACE ELEVATION: MEASURING POINT ELEVATION:



TOTAL DEPTH: 37' TD (FEET BELOW GROUND SURFACE)

_______ (FEET BELOW TOP OF CASING)

A. SURFACE COMPLETION

COMPOSITION: Concrete

SIZE: 3' x 3'

MATERIALS USED: ~~4~~ bag 80 lbs Quikrete

B. SURFACE SEAL

MATERIAL: Concrete

INTERVAL: 2' - 0' bgs

C. RISER PIPE

TYPE: Sch. 40 PVC 4"

INTERVAL: 7' ~~[illegible]~~ to 0'

HEIGHT ABOVE GROUND SURFACE: 2.5' above

D. GROUT

COMPOSITION:

INTERVAL: N/A

CALCULATED MATERIALS NEEDED:

MATERIALS USED:

E. SEAL

TYPE: Concrete mix

INTERVAL: 2' - 0'

CALCULATED MATERIALS NEEDED:

MATERIALS USED: 2 x 80 lbs Quickrete

F. FILTER PACK

TYPE: Pea gravel

INTERVAL: 37' -

CALCULATED MATERIALS NEEDED:

MATERIALS USED:

G. SCREEN

DIAMETER: 4"

TYPE: Sch. 40 PVC

SLOT SIZE: 0.010"

INTERVAL: 37' - 7'

H. BACKFILL

TYPE: Slough / Wood Plug

INTERVAL: 40' - 37'

CALCULATED MATERIALS NEEDED: —

MATERIALS USED: —

N38.92972°
W113.070590°

Monitoring Point/Location: S13 east side Sevier Lake Date: 3 April 2012 Sampler: G. Tangalos

Weather: Sunny, clear; high 30°F Visitors: Dan Stevenson (KGES); Brian (Peak)

Boring Dia. 8" Casing Dia. 4" DTW: 3.30' TD: 37.40' Pump Intake Depth: 23' Pump Top Depth: 22.5' (TOC 4")

Purge/Sampling Method: Standard Purge Vial pH: n/a Depth to Water @Sampling: ~8' b TOC N

~~Low Flow:~~
~~Calculated Purge Volume~~ ____ Tubing Leng. (ft) X ____ Tubing Dia. Factor + ____ Pump Volume X 2 = ____ Purge Volume (mL) = ____ Rounded Purge Volume (Rounded up to nearest 100 mL)

~~Tubing Diameter Factors: 3/8"= 22 mL/ft~~ 1/2"= 38 mL/ft 5/8"= 60 mL/ft

Casing Volume Above Screen

Standard Method: Calculated Purge Volume 37.4 TD (ft) - 3.3 DTW (ft) = 34.1' Water Column (ft) - 30 Scr. Leng. (ft) = 4.1 Casing Leng. X 0.66 Casing Factor X 3 = 8.118 Casing Vol. = 8.118 gal. Purge Volume (gal) (0.0)

Casing Volume Factors (gal/ft): 2"= 0.17; 4"=0.66; 5"=0.95 Screen Interval Volume Factors (Cas.Dia/Bor.Dia.)(in): 2/8"= 2.15 gal/ft; 4/10"= 2.93 gal/ft; 4/12"= 4.55 gal/ft; 5"/10"=2.54 gal/ft

Site Safety: X PPE Disposal: X Disposition of Purge Water: X 90% Recharge Level: ____ ft Sampling Flow Rate < 1,000 mL/min?

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)	Purge Volume (gal)		GW Level (ft below MP)	Comments (Color/Odor)	
0930	Arrive	@ S13.		Measure	WL	& TD						
0955	Turn	pump	on.									
0955	131 Hz	13.04	6.76	0.009	–	9.24	85.6				Stopped pump	Changing tubing on YSI.
10:00	136.6 Hz	11.46	6.75	175.7	155.3	0.88	81.5					
10:03		13.40	6.68	175.3	8.7	0.35	67.8					
10:10		13.63	6.64	175.0	-8.3	0.29	60.2				1L/15s. =	0.26 gal/15s
10:19	136.0 Hz	13.69	6.60	1~~3~~4.8	-17.0	0.21	60.8	19 gallon			3.79L/gal. =	1 gpm
10:25		13.74	6.60	174.6	-18.3	0.00	61.8	25				
10:30		13.93	6.58	174.5	-18.8	0.15	63.5	30				
10:35		14.09	6.58	174.5	-19.6	0.13	64.3	35				
10:40		13.85	6.58	174.3	-19.9	0.10	64.4	40				
10:45		13.91	6.58	174.4	-19.9	0.10	64.5	45				
–	SAMPLE –		S13-23		10:45		4/13/12					

Purge Flow Rate (mL (0) or gal per min (0.0))

Time	Purge Vol specify mL or gal	Temp (C) (0.0)	pH (0.0)	Specific Cond. (mS/cm) (0.000)	Turbidity (NTU) (0.0)	DO (mg/l) (0.0)	ORP (mV) (0.0)				GW Level (ft below MP)	Comments (Color/Odor)
Field parameters stable?		Y N	Y N	Y N	~~Y~~ N	Y N	Y N				~8'	none, clear

	Sample ID	Time	Date	Analysis	Number of Bottles
Normal	S13-	10:45	4/3/12	cations/anions/metals/TDS/stable isotopes/ ^3H/^3He/ noble gases	6 + 2 copper tubes
Duplicate	—				
MS/SD	—				
Trip Blank	—				
Equipment Blank	—				

Flow-through Cell Calibration Meter: YSI 650 MDS

Parameter	Calibration	Check	Date	Time	Calibration Standards	Initial Reading	Final Reading	Calibration within Specifications
pH			3/28/12					
Turbidity								
ORP		—	See previous logs.					
Spec Cond								
DO								
Ammonia								
Chloride								
Nitrate								

General Notes: Field filtered samples.

113.17368 38.78357 ELEV 4320

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Drill Hole Lithology Log

Hole SH2-11-400
Page 1 of
Date 12/13/11
Name Nick Mather
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
1	0	5	5	5
2	5	10	5	5

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
0						clay, lt. gray, moist, organic, organic odor
1						
2						pen 0 @ 2'
						clay, lt gray, strong organic odor, moist, roots (4.6-7'), salt crystals @7' & 8'
3	RUN 1					
4						
5						pen 0 @ 5'
	RUN 2					ct
6						
7						
8						
9						
10						

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Core Number	Top	Base	Cut	Recovered
3	10	15	5	5
4	15	20	5	5

Hole SM2-11-400
Page 2 of
Date 12/13/11
Name Nick Mathur
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						clay, lt. grey, slightly st., st., strong organic odor and roots @ 12.5'
11	Run 3					
12						
						PEA 0.5 @ 13'
13						clay, lt. grey, moist, saturated @ 17 and 18.5'
14						
15						
	Run 4					
16						
17						PEA 0 @ 17'
18						
19						
20						PEA 1.0 @ 20'

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
5	20	25	5	5
6	25	30	5	5

Hole Sn2-11-400
Page P of
Date 12/13/11
Name Nick Mstls
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
20	RUN 5					Clay, Lt gray, slightly stiff, organic material and odor
21						
22						Pen 1.5 @ 22'
23						
24						Clay, Lt gray, moist @ 25' less stiff
25	RUN 6					
26						
27						Pen 0 @ 27'
28						
29						
30						

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Core Number	Top	Base	Cut	Recovered
7	30	35	5	5
8	35	40	5	5

Hole SN2-11-400
Page 4 of
Date 12/13/11
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
30						clay, lt gray, organic [illegible] @ 30.5-31.5
31	Run					
32	7					Pen 0 @ 32'
33						
34						
35						Pen 0 @ 35
35						clay, moist, lt gray, minor silt
36	Run					
37	8					Pen 0.5 @ 37
38						
39						
40						Pen 0 @ 40

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Core Number	Top	Base	Cut	Recovered
9	40	45	5	5
10	45	50	5	5

Hole SN2-11-400
Page 5 of
Date 12/13/11
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
40	RUN 9					slst, lt gray to olive, organic seam @ 42
41						
42						pen 0.5 @ 42
43						
44						
45	RUN 10					pen 1.0 @ 45
						slst, green to gray, ~ 0.5
46						
47						pen 1.0 @ 47
48						
49						
50						

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Drill Hole Lithology Log

Hole SN2-11-400
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Date 12/13/11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
11	50	55	5	5
12	55	60	5	5

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
50						clay, green, moist, sl. stiff
51	RUN					
52	11					pen 1.0 @ 52
53						
54						
55						pen 1.0 @ 55
55						clay, grey to olive, olive/grey laminae @ 58
56	RUN					
57	12					pen 0 @ 57
58						
59						
60						pen 0 @ 60

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Core Number	Top	Base	Cut	Recovered
13	60	65	5.0	5.0
14	65	70	5.0	5.0

Hole: 5 12-11-400
Page: 7 of
Date: 12/13/11
Name: Nick Mathis
Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
60						Clay, grey to olive, moist, [illegible] laminae
61	RUN 13					
62						
63						
64						
65						Clay, lt grey, grey to lt. grey [illegible] yellowish laminae, [illegible]
66	RUN 14					
67						
68						
69						
70						

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Drill Hole Lithology Log

Hole SN2-11-400
Page 8 of
Date 12/14/12
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
15	70	75	5.0	4.0
16	75	80	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
70	RUN 15					Begin drilling on 12/14/12 CLAY Lt. brown, slightly moist, stiff
72						penometer 4.5@ 72
75	RUN 16	Chip				
77						Clay, Lt. brown to grey, less moisture, hard
80		Chip				penometer maxd@ 80'

Depth scale: 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

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Drill Hole Lithology Log

Hole SN2-11-400
Page 9 of
Date 12/14/11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
17	80	85	5.0	5.0
18	85	90	5.0	

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
81	RUN 17					
82						Clay, Lt. gray to olive, slightly moist, hard, little variation to 95'
83						
84						peronometer max @ 85'
85		chip				
86	RUN 18					
87						
88						
89						peronometer max @ 90'
90		chip				

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Core Number	Top	Base	Cut	Recovered
19	90	95	5.0	5
20	95	100	5.0	5

Hole SN2-11-400
Page 10 of
Date 12/14/11
Name Nick Mathr
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
91	RUN					
92	19					
93						
94						clay Lt. gray, sl. moist, interbedded gypsum 90-95
95		chip				penomotor max @ 95
96	RUN					
97	20					
98						
99						penometer maxed @ 100
100		chip				

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Drill Hole Lithology Log

Hole SN2-11-400
Page 11 of
Date 12/14/12
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
21	100	105	5	5
22	105	115	10	9

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	R					
101	U					
	N					
102	21					
103						Clay, Lt. brown to gray trending to Lt. brown. (103-112 ft) dry
104						
105		chip				peromefer max @ 105
	R					
106	U					
107	N					
108	22					
109						
110		chip				Peromotor max @ 110

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Core Number	Top	Base	Cut	Recovered
22 (cont)				
23	115	125	10	12

Hole SN2-11-400
Page 12 of
Date 12/14/12
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
111	Run 22 (cont)					
112						Gypsum seam (112-116) large crystals to 4 inches
113						
114						
115		Chip				
116	Run 23					Clay, Lt. brown, dry, hard, interbedded gypsum (116-118.5)
117						
118						
119						Clay, Lt. gray to olive, dry, hard, interbedded gypsum (119-122)
120		Chip				

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Drill Hole Lithology Log

Hole SN2-11-400
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Date 12/14/12
Name Nick Mather
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
23 continued				
24	125	131.5	6	6

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	RUN					
121						
	23 (cont)					
122						clay, Lt brown, dry, hard, interbedded lt gray clay (122-127)
123						
124						
125		chip				
	RUN					
126						
127	24					clay, lt gray, hard, dry
128						
129						clay, Lt brown, hard, dry
130		chip				

Penometer maxed out

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Drill Hole Lithology Log

Hole 5N2-11-400
Page 19 of
Date 12/14/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
24 continued				
25	131.5	137.5	6	6
26	137.5	147.5	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 24					
131	cont					
132	RUN 25					
133						
134						clay, lt gray, dry, hard
135		chip				
136						
137						
138	RUN 26					
139						clay, lt gray to olive, cobble (0.25"x0.15")
						small silt seam @ 40°, sl. moist
140		chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 15 of
Date 12/14/11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
26' continued				
27	147.5	151.5	5	4

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 26					clay, lt. gray to brown, silt seam (1-2mm) slightly moist
141						
142	Cont					clay, brown, hard, dry (142-142.5)
						clay, gray, hard, dry
143						
144						
145		chip				
146						clay, gray, hard, dry, interbedded gypsum
147						
148	Run 27					
149						
150		Chip				

Pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 16 of
Date 12/15/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
27 cont				
28	151.5	157.5	6.0	6.0
29	157.5	164.5	7.0	7.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 27					clay, lt. brown interbedded lt. gray clay and gypsum seam
151	Run 28					clay, lt. grey to brown w/ dk. grey interbedded organic seam
152						
153						
154						clay, lt grey to green, sl. moist
155		chip				
156						
157	Run 29					
158						silty clay, lt. tan, dk. grey laminae, moist, minor gypsum @ 161.5', stiff dry
159						
160		chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 17 of
Date 12/15/11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
29 cont				
30	164.5	167.5	3	3
31	167.5	171.5	4	4

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 29 cont					
161						
162						
163						
164						
165	R	chip				
	Run 30					
166						
167						Clay, Lt. grey to green with minor red zone, dry, hard
168	Run 31					
169						
170		chip				

plan marked out

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Drill Hole Lithology Log

Hole SN2-11-400
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Date 12/15/11
Name Nick Mstkr
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
31 cont				
32	171.5	177.5	6	6
33	177.5	187.5	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
171	Run 31 (cont)					clay, lt grey to brown, dry, hard, minor gypsum
172	RUN					clay, lt. brownish green, dry, hard
173						
174	32					clay, bluish grey, dry, hard, interbedded gypsum @ 176
175		chip				
176						
177						clay, lt. brown to grey, dry, hard
178	RUN 33					
179						
180		chip				

pl n mixed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 19 of
Date 12/15/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
33 (cont)				
34	187.5	196.5	9.0	9.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 33 cont					
181						
182						
183						
184						
185		chip				
186						clay Lt. brown, Interbedded grey clay, Dry, hard
187						
188	RUN 34					
189						clay, Lt gray + dry, hard
190		chip				

pen maxed out

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
34 (cont)				
35	196.5	201	4.5	4.5

Hole SN2-11-400
Page 20 of
Date 12/15/11
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN					
191	34					
192	cont					
193						
194		chip				sand, silty, v. fine, tan, small amount of water (194.5) ≈ 0.25"
195						
196	RUN 35					
197						clay, lt brown, interbedded green clay @ 199
198						
199						
200		chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 21 of
Date 12/16/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
35 cont				
36	201	207	6	4.0
37	207	214	7.0	7.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 35 cont					sample lost 201-203
201	Run 36					
202						
203						clay, brown, hard, dry
204						
205		chip				
206						
207	Run 37					clay, grey to green, hard, dry
208						
209						
210		chip				

pen maxed out

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
37(cont)				
38	214	217	3	3
39	217	221.5	4.5	4.5

Hole SN2-11-400
Page 22 of
Date 12 / 16 / 11
Name Nick Mathis
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 37					
211						
212						clay, brown, hard, dry
213						clay, grey to green, hd. dry
214	RUN 38					
215		chip				
216						
217	RUN 39					
218						
219						
220		chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 03 of
Date 12/16/11
Name Nick [illegible]
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
39 cont				
40	221.5	227.5	6	6
41	227.5	229	1.5	1.5
42	225	237	8	8

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 39					clay, green w/ minor red seam transition to clay, greenish brown, hd, dry
221						
222	RUN 40					clay, green hd dry
223						
224						clay, brown to blue to green, hd dry
225		Chip				
226						clay, brown, hard, dry
227						clay, blueish green, dry, hd
228	RUN 41					end of drilling 12/16/11
229	RUN 42					CLAY, gray to green, dry, hd
230		Chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 24 of
Date 12/17/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
Run 42 (cont)				
Run 43	237	247	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 42					
231						
232						
233						
234						clay, lt brown to green, dry, hard
235		chip				
236						
237	RUN 43					clay, silty, green, moist
238						clay, silty, brown, moist
239						sandy silt, tan, well sorted moist (239-244.5)
240		chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 25 of
Date 12/17/11
Name Nick Mather
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
43 (cont)				
44	247	257	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	RUN 43					
241						
242						
243						
244						clay, lt. brown to greyish green
245		chip				
246						
247	RUN 44					clay, grey to green, hd, sl. moist
248						
249						
250		chip				

Pen maxed out

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Core Number	Top	Base	Cut	Recovered
44 (cont)				
45	257	267	10	10

Hole SN2-11-400
Page 26 of
Date 12/17/11
Name Nick Mathes

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
251	RUN 44 (cont)					Clay, lt. brown to green alternating bd, sl. moist, interbedded small organic seams with coal @ 257.5
252						
253						
254						
255		Chip				
256						
257						
258	RUN 45					
259						
260		Chip				

pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 27 of
Date 12/17/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
45 cont				
46	267	277	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 45 cont					
261						clay, Lt brown, interbedded, small organic seams, with minor amounts of coal stiff dry
262						
263						clay, green, organic seams with minor coal, stiff, dry
264						
265		Chip				pen maxed out
						clay, Lt brown, moist (4" thick)
						pen 1.0 @ 265
						clay, green, small organic seams (coal) (265.5), stiff, dry
266						
267	RUN 46					
268						
269						
270						pen maxed out @ 270

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Drill Hole Lithology Log

Hole SN2-11-400
Page 23 of
Date 12 / 18 / 11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
46 (cont)				
47	277	287	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 46					CL / brn silty org. to sand hard dry
271						
272						
273						
274						
275		chip				
276						
277	RUN 47					
278						
279						
280		chip				

Pen maxed out

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
47 (cont)				
48	287	297	10	10

Hole SNR-11-400
Page 25 of
Date 12/18/11
Name Nick Ashby
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	RUN					Clay, grayish green, stiff, sl moist
281						
282	47 cont					
283						
284						
285		Chip				Pen maxed out
286						
287						Clay, brown, hard, slightly moist
288	RUN 48					Clay, green, hard, sl moist
289						
290		Chip				Pen maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 20 of
Date 12/18/11
Name Nick Mathis
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
48 Cont				
49	297	307	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 48					
291						
292						
293						clay, brown, hard, sl moist
294						
295		chip				per maxed
296						
297	RUN 49					Clay, brown, gree, alternating sli interbedded organics
298						
299						
300		chip				per maxed

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Drill Hole Lithology Log

Hole SN2-11-400
Page 21 of
Date 12/18/11
Name Nick Hathu
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
49 cont				
50	307	317	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
301	RUN					
302	49					
303	(cont)					
304						
305		chip				Pen maxed out
306						
307	RUN					clay, green, stiff, sl. moist
308	50					
309						
310		chip				pen maxed out

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Core Number	Top	Base	Cut	Recovered
50 Cont				
51	317	327		

Hole SN2-11-400
Page 32 of
Date 12 / 18 / 11
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 50 cont					
311						Clay, green, stiff, sl moist
312						
313						
314		Chip				Pen maxed out @315
315						
316						
317	RUN 51					C
318						Clay, green, hard, sl moist gypsum crystals (318-319.5)
319						Pen maxed out @ 320
320						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
51 cont				
52	327	335	10	10

Hole SN3-11-400
Page 33 of
Date 12/18/11
Name Nick Mathr
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
321	RUN 51					clay, lt. brown to green, sl moist, hard (321-321.9)
						clay, green, hard, dry
322						
323						
324						
325		chip				
326						clay, grey to green, hard, dry
327	RUN 52					
328						clay, green, hard, dry
329						
330		chip				

PLT maxed out

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Drill Hole Lithology Log

Hole SN2-11-400
Page 34 of
Date 12/13/11
Name Nick Bsth.
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
52 cont				
53	335	332	2	2

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
331	RUN					
332						
333	52					clay, green, hard, dry, small, sandy silt seam, very fine, dk grey (2" wide)
334						end of drilling 12/13/11
335		chip				clay, lt brown, dry, hd
336	RUN 53					
337						
338	RUN 54					
339						clay, lt grey to green, interbedded organic seams w/ coal
340						

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Drill Hole Lithology Log

Hole ______

Page ______ of ______

Date __/__/__

Name ______

Photos Yes / No

Core Number	Top	Base	Cut	Recovered

Depth	Graphic Log	Sample Id & Box #	Discontinuities			Lithologic Description
			Type	Graphic	Description	

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
54 (cont)				
55	347	357	10	10

Hole SN2-11-400
Page ____ of ____
Date 12/20/11
Name Nick Mathis
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	RUN 54					Clay, lt gray to green, hard, sl moist, [illegible], organic seams [illegible] coal
341						
342						
343						
344						
345						
346						
347	RUN 55					
348						
349						
350						

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Drill Hole Lithology Log

Hole SN2-11-406
Page ____ of ____
Date 12/20/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
55 cont				
56	357	367	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 55 cont					
351						
352						
353						sand, fine grained, well sorted tan to grey, sl. moist (353.5–354)
						clay, grey to green, sl. moist, hard
354						
355						
356						
357	RUN 56					
358						
359						
360						

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Drill Hole Lithology Log

Hole SN2-11-400
Page ____ of ____
Date 12/20/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
56 cont				
57	367	374		

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN					
361						clay, lt. gray, hard, dry
362	56 cont					clay, green, hard, dry interbedded organics
363						
364						clay, gray to green, dry, hd. interbedded organics
365						
366						clay, green, coal seam, hd. dry
367	RUN 57					clay, lt. grey to green, hard, dry organics @ 369-374
368						
369						
370						

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Drill Hole Lithology Log

Hole SN2-11-400
Page ____ of ____
Date 12/20/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
57 cont				
58	377	385		

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	RUN 57					
371						
372						
373						
374						
375		Chip				Clay, lt. gray to green, dry, hd.
376						
377	RUN 58					
378						
379						
380		Chip				

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
58 cont				
59	385	391	6	6

Hole SN2-11-400
Page ____ of ____
Date 12/20/11
Name Nick Mathes
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	RUN 58 cont					Clay, greyish green, hard, dry
381						
382						
383						
384						
385		chip				End of drilling 12/20/11
	RUN 59					
386						
387						
388						
389						Clay, lt. brown, dry, hard
390		chip				

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Drill Hole Lithology Log

Hole SN2-11-400
Page 40 of
Date 12/20/11
Name Nick Mathis
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
Run 59 cont				
Run 60	391	397	6.0	3.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	Run 59 cont					
391	Run 60					
392						
393						Clay, green, dry, hard
394						
395		chip				
396						
397						end of drilling 12/21/11
398						
399						
400						

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Drill Hole Lithology Log

Hole SN2-11-400
Page 41 of 50
Date 07/01/12
Name B. Alger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
61	397.5	417.00	19.5	19.5

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
397						Cly, ~~me~~ (397.5-399) reddish brown, dry pen= 3.75, homogenous, contains little to no moisture, some intermittent med olive gray cly
401						
402						Cly (399-411) medium olive gray, dry, very fractured, likely due to sonic vibrations, contains some small lithics but is in a clay matrix, well sorted
403						
404						
405	Run 61					
406						
407						
408						
409						
410						

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Drill Hole Lithology Log

Hole SN2-11-400
Page 42 of 50
Date 07/01/12
Name B. Acker
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
61	397.5	~~[illegible]~~ 417	19.5	19.5
62	417	432.5	15.5	15.5

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
411	Run 61					Cly (411-417) SAA color becoming more ~~br~~ reddish brown, still predominantly olive gray, very dry
412						
413						
414						
415						
416						
417	Run 62					Cly (417-421) med olive gray, some silt content, very fractured, dry, ~~[illegible]~~ well sorted
418						
419						
420						

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Core Number	Top	Base	Cut	Recovered
62	417	432.5	15.5	15.5

Hole SN2-11-400
Page 43 of 50
Date 07/01/12
Name B. Alcer
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
421						Clay (421-432.5) med olive gray, dry, pen = 3.5, well sorted, intermittent areas of brown to reddish brown clay
422						
423						
424						
425	Run 62					
426						
427						
428						Black lens, possibly MgO or organic in origin, dry
429						
430						

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Hole SN2-11-400
Page 44 of 50
Date 07/01/12
Name B. Alger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
62	417	432.5	15.5	15.5
63	433	439	6.0	6.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						(430 - 432.5) SAA
431	Run 62					
432						
						CL (432.5 - 433.0)
433						Cly (433 - 439) med olive gray, dry, penometer maxes out (>4.5) likely becase frozen, massive
434						
435						
436	Run 63					
437						
438						
439						
440						

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Drill Hole Lithology Log

Hole SN2-11-400
Page 45 of 50
Date 09/06/12
Name B. ALGER
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
64	439.0	447.0	8.0	9.0
65	447.0	457.0	10.0	10.5

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	Run 64					Cly (439 - 445) Reddish brown mixed with light olive gray, ~ 70% reddish brown, not stratified, Moderately sorted dry, stiff (> 4.5) white specks in photos is ice which grew on cores overnight
441						
442						
443						
444						
445						Cly (445 - 447) reddish brown. dry, stiff, MASSIVE
446						
447						Cly (447.0 - 457.0) SAA but alternating layers of light olive gray blending with reddish brown.
448						
449						
450						

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Drill Hole Lithology Log

Hole SNZ-11-400
Page 46 of 50
Date 09/01/12 D/M/Y
Name B. Acger
Photos (Yes) No

Core Number	Top	Base	Cut	Recovered
65	447.0	457.0	10.0	10.5
66	457.0	469.0	12.0	15.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	Run 65					Cly (447-457)
	Run 66					Cly (457-460) SAA

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
65	457.0	469.0	12.0	13.0

Hole SN2-11-400
Page 47 of 50
Date 09/01/12
Name B. Alger

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (460.0 - 469.0) med olive gray, dry, stiff, becomes lighter with depth
461						
462						462.0 - Gypsum crystal
463	Run 65					
464						
465						
466						Gypsum PRESENT FROM (466.0 - 468.0)
467						
468						
469						
470						

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Drill Hole Lithology Log

Hole SN2-11-400
Page 48 of 50
Date 10/01/12 D/M/Y
Name B. ALGER
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
66	469.0	486.0	17.0	19.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (469-475.5) med olive gray, transitioning to reddish brown at 475.5 ~~blk and~~, dry, stiff, mostly massive
471						
472						
473						
474	Run 66					
475						Cly (475.5-479.0) colors alternate, moderately sorted, some silt content mostly (95%) dry stiff clay. Silt is also dry
476						
477						
478						Gypsum present at 478.5, very compacted not full crystals like seen in shallow samples
479						
480						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
66	469.0	486.0	17.0	18.0
67	486.0	497.0	11.0	11.0

Hole SNZ-11-400
Page 49 of 50
Date 10/01/12
Name B. Algor
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (479 - 486) reddish brown, dry, stiff, MASSIVE, occasional gypsum "powder" layer
481						
482						
483	Run 66					
484						
485						
486						Cly (486 - 487.5) SAA
487						
488	Run 67					Cly (487.5 - 497) med olive gray AND REDDISH BROWN BANDED AND OCCASIONALLY HEAVED INTO EACH OTHER, DRY, stiff.
489						
490						

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Drill Hole Lithology Log

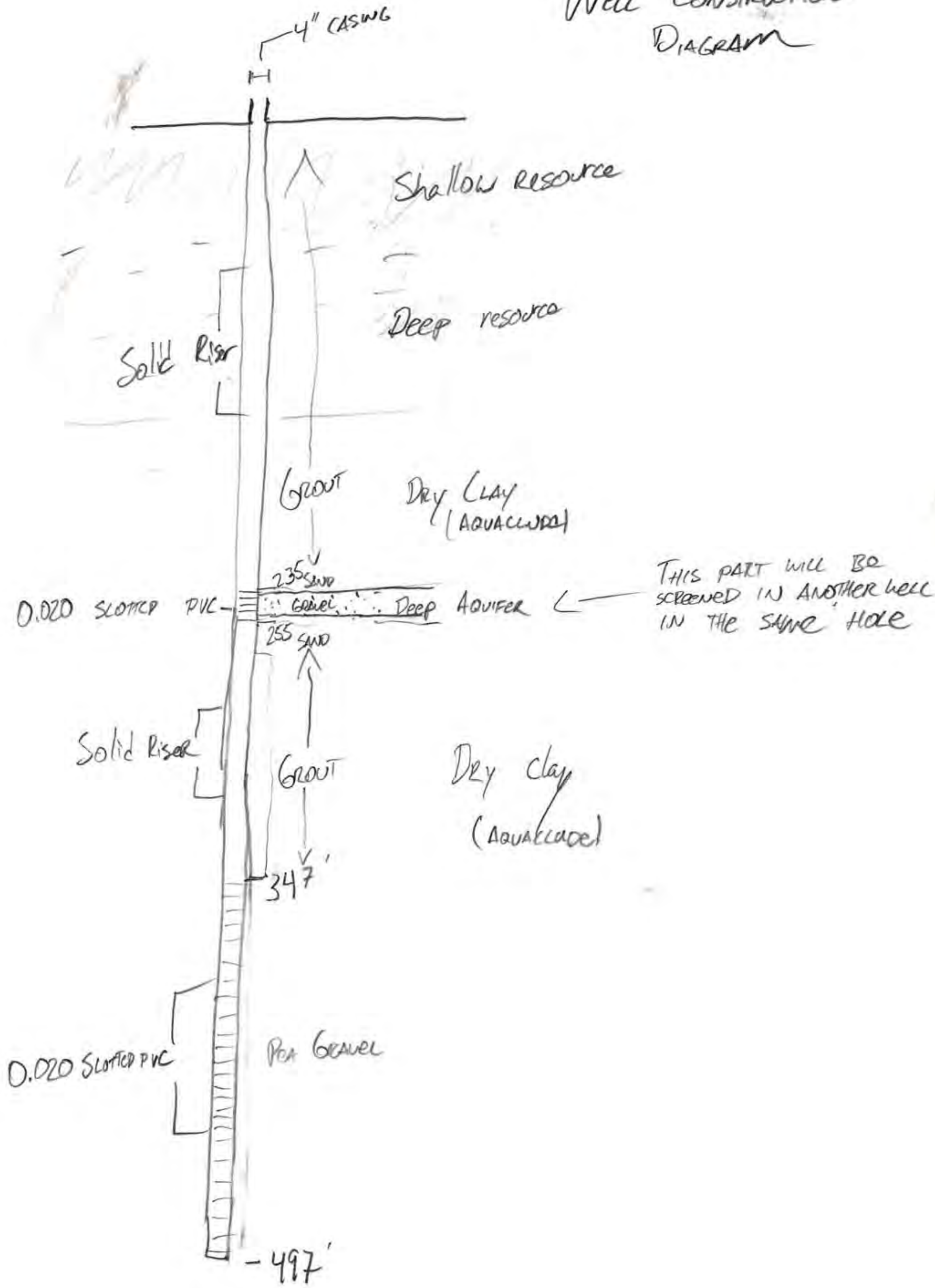
Hole SN2-11-400
Page 50 of 50
Date 10/01/12
Name B. Acger

Photos Yes / No

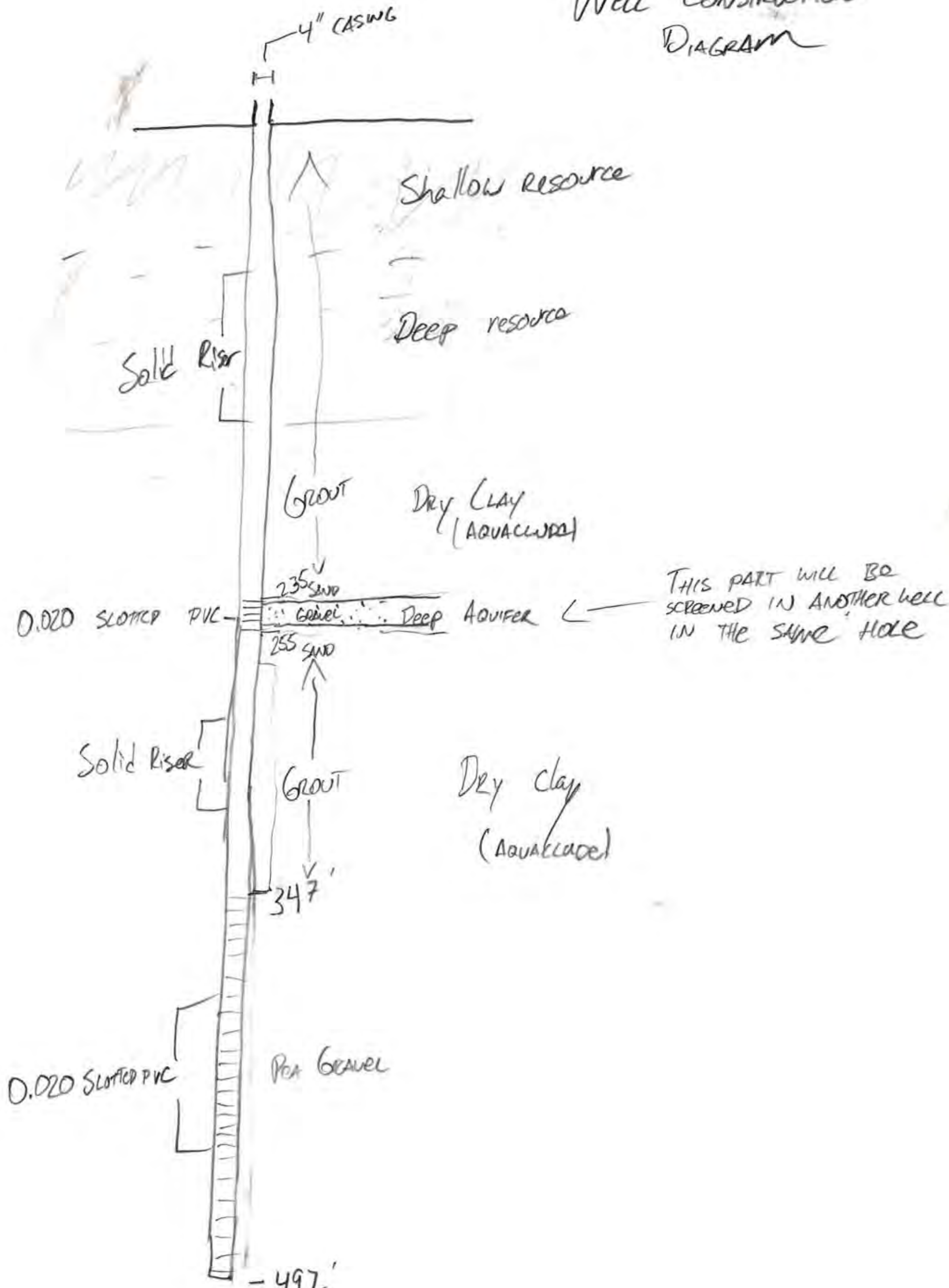
Core Number	Top	Base	Cut	Recovered
67	486.0	497.0	11.0	11.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	Run 67					
						TD = 497.0'

Well Construction Diagram



Well Construction Diagram



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Drill Hole Lithology Log

Hole SN3-12-45-4
Page 1 of 9
Date 17/02/12
Name B. Alger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
1	0.0	4.0	4.0	4.0
2	4.0	9.0	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
0						Mineralized cly (0.0) - 3.0) wet, pen = 0, halite crystls formed well sorted crystals
3	Run 1					cly (3.0-4.0) wet, pen = 0, soft, massive, marbled
4	Run 2	SN 45 SH 4.0-5.5				Cly (4.0-5.1) SAA
5						sandy cly (5.1-5.4) mostly clay matrix holding some sand particles, wet, pen = 0.5
						Cly (5.4-9.0) light gray marbled with red gray. pen = 0, saturated, organic grasses/roots beginning @ 7.0 - 9.0
9	Run 3	SN 45 SH 9.0-10.5				

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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Drill Hole Lithology Log

Hole SN3-12-45-4
Page 2 of 9
Date 17/02/12
Name B. Acoor
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
3	9.0	14.0	5.0	5.0
4	14.0	19.0	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	SN46SH 9.0-10.5	SN46SH 9.0-10.5				Cly (9.0-10.4) SAA
						Cly (10.4-12.5) med dk gray, pen=0.25, moist, no organics, massive
11						
12	Run 3					Cly (12.5-14.0) med dk gray, more stiff, damp, massive (12.5-13.0) some hardening of material, informed by driller (Darius) @ 13.0 pen=1.25
13						@ 13.75 pen=1.75
14		SN45SH 14.0-15.5				Cly (14.0-19.0) SAA but softening with depth
15						pen @ 15.0 = 1.75
16	Run 4					
17						pen @ 17.0 = 1.0
18						pen @ 18.5 = 0.5
19		SN45SH 19.0-20.5				
20						

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Drill Hole Lithology Log

Hole SN3-12-4S-4
Page 3 of 9
Date 17/02/12
Name B. Ac Gor
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
5	19.0	24.0	5.0	5.0
6	24.0	29.0	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
19		SN4S5A 19-20.5				Cly (19.0-24.0) med olv gray, moist, massive, intermediate resource.
21						pen = 0.25 @ 21
22	5 Run					
23						pen = 0.5 @ 23
24		SN4S5H 24.0-25.5				Cly (24.0-29.0) light gray, moist, some variation of color, soft sediment deformation,
25						
26						DARK HORIZON pen = 0.5
27	6					
28	Run					pen = 0.5 @ 28.0
29	Run 7	SN2IS5H 29.0-30.6				
30						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
7	29.0	34.0	5.0	5.0
8	34.0	39.0	5.0	5.0

Hole SN3-12-45-4
Page 4 of 9
Date 17/02/12
Name B. Acgor
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
	Run 7	SN45SH 29.0-30.5				Cly (29.0 - 32.5) SAA
31						
32						clay silt (32.5 - 34.0) med olive gray ~60% silt content, pen = 0.25, moist some pockets of saturation throughout
33						
34	Run 8	SN45SH 34.0-35.5				Cly (34.0-39.0) med olive gray, damp with pockets of saturation, occasional bands of crumbly clay, lithologically massive
35						pen = 1.0 @ 35.0
36						poor resonce but likely still transition zone
37						
38						pen = 1.25 @ 38.0
39	Run 9	SN45SH 39.0-40.5				
40						

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Drill Hole Lithology Log

Hole SN3-12-45-4
Page 5 of 9
Date 17/02/12
Name B. Acker
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
9	39.0	44.0	5.0	5.0
10	44.0	49.0	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
		SN45SH 39.0-40.5				Cly (39.0-43.2) SAA, softening with depth and more water with depth, intermittent gypsum crystals
41						
42	Run 9					pen = 0.5 @ 42.0
43						clayey sand (43.2-44.0) banded olive gray & med gray, saturated, pen varies 0.0-0.5 SAND is fine, subrounded.
44		SN45SH 44.0-45.5				Cly (44.0-49.0) med olv gray with some med gray, moist, pen = 0.5 throughout
45						
46	Run 10					
47						
48						
49	Run 11	SN45SH 49.0-50.5				
50						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
11	49.0	59.0	10.0	10.0

Hole SN3-12-45-4
Page 6 of 9
Date 17/02/12
Name B. Alcorn
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
		SN45 SH 49.0-50.5				Cly (49.0-51.3) SAA
51						Sandy cly (51.3-52.0) vf med gray sand in same clay as above, ~80% cly, more water content, pen=0
52	Run 11					Cly (52.0-54.0) SOS
53						
54						Cly (54.0-59.0) med olive gray moist, becoming damp with depth pen=0.5
55						
56						
57						(57.0-57.3) Gypsum, saturated around
58						banding (57.8-58.7) pen=0.5
59	Run 12	SN45 SH 59.0-60.5				
60						

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Drill Hole Lithology Log

Hole SN3-12-45-4
Page 7 of 9
Date 17/02/12
Name B. Acger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
12	59.0	69.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
		SN 45 SH 59.0-60.5				Cly (59.0 - 69.0) med olv green ~~ex~~ moist to damp, some trace silt content,
61						
62		SN 45 MC 59.0-64.0				pen = 0.75 @ 62
63	Run 12					
64						
65						pen = 0.75 @ 65
66		SN 45 MC 64.0-69.0				
67						pen = 0.75 @ 67.0
68						
69						
	Run 13	SN 45 SH 69.0-70.5				
70						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
13	69.0	79.0	10.0	10.0

Hole SN3-R-45-4
Page 8 of 9
Date 18/02/12
Name B. Alcor
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
		SN45SH 69.0-70.5				START OF DRILLING 18/02/12
						Cly (69.0-79.0) banded mostly med olv gray, some dark gray and yellow laminations, damp,
71						
72		SN45MC 69.0-74.0				pen = 0.75 @ 72.0'
73						
74	Run 13					pen = 0.50 @ 74.0'
75						
76						pen = 0.5 @ 76'
77		SN45MC 74.0-79.0				
78						pen = 0.5 @ 78'
79						
80						

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Drill Hole Lithology Log

Hole SN3-12-45-4
Page 9 of 10
Date 18/02/12
Name Brandon Algor
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
14	79.0	89.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
79–80.5		SN45SH 79.0-80.5				Cly (79.0-88.0) med olive gray, laminated with med gray and yellow bands, damp, pen = 0.5
81						
82	Run 14	SN45MC 79.0-84.0				
83						pen = 0.5 @ 83'
84						
85						
86		SN45MC 84.0-89.0				
87						WATER PRODUCING ZONE (88.0-88.1)
88						pen = 0.75 @ 88' clayey sand (88.0-88.1) med gray, saturated, sand is moderate size sub angular
89						cly (88.1 = 89.0) Same banded clay as above
90	Run 15					

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Drill Hole Lithology Log

Hole SNB-12-45-4
Page 10 of 10
Date 18/02/12
Name B. Allen
Photos (Yes) No

Core Number	Top	Base	Cut	Recovered
15	89.0	99.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
89		SN45MC 89.0-94.0				~~89.0~~ - Cly (89.0-91.0) med gray, saturated, pen = 0
91						Sand Gravel in clay matrix (91.0-96.0) Very saturated, pen - 0 poorly sorted gravels, composed of limestone, quartzite & chert, mostly sub rounded, possibly an old paleo chanel or gravel bar, fantastic resource producing area.
92						
93						
94		SN45MC 94.0-99.0				
95						
96	Run 15					Cly (96.0-99.0) reddish brown, dry pen = 4.0, END OF RESOURCE
97						Note: 10' of return, but because of heave saturation, water spread out in bags taking up less vertical space and more horizontal space
98						
99						TD = 99' STIFF RED CLAY
100						

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Drill Hole Lithology Log

Hole SN3-12-049
Page 1 of 10
Date 27/03/12
Name B. ALGER

Core Number	Top	Base	Cut	Recovered
1	0.0	4.0	4.0	4.0

Well Completion Data

Coordinates: E 311884 N 4323020
Elev ____ Datum WGS 84
Start: 27/03/12 TD: 100'
End: 28/03/12 Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						(0.0 - 0.4) Crystalized salts, halite wet
1.0						Cly (0.4 - 4.0) med olive gray & light brown sand (~10%) poorly sorted, all wet, pen = 0
2.0						
3.0						
4.0	Run 1 / Run 2					Cly (4.0 - 6.0) SDA
5.0						
6.0						Cly (6.0-9.0) med dk gray mottled w/ dark gray, pen = 0 wet, abundant roots
7.0						
8.0						
9.0						
10.0						

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Drill Hole Lithology Log

Hole SN3-12-049
Page 2 of 10
Date 27/03/12
Name B. Acker
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
2	4.0	14.0	10.0	10.0
3	14.0	24.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (9.0-10.5) SAA
						Cly (10.5-12) med olive gray, pen = 0.25 wet, mottled
11						
12						Cly (12-14) light olive gray, damp, pen = 2.0, START BRZ
13		10-20				
14						Cly (14-19) med olv gray, moist, pen = 0.25, some organic streaks
15		SN049MC				
16						
17						
18						
19						
20						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
4	24.0	34.0	10.0	10.0

Hole SN3-12-049
Page 3 of 10
Date 28/03/12
Name B. ALGER
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
	chip					Cly (19.0-24.0) med olv gray, pen=0.25 moist, mostly homogenous
21						
22						darker gray (22.1-22.5) No other changes
23						
24	Run 3 / Run 4	← SN049MC 20-30 →				Cly (24-26.5) SAA BA
25	chip					
26						
27						Clayey silt (26.5-27.5) med gray, most, pen=0 BA
28						Cly (27.5-29.0) med dkgray, pen=0, moist, sporadic silt and sand grains well sorted <5%
29						
30	chip					

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Drill Hole Lithology Log

Hole SN3-12-049
Page 4 of 10
Date 28/03/12
Name B. Alger
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
5	34.0	44.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (29.0-30.0) BAA
						Cly (30.0-31.5) light olive gray damp, pen = 1.0
31						
32						Clay ~~with~~ (31.5-34.0) med olive gray, abundant gypsum pen = 0, moist
33		← SN049MC 30-40 →				
34	Run 4 / Run 5					Cly (34.0-39.0) med olive gray, pen = 0.75, moist, intermittent <1cm pockets of saturation
35	Chip	Chip				
36						pen = 0 @ 36.5
37						
38						large gypsum crystal @ 38.5
39						
40		Chip				

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
6	44.0	54.0	10.0	10.0

Hole SN3-R-049
Page 5 of 10
Date 28/03/12 D/M/Y
Name B. Acker
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (39.0-42.6) med olive gray, moist, pen=0.5
41						
42						
						Cly (42.6-43.2) dark gray, mottled with med olv gray, moist, pen=0.5
43						
		SN049 MC 40-50				Cly (43.2-44.0) Same as (39.0-42.6)
44	Run 5 / Run 6					Cly (44.0-49.0) med olive gray, moist, pen=0.5
45		chip				
46						
47						
48						
						pen = 0.5 @ 49.0
49						
50		Chip				

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Drill Hole Lithology Log

Hole SN3-12-049
Page 6 of 10
Date 28/03/12 (cont)
Name B. Alger
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
7	54.0	64.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (49.0 - 53.0) SAA
51						
52						
53						Cly (53.0 - 54.0) laminated med olv green pen = 0.5, moist, laminations are sulphenic
54	Run 6 / Run 7					Cly (54.0 - 59.0) SAA, additionally some black banding
55						
56						
57						
58						
59						
60						

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
8	64.0	74.0	10.0	10.0

Hole SU3-12-049
Page 7 of 10
Date 28/03/12
Name B. ALGER
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (59.0-64.0) med olv gray BANDED WITH SULFER & ORGANICS, moist pen = 0.5 @ 60.0
61						
62						
63						pen = 0.25 @ 63'
64	Run 7 / Run 8	60-70				Cly (64.0-69.0) SA
65		chip				
66		SN049 MC				
67						
68						
69						
70		chip				

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Drill Hole Lithology Log

Hole SN3-12-049
Page 8 of 10
Date 28/03/12
Name B. Accer
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
9	74.0	79.0	5.0	5.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (69.0-73.4) SAA
71						
72						
73		SN073 MC 70-80				
		Sand zone 73.4-73.7				v coarse SND (73.4 - 73.7) ~~dk~~ gray lithic sand, wet, pen = 1.5, ~~sub~~rounded some LARGER GRAVEL PARTICLES, well ROUNDED
74	Run 8 / Run 9					Cly (74.0-74.8) med dk gray hard, dry, pen=4.0, START DRZ
75		Chip				Cly (74.8 - 79.0) reddish brown, pen = 4.0, dry
76						
77						
78						
79	Run 9 / Run 10					
80		Chip				

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Drill Hole Lithology Log

Hole SN3-12-049
Page 9 of 10
Date 28/03/12
Name B. Alger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
10	79.0	89.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (79.0 - 89.0) Reddish Brown with Areas of Greenish Hue, Very Dry, Hard, Pen = 4.0+, Still DRZ
81						Will continue drilling to TD of 100' for CH2MHill well purposes
82						
83						
84		80-90				
85		chip				
86		SN049MC				
87						
88						
89						
90		chip				

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Drill Hole Lithology Log

Hole SN3-12-049
Page 10 of 10
Date 28/03/12
Name B. ALGER
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
11	89.0	94.0	5.0	5.0
12	94.0	100.0 (TD)	6.0	6.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (89.0 - 94.0) SAA
91						
92						
93						
	Run 11					CRUSHED GYPSUM IN CLAY @ (93.3 - 93.8)
94	Run 12	SN049 MC 90 - 100	F		INFILL WITH GYPSUM	Cly (94.0 = 100.0) REDDISH BROWN, DRY, HARD, PEN = MAX
95		chip				
96			F			
97						
98						
99						TD @ 100' AS PREDETERMINED BY CH2MHILL FOR WELL PURPOSES
100		chip				

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Drill Hole Lithology Log

Hole SNB-12-1265
Page 1 of 7
Date 17/04/12 D/m/y
Name B. Alger

Core Number	Top	Base	Cut	Recovered
1	0.0	4.0	4.0	4.0
2	4.0	14.0	10.0	10.0

Well Completion Data

Coordinates: E 113.16162 N 38.83669
Elev Datum WGS 84 Lat/Lon
Start: 17/04/12 TD: 70'
End: 18/04/12 Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Silty Clay (0.0-4.0) light gray, saturated pen=0
1.0						
2.0						
3.0						
4.0	Qm) Km2	SN126MC 0-10				Cy (4.0-9.0) mottled, saturated, pen=0
5.0		chip				
6.0						
7.0						
8.0						
9.0						
10.0		chip				

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Drill Hole Lithology Log

Hole SNB-12-126
Page 2 of 7
Date 17/04/12
Name B. Alger
Photos (Yes) No

Core Number	Top	Base	Cut	Recovered
3	14.0	24.0	10	10

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (9.0-14.0) light grey, Saturated, pen=0
11						
12						
13						
14	Run 2 / Run 3	10-20				Cly (14.0-19.0) SAA
15		Clay SN126MC				
16						
17						
18						
19						
20		dup				

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
4	24.0	34.0	10	10

Hole SU3-12-126
Page 3 of 7
Date 17/04/12
Name B. Auger
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Cly (19.0-24.0) light gray, moist - saturated, pen=0
21						
22						
23						
24	Run 3 / Run 4					*Start Bx2
						Cly (24.0-28.0) med olv gray pen=0.25, moist
25		clip; SU126 MC 20-30				
26						
27						
28						silty cly (28-29) SAA, more silt content
29						
30		Clip				

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Drill Hole Lithology Log

Hole SN3-12-126
Page 4 of 7
Date 17/04/12
Name B. Acker
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
5	34.0	44.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (29.0-34.0) med olv gray, moist, pen= 0.25, trace silt some gypsum, more saturation near gypsum
31						
32						
33						
34	Run 4 / Run 5	30-40				Cly (34.0-39.0) SAA
35		Clip SN126MC				
36						
37						
38						
39						
40		Clip				

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Drill Hole Lithology Log

Hole SN3-12-126S
Page 5 of 7
Date 17/04/12
Name B. Acker
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
6	44.0	54.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (39.0-44.0) med olv gray some black organic content <5% pen = 0.5, moist
41						
42						
43						
	Run 5					
44	Run 6	SN126MC 40-50				Cly (44.0-46.2) SAA
45		Chp				
46						SAND (46.2-47.3) moderately coarse sub angular in clay matrix to 46.9, alone afterwards pen = 0 saturated, good aquifer
47						Cly alternating sand (47.3-48.4) descriptions match above, graphic log shows accurate thk
48						Cly (48.4-49.0) med olv gray moist, pen = 0.5
49						
50		Chp				

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Drill Hole Lithology Log

Hole SNB-12-126
Page 6 of 7
Date 17/04/12
Name B.Alger
Photos Yes / No

Core Number	Top	Base	Cut	Recovered
7	54.0	62.0	8.0	8.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
50						Cly (49.0-54.0) med olv gray pen = 0.75, moist to damp
51						
52						
53						
54	Run 6 / Run 7	SN126MC 50-60				Cly (54.0-57.0) med olv gray pen = 0.75, damp, sample stretched to 4.6'
55		clg				Sand content in Slagh
56						
57						Cly (57.0-58.0) med olv gray, pen = 3.0, dry
58						Cly (58.0-59.5) med olv gray, damp, pen = 1.25
59						
60		clg				

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
9	62.0	66.0	4.0	4.0

Hole SNB-12-126
Page 7 of 7
Date 17/04/12
Name B. Acgen
Photos (Yes) No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (59.5 - 62.0) med olv gray, pen= 4.0, dry
61						* START DRZ = 59.5
62	Run 8 / Run 9					cly (62.0 - 66.0) reddish brown hard, dry, no resource
63						
64		SN126MC 60-70				
65		Clip				
66	Run 9 / Run 10					Cly (66.0 - 70.0) SAA, but greenish brown gradating to reddish brown
67						
68						
69						TD @ 70.0' NO GEOLOGIC REASON TO CONTINUE AFTER 10.5' OF DRY CLAYS
70		Clip				

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Drill Hole Lithology Log

Hole SN3-12-270
Page 1 of 8
Date 18/04/12 (D/M/Y)
Name B. ALGAR

Core Number	Top	Base	Cut	Recovered
1	0.0	4.0	4.0	4.0
2	4.0	14.0	10.0	10.0

Well Completion Data

Coordinates: E 309413 N 4301128
Elev Datum WGS 84
Start: 18/04/12 TD: 80'
End: 18/04/12 Photos: Yes / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						Mineralized Cly (0.0-0.6) saturated, pen=0 dark gray
						Cly (0.6 -9.0) light gray, Saturated, pen=0
1.0						
2.0						
3.0						
4.0		0-10				
5.0		clip				
6.0		SN2 70MC				
7.0						
8.0						
9.0	Y					
	Y					
10.0	Y	clip				

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Drill Hole Lithology Log

Hole SW3-12-270
Page 2 of 8
Date 18/04/12
Name B. ALGER
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
3	14.0	24.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
10	Y Y					Cly (9.0-14.0) mottled to light gray, Saturated, pen=0, some roots at top
11						
12						
13						
14	Run 2 / Run 3	10-20 SW270MC				Cly (14.0-19.0) light olv gray, moist, pen=0.75, massive
15		CLY				
16						
17						
18						
19						
20		CLY				

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Drill Hole Lithology Log

Hole SN3-12-270
Page 3 of
Date 18/04/12
Name B. Acger
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
4	24.0	34.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
20						Cly (19.0-24.0) light gray, saturated to moist, pen = 0 mostly massive some areas of darker gray
21						
22						
23		SN270mc 20-30				
24	Run 3 / Run 4					Cly (24.0-27.0) SAA
25		chip				
26						
27			F	{	infill salt crystals water	Cly (27.0-29.0) mottled greens & browns moist, pen = 0, crystaline fracture with saturation
28						
29						BR2 START @ 29.0'
30		chip				

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Drill Hole Lithology Log

Hole: SN3-12-270
Page: 4 of 8
Date: 18/04/12
Name: B. Algere
Photos: Yes / No

Core Number	Top	Base	Cut	Recovered
5	34.0	44.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
30						Cly (29.0-34.0) med dk gray, pen=0.5, moist, BR2 clay, MASSIVE, more plasticy
31						
32						
33						
34	Run 4 / Run 5	30-40				Cly (34.0-39.0) SAA
35		Chip SN270MC				
36						
37						
38						
39						
40		chip				

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Drill Hole
Lithology Log

Hole SN3-12-270
Page 5 of 8
Date 18/04/12
Name B. ALGER
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
6	44.0	54.0	10.0	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (39.0-44.0) SAA, NO CHANGE
41						
42						
43						
	Run 5					
44	Run 6	SN270MC 40-50				Cly (44.0-49.0) med olv grey, pen=0.75 damp-moist, still massive
45		Chip				
46						
47						
48						
49						
50		Chip				

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Drill Hole Lithology Log

Hole SW3-12-20
Page 6 of 8
Date 18/04/12
Name B. Alger
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
7	54.0	64.0	10	10.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (49.0-54.0) med dk gray, pen=0, Massive, moist
51						
52						
53						
54	Run 6 / Run 7	SW270MC 50-60				Cly (54.0-59.0) med olv gray with dk gray & yellow banding, pen = 0.25, moist, banded, still contains reserve
55		chip				
56						
57						
58						
59						
60		chip				

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Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered
8	64.0	74.0	10.0	10.0

Hole SN3-12-270
Page 7 of 8
Date 18/04/12
Name B. Alger
Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Graphic	Description	Lithologic Description
						Cly (59.0-64.0) SAA, somewhat less banding
61						
62						
63		60-70				
64	Run 7 / Run 8					Cly (64.0-71.0) med olv gray, pen= 1.0, moist to damp, massive
65		clip				
66		SN270MC				
67						
68						
69						
70		clip				

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Drill Hole Lithology Log

Hole SN3-12-270
Page 8 of 8
Date 18/04/12
Name B. Alger
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered
9	74.0	80.0	6.0	6.0

Depth	Graphic Log	Sample Id & Box #	Discontinuities Type	Discontinuities Graphic	Discontinuities Description	Lithologic Description
						* DRZ START @ 71.0'
71						Cly (71.0-77.5) med olv gray, hard,
72						pen = 2.75 @ 72'
73						
74	Run 8 / Run 9	SN270MC 70-80				pen = 3.5 @ 74'
75		chip				
76						
77						Cly (77.5-80.0) reddish brown, dry, hard, massive, pen = 4.0 @ 80.0'
78						
79						
80		chip				TD = 80' AFTER 9.5' OF HARD DRZ SOURCELESS CLAY

APPENDIX B

Well Logs

Bedrock Wells

(Included as Attachment)

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 1 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Quaternary (late Pleistocene to Holocene) fill deposits; lacustrine and alluvial deposits of undifferentiated gravelly and alluvial deposits. Gravel content generally greater than 50% in a silty sand matrix, gravels are consistent with the Notch Peak formation.	Samples collected with 2.5" I.D. California Sampler using a 300 lb. hammer and 30-inch drop @0'-2': dry
5							
10							
15							
							@18.5 to 27': used auger sonic bit, resulted in poor recovery
20							
25							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:
DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)
WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
							@27': PP=0.5 tsf
30							@31 to 36': bucket sample collected
35							
40							combined bucket sample collected from 41' to 47' and 50' to 53'
45							@47': PP=0.5 to 0.75 tsf
50							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 3 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
							@50': PP=0.5 to 0.75 tsf
							@54': driller noted hard contact at bottom of hole
55							
60							
65							
70							
75							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 4 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
80							
85							
90							
95							
100							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 5 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
105							
110							
115							
120							
125							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1138132.65 (ft)
NORTHING (Utah SP Northing): 6756656.84 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4784.27 (ft)
WATER LEVEL: Estimated ~ 354 feet bgs
START :
END :
LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
130							
135							
140							
145							
150							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1138132.65 (ft) | NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs | START : | END : | LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
155							
160							
165						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular medium sized chips indicate a fractured zone with consistent color and minimal effervescence; no precipitate minerals noted. Hardness of 3-4.	
170							
175							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 8 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
180							
185							
190							
195							
200							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite and intermixed gray limestone. Angular coarse (pea) sized chips indicating highly fractured zone filled with calcite precipitate (white) laminations 1-2mm thick; consistent light gray color and vigorous effervescence. Trace chert chip observed with concoidal fracturing and hardness of 7 at 210-215' bgs.	
205							
210							
215							
220							
225							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1138132.65 (ft)
NORTHING (Utah SP Northing): 6756656.84 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4784.27 (ft)
WATER LEVEL: Estimated ~ 354 feet bgs
START :
END :
LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
230						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite and intermixed gray limestone. Angular fine chips indicating competent bedrock with consistent color and minimal effervescence; hardness of 3-4.	
235							
240							
245							
250							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1138132.65 (ft)
NORTHING (Utah SP Northing): 6756656.84 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4784.27 (ft)
WATER LEVEL: Estimated ~ 354 feet bgs
START :
END :
LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular fine chips indicating competent bedrock with consistent color and minimal effervescence; hardness of 3-4. Trace calcite precipitate in micro fractures and intermixed with the dolomite (dirty dolomite).	
255							
260							
265							
270							
275							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 12 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
280							
285							
290							
295							
300							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1138132.65 (ft) | NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs | START : | END : | LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
305						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular fine chips indicating competent bedrock with consistent color and minimal effervescence; hardness of 3-4. Trace calcite precipitate in micro fractures and intermixed with the dolomite (dirty dolomite).	
310							
315							
320							
325							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
330							
335							
340							
345							
350							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1138132.65 (ft) | NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs | START : | END : | LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
355							
360							
365							
370							
375							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 16 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
380							
385							
390							
395							
400							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1138132.65 (ft) | NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs | START : | END : | LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) light gray limestone. Angular fine chips indicating competent bedrock consistent color and effervesces with HCL; hardness 4. Decreasing effervescence with depth, almost completely gone by 440 feet.	
405							
410							
415							
420							
425							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT

LOCATION:

DRILLING CONTRACTOR : Gardner Drilling

EASTING (Utah SP EAST): 1138132.65 (ft)

NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary

GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs

START :

END :

LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
430							
435							
440						Notch Peak Formation (Cambrian - Ordovician) light gray to gray dolomite. Angular fine chips indicating competent bedrock consistent color and minimal effervesces; hardness 4. Trace calcite precipitation on rock fragments.	
445							
450							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 19 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) gray dolomite. Angular fine chips indicating competent bedrock, initial minor effervesces with increased effervescence ; hardness 4. Trace calcite precipitation on rock fragments.	
455							
460							
465							
470							
475							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
480							
485							
490						Notch Peak Formation (Cambrian - Ordovician) gray dolomite. Angular pea sized chips indicating a decrease in rock competency , initial minor effervesces with increased effervescence ; hardness 3- 4. Calcium carbonate precipitate binding the rock fragments together.	
495						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular fine chips indicating competent bedrock with consistent color and minimal effervescence; hardness of 4.	
500							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1138132.65 (ft)
NORTHING (Utah SP Northing): 6756656.84 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4784.27 (ft)
WATER LEVEL: Estimated ~ 354 feet bgs
START :
END :
LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular fine chips indicating competent bedrock with consistent color and slightly more effervescence; hardness of 4. Trace calcite precipitate in micro fractures and intermixed with the dolomite .	
505						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Angular fine chips indicating competent bedrock with consistent color and slightly more effervescence; hardness of 4. Trace calcite precipitate in micro fractures and intermixed with the dolomite .	
510							
515							
520							
525							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
530							
535							
540							
545							
550							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 23 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
555							
560							
565							
570							
575							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
580							
585							
590							
595							
600							

PROJECT NUMBER:	BORING NUMBER:
421350	SEV-11-013 SHEET 25 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
605							
610							
615							
620							
625							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 26 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) gray dolomite with increased calcite. Angular fine chips with rinds of white calcium carbonate. Calcium carbonate is infill of fractures indicating competent bedrock with consistent color and slightly more effervescence; hardness of 3-4. Percent calcite varies between 5 and 20 percent.	
630							
635							
640							
645							
650							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 27 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
655							
660							
665							
670							
675							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 28 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
680						Notch Peak Formation (Cambrian - Ordovician) dark-gray limestone. Angular fine chips indicating competent bedrock. A decrease in the calcium carbonate as infill of fractures indicating competent bedrock with consistent color and slightly more effervescence; hardness of 3-4.	
685							
690							
695							
700							

PROJECT NUMBER: 421350

BORING NUMBER: SEV-11-013

SHEET 29 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT

LOCATION:

DRILLING CONTRACTOR : Gardner Drilling

EASTING (Utah SP EAST): 1138132.65 (ft)

NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary

GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs

START :

END :

LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
705							
710							
715							
720							
725							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 30 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
730							
735							
740							
745							
750							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-013	SHEET 31 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
755							
760							
765							
770							
775							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-013	SHEET 32 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1138132.65 (ft) NORTHING (Utah SP Northing): 6756656.84 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4784.27 (ft)

WATER LEVEL: Estimated ~ 354 feet bgs START : END : LOGGER : A. Cantrell/J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Boring terminated at 775 feet.	
780							
785							
790							
795							
800							

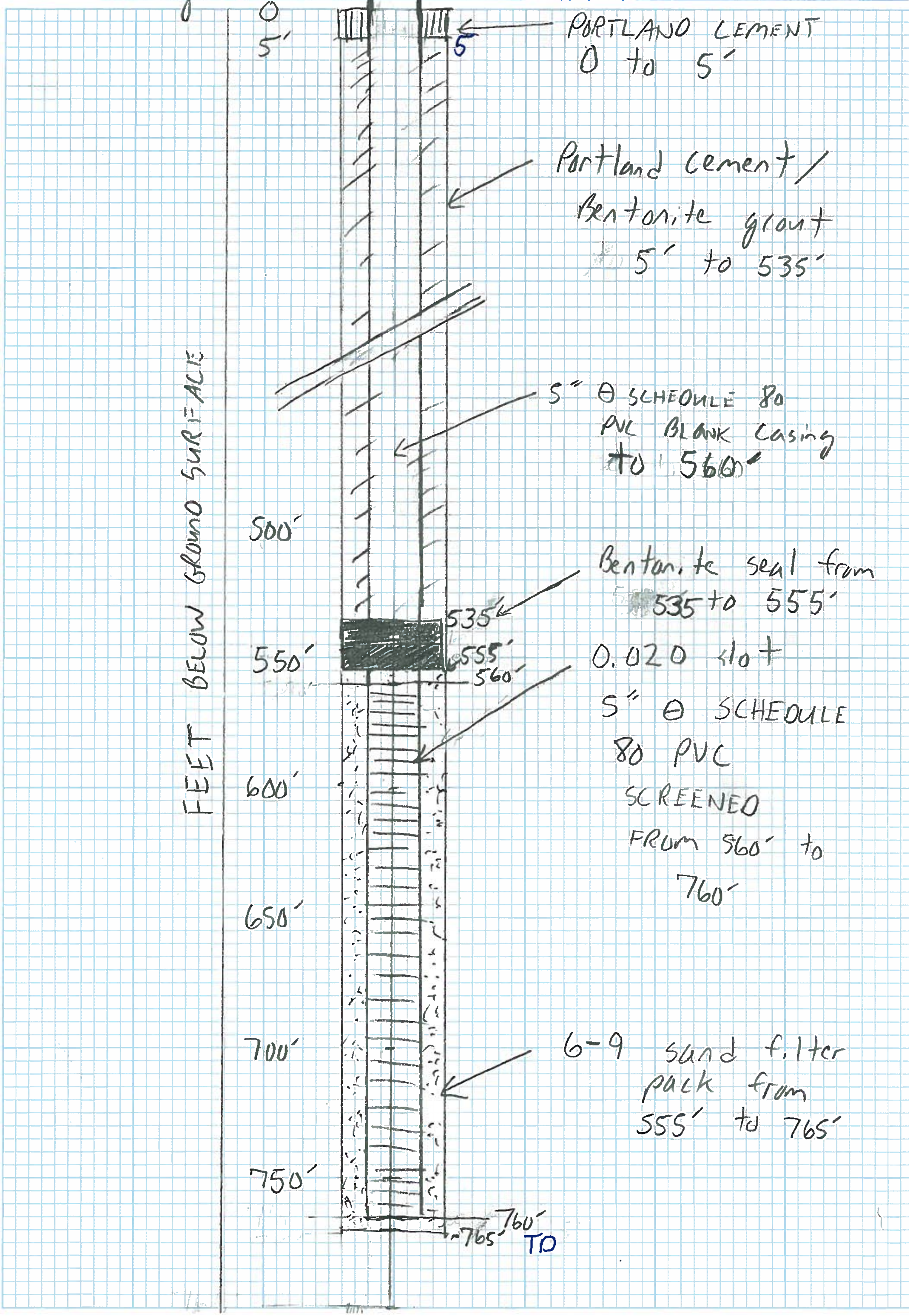
CH2MHILL

SUBJECT SEV-11-013 Well Construction Diagram

BY Stephen Hill 801-350-5214

SHEET NO. 1 of 1 DATE Jan 26, 2012

PROJECT NO.



PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 1 OF 49

CH2MHILL

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Dark Reddish gray, sub rounded to sub angular, 0.1 to 0.6 cm chips, chert and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels) .	
5							
10							
15							
20							
25							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 2 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
30							
35							
40							
45							
50							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1189459.00 (ft)
NORTHING (Utah SP Northing): 6739847.34 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4891.295 (ft)
WATER LEVEL: Estimated ~ 320 feet bgs
START :
END :
LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Silty Gravel, yellowish brown, Rounded to sub rounded grains, 0.1 to 0.6 cm chips, chert and limestone gravels, hardness 4 to 7, (10% fines, 20% sand, 70% gravel. .	
55							
60							
65							
70							
75							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 4 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Silty sand with gravel, dark reddish brown, (35% silt, 60% sand, 5% gravel)	
80						No Sample	
85							
90							
95						Gravelly silt, light gray, round to sub angular, with chips less than 1.3 cm in diameter, limestone chert and limestone, hardness 4 to 7, calcium carbonate in soil, (70% silt, 30% gravel).	
100							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
105							
110						Silty gravel, light gray, round to sub angular, with chips less than 1.3 cm in diameter, limestone chert and limestone, hardness 4 to 7. calcium carbonate in soil, (30% silt, 70% gravel).	
115							
120						Sandy gravel, dark Reddish gray, angular to sub angular, 0.1 to 1.4 cm chips, chert and limestone gravels, hardness 4 to 7, (30% sand, 70% gravels).	
125							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT   LOCATION:

DRILLING CONTRACTOR : Gardner Drilling   EASTING (Utah SP EAST): 1189459.00 (ft)   NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary   GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs   START :   END :   LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
130							
135							
140							
145						Silt/ clay, very pale brown, < 0.1cm chips, calcium carbonate in the soil, (85% fines, 15% sand)	
150							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:
DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)
WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Silty gravel, very pale brown, angular to sub angular, <1.1 cm dolomite limestone and quartz, hardness 4 to 7. calcium carbonate in the soil (20% fines, 20% sand, 60% gravel).	
155							
160							
165						Gravelly clay, very pale brown, <0.6 cm chips, calcium carbonate in soil, (65% fines, 35% gravels)	
170							
175							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
180						Clay, very pale brown, calcium carbonate in soil (95% fines, 5% gravel)	
185						Gravelly clay, reddish brown to gray, sub round to sub angular, <0.6cm chips, (60% fines, 40% gravel)	
190						Gravel, reddish brown to gray, sub angular to sub rounded, 0.5 to 1 cm chips, limestone and quartz, hardness 4 to 7, no calcite, (10% sand, 90% gravel).	
195							
200							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 9 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
205							
210							
215						Silty Gravel, pinkish gray, angular to sub angular, 0.5 to 1 cm chips, limestone and quartz, no calcite, (30% fines, 70% gravels).	
220						Gravelly silt/clay, pinking gray sub round to sub angular, <0.8 cm chips (60% fines, 40% gravel)	
225							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 10 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
230							
235							
240							
245							
250							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 11 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
255							
260							
265							
270							
275							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
280							
285							
290						Sandy silt with gravel, pink, sub round to sub angular, <0.8 cm chips, light calcite cement, (70% fines, 20% sand , 10% gravel).	
295							
300							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 13 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
305							
310							
315							
320						Gravelly silt, light gray, sub round to sub angular, <0.5 cm, light calcite cement (60% fines 40% gravels).	
325							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 14 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
330							
335							
340						Gravelly silt, light gray, sub round to sub angular, <0.5 cm chips, light calcite cement (40% fines 60% gravels).	
345							
350							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
355						Gravel/silt, light gray, sub round to sub angular, <0.5 cm chips, light calcite cement (40% fines 60% gravels).	
360							
365							
370						Gravelly clay, light gray, sub round to sub angular, <0.5 cm chips, light calcite cement (70% fines, 30% gravels).	
375							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 16 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
380							
385						Silty gravel, light reddish brown, sub round to angular, <0.5 cm chips, limestone and quartz, light calcite cement (20% fines, 10% sand, 70% gravel).	
390							
395						Gravelly silt, light reddish brown, sub round to angular, <0.5 cm chips, light calcite cement (50% fines, 10% sand, 40% gravel).	
400							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 17 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
405							
410							
415							
420							
425							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
430							
435						Gravelly silt, light reddish brown, sub round to angular, <0.5 cm chips, light calcite cement (65% fines, 20% sand, 15% gravel).	
440						Silty gravel with sand, sub round to sub angular, <0.5 cm chips, limestone and quartz (30% fines, 10% sand, 60% gravel).	
445							
450							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1189459.00 (ft)
NORTHING (Utah SP Northing): 6739847.34 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4891.295 (ft)
WATER LEVEL: Estimated ~ 320 feet bgs
START :
END :
LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Sandy gravel, light gray , sub round to sub angular, 1.1 cm chips , limestone quartz/chert, light calcium carbonate cement (5% fines, 35% sand, 60% gravel)	
455							
460						Gravelly sand dark grayish, round to sub angular, <0.3 cm chips, limestone and quartz, (5% fines, 35% sand, 60% gravel)	
465						Gravel/clay, pinkish gray, sub round to sub angular, <0.5 cm chips, limestone and quartz, light calcite cement (50% fines, 10% sand 40% gravel).	
470							
475							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 20 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Gravelly sands, dark gray to reddish brown, round to sub angular, <0.6 cm chips, limestone and quartz, hardness 5 to 7, (10% fines, 65% sand, 25% gravels.	
480							
485							
490							
495							
500							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 21 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT — LOCATION:

DRILLING CONTRACTOR : Gardner Drilling — EASTING (Utah SP EAST): 1189459.00 (ft) — NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary — GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs — START : — END : — LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
505						Gravelly clays, light gray, (65% fines, 25% gravels 10% sands).	
510							
515							
520							
525							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 22 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
530						Gravel/Clay, light gray, sub round to sub angular, <0.7cm chips, (50% fines 50% gravel and sands), light calcite cement.	
535							
540							
545							
550							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 23 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
555						Silty gravel, light gray sub round to sub angular, < 1 cm chips, limestone, light calcite cement, (30% fines, 70% gravels).	
560						Gravelly silt, light reddish brown, sub round to sub angular, < 1 cm chips, limestone, light calcite cement, (65% fines, 35% gravels).	
565							
570							
575							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1189459.00 (ft)
NORTHING (Utah SP Northing): 6739847.34 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4891.295 (ft)
WATER LEVEL: Estimated ~ 320 feet bgs
START :
END :
LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
580							
585							
590						Gravelly silt, light reddish brown, sub round to sub angular, < 1 cm chips, limestone, light calcite cement, (65% fines, 35% gravels).	
595							
600							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 25 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Silt gravel, with sand, light reddish brown, sub round to sub angular, < 1 cm chips, limestone and chert, hardness 5-7 light calcite cement, (30% fines, 10% sand, 60% gravels).	
605							
610						Silty sand/gravel with silt ,grey, sub round to sub angular, < 1.5cm chips, limestone, hardness 5-6, light calcite cement, (40% fines, 30% sand, 30% gravels).	
615							
620							
625							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Silty sand/gravel with silt ,grey, sub round to sub angular, < 1.5cm chips, limestone, hardness 5-6, light calcite cement, (40% fines, 30% sand, 30% gravels).	
630							
635							
640							
645							
650							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 27 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
655						Silty gravel, light gray, sub rounded, <2.0 cm chips, limestone, hardness s4-5, (30% fines, 10%sand, 60% gravel).	
660							
665							
670							
675							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
680							
685							
690							
695							
700							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 29 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
705							
710						Sandy silt with gravel, light gray, <0.5 cm chips (70% fines, 20% sand, 10% gravel).	
715							
720							
725							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
730							
735							
740							
745							
750							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 31 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
755							
760							
765							
770						Silty gravel, light gray, sub round to sub angular, <0.6 cm chips, limestone and quartz, hardness 4 -7, (30% fines, 10% sand, 60% gravel)	
775							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
780							
785							
790							
795							
800							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
805							
810							
815							
820						Gravelly silty sand, light brownish gray, sub round to angular, <1.1 cm chips, limestone, hardness 4 -5, (30% fines, 40% sand, 30% gravel).	
825							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 34 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
830							
835							
840							
845							
850							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 35 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
855							
860							
865						Sandy silt, light brownish gray, (85% fines, 14% sand, 1% gravel).	
870							
875							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 36 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
880							
885						Clay, light brownish gray, (95% fines, 5% sand).	
890							
895							
900							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
905							
910						Silty sand, light brownish gray (40% fines, 60% sand)	
915						Clay, light brownish gray (95% fines, 5% sand)	
920							
925							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1189459.00 (ft) | NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs | START : | END : | LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
930						Sandy silt, light brownish gray, chip size <0.6 cm (85% fines, 10% sand, 5% gravel)	
935							
940							
945						Silty sand, light brownish gray, chip size <0.6 cm (25% fines, 60% sand, 5% gravel)	
950							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
955							
960						Prospect Mountain Quartzite, reddish brown, angular, 0.3 to 0.6 cm chips, hardness 7, ~3 % dark brown to black slate fragments, (interval between 1050 ft and 1055 ft 5% carbonate fragments)	
965							
970							
975							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 40 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
980							
985							
990							
995							
1000							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 41 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1005							
1010							
1015							
1020							
1025							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT

LOCATION:

DRILLING CONTRACTOR : Gardner Drilling

EASTING (Utah SP EAST): 1189459.00 (ft)

NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary

GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs

START :

END :

LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1030							
1035							
1040							
1045							
1050							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 43 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1055							
1060							
1065							
1070							
1075							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-007	SHEET 44 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1080							
1085							
1090							
1095							
1100							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1105							
1110							
1115							
1120							
1125							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 46 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1130							
1135							
1140							
1145							
1150							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 47 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1155							
1160							
1165							
1170							
1175							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-007	SHEET 48 OF 49

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1189459.00 (ft) NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs START : END : LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1180							
1185							
1190							
1195							
1200							

PROJECT NUMBER: **421350**

BORING NUMBER: **SEV-11-007**

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT

LOCATION:

DRILLING CONTRACTOR : Gardner Drilling

EASTING (Utah SP EAST): 1189459.00 (ft)

NORTHING (Utah SP Northing): 6739847.34 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary

GROUND SURFACE ELEVATION: 4891.295 (ft)

WATER LEVEL: Estimated ~ 320 feet bgs

START :

END :

LOGGER : J.Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
1205							
1210							
1215						Boring terminated at 1215 feet.	
1220							
1225							

CH2MHILL

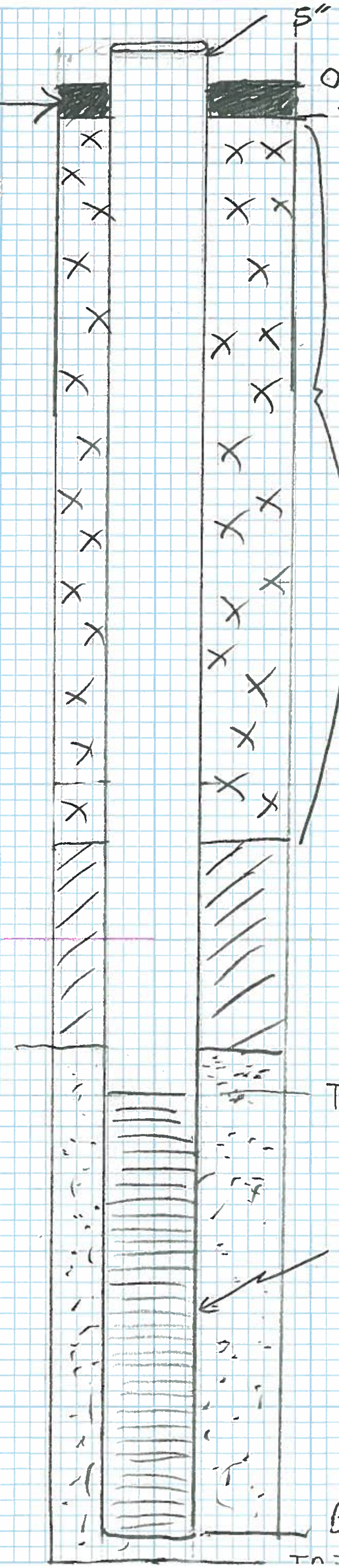
SUBJECT SEV-11-007

WELL CONSTRUCTION DESIGN

BY STEPHEN HILL

SHEET NO. 1 of 1 DATE 30 march 2012

PROJECT NO.



PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 1 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Quaternary (late Pleistocene to Holocene) fill deposits. Fine gravels sub rounded to sub angular, 0.5 to 1 cm, mixture of dolomite, chert, coated with calcium carbonate light brownish gray to dark grayish brown.	
5							
10							
15							
20							
25							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 2 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT — LOCATION:

DRILLING CONTRACTOR : Gardner Drilling — EASTING (Utah SP EAST): 1141208.32 (ft) — NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary — GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs — START : — END : — LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
30							
35						Tertiary volcanics. Volcanic Tuff, pale yellow, fine sand sized particles. 0.5 to 1 cm sub-angular, hardness of 3, friable with slight calcium carbonate cementation.	
40							
45						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to very dark gray, angular to sub rounded 0.2 to 1 cm sized chips, with a hardness of 4 to 5, composed of dolomite and limestone with calcium carbonate precipitate on fracture surfaces.	
50							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
55							
60							
65							
70							
75							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 4 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT   LOCATION:

DRILLING CONTRACTOR : Gardner Drilling   EASTING (Utah SP EAST): 1141208.32 (ft)   NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary   GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs   START :   END :   LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
80							
85							
90							
95							
100							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
105							
110							
115							
120							
125							

CH2MHILL

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 6 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
130							
135							
140							
145							
150							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 7 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
155							
160							
165							
170							
175							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 8 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to gray reddish brown, very angular to angular, 0.2 to 0.75 cm chips with a hardness of 4 to 5, predominantly dolomite, minimal to no calcium carbonate fracture coatings.	
180							
185							
190							
195							
200							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
205						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to gray reddish brown, very angular to angular, 0.1 to 1.1 cm chips with a hardness of 4 to 7, dolomite and ~5 % chert.	
210							
215							
220							
225							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 10 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT
LOCATION:
DRILLING CONTRACTOR : Gardner Drilling
EASTING (Utah SP EAST): 1141208.32 (ft)
NORTHING (Utah SP Northing): 6819770.69 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary
GROUND SURFACE ELEVATION: 4804.363 (ft)
WATER LEVEL: Estimated ~ 379 feet bgs
START :
END :
LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
230							
235							
240							
245							
250							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
255							
260							
265							
270							
275							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 12 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
280							
285							
290						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to gray reddish brown, very angular to angular, 0.1 to 1.1 cm chips with a hardness of 4 to 6, dolomite and ~5 % chert.	
295							
300							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
305							
310							
315							
320						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to gray reddish brown, very angular to angular, 0.1 to 0.5 cm chips with a hardness of 4 to 6, dolomite and ~5 % chert, minimal calcite precipitate.	
325							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 14 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
330							
335							
340							
345							
350							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 15 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
355							
360							
365							
370							
375							

PROJECT NUMBER: 421350

BORING NUMBER: SEV-11-014

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT

LOCATION:

DRILLING CONTRACTOR : Gardner Drilling

EASTING (Utah SP EAST): 1141208.32 (ft)

NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary

GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs

START :

END :

LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
380							
385							
390							
395							
400							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
405							
410							
415							
420							
425							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 18 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
430							
435							
440							
445							
450							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 19 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
455							
460							
465							
470							
475							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
480							
485							
490							
495							
500							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 21 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
505							
510						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to gray with white chert, very angular to angular, 0.2 to 0.5 cm chips with a hardness of 5 to 7, dolomite and ~5 % chert, minimal calcite precipitate.	
515						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to very dark gray, sub angular to angular, 0.1 to 0.5 cm chips with a hardness between 5 to 7, dolomite and ~5% chert, minimal calcite precipitate.	
520							
525							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 22 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
530							
535							
540							
545							
550							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
555							
560							
565							
570							
575							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 24 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
580							
585							
590						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to very dark gray, sub angular to angular, 0.2 to 1.3 cm chips with a hardness between 5 to 7, dolomite and ~5% chert, minimal calcite precipitate.	
595							
600							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT	LOCATION:
DRILLING CONTRACTOR : Gardner Drilling	EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)
DRILLING METHOD AND EQUIPMENT : Mud Rotary	GROUND SURFACE ELEVATION: 4804.363 (ft)
WATER LEVEL: Estimated ~ 379 feet bgs START : END :	LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
605							
610							
615							
620							
625							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 26 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
630							
635							
640							
645							
650							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 27 OF 32

CH2MHILL

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
655							
660							
665							
670							
675							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 28 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT   LOCATION:

DRILLING CONTRACTOR : Gardner Drilling   EASTING (Utah SP EAST): 1141208.32 (ft)   NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary   GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs   START :   END :   LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
680							
685							
690							
695							
700							

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT | LOCATION:

DRILLING CONTRACTOR : Gardner Drilling | EASTING (Utah SP EAST): 1141208.32 (ft) | NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary | GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs | START : | END : | LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
						Notch Peak Formation (Cambrian - Ordovician) dark gray-brown dolomite. Dark gray to very dark gray, sub angular to angular, 0.1 to 0.9 cm chips with a hardness between 5 to 7, dolomite and ~2% chert, minimal calcite precipitate.	
705							
710							
715							
720							
725							

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 30 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
730							
735							
740							
745							
750							

PROJECT NUMBER: 421350	BORING NUMBER: SEV-11-014	SHEET 31 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
755							
760							
765							
770							
775							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
421350	SEV-11-014	SHEET 32 OF 32

SOIL BORING LOG

PROJECT : Peak MineralsSevier Lake, UT LOCATION:

DRILLING CONTRACTOR : Gardner Drilling EASTING (Utah SP EAST): 1141208.32 (ft) NORTHING (Utah SP Northing): 6819770.69 (ft)

DRILLING METHOD AND EQUIPMENT : Mud Rotary GROUND SURFACE ELEVATION: 4804.363 (ft)

WATER LEVEL: Estimated ~ 379 feet bgs START : END : LOGGER : J. Weigel

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR,MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: LOGGING NOTES/ GEOTECHNICAL SAMPLE ID
780							
						Boring terminated at 780 feet.	
785							
790							
795							
800							

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface START : 1/7/2013 END : 4/15/2013 LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0				Tan to gray, sub rounded to sub angular, 0.1 to 0.6 cm chips, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	Fines have washed out of all sample trays.
5	5.0					
10	10.0					
15	15.0					
20	20.0					
25	25.0					
30	30.0					
35	35.0					
40	40.0					
45	45.0					
50						

PROJECT NUMBER:	BORING NUMBER:	SHEET 2 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	50.0					
55	55.0					
60	60.0				Tan to gray, sub rounded to sub angular, 0.1 to 2 cm chips, halite, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	
65	65.0				Tan to gray, sub rounded to sub angular, 0.1 to 0.6 cm chips, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	
70	70.0					
75	75.0					
80	80.0					
85	85.0				Tan to gray, sub rounded to sub angular, 0.1 to 2 cm chips, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	
90	90.0					
95	95.0					
100						

PROJECT NUMBER:	BORING NUMBER:	SHEET 3 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	100.0					
105	105.0					
110	110.0				Tan to gray, sub rounded to sub angular, 0.1 to 1 cm chips, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	
115	115.0					
120	120.0					
125	125.0					
130	130.0					
135	135.0					
140	140.0					
145	145.0					
150						

PROJECT NUMBER:	BORING NUMBER:	SHEET 4 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft

DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface

START : 1/7/2013

END : 4/15/2013

LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	150.0					
155	155.0					
160	160.0					
165	165.0					
170	170.0					
175	175.0					
180	180.0					
185	185.0					
190	190.0					
195	195.0					
200						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-11-007 North Cricket	SHEET 5 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	200.0				Gray gravels with clay matrix, sub rounded to sub angular, 0.1 to 0.5 cm chips, clayey gravel, quartzite and limestone gravels (45% fines, 10% sand, 45% gravels)	
205	205.0					
210	210.0					
215	215.0					
220	220.0					
225	225.0					
230	230.0					
235	235.0					
240	240.0					
245	245.0					
250						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	250.0					
255	255.0					
260	260.0					
265	265.0					
270	270.0					
275	275.0					
280	280.0					
285	285.0					
290	290.0					
295	295.0					
300						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah	LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft	DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter	
WATER LEVELS : 495.0 ft below ground surface START : 1/7/2013	END : 4/15/2013 LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	300.0					
305	305.0					
310	310.0					
315	315.0					
320	320.0					
325	325.0					
330	330.0					
335	335.0					
340	340.0					
345	345.0					
350						

PROJECT NUMBER:	BORING NUMBER:	SHEET 8 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft | DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface | START : 1/7/2013 | END : 4/15/2013 | LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	350.0					
355	355.0					
360	360.0					
365	365.0					
370	370.0					
375	375.0					
380	380.0					
385	385.0					
390	390.0					
395	395.0					
400						

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	400.0				Tan to gray, sub rounded to sub angular, 0.1 to 0.6 cm chips, quartzite and limestone gravels, hardness 4 to 7, (5% fines, 30% sand, 65% gravels)	
405	405.0					
410	410.0					
415	415.0					
420	420.0					
425	425.0					
430	430.0					
435	435.0					
440	440.0					
445	445.0					
450						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-11-007 North Cricket	SHEET 10 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft

DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface

START : 1/7/2013

END : 4/15/2013

LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	450.0					
455	455.0					
460	460.0					
465	465.0					
470	470.0					
475	475.0					
480	480.0					
485	485.0				Prospect Mountain Quartzite, reddish brown to gray, angular, 0.3-0.6 cm chips, hardness 7, ~3 % dark brown to black slate fragments	Bedrock
490	490.0					
495	495.0					
500						

PROJECT NUMBER:	BORING NUMBER: SHEET 11 OF 16
465077	SEV-11-007 North Cricket

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah   LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft   DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface   START : 1/7/2013   END : 4/15/2013   LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	500.0					
505	505.0					
510	510.0					
515	515.0					
520	520.0					
525	525.0					
530	530.0					
535	535.0					
540	540.0					
545	545.0					
550						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-11-007 North Cricket	SHEET 12 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft | DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface | START : 1/7/2013 | END : 4/15/2013 | LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	550.0					
555	555.0					
560	560.0					
565	565.0					
570	570.0					
575	575.0					
580	580.0					
585	585.0					
590	590.0					
595	595.0					
600						

PROJECT NUMBER: 465077	BORING NUMBER: SEV-11-007 North Cricket	SHEET 13 OF 16

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	600.0					
605	605.0					
610	610.0					
615	615.0					
620	620.0					
625	625.0					
630	630.0					
635	635.0					
640	640.0					
645	645.0					
650						

PROJECT NUMBER:	BORING NUMBER:	SHEET 14 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	650.0					
655	655.0					
660	660.0					
665						
670	670.0					
675	675.0					
680	680.0					
685	685.0					
690	690.0					
695	695.0					
700						

PROJECT NUMBER:	BORING NUMBER:	SHEET 15 OF 16
465077	SEV-11-007 North Cricket	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)
ELEVATION : 5071.0 ft
DRILLING CONTRACTOR : Gardner
DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter
WATER LEVELS : 495.0 ft below ground surface
START : 1/7/2013
END : 4/15/2013
LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	700.0					
705	705.0					
710	710.0					
715	715.0					
720	720.0					
725	725.0					
730	730.0					
735	735.0					
740	740.0					
745	745.0					
750						

PROJECT NUMBER:	BORING NUMBER: SHEET 16 OF 16
465077	SEV-11-007 North Cricket

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : North of Headlight Gap Rd (39.0 N, -113.0 E)

ELEVATION : 5071.0 ft

DRILLING CONTRACTOR : Gardner

DRILLING METHOD AND EQUIPMENT : Mud rotary changing to air foam; 12" inch casing diameter

WATER LEVELS : 495.0 ft below ground surface START : 1/7/2013 END : 4/15/2013 LOGGER : R. Hamilton

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	750.0					
755	755.0					
760	760.0					
765	765.0					
770	770.0					
775	775.0					
780	780.0					
785	785.0					
790	790.0					
795	795.0					
800	800.0					

Bottom of Hole at 784.0 ft below ground surface
4/15/2013

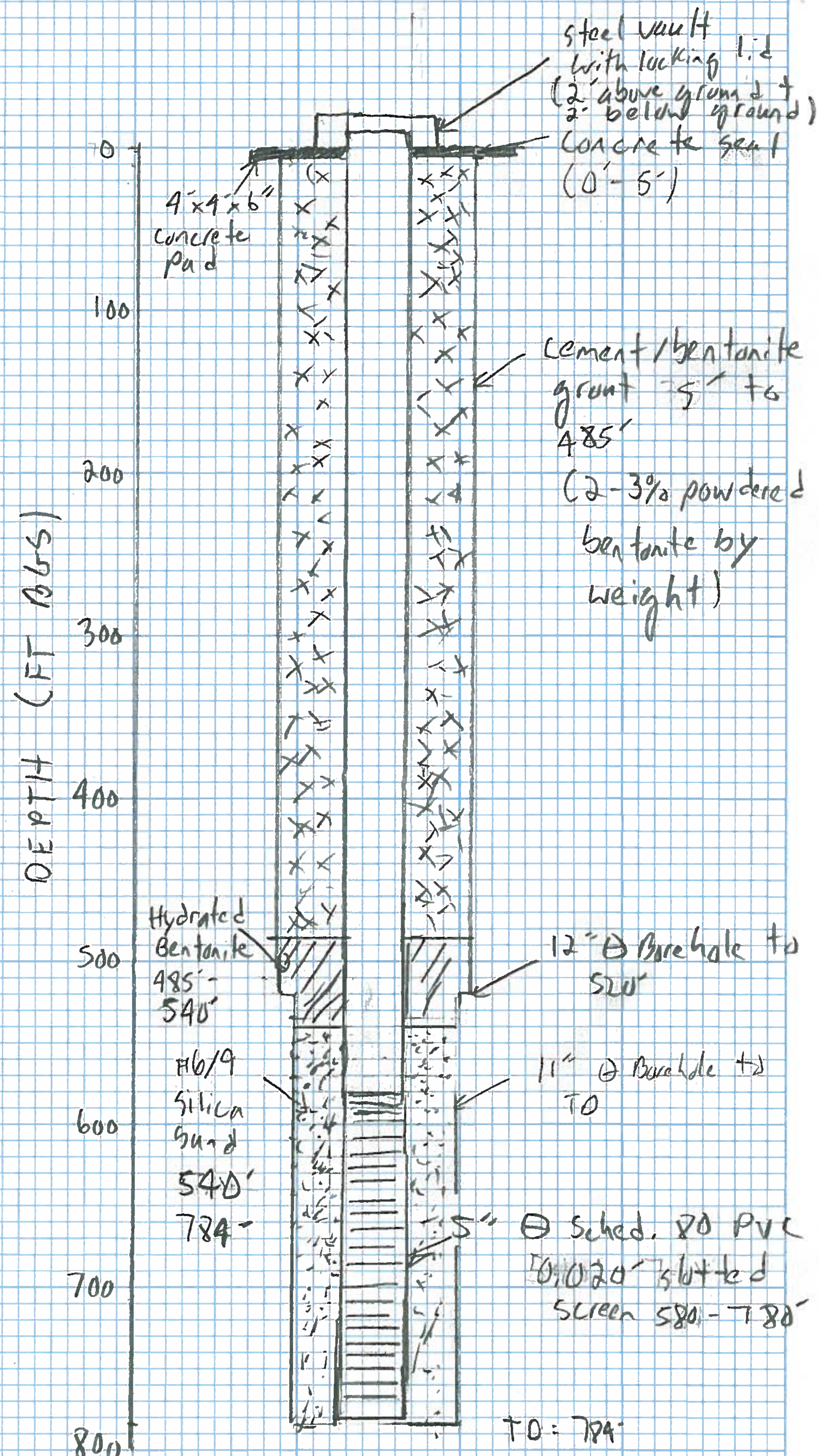
CH2MHILL

SUBJECT North Cricket Well Design

BY Stephen Hill

SHEET NO. 1 of 1 DATE 3/22/13

PROJECT NO.



APPENDIX C

Seepage Evaluation Results
(Included as Attachment)

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OQM | Organizational Quality Management Program

Memorandum

To	Greg Gillian	**Project #**	956-1
CC		**Date**	June 10, 2017
From	Michael Davis, Sean Ennis		
Subject	Sevier Lake Pond Leakage Analysis		

Introduction

Norwest Corporation (Norwest) has reviewed the historical seepage (leakage) analysis from the evaporation ponds at the Peak Minerals Sevier Dry Lake Potash Mining project and has revised the pond leakage rate calculations based on an updated leakage analysis. Norwest has developed the hydraulic properties of foundation and construction materials based on in-situ and laboratory testing completed to date, including data from the 2016 geotechnical field program, and a preliminary cross-sectional dyke layout has been developed to support the analysis. This memorandum discusses the calculated seepage losses from the pre-concentration, production and tailings ponds located on the footprint of the Seveir Lake playa.

Previous Leakage Analysis (IGES, 2012)

Intermountain GeoEnvironmental Services Inc. (IGES) completed an initial pond leakage analysis as part of the Preliminary Economic Assessment (PEA) for Peak Minerals Sevier Dry Lake Potash Mining project. This analysis was completed in 2012 as part of the Geotechnical Investigation Design Report - Evaporation Pond and Extraction Trench Design (IGES, 2012).

IGES's pond leakage estimations were calculated using the groundwater module of Slide (V6.018) software developed by Rocscience Inc. Pond leakage from a 5,000 acre production pond and a 20,000 acre pre-concentration (salt) pond were evaluated. The results of the 2012 leakage analysis are summarized in Table 1.

Table 1

2012 IGES Leakage Analysis

Pond	Leakage Rate (in/year)	Unit Rate (Litres/year per hectare)
Pre-Concentration	0.165	42,000
Production	0.262	67,000

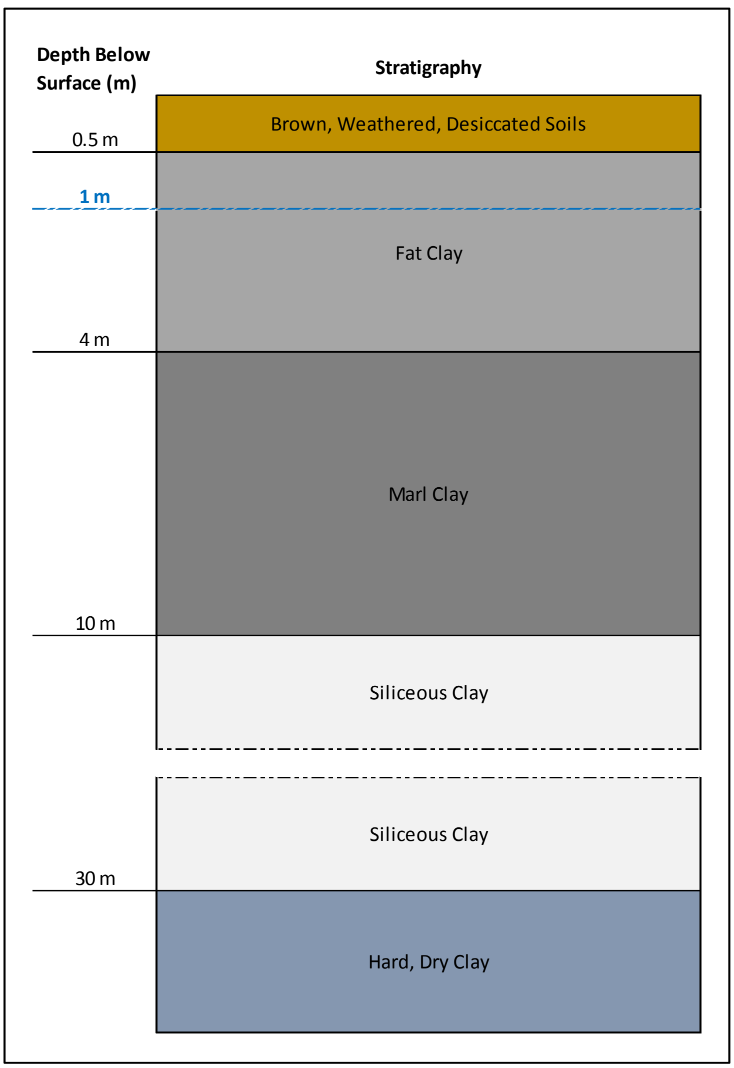
NOTE: The unit rates quoted above are based on current pond layouts.

Foundation Stratigraphy

Subsurface stratigraphy is fairly consistent throughout the Sevier Lake basin, but the deposition of materials, especially at the surface, is highly variable over the playa. The surficial soils consist of approximately 0.5 m of highly variable, weathered and desiccated materials. Beneath the surficial soils, most of the site is covered by approximately 4 m of grey, high plastic Fat Clay (IGES, 2012). The mineral body (brine) is located beneath the Fat Clay in a fissured, low plastic Marl Clay to a depth of approximately 10 m. A Siliceous Clay underlies the mineral body from approximately 10 m to approximately 30 m below surface, and a hard, dry clay is found below approximately 30 m. The water table is typically found approximately one meter below the surface of the playa.

For the purposes of the leakage analysis the foundation conditions were modeled to a depth of 15 m below surface. Figure 1 shows the generalized stratigraphy.

Figure 1
Generalized Stratigraphy



NOTE: The vertical scale has been distorted to provide clarity. Not to scale.

Hydraulic Properties

To evaluate the hydraulic flow characteristics of the foundation soils several laboratory and field tests were performed. These tests included:

- Sealed Double Ring Infiltrometer (SDRI) field tests.
- Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (ASTM D5084). Referred to as constant head permeability testing.
- Sealed Single Ring Infiltrometer (SSRI) field tests.

The Fat Clay is the confining layer of the ponds and will also be used in the construction of a low permeability blanket on the upstream side of the dykes. The hydraulic conductivity tests from within this layer have been summarized below.

The 2016 geotechnical testing program was focused on the north end of the playa, while historically, geotechnical investigations were typically focused on the south end of the playa.

SDRI Tests

Two SDRI tests were completed in 2013 near the middle of the playa and one test was completed in 2016 on the north end of the playa beneath the pre-concentration ponds. Table 2 summarizes the results of the SDRI tests along with the geometric mean of the results. The geometric mean is representative of the central tendency or typical value of a set of numbers.

Table 2
Sealed Double Ring Infiltrometer (SDRI) Results

Test ID	Hydraulic Conductivity (cm/s)
SDR1 4 (2016)	2E-8
SDRI 3 (2013)	8E-9
SDRI 2 (2013)	3E-9
GEOMETRIC MEAN	8E-9

The geometric mean of the three SDRI tests is 8E-9 cm/s.

Constant Head Permeability Tests

The results of the constant head permeability tests from the 2016 geotechnical investigation that were sampled between 1 m below ground surface and 4 m below ground surface have been summarized in Table 4 and are representative of the Fat Clay.

Table 4

2016 Constant Head Permeability Test Results

Test Location	Sample Number	Description	Depth (m)	Hydraulic Conductivity (cm/s)
ETP-2	8437	Grey [Fat] Clay	1.2	2E-7
ETP-2	8447	Grey [Fat] Clay	2.4	2E-7
ETP-2	8479	Grey [Fat] Clay	4.0	1E-7
TP-2	8886	Grey [Fat] Clay	1.2	1E-7
TP-5	8494	Grey [Fat] Clay	1.2	8E-8
TP-6	8482	Grey [Fat] Clay	1.2	9E-8
TP-9	N/A	Grey [Fat] Clay	1.2	8E-8
TP-11	8951	Grey [Fat] Clay	1.2	8E-8
GEOMETRIC MEAN				1E-7

The geometric mean of the eight constant head permeability tests is 1E-7 cm/s.

The 2016 laboratory permeability testing was compared with the tests from the same depth range from the historical laboratory testing. The geometric mean of the historical tests has been calculated from 18 data points and is 2E-7 cm/s, which is consistent with the 2016 test results. Details of the 18 tests can be found in Table A1 in Appendix A.

SSRI Tests

Four SSRI tests were completed in 2016 on the north end of the playa beneath the pre-concentration ponds. Table 3 summarizes the results of the SSRI testing. The SSRI tests are completed on a relatively small area (18 inch diameter ring) in the shallow surficial materials.

Results from the SSRI testing indicate that the materials tested are greater than three orders of magnitude more permeable than the SDRI testing and constant head testing shows for the Fat Clay. It is not known whether the tests were performed solely in the Fat Clay, or whether the results are influenced by the weathered soils above. As such, these results have been discounted in the determination of the hydraulic properties of the Fat Clay.

Table 3

Sealed Single Ring Infiltrometer (SSRI) Results

Test ID	Hydraulic Conductivity (cm/s)
TP-2	1E-5
TP-4	1E-3
TP-6	3E-4
TP-11	8E-5
GEOMETRIC MEAN	1E-4

Conclusion

The large SDRI tests and the laboratory permeability testing results are in general agreement while the SSRI tests are several orders of magnitude more permeable. The SSRI test results appear to be more representative of the brown soil layer and have not been included in the evaluation of the hydraulic properties of the Fat Clay.

Hydraulic Properties of the Materials

The foundational units and dyke construction materials have been assigned hydraulic properties based on field and laboratory testing. Table 5 summarizes the hydraulic properties that have been assigned to the foundation and construction materials.

Table 5

Hydraulic Properties of the Materials

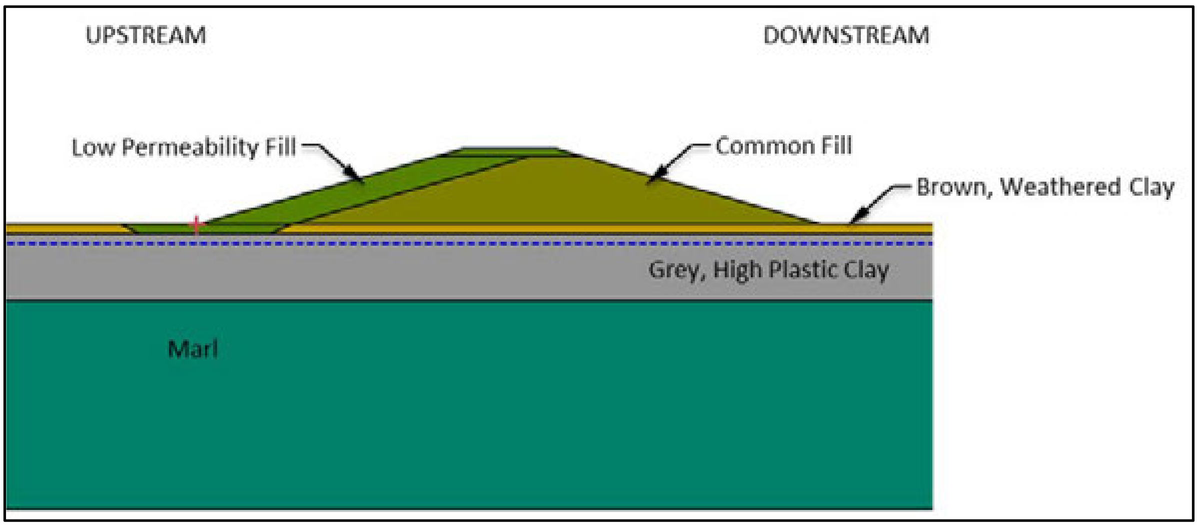
Material	Hydraulic Conductivity (cm/s)
Brown, Weathered, Desiccated Soil	1E-5
Fat Clay	1E-7
Marl Clay	1E-5
Low Permeability Fill	1E-7
Common Fill	1E-5

The absolute hydraulic properties of the Marl Clay are not important for this modeling as the Fat Clay has been modeled as the confining layer of the ponds.

Dyke Cross Section

A seepage cut-off will be excavated through the brown surficial soils into the competent Fat Clay below to prevent excessive seepage and piping in the upper foundation. The properties of the brown surficial soils are highly variable and constructing a seepage cut-off represents good design practice. The seepage cut off and upstream low permeability fill will be constructed of the Fat Clay; the common fill can be constructed of any materials found on the playa. Construction of the dykes will follow the general cross section shown on Figure 2.

Figure 2
Generalized Dyke Cross Section



Pond Leakage Analysis

Evaluating the potential leakage from the ponds was completed using the two-dimensional finite element modeling program SEEP/W 2012 (V8.14) developed by GEO-SLOPE International Ltd. Both steady-state and transient analysis were completed to gain a better understanding of how potential leakage will impact the ponds over time.

The transient analysis was based on an initial ground water condition one meter below the surface of the playa. Multiple time steps were modeled to evaluate how the wetting front develops with time. The upper 15 m of foundation was modeled, with an impermeable (model) boundary at 15 m below the surface of the playa. The embankments were modeled with a low permeability core and a seepage cut-off trench through the upper 0.5 m of weathered and desiccated clay. Figure 3 shows a screen capture of the seepage model.

Figure 3

Typical Cross-Section of the Seepage Model

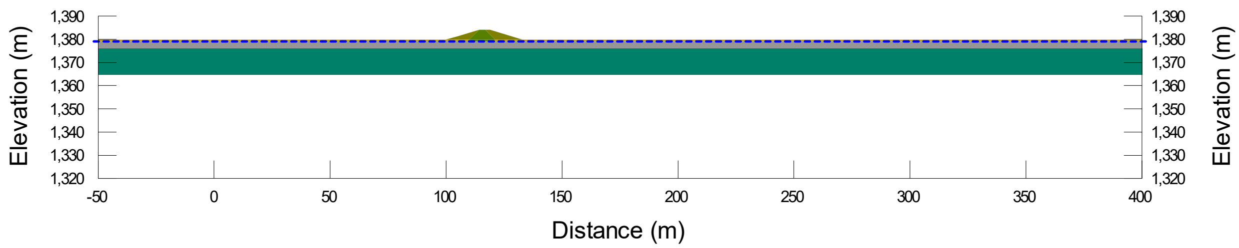


Table 6 summarizes the results of the leakage analysis. Results from the pond leakage analysis depend on two main factors:

1. the hydraulic properties of the foundation and construction materials; and
2. the design cross-section of the dykes, specifically the presence of a seepage cut off and low permeability blanket.

The size of the model was increased in both the upstream and downstream directions in order to better understand how the size of the model affects the results. It was found that there were minimal differences associated with extending the model in both the upstream and downstream directions.

The pond leakage is governed almost entirely by the area of the pond and the perimeter effects at the dykes are minimal. As such, the results of this leakage analysis can be applied to ponds of various layouts and the leakage rate is appropriate for application to the pre-concentration, production and tailings ponds.

Table 6

Leakage Analysis Results

Item	Unit	Transient Analysis Time Step						Steady State Analysis
		30 Days	90 Days	180 Days	1 Year	2 years	3 years	
Leakage Rate Through Embankment	mm/yr	6.0E-3	1.1E-2	1.5E-2	1.7E-2	1.7E-2	1.8E-2	3.1E-2
	in/yr	2.0E-4	4.0E-4	6.0E-4	7.0E-4	7.0E-4	7.0E-4	1.2E-3
Leakage Rate Through the Foundation	mm/yr	56.4	15.5	11.0	7.1	4.2	2.9	1.5
	in/yr	2.22	0.61	0.43	0.28	0.17	0.11	0.061
TOTAL LEAKAGE	**mm/yr**	**56.4**	**15.5**	**11.1**	**7.1**	**4.2**	**2.9**	**1.6**
	in/yr	**2.22**	**0.61**	**0.44**	**0.28**	**0.17**	**0.12**	**0.062**
% Through Embankment	%	0%	0%	0%	0%	0%	1%	2%
% Through Foundation	%	100%	100%	100%	100%	100%	99%	98%

The calculated steady-state leakage rate is 1.6 mm/year (0.6 inches/year), but it must be noted that the leakage rate will be significantly higher than this during the first three years of pond operation. The estimated leakage rate at various times during the first three years of pond operation can be found in Table 6.

Conclusions

The calculated steady-state leakage rate for the pre-concentration and production ponds is 1.6 mm/year (0.06 inches/year) over the entire pond area. This calculation has been based on in-situ field tests and laboratory tests of the playa materials. For the purposes of this Feasibility Study, Norwest recommends a factor of 1.5 be applied to the calculated numbers to address the highly variable foundation properties of the playa. Therefore, the steady-state leakage rate Norwest recommends for design purposes is 2.5 mm/year (0.1 inches/year).

The leakage rate from the ponds during the first three years of operations is an order of magnitude higher than the steady-state leakage rate, and this must be factored into the design and operational planning.

The pond leakage is governed almost entirely by the area of the pond and the perimeter effects at the dykes are minimal. As such, the results of this leakage analysis can be applied to ponds of various layouts and this analysis is therefore applicable to the pre-concentration, production and tailings ponds.

References

Intermountain GeoEnvironmental Services Inc., 2012 (IGES, 2012). Geotechnical Investigation Design Report - Evaporation Pond and Extraction Trench Design - Related to Sevier Lake Dry Lake Potash Mining - Sevier Dry Lake, Millard County, Utah - Peak Minerals. IGES Job No. 00301-022. October 18, 2012

CH2MHill, 2013 (CH2M, 2013). NI 43-101 Technical Report Preliminary Feasibility Study of the Sevier Lake Playa Sulphate of Potash Project Millard County, Utah. Prepared for EPM Mining Ventures Inc. October 25, 2013

Closure

Norwest has prepared this memorandum for use on the Sevier Lake Project. Calculation files in support of the results contained herein can be found at:

\\norwestcorp.net\calgary\ProjectData\CH2MHill_956\956-1_SevierLkFeasStd\Disc\Geotech\Seepage and Stability Analysis.

Yours sincerely,
NORWEST CORPORATION

Michael Davis, P.Eng.
Senior Geotechnical Engineer

Appendix A
Historical Laboratory Testing Results

NORWEST CORPORATION

Table A1

Historical Constant Head Permeability Test Results

Test Location	Sample Number	Description	Depth (m)	Hydraulic Conductivity (cm/s)
SN1-11-301	SN301SH10-11.7	N/A	3.0	6E-8
SN1-11-303	SN303SH10-12	N/A	3.0	4E-8
Trench 3	HS Trench 3 VERT	N/A	2.9	2E-7
Trench 3	HS Trench 3 HOR	N/A	3.0	2E-7
Trench 5	HS Trench 5 HOR	N/A	2.7	9E-8
Trench 5	HS Trench 5 VERT	N/A	2.7	7E-8
PE-01E	N/A	Fat Clay, Grey	1.2	2E-7
PE-01E	N/A	Fat Clay, Light Brown	2.1	1E-5
PE-03F	N/A	Fat Clay, Grey	1.2	7E-8
PE-03F	N/A	Fat Clay, Grey	2.1	3E-8
PE-05A	N/A	Fat Clay, Grey	1.2	2E-6
PE-05A	N/A	Fat Clay, Light Brown	2.1	3E-8
PE-07A	N/A	Lean Clay with Sand, Grey	1.2	8E-8
PE-12A	N/A	Fat Clay, Grey	1.2	4E-7
PE-12A	N/A	Fat Clay, Grey	2.1	2E-7
TP-02	N/A	Fat Clay, Grey	1.2	1E-6
TP-04	N/A	Fat Clay, Grey	2.1	7E-6
TP-13	N/A	Fat Clay, Light Brown	2.1	5E-7
GEOMETRIC MEAN				2E-7

APPENDIX D

Norwest April 2018 Tech Memo

(Included as Attachment)

Crystal Peak Minerals Sevier Playa Project Water Resources Technical Memo

To	LeeAnn Diamond (ldiamond@crystalpeakminerals.com) Dean Pekeski (dean@crystalpeakminerals.com)	**Project #**	89-12
CC	Greg Gillian (ggillian@norwestcorp.com)	**Date**	April 6, 2018
From	Tom Suchoski (tsuchoski@norwestcorp.com)		
Subject	Crystal Peak Minerals Sevier Playa Project Water Resources Technical Memo		

1 INTRODUCTION

Norwest Corporation (Norwest") has been requested by Crystal Peak Minerals (CPM) to provide a discussion of the water resources for the Sevier Playa to support CPM's Sevier Playa Project (SPP).

CPM acquired, as the lessee, federal and state leases on the Sevier Playa in 2011. Since that time CPM has completed numerous studies and evaluations on the Sevier Playa and surrounding areas to provide a thorough understanding of the water resources to support the project. This understanding is necessary to support the many permitting activities as well the Prefeasibility Study published in 2013, and the NI 43-101 Technical Report published in February 2018. As part of the permitting activities, the Fillmore Field Office of the West Desert District, U.S. Department of Interior, Bureau of Land Management (BLM) is preparing an Environmental Impact Statement (EIS). To support the EIS, Whetstone Associates (Whetstone) prepared a Water Resources Technical Report. The Whetstone report finalized in October 2017, primarily included data gathered to support the Prefeasibility Study which was the only data available at that time, and, based on this data, provided a discussion of the water resources on the playa.

Since the Prefeasibility Study, additional data on the water resources of the playa has been gathered and finalized as part of the Feasibility Study published in 2018. This data includes additional surface water characterizations completed by CH2M which evaluated the flows of the Sevier River, the surface runoff for the mountain watersheds surrounding the playa, and potential surface ponding resulting from precipitation. Additional monitoring wells were drilled to acquire sufficient geologic and hydrologic data on the playa. Aquifer testing was completed in order to measure hydraulic properties on the playa. Brine quality sampling was completed to characterize the brine concentration and overall water quality on the playa. Testing of brine movement and transfer was evaluated through construction of trenches and wells. While some of these tests and analyses provided information on the project's potential operations, this data is used to provide a more thorough understanding of the hydraulic properties of the playa and surrounding areas to understand the overall water resources to support the SPP.

Using the data included in the Whetstone report and the additional data collected by CPM, as part of the Feasibility Study, a new conceptual groundwater model for the SPP has been prepared.

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This memo presents a high-level discussion of the conceptual hydrologic model of the Sevier Lake Basin and includes the following:

- Surface and Groundwater Conceptual Model Summary:
  - A summary of the conceptual model of the surface and groundwater systems in the playa area.
- Supporting Information:
  - Description of the surface and groundwater systems to support the conceptual model;
  - Introduction of temporal considerations affecting the conceptual model; and
  - Differences between previous and current conceptual models.

A data summary gathered from 2014 through 2016 field and testing efforts were used to support this conceptual model and accompanying discussion. Attachments include the following:

- Attachment 1 - Figures and Tables from Whetstone 2017 Report
- Attachment 2 - Figures and Tables from Various CH2M Reports
- Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies
- Attachment 4 - Summary pf 2014-2016 CPM Groundwater Studies
- Attachment 5 - Drill Logs for 2015 Borings
- Attachment 6 - IGES Sample Results
- Attachment 7 - AQTESOLV Results
- Attachment 8 - Column Test Results
- Attachment 9 - Sevier Playa Area Groundwater Flow Estimates

2 SURFACE AND GROUNDWATER CONCEPTUAL MODEL SUMMARY

Using the geological and hydrological data collected to date, the following conceptual surface and groundwater model for the Sevier Playa and adjacent areas was developed. Major conclusions are as follows:

2.1 Surface Water

- The major inflow to the playa is via the Sevier River. During most years, surface flow does not reach the playa, due to diversion and use of water upstream. Inflow occurrences are limited to infrequent high precipitation periods when surplus water exceeds storage and use within the river system flooding of the playa occurs. Due to the large areal expanse of the playa, while a significant portion of the water evaporates, a portion infiltrates into the playa sediments.
- Runoff from the surrounding ephemeral watersheds generally is lost to infiltration and evaporation as it flows downstream toward the playa. Only during major, high intensity precipitation events does runoff reach the playa.

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2.2 Groundwater

- Groundwater flows beneath the playa in the Regional Bedrock groundwater system generally from east to west or southeast to northwest in the area of the Sevier Playa.
- Groundwater in the Regional Bedrock groundwater system may interact with the Alluvial/Colluvial sediments near the physical boundary between those two layers.
- Water quality samples demonstrate that the bedrock water types range from a weak sodium-potassium chloride, from the Cricket Mountains and Black Hills, to calcium bicarbonate-chloride, from the south, while the Alluvial/Colluvial and Playa waters are a very strong sodium-potassium chloride type water.
- A localized groundwater system exists on the north, east, and west sides of the playa where Sevier River and mountain runoff infiltrates into the Alluvial/Colluvial sediments and flows toward the playa.
- Infrequent layers of relatively coarse-grained, discontinuous sediments are interbed with fine-grained playa sediments around the edges of the playa. These coarser-grained sediments originated from erosion of the adjacent mountainsides during deposition of the basin fill. The Alluvial/Colluvial groundwater system is hydraulically connected to the Playa groundwater system via these coarser-grained layers. However, the volume of groundwater transmitted through these layers from the Alluvial/Colluvial groundwater system to the Playa groundwater system is limited by the discontinuous nature of the coarser-grained sediments within the playa.
- The portion of the water from the Alluvial/Colluvial system that is not able to move into the Playa groundwater system drains vertically into the underlying Regional Bedrock system.
- Groundwater within the playa sediments is mounded relative to that within the Alluvial/Colluvial groundwater system. This groundwater mound is caused by periodic inflows of surface water from the Sevier River, high matric forces within the clays that retain water that infiltrates into the playa sediments, the flow of groundwater from the Alluvial/Colluvial groundwater system to the Playa groundwater system via osmosis, and the capillary pull of groundwater through the Playa groundwater system from the Alluvial/Colluvial groundwater system via evaporation.
- A mixing zone exists around the margins of the playa, in which groundwater seeping out from the Playa groundwater system comingles with groundwater flowing toward the playa from the Alluvial/Colluvial groundwater system.

3 SUPPORT INFORMATION

This section addresses the various aspects of the surface and groundwater systems and the uses the data results collected from the many studies. To minimize review difficulties, copies of the figures and tables from the prior reports are included in attachments to the memo. Specifically, the figures and tables from the Whetstone (2017) and CH2M (2017) reports referred to in this memo are presented in Attachments 1 and 2, respectively. Attachments 3 and 4 present summaries of the surface and groundwater results from the 2014 to 2016 CPM field work and testing. Figures and tables developed by Norwest are provided at the end of the memo text.

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3.1 Conceptual Model Assessment

The data used to generate the conceptual model in Whetstone (2017) provide a starting point for discussions. After reviewing their conceptual model in terms of the additional new data from the CPM 2014-2016 field work, several refinements were identified.

3.1.1 Surface Water Systems

The inflows to the playa area occur from the Sevier River, the mountains surrounding the playa, and direct precipitation onto the playa. Data discussed below are from Whetstone (2017) and CH2M (2017).

3.1.1.1 Flow

Inflows from the lower reach of the Sevier River generally range from 0 to over 200 cubic feet per second (CH2M, 2017). A lack of inflow results when all water is consumed upstream, from the playa, mostly for agricultural diversions. Surface water from the Sevier River reaches the playa during wetter than normal years, due mostly to heavy snowfalls within the upstream basins.

The surrounding ephemeral watersheds draining toward the playa generally generate runoff from the upper reaches of the watersheds. However, transmission losses due to evaporation and infiltration generally reduce or consume runoff before it reaches the edge of the playa. **Attachment 3** presents the flows and anticipated surplus flows to the playa from the Sevier River and the surrounding ephemeral watersheds over a 30-year period.

3.1.1.2 Water Quality

The water quality data indicates a well-buffered sodium-chloride water type in the Sevier River with variable total dissolved solids (TDS) ranging from 884 to 4,700 milligrams/liter (mg/l). The highest concentrations typically occur in late fall and winter (October through March) sometimes with a secondary peak in April or May. Review of data indicates that water in the river sporadically exceeds State water quality standards for cadmium, lead, mercury, selenium, silver, zinc and pH. Further, the TDS concentration of the river water is typically greater than the agricultural standard (Class 4) of 1,200 mg/l at monitoring points closest to the playa.

3.1.2 Groundwater Systems

The data collected for the Prefeasibility Study and new data collected for the Feasibility Study provide a more complete understanding of the hydrologic processes within the playa sediments. Specifically, the new areas addressed include:

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- Dry clay layers at depth;
- Water levels used;
- Vertical hydraulic gradients;
- Temporal flow conditions; and
- Brine/groundwater mixing.

3.1.2.1 Hydrostratigraphic Units (HSU)

The groundwater in and adjacent to the Sevier Playa occurs in three hydrologic units:

- Alluvial/Colluvial groundwater system;
- Playa groundwater system; and
- Regional Bedrock groundwater system.

Figures 1 and 2 show cross-sections of the geologic structure of the Sevier Playa and adjacent areas as well as the interpreted lithology. These figures also show the three groundwater systems.

Alluvial/Colluvial System

For both the Cricket Mountains and the Black Hills sub-watersheds surrounding the playa, Alluvial/Colluvial sediments are quite variable in thickness. In some areas, this layer consists of a thin veneer or blanket of in-place sands, silts, and clays draped over hillsides while in others, primarily at the mouths of drainages form at the base of the mountains, this system consists of reworked alluvial fans and stream deposits that are thick and relatively coarse grained. As is typical of alluvial/colluvial sediments in the Intermountain West, these sediments tend to be interbedded due to the variable nature of the geologic forces of erosion and mass wasting that occurred intermittently over time.

Additionally, alluvial sediments occur along both the Wah Valley and Sevier River corridor. At present there is no surface evidence of surface flow or channel development from the Wah Valley. Historically it is likely that some surface water flow occurred based on the coarse nature of the sediments encountered in the Wah well upstream of the playa. The Sevier River channel has historically migrated as evidenced by the remnant oxbows and abandoned channel reaches. This results in significant alluvial sediments being deposited along the channel corridor. Based on these data, there are alluvial connections capable of conveying water into the playa.

Boring logs are used to assess the lithology of the sediments in the various zones. In using these data, the source of the log information needs to be reviewed. In some cases, the boring was conducted for the purposes of geotechnical or geologic investigation and provides a relatively detailed description of the lithology encountered. In other cases, the

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boring was conducted by a water well driller who was familiar with the area and had an anticipated target zone for water production. As a result, the overlying strata were not logged in any detail.

Examples are shown in review of the boring logs for the Bonneville and Black Hills wells. The Bonneville well log, included in **Attachment 1**, presents a relatively detailed log which indicates that the upper 20 feet consist of sandy silt overlying various clay layers of varying color and consistency, then at a depth of 225 feet another sand layer was encountered. For the Black Hills well site, Division of Water Rights has two logs for the same location. One log described the lithology by the driller as "Clay, white, greasy, heavy" for the zone 0 to 559 feet below ground surface (bgs) and one foot of hard rock from 559 to 560. However, the second log for a shallow 60-foot well by another driller that shows the upper 60 feet bgs as being a series of interbedded silt, sand, and clay lenses. Both Black Hills logs are also included in **Attachment 1**. Similar conditions exist at other well sites. Therefore, Alluvial/Colluvial sediment zones are recognized to include beds of clays and lenses of sands and silts.

For these reasons, alluvial/colluvial sediments on both the east and west of the playa consist of interbedded sands, silts, and clays of variable composition and thickness.

Aquifer tests conducted by CH2M (2012) yield a hydraulic conductivity range of the Alluvial/Colluvial strata to be from 0.06 to 51 feet per day. The high value was from the Wah Well located 9.5 miles upstream of the playa. The most reliable test results provided data within the range of 0.6 to 0.9 feet per day. Whetstone (2017) reported that the other test results were considered to be of low confidence and not reliable.

Playa System

The majority of playa sediments consist of very fine-grained clays that occur relatively consistently over the playa area. There are layers or lenses of silts and fine sands that are discontinuous and variable in thickness (**see Attachments 5 and 6**). These generally occur in areas where ephemeral channels historically flow into the lake. Sediments generally grade from coarser grained at the edge of the playa to finer grained into the playa.

Figure 3 presents a typical stratigraphic column of the sediments in the upper 100 feet of the playa sediments. The upper 10 to 12 feet consists of a plastic (fat) clay, with low hydraulic conductivity. This dense grey clay is capped by a thin salt crust that is typically several inches thick over most of the Playa, but can range up to 18 inches thick in certain areas, according to CPM auger logs (Gwynn, 2006). This zone is referred to as the Fat Clay Zone (FCZ). The FCZ is underlain by a grey, bedded, granular clay averaging 20.2 feet in thickness to a depth of 32 to 35 feet bgs. These sediments have a granular texture which

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arises from what is observed to be silt-size granules of smaller clay particles loosely bound by a soft calcareous or gypsiferous matrix. This zone is referred to as the Marl Clay Zone (MCZ). The bottom zone is the Siliceous Clay Zone (SCZ). It contains an olive grey, quartz-rich clay with a relatively low carbonate content, averaging approximately 30% carbonate content, noticeably lower than the overlying MCZ. Four sand and gravel beds have been identified within the SCZ from drillhole records, but are not consistent throughout the Playa.

Based on logs for the various wells surrounding the playa, the playa sediments in **Figures 1 and 2** are shown only below the flat area which represents the traditional playa surface. According to the Glossary of Geology (Bates and Jackson, 1980), a playa is "a dry, vegetation free, flat area at the **lowest part of an undrained desert basin**" (emphasis added). Therefore, while clayey sediments may exist on the slopes contributing to the basin, the playa sediments are shown as deposits below the relatively flat surface and do not extend up the hill sides. These circumstances are observed at the Sevier Playa.

Consistent with the stratigraphic column presented in **Figure 3** and the borehole logs from Gwynn (2006) and Wilberg (1991), discontinuous stringers of coarse alluvial/colluvial sediments are shown extending laterally into the playa sediments. As further discussed in **Attachment 3 and 4**, the production zone for the SPP is generally considered to the be the upper 75 feet of playa sediments. Below this depth, as indicated in the logs from the SN4-15 series borings (**Attachment 5**), as well as the SN3-12-400, SDL-2, SDL-3, SDL-3a, and SDL-4 logs, presented in **Attachment 1**, playa sediments below the SCZ consist predominantly of clay, interbedded with silt and sand layers. The clay at depth is generally hard and dry with occasional soft, wet lenses. Silt and sand lenses are interbedded with the clay and do not appear to be continuous across the basin. The waters found within these interbedded lenses are described as slightly salty to salty, indicating they are not fresh water. This deposition pattern is similar to that found in other Intermountain basin fills (Wilberg, 1991).

Aquifer testing of the playa sediments indicates that the hydraulic conductivity ranged from 0.01 to 24.2 feet per day (see **Attachments 4, 7, and 8**). The higher values were from six wells located in both the north near the inlet of the Sevier River and southeast of Needle Point, in wells that encountered a number of sand and silt layers. For these wells, the range of hydraulic conductivity ranged from 2.1 to 24.2 feet per day. The other wells were completed predominately in the silts and clays of the typical playa sediments and the hydraulic conductivity values ranged from 0.01 to 1.08 feet per day.

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Regional Bedrock Groundwater System

The bedrock formations in the vicinity of the playa consist of the Prospect Mountain Quartzite on the east in the Cricket Mountains, the Notch Peak Limestone in the House Range/Black Hills, and either the Prospect Mountain Quartzite or Mutual Formation on the south. Some areas of volcanic flows are also draped over these formations along the southern portion of the site area. Structurally, the playa area consists of down dropped faulting to create the depression where the sediments collected.

The aquifer tests conducted for the bedrock wells indicated hydraulic conductivities ranging from 0.9 to 133 feet per day. Some concern with the rapid recovery of a few of the wells indicated that the drawdown within the well casing maybe greater than occurs within the formation. This results from turbulence within the filter pack and well screens or incomplete well development (Whetstone, 2017). Such results likely under estimate the true hydraulic conductivity values of the aquifer.

3.2 Interaction between the HSU systems

3.2.1 Alluvial/Colluvial System

Starting at the upper most topography, meteoric water falls on the ground surface and either runs off or infiltrates into the ground depending on the intensity of the precipitation. For the Sevier Playa area, this precipitation falls either on the mountain or hill areas of the Cricket Mountains or Black Hills or onto the playa itself. The precipitation on the mountains or hills, based on the CH2M mountain runoff study (2017), results in runoff initially, with only a small percentage infiltrating into the ground. However, as flow is conveyed downstream, transmission losses from evaporation and infiltration consume the major portion of the runoff. It is only during high volume precipitation events that runoff reaches the playa from the adjacent mountain slopes. Precipitation on the playa generally ponds and evaporates relatively quickly. It is estimated that very minor portions of the ponded water infiltrate into the playa sediments.

Another source of water to the Alluvial/Colluvial system is from the alluvial aquifers associated with the different surface water drainages, such as the Sevier River. The water carried as surface flow within the channel loses some flow due to seepage into the underlying alluvial sediments via transmission losses.

These initial infiltration and transmission losses and the interflow of alluvial sediment waters make up the Alluvial/Colluvial groundwater system. This is a local groundwater system within the upper layers of sediment surrounding the playa. Some portion of these waters: flow within the alluvial/colluvial sediments to points that are in contact and interbedded with the playa sediments and seep into the Playa Groundwater system;

discharge as springs or seeps within drainages downstream where most is evaporated or transpired; or percolates downward and enters the bedrock where it joins the underlying Regional Bedrock Aquifer. As indicated by Whetstone (2017) the major portion of these flows are into the underlying Regional Bedrock System.

3.2.2 Playa System

Over recent geologic history, precipitation regimes in the vicinity of the Sevier Playa have varied from relatively wet during the formation of Lake Bonneville to the present relatively dry period resulting in the West Desert. These variations have resulted in periods of significant erosion and deposition of coarser grained sediments and quiescent periods during which generally only fine-grained sediments are deposited. Given the sediments identified in both the playa and the hill slopes above the playa, it is likely that the Sevier Lake portion of Lake Bonneville and subsequent transgressions of lake development were part of a relatively quiescent area of the lake. This is due to the generally fine-grained materials found within the hill slope and playa sediments of the Alluvial/Colluvial and Playa groundwater systems, respectively.

Vertical hydraulic gradients are evident in the Playa groundwater system, implying a hydraulic connection to surrounding formations. It was initially thought that the connection might be to the Regional Bedrock groundwater system. However, borehole logs of SN2-11-400 (drilled to a depth of 497 feet) and SN3-12-RR-7 (drilled to a depth of 240 feet) indicate that playa sediments below the SCZ are generally hard and dry below a depth of about 70 feet. Exceptions to this generality occur where thin (typically ≤ 2 feet) sand, silty sand, or silty clay layers were encountered. Additionally, the bores for SDL-2, SDL-3, SDL3a, and SDL-4 also indicate that deeper zones within the playa sediments contain dry, hard layers below the SCZ. Thus, this indicates that no continuously, vertically saturated layers have been encountered at depth to support a conclusion that the playa is directly connected to the Regional Bedrock groundwater system.

It should be noted that vertical hydraulic gradients are generally absent in the playa sediments above a depth of about 40 feet. As noted previously, the MCZ consist of a more granular structure than described by the clay designation. This granular nature increased the effective porosity of the soil and precludes horizontal hydraulic barriers that could create pressure differences within the shallow clay.

Little is known of the playa sediments below a depth of 975 feet (the greatest depth to which a borehole has been drilled from the playa surface). However, based on data collected from a gravity survey of the area, Case and Cook (1979) estimated that up to 4,600 feet of “alluvium and/or volcanics” may exist beneath the east edge of the playa.

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Thus, it can be assumed that similar conditions exist in the lower sediments as those encountered in the existing borings of the basin fill.

The fact that thick sequences of dry, hard clay exist above and below the occasional thin, discontinuous sandy or silty layers that occur at depth within the playa below the SCZ indicates that the upward hydraulic pressure in the playa sediments is not caused by interaction with groundwater in the underlying Reginal Bedrock groundwater system. Rather, as is typical of valley fill in the Basin and Range province (UWDR, 1991), groundwater in these layers of coarser sediments likely originates and is recharged from the Alluvial/Colluvial groundwater system. No evidence has been found to indicate that these coarser layers are laterally continuous between the Cricket Mountains and the Black Hills. In fact, if lateral continuity existed from east to west across the playa, a substantial loss of hydraulic head from east to west within the Playa groundwater system would be expected. However, this is not the case and water level data from the playa wells indicate a relatively flat potentiometric surface. This indicates that the vertical pressure in each discontinuous, coarser layer within the playa sediments is a function of the elevation at which that layer connects hydraulically with the adjacent Alluvial/Colluvial system.

Figures 31 and 32 of Attachment 1 and Figures 1 and **2** show cross-sections of the playa area with the potentiometric surface for the various groundwater systems. **Figures 31 and 32** show the potentiometric surfaces from 2013, while **Figure 1 and 2** show the surfaces from 2015. The Alluvial/Colluvial system exists on both the east and west sides of the playa based on site-specific data. Cross section B-B', on **Figure 32**, shows that the 2013 groundwater elevation in the Provo Well is 9 feet lower than that in the adjacent Headlight Gap well to its immediate west. When these groundwater elevations are corrected for salinity, the groundwater elevation in the Provo Well is approximately 18 feet lower than in the Headlight Gap Well as indicated in Whetstone's (2017) **Table 23 (Attachment 1)**. Furthermore, the 2013 groundwater elevation in the Bonneville Well (located east of the Provo Well) is shown on **Figure 32** as being over 70 higher than in the Provo Well. Therefore, using these data, it is concluded that a zone of depressed groundwater levels relative to the Playa groundwater system exists on the east side of the playa.

A similar situation exists on the west side of the playa. As shown in **Figure 32**, the 2013 groundwater elevation in the Red Boat Well is over 130 feet lower than in the Laceration Well in the playa sediments to the east and over 40 feet lower than in the Black Hills Well to the west. A similar situation exists on cross section A-A', **Figure 31**, which shows that the 2013 groundwater elevation in the Glitter Gulch Well is over 100 feet lower than in the Glass Ocean Well in the playa sediments to the east and over 20 feet lower than in the Miller Canyon Reservoir Well in alluvial/colluvial sediments to the west. These data

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indicate that a zone of depressed groundwater levels also exists on the west side of the playa.

Similar groundwater elevation conditions exist in 2015 along the west of the playa. On the east, the depression is filled in or less pronounced. These changes are likely due to variations in the recharge from the Cricket Mountains from precipitation and bedrock to the Alluvial/Colluvial system.

Concerns have been raised regarding the usability of the data from the Red Boat and Glitter Gulch Wells as being “unrepresentative of the ambient groundwater level at the location” since the corrected freshwater heads were “below the minimum observed heads of the regional aquifer.” However, the mere fact that groundwater elevations in the Red Boat and Glitter Gulch Wells do not agree with the water levels of the Regional Bedrock system should not inevitably lead to the conclusion that the water-level data are spurious, especially since water-level data collected from these wells over a period of nearly four years show consistent depths to water. Low hydraulic conductivity of the sediments at these locations was suggested as a potential source of error in these water-level data. However, the hydraulic conductivity of the monitored zone has no influence on the static groundwater elevation measured at a well. Therefore, data collected from the Red Boat and Glitter Gulch Wells should not be discounted.

With groundwater levels in the playa sediments being higher than those in the alluvial/colluvial sediments immediately east and west of the playa, a groundwater mound exists within the playa. The higher groundwater levels in the Playa groundwater system relative to the adjacent Alluvial/Colluvial groundwater system appear to be caused by many factors:

- Being at the terminal end of a large basin, data presented in the CH2M Water Balance Report (2017), **Figure 2 (Attachment 2)** indicate that surface water inflow to the playa is substantially greater than that which occurs from the ephemeral slopes of the Cricket Mountains and the Black Hills located east and west of the playa, respectively. A review of Google Earth photographs (each with the December date) indicates that the playa was essentially fully inundated from 1984 (the earliest available image date) through 1988. Partial ponding on the playa surface was also evident in the month of December during seven additional years between 1989 and 2013. CH2M (2017) estimated that surface water inflow to the playa from the Sevier River occurred 13 times during the 31-year period from 1985 through 2015. They further estimated that the average annual (but highly variable) inflow to the playa from the Sevier River is 90,625 acre-feet. Although a large portion of the surface water that reaches the playa likely evaporates directly from the ponded surface, substantial infiltration into the playa sediments undoubtedly also occurs, especially during prolonged periods of inundation. Given the fine-grained nature of the playa sediments, matric forces likely retain a considerable portion of the water that infiltrates prior to ultimate evaporation. Due to the low hydraulic conductivity of the playa sediments, the majority of this infiltrated water is retained in the playa sediments rather than flowing laterally outward, thereby contributing to a groundwater mound within the playa sediments.

- Flows from the Sevier River and from the Cricket Mountains and Black Hills infiltrate into the Alluvial/Colluvial sediments. These sediments are interbedded with the playa sediments and provide inflow paths into the playa. Potentiometric heads in these Alluvial/Colluvial zones, add to the development of the playa mounding.

- Elevated groundwater levels in the playa sediments relative to the immediately adjacent alluvial/colluvial sediments indicate that some groundwater probably flows outward from the playa. This hydraulic pathway is also evidenced by the higher salinity of groundwater in the alluvial sediments adjacent to the playa relative to groundwater in Alluvial/Colluvial sediments at greater distance from the playa. Compare, for instance, the total dissolved solids concentration of groundwater at the Nautilus Well [109,000 mg/l, located immediately adjacent to the playa edge] and the Provo Well [33,000 mg/l, located about 0.7 mile east of the playa edge] with that obtained from the Bonneville Well [1,060 mg/l, located about 2.4 miles from the playa edge] as noted in Whetstone (2017). However, given the high salinity of the playa groundwater relative to the alluvial/colluvial groundwater together with the high clay content of both groundwater systems, groundwater also undoubtedly also flows from the Alluvial/Colluvial groundwater system to the Playa groundwater system via osmosis. This osmotic flow raises the water table in the playa sediments relative to the alluvial sediments.

- Given the high clay content of the playa sediments, matric forces cause groundwater to rise toward the surface of the playa via capillarity until it is discharged from the playa surface via evaporation. Xiaopeng et al. (2013) report that capillary matric forces are sufficient to pull water from depths in excess of 6 meters (nearly 20 feet) in clay. This upward force creates a negative pressure that pulls groundwater from the Alluvial/Colluvial groundwater system, via the discontinuous sand lenses noted in **Figures 1, 2, and 3** into the Playa groundwater system. Together, these matric and osmotic forces create a groundwater mound in the playa sediments.

- Thus, groundwater in the Playa groundwater system influences and is influenced by groundwater in the Alluvial/Colluvial groundwater system. Groundwater flows from the Alluvial/Colluvial groundwater system toward the Playa groundwater system on both the east and west sides of the playa (**see Figures 1 and 2)**. This conclusion is consistent with hydrogeologic conditions throughout the Basin and Range province, where groundwater in unconsolidated sediments is regularly shown to flow from alluvial/colluvial sediments on mountain sides toward the intervening valleys (see, for example, Thomas et al., 1986).

3.2.3 Bedrock System

The Regional Bedrock Groundwater system flows from the Cricket Mountains westward toward the House Range/Black Hills. As show in **Figures 1 and 2**, the water levels in the bedrock wells on the east side of the playa are at a higher elevation than in the bedrock wells on the west side of the playa. Thus, the flow gradient within the bedrock is toward the west. This gradient is generally consistent with regional bedrock gradients developed by the U.S. Geological Survey (USGS) and presented by Thomas and Mason (1986), Prudic et al. (1995), Gardner et al. (2011), and Heilwell and Brooks (2011). However, several of the wells surrounding the playa (e.g., Glitter Gulch, Red Boat, and Provo wells as discussed under the Alluvial/Colluvial system) have heads that are lower than would be expected from a gradient line between the adjacent bedrock wells. Therefore, the gradient of the Regional Bedrock Groundwater system is not linear or these other wells are not directly connected to the Regional Bedrock Groundwater system.

The low permeability of the alluvial/Colluvial sediments limits the hydraulic connection with the Regional Bedrock groundwater system. Based on the different hydraulic conductivity values of the Alluvial/Colluvial system versus Regional Bedrock system, the major flux or flow path for the bedrock system would not be into or through the Alluvial/Colluvial sediments, but rather through the bedrock. Water follows the path of least resistance which for the bedrock would be through the more porous and in areas highly fractured bedrock formations.

Some interaction between the Regional groundwater system and the playa sediments undoubtedly occurs at depth near the physical boundary between playa sediments and the underlying fractured bedrock. Data presented in Whetstone (2017), **Table 33 (Attachment 1**) indicates that groundwater sampled from monitoring wells completed in quartzite on the east side of the playa contains TDS concentrations of 400 to 480 mg/l while TDS concentrations in groundwater sampled from monitoring wells completed in limestone on the west side of the playa ranges from 528 to 744 mg/l, indicating an increase in TDS concentrations in the downgradient direction. A detailed geochemical analysis would be required to determine the extent to which this increase in TDS concentration was due to flow through approximately 10 miles of limestone versus interaction with playa sediments. However, Whetstone's **Figure 39 (Attachment 1)** indicates that the concentrations of cations in bedrock groundwater on the west side of the playa are a mix of that on the east side of the playa, with concentrations of chloride generally decreasing and carbonate/bicarbonate generally increasing from east to west. On the other hand, data collected from the brines in the playa sediments show very high concentrations of chlorides and sulfates as well as high concentrations of sodium and potassium, as presented in Whetstone's, **Figure 41 (Attachment 1)**. These data indicate that the increase in TDS concentrations from east to west is more a function of dissolution of limestone than interaction with the playa sediments. Thus, the degree to which groundwater from the Regional Bedrock system interacts with the playa sediments is likely minimal. These observations, together with the dry clay layers that extend vertically to great depths beneath the brine-production zone, also indicate that the playa is not a point of evaporative discharge from the Regional Bedrock groundwater system.

3.2.4 Travel Time Assessment

Based on isotopic data collected from groundwater in the area, Whetstone (2017) concludes that groundwater in bedrock is about 10,000 years old on the east side of the playa and about 25,000 years old on the west side of the playa. This suggests that a period of about 15,000 years is required for groundwater to flow from east to west beneath the playa.

A series of calculations presented in **Attachment 9** provides estimates of potential groundwater flow through the Playa, Alluvial/Colluvial, and Regional Bedrock groundwater systems under varying assumptions. Data sources are indicated in the calculations and results are summarized in **Attachment 9**.

For the calculations summarized in **Attachment 9**, it was assumed that groundwater flows from the Cricket Mountains and the Black Hills within the Alluvial/Colluvial HSU toward the playa. Two flow directions were assumed for groundwater in the Regional Bedrock groundwater system: (1) from east to west perpendicular to the potentiometric contours presented in Whetstone (2017) **Figure 34 (Attachment 1)** and (2) from southeast to northwest diagonally beneath the playa, since "spatial variations in hydraulic conductivity and anisotropy can result in a flow direction that is not perpendicular to the potentiometric contours" (Cook, 2003).

As indicated in **Attachment 9**, the potential for groundwater flow within the playa sediments is extremely low and, has at most (i.e., in the MCZ), less than 1% of the volumetric flux capacity of the Alluvial/Colluvial groundwater system.

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On an annual basis, **Attachment 9** indicates the estimated flow of groundwater toward the playa from the Alluvial/ Colluvial groundwater system averages approximately 8,700 acre-feet from mountains east of the playa and about 4,800 acre-feet from mountains west of the playa. However, as also noted in **Attachment 9**, the groundwater flux capacity of the playa sediments is at most only 29 acre-feet per year, thereby greatly limiting the amount of groundwater that can flow from the Alluvial/Colluvial System in the Playa System. Therefore, the vast majority of groundwater from the Alluvial/Colluvial groundwater system probably flows vertically into the Regional Bedrock groundwater system, as suggested by Whetstone.

Attachment 9 indicates that the Regional Bedrock groundwater system has the capacity to transmit a large quantity of groundwater. This agrees with the observations of Whetstone (2017) that groundwater in the Regional Bedrock groundwater system experiences low seasonal fluctuations, which is typically indicative of a high degree of hydraulic interconnectivity between fractures (Cook, 2003).

As noted previously, Whetstone (2017) indicated that groundwater on the west side of the playa was approximately 15,000 years older than that on the east side of the playa. **Attachment 9** provides estimates of the distance that groundwater could flow through the various groundwater systems within a 15,000-year period. As indicated, it is estimated that groundwater in the Regional Bedrock groundwater system could flow, on average, between 41 and 145 miles within a 15,000-year period. With an east to west playa width of 6 to 10 miles and a southeast to northwest playa distance of approximately 25 miles, these calculated travel distances are in reasonable support of the groundwater age data for the Regional Bedrock groundwater system, given the potential error in the assumptions, as concluded by Whetstone.

3.2.5 Water Quality

Figures 39 through 41 of **Attachment 1** summarize the results of analyses of water quality samples collected from the Bedrock, Alluvial/Colluvial, and Playa systems, respectively. Tables of these results are presented in the Whetstone report for the Bedrock and Alluvial/Colluvial wells and the data in **Attachment 4** for the Playa wells.

3.2.5.1 Bedrock

Groundwater quality for the Regional Bedrock System varies depending on the formation. For the quartzite and volcanics, the waters encountered are a moderate sodium-weak chloride water type with slightly alkaline pH (7.70 to 8.24 s.u.) and low TDS concentrations (ranging from 400 to 480 mg/l). However, groundwater sampled at CWTW-1 (completed in the Mutual Formation) is a calcium-bicarbonate to calcium-chloride water type with more alkaline pH (8.4 to 8.5 s.u.) and lower TDS concentration (ranging from 352 to 396 mg/l). No analyses for groundwater from quartzite or volcanic were reported at concentrations above the Utah numerical groundwater standards.

The Notch Peak Formation waters from the Black Hills, Coyote, and Nighthawk wells on the west of the playa are a mixed sodium-chloride to sodium-sulfate water type with neutral pH (6.89 to 7.52 s.u.) and slightly elevated TDS concentration (528 to 744 mg/l). No constituents were reported at concentrations above the Utah groundwater standards in the CPM samples.

3.2.5.2 ALLUVIAL/COLLUVIAL

Groundwater quality in the Alluvial/Colluvial sediments indicate a sodium-chloride to sodium-sulfate type water with circum-neutral to alkaline pH (6.68 to 9.30 s.u.) and variable TDS concentration (ranging from 472 to 5,280 mg/l). One well, the 257 Cutoff well, is screened at a relatively shallow depth (45 - 60 feet bgs) in silty sand and clay adjacent to Sevier River upstream of the playa and has a sodium chloride brine composition with a substantially higher TDS concentration (ranging from 80,800 to 82,700 mg/l), likely due to connection of the alluvial fill sediments with the playa sediments. Groundwater samples for the unconsolidated deposits generally meet Utah numerical groundwater standards with the exceptions of fluoride, arsenic, and pH.

3.2.5.3 PLAYA

CPM water quality data for playa sediments are available from more than 30 wells. Data indicate that groundwater in playa sediments is a sodium-chloride brine (TDS concentrations of 13,800 to 230,000 mg/l) with neutral to alkaline pH (6.19 to 9.20 s.u.)

The brine is classified as a Class IV Saline Groundwater based on its TDS concentration greater than 10,000 mg/l. Protection levels established to protect human health and the environment and numerical groundwater standards are not applicable for Class IV groundwater.

3.2.6 Brine/Water Mixing Zone

As alluded to previously, groundwater quality data indicate that a mixing zone exists within about 0.5 to 1.0 mile of the playa edge, where groundwater from the Playa and Alluvial/Colluvial groundwater systems comingle. This comingling likely occurs due to the following factors:

- The Alluvial/Colluvial and Playa sediments are interbedded around the edges of the playa as a result of climatic changes and erosion of adjacent mountainsides during deposition of the basin fill. This interbedding, which is evident on the stratigraphic column presented in **Figure 3**, results in a transgression/regression sequence along the playa boundary.

- Infrequent periods of wetter climatic conditions resulted in layers of relatively coarse sediments being deposited onto the playa surface which then interbedded with fine-grained sediments within the playa depositional sequence. Additional runoff during wetter periods conveyed these sediments farther into the playa than normal. Based on the drilling, five sand and gravel lenses were identified in the upper playa sediments that thickened toward the playa margins. However, no evidence was identified of laterally continuous layers of coarse grained sediments extending across the playa.
- The Alluvial/Colluvial groundwater system is hydraulically connected to the Playa groundwater system via these coarser-grained, discontinuous sediments, thereby causing some inflow to the playa from the adjacent alluvial/colluvial sediments.
- Since hydraulic heads in the mixing zone are lower than in the adjacent playa and alluvium/colluvium, groundwater flows into the mixing zone from both the playa and the alluvium/colluvium.
- The osmotic interchange between fresher groundwater in the alluvium/colluvium and more saline groundwater in the playa sediments causes further mixing of brine from the Playa groundwater system with fresher water from the Alluvial/Colluvial groundwater system.

4 DIFFERENCES

This conceptual model differs from prior versions as follows:

- Playa system has only a minor connection to Regional Bedrock system – see Section 3.2.3.
- Alluvial/Colluvial system directly connected to Playa system via direct contact and interbedded sediment lenses – see Section 3.2.1.
- Alluvial/Colluvial system excess drains into Regional Bedrock system via direct contact and limited flow into Playa sediments – see Section 3.2.1.
- Main flow conveyance is within the Regional Bedrock system – see Sections 3.2.3 and 3.2.4.
- Playa system mounded above Alluvial/Colluvial system due to matric forces and head in interconnected lenses of Alluvial/Colluvial sediments – see Section 3.2.2.
- Flux through the Playa system is limited by permeability and is a minor conveyor – see Sections 3.2.2 and 3.2.4.

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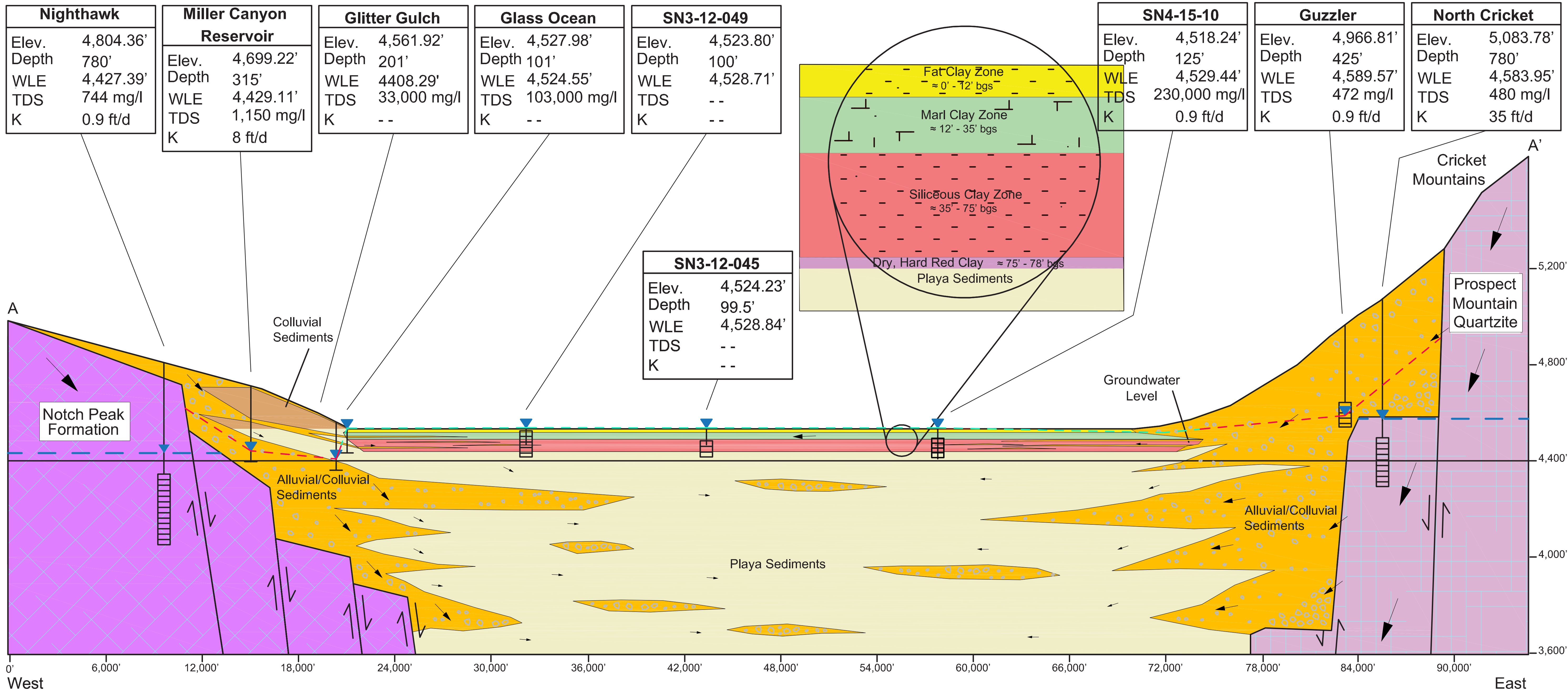

Cross Section A-A’
(Vertical Exageration 15:1)

CRYSTAL PEAK MINERALS INC.

EXPLANATION

Well Showing Screened Interval and Water Level Elevation (WLE July 2015)

Groundwater Potentiometric Surfaces
- Regional Bedrock
- Alluvial/Colluvial
- Playa

Fault Showing Direction of Movement

Key	
Elev.	Collar Elevation
Depth	Well Depth
WLE	Water Level Elevation
TDS	Total Dissolved Solids
K	Hydraulic Conductivity

NO.	DATE	REVISION	BY	APVD
0	04/04/18	INITIAL SUBMISSION	TJS	GG

DSGN	DR	CHK	APVD
TJS	TJS	GG	GG

FIGURE 1

Sevier Playa Potash Project
Hydrogeologic Cross-section
A-A'

DATE: 04/04/2018
FILE: Figure 1 Hydrogeologic Cross-section A-A'
SCALE: 1"=6000'

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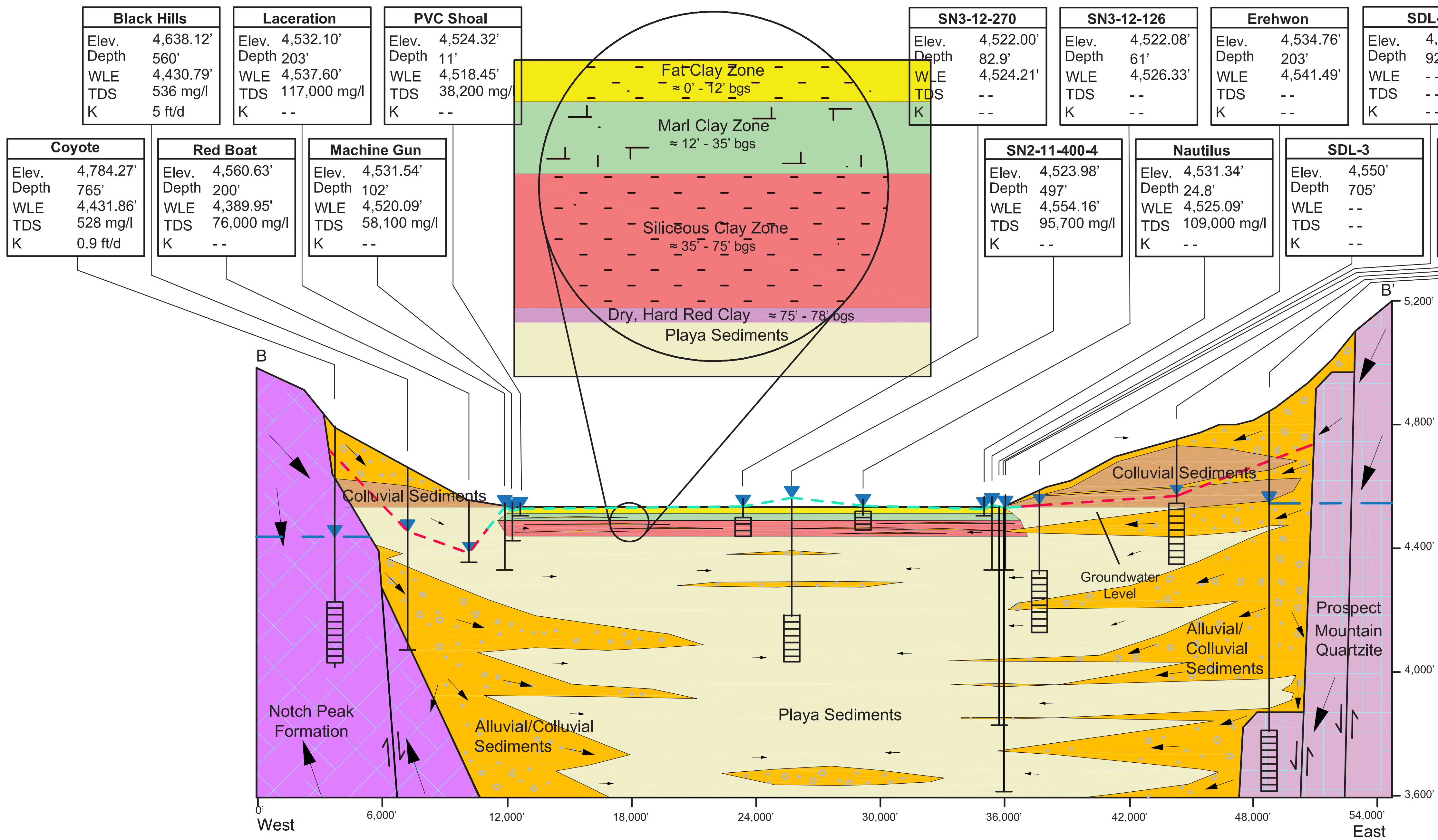

Cross Section B-B'
(Vertical Exageration 15:1)

CRYSTAL PEAK MINERALS INC.

EXPLANATION

Well Showing Screened Interval and Water Level Elevation (WLE July 2015)

Groundwater Potentiometric Surfaces
- Regional Bedrock
- Alluvial/Colluvial
- Playa

Fault Showing Direction of Movement

Key	
Elev.	Collar Elevation
Depth	Well Depth
WLE	Water Level Elevation
TDS	Total Dissolved Solids
K	Hydraulic Conductivity

NO.	DATE	REVISION	BY	APVD
0	04/04/18	INITIAL SUBMISSION	TJS	GG

DSGN	DR	CHK	APVD
TJS	TJS	GG	GG

FIGURE 2

Sevier Playa Potash Project
Hydrogeologic Cross-section
B-B'

DATE: 04/04/2018
FILE: Figure 1 Hydrogeologic Cross-section B-B'
SCALE: 1"=6000'

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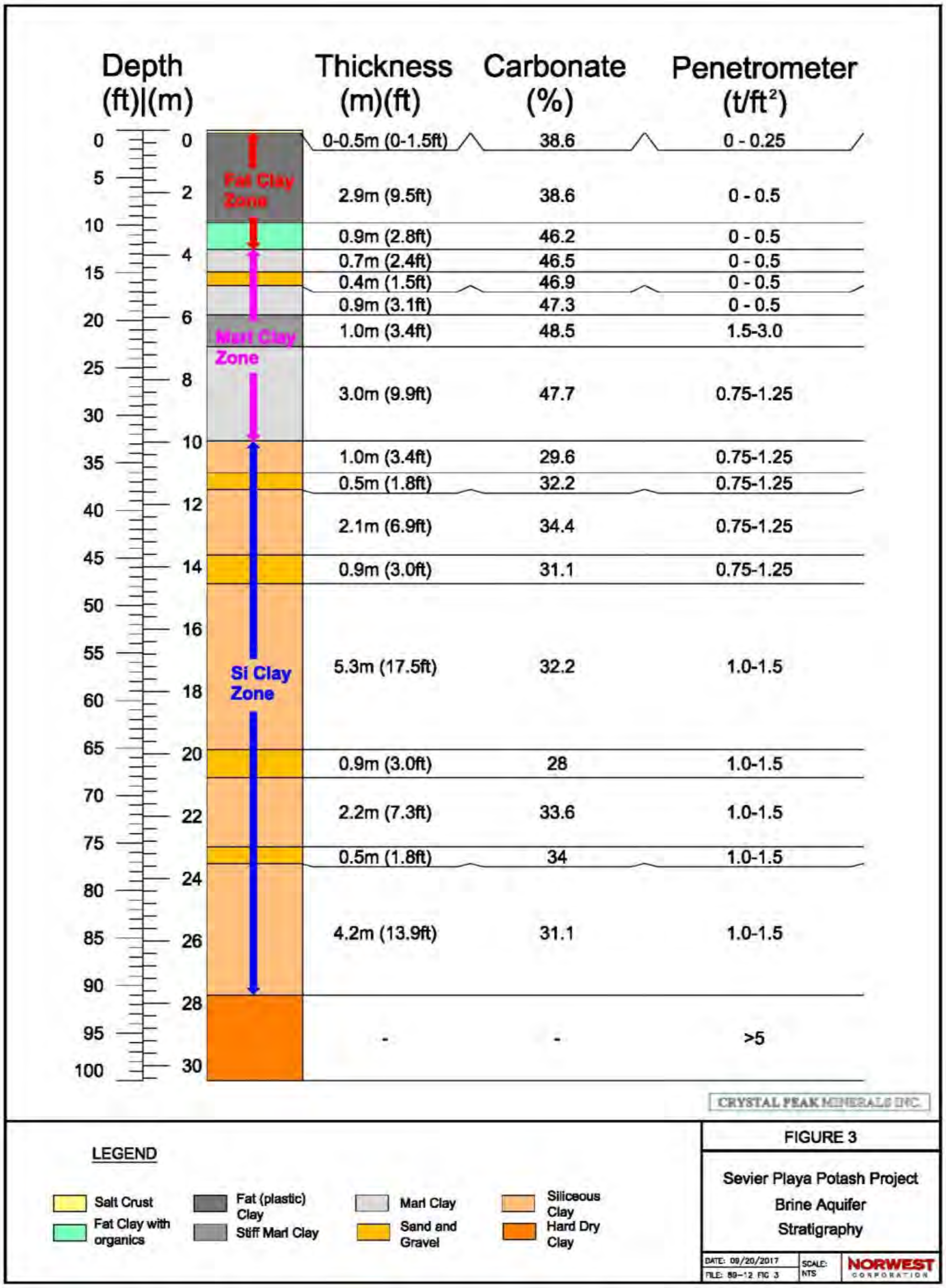
Crystal Peak Minerals Sevier Playa Project Water Resources Technical Memo

Figure 3: Stratigraphic Column



Attachments for Crystal Peak Minerals (CPM) Sevier Playa Project Water Resources Technical Memo

A data summary gathered from 2014 through 2016 field and testing efforts were used to support the conceptual model and accompanying discussion. Attachments include the following:

- Attachment 1 - Figures and Tables from Whetstone 2017 Report
- Attachment 2 - Figures and Tables from Various CH2M Reports
- Attachment 3 - Summary of 2014-2016 Surface Water CPM Studies
- Attachment 4 - Summary of 2014-2016 Groundwater CPM Studies
- Attachment 5 - Drill Logs for 2015 Sonic Borings
- Attachment 6 - IGES Sample Results
- Attachment 7 - AQTESOLV Results
- Attachment 8 - Column Test Results
- Attachment 9 - Sevier Playa Area Groundwater Flow Estimates

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Figure 31: East-West Hydrogeologic Cross Section A-A' through Sevier Playa

Final Baseline Water Resources Technical Report – Sevier Playa Potash Project 90

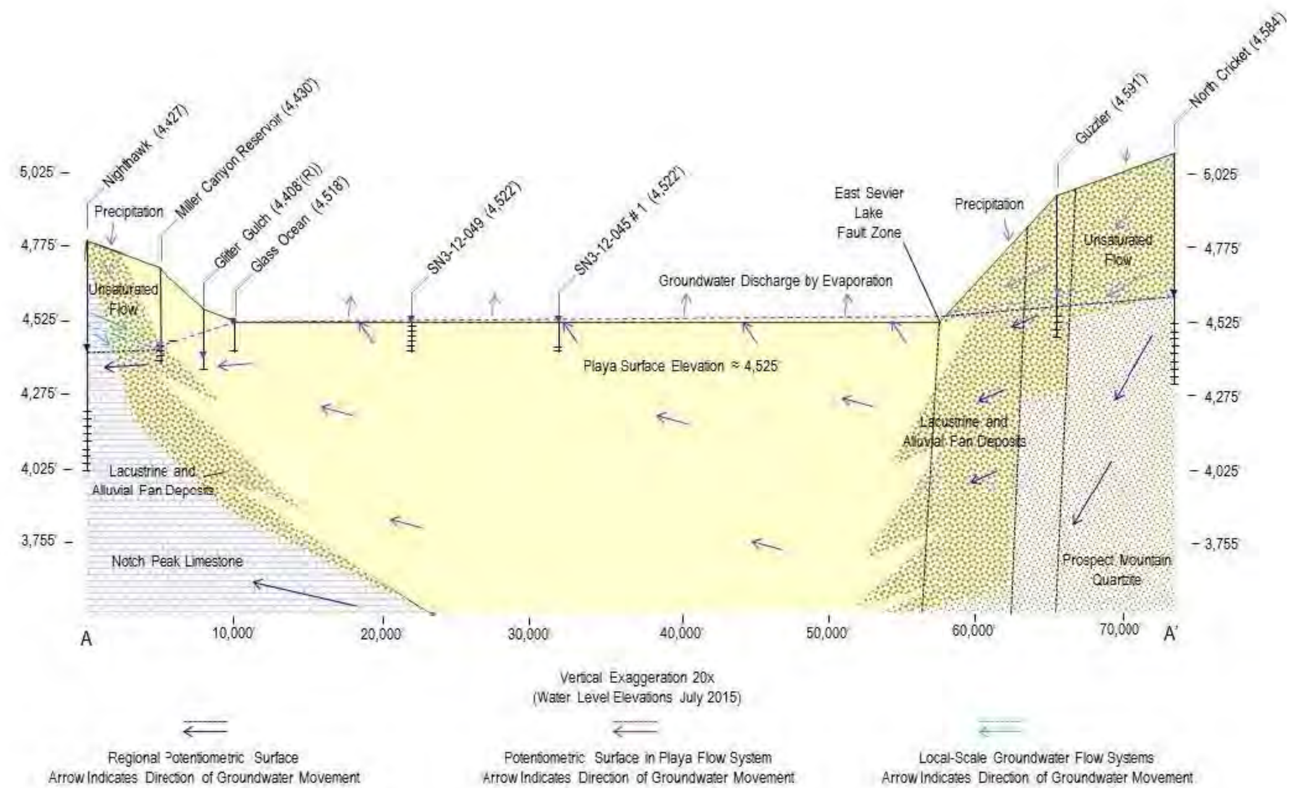


Figure 31. East-West Hydrogeologic Cross Section A - A' through Sevier Playa
(Cross section line shown on Figure 30)

4169C.171004 *Whetstone Associates*

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Figure 32: East-West Hydrogeologic Cross Section B - B' through Sevier Playa

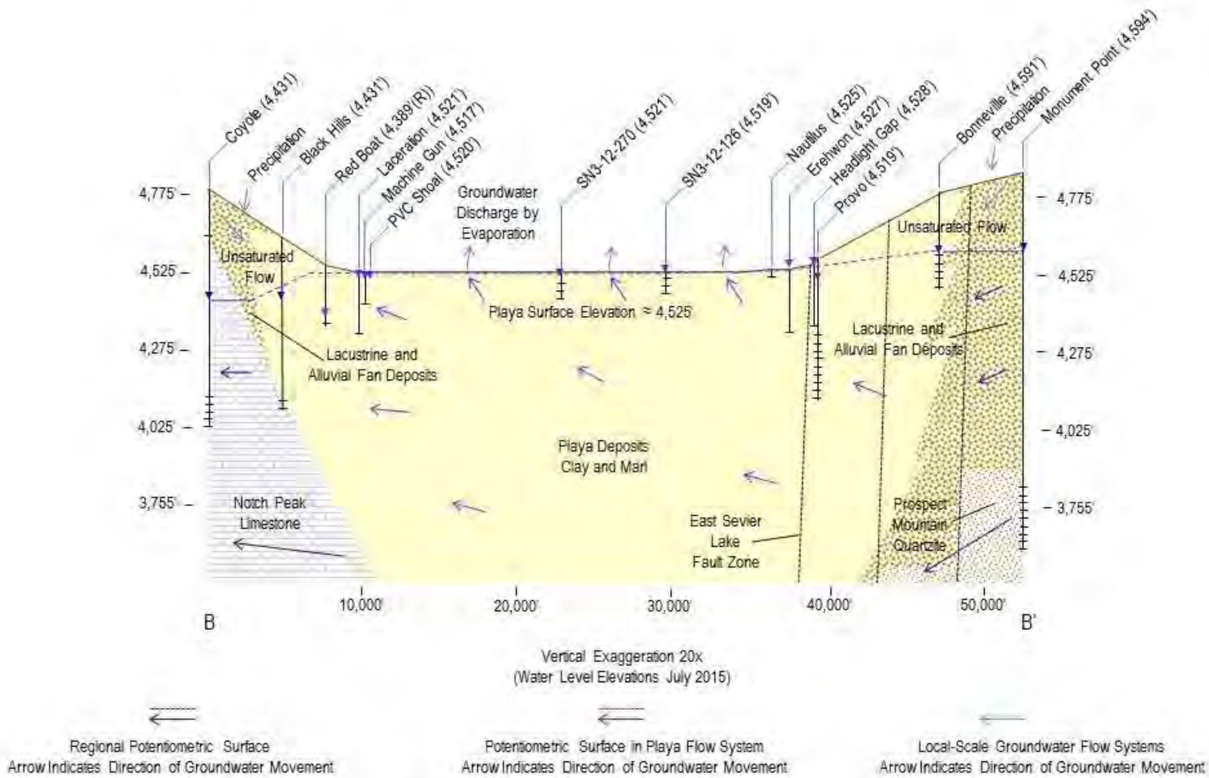
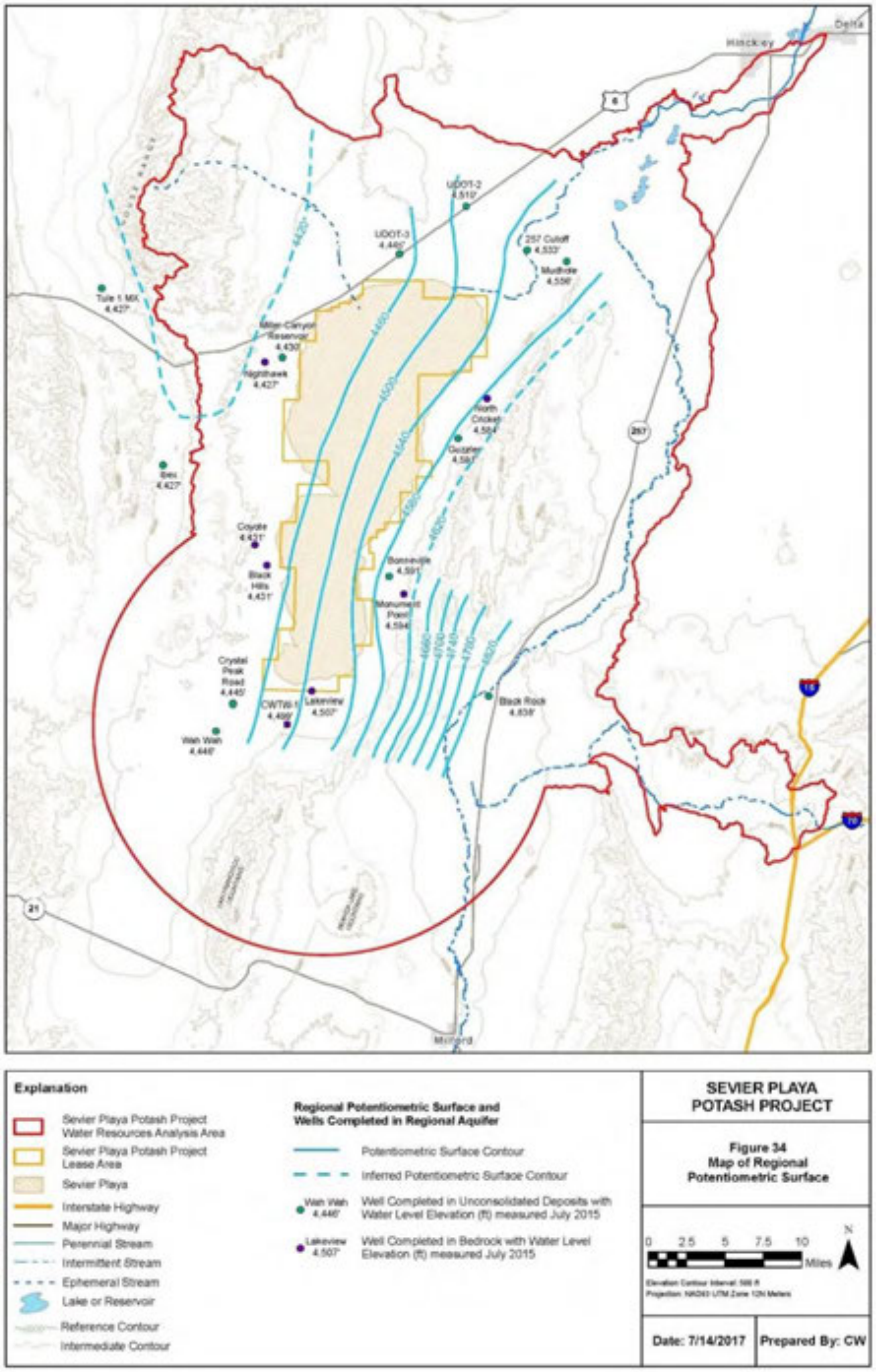


Figure 32. East-West Hydrogeologic Cross Section B - B' through Sevier Playa
(Cross section line shown on Figure 30)

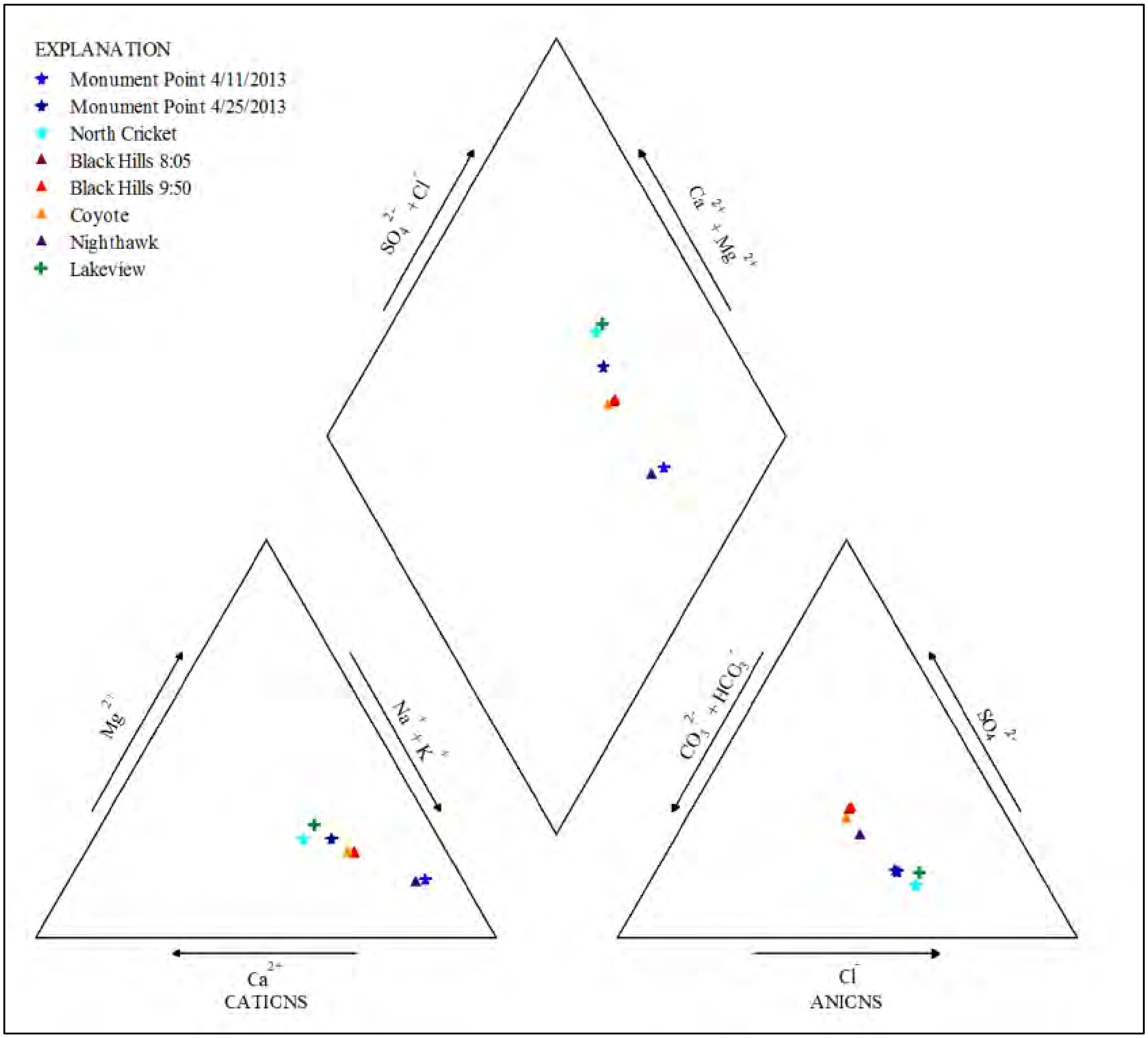
Attachment 1 - Figures and Tables from Whetstone 2017 Report

Figure 34: Map of Regional Potentiometric Surface



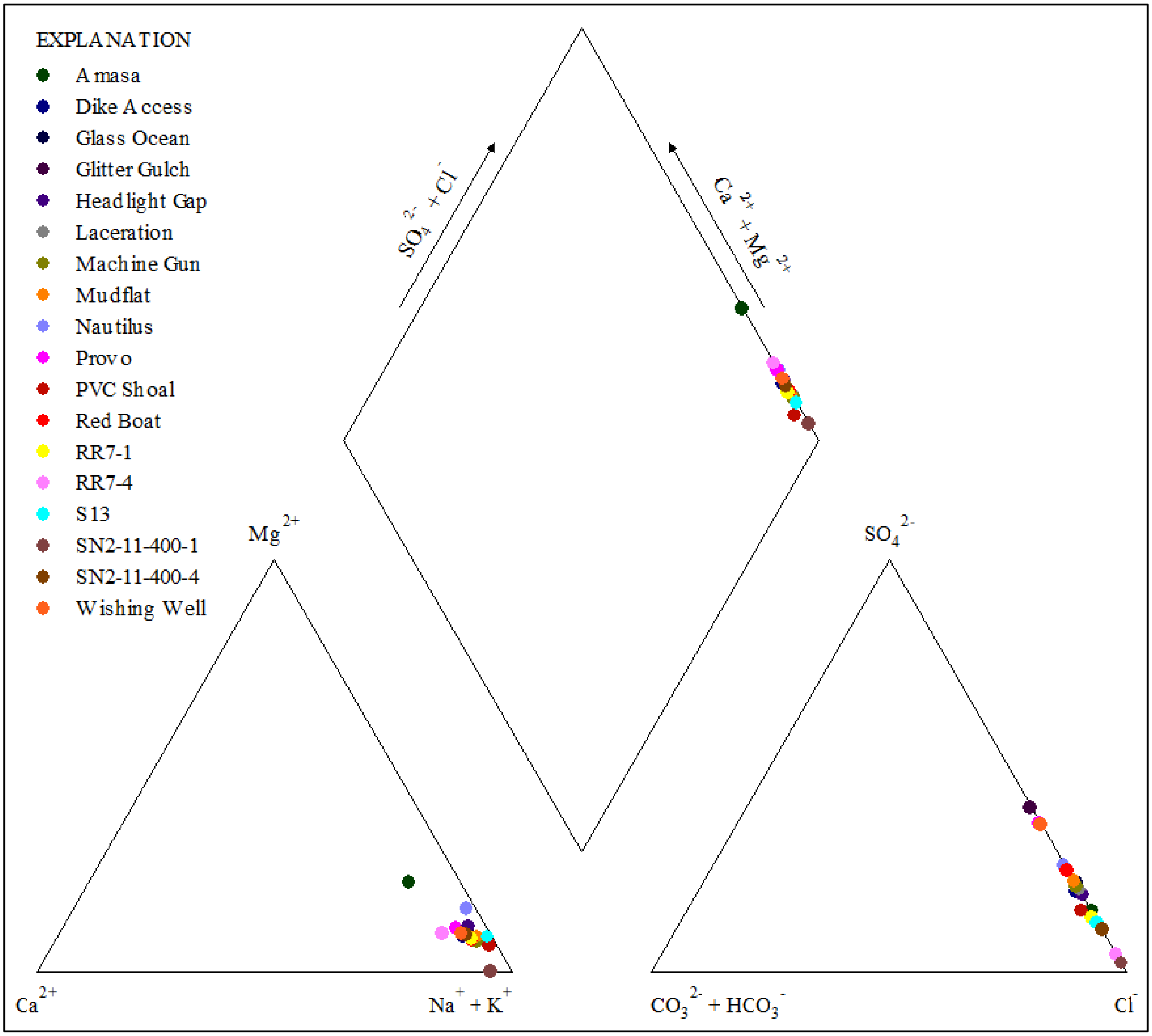
Attachment 1 - Figures and Tables from Whetstone 2017 Report

Figure 39: Piper Diagram for Project-Specific Water Quality Samples from Bedrock



Attachment 1 - Figures and Tables from Whetstone 2017 Report

Figure 41: Piper Diagram for Project-Specific Water Quality Samples from Consolidated Playa Deposits



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Attachment 1 - Figures and Tables from Whetstone 2017 Report

Table 23: Measured Water Levels for Wells in Playa Sediments

Table 23. Measured Water Levels for Wells in Playa Sediments

Well ID	Casing Elevation (ft. amsl)	Mid-Point of Screen (ft. btoc)	TDS (mg/l)	Density (g/cm3)	Date	Measured DTW (ft. btoc)	Measured WLE (ft. amsl)	Fresh Water Correction (ft.)	Fresh Water Elevation (ft. amsl)	WLE Fluctuation (ft.)
PVC Shoal	4,524.32	5.5	38,200(1)	1.027	7/27/15	4.74	4,519.58	0.02	4,519.60	0.78
					9/16/14	4.94	4,519.38	0.01	4,519.40	
					5/20/13	4.58	4,519.74	0.02	4,519.77	
					2/4/13	5.36	4,518.96	0.00	4,518.97	
					9/17/12	5.15	4,519.17	0.01	4,519.18	
					4/14/12	5.20	4,519.12	0.01	4,519.13	
Amasa	4,548.74	136	52,600(1)	1.037	7/27/15	59.79	4,488.95	2.79	4,491.74	0.09
					9/16/14	59.75	4,488.99	2.79	4,491.78	
					5/20/13	59.76	4,488.98	2.79	4,491.77	
					2/5/13	59.74	4,489.00	2.79	4,491.79	
					9/17/12	59.82	4,488.92	2.78	4,491.71	
					4/15/12	59.83	4,488.91	2.78	4,491.70	
					9/17/11	56.68 (R)	4,492.06 (R)	2.90	4,494.96 (R)	
Erehwon	4,534.76	201.5	No Data	--	7/28/15	7.32	4,527.44	--	--	2.58
					9/15/14	8.69	4,526.07			
					5/22/13	7.97	4,526.79			
					2/4/13	9.31	4,525.45			
					9/17/12	9.15	4,525.61			
					4/20/12	9.55	4,525.21			
					9/18/11	9.90	4,524.86			
Glass Ocean	4,527.98	99.5	103,000(1)	1.072	7/27/15	9.79	4,518.19	6.42	4,524.61	12.09
					9/16/14	18.45	4,509.53	5.80	4,515.33	
					5/20/13	21.88	4,506.10	5.56	4,511.66	
					2/6/13	18.10	4,509.88	5.83	4,515.71	
					9/17/12	19.37	4,508.61	5.74	4,514.35	
					4/21/12	19.55	4,508.43	5.72	4,514.15	
					9/17/11	15.95	4,512.03	5.98	4,518.01	
Glitter Gulch	4,561.92	199.5	33,000(1)	1.023	7/27/15	153.92	4,408.00 (R)	1.05	4,409.05 (R)	0.69
					9/16/14	154.10	4,407.82 (R)	1.04	4,408.86 (R)	
					5/20/13	154.37	4,407.55 (R)	1.04	4,408.59 (R)	
					2/6/13	154.32	4,407.60 (R)	1.04	4,408.64 (R)	
					9/17/12	154.61	4,407.31 (R)	1.03	4,408.34 (R)	
					4/14/12	154.20	4,407.72 (R)	1.04	4,408.76 (R)	
					9/17/11	154.40	4,407.52 (R)	1.03	4,408.55 (R)	
Headlight Gap	4,549.94	205.5	122,000(1)	1.085	7/28/15	21.81	4,528.13	15.58	4,543.71	0.81
					9/15/14	21.92	4,528.02	15.57	4,543.59	
					5/22/13	22.13	4,527.81	15.55	4,543.36	
					2/4/13	22.36	4,527.58	15.53	4,543.11	
					9/17/12	22.56	4,527.38	15.51	4,542.89	
					4/20/12	22.56	4,527.38	15.51	4,542.89	
					9/18/11	21.75	4,528.19	15.58	4,543.77	
Laceration	4,532.10	201.5	117,000(1)	1.081	7/27/15	10.62	4,521.48	15.52	4,537.00	11.36
					9/16/14	19.85	4,512.25	14.77	4,527.02	
					5/20/13	15.86	4,516.24	15.10	4,531.34	
					2/4/13	19.68	4,512.42	14.78	4,527.20	
					9/17/12	20.83	4,511.27	14.69	4,525.96	
					4/14/12	21.98	4,510.12	14.60	4,524.72	
					9/19/11	18.40	4,513.70	14.89	4,528.59	

Note: Table continued on next page

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Table 23. Measured Water Levels for Wells in Playa Sediments (Continued)

Well ID	Casing Elevation (ft. amsl)	Mid-Point of Screen (ft. btoc)	TDS[1] (mg/l)	Density (g/cm³)	Date	Measured DTW (ft. btoc)	Measured WLE (ft. amsl)	Fresh Water Correction (ft.)	Fresh Water Elevation (ft. amsl)	WLE Fluctuation (ft.)
Machine Gun	4,531.54	100.5	58,100[1]	1.040	7/27/15	14.69	4,516.85	3.46	4,520.31	2.71
					9/16/14	16.39	4,515.15	3.40	4,518.55	
					5/20/13	15.08	4,516.46	3.45	4,519.91	
					2/4/13	16.80	4,514.74	3.38	4,518.12	
					9/17/12	17.40	4,514.14	3.36	4,517.50	
					4/14/12	16.85	4,514.69	3.38	4,518.07	
					9/19/11	16.30	4,515.24	3.40	4,518.64	
Mudflat	4,528.56	201.5	84,200[1]	1.059	7/27/15	5.17	4,523.39	11.49	4,534.88	1.04
					9/16/14	5.60	4,522.96	11.46	4,534.42	
					5/20/13	5.93	4,522.63	11.44	4,534.07	
					2/20/13	5.58	4,522.98	11.47	4,534.45	
					9/17/12	6.21	4,522.35	11.43	4,533.78	
					4/15/12	62.75 (R)	4,465.81 (R)	8.12	4,473.93 (R)	
Nautilus	4,531.34	21.9	109,000[1]	1.076	7/28/15	6.55	4,524.79	1.16	4,525.95	1.34
					9/15/14	7.14	4,524.20	1.12	4,525.32	
					5/22/13	6.37	4,524.97	1.18	4,526.15	
					2/4/13	6.64	4,524.70	1.16	4,525.86	
					9/1712	7.34	4,524.00	1.10	4,525.10	
					4/20/12	7.00	4,524.34	1.13	4,525.47	
					9/18/11	6.00	4,525.34	1.20	4,526.54	
Red Boat	4,560.63	198.5	76,000[1]	1.053	7/27/15	171.80 (R)	4,388.83 (R)	1.41	4,390.24 (R)	7.65
					9/16/14	172.28 (R)	4,388.35 (R)	1.38	4,389.74 (R)	
					5/20/13	175.85 (R)	4,384.78 (R)	1.20	4,385.98 (R)	
					2/4/13	173.34 (R)	4,387.29 (R)	1.33	4,388.62 (R)	
					9/17/12	174.71 (R)	4,385.92 (R)	1.26	4,387.18 (R)	
					4/14/12	179.45 (R)	4,381.18 (R)	1.01	4,382.19 (R)	
					9/19/11	171.80	4,388.83 (R)	1.41	4,390.24 (R)	
Wishing Well	4,561.09	136	51,500[1]	1.036	7/28/15	96.53	4,464.56	1.41	4,465.98	3.95
					9/15/14	97.15	4,463.94	1.39	4,465.33	
					5/20/13	98.72	4,462.37	1.33	4,463.71	
					2/4/13	97.50	4,463.59	1.38	4,464.97	
					9/17/12	98.01	4,463.08	1.36	4,464.44	
					4/14/12	100.48	4,460.61	1.27	4,461.89	
					9/19/11	97.50	4,463.59	1.38	4,464.97	
Dike Access	4,544.74	364.75	13,800[1]	1.010	7/28/15	47.61	4,497.13	3.04	4,500.17	3.86
					9/15/14	47.90	4,496.84	3.04	4,499.88	
					5/20/13	51.47	4,493.27	3.00	4,496.27	
LL3	4,527.74	45	No Data	—	7/28/15	2.92	4,524.82	--	--	3.97
					5/14/13	3.33	4,524.41			
					7/28/15	1.30	4,522.21			
					5/14/13	2.66	4,520.85			
Provo	4,575.75	360	33,000[1]	1.023	7/28/15	56.89	4,518.86	6.95	4,525.81	0.60
					9/15/14	57.49	4,518.26	6.94	4,525.20	
					5/22/13	114.46 (R)	4,461.29 (R)	5.63 (R)	4,466.92 (R)	
QQ7	4,524.59	54	228,600[2]	1.159	7/28/15	2.10	4,522.49	8.25	4,530.74	2.61
					9/15/14	1.51	4,523.08	8.34	4,531.42	
					5/16/13	4.12	4,520.47	7.92	4,528.39	
					9/18/12	1.81	4,522.78	8.29	4,531.07	

Note: Table continued on next page

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Table 23. Measured Water Levels for Wells in Playa Sediments (Continued)

Well ID	Casing Elevation (ft. amsl)	Mid-Point of Screen (ft. btoc)	TDS (mg/l)	Density (g/cm³)	Date	Measured DTW (ft. btoc)	Measured WLE (ft. amsl)	Fresh Water Correction (ft.)	Fresh Water Elevation (ft. amsl)	WLE Fluctuation (ft.)
RR7-1	4,522.62	145	66,600(1)	1.046	7/27/15	0.00	4,522.62	6.71	4,529.33	0.00
					9/15/14	0.00	4,522.62	6.71	4,529.33	
					4/29/13	0.00	4,522.62	6.71	4,529.33	
					9/18/12	0.00	4,522.62	6.71	4,529.33	
					2/13/12	0.00	4,522.62	6.71	4,529.33	
RR7-4	4,522.93	35	191,000(1)	1.133	7/28/15	1.95	4,520.98	4.39	4,525.37	3.17
					9/15/14	1.26	4,521.67	4.48	4,526.15	
					4/29/13	3.68	4,519.25	4.16	4,523.41	
					9/18/12	2.40	4,520.53	4.33	4,524.86	
					2/13/12	4.43	4,518.50	4.06	4,522.56	
S13	4,524.38	22	194,000(1)	1.135	7/27/15	3.13	4,521.25	2.54	4,523.79	1.14
					9/15/14	3.42	4,520.96	2.51	4,523.47	
					5/22/13	3.49	4,520.89	2.50	4,523.39	
					9/26/12	2.35	4,522.03	2.65	4,524.68	
					5/23/12	3.30	4,521.08	2.52	4,523.60	
SN2-11-400-1	4,523.98	245	216,000(1)	1.150	7/28/15	3.40	4,520.58	36.27	4,556.85	0.63
					9/15/14	3.71	4,520.27	36.22	4,556.49	
					5/16/13	3.50	4,520.48	36.25	4,556.73	
					9/18/12	4.03	4,519.95	36.17	4,556.12	
SN2-11-400-4	4,523.98	422	95,700(1)	1.067	7/28/15	4.05	4,519.93	27.80	4,547.73	2.10
					9/15/14	4.55	4,519.43	27.77	4,547.20	
					5/16/13	5.38	4,518.60	27.71	4,546.31	
					9/18/12	6.15	4,517.83	27.66	4,545.49	
SN3-12-045	4,524.23	76.5	136,000(2)	1.095	7/28/15	1.81	4,522.42	7.06	4,529.48	1.02
					5/14/13	0.79	4,523.44	7.16	4,530.60	
					5/23/12	0.95	4,523.28	7.14	4,530.42	
SN3-12-049	4,523.80	55	122,600(2)	1.085	7/28/15	1.96	4,521.84	4.52	4,526.36	2.00
					5/14/13	0.80	4,523.00	4.62	4,527.62	
					5/23/12	2.80	4,521.00	4.45	4,525.45	
SN3-12-126	4,522.08	40	131,000(2)	1.091	5/15/13	2.61	4,519.47	3.40	4,522.87	1.07
					9/19/12	1.54	4,520.54	3.50	4,524.04	
					5/21/12	1.65	4,520.43	3.49	4,523.92	
SN3-12-270	4,522.00	45	217,500(2)	1.151	7/28/15	1.03	4,520.97	6.65	4,527.62	2.07
					5/15/13	3.00	4,519.00	6.35	4,525.35	
					9/19/12	1.60	4,520.40	6.56	4,526.96	
					5/22/12	3.10	4,518.90	6.33	4,525.23	

Notes: (1) TDS value is from the CPM monitoring data presented in Appendix E
(2) TDS value is the average of the resource evaluation data presented in Appendix E
(R) Indicates that the data were rejected as being unrepresentative of the ambient groundwater level at the location. See text for discussion of the Red Boat and Glitter Gulch wells. Rejected data from the Mudflat and Provo wells are not consistent with other water level measurements from the wells
DTW Depth to water
WLE Water level elevation

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Attachment 1 - Figures and Tables from Whetstone 2017 Report

Table 33: Summary of Project-Specific Water Quality Data for Wells Completed in Bedrock

Table 33. Summary of Project-Specific Water Quality Data for Wells Completed in Bedrock

Parameter	Units	Utah Groundwater Standards	Undifferentiated lower Cambrian and Precambrian Quartzite[1,2]										Notch Peak Formation[1,3]							Volcanic Bedrock
			Monitoring Well Data							CWTW-1 Airlift Samples										
			Average	Std. Dev.	Median	Range	Count	%ND	% >WQ Standard	553 feet Depth	579 Feet Depth	734 Feet Depth	Average	Std. Dev.	Median	Range	Count	%ND	% >WQ Standard	Lakeview
Major Ions and Solution Parameters																				
Bicarbonate	mg/l $CaCO_3$	—	142	3	144	138 - 145	3	0%	—	94.6	140	142	189.8	25	176.5	173 - 233	4	0%	—	113
Carbonate	mg/l $CaCO_3$	—	NC	NC	NC	<10 - <20	3	100%	—	34.6	<20	<20	NC	NC	NC	<20 - <40	4	100%	—	<20
Hardness, Ca+Mg	mg/l	—	232.3	34.7	246.4	184.5 - 265.9	3	0%	—	—	—	—	186.35	18.97	193.95	154.4 - 203.1	4	0%	—	199.9
Calcium	mg/l	—	42.2	7.9	37.8	35.6 - 53.3	3	0%	—	27.1	41.5	43.9	35.5	5.23	38.05	26.5 - 39.4	4	0%	—	37.5
Magnesium	mg/l	—	30.9	7.9	27.6	23.3 - 41.8	3	0%	—	22.8	28.3	30.5	23.8	1.5	24.1	21.5 - 25.5	4	0%	—	25.9
Potassium	mg/l	—	9.58	5.74	5.54	5.5 - 17.7	3	0%	—	7.57	6.84	6.63	11.2	0.1	11.2	11.0 - 11.3	4	0%	—	9.08
Sodium	mg/l	—	195.1	149.8	91.5	86.9 - 407	3	0%	—	56.4	43	43.8	143	42	123	110 - 214	4	0%	—	74.4
Chloride	mg/l	—	151	11	146	141 - 166	3	0%	—	113	112	116	118	23.7	105.5	102 - 159	4	0%	—	148
Fluoride	mg/l	4	0.28	0.02	0.281	0.254 - 0.304	3	0%	0%	0.289	0.27	0.275	1.036	0.299	0.913	0.836 - 1.48	4	0%	0%	0.359
Silicon	mg/l	—	6.85	1.04	6.15	6.07 - 8.32	3	0%	—	<0.5	7.63	8.92	10.72	1.9	11.65	7.48 - 12.1	4	0%	—	22.3
Sulfate	mg/l	—	58.6	5.4	62.2	50.9 - 62.7	3	0%	—	31.5	34.7	35.8	132	7	134	120 - 139	4	0%	—	55.8
Total Dissolved Solids	mg/l	—	452	37	476	400 - 480	3	0%	—	352	396	388	586	91	536	528 - 744	4	0%	—	420
Nutrients																				
Nitrate	mg/l N	10	NC	NC	NC	0.868	1	0%	0%	—	—	—	0.6128	0.0277	0.6005	0.59 - 0.66	4	0%	0%	2.73
Total Orthophosphate	mg/l P	—	NC	NC	NC	<0.05 - <0.05	1	100%	—	—	—	—	NC	NC	NC	<0.05 - <0.05	4	100%	—	<0.05
Metals																				
Aluminum	mg/l	—	NC	NC	NC	<0.1 - <0.1	3	100%	—	<0.1	<0.1	<0.1	NC	NC	NC	<0.1 - <0.1	4	100%	—	<0.1
Arsenic	mg/l	0.05	0.00539	0.00216	0.00558	0.00266 - 0.00793	3	0%	0%	<0.003	<0.0006	0.013	0.02683	0.00375	0.02805	0.0206 - 0.0306	4	0%	0%	0.0198
Beryllium	mg/l	0.004	NC	NC	NC	<0.0008 - <0.002	3	100%	0%	<0.003	<0.0006	<0.0006	NC	NC	NC	<0.0006 - <0.006	4	100%	0%	<0.0006
Boron	mg/l	—	NC	NC	NC	<0.5 - <0.5	3	100%	—	<0.5	<0.5	<0.5	0.5	0.038	<0.5	<0.5 - 0.587	4	75%	—	<0.5
Cadmium	mg/l	0.005	NC	NC	NC	<0.00009 - <0.0005	3	100%	0%	<0.0009	<0.00018	<0.00018	NC	NC	NC	<0.00018 - <0.0009	4	100%	0%	<0.00018
Chromium	mg/l	0.1	NC	NC	NC	<0.002 - <0.01	3	100%	0%	<0.01	<0.01	<0.01	NC	NC	NC	<0.01 - <0.01	4	100%	0%	<0.01
Copper	mg/l	1.3	0.002	0.0003	<0.002	0.0015 - <0.00229	3	67%	0%	<0.004	0.000801	0.00119	0.144168	0.24356	<0.004745	0.00118 - 0.566	4	25%	0%	<0.00105
Iron	mg/l	—	NC	NC	NC	<0.1 - <0.428	3	100%	—	<0.1	<0.1	<0.1	0.1258	0.0268	0.1205	<0.1 - 0.162	4	50%	—	<0.1
Lead	mg/l	0.015	NC	NC	NC	<0.0002 - <0.002	3	100%	0%	<0.002	<0.0004	<0.0004	NC	NC	NC	<0.0004 - <0.002	4	100%	0%	0.00135
Manganese	mg/l	—	0.0208	0.01	0.0263	<0.00675 - <0.0293	3	67%	—	0.0655	0.0833	0.0135	0.01613	0.00445	0.01495	<0.012 - 0.0226	4	50%	—	<0.0012
Mercury	mg/l	0.002	NC	NC	NC	<0.00015 - <0.00015	3	100%	0%	<0.00015	<0.00015	<0.00015	NC	NC	NC	<0.00015 - <0.00015	4	100%	0%	<0.00015
Selenium	mg/l	0.05	0.002	0.0003	<0.002	0.00137 - <0.002	3	67%	0%	<0.004	0.000851	0.0012	NC	NC	NC	<0.0008 - <0.004	4	100%	0%	<0.0008
Silver	mg/l	0.1	NC	NC	NC	<0.0002 - <0.002	3	100%	0%	<0.002	<0.0004	<0.0004	NC	NC	NC	<0.0004 - <0.002	4	100%	0%	<0.0004
Zinc	mg/l	5	0.064	0.071	0.019	<0.00828 - <0.164	3	67%	0%	<0.025	<0.005	<0.005	0.1103	0.0456	0.1165	0.0841 - 0.124	4	0%	0%	0.0683
Field Parameters																				
Temperature	°C	—	21.90	1.440	21.90	20.46 - 23.33	2	0%	—	—	19.6	18.4	23.82	2.48	24.09	20.65 - 26.71	3	0%	—	23
pH	s.u.	6.5-8.5	7.97	0.27	7.97	7.70 - 8.24	2	0%	0%	—	8.5	8.4	7.3	0.3	7.5	6.89 - 7.52	3	0%	0%	7.77
Specific Conductance	uS/cm	—	931	21	93	910 - 952	2	0%	—	—	700	720	964	79	932	887 - 1,072	3	0%	—	751
Turbidity	NTU	—	70	70	70	U - 140	2	0%	—	—	21.4	17	—	—	—	—	—	—	—	-86.5(R)
Dissolved Oxygen	mg/l	—	9.59	0.63	9.59	8.96 - 10.22	2	0%	—				5.48	0.75	5.92	4.43 - 6.1	3	0%	—	3
ORP	mV	—	112.5	87.5	112.5	25 - 200	2	0%	—				-79.1	50.8	-107.9	-121.7 - -7.8	3	0%	—	-16

Notes: [1] Statistics were calculated by substituting the reported detection limit for non-detect data
[2] Statistics for undifferentiated lower Cambrian and Precambrian quartzite represent data from two samples collected from Monument Point well in 2012 and 2013 and one sample from North Cricket well in 2013. Data from the Clean Water Test Well (CWTW-1) are not included in the statistics. The CWTW-1 samples were collected by air-lifting from an open borehole and are not considered to be comparable to samples from monitoring wells that were collected using standard environmental monitoring protocols
[3] Compiled data for Notch Peak Formation represent two samples collected from Black Hills well in 2012 and one each sample from Coyote and Nighthawk wells in 2012
NC = statistic not calculated, either all data were below the detection limit or there was only one sample
%ND = percent of samples reported as below the detection limit
% > WQ Standard = percent of samples reported above the Utah numerical groundwater quality standard. Non-detect data with MDLs greater than the standard are not compared to the standard
U = Analysis reported as being below the detection limit, but the detection limit was not reported
(R) = Data rejected as not being representative of sampled water
ORP = Oxidation-Reduction Potential

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077

BORING NUMBER: SEV-12-026 Bonneville   SHEET 1 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah   LOCATION : Headlight Gap Rd. (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface   START : 2/14/2013   END : 2/14/2013   LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
0–5	0.0	7.5			Silty gravel with sand (GM) 7.5YR 5/4 Brown, moist to slightly moist, medium dense, occasional cobble. Gravel (50%), Sand (25%), Clay/Silt (25%)	
10–15	7.5	10.0				
20–25	17.5	10.0			Clay (CH) 2.5Y 7/2 light grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Some $CaCO_3$ that react violently with HCL

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	SHEET 2 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	27.5					
30						
		10.0				
35						
	37.5					
40						
		8.5				
45						
	46.0	1.0				
	47.0					
50						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077

BORING NUMBER: SEV-12-026 Bonneville

SHEET 4 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CH) 5Y 6/2 light olive grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Occasional sand layer; Reacts violently with HCL
80		13.0				
85						
	87.0					
90		9.0				
95						
	96.0				Clay (CH) GLEY 6/5GY greenish grey, moist, very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%).	Reacts violently with HCL
100						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 3 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CH) 2.5Y 7/2 light grey, moist, stiff-very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%). % change at 70'bgs to Gravel (0%), Sand (15%), Clay/Silt (85%).	Clay reacts violently with HCL; rust streaks possibly silt or sand streak between 57 and 67' bgs; higher concentration of rust streaks on fine sand between 67 and 74' bgs. 2-4" silty sand hangers 69-71' bgs Sizeable mud cracks.
55						
	57.0					
60						
		10.0				
65						
	67.0					
70		7.0				
	74.0					
75						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077

BORING NUMBER: SEV-12-026 Bonneville

SHEET 5 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah | LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface | START : 2/14/2013 | END : 2/14/2013 | LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		11.0			Clay (CH) GLEY 6/1 greenish grey, moist, very stiff, high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts violently with HCL
105						
	107.0					
110						
		10.0				
115						
	117.0				Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey with black marbling; very moist, very stiff, very high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts violently with HCL; possible pyrite forming in thin organic layers
120						
		8.0				
125						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	SHEET 6 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	125.0				Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey with black marbling; moist, stiff, average-high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	
130		9.5				
	134.5					
135					Fat clay (CH) with ocassional lenses GLEY 5/1 greenish grey; moist, stiff, average-high plasticity; Gravel (0%), Sand (15%), Clay/Silt (85%)with % change at 150' to; Gravel (0%), Sand (20%), Clay/Silt (80%)	Abundannt sand layers up to 4" at 150' bgs No black marbling
	137.0					
140						
		17.5				
145						
150						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	SHEET 7 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	152.0				Silty Sand (SM): GLEY1 5/1 greenish grey, slightly moist, loose, average-high plasticity; Gravel (0%), Sand (80%), Clay/Silt (20%)	
155					Fat clay (CH) GLEY 5/1 greenish grey; moist, very stiff, average-high plasticity; Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts violently with HCL; some shells at 195' bgs ~4" organic rich layer at 200' bgs.
		12.0				
160						
	164.0					
165		12.0				
170						
		13.0 17.0				
175						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077	BORING NUMBER: SEV-12-026 Bonneville	SHEET 8 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic; 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
180						
	181.0					
185						
		13.0				
190						
	194.0					
195						
200						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077

BORING NUMBER: SEV-12-026 Bonneville

SHEET 9 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah

LOCATION : Headlight Gap Rd (38.8 N,-113.1 E)

ELEVATION : 4779.0 ft

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface

START : 2/14/2013

END : 2/14/2013

LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
205						
	207.0				Fat clay (CH) GLEY 5/1 greenish grey, moist-slightly moist,stiff, high plasticity, Gravel (0%), Sand (5%), Clay/Silt (95%)	Water level measured at 222' bgs
210						
215		15.0				
220						
	222.0					
225						

NORWEST CORPORATION

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	SHEET 10 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL-CH) GLEY 5/1 greenish grey, moist,very stiff, high plasticity, Gravel (0%), Sand (5%), Clay/Silt (95%)	Reacts with HCL
230		15.0				
235						
	237.0					
240		10.0				
245						
	247.0					
250						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	SHEET 11 OF 13
465077	SEV-12-026 Bonneville	

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah — LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft — DRILLING CONTRACTOR : Boart Longyear

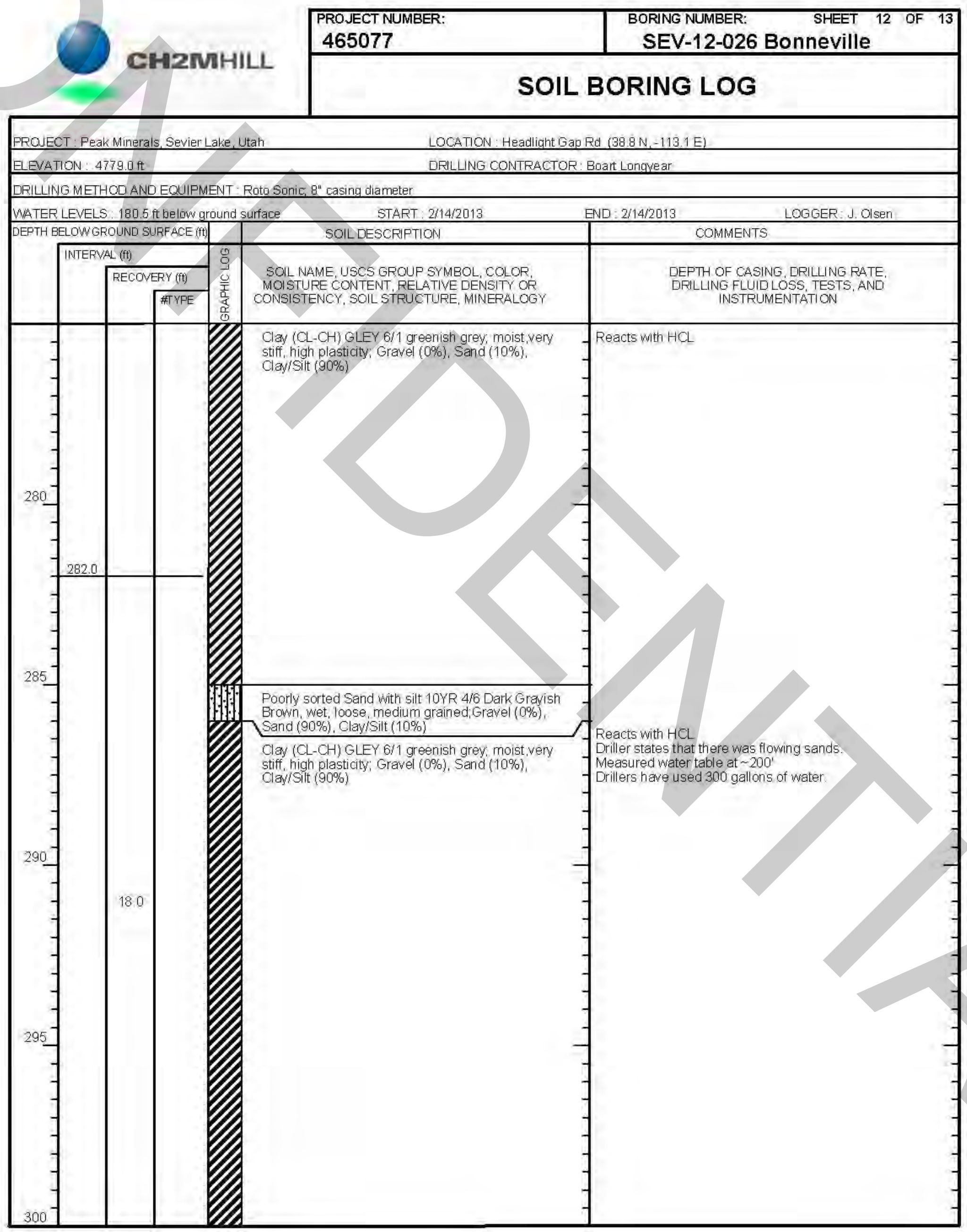
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface — START : 2/14/2013 — END : 2/14/2013 — LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		10.0			Clay (CL-CH) GLEY 5/1 greenish grey, moist,very stiff, high plasticity, Gravel (0%), Sand (7%), Clay/Silt (93%) with % change at 260' bgs to Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL
255						
	257.0					
260						
		10.0				
265						
	267.0					
270						
275		15.0				

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log


CH2MHILL

PROJECT NUMBER: 465077
BORING NUMBER: SEV-12-026 Bonneville
SHEET 12 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah
LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)
ELEVATION : 4779.0 ft
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter
WATER LEVELS : 180.5 ft below ground surface
START : 2/14/2013
END : 2/14/2013
LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#/TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
					Clay (CL-CH) GLEY 6/1 greenish grey, moist,very stiff, high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL
280						
	282.0					
285					Poorly sorted Sand with silt 10YR 4/6 Dark Grayish Brown, wet, loose, medium grained;Gravel (0%), Sand (90%), Clay/Silt (10%)	
					Clay (CL-CH) GLEY 6/1 greenish grey, moist,very stiff, high plasticity; Gravel (0%), Sand (10%), Clay/Silt (90%)	Reacts with HCL Driller states that there was flowing sands. Measured water table at ~200' Drillers have used 300 gallons of water.
290						
		18.0				
295						
300						

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Bonneville Soil Boring Log

CH2MHILL

PROJECT NUMBER: 465077

BORING NUMBER: SEV-12-026 Bonneville SHEET 13 OF 13

SOIL BORING LOG

PROJECT : Peak Minerals, Sevier Lake, Utah LOCATION : Headlight Gap Rd (38.8 N, -113.1 E)

ELEVATION : 4779.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Roto Sonic, 8" casing diameter

WATER LEVELS : 180.5 ft below ground surface START : 2/14/2013 END : 2/14/2013 LOGGER : J. Olsen

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
305, 310	300.0–312.0	12.0			Clay (CL-CH) GLEY 6/1 greenish grey, moist,very stiff, high plasticity, Gravel (0%), Sand (10%), Clay/Silt (90%)	Called bottom of hole. Driller ran an extra 10 feet in order to have solids for clean trip out.
315, 320	312.0–322.0	10.0				Extra run as stated above.
325					Bottom of Hole at 315.0 ft below ground surface 2/14/2013	

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Black Hills Well Log

Report No. 4313
Filed Jan 10 1946
Rec. by [illegible]

PAGE ______ (Leave Blank)

Report of Well and Tunnel Driller
STATE OF UTAH
(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel~~ (Strike words not needed)
   Gerald Cazier, Nephi, Utah, Driller.
2. Name and address of owner of well ~~or tunnel~~ (Strike words not needed) U. S. Grazing Service, (Fillmore, Ut,)
   P O Box 1046, S.L.C. 10-
3. Source of supply is in ______ Millard County; ______ (Leave blank) drainage area; ______ (Leave blank) artesian basin
4. The number of approved application to appropriate water is ~~One~~ 16972
5. Location of well ~~or mouth of tunnel~~ is situated at a point
   T. 23S., R. 12W. Sec. 6: N.38°45" E. 719' of SW corner
   (Describe by rectangular coordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)
6. Date on which work on well ~~or tunnel~~ was begun (Strike words not needed) April 23 1945
7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ (Strike words not needed) July 11, 1945
8. Maximum quantity of water measured as ~~flowing~~, pumped or (Strike words not needed) ______ on completion of well ~~or tunnel in sec. ft.~~ ______; or in gals. per minute about 12 Date ______

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ pump well. (Strike words not needed) Temperature of water ______ °F.
   (a) Total depth of well is 560 ft. below ground surface.
   (b) If flowing well, give water pressure (hydrostatic head) above ground surface ______ ft.
   (c) If pump well, give depth from ground surface to water surface before pumping 210 ft.; during pumping 210 ft
   (d) Size and kind of casing 6 in (If only partially cased, give details)
   (e) Depth to water bearing stratum 1 ft. (If more than one stratum, give depth to each)
   (f) If casing is perforated, give depth from ground surface to perforations ______
   (g) Log of well 559 feet through heavy greasy white clay then one foot of water to bed rock.
   (h) Well was equipped with ~~[illegible]~~, or ______ (Strike words not needed) to control flow.

(Over)

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Black Hills Well Log

10. **TUNNEL:** It is timbered, tiled, piped, open, bulkheaded, covered or ________
(Strike words not needed)

(a) Dimensions ______; total length ______; temperature of water ______ °F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel ______

(c) Log of tunnel ______

11. **GENERAL REMARKS:** (Note any general or detailed information not covered above.)

STATE OF UTAH,
COUNTY OF Juab } ss.

I, Gerald Cazier, being first duly sworn, do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Gerald Cazier
Driller

Witnessed ~~Subscribed and sworn to before me this~~ 7 day of Jan., 1946

(SEAL)

N A K Hansen
Dept. Engineer

My Commission Expires: ______

JAN 10 1946
State Engineer's
Office

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Black Hills Well Log

Listed on well record
Listed by counties
Copied rgh 2-12-47
Exam. & Recorded ... 12-23-46
Exam. for filing
Final Copy checked rgh 2-20-47
Platted & No. Assigned
Indexed rgh 2-1-7-47
Engr. loc. well
Engr. set BM
And No. C-23-12)6 ccc-1

Report No. 4911
Filed October 19, 1946
Rec. By McKim
Ret'd

PAGE .... (Leave Blank)

8.14.186

Report of Well and Tunnel Driller

STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation boring or~~ drilling well ~~or tunnel.~~ (Strike words not needed)
Vernon Pinnick Manti Utah

2. Name and address of owner of well ~~or tunnel~~ (Strike words not needed) U.S. (Government) Grazing Service Federal Bldg (Black Rock) Utah

3. Source of supply is in .... Millard County;
.... (Leave blank) drainage area; .... (Leave blank) artesian basin

4. The number of approved application to appropriate water is 16972

5. Location of well ~~or mouth of tunnel~~ is situated at a point
N. 38°45' E.719' from SW Cor. Sec.6 T23 S. R12 W.,SLB&M
(Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)

6. Date on which work on well ~~or tunnel~~ was begun May 11 - 1946 (Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ 5/17/46 (Strike words not needed)

8. Maximum quantity of water measured ~~as flowing,~~ pumped or .... on completion of well ~~or tunnel in sec. ft.~~ ....; or in gals. per minute 5 Date 5/17/46 (Strike words not needed)

DETAIL OF COLLECTING WORKS:

9. WELL: It is drilled, ~~dug, flowing or~~ pump well. Temperature of water 49 °F. (Strike words not needed)
   (a) Total depth of well is 60' ft. below ground surface.
   (b) If flowing well, give water pressure (hydrostatic head) above ground surface .... ft.
   (c) If pump well, give depth from ground surface to water surface before pumping 27'; during pumping 50'
   (d) Size and kind of casing 6" New Standard Pipe (If only partially cased, give details)
   (e) Depth to water bearing stratum 51' (If more than one stratum, give depth to each)
   (f) If casing is perforated, give depth from ground surface to perforations 50 to 51
   (g) Log of well 0-20 Top soil with fine gravel 20-48 clay & cemented gravel 48-51 Hard gravely formation 51-60 fine gravel & water
   (h) Well was equipped with cap, valve, or .... to control flow. (Strike words not needed)

(Over)

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C Black Hills Well Log

10. TUNNEL: It is timbered, tiled, piped, open, bulkheaded, covered or ________ (Strike words not needed)

(a) Dimensions ________; total length ________; temperature of water ________°F.

(b) Position of water bearing stratum or strata with reference to mouth of tunnel ________

(c) Log of tunnel ________

11. GENERAL REMARKS: (Note any general or detailed information not covered above.)

RECEIVED
OCT 19 1946
State Engineer's Office

STATE OF UTAH,
COUNTY OF Salt Lake } ss.

I, Vernon Dimick, being first duly sworn, do hereby certify that I am the driller of the aforesaid well or tunnel who furnished the foregoing statement of facts; that I have read said statement and each and all of the items therein contained are true to the best of my knowledge and belief.

Vernon Dimick
Driller

Subscribed and sworn to before me this 19 day of October, 1946.

Laurena E. Monson
Notary Public

(SEAL)

My Commission Expires:
July 18 1948

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C SDL Series Lithologic Logs

Table 7.—*Drillers' lithologic logs of selected wells*—Continued

Site number	Location and material	Thickness	Depth
	Amasa Playa HJu		
15	(C-20-12) 1aac- 1. Log by Fugro National, Inc. Alt. 4,543.8 feet		
	Sand, silty, poorly sorted...	2	2
	Gravel, silty, poorly graded, strong effervescence	7	9
	Clay, silty, weak effervescence....................	10	19
	Clay, strong effervescence...	10	29
	Clay, medium plasticity, weak effervescence..........	30	59
	Clay, high plasticity, strong effervescence........	10	69
	Clay, medium plasticity, weak effervescence..........	27	96
	Silt, nonplastic, gravel, fine, angular, weak effervescence................	4	100
	Clay, slight to medium plasticity, silt interbeds..	50	150
17	(C-20-12)10dcd- 2 Alt. 4,524.5 feet		
	Clay, tan, and gravel, unsorted......................	5	5
	Clay, tan......................	25	30
	Clay, reddish-brown	71.5	101.5
	Mud Flat Playa HJu		
18	(C-20-12)10dcd- 3 Alt. 4,525 feet		
	Clay, tan, and gravel, unsorted......................	5	5
	Clay, tan......................	30	35
	Clay, gray-green..............	2	37
	Clay, red-brown, some gypsum crystals present............	53	90
	Clay, gray-green, with some interbedded red-brown clay containing some gypsum......	40	130
	Clay, red-brown, sand, coarse	73	203
	Glitter Gulch Playa HSU		
19	(C-20-12)32aaa- 1 Alt. 4,525 feet		
	Sand, gravel, clay, unsorted......................	1	1
	Clay, tan......................	4	5
	Clay, red-brown..............	40	45
	Clay, red-brown, high plasticity...................	5	50
	Clay, red, tan, intermittent gray-green clay layers......	10	60
	Clay, red......................	2	62
	Clay, red-brown..............	39	101
	Glass Ocean Playa HSU		
20	(C-20-12)32aaa- 2 Alt. 4,525 feet		
	Sand, gravel clay, unsorted......................	1	1
	Clay, tan, gypsum present....	7	8
	Clay, red, with intermittent gray-green clay layers......	195.5	203.5
21	(C-20-12)32abd- 1 Alt. 4,550 feet		
	Sand, thin soil layer on top.	8	8
	Clay, red, low plasticity ...	17	25
	Clay, red-brown, thin layer of gray-green clay at 40 feet.........................	125	150
	Clay, alternating red-brown and gray-green..............	52	202
25	(C-22-12)14a - 1. Log by M. C. Godbe, III Alt. 4,528 feet		
	TD 975 SDL-4 (Gwynn, 2006) Needle Pt.		
	Limestone, dark gray to black, minor quartzite pebble gravel, quartz sand and grit, tan and light brown, grades downward with silt and clay, gray, interbedded with sand, salty taste...?.....................	30	30
	Clay, silty, dark, carbonaceous......................	10	40
	Clay, silty, green-gray, silt and sand, fine, silty clay zone partially cemented with gypsum and selenite crystals....................	20	60
	Sand, dark brown to gray, thin beds, grading to clay, salty........................	20	80
	Clay, gray-green, sandy zones, slight salt taste....	20	100
	Clay, gray-green, and silty clay, brown, mottled, silty-sand zones, some carbon, salty........................	100	200
	Clay, brown, mottled, silt and sand, gray-green, slightly salty..............	20	220
	Clay, gray-green and brown, mottled, hard, dense, slightly salty..............	20	240
	Clay, gray-green and brown, alternating, mottled, moderately hard, dense.........	80	320
	Clay, sandy-silty, green-gray and brown, some gypsum cementing....................	40	360
	Clay, silty, gray-green and brown, occasionally mottled, slightly salty, dense, hard, zones of carbonaceous material from 430-490............	158	518
	Sand, fine, dark gray-brown, clay bits, gray..............	7	525
	Sand and silt, brown and red-brown, scattered gypsum in clay.........................	50	575
	Silt, gray-brown..............	5	580

NORWEST CORPORATION

Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C SDL Series Lithologic Logs

Table 7.—*Drillers' lithologic logs of selected wells*—Continued

Site number	Location and material	Thickness	Depth	
	(C-22-12)14a - 1.--Continued			
	Clay, silty, gray-green and brown, occasional carbon, little salty taste..........	140	720	
	Clay, gray-green and brown, not salty....................	60	780	
	Silt and silty clay, gray-brown.........................	60	840	
	Sand, fine-grained, dark gray brown, lime and quartz grains........................	10	850	
	Sand, silt, and clay interbeds, gray-green and gray-brown, occasional carbonaceous clay.................	125	975	
26	(C-22-12)36acc- 1. Log by M. C. Godbe III Alt. 4,517 feet			SDL-2 (in Gwynn 2006) TD 840
	Clay, cream-colored, pebble gravel with limestone and quartzite clasts, sand, medium coarse, salt encrustation at top inch...........	21	21	
	Clay, blue-gray..............	7	28	
	Clay, blue to green-gray, scattered salt seams........	10	38	
	Sand, medium grain, gray.....	2	40	
	Clay, light gray, scattered salt seams..................	16	56	
	Sand, medium grain, gray.....	2	58	
	Clay, sandy, light gray......	30	88	
	Clay, light gray to green-gray with brown-black seams.	52	140	
	Clay, dense, light gray, euhedral salt (gypsum?) crystals.....................	30	170	
	Clay, dense, light green-gray	25	195	
	Clay, dense, light brown.....	5	200	
	Clay, light green-gray.......	15	215	
	Clay, silty, light green-gray, with sand, fine- to medium-grained lenses, some carbonaceous pieces and streaks...	27	242	
	Clay, dense, gray............	8	250	
	Clay, dense, gray-green, abundant carbonaceous streaks...	20	270	
	Clay, silty, dry, green-gray.	10	280	
	Clay, moderately compact, gray-green..................	40	320	
	Clay, brown..................	5	325	
	Clay, moderately compact, gray to light gray..........	35	360	
	Clay, moderately hard, alternating gray-green and brown.	28	388	
	Clay, green-gray.............	8	396	
	Clay, moderately dry, alternating gray-green and brown.	34	430	
	Clay, wet, slightly salty taste, green-gray...........	20	450	
	Clay with silt and sand interbeds, dry, salty taste, alternating gray-green and red-brown....................	78	528	
	(C-22-12)36acc- 1.—Continued			
	Unit similar to above but wetter and less salty taste....	27	555	
	Unit similar to above but with decreasing sand content.....	5	560	
	Clay, silty, dry, hard, carbonaceous, gray and gray-green, occasional sand grains......	36	596	
	Clay, wet, gray to green, sand, medium- to coarse-grained, scattered, salty taste........................	54	650	
	Clay, brown..................	5	655	
	Clay, sandy-silty, alternating wet and dry, gray-green and gray.....................	121	776	
	Clay, silty-sandy, gray to gray-green with some brown, slightly salty taste........	64	840	
29	(C-23-11) 7bbc- 2 Alt. 4,530 feet			
	Clay, sandy..................	3	3	Erehwon
	Sand, gravel, clay, unsorted, wet.........................	2	5	Playa HSU
	Clay, tan, sandy.............	2	7	
	Clay, tan....................	11	18	
	Clay, gray...................	22	40	
	Clay, black..................	5	45	
	Clay, gray-green.............	80	125	
	Clay, gray-green, high plasticity.................	78	203	
30	(C-23-11) 7bdb- 1 Alt. 4,550 feet			
	Sand, fine with clay.........	1	1	Headlight Gap
	Sand, angular, and gravel, rounded, unsorted...........	12	13	
	Clay, tan, gypsum crystals present......................	12	25	Playa HSU
	Clay, gray-green, gypsum crystals present, high plasticity..................	30	55	
	Clay, gray-green, high plasticity..................	105	160	
	Clay, gray-green alternating with brown..................	18	178	
	Clay, gray-green alternating with dark gray to black, high plasticity.............	7	185	
	Clay, gray-green alternating with brown, high plasticity..................	9	194	
	Clay, gray-green, high plasticity..................	13	207	
31	(C-23-11) 8cda- 1. Log by Stephenson Drilling Inc. Alt. 4,685 feet			
	Top soil.....................	2	2	
	Clay, blue...................	538	540	

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Attachment 1 - Figures and Tables from Whetstone 2017 Report

Whetstone Appendix C SDL Series Lithologic Logs

Table 7.--*Drillers' lithologic logs of selected wells*--Continued

TD 705

SDL-3 (Gwynn, 2006)

Site number	Location and material	Thickness	Depth
32	(C-23-11)31a -1. Log by M. C. Godbe III Alt. 4,520 feet		
	Pebble gravel, quartzite	3	3
	Sand, coarse, quartz, with clay beds, light green to gray, salty	7	10
	Clay, light green to gray, moderately dense	12	22
	Clay, brown, scattered with sand, medium coarse, quartz.	8	30
	Clay, gray-green, dense, some salt crystals	8	38
	Clay, dark gray-green, dry, carbonaceous, salty, sand seams	22	60
	Clay, gray-green, wet, some brown zones, salty taste	40	100
	Clay, light to dark gray-green, silty, some vegetal remains	20	120
	Clay, gray-green, some brown, wet, dense	12	132
	Clay, gray-green, silt, some brown streaks, wet	103	235
	Clay, dark gray-green, slightly silty, carbonaceous	20	255
	Clay, interbedded brown and gray-green, some salt and gypsum, silty in places	235	490
	Silt, brown and gray, with abundant sand	8	498
	Gypsum crystals and clay, gray	10	508
	Clay, mottled gray-green and brown, dense, some silt, salty	172	680
	Gypsum, some silt	5	685
	Clay, green-gray, mottled with brown, hard, dense	20	705
33	(C-23-11)31a -2. Log by M. C. Godbe III Alt. 4,520 feet		
	No samples	35	35
	Clay, green-gray to gray-green, occasional silty zones vegetal material, salt and gypsum in vugs	39	74
	Clay, dark gray-blue to gray, carbonaceous zones, silty	41	115
	Silty	45	160
	Clay, gray-green mottled with brown, hard, silty, little salt	55	215
	Clay, gray-green, moderately hard, wet, silty, gypsum crystals in vugs	50	265
	Clay, brown and gray-green, mottled	25	290
	Clay, gray-green, wet, scattered sand grains	5	295
	Clay, brown and gray-green, mottled	30	325
	(C-23-11)31a -2.--Continued		
	Clay, gray-green, hard, dense, silty zones, carbonaceous specks	35	360
	Clay, brown and gray-green, mottled, silty zones	130	390
	Gypsum, euhedral crystals	5	395
	Clay, gray-green, occasional brown mottling, slightly silty, moderately dense	45	540
	Clay, gray-green, some mottling, silty, some wet areas, slightly salty taste	30	570
	Silt, moderate	10	580
	Clay, gray-green, some mottling, silt	25	605
	Silt	5	610
	Clay, gray-green	70	680
	Silt, moderate, slight salt	5	685
	Clay, alternating gray-green and brown, hard, dense, carbonaceous spots	102	787
	Silt	3	790
	Carbonaceous and vegetal material	5	795
	Clay, gray-green and brown mottled, silt zones, hard, dense, slightly salty	75	870
	Clay, blue-gray to dark gray, carboneceous in spots	50	920

TD 920

SDL-3A (Gwynn, 2006)

Machine Gun Playa HSU

Site number	Location and material	Thickness	Depth
35	(C-23-12) 5cdd- 2 Alt. 4,525 feet		
	Sand	2	2
	Clay, gray-green	6	8
	Clay, gray-green, darker than above	27	35
	Clay, reddish-tan, with intermittent gray-green layers	67	102
36	(C-23-12) 5cdd- 3 Alt. 4,525.4 feet		
	Sand	2	2
	Clay, light gray-green	10	12
	Clay, red-brown	3	15
	Clay, dark gray-green	15	30
	Clay, brown	2	32
	Clay, dark gray-green with alternating brown layers	40	72
	Clay, gray-green, low plasticity, alternating thin-layered, clay, red-brown, higher plasticity	101	173
	Clay, gray-green, high plasticity	30	203
37	(C-23-12) 6ccd- 1. Log by Gerald Cazier, Driller Alt. 4,632 feet		
	Clay, white, greasy, heavy	559	559
	Bedrock with water	1	560

Interaction

Playa HSU

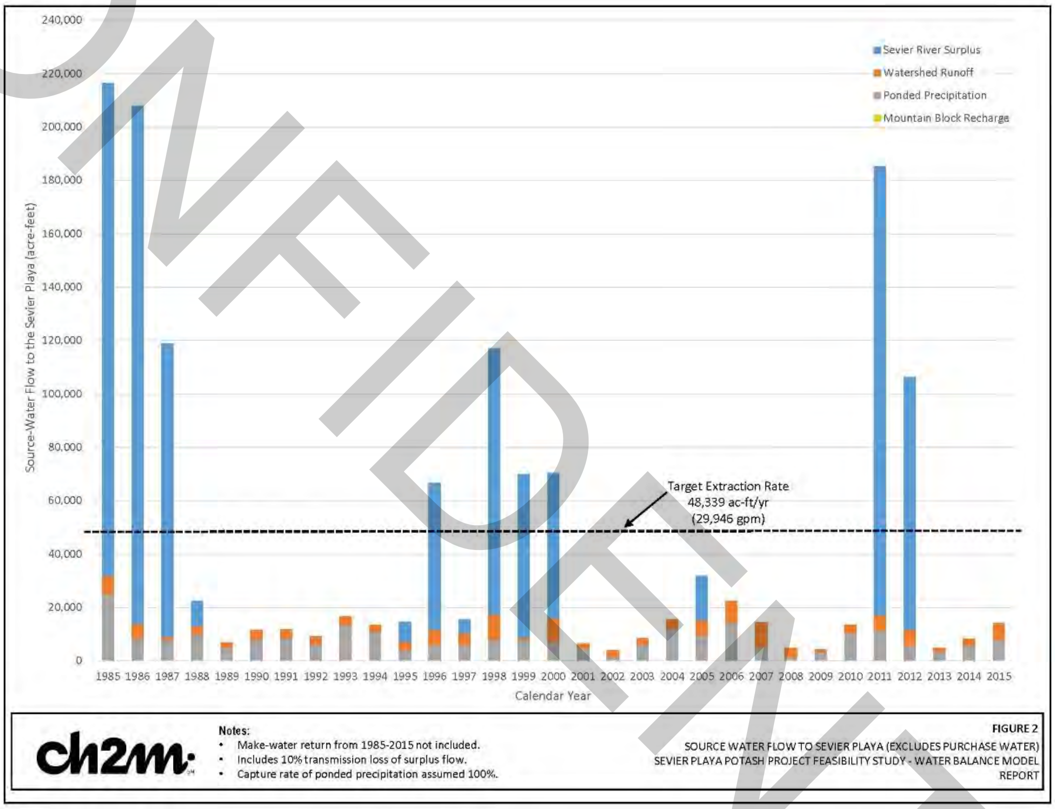
Black Hills Well

Black Hills

Attachment 2 - Figures and Tables from Various CH2M Reports

CH2M Water Balance Report (2017)

Figure 2 Source Water Flow to Sevier Playa

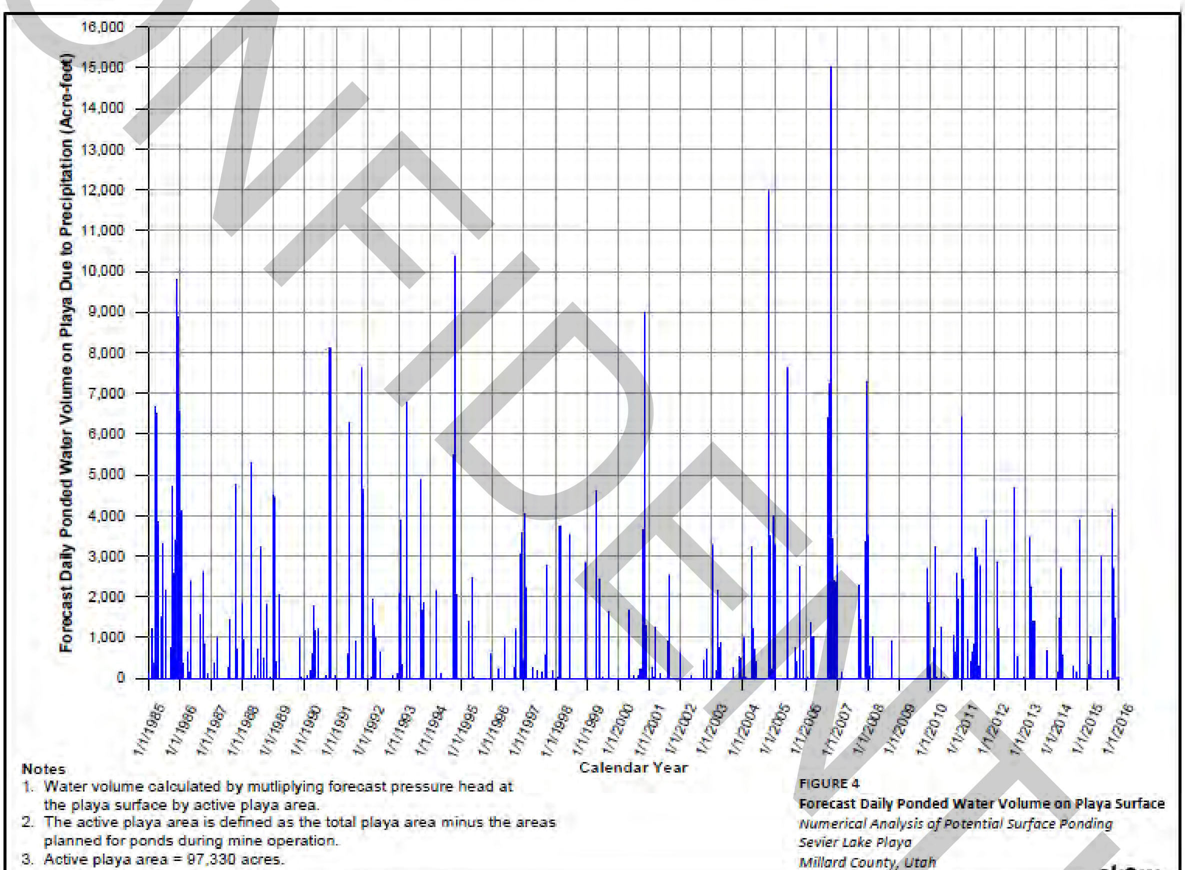


NORWEST CORPORATION

Attachment 2 - Figures and Tables from Various CH2M Reports

CH2M Water Balance Report (2017)

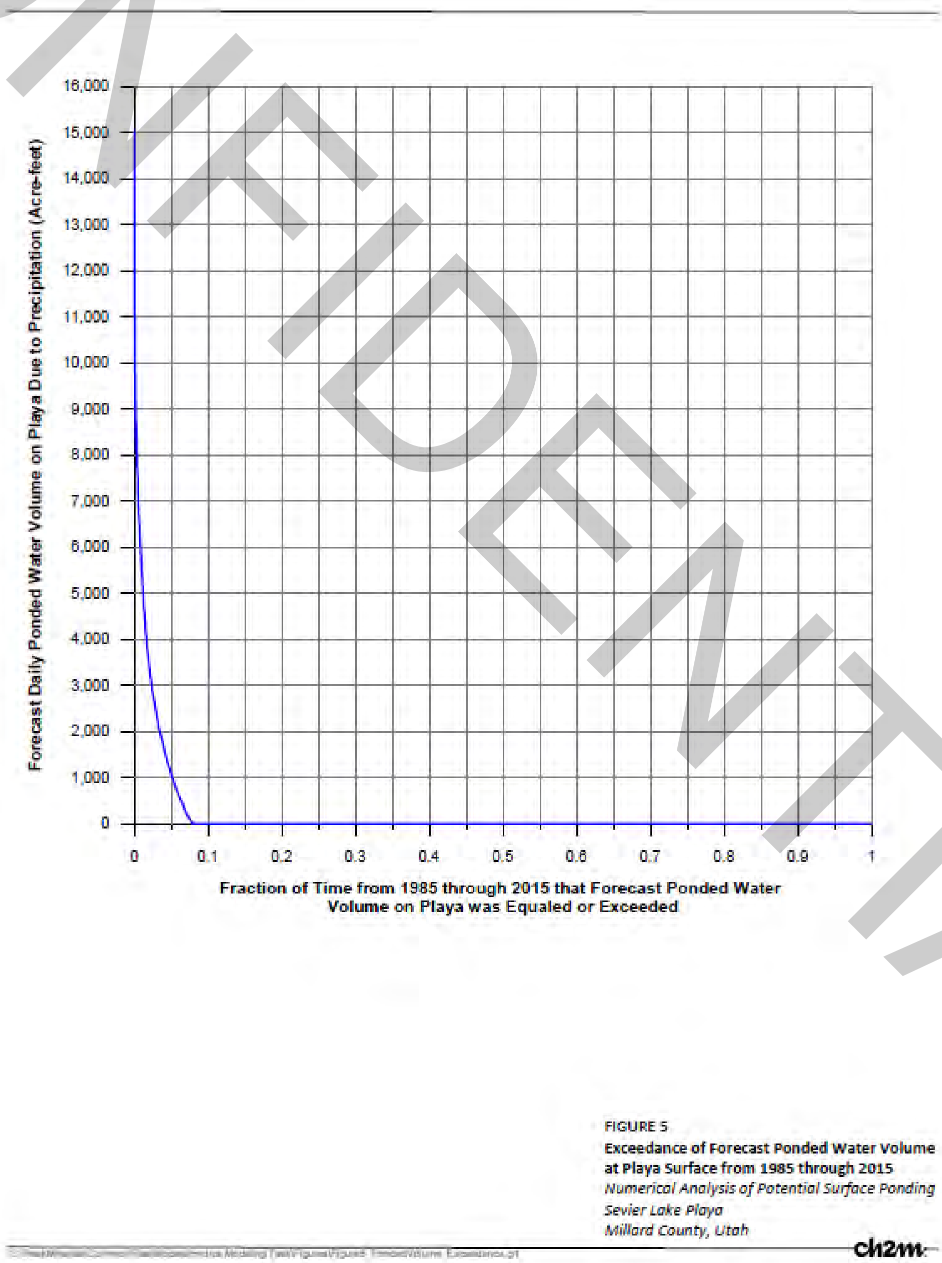
Figure 4 Forecast Daily Ponded Water Volume on Playa Surface



Attachment 2 - Figures and Tables from Various CH2M Reports

CH2M Water Balance Report (2017)

Figure 5 Fraction of Time from 1985 through 2015 that Forecast Ponded Water Volume on Playa was Equaled or Exceeded



Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies

1 INTRODUCTION

This Attachment presents a summary of the Surface Water studies that CPM conducted for the SPP during the 2014 to 2016 period.

2 2014 TO 2016 DATA

CPM conducted numerous testing programs during the period of 2014 through 2016 to further assess playa conditions. These included:

- Surface water characterization;
- Drilling of monitoring wells;
- Aquifer testing;
- Brine quality sampling;
- Trench-to-trench (TtT) testing;
- Well-to-trench (WtT) testing; and
- Column testing of in-situ samples.

2.1 Surface Water Characterization

Additional surface water characterization was performed to describe the surface water resources and to facilitate forecasting of potential water purchase requirements going forward. This characterization program consisted of three primary components:

- Evaluation of annual Sevier River flow.
- Evaluation of annual surface water runoff from the Sevier Lake Basin watersheds.
- Evaluation of annual surface water ponding due to direct precipitation on the Sevier Playa.

The results of these analyses are discussed below and summarized in the CH2M HILL (CH2M) Water Balance Report (2017). This report was previously provided to the BLM and consists of a brief summary with four appended supporting reports. **Figure 2** from the CH2M report (2017) is attached to this memo in **Attachment 2**.

2.1.1 Sevier River Flow

CH2M evaluated the Sevier River surface water flow using multiple methods, including a combination of historical flow estimation, discharge measurement, hydrograph analysis, and hydraulic modeling. These evaluations are presented in Appendix B, July 2017 Evaluation of Sevier River Transmission Losses and Discharge Report, of the CH2M report

Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies

(2017). The historical flow estimation for the Sevier River downstream from Gunnison Bend Reservoir was estimated using records provided to CPM by the Sevier River Water Users Association (SRWUA) Water Master for the lower Sevier River. Using the SRWUA records from 1985 to 2015, a 31-year history of estimated flow released from the Gunnison Bend Reservoir to the Sevier River was calculated.

Appendix B of CH2M's report (2017) provides an estimate of transmission losses (i.e., losses resulting from infiltration of water into channel sediments) from the Sevier River in the reach from Gunnison Bend Reservoir to the Sevier Playa. To quantify these losses, this reach of the Sevier River was modeled using the U.S. Army Corps of Engineers Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) software. Field data were used to validate the HEC-HMS model parameters; the field data included discharge and hydrograph data from 10 Sevier River gauging stations (installed in July 2012), sediment characterization and hydraulic conductivity analysis from 16 soil samples (collected in September 2016), and estimation of cross-sectional areas for four Sevier River stream gauging stations locations. **Table 1** below presents the estimates of infiltration rates and estimated transmission losses for the various flow scenarios over the range of purchased waters. The estimated Sevier River inflows to the playa, presented in **Figure 2** (**Attachment 2**), account for transmission losses downstream from Gunnison Bend Reservoir. These inflow estimates in **Figure 2** (**Attachment 2**) did not account for seepage or evaporation from the reservoir and only assumed a 10% transmission loss. Therefore, they are relatively optimistic.

Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies

Table 1: Long-term Condition Transmission Loss Results

Scenario Purchased Water (ac-ft/yr)*	Infiltration Rate (cfs/ac)**	Inflow Volume at Conks Dam (ac-ft/yr)*	Estimated Volume at Sevier Playa (ac-ft/yr)*	Transmission Loss (%)
Minimum 6,800	0.010	6,800	5,150	24
Maximum 6,800	0.025	6,800	2,972	56
Minimum 27,000	0.010	27,00	22,452	17
Maximum 27,000	0.025	27,000	16,414	39
Minimum 48,700	0.010	48,800	42,640	12
Maximum 48,700	0.025	48,800	39,461	28

* ac-ft/yr – acre-feet per year
** cfs/ac – cubic feet per second per acre

2.1.2 Sevier Lake Basin Watersheds

A 31-year history of the annual volume of surface water runoff from Sevier Lake Basin watersheds to the Sevier Playa was reconstructed and evaluated using the Stormwater Management Model (SWMM), as detailed in Appendix C, Surface Runoff Analysis for the Mountain Watersheds Surrounding the Sevier Lake Playa Report, of the CH2M report (2017). The primary model input parameters included precipitation, infiltration and evaporation. To refine the precipitation input parameter, 30 years of precipitation data from eight nearby meteorological stations were merged and weighted. To refine the infiltration input parameter, 40 soil samples were collected across the catchment areas for sediment characterization and hydraulic conductivity testing. Also, the watershed areas were divided into upper and lower portions to account for the differences in soils and slopes. To refine the evaporation input parameter, updated reference evapotranspiration values were obtained from the Utah Climate Center weather station located at Delta, Utah. **Table 2** below presents the estimates of runoff anticipated for the maximum, average, and minimum runoff scenarios.

Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies

Table 2: Runoff Simulation for Maximum, Average, and Minimum Runoff Scenarios

	Maximum Runoff Scenario			Average Runoff Scenario			Minimum Runoff Scenario		
	Acre-Feet	Inches	% of Total Precipitation	Acre-Feet	Inches	% of Total Precipitation	Acre-Feet	Inches	% of Total Precipitation
Total Precipitation	11,074,770	341.72	100.0	11,074,770	341.72	100.0	11,074,770	341.72	100.0
Infiltration Loss	10,758,593	331.96	97.1	10,911,892	336.69	98.5	10,985,299	338.95	99.2
Evaporation Loss	74,642	2.30	0.7	34,340	1.06	0.3	16,814	0.52	0.2
Surface Runoff	244,339	7.54	2.2	130,650	4.03	1.2	74,032	2.28	0.7

Due to the remote, arid, and ephemeral nature of streams surrounding the playa, it was not possible to calibrate these runoff calculations. However, these runoff volumes are similar to the results from the USGS (1986) and Utah Division of Water Rights (UDWR) (1991) analyses completed for the watersheds surrounding the playa. Also, as well as limited surface runoff, the division between the upper and lower portions of the watersheds resulted in some runoff from the upper portions of the watershed, but significant infiltration/transmission losses of both precipitation and surface runoff in the lower portion of the basins. Thus, it is likely that delivery of runoff from the surrounding watersheds to the playa is minimal.

2.1.3 Sevier Playa Ponded Precipitation

A 31-year history of the volume of water that ponded on the surface of the Sevier Playa due to precipitation was reconstructed and evaluated using Hydrus-1D, a one-dimensional finite element infiltration model, as detailed in Appendix D, *Technical Memorandum Results of a Numerical Analysis of Potential Surface Ponding Resulting from Direct Precipitation at Sevier Lake Playa,* of the CH2M report (2017). The primary objective of the Hydrus-1D model was to compute the ponding depth at the Playa surface as a function of historical meteorological conditions, including precipitation and potential evapotranspiration (PET), and soil hydraulic properties. The precipitation data set used in the Hydrus 1D model was the same as that described above for the surface runoff evaluation. The PET data set was from a meteorological station located in Delta, Utah. The hydraulic properties of playa sediments used in the Hydrus-1D model were based on laboratory-determined soil moisture retention curves from three sediment cores collected from the upper 12 feet of the Sevier Playa. The saturated hydraulic conductivity used in the Hydrus-1D model was based on the results of 16 laboratory permeability tests of soil samples collected within 12 feet of the Sevier Playa surface.

Attachment 3 - Summary of 2014-2016 CPM Surface Water Studies

Figure 4, from the CH2M Water Balance Modeling Report presented in **Attachment 2,** presents the results of the Hydrus-1D model and shows a forecast of daily volumes of ponded water resulting from direct precipitation over the modeled 31-year period. **Figure 5,** also from the CH2M report presented in **Attachment 2,** presents an exceedance plot for the forecast daily ponded water volume on the playa from direct precipitation. This figure shows that over the 31-year simulation period, the playa may have experienced ponded conditions due to precipitation approximately 8 percent of the time with a daily volume of ponded water on the playa equal to or exceeding 1,000 acre-feet approximately 5 percent of the time. Thus, model results indicate that significant ponding on the playa surface due to direct precipitation alone is expected to occur only once every 12 to 20 years. The volume of ponded water that could potentially be captured during mine operations, assuming 1985 through 2015 meteorological conditions, was estimated using the following approach.

Runoff estimates of runoff volumes were calculated from the meteorological data. Where the volumes were small all runoff was assumed to flow into the trenches. Where runoff volumes were larger, the excess precipitation was assumed to pond on the playa surface. When this occurred, during consecutive days of ponded conditions, some portion of the ponded volume would be a result of the ponded water that was present on the day before. The ponded volume on Day 2 of a multi-day ponding event would not be the sum of Day 1 and Day 2 because part of the first day's ponded volume would have been routed toward a trench. Thus, to account for the changing volume of available ponded water in a simplified manner, the average daily volume of any multi-day ponding event was used to calculate the volume of water that could potentially be captured. **Figure 6,** also from the CH2M report presented in **Attachment 2,** shows the simulated annual volume that would have potentially been available during the model period for routing to recharge trenches. The figure shows that the estimated volume of available water tracks closely with annual precipitation. The average volume of ponded water over the simulation period is approximately 7,500 acre-feet per year (ac-ft/yr). However, this volume assumes 100-percent capture efficiency; thus, this estimated volume could be an overestimate of what could feasibly be captured.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1 INTRODUCTION

This Attachment presents a summary of the Drilling and Groundwater studies that CPM conducted for the SPP during the 2014 to 2016 period.

1.1 Summary of Drilling Activities

1.1.1 Historic Drilling

Drilling on the Sevier Playa was conducted between 1979 and 1983 by Crystal Peak Minerals Corporation (previous lease holders, not affiliated with CPM). Over 700 auger holes were completed during that period. The holes were drilled to a depth of 20 feet and cased with 2-inch slotted polyvinyl chloride (PVC) casing. Composite samples containing brine and sediment were extracted from those holes at five-foot intervals. These sediment and brine samples were used for the following purposes:

- Mapping of surface crust
- Mapping of surface mineral chemistries
- Determining sediment mineralogy
- Testing of brine geochemistry
- Measuring sediment sample water saturation levels
- Determining depth and extent of brine within 20 feet from the surface
- Performing particle size analysis of sediment samples.

1.1.2 CPM 2011 to 2013 Program

CPM drilled 431 exploration holes to delineate resources on SITLA and BLM leases between 2011 and 2013, with drilled penetration totaling 18,306.4 feet. Exploration holes drilled by CPM from 2011 through 2013 used a combination of direct-push and mini-sonic coring techniques. The hole spacing was approximately 3,000 feet. Drilling generally progressed from the south end of the Playa northward.

Statistics for all drilling from 2011 through 2013 are presented in **Table 1** and **Table 2**. Locations of the various well types are illustrated in **Figure 1**. All holes drilled during the CPM program were of vertical orientation. Logs of these holes were provided previously.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Table 1: CPM 2011/2012 and 2013 Programs – Drill Hole Types

CPM Lease	Direct Push	Shallow Sonic	Deep Sonic	Auger	Monitor Twins	Total
Federal	357	33	1	0	10	401
State	17	7	1	1	0	26
LUMA	0	4	0	0	0	4
Total	374	44	2	1	10	431

Table 2: CPM 2011/2012 and 2013 Programs – Exploration Drill Hole Depth Summary

CPM Lease	Number of Holes	Minimum Depth (ft)	Maximum Depth (ft)	Average Depth (ft)	Total (ft)
Federal	391	15.0	497.0	42.3	16,549.9
State	26	20.0	265.0	58.1	1,512.5
LUMA	4	37.1	79.1	62.0	248.0
All leases	421	15.0	497.0	43.5	18,306.4

*** Excludes vertically-nested monitoring wells.**

1.1.3 CPM 2015 Drilling Program

Starting in September 2015, CPM commenced an infill exploration and hydrologically-focused drilling program on their BLM and SITLA leases. The primary purpose of the 2015 program was to acquire sufficient geologic and hydrologic field data to support a brine-hosted potassium mineral resource and mineral reserve estimate in accordance with National Instrument (NI) 43-101 technical reporting standards. A total of 29 boreholes were completed. Mini-sonic coring methods were used for these vertically-oriented holes. A series of 16 of these boreholes were drilled into the shallow Marl Clay Zone (MCZ) to a depth of approximately 40 feet below ground surface (bgs), with the primary objective of characterizing the shallow brine-hosted resource. A total of 12 of these holes were cored to the base of the brine-saturated Siliceous Clay Zone (SCZ), at a depth of approximately 79 feet bgs. These zones are discussed in detail below under *Playa Stratigraphy*. The base of the SCZ consisted of a target bed of hard, dry, red clay that had been identified in the prior drilling of the deeper zone. This dry clay bed was encountered in all holes drilled through the SCZ. The boreholes were drilled with a primary objective of characterizing the SCZ brine-hosted resource.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

A summary breakdown of the number and overall purpose of holes completed during the 2015 drilling program is provided in **Table 3**, and locations of the 2015 CPM program holes are illustrated in **Figure 2**. Also labeled in **Figure 2** are the hole identifications for the twin holes used for hydrologic testing. These twin hole depths are not reflected in the hole depth summary statics listed in **Table 4**.

Table 3: CPM 2015 Program – Drill Hole Types

CPM Lease	Deep Sonic Exploration	Pump Testing Twin (4-in)	WtT (4-in)	Monitor Twins (4-in)	Total
Federal	11	4	1	10	26
State	1	0	0	2	3
LUMA	0	0	0	0	0
Total	12	4	1	12	29

Table 4: CPM 2015 Programs – Exploration Drill Hole Depth Summary

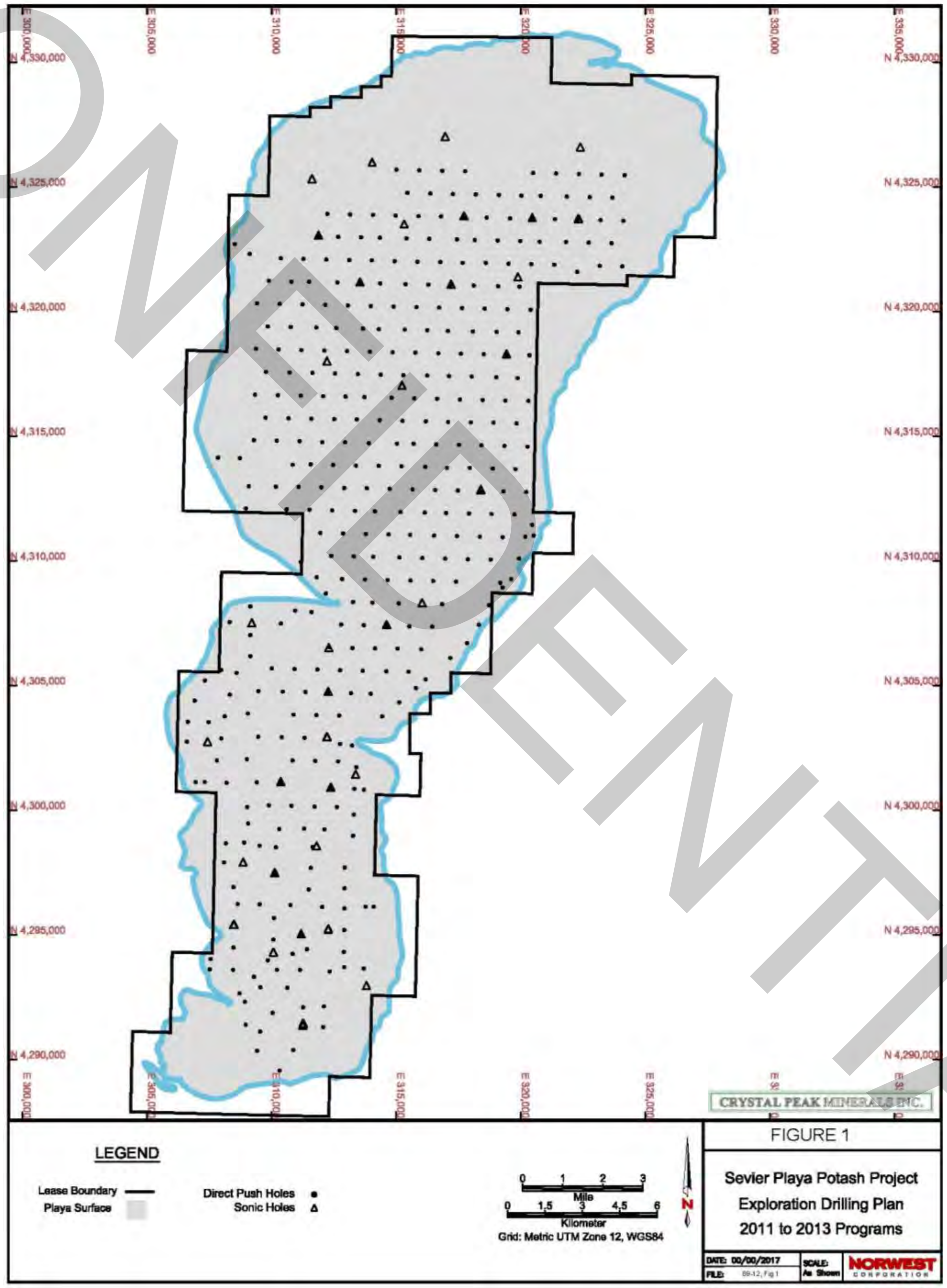
CPM Lease	Number Holes	Minimum Depth (ft)	Maximum Depth (ft)	Average Depth (ft)	Total (ft)
Federal	11	53.0	125.0	85.6	941.9
State	1	0	0	60.0	60.0
LUMA	0	-	-	-	-
All leases	12	53.0	125.0	83.5	1,001.9

* Excludes vertically-nested monitoring wells.

Drilling techniques and data collection methodologies were similar to the previous CPM sonic programs. The new sonic holes were logged in the field by Norwest geologists. The lithologic core and Shelby tube samples, along with descriptions from these field logs, together with moisture content sample results, are provided in **Attachments 5 and 6**. Where the lithology of the twin or WtW bore holes did not differ from the adjacent hole, no separate log was prepared. These data were used to further delineate brine horizon characteristics and the basal surface of the brine resource.

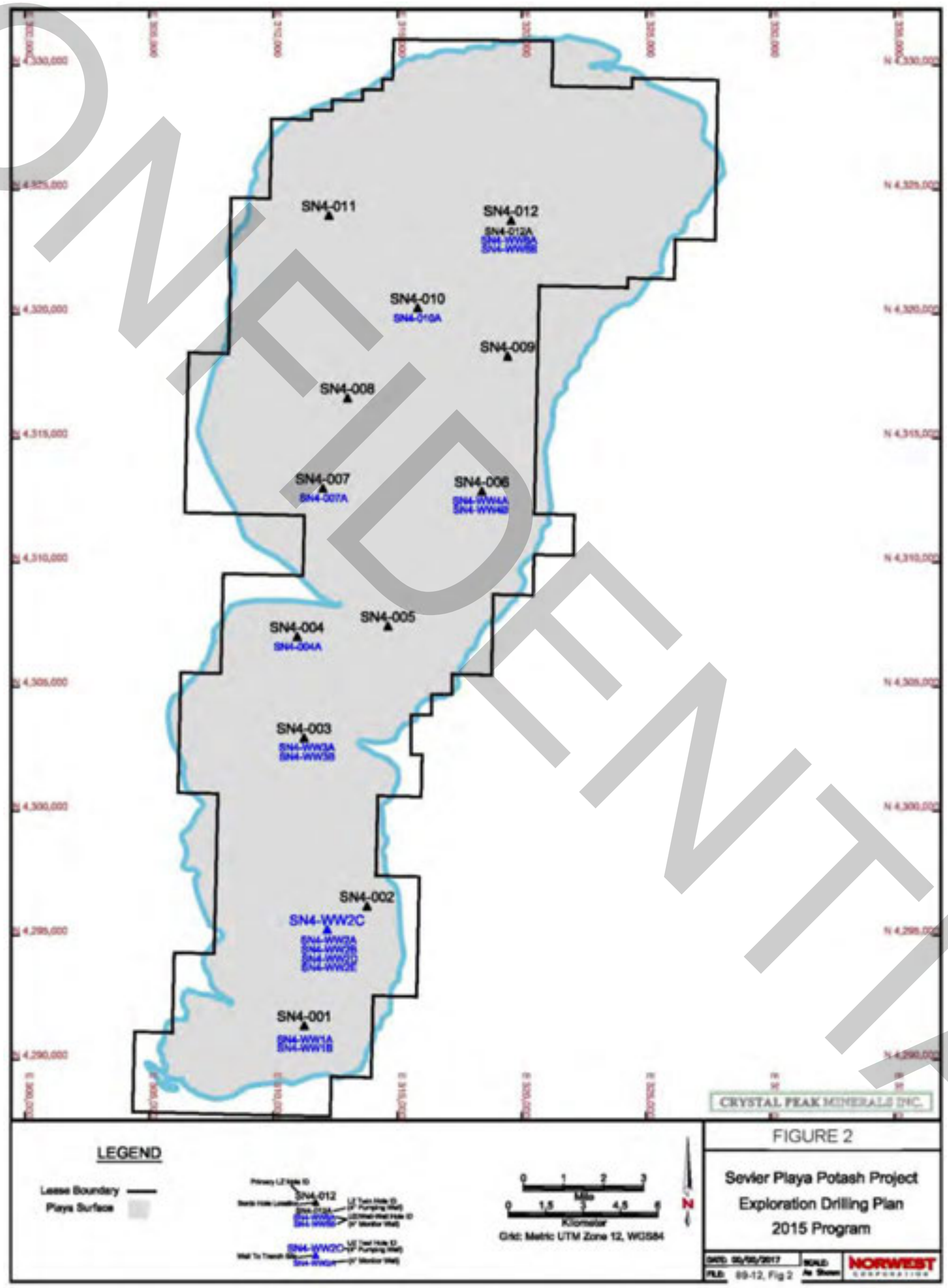
Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Figure 1: CPM Exploration Drilling Plan 2011 to 2013



Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Figure 2: CPM Exploration Drilling Plan 2015 Program



Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.1.4 Playa Stratigraphy

Figure 3 presents a typical stratigraphic column of the brine aquifers illustrating the average depth and internal features of the various horizons. The early drilling conducted by CPM divided the playa sediments into upper and lower zones. During the 2015 drilling on the playa, Norwest divided the playa sediments into three major brine-saturated horizons. Each of the three major horizons is discussed separately below.

1.1.5 Fat Clay Zone

The Fat Clay Zone (FCZ) derives its name from its physical properties, being described predominately as plastic (fat) clay, with low hydraulic conductivity. This dense grey clay is capped by a thin salt crust that is typically several inches thick over most of the Playa, but can range up to 18 inches thick in certain areas, according to CPM auger logs (Gwynn, 2006). The FCZ averages approximately 11.0 feet in thickness and is comprised of two sub-horizons. The upper part of the FCZ consists of approximately 9.35 feet of homogenous, dense, plastic clay. This clay zone is observed to contain gypsum crystals up to 6-inches in diameter. Underlying this homogenous clay is a plastic clay zone, approximately 1.64 feet thick, that contains abundant organic material, commonly appearing as grass mats and root structures, representing a dry period when the Playa surface was likely covered by grassy beds. This organic clay zone is an important marker bed that separates the FCZ from the underlying MCZ below.

1.1.6 Marl Clay Zone

The MCZ is described as a grey, bedded, granular clay averaging 20.2 feet in thickness. Previous geotechnical studies by Intermountain GeoEnvironmental Services Inc. (IGES) (2012) described these sediments as “fissured clay”, probably due to osmotic desiccation. However, none of the cores or Shelby-tube samples collected by Norwest during the 2015 drilling gave evidence of fissures. Based on Norwest’s research, it appears that these sediments have a granular texture which arises from what is observed to be silt-size granules of smaller clay particles loosely bound by a soft calcareous or gypsiferous matrix. This zone is also observed to contain numerous gypsum crystals up to 6-inches in diameter. An unconsolidated sand and gravel bed frequently occurs near the top of the MCZ, but is not consistent throughout the Playa. Where present, this sandy or gravelly zone averages a thickness of 18 inches.

A dense zone of stiff clay averaging approximately 3.1 feet thick occurs in the MCZ approximately 2.9 feet below the sand and gravel bed, where present. It has been

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

identified, in those exploration holes where handheld penetrometer readings have been taken, at regular intervals, in the core samples and used as a rough guide to determine the overall hardness of the Playa sediments. Penetrometer readings for the stiff clay zone of the MCZ range from 1.5 to 3.0 tons/square feet (t/ft^2). For comparison, the surrounding MCZ has penetrometer readings between 0 to 1.25 t/ft^2. The overlying FCZ has penetrometer readings between 0 and 0.5 t/ft^2, and underlying siliceous clay has penetrometer readings ranging from 0.75 to 1.25 t/ft^2, as shown in the right-hand column of **Figure 3**.

Below the stiff clay bed is a further 9.9 feet of marl clay that transitions rapidly into the predominantly siliceous clay of the underlying SCZ. The contact between the marl clay and underlying siliceous clay is easily supported by the sediment mineralogy and carbonate content test results from XRD mineralogy analyses. The average carbonate contents derived from drill core samples are illustrated in the stratigraphic column shown in **Figure 3**.

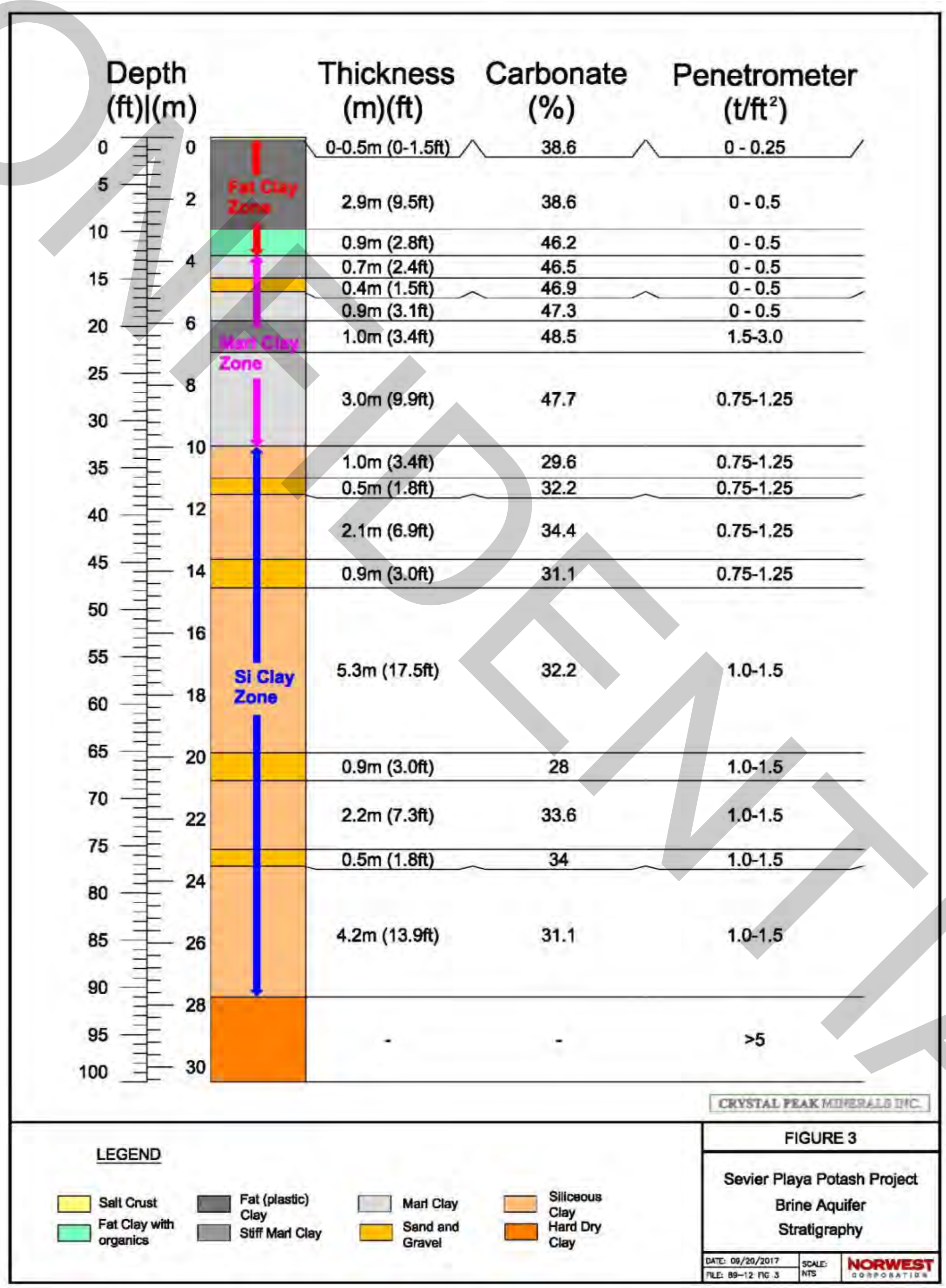
1.1.7 Siliceous Clay Zone

The SCZ is identified as an olive grey, quartz-rich clay with a relatively low carbonate content, averaging approximately 30% carbonate content, noticeably lower than the overlying MCZ. Four sand and gravel beds have been identified within the SCZ from drillhole records, but are not consistent throughout the Playa. These sand and gravel units are thicker near the margins of the lakebed and thin toward the center of the Playa, where these beds are often missing from the drillhole records. This is consistent with the depositional environment throughout the Basin and Range province. Average thicknesses of the sand and gravel beds, where present, vary from 1.6 to 2.9 feet. The base of the siliceous clay unit is marked by the presence of a dull red, dry, hard clay with hand-held penetrometer readings exceeding 5 t/ft^3. This dry clay was encountered is all boreholes drilled through the SCZ.

Drilling to date has been insufficient to accurately determine a brine resource potential below these three shallow zones.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Figure 3: Stratigraphic Column



Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.1.8 Subsurface Samples

During 2015 drilling of the wells, over every 5-foot interval, on select borings, a bulk sample was collected for moisture content analyses. Additionally, a series of 3.5- or 5-inch diameter Shelby tube samples were collected at selected points for geotechnical and column testing purposes. **Table 5** presents the depths of Shelby tube samples and indicates whether samples were also collected for moisture analyses. The results of laboratory analyses of these samples are presented in **Attachment 6.**

Table 5: Subsurface Samples

Piezometer ID	Shelby Tube Intervals				Shelby Diameter (in)	Moisture Content
	1	2	3	4		
SN4-15-001	22.0-23.5				5.0	Yes
SN4-15-WW1A	23.0-25.0				5.0	Yes
SN4-15-WW1B	13.0-15.0				5.0	Yes
SN4-15-WW2A					NA	Yes
SN4-15-WW2B					NA	No
SN4-15-WW2C	13.0-15.0	15.0-17.0			5.0	No
SN4-15-WW2D					NA	No
SN4-15-WW2E	28.0-30.0				5.0	Yes
SN4-15-002	5.0-7.0	25.0-27.0	40.0-42.0		3.0	Yes
SN4-15-003	20.0-22.0	38.0-40.0	61.0-63.0	68.0-70.0	All 3" except 68-70 is 5"	Yes
SN4-15-WW3A	22.0-24.0				5.0	No
SN4-15-WW3B					NA	No
SN4-15-004	48.0-49.0				5.0	Yes
SN4-15-004A	18.0-20.0				5.0	No
SN4-15-005	48.0-49.5				5.0	Yes
SN4-15-006	23.0-24.5	38.0-39.5	48.0-49.5	53.0-54.5	All 3" except 53.0-54.5 is 5"	Yes
SN4-15-WW4A	19.0-20.5				5.0	No
SN4-15-WW4B					NA	No
SN4-15-007	53.0-54.5				5.0	Yes
SN4-15-007A					NA	No
SN4-15-008	13.0-14.5	38.0-39.5	48.0-49.5	53.0-54.5	All 3" except 53.0-54.5 is 5"	Yes
SN4-15-009	53.0-54.5				5.0	Yes
SN4-15-010					NA	No
SN4-15-010A					NA	Yes
SN4-15-011	19.0-20.5	39.0-40.5	49.0-50.5	54.0-55.5	All 3" except 54.0-55.5 is 5"	Yes
SN4-15-012	19.0-20.5	44.0-45.5	54.0-55.5	59.0-60.5	All 3" except 59.0-60.5 is 5"	Yes
SN4-15-012A						Yes
SN4-15-WW6A	11.0-11.5	13.0-14.5	15.0-16.5	20.0-21.5	5.0	No
SN4-15-WW6B					5.0	No

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.2 Groundwater Hydrology Program

A series of wells and trenches were completed on the playa for hydrological characterization of the brine resource and recoverable reserve. Wells were completed for pumping tests and other hydrologic investigations, as well as monitoring wells near TtT testing sites and WtT cluster pairings. A discussion of relevant field work and data collection on the Sevier Playa follows below.

In **Figure 4**, the locations of the TtT and WtT test sites are shown. The overall objectives of the hydrogeological program were to:

- Assess hydraulic and solute transport properties of the MCZ.
- Assess flow of brine from trenches under long-term pumping conditions.
- Assess ability to recharge MCZ with fresh water through trenches.

1.2.1 Water Level Data

A comprehensive water level survey of the existing on- and off-Playa wells was performed in July 2015 at the start of the field program. **Table 6** summarizes the results of this survey.

NORWEST CORPORATION

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Table 6: Summary of Groundwater Levels Measured in July 2015

Well Name	Top of Casing Elevation (ft NAVD88)*	Depth to Water (ft NAVD88)*	Potentiometric Surface Elevation (ft NAVD88)*	Well Location
UDOT 2	4,690.94	180.76	4,510.18	Playa
SEV-12-022 (257 Cut Off)	4,552.84	22.14	4,530.70	Playa Margin
UDOT 3	4,660.87	215.66	4,445.21	Playa
Mudhole Well	4,559.56	3.11	4,556.45	Off Playa
Amasa Well	4,548.74	59.79	4,488.95	Playa Margin
Tule 1 MX Well	4,512.86	86.09	4,426.77	Off Playa
Mud Flat Well	4,528.56	5.17	4,523.39	Playa
LL5	4,523.51	1.30	4,522.21	Playa
LL3	4,527.74	2.92	4,524.82	Playa
SN3-12-049	4,523.80	1.96	4,521.84	Playa
SN3-12-045-Well 1	4,524.45	1.81	4,522.64	Playa
Glass Ocean Well	4,527.98	9.79	4,518.19	Playa
SEV-12-031 (Miller Canyon Reservoir)	4,699.22	268.85	4,430.37	Off Playa
Glitter Gulch Well	4,561.92	153.92	4,408.00	Playa
SEV-11-014 (Nighthawk Well)	4,804.36	376.97	4,427.39	Off Playa
SEV-11-003 (North Cricket Well)	5,083.78	499.83	4,583.95	Off Playa
SEV-12-023 (Guzzler)	4,966.81	376.23	4,590.58	Off Playa
Ibex Well	4,783.36	356.50	4,426.86	Off Playa
S13	4,524.38	3.13	4,521.25	Playa
SEV-11-013 (Coyote Well)	4,784.27	353.19	4,431.08	Off Playa
Red Boat Well	4,560.63	171.80	4,388.83	Playa Margin
SN3-12-270	4,521.74	1.03	4,520.71	Playa
Laceration Well	4,532.10	10.62	4,521.48	Playa
Machine Gun Well	4,531.54	14.69	4,516.85	Playa
PVC Shoal Well*	4,524.32	4.74	4,519.58	Playa
Black Hills Well	4,638.12	207.33	4,430.79	Off Playa
Nautilus Well	4,531.34	6.55	4,524.79	Playa
Erehwon Well	4,534.76	7.32	4,527.44	Playa
Headlight Gap Well	4,549.94	21.81	4,528.13	Playa
SEV-12-025 (Provo)	4,575.75	56.89	4,518.86	Playa Margin
SEV-12-026 (Bonneville)	4,772.15	180.84	4,591.31	Off Playa
SEV-11-007 (Monument Point Well)	4,891.30	297.64	4,593.66	Off Playa
SN2-11-400-4"	4,523.98	4.05	4,519.93	Playa
SN2-11-400-1"	4,523.98	3.40	4,520.58	Playa

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Well Name	Top of Casing Elevation (ft NAVD88)*	Depth to Water (ft NAVD88)*	Potentiometric Surface Elevation (ft NAVD88)*	Well Location
QQ7 SONIC	4,524.59	2.10	4,522.49	Playa
SN3-12-RR7	4,522.93	1.95	4,520.98	Playa
Wishing Well	4,561.09	96.53	4,464.56	Off Playa
SEV-12-027 (Dike Access)	4,544.74	47.61	4,497.13	Playa Margin
Lakeview Well	4,590.11	83.44	4,506.67	Off Playa
Black Rock Well	4,851.05	12.68	4,838.37	Off Playa
Crystal Peak Road Well	4,623.94	179.14	4,444.80	Off Playa
Wah Wah Well	4,657.58	211.65	4,445.93	Off Playa
UDOT 2	4,690.94	180.76	4,510.18	Playa

Note: Monitoring wells are generally sorted from north to south. Water levels are not corrected for salinity.
*** NAVD88 – North American Vertical Datum of 1988**

1.3 Well Aquifer Testing Program

1.3.1 Overview

Hydrologic testing of selected wells was conducted by CH2M in 2011 and 2013; the data from these wells were used in the 2013 Preliminary Feasibility Study. To further expand the database for Playa sediment hydraulic properties, 29 of the 2015 exploration boreholes were converted to hydrologic monitoring and test wells. A total of 16 of the 2015 boreholes were converted to wells completed in the shallow MCZ, with the primary objective of characterizing the MCZ brine-hosted resource and determining the horizon's hydrological properties for reserve estimation. A total of 13 of these boreholes were converted to SCZ hydrologic exploration wells, with a primary objective of characterizing the SCZ brine-hosted resource and determining the horizon's hydrological properties for reserve estimation. Some of these wells were matched with previously developed wells and others were installed in areas not yet evaluated. These wells were used to determine and expand the areal distribution of knowledge of hydraulic parameters across the Playa, gain a better understanding of the interaction between the MCZ and SCZ, and to determine the hydraulic and geochemical relationships within the various zones of Playa materials.

The sections below discuss the various well configurations, the test methods used, the data collected, and the analysis of the data to determine the hydraulic conductivity and storage values of the Playa materials.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.3.2 Well Configuration

Based on the lithologic and water occurrence logs, the wells were initially divided into an upper zone (generally shallower than 40 feet bgs) and a lower zone (generally deeper than 40 feet bgs). After geologic review, the upper zone wells were characterized as the MCZ and the lower zone wells characterized as the SCZ.

Three of the borings were completed as 6-inch diameter wells to allow evaluation of pump stress on more productive zones. The remaining wells were completed as 4-inch diameter wells. Typical well completion consisted of the following, from bottom to top:

- Five feet of solid PVC threaded casing with end cap to act as a sump.
- Variable lengths of slotted PVC threaded screen with a #10 slot aperture. The length of this screen was 40 to 60 feet for the SCZ, depending on the depth of the lower zone, and was 20 feet for the MCZ.
- Variable lengths of PVC threaded blank casing to approximately 2 feet of stick-up above ground surface (ags).
- Filter pack of pea gravel placed in the annulus between the screen/casing and the borehole wall from the bottom of the hole to a point above the top of the screened interval, depending on the zones where water was encountered.
- Three to five feet of 10- to 20-mesh sand from top of pea gravel, to minimize seepage of cement grout.
- Cement grout from the top of the 10/20 sand to a point approximately 2 feet bgs.
- PVC casing extending between 2 and 3 feet ags with lid.

Figure 5 presents diagrams of typical MCZ and SCZ monitoring well completion. The completion details for each piezometer are tabulated in **Table 7** and **Table 8**. Locations of the piezometers are presented in **Figure 4**.

Following the completion of the piezometers, each was cleaned by a combination of bailing and pumping. The standing water in the piezometer was surged and evacuated to remove any remaining drilling fluid and standing water. For most wells, the drawdown was rather rapid and the flow rates were low. The water level for these wells was drawn down to just above the pump intake, and then pumping was stopped to allow the water level to recover. This process was repeated several times, and then the pumping was continued at a lower rate. When the pumped water was relatively clear, it was determined that the well was adequately developed. One well (SN4-15-002) was dewatered within 20 minutes of the start of development pumping, and did not recover within three days following

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development pumping. Therefore, it was assumed to not be representative of the Playa sediments. Following development, the wells were allowed to stand for a period of at least three days before any additional work was undertaken to allow the water levels to equilibrate.

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Figure 4: Tested Well Locations 2015 Program

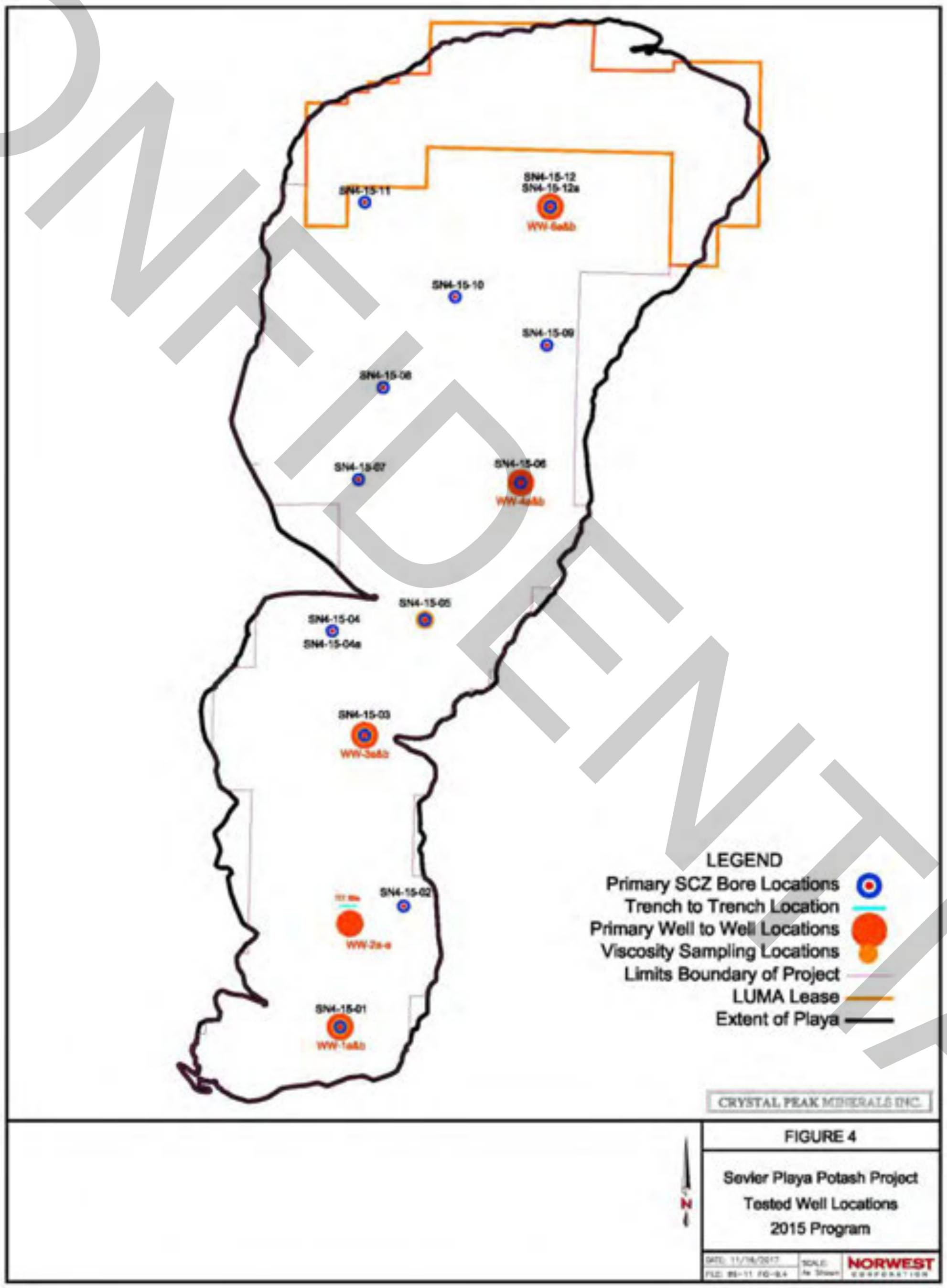

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Figure 5: Monitoring Well Typical Detail

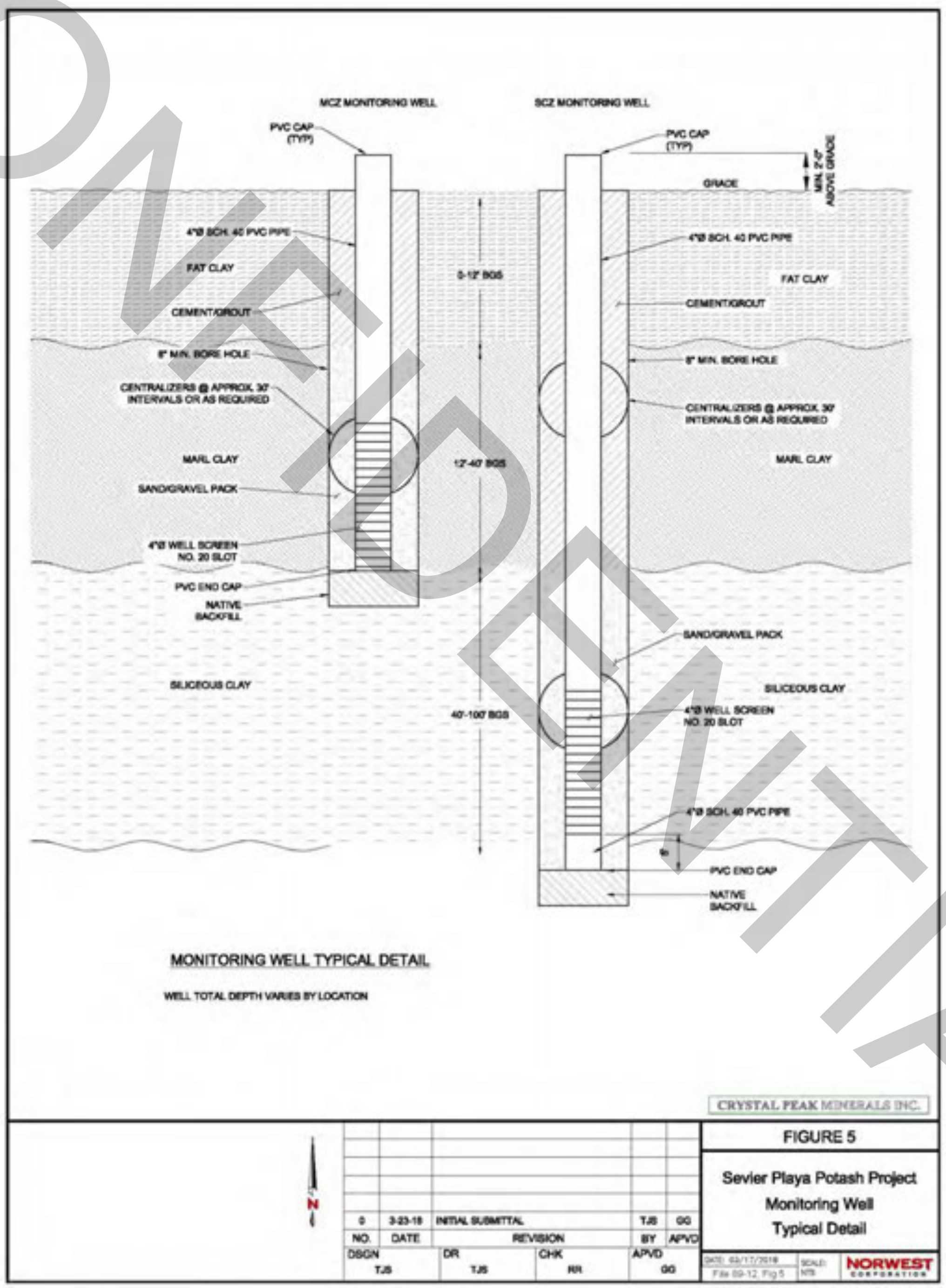

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Table 7: Piezometer Coordinates and Completion Details

Well ID	Drilling Method	UTM Zone 12 NAD 83			Hole Diameter (in)	Total Depth (ft)	Screened Interval		Casing Type
		Easting (ft)	Northing (ft)	Elevation (ft)			From	To	
SN4-15-001	Sonic	1,021,198	14,079,170	4,523.06	10	60.0	39.5	59.5	6"PVC
SN4-15-WW1A	Sonic	1,021,181	14,079,187	4,523.06	8	30.0	20.0	30.0	4" PVC
SN4-15-WW1B	Sonic	1,021,207	14,079,180	4,523.06	8	30.0	20.0	30.0	4" PVC
SN4-15-WW2A	Sonic	1,024,196	14,091,848	4,521.16	8	20.0	10.0	20.0	4" PVC
SN4-15-WW2B	Sonic	1,024,206	14,091,848	4,521.16	8	20.0	10.0	20.0	4" PVC
SN4-15-WW2C	Sonic	1,024,216	14,091,848	4,521.16	8	20.0	10.0	20.0	4" PVC
SN4-15-WW2D	Sonic	1,024,226	14,091,848	4,521.16	8	20.0	10.0	20.0	4" PVC
SN4-15-WW2E	Sonic	1,024,236	14,091,848	4,521.16	8	30.0	10.0	20.0	4" PVC
SN4-15-002	Sonic	10,281,434	14,094,945	4,521.78	8	65.0	40.0	65.0	4" PVC
SN4-15-003	Sonic	1,024,426	14,117,159	4,518.93	10	96.0	60.0	95.0	6" PVC
SN4-15-WW3A	Sonic	1,024,446	14,117,159	4,518.93	8	40.0	10.0	40.0	4" PVC
SN4-15-WW3B	Sonic	1,024,465	14,117,159	4,518.93	8	40.0	10.0	40.0	4" PVC
SN4-15-004	Sonic	1,020,240	14,130,516	4,519.29	8	53.0	38.0	53.0	4" PVC
SN4-15-004A	Sonic	1,020,220	14,130,516	4,519.29	8	30.0	10.0	30.0	4" PVC
SN4-15-005	Sonic	1,032,228	14,131,897	4,518.31	8	93.0	40.0	93.0	4" PVC
SN4-15-006	Sonic	1,044,626	14,149,695	4,517.78	8	100.0	40.0	100.0	4" PVC
SN4-15-WW4A	Sonic	1,044,626	14,149,715	4,517.78	8	30.0	10.0	30.0	4" PVC
SN4-15-WW4B	Sonic	1,044,626	14,149,735	4,517.78	8	30.0	10.0	30.0	4" PVC
SN4-15-007	Sonic	1,023,622	14,150,092	4,517.95	8	88.0	40.0	88.0	4" PVC
SN4-15-007A	Sonic	1,023,622	14,150,112	4,517.95	8	30.0	10.0	30.0	4" PVC
SN4-15-008	Sonic	1,026,883	14,162,025	4,517.42	8	100.0	40.0	100.0	4" PVC
SN4-15-010	Sonic	1,036,145	14,173,905	4,518.24	8	125.0	40.0	125.0	4" PVC
SN4-15-010A	Sonic	1,036,145	14,173,924	4,518.24	8	30.0	10.0	30.0	4" PVC
SN4-15-009	Sonic	1,048,035	14,167,533	4,518.90	8	58.0	40.0	58.0	4" PVC
SN4-15-011	Sonic	1,024,429	14,186,109	4,518.04	8	69.0	40.0	69.0	4" PVC
SN4-15-012	Sonic	1,048,478	14,185,466	4,519.46	10	89.0	36.0	89.0	6" PVC
SN4-15-012A	Sonic	1,048,474	14,185,493	4,519.46	10	89.0	36.0	89.0	4" PVC
SN4-15-WW6A	Sonic	1,048,481	14,185,509	4,519.46	8	30.0	10.0	30.0	4" PVC
SN4-15-WW6B	Sonic	1,048,481	14,185,519	4,519.46	8	30.0	10.0	30.0	4" PVC

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Table 8: Piezometer Elevation

Piezometer ID	Ground Elevation (ft)	Stick-up (ft)	Casing Elevation (ft)
SN4-15-001	4,523.06	2.81	4,525.87
SN4-15-WW1A	4,523.06	2.46	4,525.52
SN4-15-WW1B	4,523.06	2.48	4,525.54
SN4-15-WW2A	4,521.16	0.10	4,521.26
SN4-15-WW2B	4,521.16	2.90	4,524.06
SN4-15-WW2C	4,521.16	3.40	4,524.56
SN4-15-WW2D	4,521.16	2.80	4,523.96
SN4-15-WW2E	4,521.16	2.80	4,523.96
SN4-15-002	4,521.78	3.00	4,524.78
SN4-15-003	4,518.93	2.22	4,521.15
SN4-15-WW3A	4,518.93	3.71	4,522.64
SN4-15-WW3B	4,518.93	2.08	4,521.01
SN4-15-004	4,519.29	2.40	4,521.69
SN4-15-004A	4,519.29	2.50	4,521.79
SN4-15-005	4,518.31	2.10	4,520.41
SN4-15-006	4,517.78	1.65	4,519.43
SN4-15-WW4A	4,517.78	2.00	4,519.78
SN4-15-WW4B	4,517.78	2.00	4,519.78
SN4-15-007	4,517.95	1.79	4,519.74
SN4-15-007A	4,517.95	2.17	4,520.12
SN4-15-008	4,517.42	2.25	4,519.67
SN4-15-009	4,518.24	3.20	4,521.44
SN4-15-010	4,518.24	3.31	4,521.55
SN4-15-010A	4,518.90	1.48	4,520.38
SN4-15-011	4,518.04	2.17	4,520.21
SN4-15-012	4,519.46	2.00	4,521.46
SN4-15-012A	4,519.46	2.00	4,521.46
SN4-15-WW6A	4,519.46	2.25	4,521.71
SN4-15-WW6B	4,519.46	2.25	4,521.71

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The initial data collected from the piezometers included water levels, hydraulic analyses, and water quality sampling of the water bearing zones. Static water levels in 2015 were obtained using a sounding tape delineated in 0.01-foot increments. The water levels are presented in **Table 9**.

Table 9: Water Level Elevations

Piezometer ID	Casing Elevation (ft)	Depth to Water (ft)	Water Elevation (ft)
SN4-15-001	4,525.87	2.98	4,525.87
SN4-15-WW1A	4,525.52	2.20	4,525.52
SN4-15-WW1B	4,525.54	1.83	4,525.54
SN4-15-WW2A	4,521.26	1.02	4,521.26
SN4-15-WW2B	4,524.06	3.28	4,524.06
SN4-15-WW2C	4,524.56	3.40	4,524.56
SN4-15-WW2D	4,523.96	3.29	4,523.96
SN4-15-WW2E	4,523.96	2.87	4,523.96
SN4-15-002	4,524.78	2.27	4,524.78
SN4-15-003	4,521.15	2.44	4,521.15
SN4-15-WW3A	4,522.64	3.50	4,522.64
SN4-15-WW3B	4,521.01	2.30	4,521.01
SN4-15-004	4,521.69	2.00	4,521.69
SN4-15-004A	4,521.79	6.00	4,521.79
SN4-15-005	4,520.41	2.15	4,520.41
SN4-15-006	4,519.43	0.50	4,519.43
SN4-15-WW4A	4,519.78	0.49	4,519.78
SN4-15-WW4B	4,519.78	0.49	4,519.78
SN4-15-007	4,519.74	0.48	4,519.74
SN4-15-007A	4,520.12	1.90	4,520.12
SN4-15-008	4,519.67	1.81	4,519.67
SN4-15-009	4,521.44	1.33	4,521.44
SN4-15-010	4,521.55	3.05	4,521.55
SN4-15-010A	4,520.38	0.04	4,520.38
SN4-15-011	4,520.21	0.21	4,520.21
SN4-15-012	4,521.46	1.18	4,521.46
SN4-15-012A	4,521.46	1.28	4,521.46
SN4-15-WW6A	4,521.71	2.75	4,521.71
SN4-15-WW6B	4,521.71	2.90	4,521.71

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Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.3.3 Aquifer Test Methods

Several aquifer tests were conducted following the development activities. These included standard aquifer drawdown testing for single and multiple wells, injection and withdrawal testing between two wells, and push-pull testing for a single well.

Aquifer tests were performed to measure hydraulic properties of the MCZ and SCZ zones from 25 piezometers spread across the Playa. These tests consisted of 13 tests at new wells in the upper zone, 16 tests at new wells in the lower zone, and 6-verification well tests at pre-existing wells. **Figure 4** presents the location of the tested wells. **Table 10** presents the wells tested, the zones tested, and the duration of the tests.

Table 10: Aquifer Test Locations

Piezometer ID	Short-Term Well Test	Long-Term Well Test	Verification Test	Injection Test	Pump Back Test
SN4-15-001	X	X		X	X
SN4-15-002	A				
SN4-15-003	X				
SN4-15-004	X				
SN4-15-004A	X				
SN4-15-005	X				
SN4-15-006	X			A	
SN4-15-008	X				
SN4-15-009	X			X	X
SN4-15-010	X				
SN4-15-010A	X				
SN4-15-011	X				
SN4-15-012	X	X		X	X
SN4-15-012A	X				
SN3-045	X		X		
SN3-112	X		X		
SN3-226	X		X		
SN3-232	X		X		
SN3-251	X		X		
SN3-260	X	X	X	X	X
SN4-15-WW1A-B	X			X	X
SN4-15-WW2A-E	X			X	X
SN4-15-WW3A-B	X			X	X
SN4-15-WW4A-B	X			A	
SN4-15-WW6A-B	X			X	X

X – Completed test
A – Aborted test

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.3.4 Aquifer Testing – Data Collection

Observations recorded during testing included the flow rate, drawdown, and duration of pumping. Pumping duration ranged from 0.03 to 120 hours depending on well production. Following the pumping phase, the pump was shut in and the water level recovery was recorded. Typically, the short-term pumping was commenced in the early morning, the pumping phase was run during the day, pumping discontinued in the evening, and recovery allowed to occur over night. When water levels returned to 90% of drawdown recovery, measurements were discontinued. Additionally, barometric pressure was recorded in hourly increments for the Playa area to allow the testing data to be adjusted for atmospheric pressure changes. The water level data were downloaded from the transducers and barometric data from the Playa metrological station operated by CPM. For each aquifer test, drawdown data were adjusted for barometric pressure changes over the period of the test.

All hydraulic analyses for the standard single and multiple well aquifer tests were performed with AQTESOLV 4.5 or Multi-Layer Unsteady state (MLU) software. For the AQTESOLV analyses, the confined method resulted in the best data fit and was used in all cases. In some tests, multiple pumping rates were used during the tests. AQTESOLV allows inclusion of these pumping adjustments as part of the analyses. Time drawdown and recovery plots of the water-level data are presented in **Attachment 7**. Detailed numerical analysis using the MLU software allowed determinations to be made of hydraulic conductivity variations between the sands and gravels and the clays. **Table 11** presents the aquifer test results.

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Table 11: Aquifer Test Results

Piezometer ID	Max. Pumping Rate (gpm)	Pumping Duration (hrs)	Max Drawdown (ft)	Specific Capacity (gpm/ft)	Sustainable Pumping Rate (gpm)	Anticipated Max Drawdown (ft bgs)	Transmissivity Estimates (ft^2/day)	Storativity	Aquifer Thickness (ft)	Hydraulic Conductivity (ft/day)
SN4-15-001	4.68	86.8	34.7	0.135	3.9	60	15.66	0.215	21	0.75
SN4-15-003*	0	-	2.0	-	-	-	2.5	0.017	56	0.04
SN4-15-004	1.14	3.3	47.0	0.024	0.35	45	2.63	$4.1x10^{-9}$	13	0.20
SN4-15-04A**	-	-	-	-	-	-	1.5	0.004	20	0.08
SN4-15-005	4.5	3.0	48.8	0.092	4.0	56	32.63	$5.5x10^{-8}$	53	0.62
SN4-15-006	2.6	4.0	50.8	0.051	2.3	58	18.09	$2.6x10^{-8}$	60	0.30
SN4-15-008	1.0	0.9	77.0	0.013	0.47	58	3.25	$2.3x10^{-7}$	60	0.05
SN4-15-009	9.6	2.4	43.4	0.221	8.5	45	92.85	$6.5x10^{-6}$	18	5.16
SN4-15-010	23.1	1.4	76.6	0.301	17.0	66	77.75	$6.6x10^{-6}$	85	0.91
SN4-15-010A	0.6	2.1	15.6	0.038	-	-	20.79	$2.9x10^{-6}$	20	1.04
SN4-15-011	20	0.03	53.0	0.377	-	49	131.8	$1.1x10^{-5}$	29	4.54
SN4-15-012	24.4	120.0	2.1	11.619	375	56	1281.5	0.825	53	24.18
SN4-15-012A*	0	-	4.4	-	-	-	527.2	$1.7x10^{-4}$	53	9.95
SN3-045	42.0	46.0	50.7	0.828	32.0	54	124.9	0.018	59	2.12
SN3-112	1.1	1.0	61.8	0.018	0.31	54	0.6775	0.036	59	0.01
SN3-226	5	1.0	67.4	0.074	0.52	51	1.07	0.061	44	0.02
SN3-232	20	15.7	66.8	0.300	15.0	67	56.6	$5.5x10^{-4}$	59	0.96
SN3-251	8	6.0	65.4	0.122	0.75	64	1.24	0.053	49	0.03
SN3-260	34.9	72.0	15.0	2.327	95.0	67	578.8	$5.2x10^{-4}$	49	11.81
SN4-15-WW1A-B	4.6	3.0	21.5	0.214	-	-	21.57	0.316	20	1.08
SN4-15-WW2A-E	2.7	3.0	10.6	0.255	-	-	29.46	0.408	20	1.47
SN4-15-WW3A-B	6.7	4.4	3.1	2.161	-	-	413.8	0.028	30	13.79
SN4-15-WW4A-B	4.6	3.0	21.3	0.216	-	-	19.91	0.296	20	1.00
SN4-15-WW6A-B	3.4	3.0	21.0	0.162	-	-	11.75	0.171	20	0.59

*Observation well
**Slug Test

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The push-pull tests consisted of injecting a known quantity of fresh water into the brine aquifer and allowing the water to stand for a variable period of time. Each push-pull test was conducted for differing periods for a minimum of four days to several months. The wells were pumped at a known constant rate, the discharge flow electrical conductivity was monitored, and samples were collected to assess the change in the water quality.

Groundwater chemistry and stable isotope samples (deuterium (δ^2H) and oxygen 18 ($\delta^{18}O$)) were collected at varying times over the pump back duration during four push-pull tests (SN4-15-WW3A, SN4-15-012a, SN4-15-WW6A, and SN4-15-001) to assess the assimilation of the injected freshwater into the brine in the playa sediments as an indication of the process of mass transfer of ions from the brine into the injected fresh water. The ratios of δ^2H: $\delta^{18}O$ from the pump back at SN4-15-WW3A, SN4-15-012A, and SN4-15-WW6A did not change over the duration of the test indicating that injected water did not assimilate with the brine during the relatively short duration between injection and pump back at these locations (<35 days).

The time between injection and pump-back for the push-pull test at well SN4-15-001 was 87 days. The plot of $\delta^{18}O$ vs. δ^2H on **Figure 6** shows the data vary along a line from the aquifer brine end member to the freshwater endmember indicating mixing of the injected freshwater with the aquifer brine. **Figure 7** shows a plot of the relative percentages of potassium and δ^2H in the SN4-15-001 pump back samples. The change in the relative percentage between these conservative analytes over the duration of the pump back is indicative that mass transfer has occurred between the aquifer brine and the injected fresh water.

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Figure 6: Injection Test Results

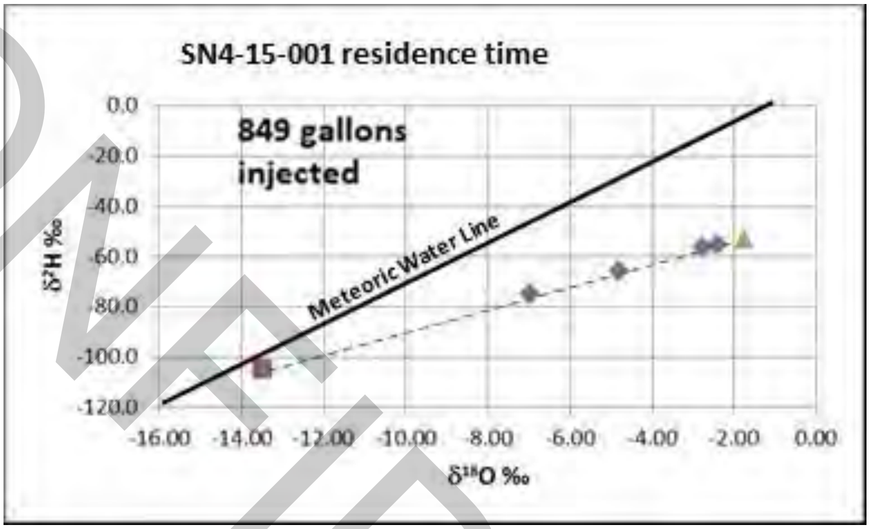
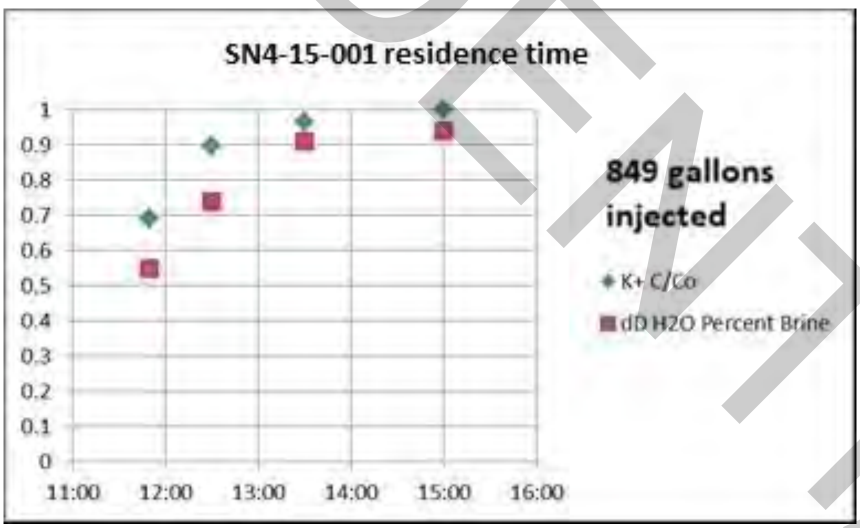


Figure 7: Injection Test Residence Time



Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.3.5 Aquifer Testing – Column Testing

Selected soil samples obtained with Shelby tubes from the MCZ and the SCZ were used for small scale testing of the flow of fresh water through the aquifer materials, under controlled conditions. Nine column tests were conducted to evaluate the vertical hydraulic conductivity in different materials, assess brine/matrix break-through relationships, and to evaluate the potential for mass transfer.

The 5-inch diameter Shelby tube samples were connected to a pressurized deionized fresh water source, and the flow rate and pressure of the inflow water was monitored and recorded along with the specific conductance of the water/brine discharged from the tubes. Also, incremental composite samples of the discharge water were collected to assess the changes in brine concentration over time. This testing assisted in monitoring the potential for fresh water breakthrough and calculation of the hydraulic conductivity and drainable percentage of the various samples. The results of these analyses are presented in **Table 12**. Locations from which the tested samples were obtained are depicted in **Figure 8**. Attachment 8 presents the results of the column tests.

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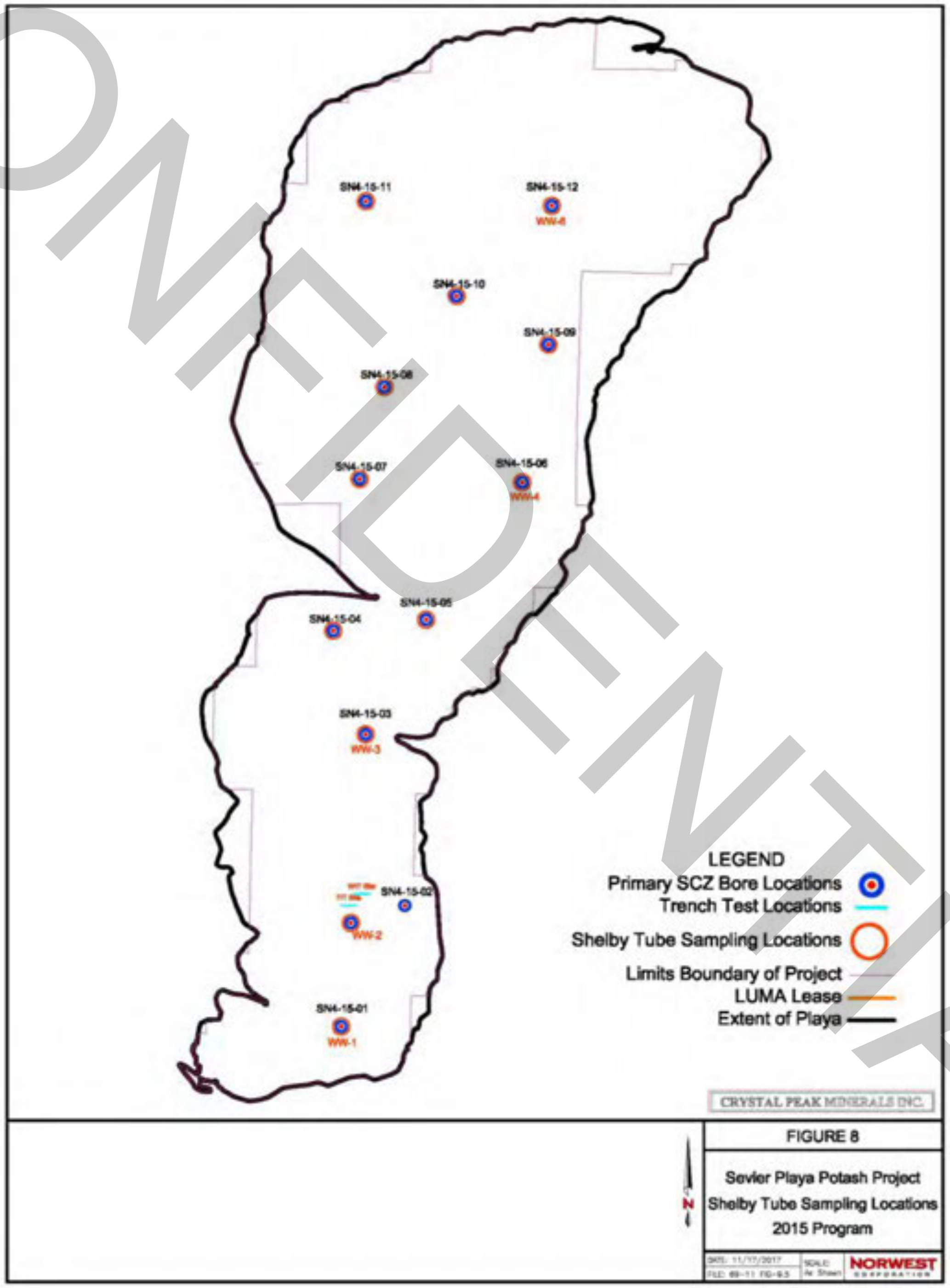
Table 12: Column Testing Results

Well ID	Depth (ft)	Material Type	Column Test		
			Hydraulic Conductivity, K_v (ft/day)	Brine Dilution	Brine Transfer
SN4-15-001	22-23.5	Clay	< 0.0003	X	X
SN4-15-WW1A	23-25	Clay			
SN4-15-WW1B	13-15	Carbonate	0.09	X	X
SN4-15-WW2C	13-15	Marl			
SN4-15-WW2C	15-17	Marl	0.26	X	X
SN4-15-WW2E	28-30	Clay			
SN4-15-002	25-27	Clay			
SN4-15-003	20-22	Clay			
SN4-15-003	38-40	Clay			
SN4-15-003	68-70	Clay/Sand	0.0026	X	X
SN4-15-WW3A	22-24	Clay	< 0.0003		
SN4-15-004	48-49	Stiff Clay			
SN4-15-004A	18-20	Marl	0.004	X	X
SN4-15-005	48-49.5	Clay			
SN4-15-006	53-54.5	Clay			
SN4-15-WW-4	19-20.5	Clay	0.013	X	X
SN4-15-007	53-54.5	Firm Clay			
SN4-15-008	13-14.5	Marl			
SN4-15-008	53-54.5	Clay			
SN4-15-010	53-54.5	Clay			
SN4-15-011	54-55.5	Clay/Sand	< 0.0003	X	X
SN4-15-012	54-55.5	Clay/Sand		X	X
SN4-15-012	59-60.5	Clay/Sand	< 0.0003		
SN4-15-WW6	10-11.5	Carbonate	0.067	X	X
SN4-15-WW6	13-14.5	Carbonate			
SN4-15-WW6	15-16.5	Clay			
SN4-15-WW6	20-21.5	Clay			

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Figure 8: Shelby Tube Sampling Locations 2015 Program



Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

1.3.6 Aquifer Testing – Relative Brine Release Capacity Testing

Selected Shelby tube soil samples collected from the MCZ and SCZ were used for reactive brine release capacity (RBRC) determinations by DB Stephens & Associates soil laboratory in Albuquerque, New Mexico (DB Stephens lab). This method predicts the volume of solution that can readily be extracted from an unstressed geologic sample which is indicative of the specific yield, of the sample.

The RBRC tests consist of obtaining an intact sub-sample from each Shelby tube sample by gently advancing a testing ring approximately 2.5-inch diameter x 1.5-inch length into the original sample. The undisturbed samples from the site were saturated in the laboratory using site-specific brine solution provided by CPM.

Once the samples were saturated, the samples were weighed. The volumetric moisture contents were calculated using the brine solution density of 0.0408 lbs/in^3. The particle density of each sample was calculated based on the assumption that the sample was 100% saturated, after the saturation stage of the test procedure. The calculated particle density was then used to calculate the total porosity of the sample.

The bottom of the sub-sample rings were then attached to a vacuum pump using tubing and permeable end caps, and subjected to a suction of 4.83 psi for 18 to 24 hours. The top end cap was fitted with a one-gallon air bladder, which allows sufficient drainage while inhibiting continuous atmospheric air flow.

Following testing, each sub-sample was first oven dried at 140°F for three days, weighed, and then again oven dried at 230°F for two days and weighed again. This double treatment was to assess the fine clay fraction to determine if there were any differences.

Based on the density of the brine, the sample mass at saturation, and the sample mass at 'vacuum dry,' the volumetric moisture (brine) contents of the samples are calculated. The difference between the volumetric moisture (brine) content of the saturated sample and the volumetric moisture (brine) content of the 'vacuum dry' sample is the "relative brine release capacity". **Table 13** presents the results for samples dried at both 140°F and 230°F. As can be seen, there is no significant difference between the results for each drying temperature.

The results of the RBRC tests were used for specific yield interpolation of the MCZ in the resource model.

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Table 13: Relative Brine Release Capacity Test Results

Temp.	Sample Number	Saturated Volumetric Brine Content (%, ft^3/ft^3)	Vacuum Dry Volumetric Brine Content (%, ft^3/ft^3)	Relative Brine Release Capacity (%, ft^3/ft^3)	Dry Bulk Density (lbs/in^3)	Applied Particle Density (lbs/in^3)	Material Description
140°F	SN4-15-WW1B SH-01 13.0-15.0	44.9	42.4	2.5	0.0480	0.0874	Clayey Silt
230°F		46.0	43.4	2.5	0.0477	0.0885	
140°F	SN4-15-WW2C SH-01 13.0-15.0	56.8	54.1	2.7	0.0343	0.0791	Clayey Silt
230°F		58.4	55.6	2.7	0.0336	0.0806	
140°F	SN4-15-WW2C SH-02 15.0-17.0	44.9	40.9	4.0	0.0473	0.0860	Silty Clay
230°F		48.2	44.2	4.0	0.0459	0.0889	
140°F	SN4-15-WW3A SH-01 22.0-24.0	33.8	32.7	1.1	0.0546	0.0824	Clay with Silt & Halite
230°F		45.0	43.9	1.1	0.0499	0.0910	
140°F	SN4-15-004A SH-01 18.0-20.0	53.9	51.6	2.3	0.0372	0.0806	Clay with Silt
230°F		56.1	53.7	2.3	0.0361	0.0824	
140°F	SN4-15-WW4A SH-01 19.0-20.5	47.8	45.1	2.7	0.0441	0.0845	Clay with Silt
230°F		48.9	46.2	2.7	0.0437	0.0853	
140°F	SN4-15-WW6A SH-02 13.0-14.5	41.9	39.4	2.4	0.0506	0.0871	Clayey Silt
230°F		43.9	41.5	2.4	0.0499	0.0885	
140°F	SN4-15-WW6A SH-01 11.0-12.5	50.5	49.2	1.3	0.0390	0.0791	Silty Clay with Halite Chunks
230°F		52.4	51.1	1.3	0.0383	0.0806	
140°F	SN4-15-008 SH01 13.0-14.5	42.0	32.8	9.2	0.0444	0.0766	Silty Clay with Halite
230°F		54.5	45.3	9.2	0.0394	0.0867	
140°F	SN4-15-003 SH-01 20.0-22.0	25.3	24.7	0.6	0.0571	0.0762	Silty Clay with Halite
230°F		47.9	47.3	0.6	0.0477	0.0918	

1.3.7 Brine Sampling

Initial water quality samples were collected following development of the sonic wells and were used to characterize the brine concentration and geochemical characteristics of each sample. For the MCZ, a sample was collected from SN4-15-WW2 through SN4-15-WW6 WtW sites. For the SCZ, a series of three samples from most of the SCZ wells were collected to characterize the brine vertically. These samples provided a description of the changes in brine chemistry both within the different aquifer zones and spatially across the Playa.

As it was necessary to obtain relatively undisturbed brine samples from the vertical profile of the strata, the standard protocol of removing three borehole volumes from the SCZ piezometers before sampling was not used as it would create a composite of the brine that included overlying layers. Instead, a low flow sampling protocol was utilized. This

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consisted of lowering the sampling pump to the depth to be sampled and extracting brine, at a low flow rate representative of the flow into the screen at that portion of the aquifer. The discharge continued until the volume of the discharge line was removed and then until the pH, electrical conductivity and temperature of the brine discharge stabilized. This sampling was repeated at the top, middle and bottom of the screen interval. **Table 14** lists the samples taken at the various well locations. These samples were analyzed for the parameters shown in **Table 15**.

Table 14: Aquifer Test Locations

Piezometer ID	Brine Chemistry	Brine Geochemical		
		Top	Middle	Bottom
SN4-15-001		X	X	X
SN3-12-RR-7	X			
SN4-15-002		X	X	X
SN4-15-003				
SN4-15-004		X	X	X
SN4-15-005		X	X	X
SN4-15-006		X	X	X
SN4-15-007		X	X	X
SN4-15-008		X	X	X
SN4-15-009		X	X	X
SN4-15-010		X	X	X
SN4-15-011		X	X	X
SN4-15-012		X	X	X
SN3-260		X	X	X
SN4-15-WW1A-B	X			X
SN4-15-WW2A-E	X			
SN4-15-WW3A-B	X			
SN4-15-WW4A-B	X			
SN4-15-WW5A-B	X			
SN4-15-WW6A-B	X			

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Table 15: Analytical Parameter List

Analytes	Metals			
Total Alkalinity as $CaCO_3$	Aluminum	Cobalt	Potassium	Vanadium
Bicarbonate as HCO_3	Antimony	Copper	Phosphorous	Zinc
Carbonate as $CaCO_3$	Arsenic	Iron	Selenium	Zirconium
Chloride	Barium	Lead	Silver	
Nitrate + Nitrite	Beryllium	Lithium	Sodium	
Sulfate	Bismuth	Magnesium	Strontium	
Total Dissolved Solids	Boron	Manganese	Thallium	
pH	Cadmium	Mercury	Tin	
Specific Conductivity	Calcium	Molybdenum	Titanium	
Specific Gravity	Chromium	Nickel	Uranium	

The water quality samples were submitted to ALS Limited Laboratories in Salt Lake City, Utah, for analysis. Analytical results were tabulated and compared to determine differences in the brine for various areas of the Playa and water bearing zones. **Table 16** presents the results of the brine quality analyses. To assist in verifying the laboratory results, duplicate samples were collected and submitted for analysis.

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Table 16 Brine Characterization for Sevier Playa

Well ID	Sample ID	Duplicate	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bicarbonate Alkalinity	Bismuth	Boron	Cadmium	Calcium	Carbonate Alkalinity	Chloride	Chromium	Cobalt	Conductivity	Copper	Hydroxide Alkalinity
				ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	umhos/cm	ug/L	mg/L
SN3-12-RR-7	W0001	N	10/31/2015	<3000	<750	<150	<300	<75.	270	<300	8200	<75.	690000	<6.0	95000	<150	<300	210000	<300	<6.0
SN4-15-001	W0001	N	10/30/2015	<3000	<750	<150	<300	<75.	260	<300	8500	<75.	820000	<6.0	120000	<150	<300	210000	<300	<6.0
SN4-15-001	W0002	N	10/30/2015	<3000	<750	<150	<300	<75.	260	<300	8000	<75.	730000	<6.0	94000	<150	<300	210000	<300	<6.0
SN4-15-001	W0003	N	10/30/2015	<3000	<750	<150	<300	<75.	270	<300	8300	<75.	780000	<6.0	87000	<150	<300	200000	<300	<6.0
SN4-15-002	W001-D1-ALS	Y	2/6/2016	<1500	<380	<75.	<150	<38.	60	<150	7600	<38.	1400000	84	68000	<75.	<150	170000	<150	<6.0
SN4-15-002	W001	N	2/6/2016	<1500	<380	<75.	<150	<38.	54	<150	7700	<38.	1400000	64	80000	<75.	<150	170000	<150	<6.0
SN4-15-002	W002	N	2/6/2016	<1500	<380	<75.	<150	<38.	54	<150	7800	<38.	1200000	32	130000	<75.	<150	170000	<150	<6.0
SN4-15-003	W002-D3-ALS	Y	2/9/2016	<1500	<380	<75.	<150	<38.	340	<150	38000	<38.	840000	<6.0	91000	<75.	<150	180000	<150	<6.0
SN4-15-003	W001	N	2/9/2016	<1500	<380	<75.	<150	<38.	380	<150	38000	<38.	790000	<6.0	91000	<75.	<150	180000	<150	<6.0
SN4-15-003	W002	N	2/9/2016	<1500	<380	<75.	<150	<38.	340	<150	33000	<38.	690000	<6.0	82000	<75.	<150	180000	<150	<6.0
SN4-15-004	W001	N	1/29/2016	<1500	<380	<75.	<150	<38.	250	<150	17000	<38.	740000	<6.0	72000	<75.	<150	180000	<150	
SN4-15-004	W002	N	1/29/2016	<1500	<380	<75.	<150	<38.	260	<150	17000	<38.	810000	<6.0	80000	<75.	<150	180000	<150	
SN4-15-004	W003	N	1/29/2016	<1500	<380	[93.]	<150	<38.	250	<150	17000	<38.	840000	<6.0	73000	<75.	<150	190000	<150	
SN4-15-005	W003-D2-ALS	Y	1/29/2016	<1500	<380	[150]	<150	<38.	470	<150	26000	<38.	250000	<6.0	110000	<75.	<150	220000	<150	
SN4-15-005	W001	N	1/29/2016	<1500	<380	[170]	<150	<38.	470	<150	20000	<38.	270000	<6.0	110000	<75.	<150	220000	<150	
SN4-15-005	W002	N	1/29/2016	<1500	<380	[130]	<150	<38.	540	<150	26000	<38.	240000	<6.0	120000	<75.	<150	220000	<150	
SN4-15-005	W003	N	1/29/2016	<1500	<380	[120]	<150	<38.	420	<150	26000	<38.	250000	<6.0	130000	<75.	<150	220000	<150	
SN4-15-006	W001	N	1/28/2016	<1500	<380	<75.	<150	<38.	460	<150	25000	<38.	380000	<6.0	65000	<75.	<150	170000	<150	
SN4-15-006	W002	N	1/28/2016	<1500	<380	<75.	<150	<38.	460	<150	24000	<38.	350000	<6.0	55000	<75.	<150	170000	<150	
SN4-15-006	W003	N	1/28/2016	<1500	<380	<75.	<150	<38.	340	<150	20000	<38.	350000	<6.0	97000	<75.	<150	200000	<150	
SN4-15-007	W001	N	1/28/2016	<1500	<380	<75.	<150	<38.	440	[180]	28000	<38.	550000	<6.0	61000	<75.	<150	160000	<150	
SN4-15-007	W002	N	1/28/2016	<1500	<380	<75.	<150	<38.	450	<150	27000	<38.	540000	<6.0	61000	<75.	<150	160000	<150	
SN4-15-007	W003	N	1/28/2016	<1500	<380	<75.	<150	<38.	450	<150	26000	<38.	500000	<6.0	56000	<75.	<150	160000	<150	
SN4-15-007A	W001	N	1/26/2016	<1500	<380	[77.]	<150	<38.	76	<150	6800	<38.	480000	96	84000	<75.	<150	210000	<150	<6.0
SN4-15-008	W002	N	1/28/2016	<1500	<380	<75.	<150	<38.	830	<150	58000	<38.	450000	<6.0	66000	<75.	<150	170000	<150	
SN4-15-008	W003	N	1/28/2016	<1500	<380	<75.	<150	<38.	620	<150	42000	<38.	360000	<6.0	75000	<75.	<150	180000	<150	
SN4-15-008	W001	N	1/26/2016	<1500	<380	<75.	<150	<38.	490	<150	36000	<38.	310000	100	60000	<75.	<150	180000	<150	<6.0
SN4-15-009	W001	N	1/27/2016	<1500	<380	<75.	<150	<38.	260	[160]	11000	<38.	740000	<6.0	33000	<75.	<150	97000	<150	<6.0
SN4-15-009	W002	N	1/27/2016	<1500	<380	<75.	<150	<38.	240	<150	11000	<38.	730000	<6.0	34000	<75.	<150	98000	<150	<6.0
SN4-15-009	W003	N	1/27/2016	<1500	<380	<75.	<150	<38.	240	<150	11000	<38.	700000	<6.0	33000	<75.	<150	98000	<150	<6.0
SN4-15-010	W001-D1-ALS	Y	1/27/2016	<1500	<380	<75.	<150	<38.	280	<150	25000	<38.	170000	<6.0	150000	<75.	<150	210000	<150	<6.0
SN4-15-010	W001	N	1/27/2016	<1500	<380	<75.	<150	<38.	260	<150	41000	<38.	290000	<6.0	120000	<75.	<150	210000	<150	<6.0
SN4-15-010	W002	N	1/27/2016	<1500	<380	<75.	<150	<38.	260	<150	38000	<38.	270000	<6.0	140000	<75.	<150	230000	<150	<6.0
SN4-15-010	W003	N	1/27/2016	<1500	<380	<75.	<150	<38.	260	<150	35000	<38.	250000	<6.0	140000	<75.	<150	210000	<150	<6.0
SN4-15-010A	W001	N	1/25/2016	<1500	<380	[210]	<150	<38.	370	<150	17000	<38.	600000	<6.0	61000	<75.	<150	180000	<150	<6.0
SN4-15-011	W001	N	1/9/2016	<1500	<380	<75.	[170]	<38.	380	<150	22000	<38.	810000	<6.0	60000	<75.	<150	160000	<150	<6.0
SN4-15-011	W002	N	1/9/2016	<1500	<380	<75.	[230]	<38.	390	<150	22000	<38.	870000	<6.0	67000	<75.	<150	160000	<150	<6.0
SN4-15-011	W003	N	1/9/2016	<1500	<380	<75.	[150]	<38.	380	<150	23000	<38.	840000	<6.0	70000	<75.	<150	160000	<150	<6.0
SN4-15-012	W001	N	1/27/2016	<1500	<380	<75.	<150	<38.	360	[240]	33000	<38.	740000	<6.0	48000	<75.	<150	140000	<150	<6.0
SN4-15-012	W002	N	1/27/2016	<1500	<380	<75.	<150	<38.	360	<150	32000	<38.	720000	<6.0	51000	<75.	<150	140000	<150	<6.0
SN4-15-012	W003	N	1/27/2016	<1500	<380	<75.	<150	<38.	380	<150	30000	<38.	730000	<6.0	49000	<75.	<150	140000	<150	<6.0
SN4-15-012A	W001	N	1/11/2016	<1500	<380	270	<150	<38.	450	<150	21000	<38.	680000	<6.0	78000	<75.	<150	170000	<150	<6.0
SN4-15-WW2C	W0001	N	10/21/2015	<3000	<750	<150	<300	<75.	350	<300	12000	<75.	680000	<6.0	120000	<150	<300	210000	<300	<6.0
SN4-15-WW3B	D2-ALS	Y	2/9/2016	<1500	<380	<75.	<150	<38.	170	<150	15000	<38.	360000	<6.0	120000	<75.	<150	220000	<150	<6.0
SN4-15-WW3B	W001	N	2/9/2016	<1500	<380	<75.	<150	<38.	170	<150	15000	<38.	370000	<6.0	120000	<75.	<150	220000	<150	<6.0
SN4-15-WW4B	W001	N	2/9/2016	<1500	<380	<75.	<150	<38.	520	<150	24000	<38.	590000	<6.0	82000	<75.	<150	170000	<150	<6.0
SN4-15-WW5A	D1-ALS	Y	1/26/2016	<1500	<380	[84.]	<150	<38.	410	<150	17000	<38.	530000	<6.0	65000	<75.	<150	190000	<150	<6.0
SN4-15-WW5A	W001	N	1/26/2016	<1500	<380	[120]	<150	<38.	440	<150	17000	<38.	570000	<6.0	72000	<75.	<150	190000	<150	<6.0
SN4-15-WW6A	W001	N	1/27/2016	<1500	<380	<75.	<150	<38.	400	<150	15000	<38.	580000	<6.0	75000	<75.	<150	180000	<150	<6.0

[X] Estimated value between statistical estimate of method/media/instrument sensitivity and a verified value for method/media/instrument
< X Value below detection
X Value above method/media/instrument sensitivity report limit
X Value above Utah State groundwater limit for drinking water

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Table 16 Brine Characterization for Sevier Playa Cont.

Well ID	Sample ID	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrate-Nitrite as N	pH	Phosphorus	Potassium	Selenium	Silver	Sodium	Specific Gravity	Strontium	Sulfate	Thallium
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	mg/L	ug/L
SN3-12-RR-7	W0001	[3200]	<150	32000	4200000	<150	<0.032	<300	<600	[42.]	6.5	<1500	3700000	<300	<150	46000000	1.121	22000	9700	<300
SN4-15-001	W0001	<1500	<150	30000	4000000	[320]	<0.032	<300	<600	[47.]	6.6	<1500	3200000	<300	<150	45000000	1.145	24000	12000	<300
SN4-15-001	W0002	<1500	<150	30000	4000000	[400]	<0.032	<300	<600	<15.	6.5	<1500	3300000	<300	<150	44000000	1.121	22000	10000	<300
SN4-15-001	W0003	<1500	<150	31000	4100000	[410]	<0.032	<300	<600	<15.	6.5	<1500	3500000	<300	<150	48000000	1.135	24000	3800	<300
SN4-15-002	W001-D1-ALS	<750	<75.	27000	2500000	970	<0.032	<150	<300		9.2	<750	2300000	<150	<75.	40000000	1.1	27000	6300	<150
SN4-15-002	W001	<750	<75.	27000	2500000	1000	<0.032	<150	<300		8.9	<750	2300000	<150	<75.	38000000	1.099	27000	7500	<150
SN4-15-002	W002	<750	<75.	26000	2500000	1700	<0.032	<150	<300		8.7	<750	2200000	<150	<75.	36000000	1.095	25000	6200	<150
SN4-15-003	W002-D1-ALS	<750	<75.	46000	2400000	3700	<0.032	<150	<300		7.1	<750	3400000	<150	<75.	42000000	1.113	24000	11000	<150
SN4-15-003	W001	<750	<75.	46000	2400000	3700	<0.032	<150	<300		7.1	<750	3400000	<150	<75.	42000000	1.121	23000	14000	<150
SN4-15-003	W002	<750	<75.	43000	2300000	3200	<0.032	<150	<300		7.1	<750	3100000	<150	<75.	36000000	1.109	21000	13000	<150
SN4-15-004	W001	<750	<75.	27000	2600000	2900	<0.032	<150	<300		6.9	<750	2300000	<150	<75.	40000000	1.107	24000	9200	<150
SN4-15-004	W002	<750	<75.	27000	2600000	2700	<0.032	<150	<300		6.9	<750	2400000	<150	<75.	40000000	1.093	25000	9800	<150
SN4-15-004	W003	<750	<75.	27000	2600000	2900	<0.032	<150	<300		6.8	<750	2300000	<150	<75.	41000000	1.11	25000	8900	<150
SN4-15-005	W001-D2-ALS	<750	<75.	31000	5400000	650	<0.032	<150	<300		7.2	<750	3800000	<150	<75.	45000000	1.178	6200	13000	<150
SN4-15-005	W001	<750	<75.	33000	5500000	890	<0.032	<150	<300		7.4	<750	4000000	<150	<75.	52000000	1.193	6700	13000	<150
SN4-15-005	W002	<750	<75.	30000	5300000	690	<0.032	<150	<300		7.2	<750	3700000	<150	<75.	56000000	1.179	6000	14000	<150
SN4-15-005	W003	<750	<75.	32000	5400000	1000	<0.032	<150	<300		7.4	<750	3800000	<150	<75.	46000000	1.179	5800	16000	<150
SN4-15-006	W001	<750	<75.	17000	1900000	4500	<0.032	<150	<300		7	[760]	1900000	<150	<75.	40000000	1.115	13000	13000	<150
SN4-15-006	W002	<750	<75.	16000	1700000	4200	<0.032	<150	<300		7.1	<750	1800000	<150	<75.	36000000	1.132	12000	10000	<150
SN4-15-006	W003	<750	<75.	14000	1700000	560	<0.032	<150	<300		6.9	[930]	1800000	<150	<75.	43000000	1.161	15000	11000	<150
SN4-15-007	W001	<750	<75.	22000	1700000	3000	<0.032	<150	<300		7.2	[880]	1900000	<150	<75.	38000000	1.104	15000	13000	<150
SN4-15-007	W002	<750	<75.	20000	1600000	3000	<0.032	<150	<300		7.1	[780]	1800000	<150	<75.	37000000	1.106	15000	13000	<150
SN4-15-007	W003	<750	<75.	20000	1500000	3200	<0.032	<150	<300		7	<750	1700000	<150	<75.	34000000	1.1	14000	13000	<150
SN4-15-007A	W001	<750	<75.	24000	1500000	<75.	<0.032	<150	<300		8.9	<750	3100000	<150	<75.	47000000	1.028	9900	7500	<150
SN4-15-008	W002	<750	<75.	40000	3900000	4400	<0.032	<150	<300		7.1	[1700]	2600000	<150	<75.	43000000	1.143	12000	13000	<150
SN4-15-008	W003	<750	<75.	36000	3400000	870	<0.032	<150	<300		8.3	<750	2500000	<150	<75.	36000000	1.131	7100	13000	<150
SN4-15-008	W001	<750	<75.	32000	2900000	760	<0.032	<150	<300		8.3	<750	2300000	<150	<75.	36000000	1.086	6700	8300	<150
SN4-15-009	W001	[1500]	<75.	11000	1500000	560	<0.032	<150	<300		7	<750	1100000	<150	<75.	20000000	1.006	40000	5300	<150
SN4-15-009	W002	[1600]	<75.	11000	1500000	290	<0.032	<150	<300		7.4	<750	1100000	<150	<75.	21000000	1.004	40000	5000	<150
SN4-15-009	W003	[1700]	<75.	11000	1400000	250	<0.032	<150	<300		7.2	<750	1000000	<150	<75.	20000000	0.9993	39000	5000	<150
SN4-15-010	W001-D1-ALS	<750	<75.	17000	1800000	2200	<0.032	<150	<300		6.7	<750	1600000	<150	<75.	33000000	1.116	4300	13000	<150
SN4-15-010	W001	<750	<75.	28000	3000000	4100	<0.032	<150	<300		6.6	<750	2600000	<150	<75.	77000000	1.161	7200	9900	<150
SN4-15-010	W002	<750	<75.	25000	2700000	3400	<0.032	<150	<300		6.6	<750	2300000	<150	<75.	59000000	1.062	6500	12000	<150
SN4-15-010	W003	<750	<75.	24000	2600000	3400	<0.032	<150	<300		6.6	<750	2200000	<150	<75.	55000000	1.059	6200	11000	<150
SN4-15-010A	W001	<750	<75.	20000	2100000	3100	<0.032	<150	<300		7.6	[760]	2400000	<150	<75.	36000000	1.008	18000	6200	<150
SN4-15-011	W001	<750	<75.	26000	2300000	4600	<0.032	<150	<300		7.1	<750	2000000	<150	<75.	37000000	1.011	24000	11000	<150
SN4-15-011	W002	[1200]	<75.	26000	2400000	4900	<0.032	<150	<300		7	<750	1900000	<150	<75.	33000000	1.02	24000	13000	<150
SN4-15-011	W003	<750	<75.	28000	2500000	4800	<0.032	<150	<300		7.1	<750	2100000	<150	<75.	35000000	1.049	25000	13000	<150
SN4-15-012	W001	6400	<75.	29000	2700000	540	<0.032	<150	<300		7	<750	1800000	<150	<75.	36000000	1.001	21000	12000	<150
SN4-15-012	W002	6500	<75.	28000	2700000	460	<0.032	<150	<300		6.8	<750	1700000	<150	<75.	33000000	1.002	20000	13000	<150
SN4-15-012	W003	5800	<75.	27000	2700000	2200	<0.032	<150	<300		6.8	<750	1700000	<150	<75.	34000000	1.01	20000	13000	<150
SN4-15-012A	W001	7600	<75.	23000	3000000	<75.	<0.032	<150	<300		6.8	<750	2000000	<150	<75.	37000000	1.018	21000	12000	<150
SN4-15-WW2C	W0001	<1500	<150	29000	3900000	<150	<0.032	<300	<600	<15.	6.8	<1500	3400000	<300	<150	46000000	1.1	20000	13000	<300
SN4-15-WW3B	D2-ALS	<750	<75.	37000	4900000	1100	<0.032	<150	<300		7.7	<750	4500000	<150	<75.	57000000	1.183	9200	11000	<150
SN4-15-WW3B	W001	<750	<75.	37000	5000000	1000	<0.032	<150	<300		7.7	<750	4500000	<150	<75.	58000000	1.184	9300	11000	<150
SN4-15-WW4B	W001	<750	<75.	22000	2700000	3800	<0.032	<150	<300		7.5	<750	2600000	<150	<75.	38000000	1.122	18000	9400	<150
SN4-15-WW5A	D1-ALS	<750	<75.	23000	2800000	280	<0.032	<150	<300		6.8	<750	2700000	<150	<75.	42000000	1.056	17000	7600	<150
SN4-15-WW5A	W001	[1500]	<75.	23000	2700000	320	<0.032	<150	<300		6.9	[800]	2600000	<150	<75.	40000000	1.018	17500	9500	<150
SN4-15-WW6A	W001	<750	<75.	21000	3000000	1600	<0.032	<150	<300		6.8	<750	2500000	<150	<75.	43000000	1.035	19000	12000	<150

[X] Estimated value between statistical estimate of method/media/instrument sensitivity and a verified value for method/media/instrument
< X Value below detection
X Value above method/media/instrument sensitivity report limit
X Value above Utah State groundwater limit for drinking water

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Table 16 Brine Characterization for Sevier Playa Cont.

Well ID	Sample ID	Tin	Titanium	Total Alkalinity	Total Dissolved Solids	Total Phosphorus	Uranium	Vanadium	Zinc	Zirconium
		ug/L	ug/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L
SN3-12-RR-7	W0001	<300	<300	270	180000	<0.15	[1700]	<300	[840]	<300
SN4-15-001	W0001	<300	<300	260	210000	<0.15	[2300]	<300	<750	<300
SN4-15-001	W0002	<300	<300	260	180000	<0.15	[1800]	<300	<750	<300
SN4-15-001	W0003	<300	<300	270	190000	<0.15	[1900]	<300	<750	<300
SN4-15-002	W001-D1-ALS	<150	<150	140	130000	<0.75	<750	<150	[730]	<150
SN4-15-002	W001	<150	<150	120	130000	<0.75	<750	<150	[730]	<150
SN4-15-002	W002	<150	<150	86	130000	<0.75	<750	<150	[730]	<150
SN4-15-003	W002-D3-ALS	<150	<150	340	160000	<0.75	<750	<150	[730]	<150
SN4-15-003	W001	<150	<150	330	160000	<0.75	<750	<150	[730]	<150
SN4-15-003	W002	<150	<150	340	160000	<0.75	<750	<150	[730]	<150
SN4-15-004	W001	<150	<150	250	140000	<0.15	[970]	<150	[380]	<150
SN4-15-004	W002	<150	<150	260	150000	<0.15	<750	<150	<380	<150
SN4-15-004	W003	<150	<150	250	140000	<0.15	[990]	<150	<380	<150
SN4-15-005	W003-D2-ALS	<150	<150	470	210000	<0.15	[1100]	<150	<380	<150
SN4-15-005	W001	<150	<150	470	200000	[0.19]	[1100]	<150	<380	<150
SN4-15-005	W002	<150	<150	540	200000	<0.15	[940]	<150	<380	<150
SN4-15-005	W003	<150	<150	420	220000	<0.15	<750	<150	<380	<150
SN4-15-006	W001	<150	<150	460	140000	<0.75	[1000]	<150	<380	<150
SN4-15-006	W002	<150	<150	460	140000	<0.75	[1100]	<150	<380	<150
SN4-15-006	W003	<150	<150	340	180000	[1.2]	[850]	<150	<380	<150
SN4-15-007	W001	<150	<150	440	130000	<0.75	[1500]	<150	<380	<150
SN4-15-007	W002	<150	<150	450	130000	<0.75	[1300]	<150	<380	<150
SN4-15-007	W003	<150	<150	450	120000	<0.75	[1100]	<150	<380	<150
SN4-15-007A	W001	<150	<150	170	170000	<0.75	[920]	<150	<380	<150
SN4-15-008	W002	<150	<150	830	140000	<0.75	[1900]	<150	[710]	<150
SN4-15-008	W003	<150	<150	620	140000	<0.75	[1300]	<150	[470]	<150
SN4-15-008	W001	<150	<150	590	160000	5.6	[840]	<150	<380	<150
SN4-15-009	W001	<150	<150	260	61000	<0.75	<750	<150	<380	<150
SN4-15-009	W002	<150	<150	240	64000	<0.75	[820]	<150	<380	<150
SN4-15-009	W003	<150	<150	240	65000	<0.75	<750	<150	<380	<150
SN4-15-010	W001-D1-ALS	<150	<150	280	220000	5.7	<750	<150	[410]	<150
SN4-15-010	W001	<150	<150	260	220000	<0.75	<750	<150	[790]	<150
SN4-15-010	W002	<150	<150	260	230000	<0.75	<750	<150	[540]	<150
SN4-15-010	W003	<150	<150	260	220000	<0.75	[1200]	<150	[690]	<150
SN4-15-010A	W001	<150	<150	370	140000	[1.2]	[830]	<150	<380	<150
SN4-15-011	W001	<150	<150	380	120000	<0.15	[880]	<150	<380	<150
SN4-15-011	W002	<150	<150	390	120000	<0.15	[1200]	<150	<380	<150
SN4-15-011	W003	<150	<150	380	130000	<0.15	<750	<150	[410]	<150
SN4-15-012	W001	<150	<150	360	110000	<0.75	[1300]	<150	<380	<150
SN4-15-012	W002	<150	<150	360	110000	<0.75	<750	<150	<380	<150
SN4-15-012	W003	<150	<150	380	210000	<0.75	<750	<150	<380	<150
SN4-15-012A	W001	<150	<150	450	140000	<0.15	[770]	<150	<380	<150
SN4-15-WW2C	W0001	<300	<300	350	200000	<0.15	[1800]	<300	<750	<300
SN4-15-WW3B	D2-ALS	<150	<150	170	200000	<0.75	<750	<150	[730]	<150
SN4-15-WW3B	W001	<150	<150	170	140000	<0.75	<750	<150	[730]	<150
SN4-15-WW4B	W001	<150	<150	520	160000	<0.75	[910]	<150	<380	<150
SN4-15-WW5A	D1-ALS	<150	<150	410	160000	<0.75	<750	<150	<380	<150
SN4-15-WW5A	W001	<150	<150	440	150000	<0.75	<750	<150	[730]	<150
SN4-15-WW6A	W001	<150	<150	400	200000	<0.15	[1800]	<300	<750	<300

[X]	Estimated value between statistical estimate of method/media/instrument sensitivity and a verified value for method/media/instrument
< X	Value below detection
X	Value above method/media/instrument sensitivity report limit
X	Value above Utah State groundwater limit for drinking water

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1.4 Analytical Program

1.4.1 Sediment Porosity Measurements

Direct measurement of sediment porosity from 18 Shelby tube core samples taken during the 2015 hydrologic testing program were undertaken by IGES, in accordance with ASTM Standard D2216. These porosity measurements, presented in **Table 17**, were used to validate the sediment porosity calculations used for brine resource determinations.

Table 17 Sediment Porosity Measurements

Hole ID	Sample ID	IGES Lab Porosity Measurement		
		Water %	Air %	Total %
SN4-15-002	SH-001_2	46.1	9.9	56.0
SN4-15-002	SH-002_2	41.4	4.6	46.0
SN4-15-002	SH-003_2	32.9	8.2	41.1
SN4-15-003	SH-001_3	38.9	9.4	48.3
SN4-15-003	SH-002_3	36.6	5.3	41.9
SN4-15-003	SH-003_3	43.0	5.5	48.5
SN4-15-006	SH-001_6	48.4	6.8	55.1
SN4-15-006	SH-002_6	52.9	1.0	54.0
SN4-15-006	SH-003_6	48.5	7.3	55.7
SN4-15-008	SH-001_8	59.3	7.6	67.0
SN4-15-008	SH-002_8	49.2	10.1	59.4
SN4-15-008	SH-003_8	49.6	8.1	57.7
SN4-15-011	SH-001_11	47.6	7.0	54.6
SN4-15-011	SH-002_11	48.5	8.1	56.6
SN4-15-011	SH-003_11	50.6	7.1	57.8
SN4-15-012	SH-001_12	44.1	9.3	53.5
SN4-15-012	SH-002_12	43.3	6.1	49.5
SN4-15-012	SH-003_12	40.4	8.3	48.7
	Average	**45.6**	**7.2**	**52.9**

1.4.2 Trench-to-Trench Test Program

A field-scale test of the proposed mine plan trench concept was initiated in 2015, shown in **Figure 9**. For the TtT test, three trenches 100 feet in length were excavated through the FCZ and into the MCZ to a depth of 20 feet bgs. The three trenches were cut parallel to each other with their centerlines spaced approximately 100 feet apart, as shown in

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Figure 9. The trenches were excavated with side wall slopes of 0.5:1 (horizontal to vertical), and trench bottoms that were approximately 4 feet wide. The test concept was to monitor water levels and chemistry while brine was pumped from the extraction trench, and fresh water (from the Lakeview Well) was supplied to the injection (recharge) trenches.

During the trench excavations, groundwater did not enter the excavation until the interface between the FCZ and MCZ was breached. Once trench depths were below the bottom of the FCZ, brine levels within the trench rose to within approximately 1-foot bgs. Thus, under natural conditions during trench testing, the brine aquifer beneath the FCZ was under approximately 10 feet of hydrostatic pressure above the top of the MCZ.

The center trench was originally designed as an extraction trench, and the two outer trenches were originally designed as recharge trenches. Prior to the start of the TtT test, the brine within the two outer recharge trenches was replaced with fresh water from the Lakeview Well. Next, the brine level in the extraction trench was drawn down and maintained near the bottom of the trench to create a driving force for the fresh water in the recharge trenches to move through the MCZ toward the extraction trench. Brine that was pumped from the extraction trench was conveyed via flexible piping approximately 1,000 feet from the TtT site, where it was discharged onto the Playa surface. A recording totalizing flow meter, installed in-line within the discharge piping, logged the cumulative brine volume extracted over the duration of the test.

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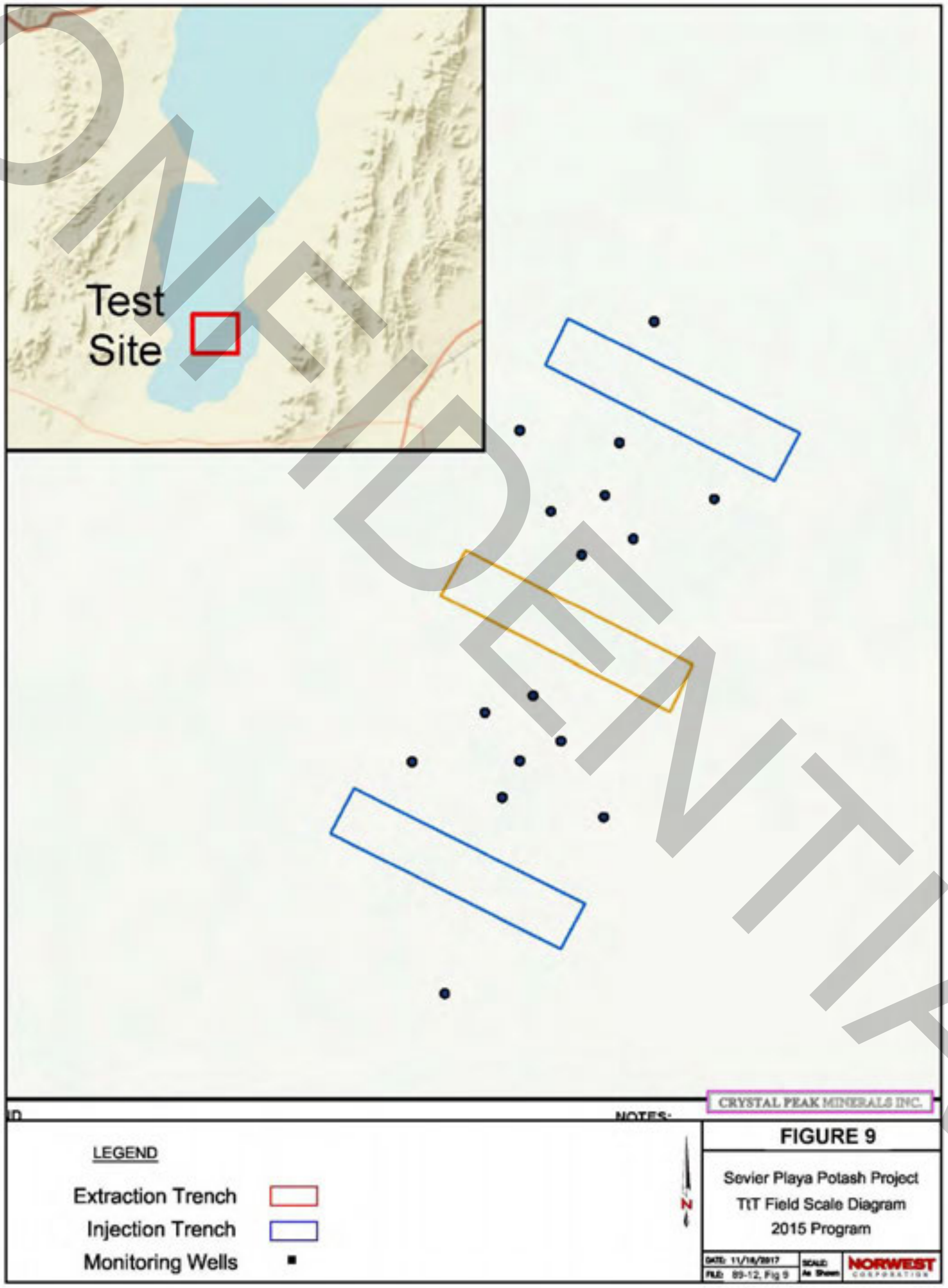
Figure 9: TtT Field Scale Diagram 2015 Program



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A total of 16 monitoring-well pairs were installed around the trenches to monitor potentiometric levels and brine chemistry during testing, as shown in **Figure 9**. These wells were designed to provide information on the timing of the fresh water "front" as it moved from the outer recharge trenches toward the center extraction trench.

The monitoring-well pairs consisted of an upper well screened from approximately 10 to 25 feet bgs and a lower well screened from 26 to 41 feet bgs. In addition to the monitoring wells, a stilling well was installed in each trench to monitor water levels inside the trenches. A subset of the wells was instrumented with AquiStar datalogging sensors that monitored pressure (i.e., brine level), water temperature and electrical conductivity in the wells. Furthermore, brine levels and electrical conductivity were manually measured at all monitoring wells throughout the test period. Water samples were also collected throughout the testing period for laboratory testing to determine major ion chemistry and stable isotope ratios of hydrogen and oxygen.

The initial TtT test began on September 1, 2015. However, unplanned downtime beginning on September 4, 2015, forced the cancellation of this test. Once water levels had recovered and equipment issues had been resolved, a second TtT test was started on September 8, 2015. The second phase of TtT testing lasted for 17 days. The total volume of brine removed from the extraction trench over the second phase of the test was 994,000 gallons. This equates to an average pumping rate of approximately 41 gpm during the test.

The total volume of fresh water that was recharged by the two trenches was on the order of 100,000 gallons. Although drawdowns in the monitoring wells were measured, significant reductions in the electrical conductivity were not detected in either the AquiStar or the manual measurements. However, after one week of pumping, water levels in the recharge trenches had declined by about 4 feet from the starting level, and no indication of fresh water had been measured in any of the monitoring wells. This suggests that either the fresh water front had not arrived at the closest monitoring well during the week the test was performed, the fresh water that had been drawn into the brine aquifer had been assimilated before reaching the nearest monitoring well, or the less-dense fresh water was more buoyant than the dense brine, and flowed near the interface between the FCZ and MCZ above the monitoring depths. After one week of pumping, significant sloughing of the side walls had occurred within the extraction trench, and the trench geometry had been compromised. Therefore, the decision was made to terminate the test.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

The trench configuration at the TtT site was redesigned in a final attempt to induce fresh water flow into the MCZ aquifer. The redesign included switching the locations of recharge and extraction trenches so that the outer trenches became extraction trenches and the center trench would become a recharge trench. Initially, extraction occurred at all three trenches in an effort to suppress the potentiometric surface prior to introducing the fresh water recharge. However, sloughing of the trench side walls and heaving from the trench bottoms precluded the recharge phase. The final TtT testing ended on October 26, 2015. Between September 26, 2015 and October 26, 2015, extraction occurred for a total of 11 days, with approximately 1.3 million gallons of brine removed.

Important observations drawn from the TtT test are as follows:

- Large volumes of brine can be extracted by pumping trenches.
- Significant artesian pressures limited fresh water recharge at the recharge trenches within the available timeframe for conducting the test.
- A more comprehensive dewatering phase to depressurize the brine aquifer would likely be required to promote gravity-recharge capacity at the recharge trenches.
- Significant sloughing of trench side walls made it difficult to maintain trench geometry.
- Alternative trench designs should be considered.

The drawdown and extraction rate data collected during the TtT test were used to estimate hydraulic properties of the brine aquifer. The horizontal hydraulic conductivity was estimated to be 7.4 feet/day for the MCZ with a storitivity value of 0.0003. Based on the data evaluation, the ratio of horizontal to vertical conductivity within the MCZ was estimated to be 1.0, meaning they were equal.

1.4.3 Well-to-Trench Test Program

Given the difficulties associated with the TtT test and the onset of colder and wetter weather, a smaller-scale, WtT test was performed approximately 2,320 feet northeast of the TtT site, as shown in **Figure 10**. One of the most problematic issues associated with the TtT test was that artesian pressures could not be reduced sufficiently within the given timeframe to test gravity-recharge of fresh water into the brine aquifer at the recharge trenches. Thus, the WtT test was designed so that fresh water could be injected under pressure directly into the MCZ using a line of five injection wells, as shown in **Figure 10**. For this test, five monitoring wells were installed between the injection wells and the extraction trench. The test concept was to monitor water levels and chemistry while brine

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

was pumped from the extraction trench and fresh water (from the Lakeview Well) was supplied to the injection wells.

The extraction trench was 60 feet long and 20 feet deep. Given the side-wall sloughing observed at the TtT test, the extraction trench at the WtT test had reduced side-wall slopes of approximately 1:1 (horizontal to vertical). The five injection wells were installed parallel to the trench and 60 feet from the trench centerline. Injection wells were spaced 10 feet apart from one another, as shown in **Figure 10**. Monitoring wells were installed parallel to the trench and 35 feet from the trench centerline. The monitoring wells were also spaced 10 feet apart. All injection and monitoring wells were screened from 10 to 20 feet bgs.

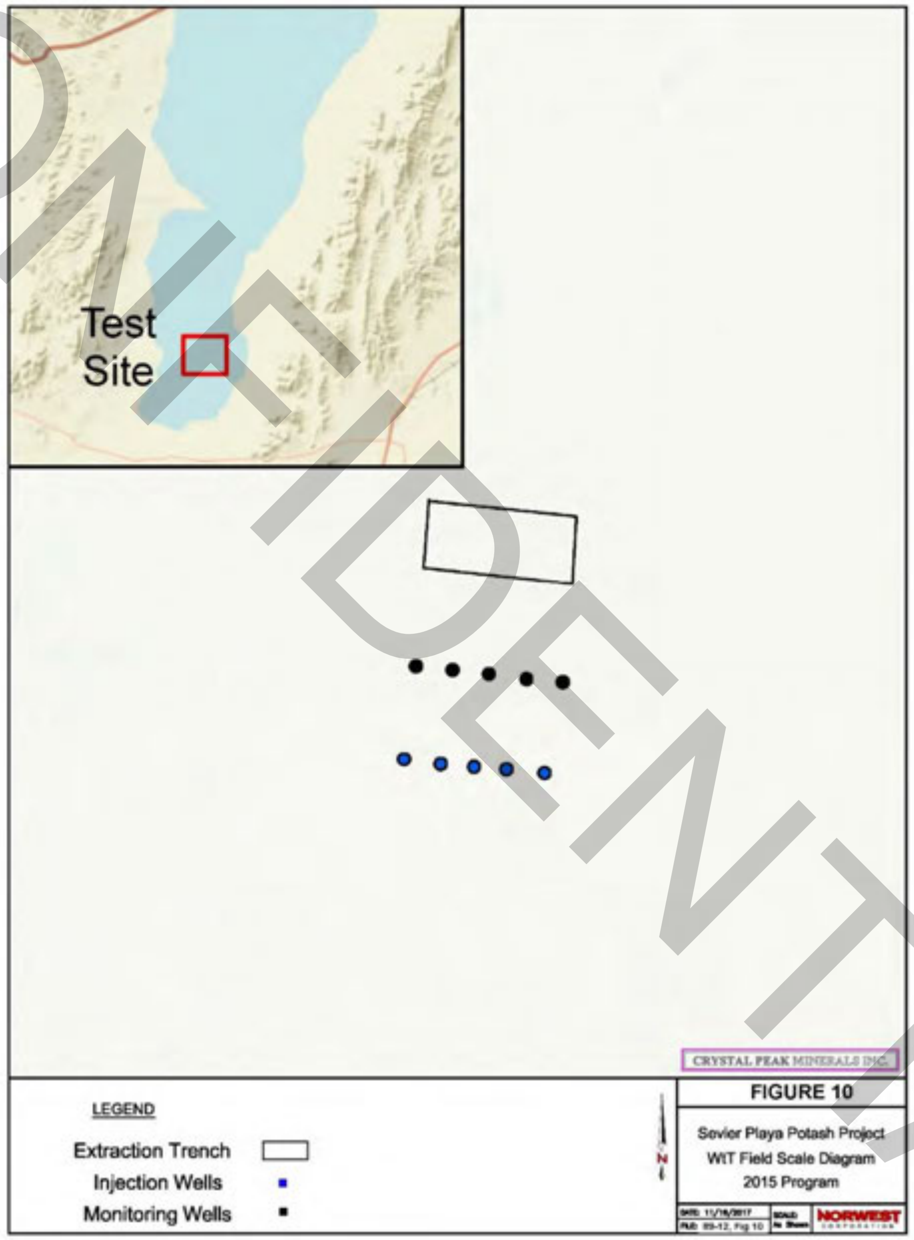
A pump was placed near the bottom of the extraction trench and operated on a near continuous basis for a two-month period. Extraction rates were in the range of 30 to 50 gpm. Flow from the trench was monitored continuously using a totalizing flow meter and a datalogger. The extracted brine was discharged approximately 1,000 feet from the test site.

Fresh water was supplied to the injection wells from the Lakeview Well. Each injection well was instrumented with a totalizing flow meter. The five injection wells operated intermittently over the course of the test and at a range of injection rates less than 1 to 4 gpm. The intermittent nature of the injection was largely due to freezing in the injection lines.

All five of the monitoring wells were instrumented with AquiStar datalogging sensors that monitored pressure (i.e., brine level), water temperature and electrical conductivity in the wells. Furthermore, brine levels and electrical conductivity were manually measured at all wells throughout the test period. Water samples were also collected during the testing period for laboratory testing to determine major ion chemistry and the stable isotope ratios of hydrogen and oxygen. Electrical conductivity profiling was also performed at each monitoring well once or twice per week, wherein an electrical conductivity probe was slowly moved downward through the screened interval and manual measurements were taken at regular intervals. This was performed to detect potential chemical stratification in the water column.

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

Figure 10: WtT Field Scale Diagram 2015 Program



The WtT test was conducted for two months and consisted of two separate injection phases. Trench extraction started on October 30, 2015, and the first phase of injection began on October 31, 2015. Injections continued intermittently for approximately two weeks until November 18, 2015, when the lines and valves on the injection system had completely frozen. Extraction from the extraction trench continued during the period that

Attachment 4 - Summary of 2014-2016 CPM Groundwater Studies

the injection wells were inoperable. A variety of improvements were made to better insulate the injection system, and on December 9, 2015, injections were restarted. Injections continued intermittently until December 24, 2015, when the injection system had again completely frozen. Extraction continued at the WtT test until January 4, 2016. During the 66-day WtT test, approximately 174,000 gallons of fresh water had been injected and 3.6 million gallons of brine had been extracted.

Important observations drawn from the WtT test include:

- Significant decreases in the potentiometric surface elevation, electrical conductivity, and K+ concentrations were measured at all monitoring wells in comparison to static, pretest conditions.
- Fresh water from the Lakeview Well was successfully injected into the MCZ at five injection well locations, and successfully extracted from a nearby trench; thereby demonstrating that mixing of Lakeview Well water with in-situ brine in the MCZ was possible and estimates of the timing were possible.
- Analysis of stable isotope samples (δ^2H and $\delta^{18}O$) indicates that the brine aquifer rapidly assimilated the injected fresh water, indicating that the mass-transfer process was active.

Data from the WtT test were used to estimate aquifer hydraulic and solute transport parameters to support the development of the Playa-wide Numerical Groundwater Flow Model and Playa-wide Numerical Solute Transport Model used to support mine planning and the reserve determination.

Attachment 5 - Drill Logs for 2015 Sonic Borings

UTM ZONE 12
E0311261
N 4291331 ELEV 4518

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-001
Page 1 of 6
Date 10/9/2015 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	6.8				
2	5.0	10.0	5.0	6.1				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
0							CLY (0-1.2) LT BRN GRY, WX @ Top, SOME SILT, ABNT CARB MINERALS, Trace VF-F BRN SAND, DAMP, LOW PLASTIC
1							PP = 0.25, SOFT
							CLY (1.2-7.5) LT GRY - LT BRN GRY, TRACE SILT & VF SAND, ABNT CARB MINERALS, MOIST, HIGH PLASTIC, OCC BLK ORG w/ SULFUR ODOR
2							PP = 0.25, V SOFT
3		SN4-15-001 MC-001 0-5'					PP = 0.25 V SOFT
4							PP = 0.25 V SOFT
				XXX	CARB MIN		ABNT CARB MINERALIZATION
							BLK ORGANIC MATTER
5							PP = 0.25, V SOFT
							PP = 0.5,
6							PP = 0.5 SOFT
7		SN4-15-001 MC-002 5-10'					PP = 0.5, SOFT
							CLY (7.5-11.5) LT GRY w/ OCC LT BRN BANDS, TRACE SILT, ABNT LARGE GYPSUM XTALS, WET, SOFT - V SOFT, LESS CARBONATE MATRIX, BECOMING MORE SATURATED @ BOTTOM
8				XXX	GYPSUM XTAL		PP = 0.75
							PP = 0
9				XXX	GYPSUM		PP = 0
10							PP = 0

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-001
Page 2 of 6
Date 10/9/2015 D/M/Y
Name A.Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	10.0	15.0	5.0	7.3				
4	15.0	20.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=0.25 V SOFT
							MANG? MINERALIZATION, BLACK SPECKLING
				XXX	LG GYPSUM XTAL		
11				XXX	LG GYP XTAL		PP=0.25 V SOFT CARBONATE MATRIX BEDDED w/ CLAY, LT GRY, (11.5-16.0) CARB is FN-MD SAND SIZE & WET, CLAY IS DAMP-MOIST, HIGH PLASTIC
12	CARB MATRIX	SN4-15-001 MC-003 10.0-15.0					PP=0.25 V. SOFT, WET
13	CLAY						PP=1.25 IN CLY BAND, DAMP
14	CARB MATRIX						PP=1.0 IN CARB MATRIX, WET
15							PP=0
16							CLAY (16.0-22.0) LT-MD GRY, SOME CARBONATE MATRIX, TRACE GYPSUM XTALS, HOMOGENEOUS, LITTLE TO NO VISIBLE BEDDING, SOFT-STIFF MOIST, HIGH PLASTIC PP=0.5
17		SN4-15-001 MC-004 15.0-20.0		RELATIVE HOMOGENEITY	STIFFENING DOWNWARD		PP=2.25
18							PP=3.25
19							PP=3.25
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-001
Page 3 of 6
Date 10/9/2015 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
5	20.0	22.0	2.0	2.6				
6	22.0	23.5	2.6	0.9				
7	23.5	25.0	1.5	2.1				
8	25.0	30.0	5.0	5.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
		SN4-15-001 MC-005 20.0-22.0				CLAY, SAA
21						
22	SHELBY TUBE	SN4-15-001 SH-01 22.0-23.5 22.0-22.9 REC				
23						CORE LOSS 22.9-23.5
		SN4-15-001 MC-006 23.5-25.0				CLY (23.5-27.5) LT GRY → TO MED GRY, SOME SILT, MINOR GYPSUM XTALS, STIFF-HARD, DAMP, HOMOGENEOUS PP=4.5
24						PP=3.25
25						PP=1.0
26						PP=1.5
27		SN4-15-001 MC-007 25.0-30.0				PP=3.25
						CLY (27.5-36.0) LT GRY- LT OLV GRY, MINOR SILT, MINOR GYPSUM XTALS, DAMP-MOIST, MOD STIFF - STIFF, HIGH PLASTIC OCC DK GRY BANDS, OCC GYPSIFEROUS BANDS, OCC CARBONATE MATRIX NODULES/BANDS PP=2.25
28						
29				DK GRY, SILTY		PP=2.5
30						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	30.0	35.0	5.0	5.8				
10	35.0	40.0	5.0	6.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-001
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Date 10/9/2015 D/M/Y
Name A.Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
30		SN4-15-001 MC-008 30.0-35.0			CARB MATRIX		PP=2.75
31							PP=2.75
32							PP=1.5
33				xxx	GYP XTLS		PP=1.5
34					CARB MATRIX BAND 2" thick		PP=2.0
35							PP=1.5
36							CLY (36.0 – 40.0) LT OLV GRY w/ DK OLV GRY BANDS, TRACE SILT, MINOR CARB MATRIX BEDS UP to 5 mm, Soft-MOD STIFF DAMP HIGH PLASTIC, OCC GYPSUM XTALS PP=1.75
37		SN4-15-001 MC-007 35.0-40.0					PP=2.5
38				xxx xx	LG GYP XTL ~3"		PP=1.25
39							PP=0.75
40							

Drill Hole Lithology Log

NORWEST CORPORATION

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Name: A. Garhart
Photos: Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
11	40.0	45.0	5.0	5.7				
12	45.0	50.0	5.0	5.8				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic / Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
40–41						CLY, (40.0-46.5) OLV GRY w/ DK OLV GRY BEDS/LAMS, VF GRN CARB MATRIX (PP = 1.0) under microscope, soft-MED STIFF DAMP-MOIST, HIGH PLASTIC, RELATIVELY HOMOGENEOUS, LGE GYPSUM XTAL'S @ BTM
41				Color banded laminations distorted from extrusion		PP = 0.5
42		SN4-15-001 MC-010 40.0-45.0				PP = 1.0
43						PP = 0.75
44						PP = 1.0
45						PP = 1.75
46						PP = 0.75
46.5						INTBD CLY & SAND (46.5-48.0) CLY-SAA SAND-FN-CRS GRN, SUBANG, PRDM QUARZITE MOIST, NON PLASTIC
47		SN4-15-001 MC-011 45.0-50.0				PP = 1.5
48						SAND (48.0-49.0) MED BRN-PNK, MD-CRS GRN, SUB RND-SUBANG, PRDM QTZITE, OCC PEBBLES up to 2.5", WET, LOOSE
49						CLY (49.0-49.6) OLV GRY-MED BRN, NO VISIBLE BEDDING, HARD-V. HARD, DAMP-DRY, LOW-NON PLASTIC PP>5.0
49.6–50						SAND (49.6-50.0) SAA (48.0-49.0) WET

Drill Hole Lithology Log

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
13	50.0	55.0	5.0	5.1				
14	55.0	58.5	3.5	3.8				
15	58.5	60.0	1.5	1.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
							CLY (50.0 – 58.3) RED BRN w/ Mottled OLV GRY, HOMOGENEOUS, TRACE PEBBLES to 5mm, TRACE GYPSUM XTALS, TRACE SAND, DAMP, HARD, HIGH DENSITY
51							PP=4.5
							PP=4.5
52		SN4-15-001 MC-012 50.0-55.0					
							PP=4.5
53							
							PP > 5.0
54							
							PP > 5.0
55							PP > 5.0
56							
		SN4-15-001 MC-013 55.0-58.5					PP > 5.0
57							PP > 5.0
58							PP > 5.0
							SAND (58.3-58.5) BRN GRY, SILTY VF-FN GRN, PRDM QTZ, MOIST, WELL SRT
		SN4-15-001 MC-014 58.5-60.0					CLY (58.5 – 60.0) RED BRN – OLV GRN MOTTLED, TRACE PEBBLES, DAMP, HARD
59							PP = 5.0
60							

UTM ZONE 12
NAD 83
N 4296139
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Drill Hole Lithology Log

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Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	3.2				
2	5.0	7.0	2.0	2.1				
3	7.0	10.0	3.0	3.8				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
0						* Note – RUN 1 compressed to 3.2 due to soft material * Contacts approximated *
						PP=0
						CLY (0.0-1.5) MD BRN, SILTY & TRACE SAND @ TOP, MASSIVE, VERY SOFT, DAMP, LOW PLASTIC
1						
						PP=0.25 CLY (1.5-9.0) LT OLV GRY-DK OLV GRY, MASSIVE w/ CARBONATE MATRIX BEDS up to 3/4", SOFT, MOIST, HIGH PLASTIC
2						
						PP=0.25
3		SN4-15-002 MC-001 0.0-5.0		CARB MATRIX BEDS		
						PP=0.75
4						
						PP=0.75
5						
6	SHELBY TUBE # SH-01	SN4-15-002 SH-01 5.0-7.0				
7						
				CARB MATRIX BEDS		PP=0.5
8						
						PP=0.75
9		SN4-15-002 MC-002 7.0-10.0				CLY (9.0-10.5) MD BRN-OLV GRY-DK OLV GRY, ABNT ORGANIC RICH LAYERS UP TO 2.5" (GRASS ?), Thickly Bedded, MOIST, SOFT, LOW-HIGH PLASTIC, MILD SULFUR ODOR, OCC GYPSUM X-TALS to 0.5"
				ORGANICS		PP=0.75
10						

Drill Hole Lithology Log

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Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	10.0	15.0	5.0	5.1				
5	15.0	20.0	5.0	5.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

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Date 23/9/2015 D/M/Y

Name A.Garhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
				XXX	LG GYP XTAL		PP=0.5 CARBONATE MATRIX (10.5 – 17.0) OLV GRY, CLAY SIZE PARTICLES TO 12.5' TO GRANULAR CARBONATE @ 12.5, SOFT, MOIST-WET, HIGH PLASTIC @ TOP to NON-PLASTIC IN GRANULAR ZONE
11							PP=0.75
12							PP=0.5
13		SN4-15-002 MC-003 10.0-15.0'					PP=0.5
14					Granular Carbonate		PP=0.5
15							PP=1.5
16							PP=1.5
17							PP=2.25 CLY (17.0 – 22.0) OLV GRY-DK OLV GRY POSSIBLY FINER GRN, MORE COMPACT CARB MATRIX? MASSIVE HOMOGENEOUS, DENSE, STIFF DAMP, HIGH PLASTIC, SLICKENSIDES IN BREAKS
18		SN4-15-002 MC-004 15.0-20.0					PP=2.25
19							PP=2.75
20							

Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	20.0	23.0	3.0	4.2				
7	23.0	25.0	2.0	0.0				
8	25.0	27.0	2.0	1.8				
9	27.0	30.0	3.0	4.1				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

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Name A Gorhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
20–21		SN4-15-002 MC-005 20.0-23.0					PP=2.25
21–22							PP=3.75
22–23							PP=0.25 CLY (22.0-23.0) LT GRY w/ OCC DK GRY MOTTLING, MASSIVE, SOFT, MOIST-WET, HIGH PLASTIC
23–25		SHELBY TUBE ATTEMPT					CORE LOSS 23.0 - 25.0, Material fell OUT OF SHELBY TUBE
25–27	SHELBY TUBE # SH-02	SN4-15-002 SH-02 25.0-27.0					
27–28		SN4-15-002 MC-006 27.0-30.0		x x	Gypsum Xtals		PP=2.25 CLY (27.0-37.5) OLV GRY, MASSIVE, HOMOGENEOUS, GYPSUM XTALS to 0.25" Throughout, SOFT, DAMP, HIGH PLASTIC
28–29				x x			PP=2.0
29–30				x x x x			PP=2.25

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Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	30.0	35.0	5.0	4.5				
11	35.0	40.0	5.0	5.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Code (From – To)	Lithologic Description Color Grain Size Sorting
				**			PP=2.25	CLY, SAA
31				*	GYPSUM X-TALS		PP=2.25	
32		SN4-15-002 MC-007 30.0-35.0		* *			PP=2.0	
33				*			PP=2.0	
34					GYPSUM LENSE		PP=1.5	
35				* *	GYPSUM X-TALS		PP=2.75	
36					CARBONATE BAND		PP=3.25	
37					CARB MATRIX BAND		PP=2.5	CLY (37.5 – 45.0) OLV GRY – DK OLV GRY, LAM & COLOR BANDED to MASSIVE, OCC LG GYPSUM X-TALS to 1.5" STIFF – V. STIFF, DRY – DAMP MOTTLED w/ YLW ORNG 43–44
38		SN4-15-002 MC-008 35.0-40.0					PP=3.75	
39				* *	LG GYPSUM X-TALS		PP=2.0	
40								

Drill Hole Lithology Log

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	40.0	42.0	2.0	1.9				
13	42.0	45.0	3.0	4.0				
14	45.0	47.0	2.0	2.0				
15	47.0	51.0	4.0	3.6				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
40–42	SHELBY TUBE #SH-03	SN4-15-002 SH-03 40.0-42.0				CLY SAA SHELBY TUBE # SH-03, end dented while pushing, should be salvagable.
42–43				LG GYPSUM XTALS		PP=2.75
43–44		SN4-15-002 MC-009 42.0-45.0		LG GYPSUM XTALS		PP=3.75
44–45				LG GYPSUM XTALS		PP=4.75
45–46						PP=3.75
46–47		SN4-15-002 MC-010 45.0-47.0				PP=3.75 CLY (45.0-51.0) GRY BRN, MASSIVE, STIFF, DRY-DAMP, NON PLASTIC
47–48						PP=3.75
48–49		SN4-15-002 MC-011 47.0-51.0				PP=3.25
49–50						PP=4.0

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
16	51.0	55.0	4.0	4.0				
17	55.0	57.0	2.0	0.0				
18	57.0	60.0	3.0	3.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
							PP=4.0
51							CLY (51.0-) MED BRN-OLV GRY, MASSIVE, HOMOGENEOUS, OCC GYPSUM XTALS/BANDS, HARD, DAMP-DRY, NON-PLASTIC
							PP >5.0
52							
							PP > 5.0
53				XXX	GYPSUM XTALS		
		SN4-15-002 MC-012 51.0-55.0					PP > 5.0
54				XXXX	GYPSUM BAND/LENSE		
							PP=3.5
55	SHELBY TUBE ATTEMPT	No sample					Shelby Tube damaged during push, no recovery
							LOST CORE 55.0-57.0
56							
57							
							PP > 5.0
58							
		SN4-15-002 MC-013 57.0-60.0		XX XX XX XX	GYPSUM XTALS		PP > 5.0
59							
							PP > 5.0
60							

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Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
19	60.0	65.0	5.0	5.2				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP > 5.0
61							
							PP > 5.0
62							
							PP > 5.0
63		SN4-15-002 MC-014 60.0-65.0					
							PP > 5.0
64							
							PP > 5.0 TD = 65.0
65							
66							
67							
65							
69							
70							

UTM ZONE 12
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N4302910
E0312245 Elev 4529

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Name A. Gerhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	2.0				
2	3.0	8.0	5.0	1.0				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
0		SN4-15-003 MC-001 0.0-3.0				CARBONATE MATRIX (0.0-2.5) V. DK GRY, GRANULAR (MD-CRS SAND SZ) V. SOFT, SATURATED, NON PLASTIC, STRONG SULFUR ODOR PP=0
1						
2						PP=0
2.5						PP=0 CLY (2.5-4.0) DK GRY w/ DK BRN CARB MATRIX BEDS, Thickly bedded, V SOFT, WET, LOW PLASTIC, STRONG SULFUR ODOR
3		SN4-15-003 MC-002 3.0-4.0				PP=0
4		CORE LOSS 4.0-8.0				CORE LOSS 4.0-8.0, VERY SOFT MATERIAL
5						
6						
7						
8		SN4-15-003 MC-003 8.0-13.0		ORGANICS		CLY (8.0-9.5) MD-DK GRY, ABNT ORGANICS LG GYPSUM XTALS, VERY SOFT, SATURATED, NON-PLASTIC, STRONG SULFUR ODOR PP=0
9				GYPSUM		
9.5				GYPSUM		PP=0 CARBONATE MATRIX (9.5-13.0) MED GRY, HOMOGENEOUS, LG GYPSUM XTALS, SOFT, WET-DAMP, LOW-NON PLASTIC
10						

Drill Hole Lithology Log

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	5.4				
5	18.0	20.0	2.0	3.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=0
				** GYPSUM		
11		SN4-15-003 MC-003 8.0-13.0				PP=0.75
12						PP=0.25
13				xxx GYPSUM LENSE		CLY (13.0-20.0) MD GRY, CARB MATRIX ~10% throughout, HOMOGENEOUS, SOFT-STIFF, HIGH PLASTIC, DAMP-MOIST, CARB MATRIX LENSE @ 17.7-18.0 (Possibly Fine grained carb matrix/marl)
						PP=1.25
14						PP=0.75
15						PP=1.25
16		SN4-15-003 MC-004 13.0-18.0				PP=2.0
17						PP=2.0
18				CARB MATRIX (Granular)		
		SN4-15-003 MC-005 18.0-20.0				PP=0.5
19						PP=0.75
20						

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	20.0	22.0	2.0	2.1				
7	22.0	28.0	6.0	6.6				
8	28.0	33.0	5.0	5.4				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
20–22	SHELBY TUBE SH-01	SN4-15-003 SH-01 20.0-22.0					SHELBY TUBE # SH-01 20.0-22.0, appears to be clay as above
22							CLY (22.0-27.3) SAA
22.5							PP=0.75
23.5							PP=0.5
24				**	GYPSUM XTALS		
24.5							PP=1.0
25				**	GYPSUM XTALS		
25.5		SN4-15-003 MC-006 22.0-28.0					PP=0.75
26.5							PP=1.25
27							PP=1.25
27.5							SAND (27.5-29.5) MD-DK GRY, MED GRN, PRED QTZ, SILTY, CARBONATE NODULES, LOOSE-LITHIFIED, DRY-WET
28–30		SN4-15-003 MC-007 28.0-33.0					
29.5				*	GYPSUM XTALS		CLY (29.5-30.5) MD GRY, HOMOGENEOUS, PP=1.25 OCC LG GYPSUM XTALS, soft-FIRM, MOIST, HIGH PLASTIC

Drill Hole Lithology Log

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	33.0	38.0	5.0	5.0				
10	38.0	40.0	2.0	1.8				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
		SN4-15-003 MC-007 28.0-33.0					PP=1.75 SAND (30.5- 31.0) SAA
31							CLAY (31.0-32.0) SAA
							PP=1.25
32							SAND (32.0–36.5) MED-DK GRY FN-CRS GRN, PRDM QTZ, SUBRND-SUBANG, POOR-MOD SORTING, GRAVEL TO 3" (local qtzite & limestone) LOOSE, SATURATED
33							
34							
35							
36		SN4-15-003 MC-008 33.0-38.0					
							CLY (36.5-53.0) OLV GRY w/ DK GRY MOTTLING, HOMOGENEOUS, OCC LG GYPSUM XTALS, STIFF-FIRM, DAMP-MOIST, HIGH PLASTIC
37				** *	GYPSUM XTALS		PP=1.75
							PP=2.25
38							
39	SHELBY TUBE #SH-02	SN4-15-003 SH-02 38.0-40.0					
40							

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Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
11	40.0	43.0	3.0	3.0				
12	43.0	48.0	5.0	5.0				
13	48.0	50.0	2.0	0.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
				**			CLY SAA
							PP= 0.75
41		SN4-15-003 MC-009 40.0-43.0		*			
					GYPSUM XTALS		PP= 0.75
42				**			
				**			PP= 0.75
43							
				** *			PP= 1.0
44							
				**	GYPSUM XTALS		PP= 1.25
45		SN4-15-003 MC-010 43.0-48.0					
							PP= 1.5
46							
				*			PP= 1.5
47				**			
							PP= 1.5
48		SHELBY ATTEMPT TUBE DAMAGED NO SAMPLE					SHELBY ATTEMPT 48.0 - 50.0 TUBE DAMAGED, NO SAMPLE
49							
50							

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Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	50.0	53.0	3.0	1.8				
15	53.0	58.0	5.0	5.0				
16	58.0	61.0	3.0	3.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description: Code (From - To) Color Grain Size Sorting
50		SN4-15-003 MC-011 50.0-53.0					CLY, SAA, deformed from retreval w/ smaller core bit.
							PP=1.0
51							PP=0.75
52							CORE LOSS 51.8-53.0, Drillers having trouble w/ recovery in 9" core barrel
53		SN4-15-003 MC-012 53.0-58.0					CLY (53.0-67.0) OLV GRY-DK OLV GRY, OCC YLW ORNG LAMINATIONS, MASSIVE-LAMINATED, SOFT-FIRM, DAMP, HIGH PLASTIC
							PP=0.25
54							PP=1.0
55							PP=1.0
56							PP=1.0
57							PP=1.0
58		SN4-15-003 MC-013 58.0-61.0					PP=0.75
59							PP=0.75
60							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-003
Page 7 of 10
Date 12/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	61.0	63.0	2.0	1.8				
18	63.0	68.0	5.0	4.8				
19	68.0	70.0	2.0	2.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
						PP=1.25
61	SHELBY TUBE # SH-03	SN4-15-003 SH-03 61.0-63.0				SHELBY TUBE # SH-03 61.0-63.0 3",
62						
63						PP=1.0
64						PP=1.25
65						PP=0.75
66		SN4-15-003 MC-014 63.0-68.0				PP=1.0
67						INTBD CLAY & SAND (67.0-70.5) CLAY-SAA SAND-DK GRY, VF GRN, Well sorted, beds to 2", LOOSE, WET
68						SHELBY TUBE # SH-04, 5" Clay & SAND, SAA
69	SHELBY TUBE # SH-04, 5"	SN4-15-003 SH-04 68.0-70.0				
70						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-003
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Date 12/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
20	70.0	73.0	3.0	3.0				
21	73.0	78.0	5.0	5.0				
22	78.0	83.0	5.0	0.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
						PP=1.75 CLY (70.5 - 78.0) OLV GRY w/ DK GRY LAMINATIONS MASSIVE - LAMINATED, SOFT - HARD, DAMP, NON - HIGH PLASTIC, STIFFENING DOWNWARD, DRYING DOWNWARD
71		SN4-15-003 MC-015 70.0-73.0				
						PP=1.25
72						
						PP=0.75
73						
						PP=1.75
74						
						PP=4.5
75						
						PP=2.75
76		SN4-15-003 MC-016 73.0-78.0				
						PP=3.25
77						
						PP=4.5
						Pocket of fn sand & pebbles 77.7-77.9, dry
78		No Sample				CORELOSS 78.0-83.0, multiple attempts to recover, pulverized core
79						
80						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-003
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Date 12/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
23	83.0	93.0	10.0	10.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
80–83		No Sample				CORE LOSS 78.0–83.0
83.0		SN4-15-003 MC-017 83.0–88.0				CLY (83.0–96.0) GRY BRN-TAN, MASSIVE – FAINTLY LAMINATED, HOMOGENEOUS, HARD, DAMP-DRY, NON-PLASTIC, CRS GRN SAND SLOUGH ON OUTSIDE OF CORE
83.5						PP: 4.5
84.5						PP=3.0
85.5						PP >4.75
86.5						PP>4.75
87.5						PP >4.75
88.0–90		SN4-15-003 MC-018 88.0–93.0				

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
74	93.0	96.0	3.0	2.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

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Date 12/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
91		SN4-15-003 MC-018 88.0-93.0				
92						
93						PP > 4.75
94		SN4-15-003 MC-019 93.0-96.0				
95						
96						

TD = 96.0
Screened w/ 6" PVC 60.0-95.0'

N4306951 UTM ZONE 12
E 0310969 NAD83
Elev 4521

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004
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Date 20/10/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	2.4				
2	3.0	8.0	5.0	5.2				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQDX = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
0							CARB MATRIX INTBD w/ CLY (0.0-1.5) LT GRY - BRN GRY, Granular carb matrix, CLY - Homogeneous, very soft, saturated NON-PLASTIC PP=0
1							
1.5		SN4-15-004 MC-001 1.5-3.0					PP=0 CLY (1.5-8.0) LT GRY, HOMOGENEOUS, MASSIVE, VERY SOFT, SATURATED, CARB MATRIX BED 2.9-3.0 NON-PLASTIC, OCC LG GYPSUM XTALS, OCC ORGANICS
2							PP=0
3					CARB MATRIX		
3.5							PP=0.5
4					CARB MATRIX		
4.5							PP=0.25
5					GYPSUM		
5.5		SN4-15-004 MC-002 3.0-8.0			GYPSUM ORGANICS		PP=0.75
6					GYPSUM		
6.5							PP=0.5
7					GYPSUM		
7.5					GYPSUM		PP=0.5
8					ORGANICS		
8.2					ORGANICS		
8.5		SN4-15-004 MC-003 8.0-13.0					PP=1.0 CLY (8.0-11.0) LT-DK GRY, ABNT ORGANICS & GYPSUM XTALS LAMINATED- MASSIVE, SOFT, WET, NON- HIGH PLASTIC
9.3					ORGANICS		
9.5					GYPSUM		PP=0.25
9.7					ORGANICS		
10							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004

Date 20/10/15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	5.0				
5	18.0	23.0	5.0	5.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=0.25
11				ORGANICS		
		SN4-15-004 MC-003 8.0-13.0				PP=0.5 CARB MATRIX/MARL (11.0 – 13.0) LT-DK GRY FN-CRS GRANULAR (CRS granules smear under pressure) SOFT, WET-SATURATED, NON-PLASTIC
12						PP=0.5
13				GYPSUM		PP=0.75 CLY (13.0-21.0) LT GRY, HOMOGENEOUS, MASSIVE, OCC GYPSUM XTALS, SOFT-FIRM, MOIST-WET, LOW-HIGH PLASTIC (POSSIBLY fn gr MARL) OCC GRY BRN BANDS
14						PP=1.25
15				GYPSUM		PP=1.5
16		SN4-15-004 MC-004 13.0-18.0				PP=0.75
17						PP=0.75
18						PP=0.75
19		SN4-15-004 MC-005 18.0-23.0				PP=0.75
20						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole: SN4-15-004

Date: 20/10/15 D/M/Y
Name: A. Garhart
Photos: Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	28.0	5.0	6.0				
7	28.0	33.0	5.0	5.2				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
							PP=0.5
21							PP=0.5 CLY (21.0-27.0) LT OLV GRY-DK GRY, COLOR BANDED LAMINATED-MASSIVE, SOFT, WET, NON PLASTIC, (POSSIBLY FN GRN MARL), MINOR MOTTLING @ Bottom
22		SN4-15-004 MC-005 18.0-23.0					PP=0.25
23							PP=0.5
24							PP=0.5
25							PP=0.25
26		SN4-15-004 MC-006 23.0-28.0					PP=0.25
27							PP=0 CARB MATRIX/MARL (27.0-29.0) OLVGRY, MASSIVE, GRANULAR, VERY SOFT, WET, NON-PLASTIC
28							PP=1.0
29		SN4-15-004 MC-007 28.0-33.0		***	GYPSUM		CLY (29.0-44.0) OLV GRY,-LTOLVGRY Thickly Bd - MASSIVE, GYPSUM BANDS up to 2", FIRM,-SOFT PP=1.0 MOIST, LOW PLASTIC - HIGH PLASTIC
30							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004
Page 4 of 6
Date 20/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	33.0	38.0	5.0	5.5				
9	38.0	43.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
				***	GYPSUM		CLY SAA
							PP=1.25
31		SN4-15-004 MC-007 28.0-33.0		*** ***	GYPSUM		
							PP=1.0
32							
				**	GYPSUM		PP=1.75
33							
							PP=0.5
34							
							PP=0.75
				*** **	GYPSUM		
35							
							PP=0.75
36		SN4-15-004 MC-008 33.0-38.0					
							PP=0.75
37				**	GYPSUM		
							PP=0.25
38							
							PP=1.25
39		SN4-15-004 MC-009 38.0-43.0					
				** * *	GYPSUM		PP=1.0
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004
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Date 20/21/10/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	43.0	48.0	5.0	5.3				
11	48.0	49.0	1.0	1.0				
12	49.0	53.0	4.0	4.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut. Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
						PP=0.5
41		SN4-15-004 MC-009 38.0-43.0				PP=0.75
42						PP=0.75
43						PP=0.5
44						SAND (44.0 – 44.8) SALT & PEPPER MOD-WELL SRT, TRACE SILT, PRDM QTZ, LOOSE, SATURATED PP=4.0
						CLY (44.8 – 47.3) OLV GRY – DK OLV GRY, MASSIVE, OCC GYPSUM XTALS HARD, DAMP, NON-LOW PLASTIC PP=4.0
45		SN4-15-004 MC-010 43.0-48.0				
46						PP=2.0
47						CLY (47.3 –) MED BRN-Mottled OLV GRY, MASSIVE, OCC GYPSUM BANDS, HARD, DRY – DAMP PP>4.5
48	SHELBY TUBE #SH01	SN4-15-004 SH-01 48.0-49.0				Shelby Tube collected 48.0 – 49.0, only 1.0' push due to stiffness of material
49		SN4-15-004 MC-011 49.0-53.0		*** GYPSUM		Start of drilling Oct 21, 2015 PP >4.5
50						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004

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Date 21/10/15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
51		SN4-15-004 MC-011 49.0-53.0					PP >4.5
52							
53				×××	GYPSUM		TD = 53.0'
							4" PVC well screened 38.0-53.0'
							11 MC samples collected
							1 5" Shelby collected
54							
55							
56							
57							
58							
59							
60							

UTM ZONE 12
NAD83
N4306981
E0310963 Elev 4521

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-004A

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Date 21/10/15 D/M/Y

Name A. Gachart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
5	18.0	20.0	2.0	2.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
5							
10							
15							
18.0-20.0	SHELBY TUBE	SN4-15-004A SH-01 18.0-20.0					SHELBY TUBE COLLECTED 18.0-20.0 #SH-01
20							
25							
30							
							TD=30.0, 4" PVC Well screened 10.0-30.0'

UTM ZONE 12
NAD 83
N4307402
E0314623 Elev 4510

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 1 of 10
Date 22/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	4.1				
2	3.0	8.0	5.0	3.2				
3	8.0	13.0	5.0	4.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
0–1							CLY Intbd w/ SAND (0.0-2.0) DK GRY-GRY BRN, CLY- MASSIVE, VERY SOFT, SATURATED, NON PLASTIC, SAND - FN GRN, MOD SRT, SILTY, LOOSE, WET-SATURATED
1–2		SN4-15-005 MC-001 0.0-3.0					PP=0
2–3							CLY (2.0-3.0) LT BRN GRY - DK GRY, MOTTLED, VERY SOFT, WET, NON PLASTIC, MARL-ESQUE
3–5					GYPSUM XTALS		CARBONATE MATRIX/MARL (3.0-9.5) FN - MED GRN GRANULAR, (smears between fingers) Buttery appearance, VERY SOFT, SATURATED, NON-PLASTIC, OCC LG GYPSUM XTALS, ABNT ORGANICS @ Bottom
5–8		SN4-15-005 MC-002 3.0-8.0					PP=0
8–9					ORGANIC		PP=0
9–10		SN4-15-005 MC-003 8.0-13.0					PP=0.75 CLY (9.5-20.5) OLV GRY - LT OLV GRY MASSIVE, HOMOGENEOUS, SOFT-STIFF, MOIST, HIGH PLASTIC (Possibly Marl), mottled w/ DK Gry @ bottom

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 2 of 10
Date 22/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	4.5				
5	18.0	23.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.0
11							
		SN4-15-005 MC-003 13.0					PP=0.75
12							
							PP=3.25
13							
							PP=1.0 RUN 4 collected w/ flapper bit, SAMPLE MC-004 May be hyper saturated
14							
							PP=0.75
15							
							PP=0.75
16		SN4-15-005 MC-004 13.0-18.0					
							PP=0.75
17							
							PP=0.75
18							
		SN4-15-005 MC-005 18.0-23.0					PP=1.25
19							
							PP=1.0
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 3 of 10
Date 22/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	28.0	5.0	5.0				
7	28.0	33.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To)	Lithologic Description Color Grain Size Sorting
							PP=1.5	CLY (20.5-22.5) BRN GRY - OLV GRY - DK GRY, Mottled, FIRM, MOIST, HIGH PLASTIC
21		SN4-15-005 MC-005 18.0-23.0					PP=1.25	
22							PP=1.25	CLY (22.5-42.5) DK OLV GRY w/ mottled DK GRY, MASSIVE, FIRM-STIFF, MOIST, HIGH PLASTIC, DISSEM GYPSUM XTALS, OCC' LG GYPSUM XTALS
23							PP=1.25	
24							PP=0.75	
25							PP=0.5	
26		SN4-15-005 MC-006 23.0-28.0					PP=2.25	
27							PP=1.0	
28		SN4-15-005 MC-007 28.0-33.0		**	GYPSUM		PP=0.75	
29							PP=0.75	
30								

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
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Date 22/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	33.0	38.0	5.0	5.0				
9	38.0	43.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1–6	Lithologic Description Code (From – To) Color Grain Size Sorting
						CLY, SAA
				GYPSUM		PP=0.75
31		SN4-15-005 MC-007 28.0-33.0		GYPSUM XTALS		PP=1.5
32						PP=1.25
33				GYPSUM		PP=1.0
34						PP=0.25
35						PP=0.5
36		SN4-15-005 MC-008 33.0-38.0				PP=0.5
37						PP=0.5
38		SN4-15-005 MC-009 38.0-43.0				PP=0.5
39				SAND LENSE ~1"		PP=0.75
40						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	43.0	48.0	5.0	5.0				
11	48.0	49.5	1.5	1.3				
12	49.5	53.0	3.5	3.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-005

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Date 22/10/15 D/M/Y

Name A Gadhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description: Code (From – To) Color Grain Size Sorting
				xxx	GYPSUM		PP=0.75
41		SN4-15-005 MC-009 38.0-43.0					
							PP=0.5
42							PP=1.0 SAND (42.5-46.5) DK GRY - SALT & PEPPER, FN-MED GRN, MOD-WELL SRT, MASSIVE, LOOSE, SATURATED, STRONG SULFUR ODOR, 1 Foot section of OLV GRY CLY 44.5-45.5
43							
44							PP=2.5
45							
46		SN4-15-005 MC-010 43.0-48.0					CLY (46.5-48.0) OLV GRY - DKGRY Mottled, HOMOGENEOUS, FIRM-STIFF, DAMP-MOIST, HIGH PLASTIC
47							PP=2.0
							PP=1.75
48	SHELBY TUBE #SH-01	SN4-15-005 SH-01 48.0-49.5					5" SHELBY TUBE Collected # SH-01 48.0-49.5
49							
50							PP=0.5

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
13	53.0	58.0	5.0	5.0				
14	58.0	63.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-005
Page 6 of 10
Date 22/23/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=0.5 CLY (49.5 - 87.0) OLV GRY w/ DK GRY LAMINATIONS, LAMINATED - MASSIVE, SOFT, MOIST-WET, HIGH PLASTIC, OCC LG GYPSUM XTALS
51		SN4-15-005 MC-011 49.5-53.0					PP=0.5
52							PP=0.5
53							PP=0.75
54							PP=0.5
55							PP=1.0
56		SN4-15-005 MC-012 53.0-58.0		**	GYPSUM XTALS		PP=0.5
57							PP=0.5
58							-Start of drilling 10/23 PP=0
59		SN4-15-006 MC-013 58.0-63.0					PP=0.5
60							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 7 of 10
Date 23/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
15	63.0	68.0	5.0	5.0				
16	68.0	73.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=0.25
61							
		SN4-15-005 MC-013 58.0-63.0					PP=0.25
62							
							PP=0.25
63							
							PP=0.5
64							
							PP=1.25
65							
							PP=1.0
66							
		SN4-15-005 MC-014 63.0-68.0					PP=1.25
67							
							PP=1.0
68							
							PP=0.5
69							
		SN4-15-005 MC-015 68.0-73.0					PP=0.75
70							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 8 of 10
Date 23/10/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	73.0	78.0	5.0	5.0				
18	78.0	83.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA, very homogeneous
							PP=0.75
71							
		SN4-15-005 MC-015 68.0-73.0					PP=0.5
72							
							PP=0.75
73							
							PP=0.75
74							
							PP=0.75
75							
							PP=0.75 Sand lense @ 75.4, saturated
76		SN4-15-005 MC-016 73.0-78.0					
							PP=0.5
77							
							PP=0.5
78							
							PP=0.5
79		SN4-15-005 MC-017 78.0-83.0					
							PP=0.75
80							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005

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Date 23 / 10 / 15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
19	83.0	88.0	5.0	5.0				
20	88.0	93.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=0.75
81							
		SN4-15-005 MC-017 78.0-83.0					PP=1.0
82							
							PP=1.0
83							
							PP=0.75
84							
							PP=1.0
85							
							PP=1.0
86							
		SN4-15-005 MC-018 83.0-88.0					PP=0.75
87							CLY (87.0–93.0) OLV GRY-DK GRY, M/W OR BRN GRY, MASSIVE-LAMINATED, SOFT-FIRM, MOIST, HIGH PLASTIC
							PP=1.25
88							
							1.75
89							
		SN4-15-005 MC-019 88.0-93.0					PP=1.5
90							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-005
Page 10 of 10
Date 23 / 10 / 15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Length, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
		SN4-15-005 MC-010 88.0-93.0					PP=1.75
91							
							PP=1.5
92							
							PP=1.25
93							TD= 93.0, well terminated due to lack of rods 4" PVC sched 40 completion Screened 40.0-93.0
94							
95							
96							
97							
98							
99							
100							

UTM Zone 12 NAD 83 N4312827 E 0318402 Elev 4527

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006

Page 1 of 10

Date 24/10/15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	3.5				
2	3.0	8.0	5.0	5.0				
3	8.0	13.0	5.0	6.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-6	Code (From – To)	Lithologic Description Color Grain Size Sorting
						PP=0	CLY (0.0–1.2) DK BRN GRY-BRN GRY MASSIVE, VERY SOFT, SATURATED, NON-PLASTIC
1		SN4-15-006 MC-001 0.0-3.0				PP=0	CARBONATE MATRIX/MARL (1.2–10.5) LT BRN GRY, GRANULAR-FN, MASSIVE, SOFT, SATURATED, NON PLASTIC OCC LG GYPSUM XTALS & DK BRN BANDS, TRACE ORGANICS
2						PP=0.25	
3				GYPSUM		PP=0.25	
4				ORGANICS		PP=0	
5		SN4-15-006 MC-002 3.0-8.0				PP=0	
6				GYPSUM		PP=0	
7						PP=0	
8		SN4-15-006 MC-003 8.0-13.0		ORGANICS		PP=0.25	
9				GYPSUM XTALS		PP=0	
10							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
Page 2 of 10
Date 24/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0					
5	18.0	23.0	5.0					

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
		SN4-15-006 MC-003 8.0-13.0					PP=0 CLY (10.5-13.0) MD-DK GRY, Mottled - MASSIVE, VERY SOFT, SATURATED, NON-PLASTIC, ABNT ORGANICS
11					ORGANICS		PP=0
12							PP=0.25
13		SN4-15-006 MC-004 13.0-18.0					CARB MATRIX/MARL (13.0-17.0) MD GRY, MASSIVE, GRANULAR-FN, PP=0 SOFT, WET-DAMP, FRIABLE @ Bottom, NON-HIGH PLASTIC
14							PP=0.25
15							PP=0.5
16							PP=0.5
17							CLY (17.0-24.5) LT OLV GRY, MASSIVE, HOMOGENEOUS, STIFF, DAMP, HIGH PP=0.5 PLASTIC, OCC Nodules of Pink salt
18		SN4-15-006 MC-005 18.0-23.0					SHELBY ATTEMPTED @ 18', No recovery PP=3.5
19							PP=2.0
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
Page 3 of 10
Date 24/10/15 D/M/Y
Name A.Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	24.5	1.5	1.4				
7	24.5	28.0	3.5	3.5				
8	28.0	33.0	5.0	5.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=2.25
21							
		SN4-15-006 MC-005 18.0-23.0					PP=2.75
22							
							PP=2.75
23	SHELBY TUBE #SH-01	SN4-15-006 SH-01 23.0-24.5					SHELBY TUBE # SH-01 23.0-24.5
24							
							PP=1.25 CLY (24.5-30.0) OLV GRY-DK GRY, MOTTLED-MASSIVE, OCC LT OLV GRY FIRM-STIFF, DAMP-MOIST, HIGH PLASTIC
25							PP=1.75
26		SN4-15-006 MC-006 24.5-28.0					PP=2.25
27							PP=2.0
28							PP=2.25
29		SN4-15-006 MC-007 28.0-33.0					PP=3.5
30							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
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Date 24/10/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	33.0	38.0	5.0	5.0				
10	38.0	39.5	1.5	1.9				
11	39.5	43.0	3.5	3.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
							PP=1.75 CLY (30.0-54.5) OLV GRY, MASSIVE, OCC DKGRY MOTTLING/LAMINATIONS FIRM, MOIST, HIGH PLASTIC, OCC LG GYPSUM XTALS
31							PP=1.75
32		SN4-15-006 MC-007 28.0-33.0					PP=0.75
33							PP=0.75
34							PP=1.25
35							PP=1.25
36							PP=1.0
37		SN4-15-006 MC-008 33.0-38.0					PP=1.25
38							PP=0.75
39	SHELBY TUBE #SH-02	SN4-15-006 SH-02 38.0-39.5					PP=0.75
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
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Date 24/25/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	43.0	48.0	5.0	5.5				
13	48.0	49.5	1.5	1.9				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
		No sample collected due to disturbance					RUN 11 collected w/ flapper bit too disturbed to sample
							PP=0.75
41							
							PP=0.75
42							
							PP=0.75
43							- Start of drilling 10/25
				**	GYPSUM		PP=1.25
44							
							PP=0.75
45				**	GYPSUM		
							PP=1.25
46		SN4-15-006 MC-009 43.0-48.0					
							PP=1.0
47							
				*	GYPSUM		PP=0.75
48	SHELBY TUBE #SH-03	SN4-15-006 SH-03 48.0-49.5					SHELBY TUBE # SH-03 48.0-49.5
49							
50							PP=0.5

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
Page 6 of 10
Date 25/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	49.5	53.0	3.5	3.5				
15	53.0	54.5	1.5	1.4				
16	54.5	58.0	3.5	0.0				
17	58.0	63.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
				✳✳ GYPSUM		CLY, SAA
						PP=0.75
51		SN4-15-006 MC-010 49.5-53.0				
						PP=0.5
52				✳✳ GYPSUM		
						PP=0.75
53	SHELBY TUBE # SH-04	SN4-15-006 SH-04 53.0-54.5				SHELBY TUBE # SH-04 5" 53.0-54.5
54						
55						Core Loss 54.5-58.0, soft material, unable to recover
56		No Sample				
57						
58						CLY (58.0-69.5) OLV GRY w/ ABNT BLACK LAMINATIONS / MINERALIZATION (MN?), MINOR GYPSUM XTALS/LENSES, SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC
						PP=0.75
59		SN4-15-006 MC-011 58.0-63.0				
						PP=0.75
60						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006

Page 7 of 10

Date 25/10/15 D/M/Y

Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
18	63.0	68.0	5.0	5.0				
19	68.0	73.0	5.0					

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=1.0
61							
		SN4-15-006 MC-011 58.0-63.0					PP=1.0
62							
							PP=1.0
63				***	GYPSUM		
							PP=1.25
64				***	GYPSUM		
							PP=1.0
65							
				***	GYPSUM		PP=1.25
66							
							PP=1.25
67		SN4-15-006 MC-012 63.0-68.0		***	GYPSUM		
							PP=1.25
68				***	GYPSUM		
							PP=1.25
69							
		SN4-15-006 MC-013 68.0-73.0					PP=1.25 CLY (69.5-95.5) LT OLV GRY - OLV GRY, MINOR DK GRY LAMS, LAMINATED - MASSIVE, SOFT - FIRM, DAMP - MOIST, HIGH PLASTIC, OCC GYPSUM BANDS
70				***	GYPSUM		

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
Page 8 of 10
Date 25/10/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
20	73.0	78.0	5.0	5.0				
21	78.0	83.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
				***	GYPSUM		PP=1.0
71		SN4-15-006 MC-013 68.0-73.0					PP=1.0
72							PR=1.25
73				***, *	GYPSUM		PP=0.75
74							PP=0.75
75				***	GYPSUM		PP=0.5
76		SN4-15-006 MC-014 73.0-78.0					PP=1.25
77							PP=1.0
78		SN4-15-006 MC-015 78.0-83.0	***	GYPSUM			PP=0.75
79							PP=1.0
80							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
22	83.0	88.0	5.0	5.0				
23	88.0	93.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-006

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Date 25/10/15 D/M/Y

Name A. Garhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
				✱✱✱	GYPSUM		CLY, SAA
							PP= 0.75
81		SN4-15-006 MC-015 78.0-83.0		✱✱✱	GYPSUM		PP=1.25
82				✱✱✱			
							PP=1.0
83							
							PP=0.75
84							
							PP=1.0
85							
							PP=0.75
86		SN4-15-006 MC-016 83.0-88.0					
							PP=0.75
87							
							PP=0.5
88							
							PP=0.75
89		SN4-15-006 MC-017 88.0-93.0					
							PP=1.0
90					SILT, DK GRY		

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-006
Page 10 of 10
Date 25/10/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
24	93.0	100.0	7.0	7.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=1.25
91						
		SN4-15-006 MC-017 88.0-93.0				PP=1.25
92						
						PP=0.5
93						
						PP=1.25
94						
						PP=0.75
95						
						PP=4.0 CLY (95.5-100.0) DK OLV GRY, MASSIVE, HARD, DRY, NON PLASTIC
96						
		SN4-15-006 MC-018 93.0-98.0				
97						PP >4.5
98						
		SN4-15-006 MC-019 98.0-100.0				
99						TD= 100.0 4" Sched 40 PVC well set, screened 40.0-100.0'
100						

UTM Zone 12
NAD 83
N4312948
E0312000 Elev 4538

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 1 of 9
Date 2/11/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	4.0				
2	3.0	8.0	5.0	4.0				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic / Geometry, Surface, Infill	H R1-5	Code (From - To) Lithologic Description Color Grain Size Sorting
0		SN4-15-007 MC-001 0.0-3.0		Salt Crust	PP=0	CLY (0.0-1.0) MD-DK GRY, MASSIVE, LG CHUNKS of Salt Crust, VERY SOFT, SATURATED, NON-PLASTIC
1					PP=0.25	CARB MATRIX/MARL (1.0-3.5) LT BRN GRY, GRANULAR-FN, MASSIVE, OCC LG GYPSUM XTALS, SOFT, WET, LOW-HIGH PLASTIC
2				GYPSUM	PP=0.25	
3		SN4-15-007 MC-002 3.0-8.0			PP=0	CLY (3.5-10.5) LT BRN GRY-BRN GRY, MASSIVE, ABNT ORGANIC HORIZONS, OCC LG GYPSUM XTALS SOFT, WET NON-LOW PLASTIC, OCC LENSES of GRANULAR MARL, DK GRY @ BTM
4				ORGANICS	PP=0.25	
5					PP=0.25	
6				MARL LENSE / ORGANICS	PP=0	
7				GYPSUM	PP=0	
8		SN4-15-007 MC-003 8.0-13.0		ORGANICS	PP=0	
9				ORGANICS	PP=0.25	
10						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007

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Date 2/11/15 D/M/Y

Name A. Gachart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	5.0				
5	18.0	23.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
					ORGANICS		PP=0 CARB MATRIX / MARL (10.5-16.0) LT GRY-DK GRY Mottled, OCC ORGANIC HORIZONS, FN-GRANULAR, SOFT, WET, LOW PLASTIC
11					ORGANICS		
		SN4-15-007 MC-003 8.0-13.0					PP=0
12					ORGANICS		
							PP=0.25
13							
							PP=0.75
14							
							PP=1.25
15							
							PP=1.0
16							
		SN4-15-007 MC-004 13.0-18.0					PP=2.75 CLY (16.0-25.0) LT OLV GRY-OLV GRY, Mottled, MASSIVE, DISSEM GYPSUM, SOFT-STIFF, DAMP-MOIST, HIGH PLASTIC, OCC MARL LENSES, OCC Thin SAND LENSES to 0.5"
17							
					MARL LENSE		PP=1.75
18							
							PP=2.25
19		SN4-15-007 MC-005 18.0-23.0					
							PP=1.75
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole: SN4-15-007
Page: 3 of 9
Date: 2/11/15 D/M/Y
Name: A. Garhart
Photos: Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	28.0	5.0	5.0				
7	28.0	33.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
							PP=1.5
21		SN4-15-007 MC-005 18.0-23.0		. . .	SAND LENSE ~0.5"		PP=1.0
22							PP=1.25
23							PP=1.0
24							PP=1.0
25							CLY (25.0-38.5) OLV GRY w/ DK GRY LAMINATIONS OCC DK BRN LAM-MASSIVE, PP=1.0 LESS GYPSUM, SOFT-FIRM, MOIST, HIGH PLASTIC
26		SN4-15-007 MC-006 23.0-28.0					PP=1.0
27							PP=1.5
28							PP=0.5
29		SN4-15-007 MC-007 28.0-33.0					PP=0.5
30							

*Note HIGH WINDS ~ 40-50 MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 4 of 9
Date 2/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	33.0	38.0	5.0	5.0				
9	38.0	43.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=0.75
31		SN4-15-007 MC-007 28.0-33.0					PP=1.0
32							PP=1.0
33							PP=1.0
34							PP=1.25
35							PP=1.0
36		SN4-15-007 MC-008 33.0-38.0					PP=1.75
37							PP=1.75
38		SN4-15-007 MC-009 38.0-43.0		**	GYPSUM		PP=1.75 CLY (38.5-53.0) OLV GRY - DK OLV GRY, MASS - Thickly Bedded, ABNT LG GYPSUM XTALS/ FIRM, MOIST, HIGH PLASTIC
39				* *			PP=1.5
40				*			

*Note: High Winds 40-50 MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 5 of 9
Date 2 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	43.0	48.0	5.0	5.0				
11	48.0	53.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill, Geometry	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						CLY, SAA
				**		PP=1.75
41		SN4-15-006 MC-009 38.0-43.0		* * GYPSUM		PP=1.25
42						PP=1.75
43						PP=1.0
44				**		PP=1.25
45				** ** GYPSUM		PP=1.75
46		SN4-15-007 MC-010 43.0-48.0		** *		PP=1.75
47						PP=1.0
48		SN4-15-007 MC-011 48.0-53.0		** *		PP=1.0
49				*** GYPSUM **		PP=1.0
50						

*Note: HIGH WINDS ~ 40-50 MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 6 of 9
Date 2/3/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	53.0	54.5	1.5	2.3				
13	54.5	58.0	3.5	3.5				
14	58.0	63.0	5.0					

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.0
51		SN4-15-007 MC-011 48.0-53.0			GYPSUM		PP=1.0
52					GYPSUM		PP=1.0
53	SHELBY TUBE # SH-01	SN4-15-007 SH-01 53.0-54.5					5" SHELBY TUBE # SH-01 53.0-54.5
54							CLY (54.5-76.0) DK OLV GRY - DK GRY, Mottled - LAMINATED, DISSEM GYPSUM, FIRM, DAMP, HIGH PLASTIC OCC BLK MINERALIZATION along bedding planes - Mang?, smears on skin
55							* Start of drilling 3-11-15 PP=1.75
							PP=1.25
56		SN4-15-007 MC-012 54.5-58.0					PP=1.5
57							PP=1.5
58		SN4-15-007 MC-013 58.0-63.0					PP=1.5
59							PP=1.25
60							

* Note: HIGH WINDS - 40-50 MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 7 of 9
Date 3/11/15 D/M/Y
Name A. Gerhart
Photos (Yes)/ No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
15	63.0	68.0	5.0	5.0				
16	68.0	73.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
				*	GYPSUM		PP=1.5
61							
		SN4-15-007 MC-013 58.0-63.0					PP=1.5
62							
				***	GYPSUM		PP=1.0
63							
							PP=1.25
64							
							PP=1.5
65							
		SN4-15-007 MC-014 63.0-68.0					PP=1.5
66							
							PP=1.25
67							
							PP=1.0
68							
							PP=1.5
69							
		SN4-15-007 MC-015 68.0-73.0					PP=1.5
70							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007
Page 8 of 9
Date 3 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	73.0	78.0	5.0	5.0				
18	78.0	83.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Sample Id & Box #	Discontinuities Graphic / Geometry, Surface, Infill	Lithologic Description
			CLY, SAA
		GYPSUM	PP=1.5
71			
			PP=1.5
72	SN4-15-007 MC-015 68.0-73.0	GYPSUM	
			PP=0.5
73			
			PP=1.0
74			
			PP=0.5
75			
			PP=0.5
76			
	SN4-15-007 MC-016 73.0-78.0	GYPSUM BEDS	CLY(76.0-84.5) OLV GRY w/ YLW GRY LAMINATIONS, LAM- Thickly Bedded, OCC HARD, DRY GYPSUM BEDS, SOFT-FIRM, DAMP, HIGH PLASTIC
77		GYPSUM BED	PP=0.5
78			
			PP=1.0
79	SN4-15-007 MC-017 78.0-83.0	GYPSUM BEDS	PP=1.0
80			

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-007

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Date 3/11/15 D/M/Y

Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
19	83.0	88.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
					GYPSUM BED		PP=1.0
81							
		SN4-15-007 MC-017 78.0-83.0					PP=1.25
82							
					GYPSUM BED		PP=1.5
83							
							PP=1.25
84							
							CLY, (84.5-88.0) DK OLV GRY, MASSIVE, OCC LG GYPSUM XTALS, HARD, DRY, NON-PLASTIC
85							
							PP > 4.5
86							
		SN4-15-007 MC-018 83.0-88.0			GYPSUM		
87							
88							
							TD = 88.0'
							Screened 40.0-88.0'
89							17 MC Samples & 1 5" Shelby collected
90							

UTM ZONE 12 N4316585
NAD 83 E 0312994
Elev 4432'

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 1 of 10
Date 5/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	3.0				
2	3.0	8.0	5.0	5.0				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From – To)	Lithologic Description Color Grain Size Sorting
0–1					Salt Crust		PP=0.0	CLY (0.0-1.5) MED GRY - BRN GRY, SILTY, LG Chunks of Salt Crust, VERY SOFT, SATURATED, NON PLASTIC STRONG SULFUR ODOR
1–2		SN4-15-008 MC-001 0.0-3.0					PP=0.0	CARBONATE MATRIX/MARL (1.5-6.0) LT-MED GRY, OCC BRN GRY, FN-Granular, HOMOGENEOUS, VERY SOFT, NON-PLASTIC
2–3							PP=0.0	
3–4							PP=0.0	
4–5							PP=0.0	
5–6							PP=0.0	
6–7		SN4-15-008 MC-002 3.0-8.0			GYPSUM		PP=0.5	CLY (6.0-10.5) BRN GRY - LT BRN GRY, OCC LG GYPSUM XTALS, OCC MATS of ORGANIC MATERIAL, SOFT, DAMP-MOIST, LOW PLASTIC
7–8					ORGANICS GYPSUM ORGANIC		PP=0.5	
8–9		SN4-15-008 MC-003 8.0-13.0			ORGANICS GYPSUM ORGANICS		PP=0.25	
9–10							PP=0.5	

Drill Hole Lithology Log

NORWEST
CORPORATION

Hole SN4-15-008
Page 2 of 10
Date 5 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	14.5	1.5	1.3				
5	14.5	18.0	3.5	3.5				
6	18.0	23.0	5.0	2.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
				ORGANICS		PP=0.75 CLY (10.5-13.0) MD GRY-DK GRY MOTTLED MASSIVE, OCC ORGANIC MATS, VERY SOFT, WET, LOW-PLASTIC
11						
		SN4-15-008 MC-003 8.0-13.0				PP=0.0
12				ORGANICS		
						PP=0.0
				ORGANICS		
13	SHELBY TUBE SH-01	SN4-15-008 SH-01 13.0-14.5				SHELBY TUBE # SH-01 13.0-14.5
14						
						CARB MATRIX/MARL (14.5-18.0) MD GRY-LT OLV GRY, GRANULAR-FN, MASSIVE, VERY SOFT, WET-SATURATED, NON-PLASTIC
15						
						PP=0
16		SN4-15-008 MC-004 14.5-18.0				
						PP=0.25
17						
						PP=0
18						CLY (18.0-20.0) LT OLV GRY, MASSIVE, HOMOGENEOUS, HARD, DAMP-DRY, NON-PLASTIC
		SN4-15-008 MC-005 18.0-23.0				PP>4.5
19						
						PP>4.5
20						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 3 of 10
Date 5/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
7	23.0	28.0	5.0	5.0				
8	28.0	33.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-5	Code (From – To) Lithologic Description Color Grain Size Sorting
						CORE LOSS 18.0-23.0, SAMPLE MC-005 IS LIKELY 18.0-20.0 ONLY.
21						
22		SN4-15-008 MC-005 18.0-23.0				
23						CLY (23.0-33.0) LT OLV GRY, OCC BLK LAMINATIONS w/ MANGANESE, MASSIVE HOMOGENEOUS FIRM, MOIST, HIGH PLASTIC, OCC DK OLV GRY COLOR BANDING, SMALL-MED GYPSUM XTALS
						PP=1.0
24						PP=1.0
25						PP=1.25
26						PP=1.25
27		SN4-15-008 MC-006 23.0-28.0				PP=1.0
28						PP=1.25
29		SN4-15-008 MC-007 28.0-33.0				PP: 1.25
30						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 4 of 10
Date 5/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	33.0	38.0	5.0	5.0				
10	38.0	39.5	1.5	2.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.25
31							
		SN4-15-008 MC-007 28.0-33.0					PP=0.75
32							
							PP=0.75
33							CLY(33.0-61.4) OLV GRY, OCC BLK MOTTLING, HOMOGENEOUS, SOFT-STIFF MOIST, HIGH PLASTIC, OCC DKGRY & YLW BRN COLOR BANDING, OCC LG GYPSUM XTALS
							PP=1.0
34							
							PP=0.5
35							
							PP=1.0
36							
		SN4-15-008 MC-008 33.0-38.0					PP=0.75
37							
							PP=1.0
38	SHELBY TUBE #SH-02	SN4-15-008 SH-02 38.0-39.5					SHELBY TUBE #SH02 38.0-39.5
39							
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 5 of 10
Date 5/6/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
11	39.5	43.0	3.5	3.5				
12	43.0	48.0	5.0	5.0				
13	48.0	49.5	1.5	1.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=1.25
41							
		SN4-15-008 MC-009 39.5-43.0					PP=2.0
42							
				**	GYPSUM		PP=2.0
43							
				**	GYPSUM		PP=1.75
44							
							PP=1.5
45							
							PP=1.25
46		SN4-15-008 MC-010 43.0-48.0		** **	GYPSUM		PP=1.5
47							
							PP=1.5
48	SHELBY TUBE #SH-03	SN4-15-008 SH-03 48.0-49.5					SHELBY TUBE # SH-03 48.0 - 49.5
49							
							START of drilling 11-6
50							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 6 of 10
Date 6 / 11 / 15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	49.5	53.0	3.5	3.5				
15	53.0	54.5	1.5	1.8				
16	54.5	58.0	3.5	3.5				
17	58.0	63.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						CLY, SAA
						PP=1.25
51		SN4-15-008 MC-011 49.5-53.0		** GYPSUM		PP=1.0
52						PP=0.25
53	SHELBY TUBE SH-04	SN4-15-008 SH-04 53.0-54.5				5" SHELBY TUBE # SH-04 53.0-54.5
54				** GYPSUM		PP=0.75
55						PP=0.5
56		SN4-15-008 MC-012 54.5-58.0				PP=0.5
57						PP=0.25
58		SN4-15-008 MC-013 58.0-63.0		** GYPSUM		PP=1.0
59						PP=1.0
60						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 7 of
Date 6/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
18	63.0	68.0	5.0	5.0				
19	68.0	73.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA, Relative homogeneity
							PP=1.0
61		SN4-15-008 MC-013 58.0-63.0			BLACK MINERALIZATION Mn?		PP=1.0 CLY(61.4-72.5) OLV GRY w/ ABNT BLK LAMINATIONS & MINERALIZATION Mn? SOFT-FIRM, DAMP-MOIST HIGH PLASTIC, OCC GYPSUM BEDS
62							PP=1.0
63							PP=1.0
64							PP=1.0
65							PP=1.0
66		SN4-15-008 MC-014 63.0-68.0					PP=1.0
67					GYPSUM BED, DRY		PP=1.5
68		SN4-15-008 MC-015 68.0-73.0					PP=1.0
69					GYPSUM BAND		PP=1.0
70							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 8 of
Date 6/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
20	73.0	78.0	5.0	5.0				
21	78.0	83.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To)	Lithologic Description Color Grain Size Sorting
								CLY, SAA
							PP=1.0	
71								
		SN4-15-008 MC-015 68.0-73.0					PP=1.0	
72					GYPSUM BAND			
							PP=1.5	CLY (72.5-75.0) OLV GRY w/ BLK MOTTLING & DK GRY COLOR BANDING, OCC HARD, DRY GYPSUM BEDS, FIRM-SOFT, DAMP-MOIST, HIGH PLASTIC
73								
							PP=1.25	
74								
							PP=1.25	
75								CLY (75.0-87.3) OLV GRY - DK GRY COLOR BANDED, SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC, ABNT BLK MINERALIZATION @ BTM
							PP=1.25	
76								
		SN4-15-008 MC-016 73.0-78.0					PP=1.0	
77								
							PP=0.5	
78								
							PP=1.0	
79	+++	SN4-15-008 MC-017 78.0-83.0		+++	SALT -		2" of clear, cubic halite/KCL, Foul odor	
				**	GYPSUM		PP=2.0	
80								

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
Page 9 of
Date 6/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
22	83.0	88.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
				** GYPSUM		CLY, SAA
						PP=1.0
81		SN4-15-008 MC-017 78.0-83.0				PP=1.0
82						
						PP=1.5
83				GYPSUM RED, HARD, DRY		
						PP=0.5
84						
						PP=1.25
85						
						PP=1.25
86		SN4-15-008 MC-018 83.0-88.0				
						PP=1.0
87						
	+ + +			+ + Salt		PP=0.5 EVAPORITE CRUST (87.3-88.6) WHITE-CLEAR, FRIABLE, DISSOLVES IN FRESH H_2O, NaCL, KCl, KSO4? DRY, HARD, FOUL-SWEET ODOR
88	+ + +			+ +		-GRAB SAMPLE COLLECTED @ 88.0' (-SN4-15-008 GRAB SAMPLE 88.0')
89		SN4-15-008 MC-019 88.0-93.0				CLY (88.6-100.0) OLV GRY w/ DK GRY & YLW GRY, MASSIVE, OCC EVAPORITE CRUST UP TO 6", SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC
						PP=1.0
90						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-008
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Date 6/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
24	93.0	100.0	7.0	7.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
	+ + +			+ +	EVAPORITE/ SALT		CLY, SAA
							PP=1.25
91		SN4-15-008 MC-019 88.0-93.0					
							PP=1.25
92							
	+ +			+ +	EVAPORITE/ SALT		PP=1.0
93				✳	GYPSUM		
							PP=1.0
94					GYPSUM BED		PP=1.25
95							
							PP=1.25
96		SN4-15-008 MC-020 93.0-98.0					PP=1.25
97				✳✳✳	SMALL GYPSUM XTALS ~2-3mm		
							PP=1.25
98		SN4-15-008 MC-021 98.0-100.0					PP=0.75
99							TD=100.0 4" Sched 40 PVC well screened 40.0-100.0'
							PP=1.0
100							

UTM ZONE 12 N4318264
NAD 83 E0319441
Elev 4521'

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-009
Page 1 of 6
Date 16/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	3.0				
2	3.0	8.0	5.0	5.0				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–R6	Code	Lithologic Description (From – To) Color Grain Size Sorting
0		SN4-15-009 MC-001 0.0-3.0			Salt Crust		PP=0	CLY (0.0-1.0) DK GRY-LT BRN GRY SILTY ABNT SALT CRUST, VERY SOFT, SATURATED, NON-PLASTIC STRONG SULFUR ODOR
1							PP=0	CARB MATRIX/MARL (1.0-3.0) LT BRN GRY, Thickly bedded FN-GRANULAR VERY SOFT, SATURATED, NON-PLASTIC
2							PP=0	
3		SN4-15-009 MC-002 3.0-8.0					PP=0.25	CLY (3.0-10.0) LT BRN GRY-DK GRY, Mottled - Thickly bedded, OCC Beds of MARL to 3" SOFT, WET-MOIST, NON-LOW Plastic, OCC ORGANIC MATS
4							PP=0.25	
5					ROOT, WOOD		PP=0.25	
6							PP=0.25	
7							PP=0.25	
8		SN4-15-009 MC-003 8.0-13.0			ORGANIC MAT			
					GYPSUM		PP=0.25	
9							PP=0	
10					ORGANIC MAT			

Note: Temp ~28°F w/20 MPH Winds, Wind chill dangerous

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-009
Page 2 of 6
Date 16/11/15 D/M/Y
Name A. Garbutt
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	5.0				
5	18.0	23.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						CLY (10.0 - 13.0) DK GRY - GRY BRN, Mottled, VERY SOFT, WET, NON-PLASTIC OCC ORGANIC MATS
						PP=0
11						
				ORGANIC MATS		PP=0
12		SN4-15-009 MC-003 8.0-13.0				
						PP=0
13						CARB MATRIX/MARL (13.0 - 18.0) MD GRY, FN → GRANULAR, MASSIVE, WET to MOIST, VERY SOFT, NON - LOW PLASTIC, Becoming dryer & friable @ 17.0'
						PP=0
14						
						PP=0
15						
						PP=0
16						
						PP=0
17		SN4-15-009 MC-004 13.0-18.0				
						PP=0
18						CLY (18.0 - 24.0) LT OLV GRY, MASSIVE, DISSEM GYPSUM, STIFF, DAMP, HIGH PLASTIC
						PP=2.25
19		SN4-15-009 MC-005 18.0-23.0				
						PP=1.75
20						

Note: Temp ~ 28°F, Wind 15-20 MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	28.0	5.0	5.0				
7	28.0	33.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-009
Page 3 of 6
Date 16/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=3.0
21							
							PP=2.5
22		SN4-15-009 MC-005 18.0-23.0					
							PP=2.75
23							
							PP=1.0
24							CLY (24.0-31.0) LT OLV GRY - DK GRY MOTTLED, OCC DRY, CRUMBLY ZONES to 3", FIRM-STIFF, DAMP, LOW-HIGH PLASTIC
							PP=2.0
25							
							PP=1.75
26							
							PP=2.5
27		SN4-15-009 MC-006 23.0-28.0					
							PP=1.5
28							
							PP=1.5
29		SN4-15-009 MC-007 28.0-33.0					
							PP=1.5
30							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-009

Page 4 of 6

Date 16/11/15 D/M/Y

Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	33.0	38.0	5.0	5.0				
9	38.0	43.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
					SAND,VF, DRY		PP=1.0
31							CLY (31.0-52.0) OLV GRY MW/OR DK GRY MOTTLED-LAMINATED DAMP, FIRM-STIFF HIGH PLASTIC, RARE SAND LENSES TO 4mm
		SN4-15-009 MC-007 28.0-33.0					PP=2.5
32							PP=2.75
33							PP=2.0
34							PP=1.75
35							PP=2.0
36							PP=2.0
37		SN4-15-009 MC-008 33.0-38.0					PP=1.75
38							PP=1.0
39		SN4-15-009 MC-009 38.0-43.0					PP=1.5
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-009
Page 5 of 6
Date 16/17/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	43.0	48.0	5.0	5.0				
11	48.0	53.0	5.0	5.8				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=1.75
41							
							PP=1.5
42		SN4-15-009 MC-009 38.0-43.0			SAND, VF, DRY		
							PP=1.75
43							Start of drilling Nov 17, 2015
							PP=1.75
44							
							PP=1.5
45							
							PP=1.25
46							
							PP=1.5
47		SN4-15-009 MC-010 43.0-48.0			VF SAND to 2mm Dry		
							PP=1.0
48							
							PP=1.0
49		SN4-15-009 MC-011 48.0-53.0					
							PP=1.0
50							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-009

Page 6 of 6

Date 17/11/15 D/M/Y

Name A. Gerhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	53.0	58.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
							PP=1.25
51					SAND, FN-MD, SATURATED		PP=1.0
52		SN4-15-009 MC-011 48.0-53.0					INTBD CLY, SAND, SILT (52.0-57.2) OLV GRY CLY-S/AA, SAND - FN-MD GRN, SUB RND, PRDM QTZ, LOOSE, SATURATED, MINOR pebbles @ 57.0'
							PP=0.25
53							PP=0
54							PP=0
55							PP=0
56							PP=0
57		SN4-15-009 MC-012 53.0-58.0					PP>4.5 CLY (57.2 – 58.0) OLV GRY - MED BRN MASSIVE, HARD, DAMP-DRY, NON-PLASTIC
58							TD = 58.0' 4" Sched 40 PVC well screened 40.0-58.0
59							
60							

UTM ZONE 12 NAD83 N4320200 E0315817 Elev 4575

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 1 of 13
Date 7/5/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	3.0	3.0	3.0				
2	3.0	8.0	5.0	5.0				
3	8.0	13.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Sample Id & Box #	Discontinuities Graphic Surface, Infill	Code (From – To)	Lithologic Description (Color Grain Size Sorting)
0–1	SN4-15-010 MC-001 0.0-3.0	SALT CRUST	PP=0	CLY (0.0-1.0) DK BRN, SILTY, SALT CRUST Throughout, MASSIVE, VERY SOFT, WET, LOW-PLASTIC
1–2			PP=0	CARB MATRIX/MARL (1.0-3.0) LT BRN GRY MASSIVE, GRANULAR-FN, VERY SOFT, WET, NON PLASTIC, STRONG SULFUR ODOR
2–3			PP=0	
3–4	SN4-15-010 MC-002 3.0-8.0	GYPSUM	PP=0.5	CLY (3.0-9.0) LT BRN GRY COLOR BANDED w/ MED GRY, OCC INTBDS of MARL to 2", MASSIVE-THICKLY BEDDED, OCC ORGANICS MATS & GYPSUM XTALS, SOFT, WET, LOW PLASTIC
4–5			PP=0.75	
5–6		GYPSUM	PP=0.5	
6–7			PP=0.5	
7–8		ORGANIC MATS	PP=0.25	
8–9	SN4-15-010 MC-003 8.0-13.0	ORGANIC MAT GYPSUM	PP=0.25	
9–10			PP=0.25	CARB MATRIX/MARL (9.0-11.0) LT BRN GRY, MASSIVE, OCC ORGANIC MATS, SOFT, SATURATED, NON-PLASTIC

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010

Page 2 of 13

Date 7/5/15 D/M/Y

Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	18.0	5.0	5.8				
5	18.0	23.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=0
11		SN4-15-010 MC-003 8.0-13.0			ORGANIC MATS W/GYPSUM		PP=0.25 CLY (11.0-13.8) LT BRN GRY W/ DK GRY MOTTLING, MASSIVE, OCC ORGANIC MATS, STRONG SULFUR ODOR, OCC GYPSUM XTALS, SOFT, MOIST-WET, LOW-PLASTIC
12					ORGANIC MATS		PP=0.5
13					ORGANIC MAT		PP=0
14							CARB MATRIX/MARL (13.8-17.5) LT BRN GRY, FN-GRANULAR, VERY SOFT, NON-LOW PLASTIC, WET-SATURATED, MASSIVE PP=0
15							PP=0
16		SN4-15-010 MC-004 13.0-18.0					PP=0.25
17							PP=0.5 CLY (17.5-22.0) LT OLV GRY MASSIVE, FRIABLE, STIFF, DAMP, LOW PLASTIC (Possibly DAMP MARL GRANULAR TEXTURE)
18							PP=2.5
		SN4-15-010 MC-005 18.0-23.0					PP=3.0
19							PP=1.5
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 3 of 13
Date 7/8/11/15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	23.0	28.0	5.0	5.0				
7	28.0	33.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=1.5
21						PP=1.25
22		SN4-15-010 MC-005 18.0-23.0				CLY (22.0-39.5) LT OLV GRY, MASSIVE, HOMOGENEOUS, FIRM-SOFT MOIST, HIGH PLASTIC, WAXY APPEARANCE, DISSEM GYPSUM, OCC BRN GRY COLOR BANDING, OCC BLK MOTTLING
						PP=1.25
23						START OF DRILLING NOV 8, 2015
						PP=0.75
24						PP=1.0
25						PP=0.5
26		SN4-15-010 MC-006 23.0-28.0				PP=0.5
27						PP=0.5
28						PP=0.25
29		SN4-15-010 MC-007 28.0-33.0				PP=0.25
30						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 4 of 13
Date 8 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
8	33.0	38.0	5.0	5.0				
9	38.0	43.0	5.0	5.0				

RQD Length = sum > 10 cm, RQDX = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=0.5
31							
		SN4-15-010 MC-007 28.0-33.0					PP=0.25
32							PP=0.25
33							PP=0.25
34							PP=0.25
35							PP=0.25
36		SN4-15-010 MC-008 33.0-38.0					PP=1.0
37							PP=0.5
38		SN4-15-010 MC-009 38.0-43.0					PP=0.75
39							PP=1.25 CLY(39.5-73.0) OLV GRY w/OCC LT OLV GRY, MASSIVE, HOMOGENEOUS, DISSEM GYPSUM, SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC, OCC LG GYPSUM XTALS, OCC MN MINERALIZATION
40							

Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
10	43.0	48.0	5.0	5.0				
11	48.0	53.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

NORWEST CORPORATION

Hole SN4-15-010
Page 5 of 13
Date 8 / 11 / 15 D/M/Y
Name A.Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
						CLY, SAA
						PP=1.0
41						
		SN4-15-010 MC-009 38.0-43.0				PP=1.75
42						
						PP=1.25
43						
				** GYPSUM		PP=1.5
44						
						PP=0.75
45						
				* GYPSUM		PP=0.75
46				** GYPSUM		
		SN4-15-010 MC-010 43.0-48.0				PP=1.5
47						
						PP=1.75
48						
				** GYPSUM		PP=1.25
49						
		SN4-15-010 MC-011 48.0-53.0		Mn?		PP=0.75
50						

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 6 of 13
Date 8/11/15 D/M/Y
Name A.Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
12	53.0	54.5	1.5	1.4				
13	54.5	58.0	3.5	3.5				
14	58.0	63.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
					} Mn?		CLY, SAA
							PP=1.0
51							
		SN4-15-010 MC-011 48.0-53.0					PP=0.75
52							
							PP=1.0
53	SHELBY TUBE #SH01	SN4-15-010 SH-01 53.0-54.5					SHELBY TUBE #SH01 53.0-54.5
54							
				*	GYPSUM		PP=0.5
55							
							PP=0.75
56				**	GYPSUM		
		SN4-15-010 MC-012 54.5-58.0					PP=1.0
57							
				∴	SANDY LENSE		PP=1.25
58							
							PP=0.5
59		SN4-15-010 MC-013 58.0-63.0					
							PP=0.75
60							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 7 of 13
Date 8/11/15 D/M/Y
Name A.Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
15	63.0	68.0	5.0	5.0				
16	68.0	73.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							CLY, SAA
							PP=0.5
61							
		SN4-15-010 MC-013 58.0-63.0					PP=0.5
62							
							PP=0.75
63							
				*	GYPSUM		PP=0.75
64							
							PP=0.75
65							
							PP=0.75
66							
		SN4-15-010 MC-014 63.0-68.0					PP=0.75
67							
							PP=0.50
68							
		SN4-15-010 MC-015 68.0-73.0					PP=0.75
69							
							PP=1.0
70							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	73.0	78.0	5.0	5.0				
18	78.0	83.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-010
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Date 8/11/15 D/M/Y
Name A.Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To)	Lithologic Description Color Grain Size Sorting
								CLY, SAA
				**	GYPSUM		PP=1.0	
71		SN4-15-010 MC-015 68.0-73.0					PP=0.75	
				*	GYPSUM			
72								
				*	GYPSUM		PP=0.5	
73							PP=0.5	CLY (73.0-76.5) OLV GRY, MASSIVE, ABNT FN GRN SAND LENSES, SOFT, DAMP-MOIST, HIGH PLASTIC
74					FN SAND LENSES To 5mm		PP=0.75	
75							PP=0.75	
76		SN4-15-010 MC-016 73.0-78.0					PP=0.75	CLY (76.5-108.8) OLV GRY-LT OLV GRY, OCC BLK LAMINATIONS & MINERALIZATIONS, Thickly bedded-LAMINATED, SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC, OCC ZONES w/ ABNT Mn mineralization along bedding planes
77							PP=1.0	
78		SN4-15-010 MC-017 78.0-83.0					PP=1.0	
79							PP=1.0	
80				∴	SAND LENSE			

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 9 of 13
Date 8 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
19	83.0	88.0	5.0	5.0				
20	88.0	93.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
					SAND LENSE		CLY, SAA
							PP=0.75
81							
		SN4-15-010 MC-017 78.0-83.0					PP=0.5
82							
							PP=0.5
83							
							PP=1.25
84							
				*	GYPSUM		
				*	GYPSUM		PP=1.25
85							
							PP=0.5
86							
		SN4-15-010 MC-018 83.0-88.0					PP=0.75
87							
							PP=1.25
88							
							PP=0.75
89		SN4-15-010 MC-019 88.0-93.0					
							PP=1.0
90							

Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
21	93.0	98.0	5.0	5.0				
22	98.0	103.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

NORWEST CORPORATION

Hole SN4-15-010

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Date 8/9 / 11 / 15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						CLY, SAA
				Mn, along BP in Granular gypsum		PP=1.0
91		SN4-15-010 MC-019 88.0-93.0				PP=1.0
92						PP=1.0
93				Mn		PP=1.0
94						PP=1.0
95				GYPSUM BED DRY		PP=1.0
96		SN4-15-010 MC-020 93.0-98.0		GYPSUM		PP=0.75
97						PP=1.25
98				GYPSUM		Start of drilling Nov 9, 2015 PP=1.25
99		SN4-15-010 MC-021 98.0-103.0				PP=1.75
100						

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
23	103.0	108.0	5.0	5.0				
24	108.0	113.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-010

Date 9/11/15 D/M/Y

Name A. Garhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
							PP=1.5
101		SN4-15-010 MC-021 98.0-103.0					
					GYPSUM BANDS		PP=1.5
102					GYPSUM		
							PP=1.5
103					GYPSUM BAND, DRY		
				*	GYPSUM		PP=1.25
104				* *			PP=1.0
105							PP=1.25
106		SN4-15-010 MC-022 103.0-108.0					PP=2.0
107					GYPSUM BANDS, DRY		PP=1.5
108		SN4-15-010 MC-023 108.0-113.0					PP=1.75 GRANULAR GYPSUM (108.8-110.8), WHITE-GRY, CRS SAND SIZE, SATURATED
109					SATURATED GRANULAR GYPSUM		CLY (110.8-112.4) OLV GRY, MASSIVE, OCC LG GYPSUM XTALS, FIRM-STIFF, DAMP-MOIST, HIGH PLASTIC
110							PP=2.25

*Note: HIGH WINDS ~40MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 12 of 13
Date 9 / 11 / 15 D/M/Y
Name A. Garhart
Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
25	113.0	118.0	5.0	5.0				
26	118.0	125.0	7.0	7.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=2.5
111						
		SN4-15-010 MC-023 108.0-113.0				PP=1.75
112						
						PP=0.5 GRANULAR GYPSUM (112.4 - 115.0) WHITE-GRY, CRS SAND SIZE, SATURATED, CLAYEY
113						
114						
115						CLAY (115.0 - 124.5) LT-DK OLV GRY LAM-MASSIVE ABNT GYPSUM XTALS, OCC DRY GYPSUM BEDS TO 4", FIRM-STIFF, DAMP, HIGH PLASTIC
						PP=2.0
116				* * GYPSUM		
		SN4-15-010 MC-024 113.0-118.0		** GYPSUM BED, DRY		
117						
						PP=2.25
118						
		SN4-15-010 MC-025 118.0-123.0				PP=2.0
119						
						PP=1.75
120						

* Note: HIGH WINDS ~40MPH

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-010
Page 13 of 13
Date 9/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Geometry, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
						PP=1.75
121						
		SN4-15-010 MC-025 118.0-123.0				PP=3.75
122						
						PP=3.75 CLY (122.5 – 125.0) MED BRN, MASSIVE, HARD, DAMP-DRY, NON-PLASTIC
123						
		SN4-15-010 MC-026 123.0-128.0				PP=4.0
124						
						PP=4.0 125 = TD
125						4" Sched 40 PVC well screened 40.0-125.0'
126						
127						
128						
129						
130						

N4323926
E0312246 Elev 4492

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011

Page 1 of 7

Date 20/11/15 D/M/Y

Name A. Garhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	4.0	4.0	4.0				
2	4.0	9.0	5.0	5.0				
3	9.0	14.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Geometry, Surface, Infill	H R1-5	Code	Lithologic Description (From – To) Color Grain Size Sorting
				SALT CRUST		PP=0	SALT CRUST w/ CLY (0.0-0.5) DK GRY-BRNGRY, ABNT HALITE, VERY SOFT, SATURATED, NON-PLASTIC, STRONG SULFUR ODOR
1						PP=0	MARL/CARB MATRIX (0.5-2.5) LT BRN GRY, MASSIVE, VERY SOFT, SATURATED, NON-PLASTIC, STRONG SULFUR ODOR
2		SN4-15-011 MC-001 0.0-4.0				PP=0	CLY (2.5-12.0) MD GRY-DKGRY MD BRN & SANDY @ TOP, MOTTLED, OCC LG GYPSUM XTALS, OCC ORGANIC MATS, SOFT, WET, NON to LOW PLASTIC, OCC SANDY BEDS
				SANDY-F. DRY			
3				ORGANIC MATS			
				GYPSUM XTALS		PP=0	
4						PP=0	
				GYPSUM			
5				SAND FN WET			
				GYPSUM		PP=0.25	
6				ORGANIC MAT			
				GYPSUM			
				ORGANIC MAT		PP=0.5	
		SN4-15-011 MC-002 4.0-9.0		GYPSUM			
7				ORGANIC MAT			
				GYPSUM		PP=0	
8						PP=0	
9				GYPSUM			
						PP=0	
10				ORGANIC MAT			

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011
Page 2 of 7
Date 20/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	14.0	19.0	5.0	2.5				
5	19.0	20.5	1.5	1.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
					ORGANIC MATS		
					GYPSUM		
					ORGANIC MATS		PP=0
					GYPSUM		
11					ORGANIC MATS		
							PP=0
12		SN4-15-011 MC-003 9.0-14.0					CARBONATE MATRIX/MARL (12.0-16.0) MD GRY-LT BRN GRY, FN CLY SZ Particles @ Top grading into COARSE GRANULAR MARL, MASSIVE, VERY SOFT, WET, NON PLASTIC
							PP=0
13							PP=0
14							PP=1.0
15							CLAY (16.0-16.5) LT OLV GRY, MASSIVE, DAMP, HARD, LOW PLASTIC
							PP=1.0
16							PP=3.0
17		SN4-15-011 MC-004 14.0-19.0					CORE LOSS 16.5-19.0, SAMPLE MC-004 is Probably 14.0-16.5 only, BIT LIKELY PLUGGED ON CONTACT w/ HARD CLAY
18							
19	SHELBY TUBE #SH-01	SN4-15-011 SH-01 19.0-20.5					3" Shelby Tube #SH-01, 19.0-20.5
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011
Page 3 of 7
Date 20/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	20.5	24.0	3.5	3.5				
7	24.0	29.0	5.0	5.0				
8	29.0	34.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
	SHELBY TUBE	SN4-15-011 SH-01 19.0-21.5					
							PP=2.5 CLY (20.5-31.5) LT OLV GRY-DK GRY MASSIVE DISSEM MANG, FIRM-STIFF, DAMP, HIGH PLASTIC OCC MANG RICH BAND To 1.0"
21							
							PP=2.75
22							
							PP=2.0
23		SN4-15-011 MC-005 20.5-24.0					
							PP=1.0
24							
							PP=1.5
25							
							PP=1.5
26							
							PP=2.0
27							
							PP=1.0
28		SN4-15-011 MC-006 24.0-29.0					
							PP=0.75
29							
							PP=0.75
30							

Note: High Winds ~20-30 MPH.

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011
Page 4 of 7
Date 20 / 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	34.0	39.0	5.0	5.0				
10	39.0	40.5	1.5	2.2				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP = 0.75
31							PP = 0.75 CLY (31.5 - 54.0) LT OLV GRY - DK OLV GRY LAMINATED - MASSIVE OCC GYPSUM XTALS, FIRM, DAMP, HIGH PLASTIC, SAND LENSES & Pockets @ 53.0 - 54.0
32							PP = 1.5
33		SN4-15-011 MC-007 29.0-34.0		*	GYPSUM		PP = 1.5
34							PP = 1.5
35							PP = 1.5
36							PP = 1.5
37							PP = 1.5
38		SN4-15-011 MC-008 34.0-39.0		*	GYPSUM		PP = 1.5
39	SHELBY TUBE SH-02	SN4-15-011 SH-02 39.0-40.5					3" Shelby Tube # SH-02 39.0-40.5
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011
Page 5 of 7
Date 20/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
11	40.5	44.0	3.5	3.5				
12	44.0	49.0	5.0	5.0				
13	49.0	50.5	1.5	1.2				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
	SHELBY TUBE SH-02						CLY, SAA
							PP=0.75
41							
							PP=0.75
42							
		SN4-15-011 MC-009 40.5-44.0					PP=0.75
43							
							PP=1.0
44							
							PP=1.0
45							
							PP=0.5
46							
							PP=0.5
47							
							PP=0.75
48							
		SN4-15-011 MC-010 44.0-49.0					PP=1.0
49							3" Shelby Tube #SH-03 49.0-50.5
	SHELBY TUBE # SH-03	SN4-15-011 SH-03 49.0-50.5					
50							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011

Page 6 of 7

Date 20/21/11/15 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	50.5	54.0	3.5	3.5				
15	54.0	55.5	1.5	1.2				
16	55.5	59.0	3.5	3.5				
17	59.0	64.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
	SHELBY TUBE SH-03						
							PP=0.75
51							
							PP=0.75
52							
		SN4-15-011 MC-011 50.5-54.0					PP=0.75
53					SAND LENSES SATURATED FN GRN		
							PP=1.0
54							5" Shelby Tube # SH-04 54.0-55.5
55	SHELBY TUBE # SH-04	SN4-15-011 SH-04 54.0-55.5					CLY, SAA
							PP-0.75 CLY (55.5-64.0) LT-DK OLV GRY W/ DK GRY color banding, LAMINATED, SOFT-FIRM, DAMP-MOIST, HIGH PLASTIC
56							
							PP=1.0
57							
							PP=1.0
58		SN4-15-011 MC-012 55.5-59.0					
							PP=1.0
59							Start of drilling Nov 21, 2015
		SN4-15-011 MC-013 59.0-64.0					PP=1.0
60							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-011
Page 7 of 7
Date 21/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
18	64.0	69.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Frac/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
60						CLY, SAA
						PP = 1.0
61						PP = 1.0
62						PP = 1.0
63		SN4-15-011 MC-013 59.0-64.0				PP = 1.0
64						PP = 1.0
65						PP = 1.0
66						PP > 4.5 CLY (66.0 - 69.0) OLV GRY & MED BRN MASSIVE VERY HARD, DAMP-DRY NON PLASTIC, OCC GYPSUM XTALS
67						PP > 4.5
68		SN4-15-011 MC-014 64.0-69.0		** * GYPSUM		PP > 4.5
69						TD = 69.0 4" sched 40 PVC well screened: 40.0-69.0
70						

UTM Zone 12 N4323730
NAD 83 E0319576
Elev 4532'

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
Page 1 of 9
Date 22/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	4.0	4.0	2.5				
2	4.0	9.0	5.0	5.0				
3	9.0	14.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic / Geometry, Surface, Infill	H R1-5	Code	Lithologic Description (From – To) Color Grain Size Sorting
0		SN4-15-012 MC-001 0.0-4.0		TRACE SALT CRUST		PP=0	CARBONATE MATRIX/MARL (0.0-5.5) LT BRN GRY - BRN GRY, MASSIVE, PRDM FN CLY SZ PARTICLES, MINOR GRANULAR INTBDS, VERY SOFT, SATURATED @ TOP to WET BELOW, NON to LOW PLASTIC, TRACE SALT CRUST @ TOP. NOTE: RUN 1 LIKELY COMPRESSED to 2.5' DUE TO SOFT MATERIAL
1						PP=0	
2						PP=0	
3						PP=0	
4		SN4-15-012 MC-002 4.0-9.0				PP=0	
5						PP=0	INTBD CLY & SAND (5.5-6.5) LT BRN GRY - YLW ORNG, CLY - MASSIVE, VERY SOFT, WET, SAND - FN-MD GRN, SUBRND, MASSIVE, LOOSE, SATURATED, OCC ORGANICS
6				ORGANIC MAT		PP=0	CLY (6.6-11.0) LT BRN GRY, MOTTLED W/ BRN GRY, MASSIVE, OCC ORGANIC MATS & GYPSUM XTALS, VERY SOFT, WET, NON to LOW PLASTIC
7				SNAIL @ 7'; ORGANIC MAT; GYPSUM; GYPSUM		PP=0	
8						PP=0	
9		SN4-15-012 MC-012 9.0-14.0				PP=0	
10							

Drill Hole Lithology Log

NORWEST CORPORATION

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	14.0	19.0	5.0	5.0				
5	19.0	20.5	1.5	1.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Hole SN4-15-012
Page 2 of 9
Date 22/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=0.25
11							CARBONATE MATRIX/MARL (11.0-16.0) MD GRY - LT OLV GRY, GRANULAR, MD - CRS GRN SAND SZ PARTICLES, SOFT WET-SATURATED, LOW PLASTIC
							PP=0
12		SN4-15-012 MC-003 9.0-14.0					PP=0.25
13							PP=0.25
14							PP=1.0
15							PP=0.75
16							CLY (16.0-35.3) LIGHT OLV GRY, MASSIVE, FIRM, DAMP-MOIST, HIGH PLASTIC, HOMOGENEOUS, FRIABLE IP
							PP=1.5
17		SN4-15-012 MC-004 14.0-19.0					PP=2.0
18							PP=1.0
19	SHELBY TUBE #1 SH-01	SN4-15-012 SH-01 19.0-20.5					3" SHELBY TUBE # SH-01, 19.0-20.5
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
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Date 22/23/ 11 / 15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	20.5	24.0	3.5	3.5				
7	24.0	29.0	5.0	5.0				
8	29.0	34.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
	SHELBY TUBE SH-01	SN4-15-012 SH-01 19.0-20.5					CLY, SAA
							PP=1.0
21							
							PP=1.0
22							
		SN4-15-012 MC-005 20.5-24.0					PP=1.5
23							
							PP=0.75
24							Start of drilling Nov 23, 2015
							PP=1.25
25							
							PP=1.0
26							
							PP=1.0
27							
		SN4-15-012 MC-006 24.0-29.0					PP=0.5
28							
							P=1.0
29							
		SN4-15-012 MC-007 29.0-34.0					PP=1.25
30							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
Page 4 of 9
Date 23/11/15 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
9	34.0	39.0	5.0	5.0				
10	39.0	44.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
							PP=1.0
31							
							PP=1.0
32							
							PP=0.75
33		SN4-15-012 MC-007 29.0-34.0					
							PP=1.5
34							
							PP=1.5
35							SAND & Gravel (35.3 – 36.8) OLVGRY-MED GRY – SALT/PEPPER, SAND-MED – CRS GRN, MOD SRT – POOR SRT, SUBRND QTZ RICH, QTZITE & LS Rock Frags, GRAVEL – 2mm – 2", Qtzite, LS, SUBRND – ROUND, LOOSE, SATURATED
36							CLY (36.8 – 38.2) DK GRY – OLV GRY MASSIVE, DISSEM GYPSUM, FIRM, MOIST, HIGH PLASTIC
37							
							PP=1.75
38		SN4-15-012 MC-008 34.0-39.0					SAND & GRAVEL (38.2 – 39.0) SAA
39		SN4-15-012 MC-009 39.0-44.0					CLY (39.0 – 43.0) OLVGRY – BRN GRY, MASSIVE – MOTTLED, BLK STREAKS (Mn?), FIRM, MOIST, HIGH PLASTIC
							PP=1.75
40							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
Page 5 of 9
Date 23/11/15 D/M/Y
Name A. Gerhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
11	44.0	45.5	1.5	1.2				
12	45.5	49.0	3.5	3.5				
13	49.0	54.0	5.0	0.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.5
41							
							PP=2.0
42		SN4-15-012 MC-009 39.0-44.0					
43							SAND (43.0-43.6) BRNGRY FN GRN, WELL SRT, SUB RND-RND, LOOSE, SATURATED, QTZ RICH
							PP=1.25
44							CLY (43.6-49.0) BRNGRY-OLV GRY MASSIVE, SANDY @ TOP, FIRM, MOIST, HIGH PLASTIC, INTBD SAND 1P - SAA
	SHELBY TUBE SH-02	SN4-15-012 SH-02 44.0-45.5					SHELBY TUBE # SH-02, 44.0-45.5'
45							
							PP=1.0
46							
							PP=1.5
47					SANDY INTERVALS & BEDS to 3" SATURATED		PP=1.75
48		SN4-15-012 MC-010 45.5-49.0					PP=1.5
49							RUN 13 Cut Nov 23. Flapper bit damaged, unable to retrieve until Flapper repaired!
50							CORE LOSS 49.0-54.0, Material too soft to recover

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
Page 6 of 9
Date 23/11/15 D/M/Y 2/12/15
Name A.Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
14	54.0	55.5	1.5	1.1				
15	55.5	59.0	3.5	3.5				
16	59.0	60.5	1.5	1.8				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill, Geometry	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
51–54		No Sample				Core Loss 49.0-54.0
54–55.5	SHELBY TUBE #SH-03	SN4-15-012 SH-03 54.0-55.5				3" Shelby Tube # SH-03, 54.0-55.5 Start of drilling Dec 2, 2015
55.5–59		SN4-15-012 MC-011 55.5-59.0		FN Sand Lenses to 3/4", WET		PP=0.5 CLY (55.5-61.0) OLV GRY-DK OLV GRY w/ BLK COLOR BANDING ASSOCIATED W/ SAND BEDS to 3/4", THICKLY BEDDED-MASSIVE, ABNT Mn, SOFT, MOIST-WET, HIGH PLASTIC; PP=0.5; PP=0.5; PP=0.5
59–60.5	SHELBY TUBE #SH-04	SN4-15-012 SH-04 59.0-60.5				5" Shelby Tube #SH-04 59.0-60.5

Drill Hole Lithology Log

NORWEST CORPORATION

Hole: SN4-15-012
Page 7 of 9
Date: 2/12/15 D/M/Y
Name: A. Garhart
Photos: (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
17	60.5	64.0	3.5	3.5				
18	64.0	69.0	5.0	3.5				
19	69.0	74.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
	SHELBY TUBE	SHELBY #SH-04					PP=0.75
61							SAND (61.0–62.5) MD GRY–OLV GRY, MASSIVE w/OCC CLY INTBDS, FN GRN, WELL SRT, SUB RND, PRDM QTZ, LOOSE, SATURATED
62							
63		SN4-15-012 MC-012 60.5–64.0					PP=1.0 CLY (62.5–67.5) OLVGRY w/OCC Mottled BLK, MASSIVE–MOTTLED, SANDY @ TOP, FIRM, MOIST, HIGH PLASTIC, OCC Mn MINERALIZATION, OCC LG GYPSUM XTALS
64							PP=1.25
							PP=1.0
65							
				. . .	FN SAND ~1/4"		PP=0.75
66							
				* **	GYPSUM XTALS		PP=0.75
67							PP=0.75
68		SN4-15-012 MC-013 64.0–69.0					CORE LOSS 67.5–69.0 * SAMPLE MC-013 IS LIKELY 64.0–67.5 ONLY *
69							CLY (69.0–75.5) LT OLV GRY–OLV GRY, LAMINATED, FAINT COLOR BANDING, ABNT LG GYPSUM XTALS, FIRM, MOIST, HIGH PLASTIC
70		SN4-15-012 MC-014 69.0–74.0					PP=1.0

Drill Hole Lithology Log

NORWEST CORPORATION

Hole: SN4-15-012
Page: 8 of 9
Date: 2/12/15 D/M/Y
Name: A. Garhart
Photos: Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
20	74.0	79.0	5.0	5.0				
21	79.0	84.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.0
71							PP=0.75
					GYPSUM		
72							PP=1.0
73		SN4-15-012 MC-014 69.0-74.0					PP=0.75
74							PP=0.25
75							PP=0.25 CLY (75.5-85.0) LT OLV GRY-OLV GRY, ABNT VF SAND BEDS to 1", LAMINATED to MASSIVE, SOFT-FIRM, MOIST, HIGH PLASTIC
76					VF SAND BEDS to 1", MOIST		PP=0.75
77							PP=1.0
78		SN4-15-012 MC-015 74.0-79.0					PP=0.5
79		SN4-15-012 MC-016 79.0-84.0					PP=1.0
80							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-012
Page 9 of 9
Date 2/12/15 D/M/Y
Name A Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
22	84.0	89.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.0
81					VF SAND BEDS to ¼"		PP=1.0
82							PP=1.0
83		SN4-15-012 MC-016 79.0-84.0					PP=1.0
84							PP=1.0
85							Gravel (85.0 - 85.5) SALT & PEPPER - MED GRY, 2mm - 6mm, SUBANG, QTZITE RF, MOD SRT, LOOSE, SATURATED
							PP=3.5
86							CLY (85.5 - 89.0) MED BRN, MASSIVE, Occ GYPSUM LENSES, HARD, DRY, NON-PLASTIC
					CYPSUM		PP>4.5
87							PP>4.5
88		SN4-15-012 MC-017 84.0-89.0					PP>4.5
89							TD = 89.0
							6" PVC Well Screened 40.0 - 89.0
90							

UTM ZONE 12 NAD 83
N4291336
E0311256 Elev 4528

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WWIA

Date 13/9/2015 D/M/Y

Name A. Gerhart

Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	5.5				
2	5.0	10.0	5.0	5.7				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1–5	Lithologic Description Code (From – To) Color Grain Size Sorting
0		SN4-15-WWIA MC-001 0.0-5.0 (Sample sat inside casing overnight due to mech failure)					CLY (0.0 - 1.5) LT BRN GRY, SILTY, SANDY & WEATHERED @ TOP, NO VISIBLE BEDDING, MOIST, SOFT, HIGH PLASTIC
							PP = 0.25
1							PP = 0
							CLY W/ CARBONATE MATRIX (1.5 - 7.5) LT GRY-LT BRN GRY, NO VISIBLE BEDDING, MOIST-WET VERY SOFT - SOFT, HIGH PLASTIC, CARB MINERAL LENSES UP to 4mm
2					CARBONATE LENSE		PP = 0.5
3							PP = 0
4					ORGANICS		w/ strong sulfur odor
							PP = 0.25
5		SN4-15-WWIA MC-002 5.0-10.0			CARBONATE LENSES		PP = 0.5
6							PP = 1.0
7							PP = 1.0 CLY (7.5 - 11.5) LT BRN GRY - BRN GRY, COLOR BANDED 2" OF BROWN ORGANIC MATERIAL @ 8.5, OCC LG GYPSUM XTALS UP TO 2.5" VERY SOFT - SOFT, MOIST - WET HIGH PLASTIC
8				*	GYPSUM XTAL		PP = 0.25 FN GRN CARBONATE MATRIX @ 9.7-10.0
					ORGANICS ROOTS?		
				*	GYPSUM XTAL		
9							PP = 0.25
10					WET CARBONATE MATRIX		

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1A
Page 2 of 3
Date 13/9/2015 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	10.0	15.0	5.0	5.4				
4	15.0	20.0	5.0	3.6				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=0.25
11				XX	GYPSUM XTAL		PP=0.25
							CARBONATE MATRIX (11.5-17.5) LT GRY, CARB MINERALS ARE GRANULAR F-MD GRN SAND SIZE BUT SMEAR to CLAY SIZE UNDER PRESSURE, LOW PLASTIC, WET, SOFT, OCC INTBD CLY@ BTM
12	CARB MATRIX	SN4-15-WW1A MC-003 10.0-15.0					PP=0.25
13							PP=1.25
14							PP=1.5
15	CARB MATRIX						PP=1.5
16							PP=1.75
17		SN4-15-WW1A MC-004 15.0-20.0					PP=0.75
							CLY (17.5-22.0) LT GRY w/ OCC DK GRY BANDS, NO VISIBLE BEDDING, OCC BEDS of CARB MATRIX, SOFT-MOD STIFF, MOIST, HIGH PLASTIC
18							PP=0.5
19							PP=0.5
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1A
Page 3 of 3
Date 13 / 9 / 2015 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
5	20.0	23.0	3.0	3.6				
6	23.0	25.0	2.0	1.9				
7	25.0	30.0	5.0	5.2				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP= 0.75
21		SN4-15-WW1A MC-005 20.0-23.0					PP=1.0
22							CLY (22.0-30.0) LT OLV GRY-DK GRY, MOTTLED, NO BEDDING, STIFF, DAMP-MOIST, HIGH PLASTIC SOFT IP, Occ Deformed Laminations, occ GYPSUM PP= 1.75
23	SHELBY TUBE 01	SN4-15-WW1A SH-01 23.0-25.0					
24							
25							CORE LOSS 24.9-25.0 PP=0.5
26		SN4-15-WW1A MC-006 25.0-30.0					PP=0.5
27							PP=2.5
28							PP=2.0
29							PP=2.75
30				XX	GYPSUM XTALS		TD=30.0

TD

UTM ZONE 12
E 0311264 Elev 4533
N 4291334

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1B

Page 1 of 3

Date 14 / 9 / 2015 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	5.3				
2	5.0	10.0	5.0	5.9				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From – To) Color Grain Size Sorting
							CLY (0.0 – 1.5) LT BRN GRY, SILTY SANDY; WX @ TOP, NO VISIBLE BEDDING, MOIST, SOFT, LOW-HIGH PLASTIC
1							PP = 0.25
							PP = 0.25
							CLY (1.5 – 7.5) CLAY w/ CARBONATE MATRIX LT GRY – LT BRN GRY NO VISIBLE BEDDING, MOIST-WET, SOFT, HIGH PLASTIC, CARBONATE MINERAL BANDS to 4mm
2		SN4-15-WW1B MC-001 0.0-5.0					PP = 0.25
3							PP = 0.25
4					CARB MINERALS		
							PP = 0.25
5							PP = 0.5
6							PP = 0.75
7							CLY (7.5 – 11.5) LT GRY – LT BRN GRY, COLOR BANDED, ABNT ORGANIC MATERIAL 8-9' LGE GYPSUM XTALS, STRONG SULFUR ODOR, MOIST-WET, SOFT, HIGH PLASTIC
							PP = 0.75
8		SN4-15-WW1B MC-002 5.0-10.0			ORGANICS		
					GYPSUM XTALS		PP = 0.25
9					ORGANICS		
					GYPSUM		PP = 0
10							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1B

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Date 14/9/2015 D/M/Y

Name A. Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	10.0	13.0	3.0	4.4				
4	13.0	15.0	2.0	1.9				
5	15.0	20.0	5.0	4.5				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
10–11		SN4-15-WW1B MC-003 10.0-13.0				PP=0.25
11–12						PP=0.25 CARBONATE MATRIX/CLAY (11.5-17.0) /LTBRN GRY-BRN GRY/ CARBONATE MINERALS ARE FN-CRS SAND SIZE BUT SMEAR UNDER PRESSURE, NO BEDDING, WET, SOFT, LOW PLASTIC ↳ to STIFF @ BTM
12–13	CARB MATRIX					
13–14	SHELBY TUBE	SN4-15-WW1B SH-01 13.0-15.0				PP=0.75
14–15						
15–16		SN4-15-WW1B 15.0-20.0 MC-004				PP=2.5
16–17						PP=1.5
17–18						CLY (17.0-21.5) LT OLV GRY w/ occ DK GRY MOTTLING, MASSIVE, HOMOGENEOUS, WAXY APPEARANCE PP=2.25 MOD STIFF-STIFF, MOIST, HIGH PLASTIC
18–19						PP=1.75
19–20						PP=3.25 CORE LOSS 19.5-20.0

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1B
Page 3 of 3
Date 14/9/2015 D/M/Y
Name A.Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
6	20.0	25.0	5.0	6.1				
7	25.0	30.0	5.0	5.6				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
							PP=1.25 CLY (21.5-27.5) LT OLV GRY MOTTLED w/ OLV GRY & DK GRY BANDS, MASSIVE - thickly bedded, Mod stiff - stiff, damp-moist, high plastic
21							PP=1.25
22		SN4-15-WW1B MC-005 20.0-25.0					PP=3.0
23							PP=3.0
24							PP=3.25
25							PP=0.5
26							PP=0.75
27		SN4-15-WW1B MC-006 25.0-30.0					PP=1.75 CLY (27.5-30.0) OLV GRY & OLV BRN COLOR BANDING, Thickly bedded, MOD STIFF - STIFF, DAMP, HIGH PLASTIC, OCC GYPSUM XTALS
28							PP=2.5
29							PP=1.75
30							TD=30.0

N4295195 UTM ZONE 12
E0312175 NAD 83
Elev 4489

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW1A
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Date 21/9/2015 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	0.0	5.0	5.0	5.1				
2	5.0	10.0	5.0	5.3				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-5	Code (From - To)	Lithologic Description Color Grain Size Sorting
0–1		SN4-15-WW2A MC-001 0-5					PP=0	CLY (0.0-1.2) LT BRN - TAN, SILTY @ TOP W/ FN GRN SAND @ BOTTOM, MASSIVE, CARBONATE MINERALS Throughout, VERY SOFT, MOIST, LOW PLASTIC
1–2				XX, XXX	CARB MATRIX SPIDER WEB		PP=0.25	CLY W/ CARBONATE MATRIX (1.2-4.4) LT GRY - LT BRNGRY, BEDS of CARB MATRIX up to 1.5" INTBD W/ CLY, SULFUR ODOR VERY SOFT - SOFT, MOIST - WET, HIGH PLASTIC
2–3				XXX, XXX, XXX			PP=0.25	
3–4				XXX, XXX, XXX	CARB MATRIX		PP=0.5	
4–5				XXX XXX	CARB MATRIX		PP=0.5	CLY (4.4-5.0) LT GRY - DK GRY COLOR BANDING, MASSIVE, TRACE CARBONATE MATRIX, SULFUR ODOR, SOFT, MOIST - WET
5–6		SN4-15-WW2A MC-002 5-10					PP=0.25	CLY (5.0-8.5) LT GRY - LT BRN GRY, 20% CARBONATE MATRIX, SULFUR ODOR, SOFT, MOIST-WET, HIGH PLASTIC
6–7							PP=0.25	
7–8				XXX	CARB MATRIX 1.5" thick		PP=0.25	
8–9				XXX	CARB MATRIX		PP=0.25	CLY W/ ORGANICS & CARBONATE (8.5-12.5) MATRIX, LT BRN GRY W/ Mottled DK GRY, STRONG SULFUR ODOR, SOFT, MOIST-WET, HIGH PLASTIC, ABNT ORGANICS Throughout W/ Red BRN COLOR & STRONG ODOR, OCC LG GYPSUM XTALS
				ΨΨ ΨΨ	ORGANICS			
9–10				XXX	CARB MATRIX LENSE		PP=0.25	

Legend: CLY, CARB MATRIX, SAND

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW2A
Page 2 of 2
Date 21/9/2015 D/M/Y
Name A. Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	10.0	15.0	5.0	5.7				
4	15.0	20.0	5.0	5.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic Surface, Infill Geometry,	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
						PP=0.5
11				ABNT ORGANICS (GRASS?) GYPSUM		
				GYPSUM		PP=0
12		SN4-15-WW2A MC-003 10-15				CARBONATE MATRIX (12.5-17.5) LT BRN GRY-MED GRY, OCC RED BRN ORGANICS @ TOP VF GRN MATRIX, GRADING INTO MDGRN @ 14.5' MILD SULFUR ODOR SOFT WET-SATURATED HIGH-LOW PLASTIC, OCC LG GYPSUM XTAL
						PP=0.25
13				ORGANICS (GRASS?)		PP=0.5
14						*NOTE* - SATURATED ZONE BEGINS @~12.5', MD GRN CARB MATRIX SMEARS UNDER PRESSURE to CLY SIZE PARTICLES
						PP=0.5
15				MED-CRS CARB MATRIX WET-SATURATED		PP=0.5
16						PP=1.25
17		SN4-15-WW2A MC-004 15-20'				CLY (17.5-20.0) MD GRY MINOR CARB MATRIX & LG GYPSUM XTALS, HOMOGENEOUS MASSIVE, SOFT-MOD STIFF, DAMP-MOIST, HIGH PLASTIC
						PP=0.5
18						PP=0.75
19				GYPSUM XTALS		PP=0.75
20						PP=1.75 TD=20.0'

4" Well completion screened 10'-20'

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW2C
Page 1 of 1
Date 22/9/2015 D/M/Y
Name A Garhart
Photos Yes / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
4	13.0	15.0	2.0	2.3				
5	15.0	17.0	2.0					

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic	Geometry, Surface, Infill	H R1-6	Lithologic Description Code (From – To) Color Grain Size Sorting
							Well to well completion 3 of 5, for lithology see SN4-15-WW2A log
11							
12							
13	SHELBY TUBE SH-01	SN4-15-WW2C SH-01 13-15'					Shelby samples wax coated, cushioned on top & bottom, bagged, capped & taped.
14							
15	SHELBY TUBE SH-02	SN4-15-WW2 SH-02 15-17'					
16							
17							
18							
19							
20							

Drill Hole Lithology Log

NORWEST CORPORATION

Hole SN4-15-WW2E

Page 1 of 1

Date 22/9/15 D/M/Y

Name A.Garhart

Photos (Yes) / No

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
1	20.0	25.0	5.0	Coil				
2	25.0	28.0	3.0	0.0				
3	28.0	30.0	2.0	2.1				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Graphic / Geometry, Surface, Infill	H R1-5	Lithologic Description Code (From - To) Color Grain Size Sorting
20						* No samples 0-20', see SN4-15-WW2A for data
						PP=1.5 CLY (20.0-25.0) MD GRY - OLV GRY, GYPSUM XTALS to 0.5" Throughout MASSIVE HOMOGENEOUS, SOFT-MOD STIFF, DAMP-MOIST, HIGH PLASTIC, MILD SULFUR ODOR, POSSIBLY VF GRN MARL/CARB MATRIX
21				GYPSUM XTALS		PP=1.0
22		SN4-15-WW2E MC-001 20.0-25.0				
						PP=0.75
23						PP=0.75
24						PP=0.75
25		CORE LOSS 25.0-28.0				CORE LOSS 25.0-28.0 Unable to recover core & subsequently washed out
26						
27						
28	SHELBY TUBE SH-01	SN4-15-WW2E SH-01 28.0-30.0				CLY (28.0-30.0) SAA, logged from end of Shelby Sample
29						
30						

Drill Hole Lithology Log

Core Number	Top	Base	Cut	Recovered	RQD Length	RQD %	Number of Fractures	Fracture Frequency
3	19.0	20.5	1.5	2.0				

RQD Length = sum > 10 cm, RQD% = RQD Length/Cut, Frac Freq = Num Fracs/Cut

NORWEST CORPORATION

Hole SN4-15-WW4A

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Date 26/10/15 D/M/Y

Name A. Garhart

Photos Yes / No

Depth	Graphic Log	Sample Id & Box #	Ang. Type (TCA)	Discontinuities Geometry, Graphic Surface, Infill	H R1-6	Lithologic Description Code (From - To) Color Grain Size Sorting
						No MC samples collected
11						For lithology see SN4-15-006 log
12						
13						
14						
15						
16						
17						
18						5" Shelby Tube # SH-01 collected 19.0-20.5
						TD = 30' Screened 10-30'
19		SN4-15-WW4A SH-01 19.0-20.5				
20						

Attachment 6 - IGES Sample Results

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004**
Location: Peak Minerals Sevier Lake, UT
Date: 10/20/2015
By: JMG

Sample Info.	Boring:	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-5'	5-10'	10-15'	15-20'	20-22'	23.5-25'	25-30'	30-35'
Water Content Determination	Initial date	10/8/15	10/8/15	10/8/15	10/8/15	10/8/15	10/8/15	10/8/15	10/8/15
	Wet soil + tare (g)	274.04	300.01	321.64	364.03	292.15	274.69	371.13	337.16
	Tare (g)	120.86	127.73	127.48	127.20	117.96	117.46	125.06	120.01
	Date	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15
	Dry soil + tare (g)	234.21	254.97	270.48	306.71	244.12	232.99	312.62	286.61
	Water content, ω (%)	35.1	35.4	35.8	31.9	38.1	36.1	31.2	30.3
	Date	10/13/15	10/13/15	10/13/15	10/13/15	10/13/15	10/13/15	10/13/15	10/13/15
	Dry soil + tare (g)	232.21	252.98	268.67	304.23	243.85	232.84	311.23	285.11
	Water content, ω (%)	37.6	37.5	37.5	33.8	38.4	36.3	32.2	31.5
	Date	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15
	Dry soil + tare (g)	229.65	250.14	267.02	300.99	243.48	232.81	309.69	282.71
	Water content, ω (%)	40.8	40.7	39.1	36.3	38.8	36.3	33.3	33.5
	Date	10/19/15	10/19/15	10/19/15	10/19/15				10/19/15
	Dry soil + tare (g)	229.02	249.07	266.60	299.83				281.73
	Water content, ω (%)	41.6	42.0	39.6	37.2				34.3
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**41.6**	**42.0**	**39.6**	**37.2**	**38.8**	**36.3**	**33.3**	**34.3**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake, UT
Date: 10/20/2015
By: IM

Sample Info.	Boring:	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001	SN4-15-001		
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014		
	Depth:	35-40'	40-45'	45-50'	50-55'	55-58.5'	58.5-60'		
Water Content Determination	Initial date	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15	10/12/15		
	Wet soil + tare (g)	362.97	352.15	342.30	352.05	341.83	332.31		
	Tare (g)	123.32	127.01	123.67	127.46	121.71	121.86		
	Date	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15	10/16/15		
	Dry soil + tare (g)	306.61	293.46	311.43	305.67	298.09	289.98		
	Water content, ω (%)	30.7	35.3	16.4	26.0	24.8	25.2		
	Date	10/19/15	10/19/15	10/19/15	10/19/15	10/19/15	10/19/15		
	Dry soil + tare (g)	305.72	291.19	311.56	305.25	297.87	290.16		
	Water content, ω (%)	31.4	37.1	16.4	26.3	25.0	25.0		
	Date		10/20/15						
	Dry soil + tare (g)		290.82						
	Water content, ω (%)		37.4						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**31.4**	**37.4**	**16.4**	**26.3**	**25.0**	**25.0**		
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/20/2015
By: BRR

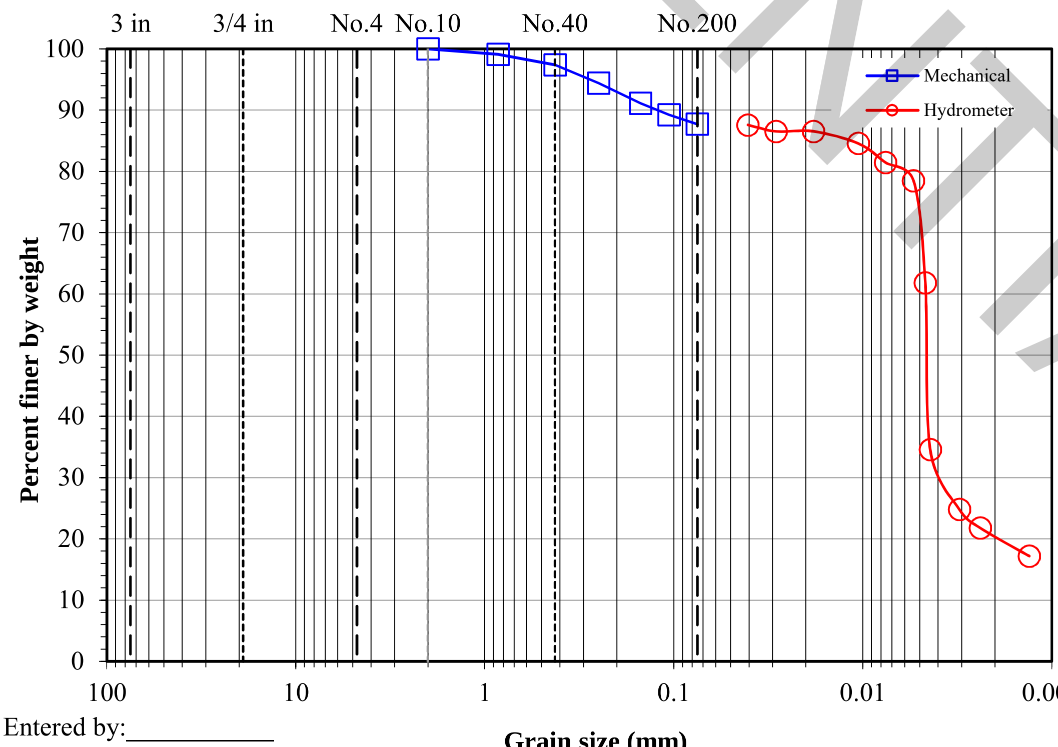
Boring No.: SN4-15-001
Sample: MC-001
Depth: 0-5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	54.80	46.37
Hydrometer fraction (g):	54.80	46.37
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	38.48	38.48
Dry soil + tare (g):	-	35.95	35.95
Tare (g):	-	22.04	22.04
Water content (%):	0.00	18.19	18.19

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.75	Assumed	α:	0.98
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.7	45.5	0.04053	87.59
6"	-	150	-		2	17.7	45	0.02879	86.53
4"	-	100	-		5	17.7	45	0.01821	86.53
3"	-	75	-		15	18	44	0.01057	84.56
1.5"	-	37.5	-		30	18.1	42.5	0.00757	81.44
3/4"	-	19	-		60	18.5	41	0.00539	78.46
3/8"	-	9.5	-		90	19	33	0.00467	61.81
No.4	-	4.75	-		120	19.4	20	0.00440	34.56
No.10	-	2	100.0	<=Split hyd.	250	21.1	15	0.00308	24.80
No.20	0.42	0.85	99.1		399	23.7	13	0.00239	21.78
No.40	1.22	0.425	97.4		1445	20.6	11.5	0.00131	17.18
No.60	2.60	0.25	94.4						
No.100	4.12	0.15	91.1						
No.140	4.99	0.106	89.2						
No.200	5.70	0.075	87.7	<=Split					



Gravel (%): 0.0
Sand (%): 12.3
Fines (%): 87.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/21/2015
By: BRR

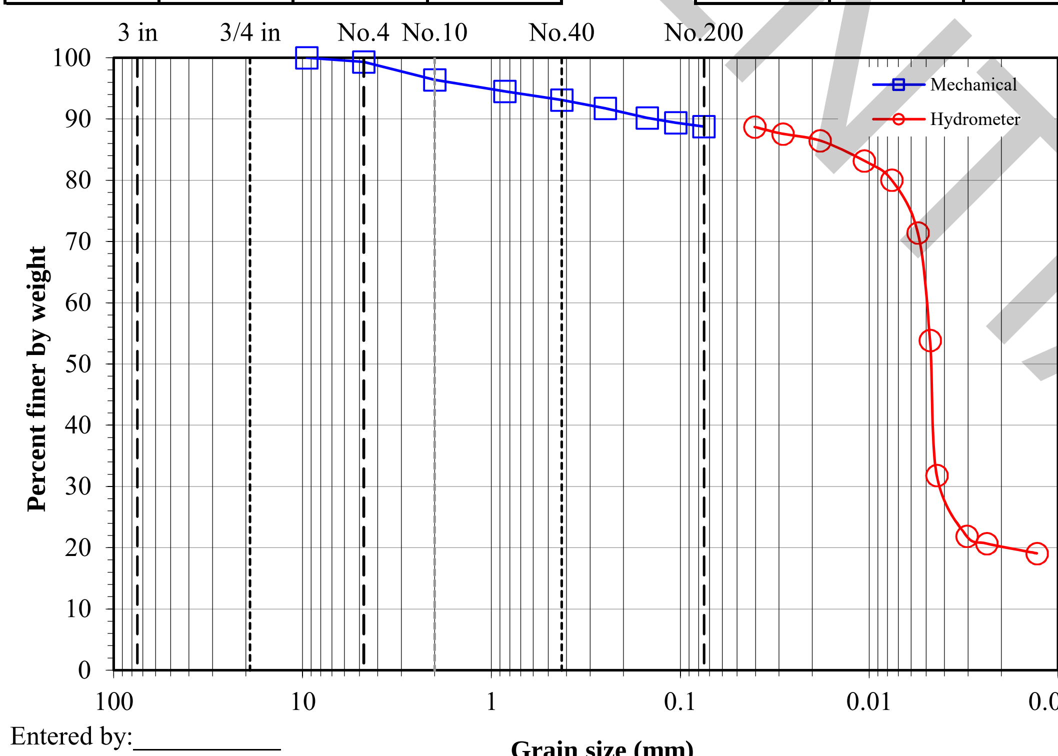
Boring No.: SN4-15-001
Sample: MC-002
Depth: 5-10'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	243.84	203.34
+#10 Coarse fraction (g):	8.42	7.34
-#10 Split fraction (g):	50.64	42.16
Hydrometer fraction (g):	50.64	42.16
Split fraction:	0.964	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	78.38	41.15	41.15
Dry soil + tare (g):	73.13	37.97	37.97
Tare (g):	37.53	22.16	22.16
Water content (%):	14.75	20.11	20.11

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	96.39
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.9	44	0.04042	88.69
6"	-	150	-		2	17.9	43.5	0.02871	87.58
4"	-	100	-		5	17.9	43	0.01824	86.48
3"	-	75	-		15	18	41.5	0.01065	83.20
1.5"	-	37.5	-		30	18.3	40	0.00761	80.03
3/4"	-	19	-		60	18.8	36	0.00552	71.41
3/8"	-	9.5	100.0		90	19.1	28	0.00477	53.84
No.4	1.41	4.75	99.3		120	19.4	18	0.00439	31.84
No.10	7.34	2	96.4	<=Split	250	21.7	13	0.00305	21.89
No.20	0.83	0.85	94.5		391	23.8	12	0.00239	20.69
No.40	1.44	0.425	93.1		1440	20.5	12	0.00130	19.09
No.60	2.04	0.25	91.7						
No.100	2.72	0.15	90.2						
No.140	3.07	0.106	89.4						
No.200	3.34	0.075	88.8						



Gravel (%): 0.7
Sand (%): 10.6
Fines (%): 88.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

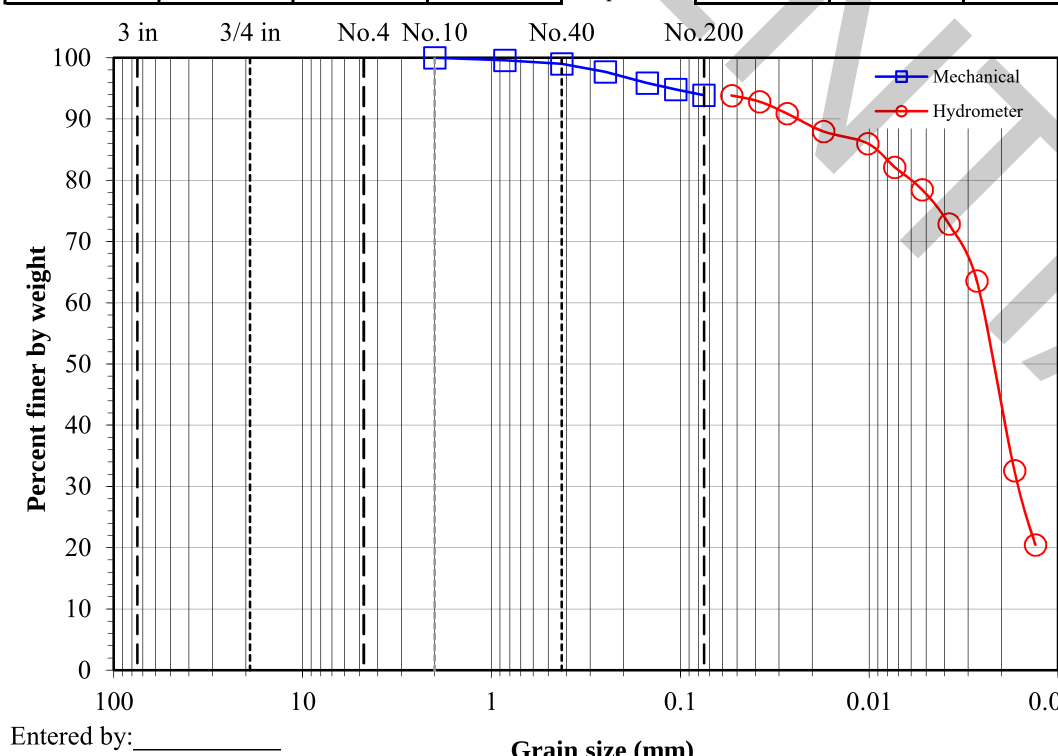
Boring No.: SN4-15-001
Sample: MC-003
Depth: 10-15'
Description: Light grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.34	50.11
Hydrometer fraction (g):	51.34	50.11
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	38.46	38.46
Dry soil + tare (g):	-	38.06	38.06
Tare (g):	-	21.77	21.77
Water content (%):	0.00	2.46	2.46

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.75	Assumed	α:	0.98
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.9	52	0.05362	93.82
6"	-	150	-		1	17.9	51.5	0.03811	92.85
4"	-	100	-		2	17.9	50.5	0.02723	90.90
3"	-	75	-		5	17.9	49	0.01748	87.97
1.5"	-	37.5	-		15	17.9	48	0.01019	86.01
3/4"	-	19	-		30	18	46	0.00734	82.15
3/8"	-	9.5	-		60	18.5	44	0.00525	78.46
No.4	-	4.75	-		120	19.1	41	0.00379	72.86
No.10	-	2	100.0	<=Split hyd.	250	20.3	36	0.00269	63.61
No.20	0.22	0.85	99.6		772	20.8	20	0.00170	32.58
No.40	0.49	0.425	99.0		1416	19.9	14	0.00132	20.48
No.60	1.14	0.25	97.7						
No.100	2.07	0.15	95.9						
No.140	2.58	0.106	94.9						
No.200	3.06	0.075	93.9	<=Split					



Gravel (%): 0.0
Sand (%): 6.1
Fines (%): 93.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

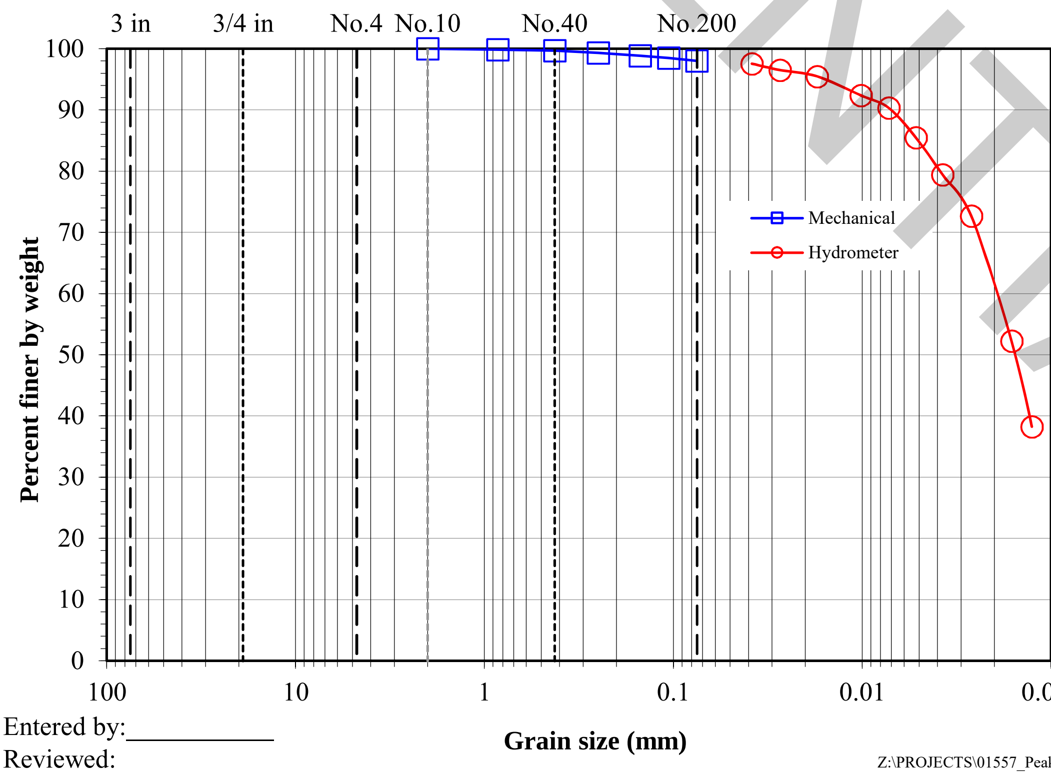
Boring No.: SN4-15-001
Sample: MC-004
Depth: 15-20'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.23	47.17
Hydrometer fraction (g):	50.23	47.17
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	37.28	37.28
Dry soil + tare (g):	-	36.35	36.35
Tare (g):	-	22.02	22.02
Water content (%):	0.00	6.49	6.49

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.75	Assumed	α:	0.98
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.8	51	0.03837	97.55
6"	-	150	-		2	17.8	50.5	0.02727	96.52
4"	-	100	-		5	17.8	50	0.01733	95.48
3"	-	75	-		15	17.8	48.5	0.01016	92.37
1.5"	-	37.5	-		30	17.9	47.5	0.00724	90.34
3/4"	-	19	-		60	18.6	45	0.00520	85.47
3/8"	-	9.5	-		120	19	42	0.00376	79.43
No.4	-	4.75	-		250	20.1	38.5	0.00265	72.67
No.10	-	2	100.0	<=Split hyd.	764	20.8	28.5	0.00162	52.24
No.20	0.08	0.85	99.8		1408	19.7	22	0.00126	38.26
No.40	0.16	0.425	99.7						
No.60	0.33	0.25	99.3						
No.100	0.53	0.15	98.9						
No.140	0.72	0.106	98.5						
No.200	0.94	0.075	98.0	<=Split					



Gravel (%): 0.0
Sand (%): 2.0
Fines (%): 98.0

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

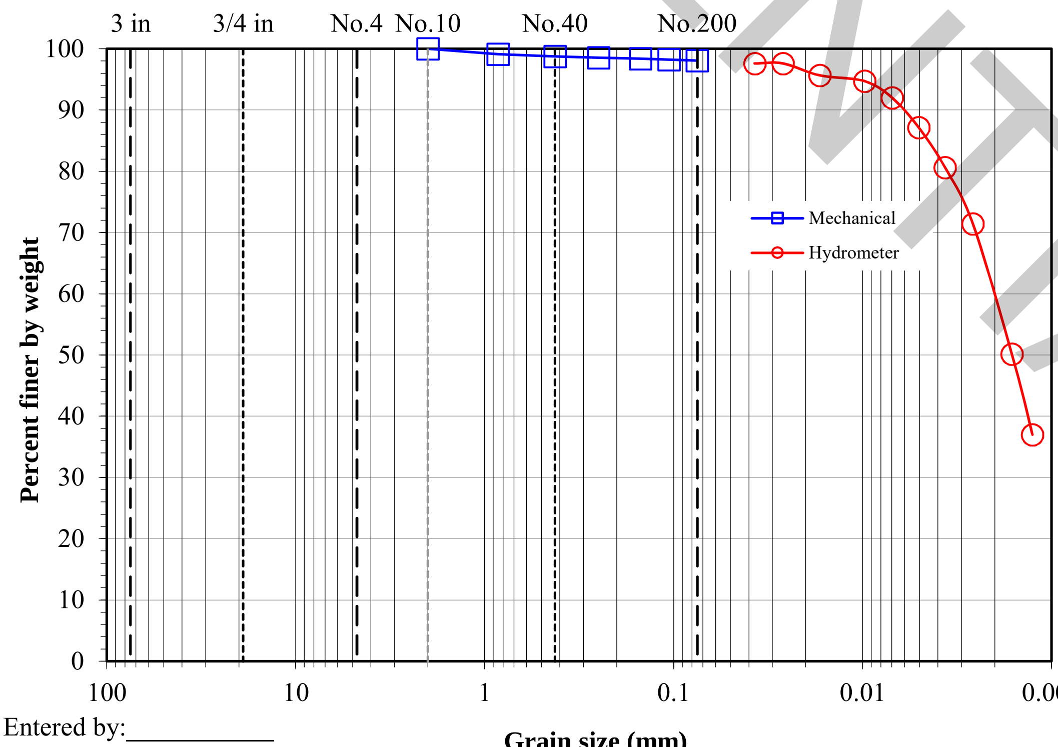
Boring No.: SN4-15-001
Sample: MC-005
Depth: 20-22'
Description: Light grey clay

				Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Split:	No			Moist soil + tare (g):	-	32.04	32.04
				Dry soil + tare (g):	-	31.92	31.92
	Moist	Dry		Tare (g):	-	21.57	21.57
Total sample wt. (g):	50.67	50.09		Water content (%):	0.00	1.16	1.16

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.75	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.98
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Hydrometer fraction (g): 50.67 (Moist), 50.09 (Dry); 1.000

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.5	54	0.03730	97.60
6"	-	150	-		2	17.5	54	0.02637	97.60
4"	-	100	-		5	17.5	53	0.01686	95.65
3"	-	75	-		15	17.6	52.5	0.00977	94.71
1.5"	-	37.5	-		30	18.1	51	0.00698	91.99
3/4"	-	19	-		60	18.2	48.5	0.00505	87.15
3/8"	-	9.5	-		120	18.9	45	0.00366	80.62
No.4	-	4.75	-		250	20.2	40	0.00261	71.41
No.10	-	2	100.0	<=Split hyd.	756	20.8	29	0.00162	50.17
No.20	0.44	0.85	99.1		1400	19.7	22.5	0.00126	37.01
No.40	0.62	0.425	98.8						
No.60	0.73	0.25	98.5						
No.100	0.81	0.15	98.4						
No.140	0.90	0.106	98.2						
No.200	0.98	0.075	98.0	<=Split					



Gravel (%): 0.0
Sand (%): 2.0
Fines (%): 98.0

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

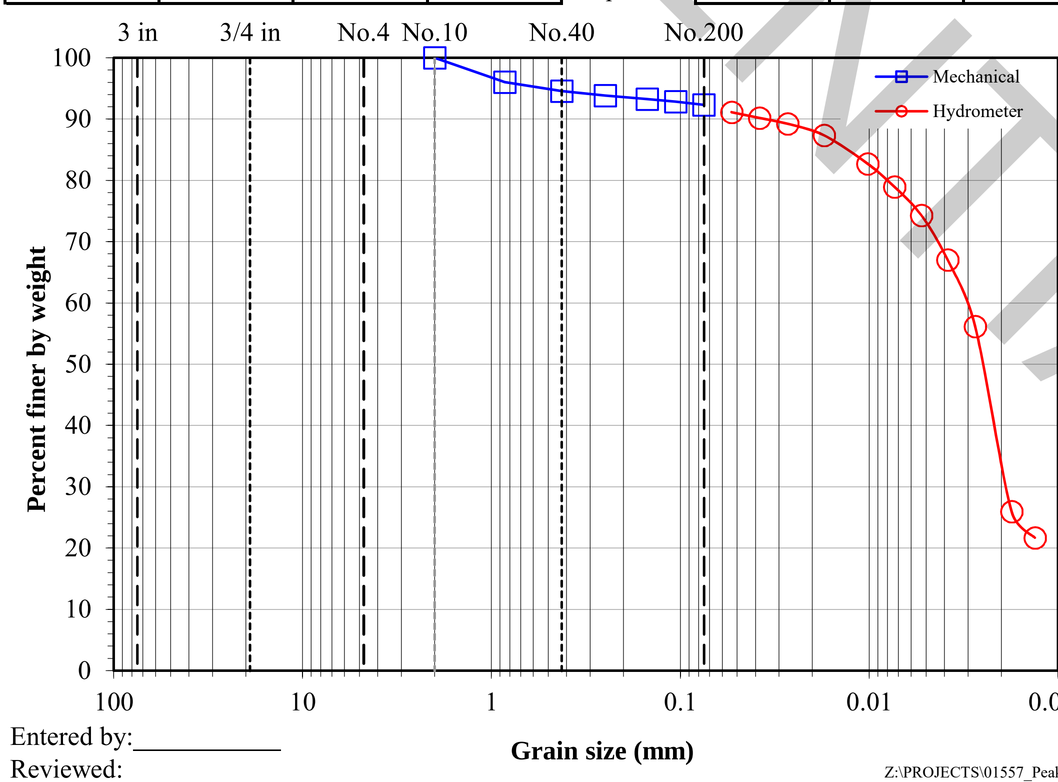
Boring No.: SN4-15-001
Sample: MC-006
Depth: 23.5-25'
Description: Light grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	52.08	51.59
Hydrometer fraction (g):	52.08	51.59
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	39.25	39.25
Dry soil + tare (g):	-	39.09	39.09
Tare (g):	-	22.20	22.20
Water content (%):	0.00	0.95	0.95

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.75	Assumed	α:	0.98
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.9	52	0.05362	91.13
6"	-	150	-		1	17.9	51.5	0.03811	90.18
4"	-	100	-		2	17.9	51	0.02709	89.23
3"	-	75	-		5	17.9	50	0.01731	87.34
1.5"	-	37.5	-		15	18.2	47.5	0.01021	82.72
3/4"	-	19	-		30	18.2	45.5	0.00735	78.93
3/8"	-	9.5	-		60	18.5	43	0.00530	74.31
No.4	-	4.75	-		120	19.2	39	0.00384	67.02
No.10	-	2	100.0	<=Split hyd.	250	20.5	33	0.00275	56.18
No.20	2.06	0.85	96.0		748	20.8	17	0.00176	25.96
No.40	2.80	0.425	94.6		1392	19.7	15	0.00133	21.71
No.60	3.19	0.25	93.8						
No.100	3.49	0.15	93.2						
No.140	3.70	0.106	92.8						
No.200	3.96	0.075	92.3	<=Split					



Gravel (%): 0.0
Sand (%): 7.7
Fines (%): 92.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

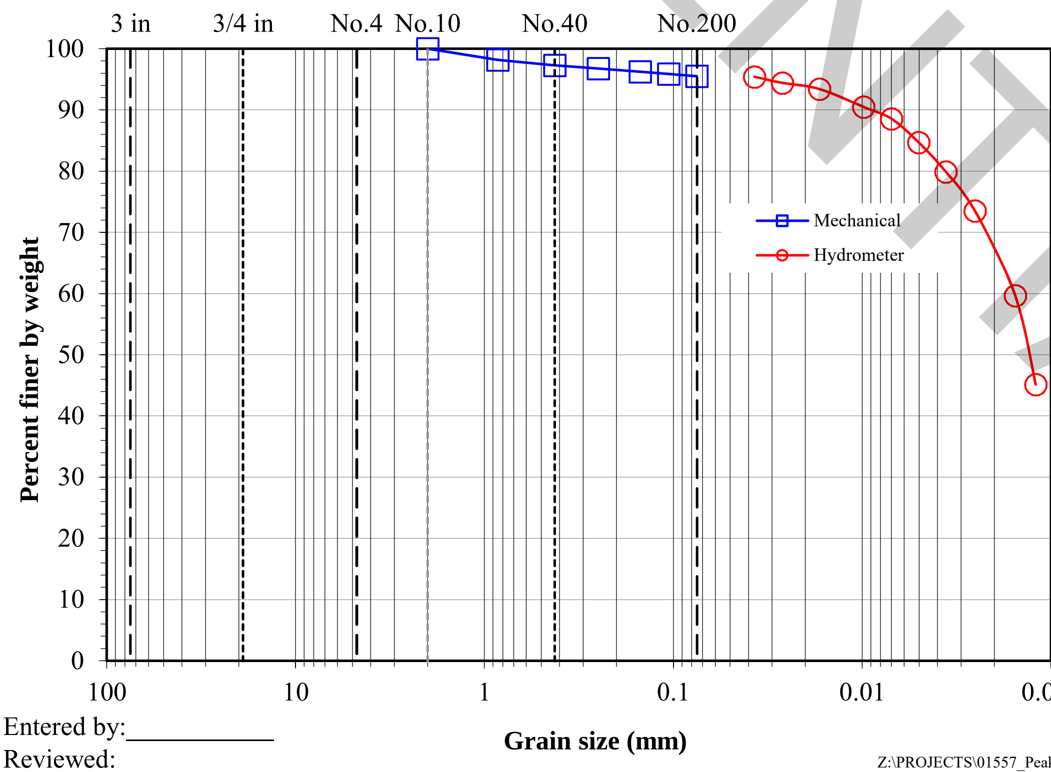
Boring No.: SN4-15-001
Sample: MC-007
Depth: 25-30'
Description: Light grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.29	47.71
Hydrometer fraction (g):	51.29	47.71
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.42	33.42
Dry soil + tare (g):	-	32.64	32.64
Tare (g):	-	22.24	22.24
Water content (%):	0.00	7.50	7.50

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.85	Assumed	α:	0.96
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.5	51.5	0.03726	95.42
6"	-	150	-		2	17.5	51	0.02648	94.42
4"	-	100	-		5	17.5	50.5	0.01684	93.41
3"	-	75	-		15	17.7	49	0.00984	90.48
1.5"	-	37.5	-		30	17.9	48	0.00701	88.56
3/4"	-	19	-		60	18.3	46	0.00503	84.72
3/8"	-	9.5	-		120	18.8	43.5	0.00362	79.91
No.4	-	4.75	-		250	20.3	40	0.00253	73.53
No.10	-	2	100.0	<=Split hyd.	740	20.8	33	0.00155	59.68
No.20	0.86	0.85	98.2		1384	19.7	26	0.00121	45.12
No.40	1.30	0.425	97.3						
No.60	1.55	0.25	96.8						
No.100	1.80	0.15	96.2						
No.140	1.98	0.106	95.9						
No.200	2.15	0.075	95.5	<=Split					



Gravel (%): 0.0
Sand (%): 4.5
Fines (%): 95.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

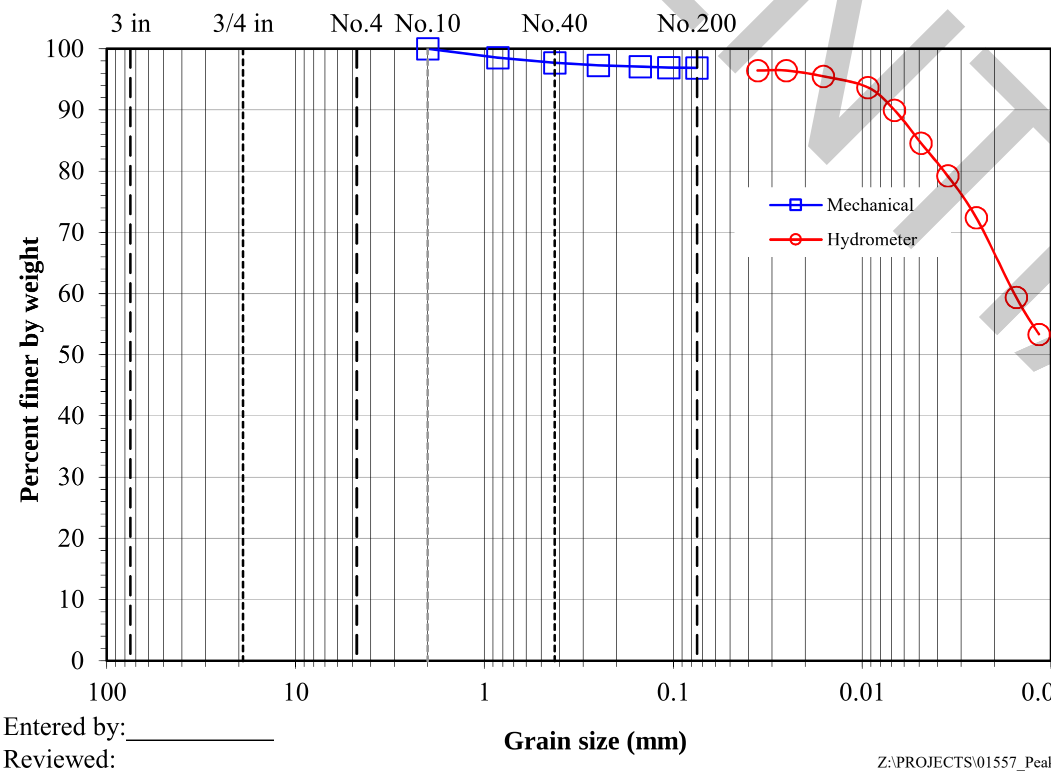
Boring No.: SN4-15-001
Sample: MC-008
Depth: 30-35'
Description: Light grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	53.28	51.15
Hydrometer fraction (g):	53.28	51.15
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	39.97	39.97
Dry soil + tare (g):	-	39.26	39.26
Tare (g):	-	22.24	22.24
Water content (%):	0.00	4.17	4.17

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.85	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.96
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.3	55.5	0.03575	96.43
6"	-	150	-		2	17.3	55.5	0.02528	96.43
4"	-	100	-		5	17.3	55	0.01608	95.50
3"	-	75	-		15	17.5	54	0.00937	93.70
1.5"	-	37.5	-		30	17.6	52	0.00676	89.99
3/4"	-	19	-		60	18.2	49	0.00489	84.61
3/8"	-	9.5	-		120	18.8	46	0.00353	79.23
No.4	-	4.75	-		250	20.4	42	0.00249	72.39
No.10	-	2	100.0	<=Split hyd.	732	20.8	35	0.00153	59.42
No.20	0.76	0.85	98.5		1376	19.7	32	0.00116	53.35
No.40	1.18	0.425	97.7						
No.60	1.39	0.25	97.3						
No.100	1.50	0.15	97.1						
No.140	1.57	0.106	96.9						
No.200	1.61	0.075	96.9	<=Split					



Gravel (%): 0.0
Sand (%): 3.1
Fines (%): 96.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

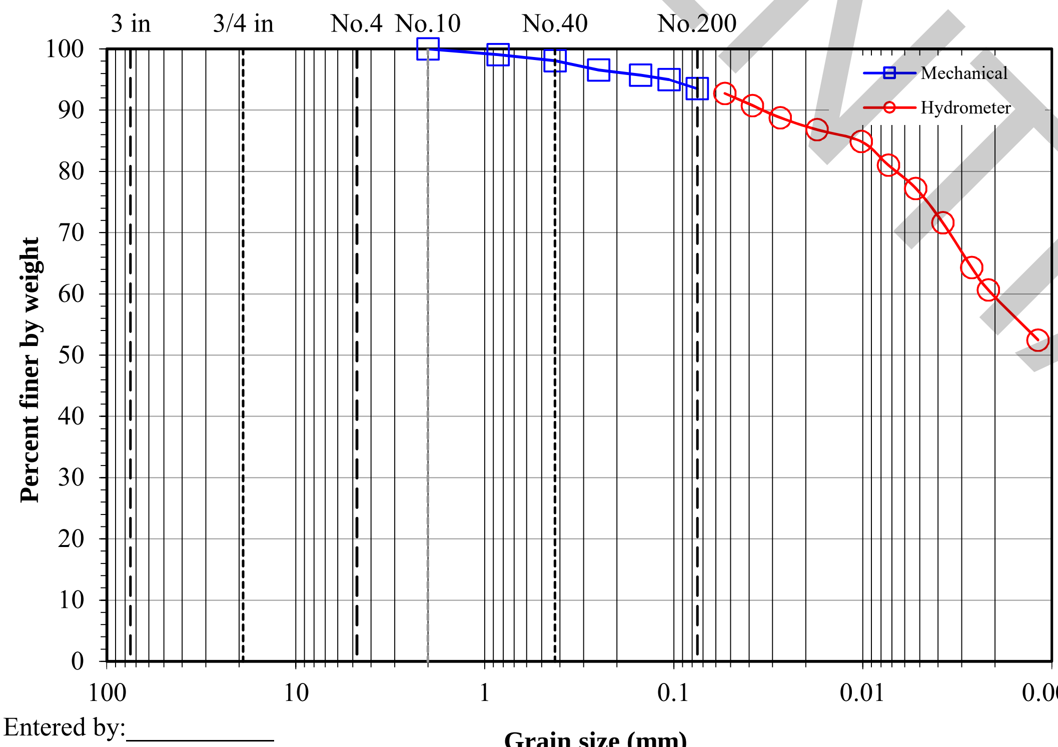
Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

Boring No.: SN4-15-001
Sample: MC-009
Depth: 35-40'
Description: Grey clay

Split:	No		Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
			Moist soil + tare (g):	-	31.86	31.86
			Dry soil + tare (g):	-	31.47	31.47
	Moist	Dry	Tare (g):	-	21.81	21.81
Total sample wt. (g):	51.03	49.05	Water content (%):	0.00	4.04	4.04

			Hydrometer data				Slope:	-0.1641
			Hyd. split:	No.10			Intercept:	16.3
Hydrometer fraction (g):	51.03	49.05	Gs:	2.8	Assumed		α:	0.97
	1.000		Bulb No.	2			Hyd. fraction:	100.00
			Dispersion period (min):	15			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.5	51	0.05370	92.74
6"	-	150	-		1	17.5	50	0.03836	90.76
4"	-	100	-		2	17.5	49	0.02740	88.79
3"	-	75	-		5	17.5	48	0.01750	86.81
1.5"	-	37.5	-		15	17.6	47	0.01019	84.88
3/4"	-	19	-		30	17.8	45	0.00732	81.02
3/8"	-	9.5	-		60	18.2	43	0.00525	77.24
No.4	-	4.75	-		120	18.9	40	0.00377	71.62
No.10	-	2	100.0	<=Split hyd.	250	20.3	36	0.00265	64.33
No.20	0.45	0.85	99.1		381	20.9	34	0.00217	60.64
No.40	0.94	0.425	98.1		1381	20.3	30	0.00118	52.48
No.60	1.69	0.25	96.6						
No.100	2.09	0.15	95.7						
No.140	2.45	0.106	95.0						
No.200	3.19	0.075	93.5	<=Split					



Gravel (%): 0.0
Sand (%): 6.5
Fines (%): 93.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

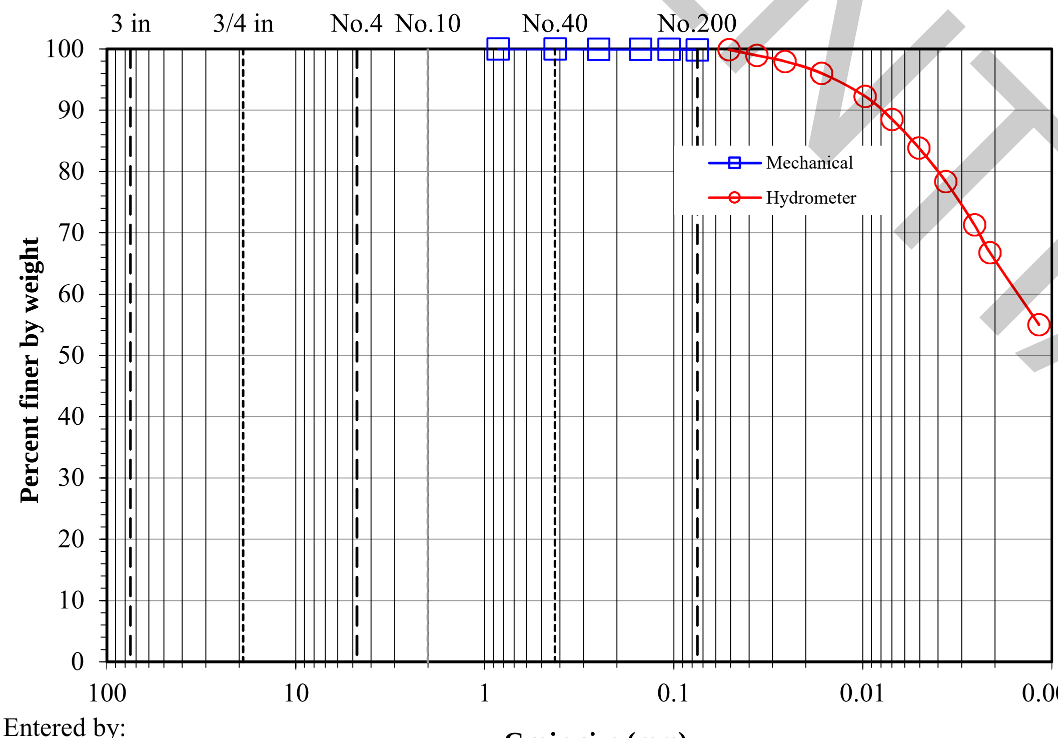
Boring No.: SN4-15-001
Sample: MC-010
Depth: 40-45'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	52.65	50.30
Hydrometer fraction (g):	52.65	50.30
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	37.92	37.92
Dry soil + tare (g):	-	37.21	37.21
Tare (g):	-	22.02	22.02
Water content (%):	0.00	4.67	4.67

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.1	56	0.05111	99.89
6"	-	150	-		1	17.1	55.5	0.03635	98.93
4"	-	100	-		2	17.1	55	0.02585	97.97
3"	-	75	-		5	17.1	54	0.01653	96.04
1.5"	-	37.5	-		15	17.3	52	0.00972	92.27
3/4"	-	19	-		30	17.5	50	0.00700	88.51
3/8"	-	9.5	-		60	17.9	47.5	0.00505	83.86
No.4	-	4.75	-		120	18.6	44.5	0.00364	78.38
No.10	-	2	-	<=Split hyd.	250	20.1	40.5	0.00257	71.31
No.20	-	0.85	100.0		373	20.8	38	0.00213	66.79
No.40	0.01	0.425	100.0		1373	20.3	32	0.00117	55.03
No.60	0.02	0.25	100.0						
No.100	0.02	0.15	100.0						
No.140	0.03	0.106	99.9						
No.200	0.07	0.075	99.9	<=Split					



Gravel (%): 0.0
Sand (%): 0.1
Fines (%): 99.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

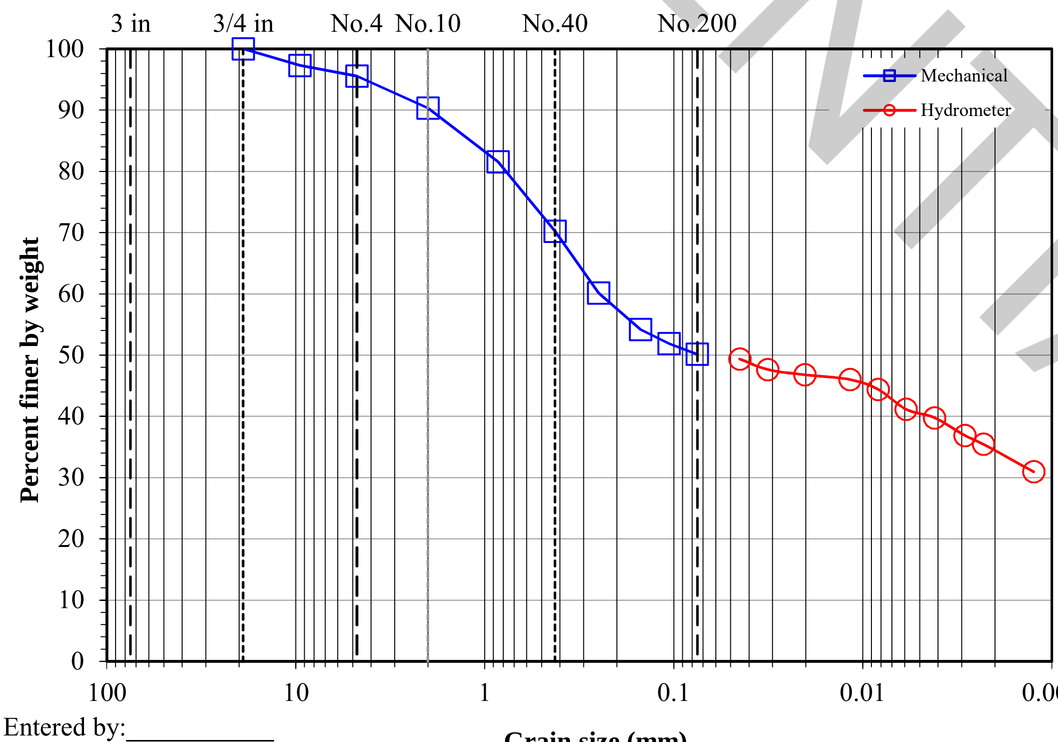
Boring No.: SN4-15-001
Sample: MC-011
Depth: 45-50'
Description: Grey sandy clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	308.54	302.78
+#10 Coarse fraction (g):	29.49	29.32
-#10 Split fraction (g):	52.18	51.13
Hydrometer fraction (g):	52.18	51.13
Split fraction:	0.903	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	76.01	48.35	48.35
Dry soil + tare (g):	75.79	47.82	47.82
Tare (g):	37.86	21.91	21.91
Water content (%):	0.58	2.05	2.05

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	90.32
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17	33	0.04475	49.36
6"	-	150	-		2	17	32	0.03188	47.65
4"	-	100	-		5	17	31.5	0.02024	46.80
3"	-	75	-		15	17.2	31	0.01170	46.02
1.5"	-	37.5	-		30	17.5	30	0.00830	44.42
3/4"	-	19	100.0		60	18	28	0.00592	41.18
3/8"	8.20	9.5	97.3		120	18.8	27	0.00417	39.77
No.4	13.48	4.75	95.5		250	20.2	25	0.00288	36.87
No.10	29.32	2	90.3	<=Split	389	21	24	0.00230	35.46
No.20	4.95	0.85	81.6		1389	20.4	21.5	0.00125	30.96
No.40	11.39	0.425	70.2						
No.60	17.08	0.25	60.1						
No.100	20.47	0.15	54.2						
No.140	21.76	0.106	51.9						
No.200	22.75	0.075	50.1						



Gravel (%): 4.5
Sand (%): 45.4
Fines (%): 50.1

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

Boring No.: SN4-15-001
Sample: MC-012
Depth: 50-55'
Description: Brown clay

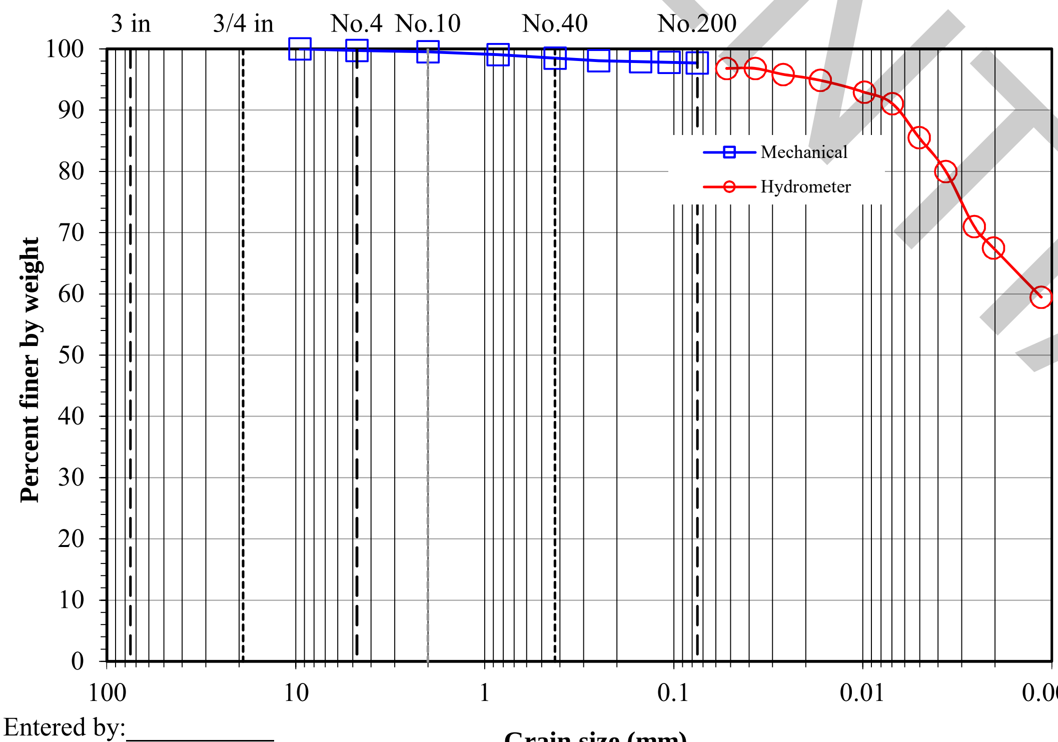
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	248.27	236.61
+#10 Coarse fraction (g):	1.07	1.06
-#10 Split fraction (g):	52.06	49.61
Hydrometer fraction (g):	52.06	49.61
Split fraction:	0.996	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	38.63	43.04	43.04
Dry soil + tare (g):	38.61	42.05	42.05
Tare (g):	37.18	22.02	22.02
Water content (%):	1.40	4.94	4.94

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
			Hyd. fraction:	99.55
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	0.61	4.75	99.7	
No.10	1.06	2	99.6	<=Split
No.20	0.25	0.85	99.1	
No.40	0.54	0.425	98.5	
No.60	0.73	0.25	98.1	
No.100	0.82	0.15	97.9	
No.140	0.87	0.106	97.8	
No.200	0.92	0.075	97.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	16.8	54	0.05247	96.81
1	16.8	54	0.03710	96.81
2	16.8	53.5	0.02638	95.84
5	16.8	53	0.01677	94.87
15	16.8	52	0.00979	92.93
30	17	51	0.00697	91.07
60	17.7	48	0.00504	85.54
120	18.4	45	0.00363	80.00
250	20.1	40	0.00258	71.01
405	21	38	0.00204	67.50
1405	20.4	34	0.00114	59.47



Gravel (%): 0.3
Sand (%): 2.0
Fines (%): 97.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project:	**Norwest Corporation**	**Boring No.:**	**SN4-15-001**
No:	**01557-004**	**Sample:**	**MC-013**
Location:	Peak Minerals Sevier Lake	**Depth:**	**55-58.5'**
Date:	10/26/2015	Description:	Brown clay
By:	BRR		

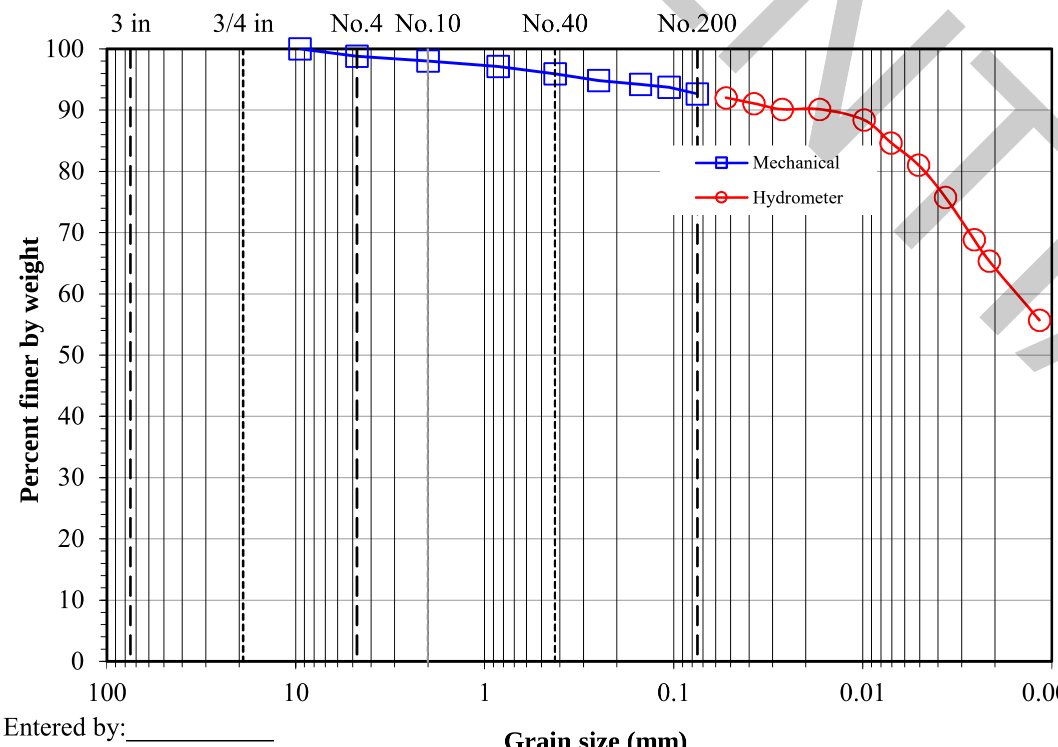
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	238.16	228.97
+#10 Coarse fraction (g):	4.63	4.51
-#10 Split fraction (g):	52.44	50.40
Hydrometer fraction (g):	52.44	50.40
Split fraction:	0.980	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	51.34	47.96	47.96
Dry soil + tare (g):	50.99	46.95	46.95
Tare (g):	37.73	21.97	21.97
Water content (%):	2.64	4.04	4.04

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	98.03
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	2.80	4.75	98.8	
No.10	4.51	2	98.0	<=Split
No.20	0.46	0.85	97.1	
No.40	1.08	0.425	95.9	
No.60	1.64	0.25	94.8	
No.100	1.98	0.15	94.2	
No.140	2.22	0.106	93.7	
No.200	2.77	0.075	92.6	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	17	53	0.05290	92.03
1	17	52.5	0.03760	91.09
2	17	52	0.02673	90.15
5	17	52	0.01691	90.15
15	17.3	51	0.00983	88.39
30	17.4	49	0.00708	84.66
60	17.8	47	0.00508	81.06
120	18.7	44	0.00365	75.78
250	20.2	40	0.00257	68.86
365	20.9	38	0.00215	65.38
1365	20.3	33	0.00116	55.72



Gravel (%): 1.2
Sand (%): 6.1
Fines (%): 92.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004
Location: Peak Minerals Sevier Lake
Date: 10/26/2015
By: BRR

Boring No.: SN4-15-001
Sample: MC-014
Depth: 58.5-60'
Description: Grey clay

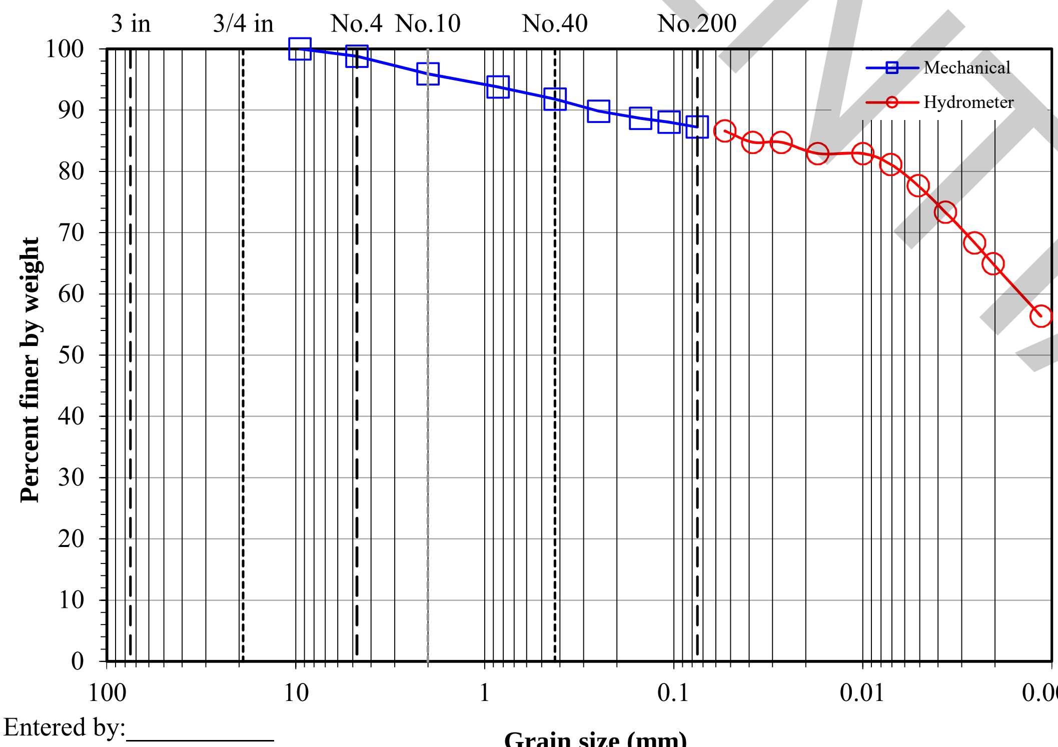
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	195.50	189.01
+#10 Coarse fraction (g):	7.78	7.66
-#10 Split fraction (g):	52.19	50.42
Hydrometer fraction (g):	52.19	50.42
Split fraction:	0.959	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	51.32	38.45	38.45
Dry soil + tare (g):	51.12	37.89	37.89
Tare (g):	37.84	21.97	21.97
Water content (%):	1.51	3.52	3.52

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	95.95
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	2.26	4.75	98.8	
No.10	7.66	2	95.9	<=Split
No.20	1.13	0.85	93.8	
No.40	2.19	0.425	91.8	
No.60	3.21	0.25	89.8	
No.100	3.83	0.15	88.7	
No.140	4.15	0.106	88.0	
No.200	4.58	0.075	87.2	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	17.6	51	0.05362	86.61
1	17.6	50	0.03831	84.76
2	17.6	50	0.02709	84.76
5	17.6	49	0.01730	82.92
15	17.6	49	0.00999	82.92
30	17.8	48	0.00712	81.16
60	18.3	46	0.00510	77.67
120	19	43.5	0.00366	73.35
250	20.3	40.5	0.00256	68.34
397	21	38.5	0.00205	64.94
1397	20.3	34	0.00114	56.36



Gravel (%): 1.2
Sand (%): 11.6
Fines (%): 87.2

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake, UT
Date: 11/11/2015
By: BRR

Sample Info.	Boring:	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002
	Sample:	MC-001	SH-001	MC-002	MC-003	MC-004	MC-005	SH-002	MC-006
	Depth:	0-5'	5-7'	7-10'	10-15'	15-20'	20-23'	25-27'	27-30'
Water Content Determination	Initial date	10/26/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15
	Wet soil + tare (g)	407.11	404.74	367.23	421.87	418.17	395.98	404.92	405.61
	Tare (g)	152.95	128.09	127.27	127.48	120.85	120.01	127.91	127.42
	Date	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15
	Dry soil + tare (g)	345.91	325.06	312.79	354.54	342.80	328.22	337.95	346.55
	Water content, ω (%)	31.7	40.5	29.3	29.7	34.0	32.5	31.9	27.0
	Date	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15
	Dry soil + tare (g)	336.74	321.96	303.24	342.99	340.37	322.42	336.76	343.49
	Water content, ω (%)	38.3	42.7	36.4	36.6	35.4	36.3	32.6	28.7
	Date	11/4/15	11/4/15	11/4/15	11/4/15		11/4/15		11/4/15
	Dry soil + tare (g)	334.53	321.54	299.85	340.19		321.57		342.83
	Water content, ω (%)	40.0	43.0	39.0	38.4		36.9		29.1
	Date	11/5/15		11/5/15	11/5/15				
	Dry soil + tare (g)	333.75		298.80	339.13				
	Water content, ω (%)	40.6		39.9	39.1				
	Date	11/9/15		11/9/15	11/9/15				
	Dry soil + tare (g)	332.07		296.06	336.94				
	Water content, ω (%)	41.9		42.2	40.5				
	Date			11/11/15					
	Dry soil + tare (g)			295.30					
	Water content, ω (%)			42.8					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**41.9**	**43.0**	**42.8**	**40.5**	**35.4**	**36.9**	**32.6**	**29.1**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/2/2015
By: BRR

Sample Info. — Boring:	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002
Sample:	MC-007	MC-008	SH-003	MC-009	MC-010	MC-011	MC-012	MC-013
Depth:	30-35'	35-40'	40-42'	42-45'	45-47'	47-51'	51-55'	57-60'
Water Content Determination — Initial date	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15	10/27/15
Wet soil + tare (g)	434.71	469.26	367.09	443.51	435.83	417.37	462.53	449.46
Tare (g)	127.12	127.31	128.43	127.56	123.67	127.58	128.19	122.36
Date	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15
Dry soil + tare (g)	370.87	400.86	321.88	381.23	368.83	352.76	398.31	387.58
Water content, ω (%)	26.2	25.0	23.4	24.6	27.3	28.7	23.8	23.3
Date	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15
Dry soil + tare (g)	368.89	398.57	320.76	378.75	367.17	350.22	396.41	385.75
Water content, ω (%)	27.2	26.1	24.1	25.8	28.2	30.2	24.7	24.2
Date								
Dry soil + tare (g)								
Water content, ω (%)								
Date								
Dry soil + tare (g)								
Water content, ω (%)								
Date								
Dry soil + tare (g)								
Water content, ω (%)								
Date								
Dry soil + tare (g)								
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Water content, ω (%)								
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Dry soil + tare (g)								
Water content, ω (%)								
Date								
Dry soil + tare (g)								
Water content, ω (%)								
Date								
Dry soil + tare (g)								
Water content, ω (%)								
[1]Water content, ω (%)	**27.2**	**26.1**	**24.1**	**25.8**	**28.2**	**30.2**	**24.7**	**24.2**
[2]Dry soil + tare (g)								
[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/2/2015
By: BRR

Sample Info.	Boring:	SN4-15-002							
	Sample:	MC-014							
	Depth:	60-65'							
Water Content Determination	Initial date	10/27/15							
	Wet soil + tare (g)	454.87							
	Tare (g)	128.76							
	Date	10/30/15							
	Dry soil + tare (g)	389.50							
	Water content, ω (%)	25.1							
	Date	11/2/15							
	Dry soil + tare (g)	387.73							
	Water content, ω (%)	25.9							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**25.9**							
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake, UT
Date: 11/4/2015
By: BRR

Sample Info.	Boring No.	SN4-15-002	SN4-15-002	SN4-15-002						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	5-7'	25-27'	40-42'						
Unit Weight Info.	Sample height, H (in)	5.575	5.222	5.523						
	Sample diameter, D (in)	2.842	2.854	2.882						
	Sample volume, V (ft^3)	0.0205	0.0193	0.0209						
	Mass rings + wet soil (g)	1021.23	1059.52	1150.71						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist soil, Ws (g)	1021.23	1059.52	1150.71						
	Moist unit wt., γ_m (pcf)	110.01	120.82	121.67						
Water Content	Wet soil + tare (g)	404.74	404.92	367.09						
	Dry soil + tare (g)	321.54	336.76	320.76						
	Tare (g)	128.09	127.91	128.43						
Water Content, w (%)		**43.0**	**32.6**	**24.1**						
Dry Unit Wt., γ_d (pcf)		**76.9**	**91.1**	**98.1**						

Entered by:___________

Reviewed:___________

Specific Gravity of Soil Solids by Water Pycnometer

(ASTM D854)

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/2/2015
By: DKS

Drill hole / Sample:	SN4-15-002	SN4-15-002	SN4-15-002			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	5-7	25-27	40-42			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, *P* (%)						
Pycnometer No.	1	2	3			
Mass of pycnometer (g)	167.64	184.35	170.58			
Mass of pycnometer, soil, and water, $M_{\rho\ ws,t}$ (g)	704.34	721.63	706.32			
Temperature, T_t (°C)	19.5	19.4	19.4			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	666.26	683.24	669.43			
Mass of tare + dry soil (g)	468.3	371.45	368.51			
Mass of tare (g)	409.04	310.52	309.47			
Mass of soil, M_s (g)	59.26	60.93	59.04			
Specific gravity of soil solids at test temperature, G_t	2.798	2.704	2.665			
Temperature coefficient, *K*	1.00010	1.00012	1.00012			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.798**	**2.704**	**2.666**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________
Reviewed by:___________

Porosity of Soil

IGES

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

Sample Info.	Boring No.	SN4-15-002	SN4-15-002	SN4-15-002						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	5-7'	25-27'	40-42'						
Unit Weight Data	Sample height, H (in)	5.575	5.222	5.523						
	Sample diameter, D (in)	2.842	2.854	2.882						
	Mass rings + wet soil (g)	1021.23	1059.52	1150.71						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist unit wt., γ_m (pcf)	110.0	120.8	121.7						
Water Content	Wet soil + tare (g)	404.74	404.92	367.09						
	Dry soil + tare (g)	321.54	336.76	320.76						
	Tare (g)	128.09	127.91	128.43						
	Water content (%)	43.0	32.6	24.1						
Specific gravity of solids, Gs		2.798	2.704	2.666						
Void ratio, e		1.271	0.853	0.697						
Porosity, n		0.560	0.460	0.411						
Total Soil Porosity, n (%)		**56.0**	**46.0**	**41.1**						
Water Porosity, n_w (%)		**46.1**	**41.4**	**32.9**						
Air Porosity, n_a (%)		**9.9**	**4.6**	**8.2**						
Comments:		Porsoity calculated using a specific gravity of water equal to 1.15.	Porsoity calculated using a specific gravity of water equal to 1.15.	Porsoity calculated using a specific gravity of water equal to 1.15.						

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake
Date: 11/4/2015
By: BRR

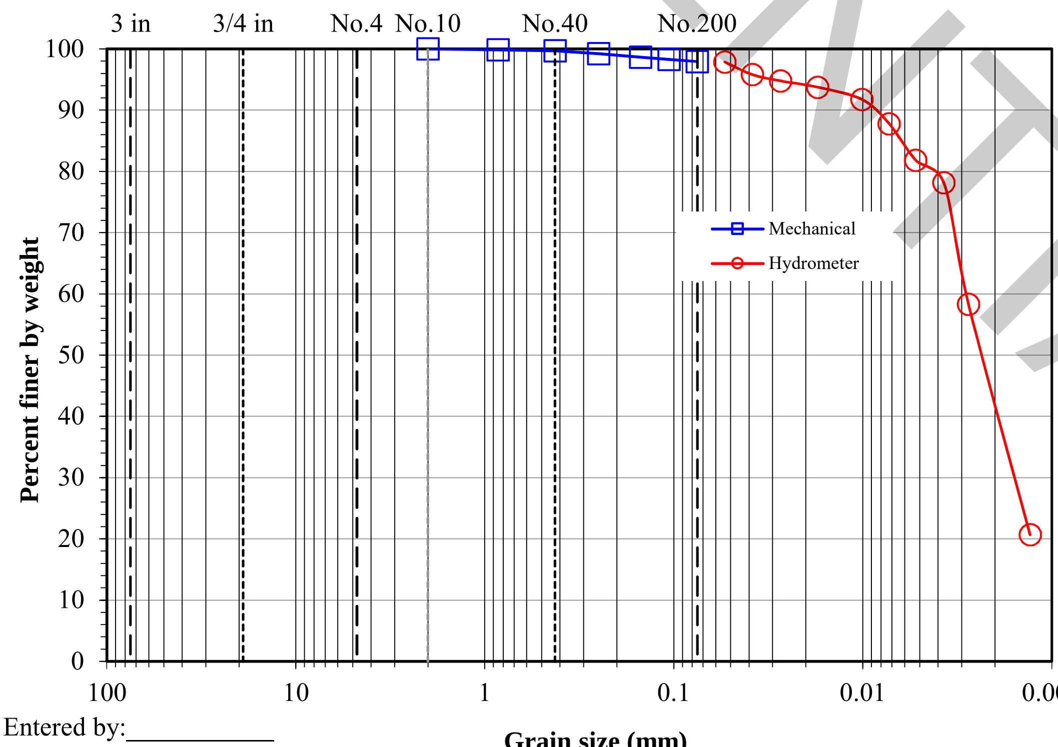
Boring No.: SN4-15-002
Sample: SH-001
Depth: 5-7'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	53.95	47.32
Hydrometer fraction (g):	53.95	47.32
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.89	35.89
Dry soil + tare (g):	-	34.18	34.18
Tare (g):	-	21.97	21.97
Water content (%):	0.00	14.00	14.00

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.798	Determined	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	16.7	52	0.05369	97.85
6"	-	150	-		1	16.7	51	0.03836	95.80
4"	-	100	-		2	16.7	50.5	0.02727	94.78
3"	-	75	-		5	16.7	50	0.01733	93.75
1.5"	-	37.5	-		15	16.8	49	0.01010	91.75
3/4"	-	19	-		30	17.1	47	0.00725	87.79
3/8"	-	9.5	-		60	17.5	44	0.00525	81.83
No.4	-	4.75	-		120	18.5	42	0.00373	78.18
No.10	-	2	100.0	<=Split hyd.	250	19.8	32	0.00276	58.29
No.20	0.07	0.85	99.9		1480	18.1	14	0.00130	20.67
No.40	0.14	0.425	99.7						
No.60	0.37	0.25	99.2						
No.100	0.65	0.15	98.6						
No.140	0.81	0.106	98.3						
No.200	0.98	0.075	97.9	<=Split					



Gravel (%): 0.0
Sand (%): 2.1
Fines (%): 97.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake
Date: 11/4/2015
By: BRR

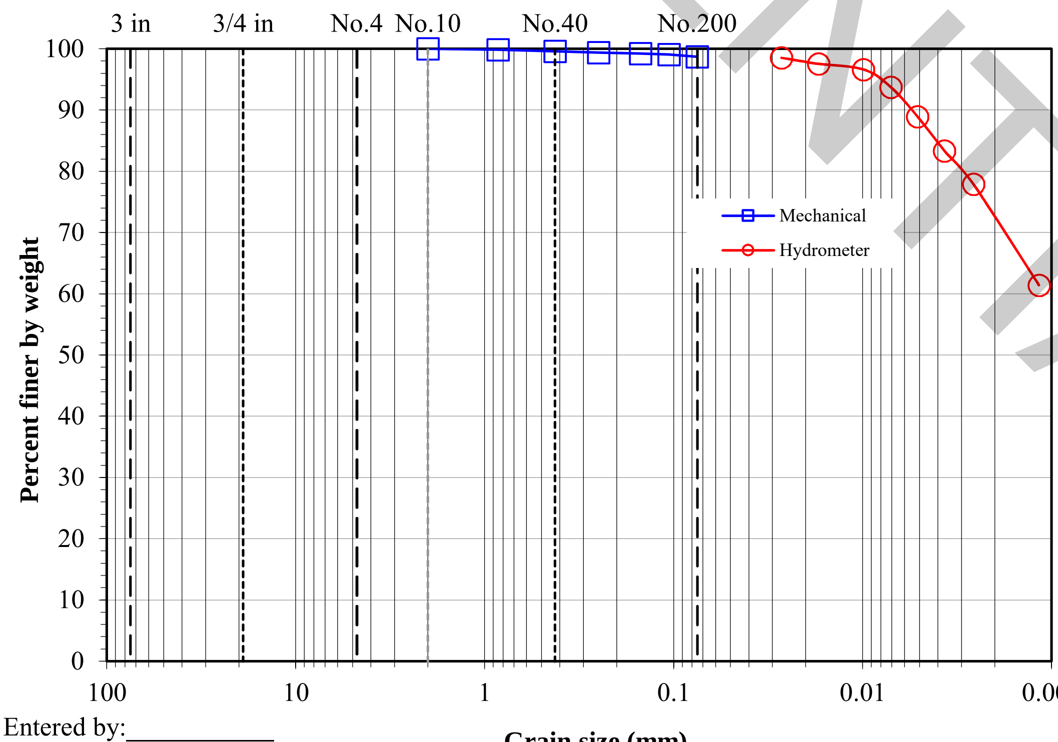
Boring No.: SN4-15-002
Sample: SH-002
Depth: 25-27'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	54.34	50.00
Hydrometer fraction (g):	54.34	50.00
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.70	34.70
Dry soil + tare (g):	-	33.69	33.69
Tare (g):	-	22.05	22.05
Water content (%):	0.00	8.68	8.68

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.704	Determined	Intercept:	16.3
Bulb No.	2		α:	0.99
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17	54	0.02689	98.51
6"	-	150	-		5	17	53.5	0.01710	97.53
4"	-	100	-		15	17.2	53	0.00990	96.62
3"	-	75	-		30	17.4	51.5	0.00709	93.75
1.5"	-	37.5	-		60	17.7	49	0.00513	88.94
3/4"	-	19	-		120	18.5	46	0.00369	83.35
3/8"	-	9.5	-		250	19.6	43	0.00260	77.90
No.4	-	4.75	-		1470	18	35	0.00117	61.40
No.10	-	2	100.0	<=Split hyd.					
No.20	0.09	0.85	99.8						
No.40	0.20	0.425	99.6						
No.60	0.31	0.25	99.4						
No.100	0.39	0.15	99.2						
No.140	0.46	0.106	99.1						
No.200	0.66	0.075	98.7	<=Split					



Gravel (%): 0.0
Sand (%): 1.3
Fines (%): 98.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake
Date: 11/4/2015
By: BRR

Boring No.: SN4-15-002
Sample: SH-003
Depth: 40-42'
Description: Grey clay with sand

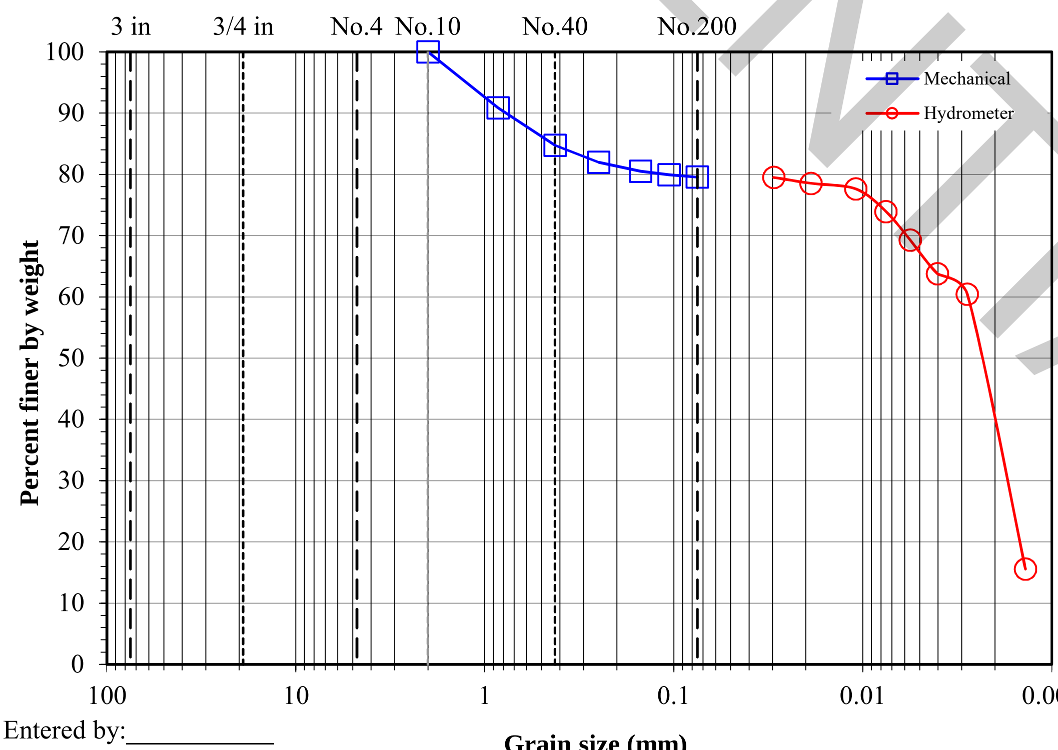
Split:	No	
	Moist	Dry
Total sample wt. (g):	53.67	51.89
Hydrometer fraction (g):	53.67	51.89
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.83	34.83
Dry soil + tare (g):	-	34.40	34.40
Tare (g):	-	21.88	21.88
Water content (%):	0.00	3.43	3.43

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.666	Determined	α:	1.00
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	4.75	0.85	90.8	
No.40	7.91	0.425	84.8	
No.60	9.35	0.25	82.0	
No.100	10.10	0.15	80.5	
No.140	10.40	0.106	80.0	
No.200	10.61	0.075	79.6	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.2	45.5	0.02956	79.49
5	17.2	45	0.01878	78.53
15	17.3	44.5	0.01088	77.62
32	17.7	42.5	0.00754	73.94
60	18	40	0.00561	69.27
120	18.7	37	0.00403	63.80
250	19.8	35	0.00280	60.42
1463	18.1	12	0.00138	15.54



Gravel (%): 0.0
Sand (%): 20.4
Fines (%): 79.6

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\II\[GSDHYDv2.xlsx]3

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: Norwest Corporation
No: 01557-004 (II)
Location: Peak Minerals Sevier Lake
Date: 11/11/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002
	Sample:	MC-001	SH-001	MC-002	MC-003	MC-004	MC-005	SH-002	MC-006
	Depth:	0-5'	5-7'	7-10'	10-15'	15-20'	20-23'	25-27'	27-30'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	2.6	2.5	3.5	4.0	4.4	4.8	4.0	3.0
Carbonate Content, Calcite Equivalent (%)		**29**	**28**	**39**	**44**	**48**	**53**	**44**	**33**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

IGES

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake
Date: 11/9/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002	SN4-15-002
	Sample:	MC-007	MC-008	SH-003	MC-009	MC-010	MC-011	MC-012	MC-013
	Depth:	30-35'	35-40'	40-42'	42-45'	45-47'	47-51'	51-55'	57-60'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	2.6	3.3	2.6	3.3	3.6	3.4	3.1	3.3
Carbonate Content, Calcite Equivalent (%)		**29**	**37**	**29**	**37**	**40**	**38**	**34**	**36**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (II)**
Location: Peak Minerals Sevier Lake
Date: 11/9/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-002							
	Sample:	MC-014							
	Depth:	60-65'							
Test Info.	Sample Weight (g):	1.00							
	Pressure Reading (psi):	3.2							
Carbonate Content, Calcite Equivalent (%)		**35**							

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/19/2015
By: IM/BRR

Sample Info.	Boring:	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	SH-001	MC-006	MC-007
	Depth:	0-3'	3-4'	8-13'	13-18'	18-20'	20-22'	22-28'	23-33'
Water Content Determination	Initial date	10/28/15	10/28/15	10/28/15	10/28/15	10/28/15	10/29/15	10/28/15	10/28/15
	Wet soil + tare (g)	1550.21	957.82	926.74	640.86	594.36	309.84	713.22	664.97
	Tare (g)	834.17	127.74	127.47	123.32	123.44	126.73	117.94	123.46
	Date	11/12/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15
	Dry soil + tare (g)	1438.68	907.44	841.43	539.49	525.62	282.60	619.55	595.69
	Water content, ω (%)	18.4	6.5	11.9	24.4	17.1	17.5	18.7	14.7
	Date	11/13/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15
	Dry soil + tare (g)	1295.37	873.65	807.07	519.13	494.64	270.71	580.48	581.36
	Water content, ω (%)	55.3	11.3	17.6	30.8	26.9	27.2	28.7	18.3
	Date	11/16/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15
	Dry soil + tare (g)	1256.51	862.76	791.36	517.29	485.16	268.77	574.42	580.11
	Water content, ω (%)	69.5	12.9	20.4	31.4	30.2	28.9	30.4	18.6
	Date	11/17/15	11/5/15	11/5/15		11/5/15	11/5/15	11/5/15	
	Dry soil + tare (g)	1254.34	857.18	783.24		481.86	268.10	572.86	
	Water content, ω (%)	70.4	13.8	21.9		31.4	29.5	30.9	
	Date	11/18/15	11/9/15	11/9/15		11/9/15	11/9/15		
	Dry soil + tare (g)	1252.94	838.18	752.87		474.31	266.49		
	Water content, ω (%)	71.0	16.8	27.8		34.2	31.0		
	Date	11/19/15	11/11/15	11/11/15		11/11/15			
	Dry soil + tare (g)	1252.42	827.98	739.71		472.76			
	Water content, ω (%)	71.2	18.5	30.5		34.8			
	Date		11/12/15	11/12/15					
	Dry soil + tare (g)		822.25	733.52					
	Water content, ω (%)		19.5	31.9					
	Date		11/13/15	11/13/15					
	Dry soil + tare (g)		816.40	728.40					
	Water content, ω (%)		20.5	33.0					
	Date		11/16/15	11/16/15					
	Dry soil + tare (g)		697.88	686.09					
	Water content, ω (%)		45.6	43.1					
	Date		11/17/15	11/17/15					
	Dry soil + tare (g)		692.05	685.64					
	Water content, ω (%)		47.1	43.2					
	Date		11/18/15						
	Dry soil + tare (g)		690.90						
	Water content, ω (%)		47.4						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**71.2**	**47.4**	**43.2**	**31.4**	**34.8**	**31.0**	**30.9**	**18.6**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/11/2015
By: IM/BRR

Sample Info.	Boring:	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003
	Sample:	MC-008	SH-002	MC-009	MC-010	MC-011	MC-012	MC-013	SH-003
	Depth:	33-38'	38-40'	40-43'	43-48'	50-53'	53-58'	58-61'	61-63'
Water Content Determination	Initial date	10/28/15	10/29/15	10/28/15	10/28/15	10/28/15	10/28/15	10/28/15	10/29/13
	Wet soil + tare (g)	763.08	362.26	604.90	643.60	628.68	738.25	710.35	340.19
	Tare (g)	126.99	129.45	122.55	126.15	127.43	128.37	153.20	140.46
	Date	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15
	Dry soil + tare (g)	697.26	322.94	533.64	548.91	532.90	610.70	582.36	299.40
	Water content, ω (%)	11.5	20.3	17.3	22.4	23.6	26.4	29.8	25.7
	Date	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15
	Dry soil + tare (g)	684.34	313.57	508.99	533.16	518.36	592.12	571.10	290.12
	Water content, ω (%)	14.1	26.4	24.8	27.1	28.2	31.5	33.3	33.5
	Date	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15
	Dry soil + tare (g)	683.51	313.17	502.32	530.60	516.24	588.77	569.35	289.03
	Water content, ω (%)	14.3	26.7	27.0	27.9	28.9	32.5	33.9	34.4
	Date			11/5/15					
	Dry soil + tare (g)			499.93					
	Water content, ω (%)			27.8					
	Date			11/9/15					
	Dry soil + tare (g)			494.01					
	Water content, ω (%)			29.9					
	Date			11/11/15					
	Dry soil + tare (g)			492.60					
	Water content, ω (%)			30.3					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**14.3**	**26.7**	**30.3**	**27.9**	**28.9**	**32.5**	**33.9**	**34.4**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/4/2015
By: IM/BRR

Sample Info.	Boring:	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003	SN4-15-003		
	Sample:	MC-014	MC-015	MC-016	MC-017	MC-018	MC-019		
	Depth:	63-68'	70-73'	73-78'	73-88'	88-93'	93-96'		
Water Content Determination	Initial date	10/28/15	10/28/15	10/28/15	10/28/15	10/28/15	10/28/15		
	Wet soil + tare (g)	594.33	652.95	701.10	683.78	667.43	629.53		
	Tare (g)	121.48	122.42	125.63	128.55	126.85	123.60		
	Date	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15	10/30/15		
	Dry soil + tare (g)	470.13	535.09	601.53	574.53	560.69	527.17		
	Water content, ω (%)	35.6	28.6	20.9	24.5	24.6	25.4		
	Date	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15	11/2/15		
	Dry soil + tare (g)	458.41	530.14	596.33	569.98	556.00	522.22		
	Water content, ω (%)	40.3	30.1	22.3	25.8	26.0	26.9		
	Date	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15	11/4/15		
	Dry soil + tare (g)	456.57	529.45	595.68	569.22	555.36	521.39		
	Water content, ω (%)	41.1	30.3	22.4	26.0	26.2	27.2		
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**41.1**	**30.3**	**22.4**	**26.0**	**26.2**	**27.2**		
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (III)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

Sample Info.	Boring No.	SN4-15-003	SN4-15-003	SN4-15-003						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	20-22'	38-40'	61-63'						
Unit Weight Info.	Sample height, H (in)	5.337	4.561	5.185						
	Sample diameter, D (in)	2.863	2.851	2.831						
	Sample volume, V (ft^3)	0.0199	0.0169	0.0189						
	Mass rings + wet soil (g)	1063.10	951.76	1031.41						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist soil, Ws (g)	1063.10	951.76	1031.41						
	Moist unit wt., γ_m (pcf)	117.88	124.53	120.39						
Water Content	Wet soil + tare (g)	309.84	362.26	340.19						
	Dry soil + tare (g)	266.49	313.17	289.03						
	Tare (g)	126.73	129.45	140.46						
Water Content, w (%)		**31.0**	**26.7**	**34.4**						
Dry Unit Wt., γ_d (pcf)		**90.0**	**98.3**	**89.6**						

Entered by:___________
Reviewed:___________

Specific Gravity of Soil Solids by Water Pycnometer

(ASTM D854)

Project: **Norwest Corporation**
No: **01557-004 (III)**
Location: Peak Minerals, Sevier Lake, UT
Date: 11/9/2015
By: ET

Drill hole / Sample:	SN4-15-003	SN4-15-003	SN4-15-003			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	20-22	38-40	61-63			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, P (%)	100	100	100			
Pycnometer No.	1	2	3			
Mass of pycnometer (g)	167.77	184.47	170.63			
Mass of pycnometer, soil, and water, $M_{\rho ws,t}$ (g)	694.07	711.17	698.47			
Temperature, T_t (°C)	21.6	21.6	21.6			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	666.04	683.00	669.20			
Mass of tare + dry soil (g)	508.32	453.72	360.72			
Mass of tare (g)	464.59	409.07	315.04			
Mass of soil, M_s (g)	43.73	44.65	45.68			
Specific gravity of soil solids at test temperature, G_t	2.786	2.709	2.785			
Temperature coefficient, K	0.99966	0.99966	0.99966			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.785**	**2.708**	**2.784**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________

Reviewed by:___________

Porosity of Soil

Project: **Norwest Corporation**
No: **01557-004 (III)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

Section	Parameter								
Sample Info.	Boring No.	SN4-15-003	SN4-15-003	SN4-15-003					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	20-22'	38-40'	61-63'					
Unit Weight Data	Sample height, H (in)	5.337	4.561	5.185					
	Sample diameter, D (in)	2.863	2.851	2.831					
	Mass rings + wet soil (g)	1063.10	951.76	1031.41					
	Mass rings/tare (g)	0.00	0.00	0.00					
	Moist unit wt., γ_m (pcf)	117.9	124.5	120.4					
Water Content	Wet soil + tare (g)	309.84	362.26	340.19					
	Dry soil + tare (g)	266.49	313.17	289.03					
	Tare (g)	126.73	129.45	140.46					
	Water content (%)	31.0	26.7	34.4					
	Specific gravity of solids, Gs	2.785	2.708	2.784					
	Void ratio, e	0.932	0.720	0.941					
	Porosity, n	0.483	0.419	0.485					
	Total Soil Porosity, n (%)	**48.3**	**41.9**	**48.5**					
	Water Porosity, n_w (%)	**38.9**	**36.6**	**43.0**					
	Air Porosity, n_a (%)	**9.4**	**5.3**	**5.5**					
	Comments:	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.					

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

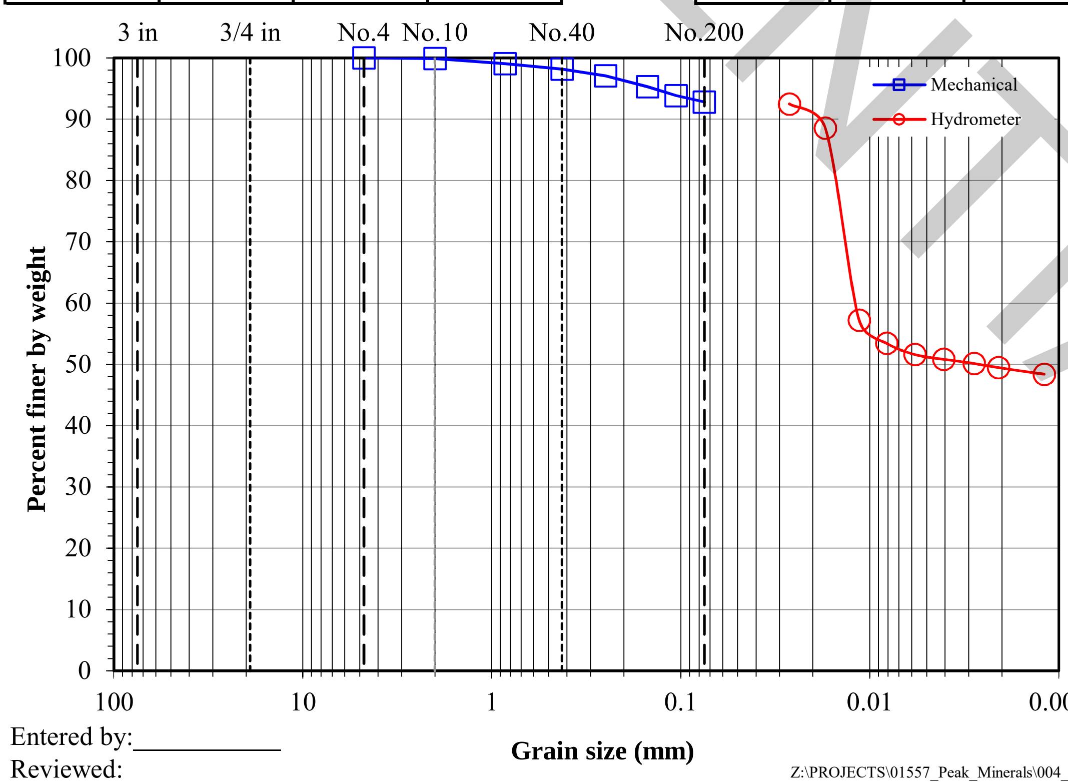
Boring No.: SN4-15-003
Sample: MC-001
Depth: 0-3'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	116.67	114.84
+#10 Coarse fraction (g):	0.12	0.12
-#10 Split fraction (g):	50.05	49.26
Hydrometer fraction (g):	50.05	49.26
Split fraction:	0.999	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.98	33.30	33.30
Dry soil + tare (g):	37.98	33.12	33.12
Tare (g):	37.75	21.86	21.86
Water content (%):	0.00	1.60	1.60

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.90
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	18.1	51	0.02665	92.50
6"	-	150	-		5	18.1	49	0.01720	88.57
4"	-	100	-		15	18.2	33	0.01138	57.19
3"	-	75	-		30	18.6	31	0.00813	53.43
1.5"	-	37.5	-		60	18.9	30	0.00577	51.60
3/4"	-	19	-		120	19.4	29.5	0.00407	50.83
3/8"	-	9.5	-		250	20.1	29	0.00280	50.15
No.4	-	4.75	100.0		449	20.8	28.5	0.00208	49.47
No.10	0.12	2	99.9	<=Split	1382	20.6	28	0.00119	48.40
No.20	0.41	0.85	99.1						
No.40	0.85	0.425	98.2						
No.60	1.39	0.25	97.1						
No.100	2.26	0.15	95.3						
No.140	3.00	0.106	93.8						
No.200	3.50	0.075	92.8						



Gravel (%): 0.0
Sand (%): 7.2
Fines (%): 92.8

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\III\hydrometers\[GSDHYDv2.xlsx]1

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: BRR

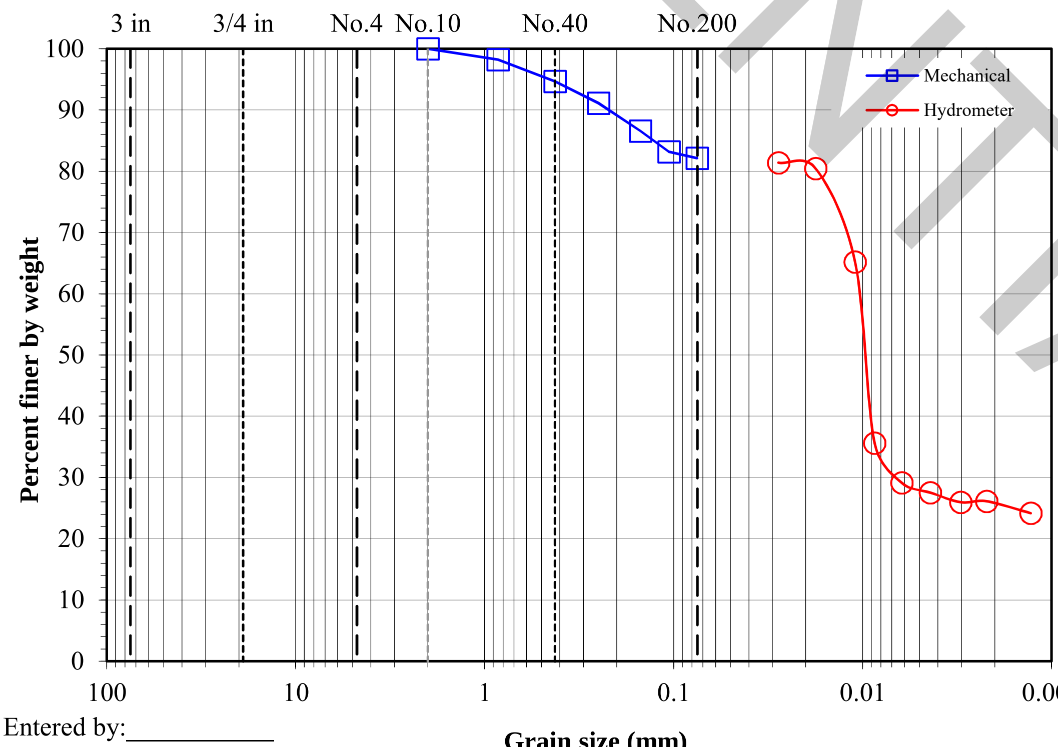
Boring No.: SN4-15-003
Sample: MC-002
Depth: 3-4'
Description: Grey clay with sand

Split:	No	
	Moist	Dry
Total sample wt. (g):	52.29	50.56
Hydrometer fraction (g):	52.39	50.66
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.56	36.56
Dry soil + tare (g):	-	36.08	36.08
Tare (g):	-	22.01	22.01
Water content (%):	0.00	3.41	3.41

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	18	46.5	0.02789	81.39
6"	-	150	-		5	18	46	0.01772	80.44
4"	-	100	-		15	18.1	38	0.01096	65.18
3"	-	75	-		30	18.3	22.5	0.00865	35.63
1.5"	-	37.5	-		60	18.8	19	0.00622	29.15
3/4"	-	19	-		120	19.5	18	0.00439	27.53
3/8"	-	9.5	-		250	20.3	17	0.00303	25.96
No.4	-	4.75	-		463	20.7	17	0.00221	26.12
No.10	-	2	100.0	<=Split hyd.	1381	20.6	16	0.00129	24.17
No.20	0.90	0.85	98.2						
No.40	2.69	0.425	94.7						
No.60	4.51	0.25	91.1						
No.100	6.80	0.15	86.6						
No.140	8.51	0.106	83.2						
No.200	9.04	0.075	82.2	<=Split					



Gravel (%): 0.0
Sand (%): 17.8
Fines (%): 82.2

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: BRR

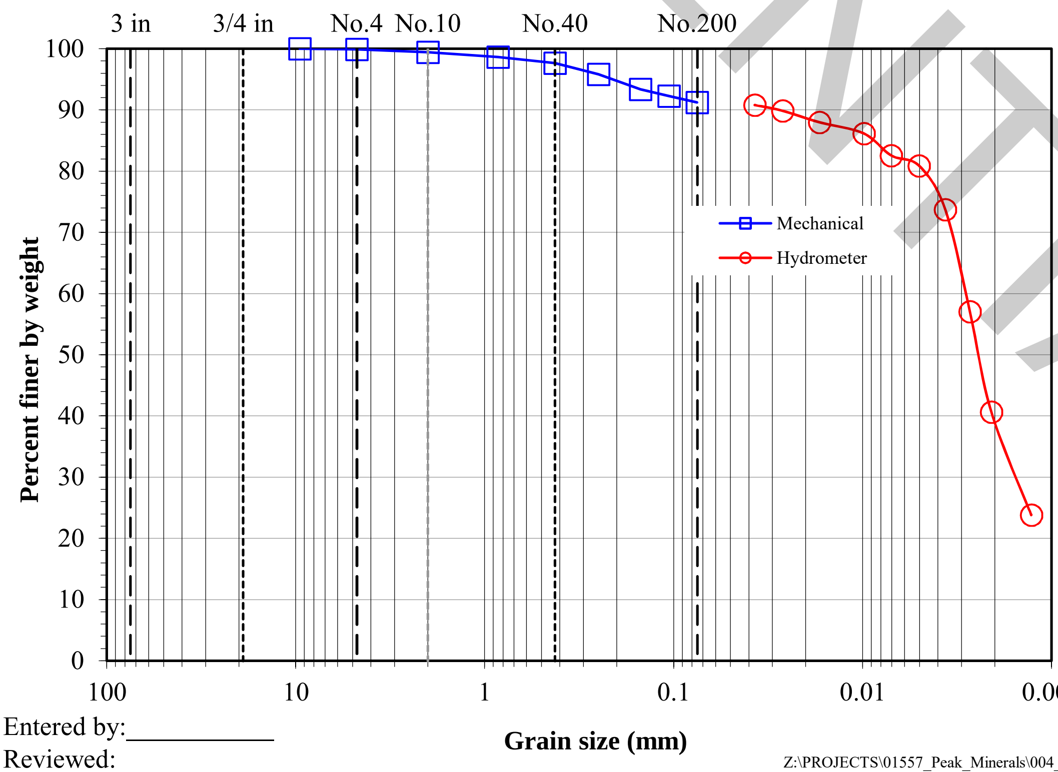
Boring No.: SN4-15-003
Sample: MC-003
Depth: 8-13'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	167.01	163.66
+#10 Coarse fraction (g):	0.92	0.92
-#10 Split fraction (g):	52.54	51.48
Hydrometer fraction (g):	52.54	51.48
Split fraction:	0.994	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	38.63	33.40	33.40
Dry soil + tare (g):	38.63	33.17	33.17
Tare (g):	37.51	21.98	21.98
Water content (%):	0.00	2.06	2.06

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	99.44
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.8	52.5	0.03724	90.79
6"	-	150	-		2	17.8	52	0.02647	89.85
4"	-	100	-		5	17.8	51	0.01692	87.98
3"	-	75	-		15	17.9	50	0.00985	86.15
1.5"	-	37.5	-		30	18.3	48	0.00707	82.57
3/4"	-	19	-		60	18.7	47	0.00502	80.87
3/8"	-	9.5	100.0		120	19.5	43	0.00365	73.71
No.4	0.14	4.75	99.9		250	20	34	0.00271	57.08
No.10	0.92	2	99.4	<=Split	468	21	25	0.00208	40.65
No.20	0.40	0.85	98.7		1389	21	16	0.00128	23.81
No.40	0.92	0.425	97.7						
No.60	1.86	0.25	95.8						
No.100	3.14	0.15	93.4						
No.140	3.71	0.106	92.3						
No.200	4.24	0.075	91.2						



Gravel (%): 0.1
Sand (%): 8.7
Fines (%): 91.2

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-004
Depth: 13-18'
Description: Grey clay

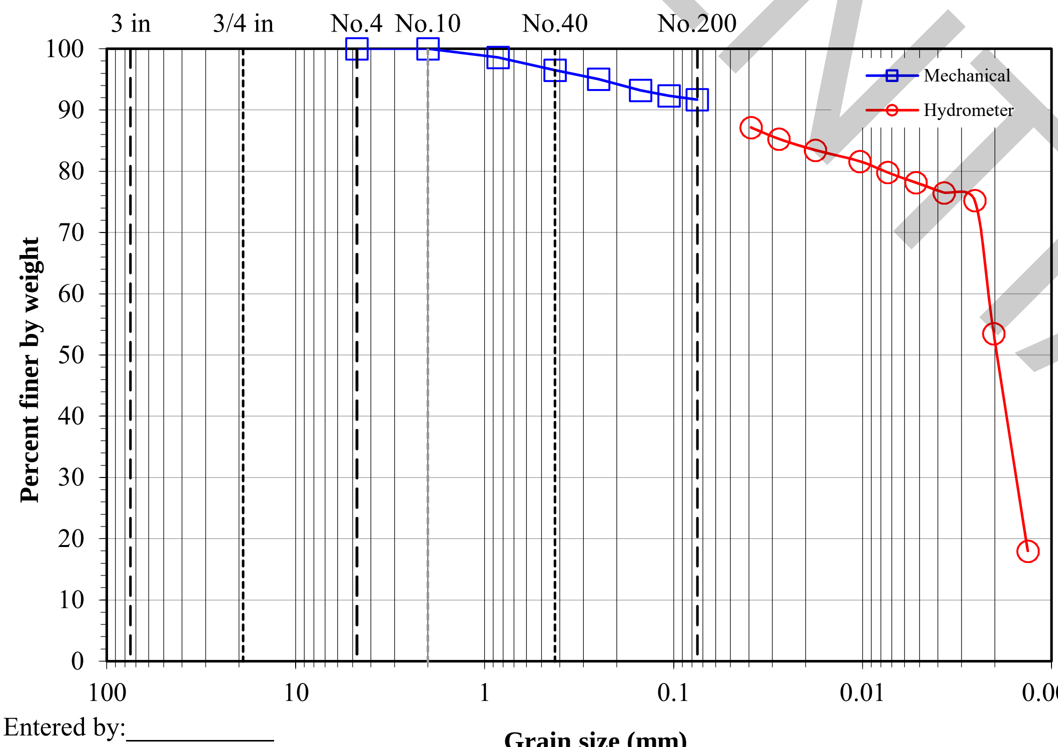
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	101.24	98.95
+#10 Coarse fraction (g):	0.02	0.02
-#10 Split fraction (g):	61.57	60.18
Hydrometer fraction (g):	51.69	48.92
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.200)
Moist soil + tare (g):	30.30	179.01	38.01
Dry soil + tare (g):	30.30	177.62	37.15
Tare (g):	30.27	117.44	21.97
Water content (%):	0.00	2.31	5.67

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.200		Intercept:	16.3
Gs:	2.7	Assumed	α:	0.99
Bulb No.	2		Hyd. fraction:	91.71
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.02	2	100.0	<=Split
No.20	0.83	0.85	98.6	
No.40	2.09	0.425	96.5	
No.60	2.99	0.25	95.0	
No.100	4.08	0.15	93.2	
No.140	4.60	0.106	92.3	
No.200	4.98	0.075	91.7	<=Split hyd.

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.7	51	0.03896	87.15
2	17.7	50	0.02783	85.29
5	17.7	49	0.01778	83.44
15	17.8	48	0.01036	81.62
30	17.9	47	0.00738	79.81
60	18.4	46	0.00524	78.16
120	18.9	45	0.00372	76.51
250	20.3	44	0.00255	75.22
469	21.6	32	0.00202	53.50
1403	20.9	13	0.00134	18.00



Gravel (%): 0.0
Sand (%): 8.3
Fines (%): 91.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-005
Depth: 18-20'
Description: Grey clay

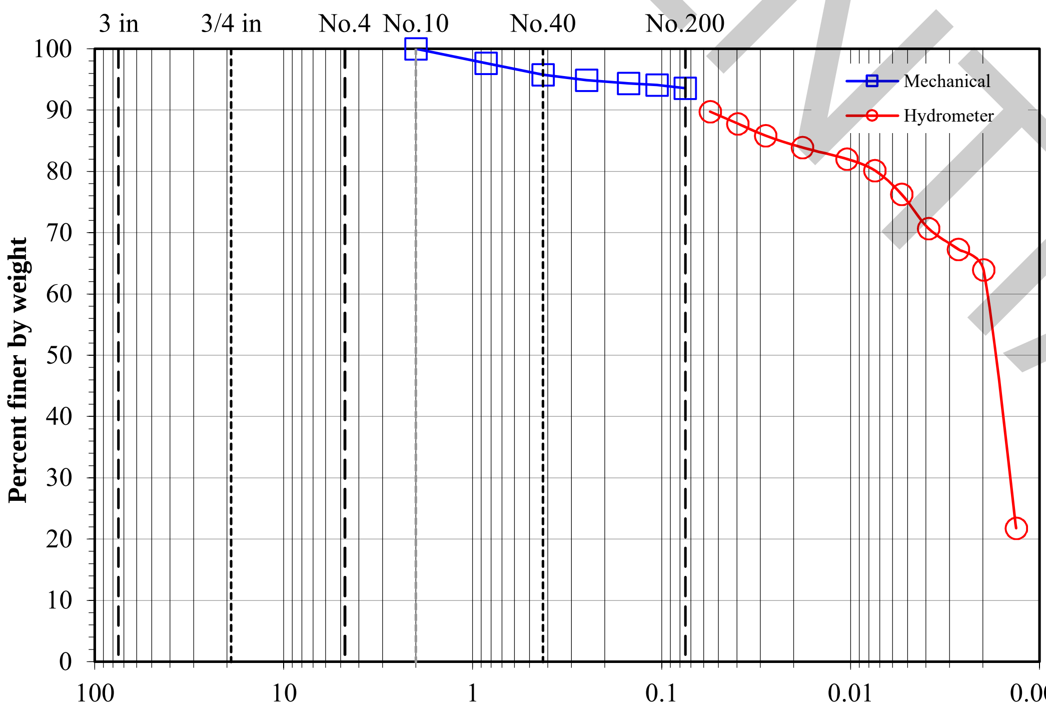
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	51.08	48.20
+#10 Coarse fraction (g):	0.00	0.00
-#10 Split fraction (g):	51.08	48.20
Hydrometer fraction (g):	51.64	47.53
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.200)
Moist soil + tare (g):	-	173.18	34.98
Dry soil + tare (g):	-	170.30	33.96
Tare (g):	-	122.10	22.16
Water content (%):	0.00	5.98	8.64

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.200		Intercept:	16.3
Gs:	2.7	Assumed	α:	0.99
Bulb No.	2		Hyd. fraction:	93.57
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split
No.20	1.14	0.85	97.6	
No.40	2.04	0.425	95.8	
No.60	2.48	0.25	94.9	
No.100	2.71	0.15	94.4	
No.140	2.85	0.106	94.1	
No.200	3.10	0.075	93.6	<=Split hyd.

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	18.1	50	0.05541	89.73
1	18.1	49	0.03957	87.79
2	18.1	48	0.02826	85.84
5	18.1	47	0.01805	83.89
15	18.3	46	0.01049	82.03
30	18.5	45	0.00747	80.17
60	18.5	43	0.00538	76.28
120	19.1	40	0.00387	70.69
250	20.2	38	0.00269	67.27
461	21.5	36	0.00198	63.93
1398	20.8	14.5	0.00133	21.78



Gravel (%): 0.0
Sand (%): 6.4
Fines (%): 93.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

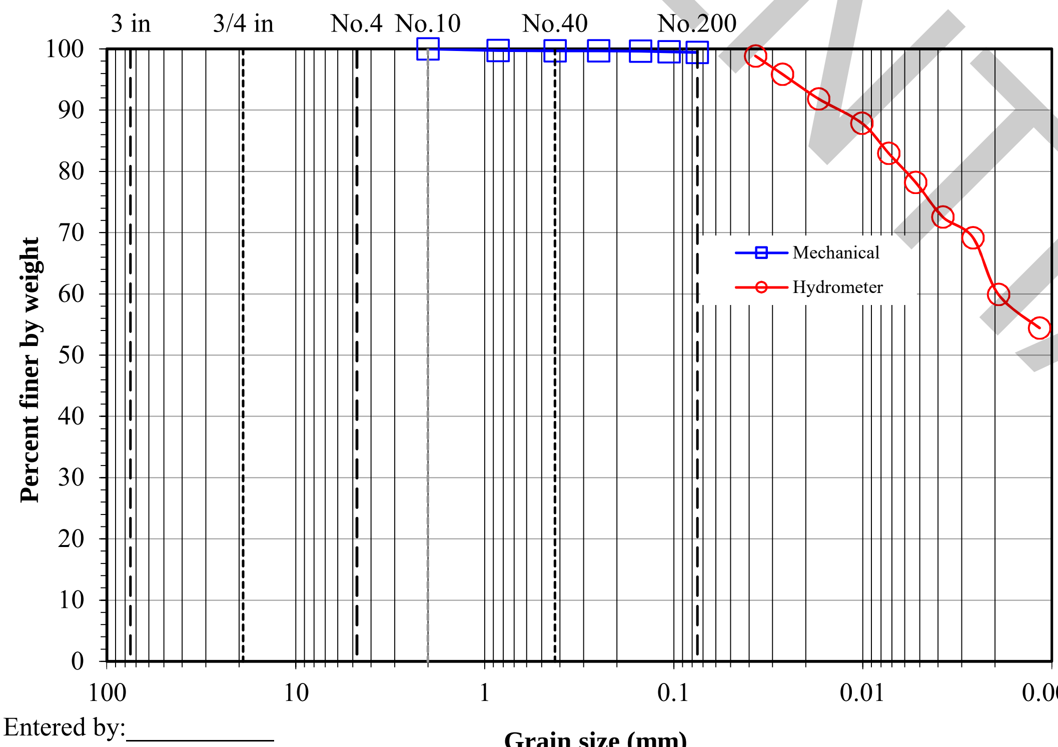
Boring No.: SN4-15-003
Sample: SH-001
Depth: 20-22'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	54.47	48.68
Hydrometer fraction (g):	54.47	48.68
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.34	36.34
Dry soil + tare (g):	-	34.80	34.80
Tare (g):	-	21.86	21.86
Water content (%):	0.00	11.90	11.90

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.785	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.8	53.5	0.03699	98.85
6"	-	150	-		2	17.8	52	0.02658	95.85
4"	-	100	-		5	17.8	50	0.01716	91.86
3"	-	75	-		15	17.8	48	0.01011	87.87
1.5"	-	37.5	-		30	18	45.5	0.00730	82.97
3/4"	-	19	-		60	18.5	43	0.00525	78.20
3/8"	-	9.5	-		120	19.3	40	0.00377	72.56
No.4	-	4.75	-		250	20.7	38	0.00261	69.18
No.10	-	2	100.0	<=Split hyd.	483	22.3	33	0.00192	59.90
No.20	0.13	0.85	99.7		1405	21.2	30.5	0.00116	54.43
No.40	0.15	0.425	99.7						
No.60	0.16	0.25	99.7						
No.100	0.19	0.15	99.6						
No.140	0.22	0.106	99.5						
No.200	0.28	0.075	99.4	<=Split					



Gravel (%): 0.0
Sand (%): 0.6
Fines (%): 99.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/31/2015
By: BRR

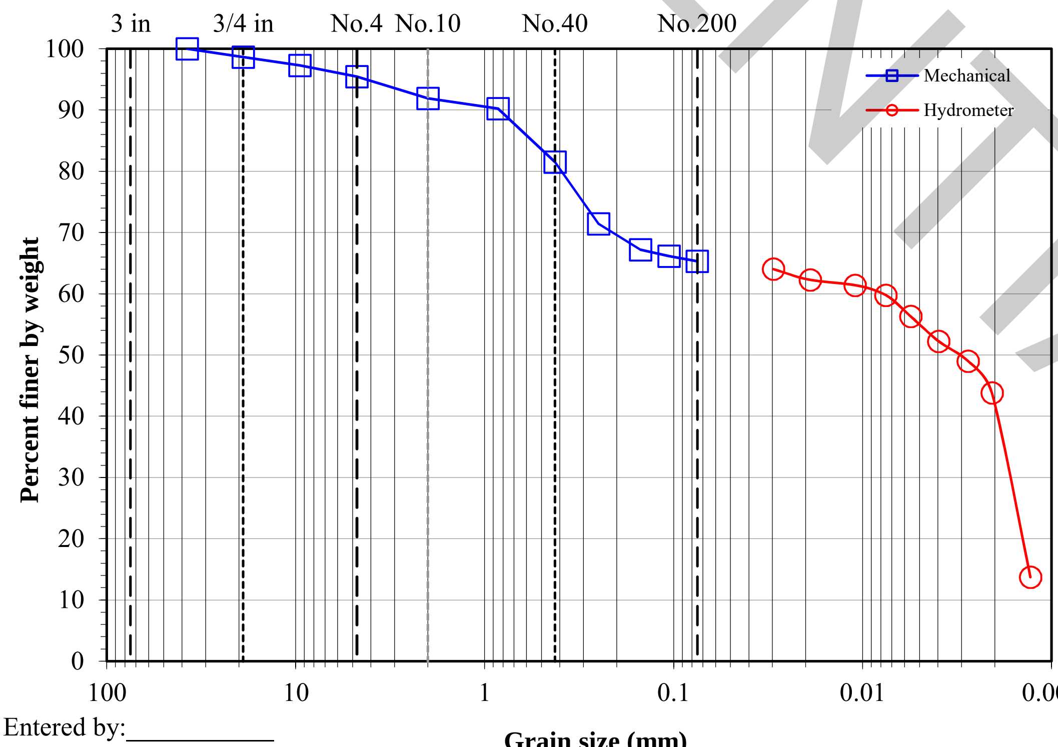
Boring No.: SN4-15-003
Sample: MC-006
Depth: 22-28'
Description: Grey sandy clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	3172.54	3140.96
+#10 Coarse fraction (g):	256.64	253.77
-#10 Split fraction (g):	50.50	50.00
Hydrometer fraction (g):	50.50	50.00
Split fraction:	0.919	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	2020.08	43.24	43.24
Dry soil + tare (g):	2002.69	43.03	43.03
Tare (g):	466.96	21.91	21.91
Water content (%):	1.13	0.99	0.99

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	91.92
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.5	40	0.02975	64.03
6"	-	150	-		5	17.5	39	0.01897	62.25
4"	-	100	-		15	17.6	38.5	0.01098	61.40
3"	-	75	-		32	18	37.5	0.00754	59.78
1.5"	-	37.5	100.0		60	18.3	35.5	0.00558	56.33
3/4"	43.30	19	98.6		120	19.3	33	0.00397	52.27
3/8"	85.44	9.5	97.3		250	20	31	0.00277	48.98
No.4	142.98	4.75	95.4		460	20.5	28	0.00207	43.84
No.10	253.77	2	91.9	<=Split	1443	20.9	11	0.00130	13.72
No.20	0.92	0.85	90.2						
No.40	5.67	0.425	81.5						
No.60	11.15	0.25	71.4						
No.100	13.44	0.15	67.2						
No.140	14.03	0.106	66.1						
No.200	14.47	0.075	65.3						



Gravel (%): 4.6
Sand (%): 30.1
Fines (%): 65.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/31/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-007
Depth: 28-33'
Description: Grey clayey sand with gravel

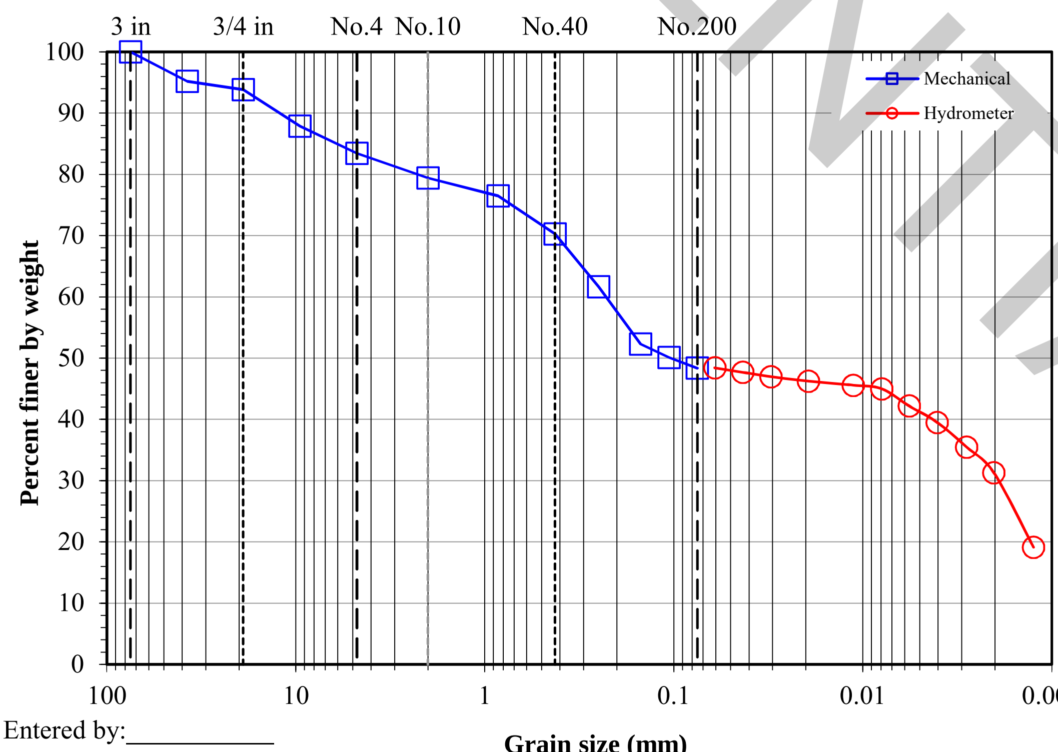
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	2662.25	2649.93
+#10 Coarse fraction (g):	547.70	545.80
-#10 Split fraction (g):	53.42	53.16
Hydrometer fraction (g):	53.42	53.16
Split fraction:	0.794	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	1853.06	42.47	42.47
Dry soil + tare (g):	1847.78	42.37	42.37
Tare (g):	328.02	22.19	22.19
Water content (%):	0.35	0.50	0.50

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	79.40
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	127.16	37.5	95.2	
3/4"	162.88	19	93.9	
3/8"	321.45	9.5	87.9	
No.4	439.52	4.75	83.4	
No.10	545.80	2	79.4	<=Split
No.20	1.95	0.85	76.5	
No.40	6.10	0.425	70.3	
No.60	11.89	0.25	61.6	
No.100	18.14	0.15	52.3	
No.140	19.61	0.106	50.1	
No.200	20.78	0.075	48.4	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	17.5	37.5	0.06074	48.41
1	17.5	37	0.04312	47.69
2	17.5	36.5	0.03061	46.97
5	17.5	36	0.01944	46.24
15	17.7	35.5	0.01124	45.58
30	18.1	35	0.00794	44.99
60	18.4	33	0.00568	42.19
120	19.1	31	0.00404	39.52
250	20.1	28	0.00282	35.49
500	20.6	25	0.00203	31.31
1452	21	16.5	0.00125	19.14



Gravel (%): 16.6
Sand (%): 35.1
Fines (%): 48.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: BRR

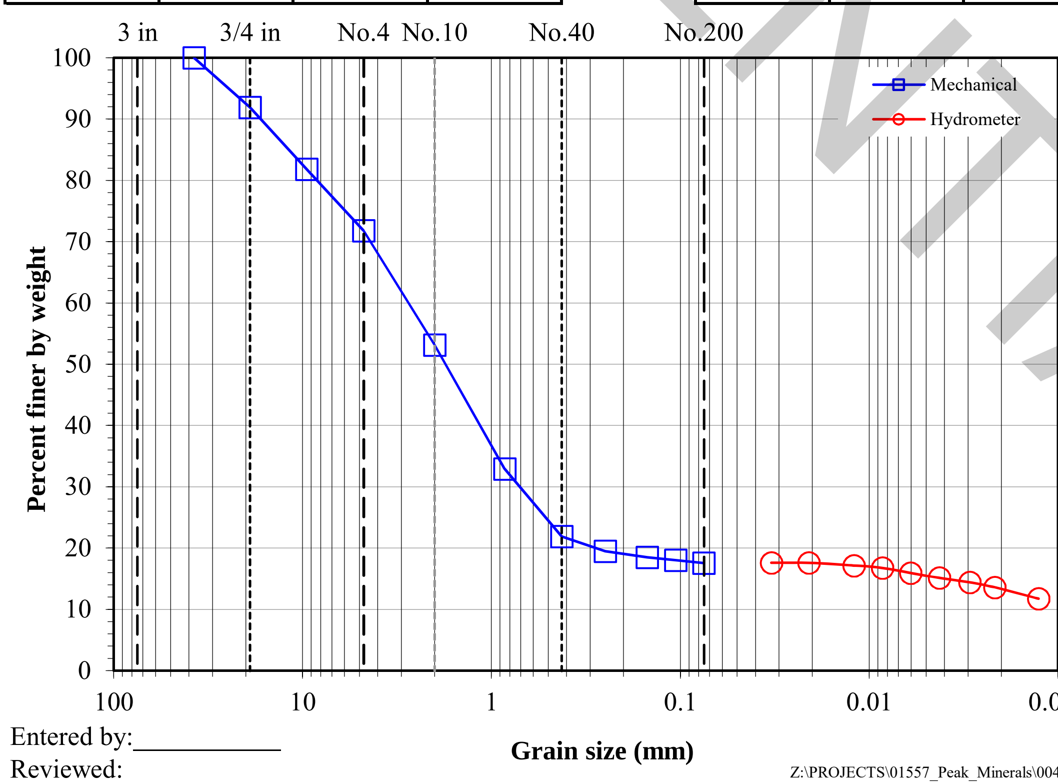
Boring No.: SN4-15-003
Sample: MC-008
Depth: 33-38'
Description: Grey clayey sand with gravel

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	3679.52	3631.60
+#10 Coarse fraction (g):	1714.43	1701.51
-#10 Split fraction (g):	56.08	55.08
Hydrometer fraction (g):	56.08	55.08
Split fraction:	0.531	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	2725.56	43.53	43.53
Dry soil + tare (g):	2710.40	43.15	43.15
Tare (g):	714.58	22.19	22.19
Water content (%):	0.76	1.81	1.81

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.86	Assumed	α:	0.96
Bulb No.	2		Hyd. fraction:	53.15
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.9	23	0.03302	17.60
6"	-	150	-		5	17.9	23	0.02089	17.60
4"	-	100	-		15	18	22.5	0.01208	17.16
3"	-	75	-		30	18.4	22	0.00853	16.78
1.5"	-	37.5	100.0		60	18.7	21	0.00605	15.91
3/4"	294.41	19	91.9		120	19.5	20	0.00426	15.15
3/8"	660.94	9.5	81.8		250	20.4	19	0.00294	14.41
No.4	1023.92	4.75	71.8		457	21	18	0.00217	13.61
No.10	1701.51	2	53.1	<=Split	1373	20.9	16	0.00127	11.74
No.20	20.97	0.85	32.9						
No.40	32.40	0.425	21.9						
No.60	34.90	0.25	19.5						
No.100	35.92	0.15	18.5						
No.140	36.39	0.106	18.0						
No.200	36.88	0.075	17.6						



Gravel (%): 28.2
Sand (%): 54.2
Fines (%): 17.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

Boring No.: SN4-15-003
Sample: SH-002
Depth: 38-40'
Description: Grey clay with sand

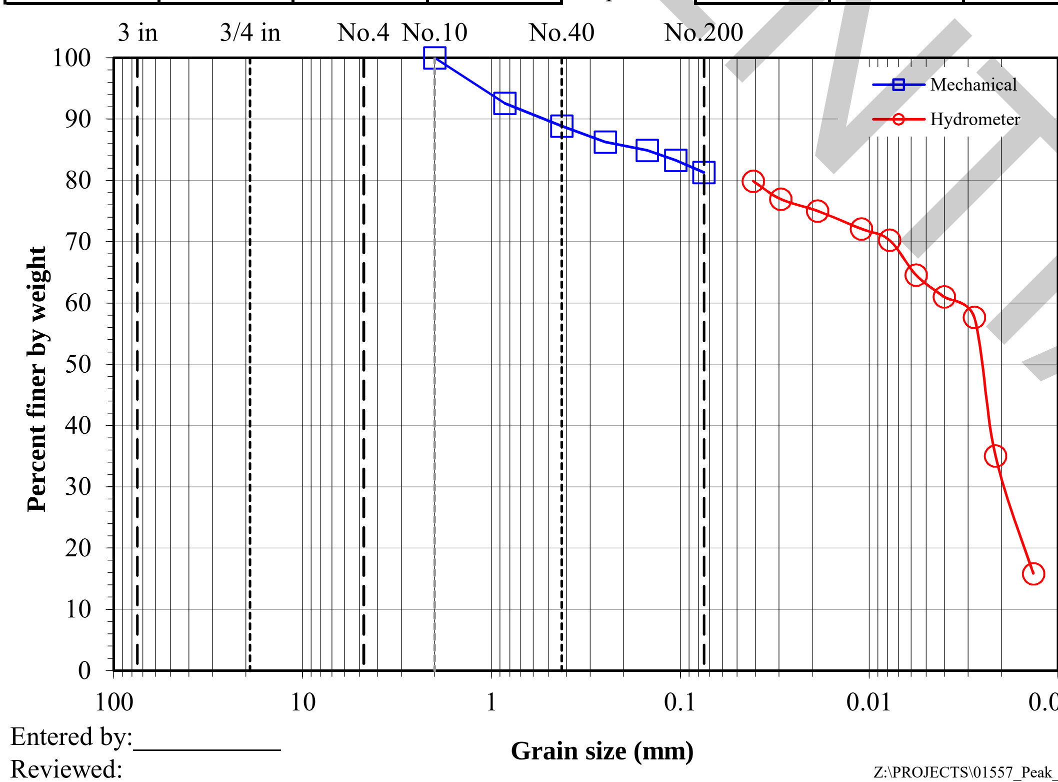
	Moist	Dry
Split:	No	
Total sample wt. (g):	54.90	50.71
Hydrometer fraction (g):	54.90	50.71
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.61	35.61
Dry soil + tare (g):	-	34.58	34.58
Tare (g):	-	22.13	22.13
Water content (%):	0.00	8.27	8.27

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.708	Determined	α:	0.99
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	3.75	0.85	92.6	
No.40	5.63	0.425	88.9	
No.60	6.98	0.25	86.2	
No.100	7.65	0.15	84.9	
No.140	8.48	0.106	83.3	
No.200	9.48	0.075	81.3	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.8	45	0.04118	79.88
2	17.8	43.5	0.02951	76.96
5	17.8	42.5	0.01883	75.01
15	17.8	41	0.01102	72.09
30	18.1	40	0.00783	70.27
60	18.4	37	0.00565	64.56
120	19.2	35	0.00402	61.01
250	20.5	33	0.00278	57.67
475	22.3	21	0.00215	35.07
1397	20.6	11.5	0.00135	15.85



Gravel (%): 0.0
Sand (%): 18.7
Fines (%): 81.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

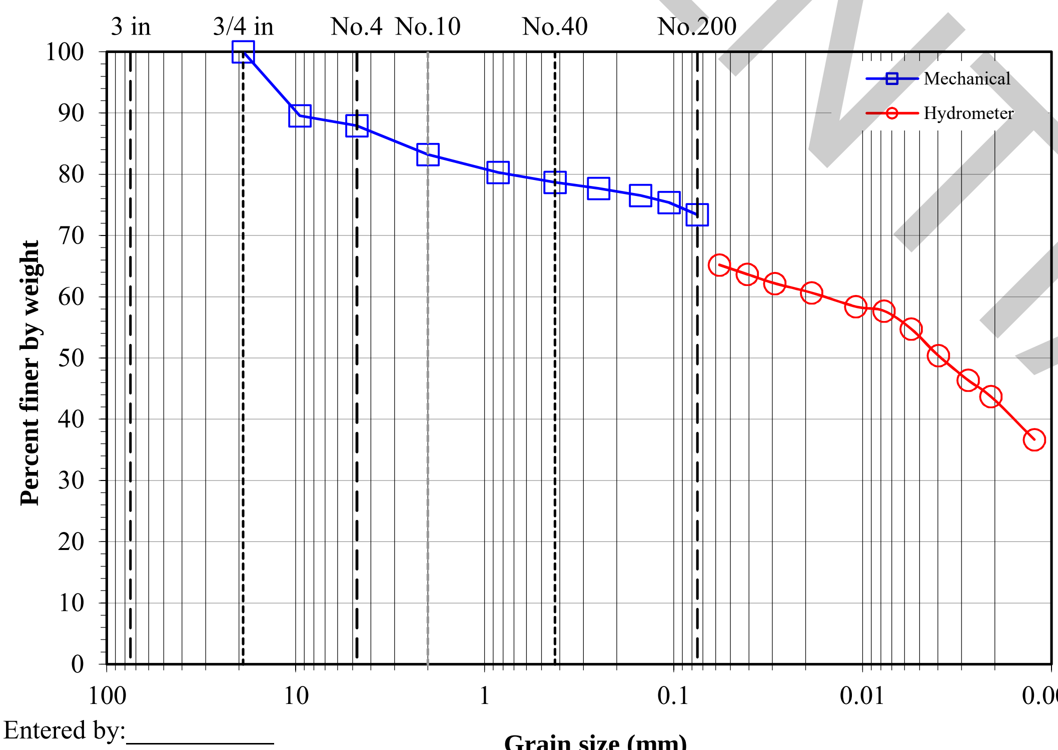
Boring No.: SN4-15-003
Sample: MC-009
Depth: 40-43'
Description: Grey clay with sand

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	164.03	159.54
+#10 Coarse fraction (g):	27.96	26.74
-#10 Split fraction (g):	25.37	24.76
Hydrometer fraction (g):	51.27	47.88
Split fraction:	0.832	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.200)
Moist soil + tare (g):	196.06	147.05	32.85
Dry soil + tare (g):	192.77	146.44	32.13
Tare (g):	120.84	121.68	21.95
Water content (%):	4.57	2.46	7.07

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.200		Intercept:	16.3
Gs:	2.7	Assumed	α:	0.99
Bulb No.	2		Hyd. fraction:	73.42
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.7	47	0.05734	65.22
6"	-	150	-		1	17.7	46	0.04093	63.70
4"	-	100	-		2	17.7	45	0.02921	62.18
3"	-	75	-		5	17.7	44	0.01864	60.67
1.5"	-	37.5	-		15	17.7	42.5	0.01091	58.39
3/4"	-	19	100.0		30	17.9	42	0.00773	57.70
3/8"	16.67	9.5	89.6		60	18.2	40	0.00554	54.77
No.4	19.26	4.75	87.9		120	18.8	37	0.00399	50.42
No.10	26.74	2	83.2	<=Split	250	20.4	34	0.00277	46.40
No.20	0.88	0.85	80.3		437	21.5	32	0.00210	43.73
No.40	1.36	0.425	78.7		1374	20.8	27.5	0.00123	36.68
No.60	1.65	0.25	77.7						
No.100	1.99	0.15	76.6						
No.140	2.33	0.106	75.4						
No.200	2.92	0.075	73.4	<=Split hyd.					



Gravel (%): 12.1
Sand (%): 14.5
Fines (%): 73.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

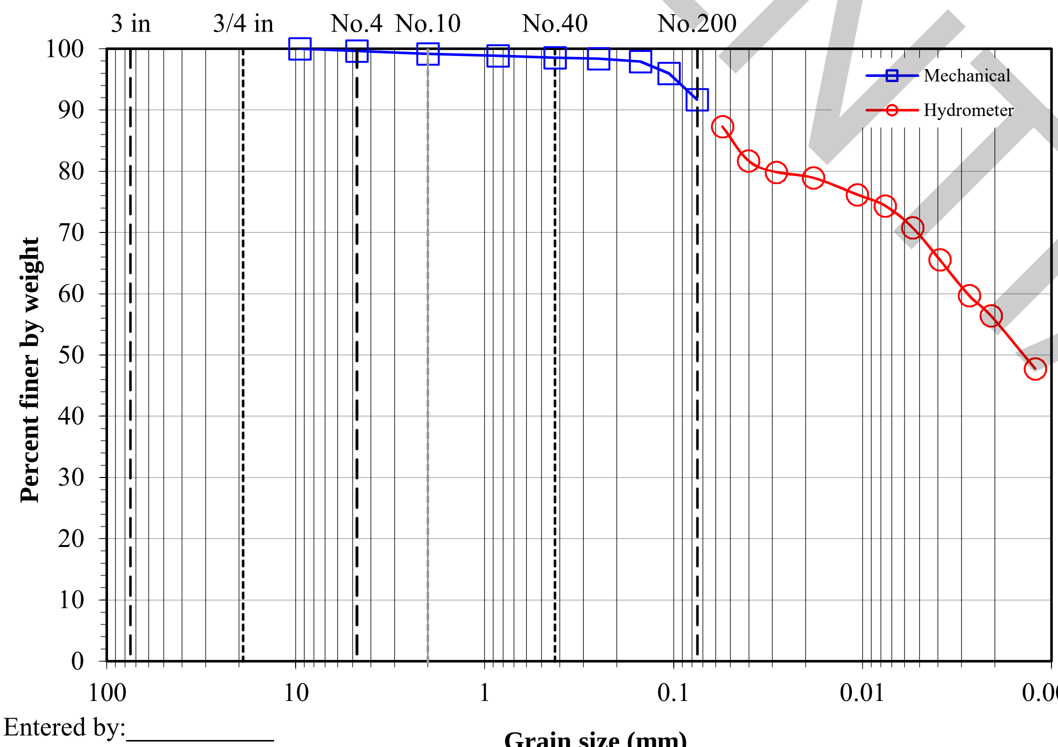
Boring No.: SN4-15-003
Sample: MC-010
Depth: 43-48'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	150.70	146.46
+#10 Coarse fraction (g):	1.22	1.19
-#10 Split fraction (g):	75.98	73.84
Hydrometer fraction (g):	51.00	48.81
Split fraction:	0.992	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.200)
Moist soil + tare (g):	128.93	198.70	37.42
Dry soil + tare (g):	128.76	196.56	36.76
Tare (g):	122.19	122.72	22.06
Water content (%):	2.59	2.90	4.49

Hydrometer data				
Hyd. split:	No.200		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.7	Assumed	α:	0.99
Bulb No.	2		Hyd. fraction:	91.69
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.6	51	0.05518	87.29
6"	-	150	-		1	17.6	48	0.04021	81.71
4"	-	100	-		2	17.6	47	0.02871	79.86
3"	-	75	-		5	17.6	46.5	0.01824	78.93
1.5"	-	37.5	-		15	17.7	45	0.01067	76.18
3/4"	-	19	-		30	17.8	44	0.00760	74.37
3/8"	-	9.5	100.0		60	18.2	42	0.00544	70.81
No.4	0.54	4.75	99.6		120	19	39	0.00391	65.56
No.10	1.19	2	99.2	<=Split	250	20.6	35.5	0.00273	59.71
No.20	0.27	0.85	98.8		429	21.6	33.5	0.00209	56.40
No.40	0.49	0.425	98.5		1366	20.9	29	0.00122	47.76
No.60	0.60	0.25	98.4						
No.100	0.94	0.15	97.9						
No.140	2.38	0.106	96.0						
No.200	5.58	0.075	91.7	<=Split hyd.					



Gravel (%): 0.4
Sand (%): 7.9
Fines (%): 91.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-011
Depth: 50-53'
Description: Grey sandy clay

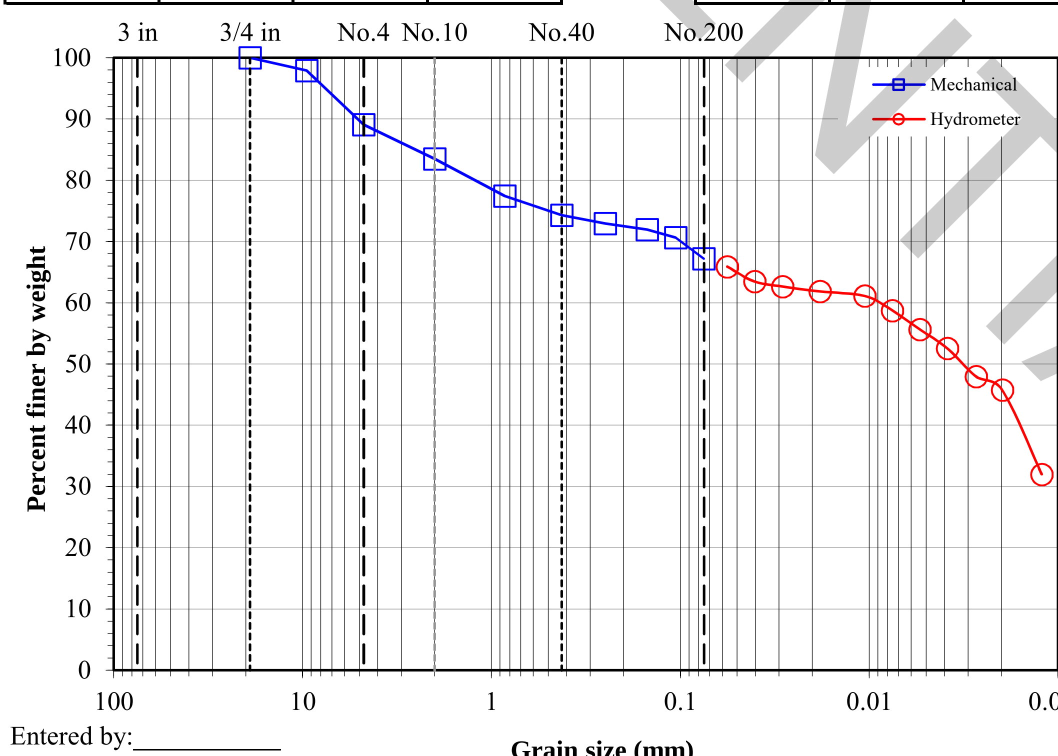
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	123.73	121.63
+#10 Coarse fraction (g):	20.28	20.09
-#10 Split fraction (g):	50.86	49.92
Hydrometer fraction (g):	50.86	49.92
Split fraction:	0.835	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	76.17	34.94	34.94
Dry soil + tare (g):	75.80	34.70	34.70
Tare (g):	37.59	21.91	21.91
Water content (%):	0.97	1.88	1.88

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	83.48
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	100.0	
3/8"	2.52	9.5	97.9	
No.4	13.30	4.75	89.1	
No.10	20.09	2	83.5	<=Split
No.20	3.61	0.85	77.4	
No.40	5.51	0.425	74.3	
No.60	6.30	0.25	73.0	
No.100	6.91	0.15	71.9	
No.140	7.68	0.106	70.6	
No.200	9.76	0.075	67.2	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	18.5	44.5	0.05647	65.89
1	18.5	43	0.04047	63.46
2	18.5	42.5	0.02875	62.65
5	18.5	42	0.01826	61.84
15	18.7	41.5	0.01056	61.10
30	18.9	40	0.00755	58.74
60	19.3	38	0.00540	55.65
120	19.7	36	0.00386	52.55
250	20.4	33	0.00271	47.94
474	21.1	31.5	0.00198	45.76
1398	21.1	23	0.00122	31.99



Gravel (%): 10.9
Sand (%): 21.9
Fines (%): 67.2

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-012
Depth: 53-58'
Description: Grey clay

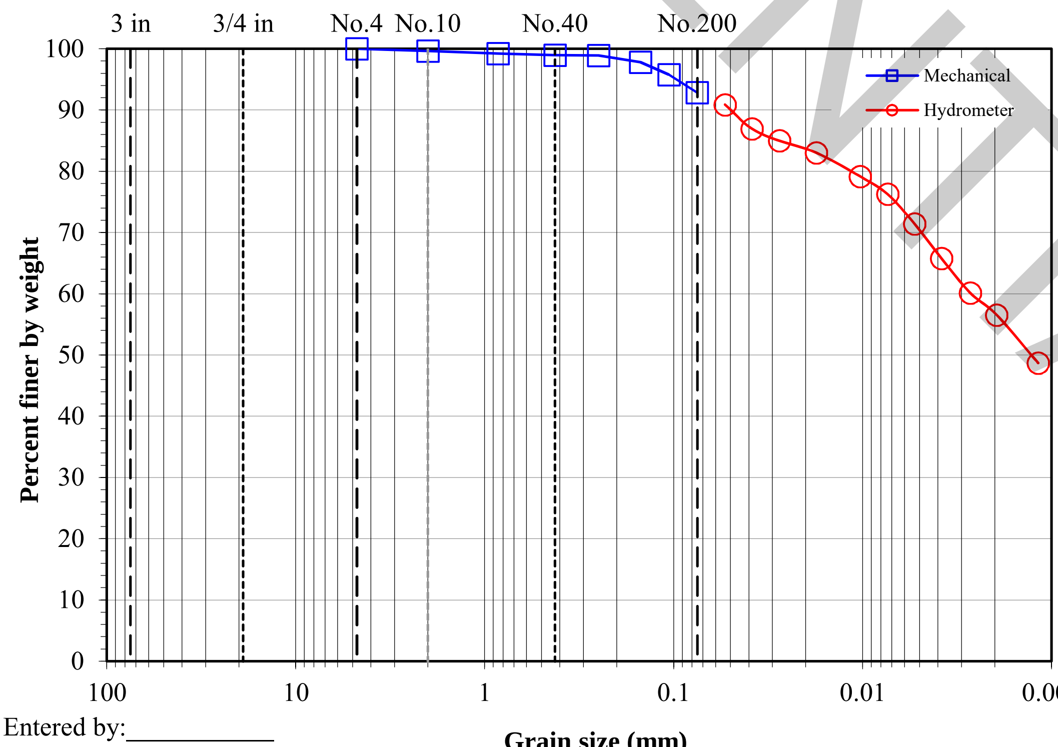
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	138.97	135.42
+#10 Coarse fraction (g):	0.50	0.50
-#10 Split fraction (g):	50.35	49.06
Hydrometer fraction (g):	50.35	49.06
Split fraction:	0.996	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	38.21	33.21	33.21
Dry soil + tare (g):	38.21	32.92	32.92
Tare (g):	37.69	21.89	21.89
Water content (%):	0.00	2.63	2.63

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.63
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.50	2	99.6	<=Split
No.20	0.20	0.85	99.2	
No.40	0.33	0.425	99.0	
No.60	0.35	0.25	98.9	
No.100	0.91	0.15	97.8	
No.140	1.90	0.106	95.8	
No.200	3.35	0.075	92.8	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	18.6	50	0.05351	90.88
1	18.6	48	0.03860	86.95
2	18.6	47	0.02756	84.98
5	18.6	46	0.01759	83.01
15	18.8	44	0.01032	79.17
30	18.9	42.5	0.00739	76.26
60	19.1	40	0.00532	71.43
120	19.7	37	0.00383	65.78
250	20.3	34	0.00270	60.14
481	21.1	32	0.00195	56.55
1405	21.1	28	0.00118	48.69



Gravel (%): 0.0
Sand (%): 7.2
Fines (%): 92.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

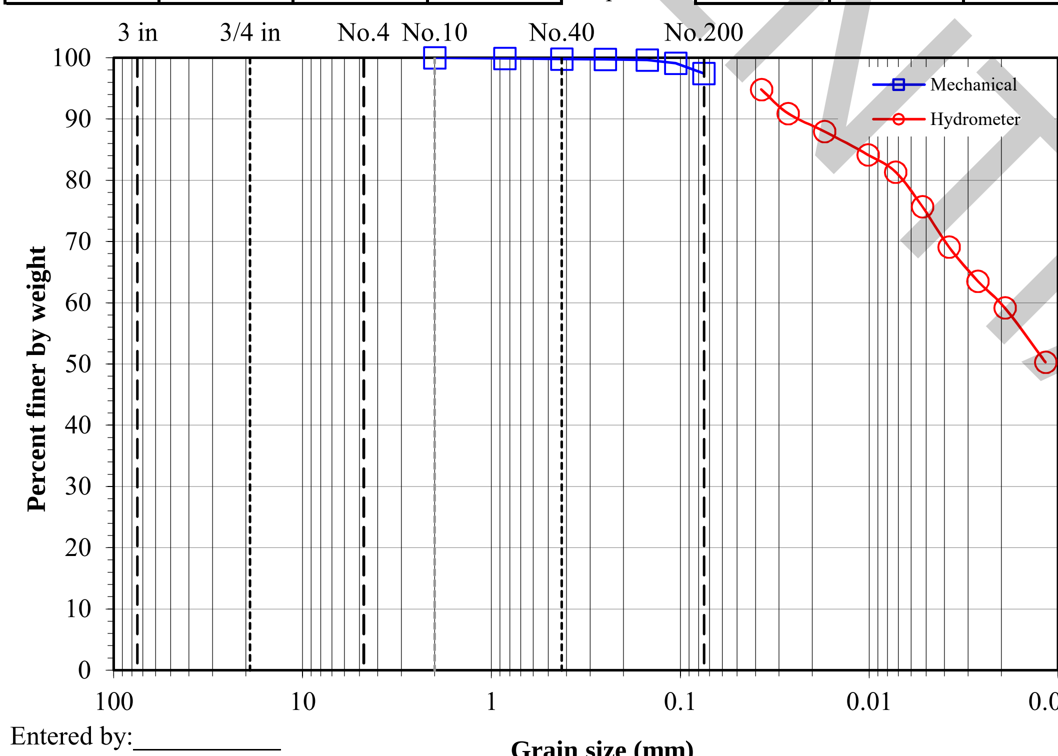
Boring No.: SN4-15-003
Sample: MC-013
Depth: 58-61'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.63	49.55
Hydrometer fraction (g):	50.63	49.55
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.62	35.62
Dry soil + tare (g):	-	35.32	35.32
Tare (g):	-	21.57	21.57
Water content (%):	0.00	2.18	2.18

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.7	52.5	0.03727	94.82
6"	-	150	-		2	17.7	50.5	0.02691	90.91
4"	-	100	-		5	17.7	49	0.01728	87.98
3"	-	75	-		15	17.9	47	0.01015	84.15
1.5"	-	37.5	-		30	18.2	45.5	0.00725	81.35
3/4"	-	19	-		60	18.7	42.5	0.00524	75.70
3/8"	-	9.5	-		120	19.3	39	0.00379	69.12
No.4	-	4.75	-		250	20	36	0.00266	63.55
No.10	-	2	100.0	<=Split hyd.	488	21.2	33.5	0.00192	59.18
No.20	0.06	0.85	99.9		1413	21	29	0.00117	50.30
No.40	0.11	0.425	99.8						
No.60	0.14	0.25	99.7						
No.100	0.17	0.15	99.7						
No.140	0.44	0.106	99.1						
No.200	1.26	0.075	97.5	<=Split					



Gravel (%): 0.0
Sand (%): 2.5
Fines (%): 97.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 11/9/2015
By: BRR

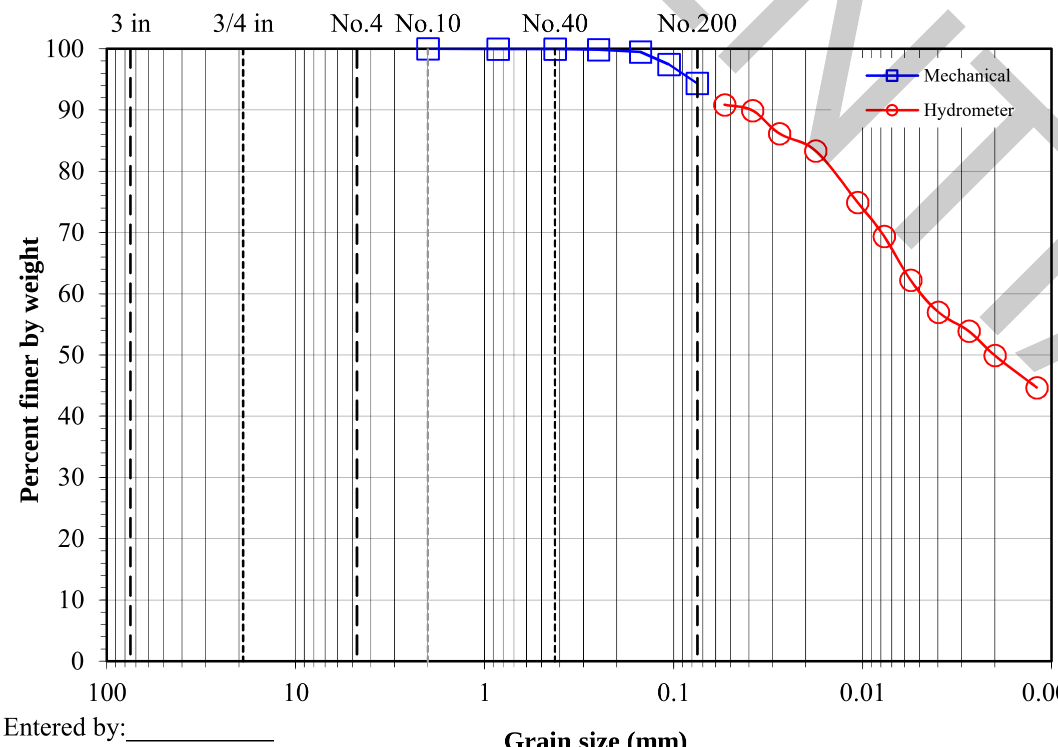
Boring No.: SN4-15-003
Sample: SH-003
Depth: 61-63'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	55.62	51.59
Hydrometer fraction (g):	55.62	51.59
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.24	34.24
Dry soil + tare (g):	-	33.35	33.35
Tare (g):	-	21.95	21.95
Water content (%):	0.00	7.81	7.81

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.784	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	16.5	52.5	0.05376	90.86
6"	-	150	-		1	16.5	52	0.03822	89.92
4"	-	100	-		2	16.5	50	0.02759	86.15
3"	-	75	-		5	16.5	48.5	0.01771	83.33
1.5"	-	37.5	-		15	16.7	44	0.01064	74.94
3/4"	-	19	-		30	17	41	0.00770	69.41
3/8"	-	9.5	-		60	17.8	37	0.00557	62.21
No.4	-	4.75	-		120	18.9	34	0.00398	57.01
No.10	-	2	100.0	<=Split hyd.	250	20.5	32	0.00274	53.90
No.20	0.02	0.85	100.0		467	22.3	29.5	0.00200	49.94
No.40	0.03	0.425	99.9		1389	21	27	0.00120	44.69
No.60	0.09	0.25	99.8						
No.100	0.28	0.15	99.5						
No.140	1.31	0.106	97.5						
No.200	2.92	0.075	94.3	<=Split					



Gravel (%): 0.0
Sand (%): 5.7
Fines (%): 94.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

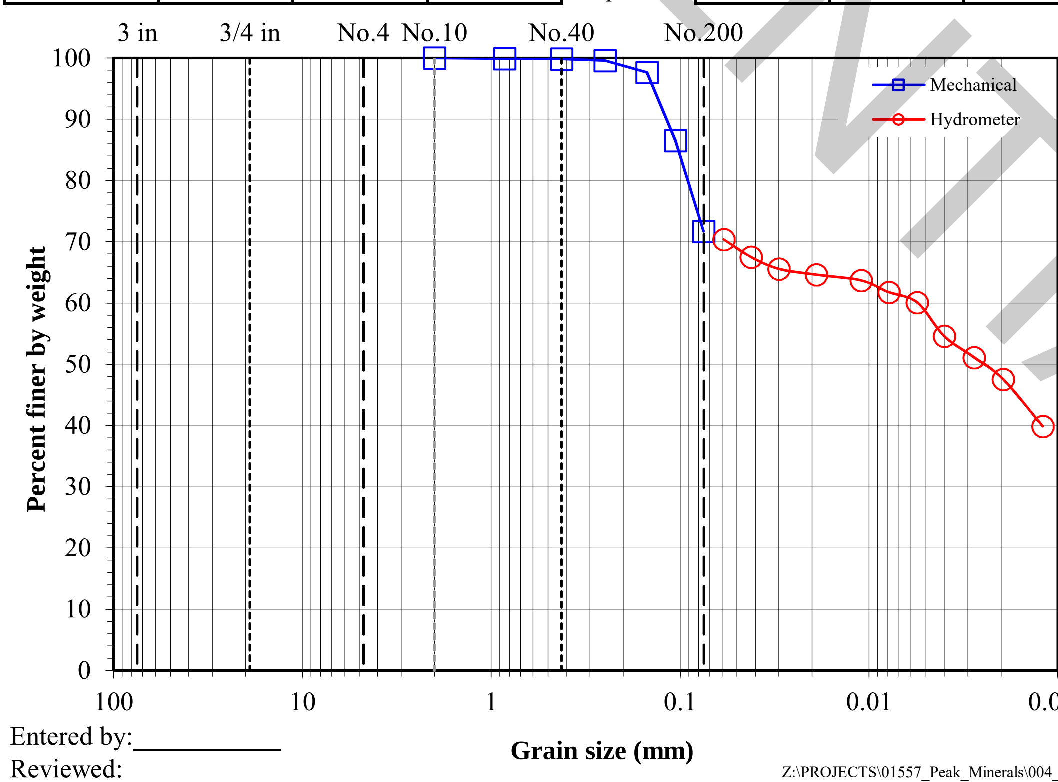
Boring No.: SN4-15-003
Sample: MC-014
Depth: 63-68'
Description: Grey clay with sand

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.14	50.36
Hydrometer fraction (g):	51.14	50.36
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	37.12	37.12
Dry soil + tare (g):	-	36.89	36.89
Tare (g):	-	22.09	22.09
Water content (%):	0.00	1.55	1.55

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	18.1	40.5	0.05880	70.39
6"	-	150	-		1	18.1	39	0.04211	67.50
4"	-	100	-		2	18.1	38	0.03002	65.58
3"	-	75	-		5	18.1	37.5	0.01906	64.62
1.5"	-	37.5	-		15	18.2	37	0.01103	63.70
3/4"	-	19	-		30	18.2	36	0.00787	61.77
3/8"	-	9.5	-		60	18.8	35	0.00557	60.10
No.4	-	4.75	-		120	19.4	32	0.00399	54.58
No.10	-	2	100.0	<=Split hyd.	250	20.3	30	0.00278	51.12
No.20	0.04	0.85	99.9		513	21	28	0.00195	47.56
No.40	0.08	0.425	99.8		1420	21	24	0.00120	39.87
No.60	0.22	0.25	99.6						
No.100	1.18	0.15	97.7						
No.140	6.78	0.106	86.5						
No.200	14.27	0.075	71.7	<=Split					



Gravel (%): 0.0
Sand (%): 28.3
Fines (%): 71.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-015
Depth: 70-73'
Description: Grey clay

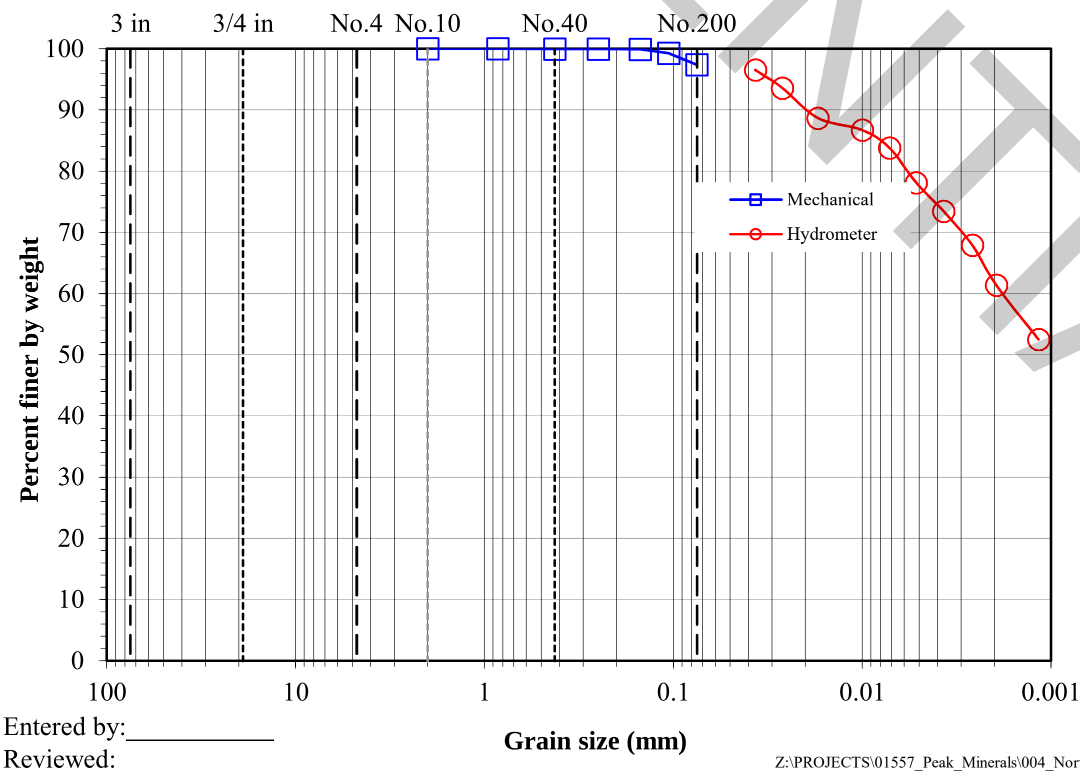
Split:	No	
	Moist	Dry
Total sample wt. (g):	50.29	49.28
Hydrometer fraction (g):	50.29	49.28
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.44	36.44
Dry soil + tare (g):	-	36.15	36.15
Tare (g):	-	22.02	22.02
Water content (%):	0.00	2.05	2.05

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.01	0.85	100.0	
No.40	0.02	0.425	100.0	
No.60	0.02	0.25	100.0	
No.100	0.06	0.15	99.9	
No.140	0.35	0.106	99.3	
No.200	1.28	0.075	97.4	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	18.2	53	0.03685	96.54
2	18.2	51.5	0.02647	93.59
5	18.2	49	0.01717	88.68
15	18.2	48	0.01001	86.71
30	18.3	46.5	0.00718	83.81
60	18.8	43.5	0.00518	78.12
120	19.4	41	0.00372	73.47
250	20.2	38	0.00262	67.92
465	21	34.5	0.00195	61.38
1399	20.9	30	0.00117	52.49



Gravel (%): 0.0
Sand (%): 2.6
Fines (%): 97.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-016
Depth: 73-78'
Description: Grey clay with sand

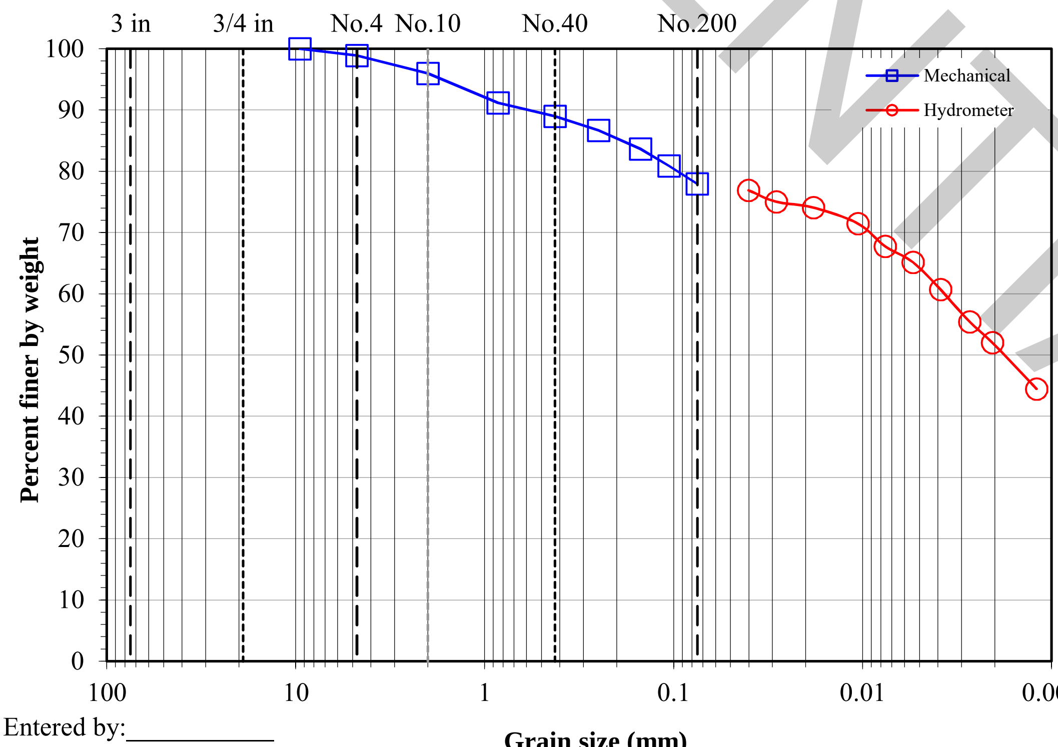
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	182.31	179.05
+#10 Coarse fraction (g):	7.22	7.20
-#10 Split fraction (g):	50.49	49.55
Hydrometer fraction (g):	50.49	49.55
Split fraction:	0.960	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	46.07	43.15	43.15
Dry soil + tare (g):	46.05	42.76	42.76
Tare (g):	37.80	22.10	22.10
Water content (%):	0.24	1.89	1.89

Hydrometer data			
Hyd. split:	No.10	Slope:	-0.1641
Gs:	2.8 Assumed	Intercept:	16.3
Bulb No.	2	α:	0.97
Dispersion period (min):	15	Hyd. fraction:	95.98
		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	1.95	4.75	98.9	
No.10	7.20	2	96.0	<=Split
No.20	2.48	0.85	91.2	
No.40	3.61	0.425	89.0	
No.60	4.81	0.25	86.7	
No.100	6.37	0.15	83.6	
No.140	7.79	0.106	80.9	
No.200	9.31	0.075	77.9	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.6	45	0.04020	76.89
2	17.6	44	0.02869	75.01
5	17.6	43.5	0.01823	74.07
15	18.1	42	0.01060	71.46
30	18.2	40	0.00761	67.75
60	18.7	38.5	0.00542	65.14
120	19.3	36	0.00388	60.70
250	20.2	33	0.00272	55.44
441	21	31	0.00206	52.02
1374	20.9	27	0.00120	44.47



Gravel (%): 1.1
Sand (%): 21.0
Fines (%): 77.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

Boring No.: SN4-15-003
Sample: MC-017
Depth: 83-88'
Description: Grey clay with sand

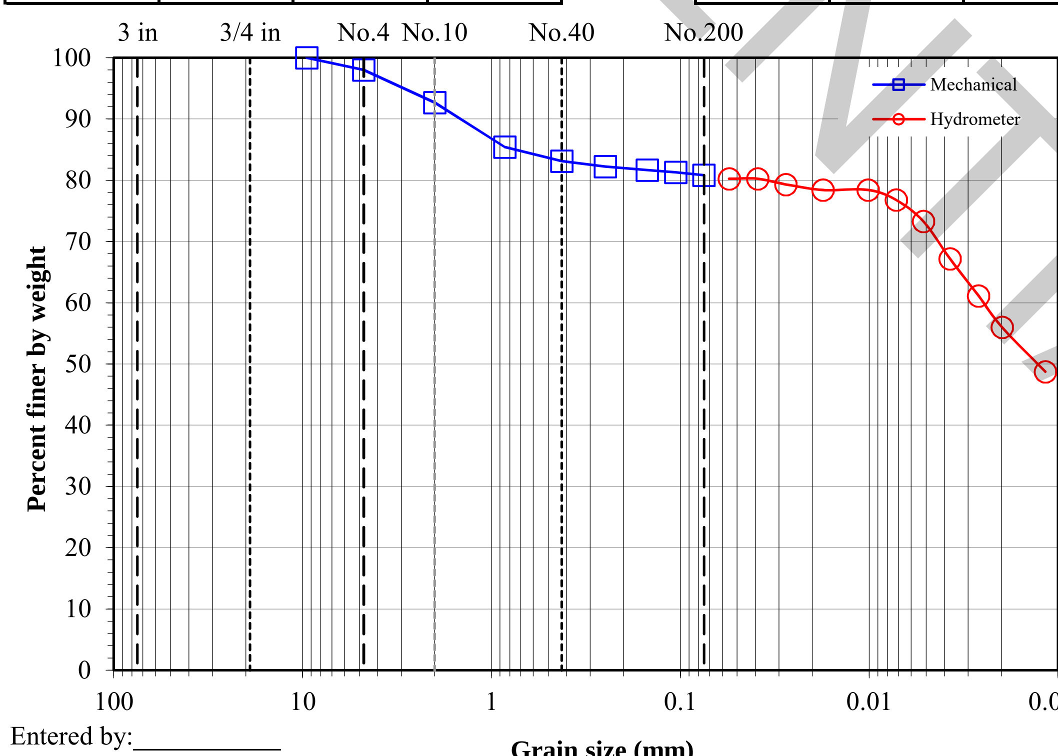
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	151.99	149.05
+#10 Coarse fraction (g):	10.97	10.87
-#10 Split fraction (g):	50.26	49.25
Hydrometer fraction (g):	50.26	49.25
Split fraction:	0.927	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	54.88	38.38	38.38
Dry soil + tare (g):	54.73	38.05	38.05
Tare (g):	37.72	22.02	22.02
Water content (%):	0.88	2.06	2.06

Hydrometer data			
		Slope:	-0.1641
Hyd. split:	No.10	Intercept:	16.3
Gs:	2.8 Assumed	α:	0.97
Bulb No.	2	Hyd. fraction:	92.71
Dispersion period (min):	15	Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	2.99	4.75	98.0	
No.10	10.87	2	92.7	<=Split
No.20	3.88	0.85	85.4	
No.40	5.10	0.425	83.1	
No.60	5.55	0.25	82.3	
No.100	5.87	0.15	81.7	
No.140	6.07	0.106	81.3	
No.200	6.30	0.075	80.8	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	17.7	48	0.05519	80.24
1	17.7	48	0.03902	80.24
2	17.7	47.5	0.02773	79.33
5	17.7	47	0.01762	78.42
15	17.7	47	0.01017	78.42
30	18.2	46	0.00722	76.79
60	18.6	44	0.00517	73.31
120	19.3	40.5	0.00374	67.20
250	20.1	37	0.00264	61.14
457	20.9	34	0.00198	55.99
1390	21	30	0.00117	48.74



Gravel (%): 2.0
Sand (%): 17.1
Fines (%): 80.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

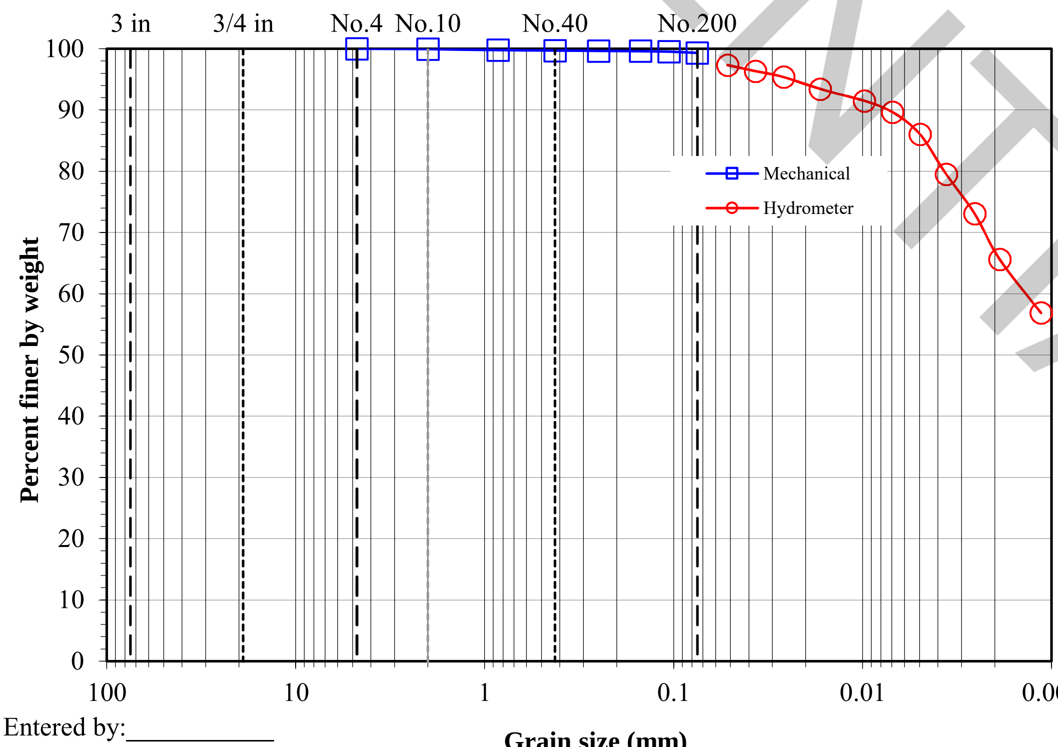
Boring No.: SN4-15-003
Sample: MC-018
Depth: 88-93'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	175.81	171.10
+#10 Coarse fraction (g):	0.11	0.11
-#10 Split fraction (g):	51.08	49.71
Hydrometer fraction (g):	51.08	49.71
Split fraction:	0.999	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.20	44.12	44.12
Dry soil + tare (g):	37.20	43.53	43.53
Tare (g):	37.03	22.12	22.12
Water content (%):	0.00	2.76	2.76

Hydrometer data			
		Slope:	-0.1641
Hyd. split:	No.10	Intercept:	16.3
Gs:	2.8 Assumed	α:	0.97
Bulb No.	2	Hyd. fraction:	99.94
Dispersion period (min):	15	Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.6	54	0.05193	97.33
6"	-	150	-		1	17.6	53.5	0.03692	96.36
4"	-	100	-		2	17.6	53	0.02625	95.38
3"	-	75	-		5	17.6	52	0.01678	93.44
1.5"	-	37.5	-		15	17.6	51	0.00979	91.49
3/4"	-	19	-		30	17.9	50	0.00697	89.67
3/8"	-	9.5	-		60	18.6	48	0.00498	86.07
No.4	-	4.75	100.0		120	19.2	44.5	0.00361	79.51
No.10	0.11	2	99.9	<=Split	250	20.1	41	0.00255	73.08
No.20	0.06	0.85	99.8		481	20.9	37	0.00188	65.63
No.40	0.12	0.425	99.7		1415	20.9	32.5	0.00114	56.87
No.60	0.15	0.25	99.6						
No.100	0.16	0.15	99.6						
No.140	0.21	0.106	99.5						
No.200	0.31	0.075	99.3						



Gravel (%): 0.0
Sand (%): 0.7
Fines (%): 99.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (III)
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: BRR

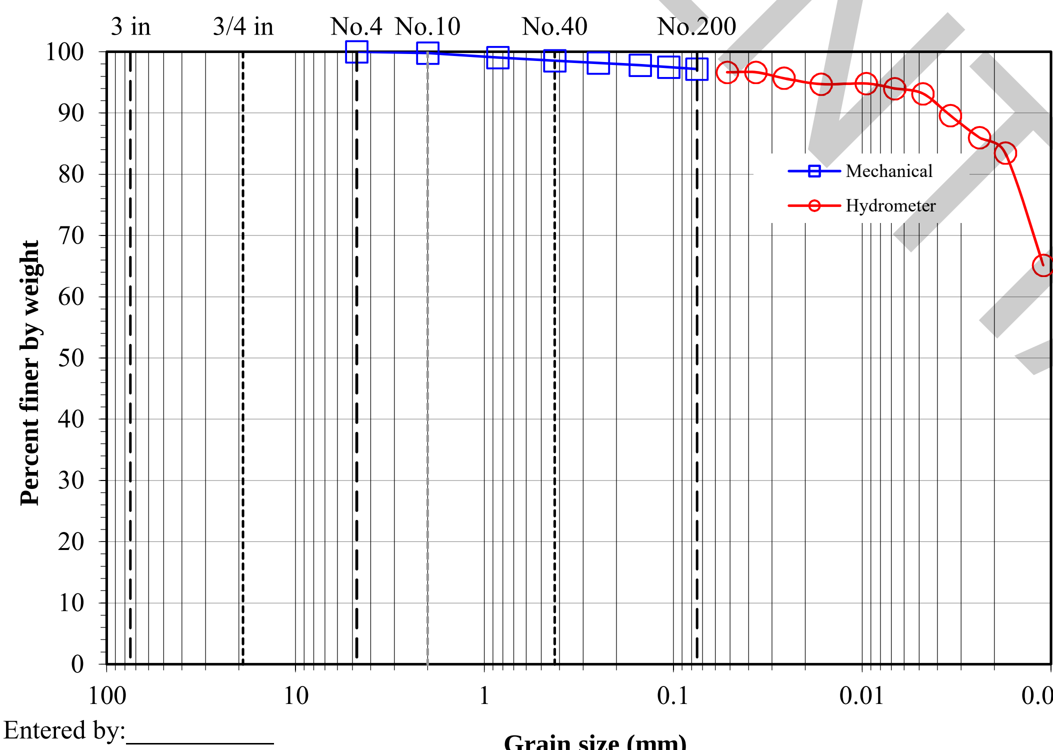
Boring No.: SN4-15-003
Sample: MC-019
Depth: 93-96'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	163.30	159.69
+#10 Coarse fraction (g):	0.37	0.37
-#10 Split fraction (g):	51.15	50.02
Hydrometer fraction (g):	51.15	50.02
Split fraction:	0.998	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.75	39.96	39.96
Dry soil + tare (g):	37.75	39.56	39.56
Tare (g):	37.32	21.92	21.92
Water content (%):	0.00	2.27	2.27

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	99.77
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	17.8	54	0.05181	96.66
6"	-	150	-		1	17.8	54	0.03664	96.66
4"	-	100	-		2	17.8	53.5	0.02605	95.69
3"	-	75	-		5	17.8	53	0.01656	94.73
1.5"	-	37.5	-		15	18	53	0.00954	94.81
3/4"	-	19	-		30	18.4	52.5	0.00675	94.01
3/8"	-	9.5	-		60	18.7	52	0.00478	93.17
No.4	-	4.75	100.0		120	19.4	50	0.00342	89.61
No.10	0.37	2	99.8	<=Split	250	20	48	0.00240	86.00
No.20	0.35	0.85	99.1		473	20.9	46.5	0.00175	83.48
No.40	0.61	0.425	98.6		1407	21	37	0.00110	65.17
No.60	0.79	0.25	98.2						
No.100	0.99	0.15	97.8						
No.140	1.14	0.106	97.5						
No.200	1.30	0.075	97.2						



Gravel (%): 0.0
Sand (%): 2.8
Fines (%): 97.2

Entered by:___________
Reviewed:___________

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Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

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Project: **Norwest Corporation**
No: **01557-004 (III)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/6/2015
By: JDF

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-003	SN4-15-003	SN4-15-003					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	20-22'	38-40'	61-63'					
Test Info.	Sample Weight (g):	1.00	1.00	1.00					
	Pressure Reading (psi):	3.1	2.4	3.0					
Carbonate Content, Calcite Equivalent (%)		**34**	**27**	**33**					

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (IV)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: IM/ ET

Sample Info.	Boring:	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	11/9/15	11/9/15	11/9/15	11/9/15	11/9/15	11/9/15	11/9/15	11/9/15
	Wet soil + tare (g)	373.52	408.39	471.67	431.35	451.46	395.86	422.35	373.51
	Tare (g)	127.88	124.62	126.98	127.73	123.45	123.24	127.33	121.42
	Date	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15
	Dry soil + tare (g)	341.69	349.77	395.27	362.67	383.92	321.50	342.67	315.01
	Water content, ω (%)	14.9	26.0	28.5	29.2	25.9	37.5	37.0	30.2
	Date	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15
	Dry soil + tare (g)	335.82	335.86	380.03	351.00	373.15	313.74	339.32	310.91
	Water content, ω (%)	18.1	34.3	36.2	36.0	31.4	43.1	39.2	33.0
	Date	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15
	Dry soil + tare (g)	327.70	327.63	371.90	344.70	363.35	308.40	338.12	308.52
	Water content, ω (%)	22.9	39.8	40.7	39.9	36.7	47.2	40.0	34.7
	Date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15
	Dry soil + tare (g)	307.82	319.50	363.75	339.33	351.90	303.05	337.20	306.34
	Water content, ω (%)	36.5	45.6	45.6	43.5	43.6	51.6	40.6	36.3
	Date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15
	Dry soil + tare (g)	302.84	318.37	362.58	338.62	349.74	302.14	337.10	306.03
	Water content, ω (%)	40.4	46.5	46.3	44.0	45.0	52.4	40.6	36.6
	Date	11/18/15	11/18/15	11/18/15		11/18/15	11/18/15		
	Dry soil + tare (g)	299.35	317.56	361.73		348.15	301.45		
	Water content, ω (%)	43.3	47.1	46.8		46.0	53.0		
	Date	11/19/15	11/19/15	11/19/15		11/19/15	11/19/15		
	Dry soil + tare (g)	296.83	317.17	361.33		347.21	301.05		
	Water content, ω (%)	45.4	47.4	47.1		46.6	53.3		
	Date	11/24/15				11/24/15			
	Dry soil + tare (g)	290.49				344.59			
	Water content, ω (%)	51.1				48.3			
	Date	11/25/15							
	Dry soil + tare (g)	289.66							
	Water content, ω (%)	51.8							
	Date	11/30/15							
	Dry soil + tare (g)	289.56							
	Water content, ω (%)	51.9							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**51.9**	**47.4**	**47.1**	**44.0**	**48.3**	**53.3**	**40.6**	**36.6**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004**
Location: Peak Minerals Sevier Lake, UT
Date: 11/24/2015
By: IM/ ET

Sample Info.	Boring:	SN4-15-004	SN4-15-004	SN4-15-004					
	Sample:	MC-009	MC-010	MC-011					
	Depth:	38-43'	43-48'	49-53'					
Water Content Determination	Initial date	11/9/15	11/9/15	11/9/15					
	Wet soil + tare (g)	391.94	422.51	393.16					
	Tare (g)	124.39	153.19	125.05					
	Date	11/11/15	11/11/15	11/11/15					
	Dry soil + tare (g)	330.66	360.21	340.98					
	Water content, ω (%)	29.7	30.1	24.2					
	Date	11/12/15	11/12/15	11/12/15					
	Dry soil + tare (g)	327.19	357.17	339.45					
	Water content, ω (%)	31.9	32.0	25.1					
	Date	11/13/15	11/13/15	11/13/15					
	Dry soil + tare (g)	325.13	356.04	338.78					
	Water content, ω (%)	33.3	32.8	25.4					
	Date	11/16/15	11/16/15	11/16/15					
	Dry soil + tare (g)	322.95	355.14	338.07					
	Water content, ω (%)	34.7	33.4	25.9					
	Date	11/17/15	11/17/15	11/17/15					
	Dry soil + tare (g)	322.58	355.03	338.08					
	Water content, ω (%)	35.0	33.4	25.9					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**35.0**	**33.4**	**25.9**					
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\IV\[M140v1.xlsm]2

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

IGES

Project: **Norwest Corporation**
No: **01557-004 (IV)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/25/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004	SN4-15-004
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	3.9	3.7	4.4	4.4	4.9	4.0	2.3	2.9
Carbonate Content, Calcite Equivalent (%)		**44**	**42**	**50**	**49**	**56**	**45**	**26**	**32**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (IV)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/18/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-004	SN4-15-004	SN4-15-004					
	Sample:	MC-009	MC-010	MC-011					
	Depth:	38-43'	43-48'	49-53'					
Test Info.	Sample Weight (g):	1.00	1.00	1.00					
	Pressure Reading (psi):	3.2	3.7	2.5					
Carbonate Content, Calcite Equivalent (%)		**35**	**41**	**28**					

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (V)
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	11/9/15	11/9/15	11/9/15	11/9/15	11/9/15	11/10/15	11/10/15	11/10/15
	Wet soil + tare (g)	417.04	383.37	371.11	350.17	428.00	434.87	440.66	538.73
	Tare (g)	120.98	124.11	127.02	123.41	151.53	127.44	127.31	121.48
	Date	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15
	Dry soil + tare (g)	384.02	352.44	320.50	291.60	372.13	364.69	357.88	461.19
	Water content, ω (%)	12.6	13.5	26.2	34.8	25.3	29.6	35.9	22.8
	Date	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15
	Dry soil + tare (g)	379.13	346.66	310.80	289.59	360.37	353.88	351.67	446.36
	Water content, ω (%)	14.7	16.5	32.8	36.5	32.4	35.8	39.7	28.4
	Date	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15
	Dry soil + tare (g)	373.12	340.44	304.94	289.04	352.97	349.75	349.72	438.01
	Water content, ω (%)	17.4	19.8	37.2	36.9	37.2	38.3	40.9	31.8
	Date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15
	Dry soil + tare (g)	348.62	327.00	299.97	288.62	346.50	346.93	348.16	428.60
	Water content, ω (%)	30.1	27.8	41.1	37.3	41.8	40.1	41.9	35.9
	Date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15
	Dry soil + tare (g)	339.59	323.57	299.57	288.52	345.50	346.56	347.90	426.98
	Water content, ω (%)	35.4	30.0	41.5	37.3	42.5	40.3	42.1	36.6
	Date	11/18/15	11/18/15			11/18/15			11/18/15
	Dry soil + tare (g)	330.92	320.50			344.86			425.62
	Water content, ω (%)	41.0	32.0			43.0			37.2
	Date	11/19/15	11/19/15						11/19/15
	Dry soil + tare (g)	323.69	318.20						424.75
	Water content, ω (%)	46.1	33.6						37.6
	Date	11/20/15	11/20/15						11/20/15
	Dry soil + tare (g)	318.62	316.46						424.15
	Water content, ω (%)	49.8	34.8						37.9
	Date	11/23/15	11/23/15						
	Dry soil + tare (g)	311.83	313.18						
	Water content, ω (%)	55.1	37.1						
	Date	11/24/15	11/24/15						
	Dry soil + tare (g)	311.30	312.82						
	Water content, ω (%)	55.6	37.4						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**55.6**	**37.4**	**41.5**	**37.3**	**43.0**	**40.3**	**42.1**	**37.9**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (V)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	49.5-53'	53-58'	58-63'	63-68'	68-73'	73-78'
Water Content Determination	Initial date	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15
	Wet soil + tare (g)	543.04	580.27	412.88	493.32	521.70	458.38	507.64	461.59
	Tare (g)	127.41	123.32	123.59	126.81	128.76	122.67	122.35	128.36
	Date	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15
	Dry soil + tare (g)	489.30	556.30	364.50	418.21	447.08	390.28	424.65	392.86
	Water content, ω (%)	14.8	5.5	20.1	25.8	23.4	25.4	27.5	26.0
	Date	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15
	Dry soil + tare (g)	481.80	544.13	355.99	406.92	435.03	383.77	410.36	382.60
	Water content, ω (%)	17.3	8.6	24.5	30.8	28.3	28.6	33.8	31.1
	Date	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15
	Dry soil + tare (g)	476.75	533.09	352.24	401.49	429.39	382.08	404.72	377.99
	Water content, ω (%)	19.0	11.5	26.5	33.4	30.7	29.4	36.4	33.5
	Date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15
	Dry soil + tare (g)	467.76	503.15	347.26	395.63	424.00	380.46	400.42	373.46
	Water content, ω (%)	22.1	20.3	29.3	36.3	33.1	30.2	38.6	36.0
	Date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15
	Dry soil + tare (g)	464.58	500.09	345.98	394.39	423.21	380.26	399.63	372.62
	Water content, ω (%)	23.3	21.3	30.1	37.0	33.4	30.3	39.0	36.4
	Date	11/18/15	11/18/15	11/18/15	11/18/15				
	Dry soil + tare (g)	461.36	498.93	344.78	393.45				
	Water content, ω (%)	24.5	21.7	30.8	37.5				
	Date	11/19/15		11/19/15					
	Dry soil + tare (g)	458.74		343.81					
	Water content, ω (%)	25.4		31.4					
	Date	11/20/15		11/20/15					
	Dry soil + tare (g)	456.16		342.94					
	Water content, ω (%)	26.4		31.9					
	Date	11/23/15		11/23/15					
	Dry soil + tare (g)	448.98		340.76					
	Water content, ω (%)	29.3		33.2					
	Date	11/24/15							
	Dry soil + tare (g)	447.19							
	Water content, ω (%)	30.0							
	Date	11/30/15							
	Dry soil + tare (g)	435.26							
	Water content, ω (%)	35.0							
	Date	12/1/15							
	Dry soil + tare (g)	435.26							
	Water content, ω (%)	35.0							
	[1]Water content, ω (%)	**35.0**	**21.7**	**33.2**	**37.5**	**33.4**	**30.3**	**39.0**	**36.4**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\V\[M140v1.xlsm]2

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (V)
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-005	SN4-15-005	SN4-15-005					
	Sample:	MC-017	MC-018	MC-019					
	Depth:	78-83'	83-88'	88-93'					
Water Content Determination	Initial date	11/10/15	11/10/15	11/10/15					
	Wet soil + tare (g)	525.73	473.67	493.55					
	Tare (g)	112.19	127.19	123.51					
	Date	11/11/15	11/11/15	11/11/15					
	Dry soil + tare (g)	441.84	399.09	418.27					
	Water content, ω (%)	25.4	27.4	25.5					
	Date	11/12/15	11/12/15	11/12/15					
	Dry soil + tare (g)	430.64	390.55	407.79					
	Water content, ω (%)	29.9	31.6	30.2					
	Date	11/13/15	11/13/15	11/13/15					
	Dry soil + tare (g)	424.61	386.06	402.52					
	Water content, ω (%)	32.4	33.8	32.6					
	Date	11/16/15	11/16/15	11/16/15					
	Dry soil + tare (g)	418.10	379.92	397.38					
	Water content, ω (%)	35.2	37.1	35.1					
	Date	11/17/15	11/17/15	11/17/15					
	Dry soil + tare (g)	416.63	378.38	396.57					
	Water content, ω (%)	35.8	37.9	35.5					
	Date	11/18/15	11/18/15						
	Dry soil + tare (g)	415.53	377.08						
	Water content, ω (%)	36.3	38.7						
	Date		11/19/15						
	Dry soil + tare (g)		376.13						
	Water content, ω (%)		39.2						
	Date		11/20/15						
	Dry soil + tare (g)		375.25						
	Water content, ω (%)		39.7						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**36.3**	**39.7**	**35.5**					
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: Norwest Corporation
No: 01557-004 (V)
Location: Peak Minerals Sevier Lake, UT
Date: 11/25/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	3.8	2.6	3.7	4.3	4.8	2.7	2.3	3.0
Carbonate Content, Calcite Equivalent (%)		**43**	**29**	**41**	**48**	**55**	**30**	**26**	**34**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (V)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/25/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005	SN4-15-005
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	49.5-53'	53-58'	58-63'	63-68'	68-73'	73-78'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	3.4	3.1	3.2	3.5	3.2	2.9	3.5	3.3
Carbonate Content, Calcite Equivalent (%)		**38**	**35**	**36**	**40**	**35**	**32**	**39**	**37**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: Norwest Corporation
No: 01557-004 (V)
Location: Peak Minerals Sevier Lake, UT
Date: 11/25/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-005	SN4-15-005	SN4-15-005					
	Sample:	MC-017	MC-018	MC-019					
	Depth:	78-83'	83-88'	88-93'					
Test Info.	Sample Weight (g):	1.00	1.00	1.00					
	Pressure Reading (psi):	3.1	3.2	4.0					
Carbonate Content, Calcite Equivalent (%)		**35**	**36**	**44**					

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (VI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: BRR / IM / ET

Sample Info.									
	Boring:	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	SH-001	MC-006	MC-007
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-24.5'	24.5-28'	28-33'
Water Content Determination	Initial date	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/10/15	11/11/15	11/11/15
	Wet soil + tare (g)	456.03	475.05	485.16	474.89	477.65	260.32	510.26	516.10
	Tare (g)	126.13	114.69	127.58	120.00	128.45	127.27	151.53	128.52
	Date	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/11/15	11/12/15	11/12/15
	Dry soil + tare (g)	422.11	421.49	413.76	405.28	393.56	220.70	446.00	421.37
	Water content, ω (%)	11.5	17.5	24.9	24.4	31.7	42.4	21.8	32.3
	Date	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/12/15	11/13/15	11/13/15
	Dry soil + tare (g)	415.64	413.88	406.11	396.53	382.50	220.09	426.91	408.82
	Water content, ω (%)	14.0	20.4	28.4	28.3	37.5	43.3	30.3	38.3
	Date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/13/15	11/16/15	11/16/15
	Dry soil + tare (g)	402.91	400.74	394.91	386.18	381.71	219.83	413.96	405.16
	Water content, ω (%)	19.2	26.0	33.8	33.3	37.9	43.7	36.7	40.1
	Date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/16/15	11/17/15	11/17/15
	Dry soil + tare (g)	397.64	396.16	390.92	383.31	381.79	219.60	412.05	404.84
	Water content, ω (%)	21.5	28.0	35.8	34.8	37.8	44.1	37.7	40.3
	Date	11/18/15	11/18/15	11/18/15	11/18/15		11/17/15	11/18/15	
	Dry soil + tare (g)	391.48	391.43	386.85	380.54		219.60	410.77	
	Water content, ω (%)	24.3	30.2	37.9	36.2		44.1	38.4	
	Date	11/19/15	11/19/15	11/19/15	11/19/15			11/19/15	
	Dry soil + tare (g)	384.09	387.31	383.61	378.27			409.89	
	Water content, ω (%)	27.9	32.2	39.7	37.4			38.8	
	Date	11/20/15	11/20/15	11/20/15	11/20/15				
	Dry soil + tare (g)	377.28	383.69	380.68	376.43				
	Water content, ω (%)	31.4	34.0	41.3	38.4				
	Date	11/23/15	11/23/15	11/23/15	11/23/15				
	Dry soil + tare (g)	350.82	373.65	371.74	371.73				
	Water content, ω (%)	46.8	39.2	46.5	41.0				
	Date	11/24/15	11/24/15	11/24/15	11/24/15				
	Dry soil + tare (g)	345.57	371.00	369.36	370.50				
	Water content, ω (%)	50.3	40.6	47.9	41.7				
	Date	11/30/15	11/30/15	11/30/15	11/30/15				
	Dry soil + tare (g)	336.76	353.83	347.75	359.08				
	Water content, ω (%)	56.6	50.7	62.4	48.4				
	Date	12/1/15	12/1/15	12/1/15	12/1/15				
	Dry soil + tare (g)	336.75	353.83	347.75	359.08				
	Water content, ω (%)	56.6	50.7	62.4	48.4				
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
[1]Water content, ω (%)		**56.6**	**50.7**	**62.4**	**48.4**	**37.8**	**44.1**	**38.8**	**40.3**
[2]Dry soil + tare (g)									
[2]Water content, ω (%)									

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

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Project: **Norwest Corporation**
No: **01557-004 (VI)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: BRR / IM / ET

Sample Info.	Boring:	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006
	Sample:	MC-008	SH-002	MC-009	SH-003	MC-010	MC-011	MC-012	MC-013
	Depth:	33-38'	38-39.5'	43-48'	48-49.5'	49.5-53'	58-63'	63-68'	68-73'
Water Content Determination	Initial date	11/11/15	11/10/15	11/11/15	11/10/15	11/11/15	11/11/15	11/11/15	11/11/15
	Wet soil + tare (g)	443.54	292.52	493.18	328.47	579.96	558.70	566.70	562.19
	Tare (g)	120.08	121.85	128.18	124.03	127.97	127.01	128.03	127.48
	Date	11/12/15	11/11/15	11/12/15	11/11/15	11/12/15	11/12/15	11/12/15	11/12/15
	Dry soil + tare (g)	373.04	240.81	410.61	274.07	479.59	473.09	474.61	467.48
	Water content, ω (%)	27.9	43.5	29.2	36.3	28.5	24.7	26.6	27.9
	Date	11/13/15	11/12/15	11/13/15	11/12/15	11/13/15	11/13/15	11/13/15	11/13/15
	Dry soil + tare (g)	358.57	239.10	397.19	268.60	458.83	448.34	446.98	443.69
	Water content, ω (%)	35.6	45.6	35.7	41.4	36.6	34.3	37.5	37.5
	Date	11/16/15	11/13/15	11/16/15	11/13/15	11/16/15	11/16/15	11/16/15	11/16/15
	Dry soil + tare (g)	349.86	238.34	390.02	266.62	451.63	439.74	438.43	434.26
	Water content, ω (%)	40.8	46.5	39.4	43.4	39.6	38.0	41.3	41.7
	Date	11/17/15	11/16/15	11/17/15	11/16/15	11/17/15	11/17/15	11/17/15	11/17/15
	Dry soil + tare (g)	348.81	237.81	389.12	265.09	450.73	438.65	437.21	433.11
	Water content, ω (%)	41.4	47.2	39.9	44.9	40.0	38.5	41.9	42.2
	Date	11/18/15	11/17/15		11/17/15			11/18/15	11/18/15
	Dry soil + tare (g)	347.96	237.88		265.01			436.44	432.30
	Water content, ω (%)	41.9	47.1		45.0			42.2	42.6
	Date	11/19/15							
	Dry soil + tare (g)	347.47							
	Water content, ω (%)	42.2							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**42.2**	**47.1**	**39.9**	**45.0**	**40.0**	**38.5**	**42.2**	**42.6**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (VI)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: BRR / IM / ET

Sample Info.	Boring:	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006	SN4-15-006		
	Sample:	MC-014	MC-015	MC-016	MC-017	MC-018	MC-019		
	Depth:	73-78'	78-83'	83-88'	88-93'	93-98'	98-100'		
Water Content Determination	Initial date	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15	11/11/15		
	Wet soil + tare (g)	425.32	418.43	483.46	442.95	451.06	451.08		
	Tare (g)	127.48	127.36	127.00	121.32	128.14	127.51		
	Date	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15	11/12/15		
	Dry soil + tare (g)	350.06	340.38	407.37	364.51	376.58	390.10		
	Water content, ω (%)	33.8	36.6	27.1	32.3	30.0	23.2		
	Date	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15	11/13/15		
	Dry soil + tare (g)	345.52	329.60	381.02	353.08	371.74	388.11		
	Water content, ω (%)	36.6	43.9	40.3	38.8	32.6	24.2		
	Date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15		
	Dry soil + tare (g)	345.07	328.09	377.04	351.44	371.46	387.84		
	Water content, ω (%)	36.9	45.0	42.6	39.8	32.7	24.3		
	Date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15		
	Dry soil + tare (g)	345.20	328.16	376.90	351.43	371.45	387.79		
	Water content, ω (%)	36.8	45.0	42.6	39.8	32.7	24.3		
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**36.8**	**45.0**	**42.6**	**39.8**	**32.7**	**24.3**		
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (VI)
Location: Peak Minerals Sevier Lake, UT
Date: 11/18/2015
By: BRR

Sample Info.	Boring No.	SN4-15-006	SN4-15-006	SN4-15-006						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	23-24.5'	38-39.5'	48-49.5'						
Unit Weight Info.	Sample height, H (in)	3.964	4.948	4.525						
	Sample diameter, D (in)	2.829	2.796	2.839						
	Sample volume, V (ft^3)	0.0144	0.0176	0.0166						
	Mass rings + wet soil (g)	742.06	946.67	842.86						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist soil, Ws (g)	742.06	946.67	842.86						
	Moist unit wt., γ_m (pcf)	113.46	118.71	112.10						
Water Content	Wet soil + tare (g)	260.32	292.52	328.47						
	Dry soil + tare (g)	219.60	237.88	265.01						
	Tare (g)	127.27	121.85	124.03						
Water Content, w (%)		**44.1**	**47.1**	**45.0**						
Dry Unit Wt., γ_d (pcf)		**78.7**	**80.7**	**77.3**						

Entered by:___________

Reviewed:___________

Porosity of Soil

Project: **Norwest Corporation**
No: **01557-004 (VI)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/18/2015
By: BRR

Sample Info.	Boring No.	SN4-15-006	SN4-15-006	SN4-15-006
	Sample:	SH-001	SH-002	SH-003
	Depth:	23-24.5'	38-39.5'	48-49.5'
Unit Weight Data	Sample height, H (in)	3.964	4.948	4.525
	Sample diameter, D (in)	2.829	2.796	2.839
	Mass rings + wet soil (g)	742.06	946.67	842.86
	Mass rings/tare (g)	0.00	0.00	0.00
	Moist unit wt., γ_m (pcf)	113.5	118.7	112.1
Water Content	Wet soil + tare (g)	260.32	292.52	328.47
	Dry soil + tare (g)	219.60	237.88	265.01
	Tare (g)	127.27	121.85	124.03
	Water content (%)	44.1	47.1	45.0
	Specific gravity of solids, Gs	2.810	2.809	2.798
	Void ratio, e	1.228	1.173	1.260
	Porosity, n	0.551	0.540	0.557
	Total Soil Porosity, n (%)	**55.1**	**54.0**	**55.7**
	Water Porosity, n_w (%)	**48.4**	**52.9**	**48.5**
	Air Porosity, n_a (%)	**6.8**	**1.0**	**7.3**

Comments:
SN4-15-006 SH-001: Porosity calculated using a specific gravity of water equal to 1.15.
SN4-15-006 SH-002: Porosity calculated using a specific gravity of water equal to 1.15.
SN4-15-006 SH-003: Porosity calculated using a specific gravity of water equal to 1.15.

Entered by:___________
Reviewed:___________

Specific Gravity of Soil Solids by Water Pycnometer

(ASTM D854)

Project: Norwest Corporation
No: 01557-004 (VI)
Location: Peak Minerals Sevier Lake, UT
Date: 11/17/2015
By: DKS

Drill hole / Sample:	SN4-15-006	SN4-15-006	SN4-15-006			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	23-24.5	38-39.5	48-49.5			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, P (%)						
Pycnometer No.	1	2	3			
Mass of pycnometer (g)	167.64	184.35	170.58			
Mass of pycnometer, soil, and water, $M_{\rho ws,t}$ (g)	697.19	718.66	706.43			
Temperature, T_t (°C)	21.9	21.9	21.9			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	666.01	682.97	669.17			
Mass of tare + dry soil (g)	358.62	364.89	466.94			
Mass of tare (g)	310.22	309.49	408.96			
Mass of soil, M_s (g)	48.4	55.4	57.98			
Specific gravity of soil solids at test temperature, G_t	2.811	2.810	2.799			
Temperature coefficient, K	0.99959	0.99959	0.99959			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.810**	**2.809**	**2.798**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________

Reviewed by:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VI)
Location: Peak Minerals Sevier Lake
Date: 11/17/2015
By: BRR

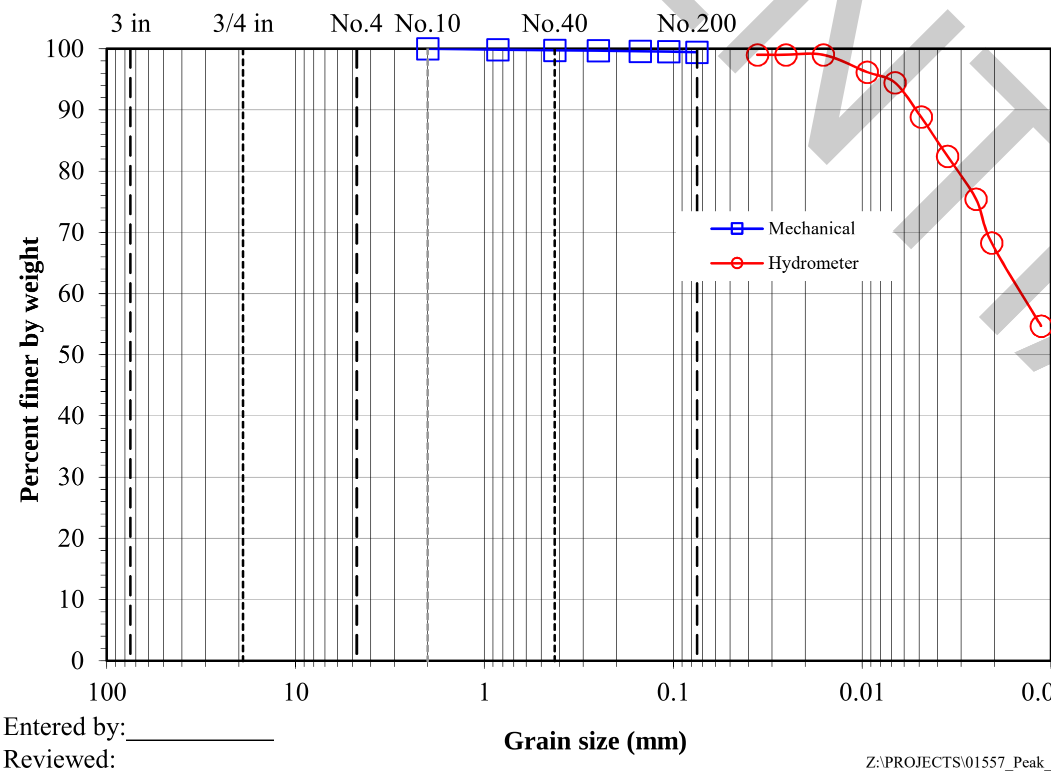
Boring No.: SN4-15-006
Sample: SH-001
Depth: 23-24.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	53.65	50.67
Hydrometer fraction (g):	53.65	50.67
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	32.16	32.16
Dry soil + tare (g):	-	31.59	31.59
Tare (g):	-	21.90	21.90
Water content (%):	0.00	5.88	5.88

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.810	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.2	56	0.03599	99.01
6"	-	150	-		2	17.2	56	0.02545	99.01
4"	-	100	-		5	17.2	56	0.01609	99.01
3"	-	75	-		15	17.3	54.5	0.00944	96.19
1.5"	-	37.5	-		30	17.7	53.5	0.00671	94.45
3/4"	-	19	-		60	18	50.5	0.00488	88.85
3/8"	-	9.5	-		120	18.7	47	0.00354	82.46
No.4	-	4.75	-		250	20.2	43	0.00250	75.46
No.10	-	2	100.0	<=Split hyd.	382	21.3	39	0.00207	68.29
No.20	0.07	0.85	99.9		1440	20.8	32	0.00113	54.73
No.40	0.12	0.425	99.8						
No.60	0.17	0.25	99.7						
No.100	0.21	0.15	99.6						
No.140	0.25	0.106	99.5						
No.200	0.29	0.075	99.4	<=Split					



Gravel (%): 0.0
Sand (%): 0.6
Fines (%): 99.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VI)
Location: Peak Minerals Sevier Lake
Date: 11/17/2015
By: BRR

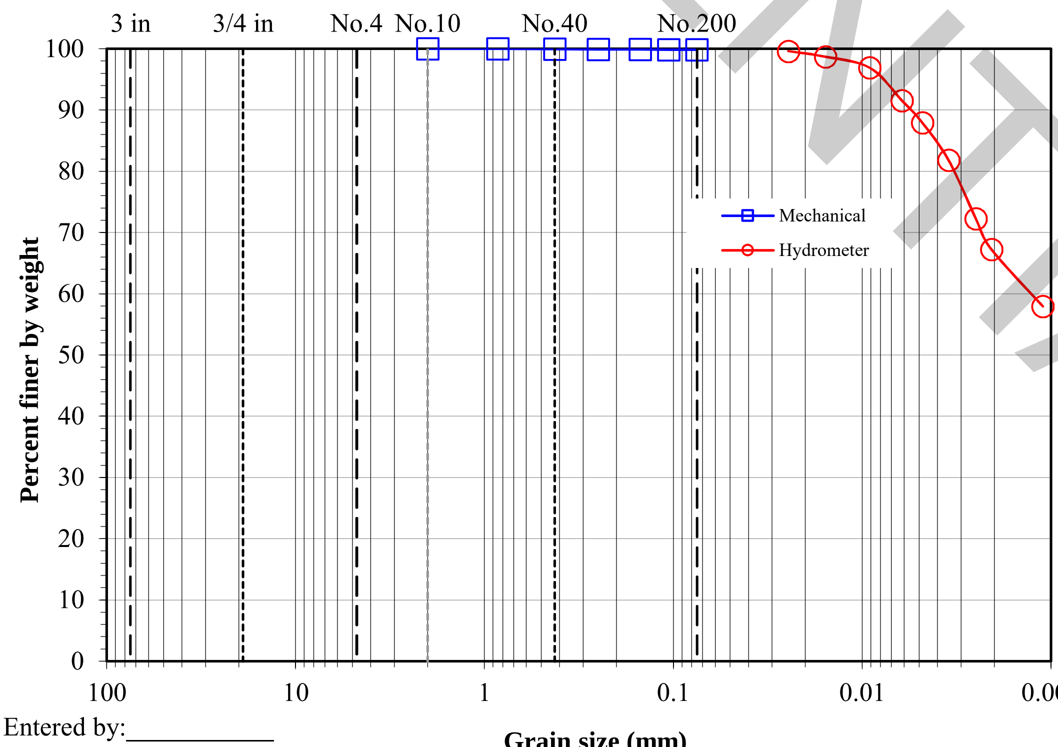
Boring No.: SN4-15-006
Sample: SH-002
Depth: 38-39.5
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	56.89	52.89
Hydrometer fraction (g):	56.89	52.89
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	31.39	31.39
Dry soil + tare (g):	-	30.73	30.73
Tare (g):	-	22.01	22.01
Water content (%):	0.00	7.57	7.57

Hydrometer data			
		Slope:	-0.1641
Hyd. split:	No.10	Intercept:	16.3
Gs:	2.809 Determined	α:	0.97
Bulb No.	2	Hyd. fraction:	100.00
Dispersion period (min):	15	Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.6	58.5	0.02458	99.61
6"	-	150	-		5	17.6	58	0.01564	98.69
4"	-	100	-		15	17.7	57	0.00913	96.90
3"	-	75	-		35	18	54	0.00616	91.54
1.5"	-	37.5	-		60	18.1	52	0.00480	87.92
3/4"	-	19	-		120	18.8	48.5	0.00349	81.80
3/8"	-	9.5	-		250	20.1	43	0.00250	72.27
No.4	-	4.75	-		375	21.2	40	0.00207	67.23
No.10	-	2	100.0	<=Split hyd.	1432	20.9	35	0.00111	57.97
No.20	0.01	0.85	100.0						
No.40	0.04	0.425	99.9						
No.60	0.05	0.25	99.9						
No.100	0.06	0.15	99.9						
No.140	0.07	0.106	99.9						
No.200	0.08	0.075	99.8	<=Split					



Gravel (%): 0.0
Sand (%): 0.2
Fines (%): 99.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VI)
Location: Peak Minerals Sevier Lake
Date: 11/18/2015
By: BRR

Boring No.: SN4-15-006
Sample: SH-003
Depth: 48-49.5'
Description: Grey clay

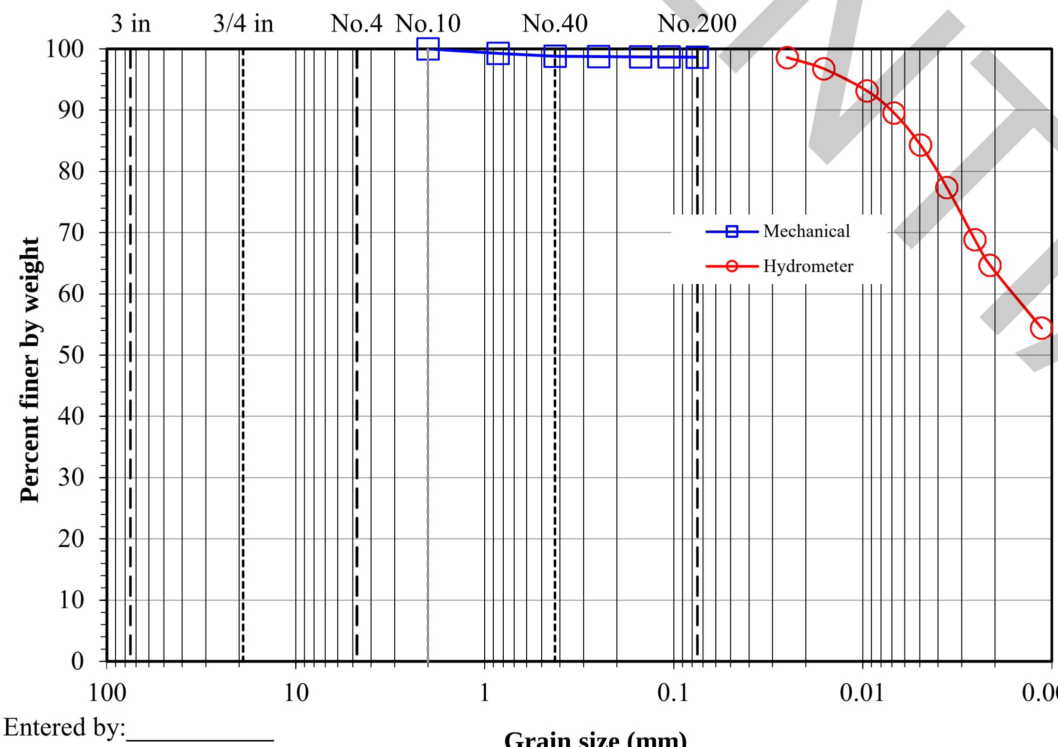
	Moist	Dry
Split:	No	
Total sample wt. (g):	55.89	52.84
Hydrometer fraction (g):	55.89	52.84
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	31.38	31.38
Dry soil + tare (g):	-	30.87	30.87
Tare (g):	-	22.04	22.04
Water content (%):	0.00	5.78	5.78

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.798	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.40	0.85	99.2	
No.40	0.63	0.425	98.8	
No.60	0.67	0.25	98.7	
No.100	0.68	0.15	98.7	
No.140	0.70	0.106	98.7	
No.200	0.72	0.075	98.6	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	16.6	58	0.02512	98.60
5	16.6	57	0.01608	96.76
15	16.7	55	0.00949	93.14
30	16.9	53	0.00684	89.55
60	17.6	50	0.00495	84.33
120	18.6	46	0.00359	77.39
250	20.2	41	0.00255	68.87
368	21.2	38.5	0.00212	64.68
1424	20.8	33	0.00113	54.44



Gravel (%): 0.0
Sand (%): 1.4
Fines (%): 98.6

Entered by:___________
Reviewed:___________

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Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (VI)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/11/2015
By: BRR

Calibration Information	
Slope:	0.11046
y-intercept:	0.00107

Sample Info.	Boring No.	SN4-15-006	SN4-15-006	SN4-15-006					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	23-24.5'	38-39.5'	48-49.5'					
Test Info.	Sample Weight (g):	1.00	1.00	1.00					
	Pressure Reading (psi):	4.8	2.9	2.4					
Carbonate Content, Calcite Equivalent (%)		**53**	**32**	**27**					

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (VII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/3/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15
	Wet soil + tare (g)	396.83	420.89	354.74	357.71	349.66	355.60	351.01	329.90
	Tare (g)	128.29	152.94	123.67	124.43	126.73	127.57	128.08	117.46
	Date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Dry soil + tare (g)	366.23	383.30	309.41	299.88	288.24	292.87	283.00	272.07
	Water content, ω (%)	12.9	16.3	24.4	33.0	38.0	37.9	43.9	37.4
	Date	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15
	Dry soil + tare (g)	348.63	365.13	288.82	292.16	282.51	286.17	276.96	265.64
	Water content, ω (%)	21.9	26.3	39.9	39.1	43.1	43.8	49.7	43.4
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15
	Dry soil + tare (g)	340.35	360.95	280.23	291.33	281.96	285.35	276.36	264.35
	Water content, ω (%)	26.6	28.8	47.6	39.8	43.6	44.5	50.3	44.6
	Date	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15
	Dry soil + tare (g)	332.48	357.72	272.97	290.79	281.58	284.74	275.94	263.18
	Water content, ω (%)	31.5	30.8	54.8	40.2	44.0	45.1	50.8	45.8
	Date	11/30/15	11/30/15	11/30/15			11/30/15		11/30/15
	Dry soil + tare (g)	309.51	349.61	262.54			281.71		259.21
	Water content, ω (%)	48.2	36.2	66.4			47.9		49.9
	Date	12/1/15	12/1/15	12/1/15			12/1/15		12/1/15
	Dry soil + tare (g)	309.50	349.61	262.53			281.69		258.70
	Water content, ω (%)	48.2	36.2	66.4			48.0		50.4
	Date								12/2/15
	Dry soil + tare (g)								258.12
	Water content, ω (%)								51.0
	Date								12/3/15
	Dry soil + tare (g)								257.72
	Water content, ω (%)								51.5
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
[1]Water content, ω (%)		**48.2**	**36.2**	**66.4**	**40.2**	**44.0**	**48.0**	**50.8**	**51.5**
[2]Dry soil + tare (g)									
[2]Water content, ω (%)									

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (VII)
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	48-53'	54.5-58'	58-63'	63-68'	68-73'	73-78'
Water Content Determination	Initial date	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15
	Wet soil + tare (g)	359.84	344.50	376.67	339.11	357.00	380.53	342.81	448.84
	Tare (g)	128.62	118.35	122.89	122.63	123.34	123.83	127.67	224.04
	Date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Dry soil + tare (g)	294.69	277.11	319.42	283.20	293.35	309.91	282.19	385.10
	Water content, ω (%)	39.2	42.4	29.1	34.8	37.4	38.0	39.2	39.6
	Date	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15
	Dry soil + tare (g)	289.56	272.54	317.12	279.89	290.80	307.60	281.24	384.33
	Water content, ω (%)	43.7	46.7	30.7	37.7	39.5	39.7	40.1	40.2
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15		
	Dry soil + tare (g)	288.79	271.94	316.79	279.52	290.50	307.31		
	Water content, ω (%)	44.4	47.2	30.9	38.0	39.8	39.9		
	Date	11/25/15	11/25/15						
	Dry soil + tare (g)	288.20	271.54						
	Water content, ω (%)	44.9	47.6						
	Date	11/30/15							
	Dry soil + tare (g)	286.79							
	Water content, ω (%)	46.2							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**46.2**	**47.6**	**30.9**	**38.0**	**39.8**	**39.9**	**40.1**	**40.2**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (VII)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-007	SN4-15-007						
	Sample:	MC-017	MC-018						
	Depth:	78-83'	83-88'						
Water Content Determination	Initial date	11/18/15	11/18/15						
	Wet soil + tare (g)	456.17	347.75						
	Tare (g)	210.99	128.46						
	Date	11/20/15	11/20/15						
	Dry soil + tare (g)	385.41	302.51						
	Water content, ω (%)	40.6	26.0						
	Date	11/23/15	11/23/15						
	Dry soil + tare (g)	384.41	302.27						
	Water content, ω (%)	41.4	26.2						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**41.4**	**26.2**						
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\VII\[M140v1.xlsm]3

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: Norwest Corporation
No: 01557-004 (VII)
Location: Peak Minerals Sevier Lake
Date: 12/3/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

		SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007
Sample Info.	Boring No.	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	4.4	3.7	4.2	4.2	4.1	4.4	5.1	3.5
Carbonate Content, Calcite Equivalent (%)		**50**	**42**	**48**	**48**	**47**	**50**	**58**	**40**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (VII)**
Location: Peak Minerals Sevier Lake
Date: 12/1/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007	SN4-15-007
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	48-53'	54.5-58'	58-63'	63-68'	68-73'	73-78'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	2.7	2.7	3.4	2.7	2.5	2.4	3.2	2.4
Carbonate Content, Calcite Equivalent (%)		**30**	**30**	**38**	**30**	**28**	**27**	**36**	**27**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (VII)**
Location: Peak Minerals Sevier Lake
Date: 11/24/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-007	SN4-15-007						
	Sample:	MC-017	MC-018						
	Depth:	78-83'	83-88'						
Test Info.	Sample Weight (g):	1.00	1.00						
	Pressure Reading (psi):	2.4	2.8						
Carbonate Content, Calcite Equivalent (%)		**27**	**31**						

Entered by:___________

Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	14.5-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/18/15	11/20/15	11/20/15
	Wet soil + tare (g)	339.03	319.22	341.95	341.34	361.66	336.73	352.83	336.60
	Tare (g)	123.07	123.45	127.81	127.35	128.34	129.04	128.57	127.37
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15
	Dry soil + tare (g)	303.55	253.20	261.83	264.10	302.75	268.03	281.90	265.61
	Water content, ω (%)	19.7	50.9	59.8	56.5	33.8	49.4	46.3	51.4
	Date	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15
	Dry soil + tare (g)	299.75	252.10	259.70	262.59	302.75	267.87	281.60	264.87
	Water content, ω (%)	22.2	52.2	62.4	58.2	33.8	49.6	46.5	52.2
	Date	11/30/15	11/30/15	11/30/15	11/30/15				11/30/15
	Dry soil + tare (g)	261.61	248.26	253.39	255.32				263.45
	Water content, ω (%)	55.9	56.9	70.5	67.2				53.8
	Date	12/1/15	12/1/15	12/1/15	12/1/15				
	Dry soil + tare (g)	261.55	248.16	253.27	255.32				
	Water content, ω (%)	56.0	57.0	70.7	67.2				
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**56.0**	**57.0**	**70.7**	**67.2**	**33.8**	**49.6**	**46.5**	**53.8**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	39.5-43'	43-48'	49.5-53'	54.5-58'	58-63'	63-68'	68-73'	73-78'
Water Content Determination	Initial date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Wet soil + tare (g)	324.39	361.66	382.76	309.52	334.17	353.11	368.72	326.23
	Tare (g)	119.89	139.81	121.75	122.54	127.48	127.00	120.56	127.96
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15
	Dry soil + tare (g)	260.90	298.65	301.18	248.50	276.47	287.88	300.08	269.70
	Water content, ω (%)	45.0	39.7	45.5	48.4	38.7	40.5	38.2	39.9
	Date	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15
	Dry soil + tare (g)	260.71	298.48	300.77	247.68	276.18	287.71	300.08	269.69
	Water content, ω (%)	45.2	39.8	45.8	49.4	39.0	40.7	38.2	39.9
	Date				11/30/15				
	Dry soil + tare (g)				244.61				
	Water content, ω (%)				53.2				
	Date				12/1/15				
	Dry soil + tare (g)				244.49				
	Water content, ω (%)				53.3				
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**45.2**	**39.8**	**45.8**	**53.3**	**39.0**	**40.7**	**38.2**	**39.9**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008	SN4-15-008
	Sample:	MC-017	MC-018	MC-019	MC-020	MC-021	SH-001	SH-002	SH-003
	Depth:	78-83'	83-88'	88-93'	93-98'	98-100'	13-14.5'	38-39.5'	48-49.5'
Water Content Determination	Initial date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/24/15	11/24/15	11/24/15
	Wet soil + tare (g)	342.09	311.40	395.13	341.56	353.36	281.76	315.16	287.87
	Tare (g)	128.19	121.31	121.86	122.44	128.14	127.71	128.86	128.45
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/25/15	11/25/15	11/25/15
	Dry soil + tare (g)	287.52	260.58	306.92	289.66	297.07	231.51	254.01	236.93
	Water content, ω (%)	34.2	36.5	47.7	31.0	33.3	48.4	48.9	47.0
	Date	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/30/15	11/30/15	11/30/15
	Dry soil + tare (g)	287.34	260.33	306.79	289.19	296.35	215.76	253.44	235.88
	Water content, ω (%)	34.4	36.7	47.8	31.4	33.9	75.0	49.5	48.4
	Date					11/30/15	12/1/15		
	Dry soil + tare (g)					294.80	215.74		
	Water content, ω (%)					35.1	75.0		
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
[1]Water content, ω (%)		**34.4**	**36.7**	**47.8**	**31.4**	**35.1**	**75.0**	**49.5**	**48.4**
[2]Dry soil + tare (g)									
[2]Water content, ω (%)									

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

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Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: **Norwest Corporation**
No: **01557-004 (VIII)**
Location: Peak Mineral Sevier Lake, UT
Date: 12/1/2015
By: ET

Sample Info.	Boring No.	SN4-15-008	SN4-15-008	SN4-15-008						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	13-14.5'	38-39.5'	48-49.5'						
Unit Weight Info.	Sample height, H (in)	5.785	5.292	5.644						
	Sample diameter, D (in)	2.829	2.870	2.852						
	Sample volume, V (ft^3)	0.0210	0.0198	0.0209						
	Mass rings + wet soil (g)	948.56	1413.77	1487.93						
	Mass rings/tare (g)	0.00	454.78	454.78						
	Moist soil, Ws (g)	948.56	958.99	1033.15						
	Moist unit wt., γ_m (pcf)	99.38	106.71	109.16						
Water Content	Wet soil + tare (g)	281.76	315.16	287.87						
	Dry soil + tare (g)	215.74	253.44	235.88						
	Tare (g)	127.71	128.86	128.45						
Water Content, w (%)		**75.0**	**49.5**	**48.4**						
Dry Unit Wt., γ_d (pcf)		**56.8**	**71.4**	**73.6**						

Entered by:___________
Reviewed:___________

Porosity of Soil

Project: **Norwest Corporation**
No: **01557-004 (VIII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/4/2015
By: BRR

Sample Info.	Boring No.	SN4-15-008	SN4-15-008	SN4-15-008					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	13-14.5'	38-39.5'	48-49.5'					
Unit Weight Data	Sample height, H (in)	5.785	5.292	5.644					
	Sample diameter, D (in)	2.829	2.870	2.852					
	Mass rings + wet soil (g)	948.56	1413.77	1487.93					
	Mass rings/tare (g)	0.00	454.78	454.78					
	Moist unit wt., γ_m (pcf)	99.4	106.7	109.2					
Water Content	Wet soil + tare (g)	281.76	315.16	287.87					
	Dry soil + tare (g)	215.74	253.44	235.88					
	Tare (g)	127.71	128.86	128.45					
	Water content (%)	75.0	49.5	48.4					
	Specific gravity of solids, Gs	2.754	2.812	2.788					
	Void ratio, e	2.028	1.460	1.366					
	Porosity, n	0.670	0.594	0.577					
	Total Soil Porosity, n (%)	**67.0**	**59.4**	**57.7**					
	Water Porosity, n_w (%)	**59.3**	**49.2**	**49.6**					
	Air Porosity, n_a (%)	**7.6**	**10.1**	**8.1**					
	Comments:	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.					

Entered by:___________
Reviewed:___________

Specific Gravity of Soil Solids by Water Pycnometer

(ASTM D854)

Project: **Norwest Corporation**
No: **01557-004 (VIII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/4/2015
By: BRR

Drill hole / Sample:	SN4-15-008	SN4-15-008	SN4-15-008			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	13-14.5'	38-39.5'	48-49.5'			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, P (%)	100	100	100			
Pycnometer No.	2	3	8			
Mass of pycnometer (g)	184.34	170.57	188.9			
Mass of pycnometer, soil, and water, $M_{\rho ws,t}$ (g)	719.29	707.79	726.53			
Temperature, T_t (°C)	21.8	21.8	21.8			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	682.98	669.18	687.55			
Mass of tare + dry soil (g)	367.21	370.54	370.24			
Mass of tare (g)	310.21	310.63	309.46			
Mass of soil, M_s (g)	57	59.91	60.78			
Specific gravity of soil solids at test temperature, G_t	2.755	2.813	2.789			
Temperature coefficient, K	0.99961	0.99961	0.99961			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.754**	**2.812**	**2.788**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________

Reviewed by:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

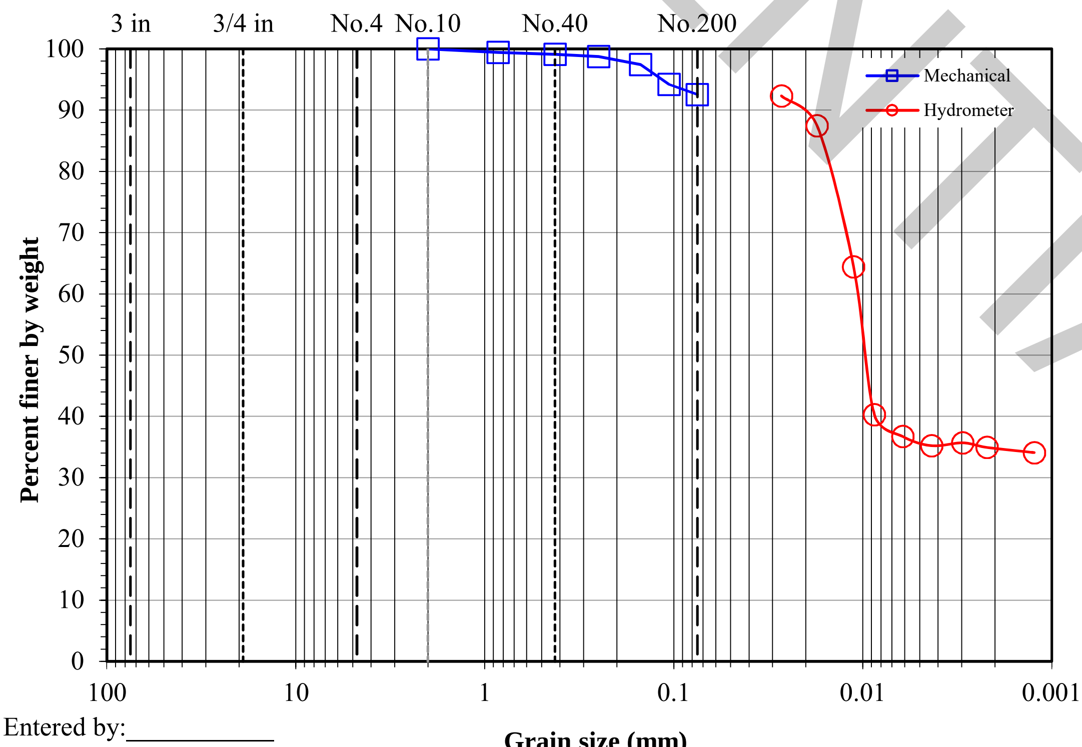
Boring No.: SN4-15-008
Sample: MC-001
Depth: 0-3'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	51.01	50.07
Hydrometer fraction (g):	51.01	50.07
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	30.23	30.23
Dry soil + tare (g):	-	30.07	30.07
Tare (g):	-	21.58	21.58
Water content (%):	0.00	1.88	1.88

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
			Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	16.4	52	0.02694	92.32
6"	-	150	-		5	16.4	49.5	0.01748	87.49
4"	-	100	-		15	16.8	37.5	0.01119	64.44
3"	-	75	-		30	16.8	25	0.00867	40.26
1.5"	-	37.5	-		60	17.6	23	0.00615	36.73
3/4"	-	19	-		120	18.6	22	0.00432	35.22
3/8"	-	9.5	-		250	19.7	22	0.00296	35.68
No.4	-	4.75	-		448	20.2	21.5	0.00220	34.93
No.10	-	2	100.0	<=Split hyd.	1415	20.5	21	0.00124	34.09
No.20	0.28	0.85	99.4						
No.40	0.44	0.425	99.1						
No.60	0.62	0.25	98.8						
No.100	1.27	0.15	97.5						
No.140	2.91	0.106	94.2						
No.200	3.73	0.075	92.5	<=Split					



Gravel (%): 0.0
Sand (%): 7.5
Fines (%): 92.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

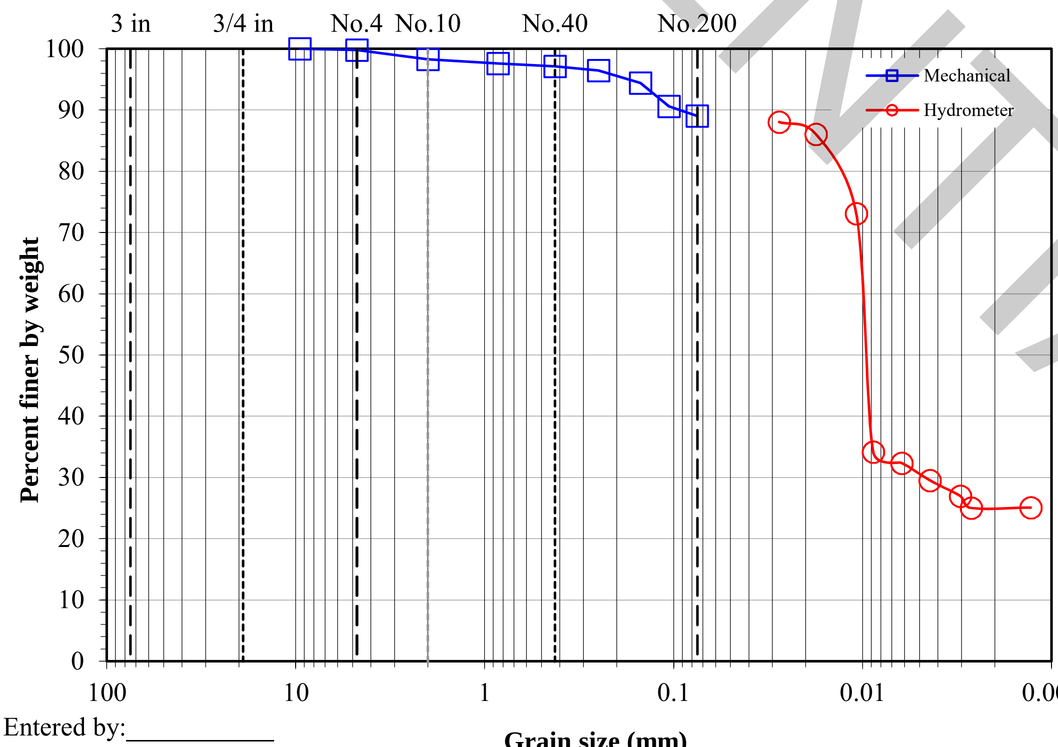
Boring No.: SN4-15-008
Sample: MC-002
Depth: 3-8'
Description: Grey clay

	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	101.01	94.50
+#10 Coarse fraction (g):	1.70	1.62
-#10 Split fraction (g):	50.83	47.53
Hydrometer fraction (g):	50.83	47.53
Split fraction:	0.983	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	50.46	31.21	31.21
Dry soil + tare (g):	49.87	30.60	30.60
Tare (g):	37.41	21.80	21.80
Water content (%):	4.74	6.93	6.93

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	98.29
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.5	48	49.00000	88.04
6"	-	150	-		5	17.5	47	0.01767	86.04
4"	-	100	-		15	17.6	40.5	0.01080	73.07
3"	-	75	-		30	17.9	21	0.00878	34.15
1.5"	-	37.5	-		60	18.4	20	0.00621	32.36
3/4"	-	19	-		120	18.8	18.5	0.00441	29.54
3/8"	-	9.5	100.0		250	19.8	17	0.00305	26.97
No.4	0.19	4.75	99.8		329	19.9	16	0.00267	25.01
No.10	1.62	2	98.3	<=Split	1400	20.1	16	0.00129	25.10
No.20	0.32	0.85	97.6						
No.40	0.56	0.425	97.1						
No.60	0.90	0.25	96.4						
No.100	1.87	0.15	94.4						
No.140	3.72	0.106	90.6						
No.200	4.47	0.075	89.0						



Gravel (%): 0.2
Sand (%): 10.8
Fines (%): 89.0

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-003
Depth: 8-13'
Description: Grey clay

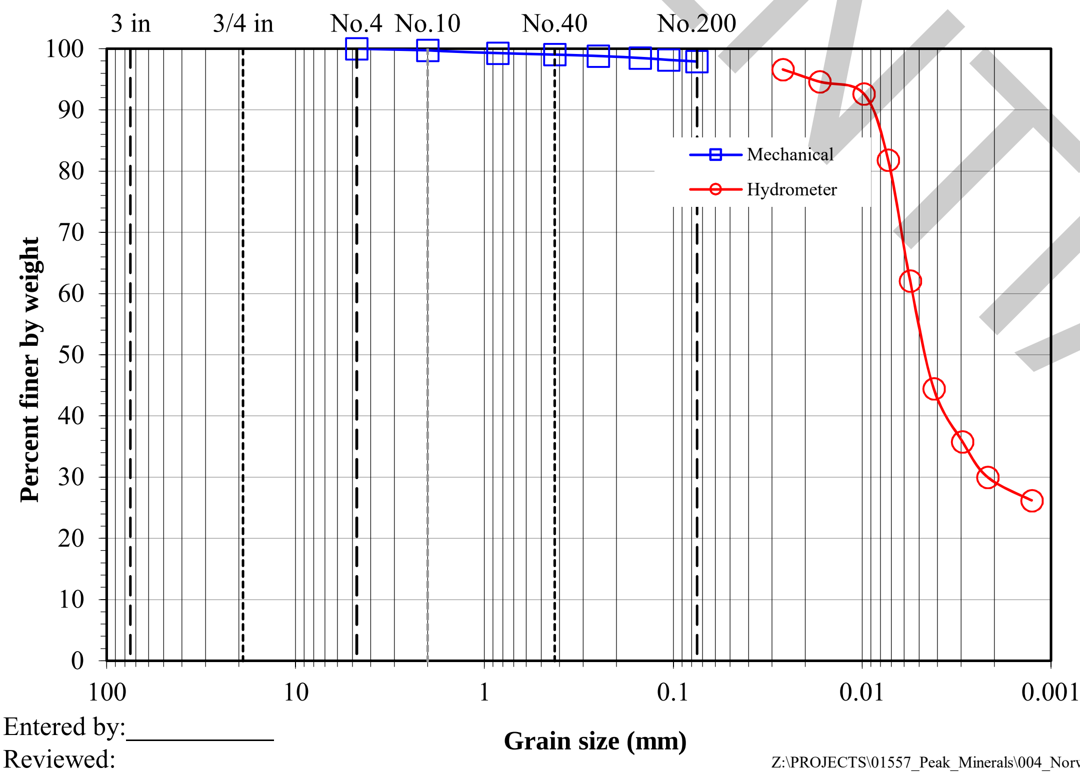
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	123.92	118.43
+#10 Coarse fraction (g):	0.28	0.28
-#10 Split fraction (g):	50.82	48.56
Hydrometer fraction (g):	50.82	48.56
Split fraction:	0.998	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	30.71	34.92	34.92
Dry soil + tare (g):	30.71	34.33	34.33
Tare (g):	30.26	21.64	21.64
Water content (%):	0.00	4.65	4.65

Hydrometer data			
Hyd. split:	No.10	Slope:	-0.1641
Gs:	2.8 Assumed	Intercept:	16.3
Bulb No.	2	α:	0.97
		Hyd. fraction:	99.76
Dispersion period (min):	15	Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.28	2	99.8	<=Split
No.20	0.23	0.85	99.3	
No.40	0.34	0.425	99.1	
No.60	0.48	0.25	98.8	
No.100	0.62	0.15	98.5	
No.140	0.78	0.106	98.2	
No.200	0.91	0.075	97.9	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.9	52.5	0.02629	96.60
5	17.9	51.5	0.01681	94.61
15	17.9	50.5	0.00980	92.63
30	18.2	45	0.00728	81.81
60	18.6	35	0.00558	62.09
120	19.2	26	0.00418	44.44
252	19.9	21.5	0.00295	35.79
479	20.3	18.5	0.00217	30.00
1425	20.7	16.5	0.00127	26.19



Gravel (%): 0.0
Sand (%): 2.1
Fines (%): 97.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/4/2015
By: BRR

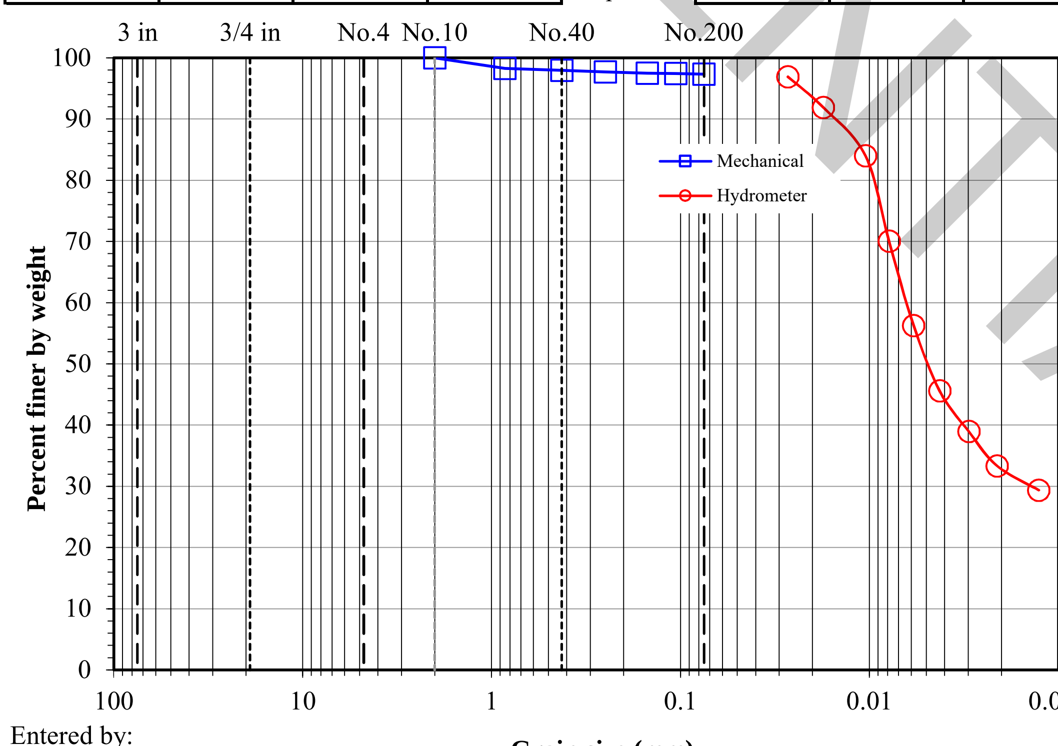
Boring No.: SN4-15-008
Sample: SH-001
Depth: 13-14.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	52.09	48.73
Hydrometer fraction (g):	52.09	48.73
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	32.43	32.43
Dry soil + tare (g):	-	31.76	31.76
Tare (g):	-	22.03	22.03
Water content (%):	0.00	6.89	6.89

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.754	Determined	Intercept:	16.3
Bulb No.	2		α:	0.98
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	16.8	52.5	0.02701	96.91
6"	-	150	-		5	16.8	50	0.01753	91.90
4"	-	100	-		15	17.1	46	0.01049	84.01
3"	-	75	-		30	17.3	39	0.00786	70.05
1.5"	-	37.5	-		60	17.9	32	0.00583	56.27
3/4"	-	19	-		120	18.7	26.5	0.00425	45.59
3/8"	-	9.5	-		250	19.6	23	0.00298	38.96
No.4	-	4.75	-		507	20.5	20	0.00211	33.34
No.10	-	2	100.0	<=Split hyd.	1435	20.6	18	0.00127	29.37
No.20	0.84	0.85	98.3						
No.40	1.00	0.425	97.9						
No.60	1.13	0.25	97.7						
No.100	1.21	0.15	97.5						
No.140	1.25	0.106	97.4						
No.200	1.30	0.075	97.3	<=Split					



Gravel (%): 0.0
Sand (%): 2.7
Fines (%): 97.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-004
Depth: 14.5-18'
Description: Grey clay

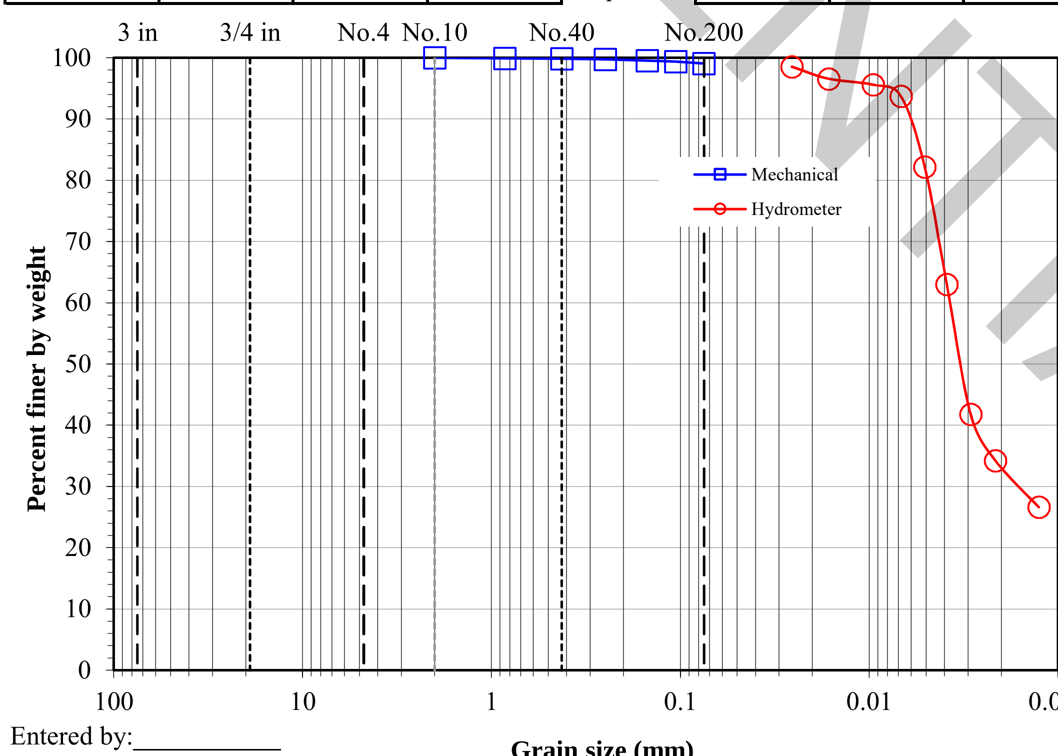
Split:	No	
	Moist	Dry
Total sample wt. (g):	51.04	49.72
Hydrometer fraction (g):	51.04	49.72
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.43	36.43
Dry soil + tare (g):	-	36.06	36.06
Tare (g):	-	22.16	22.16
Water content (%):	0.00	2.66	2.66

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.06	0.85	99.9	
No.40	0.08	0.425	99.8	
No.60	0.12	0.25	99.8	
No.100	0.23	0.15	99.5	
No.140	0.31	0.106	99.4	
No.200	0.46	0.075	99.1	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	18	54.5	0.02569	98.52
5	18	53.5	0.01643	96.58
15	18	53	0.00954	95.60
30	18.2	52	0.00680	93.74
60	18.5	46	0.00508	82.18
120	19.2	36	0.00388	63.00
248	19.8	25	0.00291	41.82
471	20.3	21	0.00215	34.24
1417	20.7	17	0.00127	26.62



Gravel (%): 0.0
Sand (%): 0.9
Fines (%): 99.1

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/16/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-005
Depth: 18-23'
Description: Grey clay

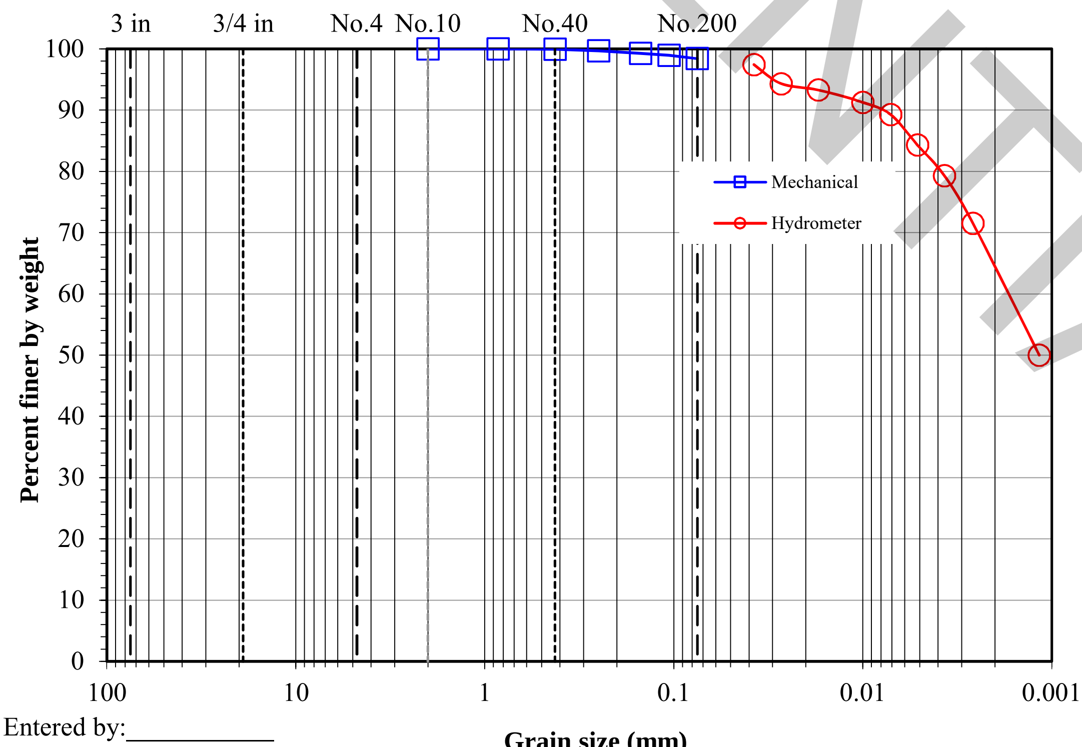
Split:	No	
	Moist	Dry
Total sample wt. (g):	50.10	46.82
Hydrometer fraction (g):	50.10	46.82
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	32.83	32.83
Dry soil + tare (g):	-	32.13	32.13
Tare (g):	-	22.15	22.15
Water content (%):	0.00	7.01	7.01

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.01	0.85	100.0	
No.40	0.02	0.425	100.0	
No.60	0.14	0.25	99.7	
No.100	0.34	0.15	99.3	
No.140	0.50	0.106	98.9	
No.200	0.74	0.075	98.4	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	18.1	51	0.03769	97.43
2	18.1	49.5	0.02706	94.33
5	18.1	49	0.01720	93.29
15	18.2	48	0.01001	91.27
30	18.4	47	0.00713	89.29
60	18.8	44.5	0.00514	84.30
120	19.2	42	0.00370	79.31
250	20.3	38	0.00261	71.53
1462	20.7	27.5	0.00116	49.99



Gravel (%): 0.0
Sand (%): 1.6
Fines (%): 98.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/16/2015
By: BRR

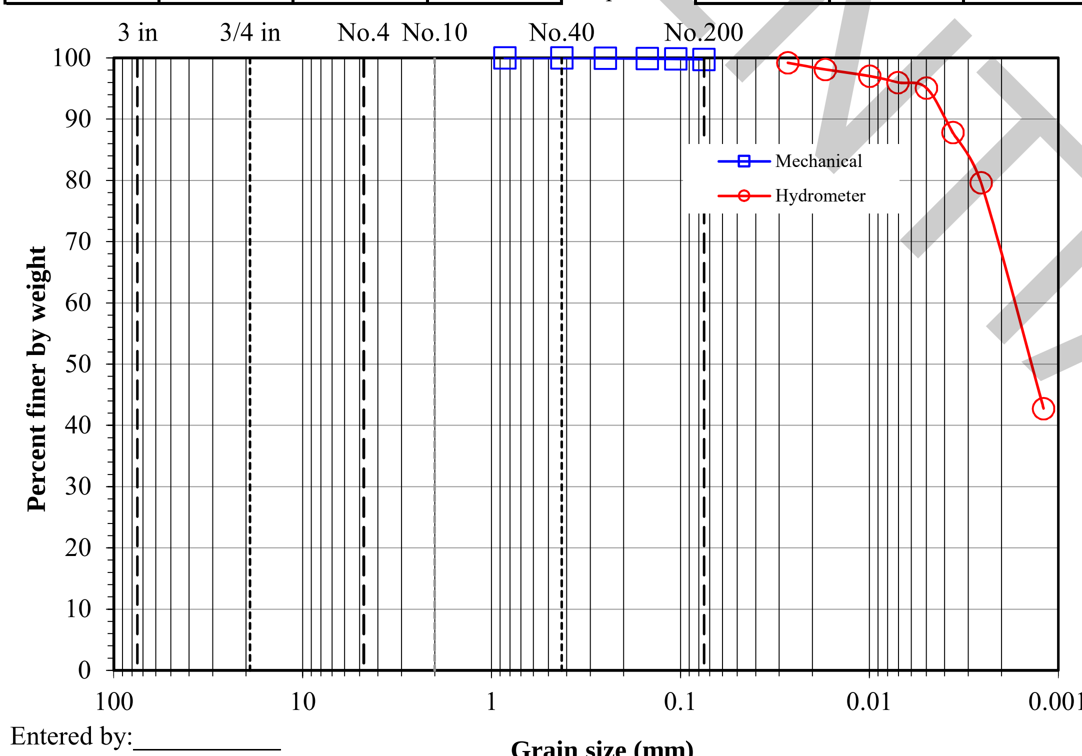
Boring No.: SN4-15-008
Sample: MC-006
Depth: 23-28'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.41	44.56
Hydrometer fraction (g):	50.41	44.56
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	31.88	31.88
Dry soil + tare (g):	-	30.67	30.67
Tare (g):	-	21.46	21.46
Water content (%):	0.00	13.14	13.14

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	18.3	49.5	0.02699	99.21
6"	-	150	-		5	18.3	49	0.01716	98.12
4"	-	100	-		15	18.3	48.5	0.00996	97.03
3"	-	75	-		30	18.4	48	0.00706	96.00
1.5"	-	37.5	-		60	18.8	47.5	0.00500	95.10
3/4"	-	19	-		120	19.5	44	0.00362	87.82
3/8"	-	9.5	-		250	20.5	40	0.00256	79.60
No.4	-	4.75	-		1470	20.7	23	0.00120	42.75
No.10	-	2	-	<=Split hyd.					
No.20	-	0.85	100.0						
No.40	0.01	0.425	100.0						
No.60	0.02	0.25	100.0						
No.100	0.04	0.15	99.9						
No.140	0.06	0.106	99.9						
No.200	0.11	0.075	99.8	<=Split					



Gravel (%): 0.0
Sand (%): 0.2
Fines (%): 99.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

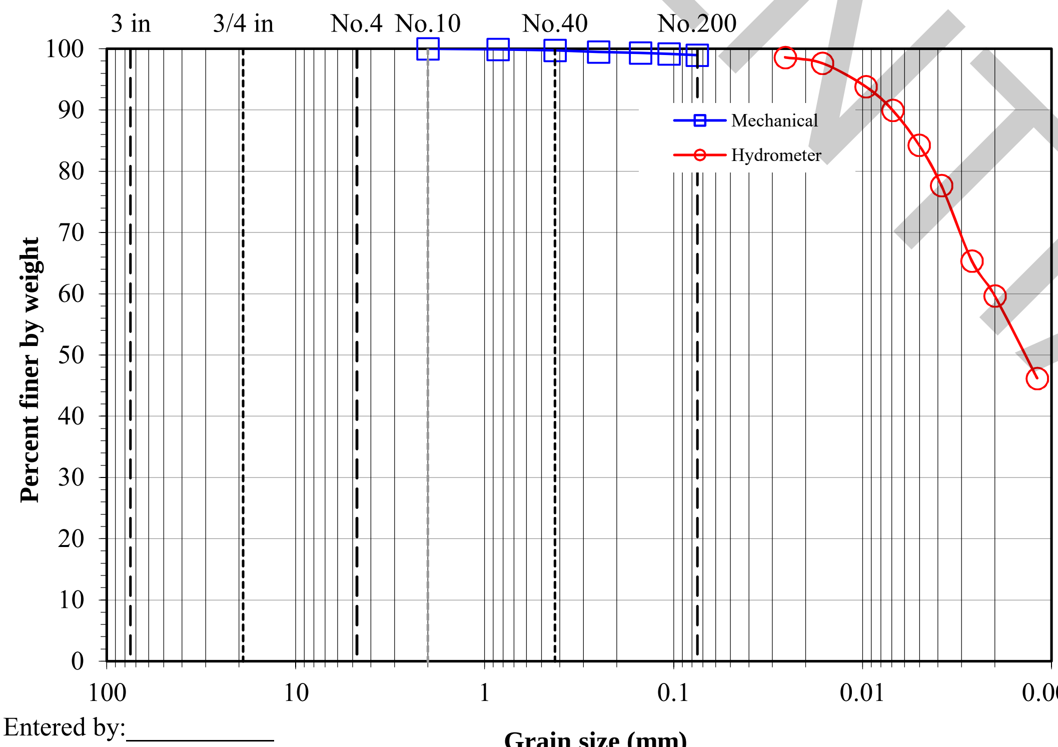
Boring No.: SN4-15-008
Sample: MC-007
Depth: 28-33'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.81	49.65
Hydrometer fraction (g):	50.81	49.65
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.18	35.18
Dry soil + tare (g):	-	34.88	34.88
Tare (g):	-	22.02	22.02
Water content (%):	0.00	2.33	2.33

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.9	54.5	0.02573	98.61
6"	-	150	-		5	17.9	54	0.01636	97.63
4"	-	100	-		15	18.1	52	0.00963	93.82
3"	-	75	-		30	18.2	50	0.00694	89.96
1.5"	-	37.5	-		60	18.6	47	0.00503	84.28
3/4"	-	19	-		109	19.1	43.5	0.00383	77.66
3/8"	-	9.5	-		250	20	37	0.00264	65.37
No.4	-	4.75	-		455	20.3	34	0.00200	59.65
No.10	-	2	100.0	<=Split hyd.	1400	20.8	27	0.00119	46.20
No.20	0.06	0.85	99.9						
No.40	0.14	0.425	99.7						
No.60	0.26	0.25	99.5						
No.100	0.33	0.15	99.3						
No.140	0.42	0.106	99.2						
No.200	0.52	0.075	99.0	<=Split					



Gravel (%): 0.0
Sand (%): 1.0
Fines (%): 99.0

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

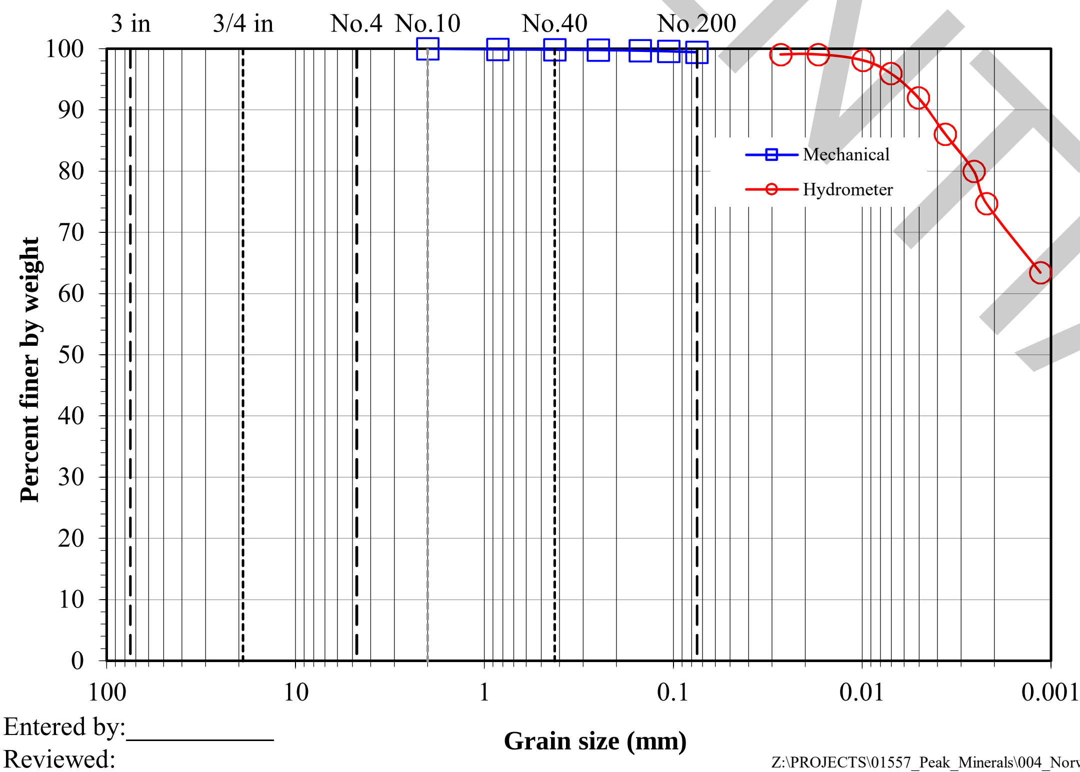
Boring No.: SN4-15-008
Sample: MC-008
Depth: 33-38'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.69	45.38
Hydrometer fraction (g):	50.69	45.38
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	42.30	42.30
Dry soil + tare (g):	-	40.17	40.17
Tare (g):	-	21.98	21.98
Water content (%):	0.00	11.71	11.71

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.3	50.5	0.02705	99.08
6"	-	150	-		5	17.3	50.5	0.01711	99.08
4"	-	100	-		15	17.5	50	0.00991	98.11
3"	-	75	-		30	17.5	49	0.00707	95.97
1.5"	-	37.5	-		60	18.2	47	0.00506	92.03
3/4"	-	19	-		120	19.1	44	0.00364	86.05
3/8"	-	9.5	-		250	19.8	41	0.00256	79.97
No.4	-	4.75	-		352	20	38.5	0.00220	74.73
No.10	-	2	100.0	<=Split hyd.	1402	20.9	33	0.00114	63.41
No.20	0.04	0.85	99.9						
No.40	0.07	0.425	99.8						
No.60	0.10	0.25	99.8						
No.100	0.14	0.15	99.7						
No.140	0.20	0.106	99.6						
No.200	0.26	0.075	99.4	<=Split					



Gravel (%): 0.0
Sand (%): 0.6
Fines (%): 99.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/4/2015
By: BRR

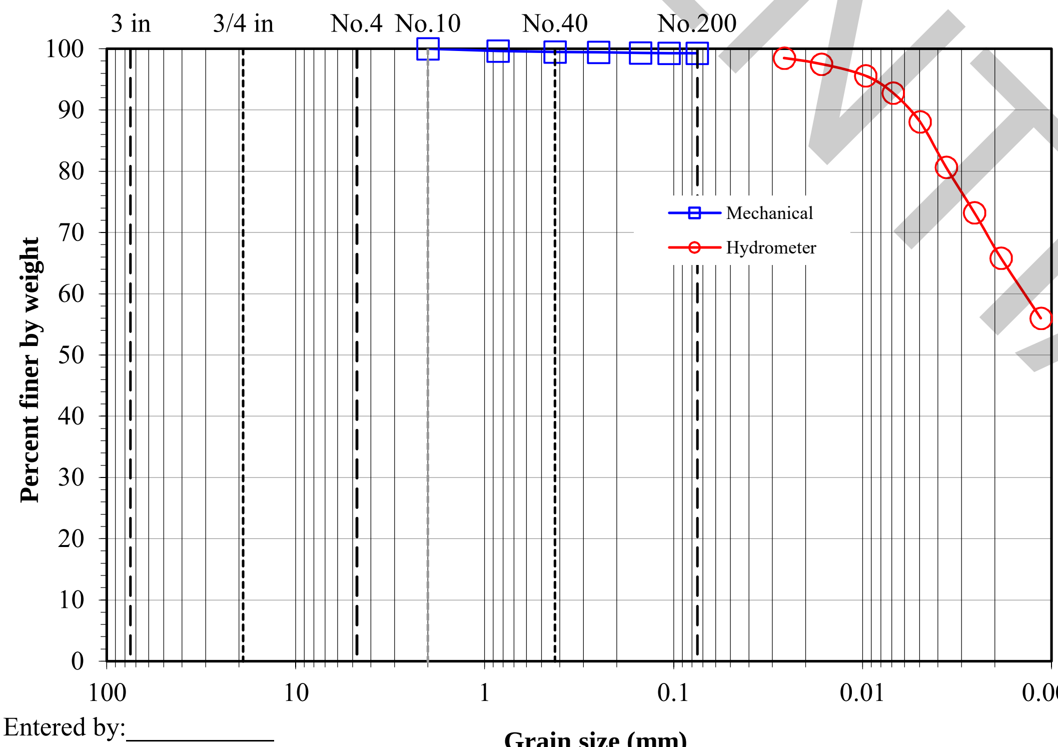
Boring No.: SN4-15-008
Sample: SH-002
Depth: 38-39.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.01	49.34
Hydrometer fraction (g):	50.01	49.34
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.79	33.79
Dry soil + tare (g):	-	33.63	33.63
Tare (g):	-	21.88	21.88
Water content (%):	0.00	1.36	1.36

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.812	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	16.7	54.5	0.02603	98.49
6"	-	150	-		5	16.7	54	0.01655	97.51
4"	-	100	-		15	16.8	53	0.00965	95.59
3"	-	75	-		30	17.1	51.5	0.00691	92.78
1.5"	-	37.5	-		60	17.6	49	0.00498	88.10
3/4"	-	19	-		120	18.5	45	0.00362	80.65
3/8"	-	9.5	-		250	19.5	41	0.00256	73.25
No.4	-	4.75	-		499	20.5	37	0.00185	65.84
No.10	-	2	100.0	<=Split hyd.	1428	20.4	32	0.00114	56.01
No.20	0.18	0.85	99.6						
No.40	0.25	0.425	99.5						
No.60	0.28	0.25	99.4						
No.100	0.33	0.15	99.3						
No.140	0.35	0.106	99.3						
No.200	0.37	0.075	99.3	<=Split					



Gravel (%): 0.0
Sand (%): 0.7
Fines (%): 99.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

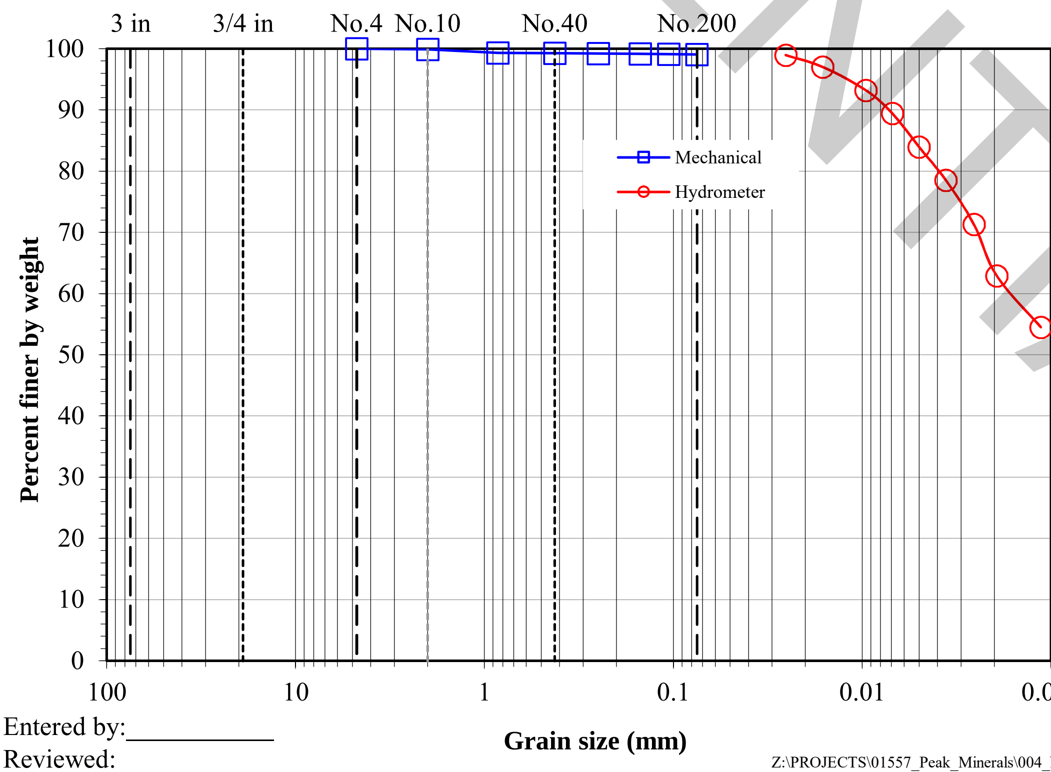
Boring No.: SN4-15-008
Sample: MC-009
Depth: 39.5-43'
Description: Grey clay

Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	143.40	140.36
+#10 Coarse fraction (g):	0.15	0.15
-#10 Split fraction (g):	51.94	50.84
Hydrometer fraction (g):	51.94	50.84
Split fraction:	0.999	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.39	37.78	37.78
Dry soil + tare (g):	37.39	37.45	37.45
Tare (g):	37.18	22.25	22.25
Water content (%):	0.00	2.17	2.17

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.89
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.6	56	0.02539	98.94
6"	-	150	-		5	17.6	55	0.01624	97.04
4"	-	100	-		15	17.6	53	0.00959	93.23
3"	-	75	-		30	17.6	51	0.00692	89.42
1.5"	-	37.5	-		60	18.2	48	0.00501	83.96
3/4"	-	19	-		120	18.9	45	0.00361	78.55
3/8"	-	9.5	-		250	19.8	41	0.00256	71.31
No.4	-	4.75	100.0		464	20.2	36.5	0.00194	62.91
No.10	0.15	2	99.9	<=Split	1447	20.6	32	0.00113	54.51
No.20	0.29	0.85	99.3						
No.40	0.31	0.425	99.3						
No.60	0.34	0.25	99.2						
No.100	0.37	0.15	99.2						
No.140	0.40	0.106	99.1						
No.200	0.42	0.075	99.1						



Gravel (%): 0.0
Sand (%): 0.9
Fines (%): 99.1

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-010
Depth: 43-48'
Description: Grey clay

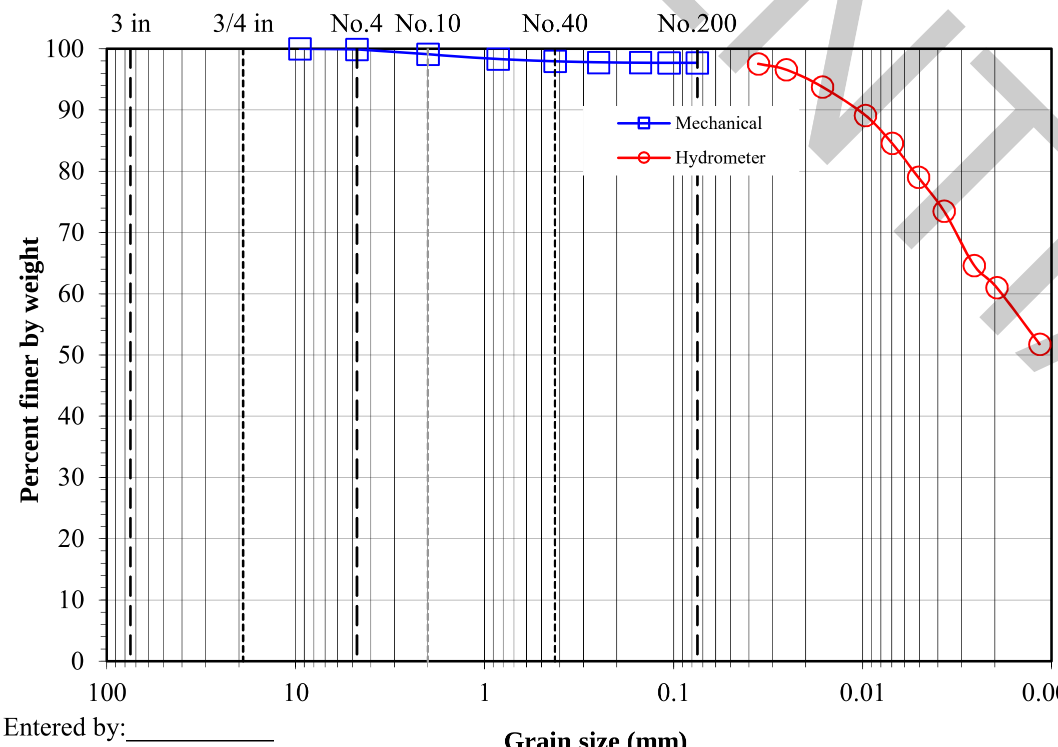
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	129.24	126.42
+#10 Coarse fraction (g):	1.17	1.15
-#10 Split fraction (g):	52.39	51.25
Hydrometer fraction (g):	52.39	51.25
Split fraction:	0.991	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	48.80	41.06	41.06
Dry soil + tare (g):	48.60	40.65	40.65
Tare (g):	37.71	22.27	22.27
Water content (%):	1.84	2.23	2.23

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.09
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	0.14	4.75	99.9	
No.10	1.15	2	99.1	<=Split
No.20	0.39	0.85	98.3	
No.40	0.59	0.425	98.0	
No.60	0.68	0.25	97.8	
No.100	0.70	0.15	97.7	
No.140	0.71	0.106	97.7	
No.200	0.72	0.075	97.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	18	56	0.03572	97.52
2	18	55.5	0.02540	96.59
5	18	54	0.01634	93.78
15	18.1	51.5	0.00968	89.14
30	18.4	49	0.00699	84.58
60	18.6	46	0.00508	79.04
118	18.8	43	0.00371	73.50
260	20	38	0.00257	64.63
463	20.3	36	0.00195	61.01
1408	20.6	31	0.00116	51.77



Gravel (%): 0.1
Sand (%): 2.2
Fines (%): 97.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/4/2015
By: BRR

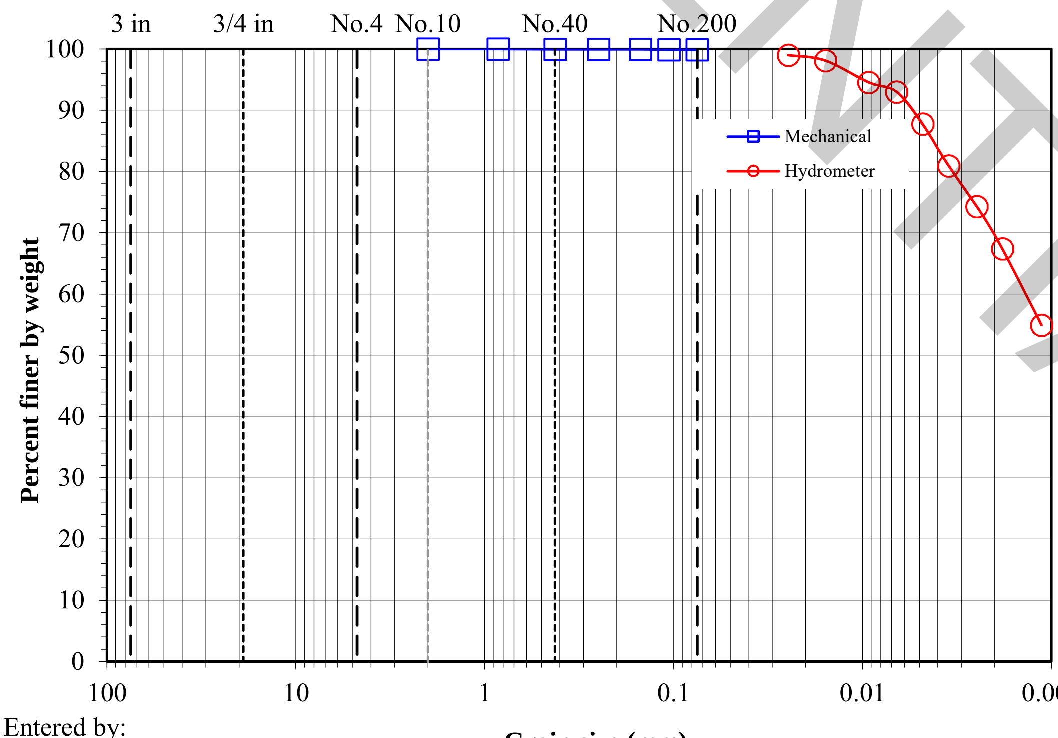
Boring No.: SN4-15-008
Sample: SH-003
Depth: 48-49.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	55.13	54.19
Hydrometer fraction (g):	55.13	54.19
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.15	33.15
Dry soil + tare (g):	-	32.96	32.96
Tare (g):	-	21.95	21.95
Water content (%):	0.00	1.73	1.73

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.788	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	16.6	59.5	0.02473	99.01
6"	-	150	-		5	16.6	59	0.01574	98.11
4"	-	100	-		15	16.7	57	0.00930	94.57
3"	-	75	-		30	17.3	56	0.00660	93.01
1.5"	-	37.5	-		60	17.6	53	0.00481	87.76
3/4"	-	19	-		120	18.5	49	0.00350	80.94
3/8"	-	9.5	-		250	19.8	45	0.00248	74.29
No.4	-	4.75	-		491	20.5	41	0.00182	67.40
No.10	-	2	100.0	<=Split hyd.	1420	20.7	34	0.00113	54.93
No.20	0.01	0.85	100.0						
No.40	0.03	0.425	99.9						
No.60	0.04	0.25	99.9						
No.100	0.04	0.15	99.9						
No.140	0.05	0.106	99.9						
No.200	0.07	0.075	99.9	<=Split					



Gravel (%): 0.0
Sand (%): 0.1
Fines (%): 99.9

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

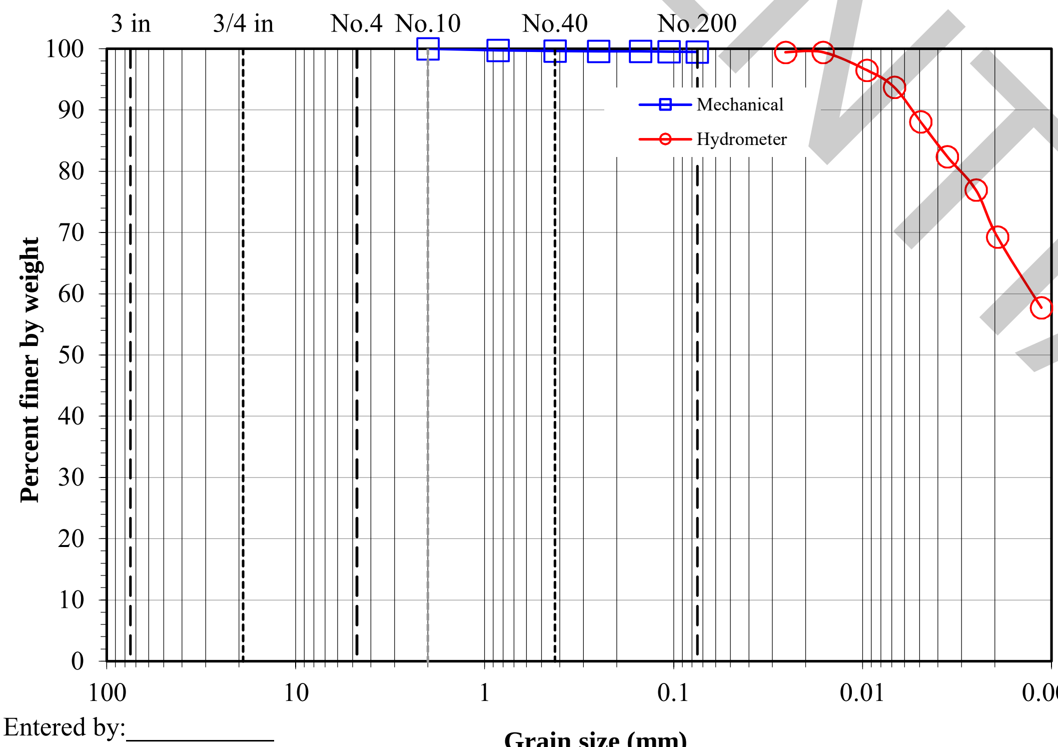
Boring No.: SN4-15-008
Sample: MC-011
Depth: 49.5-53'
Description: Grey clay

		Moist	Dry
Split:	No		
Total sample wt. (g):		51.00	49.70
Hydrometer fraction (g):		51.00	49.70
		1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.99	36.99
Dry soil + tare (g):	-	36.61	36.61
Tare (g):	-	22.04	22.04
Water content (%):	0.00	2.61	2.61

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.8	55	0.02562	99.44
6"	-	150	-		5	17.8	55	0.01620	99.44
4"	-	100	-		15	17.8	53.5	0.00951	96.52
3"	-	75	-		30	18.1	52	0.00681	93.72
1.5"	-	37.5	-		60	18.6	49	0.00493	88.09
3/4"	-	19	-		120	19	46	0.00357	82.41
3/8"	-	9.5	-		250	19.9	43	0.00252	76.95
No.4	-	4.75	-		448	20.2	39	0.00194	69.28
No.10	-	2	100.0	<=Split hyd.	1432	20.5	33	0.00113	57.72
No.20	0.14	0.85	99.7						
No.40	0.17	0.425	99.7						
No.60	0.20	0.25	99.6						
No.100	0.21	0.15	99.6						
No.140	0.24	0.106	99.5						
No.200	0.26	0.075	99.5	<=Split					



Gravel (%): 0.0
Sand (%): 0.5
Fines (%): 99.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

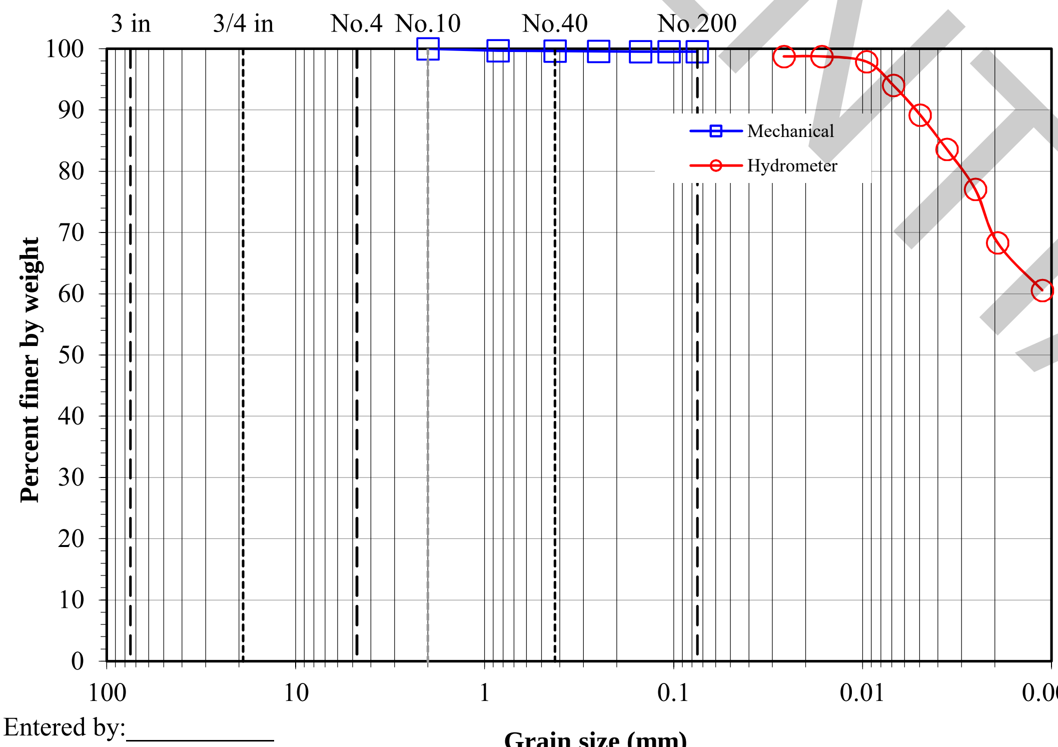
Boring No.: SN4-15-008
Sample: MC-012
Depth: 54.5-58'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.81	48.96
Hydrometer fraction (g):	50.81	48.96
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	39.32	39.32
Dry soil + tare (g):	-	38.70	38.70
Tare (g):	-	22.26	22.26
Water content (%):	0.00	3.77	3.77

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.3	54	0.02606	98.75
6"	-	150	-		5	17.3	54	0.01648	98.75
4"	-	100	-		15	17.6	53.5	0.00953	97.89
3"	-	75	-		30	17.8	51.5	0.00687	94.02
1.5"	-	37.5	-		60	18.1	49	0.00496	89.20
3/4"	-	19	-		120	18.8	46	0.00358	83.57
3/8"	-	9.5	-		250	19.7	42.5	0.00253	77.04
No.4	-	4.75	-		456	20.2	38	0.00194	68.35
No.10	-	2	100.0	<=Split hyd.	1440	20.5	34	0.00112	60.57
No.20	0.15	0.85	99.7						
No.40	0.17	0.425	99.7						
No.60	0.21	0.25	99.6						
No.100	0.22	0.15	99.6						
No.140	0.22	0.106	99.6						
No.200	0.23	0.075	99.5	<=Split					



Gravel (%): 0.0
Sand (%): 0.5
Fines (%): 99.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-013
Depth: 58-63'
Description: Grey clay

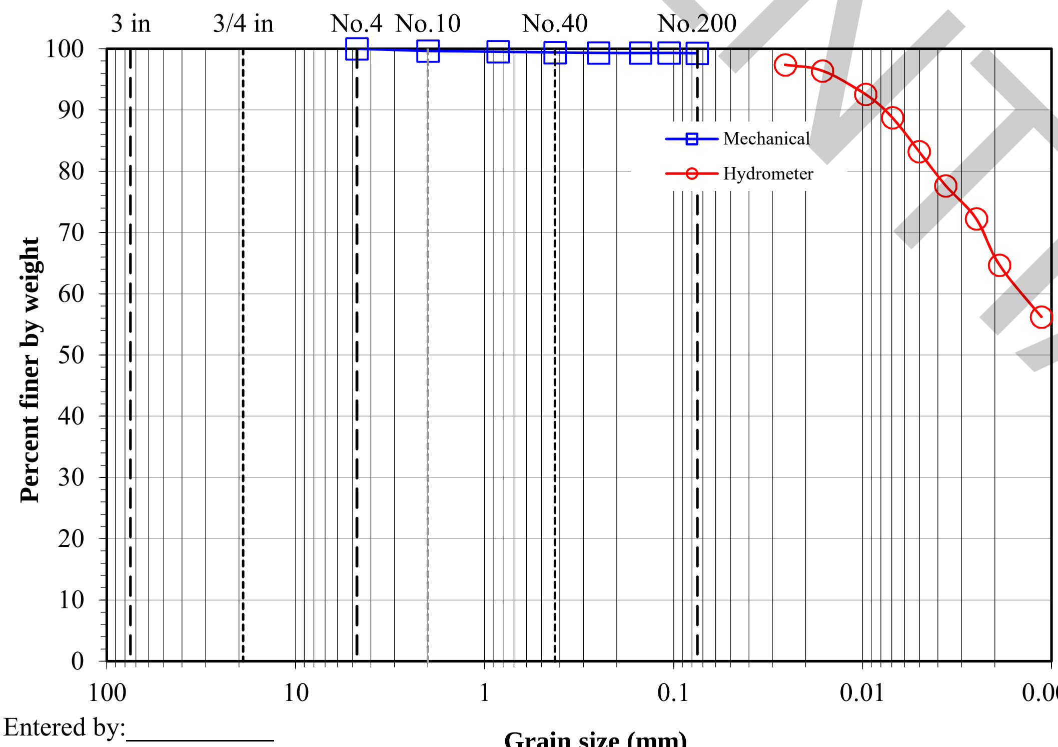
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	142.39	137.49
+#10 Coarse fraction (g):	0.54	0.53
-#10 Split fraction (g):	51.87	50.08
Hydrometer fraction (g):	51.87	50.08
Split fraction:	0.996	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	41.48	40.37	40.37
Dry soil + tare (g):	41.40	39.73	39.73
Tare (g):	37.85	21.78	21.78
Water content (%):	2.25	3.57	3.57

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.61
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.53	2	99.6	<=Split
No.20	0.05	0.85	99.5	
No.40	0.12	0.425	99.4	
No.60	0.14	0.25	99.3	
No.100	0.15	0.15	99.3	
No.140	0.16	0.106	99.3	
No.200	0.17	0.075	99.3	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.9	54.5	0.02573	97.38
5	17.9	54	0.01636	96.42
15	17.9	52	0.00965	92.57
30	18	50	0.00696	88.76
60	18.6	47	0.00503	83.23
120	19.1	44	0.00364	77.66
260	20	41	0.00251	72.26
487	20.3	37	0.00189	64.68
1434	20.8	32.5	0.00113	56.22



Gravel (%): 0.0
Sand (%): 0.7
Fines (%): 99.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

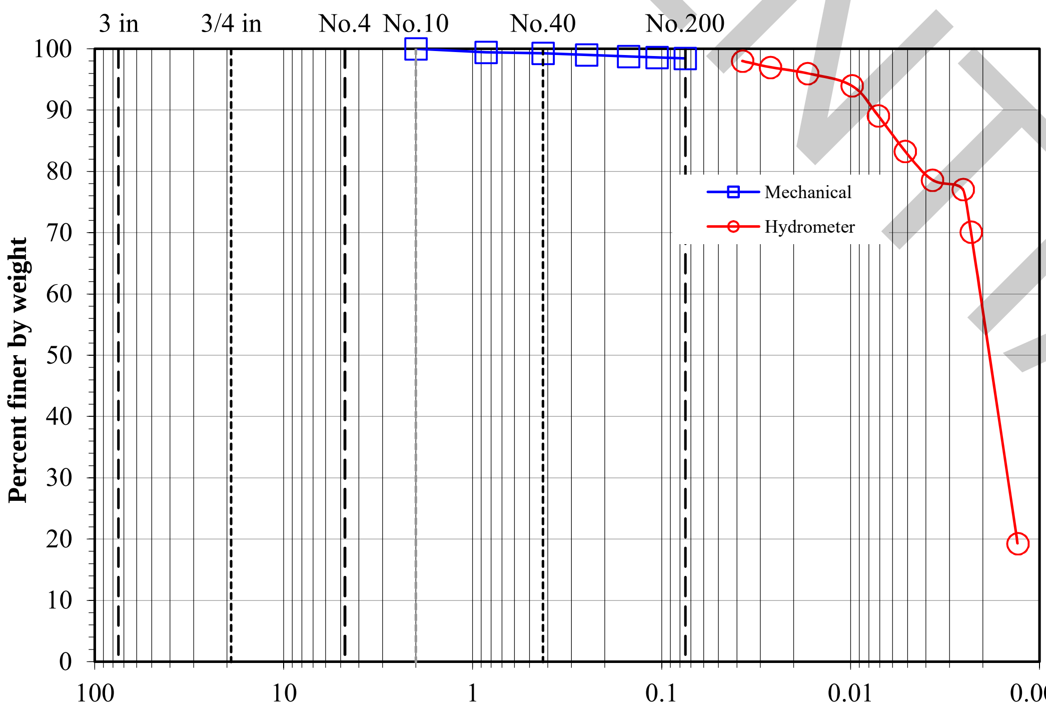
Boring No.: SN4-15-008
Sample: MC-014
Depth: 63-68'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.75	48.29
Hydrometer fraction (g):	50.75	48.29
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.11	35.11
Dry soil + tare (g):	-	34.47	34.47
Tare (g):	-	21.93	21.93
Water content (%):	0.00	5.10	5.10

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17	53	0.03740	98.00
6"	-	150	-		2	17	52.5	0.02659	96.99
4"	-	100	-		5	17	52	0.01691	95.99
3"	-	75	-		15	17	51	0.00986	93.98
1.5"	-	37.5	-		30	17.2	48.5	0.00714	89.06
3/4"	-	19	-		60	17.8	45.5	0.00515	83.30
3/8"	-	9.5	-		120	18.5	43	0.00369	78.60
No.4	-	4.75	-		250	19.6	42	0.00255	77.07
No.10	-	2	100.0	<=Split hyd.	321	19.8	38.5	0.00231	70.14
No.20	0.27	0.85	99.4		1399	20.5	13	0.00131	19.30
No.40	0.35	0.425	99.3						
No.60	0.48	0.25	99.0						
No.100	0.60	0.15	98.8						
No.140	0.68	0.106	98.6						
No.200	0.76	0.075	98.4	<=Split					



Gravel (%): 0.0
Sand (%): 1.6
Fines (%): 98.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

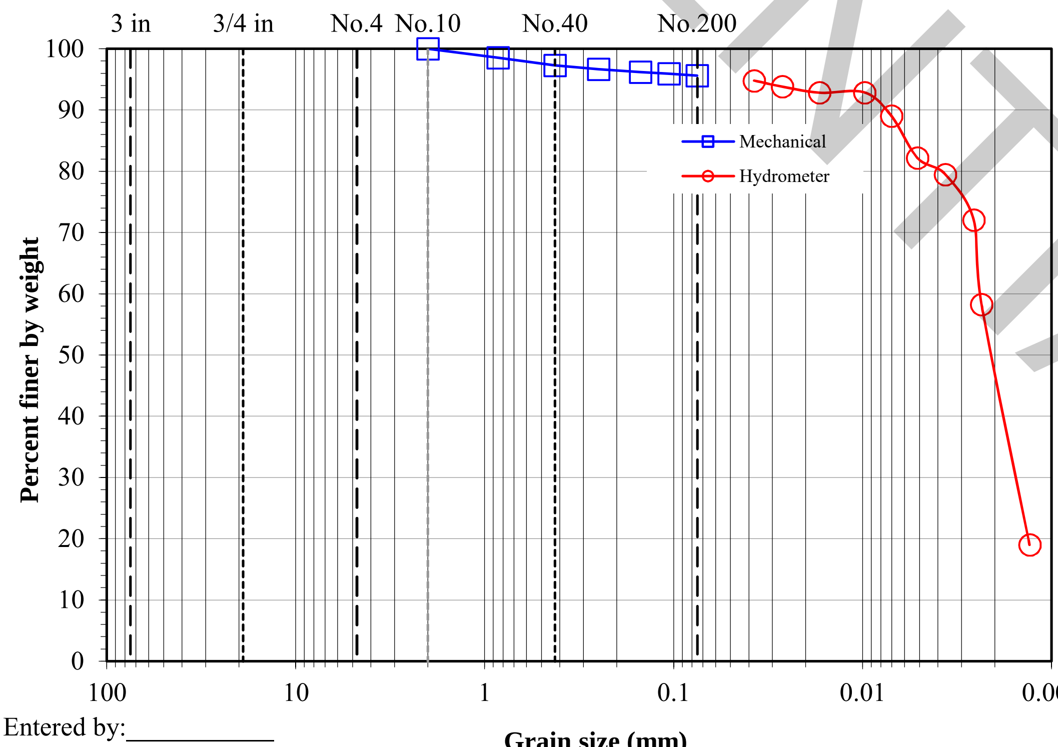
Boring No.: SN4-15-008
Sample: MC-015
Depth: 68-73'
Description: Grey clay

Split:	No		
	Moist	Dry	
Total sample wt. (g):	50.24	49.05	
Hydrometer fraction (g):	50.24	49.05	
	1.000		

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.30	35.30
Dry soil + tare (g):	-	34.98	34.98
Tare (g):	-	21.79	21.79
Water content (%):	0.00	2.43	2.43

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.7	52	0.03747	94.80
6"	-	150	-		2	17.7	51.5	0.02664	93.81
4"	-	100	-		5	17.7	51	0.01693	92.82
3"	-	75	-		15	17.8	51	0.00977	92.87
1.5"	-	37.5	-		30	18	49	0.00703	89.00
3/4"	-	19	-		60	18.2	45.5	0.00513	82.18
3/8"	-	9.5	-		120	18.8	44	0.00365	79.48
No.4	-	4.75	-		250	19.9	40	0.00258	72.05
No.10	-	2	100.0	<=Split hyd.	337	20	33	0.00235	58.27
No.20	0.73	0.85	98.5		1398	20.5	13	0.00131	19.00
No.40	1.34	0.425	97.3						
No.60	1.65	0.25	96.6						
No.100	1.87	0.15	96.2						
No.140	1.99	0.106	95.9						
No.200	2.16	0.075	95.6	<=Split					



Gravel (%): 0.0
Sand (%): 4.4
Fines (%): 95.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-016
Depth: 73-78'
Description: Grey clay

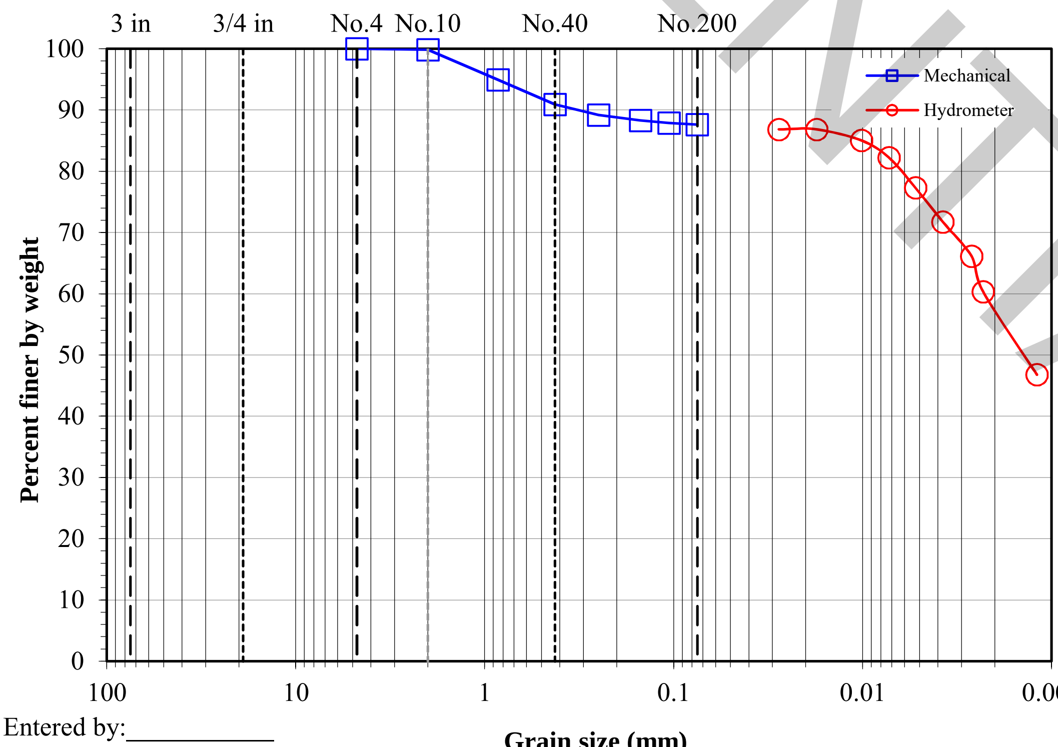
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	115.31	112.60
+#10 Coarse fraction (g):	0.19	0.19
-#10 Split fraction (g):	50.08	48.90
Hydrometer fraction (g):	50.08	48.90
Split fraction:	0.998	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	41.13	35.52	35.52
Dry soil + tare (g):	41.08	35.20	35.20
Tare (g):	38.19	21.91	21.91
Water content (%):	1.73	2.41	2.41

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.83
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.19	2	99.8	<=Split
No.20	2.39	0.85	95.0	
No.40	4.38	0.425	90.9	
No.60	5.22	0.25	89.2	
No.100	5.66	0.15	88.3	
No.140	5.85	0.106	87.9	
No.200	5.98	0.075	87.6	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.3	48	0.02774	86.84
5	17.3	48	0.01754	86.84
15	17.7	47	0.01017	85.04
30	18.1	45.5	0.00726	82.24
60	18.1	43	0.00525	77.30
120	19	40	0.00377	71.76
250	19.7	37	0.00265	66.13
345	20	34	0.00230	60.33
1394	20.7	27	0.00120	46.79



Gravel (%): 0.0
Sand (%): 12.4
Fines (%): 87.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-017
Depth: 78-83'
Description: Grey clay

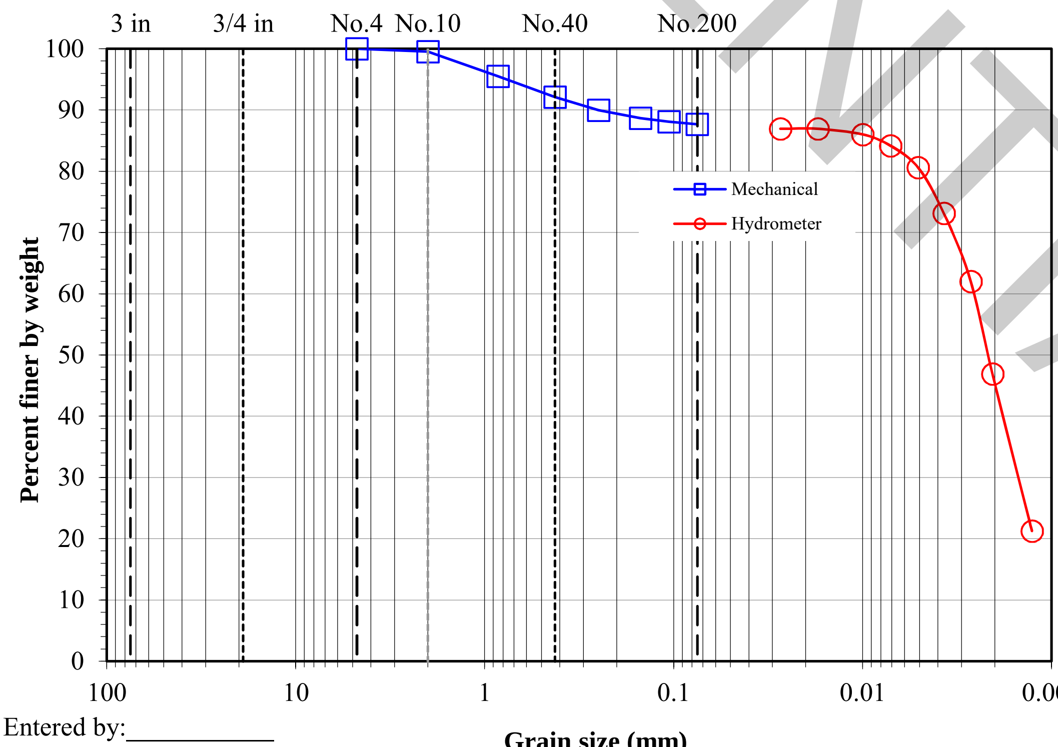
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	85.82	84.03
+#10 Coarse fraction (g):	0.39	0.39
-#10 Split fraction (g):	51.50	50.42
Hydrometer fraction (g):	51.50	50.42
Split fraction:	0.995	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	38.20	30.76	30.76
Dry soil + tare (g):	38.20	30.57	30.57
Tare (g):	37.64	21.70	21.70
Water content (%):	0.00	2.14	2.14

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.54
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.39	2	99.5	<=Split
No.20	2.05	0.85	95.5	
No.40	3.76	0.425	92.1	
No.60	4.84	0.25	90.0	
No.100	5.50	0.15	88.7	
No.140	5.79	0.106	88.1	
No.200	6.01	0.075	87.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.5	49.5	0.02726	86.93
5	17.5	49.5	0.01724	86.93
15	17.6	49	0.00999	86.02
30	17.7	48	0.00712	84.14
60	18.4	46	0.00509	80.61
120	18.8	42	0.00371	73.13
250	19.6	36	0.00268	62.00
472	20.1	28	0.00206	46.91
1454	20.5	14.5	0.00127	21.26



Gravel (%): 0.0
Sand (%): 12.3
Fines (%): 87.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/21/2015
By: BRR

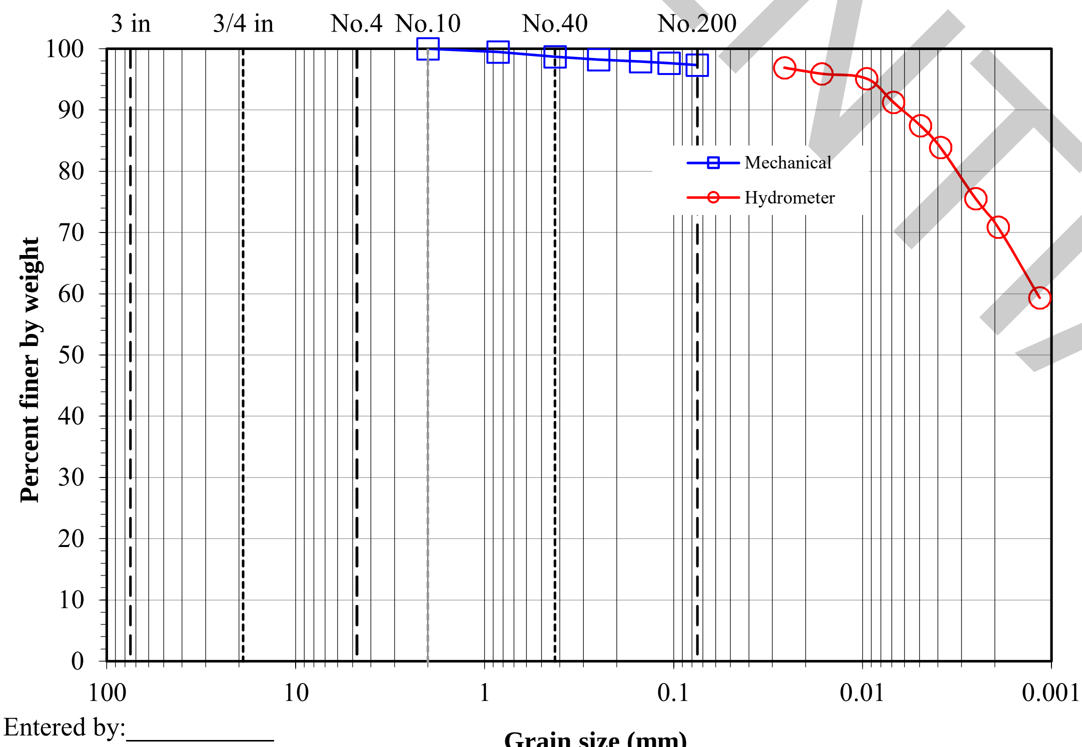
Boring No.: SN4-15-008
Sample: MC-018
Depth: 83-88'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.11	49.99
Hydrometer fraction (g):	51.11	49.99
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	39.27	39.27
Dry soil + tare (g):	-	38.89	38.89
Tare (g):	-	21.99	21.99
Water content (%):	0.00	2.25	2.25

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.7	54	0.02593	96.90
6"	-	150	-		5	17.7	53.5	0.01649	95.93
4"	-	100	-		15	18.1	53	0.00953	95.13
3"	-	75	-		30	18.1	51	0.00688	91.25
1.5"	-	37.5	-		60	18.3	49	0.00495	87.46
3/4"	-	19	-		100	19	47	0.00388	83.88
3/8"	-	9.5	-		250	19.9	42.5	0.00253	75.55
No.4	-	4.75	-		447	20.3	40	0.00192	70.87
No.10	-	2	100.0	<=Split hyd.	1353	20.5	34	0.00116	59.33
No.20	0.27	0.85	99.5						
No.40	0.64	0.425	98.7						
No.60	0.88	0.25	98.2						
No.100	1.05	0.15	97.9						
No.140	1.18	0.106	97.6						
No.200	1.32	0.075	97.4	<=Split					



Gravel (%): 0.0
Sand (%): 2.6
Fines (%): 97.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-019
Depth: 88-93'
Description: Grey clay

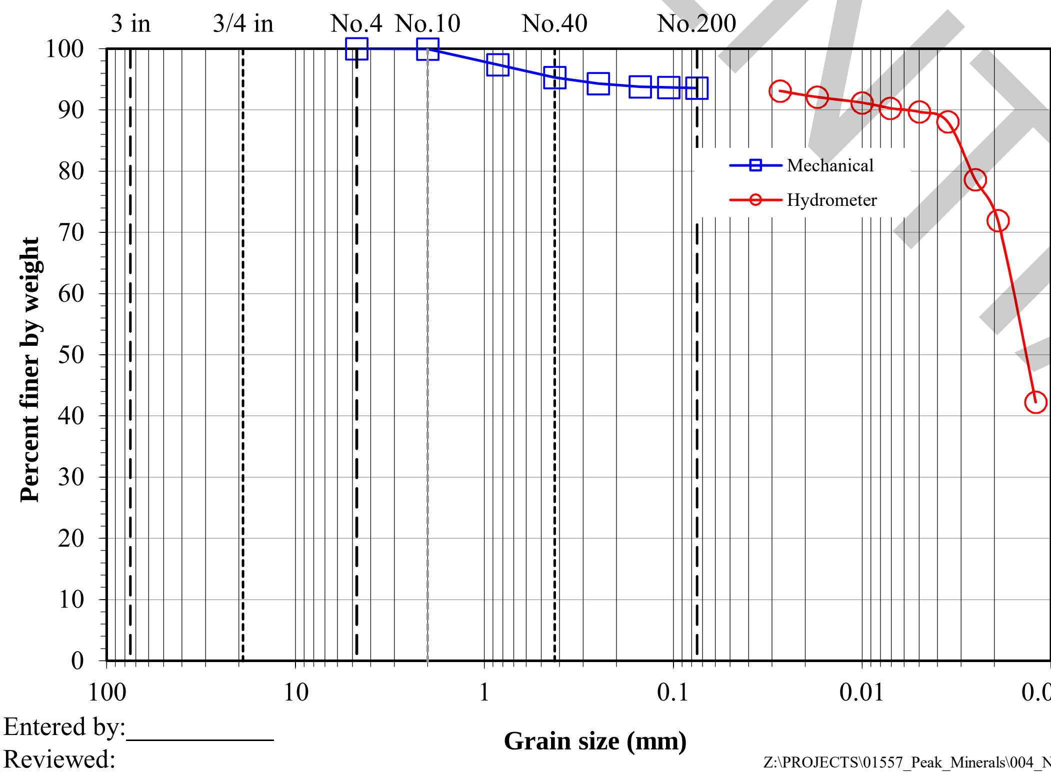
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	1646.99	1566.87
+#10 Coarse fraction (g):	0.75	0.70
-#10 Split fraction (g):	51.02	48.54
Hydrometer fraction (g):	51.02	48.54
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	187.91	39.07	39.07
Dry soil + tare (g):	184.00	38.25	38.25
Tare (g):	128.44	22.21	22.21
Water content (%):	7.04	5.11	5.11

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.96
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.70	2	100.0	<=Split
No.20	1.25	0.85	97.4	
No.40	2.26	0.425	95.3	
No.60	2.74	0.25	94.3	
No.100	2.99	0.15	93.8	
No.140	3.06	0.106	93.7	
No.200	3.09	0.075	93.6	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	16.2	51	0.02729	93.10
5	16.2	50.5	0.01735	92.11
15	16.4	50	0.01004	91.20
30	16.6	49.5	0.00712	90.29
60	17.5	49	0.00500	89.68
120	18.4	48	0.00353	88.08
250	19.6	43	0.00253	78.63
455	20.3	39.5	0.00191	71.96
1415	20.8	24.5	0.00121	42.26



Gravel (%): 0.0
Sand (%): 6.4
Fines (%): 93.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/18/2015
By: BRR

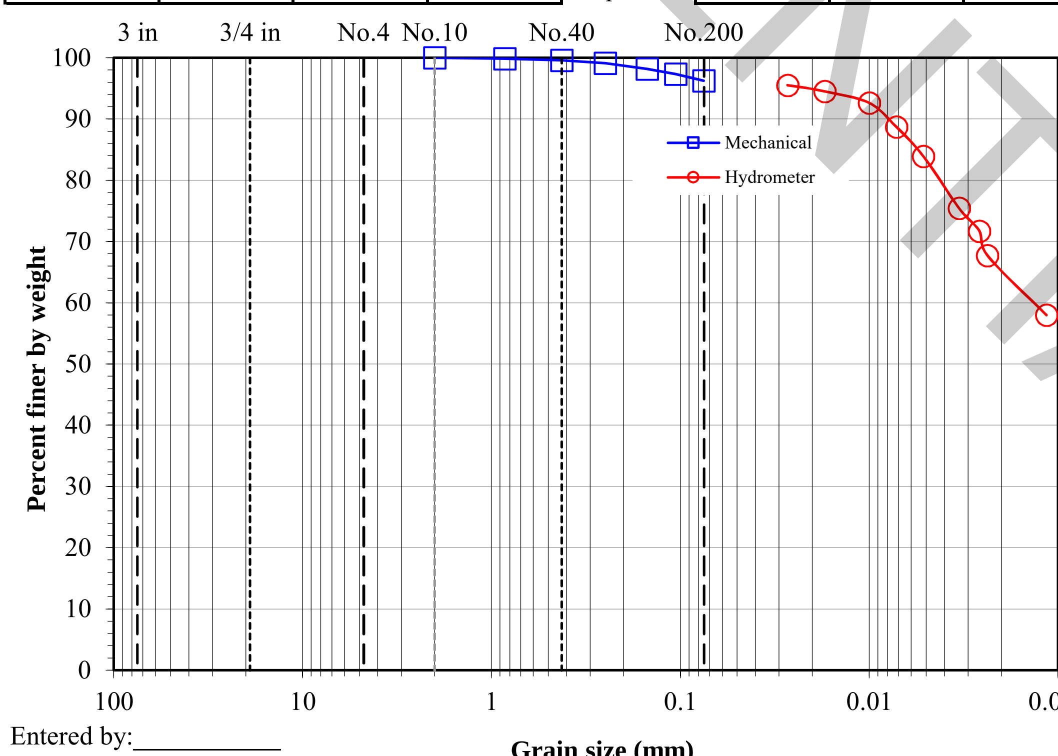
Boring No.: SN4-15-008
Sample: MC-020
Depth: 93-98'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.04	47.88
Hydrometer fraction (g):	50.04	47.88
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.79	35.79
Dry soil + tare (g):	-	35.20	35.20
Tare (g):	-	22.12	22.12
Water content (%):	0.00	4.51	4.51

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	16.4	51.5	0.02708	95.53
6"	-	150	-		5	16.4	51	0.01722	94.51
4"	-	100	-		15	16.7	50	0.01000	92.62
3"	-	75	-		30	17	48	0.00719	88.71
1.5"	-	37.5	-		60	17.6	45.5	0.00517	83.92
3/4"	-	19	-		150	19	41	0.00334	75.44
3/8"	-	9.5	-		250	19.7	39	0.00261	71.70
No.4	-	4.75	-		313	19.8	37	0.00237	67.70
No.10	-	2	100.0	<=Split hyd.	1395	20.7	32	0.00115	57.98
No.20	0.07	0.85	99.9						
No.40	0.19	0.425	99.6						
No.60	0.42	0.25	99.1						
No.100	0.88	0.15	98.2						
No.140	1.28	0.106	97.3						
No.200	1.79	0.075	96.3	<=Split					



Gravel (%): 0.0
Sand (%): 3.7
Fines (%): 96.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (VIII)
Location: Peak Minerals, Sevier Lake, UT
Date: 12/16/2015
By: BRR

Boring No.: SN4-15-008
Sample: MC-021
Depth: 98-100'
Description: Grey clay

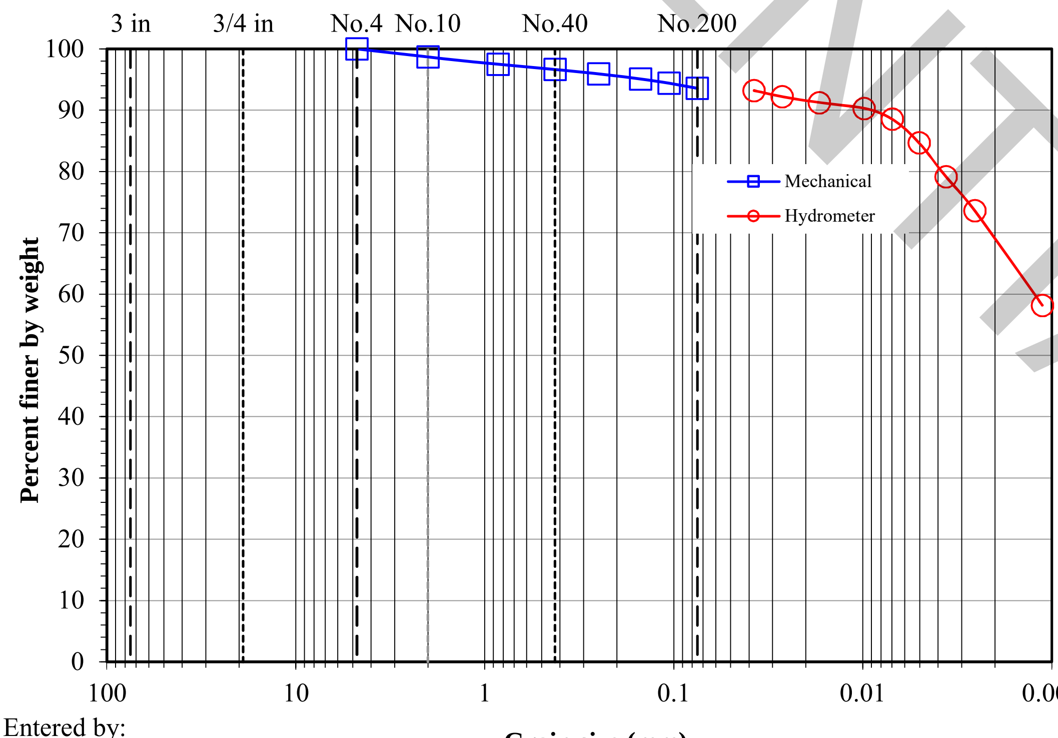
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	115.35	107.38
+#10 Coarse fraction (g):	1.39	1.38
-#10 Split fraction (g):	52.42	48.76
Hydrometer fraction (g):	52.42	48.76
Split fraction:	0.987	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	39.28	38.30	38.30
Dry soil + tare (g):	39.27	37.16	37.16
Tare (g):	37.68	21.99	21.99
Water content (%):	0.63	7.51	7.51

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	98.71
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	1.38	2	98.7	<=Split
No.20	0.60	0.85	97.5	
No.40	1.01	0.425	96.7	
No.60	1.38	0.25	95.9	
No.100	1.80	0.15	95.1	
No.140	2.12	0.106	94.4	
No.200	2.54	0.075	93.6	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.8	51.5	0.03763	93.21
2	17.8	51	0.02675	92.22
5	17.8	50.5	0.01701	91.24
15	17.9	50	0.00985	90.31
30	18.4	49	0.00699	88.56
60	18.5	47	0.00504	84.68
120	19.3	44	0.00363	79.14
250	20.1	41	0.00255	73.60
1454	20.7	33	0.00112	58.17



Gravel (%): 0.0
Sand (%): 6.4
Fines (%): 93.6

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\VIII\hydrometers\[GSDHYDv2.xlsx]21

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (VIII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-008	SN4-15-008	SN4-15-008					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	13-14.5'	38-39.5'	48-49.5'					
Test Info.	Sample Weight (g):	1.00	1.00	1.00					
	Pressure Reading (psi):	5.1	3.0	2.8					
Carbonate Content, Calcite Equivalent (%)		**58**	**34**	**31**					

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (IX)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/15/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	12/4/15	12/4/15	12/4/15	12/4/15	12/4/15	12/4/15	12/4/15	12/4/15
	Wet soil + tare (g)	383.36	336.96	369.63	394.89	376.52	340.91	361.83	386.22
	Tare (g)	119.62	150.75	127.88	152.70	127.47	125.03	122.66	123.41
	Date	12/8/15	12/8/15	12/8/15	12/8/15	12/8/15	12/8/15	12/8/15	12/8/15
	Dry soil + tare (g)	354.15	277.59	286.43	324.70	309.16	277.62	293.44	318.84
	Water content, ω (%)	12.5	46.8	52.5	40.8	37.1	41.5	40.0	34.5
	Date	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15
	Dry soil + tare (g)	352.20	276.49	284.98	324.35	309.11	277.57	293.24	318.46
	Water content, ω (%)	13.4	48.1	53.9	41.1	37.1	41.5	40.2	34.7
	Date	12/10/15	12/10/15	12/10/15					
	Dry soil + tare (g)	300.18	274.13	282.70					
	Water content, ω (%)	46.1	50.9	56.1					
	Date	12/11/15	12/11/15	12/11/15					
	Dry soil + tare (g)	293.74	274.13	282.60					
	Water content, ω (%)	51.5	50.9	56.3					
	Date	12/14/15							
	Dry soil + tare (g)	290.84							
	Water content, ω (%)	54.0							
	Date	12/15/15							
	Dry soil + tare (g)	290.72							
	Water content, ω (%)	54.1							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**54.1**	**50.9**	**56.3**	**41.1**	**37.1**	**41.5**	**40.2**	**34.7**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\IX\[M140v1.xlsm]1

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (IX)
Location: Peak Minerals Sevier Lake, UT
Date: 12/10/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009				
	Sample:	MC-009	MC-010	MC-011	MC-012				
	Depth:	38-43'	43-48'	48-53'	53-58'				
Water Content Determination	Initial date	12/7/15	12/7/15	12/7/15	12/7/15				
	Wet soil + tare (g)	270.42	277.91	312.08	310.92				
	Tare (g)	127.73	126.53	127.25	119.13				
	Date	12/8/15	12/8/15	12/8/15	12/8/15				
	Dry soil + tare (g)	228.89	235.83	263.81	268.27				
	Water content, ω (%)	41.1	38.5	35.3	28.6				
	Date	12/9/15	12/9/15	12/9/15	12/9/15				
	Dry soil + tare (g)	228.42	235.23	263.29	268.06				
	Water content, ω (%)	41.7	39.3	35.9	28.8				
	Date	12/10/15	12/10/15	12/10/15					
	Dry soil + tare (g)	228.31	235.00	263.19					
	Water content, ω (%)	41.9	39.6	36.0					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**41.9**	**39.6**	**36.0**	**28.8**				
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (IX)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: JDF/NB

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Test Info.	Sample Weight (g):	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	3.4	4.2	4.1	3.7	4.4	4.7	4.4	2.7
Carbonate Content, Calcite Equivalent (%)		**38**	**47**	**47**	**42**	**50**	**54**	**50**	**30**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (IX)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: JDF

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-009	SN4-15-009	SN4-15-009	SN4-15-009				
	Sample:	MC-009	MC-010	MC-011	MC-012				
	Depth:	38-43'	43-48'	48-53'	53-58'				
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00				
	Pressure Reading (psi):	2.4	2.6	3.0	2.9				
Carbonate Content, Calcite Equivalent (%)		**27**	**29**	**34**	**33**				

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (X)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Water Content Determination	Initial date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15
	Wet soil + tare (g)	364.41	350.48	369.23	363.54	320.72	317.91	389.46	325.89
	Tare (g)	124.62	123.03	123.34	122.97	128.57	121.99	123.71	124.48
	Date	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15
	Dry soil + tare (g)	330.00	283.22	296.05	292.18	263.95	255.49	305.72	257.81
	Water content, ω (%)	16.8	42.0	42.4	42.2	41.9	46.8	46.0	51.1
	Date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Dry soil + tare (g)	323.88	279.95	292.14	288.39	263.72	254.37	302.41	256.49
	Water content, ω (%)	20.3	44.9	45.7	45.4	42.2	48.0	48.7	52.6
	Date	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15
	Dry soil + tare (g)	292.25	275.40	286.17	282.06	263.44	253.32	298.50	254.65
	Water content, ω (%)	43.0	49.3	51.0	51.2	42.5	49.2	52.0	54.7
	Date	11/24/15	11/24/15	11/24/15	11/24/15			11/24/15	11/24/15
	Dry soil + tare (g)	288.41	274.67	285.21	280.76			297.90	254.36
	Water content, ω (%)	46.4	50.0	51.9	52.5			52.6	55.1
	Date	11/25/15	11/25/15	11/25/15	11/25/15			11/25/15	
	Dry soil + tare (g)	286.06	274.10	284.55	279.68			297.46	
	Water content, ω (%)	48.5	50.6	52.5	53.5			52.9	
	Date	11/30/15	11/30/15	11/30/15	11/30/15				
	Dry soil + tare (g)	284.27	271.69	282.01	271.53				
	Water content, ω (%)	50.2	53.0	55.0	61.9				
	Date				12/1/15				
	Dry soil + tare (g)				271.42				
	Water content, ω (%)				62.1				
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**50.2**	**53.0**	**55.0**	**62.1**	**42.5**	**49.2**	**52.9**	**55.1**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: Norwest Corporation
No: 01557-004 (X)
Location: Peak Minerals Sevier Lake, UT
Date: 12/1/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	48-53'	54.5-58'	58-63'	63-68'	68-73'	73-78'
Water Content Determination	Initial date	11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/17/15	11/17/15	11/17/15
	Wet soil + tare (g)	323.89	318.26	377.98	346.44	349.45	346.88	404.14	356.97
	Tare (g)	121.43	128.52	140.98	140.80	128.44	122.42	123.44	128.52
	Date	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15
	Dry soil + tare (g)	264.18	264.42	315.66	293.16	288.10	296.95	347.00	309.46
	Water content, ω (%)	41.8	39.6	35.7	35.0	38.4	28.6	25.6	26.3
	Date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Dry soil + tare (g)	263.53	263.81	315.08	287.16	281.67	293.88	342.76	305.68
	Water content, ω (%)	42.5	40.2	36.1	40.5	44.2	30.9	28.0	29.0
	Date	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15
	Dry soil + tare (g)	262.68	263.00	314.31	285.87	279.78	288.66	336.20	299.24
	Water content, ω (%)	43.3	41.1	36.7	41.8	46.0	35.0	31.9	33.8
	Date					11/24/15	11/24/15	11/24/15	11/24/15
	Dry soil + tare (g)					279.52	287.57	334.78	297.93
	Water content, ω (%)					46.3	35.9	32.8	34.9
	Date						11/25/15	11/25/15	11/25/15
	Dry soil + tare (g)						286.61	333.67	296.85
	Water content, ω (%)						36.7	33.5	35.7
	Date						11/30/15	11/30/15	11/30/15
	Dry soil + tare (g)						278.01	321.54	288.05
	Water content, ω (%)						44.3	41.7	43.2
	Date						12/1/15	12/1/15	12/1/15
	Dry soil + tare (g)						277.89	321.29	288.02
	Water content, ω (%)						44.4	41.9	43.2
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**43.3**	**41.1**	**36.7**	**41.8**	**46.3**	**44.4**	**41.9**	**43.2**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F

[2]at 230 deg. F

Entered by:___________

Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\X\[M140v1.xlsm]2

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (X)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/2/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-017	MC-018	MC-019	MC-020	MC-021	MC-022	MC-023	MC-024
	Depth:	78-83'	83-88'	88-93'	93-98'	98-103'	103-108'	108-113'	113-118'
Water Content Determination	Initial date	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/18/15	11/18/15
	Wet soil + tare (g)	396.63	373.47	336.60	369.30	355.28	350.31	358.20	363.68
	Tare (g)	127.58	128.09	122.74	117.89	121.86	123.54	152.78	121.70
	Date	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15	11/20/15
	Dry soil + tare (g)	336.57	319.53	292.86	316.69	304.28	295.74	327.81	326.92
	Water content, ω (%)	28.7	28.2	25.7	26.5	28.0	31.7	17.4	17.9
	Date	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15	11/23/15
	Dry soil + tare (g)	328.86	311.81	284.59	308.59	296.07	289.77	312.73	326.53
	Water content, ω (%)	33.7	33.6	32.1	31.8	34.0	36.4	28.4	18.1
	Date	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	11/24/15	
	Dry soil + tare (g)	327.24	310.31	282.82	307.52	295.00	289.04	311.59	
	Water content, ω (%)	34.8	34.7	33.6	32.6	34.8	37.0	29.3	
	Date	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	11/25/15	
	Dry soil + tare (g)	325.89	309.13	281.43	306.71	294.39	288.67	311.16	
	Water content, ω (%)	35.7	35.5	34.8	33.1	35.3	37.3	29.7	
	Date	11/30/15	11/30/15	11/30/15	11/30/15				
	Dry soil + tare (g)	313.08	301.66	272.17	302.63				
	Water content, ω (%)	45.0	41.4	43.1	36.1				
	Date	12/1/15	12/1/15	12/1/15	12/1/15				
	Dry soil + tare (g)	312.89	301.66	271.54	302.60				
	Water content, ω (%)	45.2	41.4	43.7	36.1				
	Date			12/2/15					
	Dry soil + tare (g)			271.46					
	Water content, ω (%)			43.8					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**45.2**	**41.4**	**43.8**	**36.1**	**35.3**	**37.3**	**29.7**	**18.1**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (X)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/30/2015
By: IM / ET

Sample Info.	Boring:	SN4-15-010	SN4-15-010						
	Sample:	MC-025	MC-026						
	Depth:	118-123'	123-125'						
Water Content Determination	Initial date	11/18/15	11/18/15						
	Wet soil + tare (g)	356.53	372.13						
	Tare (g)	120.95	127.13						
	Date	11/20/15	11/20/15						
	Dry soil + tare (g)	313.84	325.02						
	Water content, ω (%)	22.1	23.8						
	Date	11/23/15	11/23/15						
	Dry soil + tare (g)	309.16	322.86						
	Water content, ω (%)	25.2	25.2						
	Date	11/24/15							
	Dry soil + tare (g)	308.69							
	Water content, ω (%)	25.5							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**25.5**	**25.2**						
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: Norwest Corporation
No: 01557-004 (X)
Location: Peak Minerals Sevier Lake, UT
Date: 12/3/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-001	MC-002	MC-003	MC-004	MC-005	MC-006	MC-007	MC-008
	Depth:	0-3'	3-8'	8-13'	13-18'	18-23'	23-28'	28-33'	33-38'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	4.3	3.9	4.5	4.0	4.1	4.6	4.3	4.5
Carbonate Content, Calcite Equivalent (%)		**49**	**44**	**51**	**45**	**47**	**52**	**49**	**51**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (X)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/3/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	MC-015	MC-016
	Depth:	38-43'	43-48'	48-53'	54.5-58'	58-63'	63-68'	68-73'	73-78'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	3.0	2.7	2.6	2.6	2.6	2.8	2.2	2.5
Carbonate Content, Calcite Equivalent (%)		**34**	**30**	**29**	**29**	**29**	**31**	**24**	**28**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (X)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/3/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010	SN4-15-010
	Sample:	MC-017	MC-018	MC-019	MC-020	MC-021	MC-022	MC-023	MC-024
	Depth:	78-83'	83-88'	88-93'	93-98'	98-103'	103-108'	108-113'	113-118'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	2.6	3.1	2.4	2.3	2.6	2.5	1.9	0.9
Carbonate Content, Calcite Equivalent (%)		**29**	**35**	**27**	**25**	**29**	**28**	**21**	**9**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (X)**
Location: Peak Minerals Sevier Lake, UT
Date: 11/25/2015
By: BRR

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-010	SN4-15-010						
	Sample:	MC-025	MC-026						
	Depth:	118-123'	123-125'						
Test Info.	Sample Weight (g):	1.00	1.00						
	Pressure Reading (psi):	2.1	2.6						
Carbonate Content, Calcite Equivalent (%)		**23**	**29**						

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/17/2015
By: ET / IM

	Field								
Sample Info.	Boring:	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011
	Sample:	MC-001	MC-002	MC-003	MC-004	SH-001	MC-005	MC-006	MC-007
	Depth:	0-4'	4-9'	9-14'	14-19'	19-20.5'	20.5-24'	24-29'	29-34'
Water Content Determination	Initial date	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15
	Wet soil + tare (g)	339.83	285.39	302.23	294.08	280.52	293.38	285.94	318.67
	Tare (g)	150.25	127.49	127.51	123.66	127.67	124.73	128.43	126.90
	Date	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15
	Dry soil + tare (g)	314.87	244.22	256.82	252.05	234.84	246.31	240.86	268.81
	Water content, ω (%)	15.2	35.3	35.1	32.7	42.6	38.7	40.1	35.1
	Date	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15
	Dry soil + tare (g)	309.12	238.30	252.30	251.92	234.69	246.18	240.54	267.51
	Water content, ω (%)	19.3	42.5	40.0	32.9	42.8	38.9	40.5	36.4
	Date	12/11/15	12/11/15	12/11/15					12/11/15
	Dry soil + tare (g)	301.78	234.90	248.09					266.93
	Water content, ω (%)	25.1	47.0	44.9					36.9
	Date	12/14/15	12/14/15	12/14/15					12/14/15
	Dry soil + tare (g)	280.72	231.75	239.88					266.16
	Water content, ω (%)	45.3	51.4	55.5					37.7
	Date	12/15/15	12/15/15	12/15/15					
	Dry soil + tare (g)	277.50	231.35	238.08					
	Water content, ω (%)	49.0	52.0	58.0					
	Date	12/16/15	12/16/15	12/16/15					
	Dry soil + tare (g)	275.25	230.80	231.81					
	Water content, ω (%)	51.7	52.8	67.5					
	Date	12/17/15	12/17/15	12/17/15					
	Dry soil + tare (g)	275.22	230.80	231.77					
	Water content, ω (%)	51.7	52.8	67.6					
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**51.7**	**52.8**	**67.6**	**32.9**	**42.8**	**38.9**	**40.5**	**37.7**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/14/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011
	Sample:	MC-008	MC-009	MC-010	MC-011	MC-012	MC-013	MC-014	SH-002
	Depth:	34-39'	40.5-44'	44-49'	50.5-54'	55.5-59'	59-64'	64-69'	39-40.5'
Water Content Determination	Initial date	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/7/15	12/8/15
	Wet soil + tare (g)	320.54	336.45	356.41	361.86	334.26	328.82	361.05	300.42
	Tare (g)	122.68	139.73	128.19	140.86	117.61	127.11	128.33	122.42
	Date	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15	12/9/15
	Dry soil + tare (g)	262.42	275.23	291.70	302.13	270.76	268.81	310.28	245.23
	Water content, ω (%)	41.6	45.2	39.6	37.0	41.5	42.4	27.9	44.9
	Date	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15	12/10/15
	Dry soil + tare (g)	261.79	273.67	290.85	301.32	269.97	268.20	309.96	244.68
	Water content, ω (%)	42.2	46.9	40.3	37.7	42.2	43.0	28.1	45.6
	Date	12/11/15	12/11/15	12/11/15	12/11/15	12/11/15	12/11/15		12/11/15
	Dry soil + tare (g)	261.57	272.90	290.52	300.94	269.59	267.87		244.59
	Water content, ω (%)	42.5	47.7	40.6	38.1	42.6	43.3		45.7
	Date		12/14/15						
	Dry soil + tare (g)		272.07						
	Water content, ω (%)		48.6						
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**42.5**	**48.6**	**40.6**	**38.1**	**42.6**	**43.3**	**28.1**	**45.7**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/11/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-011							
	Sample:	SH-003							
	Depth:	49-50.5'							
Water Content Determination	Initial date	12/8/15							
	Wet soil + tare (g)	295.32							
	Tare (g)	127.69							
	Date	12/9/15							
	Dry soil + tare (g)	241.05							
	Water content, ω (%)	47.9							
	Date	12/10/15							
	Dry soil + tare (g)	240.69							
	Water content, ω (%)	48.3							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Water content, ω (%)								
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	Dry soil + tare (g)								
	Water content, ω (%)								
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	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
[1]Water content, ω (%)		**48.3**							
[2]Dry soil + tare (g)									
[2]Water content, ω (%)									

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals, Sevier Lake, UT
Date: 12/14/2015
By: ET

Section										
Sample Info.	Boring No.	SN4-15-011	SN4-15-011	SN4-15-011						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	19-20.5'	39-40.5'	49-50.5'						
Unit Weight Info.	Sample height, H (in)	5.984	5.504	6.037						
	Sample diameter, D (in)	2.869	2.840	2.870						
	Sample volume, V (ft^3)	0.0224	0.0202	0.0226						
	Mass rings + wet soil (g)	1157.75	1015.86	1143.06						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist soil, Ws (g)	1157.75	1015.86	1143.06						
	Moist unit wt., γ_m (pcf)	114.01	111.00	111.50						
Water Content	Wet soil + tare (g)	280.52	300.42	295.32						
	Dry soil + tare (g)	234.69	244.59	240.69						
	Tare (g)	127.67	122.42	127.69						
	Water Content, w (%)	**42.8**	**45.7**	**48.3**						
	Dry Unit Wt., γ_d (pcf)	**79.8**	**76.2**	**75.2**						

Entered by:___________

Reviewed:___________

<u>**Specific Gravity of Soil Solids by Water Pycnometer**</u>

(ASTM D854)

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: DKS

Drill hole / Sample:	SN4-15-011	SN4-15-011	SN4-15-011			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	19-20.5	39-40.5	49-50.5			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, P (%)	100	100	100			
Pycnometer No.	1	2	3			
Mass of pycnometer (g)	167.62	184.33	170.68			
Mass of pycnometer, soil, and water, $M_{\rho ws,t}$ (g)	706.87	722.92	709.35			
Temperature, T_t (°C)	21.7	21.7	21.7			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	666.03	682.99	669.19			
Mass of tare + dry soil (g)	379.1	392.8	395.05			
Mass of tare (g)	315.78	330.85	333.19			
Mass of soil, M_s (g)	63.32	61.95	61.86			
Specific gravity of soil solids at test temperature, G_t	2.817	2.813	2.851			
Temperature coefficient, K	0.99963	0.99963	0.99963			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.816**	**2.812**	**2.850**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________

Reviewed by:___________

Porosity of Soil

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: NB/ET

Sample Info.	Boring No.	SN4-15-011	SN4-15-011	SN4-15-011					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	19-20.5'	39-40.5'	49-50.5'					
Unit Weight Data	Sample height, H (in)	5.984	5.504	6.037					
	Sample diameter, D (in)	2.869	2.840	2.870					
	Mass rings + wet soil (g)	1157.75	1015.86	1143.06					
	Mass rings/tare (g)	0.00	0.00	0.00					
	Moist unit wt., γ_m (pcf)	114.0	111.0	111.5					
Water Content	Wet soil + tare (g)	280.52	300.42	295.32					
	Dry soil + tare (g)	234.69	244.59	240.69					
	Tare (g)	127.67	122.42	127.69					
	Water content (%)	42.8	45.7	48.3					
	Specific gravity of solids, Gs	2.816	2.812	2.850					
	Void ratio, e	1.202	1.304	1.367					
	Porosity, n	0.546	0.566	0.578					
	Total Soil Porosity, n (%)	**54.6**	**56.6**	**57.8**					
	Water Porosity, n_w (%)	**47.6**	**48.5**	**50.6**					
	Air Porosity, n_a (%)	**7.0**	**8.1**	**7.1**					
	Comments:	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.					

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

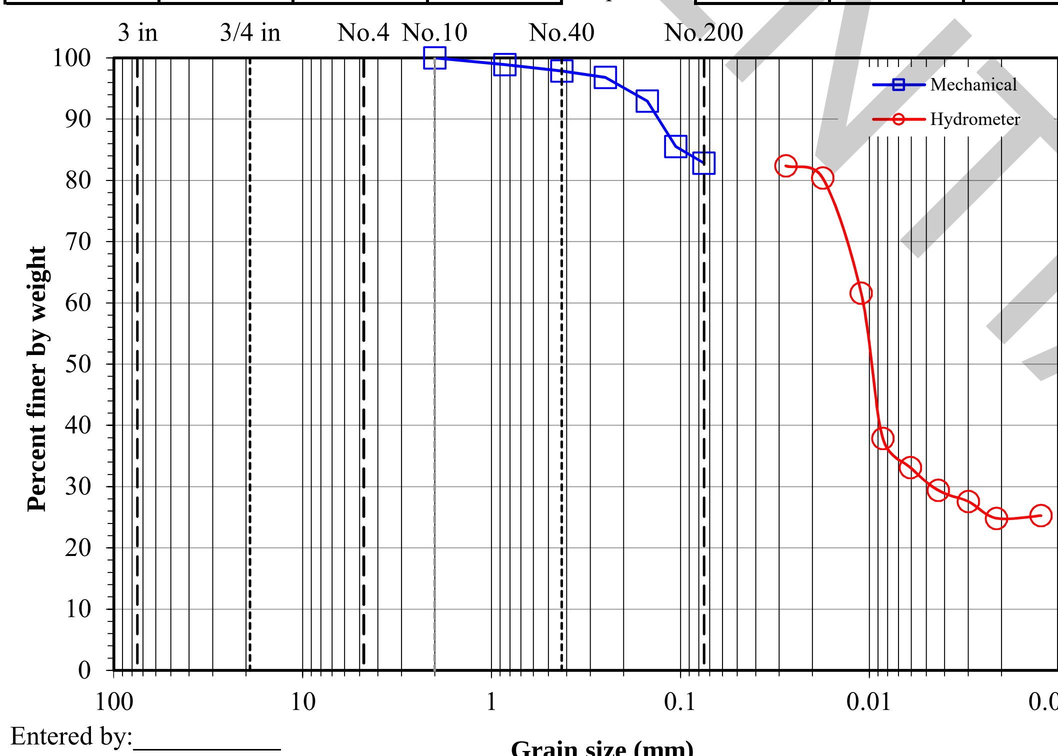
Boring No.: SN4-15-011
Sample: MC-001
Depth: 0-4'
Description: Grey clay with sand

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.79	48.49
Hydrometer fraction (g):	50.79	48.49
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.11	33.11
Dry soil + tare (g):	-	32.62	32.62
Tare (g):	-	22.29	22.29
Water content (%):	0.00	4.74	4.74

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.85	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.96
			Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	18.3	45.5	0.02768	82.37
6"	-	150	-		5	18.3	44.5	0.01767	80.39
4"	-	100	-		15	18.3	35	0.01105	61.60
3"	-	75	-		30	18.4	23	0.00850	37.90
1.5"	-	37.5	-		60	18.8	20.5	0.00608	33.13
3/4"	-	19	-		120	19.3	18.5	0.00432	29.39
3/8"	-	9.5	-		250	19.7	17.5	0.00300	27.59
No.4	-	4.75	-		500	20.2	16	0.00213	24.84
No.10	-	2	100.0	<=Split hyd.	1450	21.2	16	0.00123	25.27
No.20	0.53	0.85	98.9						
No.40	1.05	0.425	97.8						
No.60	1.55	0.25	96.8						
No.100	3.42	0.15	92.9						
No.140	7.01	0.106	85.5						
No.200	8.33	0.075	82.8	<=Split					



Gravel (%): 0.0
Sand (%): 17.2
Fines (%): 82.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

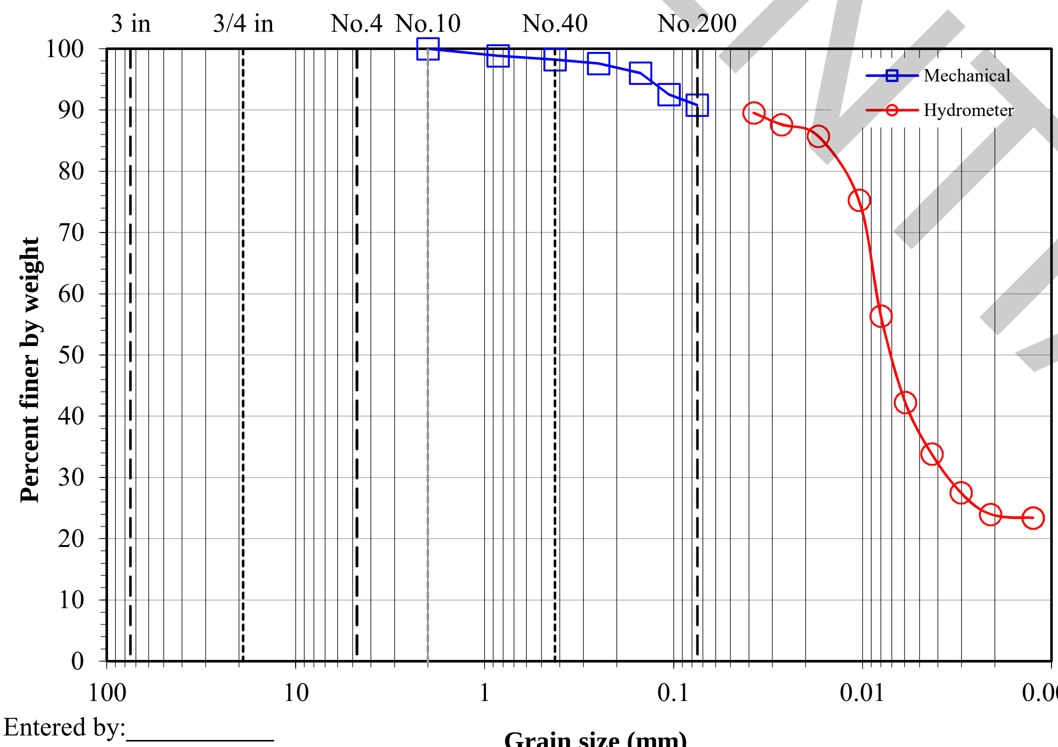
Boring No.: SN4-15-011
Sample: MC-002
Depth: 4-9'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	52.00	50.95
Hydrometer fraction (g):	52.00	50.95
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	32.42	32.42
Dry soil + tare (g):	-	32.21	32.21
Tare (g):	-	22.03	22.03
Water content (%):	0.00	2.06	2.06

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	18.1	51	0.03769	89.53
6"	-	150	-		2	18.1	50	0.02692	87.63
4"	-	100	-		5	18.1	49	0.01720	85.73
3"	-	75	-		15	18.1	43.5	0.01046	75.27
1.5"	-	37.5	-		30	18.4	33.5	0.00800	56.39
3/4"	-	19	-		60	18.7	26	0.00595	42.25
3/8"	-	9.5	-		120	19.1	21.5	0.00431	33.86
No.4	-	4.75	-		250	19.9	18	0.00302	27.54
No.10	-	2	100.0	<=Split hyd.	520	20.5	16	0.00211	23.99
No.20	0.59	0.85	98.8		1440	21.4	15.5	0.00126	23.42
No.40	0.91	0.425	98.2		1440	21.4	15.5	0.00126	23.42
No.60	1.23	0.25	97.6						
No.100	2.02	0.15	96.0						
No.140	3.80	0.106	92.5						
No.200	4.69	0.075	90.8	<=Split					



Gravel (%): 0.0
Sand (%): 9.2
Fines (%): 90.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

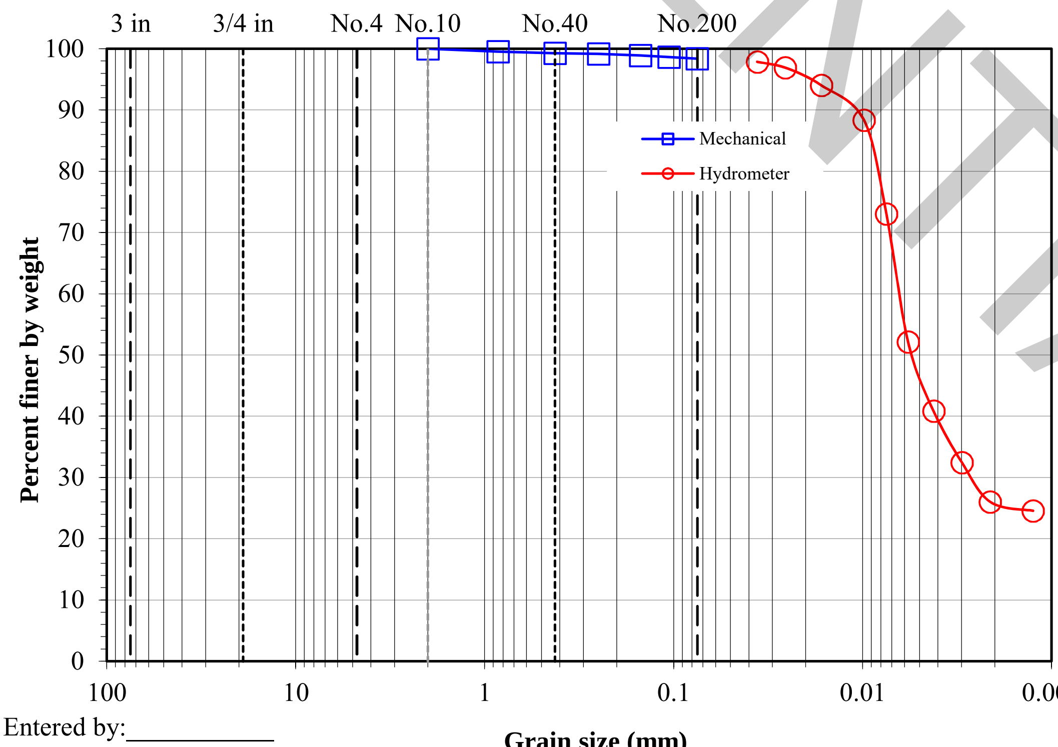
Boring No.: SN4-15-011
Sample: MC-003
Depth: 9-14'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.36	50.54
Hydrometer fraction (g):	51.36	50.54
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.72	34.72
Dry soil + tare (g):	-	34.52	34.52
Tare (g):	-	22.12	22.12
Water content (%):	0.00	1.61	1.61

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	18	55	0.03613	97.87
6"	-	150	-		2	18	54.5	0.02569	96.91
4"	-	100	-		5	18	53	0.01652	94.04
3"	-	75	-		15	18.1	50	0.00983	88.33
1.5"	-	37.5	-		30	18.2	42	0.00748	73.04
3/4"	-	19	-		60	18.6	31	0.00575	52.13
3/8"	-	9.5	-		120	19.1	25	0.00421	40.84
No.4	-	4.75	-		250	19.7	20.5	0.00298	32.47
No.10	-	2	100.0	<=Split hyd.	512	20.3	17	0.00212	26.02
No.20	0.23	0.85	99.5		1436	21.4	16	0.00125	24.56
No.40	0.36	0.425	99.3						
No.60	0.42	0.25	99.2						
No.100	0.56	0.15	98.9						
No.140	0.68	0.106	98.7						
No.200	0.83	0.075	98.4	<=Split					



Gravel (%): 0.0
Sand (%): 1.6
Fines (%): 98.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-004
Depth: 14-19'
Description: Grey clay

	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	117.43	114.90
+#10 Coarse fraction (g):	0.43	0.43
-#10 Split fraction (g):	52.15	51.02
Hydrometer fraction (g):	52.15	51.02
Split fraction:	0.996	

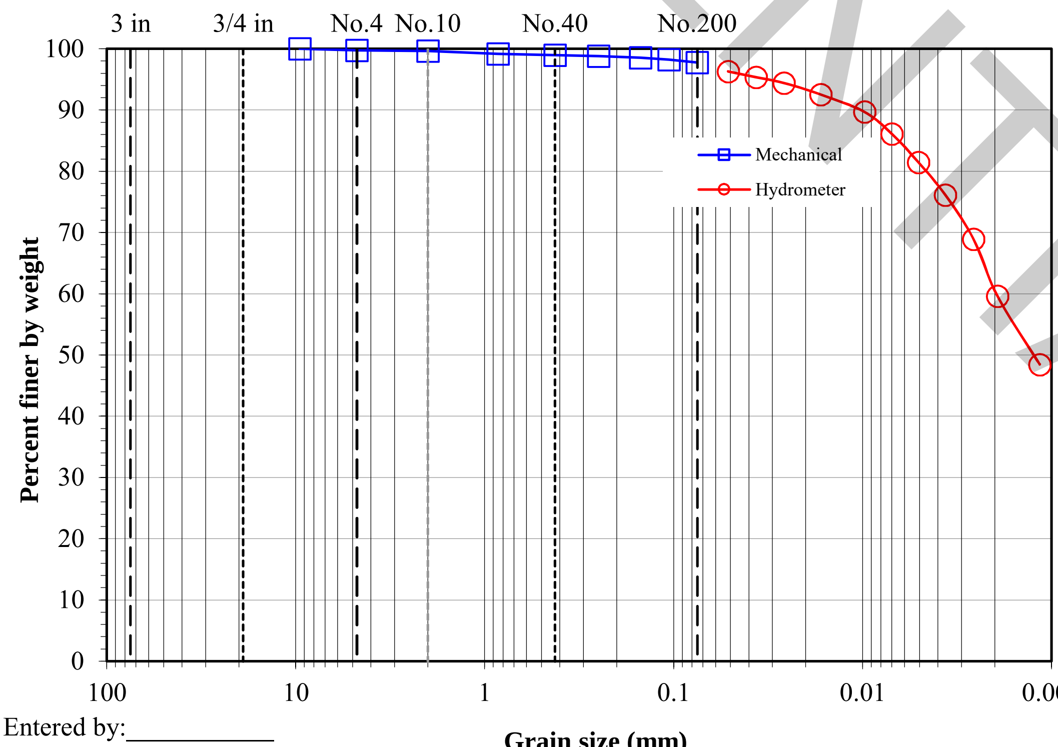
Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.83	36.48	36.48
Dry soil + tare (g):	37.83	36.17	36.17
Tare (g):	37.55	22.17	22.17
Water content (%):	0.00	2.21	2.21

Hydrometer data

Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	99.63
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	0.28	4.75	99.8	
No.10	0.43	2	99.6	<=Split
No.20	0.24	0.85	99.2	
No.40	0.34	0.425	99.0	
No.60	0.43	0.25	98.8	
No.100	0.56	0.15	98.5	
No.140	0.72	0.106	98.2	
No.200	0.96	0.075	97.8	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	17.3	55	0.05155	96.30
1	17.3	54.5	0.03666	95.36
2	17.3	54	0.02606	94.41
5	17.3	53	0.01667	92.52
15	17.3	51.5	0.00978	89.68
30	17.8	49.5	0.00701	86.11
60	18	47	0.00507	81.46
120	18.8	44	0.00365	76.12
250	19.7	40	0.00259	68.93
480	20.1	35	0.00194	59.64
1460	20.5	29	0.00115	48.46



Gravel (%): 0.2
Sand (%): 2.0
Fines (%): 97.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*
(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: SN4-15-011
Sample: SH-001
Depth: 19-20.5'
Description: Grey clay

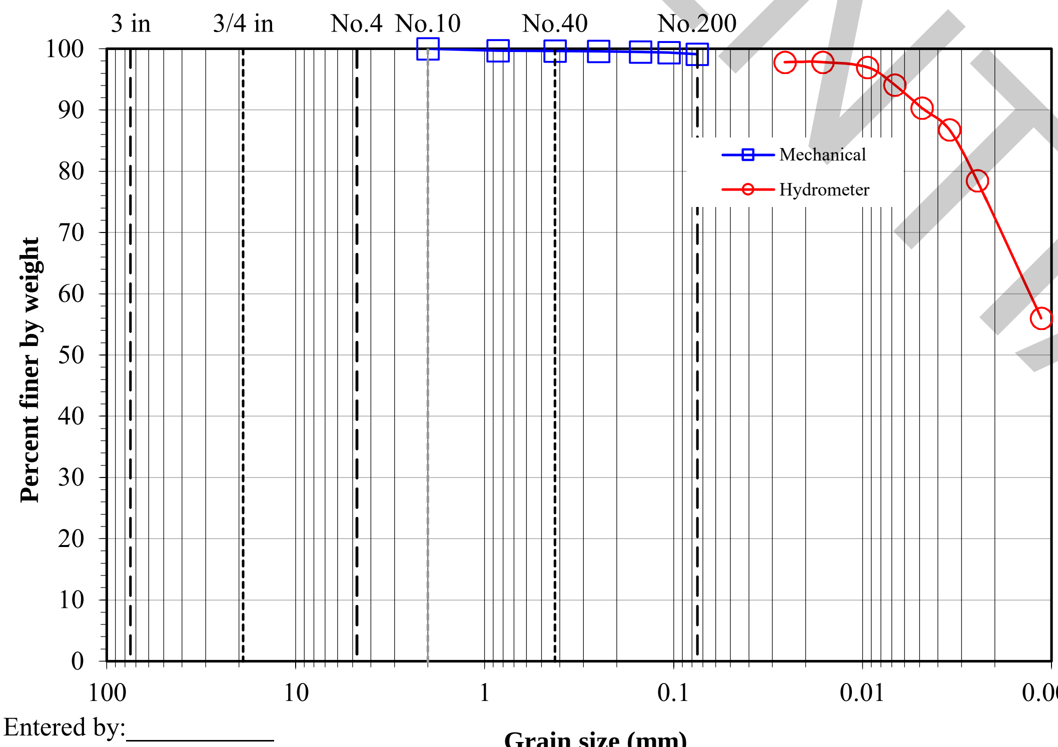
	Moist	Dry
Split:	No	
Total sample wt. (g):	50.40	49.38
Hydrometer fraction (g):	50.40	49.38
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.31	33.31
Dry soil + tare (g):	-	33.08	33.08
Tare (g):	-	22.00	22.00
Water content (%):	0.00	2.08	2.08

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.816	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.16	0.85	99.7	
No.40	0.18	0.425	99.6	
No.60	0.21	0.25	99.6	
No.100	0.26	0.15	99.5	
No.140	0.31	0.106	99.4	
No.200	0.44	0.075	99.1	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.8	54	0.02579	97.83
5	17.8	54	0.01631	97.83
15	18.1	53.5	0.00943	96.98
30	18.2	52	0.00677	94.09
60	18.6	50	0.00486	90.35
120	19.4	48	0.00347	86.78
250	20.5	43.5	0.00248	78.45
1430	20.6	32	0.00114	56.01



Gravel (%): 0.0
Sand (%): 0.9
Fines (%): 99.1

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-005
Depth: 20.5-24'
Description: Grey clay

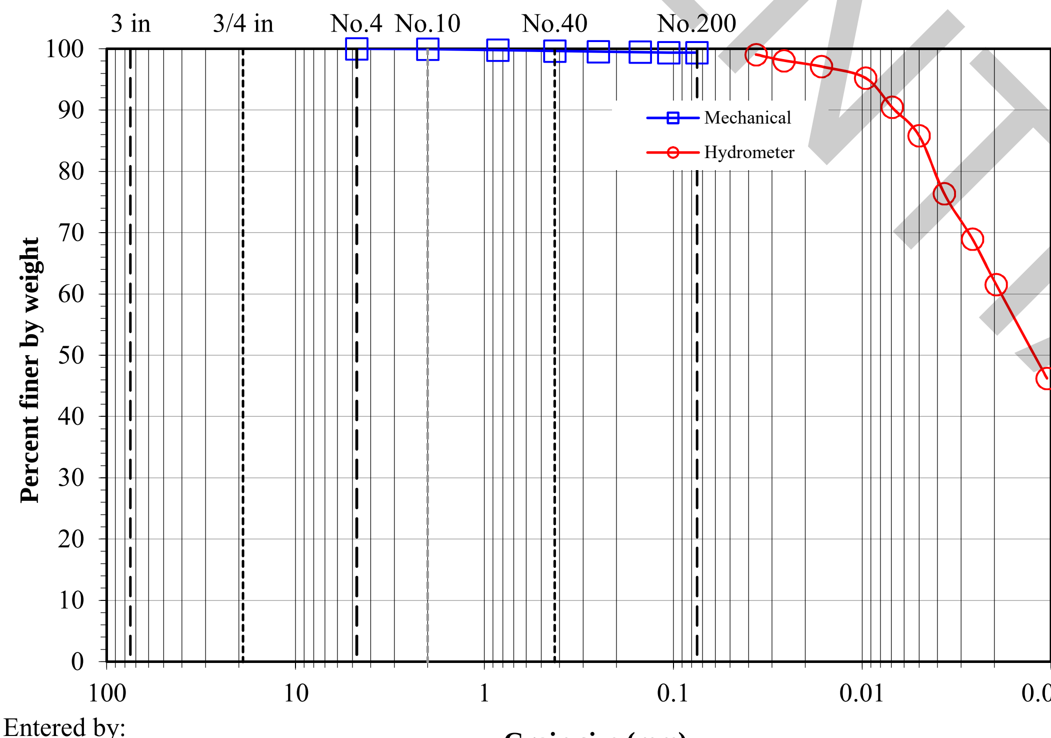
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	107.47	105.94
+#10 Coarse fraction (g):	0.03	0.03
-#10 Split fraction (g):	50.47	49.75
Hydrometer fraction (g):	50.47	49.75
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	112.92	30.62	30.62
Dry soil + tare (g):	112.91	30.50	30.50
Tare (g):	112.79	22.16	22.16
Water content (%):	8.33	1.44	1.44

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	99.97
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.03	2	100.0 <=Split
No.20	0.09	0.85	99.8
No.40	0.18	0.425	99.6
No.60	0.21	0.25	99.5
No.100	0.25	0.15	99.5
No.140	0.30	0.106	99.4
No.200	0.31	0.075	99.3

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.2	55	0.03650	99.05
2	17.2	54.5	0.02596	98.08
5	17.2	54	0.01651	97.11
15	17.4	53	0.00961	95.25
30	17.6	50.5	0.00696	90.47
60	18.2	48	0.00501	85.86
120	18.8	43	0.00368	76.38
250	19.7	39	0.00261	68.98
466	20.5	35	0.00195	61.54
1785	21.1	27	0.00105	46.22



Gravel (%): 0.0
Sand (%): 0.7
Fines (%): 99.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

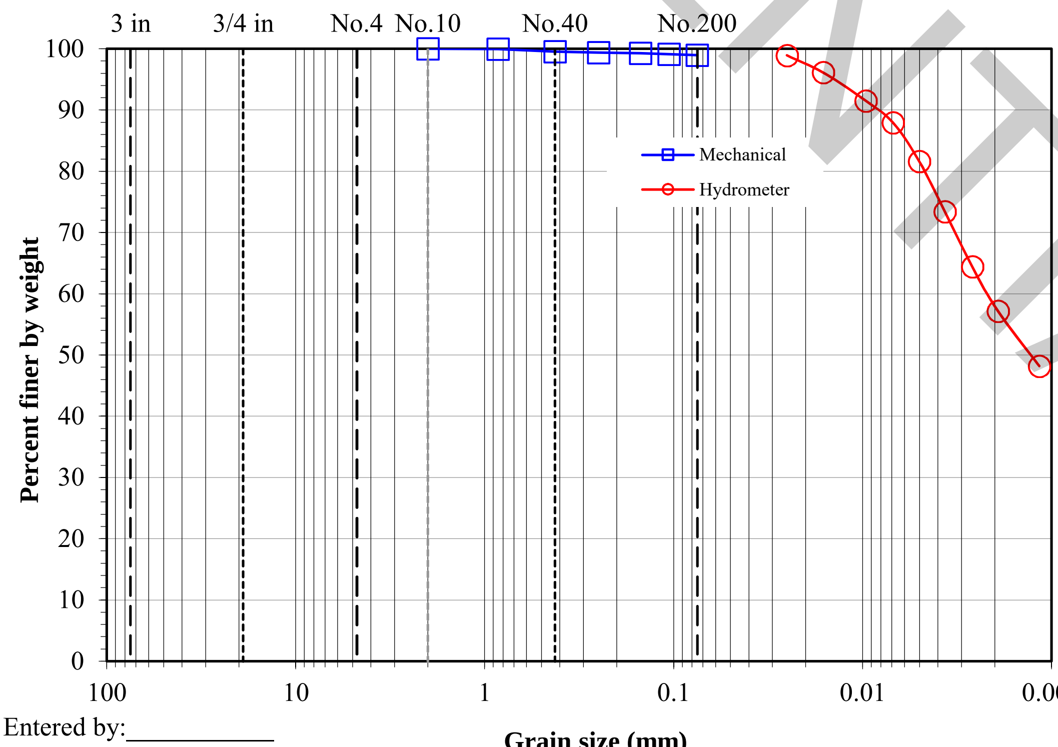
Boring No.: SN4-15-011
Sample: MC-006
Depth: 24-29'
Description: Grey clay

		Moist	Dry
Split:	No		
Total sample wt. (g):		52.34	51.84
Hydrometer fraction (g):		52.34	51.84
		1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	30.33	30.33
Dry soil + tare (g):	-	30.25	30.25
Tare (g):	-	21.99	21.99
Water content (%):	0.00	0.97	0.97

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.4	57	0.02515	98.92
6"	-	150	-		5	17.4	55.5	0.01619	96.12
4"	-	100	-		15	17.5	53	0.00960	91.49
3"	-	75	-		30	17.9	51	0.00690	87.91
1.5"	-	37.5	-		60	18.5	47.5	0.00501	81.62
3/4"	-	19	-		120	19	43	0.00367	73.41
3/8"	-	9.5	-		250	19.8	38	0.00263	64.40
No.4	-	4.75	-		491	20.4	34	0.00192	57.17
No.10	-	2	100.0	<=Split hyd.	1415	21.3	29	0.00116	48.20
No.20	0.04	0.85	99.9						
No.40	0.24	0.425	99.5						
No.60	0.32	0.25	99.4						
No.100	0.39	0.15	99.2						
No.140	0.45	0.106	99.1						
No.200	0.55	0.075	98.9	<=Split					



Gravel (%): 0.0
Sand (%): 1.1
Fines (%): 98.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-007
Depth: 29-34'
Description: Grey clay

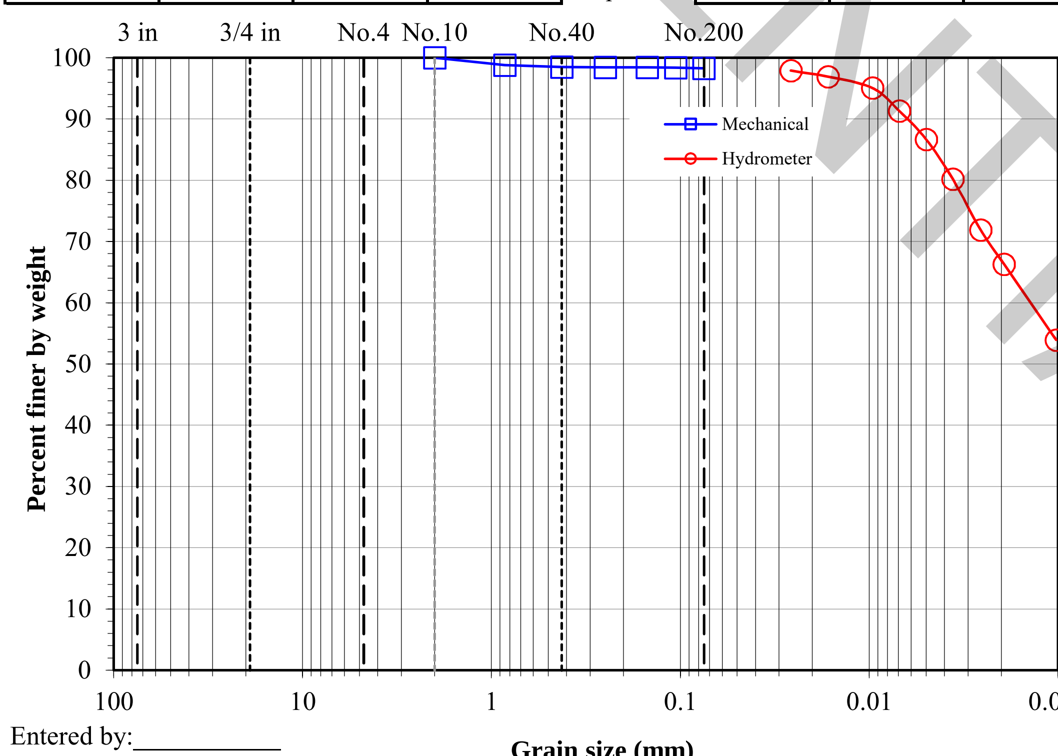
Split:	No	
	Moist	Dry
Total sample wt. (g):	50.69	49.84
Hydrometer fraction (g):	50.69	49.84
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.38	33.38
Dry soil + tare (g):	-	33.19	33.19
Tare (g):	-	22.02	22.02
Water content (%):	0.00	1.70	1.70

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.59	0.85	98.8	
No.40	0.75	0.425	98.5	
No.60	0.77	0.25	98.5	
No.100	0.79	0.15	98.4	
No.140	0.80	0.106	98.4	
No.200	0.85	0.075	98.3	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.1	54.5	0.02599	97.89
5	17.1	54	0.01653	96.92
15	17.3	53	0.00962	95.06
30	17.6	51	0.00692	91.30
60	18.1	48.5	0.00499	86.66
120	18.9	45	0.00361	80.20
250	19.9	40.5	0.00257	71.88
458	20.5	37.5	0.00193	66.30
1778	21.1	31	0.00102	53.93



Gravel (%): 0.0
Sand (%): 1.7
Fines (%): 98.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-008
Depth: 34-39'
Description: Grey clay

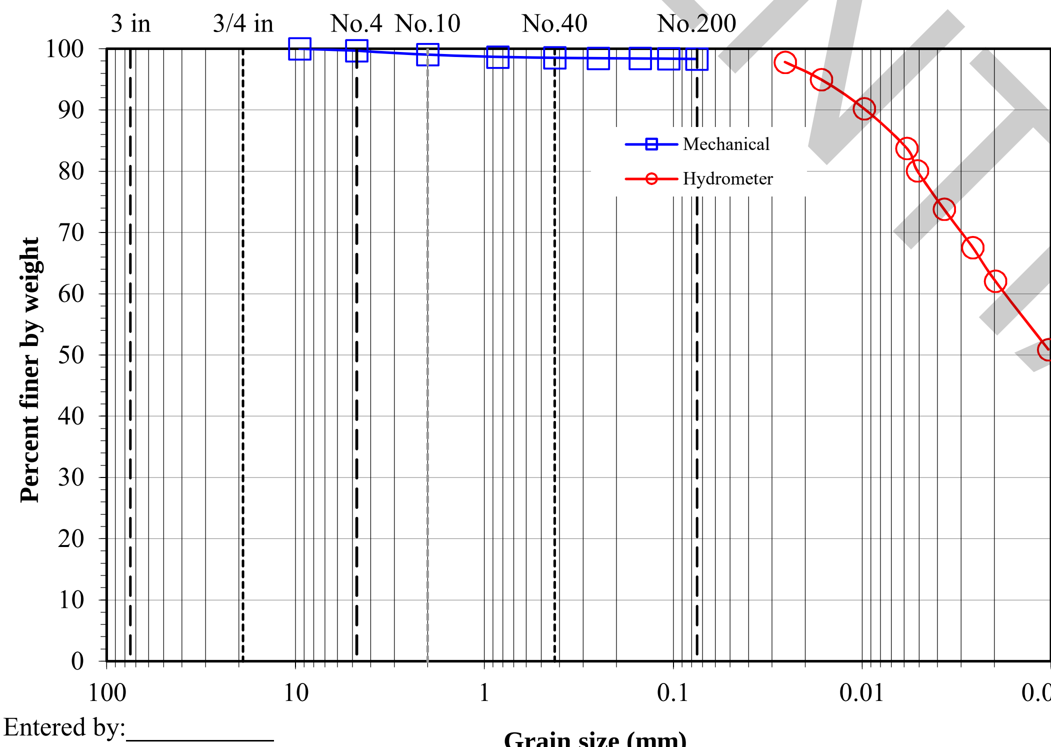
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	88.10	86.55
+#10 Coarse fraction (g):	0.83	0.82
-#10 Split fraction (g):	51.33	50.43
Hydrometer fraction (g):	51.33	50.43
Split fraction:	0.991	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	127.90	28.60	28.60
Dry soil + tare (g):	127.88	28.48	28.48
Tare (g):	126.77	21.79	21.79
Water content (%):	1.80	1.79	1.79

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	99.05
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	0.29	4.75	99.7	
No.10	0.82	2	99.1	<=Split
No.20	0.22	0.85	98.6	
No.40	0.26	0.425	98.5	
No.60	0.32	0.25	98.4	
No.100	0.32	0.15	98.4	
No.140	0.34	0.106	98.4	
No.200	0.37	0.075	98.3	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.3	55.5	0.02563	97.83
5	17.3	54	0.01648	94.98
15	17.3	51.5	0.00978	90.22
45	17.8	48	0.00581	83.77
60	18.1	46	0.00511	80.09
120	19	42.5	0.00369	73.80
250	20	39	0.00260	67.56
450	20.5	36	0.00197	62.06
1770	21.1	30	0.00103	50.90



Gravel (%): 0.3
Sand (%): 1.3
Fines (%): 98.3

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

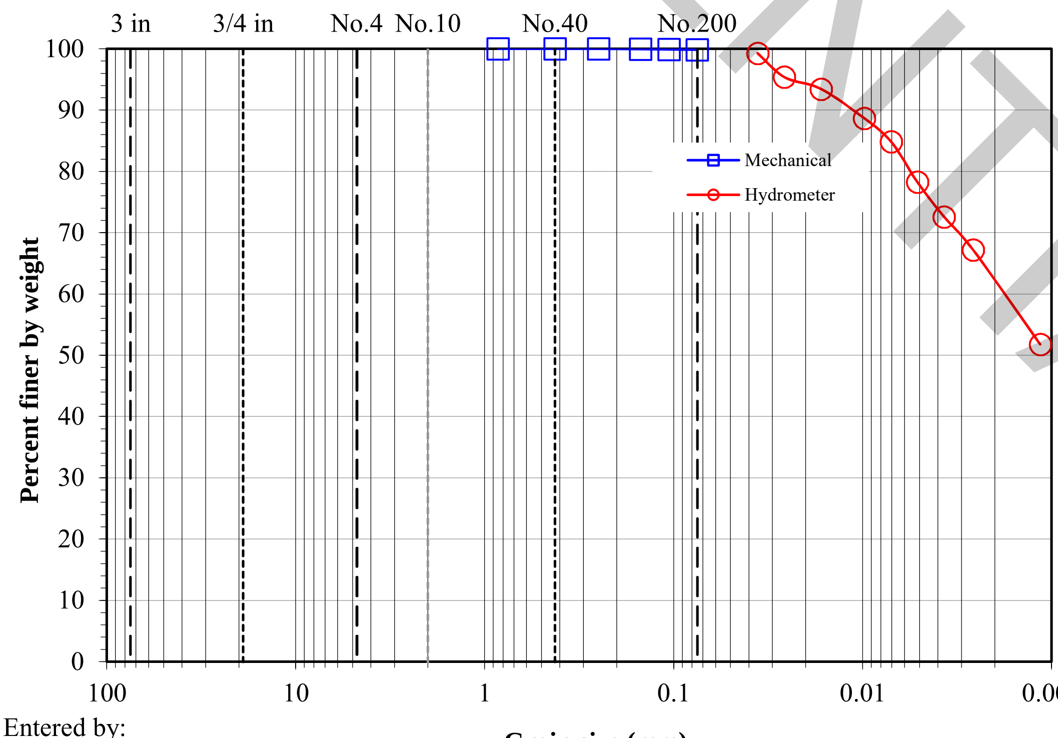
Boring No.: SN4-15-011
Sample: SH-002
Depth: 39-40.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.42	49.76
Hydrometer fraction (g):	51.42	49.76
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.34	34.34
Dry soil + tare (g):	-	33.94	33.94
Tare (g):	-	21.96	21.96
Water content (%):	0.00	3.34	3.34

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.812	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	18.2	55	0.03592	99.26
6"	-	150	-		2	18.2	53	0.02597	95.38
4"	-	100	-		5	18.2	52	0.01660	93.44
3"	-	75	-		15	18.4	49.5	0.00981	88.67
1.5"	-	37.5	-		30	18.5	47.5	0.00706	84.83
3/4"	-	19	-		60	19	44	0.00513	78.24
3/8"	-	9.5	-		120	19.4	41	0.00371	72.59
No.4	-	4.75	-		250	20.4	38	0.00260	67.19
No.10	-	2	-	<=Split hyd.	1438	20.7	30	0.00115	51.78
No.20	-	0.85	100.0						
No.40	0.01	0.425	100.0						
No.60	0.01	0.25	100.0						
No.100	0.02	0.15	100.0						
No.140	0.04	0.106	99.9						
No.200	0.09	0.075	99.8	<=Split					



Gravel (%): 0.0
Sand (%): 0.2
Fines (%): 99.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

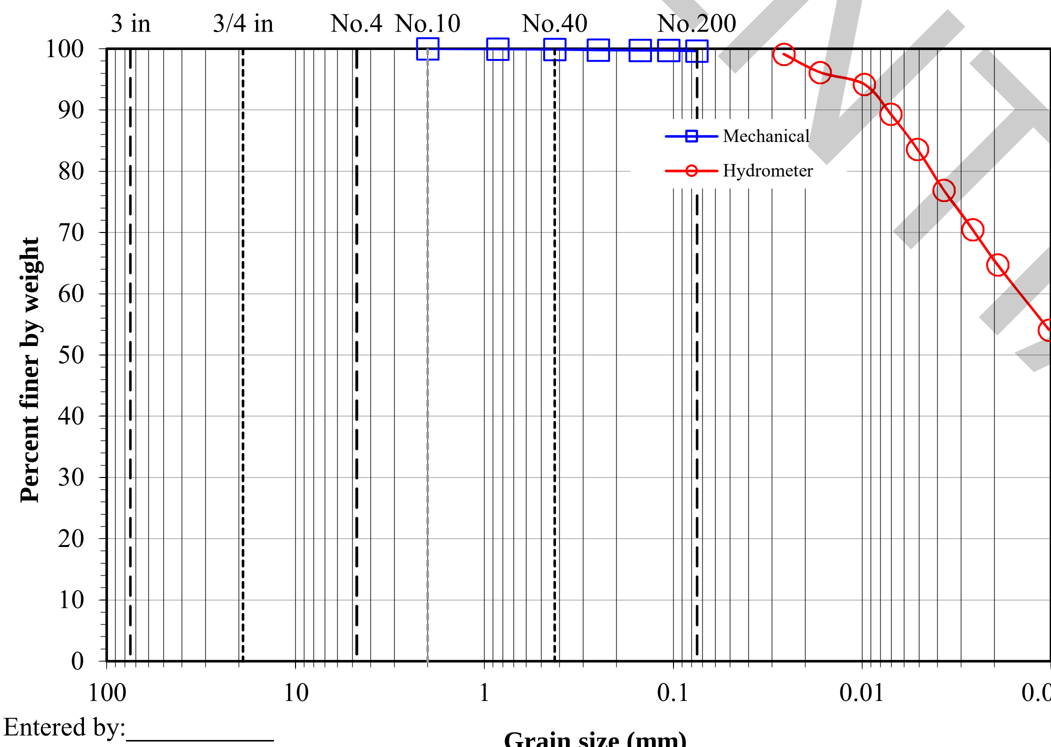
Boring No.: SN4-15-011
Sample: MC-009
Depth: 40.5-44'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.20	48.80
Hydrometer fraction (g):	50.20	48.80
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	34.90	34.90
Dry soil + tare (g):	-	34.54	34.54
Tare (g):	-	22.00	22.00
Water content (%):	0.00	2.87	2.87

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		2	17.4	54	0.02603	99.12
6"	-	150	-		5	17.4	52.5	0.01673	96.15
4"	-	100	-		15	17.5	51.5	0.00975	94.20
3"	-	75	-		30	17.7	49	0.00705	89.33
1.5"	-	37.5	-		60	18.2	46	0.00510	83.59
3/4"	-	19	-		120	18.8	42.5	0.00370	76.91
3/8"	-	9.5	-		250	20	39	0.00260	70.48
No.4	-	4.75	-		474	20.5	36	0.00192	64.74
No.10	-	2	100.0	<=Split hyd.	1793	21.1	30.5	0.00102	54.09
No.20	0.03	0.85	99.9						
No.40	0.06	0.425	99.9						
No.60	0.10	0.25	99.8						
No.100	0.12	0.15	99.8						
No.140	0.14	0.106	99.7						
No.200	0.17	0.075	99.7	<=Split					



Gravel (%): 0.0
Sand (%): 0.3
Fines (%): 99.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-010
Depth: 44-49'
Description: Grey clay

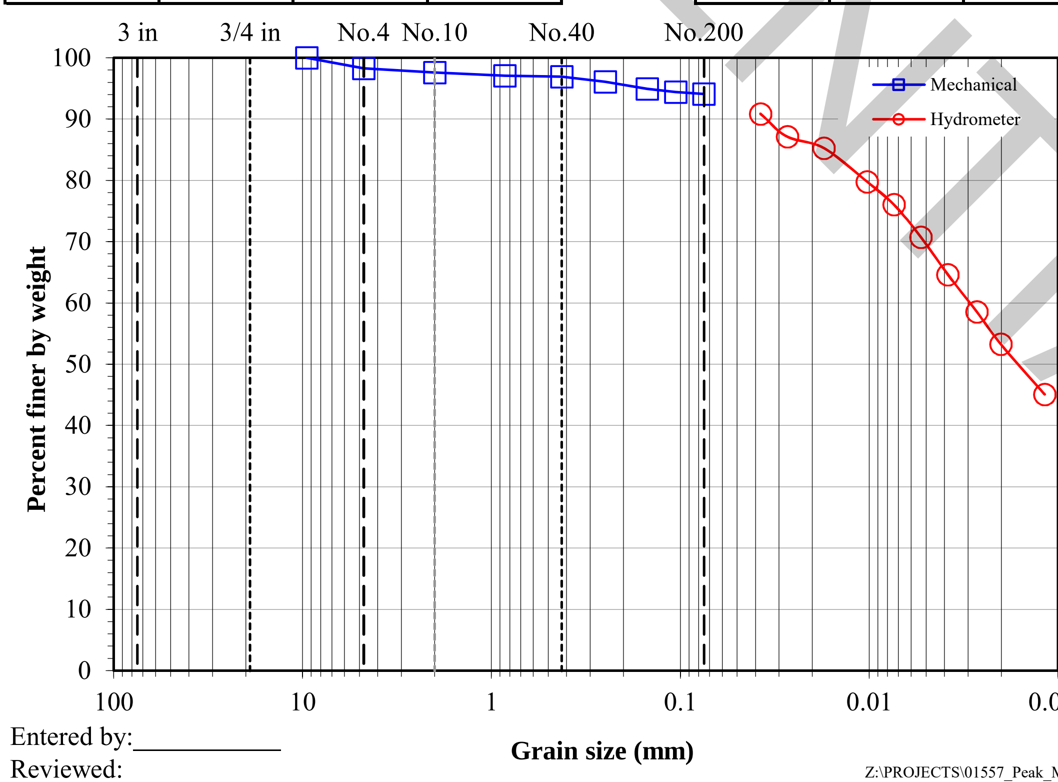
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	102.81	100.95
+#10 Coarse fraction (g):	2.46	2.43
-#10 Split fraction (g):	51.65	50.71
Hydrometer fraction (g):	51.65	50.71
Split fraction:	0.976	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	131.98	34.03	34.03
Dry soil + tare (g):	131.93	33.81	33.81
Tare (g):	128.08	21.96	21.96
Water content (%):	1.30	1.86	1.86

Hydrometer data

Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	97.59
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	16.5	53	0.03764	90.86
6"	-	150	-		2	16.5	51	0.02719	87.14
4"	-	100	-		5	16.5	50	0.01737	85.27
3"	-	75	-		15	16.8	47	0.01029	79.80
1.5"	-	37.5	-		30	16.8	45	0.00742	76.07
3/4"	-	19	-		60	17.5	42	0.00534	70.77
3/8"	-	9.5	100.0		120	18.5	38.5	0.00384	64.65
No.4	1.76	4.75	98.3		250	19.6	35	0.00270	58.58
No.10	2.43	2	97.6	<=Split	463	20.3	32	0.00201	53.27
No.20	0.27	0.85	97.1		1423	20.8	27.5	0.00118	45.08
No.40	0.36	0.425	96.9						
No.60	0.79	0.25	96.1						
No.100	1.37	0.15	95.0						
No.140	1.65	0.106	94.4						
No.200	1.82	0.075	94.1						



Gravel (%): 1.7
Sand (%): 4.2
Fines (%): 94.1

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: BRR

Boring No.: **SN4-15-011**
Sample: **SH-003**
Depth: **49-50.5'**
Description: Grey clay

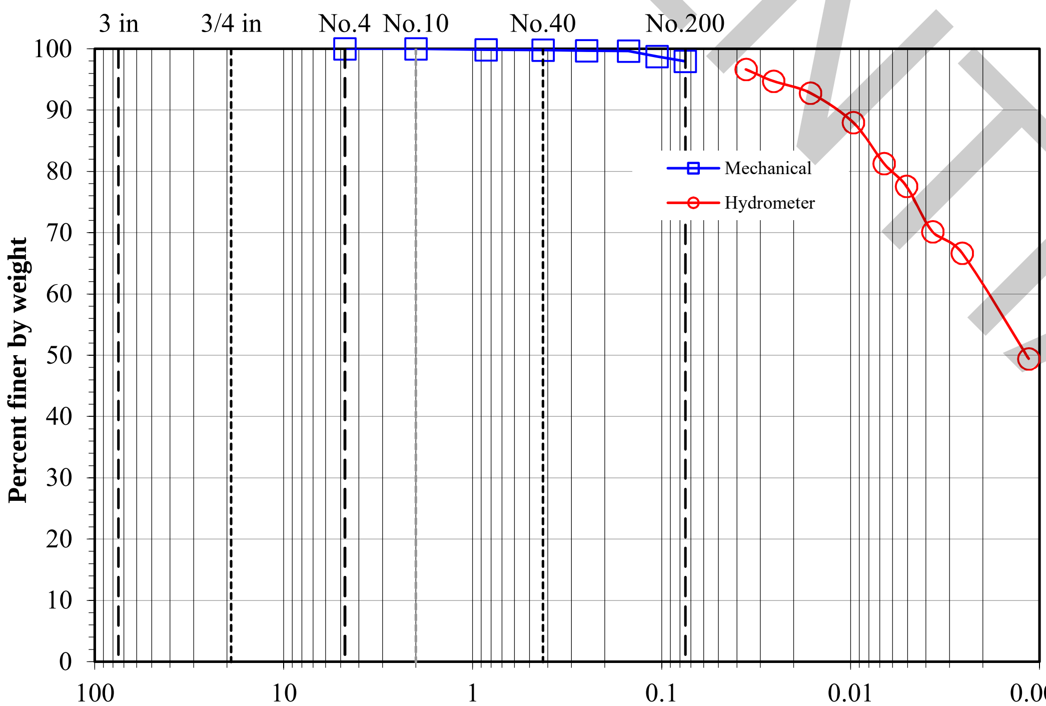
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	117.77	115.10
+#10 Coarse fraction (g):	0.03	0.03
-#10 Split fraction (g):	50.95	49.79
Hydrometer fraction (g):	50.95	49.79
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	37.92	36.87	36.87
Dry soil + tare (g):	37.92	36.53	36.53
Tare (g):	37.86	21.88	21.88
Water content (%):	0.00	2.32	2.32

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.850	Determined	α:	0.96
Bulb No.	2		Hyd. fraction:	99.97
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.03	2	100.0	<=Split
No.20	0.06	0.85	99.9	
No.40	0.09	0.425	99.8	
No.60	0.14	0.25	99.7	
No.100	0.17	0.15	99.6	
No.140	0.61	0.106	98.7	
No.200	1.00	0.075	98.0	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	18.5	54	0.03581	96.64
2	18.5	53	0.02560	94.72
5	18.5	52	0.01637	92.79
15	18.5	49.5	0.00970	87.98
34	18.6	46	0.00666	81.28
60	19	44	0.00508	77.60
120	19.6	40	0.00369	70.15
250	20.5	38	0.00257	66.67
1446	20.7	29	0.00114	49.43



Gravel (%): 0.0
Sand (%): 2.0
Fines (%): 98.0

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

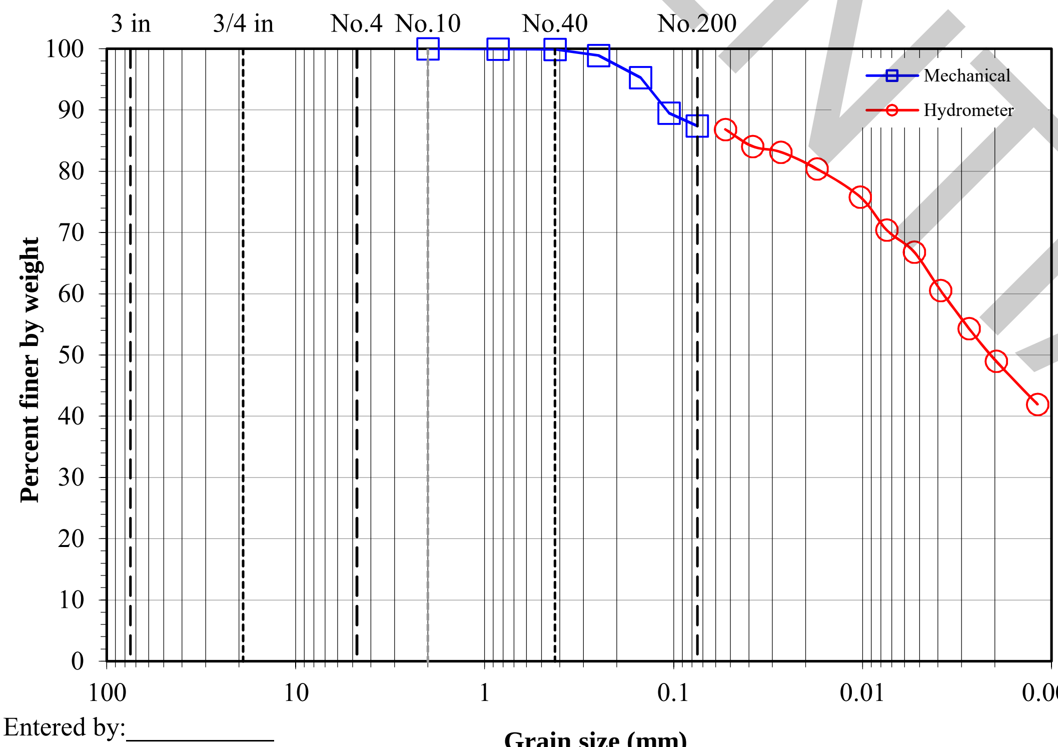
Boring No.: SN4-15-011
Sample: MC-011
Depth: 50.5-54'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	53.23	52.53
Hydrometer fraction (g):	53.23	52.53
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.79	33.79
Dry soil + tare (g):	-	33.63	33.63
Tare (g):	-	21.64	21.64
Water content (%):	0.00	1.33	1.33

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	18.1	51	0.05330	86.84
6"	-	150	-		1	18.1	49.5	0.03827	84.07
4"	-	100	-		2	18.1	49	0.02719	83.15
3"	-	75	-		5	18.1	47.5	0.01745	80.38
1.5"	-	37.5	-		15	18.2	45	0.01030	75.81
3/4"	-	19	-		30	18.5	42	0.00745	70.40
3/8"	-	9.5	-		60	18.8	40	0.00534	66.84
No.4	-	4.75	-		120	19.2	36.5	0.00387	60.54
No.10	-	2	100.0	<=Split hyd.	250	19.8	33	0.00273	54.33
No.20	0.02	0.85	100.0		498	20.3	30	0.00197	49.00
No.40	0.06	0.425	99.9		1420	21.1	26	0.00119	41.95
No.60	0.59	0.25	98.9						
No.100	2.48	0.15	95.3						
No.140	5.53	0.106	89.5						
No.200	6.61	0.075	87.4	<=Split					



Gravel (%): 0.0
Sand (%): 12.6
Fines (%): 87.4

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-012
Depth: 55.5-59'
Description: Grey clay

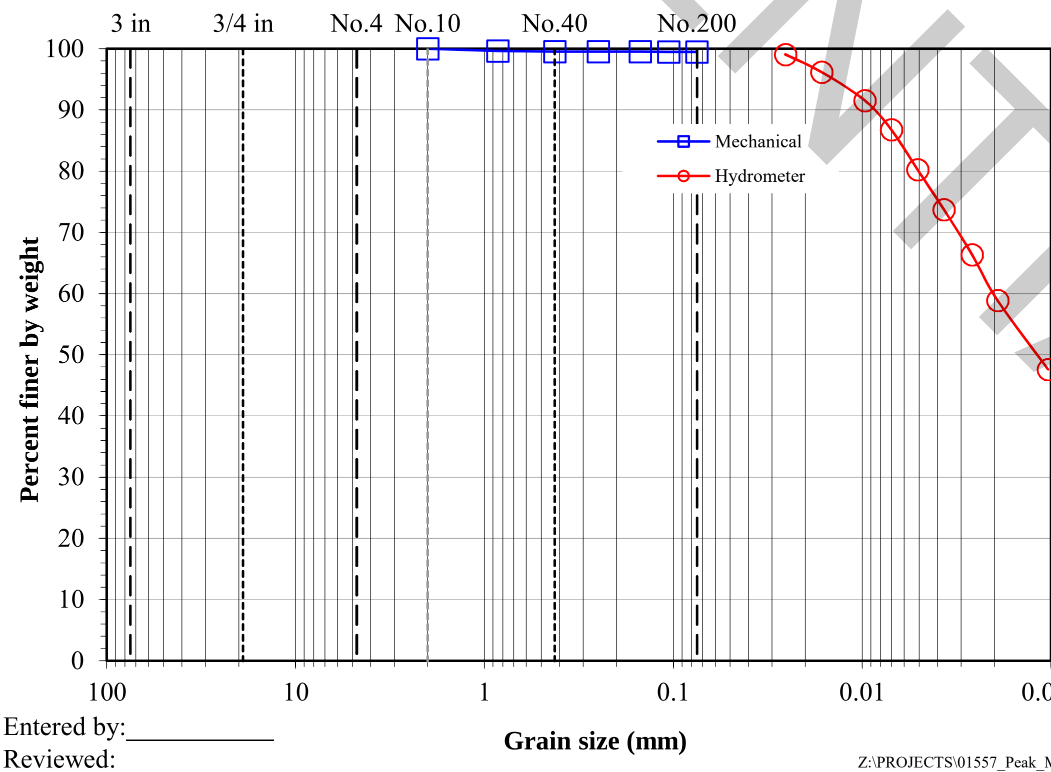
Split:	No		
	Moist	Dry	
Total sample wt. (g):	51.14	50.36	
Hydrometer fraction (g):	51.14	50.36	
	1.000		

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	36.41	36.41
Dry soil + tare (g):	-	36.19	36.19
Tare (g):	-	21.94	21.94
Water content (%):	0.00	1.54	1.54

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	100.00
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.18	0.85	99.6	
No.40	0.23	0.425	99.5	
No.60	0.23	0.25	99.5	
No.100	0.24	0.15	99.5	
No.140	0.25	0.106	99.5	
No.200	0.27	0.075	99.5	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17.7	55.5	0.02550	99.06
5	17.7	54	0.01640	96.17
15	18.1	51.5	0.00968	91.53
30	18.2	49	0.00701	86.77
60	18.7	45.5	0.00510	80.25
120	19.2	42	0.00370	73.73
250	20	38	0.00262	66.37
490	20.5	34	0.00192	58.89
1810	21.1	28	0.00104	47.60



Gravel (%): 0.0
Sand (%): 0.5
Fines (%): 99.5

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/28/2015
By: BRR

Boring No.: SN4-15-011
Sample: MC-013
Depth: 59-64'
Description: Grey clay

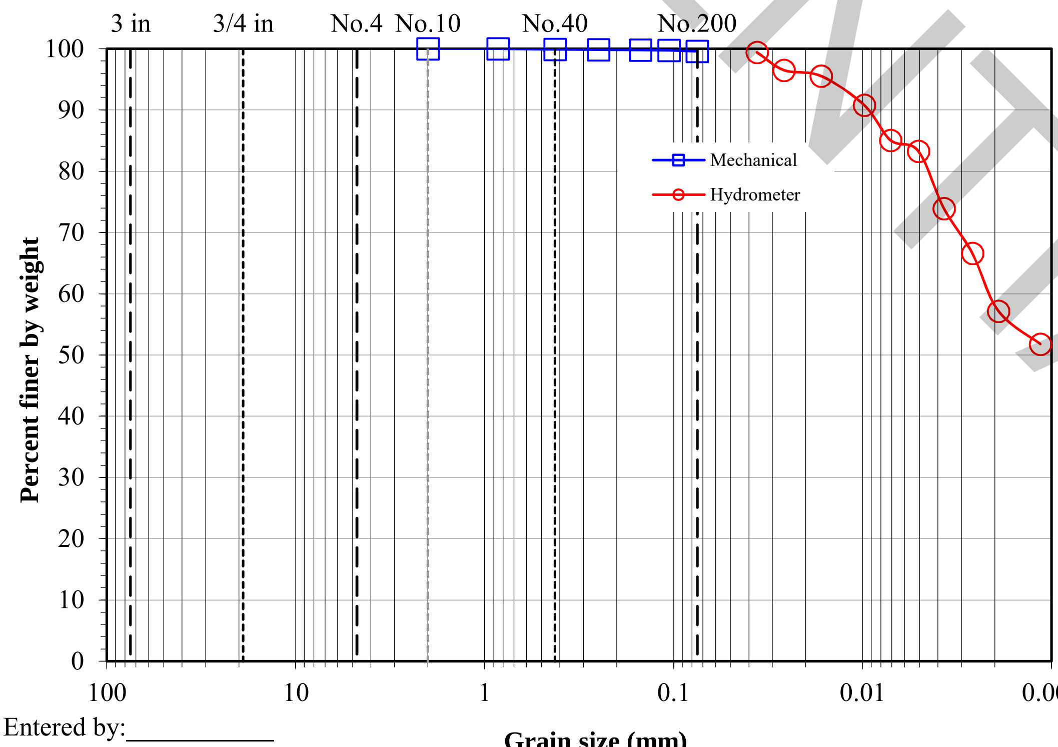
	Moist	Dry
Split:	No	
Total sample wt. (g):	50.97	50.10
Hydrometer fraction (g):	50.97	50.10
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	31.16	31.16
Dry soil + tare (g):	-	31.00	31.00
Tare (g):	-	21.78	21.78
Water content (%):	0.00	1.74	1.74

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
			Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.01	0.85	100.0	
No.40	0.05	0.425	99.9	
No.60	0.08	0.25	99.8	
No.100	0.10	0.15	99.8	
No.140	0.14	0.106	99.7	
No.200	0.20	0.075	99.6	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	17.3	55.5	0.03625	99.41
2	17.3	54	0.02606	96.51
5	17.3	53.5	0.01658	95.54
15	17.5	51	0.00980	90.79
30	17.7	48	0.00712	85.08
60	18	47	0.00507	83.27
120	18.8	42	0.00371	73.94
250	19.8	38	0.00263	66.63
504	20.3	33	0.00191	57.18
1430	21.3	30	0.00115	51.80



Gravel (%): 0.0
Sand (%): 0.4
Fines (%): 99.6

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XI)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

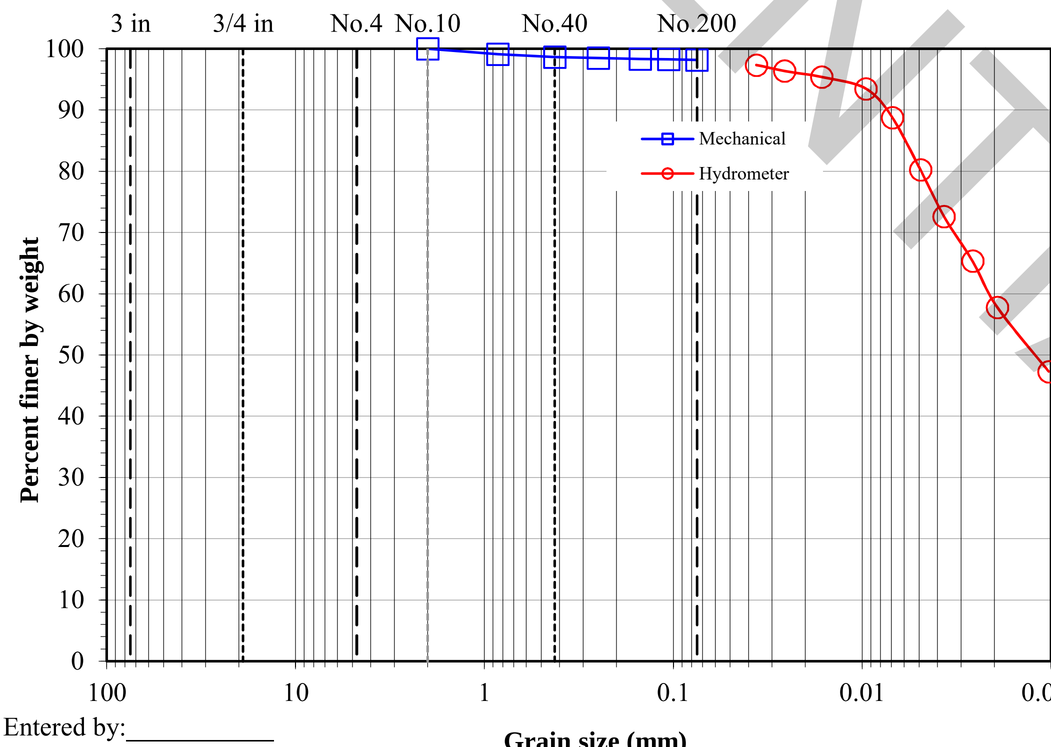
Boring No.: SN4-15-011
Sample: MC-014
Depth: 64-69'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.01	49.19
Hydrometer fraction (g):	50.01	49.19
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	35.90	35.90
Dry soil + tare (g):	-	35.67	35.67
Tare (g):	-	21.94	21.94
Water content (%):	0.00	1.68	1.68

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.85	Assumed	α:	0.96
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		1	17.3	54	0.03636	97.35
6"	-	150	-		2	17.3	53.5	0.02585	96.38
4"	-	100	-		5	17.3	53	0.01644	95.40
3"	-	75	-		15	17.4	52	0.00958	93.49
1.5"	-	37.5	-		30	17.7	49.5	0.00692	88.75
3/4"	-	19	-		64	18.3	45	0.00492	80.23
3/8"	-	9.5	-		120	18.8	41	0.00370	72.64
No.4	-	4.75	-		250	20	37	0.00261	65.35
No.10	-	2	100.0	<=Split hyd.	482	20.5	33	0.00193	57.76
No.20	0.43	0.85	99.1		1801	21.1	27.5	0.00103	47.29
No.40	0.67	0.425	98.6						
No.60	0.74	0.25	98.5						
No.100	0.83	0.15	98.3						
No.140	0.84	0.106	98.3						
No.200	0.90	0.075	98.2	<=Split					



Gravel (%): 0.0
Sand (%): 1.8
Fines (%): 98.2

Entered by:___________
Reviewed:___________

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Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

IGES

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/18/2015
By: JDF/NB

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011
	Sample:	MC-001	MC-002	MC-003	MC-004	SH-001	MC-005	MC-006	MC-007
	Depth:	0-4'	4-9'	9-14'	14-19'	19-20.5'	20.5-24'	24-29'	29-34'
Test Info.	Sample Weight (g):	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	4.0	3.9	3.8	3.9	4.7	3.9	4.9	3.4
Carbonate Content, Calcite Equivalent (%)		**45**	**44**	**43**	**44**	**54**	**44**	**56**	**38**

Entered by:___________

Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: NB

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011	SN4-15-011
	Sample:	MC-008	SH-002	MC-009	MC-010	SH-003	MC-011	MC-012	MC-013
	Depth:	34-39'	39-40.5'	40.5-44'	44-49'	49-50.5'	50.5-54'	55.5-59'	59-64'
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Pressure Reading (psi):	2.2	3.0	2.3	2.7	3.3	2.6	2.8	2.8
Carbonate Content, Calcite Equivalent (%)		**24**	**34**	**25**	**30**	**37**	**29**	**31**	**31**

Entered by:___________
Reviewed:___________

Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (XI)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: JDF

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-011							
	Sample:	MC-014							
	Depth:	64-69'							
Test Info.	Sample Weight (g):	1.00							
	Pressure Reading (psi):	2.6							
Carbonate Content, Calcite Equivalent (%)		**29**							

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/17/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012
	Sample:	MC-001	MC-002	MC-003	MC-004	SH-001	MC-005	MC-006	MC-007
	Depth:	0-4'	4-9'	9-14'	14-19'	19-20.5'	20.5-24'	24-29'	29-34'
Water Content Determination	Initial date	12/8/15	12/8/15	12/8/15	12/8/15	12/14/15	12/8/15	12/8/15	12/8/15
	Wet soil + tare (g)	318.79	303.61	315.50	312.57	268.17	298.18	314.83	288.31
	Tare (g)	127.37	127.74	129.43	127.28	123.33	128.39	120.54	127.69
	Date	12/14/15	12/14/15	12/14/15	12/14/15	12/15/15	12/14/15	12/14/15	12/14/15
	Dry soil + tare (g)	267.62	245.06	259.69	263.11	227.93	251.04	257.09	241.09
	Water content, ω (%)	36.5	49.9	42.8	36.4	38.5	38.4	42.3	41.6
	Date	12/15/15	12/15/15	12/15/15	12/15/15	12/16/15	12/15/15	12/15/15	12/15/15
	Dry soil + tare (g)	262.95	243.29	258.86	263.11	227.83	251.04	257.00	240.36
	Water content, ω (%)	41.2	52.2	43.8	36.4	38.6	38.4	42.4	42.6
	Date	12/16/15	12/16/15	12/16/15					12/16/15
	Dry soil + tare (g)	249.22	240.27	256.16					236.63
	Water content, ω (%)	57.1	56.3	46.8					47.4
	Date	12/17/15	12/17/15	12/17/15					12/17/15
	Dry soil + tare (g)	249.19	240.22	256.11					236.55
	Water content, ω (%)	57.1	56.4	46.9					47.5
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**57.1**	**56.4**	**46.9**	**36.4**	**38.6**	**38.4**	**42.4**	**47.5**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\XII\[M140v1.xlsm]1

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/17/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012A	SN4-15-012	SN4-15-012	SN4-15-012
	Sample:	MC-008	MC-009	SH-002	MC-010	MC-001	SH-003	MC-011	MC-012
	Depth:	34-39'	39-44'	44-45.5'	45.5-49'	49-54'	54-55.5'	55.5-59'	60.5-64'
Water Content Determination	Initial date	12/8/15	12/8/15	12/14/15	12/8/15	12/8/15	12/14/15	12/8/15	12/8/15
	Wet soil + tare (g)	340.10	311.93	241.32	404.90	317.78	271.92	339.02	325.33
	Tare (g)	127.67	122.35	124.42	212.11	120.45	126.73	123.25	124.68
	Date	12/14/15	12/14/15	12/15/15	12/14/15	12/14/15	12/15/15	12/14/15	12/14/15
	Dry soil + tare (g)	302.49	271.61	211.39	354.24	268.93	237.29	280.51	273.96
	Water content, ω (%)	21.5	27.0	34.4	35.6	32.9	31.3	37.2	34.4
	Date	12/15/15	12/15/15	12/16/15	12/15/15	12/15/15	12/16/15	12/15/15	12/15/15
	Dry soil + tare (g)	302.48	271.59	210.91	354.18	268.93	236.44	280.12	273.92
	Water content, ω (%)	21.5	27.0	35.2	35.7	32.9	32.3	37.5	34.4
	Date			12/17/15			12/17/15		
	Dry soil + tare (g)			210.76			236.23		
	Water content, ω (%)			35.4			32.6		
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**21.5**	**27.0**	**35.4**	**35.7**	**32.9**	**32.6**	**37.5**	**34.4**
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

Z:\PROJECTS\01557_Peak_Minerals\004_Norwest\XII\[M140v1.xlsm]2

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/15/2015
By: ET / IM

Sample Info.	Boring:	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012	SN4-15-012			
	Sample:	MC-013	MC-014	MC-015	MC-016	MC-017			
	Depth:	64-69'	69-74'	74-79'	79-84'	84-89'			
Water Content Determination	Initial date	12/11/15	12/11/15	12/11/15	12/11/15	12/11/15			
	Wet soil + tare (g)	286.25	309.04	300.35	303.70	337.27			
	Tare (g)	124.50	122.87	123.70	128.63	123.55			
	Date	12/14/15	12/14/15	12/14/15	12/14/15	12/14/15			
	Dry soil + tare (g)	242.98	253.68	251.18	254.60	300.25			
	Water content, ω (%)	36.5	42.3	38.6	39.0	21.0			
	Date	12/15/15	12/15/15	12/15/15	12/15/15	12/15/15			
	Dry soil + tare (g)	242.85	253.49	250.92	254.40	300.21			
	Water content, ω (%)	36.7	42.5	38.9	39.2	21.0			
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	[1]Water content, ω (%)	**36.7**	**42.5**	**38.9**	**39.2**	**21.0**			
	[2]Dry soil + tare (g)								
	[2]Water content, ω (%)								

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/17/2015
By: ET

Sample Info.	Boring No.	SN4-15-012	SN4-15-012	SN4-15-012						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	19-20.5'	44-45.5'	54-55.5'						
Unit Weight Info.	Sample height, H (in)	6.016	5.996	5.599						
	Sample diameter, D (in)	2.867	2.877	2.855						
	Sample volume, V (ft^3)	0.0225	0.0226	0.0207						
	Mass rings + wet soil (g)	1159.81	1217.34	1111.36						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist soil, Ws (g)	1159.81	1217.34	1111.36						
	Moist unit wt., γ_m (pcf)	113.77	118.98	118.12						
Water Content	Wet soil + tare (g)	268.17	241.32	271.92						
	Dry soil + tare (g)	227.83	210.76	236.23						
	Tare (g)	123.33	124.42	126.73						
Water Content, w (%)		**38.6**	**35.4**	**32.6**						
Dry Unit Wt., γ_d (pcf)		**82.1**	**87.9**	**89.1**						

Entered by:___________

Reviewed:___________

Specific Gravity of Soil Solids by Water Pycnometer

(ASTM D854)

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals, Sevier Lake, UT
Date: 12/29/2015
By: DKS

Drill hole / Sample:	SN4-15-012	SN4-15-012	SN4-15-012			
Sample No:	SH-001	SH-002	SH-003			
Depth (ft)	19-20.5	44-45.5	54-55.5			
Engineering Classification	Not req.	Not req.	Not req.			
Method	A	A	A			
Material passing No. 4 sieve, P (%)	100	100	100			
Pycnometer No.	1	2	3			
Mass of pycnometer (g)	167.02	184.33	170.68			
Mass of pycnometer, soil, and water, $M_{\rho ws,t}$ (g)	706.35	724.61	708.46			
Temperature, T_t (°C)	21.5	21.5	21.6			
Mass of pycnometer and water at test temperature, $M_{pw,t}$ (g)	666.05	683.02	669.20			
Mass of tare + dry soil (g)	378.93	375.28	387.63			
Mass of tare (g)	316.57	310.4	326.37			
Mass of soil, M_s (g)	62.36	64.88	61.26			
Specific gravity of soil solids at test temperature, G_t	2.827	2.786	2.785			
Temperature coefficient, K	0.99968	0.99968	0.99966			
Specific gravity of soil solids at 20°C, $G_{20°C}$	**2.826**	**2.785**	**2.784**			
Apparent specific gravity of solids retained on No. 4, $G_{1@20°C}$						
Average specific gravity at 20°C, $G_{avg\ @20°C}$						

Entered by:___________
Reviewed by:___________

Porosity of Soil

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/29/2015
By: NB/ET

Sample Info.	Boring No.	SN4-15-012	SN4-15-012	SN4-15-012						
	Sample:	SH-001	SH-002	SH-003						
	Depth:	19-20.5'	44-44.5'	54-55.5'						
Unit Weight Data	Sample height, H (in)	6.016	5.996	5.599						
	Sample diameter, D (in)	2.867	2.877	2.855						
	Mass rings + wet soil (g)	1159.81	1217.34	1111.36						
	Mass rings/tare (g)	0.00	0.00	0.00						
	Moist unit wt., γ_m (pcf)	113.8	119.0	118.1						
Water Content	Wet soil + tare (g)	268.17	241.32	271.92						
	Dry soil + tare (g)	227.83	210.76	236.23						
	Tare (g)	123.33	124.42	126.73						
	Water content (%)	38.6	35.4	32.6						
Specific gravity of solids, Gs		2.826	2.785	2.784						
Void ratio, e		1.149	0.979	0.951						
Porosity, n		0.535	0.495	0.487						
Total Soil Porosity, n (%)		**53.5**	**49.5**	**48.7**						
Water Porosity, n_w (%)		**44.1**	**43.3**	**40.4**						
Air Porosity, n_a (%)		**9.3**	**6.1**	**8.3**						
Comments:		Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.	Porosity calculated using a specific gravity of water equal to 1.15.						

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

Boring No.: SN4-15-012
Sample: SH-001
Depth: 19-20.5'
Description: Grey clay

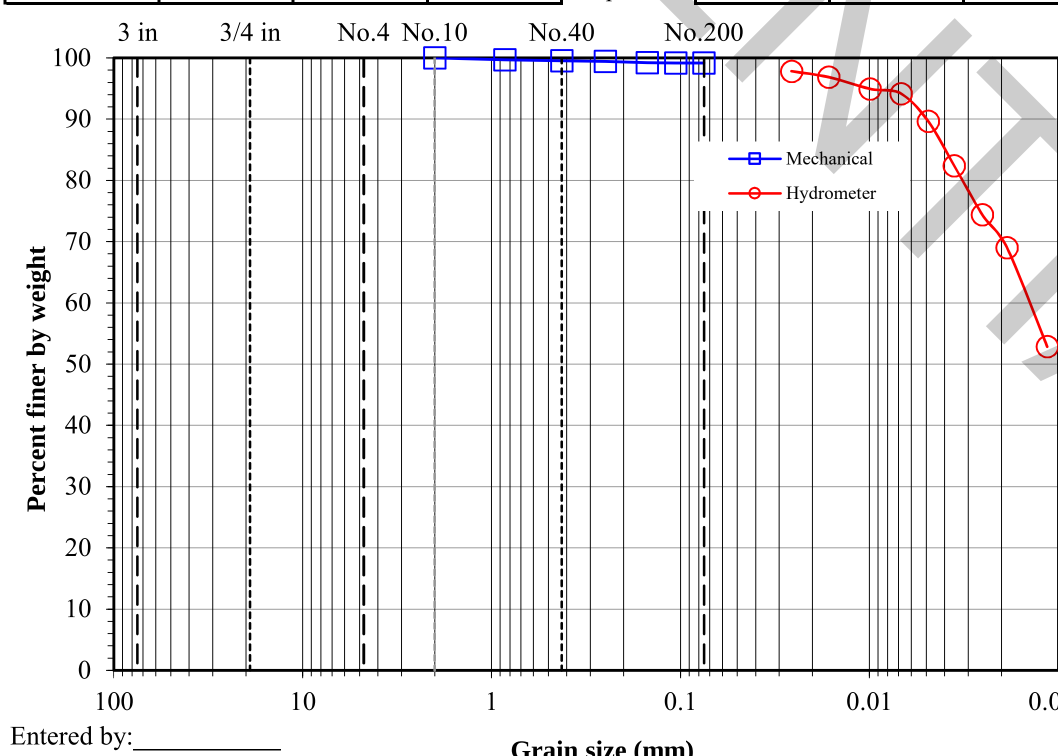
Split:	No		
	Moist	Dry	
Total sample wt. (g):	51.23	50.40	
Hydrometer fraction (g):	51.23	50.40	
	1.000		

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	31.29	31.29
Dry soil + tare (g):	-	31.14	31.14
Tare (g):	-	22.07	22.07
Water content (%):	0.00	1.65	1.65

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.826	Determined	α:	0.96
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	-	
No.10	-	2	100.0	<=Split hyd.
No.20	0.17	0.85	99.7	
No.40	0.24	0.425	99.5	
No.60	0.30	0.25	99.4	
No.100	0.39	0.15	99.2	
No.140	0.41	0.106	99.2	
No.200	0.42	0.075	99.2	<=Split

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	16.1	55.5	0.02583	97.82
5	16.1	55	0.01643	96.86
14	16.1	54	0.00993	94.95
30	16.5	53.5	0.00679	94.16
60	17.2	51	0.00489	89.67
120	18.1	47	0.00355	82.40
250	19.5	42.5	0.00252	74.38
469	20.4	39.5	0.00187	69.02
1422	20.6	31	0.00114	52.85



Gravel (%): 0.0
Sand (%): 0.8
Fines (%): 99.2

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Norwest Corporation
No: 01557-004 (XII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

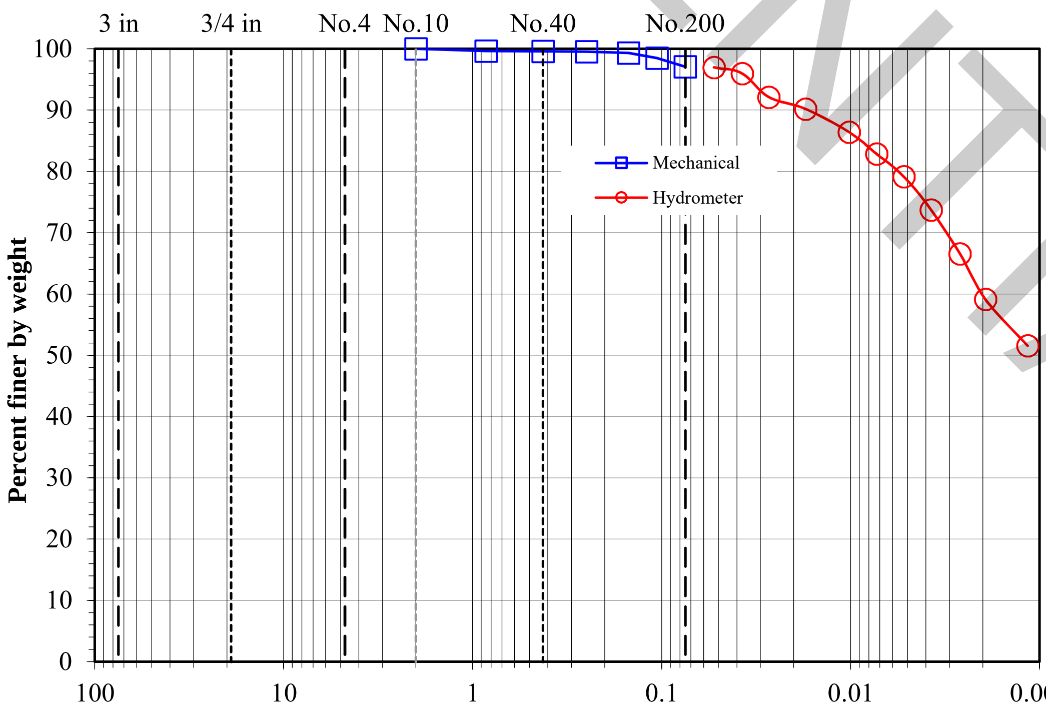
Boring No.: SN4-15-012
Sample: SH-002
Depth: 44-45.5'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	51.54	50.26
Hydrometer fraction (g):	51.54	50.26
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	32.01	32.01
Dry soil + tare (g):	-	31.76	31.76
Tare (g):	-	21.98	21.98
Water content (%):	0.00	2.56	2.56

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.785	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	16.1	54.5	0.05285	96.96
6"	-	150	-		1	16.1	54	0.03758	95.99
4"	-	100	-		2	16.1	52	0.02715	92.12
3"	-	75	-		5	16.1	51	0.01735	90.19
1.5"	-	37.5	-		15	16.3	49	0.01020	86.41
3/4"	-	19	-		30	17	47	0.00729	82.84
3/8"	-	9.5	-		60	17.4	45	0.00522	79.14
No.4	-	4.75	-		120	18.3	42	0.00375	73.72
No.10	-	2	100.0	<=Split hyd.	250	19.7	38	0.00264	66.58
No.20	0.18	0.85	99.6		487	20.4	34	0.00194	59.15
No.40	0.22	0.425	99.6		1440	20.7	30	0.00116	51.54
No.60	0.24	0.25	99.5						
No.100	0.33	0.15	99.3						
No.140	0.75	0.106	98.5						
No.200	1.46	0.075	97.1	<=Split					



Gravel (%): 0.0
Sand (%): 2.9
Fines (%): 97.1

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: Norwest Corporation
No: 01557-004 (XII)
Location: Peak Minerals Sevier Lake, UT
Date: 12/22/2015
By: BRR

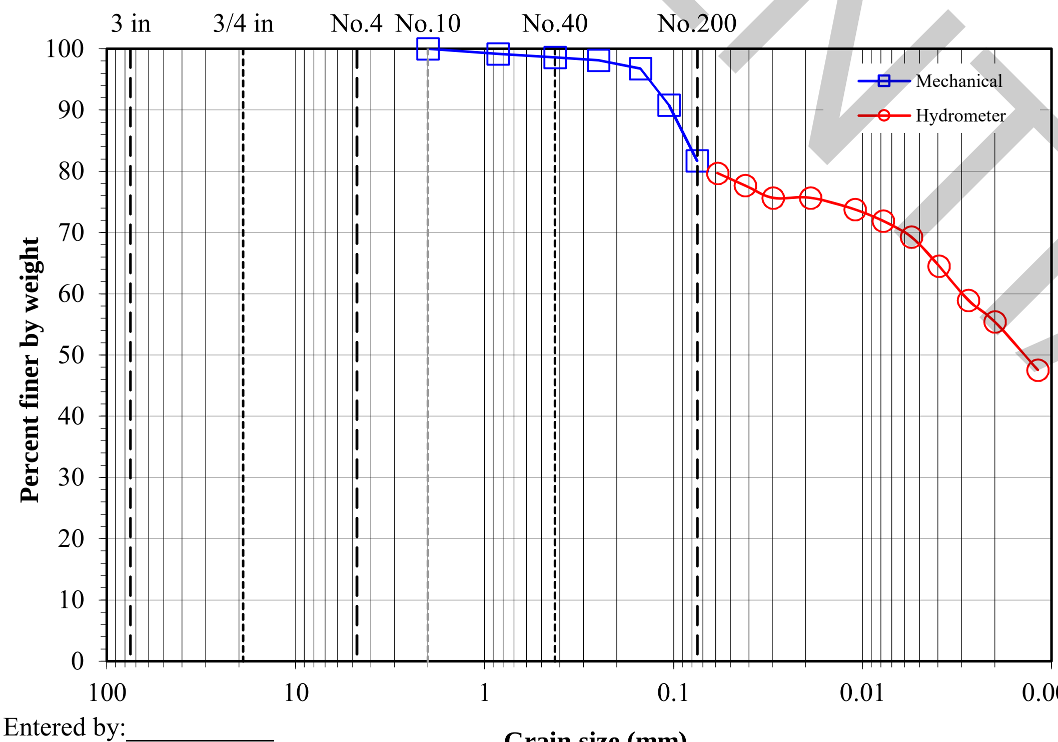
Boring No.: SN4-15-012
Sample: SH-003
Depth: 54-55.5'
Description: Grey clay with sand

Split:	No	
	Moist	Dry
Total sample wt. (g):	50.59	48.38
Hydrometer fraction (g):	50.59	48.38
	1.000	

Water content data	C.F.(+)	S.F.(-)	Hyd.(-No.10)
Moist soil + tare (g):	-	33.54	33.54
Dry soil + tare (g):	-	33.04	33.04
Tare (g):	-	22.08	22.08
Water content (%):	0.00	4.56	4.56

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.784	Determined	α:	0.97
Bulb No.	2		Hyd. fraction:	100.00
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
8"	-	200	-		0.5	16.2	44	0.05865	79.69
6"	-	150	-		1	16.2	43	0.04185	77.68
4"	-	100	-		2	16.2	42	0.02985	75.67
3"	-	75	-		5	16.2	42	0.01888	75.67
1.5"	-	37.5	-		15	16.4	41	0.01097	73.75
3/4"	-	19	-		30	16.7	40	0.00779	71.87
3/8"	-	9.5	-		60	17.6	38.5	0.00552	69.26
No.4	-	4.75	-		120	18.3	36	0.00395	64.54
No.10	-	2	100.0	<=Split hyd.	250	19.3	33	0.00276	58.96
No.20	0.41	0.85	99.2		479	20.4	31	0.00200	55.43
No.40	0.68	0.425	98.6		1433	20.8	27	0.00118	47.57
No.60	0.92	0.25	98.1						
No.100	1.56	0.15	96.8						
No.140	4.44	0.106	90.8						
No.200	8.85	0.075	81.7	<=Split					



Gravel (%): 0.0
Sand (%): 18.3
Fines (%): 81.7

Entered by:___________
Reviewed:___________

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Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (XII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/16/2015
By: NB

Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-012	SN4-15-012	SN4-15-012					
	Sample:	SH-001	SH-002	SH-003					
	Depth:	19-20.5'	44-45.5'	54-55.5'					
Test Info.	Sample Weight (g):	1.01	1.00	1.00					
	Pressure Reading (psi):	3.8	2.0	1.7					
Carbonate Content, Calcite Equivalent (%)		**43**	**22**	**18**					

Entered by:___________
Reviewed:___________

Water Content of Soil and Rock by Mass

(In general accordance with ASTM D2216)

IGES

Project: **Norwest Corporation**
No: **01557-004 (XIII)**
Location: Peak Minerals, Sevier Lake, UT
Date: 12/30/2015
By: ET

Sample Info.	Boring:	SN4-15-WW2A	SN4-15-WW2A	SN4-15-WW2A	SN4-15-WW2A				
	Sample:	MC-001	MC-002	MC-003	MC-004				
	Depth:	0-5'	5-10'	10-15'	15-20'				
Water Content Determination	Initial date	12/23/15	12/23/15	12/24/15	12/24/15				
	Wet soil + tare (g)	280.12	328.88	306.40	320.59				
	Tare (g)	122.79	128.46	127.49	123.81				
	Date	12/28/15	12/28/15	12/28/15	12/28/15				
	Dry soil + tare (g)	231.90	263.57	242.20	260.00				
	Water content, ω (%)	44.2	48.3	56.0	44.5				
	Date	12/29/15	12/29/15	12/29/15	12/29/15				
	Dry soil + tare (g)	231.33	263.24	241.99	259.91				
	Water content, ω (%)	45.0	48.7	56.3	44.6				
	Date	12/30/15							
	Dry soil + tare (g)	231.04							
	Water content, ω (%)	45.3							
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
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	Dry soil + tare (g)								
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	Water content, ω (%)								
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	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
	Date								
	Dry soil + tare (g)								
	Water content, ω (%)								
[1]Water content, ω (%)		**45.3**	**48.7**	**56.3**	**44.6**				
[2]Dry soil + tare (g)									
[2]Water content, ω (%)									

[1]at 140 deg. F
[2]at 230 deg. F

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XIII)
Location: Peak Minerals Sevier Lake, UT
Date: 1/6/2016
By: BRR

Boring No.: SN4-15-WW2A
Sample: MC-003
Depth: 10-15'
Description: Grey clay

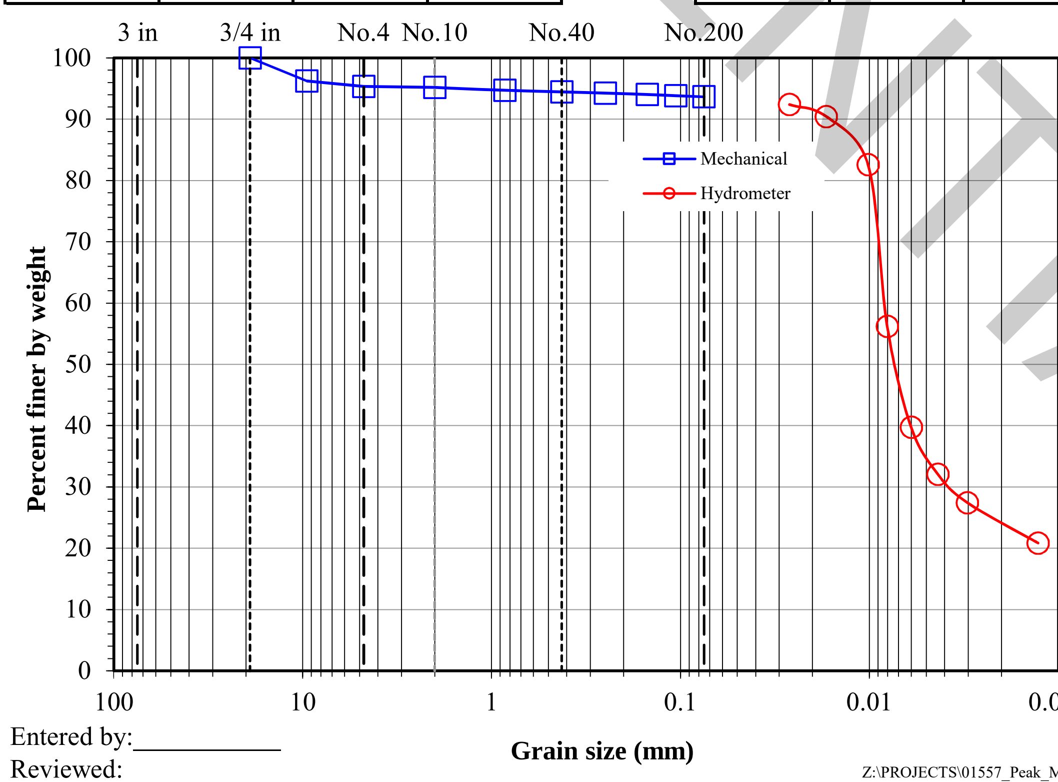
Split:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	221.77	215.13
+#10 Coarse fraction (g):	10.42	10.38
-#10 Split fraction (g):	48.59	47.07
Hydrometer fraction (g):	48.59	47.07
Split fraction:	0.952	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	133.78	46.25	46.25
Dry soil + tare (g):	133.74	45.49	45.49
Tare (g):	122.10	21.92	21.92
Water content (%):	0.34	3.22	3.22

Hydrometer data				
			Slope:	-0.1641
Hyd. split:	No.10		Intercept:	16.3
Gs:	2.8	Assumed	α:	0.97
Bulb No.	2		Hyd. fraction:	95.18
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	100.0	
3/8"	8.07	9.5	96.2	
No.4	10.02	4.75	95.3	
No.10	10.38	2	95.2	<=Split
No.20	0.23	0.85	94.7	
No.40	0.34	0.425	94.5	
No.60	0.46	0.25	94.2	
No.100	0.57	0.15	94.0	
No.140	0.66	0.106	93.8	
No.200	0.75	0.075	93.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	18.5	51	0.02651	92.40
5	18.5	50	0.01694	90.44
15	18.5	46	0.01017	82.61
30	18.6	32.5	0.00804	56.21
60	19	24	0.00601	39.74
120	19.4	20	0.00434	32.08
250	20	17.5	0.00303	27.44
1442	20.6	14	0.00128	20.84



Gravel (%): 4.7
Sand (%): 1.7
Fines (%): 93.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

Project: Norwest Corporation
No: 01557-004 (XIII)
Location: Peak Minerals Sevier Lake, UT
Date: 1/6/2016
By: BRR

Boring No.: SN4-15-WW2A
Sample: MC-004
Depth: 15-20'
Description: Grey clay

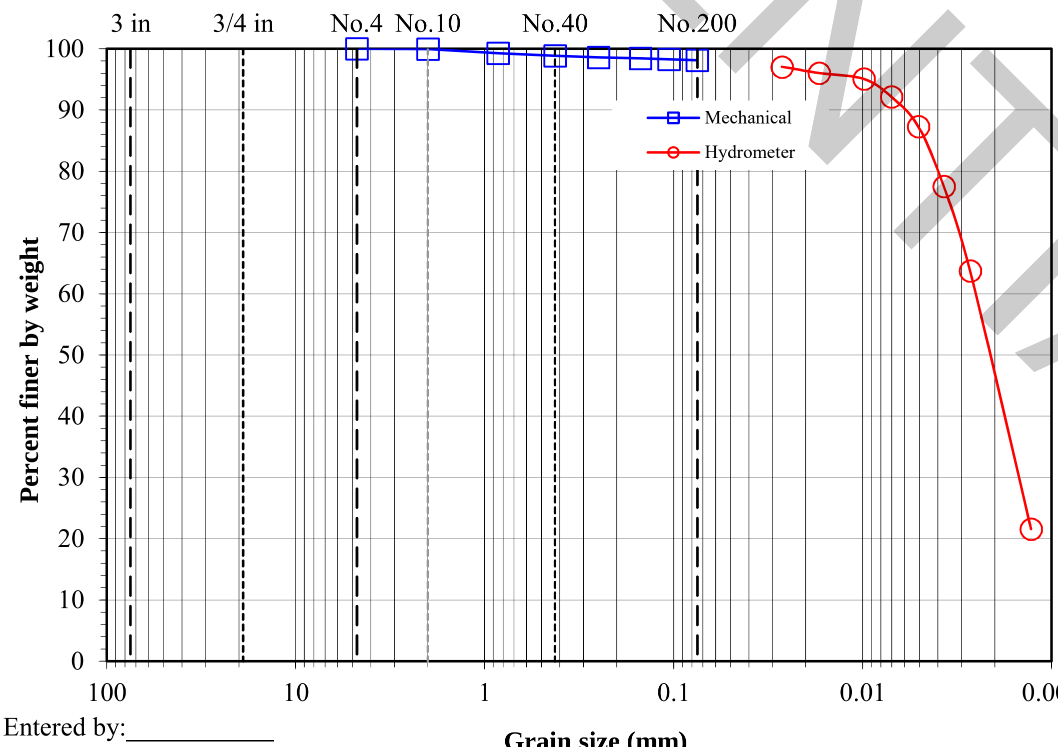
	Moist	Dry
Split:	Yes	
Split sieve:	#10	
Total sample wt. (g):	225.06	219.98
+#10 Coarse fraction (g):	0.06	0.06
-#10 Split fraction (g):	48.85	47.75
Hydrometer fraction (g):	48.85	47.75
Split fraction:	1.000	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	128.27	53.15	53.15
Dry soil + tare (g):	128.27	52.45	52.45
Tare (g):	128.21	22.16	22.16
Water content (%):	0.00	2.31	2.31

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.8	Assumed	Intercept:	16.3
Bulb No.	2		α:	0.97
Dispersion period (min):	15		Hyd. fraction:	99.97
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	-	
No.4	-	4.75	100.0	
No.10	0.06	2	100.0	<=Split
No.20	0.34	0.85	99.3	
No.40	0.54	0.425	98.8	
No.60	0.66	0.25	98.6	
No.100	0.73	0.15	98.4	
No.140	0.81	0.106	98.3	
No.200	0.89	0.075	98.1	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	17	52	0.02673	97.05
5	17	51.5	0.01700	96.03
15	17.1	51	0.00985	95.06
30	17.4	49.5	0.00705	92.15
60	17.9	47	0.00507	87.31
120	18.7	42	0.00372	77.52
250	19.6	35	0.00270	63.73
1433	20.6	14	0.00128	21.58



Gravel (%): 0.0
Sand (%): 1.9
Fines (%): 98.1

Entered by:___________
Reviewed:___________

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Rapid Determination of Carbonate Content of Soils

(*ASTM D4373*)

Project: **Norwest Corporation**
No: **01557-004 (XIII)**
Location: Peak Minerals Sevier Lake, UT
Date: 12/31/2015
By: NB

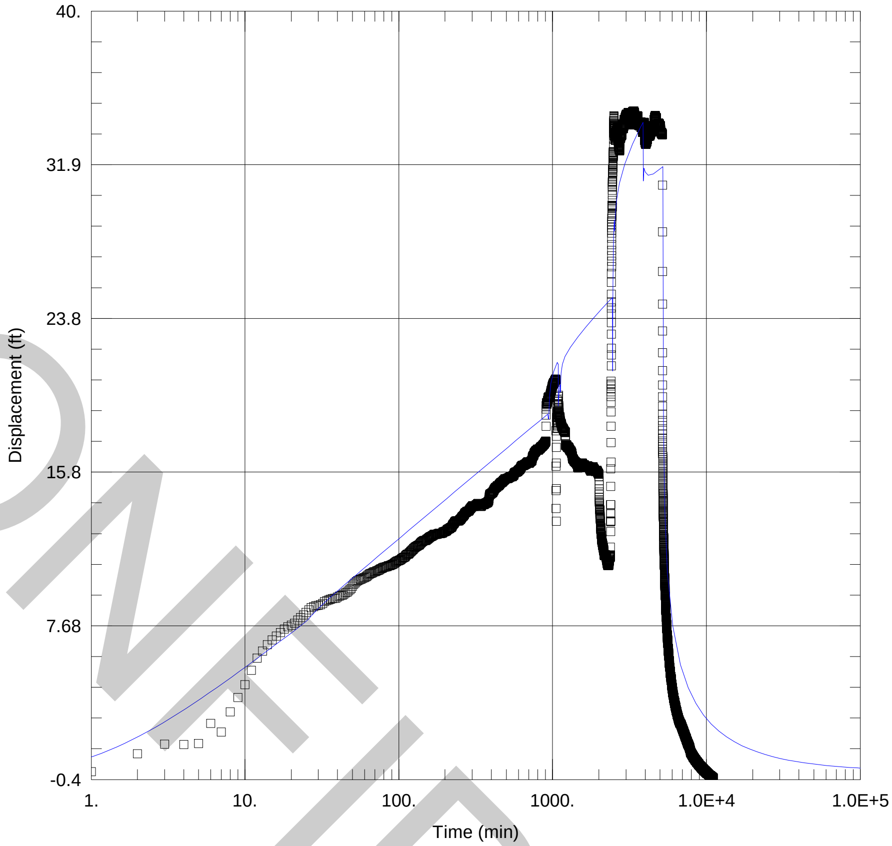
Calibration Information	
Slope:	0.11721
y-intercept:	-0.0147

Sample Info.	Boring No.	SN4-15-WW2A	SN4-15-WW2A	SN4-15-WW2A	SN4-15-WW2A				
	Sample:	MC-001	MC-002	MC-003	MC-004				
	Depth:	0-5'	5-10'	10-15'	15-20'				
Test Info.	Sample Weight (g):	1.00	1.00	1.00	1.00				
	Pressure Reading (psi):	1.8	1.9	4.1	4.1				
Carbonate Content, Calcite Equivalent (%)		**20**	**21**	**47**	**47**				

Entered by:___________
Reviewed:___________

Attachment 7 - AQTESOLV Results

B-1 - AQT Analyses Results



WELL TEST ANALYSIS

Data Set: T:\...\15-01 Pump Well.aqt
Date: 10/05/17 Time: 14:06:28

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-01	0	0

SOLUTION

Aquifer Model: Confined

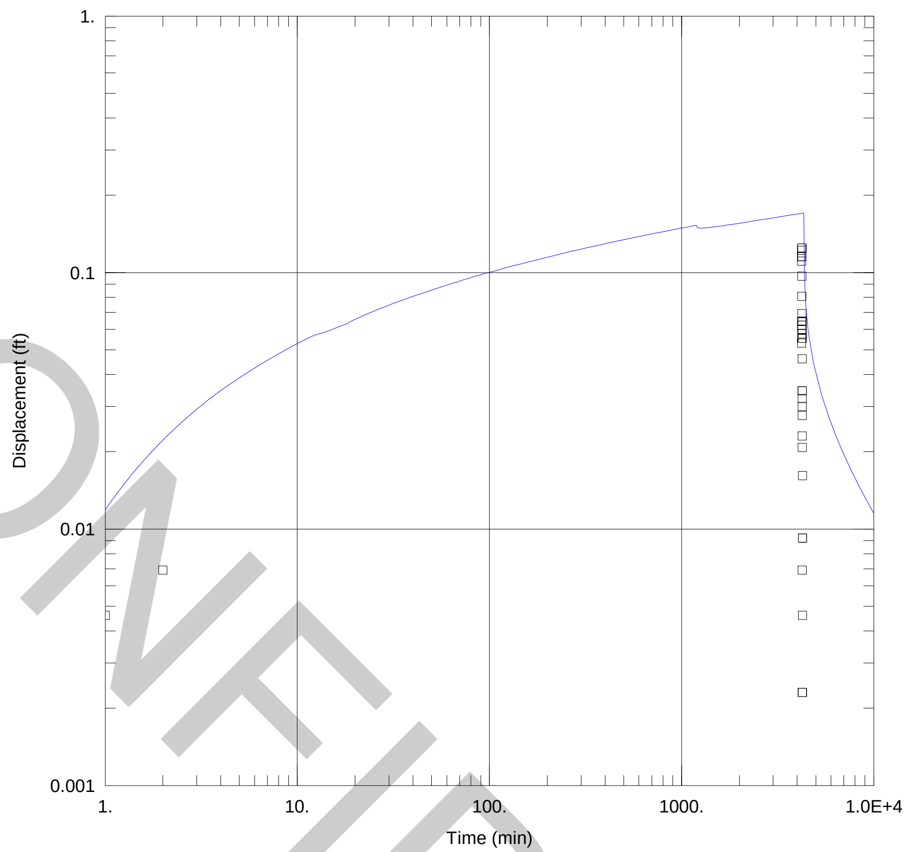
Solution Method: Theis

T = 15.66 ft^2/day

S = 0.215

Kz/Kr = 1.

b = 65. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-03 Obs Well.aqt
Date: 10/05/17 Time: 14:07:51

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: SN3-260
Test Date: 2/5/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-260	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-03	45	0

SOLUTION

Aquifer Model: Confined

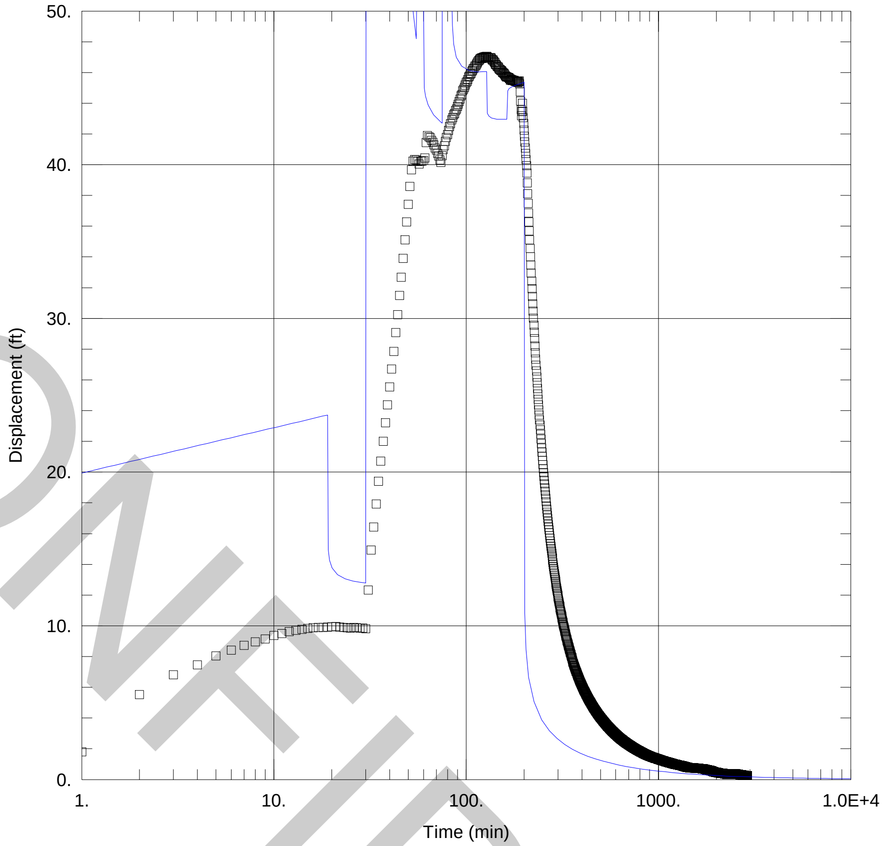
Solution Method: Theis

T = 2.488E+4 ft^2/day

Kz/Kr = 1.

S = 0.01728

b = 89. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-04 Pump Well.aqt
Date: 10/05/17 Time: 14:08:11

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-04	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-04	0	0

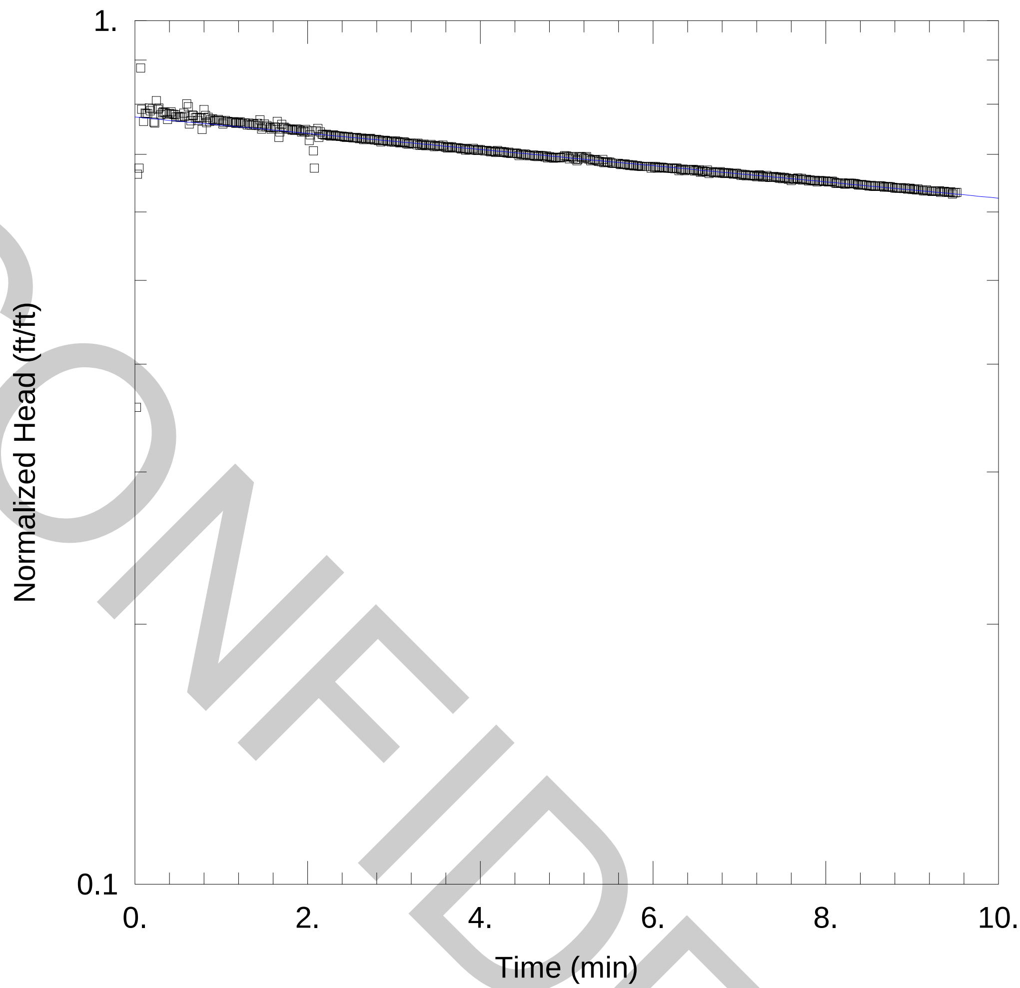
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 2.629 ft^2/day
Kz/Kr = 1.

S = 4.128E-9
b = 41. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-04 Slug Test.aqt
Date: 10/05/17 Time: 14:08:28

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-04
Test Date: 12/4/16

AQUIFER DATA

Saturated Thickness: 41. ft Anisotropy Ratio (Kz/Kr): 1.

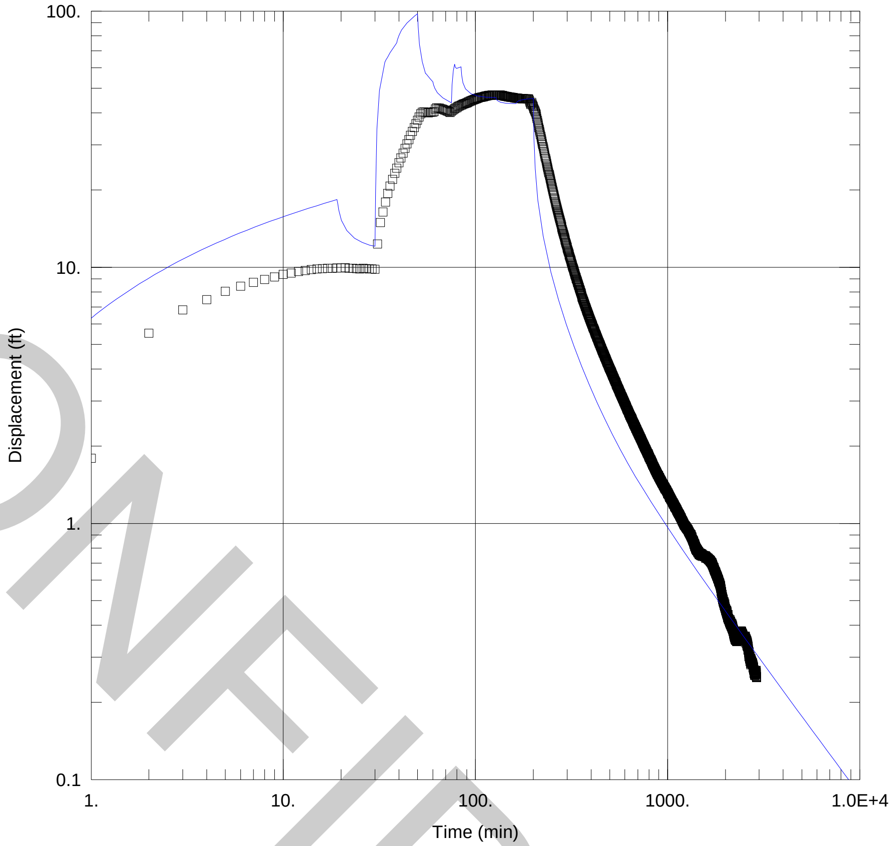
WELL DATA (15-04)

Initial Displacement: -2.067 ft Static Water Column Height: 50.99 ft
Total Well Penetration Depth: 41. ft Screen Length: 15. ft
Casing Radius: 0.25 ft Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.2161 ft/day y0 = -1.598 ft



WELL TEST ANALYSIS

Data Set: T:\...\15-04a Obs Well.aqt
Date: 10/05/17 Time: 14:08:42

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-04a	20	0

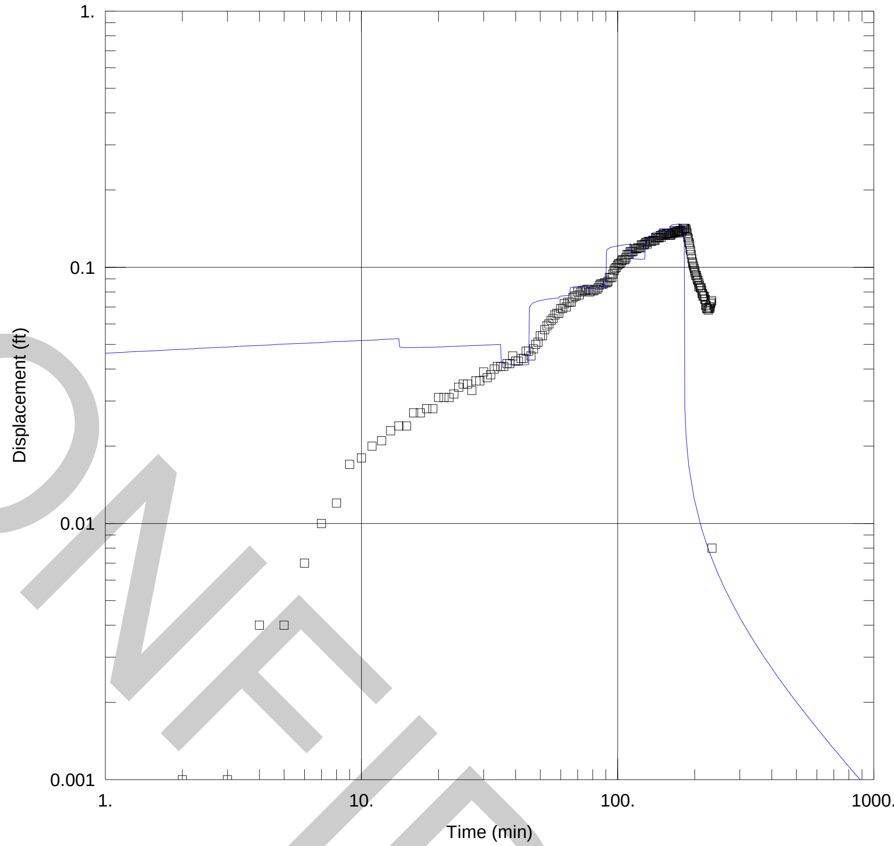
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-04a	20	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.5 ft^2/day
S = 0.003879
Kz/Kr = 1.
b = 41. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-05 Obs Well 1.aqt
Date: 10/05/17 Time: 14:08:58

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-05 Obs 1	-15	6

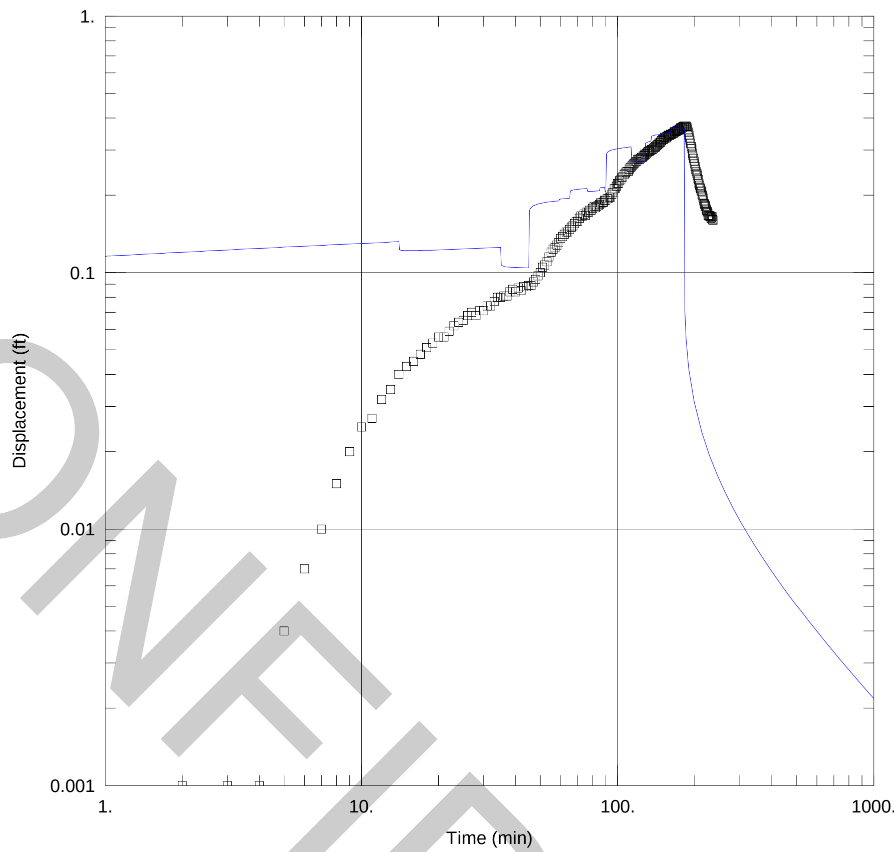
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-05 Obs 1	-15	6

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 1.109E+4 ft^2/day S = 3.295E-5
Kz/Kr = 1. b = 81. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-05 Obs Well 2.aqt
Date: 10/05/17 Time: 14:09:10

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-05 Obs 2	-15	0

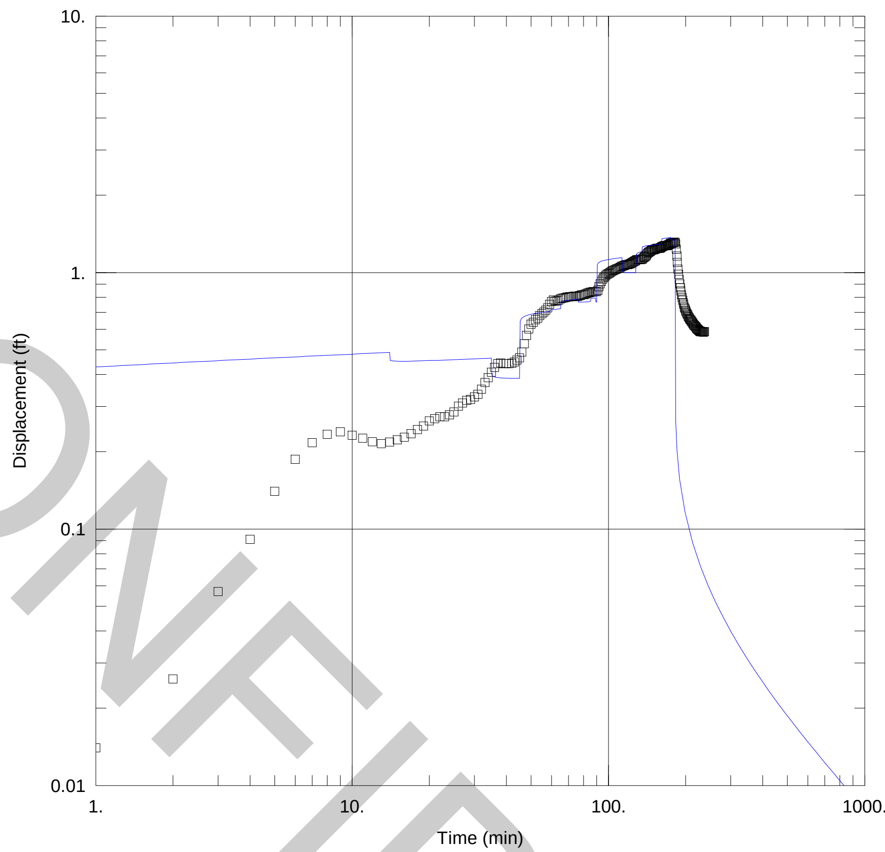
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-05 Obs 2	-15	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 4414.4 ft^2/day
S = 1.35E-5
Kz/Kr = 1.
b = 81. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-05 Obs Well 3.aqt
Date: 10/05/17 Time: 14:09:21

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-05 Obs 3	-20	0

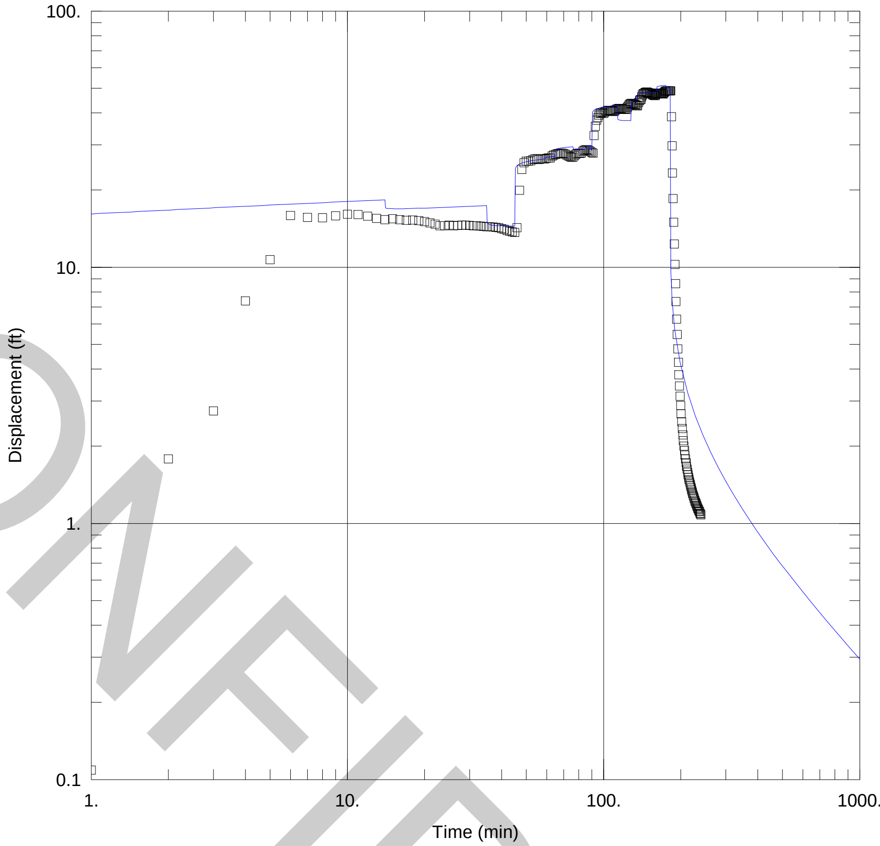
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-05 Obs 3	-20	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1191.6 ft^2/day
S = 3.697E-6
Kz/Kr = 1.
b = 81. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-05 Pump Well.aqt
Date: 10/05/17 Time: 14:09:33

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-05	0	0

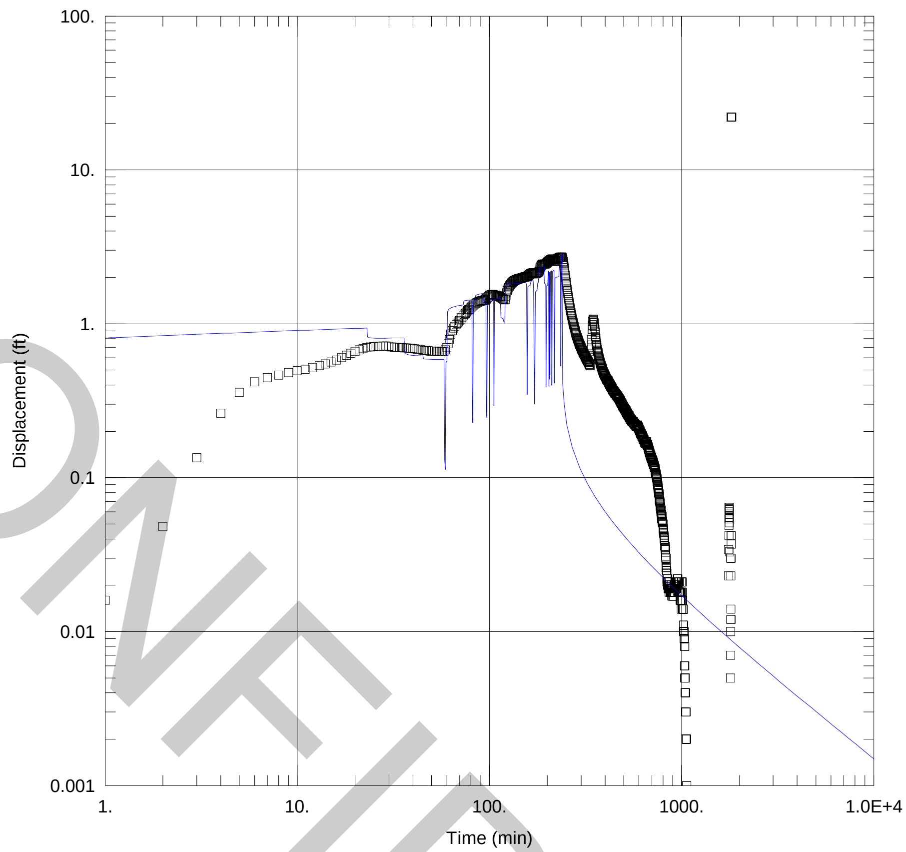
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-05	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 32.63 ft^2/day
S = 5.532E-8
Kz/Kr = 1.
b = 81. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-06 Obs Well.aqt
Date: 10/05/17 Time: 14:09:45

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-06 Obs	20	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-06 Obs	20	0

SOLUTION

Aquifer Model: Confined

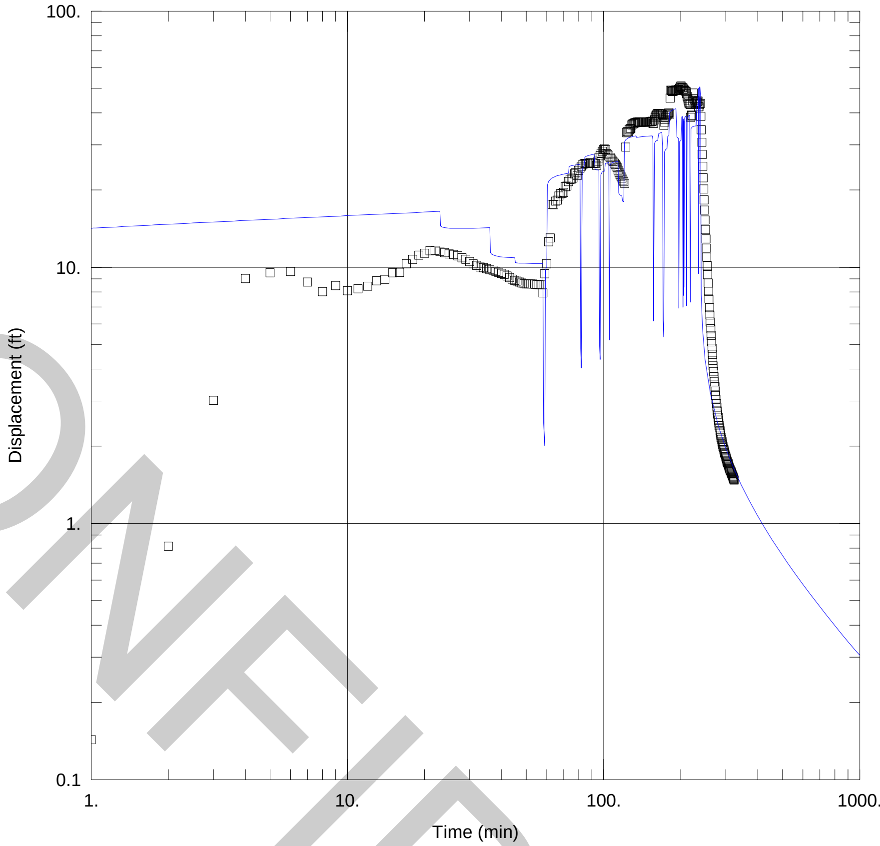
Solution Method: Theis

T = 321.6 ft^2/day

S = 3.627E-7

Kz/Kr = 1.

b = 88. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-06 Pump Well.aqt
Date: 10/05/17 Time: 14:10:32

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-06	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-06	0	0

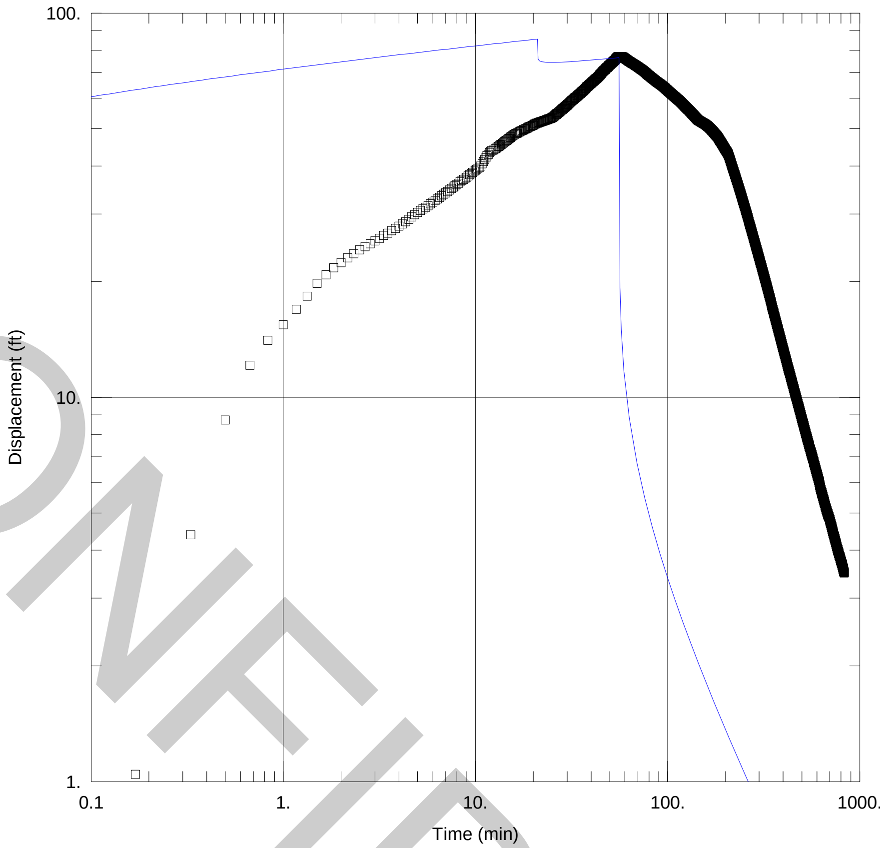
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 18.09 ft^2/day
Kz/Kr = 1.

S = 2.617E-8
b = 88. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-08 Pump Well.aqt
Date: 10/05/17 Time: 14:10:44

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-08	0	0

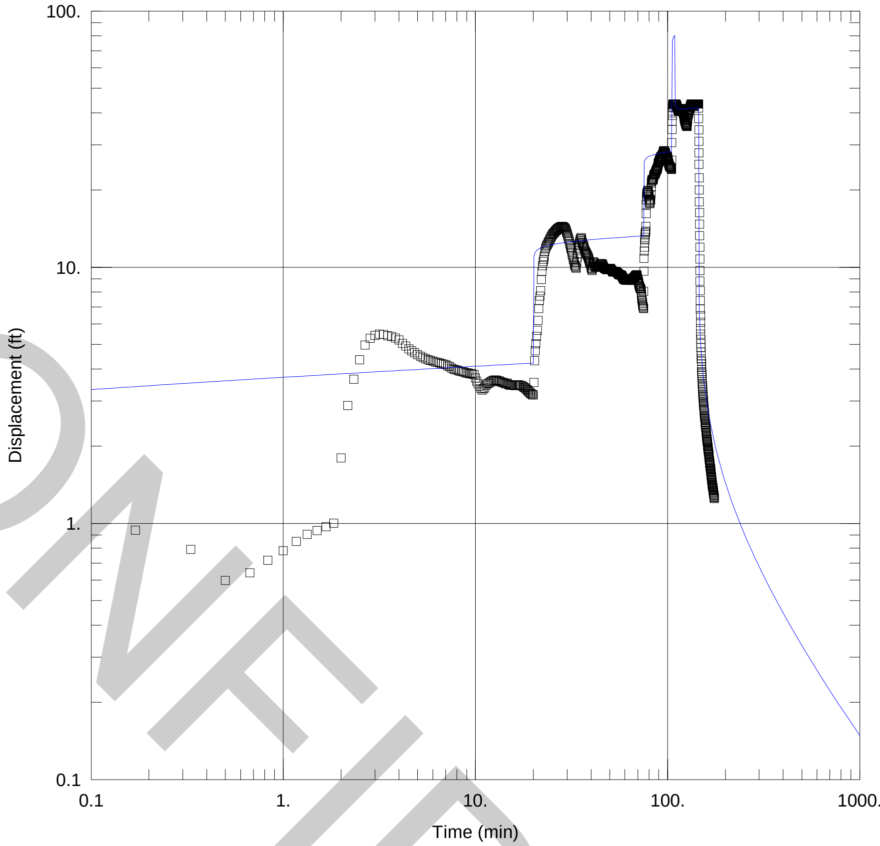
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-08	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 3.247 ft^2/day
S = 2.277E-7
Kz/Kr = 1.
b = 88. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-09 Pump Well.aqt
Date: 10/05/17 Time: 14:10:57

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-09	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-09	0	0

SOLUTION

Aquifer Model: Confined

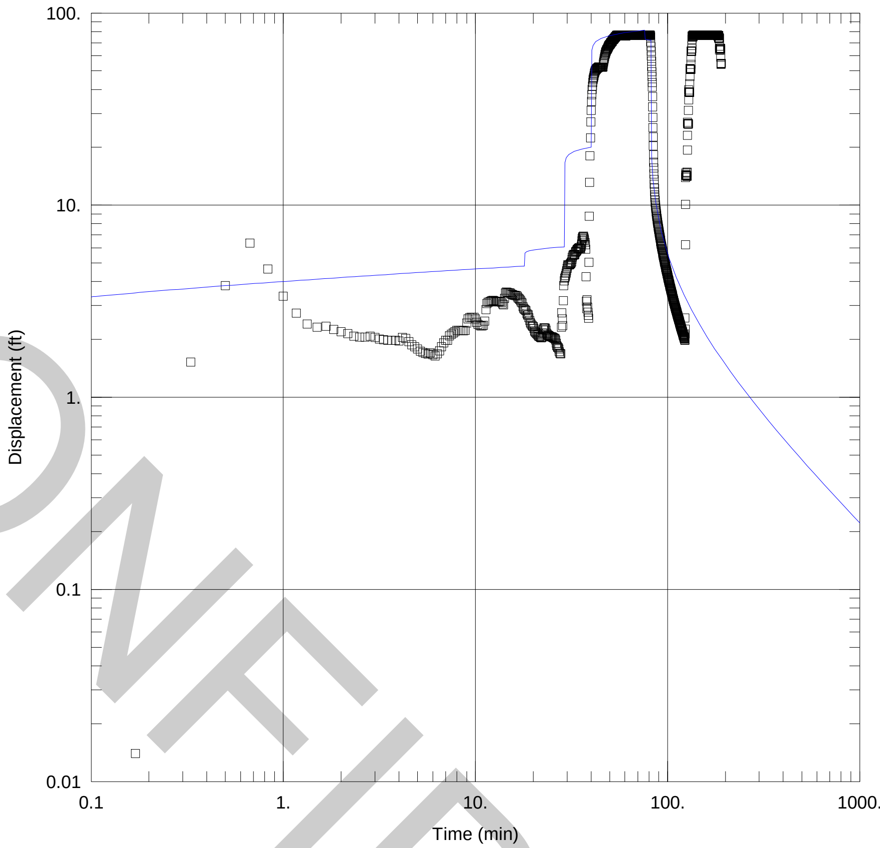
Solution Method: Theis

T = 92.85 ft^2/day

S = 6.511E-6

Kz/Kr = 1.

b = 46. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-10 Pump Well.aqt
Date: 10/05/17 Time: 14:14:00

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-10	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-10	0	0

SOLUTION

Aquifer Model: Confined

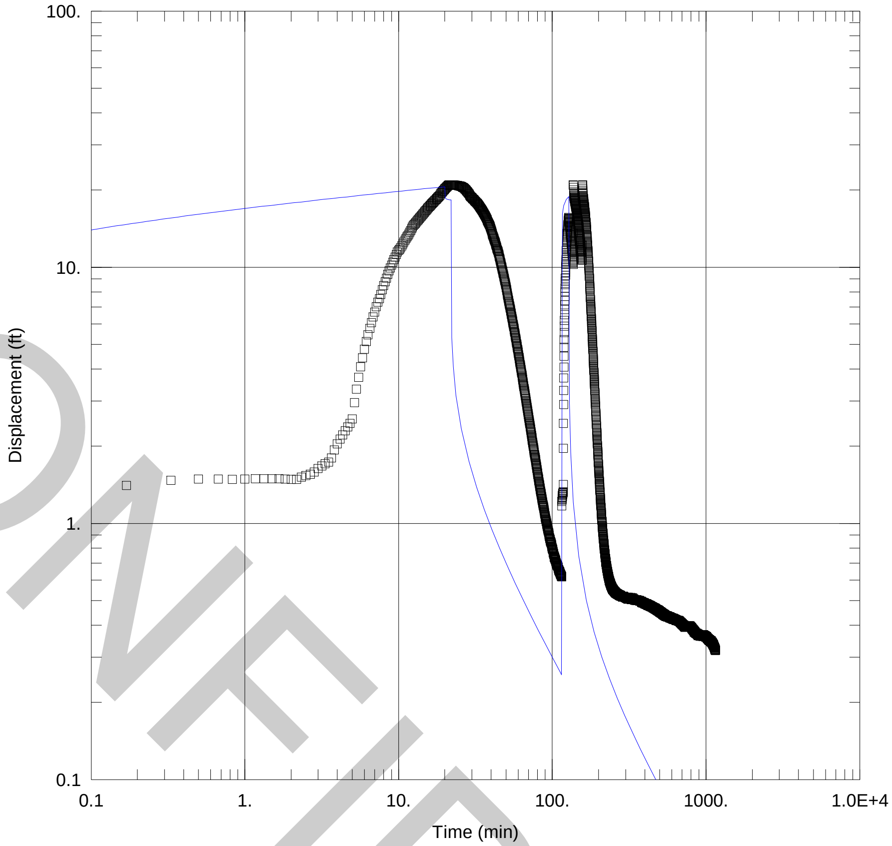
Solution Method: Theis

T = 77.75 ft^2/day

S = 6.606E-6

Kz/Kr = 1.

b = 113. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-10a Obs Well.aqt
Date: 10/05/17 Time: 14:14:17

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-10a obs	-20	0

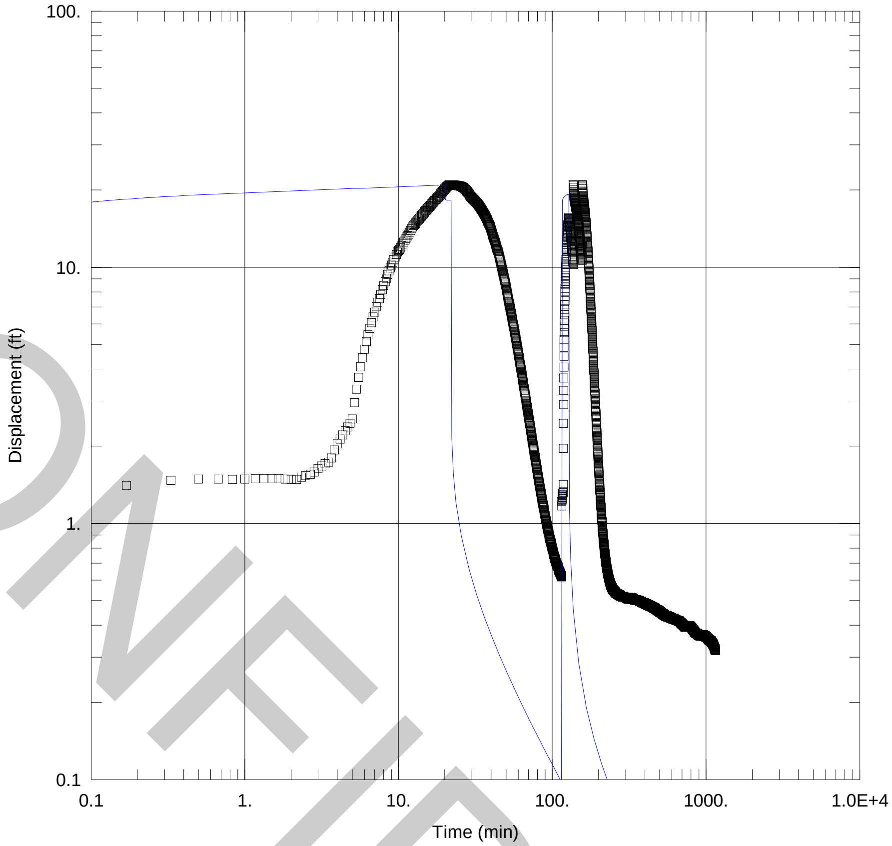
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-10a obs	-20	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 7.926 ft^2/day S = 9.884E-7
Kz/Kr = 1. b = 113. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-10a Pump Well.aqt
Date: 10/05/17 Time: 14:14:31

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-10a	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-10a	0	0

SOLUTION

Aquifer Model: Confined

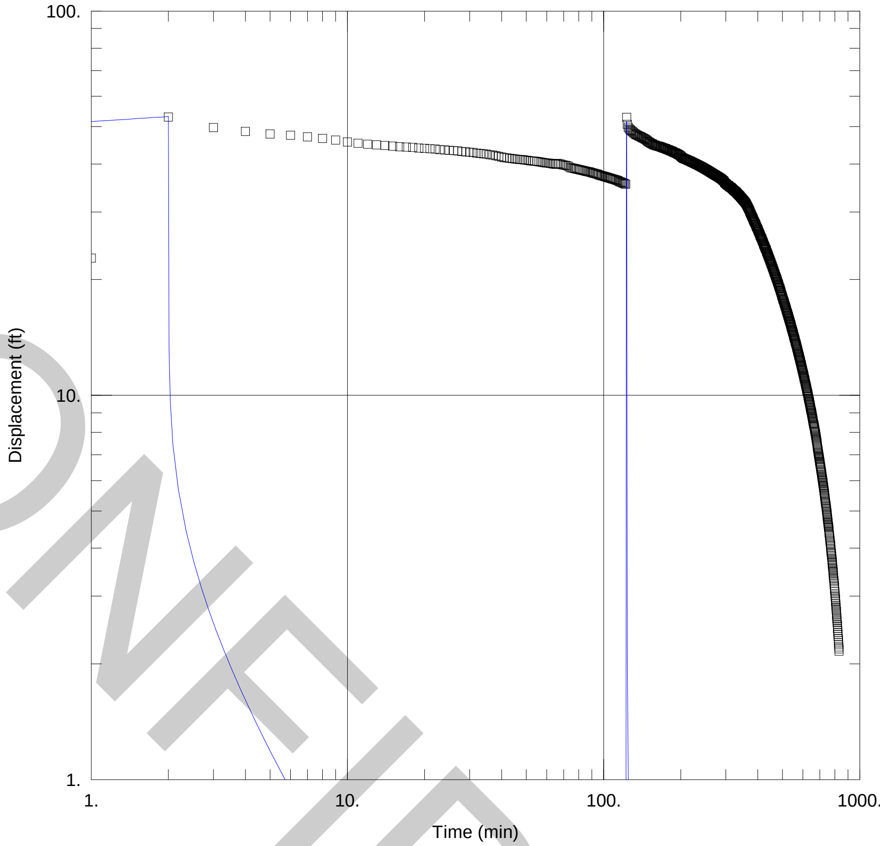
Solution Method: Theis

T = 20.79 ft^2/day

S = 2.853E-6

Kz/Kr = 1.

b = 113. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-11 Pump Well.aqt
Date: 10/05/17 Time: 14:15:06

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-11	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-11	0	0

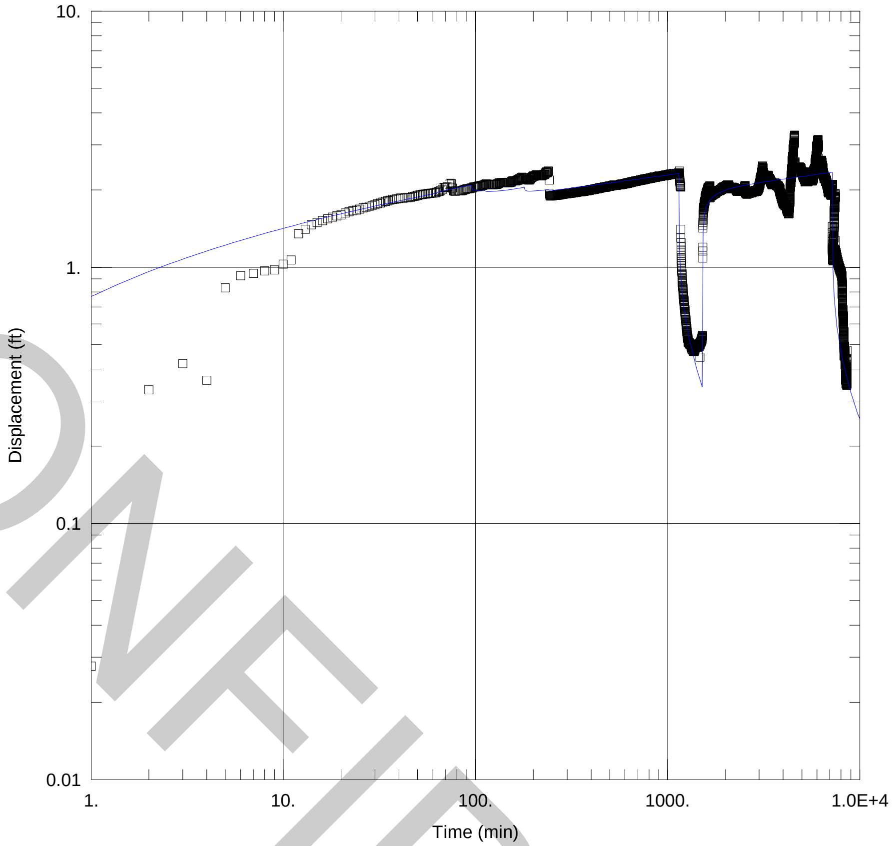
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 131.8 ft^2/day
Kz/Kr = 1.

S = 1.106E-5
b = 51. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-12 Pump Well.aqt
Date: 10/05/17 Time: 14:15:21

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-12
Test Date: 1/6/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-12	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-12	0	0

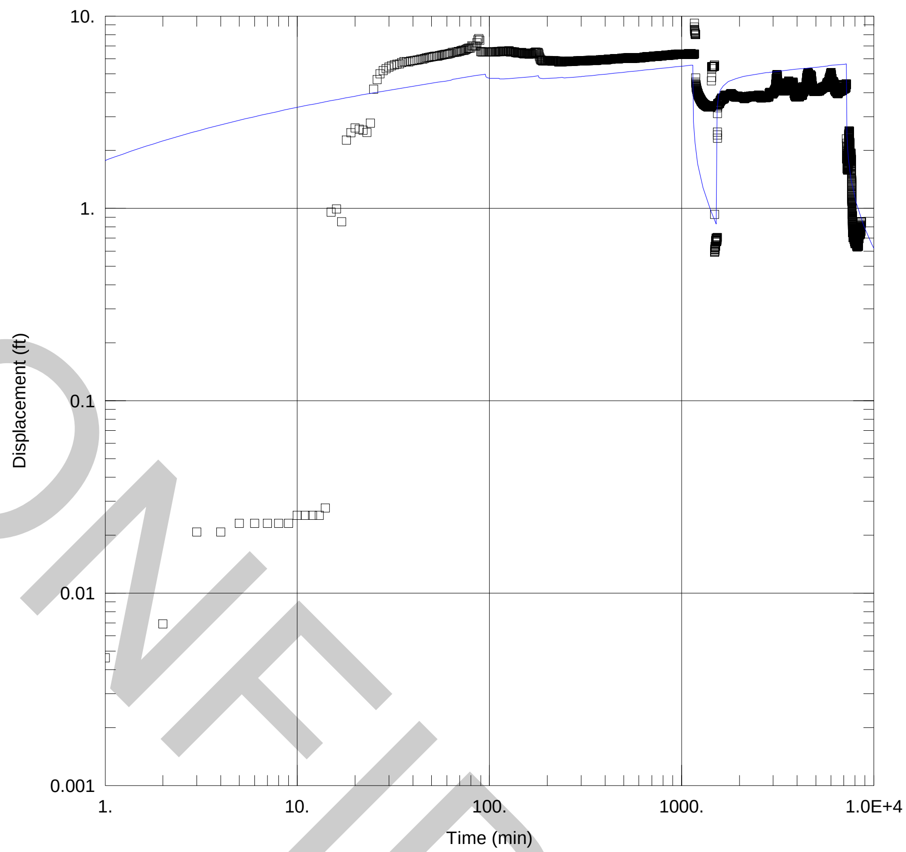
SOLUTION

Aquifer Model: Confined

$T = 1281.5$ ft^2/day
Kz/Kr = 1.

Solution Method: Theis

S = 0.8245
b = 53. ft



WELL TEST ANALYSIS

Data Set: T:\...\15-12a Obs Well.aqt
Date: 10/05/17 Time: 14:15:35

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-12
Test Date: 1/6/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-12	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-12a	20	0

SOLUTION

Aquifer Model: Confined

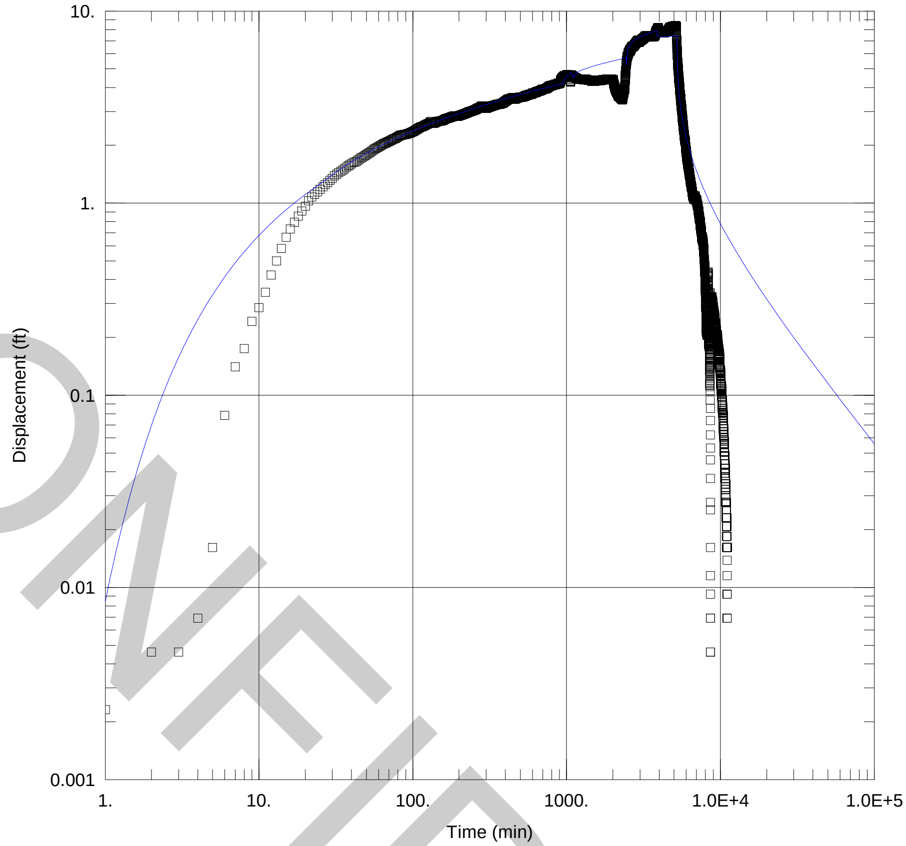
Solution Method: Theis

T = 527.2 ft^2/day

S = 0.000169

Kz/Kr = 1.

b = 89. ft



WELL TEST ANALYSIS

Data Set: T:\...\RR-7.aqt
Date: 10/05/17 Time: 14:15:47

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

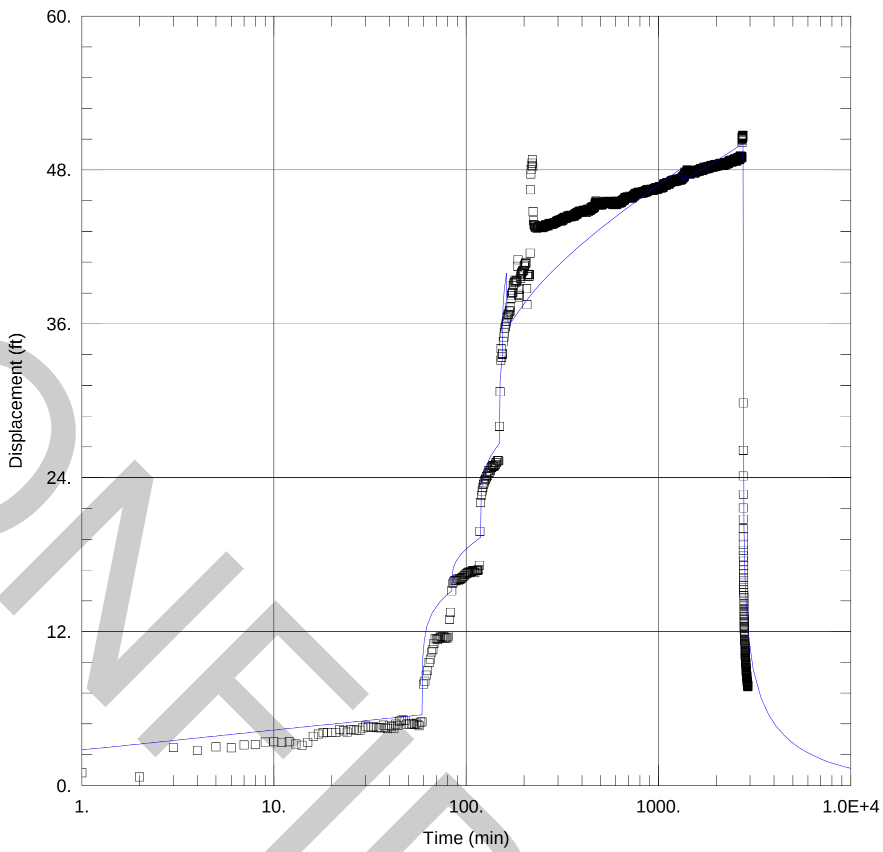
Observation Wells

Well Name	X (ft)	Y (ft)
□ RR-7	0	40

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 56.18 ft^2/day
S = 0.0003071
Kz/Kr = 1.
b = 65. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-045.aqt
Date: 10/05/17 Time: 14:16:10

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-045
Test Date: 9/1/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-045	1034514.14	14184600.29

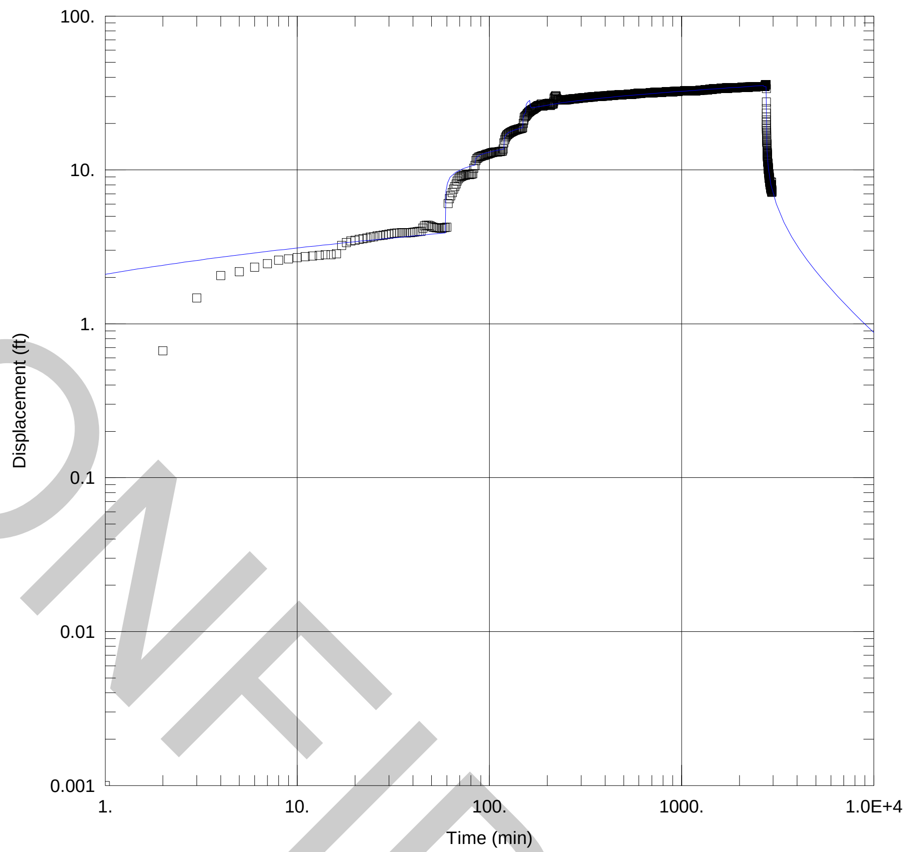
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-045	1034514.14	14184600.29

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 124.9 ft^2/day
S = 0.01875
Kz/Kr = 1.
b = 45. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-045-1.aqt
Date: 10/05/17 Time: 14:16:23

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-045
Test Date: 9/1/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-045	1034514.14	14184600.29

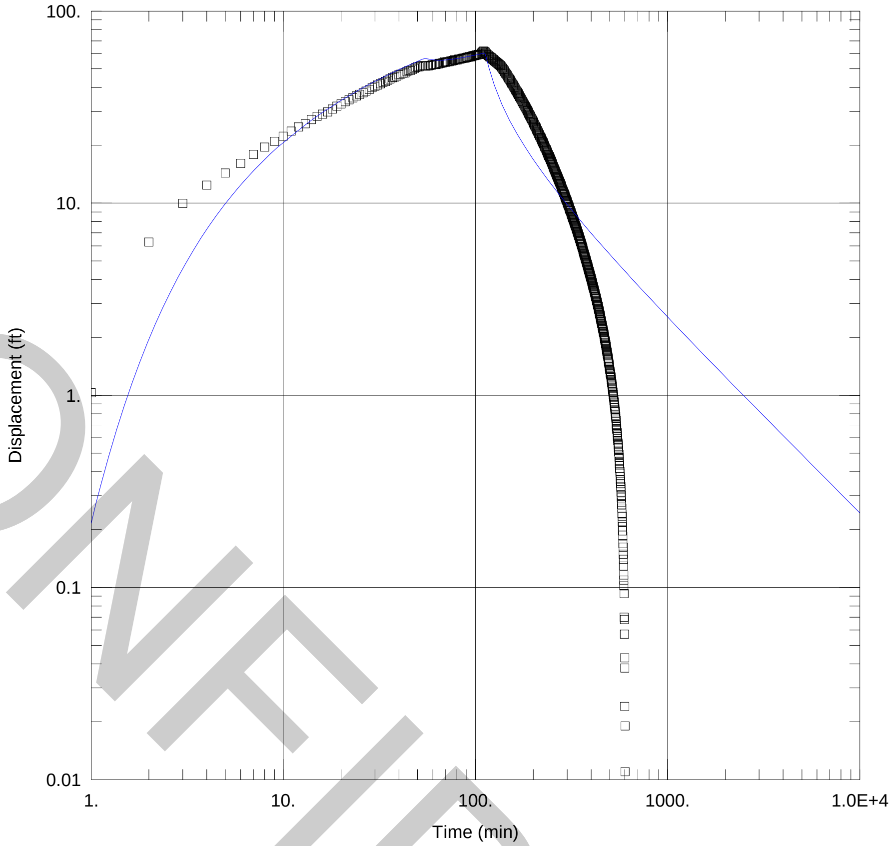
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-045-1	1034534.15	14184600.19

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 191.4 ft^2/day S = 6.39E-6
Kz/Kr = 1. b = 86.5 ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-112.aqt
Date: 10/05/17 Time: 14:17:33

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-112
Test Date: 8/31/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-112	1024361.32	14166575.22

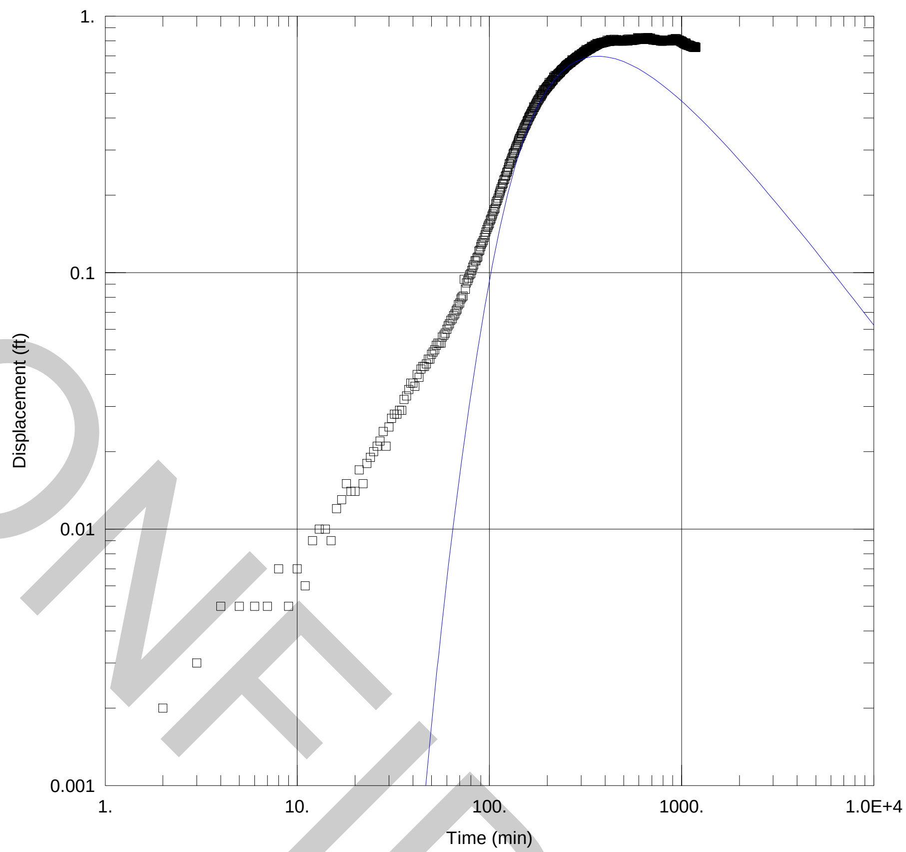
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-112	1024361.32	14166575.22

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.6775 ft^2/day
S = 0.03602
Kz/Kr = 1.
b = 45. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-112-1.aqt
Date: 10/05/17
Time: 14:17:49

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-112
Test Date: 8/31/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-112	1024361.32	14166575.22

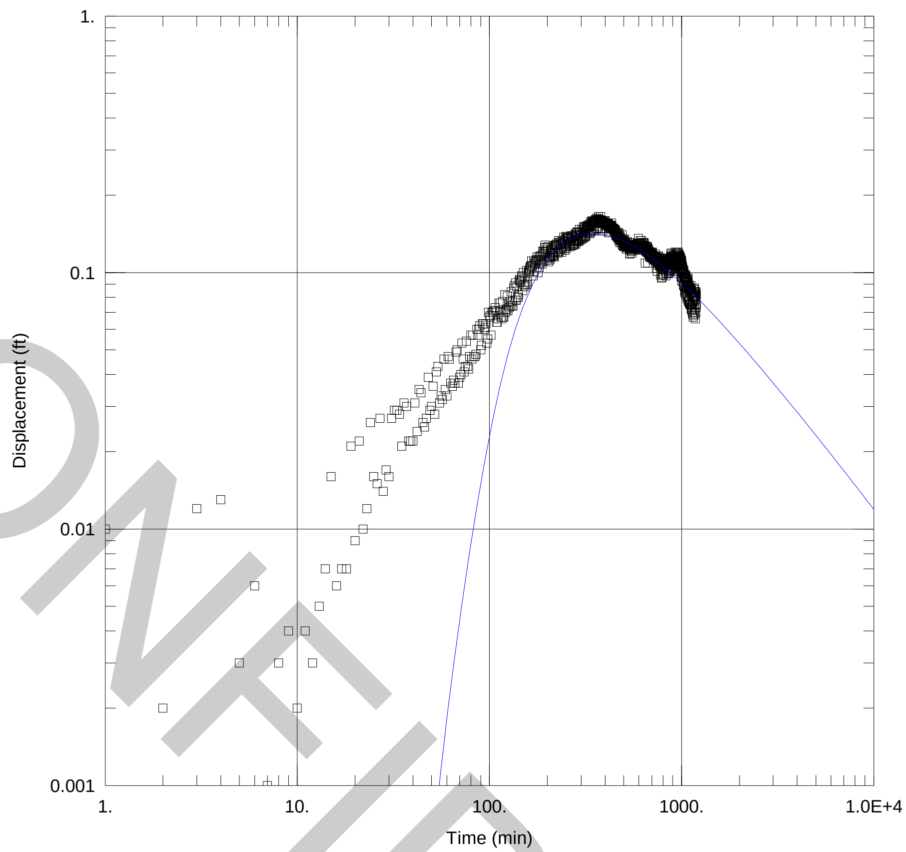
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-112-1	1024381.3	14166575.13

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.01559 cm^2/sec
S = 0.003417
Kz/Kr = 0.001
b = 45. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-112-2.aqt
Date: 10/05/17 Time: 14:18:05

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-112
Test Date: 8/31/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-112	1024361.32	14166575.22

Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-112-2	1024381.27	14166565.15

SOLUTION

Aquifer Model: Confined

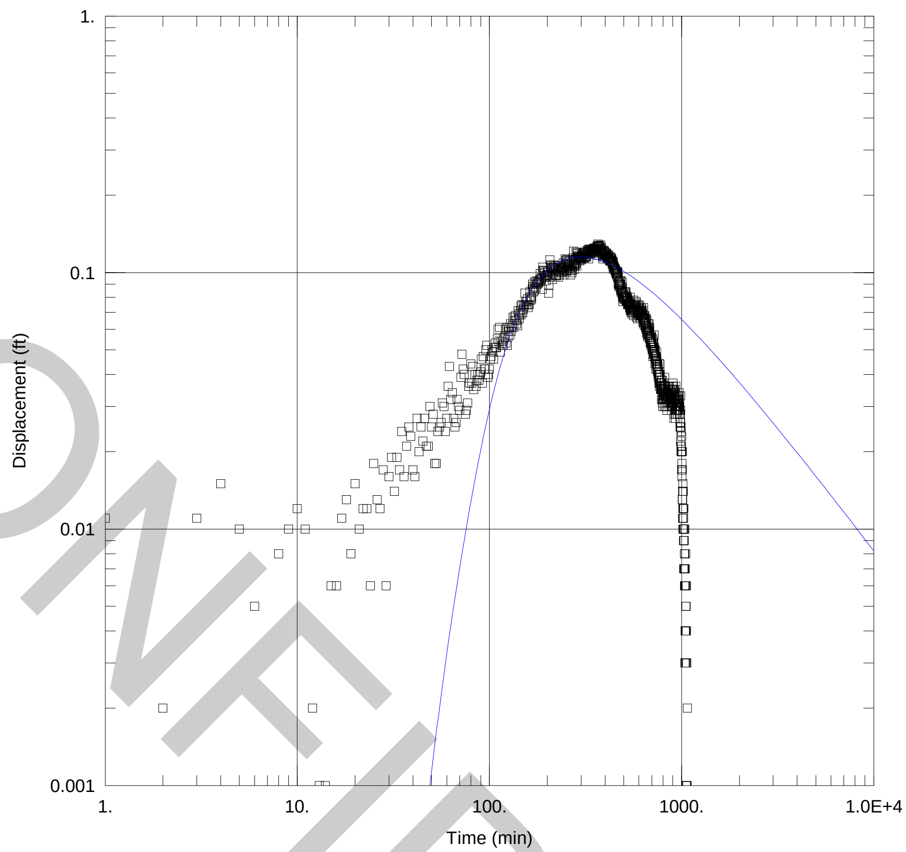
Solution Method: Theis

T = 0.08156 cm^2/sec

S = 0.01341

Kz/Kr = 1.

b = 45. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-112-3.aqt
Date: 10/05/17 Time: 14:18:16

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-112
Test Date: 8/31/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-112	1024361.32	104166575.2

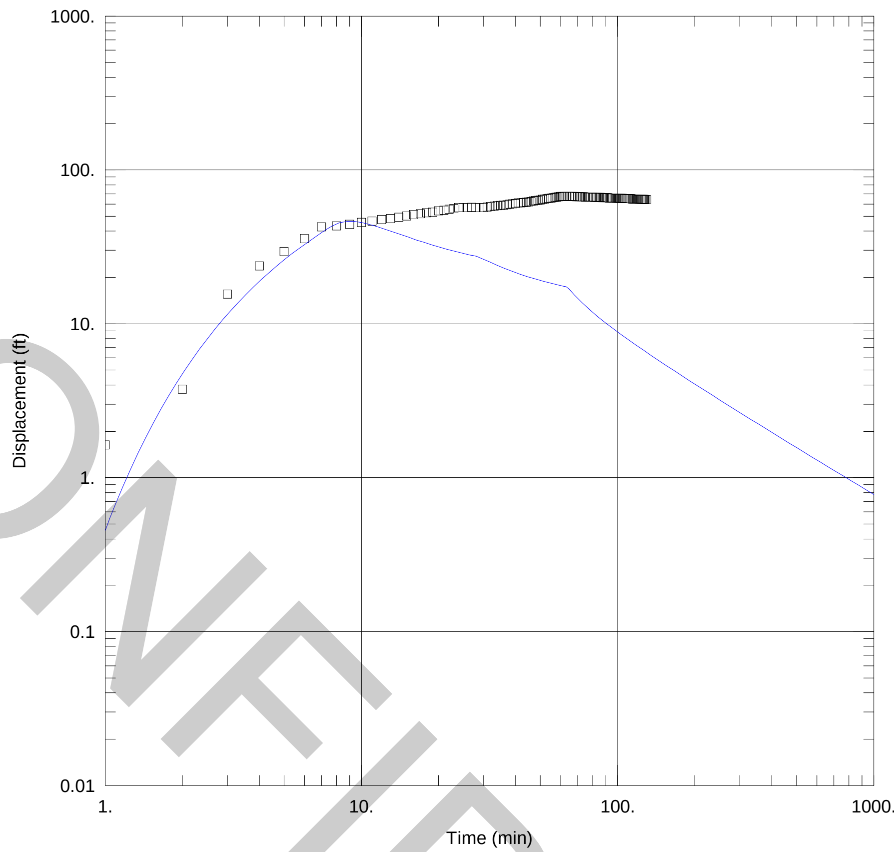
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-112-3	1024381.2	14166555.14

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.119 cm^2/sec
S = 1.019E-15
Kz/Kr = 1.
b = 45. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-226 Pump Well.aqt
Date: 10/05/17 Time: 14:18:28

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-226
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-226	1036864.5	14134749.76

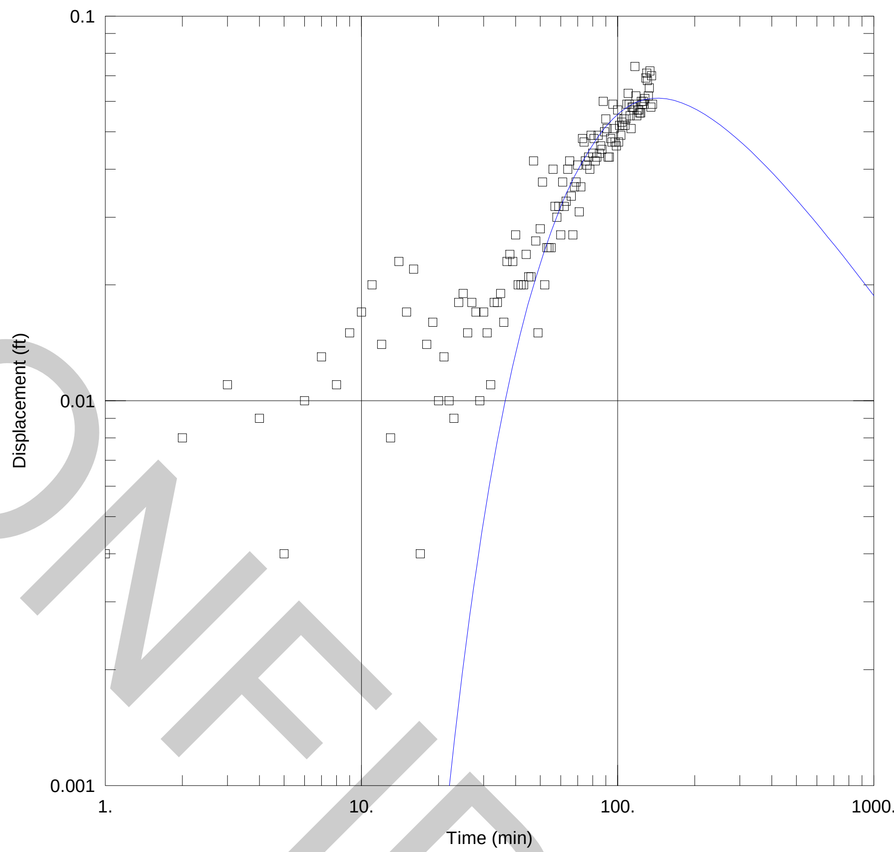
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-226	1036864.5	14134749.76

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.069 ft^2/day
S = 0.06119
Kz/Kr = 1.
b = 35. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-226-1.aqt
Date: 10/05/17 Time: 14:18:45

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-226
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-226	1036864.5	14134749.76

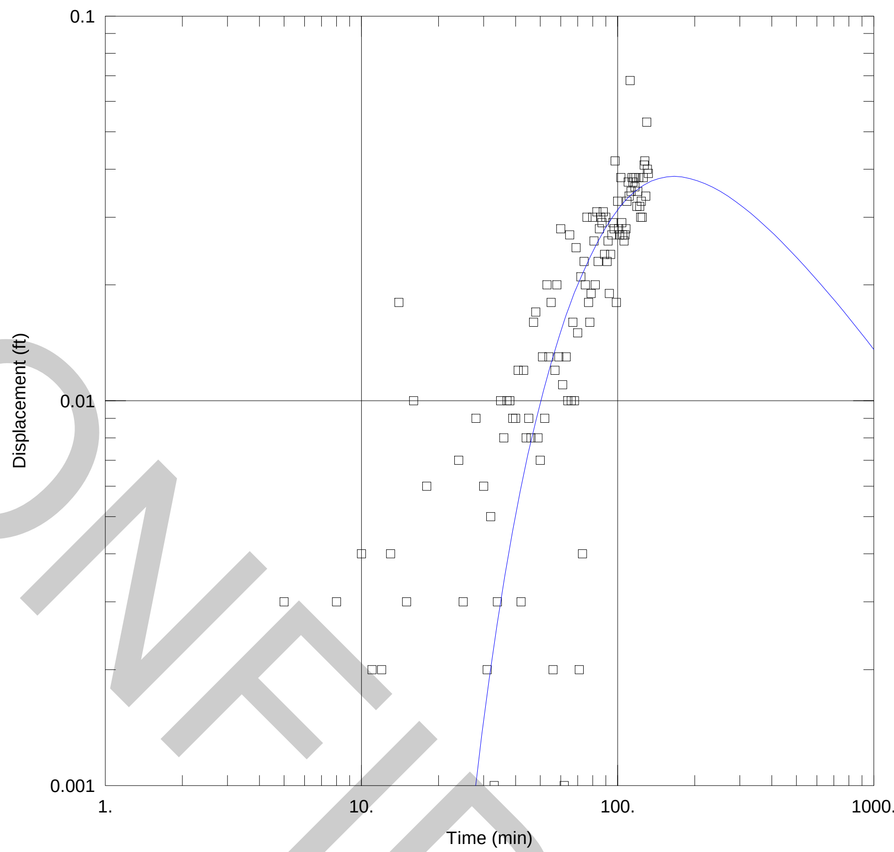
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-226-1	1036884.61	14134769.65

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.4219 cm^2/sec
S = 0.01701
Kz/Kr = 1.
b = 72. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-226-2.aqt
Date: 10/05/17 Time: 14:18:59

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-226
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-226	1036864.5	14134749.76

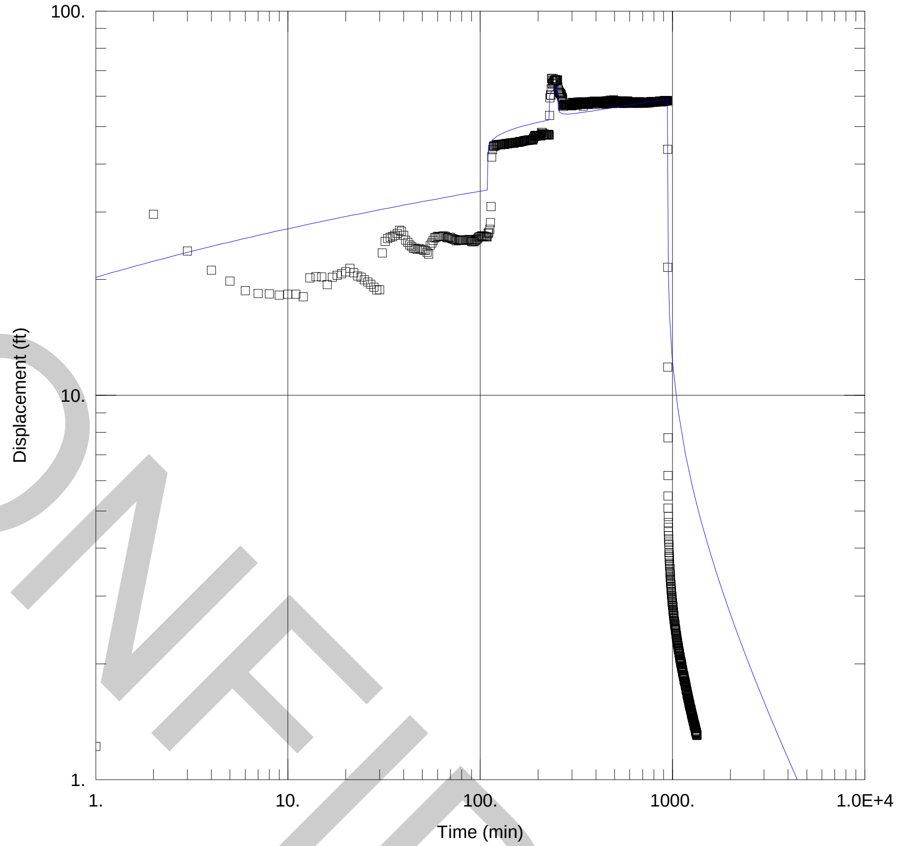
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-226-2	1036884.55	14134759.64

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.5671 cm^2/sec
S = 0.04368
Kz/Kr = 1.
b = 72. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-232_Pumping_Well.aqt
Date: 10/05/17 Time: 14:19:35

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-232
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-232	1032209.97	14131893.99

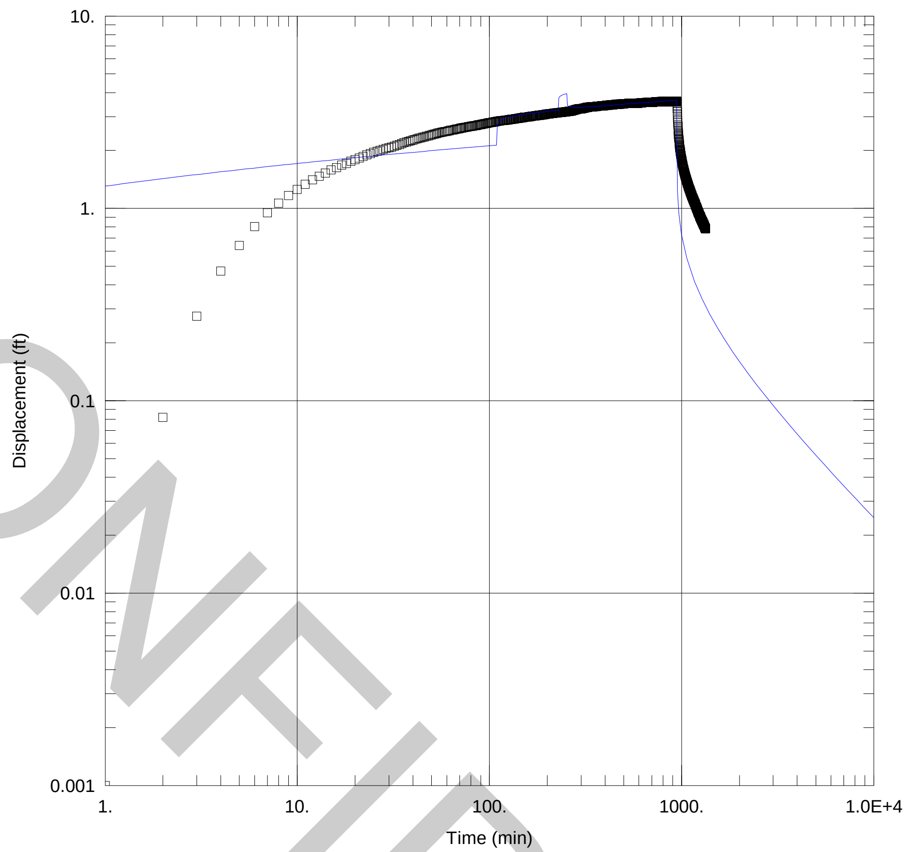
Observation Wells

Well Name	X (ft)	Y (ft)
SN3-232	1032209.97	14131893.99

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 56.65 ft^2/day
S = 0.000559
Kz/Kr = 1.
b = 90. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-232-1.aqt
Date: 10/05/17 Time: 14:19:46

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-232-1
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-232	1032209.97	14131893.99

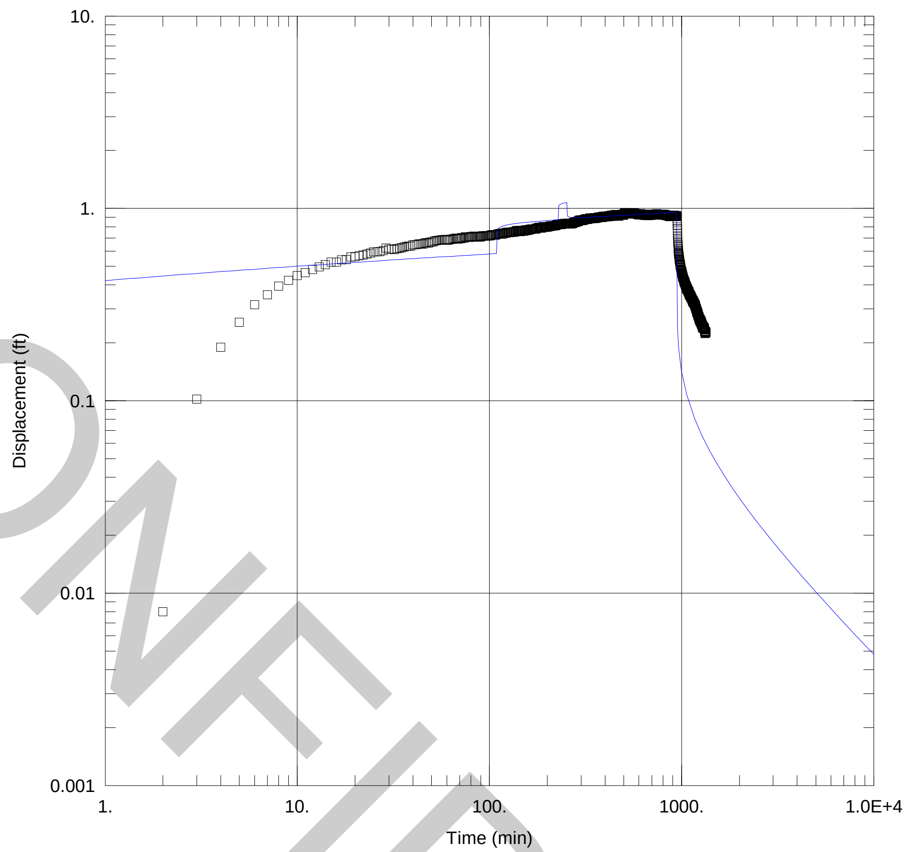
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-232-1	1032209.94	14131883.98

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 10.27 cm^2/sec S = 9.079E-6
Kz/Kr = 1. b = 87. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-232-2.aqt
Date: 10/05/17 Time: 14:19:56

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-232-2
Test Date: 8/29/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-232	1032209.97	14131893.99

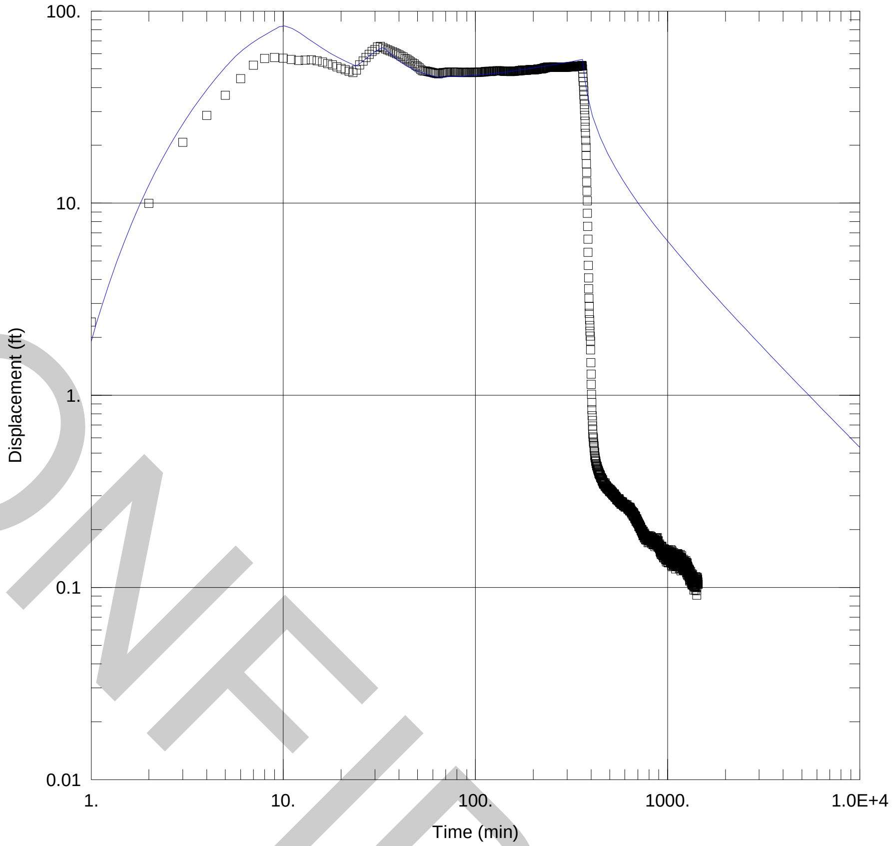
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-232-2	1032209.88	14131874.01

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 52.8 cm^2/sec
S = 8.967E-8
Kz/Kr = 1.
b = 87. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-251 Confined.aqt
Date: 10/05/17 Time: 14:20:09

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-251
Test Date: 8/27/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-251	0	0

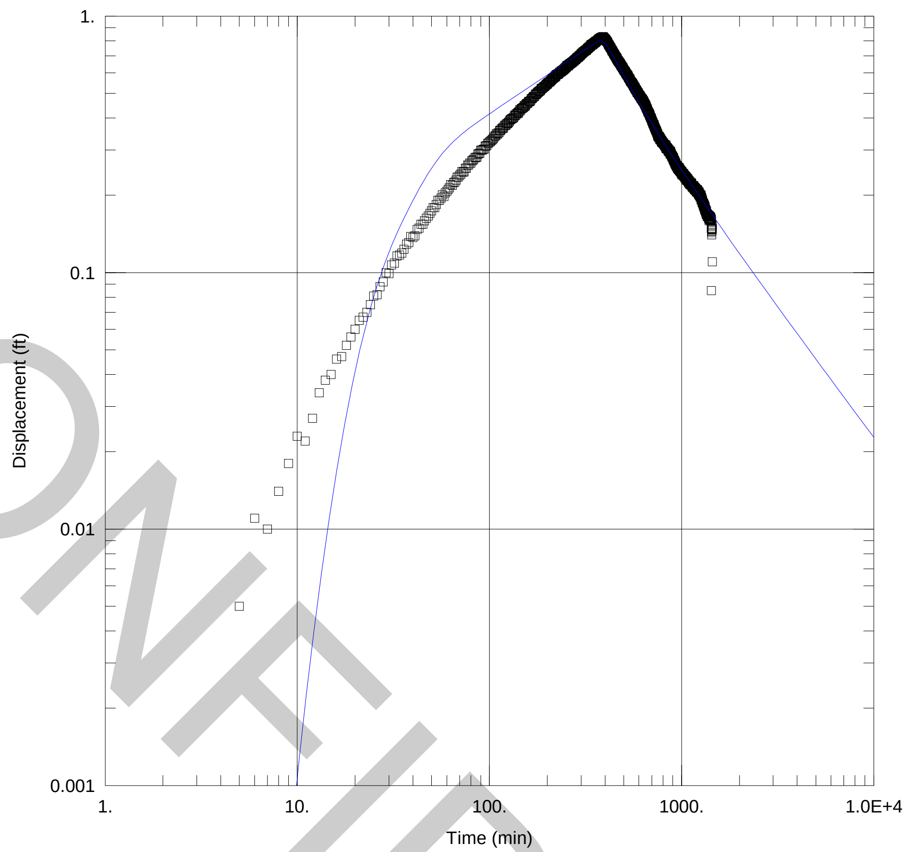
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-251	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.236 ft^2/day
S = 0.05335
Kz/Kr = 1.
b = 80. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-251-1Confined.aqt
Date: 10/05/17 Time: 14:20:22

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-251
Test Date: 8/27/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-251	1024547.44	14123096.74

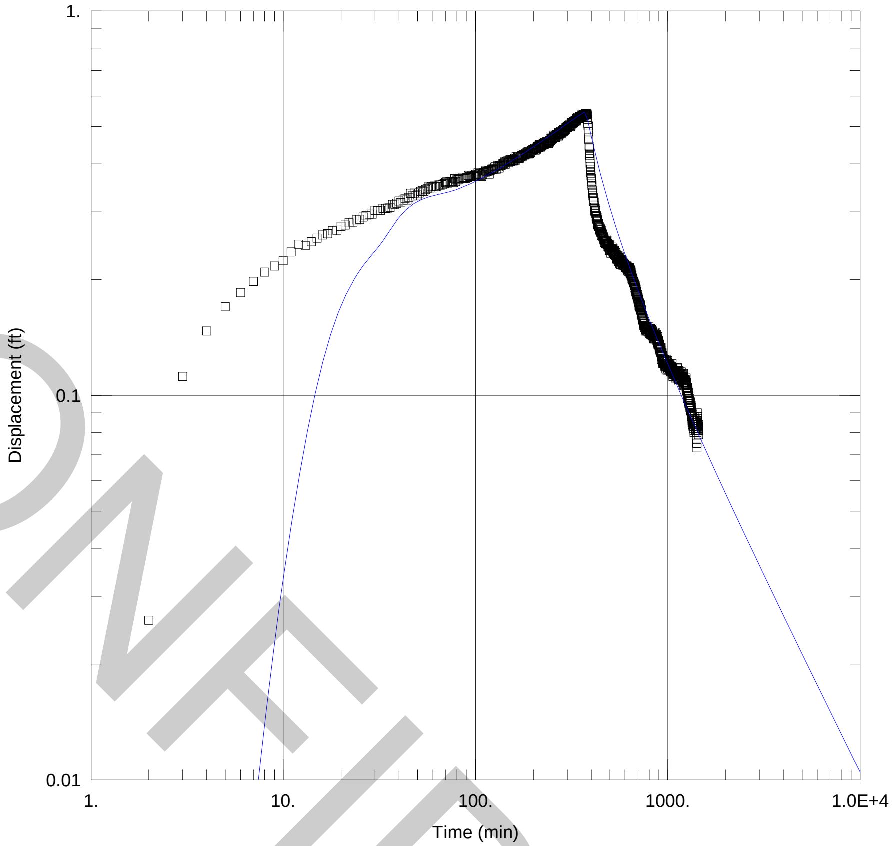
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-251-1	1024547.38	14123086.74

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.3111 cm^2/sec
S = 0.05068
Kz/Kr = 1.
b = 89. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-251-2 Confined.aqt
Date: 10/05/17
Time: 14:20:31

PROJECT INFORMATION

Company: Norwest
Client: Peak Minerals
Project: 87-10
Location: Sevier Lake
Test Well: SN3-251
Test Date: 8/27/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-251	1024547.44	14123096.74

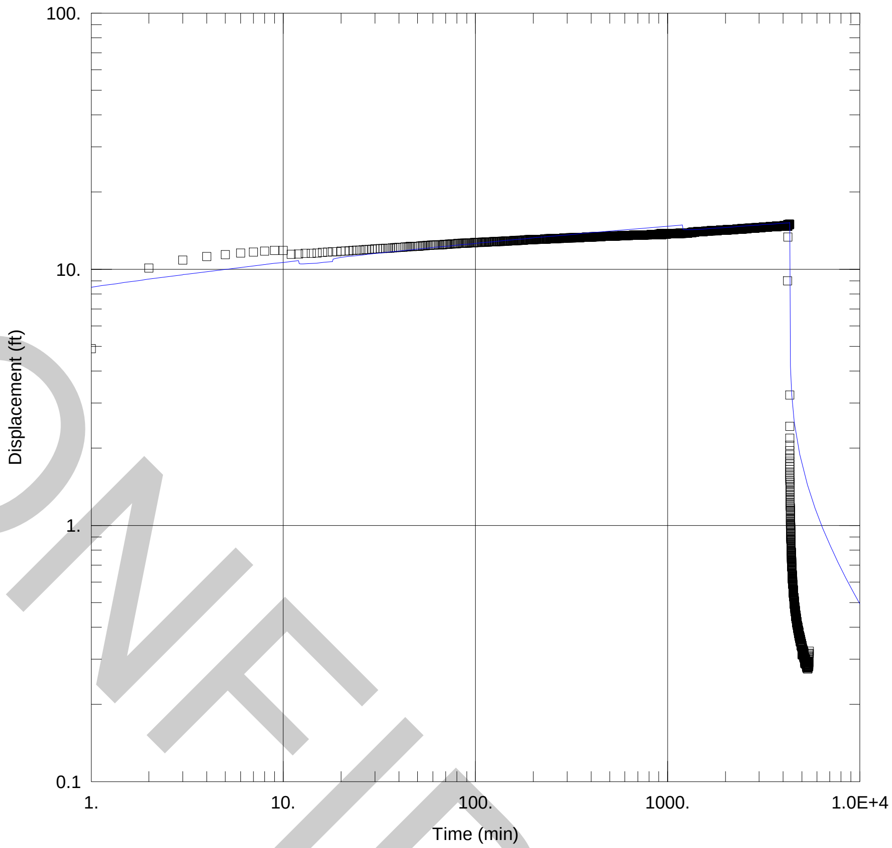
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-251-2	1024547.34	14123076.73

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.6783 cm^2/sec
S = 0.01216
Kz/Kr = 1.
b = 89. ft



WELL TEST ANALYSIS

Data Set: T:\...\SN3-260 Pump Well.aqt
Date: 10/05/17 Time: 14:20:43

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: SN3-260
Test Date: 2/5/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
SN3-260	0	0

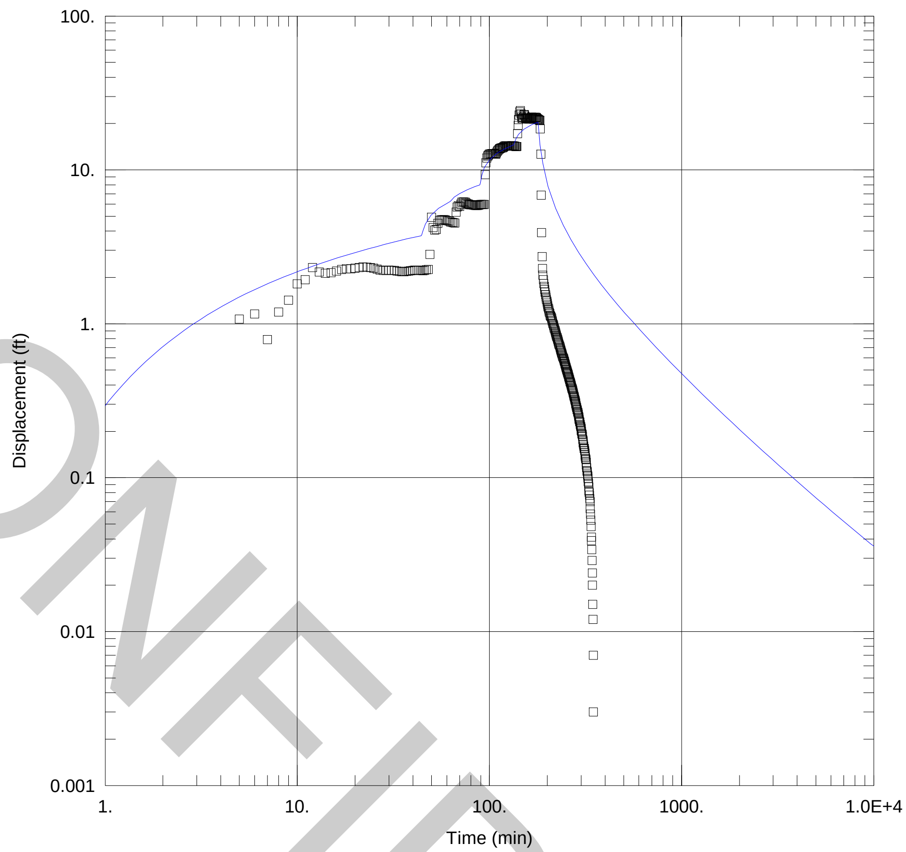
Observation Wells

Well Name	X (ft)	Y (ft)
□ SN3-260	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 578.8 ft^2/day
S = 0.0005218
Kz/Kr = 1.
b = 89. ft



WELL TEST ANALYSIS

Data Set: T:\...\WW-1 Pump Well.aqt
Date: 10/05/17 Time: 14:20:55

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
WW-1	0	0

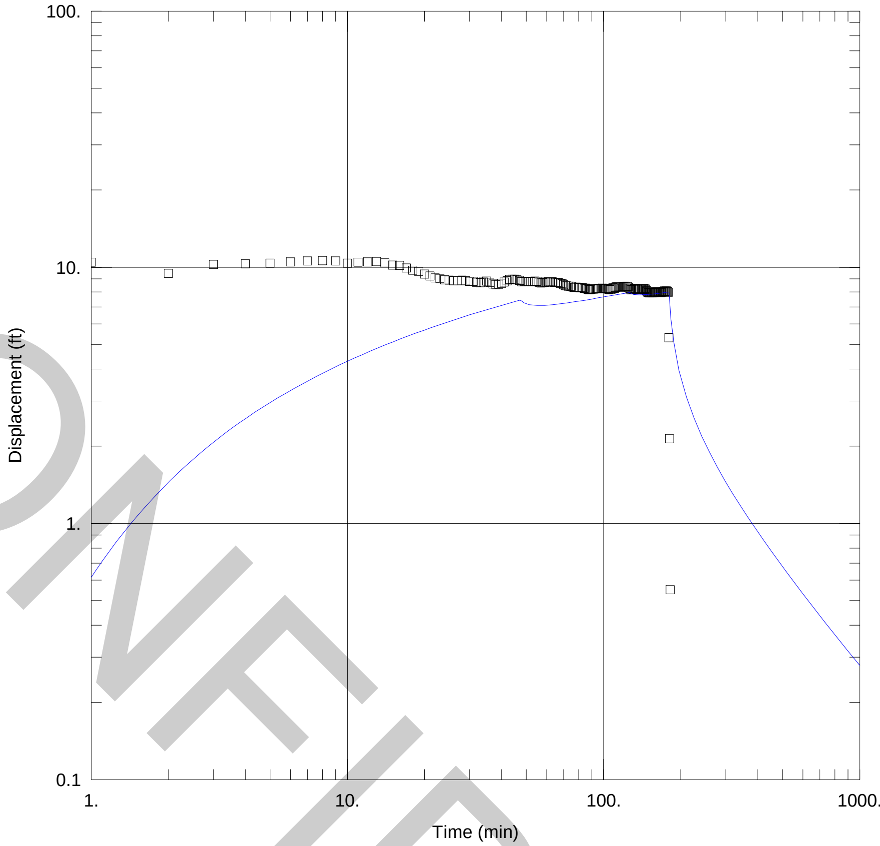
Observation Wells

Well Name	X (ft)	Y (ft)
□ WW-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 21.57 ft^2/day
S = 0.3156
Kz/Kr = 1.
b = 32. ft



WELL TEST ANALYSIS

Data Set: T:\...\WW-2 Pump Well.aqt
Date: 10/05/17 Time: 14:21:11

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
WW-2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ WW-2	0	0

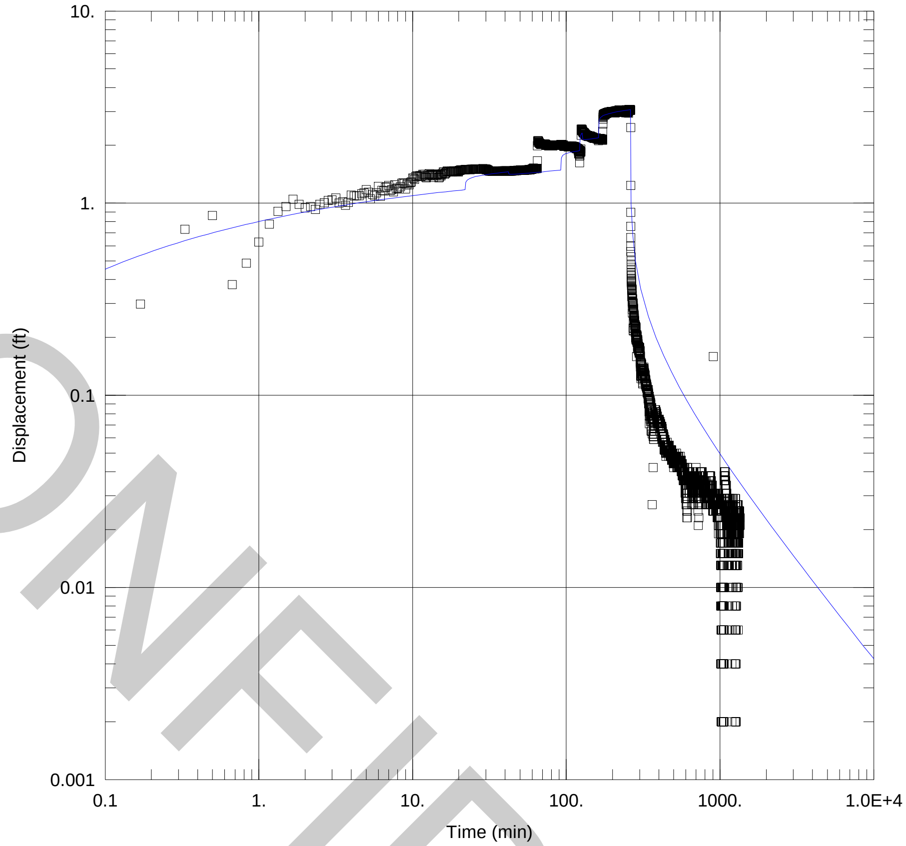
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 29.46 ft^2/day
Kz/Kr = 1.

S = 0.4076
b = 32. ft



WELL TEST ANALYSIS

Data Set: T:\...\WW-3 Pump Well.aqt
Date: 10/05/17 Time: 14:21:23

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
WW-3	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ WW-3	0	0

SOLUTION

Aquifer Model: Confined

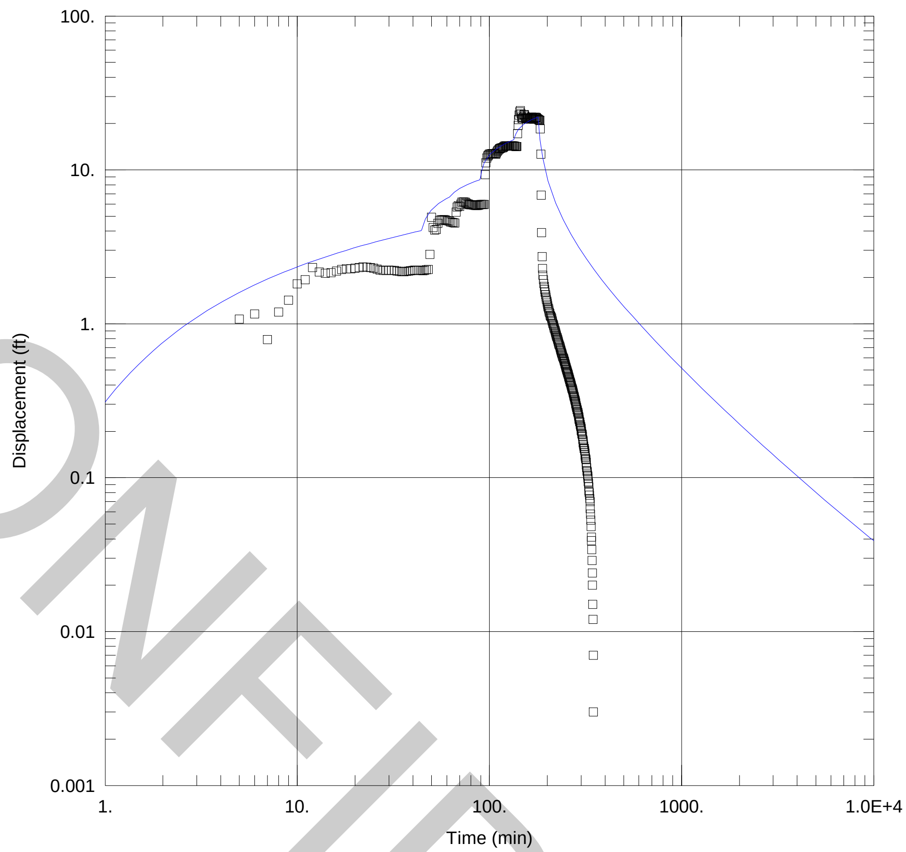
Solution Method: Theis

T = 477.8 ft^2/day

S = 0.02777

Kz/Kr = 1.

b = 52. ft



WELL TEST ANALYSIS

Data Set: T:\...\WW-4 Pump Well.aqt
Date: 10/05/17 Time: 14:21:35

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
WW-4	0	0

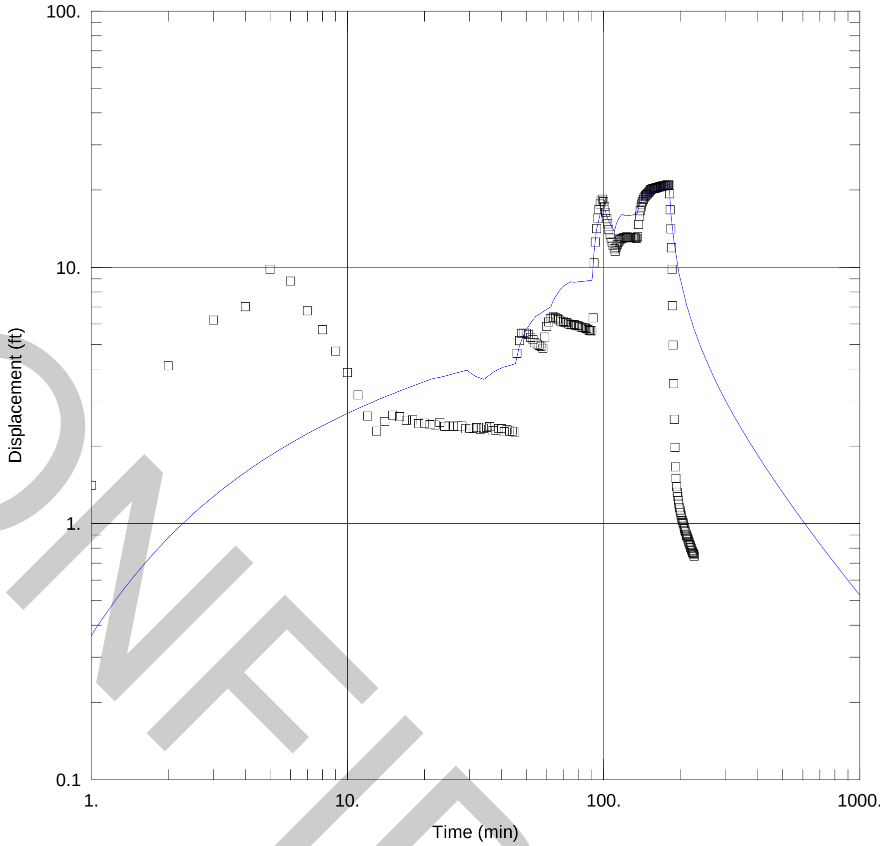
Observation Wells

Well Name	X (ft)	Y (ft)
□ WW-4	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 19.91 ft^2/day
S = 0.296
Kz/Kr = 1.
b = 32. ft



WELL TEST ANALYSIS

Data Set: T:\...\WW-6 Pump Well.aqt
Date: 10/05/17 Time: 14:21:50

PROJECT INFORMATION

Company: Norwest Corporation
Client: Peak Minerals
Project: 89-10
Location: Sevier Lake
Test Well: 15-01
Test Date: 1/26/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
WW-6	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ WW-6	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 11.75 ft^2/day S = 0.1712
Kz/Kr = 1. b = 32. ft

Attachment 8 - Column Test Results

B-3 - Column Test Results

July 8, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-001 SH-01 22.0-23.5 Leachate Test
Sevier Lake Project
Millard County, Utah

1. Introduction

On Wednesday, November 4, 2015 GSH Geotechnical began the leachate column testing on Shelby tube SH-01 from well SN4-15-001 at a depth of 22.0 to 23.5 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, a HANNA HI98195 multi-parameter water quality meter was used to record the parameters on a 10 minutes interval. The meter was calibrated before the start of the test.

A constant head pressure of 10 cm of well water that was provided from the project site was applied for duration of the test. The test was terminated after 5 days due to the lack of discharge water from the core.

The table below presents the timeline for the test:

Date	Time	Notes
4-Nov-15	13:08	Quick calibration
	13:12	EC calibration
	13:26	Start meter logging at 10 minute interval
	13:29	Begin test at 10 cm of head
9-Nov-15	13:35	Terminate test; no flow

3. Hydraulic Conductivity Data

The table below presents the hypothetical hydraulic conductivity for the test assuming 1 ml of discharge water. This hydraulic conductivity is to be considered the highest given the parameters of the test, but in actuality may be much lower.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)
Sample 01	1	5	12.04	19.69	4.00459E-08

4. Meter Logging Data

Due to the lack of discharge water from the core, no meter logging data is available for this test.

5. CLOSURE

After the tests were terminated the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

RAG:lb

Addressee (email)

February 25, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-003 SH-04 68.0-70.0 Leachate Test - Updated
Sevier Lake Project
Millard County, Utah

1. INTRODUCTION

On Monday, November 9, 2015 GSH Geotechnical began the leachate column testing on shelby tube SH-04 from well SN4-15-003 at a depth of 68.0 to 70.0 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, a HANNA HI98195 multi-parameter water quality meter was used to record the parameters on a 10 minutes interval. The meter was calibrated before the start of the test.

A constant head pressure of 10 cm of well water that was provided from the project site was applied for the first 8 days of the test. On November 17, 2015 the head was raised to 3.5 feet (1.5 psi) and again on November 20, 2015 to 6.9 feet (3.0 psi). Breakthrough was observed on December 1, 2015 and GSH began the collection of the first composite sample of discharge water. Flow was extremely slow due to the nature of the clay soil within the tube and more pressure was needed to force the water through the core. A pressure vessel containing the provided well water was attached to the apparatus and the head pressure was raised on December 10, 2015 to 5 psi. On December 15, 2015 the pressure was increased to 10 psi.

On December 21, 2015, 620 ml of water had been discharged, enough to fill the sample bottles. The sample was bottled and sent to ALS Environmental Laboratories for analysis. The test continued until February 1, 2016 upon which it was terminated on direction from Norwest, due to the slow flow of the sample.

The table below presents the timeline for the test.

Date	Time	Notes
9-Nov-15	15:57	Begin Test
17-Nov-15	16:00	Increase head to 3.5 feet (1.5 psi)
20-Nov-15	9:14	Increase head to 6.9 feet (3.0 psi)
23-Nov-15		Observed increase in EC, water in flow cell
1-Dec-15	8:45	Begin collecting sample 01; 44.36 mS/cm
10-Dec-15	10:10	Pause test to hook up pressure vessel; 30ml in graduated cylinder
	10:18	Restart test at 5 psi
15-Dec-15	9:52	Increase head to 10 psi
21-Dec-15	11:30	Collect sample 01; 188.5 mS/cm, 650 ml
1-Feb-16	13:15	Terminate test; total volume 1680 ml (including lab samples)

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the sample and for the overall test.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	620	6.07	12.04	63.18	9.33134E-07	188.5
Overall*	1680	48.14			3.18733E-07	NA

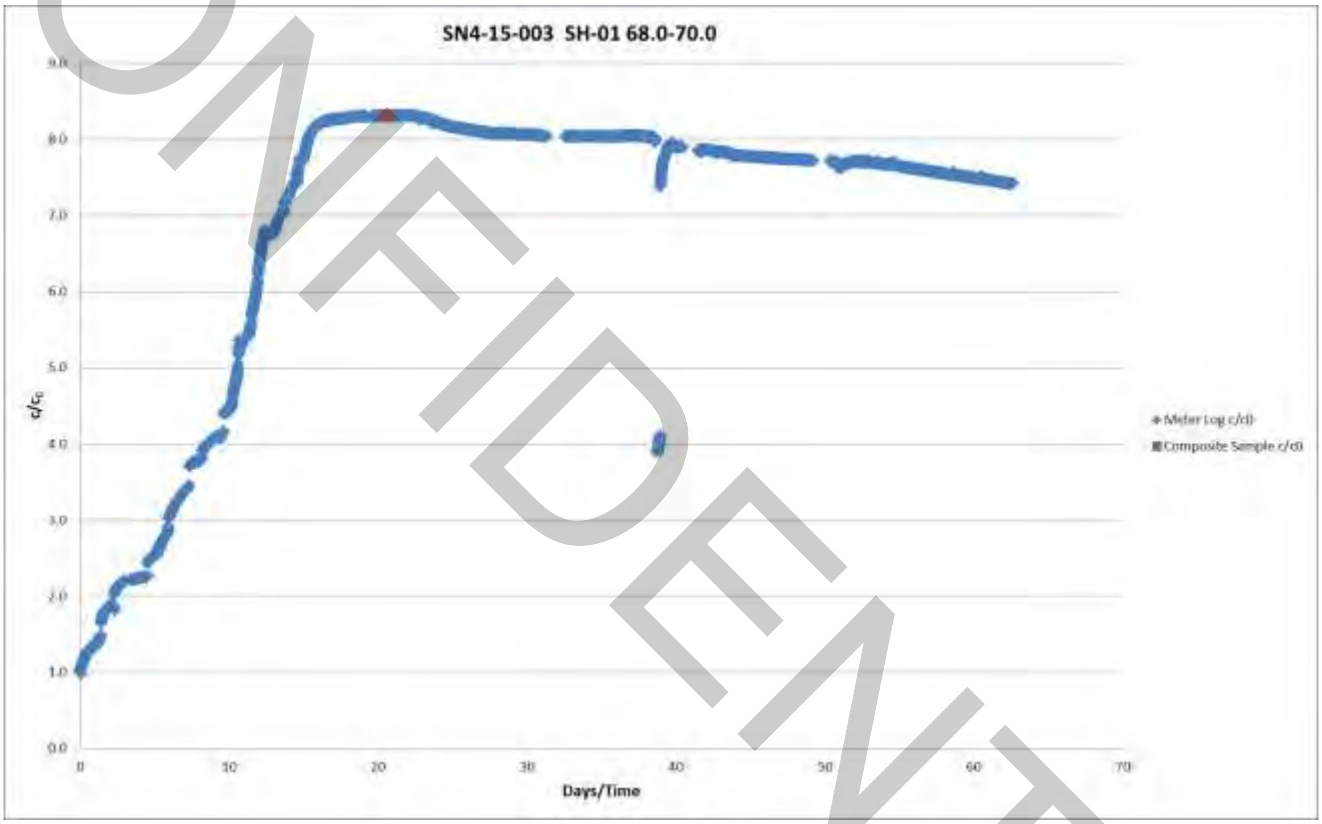
*calculations based on 10 psi head with a start date of December 15, 2015

4. Meter Logging Data

Data obtained from the meter logging is included as attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings, readings taken before breakthrough, and readings recorded after the test was terminated. Notes are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, pH, Oxidation Reduction Potential, Electrical Conductivity, Absolute Electrical Conductivity, Resistivity, Total Dissolved Solids, and Salinity. Note: Salinity exceeds meter capabilities at 70 psu. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



The relatively slow rise in electrical conductivity from December 2nd to approximately December 15th is likely due to the relatively low head and as a result, a low volume of water passed through the flow cell in that time frame. The test was running at a head pressure of approximately 3 psi until December 10th when it was raised to 5 psi and raised again on December 15th to 10 psi. This increased the flow and the electrical conductivity increased accordingly.

The sharp drop in electrical conductivity observed on January 8th was due to dilution of the flow cell with distilled water. At this time, the flow cell was disturbed and a small amount of discharge water spilled from the cell. Part of the probe was left unsubmerged and distilled water was added to keep the probe saturated.

5. CLOSURE

After the test was terminated the ends of the shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

Reviewed by:

Alan D. Spilker, P.E.
President/Senior Geotechnical Engineer

RAG/ADS:cai

Addressee (email)

August 5, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-004A SH-01 18.0-20.0 Leachate Test - Complete
Sevier Lake Project
Millard County, Utah

1. Introduction

On Tuesday, February 2, 2016, GSH Geotechnical, Inc. (GSH) began the leachate column testing on Shelby tube SH-01 from well SN4-15-004A at a depth of 18.0 to 20.0 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, a HANNA HI 98195 multi-parameter water quality meter was used to record the parameters at a 10-minute interval. The meter was calibrated by GSH prior to the start of the test. Additionally, the HANNA HI 98195 multi-parameter water quality meter was used to take 1-time readings of the composite samples.

A constant head pressure of 2 psi of well water that was provided from the project site was applied for the approximately first 2 days of the test. On February 4, 2016, the head pressure was raised to 5 psi and maintained for approximately 4 more days. With no breakthrough observed, GSH raised the head pressure to 10 psi on February 8, 2016 at 10:00. Breakthrough was observed the morning of February 9, 2016. GSH began collecting the first composite effluent leachate sample at 10:00 on February 9, 2016. On February 12, 2016, 440 ml of discharge water was collected with a measured composite electrical conductivity (EC) of 166.7 mS/cm. On February 16, 2016, GSH began collecting hydraulic conductivity sample HC-01 at 10:15. HC-01 was collected on February 19, 2016 at 07:30 with a composite EC of 139.9 mS/cm and a discharge volume of 320 ml. GSH began collecting the second hydraulic conductivity sample (HC-02) sample on February 22, 2016 at 16:45. On February 24, 2016 at 16:00, 135 ml of effluent leachate water with a composite EC of 135.8 mS/cm was collected. On March 10, 2016 GSH began collecting the third hydraulic conductivity sample at 09:30. HC-03 was collected on March 21, 2016 at 11:00 with a discharge volume of 510 ml and composite EC of 144.3 mS/cm. at 11:15 the same day GSH began collecting the fourth and final hydraulic conductivity sample. HC-04 was collected on April 11, 2016 at 10:30 with a discharge volume of 890 ml with a composite EC of 133.1 mS/cm. GSH began collecting the second and final leachate composite sample of the first test run at 14:30 on April 12, 2016. On May 4, 2016, at 08:30, 1005 ml of effluent leachate water with a composite EC of 100.5 mS/cm was collected. The first test run was terminated 1 hour later.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on February 12 and May 12, 2016. Hydraulic conductivity samples were not sent in for laboratory analysis and were emptied into the discharge bucket after the volume and time of the sample was recorded.

On June 6, 2016 at 12:00, GSH began the second test run with a constant head pressure of 5 psi. At 13:30 the same day the head pressure was raised to 10 psi and breakthrough occurred at approximately 20:00. GSH began collecting the third composite sample at 09:00 on June 7, 2016. Sample 04 was collected on July 1, 2016 at 12:30 with a total volume of 1000 ml and with a composite EC of 69.65 mS/cm. GSH began collecting the fourth composite sample at 13:00 on July 8, 2016. Sample 04 (675 ml) was collected at 14:30 on July 19, 2016, with a composite EC of 53.83 mS/cm. The second test run was terminated at 14:45. A total of 2,215 ml of water had been discharged during the second test run.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on July 15 and August 1, 2016. Hydraulic conductivity samples were not sent in for laboratory analysis and were emptied into the discharge bucket after the volume and time of the sample was recorded.

The table below presents the timeline for the test:

Date	Time	Notes
2-Feb-16	8:20	Quick calibrate Hanna meter
	8:30	EC calibrate Hanna meter
	9:00	Begin test at 2 psi
4-Feb-16	7:45	Raise head to 5 psi
8-Feb-16	10:00	Raise head to 10 psi
9-Feb-16	10:00	Begin collecting sample 01; 143.4 mS/cm

Date	Time	Notes
12-Feb-16	8:00	Collect sample 01; 440 ml, 166.7 mS/cm
16-Feb-16	10:15	Begin collecting HC-01; 141.5 mS/cm
19-Feb-16	7:30	Collect HC-01; 320 ml, 139.9 mS/cm
22-Feb-16	16:45	Begin collecting HC-02; 131.1 mS/cm
24-Feb-16	16:00	Collect HC-02; 135 ml, 135.8 mS/cm
10-Mar-16	9:30	Begin collecting HC-03; 140.4 mS/cm
21-Mar-16	11:00	Collect HC-03; 510 ml, 144.3 mS/cm
	11:15	Begin collecting HC-04
11-Apr-16	10:30	Collect HC-04; 890 ml, 133.1 mS/cm
12-Apr-16	14:30	Begin collecting sample 02; 115.1 mS/cm
4-May-16	8:30	Collect sample 02; 1005 ml, 100.5 mS/cm
	9:30	Terminate test; 3.2L + samples
6-Jun-16	11:55	Calibrate meter
	12:00	Begin retest at 5 psi
	13:30	Raise head to 10 psi
7-Jun-16	9:00	Begin collecting sample 03; 74.83 mS/cm
1-Jul-16	12:30	Collect sample 03; 1000ml, 69.65 mS/cm
8-Jul-16	13:00	Begin collecting sample 04; 58.46 mS/cm
19-Jul-16	14:30	Collect sample 04; 675ml, 53.83 mS/cm
	14:45	Terminate Test; 540 ml + samples

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the samples and for the overall test.

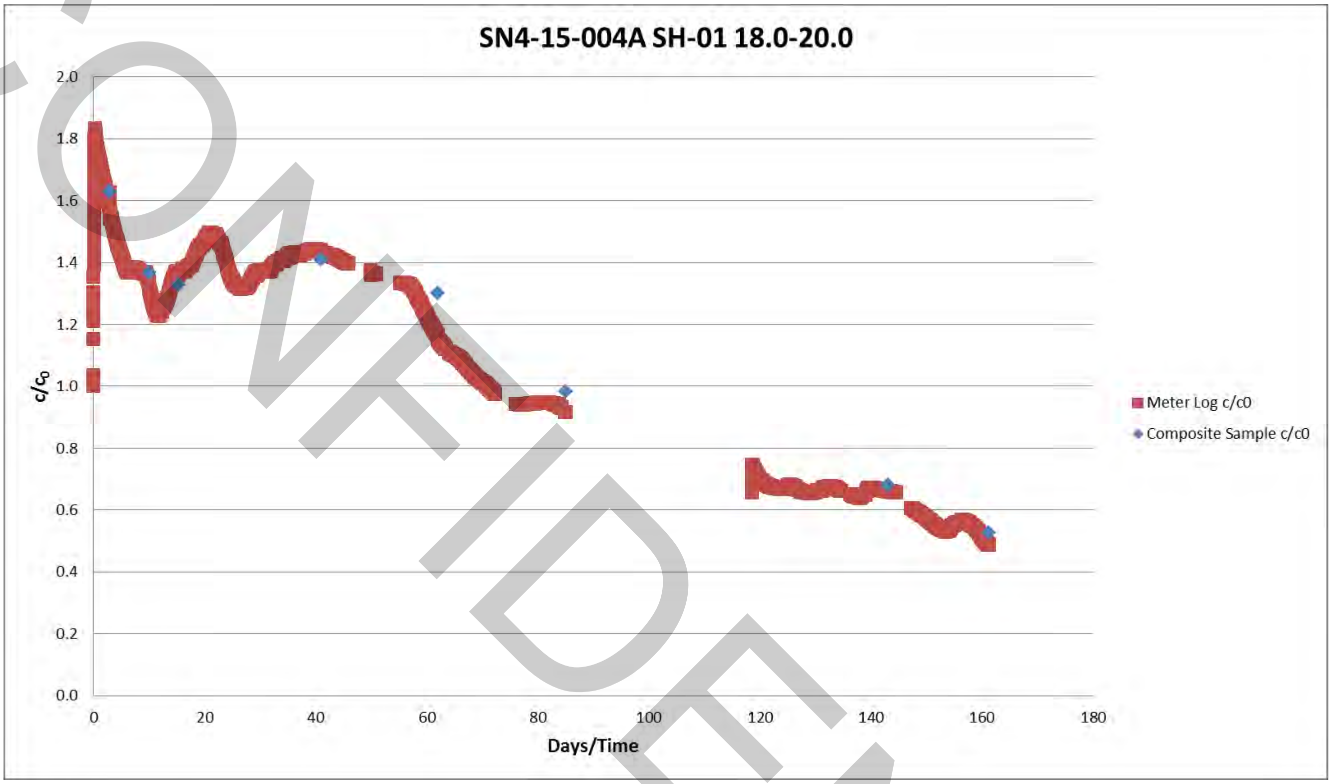
<table>
<tr><th></th><th>Quantity Measured (ml)</th><th>Duration (days)</th><th>Cross-Sectional Area (cm^2)</th><th>Length of Core (cm)</th><th>Head Pressure (cm)</th><th>Hydraulic Conductivity (cm/sec)</th><th>Composite Electrical Conductivity (mS/cm)</th></tr>
<tr><td>Sample 01</td><td>440</td><td>2.9167</td><td rowspan="11">12.04</td><td rowspan="11">58.42</td><td rowspan="11">703.07</td><td>1.27502E-06</td><td>166.7</td></tr>
<tr><td>HC-01</td><td>320</td><td>2.8858</td><td>9.37215E-07</td><td>139.9</td></tr>
<tr><td>HC-02</td><td>135</td><td>1.96875</td><td>5.7956E-07</td><td>135.8</td></tr>
<tr><td>HC-03</td><td>510</td><td>11.0026</td><td>3.91769E-07</td><td>144.3</td></tr>
<tr><td>HC-04</td><td>890</td><td>20.9688</td><td>3.58733E-07</td><td>133.1</td></tr>
<tr><td>Sample 02</td><td>1005</td><td>21.75</td><td>3.90537E-07</td><td>100.5</td></tr>
<tr><td>Part 1 Overall</td><td>4595</td><td>85.02</td><td>4.56793E-07</td><td>NA</td></tr>
<tr><td>Sample 03</td><td>1000</td><td>24.1458</td><td>3.50037E-07</td><td>69.65</td></tr>
<tr><td>Sample 04</td><td>675</td><td>11.0625</td><td>5.1571E-07</td><td>53.83</td></tr>
<tr><td>Part 2 Overall</td><td>2215</td><td>42.2292</td><td>4.43319E-07</td><td>NA</td></tr>
<tr><td>Total</td><td>6810</td><td>127.2492</td><td>4.52322E-07</td><td>NA</td></tr>
</table>

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings and readings recorded after the test was terminated. Remarks relevant to the test are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, pH, mV, Oxidation Reduction Potential, Electrical Conductivity, Absolute Electrical Conductivity, Resistivity, Total Dissolved Solids, Salinity, and Pressure. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



Although an effort was made to keep the pressure steady at 10 psi throughout the first and second test runs, respectively, the small spikes in the curve can be attributed to refilling the chamber to operating pressure and briefly (about 5 minutes) refilling the chamber with well water.

5. CLOSURE

After the tests were terminated, the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Geotechnical Engineer/Geologist

Reviewed by:

Matt Gallegos
Senior Engineer

RAG/MG:cai

Addressee (email)

July 8, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-011 SH-04 54.0-55.5 Leachate Test
Sevier Lake Project
Millard County, Utah

1. INTRODUCTION

On Tuesday, February 2, 2016 GSH Geotechnical began the leachate column testing on Shelby tube SH-04 from well SN4-15-011 at a depth of 54.0 to 55.5 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, an INW AquiStar CT2X multi-parameter water quality meter was used to record the parameters at a 10 minute interval. The meter was calibrated by INW prior to arrival at the GSH laboratory.

A constant head pressure of 2 psi of well water that was provided from the project site was applied for the first 2 days of the test. After no flow was observed the head pressure was increased to 5 psi at 07:45 on February 4, 2016. The head pressure was raised again on February 8, 2016 to a pressure of 10 psi. After breakthrough was observed, GSH began collecting the first and only composite sample on February 22, 2016 at 08:30. Flow was very slow and on May 4, 2016 enough discharge water (835 ml) had been collected for the composite sample with an electoral conductivity of 161.7 mS/cm. The test was terminated after collection of the sample under direction from Norwest due to the slow flow of the discharge water.

The table below presents the timeline for the test.

Date	Time	Notes
2-Feb-16	11:30	Begin test at 2 psi
4-Feb-16	7:45	Raise head to 5 psi
8-Feb-16	10:00	Raise head to 10 psi
22-Feb-16	8:30	Begin collecting Sample 01; ~164.7 mS/cm
4-May-16	9:00	Collect Sample 01; 835 ml. 161.7 mS/cm
	9:45	Terminate test; 90 ml + sample, soil heaved .25 inches in tube

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the sample and for the overall test.

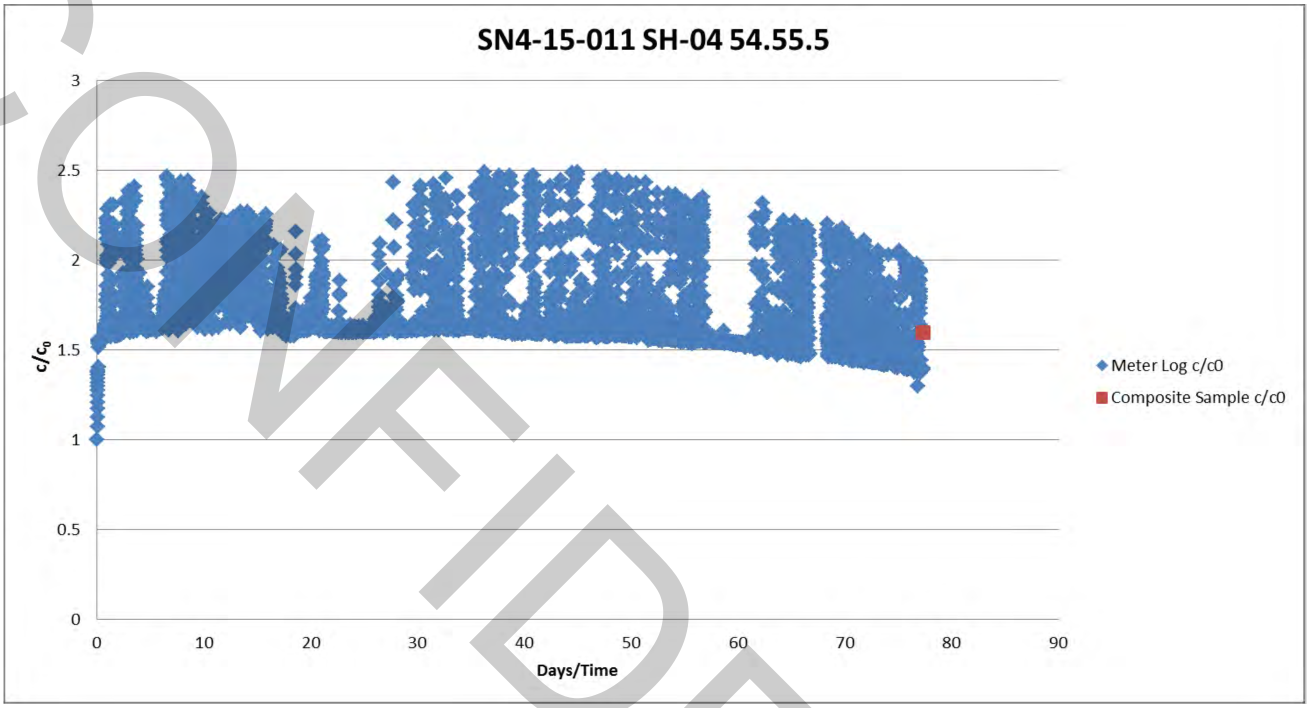
	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	835	72.02	12.04	27.31	4.58088E-08	161.7
Overall*	925	77.28			4.72923E-08	NA

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings, readings taken before breakthrough, and readings recorded after the test was terminated. Notes are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, Electrical Conductivity, Pressure, Salinity, and Total Dissolved Solids. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



The frequent spikes in the electrical conductivity from the meter log can likely be attributed to an anomaly within the transducer, due to the similar electrical conductivity of the composite sample the baseline of the meter log electrical conductivity can be considered reliable.

GSH

5. CLOSURE

After the test was terminated the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

Reviewed by:

Alan D. Spilker, P.E.
President/Senior Geotechnical Engineer

RAG/ADS:lb

Addressee (email)

July 8, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-012 SH-02 59.0-60.5 Leachate Test
Sevier Lake Project
Millard County, Utah

1. Introduction

On Friday, January 8, 2016, GSH Geotechnical, Inc. (GSH) began the leachate column testing on Shelby tube SH-02 from well SN4-15-012 at a depth of 59.0 to 60.5 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, a HANNA HI98195 multi-parameter water quality meter was used to record the parameters on a 10-minute interval. The meter was calibrated before the start of the test.

The test was started with a constant head pressure of 5 psi. On January 12, 2016, the head pressure was increased to 10 psi for the duration of the test. The test was terminated after 24 days due to the lack of discharge water from the core.

The table on the following page presents the timeline for the test:

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190
www.gshgeo.com

GSH Geotechnical, Inc.
1596 West 2650 South, Suite 107
Ogden, Utah 84401
Tel: 801.393.2012

Date	Time	Notes
8-Jan-16	15:00	Begin test at 5 psi
12-Jan-16	14:00	Raise head to 10 psi
1-Feb-16	13:20	Terminate test; no breakthrough

3. Hydraulic Conductivity Data

The table below presents the hypothetical hydraulic conductivity for the test assuming 1 ml of discharge water. This hydraulic conductivity is to be considered the highest given the parameters of the test, but in actuality may be much lower.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)
Sample 01	1	19.97	12.04	38.735	2.80369E-10

4. Meter Logging Data

Due to the lack of discharge water from the core, no meter logging data is available for this test.

5. CLOSURE

After the tests were terminated, the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

RAG:jlh

Addressee (email)

April 11, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-WW1B SH-01 13.0-15.0 Leachate Test - Complete
Sevier Lake Project
Millard County, Utah

1. INTRODUCTION

On Monday, February 1, 2016 GSH Geotechnical began the leachate column testing on shelby tube SH-01 from well SN4-15-WW1B at a depth of 13.0 to 15.0 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted at the ends of the tube in order to hydraulically seal and connect the sample to the leaching apparatus. For the duration of the test, an INW AquiStar CT2X multi-parameter water quality meter was used to record the parameters at a 10 minute interval. The meter was calibrated by INW prior to arrival at the GSH laboratory. Additionally, a HANNA HI 98195 multi-parameter water quality meter was used to take 1-time readings of the composite samples.

A constant head pressure of 2 psi of well water that was provided from the project site was applied for the duration of the first test run. Breakthrough occurred at 21:40 hours on February 1, 2016. The following morning at 09:00 GSH began collecting the first leachate (effluent)

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190
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1596 West 2650 South, Suite 107
Ogden, Utah 84401
Tel: 801.393.2012

sample. At 08:00 on February 3, 2016 890 ml of discharge water had been collected with a composite electrical conductivity (EC) of 193.7 mS/cm. On February 4, 2016 GSH began collecting a second composite sample leachate (effluent) of 450 ml between 08:00 and 16:15. The measured EC for this second composite sample was 78.79 mS/cm. On February 8, 2016 at 10:30 GSH began collecting the third and final composite sample of the first test run. 500 ml of leachate water was collected on February 9, 2016 at 07:45 with a composite EC of 25.55 mS/cm. A total volume of 5,440 ml was discharge during the first test.

The composite sample bottles from the first test run were delivered to ALS Environmental Laboratories for analysis on February 12th of 2016.

On March 2, 2016 at 12:30 the second test run was started with a constant head pressure of 2 psi. Breakthrough was observed at 15:30 and GSH began collecting the fourth composite sample. At 20:45 the same day, 510 ml was collected with a composite EC of 25.30 mS/cm. Five days later on March 7, 2016 GSH began collecting the fifth composite sample. Composite Sample 05 (610 ml) was collected at 16:15 the same day with an EC of 2,842 uS/cm. The second test run was terminated on March 8, 2016 at 08:00, 7,780 ml was discharged. Between the first and second samples of the second test run (Samples 04 and 05), 2 hydraulic conductivity samples were collected, data for these samples are presented in the corresponding section of this report.

The composite sample bottles from the second test run were delivered to ALS Environmental Laboratories for analysis on March 4th and 21st of 2016.

The table below presents the timeline for the tests:

Date	Time	Notes
1-Feb-16	16:15	Begin test at 2 psi
2-Feb-16	9:00	Begin collecting sample 01; ~214.6 mS/cm
3-Feb-16	8:00	Collect sample 01; 890 ml, 193.7 mS/cm
4-Feb-16	8:00	Begin collecting sample 02
	16:15	Collect sample 02; 450 ml, 78.79 mS/cm
8-Feb-16	10:30	Begin collecting sample 03; ~29 mS/cm
9-Feb-16	7:45	Collect sample 03; 500 ml, 25.55 mS/cm
	8:00	Terminate test; 5440 ml total
2-Mar-16	12:30	Restart test at 2 psi
	15:30	Observe breakthrough, begin collecting sample 04
	20:45	Collect sample 04; 510 ml, 25.30 mS/cm
3-Mar-16	7:30	Begin collecting HC-01
	13:00	Collect HC-01; 570 ml, 7760 uS/cm
	13:30	Begin collecting HC-02
4-Mar-16	8:30	Collect HC-02; 765 ml, 6153 uS/cm
7-Mar-16	9:30	Begin collecting sample 05

	16:15	Collect sample 05; 610 ml, 2842 uS/cm
8-Mar-16	8:00	Terminate test; 7780 ml total

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the samples and for the overall test.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	890	0.96	12.04	34.29	2.30382E-05	193.7
Sample 02	450	0.34			3.24746E-05	78.79
Sample 03	500	0.89			1.40086E-05	25.55
Part 1 Overall	5440	7.65			1.76261E-05	NA
Sample 04	510	0.22			5.78358E-05	25.30
HC-01	570	0.23			6.16929E-05	7.76
HC-02	765	0.79			2.39704E-05*	6.15
Sample 05	610	0.28			5.38037E-05	2.84
Part 2 Overall	7780	5.81			3.32041E-05	NA
Total	13220	13.47			2.43489E-05	NA

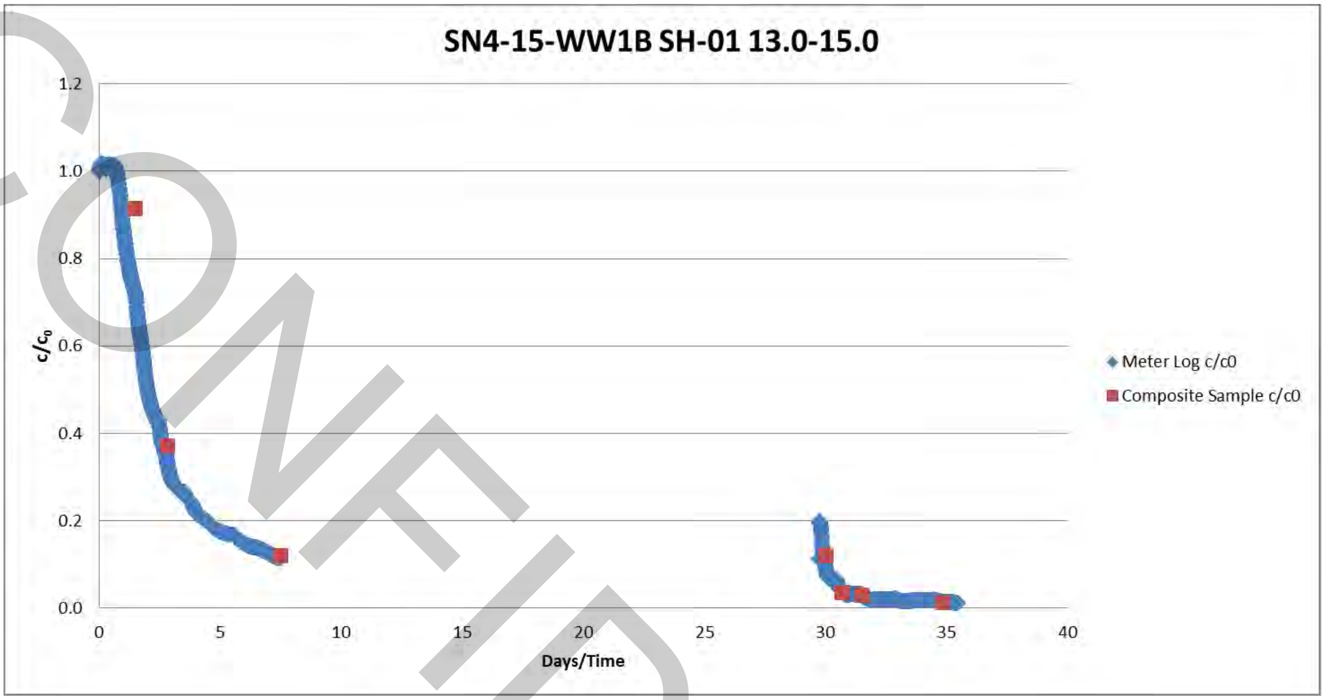
* constant head pressure not properly maintained at 2 psi

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings and readings recorded after the test was terminated. Remarks relevant to the test are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, Electrical Conductivity, Pressure, Salinity, and Total Dissolved Solids. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



Due to the relatively high hydraulic conductivity of the tested soil, maintaining a perfect constant head using the pressure apparatus was challenging. The relatively low air volume (which is pressurized to the desired head) to water volume within the pressure chamber of the apparatus causes the pressure to drop relatively quickly for a soil of relatively high hydraulic conductivity. Although an effort was made to keep the pressure steady at 2 psi, the small spikes in the curve can be attributed to refilling the chamber to operating pressure and briefly (about 5 minutes) refilling the chamber with well water.

5. CLOSURE

After the tests were terminated the ends of the shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.	Reviewed by:
Robert A. Gifford Staff Engineer/Geologist	Alan D. Spilker, P.E. President/Senior Geotechnical Engineer State of Utah No. 334228

RAG/ADS:cai

Addressee (email)

April 11, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-WW2C SH-01 13.0-15.0 Leachate Test - Complete
Sevier Lake Project
Millard County, Utah

1. Introduction

On Friday, January 8, 2016 GSH Geotechnical began the leachate column testing on shelby tube SH-01 from well SN4-15-WW2C at a depth of 13.0 to 15.0 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, an INW AquiStar CT2X multi-parameter water quality meter was used to record the parameters at a 10 minute interval. The meter was calibrated by INW prior to arrival at the GSH laboratory. Additionally, a HANNA HI 98195 multi-parameter water quality meter was used to take 1-time readings of the composite samples.

A constant head pressure of 5 psi of well water that was provided from the project site was applied for the first hour of the first test run. Breakthrough was observed after the first hour and the pressure was decreased to 2 psi. At 15:35 on January 8, 2016 GSH began collecting the first composite sample of discharge water. At 21:50 the same day, enough water (645 ml) had been discharged and the first sample was collected with a composite electrical conductivity (EC) of 195.2 mS/cm.

When the EC had dropped below 100 mS/cm on January 12, 2016, GSH began collecting the second composite sample at 16:38. The following day at 7:15, 500 ml had been collected with a composite EC of 87.75 mS/cm. On January 18, 2016 at 15:06 GSH began collecting the third sample. 595 ml of composite sample was collected on January 20, 2016 with an EC of 35.64 mS/cm. Collection of the fourth and final composite sample was started on February 1, 2016 at 12:30 and 475 ml was collected on February 2, 2016 at 14:45 with an EC of 6.7 mS/cm. The first test run was terminated shortly after the fourth sample was collected at 15:00 a total of 12,460 of water had been discharged. After the boots were removed from the shelby tube, it was observed that the surface of the material had recessed approximately 1 cm into the tube. This is likely due to the collapse of the matrix within the marl-type soil.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on January 15th, 29th and February 12th of 2016.

On February 23, 2016 at 09:00 GSH began the second test run with a constant head of 2 psi. Breakthrough occurred at 10:30 and collection of the fifth composite sample began at 11:00. At 18:45 the same day, Sample 05 was collected with a total volume of 485 ml and an EC of 9,936 uS/cm. GSH began collecting the sixth composite sample at 09:30 of March 1, 2016. Sample 06 (590 ml) was collected at 16:30 the same day, with a composite EC of 2,150 uS/cm. The following day, at 11:00, the second test run was terminated. A total of 7,580 ml of water had been discharged during the second test run. Additionally, between the first and second samples of the second test run (Samples 05 and 06), a hydraulic conductivity sample was collected. Data for the hydraulic conductivity sample is presented in the corresponding section of this report.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on March 4th of 2016.

The table below presents the timeline for the test:

Date	Time	Notes
8-Jan-16	14:00	Set up core
	14:18	Begin test at 5 psi
	15:15	Visual breakthrough; decrease to 2 psi, EC >200mS/cm (191.4 mS/cm A)
	15:35	Begin sample collection 01
	21:50	Collect sample 01; 645 ml, 195.2 mS/cm
12-Jan-16	16:38	Begin collecting 02
13-Jan-16	7:15	Collect sample 02; 500 ml, 87.75 mS/cm
18-Jan-16	15:06	Begin collecting 03; ~38 mS/cm
20-Jan-16	8:40	Collect sample 03; 595, 35.64 mS/cm
1-Feb-16	12:30	Begin collecting 04; ~7 mS/cm

2-Feb-16	14:45	Collect sample 04; 475 ml, 6.7 mS/cm
	15:00	Terminate test; 12460 ml total, soil column recessed .5" into tube
23-Feb-16	9:00	Restart test at 2 psi
	11:00	Begin collecting 05
	18:15	Collect sample 05; 485 ml, 9936 uS/cm
25-Feb-16	14:45	Begin collecting HC-01
	17:45	Collect HC-01; 210 ml, 3232 uS/cm
1-Mar-16	9:30	Begin collecting sample 06
	16:30	Collect sample 06; 590 ml, 2150 uS/cm
2-Mar-16	11:00	Terminate test; 7580 ml total, soil column recessed .5" into tube

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the samples and for the overall test.

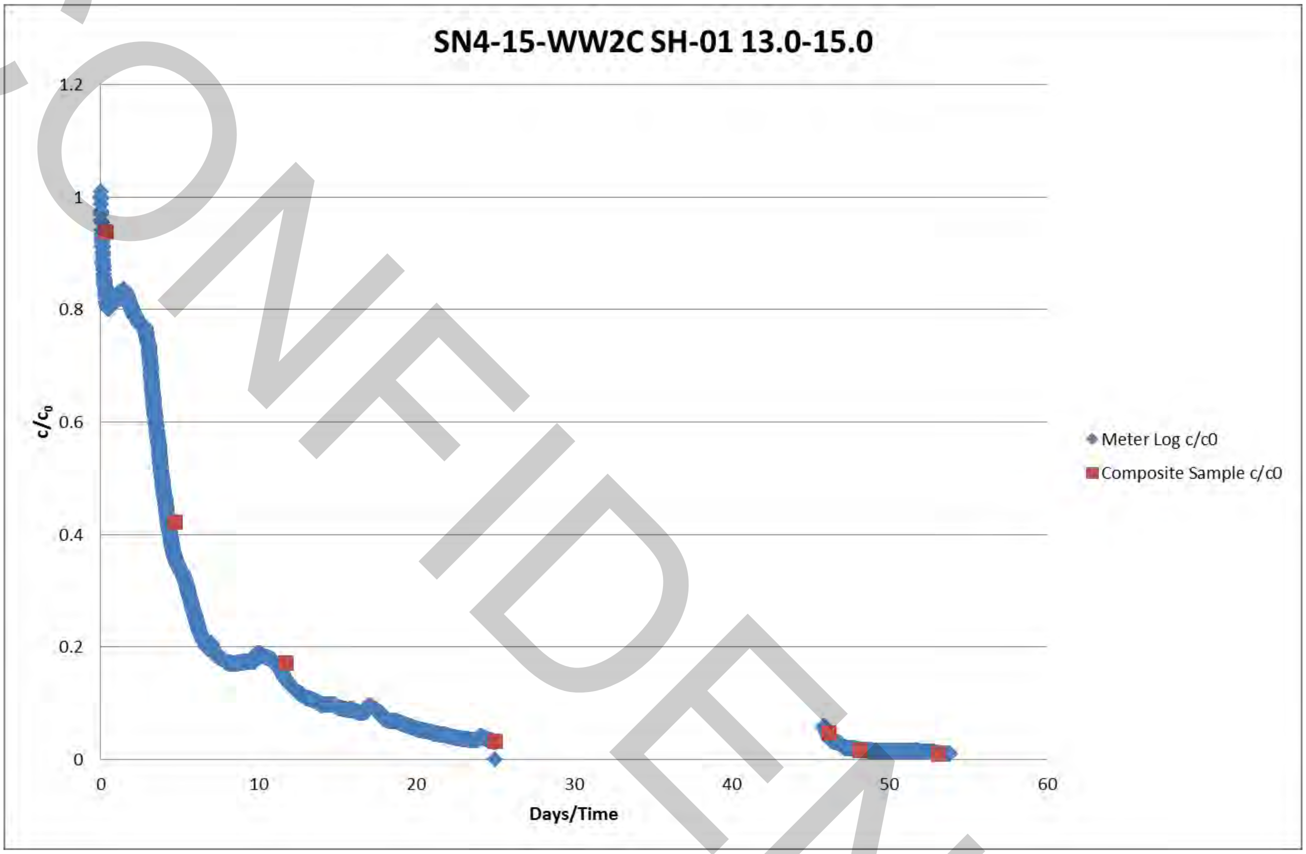
	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	645	0.26	12.04	52.71	9.44292E-05	195.2
Sample 02	500	0.61			3.12996E-05	87.75
Sample 03	595	1.73			1.30978E-05	35.64
Sample 04	475	1.09			1.65574E-05	6.7
Part 1 Overall	12460	25.0			1.90094E-05	NA
Sample 05	485	0.30			6.12112E-05	9.94
HC-01	210	0.13			6.40509E-05	3.23
Sample 06	590	0.29			7.71216E-05	2.15
Part 2 Overall	7580	8.08			3.57517E-05	NA
Total	20040	33.07			2.31013E-05	NA

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings and readings recorded after the test was terminated. Remarks relevant to the test are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, Electrical Conductivity, Pressure, Salinity, and Total Dissolved Solids. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



Due to the relatively high hydraulic conductivity of the tested soil, maintaining a perfect constant head using the pressure apparatus was challenging. The relatively low air volume (which is pressurized to the desired head) to water volume within the chamber of the apparatus causes the pressure to drop relatively quickly with a soil of high hydraulic conductivity. Although an effort was made to keep the pressure steady at 2 psi, the small spikes in the curve can be attributed to refilling the chamber to operating pressure and briefly (about 5 minutes) refilling the chamber with well water.

5. CLOSURE

After the tests were terminated the ends of the shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.	Reviewed by:
Robert A. Gifford	Alan D. Spilker, P.E.
Staff Engineer/Geologist	President/Senior Geotechnical Engineer

RAG/ADS:cai

Addressee (email)

July 8, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-WW3A SH-01 22.0-24.0 Leachate Test
Sevier Lake Project
Millard County, Utah

1. Introduction

On Wednesday, February 3, 2016, GSH Geotechnical, Inc. (GSH) began the leachate column testing on Shelby tube SH-01 from well SN4-15-WW3A at a depth of 22.0 to 24.0 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, a HANNA HI98195 multi-parameter water quality meter was used to record the parameters on a 10-minute interval. The meter was calibrated before the start of the test.

The test was started with a constant head pressure of 2 psi. On February 5, 2016, the head pressure was increased to 5 psi and again on February 8, 2016 to 10 psi, where it remained for the duration of the test. The test was terminated after 19 days due to the lack of discharge water from the core.

The table on the following page presents the timeline for the test:

Date	Time	Notes
3-Feb-16	8:45	Begin test @ 2 psi
5-Feb-16	8:30	Raise head to 5 psi
8-Feb-16	10:00	Raise head to 10 psi
22-Feb-16	15:15	Terminate test, no discharge

3. Hydraulic Conductivity Data

The table below presents the hypothetical hydraulic conductivity for the test assuming 1 ml of discharge water. This hydraulic conductivity is to be considered the highest given the parameters of the test, but in actuality may be much lower.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)
Sample 01	1	14.22	12.04	48.90	4.97066E-10

4. Meter Logging Data

Due to the lack of discharge water from the core, no meter logging data is available for this test.

5. CLOSURE

After the tests were terminated, the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

RAG:jlh

Addressee (email)

July 1, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-WW4A SH-01 19.0-20.5 Leachate Test - Complete
Sevier Lake Project
Millard County, Utah

1. Introduction

On Tuesday, February 9, 2016 GSH Geotechnical began the leachate column testing on Shelby tube SH-01 from well SN4-15-WW4A at a depth of 19.0 to 20.5 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and to provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the first part of the test, an INW AquiStar CT2X multi-parameter water quality meter was used to record the parameters at a 10 minute interval. For the second part of the test a HANNA HI98195 multi-parameter water quality meter was used to record the parameters on a 10 minutes interval. The meter was calibrated by INW prior to arrival at the GSH laboratory. The Hanna meter was calibrated by GSH prior to the start of the second part of the test. Additionally, the HANNA HI 98195 multi-parameter water quality meter was used to take 1-time readings of the composite samples.

A constant head pressure of 5 psi of well water that was provided from the project site was applied for the first hour of the first test run. Breakthrough was observed 1 day after the test began and at 13:30 on February 10, 2016 GSH began collecting the first composite sample of discharge water. At 08:00 on February 12, 2016 enough water (570 ml) had been discharged and the first sample was collected with a composite electrical conductivity (EC) of 176.7 mS/cm.

On February 26, 2016, GSH began collecting the second composite sample at 10:45. Five days later on March 2, 2016, 460 ml had been collected with a composite EC of 83.2 mS/cm. On March 21, 2016 at 11:00 GSH began collecting the third sample and 835 ml of composite sample was collected on March 30, 2016 with an EC of 6,116 uS/cm. The first test run was terminated shortly after the third sample was collected. At 09:30 a total of 7,340 ml of water had been discharged. Throughout the duration of the first test, 4 hydraulic conductivity samples were collected.

The composite sample bottles from the first test run were delivered to ALS Environmental Laboratories (ALS) for analysis on February 12th, March 4th, and April 5th of 2016.

On May 4, 2016 at 11:30 GSH began the second test run with a constant head of 5 psi. Breakthrough was observed 2 days later and collection of the 4th sample was initiated. On May 11, 2016, 5 days after collection of the 4th sample had begun, GSH terminated collection due to the slow leaching rate at 5 psi. GSH increased the head pressure to 10 psi and restarted collection of the fourth composite sample. At 17:30 on May 13, 2016, Sample 04 was collected with a total volume of 975 ml and an EC of 2,727 uS/cm. GSH began collecting the fifth composite sample at 12:00 on May 17, 2016. Sample 07 (865 ml) was collected at 16:15 the next day, with a composite EC of 2,066 uS/cm. Shortly after collection of Sample 05, the second test run was terminated. A total of 4,140 ml of water had been discharged during the second test run.

The composite sample bottles from the second test run were delivered to ALS for analysis on May 12th and 19th of 2016.

Data for the hydraulic conductivity sample is presented in the corresponding section of this report.

The table below presents the timeline for the test:

Date	Time	Notes
9-Feb-16	10:00	Begin Test
10-Feb-16	8:00	Increase head to 5 psi
	13:30	Begin collecting sample 01
12-Feb-16	8:00	Collect sample 01; 570 ml, 176.7 mS/cm
16-Feb-16	10:15	Begin collecting HC-01; ~154.6 mS/cm
19-Feb-16	7:30	Collect HC-01; 460 ml, 143.6 mS/cm
22-Feb-16	16:00	Begin collecting HC-02; ~115.3 mS/cm

Date	Time	Notes
24-Feb-16	16:00	Collect HC-02; 205 ml, 109.9 mS/cm
26-Feb-16	10:45	Begin collecting sample 02; 96.6 mS/cm
2-Mar-16	15:30	Collect sample 02; 460 ml, 83.2 mS/cm
7-Mar-16	9:30	Begin collecting HC-03
14-Mar-16	10:45	Collect HC-03; 585 ml, 37.16 mS/cm
	11:45	Begin collecting HC-04
21-Mar-16	11:00	Collect HC-04; 635 ml, 15.70 mS/cm
	11:00	Begin collecting sample 03
30-Mar-16	8:30	Collect sample 03; 835 ml, 6116 Us/cm
	9:30	Terminate test; 6170 ml
4-May-16	11:30	Restart test at 5 psi
6-May-16	9:00	Begin collecting sample 04
11-May-16	11:00	Terminate 04, Restart 04, Increase to 10 psi
13-May-16	17:30	Collect sample 04; 975 ml, 2727 uS/cm
17-May-16	12:00	Begin collecting sample 05; 2235 uS/cm
18-May-16	16:15	Collect sample 05; 865 ml, 2066 uS/sm
		Terminate test; 2.3l + samples

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the samples and for the overall test.

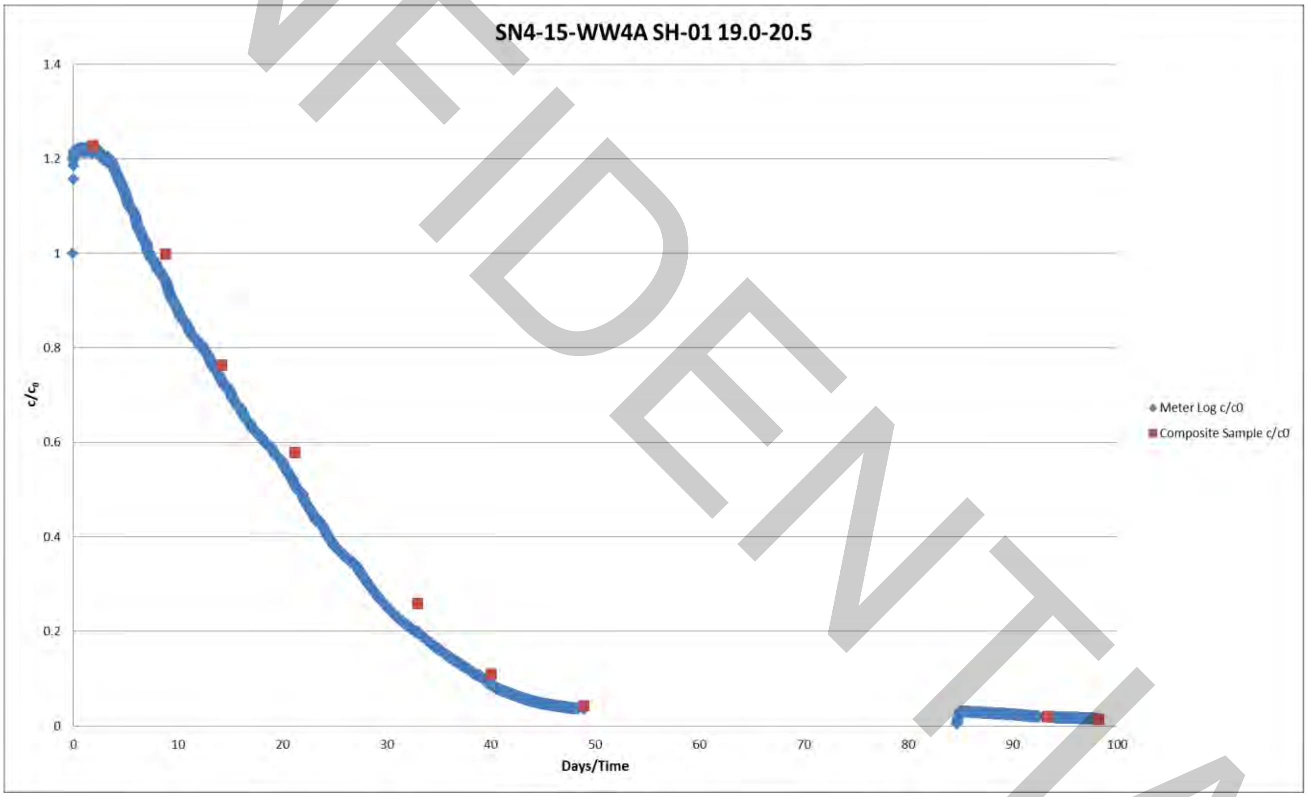
	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	570	1.77			4.43572E-06	176.7
HC-01	460	2.89			2.1966E-06	143.6
HC-02	205	2.00			1.41248E-06	109.9
Sample 02	460	5.13			1.23617E-06	83.2
HC-03	585	5.05			1.59567E-06	37.16
HC-04	635	6.97			1.25568E-06	15.7
Sample 03	835	8.94	12.04	47.63	1.28745E-06	6.12
Part 1 Overall	7340	49.98			2.02379E-06	
Sample 04	975	2.27			5.91677E-06	2.7
Sample 05	865	1.18			1.01266E-05	2.1
Part 2 Overall	4140	7.22			7.90304E-06	
Overall	11480	57.20			2.76579E-06	176.7

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings and readings recorded after the test was terminated. Remarks relevant to the test are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, Electrical Conductivity, Pressure, Salinity, and Total Dissolved Solids. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



5. CLOSURE

After the tests were terminated the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Engineer/Geologist

RAG:lb

Addressee (email)

July 8, 2016
Job No. 1996-001-15

Mr. Tom Suchoski
Norwest Corporation
American Plaza II
57 West 200 South, Suite 500
Salt Lake City, Utah 84101

Mr. Suchoski:

Re: Report
SN4-15-WW6A SH-01 11.0-12.5 Leachate Test - Complete
Sevier Lake Project
Millard County, Utah

1. Introduction

On Friday, January 8, 2016, GSH Geotechnical, Inc. (GSH) began the leachate column testing on Shelby tube SH-01 from well SN4-15-WW6A at a depth of 11.0 to 12.5 feet. The purpose of this test was to obtain the relationship of the flux of fresh water fluid through the core and the change in water quality over time, as well as the hydraulic parameters of the column of soil in order to correlate the data with laboratory testing and provide accurate information to estimate the performance of the in-situ soil in the field.

2. Column Testing

The Shelby tube was trimmed and cut in a manner which minimized disturbance to the core. A rubber boot was fitted on the top and bottom of the tube in order to connect it to the leaching apparatus. For the duration of the test, an INW AquiStar CT2X multi-parameter water quality meter was used to record the parameters at a 10-minute interval. The meter was calibrated by INW prior to arrival at the GSH laboratory. Additionally, a HANNA HI 98195 multi-parameter water quality meter was used to take 1-time readings of the composite samples.

A constant head pressure of 5 psi of well water that was provided from the project site was applied for the first 50 minutes of the test at which breakthrough was observed. Shortly after breakthrough, the head pressure was reduced to 2 psi. GSH began collecting the first composite effluent leachate sample at 16:15 on January 8, 2016. On January 11, 2016, 530 ml of discharge water was collected with a composite electrical conductivity (EC) of 154.7 mS/cm. On

January 15, 2016, GSH began collecting hydraulic conductivity sample HC-01 at 11:35. HC-01 was collected on January 20, 2016 at 16:40 with a discharge volume of 255 ml. Flow was relatively slow and GSH increased the head pressure 10 psi after HC-01 was collected. GSH began collecting the second composite sample after the pressure was increased at 16:40. At 21:00, 605 ml of effluent leachate water with a composite EC of 106.5 mS/cm was collected. GSH began collecting the third and final leachate composite sample at 12:30 on February 1, 2016. On February 2, 2016, at 08:15, 680 ml of effluent leachate water with a composite EC of 26.5 mS/cm was collected. The test was terminated 50 minutes later.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on January 11, January 20, and February 2, 2016. Hydraulic conductivity samples were not sent in for laboratory analysis and were emptied into the discharge bucket after the volume and time of the sample was recorded.

On March 9, 2016 at 09:30, GSH began the second test run with a constant head of 5 psi. Breakthrough occurred at approximately 11:00 and GSH began collecting the fourth composite sample. At 16:30 the same day, Sample 04 was collected with a total volume of 510 ml and with a composite EC of 16.31 mS/cm. GSH began collecting the fifth composite sample at 08:30 on March 22, 2016. Sample 05 (380 ml) was collected at 17:30 the same day, with a composite EC of 6,812 uS/cm. The following day, at 09:00, the second test run was terminated. A total of 13,530 ml of water had been discharged during the second test run. Additionally, between the first and second samples of the second test run (Samples 05 and 06), 5 hydraulic conductivity samples were collected. Data for the hydraulic conductivity sample is presented in the corresponding section of this report.

The composite sample bottles were delivered to ALS Environmental Laboratories for analysis on March 21 and April 5, 2016. Hydraulic conductivity samples were not sent in for laboratory analysis and were emptied into the discharge bucket after the volume and time of the sample was recorded.

The table below presents the timeline for the test:

Date	Time	Notes
8-Jan-16	14:30	Begin test at 5 psi
	15:20	Visual breakthrough; decrease to 2 psi
	16:15	Begin collecting sample 01; 91.63 mS/cm
11-Jan-16	14:50	Collect sample 01; 530 ml, 154.7 mS/cm
15-Jan-16	11:35	Begin collecting HC-01; ~144-145 mS/cm
20-Jan-16	16:40	Collect HC-01; 255 ml
	16:40	Increase to 10 psi, Begin collecting sample 02
	21:00	Collect sample 02; 605 ml, 106.5 mS/cm
1-Feb-16	12:30	Begin collecting sample 03; ~28mS/cm
2-Feb-16	8:15	Collect sample 03; 680 ml, 26.5 mS/cm

Date	Time	Notes
	9:05	Terminate test, soil column had pushed down approx. 1" in tube
8-Jan-16	14:30	Begin test at 5 psi
	15:20	Visual breakthrough; decrease to 2 psi
	16:15	Begin sample collection; 91.63 mS/cm (80.54 mS/cm A)
11-Jan-16	14:50	Collect sample 01; 154.7 mS/cm (139.5 mS/cm A), 530 ml
15-Jan-16	11:35	Begin sample collection 02 ~144-145 mS/cm
20-Jan-16	16:40	Increase to 10 psi, abort previous collection (255 ml), restart
20-Jan-16	21:00	Collect sample 02; 106.5 mS/cm (92.10 mS/cm A), 605 ml
1-Feb-16	12:30	Begin sample collection 03; ~28mS/cm
2-Feb-16	8:15	Collect sample 03; 26.5 mS/cm, 680 ml
	9:05	Terminate test, soil had pushed down approx. 1"
9-Mar-19	9:30	Restart test at 5 psi
	11:00	Begin collecting sample 04
	16:30	Collect sample 04; 510 ml, 16.31 mS/cm
10-Mar-16	9:30	Begin collecting HC-01
	17:15	Collect HC-01; 655 ml, 10.53 mS/cm
11-Mar-16	8:45	Begin collecting HC-02
	16:00	Collect HC-02; 435 ml, 11.11 mS/cm
14-Mar-16	11:15	Begin collecting HC-03
15-Mar-16	16:45	Collect HC-03; 1080 ml, 10.32 mS/cm
16-Mar-16	17:00	Begin collecting HC-04
17-Mar-16	15:30	Collect HC-04; 630 ml, 9498 uS/cm
21-Mar-16	11:15	Begin collecting HC-05
22-Mar-16	8:30	Collect HC-05; 910 ml, 6829 uS/cm
	8:30	Begin collecting sample 05
	17:30	Collect sample 05; 380 ml, 6812 uS/cm
23-Mar-16	9:00	Terminate test; soil pushed down approx. 2", 12.75 l in bucket

3. Hydraulic Conductivity Data

The table below presents the hydraulic conductivity for the samples and for the overall test.

	Quantity Measured (ml)	Duration (days)	Cross-Sectional Area (cm^2)	Length of Core (cm)	Head Pressure (cm)	Hydraulic Conductivity (cm/sec)	Composite Electrical Conductivity (mS/cm)
Sample 01	530	2.94	12.04	48.58	140.61	6.33263E-06	154.7
HC-01	255	5.21			140.61	1.72044E-06	NA
Sample 02	605	0.18			703.07	2.35491E-05	106.5
Sample 03	680	0.82			703.07	5.8074E-06	26.5
Part 1 Overall	14570	23.69			703.07	4.32284E-06	NA
Sample 04	510	0.29			351.54	2.45777E-05	16.31
HC-01	655	0.32			351.54	2.85123E-05	10.53
HC-02	435	0.30			351.54	2.02394E-05	11.11
HC-03	1080	1.23			351.54	1.23498E-05	10.32
HC-04	630	0.94			351.54	9.44557E-06	9.50
HC-05	910	0.89			351.54	1.44461E-05	6.83
Sample 05	380	0.38			351.54	1.42433E-05	6.81
Part 2 Overall	13530	13.98			351.54	1.36043E-05	NA
Total*	28100	37.67			NA	NA	NA

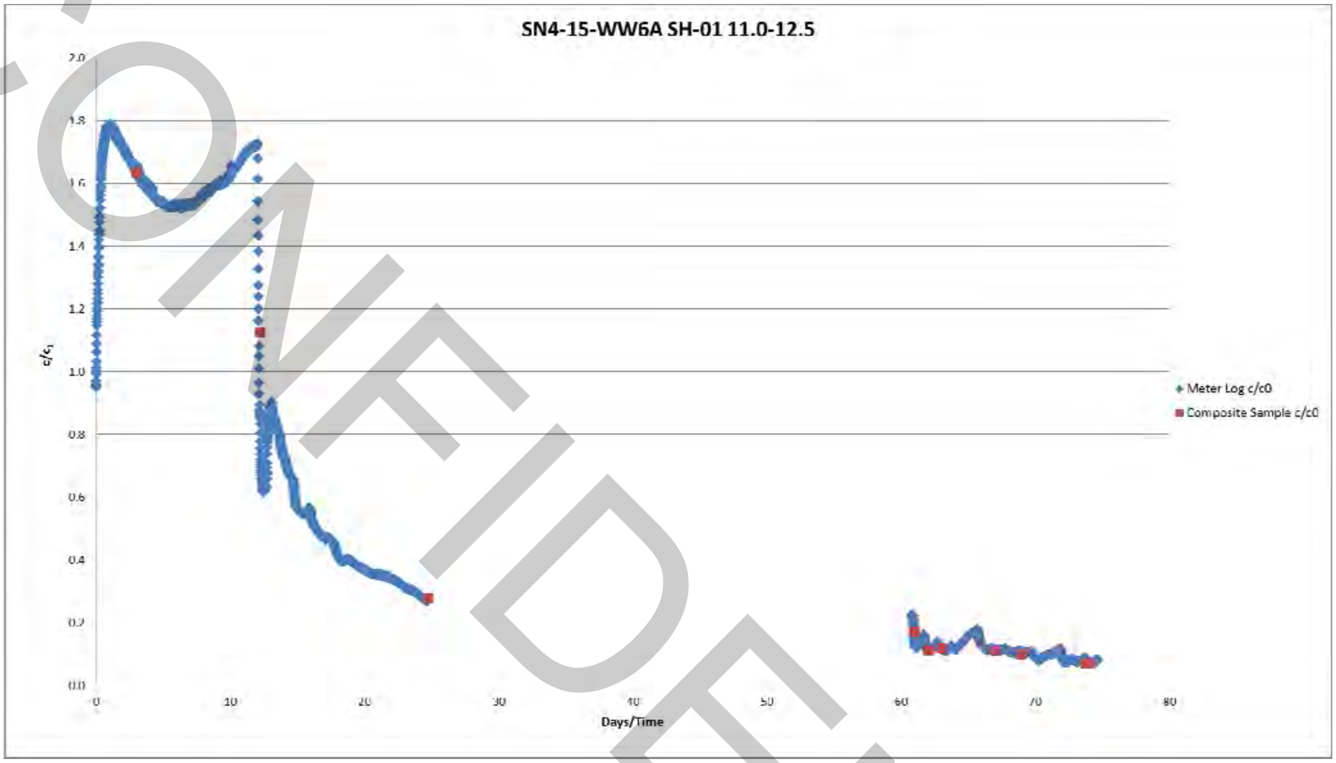
* A total hydraulic conductivity could not be completed for the test due to different head pressures for the first and second test runs

4. Meter Logging Data

Data obtained from the meter logging is included as Attachment 1 in the form of a Microsoft Excel file. The spreadsheet is edited to remove erroneous readings and readings recorded after the test was terminated. Remarks relevant to the test are highlighted in yellow and are included to reflect sample collection times, volumes, and other pertinent information.

The meter was set to record Date, Time, Temperature, Electrical Conductivity, Pressure, Salinity, and Total Dissolved Solids. The recording interval was set for 10 minutes.

The chart below plots the days/time of the readings vs. the ratio of initial EC (c0) at breakthrough and metered/composite EC (c):



The abrupt change of electrical conductivity at approximately day 12 of the test is likely due to the increase in head pressure and quicker flow water through the core.

Due to the relatively high hydraulic conductivity of the tested soil, maintaining a perfect constant head using the pressure apparatus was challenging. The relatively low air volume (which is pressurized to the desired head) to water volume within the chamber of the apparatus causes the pressure to drop relatively quickly with a soil of high hydraulic conductivity. Although an effort was made to keep the pressure steady at 10 and 5 psi throughout the first and second test runs, respectively, the small spikes in the curve can be attributed to refilling the chamber to operating pressure and briefly (about 5 minutes) refilling the chamber with well water.

5. CLOSURE

After the tests were terminated, the ends of the Shelby tube were capped and sealed. The tube was placed into storage at the GSH laboratory in the event that future testing is desired.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Geotechnical Engineer/Geologist

Reviewed by:

Lindsey Bradshaw

Lindsey Bradshaw
Environmental Technician

RAG/LB:jlh

Addressee (email)

Attachment 9 - Sevier Playa Groundwater Flow Estimates

SEVIER PLAYA GROUNDWATER FLOW ESTIMATES

Zone/Condition	Hydraulic Gradient		Hydraulic Conductivity		Groundwater Flux		Potential Volumetric Groundwater Flux						Average Linear Groundwater Velocity				15,000-yr Flow Distance (mi)	
	Fraction	Reference	(ft/day)	Reference	(ft/day)	(ft/yr)	Width (mi)	Reference	Thickness (ft)	Reference	(ft^3/yr)	(acre-ft/yr)	Porosity	Reference	(ft/day)	(ft/yr)	Individual	Mean
Playa, high K: north end	2.5E-04	1	6.0E-03	8	1.5E-06	5.4E-04	14	14	58	17	2,304	0.1	0.32	10	4.6E-06	1.7E-03	0.005	0.008
Playa, high K: south end	5.7E-04	2	6.0E-03	8	3.4E-06	1.3E-03	15	15	58	17	5,774	0.1	0.32	10	1.1E-05	3.9E-03	0.011	
Playa, marl clay, north end	2.5E-04	1	3.6E+00	9	8.9E-04	3.2E-01	14	14	21	18	503,267	12	0.46	21	1.9E-03	7.0E-01	2	3
Playa, marl clay, south end	5.7E-04	2	3.6E+00	9	2.1E-03	7.6E-01	15	15	21	18	1,261,361	29	0.46	21	4.5E-03	1.6E+00	5	
Playa, low K: north end	2.5E-04	1	6.6E-04	10	1.6E-07	5.9E-05	14	14	58	17	253	0.01	0.32	10	5.1E-07	1.8E-04	0.0005	0.0009
Playa, low K: south end	5.7E-04	2	6.6E-04	10	3.8E-07	1.4E-04	15	15	58	17	635	0.01	0.32	10	1.2E-06	4.3E-04	0.0012	
Alluvium/colluvium east of playa	8.7E-03	3	8.5E+00	11	7.4E-02	2.7E+01	29	16	91	19	377,409,004	8,664	0.18	22	4.1E-01	1.5E+02	427	332
Alluvium/colluvium west of playa	4.8E-03	4	8.5E+00	11	4.1E-02	1.5E+01	29	16	91	19	209,039,619	4,799	0.18	22	2.3E-01	8.3E+01	237	
Bedrock, regional K: east-west gradient, north enc	2.0E-03	5	2.0E+00	12	4.0E-03	1.5E+00	14	14	5400	20	588,629,798	13,513	0.12	12	3.4E-02	1.2E+01	35	41
Bedrock, regional K: east-west gradient, south end	3.4E-03	6	2.0E+00	12	6.8E-03	2.5E+00	15	15	5400	20	1,056,719,712	24,259	0.12	12	5.6E-02	2.1E+01	58	
Bedrock, regional K: southeast-northwest gradient	1.8E-03	7	2.0E+00	12	3.6E-03	1.3E+00	29	16	5400	20	1,076,226,914	24,707	0.12	12	3.0E-02	1.1E+01	31	
Bedrock, site K: east-west gradient, north end	2.0E-03	5	7.0E+00	13	1.4E-02	5.2E+00	14	14	5400	20	2,060,204,292	47,296	0.12	12	1.2E-01	4.3E+01	122	145
Bedrock, site K: east-west gradient, south enc	3.4E-03	6	7.0E+00	13	2.4E-02	8.6E+00	15	15	5400	20	3,698,518,992	84,906	0.12	12	2.0E-01	7.2E+01	205	
Bedrock, site K: southeast-northwest gradient	1.8E-03	7	7.0E+00	13	1.2E-02	4.6E+00	29	16	5400	20	3,766,794,198	86,474	0.12	12	1.0E-01	3.8E+01	107.9	

References:
1. Average of hydraulic gradients, SN3-12-045 to SN3-12-049 (4.3E-04) and LL3 to LL5 (1.7E-04)
2. Average hydraulic gradient between SN3-12-270 and the PVC Shoal Well.
3. Average hydraulic gradient between the Bonneville Well and the Provo Well
4. Average hydraulic gradient between the Miller Canyon Reservoir Well and the Glitter Gulch Well.
5. Average hydraulic gradient between the North Cricket Well and the Nighthawk Well
6. Average hydraulic gradient between the Monument Point Well and the Black Hills Well.
7. Average hydraulic gradient between the Monument Point Well and the Nighthawk Well.
8. Average of values reported by Czarnecki (1997) for hard, compacted playa surface.
9. Average from single-well pumping tests in the marl clay (URZ) playa unit, from Table 26 of Whetstone (2017).
10. Value from Table 1 of Bedinger et al. (1989) for fine-grained basin fill in the Great Basin.
11. Average from pumping tests in unconsolidated deposits, from Table 25 of Whetstone (2017)
12. Value from Table 1 of Bedinger et al. (1989) for fractured carbonate rocks in the Great Basin
13. Average from pumping tests in bedrock, from Table 25 of Whetstone (2017)
14. East shoreline distance from well S13 to the north end of the BLM lease, scaled from Figure 2 of Whetstone (2017)
15. East shoreline distance from well S13 to the south end of the BLM lease, scaled from Figure 2 of Whetstone (2017)
16. Shoreline distance from the north to the south ends of the BLM lease, scaled from Figure 2 of Whetstone (2017)
17. Thickness of siliceous clay below the marl clay (from 33 to 91 ft bgs), based on CPM drilling.
18. Thickness of marl clay (from 12 to 33 ft bgs), based on CPM drilling.
19. Thickness of playa sediments above the hard, dry clay layer, based on CPM drilling.
20. Maximum depth of carbonate aquifer (10,000 ft) modeled by Prudic et al. (1995) minus thickness of basin fill (4,600 ft) as identified by Case and Cook (1979)
21. Average water-related porosity of playa samples collected by Norwest during the 2014-2016 exploration season.
22. Value from Table 1 of Bedinger et al. (1989) for coarse-grained basin fill in the Great Basin.

Attachment 9 - Sevier Playa Groundwater Flow Estimates

Sevier Playa Groundwater Flow Estimates Cont.

SEVIER PLAYA AREA HYDRAULIC GRADIENTS

Potentiometric Surface Data - Playa Groundwater System

Date	Fresh Water Elev. (ft)		Distance	Gradient
	SN3-12-045	SN3-12-049	(ft)	(ft/ft)
5/23/2012	4,530.42	4,525.45	11,604.7	4.3E-04
5/14/2013	4,530.60	4,527.62	11,604.7	2.6E-04
7/28/2015	4,529.48	4,526.36	11,604.7	2.7E-04
			Mean	3.2E-04

Date	Fresh Water Elev. (ft)		Distance	Gradient
	LL3	LL5	(ft)	(ft/ft)
5/14/2013	4,524.82	4,522.21	17,857.2	1.5E-04
7/28/2015	4,524.41	4,520.85	17,857.2	2.0E-04
			Mean	1.7E-04

Mean = 2.5E-04

Date	Fresh Water Elev. (ft)		Distance	Gradient
	SN3-12-270	PVC Shoal	(ft)	(ft/ft)
9/19/2012	4,526.96	4,519.18	12,416.3	6.3E-04
5/14/2013	4,525.35	4,519.77	12,416.3	4.5E-04
7/28/2015	4,527.62	4,519.60	12,416.3	6.5E-04
			Mean	5.7E-04

Potentiometric Surface Data - Alluvial/Colluvial Groundwater System

Date	Fresh Water Elev. (ft)		Distance	Gradient
	Bonneville	Provo	(ft)	(ft/ft)
9/15/2014	4,591.50	4,525.20	7,548.5	8.8E-03
7/28/2015	4,591.31	4,525.81	7,548.5	8.7E-03
			Mean	8.7E-03

Date	Fresh Water Elev. (ft)		Distance	Gradient
	Miller Cyn	Glitter Glch	(ft)	(ft/ft)
5/23/2013	4,430.63	4,408.59	4,473.1	4.9E-03
9/16/2014	4,430.39	4,408.86	4,473.1	4.8E-03
7/27/2015	4,430.37	4,409.05	4,473.1	4.8E-03
			Mean	4.8E-03

Potentiometric Surface Data - Regional Bedrock Groundwater System

Date	Fresh Water Elev. (ft)		Distance	Gradient
	No. Cricket	Nighthawk	(ft)	(ft/ft)
9/15/2014	4,583.93	4,427.41	77,492.9	2.0E-03
7/27/2015	4,583.95	4,427.39	77,492.9	2.0E-03
			Mean	2.0E-03

Date	Fresh Water Elev. (ft)		Distance	Gradient
	Monument Pt	Black Hills	(ft)	(ft/ft)
9/17/2012	4,594.15	4,431.07	48,180.6	3.4E-03
2/5/2013	4,594.01	4,430.90	48,180.6	3.4E-03
5/22/2013	4,594.13	4,430.97	48,180.6	3.4E-03
9/15/2014	4,593.93	4,430.77	48,180.6	3.4E-03
7/28/2015	4,593.66	4,430.79	48,180.6	3.4E-03
			Mean	3.4E-03

Date	Fresh Water Elev. (ft)		Distance	Gradient
	Monument Pt	Nighthawk	(ft)	(ft/ft)
9/17/2012	4,594.15	4,427.67	93,359.8	1.8E-03
2/5/2013	4,594.01	4,427.48	93,359.8	1.8E-03
5/22/2013	4,594.13	4,427.62	93,359.8	1.8E-03
9/15/2014	4,593.93	4,427.41	93,359.8	1.8E-03
7/28/2015	4,593.66	4,427.39	93,359.8	1.8E-03
			Mean	1.8E-03

Water level data from Tables 22 and 23 of Whetstone (2017

Distance Between Wells

Well	Groundwater System	Northing (m)	Easting (m)	Distance (m)	Distance (ft)
SN3-12-045	Playa	4,322,931.238	315,350.249		
SN3-12-049	Playa	4,323,013.839	311,814.088	3,537.126	11,604.7
LL3	Playa	4,326,558.033	322,398.411		
LL5	Playa	4,326,975.573	316,971.585	5,442.865	17,857.2
SN3-12-270	Playa	4,301,096.459	310373.736		
PVC Shoal	Playa	4,300,949.310	306,592.104	3,784.494	12,416.3
Bonneville	Alluvial/Colluvial	4,299,779.095	317,620.115		
Provo	Alluvial/Colluvial	4,299,963.801	315,326.771	2,300.770	7,548.5
Miller Cyn Res	Alluvial/Colluvial	4,322,349.859	306,412.000		
Glitter Gulch	Alluvial/Colluvial	4,322,831.124	307,775.286	1,363.415	4,473.1
North Cricket	Regional Bedrock	4,318,516.348	327,907.318		
Nighthawk	Regional Bedrock	4,322,356.885	304,601.819	23,619.822	77,492.9
Monument Pt	Regional Bedrock	4,297,920.869	319,183.604		
Black Hills	Regional Bedrock	4,300,942.405	304,812.365	14,685.441	48,180.6
Monument Pt	Regional Bedrock	4,297,920.869	319,183.604		
Nighthawk	Regional Bedrock	4,322,356.885	304,601.819	28,456.060	93,359.8

Coordinates from Tables 20 and 21 of Whetstone (2017

APPENDIX E

Anticipated Construction Schedule

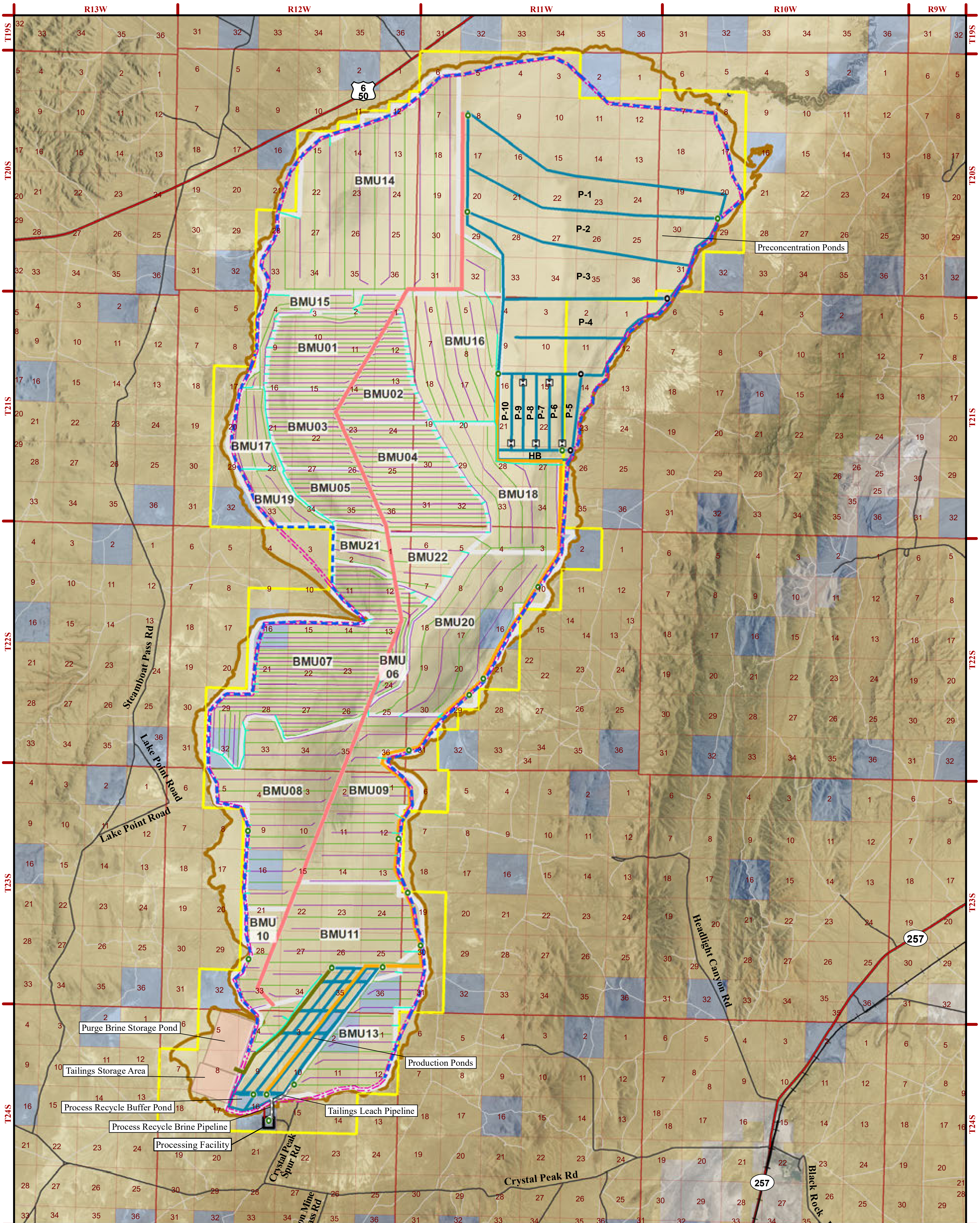
Sevier Playa Project Construction and Production Schedule for Permitting Purposes, Rev. 8

Permitting Schedule	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32	Year 33	Year 34	Year 35
Off-Lease Features																																			
Long Ridge Communication Tower construction																																			
Black Rock Communication Tower construction																																			
Power to Processing Facility - 69-kV Power and Communication Lines construction																																			
Power to Rail Loadout - 12.47-kV Power and Communication Line construction of the portion that will supply power to the 12.47-kV Power Line Spurs																																			
Power to water supply wells - 12.47-kV Power Line Spurs construction																																			
Power to Rail Loadout - 12.47-kV Power and Communication Line construction to the Rail Loadout																																			
Power to preconcentration ponds - 25-kV Power Line Construction																																			
Rail Spur and Rail Loadout Facility construction																																			
Natural Gas Pipeline construction																																			
Water supply wells, pipelines, and spurs construction																																			
Access road construction																																			
Perimeter Road construction																																			
Preconcentration pond construction																																			
Brine transfer canal																																			
Recharge canal																																			
Recharge collectors																																			
On-Lease Features																																			
Ponds and Processing Facility																																			
Perimeter Road construction																																			
Preconcentration pond construction																																			
Production pond construction																																			
Power to production ponds, recharge canal, and brine transfer canal - 12.47-kV Power Line construction																																			
Processing Facility construction																																			
Processing Facility startup																																			
First feed to plant																																			
Purge Brine Storage Pond	Lift 1			Lift 2					Lift 3										Lift 4																
Tailings Storage Area			Lift 1		Lift 2			Lift 3		Lift 4																									
Extraction Canal, Brine Transfer Canal, Recharge Canal, and Sevier River Berm and Diversion																																			
Extraction canal																																			
Brine transfer canal																																			
Recharge canal																																			
Sevier River berm, diversion, and drop structure																																			
BMUs																																			
BMU1, BMU2, BMU4																																			
BMU5																																			
BMU9																																			
BMU3																																			
BMU15																																			
BMU21, BMU19, BMU17																																			
BMU22																																			
BMU20																																			
BMU14																																			
BMU18																																			
BMU16																																			
BMU13																																			
BMU7																																			
BMU11																																			
BMU6																																			
BMU8																																			
BMU10																																			
Extraction Wells																																			
169 wells																																			
392 wells																																			
404 wells																																			
184 wells																																			
1026 wells																																			
191 wells																																			

Construction	
Operation and maintenance/drilling	
Production	

APPENDIX F

30% Design Cross-sections for Preconcentration, Production, and Waste Storage Ponds



Proposed Project Features

- Recharge Trench
- Recharge Collector
- Extraction Trench
- Recharge Canal
- Extraction Canal
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Process Recycle Brine Pipeline and Tailings Leach Pipeline
- Preconcentration and Production Ponds
- Preconcentration Pond Weir
- Pump Station - On Lease
- Pump Station - Off Lease
- Sevier River Diversion
- Brine Mining Unit Boundary
- Perimeter Road
- Haul Roads

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

N 0 1 2 4 Miles

1 in = 2 miles

Sources:
Project features, Crystal Peak Minerals, 2015, 2016, 2017;
Public land survey system, BLM 2013;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagy, USDA/APFO 2016

Notes:
• The utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.
• Some features have been graphically offset to improve map legibility.

NO.	DATE	REVISION	BY	APVD
0	8/31/2018	Initial Submission		

DSGN | DR | CHK | APVD

FIGURE 1

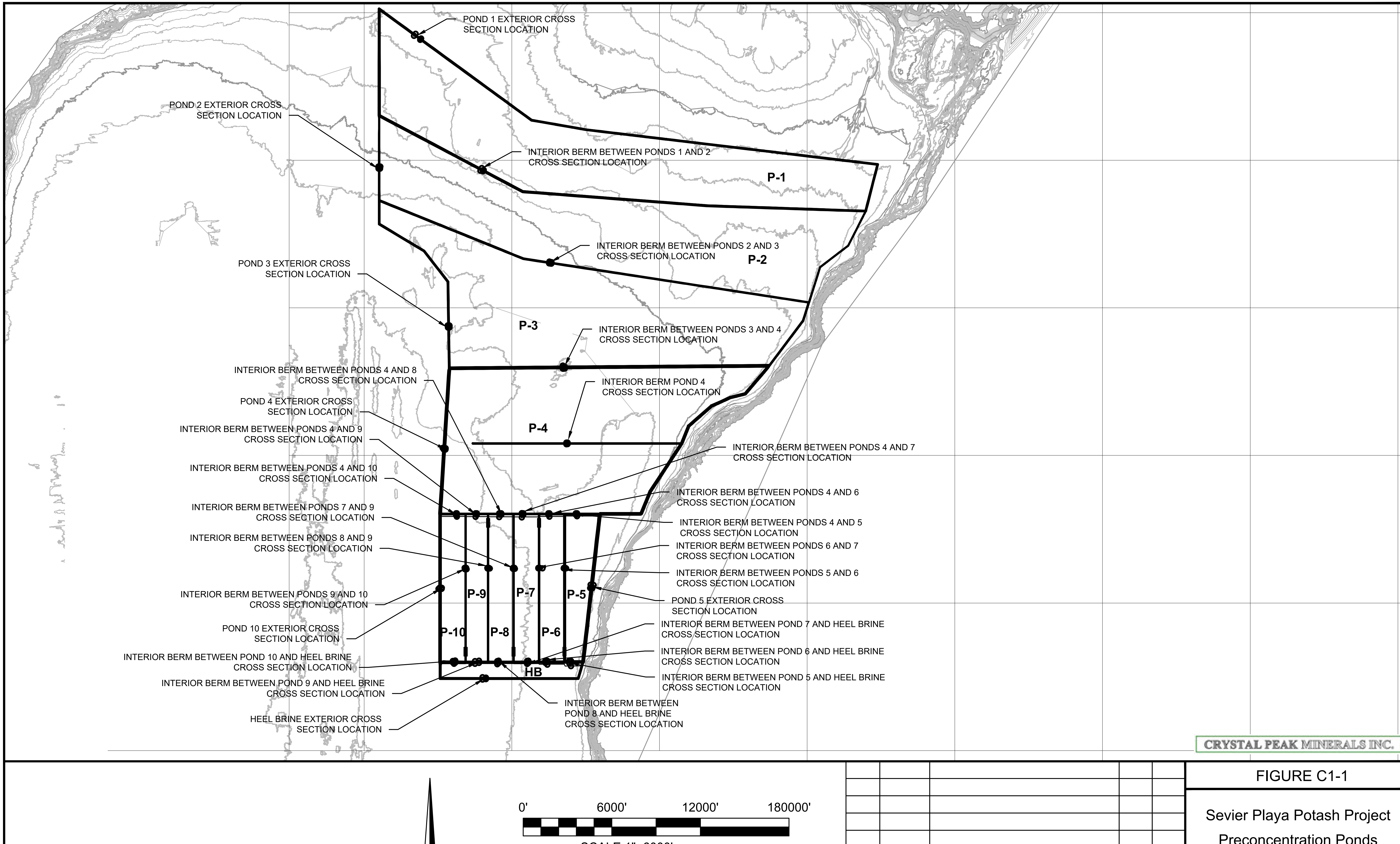
Sevier Playa Potash Project
Mine Plan Trench Layout

DAM SAFETY

DATE: 8/31/2018 SCALE: 1:150,000

CRYSTAL PEAK MINERALS INC.

MP_Fig 6-2 - Trench Layout With Section Lines 180831 8/31/2018 11:05:43 AM



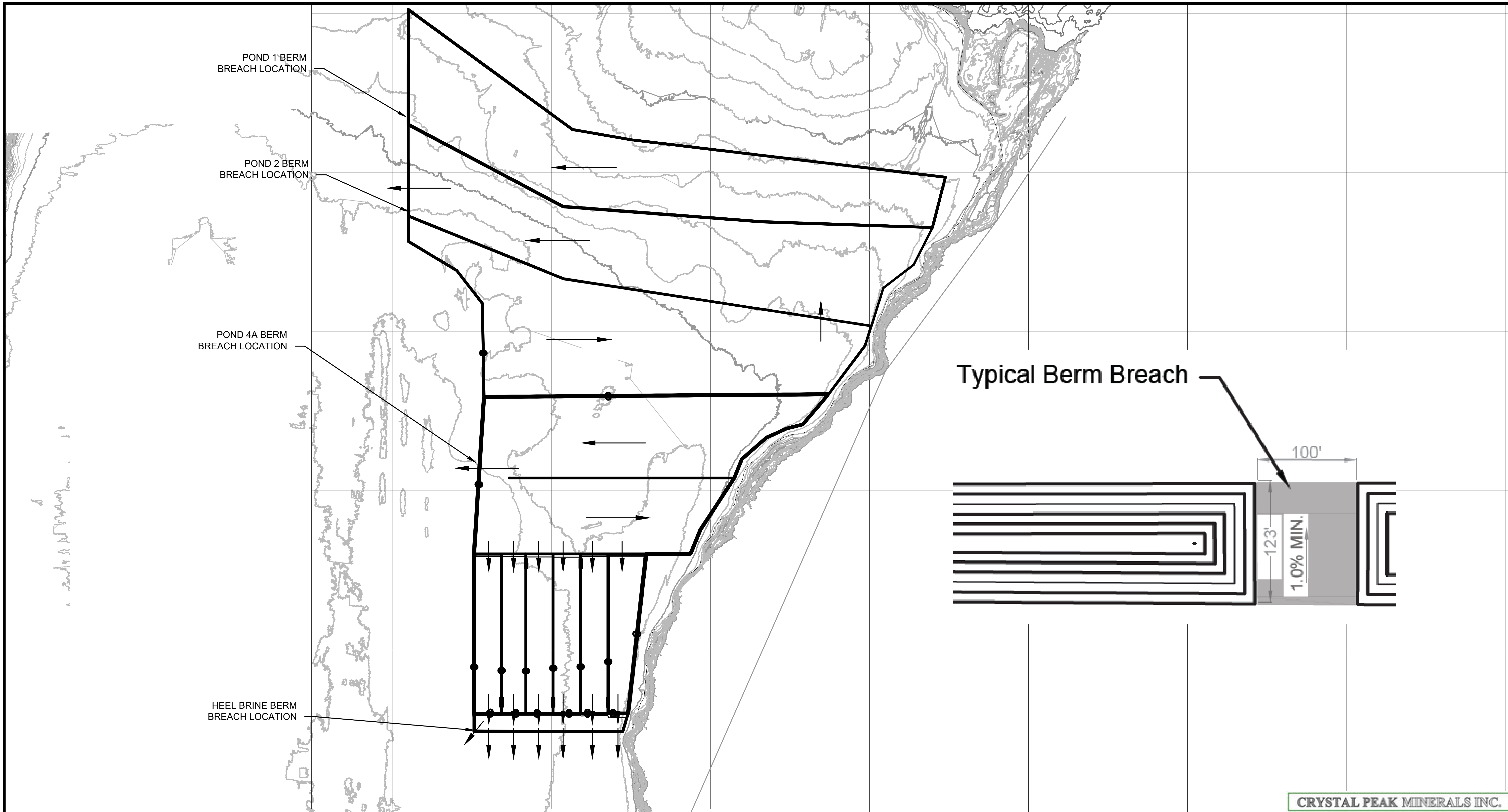
NO.	DATE	REVISION	BY	APVD
0	08-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

FIGURE C1-1

Sevier Playa Potash Project
Preconcentration Ponds
Plan View

DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=6000'
NORWEST now Stantec



CRYSTAL PEAK MINERALS INC.

N

0' 6000' 12000' 180000'

SCALE:1"=6000'

NO.	DATE	REVISION	BY	APVD
0	08-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

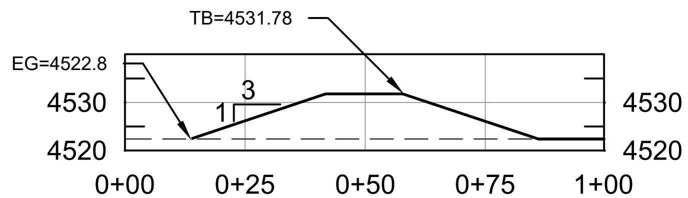
FIGURE C1-2

Sevier Playa Potash Project
Preconcentration Ponds
Plan View

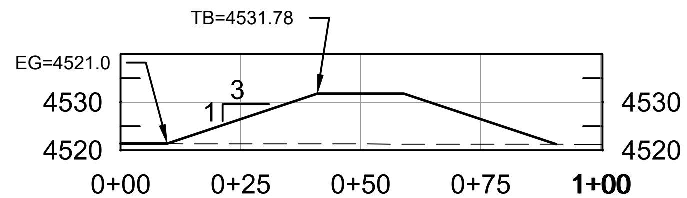
DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg

SCALE: 1"=6000'

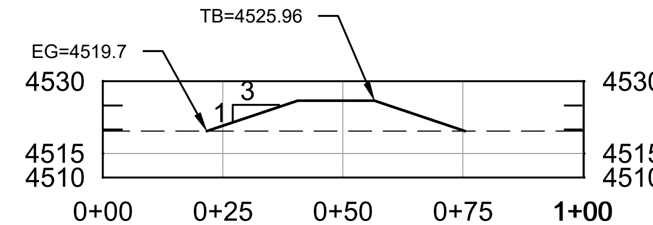
NORWEST now Stantec



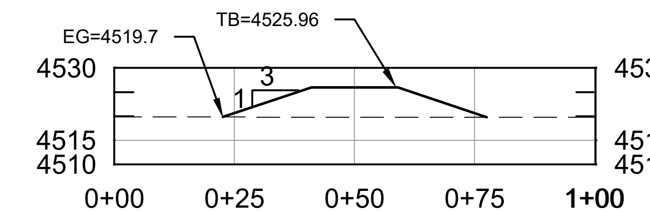
PRE-CONCENTRATION
POND 1 EXTERIOR BERM



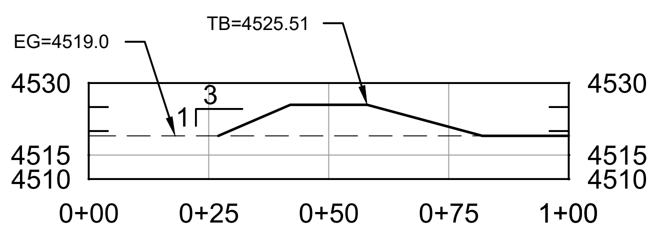
PRE-CONCENTRATION
POND 1 INTERIOR BERM



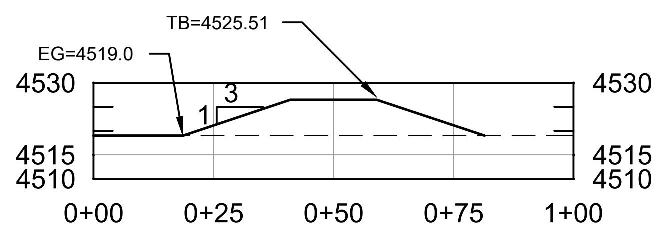
PRE-CONCENTRATION
POND 2 EXTERIOR BERM



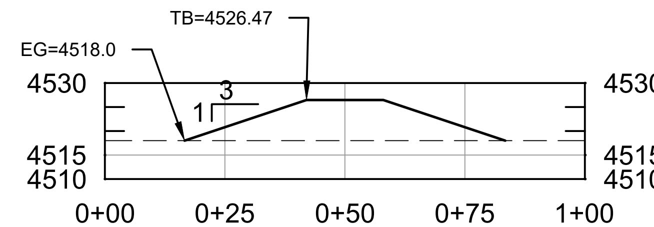
PRE-CONCENTRATION
POND 2 INTERIOR BERM



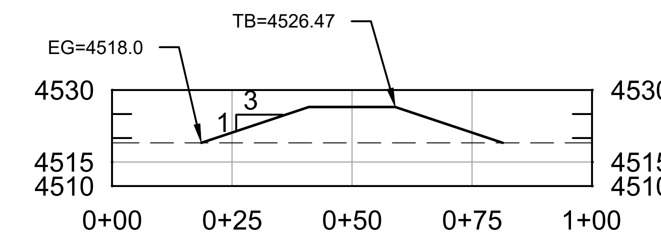
PRE-CONCENTRATION
POND 3 EXTERIOR BERM



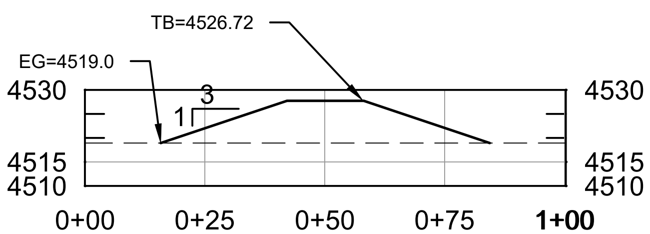
PRE-CONCENTRATION
POND 3 INTERIOR BERM



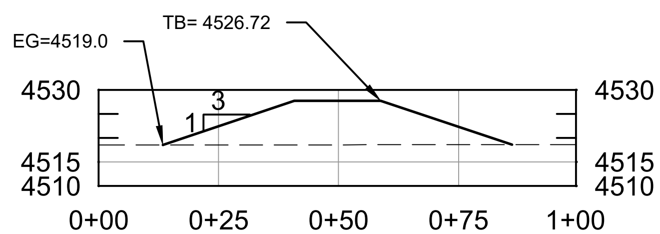
PRE-CONCENTRATION
POND 4 EXTERIOR BERM



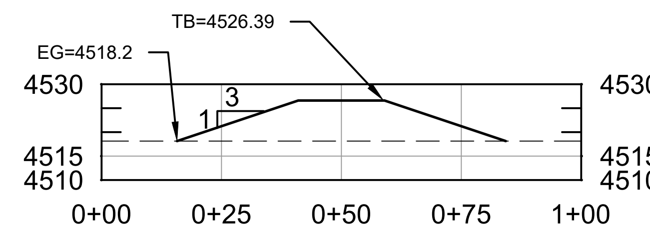
PRE-CONCENTRATION
POND 4 INTERIOR BERM



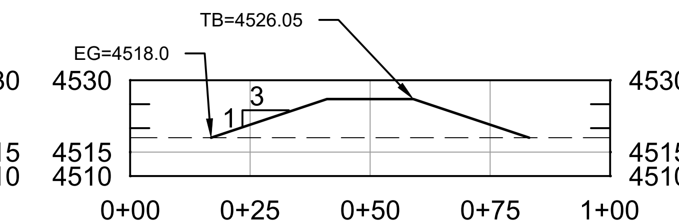
PRE-CONCENTRATION
POND 5 EXTERIOR BERM



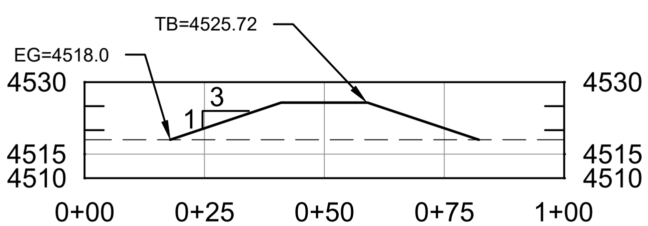
PRE-CONCENTRATION
POND 5 INTERIOR BERM



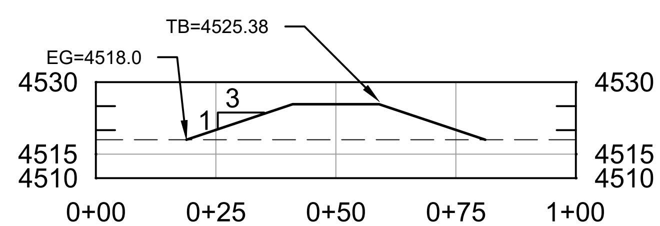
PRE-CONCENTRATION
POND 6 INTERIOR BERM



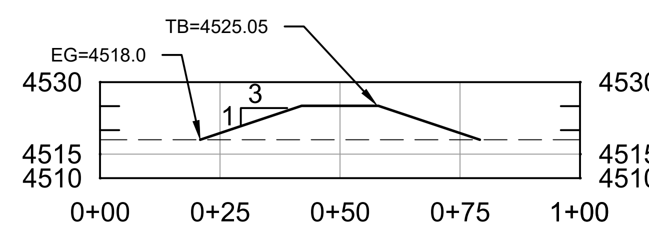
PRE-CONCENTRATION
POND 7 INTERIOR BERM



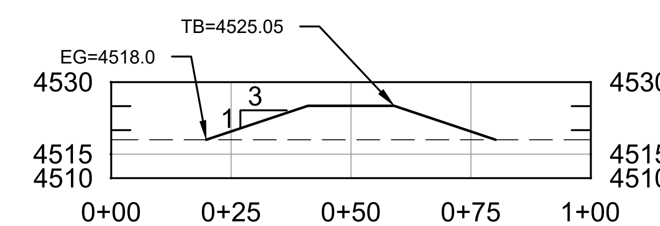
PRE-CONCENTRATION
POND 8 INTERIOR BERM



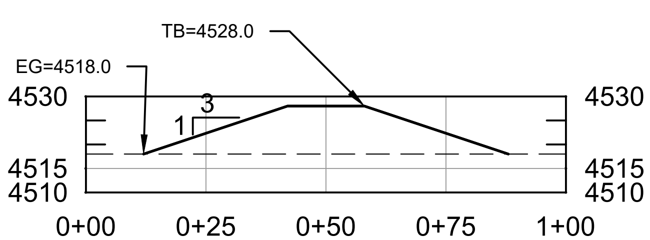
PRE-CONCENTRATION
POND 9 INTERIOR BERM



PRE-CONCENTRATION
POND 10 EXTERIOR BERM



PRE-CONCENTRATION
POND 10 INTERIOR BERM



HEEL BRINE POND
EXTERIOR BERM

CRYSTAL PEAK MINERALS INC.

LEGEND

EXISTING GROUND

5 YEAR SURFACE

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'

NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

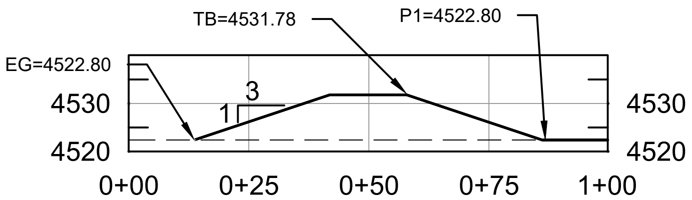
FIGURE C1-3

Sevier Playa Potash Project
Pre-Concentration Ponds
Year-5 Cross Sections

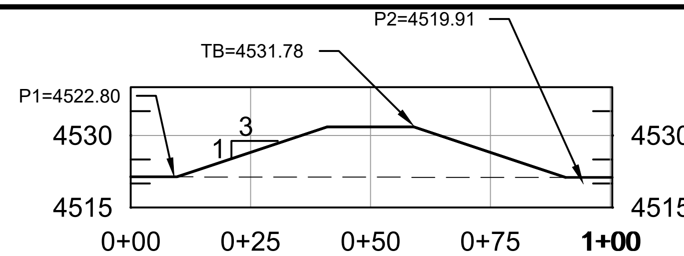
DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg

SCALE: 1"=40'

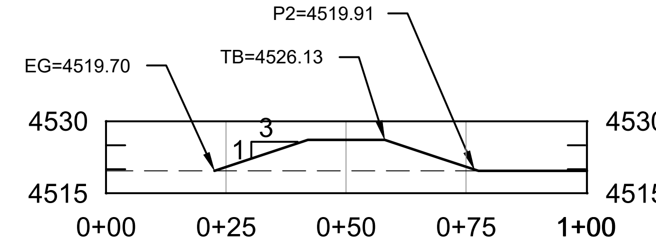
NORWEST CORPORATION



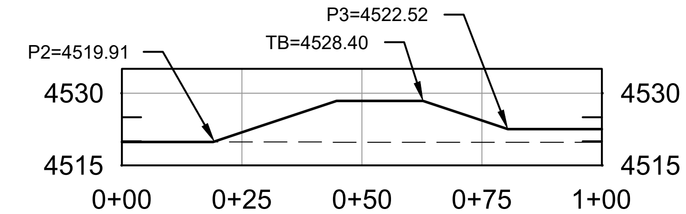
POND 1 EXTERIOR BERM



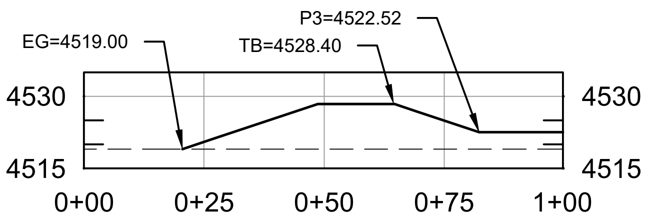
POND 1-POND 2
INTERIOR BERM



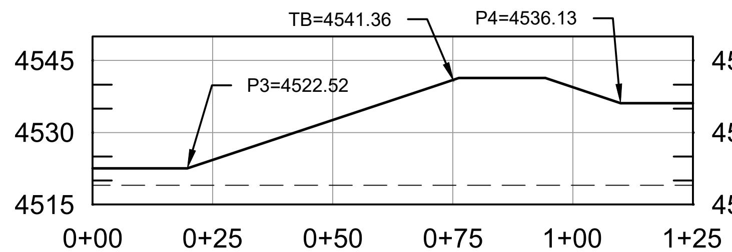
POND 2 EXTERIOR BERM



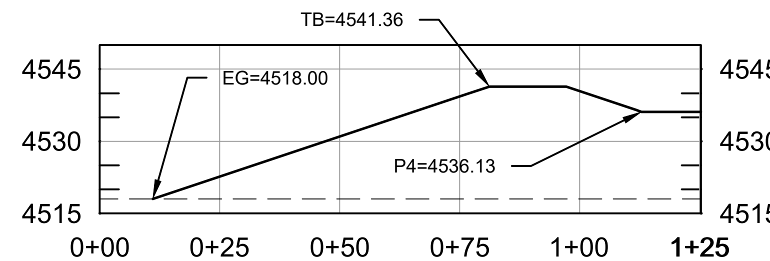
POND 2-POND 3
INTERIOR BERM



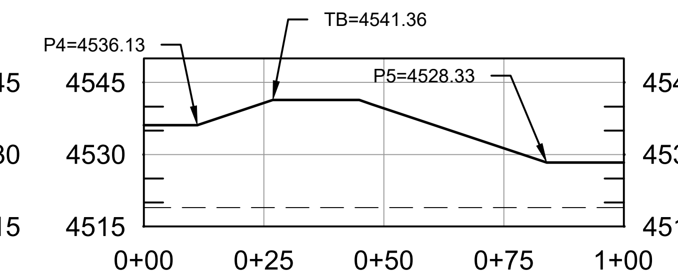
POND 3 EXTERIOR BERM



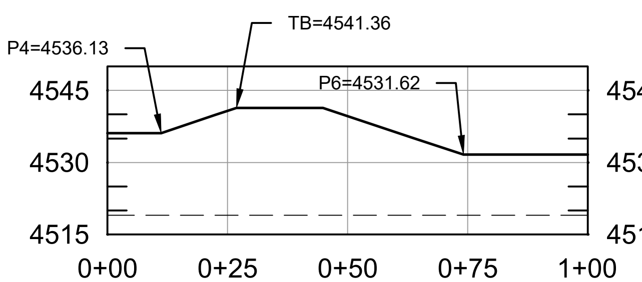
POND 3-POND 4
INTERIOR BERM



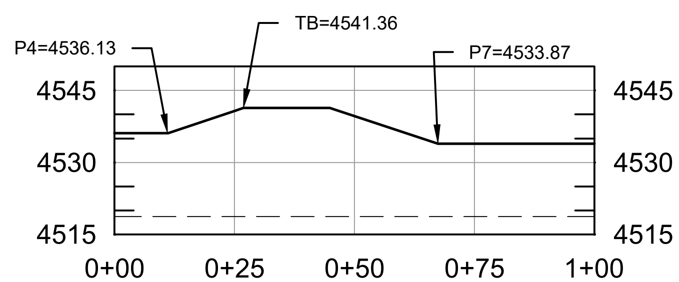
POND 4 EXTERIOR BERM



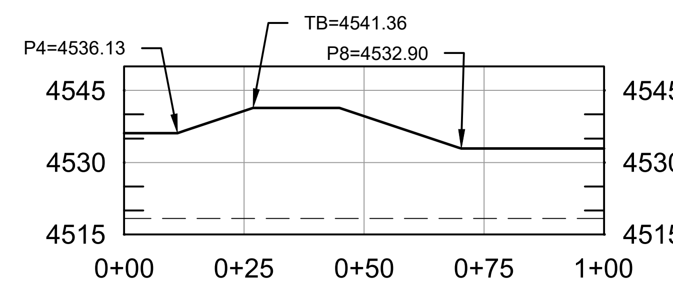
POND 4-POND 5
INTERIOR BERM



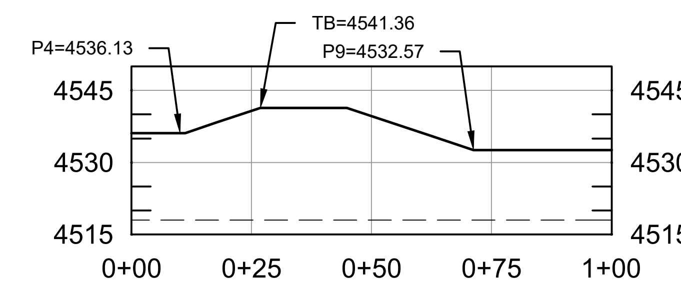
POND 4-POND 6
INTERIOR BERM



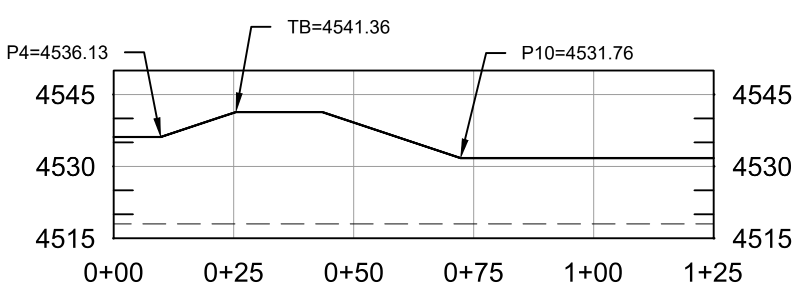
POND 4-POND 7
INTERIOR BERM



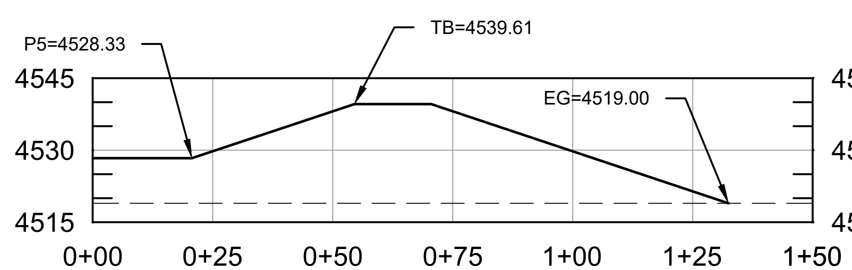
POND 4-POND 8
INTERIOR BERM



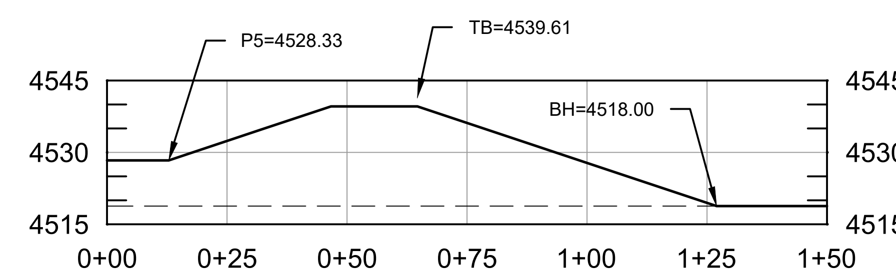
POND 4-POND 9
INTERIOR BERM



POND 4-POND 10
INTERIOR BERM



POND 5 EXTERIOR BERM



POND 5-BRINE HEEL
INTERIOR BERM

CRYSTAL PEAK MINERALS INC.

LEGEND

EXISTING GROUND

30 YEAR SURFACE

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'

NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

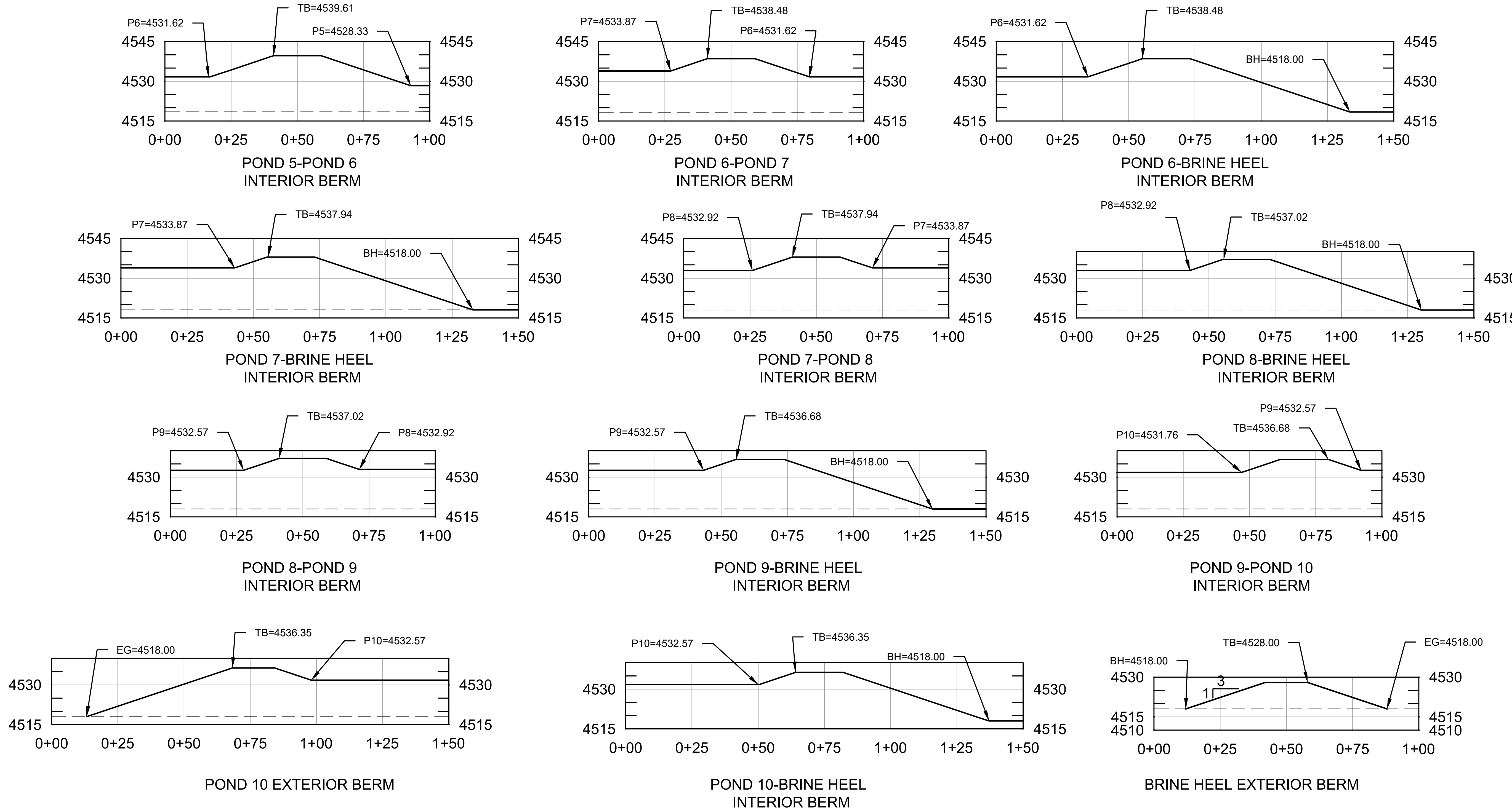
FIGURE C1-4

Sevier Playa Potash Project
Pre-Concentration Ponds
Year-30 Cross Sections

DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg

SCALE: 1"=40'

NORWEST
CORPORATION



CRYSTAL PEAK MINERALS INC.

LEGEND

- - - EXISTING GROUND

——— 30 YEAR SURFACE

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'

NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

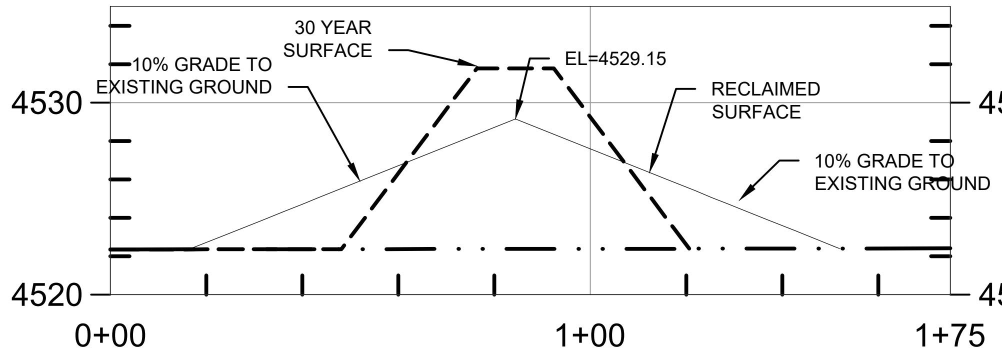
DSGN	DR	CHK	APVD
NS	NS	AB	AB

FIGURE C1-5

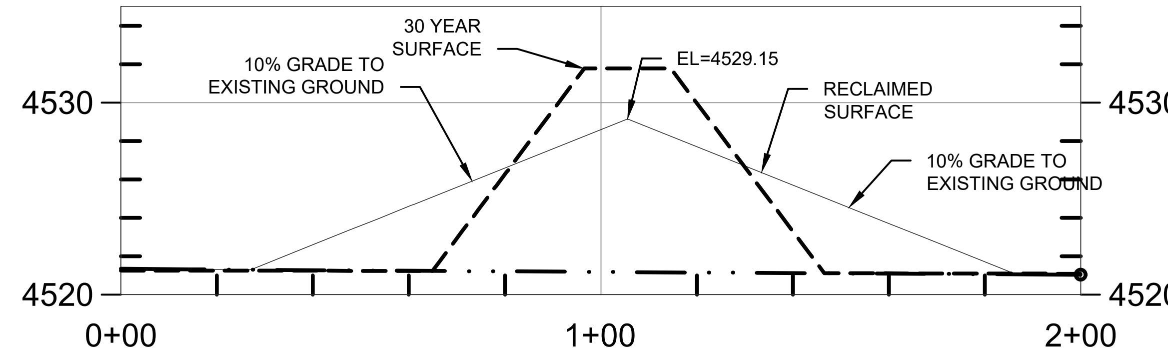
Sevier Playa Potash Project
Pre-Concentration Ponds
Year-30 Cross Sections

DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'

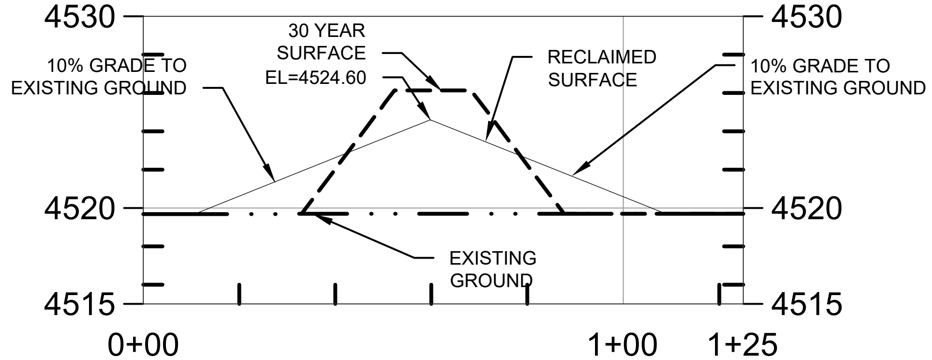
NORWEST CORPORATION



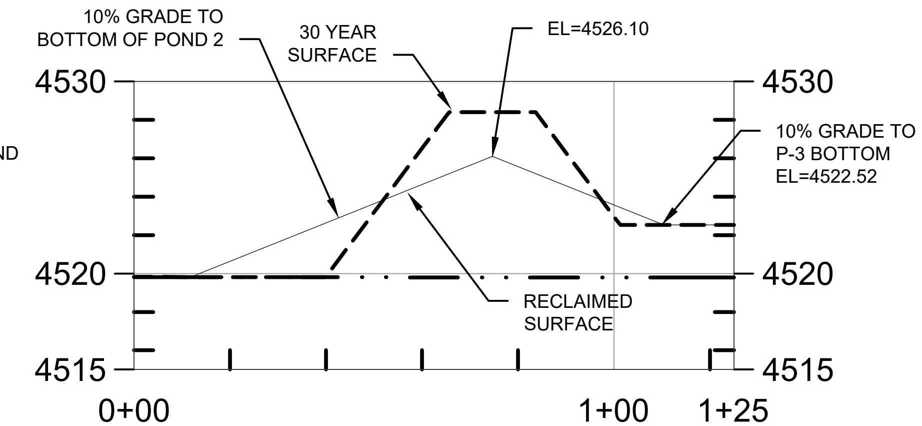
POND 1 EXTERIOR BERM



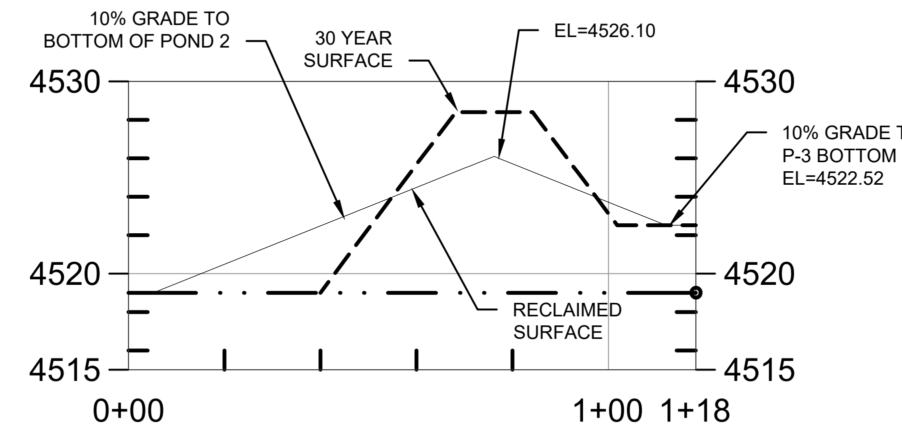
INTERIOR BERM BETWEEN PONDS 1 AND 2



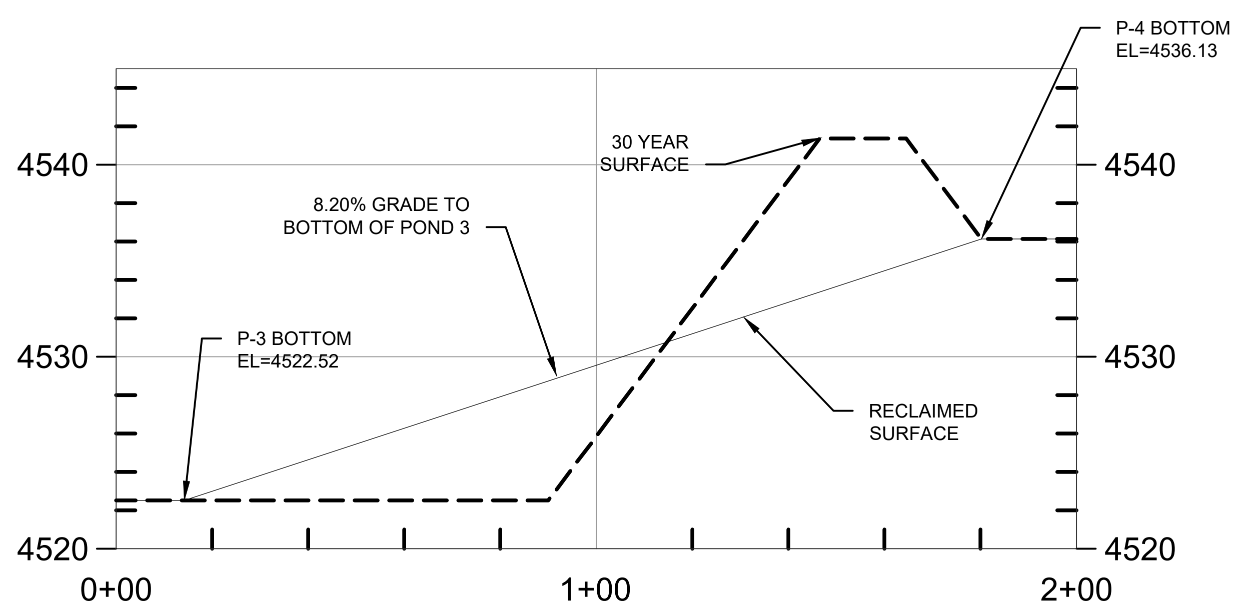
POND 2
EXTERIOR BERM



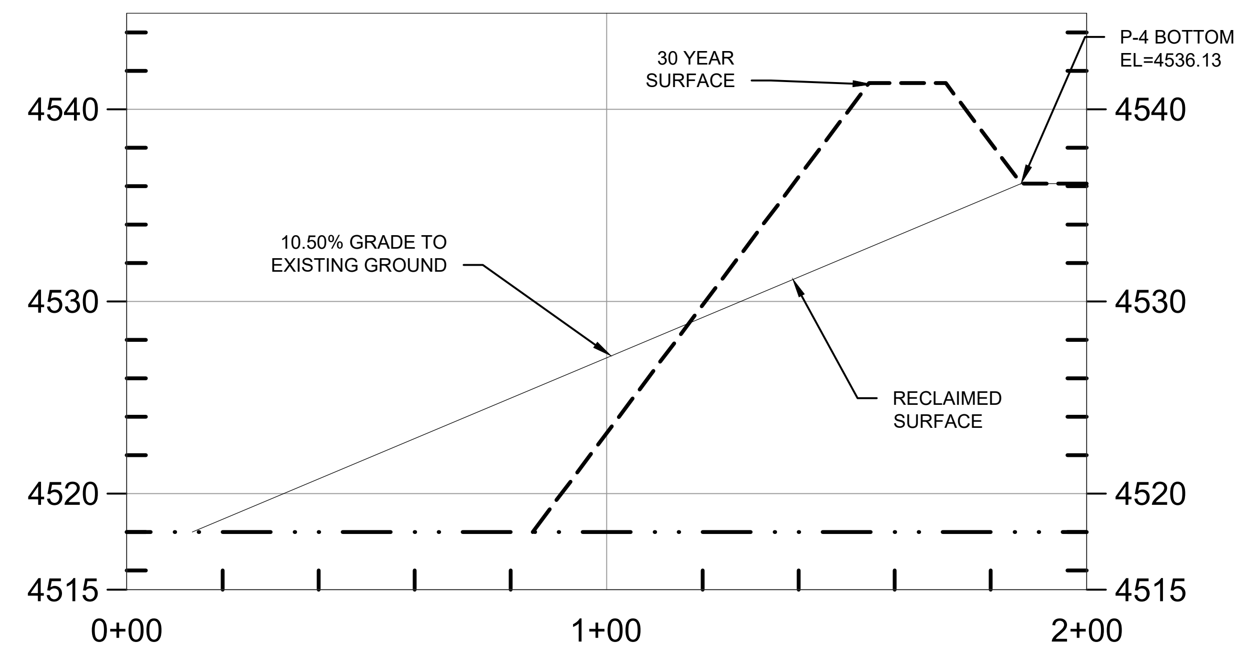
INTERIOR BERM
BETWEEN POND 2 AND 3



POND 3
EXTERIOR BERM



INTERIOR BERM
BETWEEN PONDS 3 AND 4



POND 4
EXTERIOR BERM

CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'
VERTICAL SCALE:1"=10'

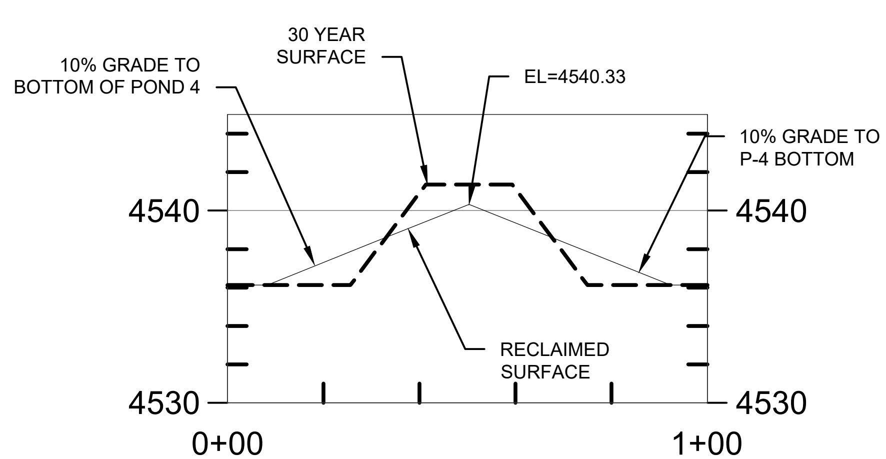
NO.	DATE	REVISION	BY	APVD
0	08-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

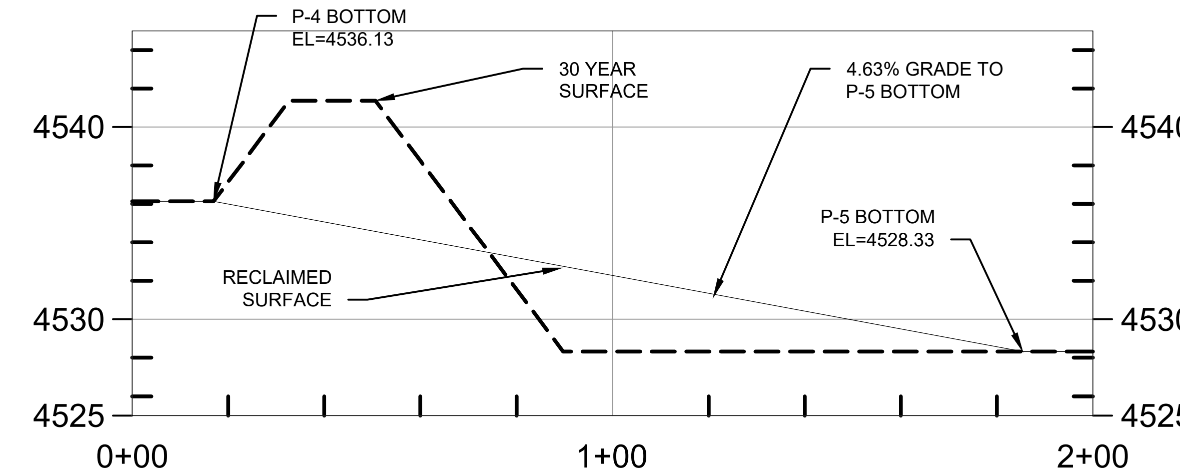
FIGURE C1-6

Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

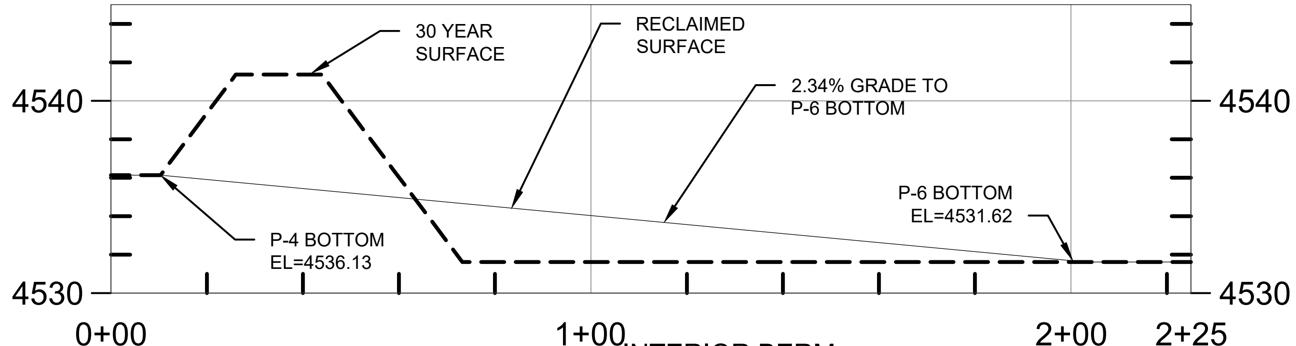
DATE: 09/15/2018
SCALE: 1"=40'
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
NORWEST now Stantec



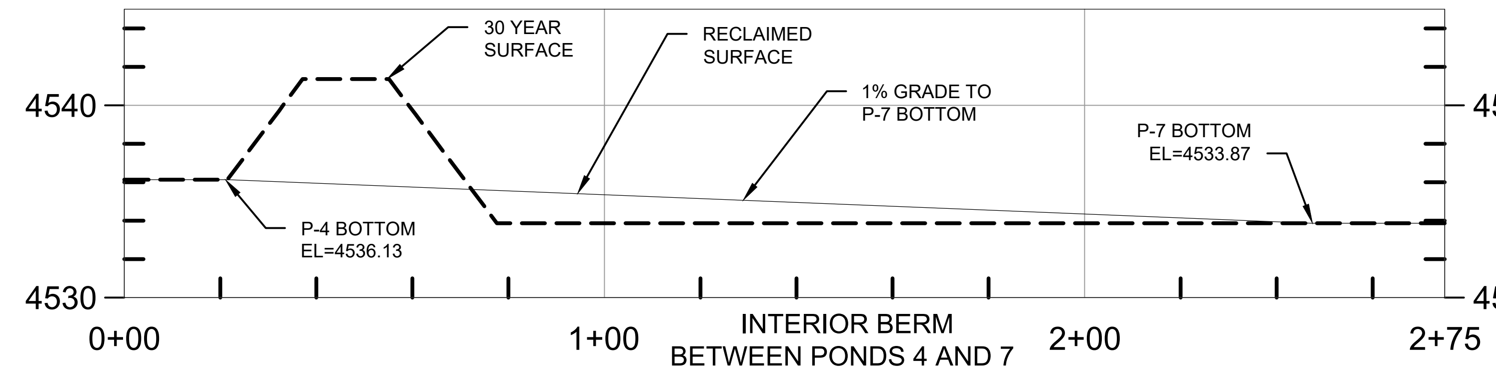
INTERIOR BERM
WITHIN POND 4



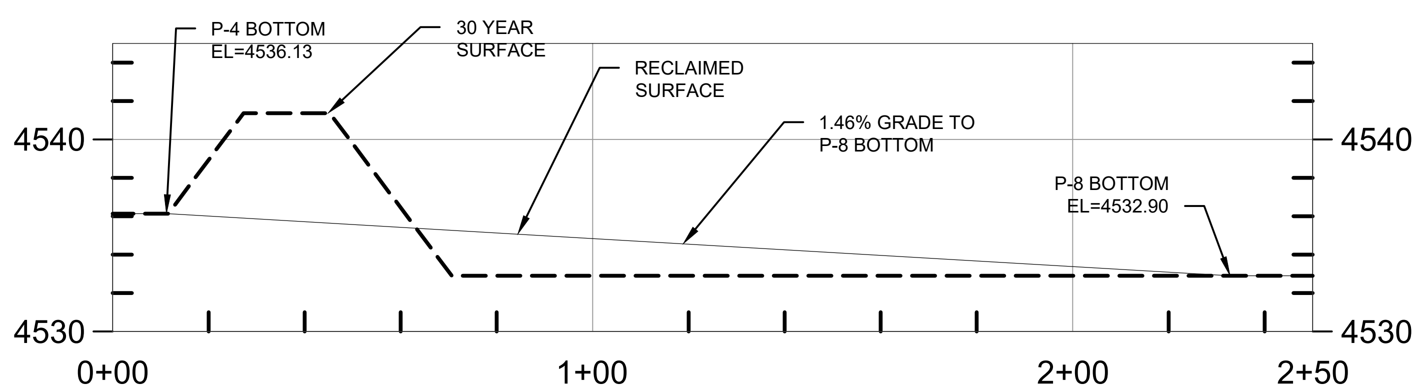
INTERIOR BERM
BETWEEN PONDS 4 AND 5



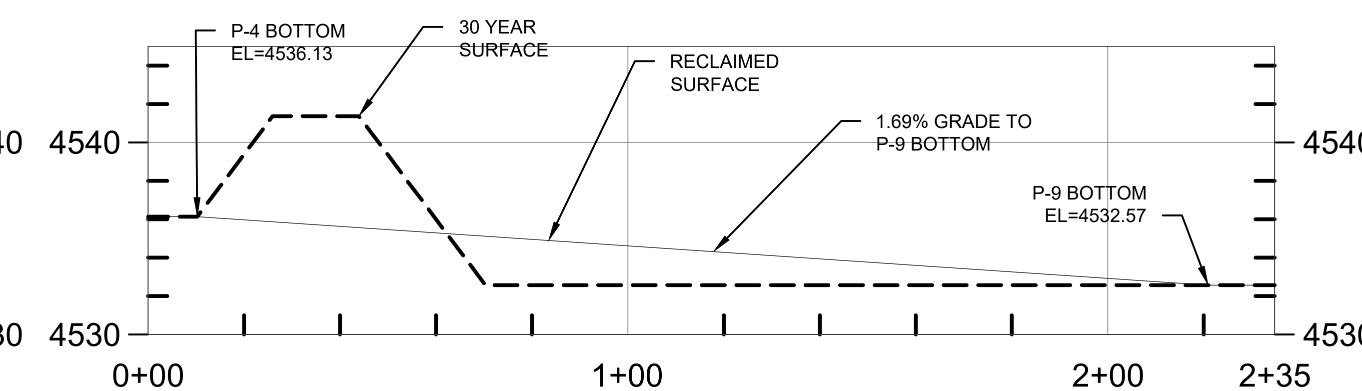
INTERIOR BERM
BETWEEN PONDS 4 AND 6



INTERIOR BERM
BETWEEN PONDS 4 AND 7



INTERIOR BERM
BETWEEN PONDS 4 AND 8



INTERIOR BERM
BETWEEN PONDS 4 AND 9

CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'
VERTICAL SCALE:1"=10'

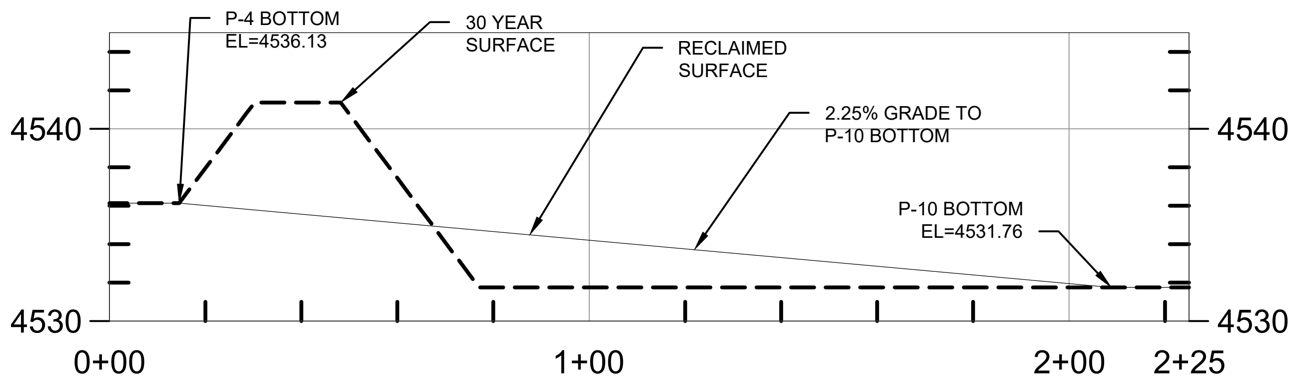
NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

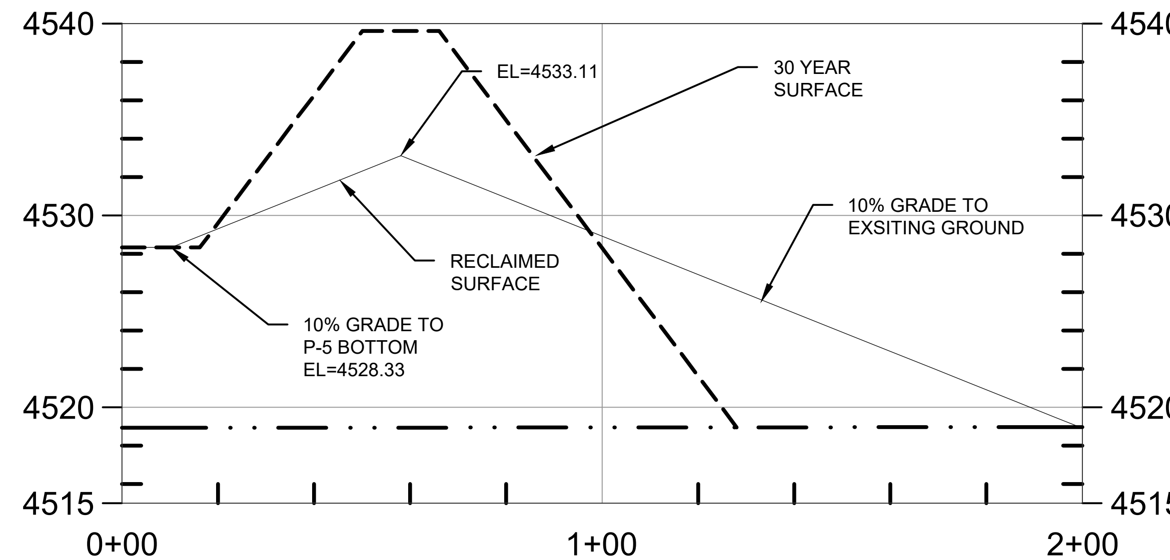
FIGURE C1-7

Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

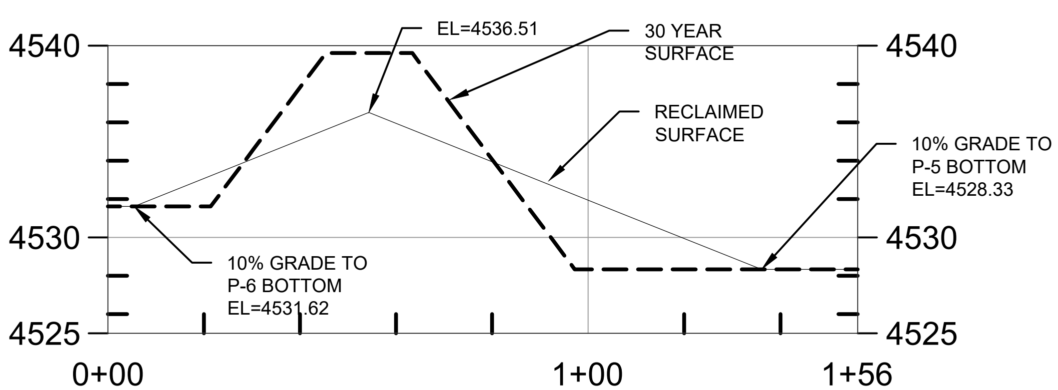
DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'
NORWEST now Stantec



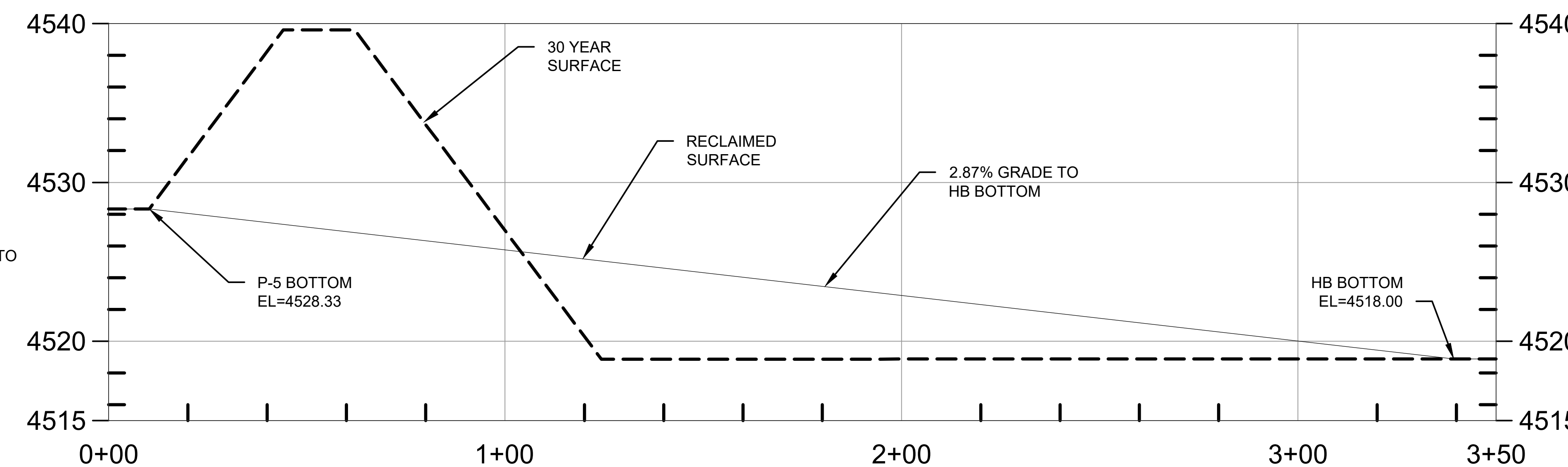
INTERIOR BERM
BETWEEN PONDS 4 AND 10



POND 5 EXTERIOR BERM



INTERIOR BERM
BETWEEN PONDS 5 AND 6



INTERIOR BERM
BETWEEN POND 5 AND HEEL BRINE

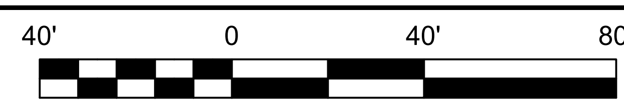
CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.



SCALE:1"=40'
VERTICAL SCALE:1"=10'

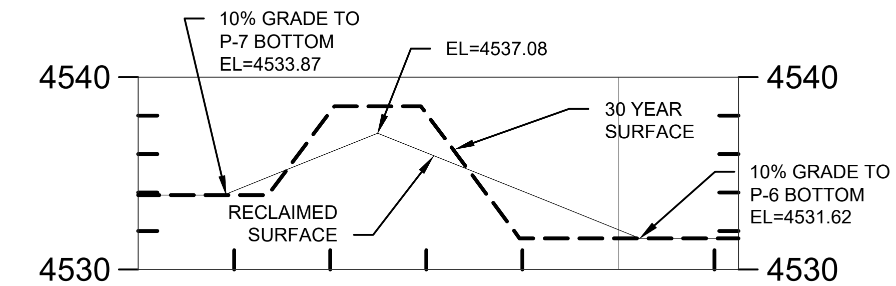
NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

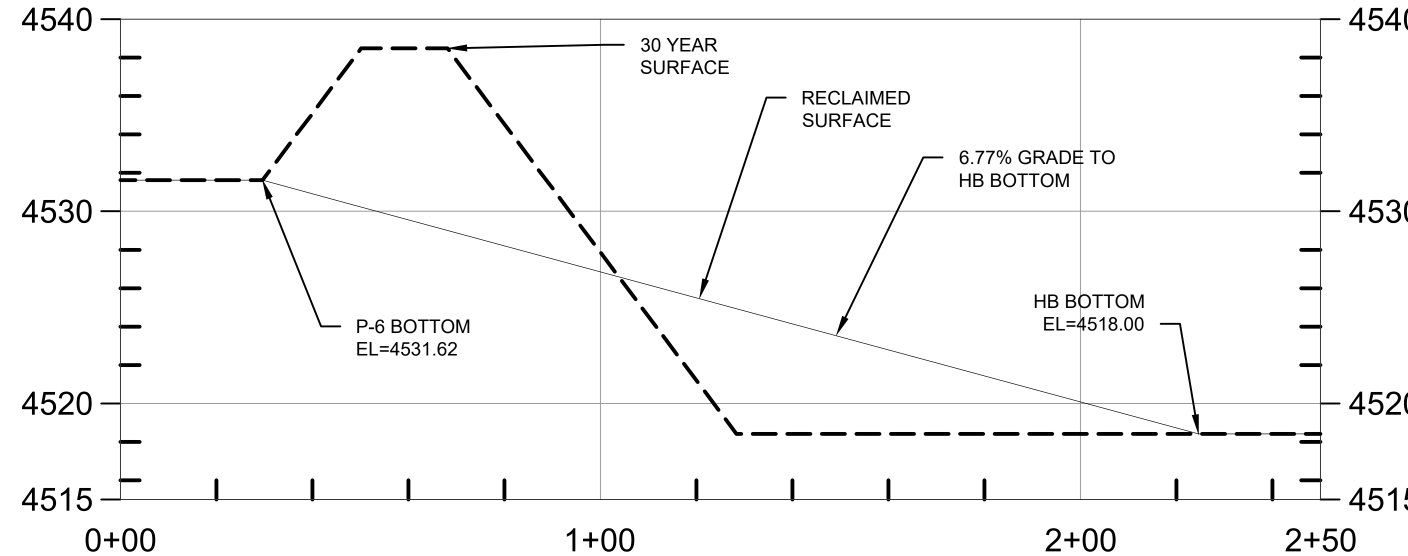
FIGURE C1-8

Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

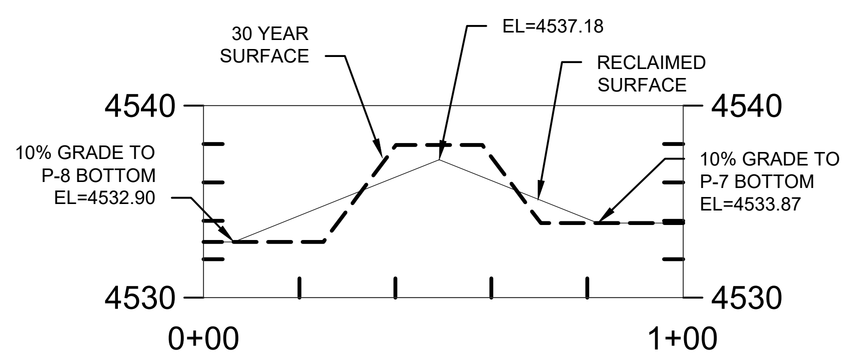
DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'
NORWEST now Stantec



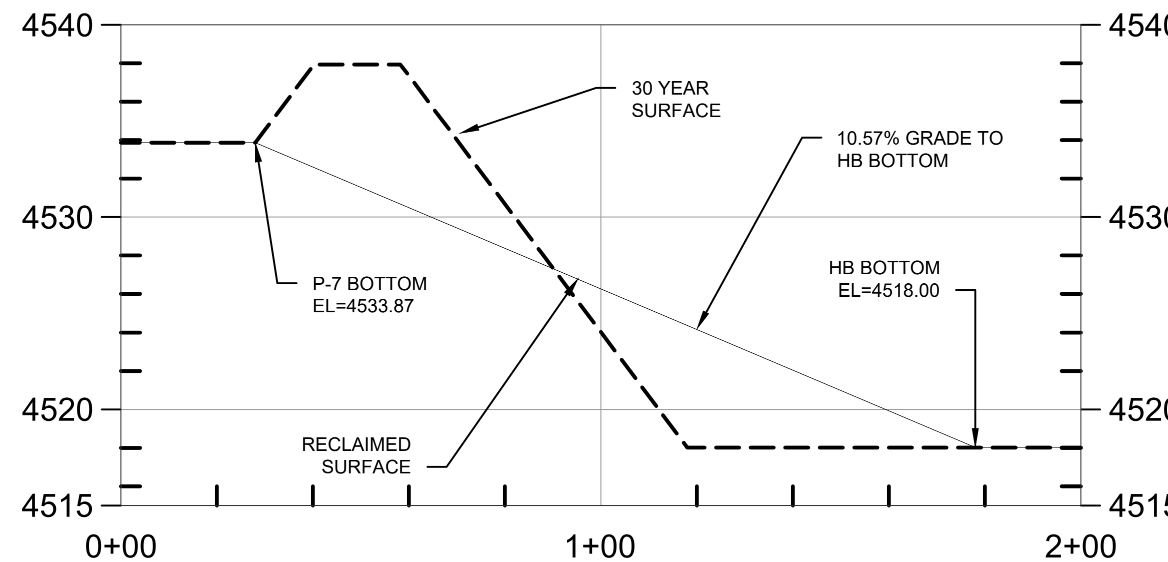
INTERIOR BERM
BETWEEN PONDS 6 AND 7



INTERIOR BERM
BETWEEN POND 6 AND HEEL BRINE



INTERIOR BERM
BETWEEN PONDS 7 AND 8



INTERIOR BERM
BETWEEN POND 7 AND HEEL BRINE

CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'
VERTICAL SCALE:1"=10'

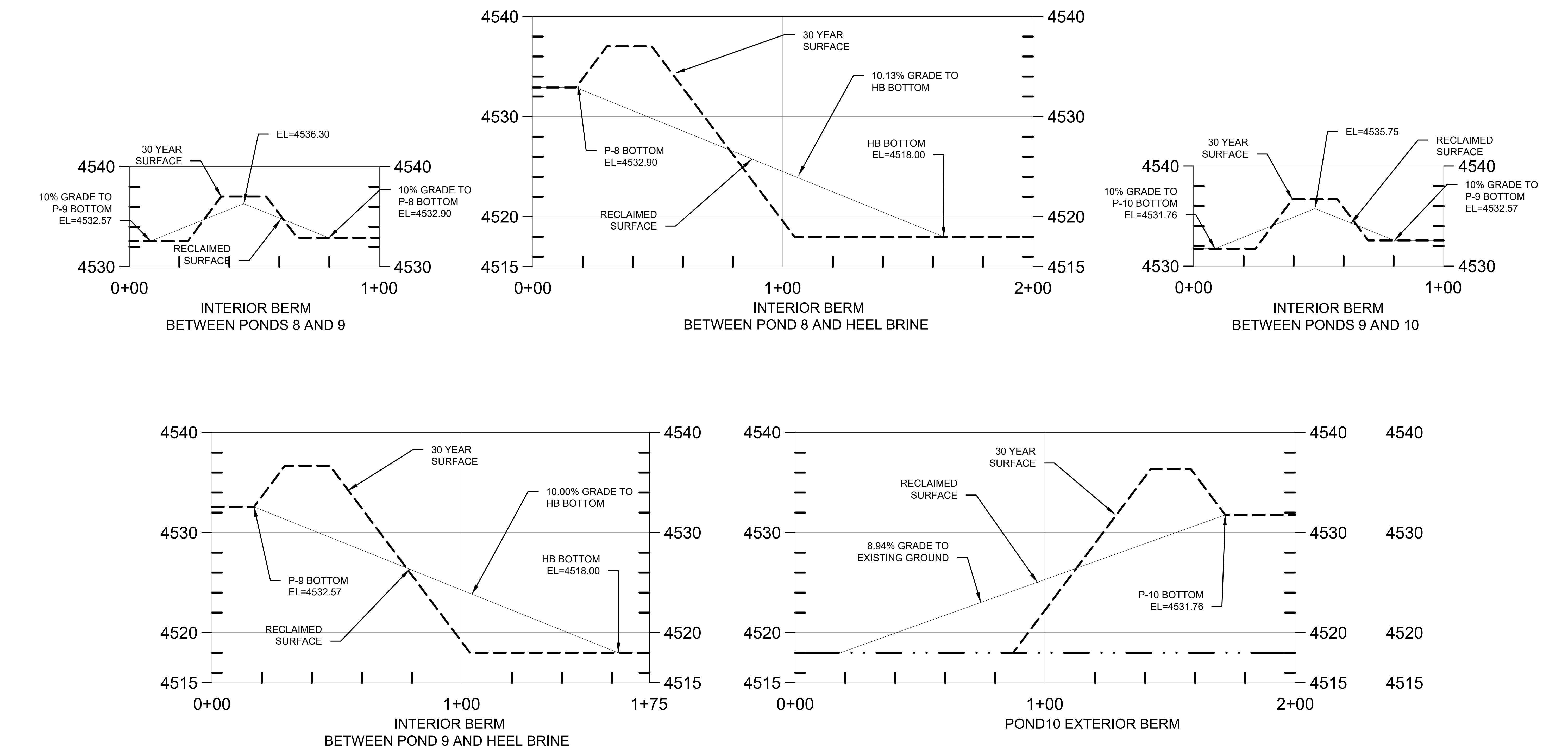
NO.	DATE	REVISION	BY	APVD
0	08-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

FIGURE C1-9

Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'
NORWEST now Stantec



CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'
VERTICAL SCALE:1"=10'

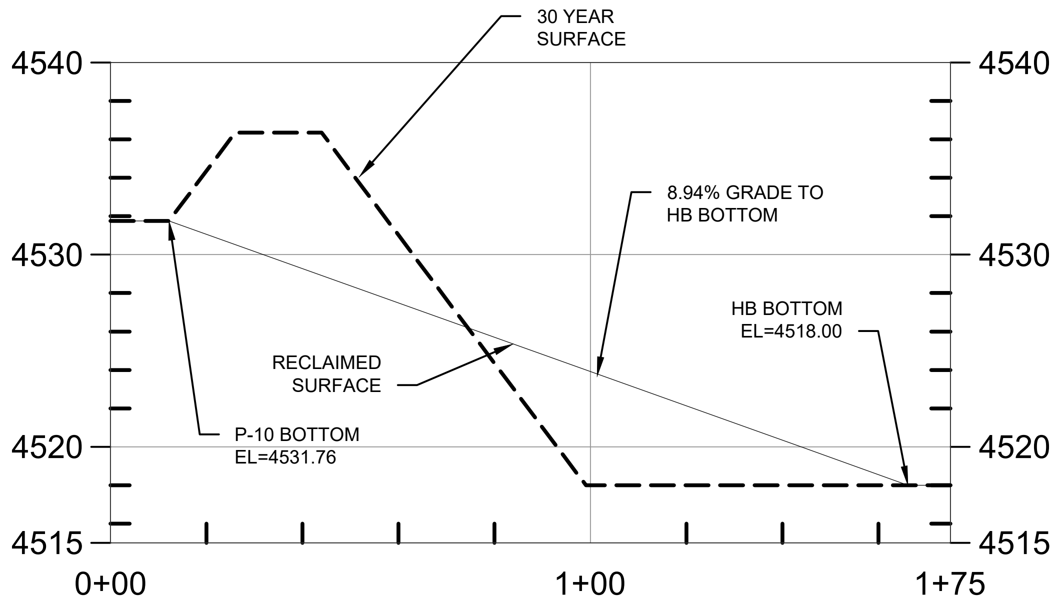
NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

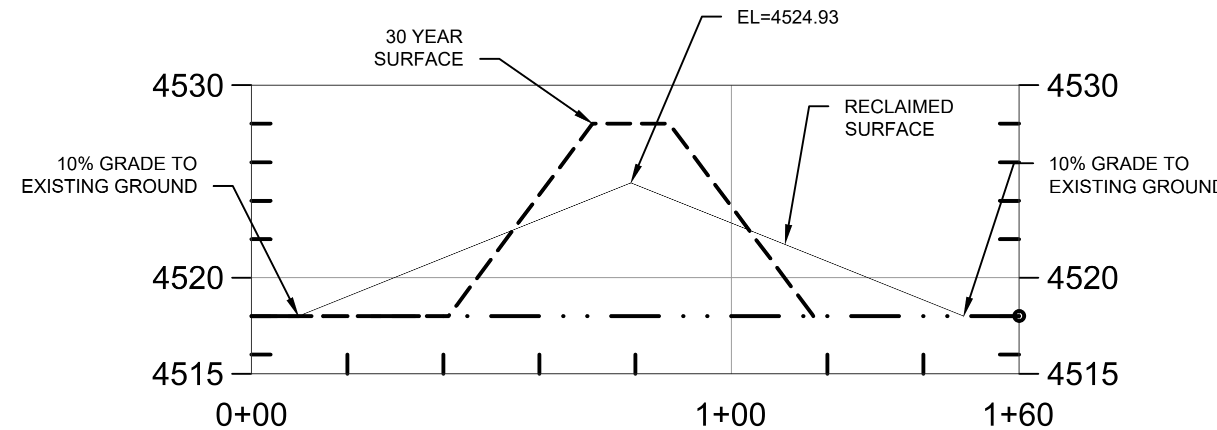
FIGURE C1-10

Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'
NORWEST Stantec



INTERIOR BERM
POND 10 AND HEEL BRINE



HEEL BRINE EXTERIOR BERM

CRYSTAL PEAK MINERALS INC.

LEGEND

- 30 YEAR SURFACE
- RECLAIMED SURFACE
- EXISTING GROUND

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

40' 0 40' 80'

SCALE:1"=40'
VERTICAL SCALE:1"=10'

NO.	DATE	REVISION	BY	APVD
0	09-15-18	INITIAL SUBMITTAL	NS	AB

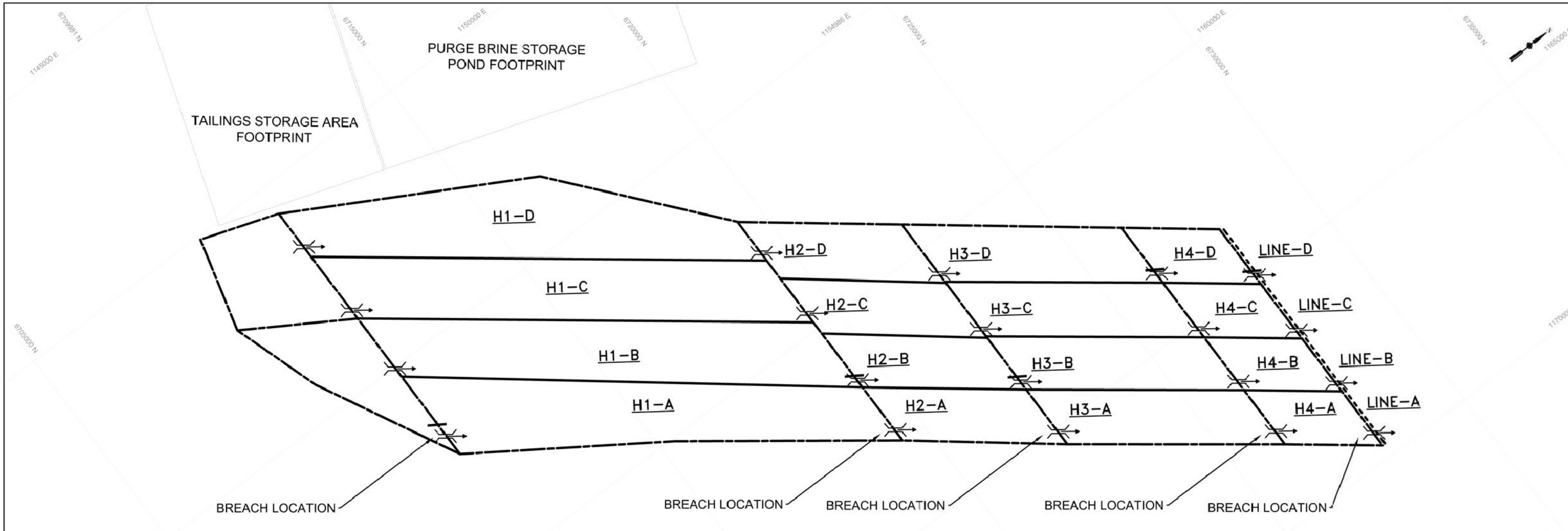
DSGN	DR	CHK	APVD
NS	NS	AB	AB

FIGURE C1-11

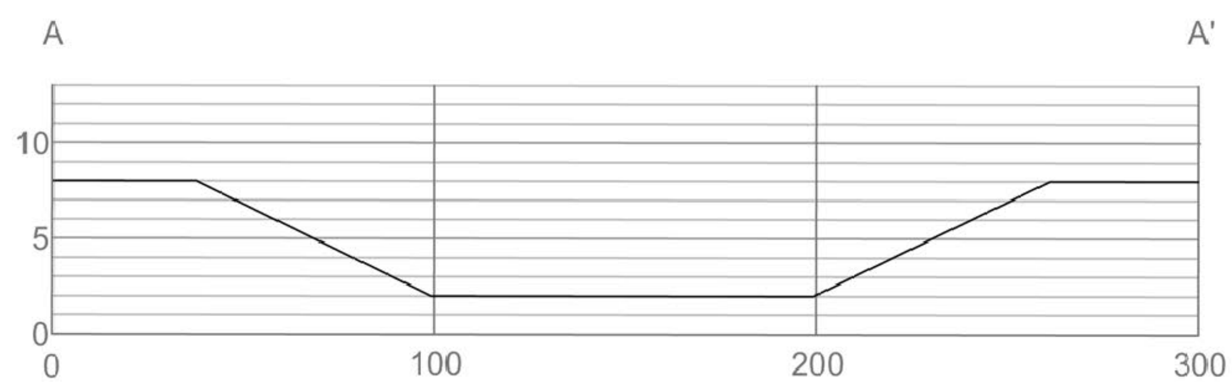
Sevier Playa Potash Project
Preconcentration Ponds
Reclaimed Cross Sections

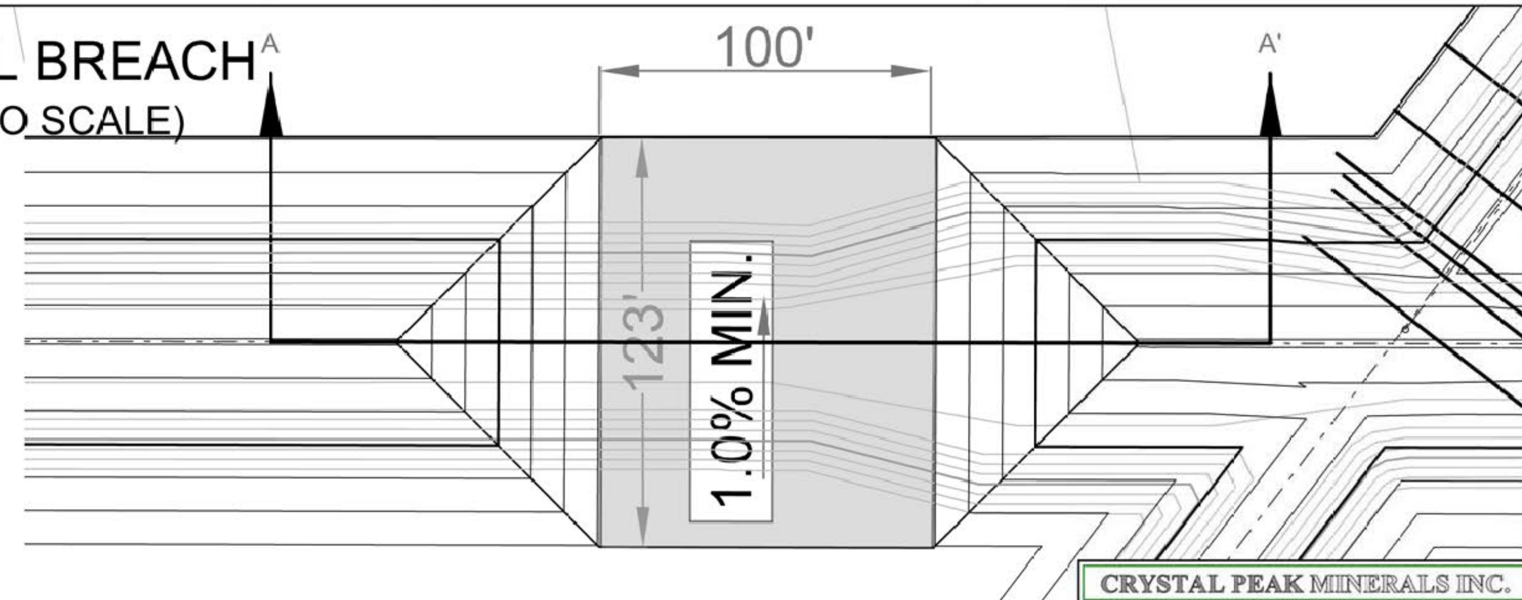
DATE: 09/15/2018
c:\dogm drawings\89-11-c-203 preconcentration cross sections.dwg
SCALE: 1"=40'

NORWEST Stantec



TYPICAL BREACH
(NOT TO SCALE)





LEGEND

- Berm Location
- Cross-section Location
- Breach Location
- H1-A Production Cell #-Line Letter

0 2000 4000 6000
FEET

NO.	DATE	REVISION	BY	APVD
0	10-5-18	INITIAL SUBMITTAL	GWH	AB

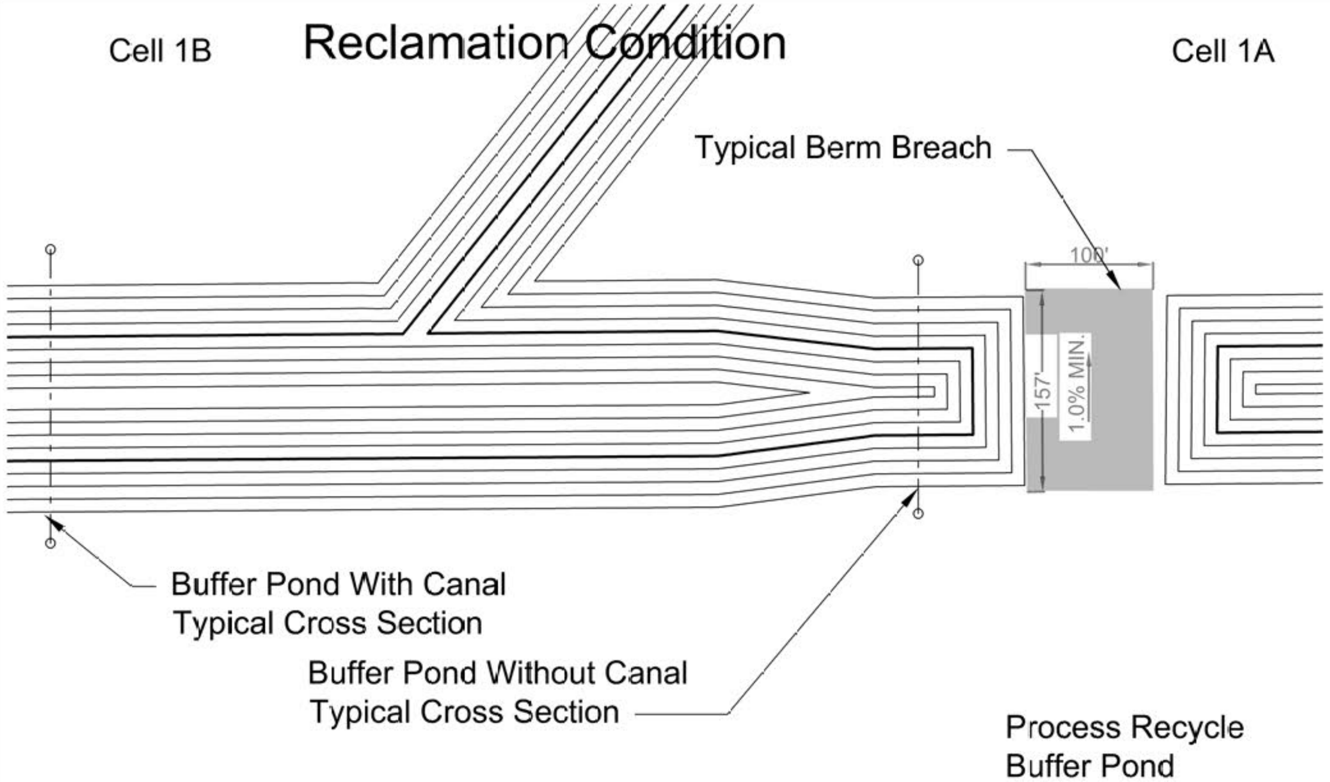
DSGN	DR	CHK	APVD
POK	TJS	AB	AB

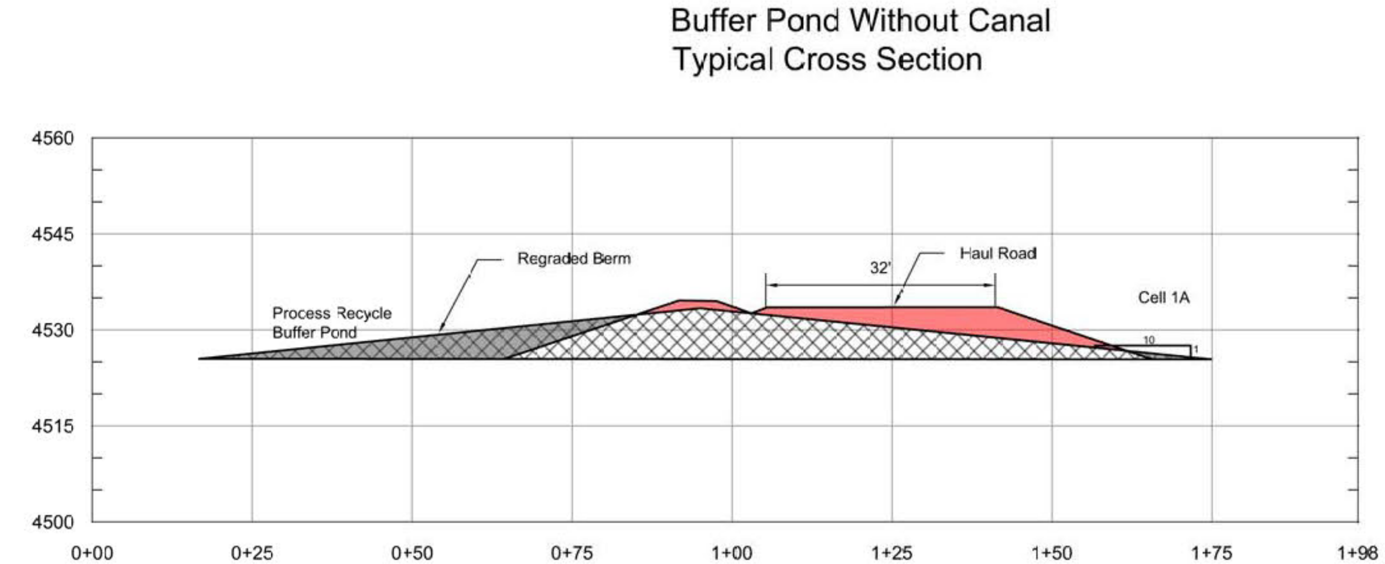
FIGURE C2-0

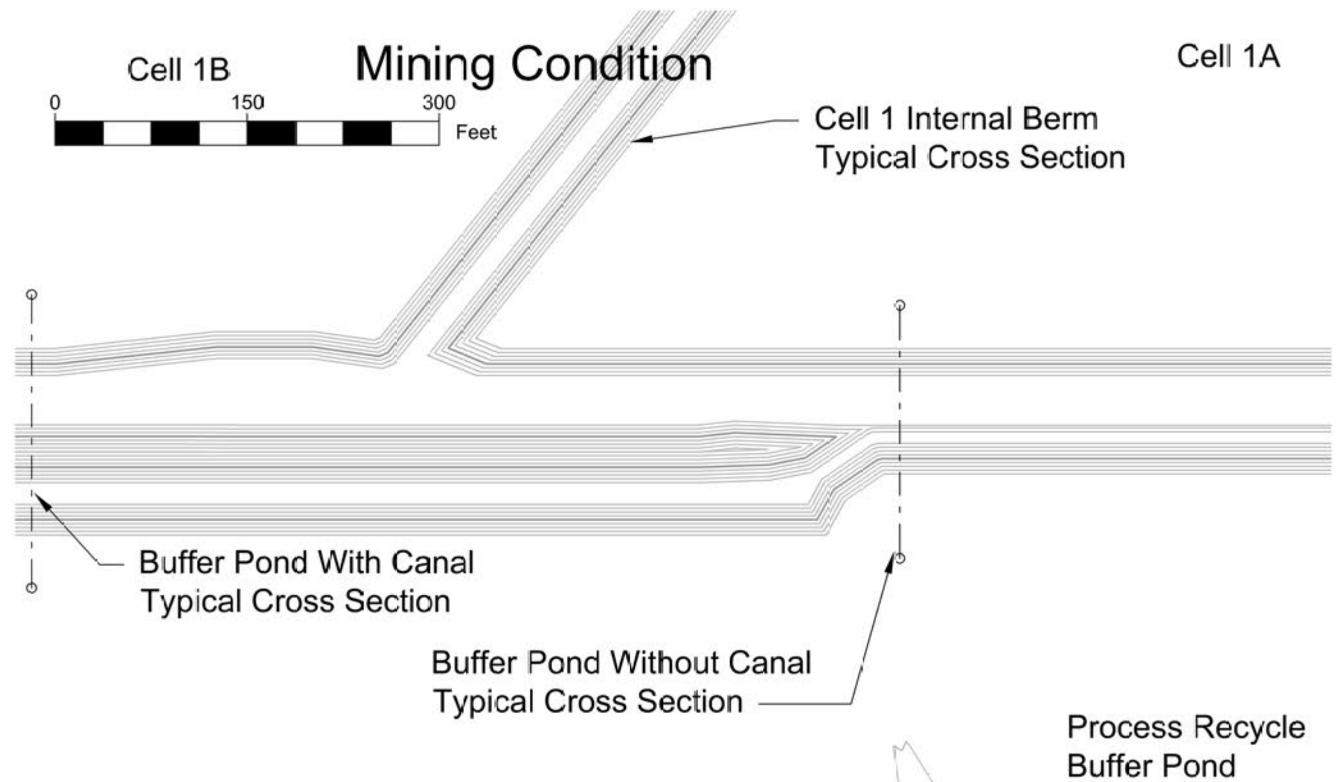
Sevier Playa Potash Project
Production Pond
Plan-View

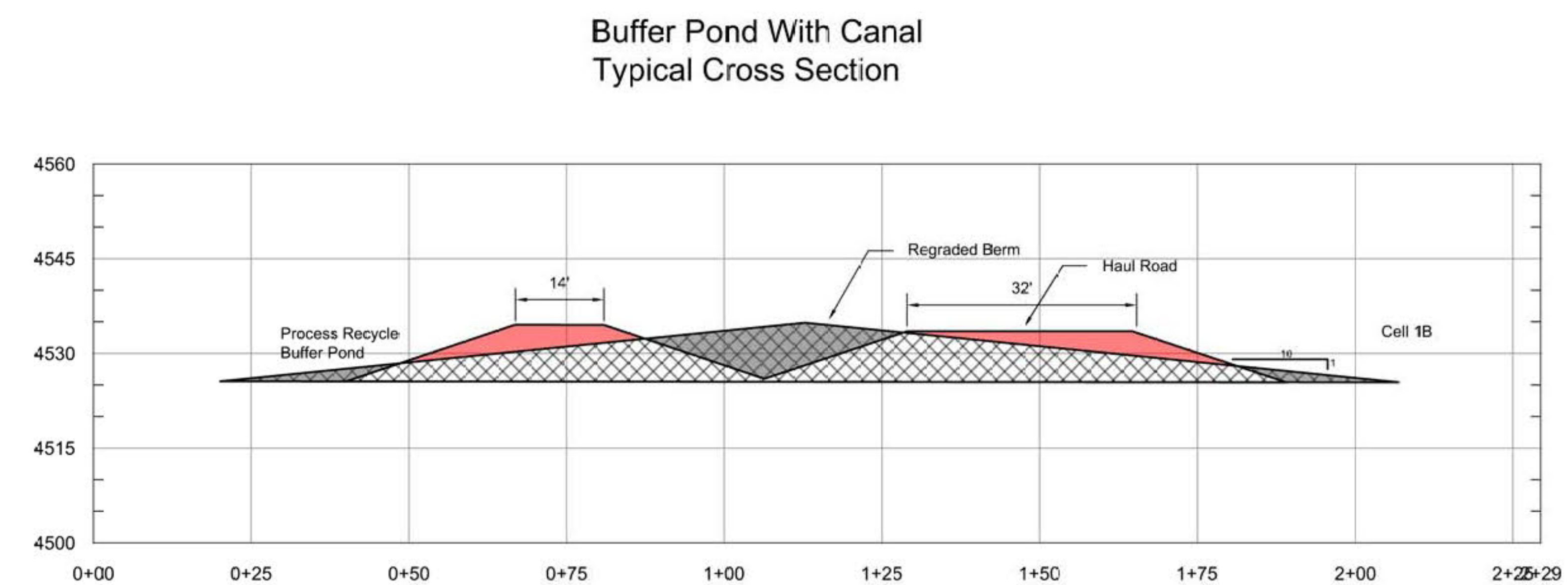
DATE: 10/5/2018
FILE: Figure C2-0 Production Plan View.dwg
SCALE: As Shown

NORWEST CORPORATION









CRYSTAL PEAK MINERALS INC.

LEGEND

Reclaimed Condition Contours (1')

Mining Condition Contours (1')

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

N

NO.	DATE	REVISION	BY	APVD
0	9-5-18	INITIAL SUBMITTAL	TJS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

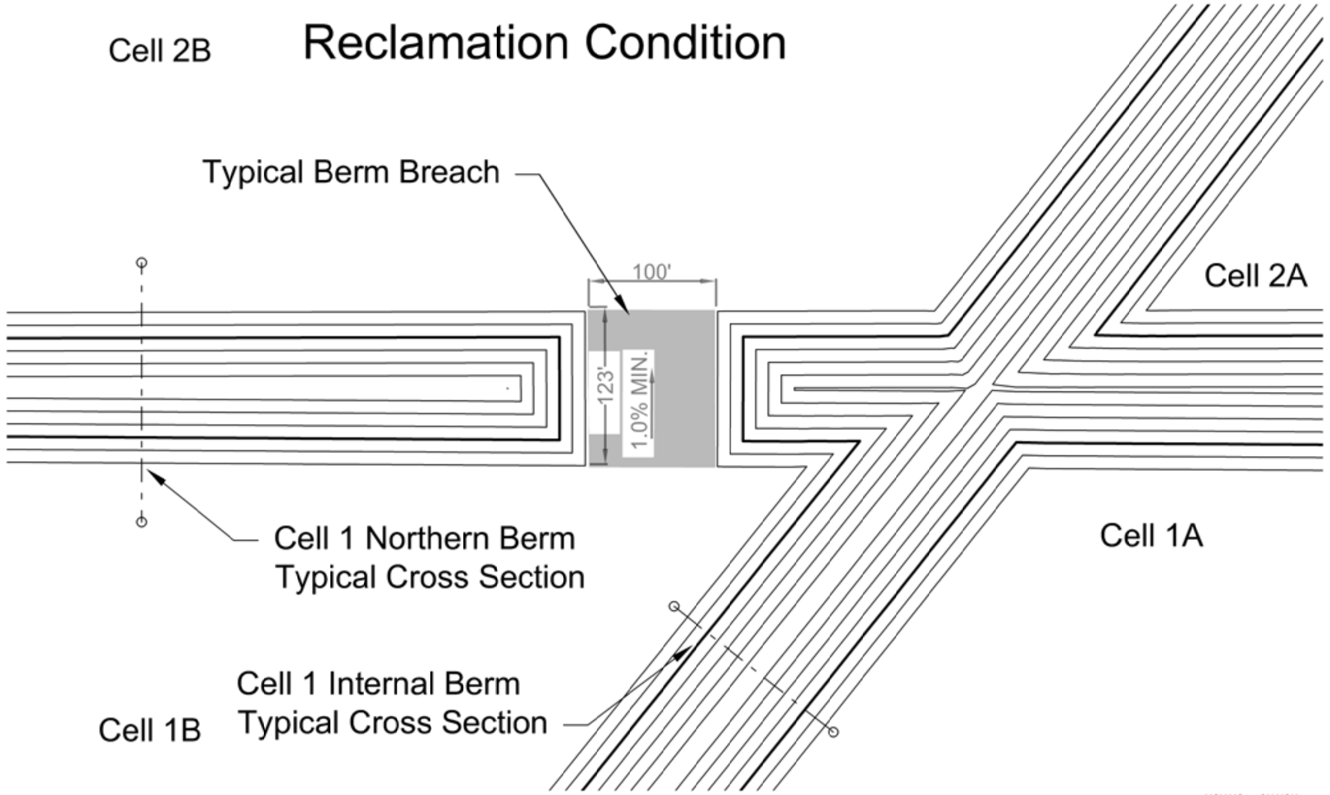
FIGURE C2-1

Sevier Playa Potash Project
Production Ponds
Buffer Pond Berm Cross Section

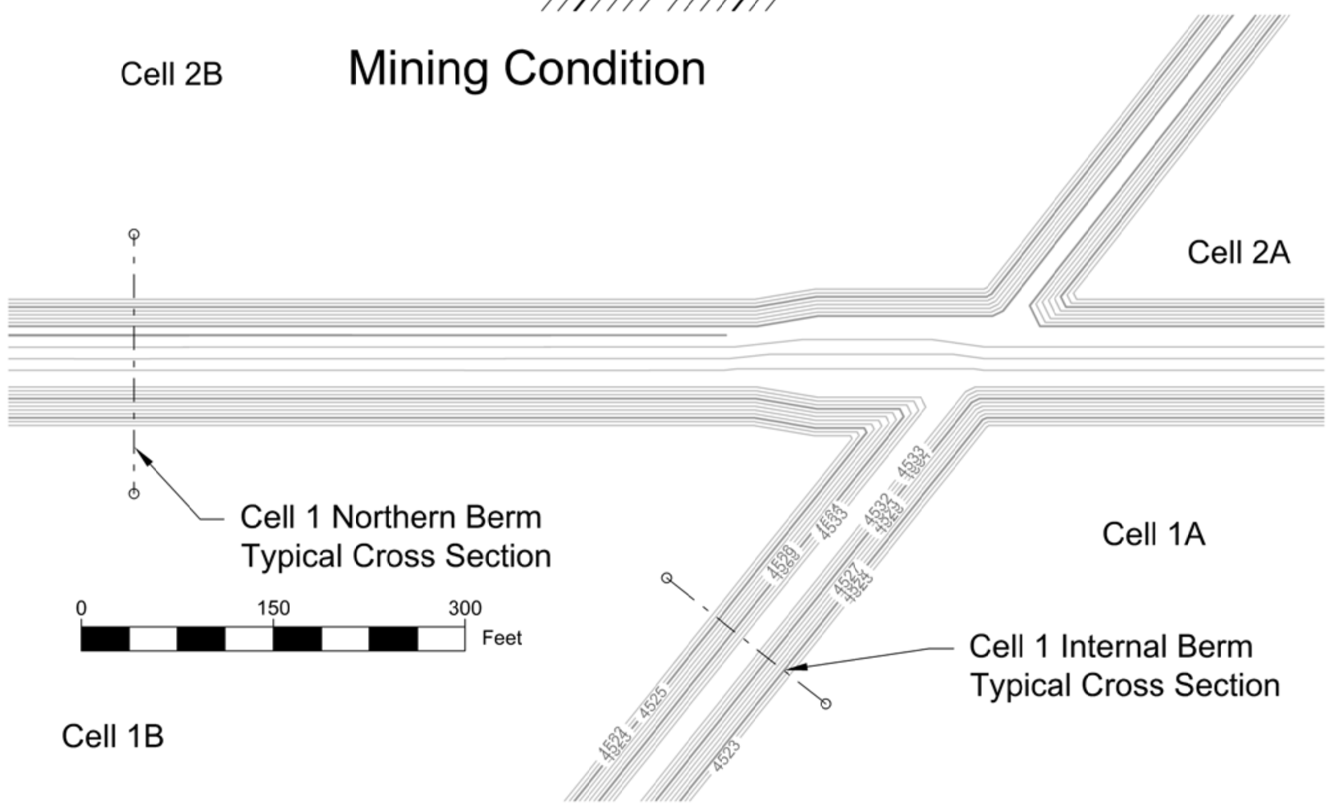
DATE: 07/27/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: As Shown

NORWEST CORPORATION

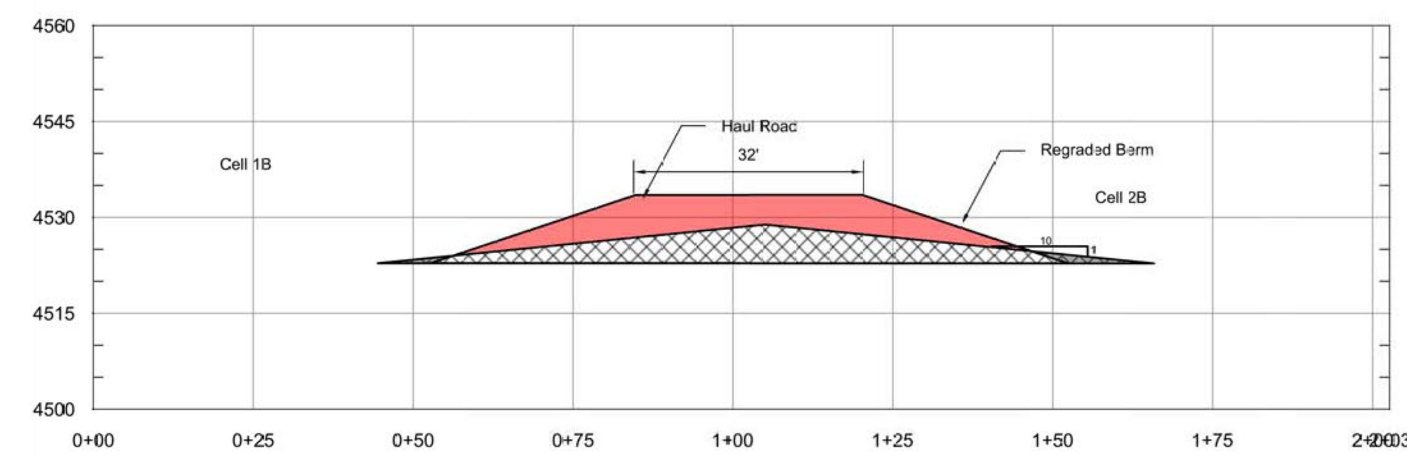
Reclamation Condition



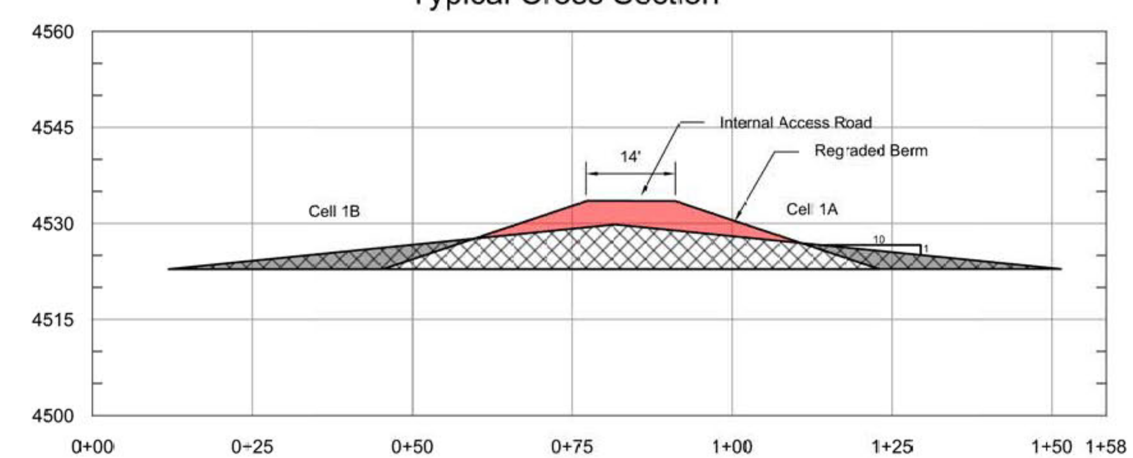
Mining Condition



Cell 1 Northern Berm
Typical Cross Section



Cell 1 Internal Berm
Typical Cross Section



CRYSTAL PEAK MINERALS INC.

LEGEND

Reclaimed Condition Contours (1')
Mining Condition Contours (1')

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

N

NO.	DATE	REVISION	BY	APVD
0	9-5-18	INITIAL SUBMITTAL	TJS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

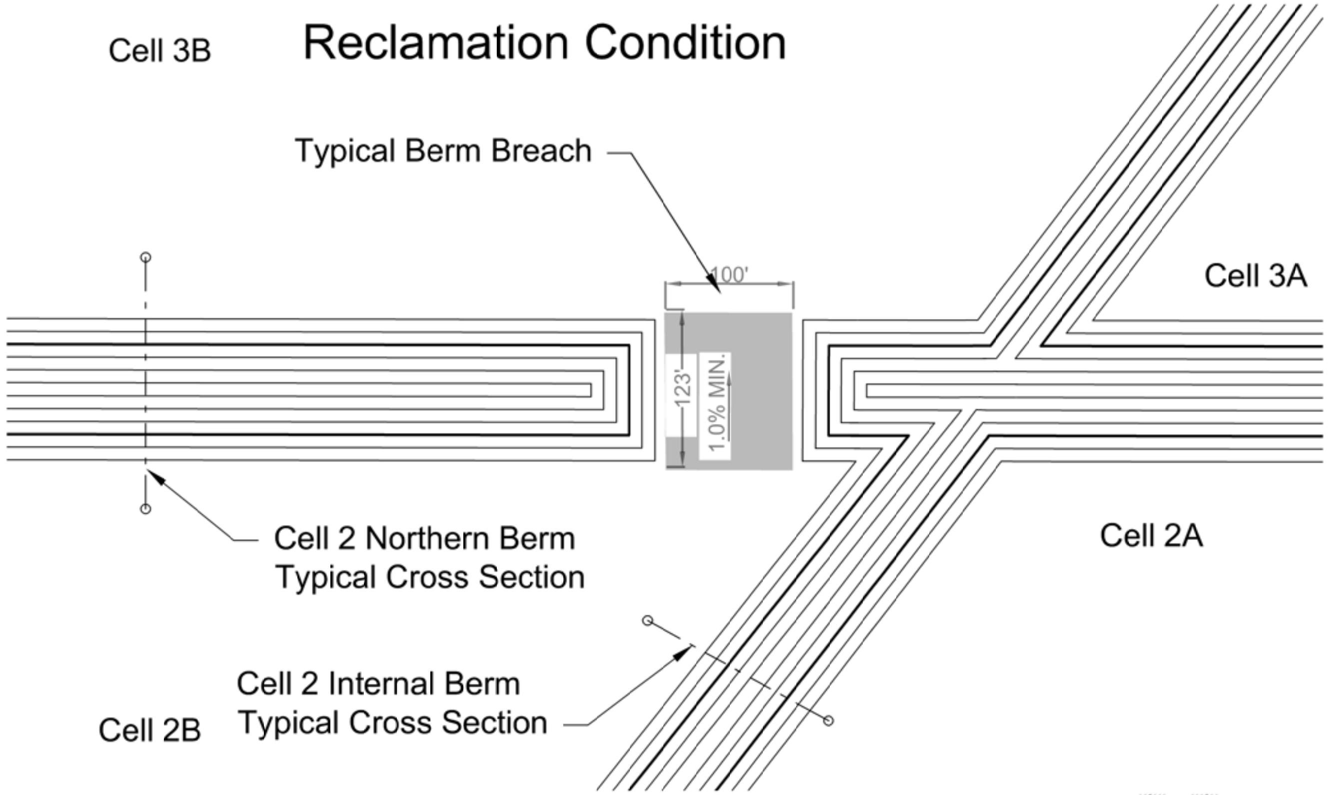
FIGURE C2-2

Sevier Playa Potash Project
Production Ponds
Cell 1 Berm Cross Sections

DATE: 07/27/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: As Shown
NORWEST CORPORATION

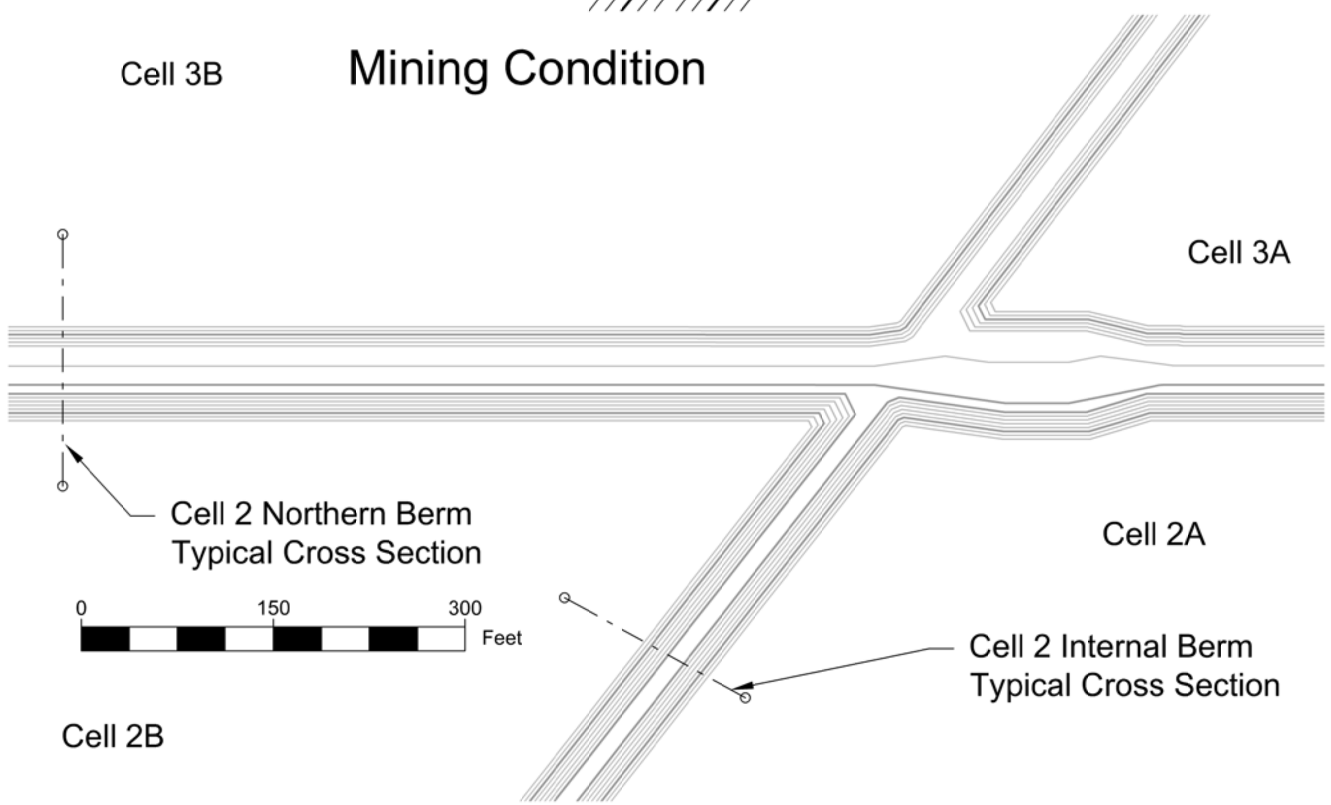
Cell 3B

Reclamation Condition

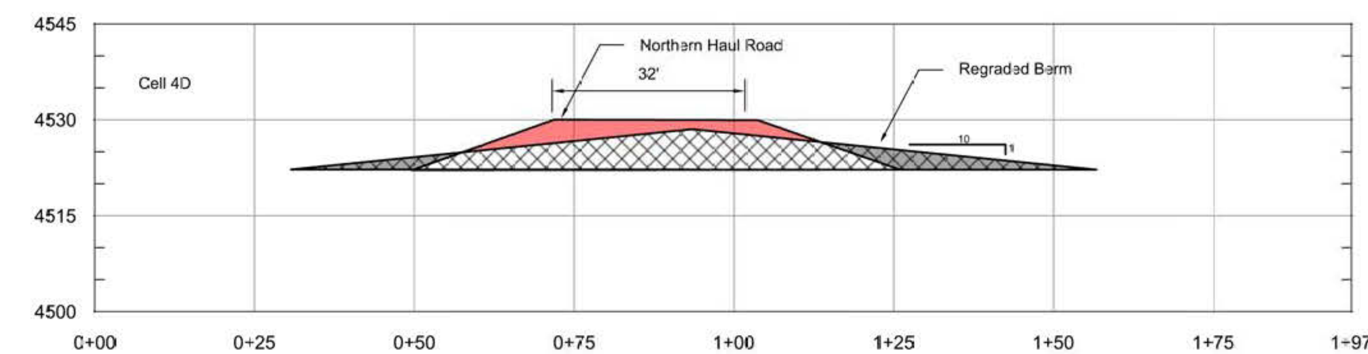


Cell 3B

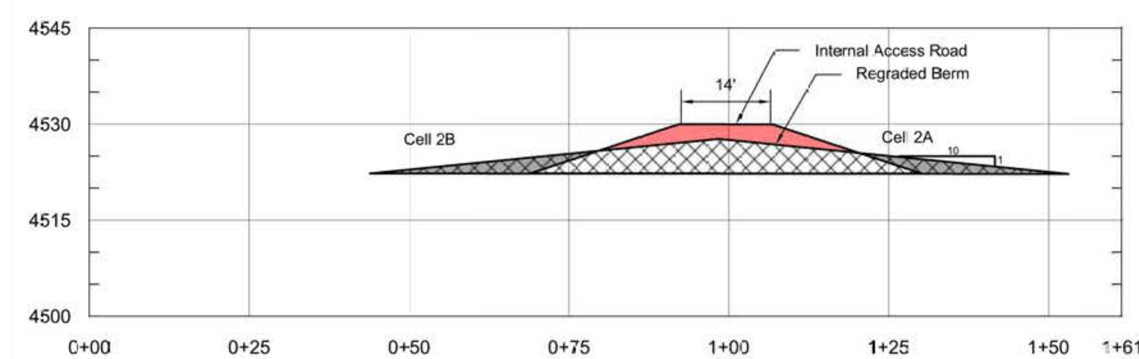
Mining Condition



Cell 2 Northern Berm
Typical Cross Section



Cell 2 Internal Berm
Typical Cross Section



CRYSTAL PEAK MINERALS INC.

LEGEND

Reclaimed Condition Contours (1')
Mining Condition Contours (1')

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
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4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

N

NO.	DATE	REVISION	BY	APVD
0	9-5-18	INITIAL SUBMITTAL	TJS	AB

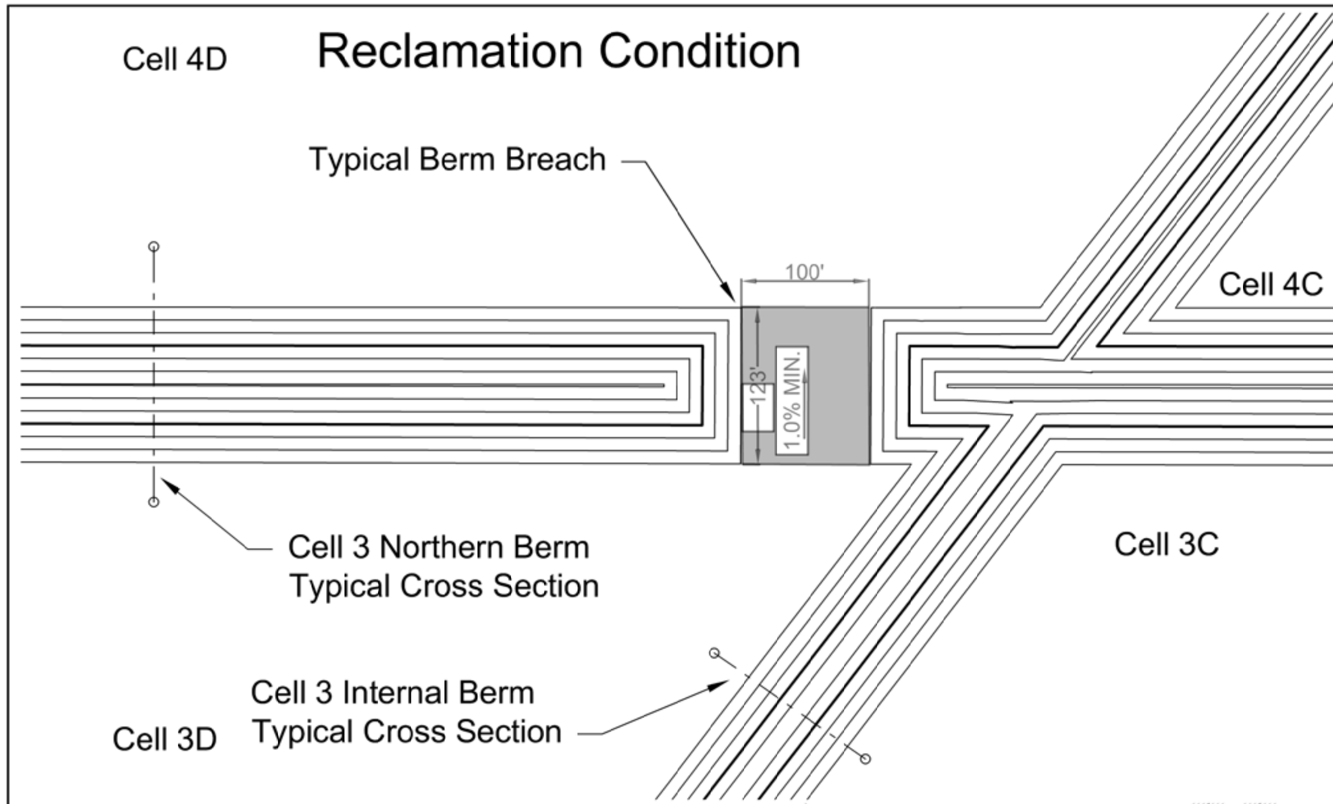
DSGN	DR	CHK	APVD
NS	NS	AB	AB

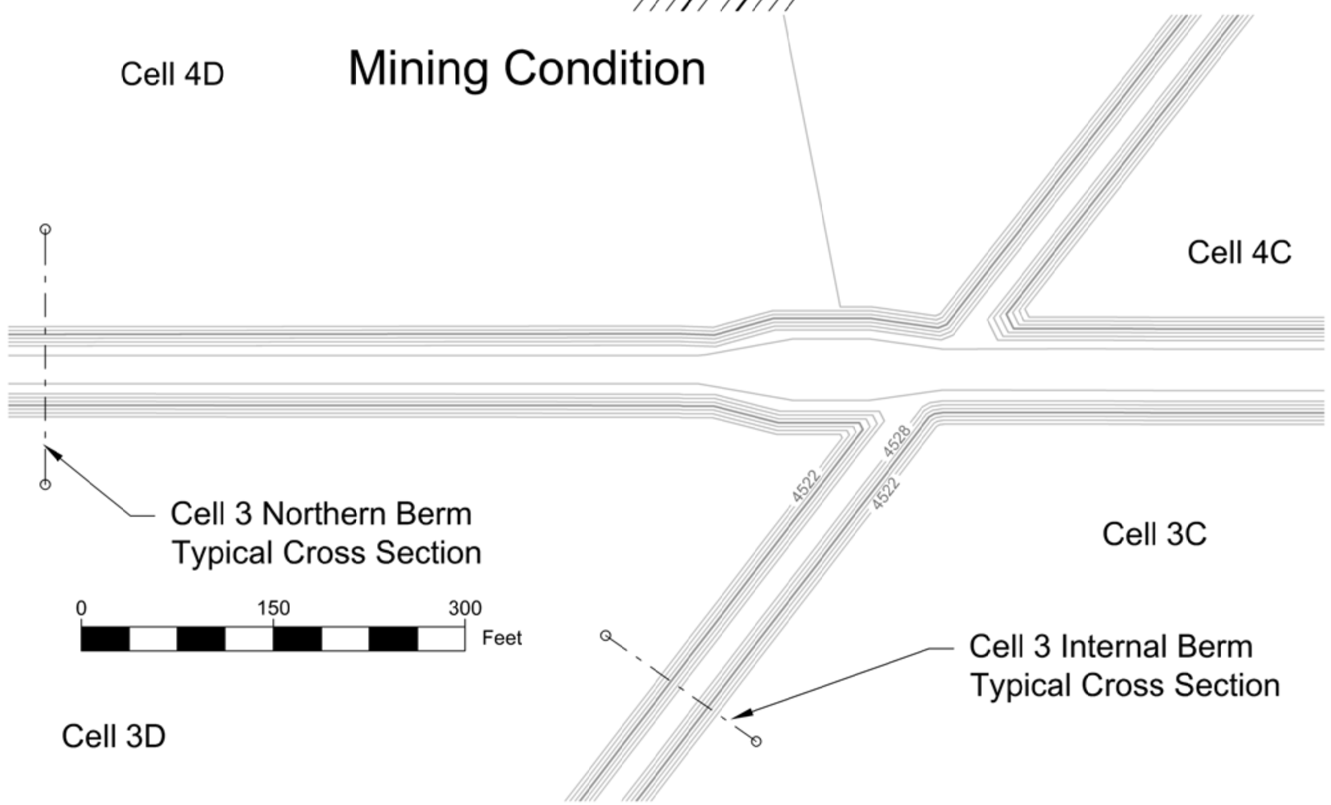
FIGURE C2-3

Sevier Playa Potash Project
Production Ponds
Cell 2 Berm Cross Sections

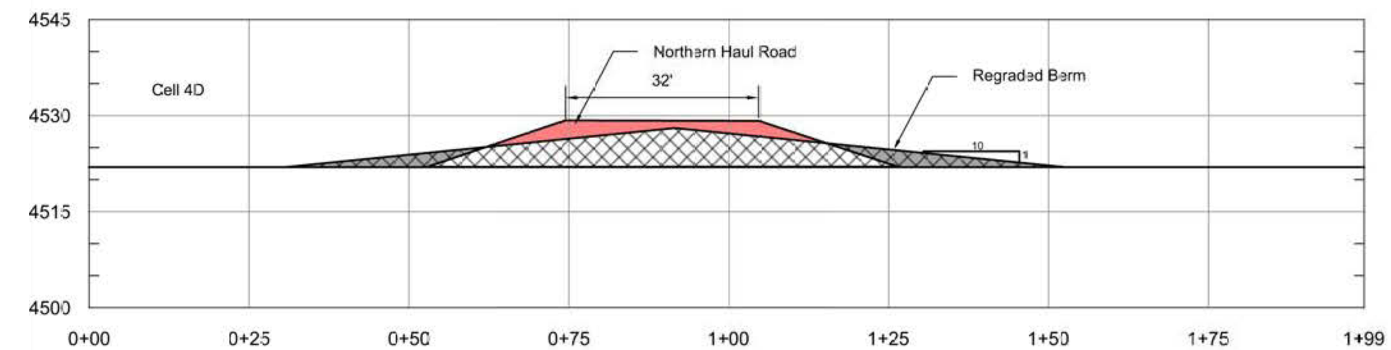
DATE: 07/27/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: As Shown

NORWEST CORPORATION

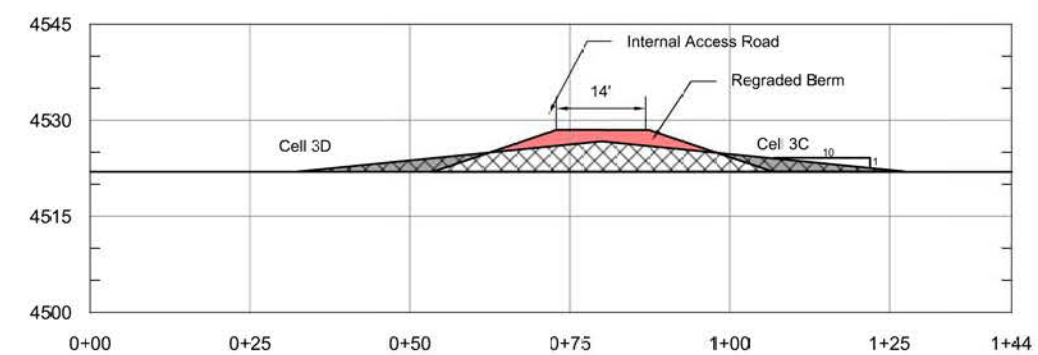




Cell 3 Northern Berm
Typical Cross Section



Cell 3 Internal Berm
Typical Cross Section



CRYSTAL PEAK MINERALS INC.

LEGEND

Reclaimed Condition Contours (1')
Mining Condition Contours (1')

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
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4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

N

NO.	DATE	REVISION	BY	APVD
0	9-5-18	INITIAL SUBMITTAL	TJS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

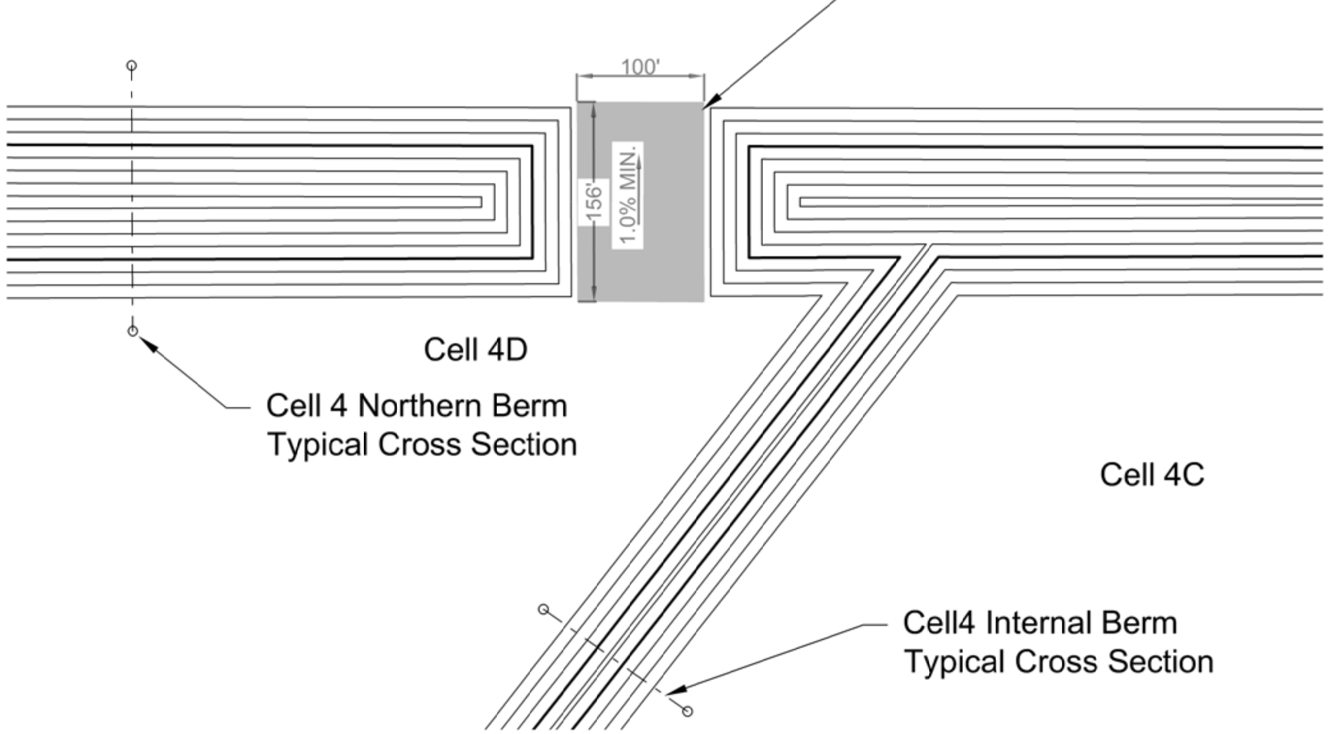
FIGURE C2-4

Sevier Playa Potash Project
Production Ponds
Cell 3 Berm Cross Sections

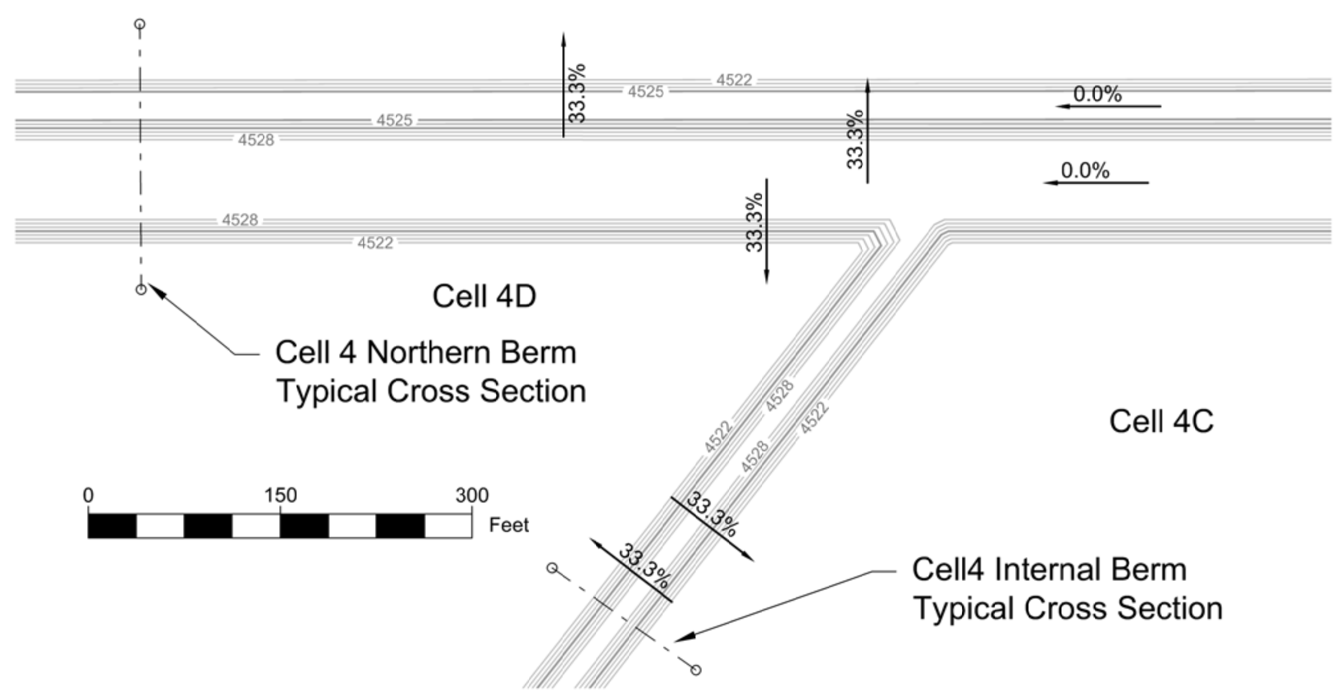
DATE: 07/27/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: As Shown

NORWEST CORPORATION

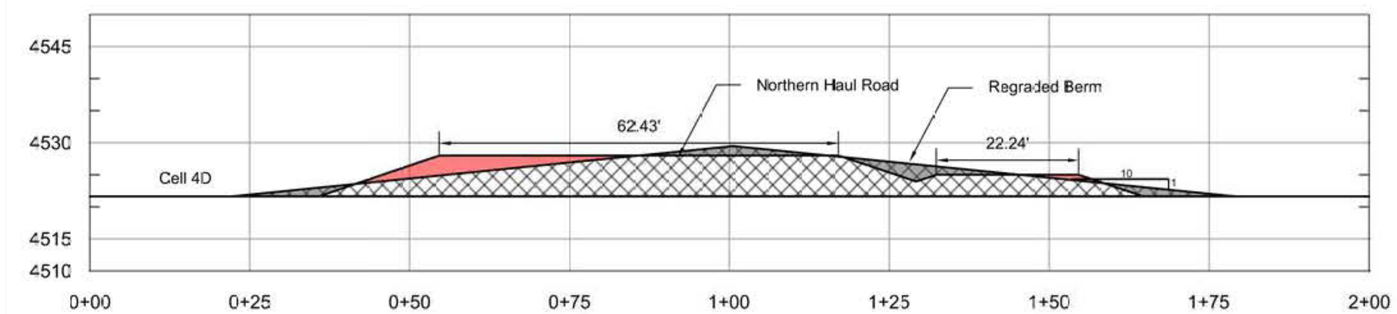
Reclamation Condition



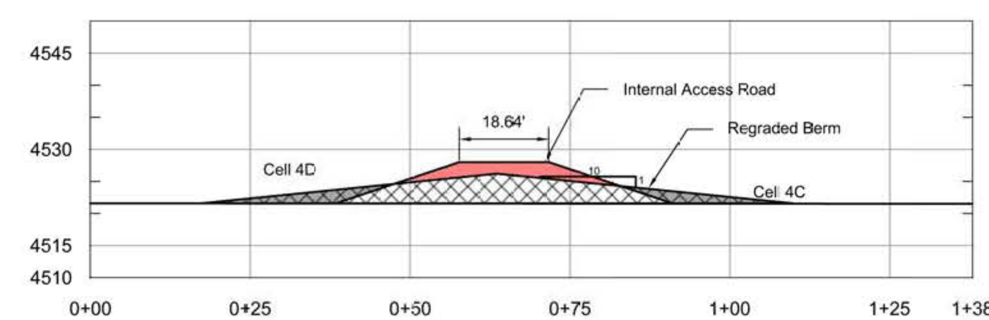
Mining Condition



Cell 4 Northern Berm
Typical Cross Section



Cell 4 Internal Berm
Typical Cross Section



CRYSTAL PEAK MINERALS INC.

LEGEND

Reclaimed Condition Contours (1')
Mining Condition Contours (1')

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
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N

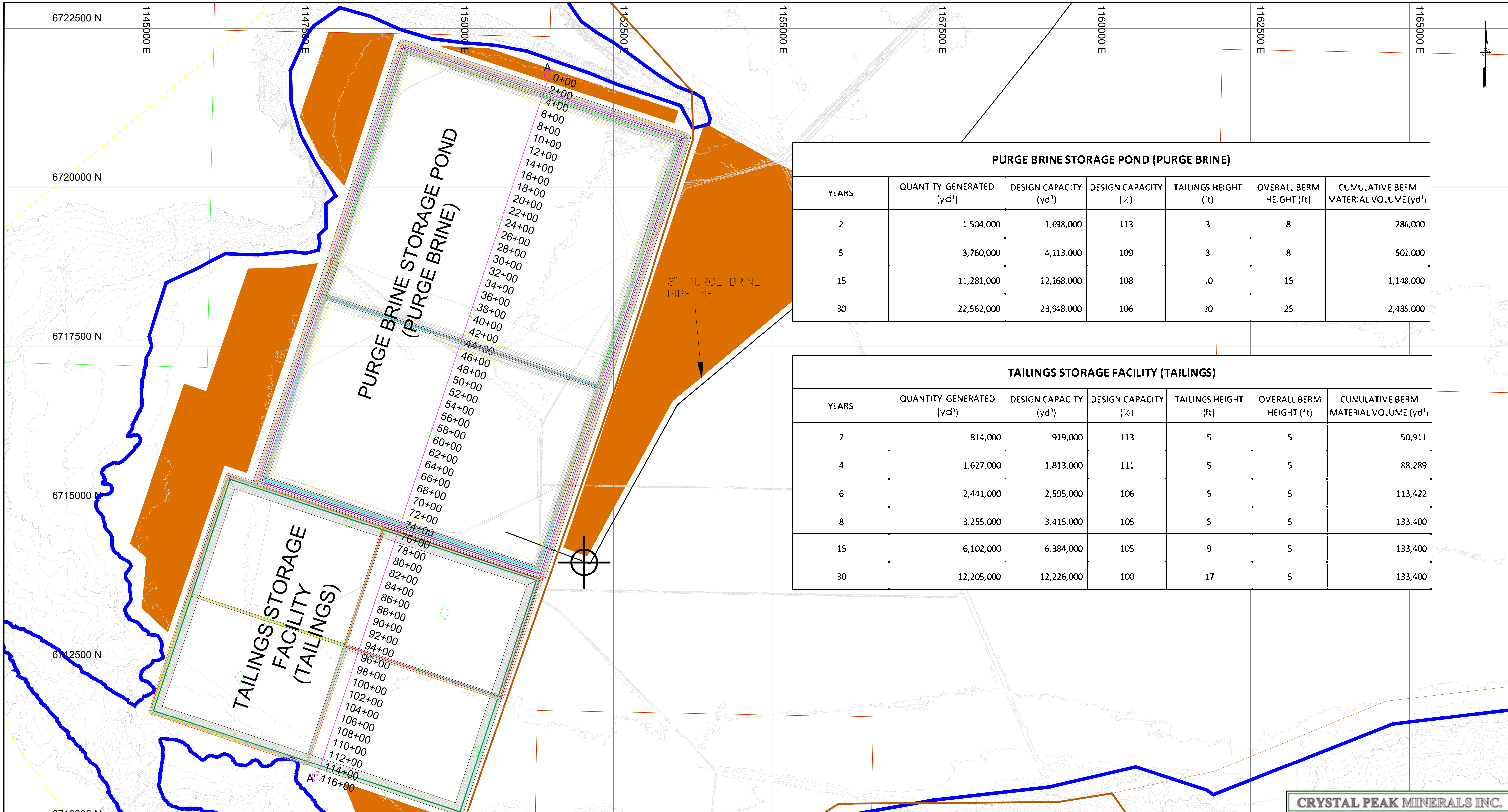
NO.	DATE	REVISION	BY	APVD
0	9-5-18	INITIAL SUBMITTAL	TJS	AB

DSGN	DR	CHK	APVD
NS	NS	AB	AB

FIGURE C2-5

Sevier Playa Potash Project
Production Ponds
Cell 4 Berm Cross Sections

DATE: 07/27/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: As Shown
NORWEST CORPORATION



PURGE BRINE STORAGE POND (PURGE BRINE)

YEARS	QUANTITY GENERATED (yd^3)	DESIGN CAPACITY (yd^3)	DESIGN CAPACITY (%)	TAILINGS HEIGHT (ft)	OVERALL BERM HEIGHT (ft)	CUMULATIVE BERM MATERIAL VOLUME (yd^3)
2	1,504,000	1,698,000	113	3	8	286,000
5	3,760,000	4,113,000	109	3	8	502,000
15	11,281,000	12,168,000	108	10	15	1,148,000
30	22,562,000	23,948,000	106	20	25	2,485,000

TAILINGS STORAGE FACILITY (TAILINGS)

YEARS	QUANTITY GENERATED (yd^3)	DESIGN CAPACITY (yd^3)	DESIGN CAPACITY (%)	TAILINGS HEIGHT (ft)	OVERALL BERM HEIGHT (ft)	CUMULATIVE BERM MATERIAL VOLUME (yd^3)
2	814,000	919,000	113	5	5	50,911
4	1,627,000	1,813,000	112	5	5	88,289
6	2,441,000	2,595,000	106	5	5	113,422
8	3,255,000	3,415,000	105	5	5	133,400
15	6,102,000	6,384,000	105	9	5	133,400
30	12,205,000	12,226,000	100	17	5	133,400

LEGEND

- Purge Brine Berm Crest (2 years)
- Purge Brine Berm Crest (5 years)
- Purge Brine Berm Crest (15-30 years)
- Borrow Area
- Filter Cake Berm Crest (2 years)
- Filter Cake Berm Crest (4 years)
- Filter Cake Berm Crest (6 years)
- Filter Cake Berm Crest (15-30 years)
- Sevier Playa Boundary
- Perimeter Road
- State Lease Boundary
- Federal Lease Boundary
- Purge Brine Fill Station Dust Suppression

NOTES:

1. THE AREA DELINEATED FOR THE BORROW AREA ACCOUNTS FOR AN OFFSET OF 500FT FROM WELLS AND TRENCH. TO ACCOUNT FOR THIS DELINEATION, THE BORROW AREA FOOTPRINT HAS BEEN INCREASED BY 20 PERCENT.
2. DEPTH OF BORROW AREAS ARE APPROXIMATELY 2 FEET.

1500 0 750 1500 3000
FEET

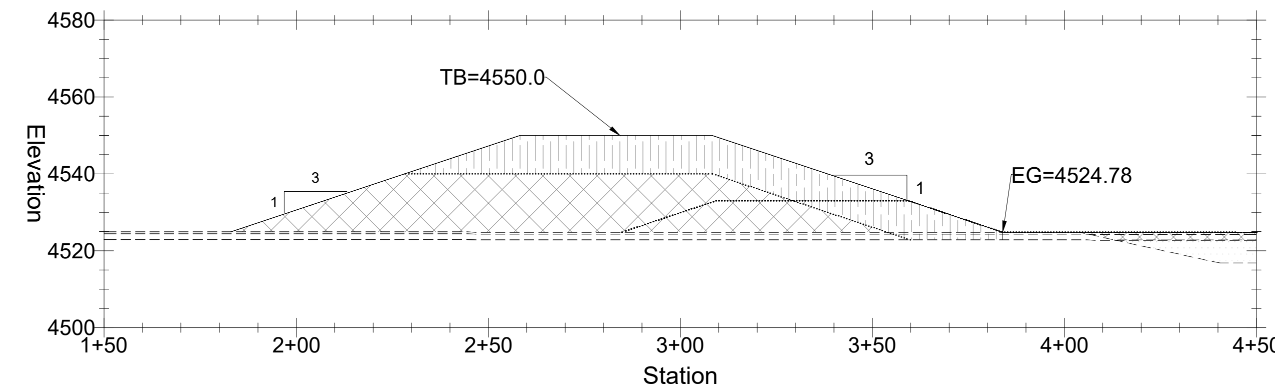
NO.	DATE	REVISION	BY	APVD
0	10-1-18	INITIAL SUBMITTAL	PK	AB

DSGN	DR	CHK	APVD
PK	PK	AB	AB

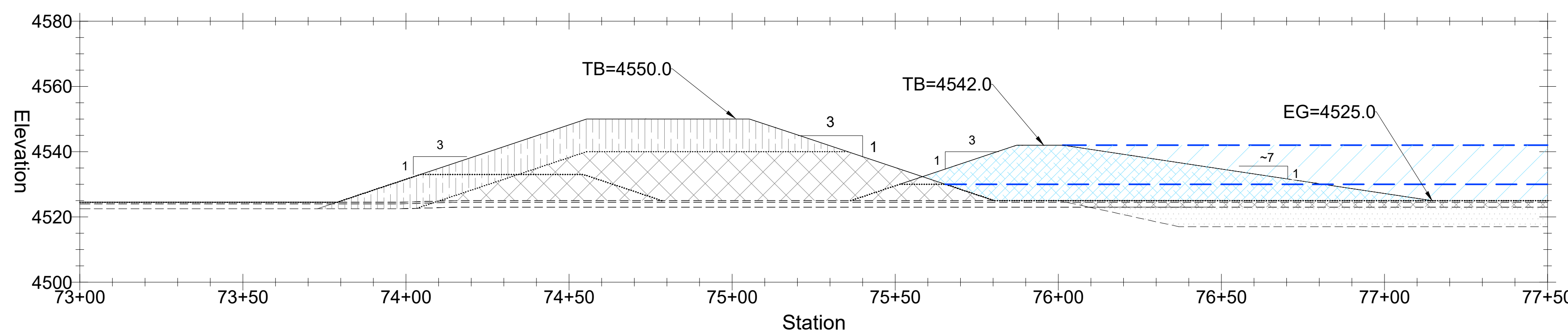
FIGURE C3-1

Sevier Playa Potash Project
Waste Product Storage Facility
Plan-View

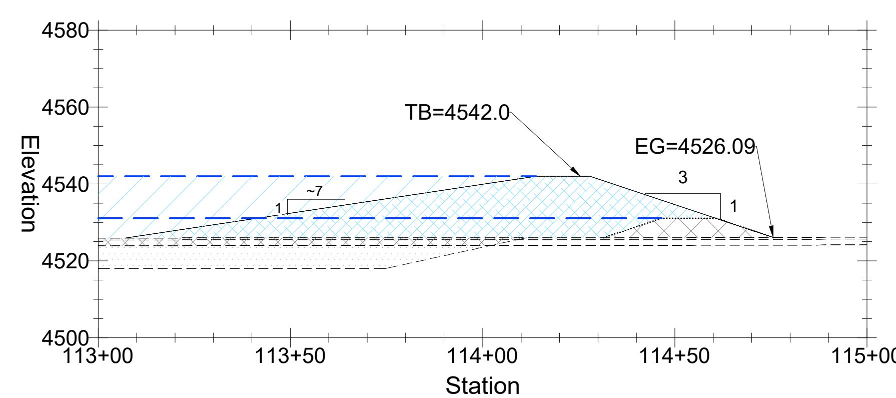
DATE: 10/01/2018
Figure C3-X TSF.dwg
TYPICAL CROSS SECTIONS
SCALE: 1"=1500'
NORWEST Stantec



PURGE BRINE STORAGE POND



PURGE BRINE STORAGE POND AND TAILINGS STORAGE AREA



TAILINGS STORAGE AREA

CRYSTAL PEAK MINERALS INC.

LEGEND

- Existing Ground
- Operational Ground
- Finished Ground
- Low Permeability Fill
- Common Fill
- Compacted Filter Cake
- Filter Cake

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

50 0 50 100

SCALE 1" = 50'-0"

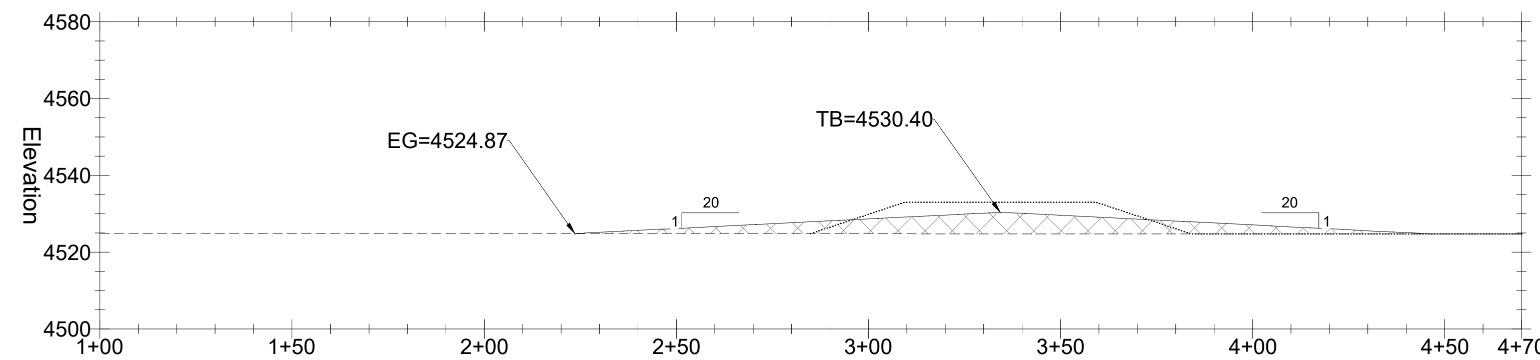
NO.	DATE	REVISION	BY	APVD
0	10-1-18	INITIAL SUBMITTAL	PK	AB

DSGN	DR	CHK	APVD
PK	PK	AB	AB

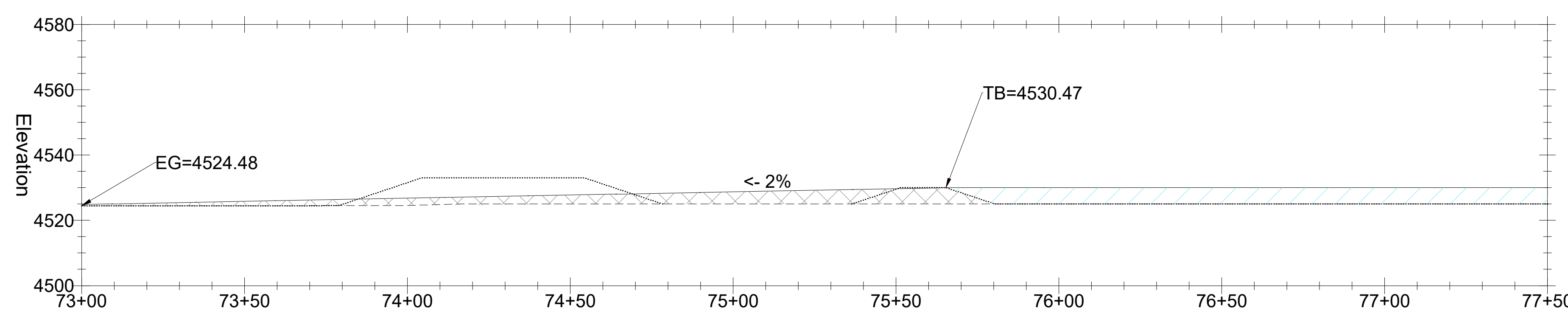
FIGURE C3-2

Sevier Playa Potash Project
Waste Product Storage Facility
Life of Mine Typical
Cross Sections

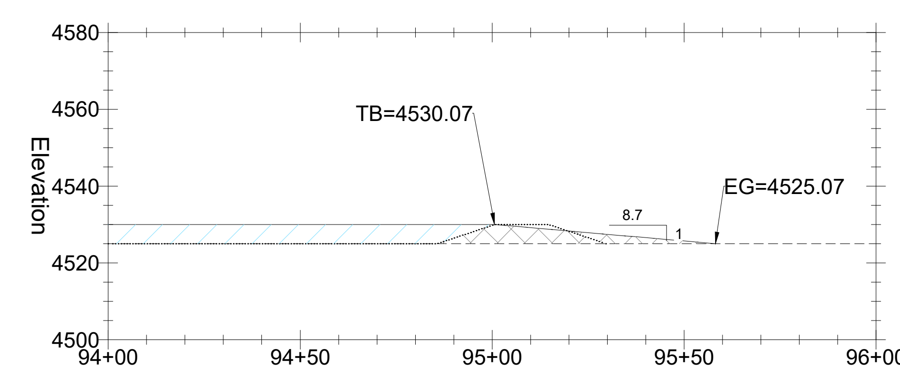
DATE: 10/01/2018
Figure C3-X TSF.dwg
TYPICAL CROSS SECTIONS
SCALE: 1"=40'
NORWEST Stantec



PURGE BRINE STORAGE POND



PURGE BRINE STORAGE POND AND TAILINGS STORAGE AREA



TAILINGS STORAGE AREA

CRYSTAL PEAK MINERALS INC.

LEGEND

- Existing Ground
- Operational Ground
- Finished Ground
- Common Fill
- Filter Cake

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

50 0 50 100

SCALE1" = 50'-0"

NO.	DATE	REVISION	BY	APVD
0	10-1-18	INITIAL SUBMITTAL	PK	AB

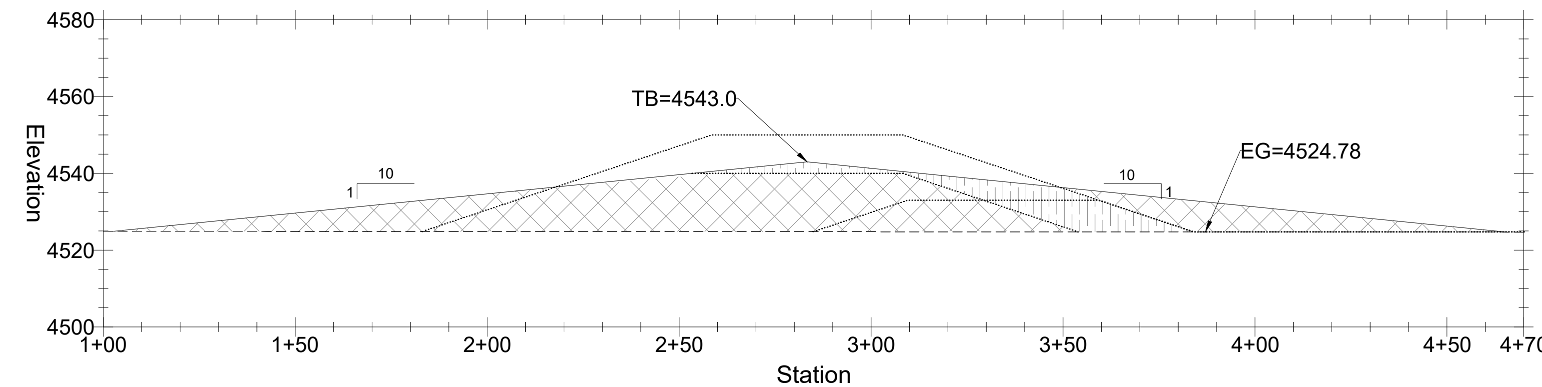
DSGN	DR	CHK	APVD
PK	PK	AB	AB

FIGURE C3-3

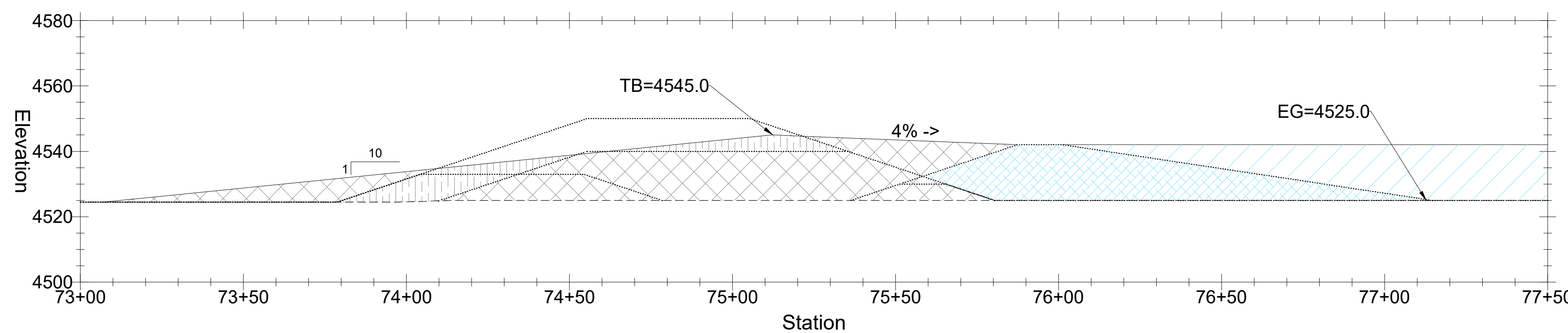
Sevier Playa Potash Project
Waste Product Storage Facility
Year 5 Reclamation Typical
Cross Sections

DATE: 10/01/2018
Figure C3-X TSF.dwg
TYPICAL CROSS SECTIONS
SCALE: 1"=40'

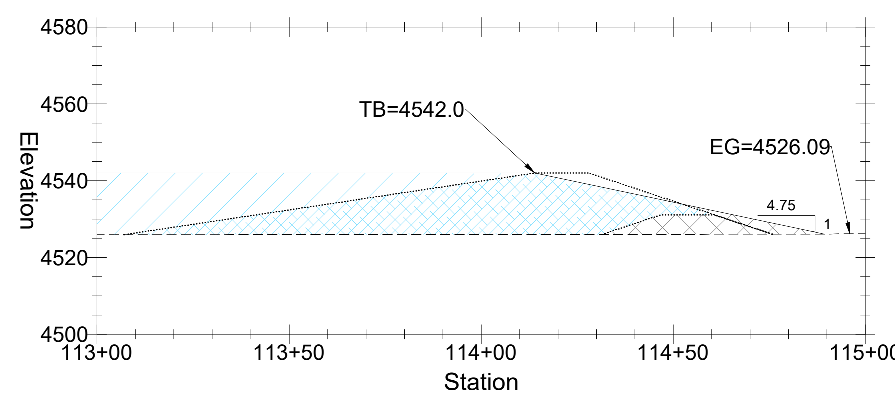
NORWEST Stantec



PURGE BRINE STORAGE POND



PURGE BRINE STORAGE POND AND TAILINGS STORAGE AREA



TAILINGS STORAGE AREA

CRYSTAL PEAK MINERALS INC.

LEGEND

- Existing Ground
- Operational Ground
- Finished Ground
- Low Permeability Fill
- Common Fill
- Compacted Filter Cake
- Filter Cake

NOTES:

1. SOURCE BERM MATERIAL WITHIN THE FOOTPRINT OF THE PONDS DURING INITIAL CONSTRUCTION.
2. DO NOT EXCAVATE CLOSER THAN 20' FROM THE TOE OF THE BERM FOR SOURCE MATERIAL. FURTHER GEOTECHNICAL FIELD TEST PROGRAM IS REQUIRED PRIOR TO BEGINNING CONSTRUCTION.
3. REMOVE TOP 6" OF UNSUITABLE NATIVE MATERIAL WITHIN FOOTPRINT OF THE BERMS AND DISCARD.
4. DIGGING DEPTH IS INDICATIVE OF THE DEPTH TO MARL CLAY. LEAVE 2 FEET OF FAT CLAY BARRIER BETWEEN TOP OF MARL AND THE POND FLOOR.

50 0 50 100

SCALE: 1" = 50'-0"

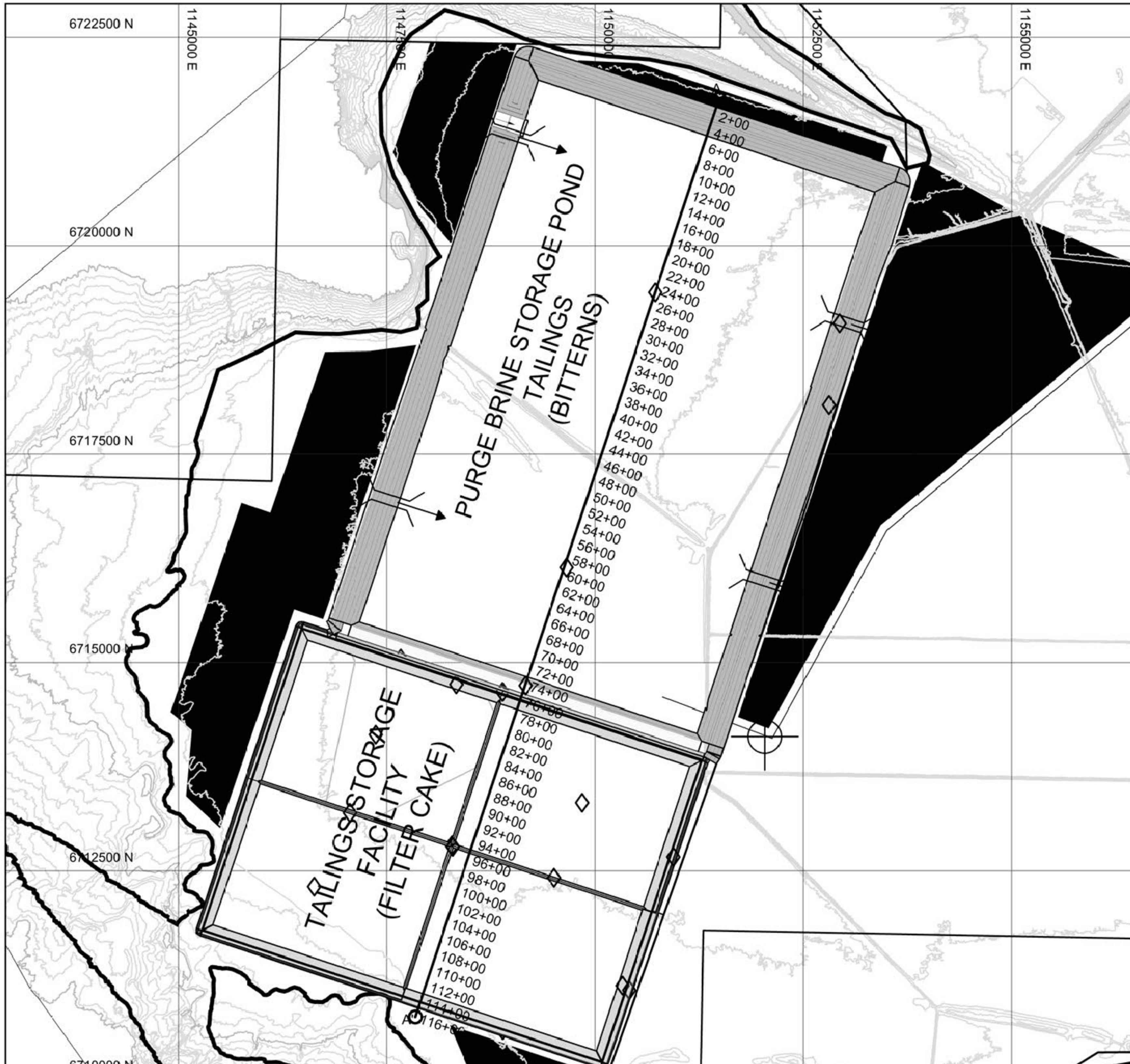
NO.	DATE	REVISION	BY	APVD
0	10-1-18	INITIAL SUBMITTAL	PK	AB

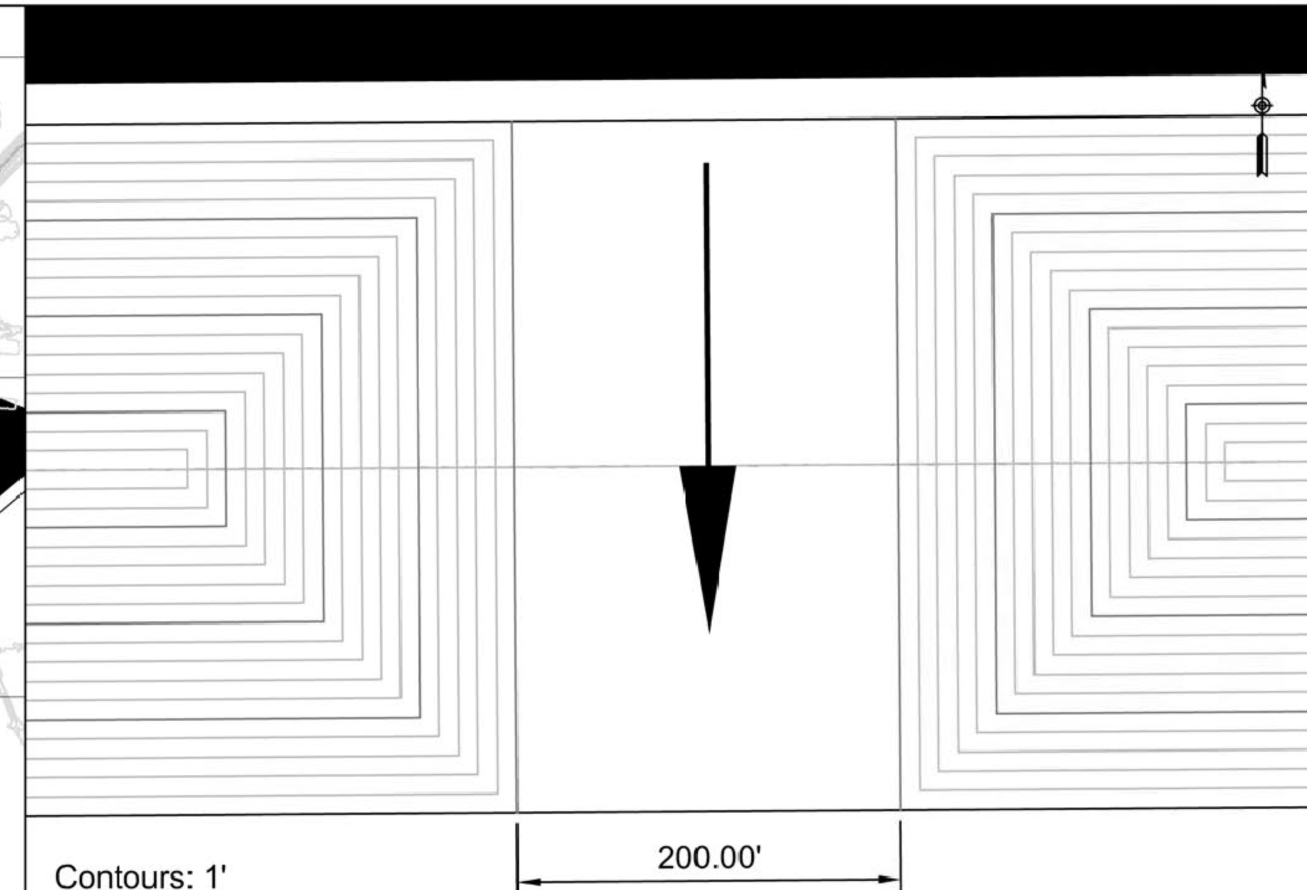
DSGN	DR	CHK	APVD
PK	PK	AB	AB

FIGURE C3-4

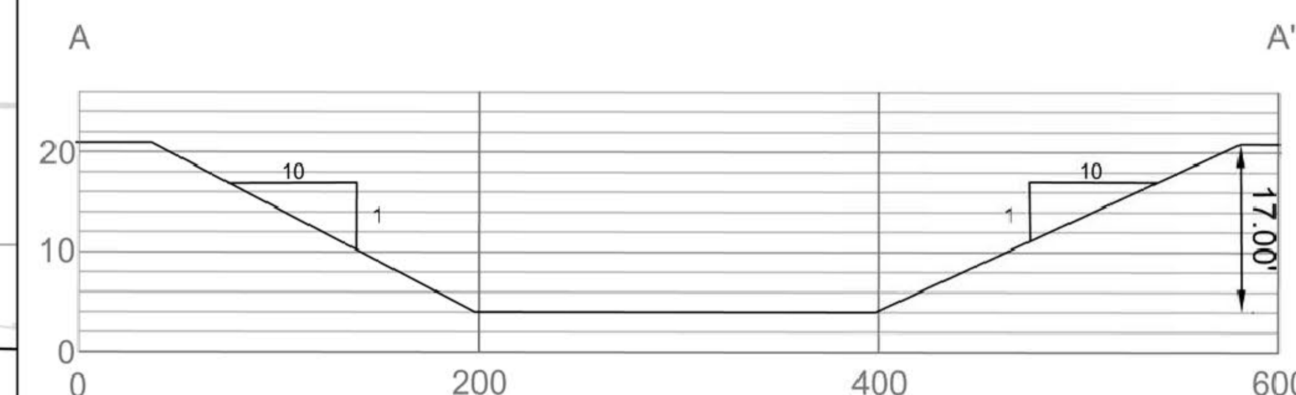
Sevier Playa Potash Project
Waste Product Storage Facility
Life of Mine Reclamation Typical
Cross Sections

DATE: 10/01/2018
Figure C3-X TSF.dwg
TYPICAL CROSS SECTIONS
SCALE: 1"=40'
NORWEST Stantec





TYPICAL BREACH CONFIGURATION



CRYSTAL PEAK MINERALS INC.

LEGEND

- Purge Brine Berm Crest (2 years)
- Purge Brine Berm Crest (5 years)
- Purge Brine Berm Crest (15-30 years)
- Borrow Area
- Filter Cake Berm Crest (2 years)
- Filter Cake Berm Crest (4 years)
- Filter Cake Berm Crest (6 years)
- Filter Cake Berm Crest (15-30 years)
- Sevier Playa Boundary
- Perimeter Road
- State Lease Boundary
- Federal Lease Boundary
- Purge Brine Fill Station Dust Suppression
- Breach Location

NOTES:

1. THE AREA DELINEATED FOR THE BORROW AREA ACCOUNTS FOR AN OFFSET OF 500FT FROM WELLS AND TRENCH. TO ACCOUNT FOR THIS DELINEATION, THE BORROW AREA FOOTPRINT HAS BEEN INCREASED BY 20 PERCENT.
2. DEPTH OF BORROW AREAS ARE APPROXIMATELY 2 FEET.

1500 0 750 1500 3000

FEET

NO.	DATE	REVISION	BY	APVD
2	07-31-18	PROGRESS DESIGN DETAILS	PK	AB
1	01-05-18	MADE REQUESTED CHANGES	GWH	AB
0	10-25-17	INITIAL SUBMITTAL	GWH	AB

DSGN	DR	CHK	APVD
GWH	GWH	AB	AB

FIGURE C3-5

Sevier Playa Potash Project
Waste Product Storage Facility
Plan-View

DATE: 09/22/2018
Figure 6-28 PCP TYPICAL CROSS SECTIONS
SCALE: 1"=1500'

APPENDIX G

Water Monitoring Plan for the Sevier Playa Potash Project (WMP)

(Included as Attachment)

Stantec

Water Monitoring Plan for the Sevier Playa Potash Project

June 4, 2019

Prepared by:
Stantec Consulting Services, Inc.
American Plaza II
57 W. 200 So., Suite 500
Salt Lake City, UT 84101

Prepared for:
Crystal Peak Minerals
2150 South 1300 East, Suite 550
Salt Lake City, Utah 84106

Revision	Description	Author		Quality Check		Independent Review	
10/25/18	Final Draft	Tom Suchoski/ Rich White	10/25/18	Rich White	10/25/18	Toni Jack	10/25/18
2/11/19	Draft Revision	Tom Suchoski/ Rich White	2/11/19			Toni Jack	2/11/19
2/14/19	Draft Revision	Tom Suchoski	2/13/19			Toni Jack	2/14/19
4/5/19	Draft Revision	Tom Suchoski/ Rich White	4/3/19	Betsy Lang	4/4/19	Toni Jack	4/5/19
4/15/19	Draft Revision	Tom Suchoski/ Rich White	4/16/19	Betsy Lang	4/16/19	Toni Jack	4/15/19
6/4/19	Draft Revision	Rich White	6/4/19	Betsy Lang	6/4/19	Tom Suchoski	6/4/19

Sign-off Sheet

This document entitled Water Monitoring Plan for the Sevier Playa Potash Project was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Crystal Peak Minerals, Inc. ("CPM"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ____

(signature)

Tom Suchoski/Rich White

Reviewed by ____

(signature)

Rich White

Approved by ____

(signature)

Tom Suchoski

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Abbreviations

ac-ft	acre-feet (ac-ft)
AF/yr	Acre Feet per year
AO	Authorized Officer
bgs	below ground surface
BLM	U.S. Bureau of Land Management
CPM	Peak Minerals Inc. (DBA “Crystal Peak Minerals”)
FCZ	Fat Clay Zone
HSU	hydrostratigraphic unit
MCZ	Marl Clay Zone
mg/L	Milligrams per liter
Plan	Water Monitoring Plan
Project	Sevier Playa Potash Project
SCZ	Siliceous Clay Zone
SITLA	State of Utah School and Institutional Trust Lands Administration
SOP	Sulfate of potash
Stantec	Stantec Consulting Services Inc.
SWCA	SWCA Environmental Consultants
t/ft^2	tons/square feet
TDS	total dissolved solids
TMDL	total maximum daily load
UDWQ	Utah Division of Water Quality
USGS	U.S. Geological Survey
UGWQS	Utah Groundwater Quality Standard
WDWQ	Utah Division of Water Quality
XRD	X-ray Powder Diffraction

1.0 INTRODUCTION

1.1 Background

Crystal Peak Minerals ("CPM") is proposing to construct and operate the Sevier Playa Potash Project ("Project") on federal, state, and private lands in Millard County, Utah (Figure 1-1). The Project would be designed to produce an average of approximately 328,500 tons per year of potash in the form of potassium sulfate (K_2SO_4), also known as sulfate of potash ("SOP"), as well as other associated minerals. CPM owns as lessee, or through agreement, controls the right to develop and operate potassium mineral leases on approximately 118,000 acres of land on and adjacent to the Sevier Playa administered by the U.S. Bureau of Land Management ("BLM"), and controls through agreement potash mineral leases on an additional approximately 6,400 acres of state lands administered by the State of Utah School and Institutional Trust Lands Administration ("SITLA").

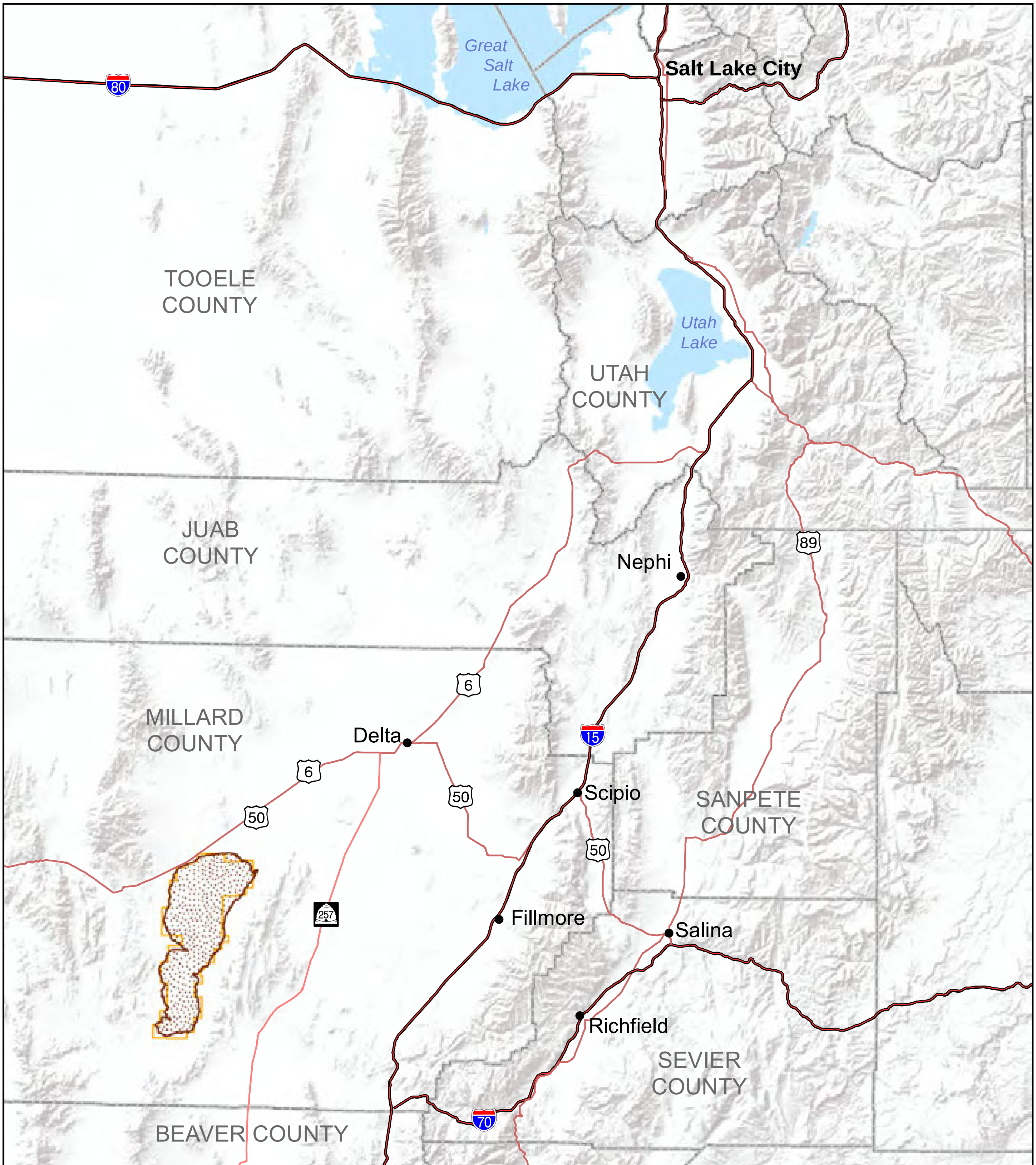
In general, the on-lease mining design for the Project would consist of the following three major features: 1) a brine extraction system consisting of canals, trenches, and wells; 2) a recharge system consisting of canals and trenches; and 3) a series of evaporation ponds consisting of preconcentration and production ponds (Figures 1-2 and 1-3). Details regarding the proposed activities are presented in the Mining Plan and Plan of Development. The brines extracted from below the surface of the Sevier Playa would be concentrated by solar evaporation in a series of Preconcentration Ponds. The brines would be further evaporated, and the potassium-rich salts precipitated in the Production Ponds would be harvested and transported to an on-lease Processing Facility. The salts would be processed at the Processing Facility to produce saleable SOP, as well as other associated minerals.

Infrastructure to support the Project would include: 1) access roads; 2) communication towers; 3) power and communications lines; 4) a natural gas pipeline; 5) a rail loadout facility and associated rail spur; and 6) water supply facilities (Figure 1-4). These components would all be located on off-lease lands.

The Utah Division of Water Quality ("UDWQ"), as the regulatory agency with jurisdiction over groundwater within the state, requires that a baseline assessment of the groundwater resources in the area be prepared as part of an anticipated Groundwater Discharge Permit application. Further, the federal lease held by CPM contains two special lease stipulations that require monitoring of surface and groundwater in the vicinity of the Project (BLM, 2011).

Special Stipulation 8 of the federal leases states:

> "The lessee at his expense, will be responsible to replace any water resources (that contain in a base line analysis of <10,000 mg/L TDS [total dissolved solids]), that are lost or adversely affected (quality or quantity) by their mining operations. . . . If replacement is required, the lessee shall replace the sources with an alternate source in the same quantity and quality to maintain existing uses. . . . The lessee/operator shall obtain sufficient baseline data and monitoring in order to establish parameters to show whether water resources are affected."



Sevier Playa Boundary

BLM and SITLA Lease Boundary

N

0 20 40 Miles

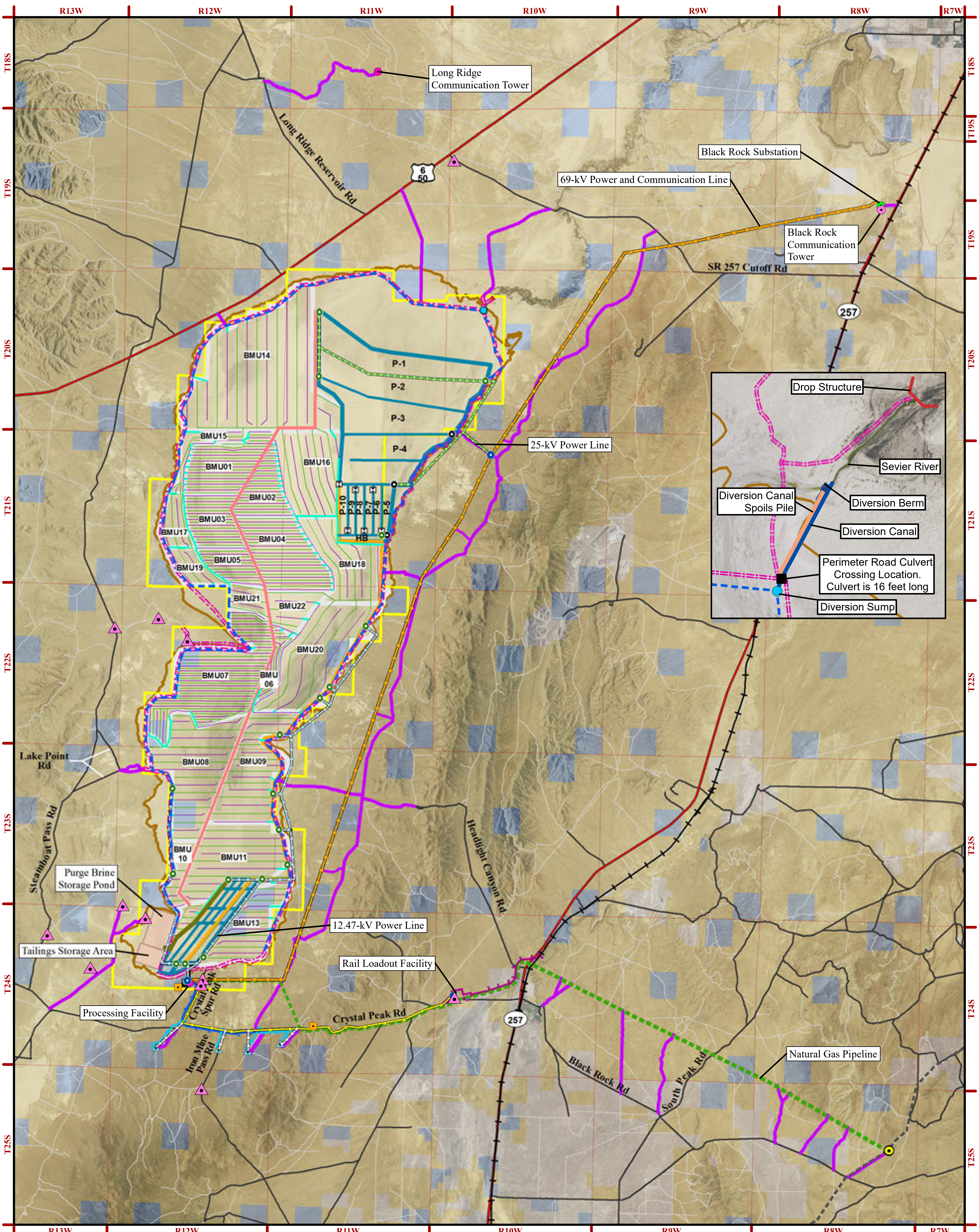
1 in = 20 miles 1:1,267,200

Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

FIGURE 1-1
Regional Vicinity

SEVIER PLAYA POTASH PROJECT

WMP Fig 1-1 - Regional Location Map 20171026 10/26/2017 4:33:44 PM



Proposed Project Features

- 69-kV Power and Communication Line
- 25-kV Power Line
- 12.47-kV Power Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Access Road - Off-Lease
- Perimeter Road and Spurs - On-Lease
- Rail Spur and Access Corridor
- Recharge Trench
- Extraction Trench
- Recharge Collector
- Recharge Canal
- Extraction Canal
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Preconcentration and Production Ponds
- Pump Station - Off-Lease
- Pump Station - On-Lease
- Gravel Pit
- Preconcentration Pond Weir
- Water Supply Pipeline
- Water Supply Pipeline Spur
- Water Supply Well
- Communication Tower
- Substation
- Sevier River Diversion
- Brine Mining Unit Boundary
- Natural Gas Pipeline
- Water Monitoring Well

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- Kern River Natural Gas Pipeline
- Kern River Valve Station
- Black Rock Substation
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

N

0 2 4 Miles

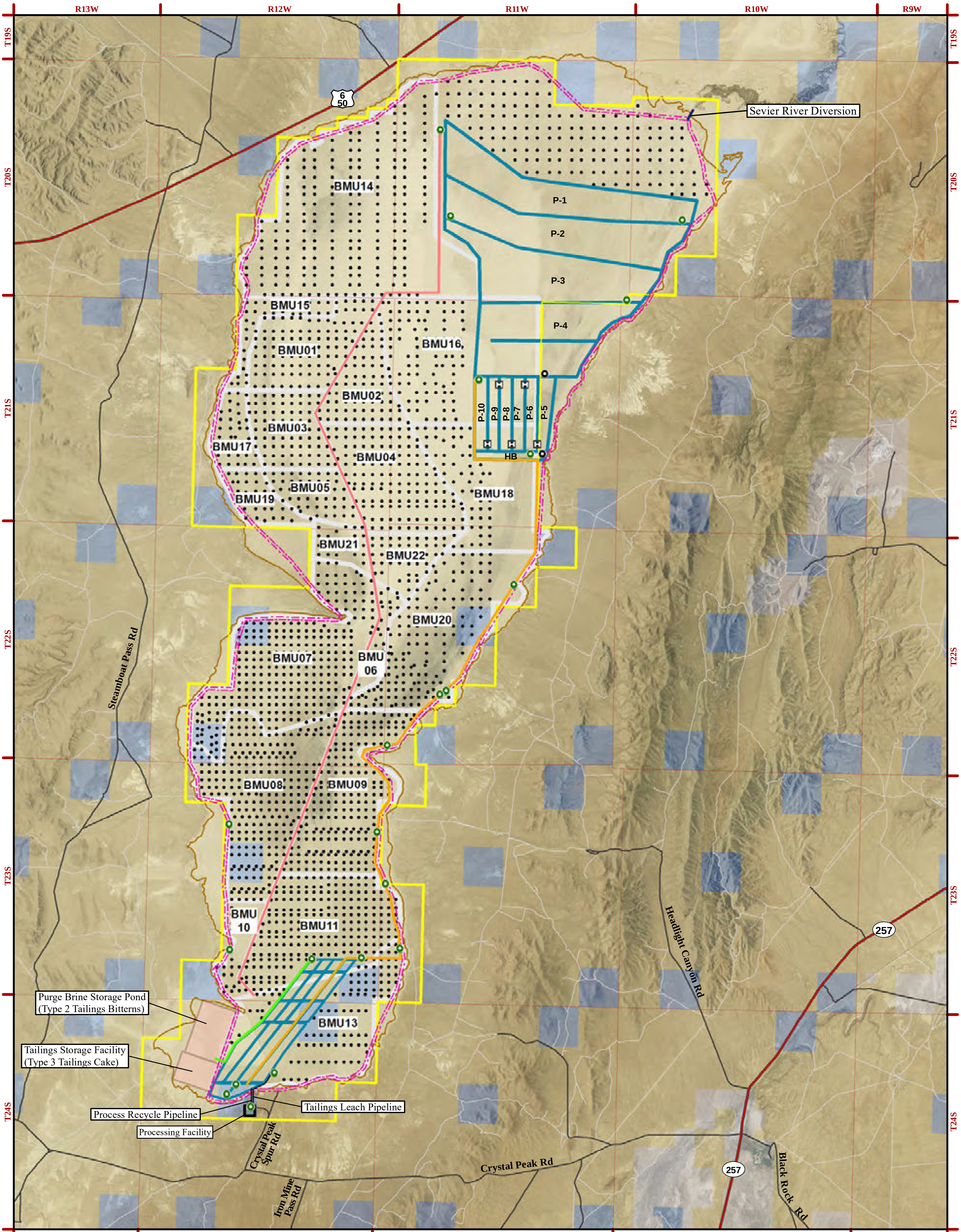
1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015-2019;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Landownership, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagery, USDA/APFO 2016

Note:
The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the Project.

FIGURE 1-2
Proposed Layout of Mine Facilities
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

WMP Fig 1-2 - Project Facilities Overview 190402 4/2/2019 4:38:00 PM



Project Features

- Siliceous Clay Well
- Perimeter Road
- Brine Mining Unit Boundary
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Main Extraction Canal
- Preconcentration Pond Weir
- Pump Station
- Pump Station - Off Lease
- Sevier River Diversion
- Tailings Area
- Preconcentration and Production Ponds
- Processing Facility

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township and Range

Land Ownership

- BLM
- State Lands
- Private

N

0 2 4 Miles

1:150,000

Sources:
Project features, Crystal Peak Minerals 2015, 2016, 2017;
Sevier Playa Boundary, SWCA 2015;
Norwest, 2017;
Public land survey system, BLM 2013;
Roads, Millard County, 2013;
Aerial Imagy, NAIP 2016

Figure 1-3
Mine Plan Extraction Well Locations
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT
10/26/2017

Notes:
• The project facilities not drawn to exact scale to improve legibility of figure.
• The project facilities shown on this map are draft and may be revised and/or refined throughout the development of the project.
• All production extraction features will terminate at least 500 feet inside lease boundary.

WMP Fig 2-3 Extraction Well Locations20171026 10/26/2017 4:17:27 PM

Proposed Project Features

- Water Supply Pipeline
- Water Supply Pipeline Spur
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Water Supply Well
- Access Road - Off-Lease
- Processing Plant Perimeter Security Fence

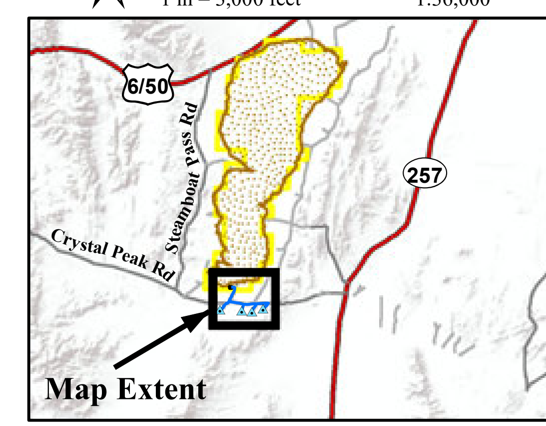
General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Class B Road
- Dirt Track Road
- Land Ownership
  - BLM
  - State Lands

N

0 0.5 1 Miles

1 in = 3,000 feet 1:36,000



Note:
- The Utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

Sources:
Project features, Crystal Peak Minerals, 2016-2019;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Aerial Imagy, USDA/APFO 2016

Figure 1-4
Water Supply and Distribution Facility Overview

WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

WMP_Fig_1-4 Water Well and Water LIne Overview190403 4/3/2019 11:47:37 AM

Special Stipulation 13 of the federal leases states:

> "Sufficient base line data shall be established prior to conducting any surface disturbing activity which shall be determined necessary by the AO [Authorized Officer]. In order to accomplish this, the lessee shall submit for review and approval by the AO a plan to analyze ground and surface water interactions as part of any operations or exploration on the leases. The plan shall be submitted prior to or concurrent with a Mining or Exploration plan, under 43 CFR 3592.1. The plan shall include, but not be limited to the following items, and shall describe how the lessee proposes to; (1) develop sufficient baseline groundwater information to document existing hydrogeology associated with Sevier Lake basin fill and underlying carbonates, encompassing a reasonable area of potential resources, springs, and the alluvial and bedrock aquifers. This shall include items such as the location, size, and depth of any hole that would encounter water and/or brine as well as any information that would be collected on each hole. (2) Determine the potential impacts to existing water right holders, wells, wetlands, and surface and groundwater throughout their operations. Water chemistry (including stable isotopes as necessary), estimated flow and water quantity (water balance) shall be addressed. (3) Monitor the actual impacts to groundwater resources throughout and surrounding the operation including but not limited to changes in meteoric precipitation and springs, wells (base conditions, water levels, and chemistry conditions prior to construction and monitoring after construction), wetlands, and ditches. Wells, wetlands, and springs (at sites determined to be relevant based upon the groundwater study that would be conducted prior to development) shall be monitored during operations in order to minimize potential impacts to groundwater resources by allowing an early identification. Further, the plan shall contain sufficient detail to allow it to be independently assessed and include such things as the type of groundwater model that would be used (and/or other methods of analysis), phasing of the analysis and proposed iterative studies. The plan shall also contain a list of people and their qualifications to accomplish the work and a list of deliverables with a timing schedule. The lessee shall be responsible for any cost incurred for the plan and the accomplishing of the work."

1.2 Plan Purpose

This Water Monitoring Plan ("Plan") was developed to address the applicable requirements of the above-noted rules and stipulations. Implementation of this Plan would be the responsibility of those individuals listed in Attachment A. The intent of this Plan is to provide a framework for the collection of both baseline and operational hydrologic data in the vicinity of the Sevier Playa to aid in assessing the impacts of the Project, if any, on surface and groundwater. Specifically, in accordance with Special Stipulation 13, this Plan was designed to:

1. Document baseline groundwater conditions associated with the playa sediments as well as the adjacent alluvial/colluvial sediments and the bedrock that underlies the region;
2. Provide sufficient data to evaluate the potential impacts of Project operations on existing water right holders, wells, riparian areas, surface water, and groundwater;
3. Provide a framework for monitoring hydrologic resources in the vicinity of the Sevier Playa to determine whether Project operations impact surface and groundwater resources near the playa, thereby allowing an early identification of impacts and the development of mitigation plans to minimize those impacts; and
4. Define a framework and schedule for evaluation and reporting of Project water-resource data.

With respect to Item 3 above, CPM would implement an adaptive management approach to the collection and evaluation of data under this Plan. This approach is summarized graphically in Figure 1-5. The first two phases of this cycle have been completed. However, under adaptive management, these phases would be re-visited over time. Future data collected under this Plan would determine the extent to which adaptations of the Plan and/or Project operations become necessary. Such adaptations may include the installation of new monitoring wells, changes to the analyte list, modifications to the frequency at which data are collected, alterations to the methods used to handle products, etc. As these adaptations are made, critical threats (e.g., contamination of local groundwater supplies) would be re-evaluated and future monitoring efforts would be modified, if necessary. The cycle would then continue.

The focus of this Plan is the collection of baseline data and documentation of baseline hydrologic conditions within and near the playa (i.e., Item 1 above). Hydrologic data collected prior to 2018 would also be evaluated under this Plan to determine the appropriateness of including these data in the Project baseline database. While this Plan would serve as a framework for monitoring hydrologic conditions during the period of Project operations (Item 3 above), experience gained during the baseline monitoring period may dictate modifications to ensure that the Plan remains appropriately focused during the operational period. Any such modifications would be submitted to UDWQ and BLM for approval before they are implemented.

The baseline and operational data would serve as the basis for evaluating the potential impacts of Project operations on baseline water resources (i.e., Item 2 above). Therefore, this Plan presents a discussion of the statistical evaluations and data-analysis methods that would be used to assess the extent and magnitude of Project impacts, if any, on water resources (see Attachment C). This evaluation would be ongoing during the course of operations and would be discussed in quarterly data submittals and annual water-monitoring reports as further described in this Plan.

For ease of review, this Plan is divided into five sections, including this introduction (Section 1). Section 2 provides information regarding the hydrologic setting of the Sevier Playa. A description of methods proposed for the collection and validation of historic and new baseline data is presented in Section 3, followed in Section 4 by a discussion of planned data-evaluation procedures. References cited in this Plan are presented in Section 5. Appendices follow the text.

Figure 1-5. Adaptive Management Cycle[1]

[1] Source: https://www.miradi.org/open-standards/

2.0 HYDROLOGIC SETTING

The area of interest associated with this Plan is shown in Figure 2-1. This area extends generally 3 to 4 miles beyond the lease area on the west, south, and east sides of the playa, with the western boundary of the area extending into the foothills of the House Range and Black Hills, the eastern boundary extending to the ridge of the Cricket Mountains, and the southern boundary extending to the foothills of the San Francisco Range. On the north, the area of interest extends north of US Highway 6/50 and northeast to Conks Dam.

The area of interest shown on Figure 2-1 is generally smaller than that being evaluated by BLM in their Environmental Impact Statement regarding the Project. However, this boundary was set to extend beyond areas where it could reasonably be expected that water resources may be impacted by Project operations. The monitoring network described in Section 3.0, which includes surface-water monitoring locations as well as several existing and proposed groundwater monitoring wells, is designed to evaluate potential impacts on surface and groundwater quality or on hydrologic conditions resulting from Project operations (including brine extraction, brine processing, and freshwater well pumping). If future data indicate that hydrologic impacts from this Project may extend beyond the area of interest shown on Figure 2-1, the monitoring network would be expanded accordingly to ensure that the extent of those impacts is properly assessed.

2.1 PHYSIOGRAPHIC SETTING

The Sevier Playa is a terminal playa at the downstream end of the Sevier River, the drainage area of which covers approximately 16,200 square miles. The Sevier Playa area is characterized by north-trending, block-faulted ranges and alluvial slopes that encircle the down-dropped sediment-filled Sevier Lake graben, which forms the lowest part of the basin (Wilberg 1991). The Sevier River enters the basin from the northeast, between the Cricket Mountains and Long Ridge. There is no surface drainage out of the Sevier Playa. Based on LIDAR data, the surface of the Sevier Playa is relatively flat, but slopes very gently to a low point in the southern part of the northern half of the playa.

The Sevier Playa is located in western Utah's Sevier Desert, in a broad valley that is 10 to 15 miles wide and bounded on the east by the Cricket Mountains and on the west by the Black Hills portion of the House Range. South and southwest of Sevier Playa are the San Francisco and Wah Wah Mountains, respectively, which together flank the Wah Wah Valley (Figure 2-1). North of Sevier Playa, a portion of the topography slopes toward the playa as part of the gently south-sloping surface of the Sevier Desert. About 7 miles north of the playa, the topography divides and slopes to the north, away from the playa.

LEGEND

Sevier Playa Potash Project Water Resources Area of Interest

Sources:
Sevier Playa Potash Project Water Resources Analysis Area, Baseline Water Resources Technical Report for the Sevier Playa Potash Project, Whetstone 2017;
Land Jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO/NAIP 2016

0 5 10 20
Miles

1 inch = 10 miles

N

Figure 2-1
Physiographic Location
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

2.2 GEOLOGY

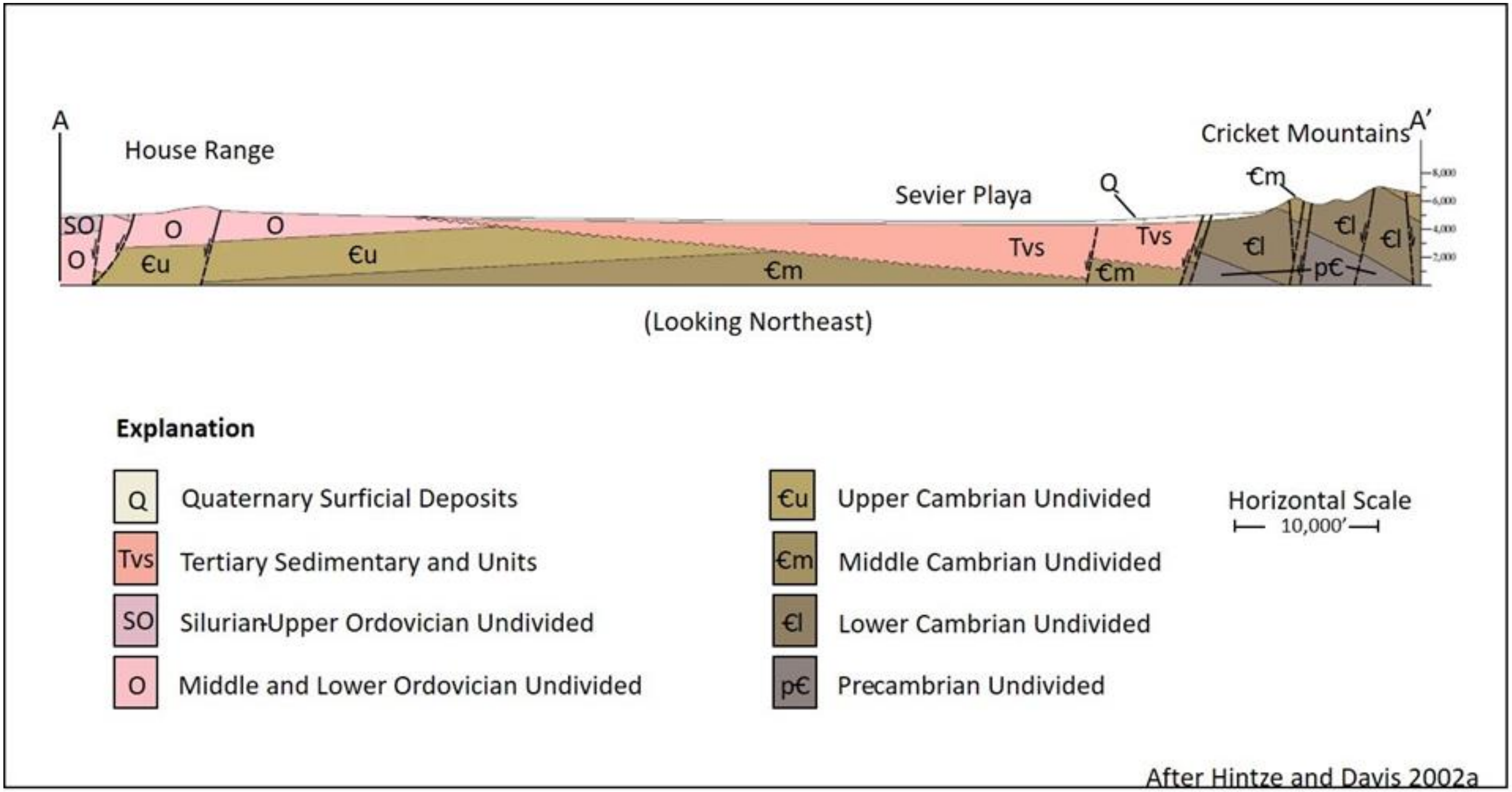
The Sevier Playa Basin lies within the Great Basin, an area of internal drainage within the Basin and Range physiographic province. The playa is a remnant of a succession of pluvial lakes (lakes fed by abundant rainfall during glacial periods) that formed during the Pleistocene epoch and culminated with the final high stand of Lake Bonneville approximately 15,000 years ago. Quaternary surficial materials were deposited in lacustrine and deltaic environments during the pluvial period, with playa and eolian environments developing as Lake Bonneville receded (Wilberg 1991).

The Sevier Playa is within an asymmetrical east-dipping graben between the Cricket Mountains and the House Range. The graben is bound to the east and west by high-angle normal faults. To the east, the faults are collectively referred to as the East Sevier Lake Fault Zone and are down-dropped approximately 4,000 feet to the west. Sedimentary fill near the east margin of the graben is estimated to be 4,600 feet thick (Case and Cook 1979). The West Sevier Lake Fault Zone is more loosely defined by high-angle normal faults near the north and central parts of the playa.

The Sevier Playa is composed of unconsolidated lacustrine, clayey sediments. Along the margins of the playa, these sediments interbed discontinuously with alluvial fan and colluvial deposits that generally consist of poorly sorted silt to cobble-sized material. These unconsolidated lacustrine, alluvial, and colluvial deposits overlie Cambrian to Ordovician-age limestone, dolomite, and quartzite (Hintze and Davis 2002a, 2002b), as indicated in the generalized stratigraphic cross section presented in Figure 2-2.

Tangalos et al. (2016) divided the Sevier Lake Basin into three hydrostratigraphic units ("HSUs") consisting of the Playa HSU, the Alluvial/Colluvial HSU, and the Regional Bedrock HSU. Heilweil and Brooks (2011) and Wilberg (1991) varied in their terminology from that of Tangalos et al. (2016) but still noted similar geologic conditions consisting of unconsolidated basin-fill and playa sediments as well as regionally-extensive bedrock. The terminology of Tangalos et al. (2016) will be used in this document. The Playa HSU, which represents the localized brine aquifer that is of interest to the Project, is further described in Section 2.4.1 of this Plan.

Figure 2-2 Stratigraphic Cross Section



2.3 SURFACE WATER

2.3.1 Sevier Playa

Surface water flows onto the Sevier Playa from the Sevier River and local ephemeral drainages that flow only in response to snowmelt or high-intensity rainfall. The upstream use of surface water for agricultural purposes and upstream storage in retention facilities greatly limits the volume of Sevier River water that enters the playa. Furthermore, transmission losses due to evaporation and infiltration generally reduce or consume ephemeral runoff before it reaches the edge of the playa.

Satellite imagery acquired from August 1999 through August 2002 (Gwynn 2006) indicates that water on the surface of the Sevier Playa occurs typically during November through April, though likely amounting to only several inches in depth due to local atmospheric conditions and substantial flow control placed on the river by upstream irrigation reservoirs (e.g., Gunnison Bend Reservoir and DMAD Reservoir[2]). During the remainder of the year (May through October), the majority of the playa's surface is typically dry. However, periodic wet climatic conditions occasionally create substantial flow onto the Sevier Playa and cover the playa with water. For example, from 1983 to 1987, runoff of about 2.27 million acre-feet (ac-ft) in the Sevier River reestablished Sevier Lake, which reached a maximum lake elevation of 4,527 feet in June 1985. In late 2011 and early 2012, Sevier Lake received an estimated 250,000 ac-ft of water, resulting in widespread inundation of the playa and up to 4.5 feet of standing water in some locations. The historical record of surface water is not complete, but periods of abnormally wet climatic conditions that flood the playa appear to occur with a frequency of about once every two decades.

2.3.2 Sevier River Below Gunnison Bend Reservoir

Regulations promulgated by UDWQ in UAC R317-2-13.6a classify the Sevier River below Gunnison Bend Reservoir as a Category 3 waterbody that is designated as Beneficial Use Class 2B, 3C, and 4 waters (secondary contact recreation, non-game fish and other aquatic life, and agricultural use, respectively). A 6-mile segment (Figure 2-3) of the Sevier River, directly above Crafts Lake, is mapped by the U.S. Geological Survey ("USGS") as a perennial stream (USGS 2014). The remaining segments of the river below Gunnison Bend Reservoir are mapped as intermittent (UDWQ 2014).

Surface water quality is subject to Section 303(d) of the Clean Water Act, which requires States to identify streams and lakes that do not meet water quality standards for their intended beneficial use and to establish total maximum daily loads (TMDLs) for various pollutants. Utah's 303(d) listed streams and established TMDLs are summarized in the 2016 Final Integrated Report (UDWQ 2016). Sevier River is not 303(d) listed below Gunnison Bend Reservoir and does not have a TMDL.

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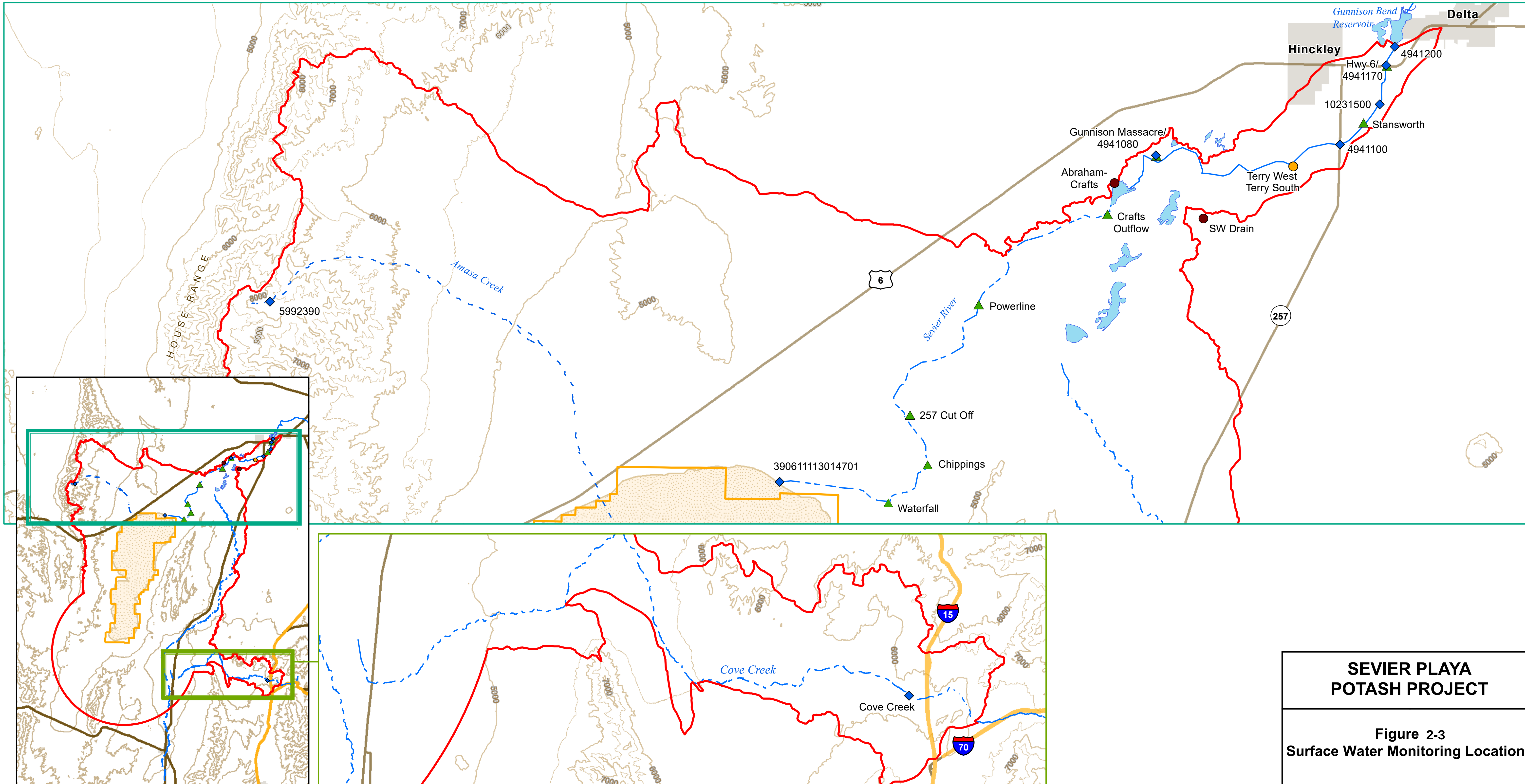
[2] DMAD Reservoir gained its name from the four irrigation companies that cooperated to build the dam in 1959 that created the reservoir (Delta, Melville, Abraham, and Deseret irrigation companies).



SEVIER PLAYA POTASH PROJECT

Figure 2-3
Surface Water Monitoring Locations

WATER MONITORING PLAN

0 1.5 3 4.5 6 Miles

N

Elevation Contour Interval: 500 ft
Projection: NAD83 UTM Zone 12N Meters

Date: 7/14/2017

Explanation

- Whetstone 2017 Boundary for Water Resources Analysis Area
- Sevier Playa Potash Project Lease Area
- Sevier Playa
- Interstate Highway
- Major Highway
- Perennial Stream
- Intermittent Stream
- Ephemeral Stream
- Lake or Reservoir
- 6000 Reference Contour
- Intermediate Contour

Surface Water Monitoring Stations

- Main Channel
- Irrigation Diversion
- Irrigation Return

Sampled during 2012/2013 investigation

- Station with Publicly Available Monitoring Data

Source:
Baseline Water Resources Technical Report for the Sevier Playa Potash Project (Whetstone, 2017)

Baseline surface water monitoring for the Project was performed for CPM by CH2M in 2012 and 2013 at several points along and near the Sevier River. The purpose of this monitoring was to assess streamflow and/or water quality below Gunnison Bend Reservoir. These baseline data can be supplemented with surface water data that are publicly available from sources maintained by the U.S. Geological Survey and the U.S. Environmental Protection Agency (Whetstone 2017). Locations where surface water data have been collected in the Project vicinity are shown on Figure 2-3. Streamflow data collected during 2012 and 2013 do not indicate a correlation between spring run-off or precipitation and flow in the Sevier River below Gunnison Bend Reservoir. This lack of correlation is not unexpected, given that flow in the river is highly controlled by upstream reservoirs, irrigation return flow, and groundwater seepage from Gunnison Bend Reservoir (CH2M 2015).

The Sevier River between the US Highway 6/50 and Stansworth monitoring locations (a river reach of 3.7 miles) experienced an increased flow up to 95 percent during 2012 and 2013 due to irrigation return water (CH2M 2015). During this period, the Sevier River continued to gain 3 percent water between the Conks Dam and Gunnison Massacre monitoring locations. Below Crafts Lake, the Sevier River transitions to a losing river, with an annual flow decrease of 13 to 18 percent during 2012 and 2013 over a distance of 18.8 miles (CH2M 2013). Although the magnitude of the losses and gains likely varies from year to year, the transition from a gaining river above Crafts Lake to a losing river below that location is probably consistent.

Water quality data for the Sevier River below Gunnison Bend Reservoir are available from four locations monitored by CPM (Table 2-1). Review of the CPM water quality data indicates that Sevier River below Crafts Outflow is well buffered sodium chloride water with variable TDS concentrations ranging from 884 to 4,700 mg/L. The highest concentrations typically occur in late fall and winter (October through March) sometimes with a secondary peak in April or May. This chemistry is consistent with UDWQ water quality monitoring at Deseret, Utah (No. 4941100), just below the Stansworth location (see Figure 2-3) that averaged 2,416 mg/L TDS for 186 samples collected between May 1980 and September 2014 (Whetstone, 2017). TDS concentrations in the Sevier River are typically greater than the agricultural standard (Class 4) of 1,200 mg/L at monitoring points closest to the playa. Review of water quality data collected from the Sevier River at the locations shown on Figure 2-3 indicates that water in the river sporadically exceeds the lowest Class 2B (recreation and aesthetics), Class 3C (non-game fish and other aquatic life), and Class 4 (agriculture) Utah State Class water quality standards for cadmium, lead, mercury, selenium, silver, zinc, and pH.

Table 2-1 Surface Water Samples Collected by CPM from Sevier River, below Gunnison Bend Reservoir

Parameter	Units	Lowest Standard Class 2B, 3C, 4	Crafts Outflow	257 Cutoff		Chippings	Waterfall
			Crafts Outflow SW-06102013 Lab ID # 1306182-005 06/10/2013	Sevier River Baseline Lab ID # 1202158-002 02/09/2012	257 Cutoff SW-06102013 Lab ID # 1306182-002 06/10/2013	Chippings 06102013 Lab ID # 1306182-001 06/10/2013	Waterfall SW-06102013 Lab ID # 1306182-004 06/10/2013
Major Ions and Solution Parameters							
Bicarbonate Alkalinity	mg/L $CaCO_3$	–	438.	240	352.	331	295
Carbonate Alkalinity	mg/L $CaCO_3$	–	<20	<40	<20	<20	52.9
Calcium	mg/L	–	192	55.9	191	199 J	153
Magnesium	mg/L	–	252	56	313	333	294
Potassium	mg/L	–	11.9	5.8	15.3	16.1	16.4
Sodium	mg/L	–	1,090	163	1,360	1,450	1,220
Chloride	mg/L	–	667	218	1,300	2,110	1,200
Fluoride	mg/L	–	0.675	0.365	0.646	0.701	0.622
Silicon	mg/L	–	14	4.98	5.9	<5	<5
Sulfate	mg/L	–	1,330	286	1,550	1,350	1,360
TDS	mg/L	1,200	3,900	884	4,700	4,700	4,100
Nutrients							
Nitrate	mg/L as N	4	<0.01	<0.01	<0.01	<0.01	<0.01
Total Orthophosphate	mg/L as P	–	<0.05	<0.05	<0.05	<0.05	<0.05
Metals (total)							
Aluminum	mg/L	0.087	<1	0.313	<1	<1	<1
Arsenic	mg/L	0.1	0.0297	0.00758	0.0293	0.0204	0.0151

Parameter	Units	Lowest Standard Class 2B, 3C, 4	Crafts Outflow	257 Cutoff		Chippings	Waterfall
			Crafts Outflow SW-06102013 Lab ID # 1306182-005 06/10/2013	Sevier River Baseline Lab ID # 1202158-002 02/09/2012	257 Cutoff SW-06102013 Lab ID # 1306182-002 06/10/2013	Chippings 06102013 Lab ID # 1306182-001 06/10/2013	Waterfall SW-06102013 Lab ID # 1306182-004 06/10/2013
Beryllium	mg/L	–	<0.01	<0.0006	<0.01	<0.01	<0.01
Boron	mg/L	0.75	<5	<0.5	<5	<5	<5
Cadmium	mg/L	0.00025	<0.0025	<0.00018	<0.0025	<0.0025	<0.0025
Chromium	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	0.009	<0.01	<0.00212	<0.01	<0.01	<0.01
Iron	mg/L	1.0	<1	0.227	<1	<1	<1
Lead	mg/L	0.0025	<0.01	<0.0004	<0.01	<0.01	<0.01
Manganese	mg/L	...	<0.0124	0.00842	<0.01	<0.01	<0.01
Mercury	mg/L	0.000012	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Selenium	mg/L	0.0046	<0.01	<0.0008	<0.01	<0.01	<0.01
Silver	mg/L	0.0016	<0.01	<0.0004	<0.01	<0.01	<0.01
Zinc	mg/L	0.12	<0.025	<0.00568	<0.0283	<0.025	<0.025

Note: Bolded values exceed lowest standard for Class 2B, 3C, or 4 water. Non-detect data with minimum detection limit above the standard were not compared to the standard.
The stations are listed in downstream order.

2.4 GROUNDWATER

2.4.1 Playa HSU

The stratigraphy of the brine-saturated sediments of the Playa HSU, in downward order from the surface, is divided into three lithologic horizons consisting of fat (i.e., cohesive, compressible, high plasticity) clay, marl (i.e., calcium carbonate-rich) clay, and siliceous (i.e., high silica, low carbonate content) clay (Figure 2-4). The Fat Clay Zone ("FCZ") has a low hydraulic conductivity. This dense grey clay is capped by a thin salt crust that is typically a few inches thick over most of the Playa but can range up to 18 inches thick in certain areas.

The FCZ extends to a depth of about 12 feet below ground surface ("bgs") and is comprised of two sub-horizons. The upper part of the FCZ consists of approximately 9 to 10 feet of homogenous, dense, plastic clay. This clay zone contains gypsum crystals up to 6-inches in diameter. Underlying this homogenous clay is a plastic clay zone that contains abundant organic material, commonly appearing as grass mats and root structures, likely representing a dry period when the Playa surface was covered by grassy beds. This organic clay zone is an important marker bed that represents the bottom of the FCZ.

The Marl Clay Zone ("MCZ") has a higher hydraulic conductivity than the FCZ and consists of calcium carbonate-rich grey, bedded, granular clay that extends from about 12 to 40 feet bgs. The MCZ is the primary host of potash brine to be produced by the Project.

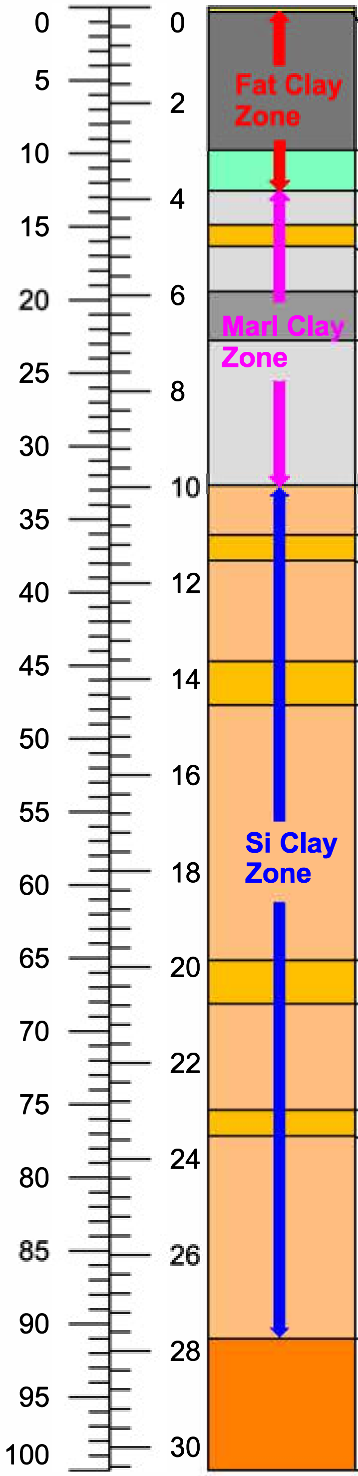
Previous geotechnical studies by Intermountain GeoEnvironmental Services (2012) described the MCZ sediments as "fissured clay", probably due to osmotic desiccation. However, more recent field investigations indicate that these sediments have a granular texture that arises from what is observed to be silt-size granules of smaller clay particles loosely bound by a soft calcareous or gypsiferous matrix. This zone also contains numerous gypsum crystals up to 6-inches in diameter. An unconsolidated sand and gravel bed frequently occurs near the top of the MCZ but is not consistent throughout the Playa. Where present, this sandy or gravelly zone has an average thickness of 18 inches.

A dense zone of stiff clay averaging approximately 3 feet thick occurs in the MCZ approximately 3 feet below the sand and gravel bed, where present. Penetrometer readings for the stiff clay zone of the MCZ range from 1.5 to 3.0 tons/square feet (t/ft^2). For comparison, the surrounding MCZ exhibits penetrometer readings between 0 and 1.25 t/ft^2 while the overlying FCZ exhibits penetrometer readings between 0 and 0.5 t/ft^2 (see Figure 2-4).

Below the stiff clay bed of the MCZ is an additional 10$\pm$ feet of marl clay that transitions rapidly into the predominantly siliceous clay of the underlying Siliceous Clay Zone ("SCZ"). The contact between the marl clay and underlying siliceous clay was identified using sediment mineralogy and carbonate content test results from X-ray Powder Diffraction ("XRD") mineralogy analyses, as illustrated in the stratigraphic column shown in Figure 2-4.

The SCZ is an olive grey, quartz-rich clay with a carbonate content that is noticeably lower than the overlying MCZ. Discontinuous sand and gravel beds have been identified within the SCZ from drill-hole records. These sand and gravel units are generally thicker near the margins of the playa and are often missing toward the center of the playa. Average thicknesses of the sand and gravel beds, where present, vary from about 1.5 to 3 feet.

Depth (ft)|(m)	Thickness (m)(ft)	Carbonate (%)	Penetrometer (t/ft²)
	0-0.5m (0-1.5ft)	38.6	0 - 0.25
	2.9m (9.5ft)	38.6	0 - 0.5
	0.9m (2.8ft)	46.2	0 - 0.5
	0.7m (2.4ft)	46.5	0 - 0.5
	0.4m (1.5ft)	46.9	0 - 0.5
	0.9m (3.1ft)	47.3	0 - 0.5
	1.0m (3.4ft)	48.5	1.5-3.0
	3.0m (9.9ft)	47.7	0.75-1.25
	1.0m (3.4ft)	29.6	0.75-1.25
	0.5m (1.8ft)	32.2	0.75-1.25
	2.1m (6.9ft)	34.4	0.75-1.25
	0.9m (3.0ft)	31.1	0.75-1.25
	5.3m (17.5ft)	32.2	1.0-1.5
	0.9m (3.0ft)	28	1.0-1.5
	2.2m (7.3ft)	33.6	1.0-1.5
	0.5m (1.8ft)	34	1.0-1.5
	4.2m (13.9ft)	31.1	1.0-1.5
	-	-	>5



CRYSTAL PEAK MINERALS INC.

LEGEND

Salt Crust
Fat Clay with organics
Fat (plastic) Clay
Stiff Marl Clay
Marl Clay
Sand and Gravel
Siliceous Clay
Hard Dry Clay

FIGURE 2-4

Sevier Playa Potash Project
Brine Aquifer
Stratigraphy

DATE: 09/20/2017
FILE: 89-12 FIG 3
SCALE: NTS
NORWEST CORPORATION

The SCZ is generally between 10 and 40 feet thick in the south end of the playa and between 40 and 80 feet thick in the central and northern regions of the playa. The base of the SCZ is marked by a dull red, relatively dry, hard clay that occurs beneath the entire area. The top of this red, hard, dry clay, which was encountered in all boreholes drilled through the SCZ, lies at a maximum depth of approximately 120 feet bgs.

Extraction wells would produce potash brine from the lower portion of the MCZ and the upper portion of the SCZ. Under current plans, the average depth of extraction wells would be about 77 feet, but well depths may vary from 61 to 110 feet, based on the depth of the brine resource.

Underlying the resource zone, several lean clay horizons have been logged to a depth of 497 feet bgs (the depth to which monitoring well SN2-11-400 was drilled). Occasional sand to sandy silt zones (ranging in thickness from less than 1 inch to 5.5 feet) exist below the resource zone. The field logs describe many of these zones as being moist, while two of the thickest of these zones were saturated and SN2-11-400 was completed across these two separate zones, while the materials above and below these moist zones are described in the field notes as being hard and dry. Data summarized by Whetstone (2017) indicate that measured water levels in wells monitoring these discontinuous sandy zones below the SZC are generally within about 5 feet of the playa surface. Following correction for salinity, the equivalent freshwater levels in the deep playa sediments are near or above the surface elevation of the playa. These head values indicate that these saturated zones are under confined conditions. While some zones of minor saturation exist locally, no laterally continuous zones of saturation have been identified in these lean clay horizons that underlie the red, hard, dry clay at the bottom of the SCZ.

The water table within the Playa HSU is relatively flat, mimicking the playa surface. It appears that groundwater within the playa sediments is mounded relative to that within the adjacent Alluvial/Colluvial groundwater system. This groundwater mound is likely caused by periodic inflows of surface water from the Sevier River and nearby ephemeral washes, high matric forces within the clays that retain water that infiltrates into the playa sediments, and capillary forces created by the evaporative pull of groundwater through the playa sediments.

Aquifer testing indicates that the hydraulic conductivity of the playa sediments ranges from 0.01 to 24.2 feet per day. The higher values were from wells that encountered several silt and sand layers near the inlet of the Sevier River and southeast of Needle Point. The remaining wells were completed predominately in the more-typical silt and clay playa sediments where hydraulic conductivity values ranged from 0.01 to 1.08 feet per day.

2.4.2 Alluvial/Colluvial HSU

As is typical of alluvial/colluvial sediments in the Intermountain West, the sediments that comprise the Alluvial/Colluvial HSU are quite variable in thickness and composition. In some areas, this layer consists of a thin veneer or blanket of in-place sands, silts, and clays draped over hillsides while in others, primarily at the mouths of drainages formed at the base of the mountains, this HSU consists of reworked alluvial fans and stream deposits that are thick and relatively coarse grained. These sediments tend to be interbedded due to the variable nature of the geologic forces of erosion and mass wasting that occurred intermittently over time.

Groundwater in the Alluvial/Colluvial HSU originates from the infiltration of precipitation, snowmelt, and seepage into the underlying alluvial sediments as runoff flows in ephemeral channels. This groundwater flows within the alluvial/colluvial sediments to points that are in contact and interbedded with the playa sediments; discharges as seeps; or percolates vertically or laterally and enters the bedrock where it recharges the underlying Regional Bedrock HSU.

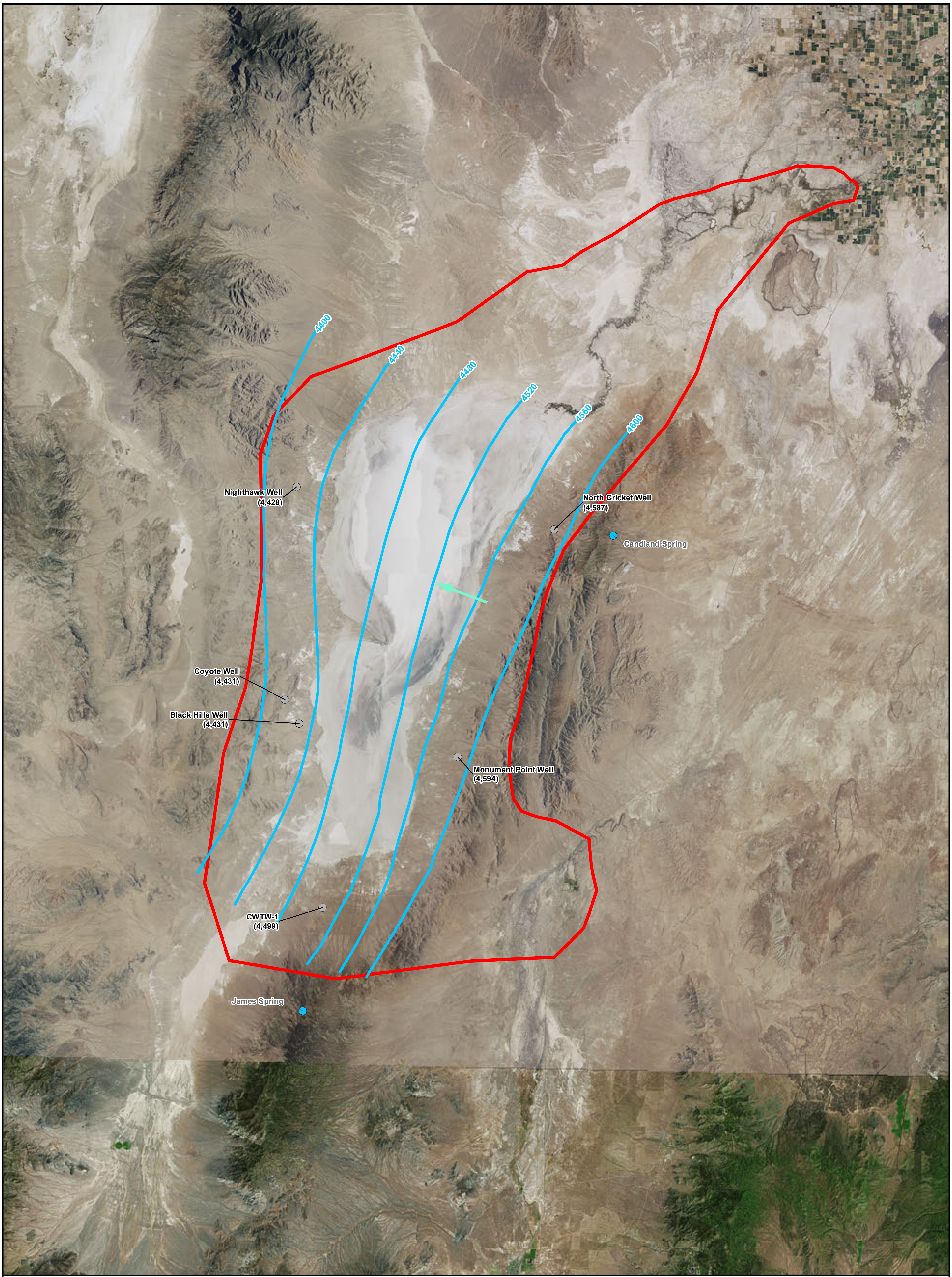
Aquifer tests conducted in the Project area and summarized by Whetstone (2017) show the range of hydraulic conductivity of the Alluvial/Colluvial HSU strata to be from 0.06 to 51 ft/day. The high value was from the Wah Wah Well located 9.5 miles south of the playa. The most reliable test results provided hydraulic conductivity data for the alluvial/colluvial sediments within the range of 0.6 to 0.9 feet per day.

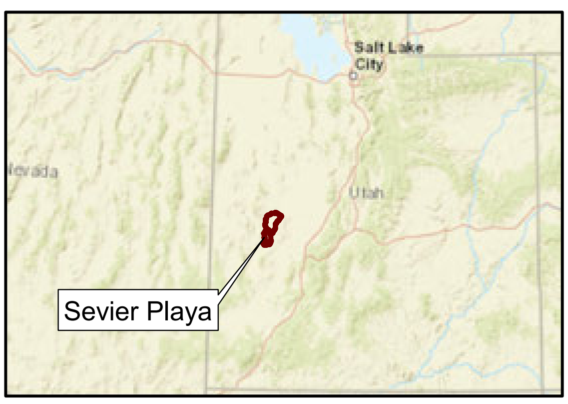
2.4.3 Regional Bedrock HSU

The bedrock formations in the vicinity of the playa consist of the Prospect Mountain Quartzite in the Cricket Mountains east of the playa, the Notch Peak Limestone in the House Range/Black Hills west of the playa, and either the Prospect Mountain Quartzite or Mutual Formation in the San Francisco Mountains south of the playa. Some areas of volcanic flows are also draped over these formations along the southern portion of the area.

Potentiometric data collected from wells completed in bedrock near the playa indicate that groundwater in the Regional Bedrock HSU flows to the west-northwest beneath the playa (Figure 2-5), with a horizontal hydraulic gradient of approximately 0.003 feet per foot through the central portion of the basin. This groundwater flow direction is in general agreement with the south-southeast to north-northwest regional groundwater flow direction described by Heilweil and Brooks (2011).

Aquifer tests conducted by CPM in the Project area and summarized by Whetstone (2017) indicate that the hydraulic conductivity of the Regional Bedrock HSU in the vicinity of the playa ranges from 0.9 to 133 feet per day. This range is typical of those presented by Bedinger et al. (1989), Belcher et al. (2002), and Sweetkind et al. (2011) for fractured carbonate and metamorphic rocks in the Great Basin.





Legend

- Bedrock Well
- Mountain Spring
- Horizontal Direction of Groundwater Flow
- Bedrock HSU Potentiometric Surface Contours
- Sevier Playa Potash Project Water Resources Area of Interest

N

0 2.5 5 Miles

1:330,600

Sources:
Sevier Playa Potash Project Water Resources Analysis Area, Baseline Water Resources Technical Report for the Sevier Playa Potash Project, Whetstone 2017;
Bedrock HSU Potentiometric Surface Contours, Tangalos, et al, 2016;
Aerial Imagy, NAIP/USDA/APFO 2016

Notes:
HSU - hydrostratigraphic unit
(750) - Potentionmetric Elevation

Figure 2-5
Potentiometric Contour Map of the Bedrock Hydrostratigraphic Unit

WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

2.4.4 Groundwater Quality

CPM collected groundwater samples in 2012 and 2013 from wells completed in the Playa, Alluvial/Colluvial, and Regional Bedrock HSUs throughout the playa region. The existing wells from which these samples were collected are shown in Figure 3-1. The results of analyses of these samples are detailed in Whetstone (2017), discussed below, and summarized in Attachment B.

Groundwater in the Playa HSU is a sodium-chloride brine (TDS concentrations of 13,800–194,000 mg/L) with near-neutral pH (6.19–7.90). The brine is classified by UDWQ as a Class IV groundwater, based on its TDS concentration being greater than 10,000 mg/L. State of Utah groundwater quality standards ("UGWQS") for Class IV groundwater have not been established. Rather, protection levels for Class IV groundwater are established on a case-by-case basis to protect human health and the environment.

Groundwater in the Alluvial/Colluvial HSU is a sodium-chloride to sodium-sulfate type water with near-neutral to alkaline pH (6.68–9.30) and variable TDS concentrations ranging from 472 to 3,410 mg/L. TDS concentrations tend to be higher near the playa where interaction with playa groundwater is probable. The exception to this generality is the 257 Cutoff well, located about 5 miles northeast of the playa. This well is screened shallower than the other wells in the Alluvial/Colluvial HSU and contains a sodium chloride brine composition with TDS concentrations ranging from 80,800 to 82,700 mg/L, likely due to evaporation of near-surface groundwater.

Fluoride, arsenic and pH results were above the UGWQS in some alluvial/colluvial wells. Arsenic was detected once in the Crystal Peak Road, Miller Canyon, and UDOT 2 wells, and twice in the 257 Cutoff well at concentrations ranging from 0.0519 to 0.652 (UGWQS of 0.05 mg/L). Fluoride was detected once in the Bonneville well at 6.36 mg/L (above UGWQS of 0.359 mg/L). The field parameter pH was above the UGWQS of 7.77 in the Bonneville well at 8.82, the UDOT 2 well at 9.14, and the UDOT 3 well at 9.30. The remaining analytical results from the alluvial/colluvial wells were reported at concentrations below the applicable UGWQS.

The Regional Bedrock HSU includes zones of Lower Cambrian and Precambrian quartzite, the Notch Peak Formation, and areas of volcanic bedrock. Analytical results from the Monument Point and North Cricket wells indicate that groundwater in the quartzite east of the playa is a sodium-chloride water with slightly alkaline pH (7.70–8.24) and relatively low TDS concentrations ranging from 400 to 480 mg/L. A groundwater sample collected from the CWTW-1 freshwater supply exploration borehole was characterized as a calcium-bicarbonate to calcium-chloride composition with alkaline pH (8.4–8.5) and TDS concentrations ranging from 352 to 396 mg/L. The analytical results for groundwater collected from wells completed in quartzite bedrock were all reported at concentrations below the UGWQS.

Analytical results from the Black Hills, Coyote, and Nighthawk wells west of the playa indicate the groundwater in the Notch Peak Formation is a sodium-chloride to sodium-sulfate water with near-neutral pH (6.89–7.52) and moderate TDS concentrations (528–744 mg/L). The analytical results from wells completed in the limestone/dolomite bedrock were reported at concentrations below the UGWQS.

An analytical result from the Lakeview well screened in volcanic rock near the south end of the playa indicates the groundwater at this location is a sodium-chloride composition with slightly alkaline pH (7.77) and relatively low TDS concentration (420 mg/L). The analytical results from the volcanic bedrock were reported at concentrations below the UGWQS.

2.5 WATER RIGHTS

Water rights surrounding the Sevier Playa were summarized by Whetstone (2017). Within their area of evaluation, they found 712 perfected water right points of diversion, 533 approved water right points of diversion, and 265 water right points of diversion that were unapproved or had been terminated within their area of analysis, which was somewhat more extensive than the area of interest shown on Figure 2-1. Of the 1,245 point of diversion applications that had been perfected or approved, 760 were for underground water, 253 were for surface water, 204 were point to point diversions, 5 were spring water rights, 7 were re-diversion water rights, and 3 were return water rights. The largest percentages of approved uses are for stock watering (25%), mining (15%) and combined domestic/irrigation/stock watering (10%).

CPM owns or controls 431 approved water right points of diversion, of which 147 are for surface water and 284 are for underground water. The water right points of diversion owned or controlled by CPM are summarized in Table 2-2.

Table 2-2 Summary of Water Right Points of Diversion Owned or Controlled by CPM

Water Right Number	Quantity (AF/yr)	Water Source
69-106	1,000	Fresh water: Sevier River and underground wells
69-110	20,000	Brine water
69-111	500	Freshwater – groundwater
69-112	222,000	Brine water
69-113	28,000	Brine water
69-117	250,000	Sevier Lake and adjacent ephemeral streams

2.6 RIPARIAN AREAS

In 2016, SWCA Environmental Consultants (“SWCA”) prepared a wetland and riparian baseline inventory for the Project Area as well as the Sevier River corridor from the Sevier Playa to Gunnison Bend Reservoir (SWCA 2016). A copy of this report was provided previously to BLM. The inventory began with desktop identification and interpretation of wetlands and riparian areas using high-resolution aerial photographs and other data sources in ArcGIS. A field visit was then conducted to refine the desktop mapping and correlate the results of the desktop study to actual ground conditions.

SWCA’s remote sensing specialist identified the centerline of the river between the Sevier Playa and the location where the river consistently aligned with the National Hydrography Dataset (USGS 1999) by interpreting aerial imagery from the National Agriculture Imagery Program (U.S. Department of Agriculture Farm Service Agency 2014). In some areas, the river channel splits, with a bed, a bank, open water, and wetland or riparian vegetation being present along two or more channels. To be conservative, the study area was expanded to include areas where these channels were identified. Human-made diversion structures and ditches also exist along the Sevier River channel; the study area was not expanded to capture channels that appeared human-made (SWCA 2016).

Riparian vegetation, mostly in the form of invasive salt cedar and salt cedar intermixed with wetland floodplain vegetation, are common along the banks and floodplains of the Sevier River upstream from the Sevier Playa. At the inlet of the Sevier River onto the Sevier Playa, the river corridor dissipates into an alluvial fan of shallow, wandering, braided channels. In this area, vegetation is present in some locations between and around the margins of the channels, as well as in depressions and around the margins left by previous channels. The vegetation is primarily herbaceous wetland and wetland floodplain vegetation intermixed with unvegetated playa areas (SWCA 2016).

Based on a review of aerial imagery, the distribution and extent of vegetated and unvegetated areas at the inlet and on the Sevier Playa has substantial annual variation controlled by inundation and shifting soils, which are related to the volume of water flowing onto the Sevier Playa. In wetter years, such as 2011, the area is largely inundated with water, and vegetation is largely absent. In drier years, such as 2014 and 2016, herbaceous and annual vegetation are extensive (SWCA 2016).

3.0 DATA COLLECTION AND VALIDATION

Data will be collected under this Plan from the locations shown on Figure 3-1. Details regarding planned project sampling and data validation procedures are presented in the *Combined Sampling and Analysis Plan and Quality Assurance Project Plan for the Sevier Playa Project* provided in Attachment C.

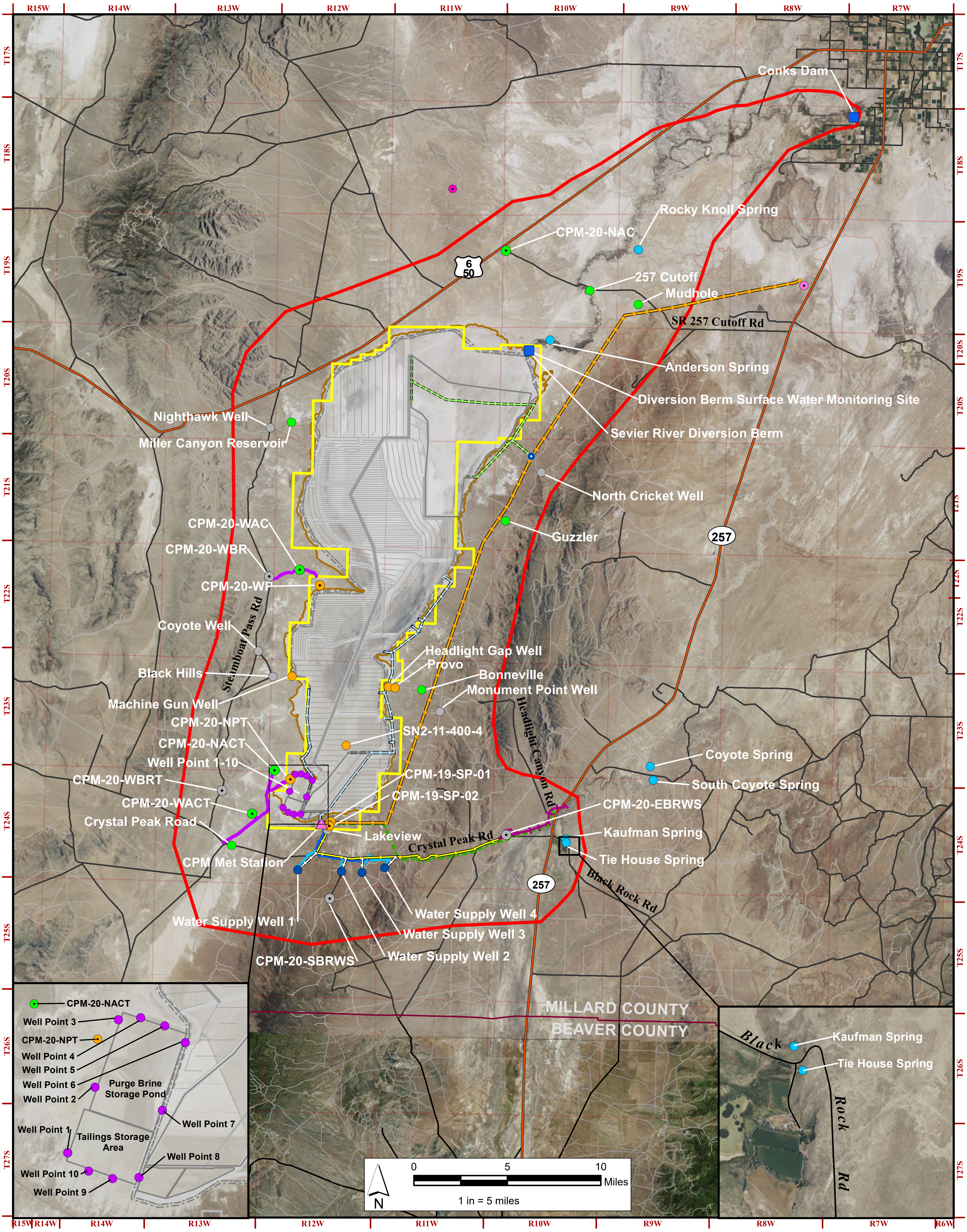
The goal of monitoring during the baseline data-collection period will be to develop a statistically valid database that adequately describes pre-Project hydrologic conditions. To that end, data will be collected quarterly during the baseline period to assess seasonal variations in hydrologic conditions within the area of interest.

It is currently anticipated that Project construction would begin in Fall 2019. Since baseline monitoring under this Plan began in September 2018, this will allow monitoring during five quarterly events prior to the start of construction. The U.S. Environmental Protection Agency (2009) recommends that a minimum of eight to ten independent baseline observations be collected before running most statistical tests. Thus, the period of baseline data collection would likely extend beyond the start of Project construction. This is not considered problematic for the following reasons:

- CPM began collecting hydrologic data from the playa area in 2011. These data would be reviewed for validation and if found valid, would be included in the baseline database.
- Given the typical hydraulic conductivities discussed in Section 2.4, it is estimated that average linear groundwater velocities in the Playa HSU are substantially less than 1 ft/yr. As a result, any impacts to groundwater in the Alluvial/Colluvial and Regional Bedrock HSUs caused by Project construction on the playa would not be observable for a period of several years. Thus, data collected from the Alluvial/Colluvial and Regional Bedrock HSUs during the one or two years following the onset of construction would still be indicative of baseline conditions.
- Only one water supply well would be drilled initially, and this well would be pumped only intermittently during the baseline sampling period as Project facilities are being constructed. This well (and the other three eventual water supply wells) would be drilled approximately 3 miles south of the Processing Facility area and 3.5 miles south of the playa. Because the first fresh water production well would be pumped only intermittently, it is unlikely that the radius of influence due to this well would extend to the playa.
- As a terminal basin, no surface water flows out of the playa. Furthermore, the inflow of Project-related recharge water to the playa would not occur until at least one year after construction begins. Thus, data collected from the Sevier River monitoring locations following the beginning of construction would still be indicative of baseline conditions.

Given these circumstances, it is concluded that sufficient data will be available to assess baseline conditions, even if some of these data are collected following the startup of construction operations.

The goal of monitoring during the period of Project operations would be to determine whether or not the Project has an adverse impact on water resources. Decisions regarding the frequency of monitoring during the Project operational period would be made following the collection and review of the baseline data. These decisions would be presented to UDWQ and BLM for approval and incorporated into this Plan before implementation.



Existing and Proposed Proposed Project Features

- Existing Playa Aquifer Well
- Proposed Playa Aquifer Well
- Existing Alluvial/Colluvial Aquifer Well
- Proposed Alluvial/Colluvial Aquifer Well
- Existing Bedrock Aquifer Well
- Proposed Bedrock Aquifer Well
- Proposed Well Point Location
- Proposed Water Supply Well
- Surface Water Monitoring Site
- Spring
- Proposed Sevier River Diversion Berm
- Sevier Playa Potash Project Water Resources Area of Interest
- BLM/SITLA Lease Boundary
- Access Road - Off-Lease
- Proposed 69-kV Power and Communication Line
- Proposed 25-kV Power Line
- Proposed 12.47-kV Power Line
- Proposed 12.47-kV Power and Communication Line
- Proposed 12.47-kV Power Line Spur
- Proposed Rail Spur and Access Corridor
- Proposed Rail Loadout Facility
- Proposed Natural Gas Pipeline
- Proposed Communication Tower
- Proposed Substation
- Meteorological Station
- Proposed Water Supply Pipeline
- Proposed Water Supply Pipeline Spur

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018, 2019;
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2016

NO.	DATE	REVISION	BY	APVD
4	2/15/2019	Revised based on comments		
3	10/15/2018	Revised based on comments		
2	7/18/2018	Revised based on comments		
1	6/19/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN | DR | CHK | APVD

FIGURE 3-1

Sevier Playa Potash Project
Surface and Groundwater
Monitoring Network

DATE: 4/11/2019 | SCALE: 1:318,859

CRYSTAL PEAK MINERALS INC.

D:\GIS\Peak Minerals\Operational Monitoring Plan\WMP Fig 3-1 - Groundwater_Monitoring_Network_190411.mxd4/11/2019 4:59:17 PM

Two sedimentation ponds (one at the Processing Facility and one at the rail loadout facility) would be constructed to control Project storm-water runoff. These ponds would be permitted and monitored under the UDWQ Utah Pollutant Discharge Elimination System. Since they would be monitored under a State-issued permit, they are not included in this Plan.

3.1 METEOROLOGICAL DATA COLLECTION

Data on file with the Western Regional Climate Center indicate that the National Weather Service maintained a weather monitoring station at the south end of the Sevier Playa from October 1987 through April 1993.[3] Data collected from this station included precipitation (rainfall and snowfall), snow depth, air temperature, evaporation, and wind movement.

CPM has maintained a meteorological station since November 2011 at the location shown on Figure 3-1. Data collected at this station include wind direction and speed, air temperature, solar radiation, relative humidity, precipitation, and barometric pressure. CPM would maintain this station through the Project operational period. Data collected during the Project baseline and operational periods would be compared with the prior National Weather Service data to understand trends in climatic patterns that may influence the hydrologic regime of the Sevier Playa region.

3.2 SURFACE WATER DATA COLLECTION

Surface water flow and quality data will be collected during the baseline period from two locations on the Sevier River, as indicated in Table 3-1 and shown on Figure 3-1. Access to these sampling locations will be via existing routes.

Since the Sevier Playa is a terminal playa at the downstream end of the Sevier River, no surface water discharge locations exist downstream from the proposed Project operations. As a result, no potential downstream surface water monitoring locations exist.

Table 3-1 Proposed Surface Water Monitoring Locations

Site Name	Location (NAD83 degrees)		Monitoring Purpose
	Latitude	Longitude	
Sevier River below Conks Dam	39.278885	-112.683384	Downstream from all irrigation diversions
Sevier River at Diversion Structure	39.092431	-113.002535	Inflow to playa

Note: In all cases, surface water will be monitored in accordance with Section 4.2 of the SAP/QAPP, with samples being analyzed for the parameters contained in Table 3-1 of the SAP/QAPP. Data Quality Objectives and Measurement Quality Objectives for surface water sampling are outlined in Sections 3.2 and 3.3, respectively, of the SAP/QAPP and summarized in Table 3-3 of the SAP/QAPP.

Surface water data will be collected during the baseline period as indicated in Section 6.3 of Attachment C. Following collection of the baseline data, all valid data will be reviewed, and a list of monitoring parameters and schedules will be developed for monitoring during the operational period. Any modifications to this Plan to accommodate surface

[3] https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut7747

water sampling during the Project operational period would be submitted to UDWQ and BLM for review and approval prior to implementation.

The Conks Dam surface-water sampling location is downstream from all irrigation diversions on the Sevier River. Data collected from the river at this location will be indicative of the quality of surface water used for irrigation and the quantity of water released to the channel at the downstream extent of irrigation diversions.

As indicated in Section 2.3.2, the Sevier River gains flow between Conks Dam and Crafts Lake due to irrigation return flows. Below Crafts Lake, the Sevier River loses flow to channel seepage and evapotranspiration. Therefore, data collected from the river at the Diversion Structure location will be generally indicative of the quality and quantity of water that enters the playa.

Given the high degree to which the Sevier River is regulated at and above Gunnison Bend Reservoir, it is possible that one or both of the Sevier River monitoring locations will be dry when sampling is attempted, particularly during the baseline monitoring period when Project recharge water is not being conveyed by the river. Such conditions will be noted on the field logs. Publicly-available data collected from the applicable locations shown on Figure 2-3 will be evaluated as outlined in Section 3.5 and, where valid, will be incorporated into the surface water baseline database to provide additional understanding on baseline surface-water conditions in the area.

3.3 GROUNDWATER DATA COLLECTION

Groundwater level and quality data will be collected during the baseline period from 16 existing monitoring wells and 16 proposed monitoring wells, when completed, as indicated in Table 3-2 and shown on Figure 3-1. These wells will be divided between the various HSUs as follows:

- Playa HSU: 4 existing and 4 proposed monitoring wells
- Alluvial/Colluvial HSU: 6 existing and 4 proposed monitoring wells
- Regional Bedrock HSU: 6 existing and 8 proposed monitoring/production wells
- Well Points: 10 proposed well points

Access to these sampling locations will be via existing routes, as shown on Figure 3-1.

Four of the proposed new wells in the Regional Bedrock HSU would be freshwater production wells. As noted in Figure 3-1, two of the remaining proposed Regional Bedrock HSU monitoring wells would be installed west of the playa, one would be installed south of the freshwater production wells, and one would be installed east of the freshwater production wells. The proposed monitoring wells south and east of the freshwater well field would be installed concurrent with the installation of the first freshwater production well. The terminal stratigraphy of the proposed Regional Bedrock HSU production and monitoring wells would depend on local subsurface conditions. However, in any case they would be constructed to monitor and/or produce groundwater from the Regional Bedrock HSU.

Table 3-2 Proposed Groundwater Monitoring Locations

Well Name	Location (NAD83 degrees)		Sampling Method	Monitoring Purpose
	Latitude	Longitude		
Playa HSU Wells (Existing)				
Headlight Gap	38.8296586	-113.1341471	Low-Flow	Groundwater flow to/from east edge of playa
Machine Gun	38.8361191	-113.2298862	Low-Flow	Groundwater flow to/from west edge of playa
Provo	38.8291203	-113.1274863	Snap	Groundwater flow to/from east edge of playa
SN2-11-400-4	38.7835250	-113.1744970	Snap	Groundwater in south-central portion of playa. Monitor influence of water supply wells on the Playa HSU.
Playa HSU Wells (Proposed)				
CPM-19-SP-01	38.726343	-113.192944	TBD	Groundwater flow to/from south edge of playa. Monitor influence of water supply wells on the Playa HSU.
CPM-19-SP-02	38.723402	-113.191879	TBD	Groundwater flow to/from south edge of playa. Monitor influence of water supply wells on the Playa HSU.
CPM-20-WP	38.9070000	-113.204567	TBD	Groundwater flow to/from west edge of playa
CPM-20-NPT	38.756441	-113.231382	TBD	Groundwater flow to/from playa near waste product storage area
Alluvial/Colluvial HSU Wells (Existing)				
257 Cutoff	39.1405648	-112.9426389	Snap	Groundwater in Sevier River alluvium north of playa
Bonneville	38.8279350	-113.1010343	Snap	Groundwater flow to/from east side of playa
Crystal Peak Road	38.7040571	-113.2856608	Low-Flow	Groundwater flow to/from south side of playa
Guzzler	38.9605644	-113.0213739	Snap	Groundwater flow to/from east side of playa
Miller Canyon Reservoir	39.0332852	-113.2365813	Snap	Groundwater flow to/from west side of playa
Mudhole	39.1305575	-112.8943545	Low-Flow	Groundwater flow to/from north side of playa
Alluvial/Colluvial Wells (Proposed)				
CPM-20-NACT	38.762242	-113.244973	TBD	Groundwater flow to/from northwest side of waste product storage area
CPM-20-WACT	38.7232486	-113.250747	TBD	Groundwater flow to/from southwest side of waste product storage area
CPM-20-WAC	38.9186167	-113.224933	TBD	Groundwater flow to/from west side of playa
CPM-20-NAC	39.1700167	-113.027133	TBD	Groundwater flow to/from north side of playa
Regional Bedrock HSU Wells (Existing)				
Black Hills	38.8356642	-113.2488075	Low-Flow	Regional groundwater downgradient from the playa
Coyote	38.8550295	-113.2637821	Snap	Regional groundwater downgradient from the playa
Lakeview	38.7175450	-113.1909711	Low-Flow	Regional groundwater cross-gradient from the playa
Monument Point	38.8115229	-113.0825462	Snap	Regional groundwater upgradient from the playa
Nighthawk	39.0284436	-113.2573385	Snap	Regional groundwater downgradient from the playa
North Cricket	38.9987550	-112.9872956	Snap	Regional groundwater upgradient from the playa
Regional Bedrock Wells (Proposed)				
CPM-20-WBRT	38.748624	-113.250783	TBD	Regional groundwater downgradient from the playa
CPM-20-WBR	38.9129333	-113.2550500	TBD	Regional groundwater downgradient from the playa
CPM-20-SBRWS	38.66426	-113.18734	TBD	Regional groundwater upgradient from the water supply wells
CPM-20-EBRWS	38.71673	-113.01396	TBD	Regional groundwater east of the water supply wells
Water Supply 1	38.6861005	-113.2194244	TBD	Potential impacts to regional groundwater from pumping
Water Supply 2	38.6857800	-113.1761975	TBD	Potential impacts to regional groundwater from pumping
Water Supply 3	38.6850996	-113.1557851	TBD	Potential impacts to regional groundwater from pumping
Water Supply 4	38.6895652	-113.1334771	TBD	Potential impacts to regional groundwater from pumping
Waste Product Storage Areas Well Points (Proposed)				
Well Points 1-10	Perimeter of proposed waste product storage area		Water Level	Groundwater flow toward and/or away from the future waste product storage area

Note: In all cases, groundwater will be monitored in accordance with Section 4.1 of the SAP/QAPP, with samples being analyzed for the parameters contained in Table 3-2 of the SAP/QAPP. Data Quality Objectives and Measurement Quality Objectives for groundwater sampling are outlined in Sections 3.2 and 3.3, respectively, of the SAP/QAPP and summarized in Table 3-3 of the SAP/QAPP.

Groundwater level and quality data will be collected during the baseline period as indicated in Sections 6.4 of Attachment C. Following collection of the baseline data, all data will undergo review and validation as indicated in Section 3.4 of Attachment C, and a list of monitoring parameters and schedules will be developed for the operational period. Any modifications to this Plan to accommodate groundwater sampling during the Project operational period would be submitted to UDWQ and BLM for review and approval prior to implementation of sampling.

The rationale for monitoring the selected existing wells and the locations for the proposed wells is discussed further in Section 4.1 of Attachment C. These wells (both existing and proposed) were selected to monitor conditions regionally upgradient (east), downgradient (west) and cross-gradient (north and south) from the playa. Hence, it is anticipated that data obtained from these wells will provide a good indication of spatial variations in baseline groundwater levels and quality near the playa and proposed Project operations.

Assuming weather conditions are conducive to playa access, CPM plans to drill two of the proposed Playa HSU monitoring wells in calendar year 2019. The remaining proposed monitoring wells would be drilled at least two years prior to the construction of facilities in the immediate vicinity. The order in which these new monitoring wells are drilled would be determined by the schedule of Project operations, with the goal of establishing a statistically valid understanding of baseline conditions prior to potential impacts from Project operations.

Ten well points would also be installed around the perimeter of the Waste Product Storage Area (which consists of the Purge Brine Storage Ponds and the Tailings Storage Area) in the southwest corner of the playa (see Section 4.1.2.5 of Attachment C). The well points would be installed into the Marl Clay Zone concurrent with initial construction of the Waste Product Storage Area berms, approximately 20 feet from the outside toe of the ultimate berm footprint. The purpose of these well points would be to determine whether and where leakage is occurring from the Waste Product Storage Area, and to determine the direction of flow for mitigation purposes. The groundwater encountered at these well points would be monitored for water level and specific conductance throughout the Project operational period, as discussed in Section 4.1.2.5 of Attachment C.

If leakage is detected from the Waste Product Storage Area, an evaluation would be made of the appropriateness of the then-existing wells to monitor that leakage. If the monitoring system is deemed to be inadequate, additional monitoring wells would be added and changes would be made to this Plan as needed. All such changes would be presented to UDWQ and BLM for approval before implementation.

3.4 SPRING DATA COLLECTION

Under Federal Lease Special Stipulation 13, regional springs were to be included in the Project water monitoring program. However, the majority of the springs identified in the region by Whetstone (2017) are geographically remote from and at substantially higher elevations than the proposed Project operations. Thus, it is highly unlikely that these springs would be impacted by the Project. Although springs shown on Figure 3-1 that are closer and at similar elevations to the Project may be monitored during the baseline period, the collection of consistent data from these springs would be difficult for the following reasons:

- Anderson Spring – Located about two miles upstream from the playa. This spring discharges into the bottom of the Sevier River channel. Hence, it cannot be monitored during periods when the river is flowing at that location.

- Rocky Knoll Spring – Located about 8 miles northeast of the north end of the playa. This “spring” is actually an area of moist soil occupied by tamarisk and other phreatophytes. No flow has been observed from this location for the past several years.
- Kaufman Seep and Tie House Spring – Both located about 11 miles east-southeast of the south end of the playa. These sources are located on private land and may not be accessible.

Because Kaufman Spring is located on private land, consideration was given to monitoring the nearby Coyote Spring and Coyote South Spring as an alternate method to monitor the potential impacts of project construction (particularly installation of the natural gas pipeline) and pumping the fresh water production wells. However, a recent hydrogeologic assessment of the area of these springs concluded that a hydraulic connection between the springs and the regional aquifer that supplies the proposed freshwater wells does not likely exist (Summers 2018). As a result, there is not a valid hydrologic reason to include Coyote Spring or Coyote South Spring as part of the Project ground water monitoring plan (Summers 2018). This is based on the assessment of possible effects at the springs over the life of the Project (personal communication, Paul Summers, April 2019).

Kaufman Spring is also considered not likely to be at risk for impacts from pumping the fresh water production wells during the life of the Project (personal communication, Paul Summers, April 2019). Further, use of Coyote Spring[s] as an indicator for monitoring possible impacts to Kaufman Spring is not a valid approach because Coyote Springs and the Kaufman Spring are supplied by water from two different aquifers which are not hydraulically connected (Summers 2018).

3.5 DATA VALIDATION

All surface and groundwater data collected under this Plan will be validated as discussed in Section 3.4 of Attachment C. As noted in Section 2.3 of Attachment C, CPM began monitoring groundwater within and near the Sevier Playa in 2011. This effort was expanded in 2012 to include monitoring of discharge and water quality in the Sevier River. These pre-2018 data will also be reviewed using the data validation process presented in Section 3.4 of Attachment C. Any surface and groundwater data collected prior to 2018 that are determined to be valid will be incorporated into the baseline database and used to establish pre-project hydrologic conditions within and near the playa.

3.6 REPORTING

It is anticipated that water quality data from the laboratories will be provided to CPM via electronic file transfer. All monitoring data will be maintained in an electronic database by CPM for documentary and comparative purposes. Selection of the software and preparation of the database will be conducted following the start of data collection.

CPM will incorporate the validated laboratory and field data into a database application where data can be queried by location(s), individual constituent of concern, sample medium, etc. The database may be linked to an electronic site map capable of showing the associated sample locations. These data will be supplied electronically to UDWQ and BLM on a quarterly basis, normally within 45 days of receiving and validating data from that sampling event. This submittal will include tabulated field and laboratory analytical results and data collected from the meteorological station maintained by CPM at the Sevier Playa. This will be accompanied by a validation summary like that provided in Attachment D.

3.6.1 Baseline Reporting

A valid baseline dataset will serve as the basis for evaluating changes to water resources within and near the playa that may be associated with Project operations. Following generation of the valid baseline database, a baseline monitoring summary will be prepared in which all surface water flow and quality, groundwater elevation and quality, and meteorological data will be presented. The data will also be plotted for graphical display (e.g., time series plots, histograms, box-whisker plots, etc.) as needed to support the analyses.

Baseline data will be evaluated for statistical distribution(s), outliers, summary statistics, and handling of non-detect data. This will be accomplished using the latest version of ProUCL[4] or other appropriate statistical evaluation package.

The baseline data report will present an evaluation of spatial and seasonal variations in surface and groundwater quantity and quality. This will be accomplished using time-series plots, trilinear diagrams of chemical data, iso-concentration lines, and other appropriate evaluations of flow, water-level, and water quality data as supported by the data. Additionally, summary statistics will be calculated on the data. The data will be assessed at individual locations and, in the case of groundwater, by grouping wells according to their HSU. This assessment will include comparisons with applicable UDWQ water-quality standards as promulgated in R317-2 (surface water) and R317-6 (groundwater) as well as the requirements of Special Stipulation 8 of the federal leases.

To the extent supported by the data, the baseline data report will include appropriate plots of iso-concentration contours for select chemical constituents, graphs that show concentrations of selected parameters over time, comparison to relevant water quality standards, summary statistics, and a description of data validation. The statistical evaluation will include an establishment of threshold values (e.g., upper tolerance limits or upper prediction limits, as further discussed in Section 4) against which future data may be compared to determine whether or not Project operations have resulted in water-resource impacts. Report appendices will include copies of pertinent field notes, laboratory analytical results, QC data, data validation results, well records, well testing data, water level data, field water quality measurements, and other field data, as applicable.

3.6.2 Operational Reporting

Each post-baseline quarterly data submittal would include a statistical evaluation of the data as outlined in Section 4. This would include a location-by-location comparison to determine if the most recent analytical results are statistically different than the baseline conditions at a reasonable level of significance. If this evaluation indicates that Project operations have potentially adversely impacted water resources, the quarterly data submittal would include recommendations for impact verification and/or mitigation. For example, if it is suspected that leakage from the Waste Product Storage Area on the southwest portion of the playa has adversely affected off-playa groundwater in the Alluvial/Colluvial or Regional Bedrock HSU in that area, these recommendations would, as a minimum, include a meeting with UDWQ and BLM to discuss an appropriate path forward for assessing and mitigating the impacts. Depending on the potential impact, these recommendations may also include re-sampling of existing monitoring wells

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[4] ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency for the evaluation of environmental data. Additional information regarding ProUCL can be found at https://www.epa.gov/land-research/proucl-version-5100-documentation-downloads

and/or installation and sampling of new off-playa monitoring wells south, west, and/or northwest of the Waste Product Storage Area within the area of interest shown on Figure 3-1. If additional off-playa monitoring wells are required to properly assess the extent and magnitude of impacts, these would be installed only after required cultural resource, biological, and other clearances were obtained and applicable permits are issued.

CPM would also prepare annual reports detailing the results of meteorological data collected and surface and groundwater monitoring completed during the prior calendar year. Annual monitoring reports would be electronically submitted to the BLM and UDWQ by the end of the first calendar quarter of the following year. The annual reports would include all field and laboratory results, a brief narrative describing any changes and the significance of those changes observed during the year, with updated copies of the above tables and graphs as appropriate. Data would be presented cumulatively as appropriate to allow trends to be assessed.

The annual reports would also include recommended steps for optimization of the monitoring program (when applicable) and a discussion of identified impacts to surface or groundwater resources. If exceedances or changes identified during the year suggest that Project operations are adversely impacting water resources in the area, the results of the adaptive management approach to impact mitigation would be discussed (see Section 1.2), specific actions taken to mitigate those impacts would be summarized, and recommendations for further mitigation would be provided to UDWQ and BLM. Where appropriate, the mitigation measures may include additional sampling, review of sampling protocols, recommend changes to the operational monitoring plan, additional placement of monitoring wells, changes in Project operation, or other recommendations to mitigate observed negative impacts to water resources.

4.0 DATA EVALUATION

An important purpose of the water monitoring program is to detect statistically significant changes to local water resources following the startup of Project operations. This would be accomplished by comparing baseline and operational data using EPA's ProUCL or other appropriate statistical approaches as noted in Section 3.5 of this Plan. Guidance provided by the U.S. Environmental Protection Agency (2009) and other appropriate statistical references would be used to select data analysis methods that are applicable to the data set. Furthermore, since reversals of the flow direction near a well could cause abrupt changes in the water chemistry (Fetter 1980), basic observation of data trends would be employed.

Each data set would be evaluated for potential outliers, potential trends, and underlying statistical distributions. Baseline and operational water quality data would be summarized using measures of central tendency and dispersion including mean, minimum, maximum, and standard deviation complimented by time-series plots, histograms, box plots, etc. to graphically present the data. Baseline data would be evaluated to establish control limits (e.g., upper tolerance limits and/or upper prediction limits) against which data collected during Project operations would be compared. The methods used to develop these limits would depend upon the statistical distributions exhibited by the data. Guidance provided by the U.S. Environmental Protection Agency (2009) would be relied upon when establishing the baseline control limits. Standards and limits as prescribed by UDWQ would be used as regulatory controls.

The statistical distribution of the baseline data would be assessed and an appropriate method would be used to test the significance of differences between baseline and operational data. It is anticipated that these methods would include: the classical normal distribution, the non-parametric Kruskal-Wallis (1952) analysis of variance, the non-parametric Friedman (1939) method, the Wilcoxon-Mann-Whitney test (Bain and Engelhardt 1992), or other appropriate methods. Post-hoc statistical tests would be performed if required by the analytical approach.

Trend analyses would be performed using ordinary least squares regression models, Mann-Kendall analysis, or Theil-Sen analysis, depending on the statistical distribution. The appropriateness of seasonally adjusting the time-trend data using the methods of Hirsch et al. (1982) would also be evaluated.

The U.S. Environmental Protection Agency (2009) recommends that a minimum of 8 to 10 independent baseline observations be collected before running most statistical tests. UDWQ recommends a minimum of 10 data points at individual sites except for metals analysis and in cases where access is limited or analytical protocols are supported by fewer samples (Toole 2010). If less than 10 samples are collected from a location when establishing baseline conditions, the data would be reviewed to determine if sound decisions can be made. Although still a small sample size by statistical standards, these levels may allow for acceptable estimates of variability and evaluation of trends and goodness-of fit. If sound decisions cannot be made with the smaller data set, then additional baseline data would be collected to ensure an adequate baseline data set. Such samples may be collected after the start of construction activities and would only be included in the data set if their use as representative of undisturbed conditions could be justified. Given the low permeability of the playa sediments, the travel time for water and brines in and surrounding the playa would allow a few years before any affect from construction activities could reach the surrounding monitoring points.

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ATTACHMENT A

Water Monitoring Plan Key Responsibilities

SEVIER PLAYA POTASH PROJECT
WATER MONITORING PLAN
KEY RESPONSIBILITIES

The responsibilities of key personnel involved in the generation and review of waster-resource data associated with the Sevier Playa Potash Project (the "Project") are presented below. Contact information for these individuals is presented in Table 1. As significant changes to duties or personnel occur, CPM will document those changes by updating this document within 60 days of the change(s) and notify UDWQ and BLM accordingly. Where changes do not reflect an alteration in the overall scope of the activities or a change of requirements, such changes will be identified in the annual Project report.

UDWQ Lead Engineer – Wynn John P.E.: Mr. John will be the primary UDWQ contact for issues related to compliance of the Project to the UDWQ Groundwater Discharge Permit. He will review the Project Water Monitoring Plan ("WMP") and the Sampling and Analysis Plan/Quality Assurance Project Plan ("SAP/QAPP") and will be responsible for determining compliance of the WMP and SAP/QAPP with state regulatory requirements. He will also review future monitoring data and audit monitoring activities.

BLM Authorized Officer – Mike Gates: Mr. Gates will be the primary BLM contact responsible for ensuring proper implementation of the WMP and SAP/QAPP. He will review the WMP and SAP/QAPP, audit monitoring activities, and assess the adequacy of the resulting data for meeting the requirements of the federal lease Special Stipulations.

Project Manager – LeeAnn Diamond, P.G.: The Project Manager ("PM") will provide overall direction to task managers and monitoring personnel necessary to accomplish the objectives of the WMP and SAP/QAPP, including development and completion of the technical work scope; coordination and execution of the scope, schedule, and budget requirements; reporting on the status of monitoring activities; assuring that staff with appropriate technical qualifications is utilized during implementation of the WMP and SAP/QAPP; and serving as primary liaison between CPM and the affected agencies (UDWQ and BLM). Ms. Diamond has a Bachelor of Science degree in geological engineering, 17 years of environmental project management experience, and 10 years of groundwater and soil monitoring and Phase I environmental investigation experience.

Discipline Manager – Leigh Beem, P.G.: The Discipline Manager ("DM") is responsible for conducting and/or oversight of field activities associated with implementation of the WMP and SAP/QAPP. Specific DM responsibilities include:

- Conduct or oversee installation of monitoring wells, downhole testing, and sample collection activities and ensure that work performed by the analytical laboratories is conducted in accordance with accepted protocols;
- Ensure that all field and data management personnel have reviewed the WMP and SAP/QAPP, are properly trained in procedures discussed in this document, and follow established policies and procedures;

- Review and validate testing and analytical results to ensure that the results fulfill the data quality objectives established in the WMP and SAP/QAPP; and
- Direct or prepare annual reports in which data collection activities are summarized and the resulting data are presented.

Mr. Beem has both a Bachelor of Science degree and a Master of Science degree in geology and 28 years of experience working RCRA-regulated sites, CERCLA-affected sites, leaking underground storage tanks, Phase I and II environmental investigations, groundwater monitoring and remediation, fate and transport modeling, and environmental risk assessments.

Quality Assurance Officer – Betsy Lang: The Quality Assurance Officer ("QAO") will oversee implementation of the WMP and SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the QAO include:

- Provide independent QA oversight during implementation of the WMP and SAP/QAPP;
- Review log books, chain-of-custody forms, and laboratory analytical reports to determine if data meet the requirements of the WMP and SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the WMP and SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate measurement quality objectives;
- Report data quality issues, quality control ("QC") concerns, and data non-conformance to established standards to the PM and DM;
- Periodically review the groundwater and surface water sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the WMP and SAP/QAPP; and
- Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the WMP and SAP/QAPP.

Ms. Lang has a Bachelor of Science in Environmental Engineering and 7 years of experience in environmental compliance and reporting, groundwater monitoring, and data management.

Project Reviewer – Thomas J. Suchoski, P.G.: The Project Reviewer will provide oversight of technical and quality assurance efforts during implementation of the WMP and SAP/QAPP. He will also assist in the preparation of future updates to the WMP and SAP/QAPP as needed. Mr. Suchoski has a Bachelor of Science degree in geology and a Master of Science degree in hydrology. He has 38 years of experience working with surface and groundwater baseline studies, water well drilling and development, water monitoring and risk assessments, RCRA, CERCLA, Phase I and II environmental investigations, and environmental permitting.

Laboratory Managers

The laboratories and managers for the laboratories that may work on this Project are: Kyle Gross, American West Analytical Laboratory (Salt Lake City, Utah), and John Hawkins, ESC Lab Sciences (Mt. Juliet, Tennessee). The laboratory managers will be responsible for ensuring that all quality assurance/ quality control procedures are implemented in accordance with in-house plans. They will also serve as the primary point of contact between CPM, its contractors, and the laboratory if questions arise during the data validation process.

Table 1-1 Project Contact Information

Name	Project Position	Agency/Company	Contact Information
Mike Gates	BLM Authorized Officer	BLM	Phone: 435-743-3100 E-mail: **mgates@blm.gov**
Wynn John	Environmental Scientist	UDWQ	Phone: 801-536-4355 E-mail: **wjohn@utah.gov**
LeeAnn Diamond	Project Manager	CPM	Phone: 801-485-0223 email: **ldiamond@crystalpeakminerals.com**
Betsy Lang	Quality Assurance Officer	CPM	Phone: 801-485-0223 email: **betsy@crystalpeakminerals.com**
Leigh Beem	Discipline Manager	Johnston-Leigh	Phone: 801-726-6845 Email: **leigh@johnstonleighinc.com**
Tom Suchoski	Senior Hydrologist	Norwest-Stantec	Phone: 801-539-0044 email: **tsuchoski@norwestcorp.com**
John Hawkins	Lab Manager	ESC Laboratories	Phone: 615-773-9669 email: **JHawkins@esclabsciences.com**
Kyle Gross	Lab Manager	AWAL	Phone: 801-263-8686 email: **awal@awal-labs.com**

ATTACHMENT B

Summary of Historical Groundwater Data

Table B-1. Groundwater Analytical Results 2012–2013: Bedrock

			Bedrock							
			Prospect Mountain Quartzite			**Notch Peak Formation**				**Unidentified Lava Fm**
	Station Name		**Monument Point**		**North Cricket**	**Black Hills**		**Coyote**	**Nighthawk**	**Lakeview**
	Sample ID Lab ID		SEV-11-007 1204204-001A, 1204204-001B, 1204204-001C 04/11/2012	Monument Point 1305029-003A, 1305029-003B, 1305029-003C 04/25/2013	N. Cricket-Baseline-001 1304401-001A, 1304401-001B, 1304401-001C 04/11/2013	Black Hills Baseline - 08:05 1202170-004A, 1202170-004B, 1202170-004C 02/10/2012	Black Hills Baseline - 09:50 1202170-001A, 1202170-001B, 1202170-001C 02/10/2012	SEV-11-013 1203367-001A, 1203367-001B, 1203367-001C 03/22/2012	SEV-11-014 1203303-001A, 1203303-001B, 1203303-001C 03/19/2012	Lakeview Baseline 1202149-001A, 1202149-001B, 1202149-001C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**								
Major Ions and TDS										
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	145.	144.	138.	175.	173.	178. J	233.	113.
Carbonate	mg/L $CaCO_3$	–	<20	<10	<20	<20	<20	<20 J	<40	<20
Hardness, Ca+Mg	mg/L	–	265.9	184.5	246.4	197.3	203.1	190.6	154.4	199.9
Calcium	mg/L	–	37.8	35.6	53.3 J	38.4 J	39.4	37.7	26.5	37.5
Magnesium	mg/L	–	41.8	23.3	27.6	24.7	25.5	23.5	21.5	25.9
Potassium	mg/L	–	17.7	5.54	5.5	11.1	11.0	11.3	11.3	9.08
Sodium	mg/L	–	407.	86.9	91.5	121.	125.	110.	214.	74.4
Chloride	mg/L	–	146.	141.	166.	105.	106.	102. J	159.	148.
Fluoride	mg/L	4	0.281	0.254	0.304	0.907	0.919	0.836 J	1.48	0.359
Silicon	mg/L	–	6.07	6.15	8.32	12.	12.1	11.3	7.48	22.3
Sulfate	mg/L	–	62.2	62.7	50.9	132.	136.	120. J	139.	55.8
Total dissolved solids	mg/L	–	400.	476.	480.	536.	536.	528. J	744.	420.
Nutrients										
Nitrate	mg/L N	10	0.868 J	–	–	0.604	0.590	0.597 J	0.66	2.73
Total Orthophosphate	mg/L P	–	<0.05	–	–	<0.05	<0.05	<0.05 J	<0.05	<0.05
Dissolved metals										
Aluminum	mg/L	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	mg/L	0.05	0.00793	0.00558	0.00266	0.0277	0.0284	0.0206	0.0306	0.0198
Beryllium	mg/L	0.004	<0.0003	<0.002	<0.002	<0.006	<0.006	<0.0006	<0.0006	<0.0006
Boron	mg/L	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.587 J	<0.5
Cadmium	mg/L	0.005	<0.00009	<0.0005	<0.0005	<0.0009	<0.0009	<0.00018	<0.00018	<0.00018
Chromium	mg/L	0.1	<0.01	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	1.3	0.0015	<0.00229	<0.002	0.566 J	<0.008	0.00118	0.00149	<0.00105
Iron	mg/L	–	<0.1	<0.1	<0.428	<0.1	<0.1	0.141	0.162	<0.1
Lead	mg/L	0.015	<0.0002	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.0004	0.00135
Manganese	mg/L	–	0.0263	<0.00675	<0.0293	<0.012	<0.012	0.0179	0.0226	<0.0012
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Selenium	mg/L	0.05	0.00137	<0.002	<0.002	<0.004	<0.004	<0.0008	<0.0008	<0.0008
Silver	mg/L	0.1	<0.0002	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.0004	<0.0004
Zinc	mg/L	5	0.019	<0.164	<0.00828	0.124	0.120	0.0841	0.113	0.0683

			Bedrock							
			Prospect Mountain Quartzite			Notch Peak Formation				Unidentified Lava Fm
	Station Name		**Monument Point**		**North Cricket**	**Black Hills**		**Coyote**	**Nighthawk**	**Lakeview**
	Sample ID Lab ID		SEV-11-007 1204204-001A, 1204204-001B, 1204204-001C 04/11/2012	Monument Point 1305029-003A, 1305029-003B, 1305029-003C 04/25/2013	N. Cricket-Baseline-001 1304401-001A, 1304401-001B, 1304401-001C 04/11/2013	Black Hills Baseline - 08:05 1202170-004A, 1202170-004B, 1202170-004C 02/10/2012	Black Hills Baseline - 09:50 1202170-001A, 1202170-001B, 1202170-001C 02/10/2012	SEV-11-013 1203367-001A, 1203367-001B, 1203367-001C 03/22/2012	SEV-11-014 1203303-001A, 1203303-001B, 1203303-001C 03/19/2012	Lakeview Baseline 1202149-001A, 1202149-001B, 1202149-001C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**								
Field parameters										
DTW	feet	–	–	–	499	–	85	391	476	85
Temperature	°C	–	23	–	20	–	24	27	21	23
pH	s.u.	6.5–8.5	8.24	–	7.70	–	7.52	7.50	6.89	7.77
SC	μS/cm	–	952	–	910	–	932	887	1,072	751
Turbidity	NTU	–	140	–	0.0	–	R	–	–	R
DO	mg/L	–	10	–	9	–	4	6	6	3
ORP	mV	–	200	–	25	–	-8	-108	-122	-16

DO = dissolved oxygen

DTW = depth to water

ND = statistic not calculated, all data below the detection limit

%ND = percent of samples reported as below the detection limit

% > WQ Standard = percent of samples reported above the groundwater quality standard

TDS = total dissolved solids

SC = specific conductance

ORP = oxidation-reduction potential

H = sample exceeded holding time

J = data were qualified as an estimated value

R = data rejected as not representative of sample

U = detected in equipment blank

s.u. = standard unit

Table B-2. Groundwater Analytical Results, 2012–2013: Alluvial/Colluvial Deposits

Parameter	Station Name / Sample ID Lab ID / Units	Utah Groundwater Standard	Unconsolidated Deposits										
	Station Name		257 Cutoff Well		Black Rock	Bonneville	Crystal Peak Road	Guzzler	Miller Canyon Reservoir	Mudhole	UDOT 2	UDOT 3	Wah Wah
	Sample ID Lab ID		257 Cutoff 1305029-001A, 1305029-001B, 1305029-001C 04/27/2013	257 Cutoff-Well-06102013 1306182-003A, 1306182-003B, 1306182-003C 06/10/2013	Blackrock Baseline 1202158-001A, 1202158-001B, 1202158-001C 02/09/2012	Bonneville 1303067-003A, 1303067-003B, 1303067-003C 03/03/2013	CPR Baseline 1202300-001A, 1202300-001B, 1202300-001C 02/20/2012	Guzzler 1303067-002A, 1303067-002B, 1303067-002C 03/01/2013	Miller Canyon 1304417-001A, 1304417-001B, 1304417-001C 04/12/2013	Mudhole Baseline 1202158-003A, 1202158-003B, 1202158-003C 02/09/2012	UDOT 2 1304402-001A, 1304402-001B, 1304402-001C 04/10/2013	UDOT 3 1304402-002A, 1304402-002B, 1304402-002C 04/11/2013	Wah Wah Baseline 1202149-002A, 1202149-002B, 1202149-002C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**											
Major Ions and TDS													
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	348.	363.	320.	399.	111.	147.	236.	156.	209.	136.	124.
Carbonate	mg/L $CaCO_3$	–	<20	<20	<40	28.6	<20	<10	<20	<20	<20	35.8	<20
Hardness, Ca+Mg	mg/L	–	8,918.5	11,688.	462.	37.9	772.2	240.2	57.1	249.	129.1	202.2	306.5
Calcium	mg/L	–	845.	690.	83.3	<7.6	117.	43.1	<8.28	47.1	<24.9	<23	51.9
Magnesium	mg/L	–	1,660.	2,430.	61.9	4.61	117.	32.3	8.87	32.	16.3	35.3	43.1
Potassium	mg/L	–	397.	373.	37.2	5.8	25.3	6.73	14.	11.4	5.22	19.	16.3
Sodium	mg/L	–	15,500.	23,900.	598.	385.	865.	69.2	430.	149.	791.	1,030.	318.
Chloride	mg/L	–	29,600.	33,000.	1,320.	193.	1,340.	144.	299.	241.	889.	1,140.	546.
Fluoride	mg/L	4	0.5	0.219	1.52	6.36	0.635	0.418	2.29	0.468	1.58	1.6	0.564
Silicon	mg/L	–	33.1	12.5	20.6	6.44	17.9	6.94	7.03	13.7	12.9 J	<0.651	18.2
Sulfate	mg/L	–	16,400.	14,000.	583.	226.	730.	35.5	263.	127.	333.	602.	458. J
Total dissolved solids	mg/L	–	82,700.	80,800.	3,180.	1,060.	3,410.	472.	1,150.	688.	2,000.	2,820.	1,330.
Nutrients													
Nitrate	mg/L N	10	–	<0.01	<0.01	–	0.273	–	–	<0.01	–	–	2.93
Total orthophosphate	mg/L P	–	–	0.104	0.136	–	<0.05	–	–	<0.05	–	–	<0.05
Dissolved Metals													
Aluminum	mg/L	–	<1.44	<1	<0.1	<0.11	0.17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	mg/L	0.05	0.652 J	0.267	0.0421	0.00443	0.0519	<0.002	0.182	0.0365	0.223	<0.002	0.0254
Beryllium	mg/L	0.004	<0.002	<0.01	<0.0006	<0.002	<0.003	<0.002	<0.002	<0.0006	<0.002	<0.002	<0.0006
Boron	mg/L	–	11.	8.18	2.06	2.79	0.832 J	<0.5	0.818	<0.5	2.33	2.87	<0.5
Cadmium	mg/L	0.005	<0.0005	<0.0025	<0.00018	<0.0005	<0.0009	<0.0005	<0.0005	<0.00018	<0.0005	<0.0005	<0.00018
Chromium	mg/L	0.1	<0.00646	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<0.002	<0.01
Copper	mg/L	1.3	<0.00412	<0.01	<0.00218	<0.002	<0.004	<0.00238	<0.002	<0.0008	<0.002	<0.002	<0.000986
Iron	mg/L	–	<0.1	6.01	0.763	<0.1	0.122	<0.1	<0.1	0.28	<0.406	<0.801	<0.1
Lead	mg/L	0.015	0.00249	<0.01	<0.0004	<0.002	<0.002	<0.002	<0.002	<0.0004	0.00513	<0.002	0.000743
Manganese	mg/L	–	0.689	1.54	0.338	<0.0356	0.0166	<0.103	<0.0407	0.0163	<0.0263	<0.0526	<0.0012
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015

	Station Name		Unconsolidated Deposits											
			257 Cutoff Well		**Black Rock**	**Bonneville**	**Crystal Peak Road**	**Guzzler**	**Miller Canyon Reservoir**	**Mudhole**	**UDOT 2**	**UDOT 3**	**Wah Wah**
	Sample ID Lab ID		257 Cutoff 1305029-001A, 1305029-001B, 1305029-001C 04/27/2013	257 Cutoff-Well-06102013 1306182-003A, 1306182-003B, 1306182-003C 06/10/2013	Blackrock Baseline 1202158-001A, 1202158-001B, 1202158-001C 02/09/2012	Bonneville 1303067-003A, 1303067-003B, 1303067-003C 03/03/2013	CPR Baseline 1202300-001A, 1202300-001B, 1202300-001C 02/20/2012	Guzzler 1303067-002A, 1303067-002B, 1303067-002C 03/01/2013	Miller Canyon 1304417-001A, 1304417-001B, 1304417-001C 04/12/2013	Mudhole Baseline 1202158-003A, 1202158-003B, 1202158-003C 02/09/2012	UDOT 2 1304402-001A, 1304402-001B, 1304402-001C 04/10/2013	UDOT 3 1304402-002A, 1304402-002B, 1304402-002C 04/11/2013	Wah Wah Baseline 1202149-002A, 1202149-002B, 1202149-002C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**											
Selenium	mg/L	0.05	<0.005	<0.01	<0.0008	<0.002	<0.004	<0.002	<0.002	<0.0008	<0.002	<0.002	0.00208
Silver	mg/L	0.1	<0.002	<0.01	<0.0004	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.002	<0.002	<0.0004
Zinc	mg/L	5	<0.128	<0.0719	0.121	0.323	<0.025	<0.0352	<0.0225	<0.0104	<0.005	<0.00879	0.15
Field Parameters													
DTW	feet	–	21	–	12	181	179	376	269	3	187	–	212
Temperature	°C	–	16	–	13	15	12	21	16	20	21	16	16
pH	s.u.	6.5–8.5	7.16	–	7.48	8.82	7.56	7.28	6.68	7.69	9.14	9.30	7.79
SC	µS/cm	–	99,900	–	4,260	1,980	4,135	790	2,100	1,117	3,920	5,230	2,013
Turbidity	NTU	–	571	–	R	515	2,146	203	25	R	116	23	R
DO	mg/L	–	0	–	0	9	3	10	11	0	12	10	1
ORP	mV	–	-175	–	-148	-151	180	14	121	-157	-182	-36	0

= exceeds lowest applicable WQ standard

DO = dissolved oxygen

DTW = depth to water

ND = statistic not calculated, all data below the detection limit

%ND = percent of samples reported as below the detection limit

% > WQ standard = percent of samples reported above the groundwater quality standard

TDS = total dissolved solids

SC = specific conductance

ORP = oxidation-reduction potential

H = sample exceeded holding time

J = data were qualified as an estimated value

R = data rejected as not representative of sample

U = detected in equipment blank

s.u. = standard unit

Table B-3. Groundwater Analytical Results, 2012–2013: Playa Sediments

Parameter	Station Name / Sample ID Lab ID / Units	Utah Groundwater Standard	Playa Sediments																
	Station Name		Amasa	Dike Access	Glass Ocean	Glitter Gulch	Headlight Gap	Laceration	Machine Gun	Mudflat	Nautilus	Provo	PVC Shoal	Red Boat	RR7-1	RR7-4	S13	SN2-11-400-4	Wishing Well
	Sample ID Lab ID		Amasa Baseline 1202119-001A, 1202119-001B, 1202119-001C 02/07/2012	Dike Access 1303067-001A, 1303067-001B, 1303067-001C 02/27/2013	Glass Ocean Baseline 1202244-002A, 1202244-002B, 1202244-002C 02/15/2012	Glitter Gulch Baseline 1202244-001A, 1202244-001B, 1202244-001C 02/15/2012	Head Light Gap Baseline 1202283-001A, 1202283-001B, 1202283-001C 02/17/2012	Laceration Baseline 1202170-002A, 1202170-002B, 1202170-002C 02/10/2012	Machine Gun Baseline 1202119-003A, 1202119-003B, 1202119-003C 02/07/2012	Mudflat Baseline 1202300-002A, 1202300-002B 02/20/2012	Natilus Baseline 1202283-002A, 1202283-002B, 1202283-002C 02/17/2012	Provo 1305029-002A, 1305029-002B, 1305029-002C 04/29/2013	PVC Shoal Baseline 1202119-002A, 1202119-002B, 1202119-002C 02/07/2012	Red Boat Baseline 1202224-002A, 1202224-002B, 1202224-002C 02/14/2012	RR7-1-100 1203461-003A, 1203461-003B, 1203461-003C 03/28/2012	RR7-4-35 1203461-001A, 1203461-001B, 1203461-001C 03/28/2012	S13-23 1204046-001A, 1204046-001B, 1204046-001C 04/03/2012	SN2-11-400-4" Baseline 1202320-002A, 1202320-002B, 1202320-002C 02/21/2012	Wishing Well Baseline 1202224-001A, 1202224-001B, 1202224-001C 02/14/2012
	Units																		
Major Ions and TDS																			
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	101.	91.3	88.3	122.	99.2	92.8	122.	175.	215.	104.	706.	111.	348.	262.	308.	65.5	81.9
Carbonate	mg/L $CaCO_3$	–	<10	<10	<10	<20	<10	<10	<10	<20	<20	<10	<10	<10	<20	<20	<20	<10	<10
Hardness, Ca+Mg	mg/L	–	12,259.	1,546.8	6,474.5	4,555.9	9,815.	6,429.5	4,645.2	7,749.	12,715.	4,421.8	1,869.7	4,601.3	7,547.	37,121.	15,570.	10,558.	4,133.
Calcium	mg/L	–	1,640.	253.	835.	717.	974.	817.	633.	820.	576.	665.	146.	704.	1,100.	7,780. J	652.	1,550.	661.
Magnesium	mg/L	–	1,990.	223.	1,070.	674.	1,800.	1,070.	747.	1,390.	2,750.	673.	367.	693.	1,170.	4,310.	3,400.	1,630.	605.
Potassium	mg/L	–	366.	19.3	181.	84.4	285.	92.9	123.	783.	1,000.	39.7	372.	73.	186.	2,550.	2,560.	211.	80.2
Sodium	mg/L	–	11,600.	4,190.	18,800.	12,100.	26,000.	23,600.	17,600.	26,700.	27,600.	9,750.	9,600.	15,100.	24,300.	70,900.	66,900.	30,400.	10,500.
Chloride	mg/L	–	21,300.	5,590.	23,200.	11,800.	39,300.	29,000.	22,700.	39,500.	41,300.	10,300.	17,600.	19,200.	26,800.	116,000.	107,000. J	44,600.	11,200.
Fluoride	mg/L	4	<1	0.797	<0.1	<0.1	<0.1	<0.1	<1	0.122	0.136	0.226	<1	0.337	1.	<0.5	<0.5	0.202	0.833 J
Silicon	mg/L	–	19.9	8.55	6.2	8.57	8.23	7.3	8.49	9.	9.25	8.25	11.3	3.59	6.14	15.3	15.2	7.87	6.7
Sulfate	mg/L	–	5,010.	1,860.	8,580.	10,600.	12,100.	9,810.	8,140.	15,100.	19,600.	7,840.	4,220.	8,440.	5,590.	6,930.	19,900.	6,950.	8,480.
Total dissolved solids	mg/L	–	52,600.	13,800.	103,000.	33,000.	122,000.	117,000.	58,100.	84,200.	109,000.	33,000.	38,200.	76,000.	66,600.	191,000.	194,000.	95,700.	51,500.
Nutrients																			
Nitrate	mg/L N	10	39.8	–	0.271	<0.01	<0.01	<0.02	<0.0556	12.5	8.08	–	1.26	<0.01	<0.01	<0.01	0.0255	<0.01	<0.01
Total Orthophosphate	mg/L P	–	<0.05	–	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	–	8.59	<0.05	0.0625	0.222	0.226	<0.1	<0.05
Dissolved Metals																			
Aluminum	mg/L	–	0.227	<0.2	0.181	0.115	0.164 J	0.179	<1	0.345	0.145	<0.2	<0.1	0.129	0.205	0.377 J	0.3 J	0.565	0.105
Arsenic	mg/L	0.05	0.129	<0.002	0.055	0.296	0.0557	0.771	0.264	0.0522	0.124	0.0729	0.0717	0.125	<0.015	0.0184 J	0.264 J	0.111	0.0678
Beryllium	mg/L	0.004	<0.006	<0.002	<0.015	<0.003	<0.006	<0.006	<0.006	<0.006	<0.006	<0.002	<0.006	<0.006	<0.015	<0.015 J	<0.015	<0.006	<0.003
Boron	mg/L	–	9.26	1.55	5.61	5.93	11.3	3.57	4.15	14.7	33.7	3.14	1.76	3.63	3.12	12.	17.8	3.53	4.28
Cadmium	mg/L	0.005	<0.0018	<0.0005	0.00154	0.00234	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0005	<0.0018	<0.0009	<0.0018	<0.0018	<0.0045	<0.0018	0.0012
Chromium	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	0.0192	<0.01	0.018	0.0305 J	<0.01 J	<0.01	<0.01
Copper	mg/L	1.3	0.0293	<0.0039	0.0343	0.0479	0.202	0.194	0.0429	0.053	0.0897	<0.002	<0.008	0.0354	0.0418	0.0647	0.135	0.0307	0.0295
Iron	mg/L	–	0.246	<0.168	0.116	0.33	<0.1	0.95	0.255	<0.1	0.236	<0.123	<0.1	0.187	21.9	1.55 J	0.269 J	0.678	0.31
Lead	mg/L	0.015	<0.004	<0.002	0.00693	<0.002	0.00925 J	<0.004	0.123	0.00443	0.0161	0.00215	<0.004	0.0138	<0.004	<0.004	<0.01	<0.004	<0.002
Manganese	mg/L	–	0.121	0.795	0.156	0.138	0.0763 J	0.0745	0.352	0.385	0.0562	1.94	0.154	0.106	2.88	0.125	0.312	0.796	0.21
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015 J	<0.00015 J	<0.00015	<0.00015

Parameter	Station Name / Sample ID Lab ID / Units	Utah Groundwater Standard	Playa Sediments																
	Station Name		**Amasa**	**Dike Access**	**Glass Ocean**	**Glitter Gulch**	**Headlight Gap**	**Laceration**	**Machine Gun**	**Mudflat**	**Nautilus**	**Provo**	**PVC Shoal**	**Red Boat**	**RR7-1**	**RR7-4**	**S13**	**SN2-11-400-4**	**Wishing Well**
	Sample ID Lab ID		Amasa Baseline 1202119-001A, 1202119-001B, 1202119-001C 02/07/2012	Dike Access 1303067-001A, 1303067-001B, 1303067-001C 02/27/2013	Glass Ocean Baseline 1202244-002A, 1202244-002B, 1202244-002C 02/15/2012	Glitter Gulch Baseline 1202244-001A, 1202244-001B, 1202244-001C 02/15/2012	Head Light Gap Baseline 1202283-001A, 1202283-001B, 1202283-001C 02/17/2012	Laceration Baseline 1202170-002A, 1202170-002B, 1202170-002C 02/10/2012	Machine Gun Baseline 1202119-003A, 1202119-003B, 1202119-003C 02/07/2012	Mudflat Baseline 1202300-002A, 1202300-002B 02/20/2012	Natilus Baseline 1202283-002A, 1202283-002B, 1202283-002C 02/17/2012	Provo 1305029-002A, 1305029-002B, 1305029-002C 04/29/2013	PVC Shoal Baseline 1202119-002A, 1202119-002B, 1202119-002C 02/07/2012	Red Boat Baseline 1202224-002A, 1202224-002B, 1202224-002C 02/14/2012	RR7-1-100 1203461-003A, 1203461-003B, 1203461-003C 03/28/2012	RR7-4-35 1203461-001A, 1203461-001B, 1203461-001C 03/28/2012	S13-23 1204046-001A, 1204046-001B, 1204046-001C 04/03/2012	SN2-11-400-4" Baseline 1202320-002A, 1202320-002B, 1202320-002C 02/21/2012	Wishing Well Baseline 1202224-001A, 1202224-001B, 1202224-001C 02/14/2012
Parameter	**Units**	**Utah Groundwater Standard**																	
Selenium	mg/L	0.05	0.0727	<0.002	0.00701	<0.004	<0.008	<0.004	<0.004	<0.008	<0.008	<0.002	<0.004	<0.004	<0.008	<0.008	<0.02 J	<0.008	<0.004
Silver	mg/L	0.1	<0.004	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002	<0.004	<0.002	<0.004	<0.004	<0.01	<0.004	<0.002
Zinc	mg/L	5	0.122	2.56	3.16	1.49	<3.01	2.13	2.33	0.151	<2.47	0.906	<0.05	7.75	<0.05	<0.05	0.164	0.0568	0.0598
Field Parameters																			
DTW	feet	–	60	34	18	155	109	86	38	129	12	87	10	176	0	5	3	–	98
Temperature	°C	–	1	16	7	13	14	14	14	14	11	20	–	15	–	16	14	12	12
pH	s.u.	6.5–8.5	7.04	7.27	7.55	7.58	7.62	7.38	7.4	6.96	7.52	7.9	–	7.37	–	6.19	6.58	7.41	7.72
SC	µS/cm	–	42,590	59,800	65,390	21,590	76,120	71,330	70,910	103,900	86,030	99,900	–	26,240	–	177,600	174,400	111,600	33,540
Turbidity	NTU	–	R	709	R	245	19	R	R	328	188	179	–	45	–	58	R	1	132
DO	mg/L	–	1	10	1	5	1	0	2	2	2	1	–	4	–	0	0	17	1
ORP	mV	–	42	50	84	119	149	-108	-35	-53	128	-177	–	34	–	10	65	-146	-85

= exceeds lowest applicable WQ standard

DO = dissolved oxygen

DTW = depth to water

ND = statistic not calculated, all data below the detection limit

%ND = percent of samples reported as below the detection limit

% > WQ standard = percent of samples reported above the groundwater quality standard

TDS = total dissolved solids

SC = specific conductance

ORP = oxidation-reduction potential

H = sample exceeded holding time

J = data were qualified as an estimated value

R = data rejected as not representative of sample

U = detected in equipment blank

s.u. = standard unit

1

ATTACHMENT C

Combined Sampling and Analysis Plan and Quality Assurance Project Plan for the Sevier Playa Project

COMBINED SAMPLING AND ANALYSIS PLAN
AND
QUALITY ASSURANCE PROJECT PLAN FOR THE
SEVIER PLAYA PROJECT

CRYSTAL PEAK MINERALS
SEVIER PLAYA POTASH PROJECT

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Revision	Description	Author		Quality Check		Independent Review	
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Reviewed by ____

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Rich White

Approved by ____

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Tom Suchoski

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ABBREVIATIONS

AMSL	above mean sea level
ASTM	American Society of Testing Materials
BLM	U.S. Bureau of Land Management
BTOC	below top of casing
CCVs	Continuing Calibration Verification Standards
CDFM	Corehole Dynamic Flowmeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CoC	Chain of Custody
CPM	Peak Minerals Inc. (DBA "Crystal Peak Minerals")
DO	dissolved oxygen
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
ft	feet
HSU	Hydrostratigraphic unit
ICV	Initial calibration value
ITRC	Interstate Technology and Regulatory Council
K_2SO_4	Potassium sulfate
LCSD	Laboratory Control Sample Duplicates
LCS	laboratory control sample
LMS	Laboratory matrix spike
LMSD	Laboratory Matrix Spike Duplicates
MDL	method (or minimum) detection limit
mg/L	milligrams per liter
ml	milliliter
MQO	Measurement Quality Objectives
MS	matrix spikes
MS/MSD	matrix spike/matrix spike duplicate
MTM	Monitoring Task Manager
NELAP	National Environmental Accreditation Program
NTU	Nephelometric Turbidity Units
Pace	Pace Laboratories, formerly ESC Lab Sciences

PM	Project Manager
PQL	practical quantitation limit
Project	Sevier Playa Potash Project
PSI	pounds per square inch
PVC	polyvinyl chloride
QAO	Quality Assurance Officer
QA/QC	quality assurance and quality control
QC	quality control
QCS	quality control summary
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
SAP	Sampling Analysis Plan
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SC	Specific conductance
SITLA	State of Utah School and Institutional Trust Lands Administration
SOP	Sulfate of potash
SW	southwest
TDS	total dissolved solids
TSS	total suspended solids
UAC	Utah Administrative Code
UDWQ	Utah Division of Water Quality
ug/l	Micrograms per liter
WPSA	Waste Product Storage Area

1 INTRODUCTION

1.1 Background

Crystal Peak Minerals ("CPM") is proposing to construct and operate the Sevier Playa Potash Project ("Project") on federal, state, and private lands in Millard County, Utah. The Project would be designed to produce an average of approximately 328,500 tons per year of potash in the form of potassium sulfate ("K_2SO_4"), also known as sulfate of potash ("SOP"), as well as other associated minerals. CPM controls through agreement the right to develop and operate potassium mineral leases on approximately 118,000 acres of land administered by the U.S. Bureau of Land Management ("BLM"), and controls through agreement potash mineral leases on an additional approximately 6,400 acres of state lands administered by the State of Utah School and Institutional Trust Lands Administration ("SITLA").

In general, the on-lease mining design for the Project would consist of the following three major features: (1) a brine extraction system consisting of canals, trenches, and wells; (2) a recharge system consisting of canals and trenches; and (3) a series of evaporation ponds consisting of preconcentration and production ponds. The brines extracted from below the surface of the Sevier Playa would be concentrated by solar evaporation in a series of preconcentration ponds. The brines would be further evaporated, and the potassium-rich salts precipitated in the production ponds would be harvested and transported to an on-lease processing facility. The salts would be processed at the processing facility to produce saleable SOP, as well as other associated minerals.

Infrastructure to support the Project would include: (1) access roads, (2) communication towers, (3) power and communications lines, (4) a natural gas pipeline, (5) a rail loadout facility and associated rail spur, (6) water supply facilities, 7) groundwater monitoring wells; and 8) gravel pits. These components would all be located on off-lease lands.

The Utah Division of Water Quality ("UDWQ"), as the regulatory agency with jurisdiction over groundwater within the state, requires that a baseline assessment of the groundwater resources in the area be prepared as part of an anticipated Groundwater Discharge Permit application. Further, the federal lease held by CPM contains two Special Stipulations that require monitoring of surface and groundwater in the vicinity of the Project (BLM 2011).

Special Stipulation 8 of the federal leases states:

> "The Lessee at his expense, will be responsible to replace any water resources (that contain in a base line analysis of <10,000 mg/L TDS), that are lost or adversely affected (quality or quantity) by their mining operations. . . .If replacement is required, the lessee shall replace

the sources with an alternate source in the same quantity and quality to maintain existing uses. . . . The lessee/operator shall obtain sufficient base line data and monitoring in order to establish parameters to show whether water resources are affected."

Special Stipulation 13 of the federal leases states:

> "Sufficient base line data shall be established prior to conducting any surface disturbing activity which shall be determined necessary by the AO [Authorized Officer]. In order to accomplish this, the lessee shall submit for review and approval by the AO a plan to analyze ground and surface water interactions as part of any operations or exploration on the leases. The plan shall be submitted prior to or concurrent with a Mining or Exploration plan, under 43 CFR 3592.1. The plan shall include, but not be limited to the following items, and shall describe how the lessee proposes to: (1) Develop sufficient baseline groundwater information to document existing hydrogeology associated with Sevier Lake basin fill and underlying carbonates, encompassing a reasonable area of potential resources, springs, and the alluvial and bedrock aquifers. This shall include items such as the location, size, and depth of any hole that would encounter water and/or brine as well as any information that would be collected on each hole. (2) Determine the potential impacts to existing water right holders, wells, wetlands, and surface and groundwater throughout their operations. Water chemistry (including stable isotopes as necessary), estimated flow and water quantity (water balance) shall be addressed. (3) Monitor the actual impacts to groundwater resources throughout and surrounding the operation including but not limited to changes in meteoric precipitation and springs, wells (base conditions, water levels, and chemistry conditions prior to construction and monitoring after construction), wetlands, and ditches. Wells, wetlands, and springs (at sites determined to be relevant based upon the groundwater study that would be conducted prior to development) shall be monitored during operations in order to minimize potential impacts to groundwater resources by allowing an early identification. Further, the plan shall contain sufficient detail to allow it to be independently assessed and include such things as the type of groundwater model that would be used (and/or other methods of analysis), phasing of the analysis and proposed iterative studies. The plan shall also contain a list of people and their qualifications to accomplish the work and a list of deliverables with a timing schedule. The lessee shall be responsible for any cost incurred for the plan and the accomplishing of the work."

1.2 Objectives of this SAP/QAPP

The purpose of this Sampling and Analysis Plan/Quality Assurance Project Plan ("SAP/QAPP") is to present methods for collecting and validating the above-required data. This SAP/QAPP provides a description of the procedures for collecting surface and groundwater data to supplement data collected to date; to better assess the seasonal fluctuations within the hydrologic regime; to monitor wells, springs, and streams; and to ensure a valid data set that can be used to evaluate potential future impacts from the proposed Project. The collection of meteorological data at the site is discussed in the associated Water Monitoring Plan (Norwest 2019).

At the request of BLM, this plan was prepared in general accordance with guidance provided by the U.S. Environmental Protection Agency ("EPA") (2002 and 2012) for the preparation of Quality Assurance Project Plans and Sampling and Analysis Plans, respectively. To avoid duplication, the Sampling and Analysis Plan and the Quality Assurance Project Plan have been combined in this document, which was organized using the template prepared by the EPA (2012). The use of this template and guidance should not be construed as implying the Project falls under the umbrella of the Resource Conservation and Recovery Act ("RCRA") or the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA").

1.3 Area of Interest

The area of interest associated with this SAP/QAPP consists of the Sevier Playa and adjacent areas located in Millard County, Utah. Figure 2-2, a map showing the area of interest, together with additional information regarding the playa and adjacent areas, is presented in Section 2.1 of this document.

1.4 Sampling Area Location

The Sevier Playa is a terminal basin located at the downstream end of the Sevier River in west-central Utah. As a salt-encrusted and occasionally-flooded area, the playa is not in current use. Areas adjacent to the playa are currently used as rangeland and wildlife habitat.

1.5 Responsible Agency

Monitoring activities conducted under this SAP/QAPP will be performed by or under contract to CPM. The resulting data will be submitted to UDWQ and BLM for review to ensure that CPM is in compliance with the requirements of the state groundwater discharge permit and the federal lease Special Stipulations, respectively.

1.6 Project Organization

The SAP/QAPP organizational chart is presented in Figure 1-1, with the responsibilities of key Project personnel presented below. Contact information for these individuals is presented in Table 1-1. Some team members may be responsible for more than one position.

As significant changes to duties or personnel occur, CPM will document and append such changes to this SAP/QAPP within 60 days of the change(s) and notify UDWQ and BLM. Where changes do not reflect an alteration in the overall scope of the activities or a change of requirements, such changes will be incorporated into the next required SAP/QAPP revision.

UDWQ Lead Engineer: This individual will be the primary UDWQ contact for issues related to compliance of the Project to the UDWQ Groundwater Discharge Permit. He/she will review this SAP/QAPP and will be responsible for determining compliance of the SAP/QAPP with state regulatory requirements. He/she will also review future monitoring data and audit monitoring activities.

BLM Authorized Officer: The Authorized Officer will be the primary BLM contact responsible for ensuring proper implementation of the SAP/QAPP. They will review this SAP/QAPP, audit monitoring activities, and assess the adequacy of the resulting data for meeting the requirements of the federal lease Special Stipulations.

CPM Project Manager: The CPM Project Manager ("PM") will provide overall direction to task managers and monitoring personnel necessary to accomplish the objectives of the SAP/QAPP, including development and completion of the technical work scope; coordination and execution of the scope, schedule, and budget requirements; reporting on the status of monitoring activities; assuring that staff with appropriate technical qualifications are utilized during implementation of the SAP/QAPP; and serving as primary liaison between CPM and the affected agencies (UDWQ and BLM).

Monitoring Task Manager: The Monitoring Task Manager ("MTM") is responsible for conducting and/or oversight of field activities associated with implementation of the SAP/QAPP. Specific MTM responsibilities include:

- Conduct or oversee installation of monitoring wells, downhole testing, and sample collection activities and ensure that work performed by the analytical laboratories is conducted in accordance with accepted protocols;
- Ensure that all field and data management personnel have reviewed the SAP/QAPP, are properly trained in procedures discussed in this document, and follow established policies and procedures;
- Review and validate testing and analytical results to ensure that the results fulfill the data quality objectives ("DQOs") established in the SAP/QAPP; and
- Direct or prepare annual reports in which data collection activities are summarized and the resulting data are presented.

Figure 1-1 Project Personnel Organization Chart

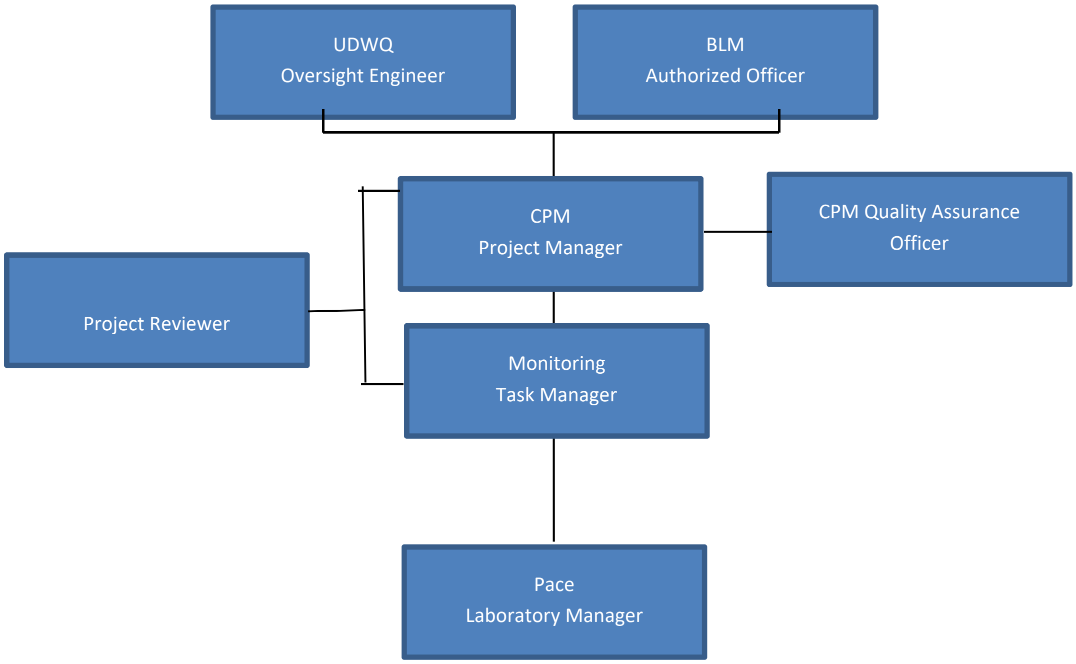


Table 1-1 Distribution List

Position	Agency	Contact Information
BLM Authorized Officer	BLM	Phone: 435-743-3100
UDWQ Lead Engineer	UDWQ	Phone: 801-536-4355
CPM Project Manager	CPM	Phone: 801-485-0223
CPM Quality Assurance Officer	CPM	Phone: 801-485-0223
Monitoring Task Manager	Johnston-Leigh	Phone: 801-726-6845
Project Reviewer	Stantec	Phone: 801-539-0044
Pace Laboratory Manager	Pace Labs	Phone: 615-773-9669

CPM Quality Assurance Officer: The Quality Assurance Officer ("QAO") will oversee implementation of the SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the QAO include:

- Provide independent QA oversight during implementation of the SAP/QAPP;
- Review log books, chain-of-custody (CoC) forms, and laboratory analytical reports to determine if data meet the requirements of the SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate measurement quality objectives ("MQOs");

- Report data quality issues, quality control ("QC") concerns, and data non-conformance to established standards to the PM and DM;
- Periodically review the groundwater and surface water sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the SAP/QAPP; and
- Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the SAP/QAPP.

Project Reviewer: The Project Reviewer will provide oversight of technical and quality assurance efforts during implementation of the SAP/QAPP. They will also assist in the preparation of future updates to the SAP/QAPP as needed.

Laboratory Manager: The laboratory that would work on this Project is Pace Labs, formerly ESC Lab Sciences ("Pace") in Mt. Juliet, Tennessee. The laboratory manager will be responsible for ensuring that all quality assurance/quality control procedures are implemented in accordance with in-house plans and this SAP/QAPP. He/she will also serve as the primary point of contact between CPM, its contractors, and the laboratory if questions arise during the data validation process.

2 BACKGROUND

2.1 Sampling Area Description

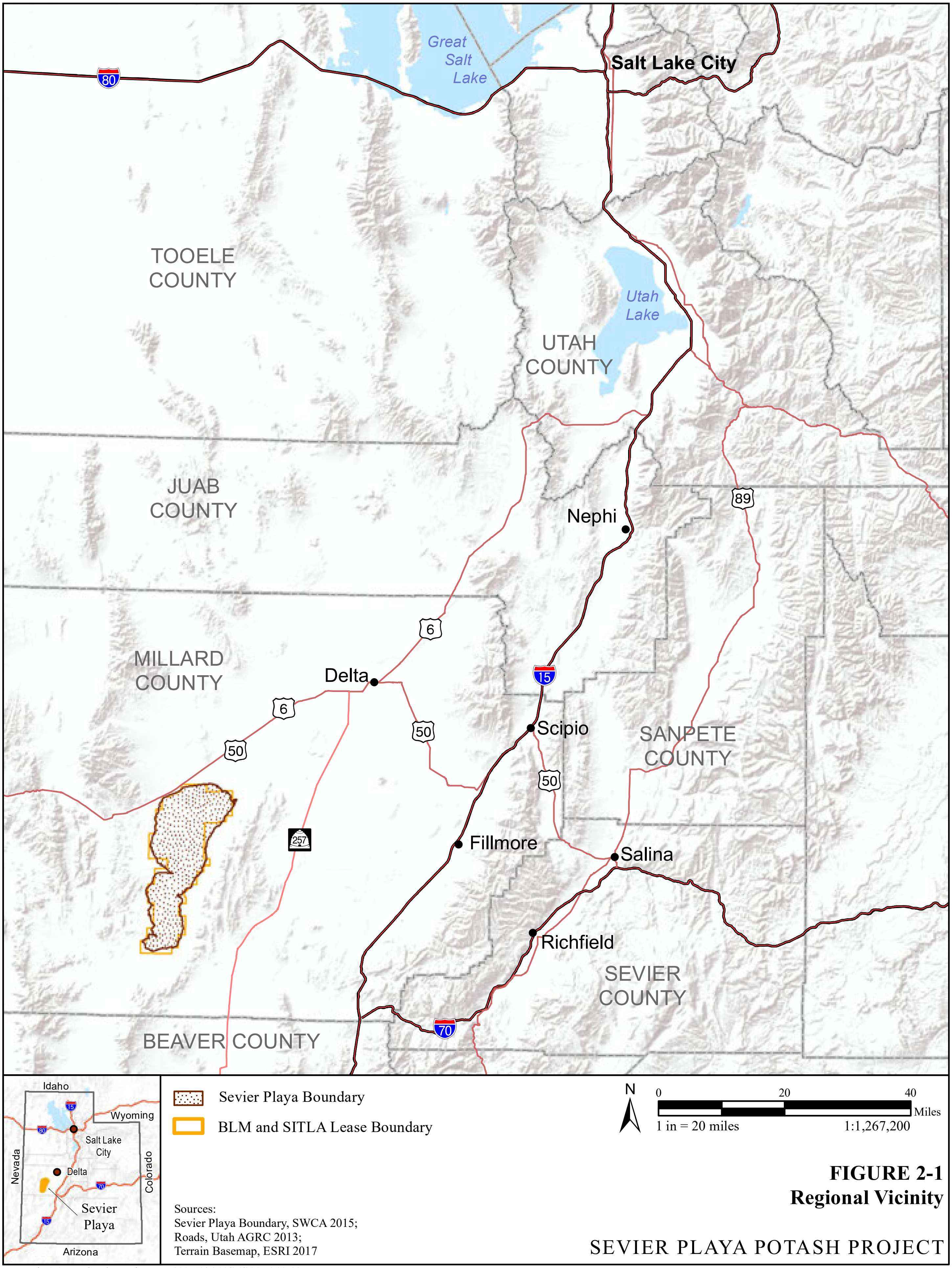
The Sevier Playa is located in west-central Utah approximately 140 miles southwest of Salt Lake City and about midway between the towns of Delta (30 miles to the northeast) and Milford (25 miles to the south-southeast) (Figures 2-1 and 2-2). The playa is approximately 26 miles long by an average of 8 miles wide and covers approximately 130,000 acres at an average elevation of about 4,514 feet above mean sea level ("AMSL"). The center of the playa is located at about latitude 38.921^{o} North, longitude 113.134^{o} West.

The area of interest associated with this SAP/QAPP is shown in Figures 2-2 and 4-1. This area extends generally 3 to 4 miles beyond the lease area on the west, south, and east sides of the playa. On the north, the area of interest extends north of US Highway 6/50 and northeast to Conks Dam. This area is considered sufficient to monitor the potential hydrologic impacts of the Project, as further explained in the companion Water Monitoring Plan (Stantec 2019).

2.2 Operational History

According to Brebner et al. (2018), a prior developer of the Sevier Playa assembled a lease position in 1978 that encompassed the entire surface of the Sevier Playa, including the current Project area. This company carried out significant site activities through 1990 focused on resource characterization and measurement of climatic conditions. These leases were eventually relinquished back to the resource owners.

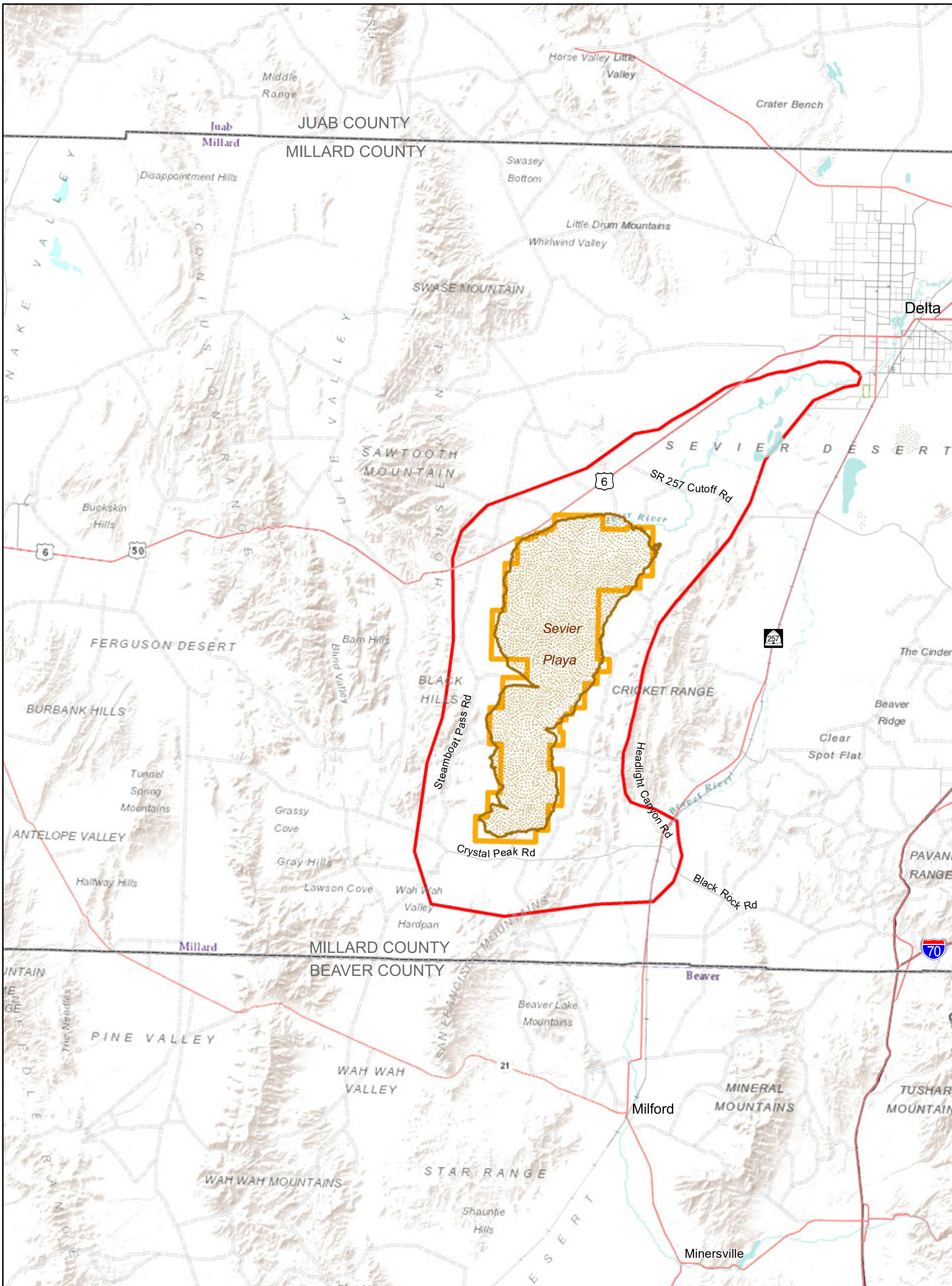
CPM was granted potash leases from SITLA in 2008 and installed wells in the southern portion of the playa to monitor and confirm brine chemistry. CPM also controls development rights to federal potassium leases that were granted to others from BLM by competitive bid in 2011. Since then, CPM has focused its efforts on further evaluation of the mineral potential of the playa and obtaining the permits necessary to begin extraction of the playa's resources. This has included drilling of more than 400 boreholes and the installation and testing of over 90 wells. The wells and borings have concentrated on conditions within the upper 100 feet of the playa surface, but several boreholes have also been completed to depths up to about 500 feet below ground surface to evaluate the stratigraphy of the playa.

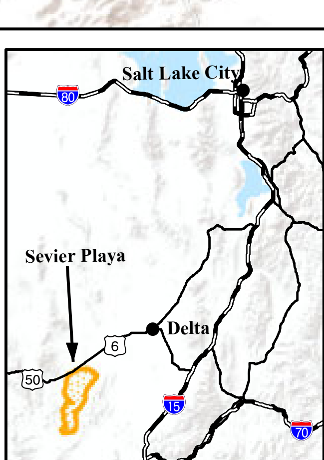


Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

FIGURE 2-1
Regional Vicinity

SEVIER PLAYA POTASH PROJECT





Project Vicinity

- Sevier Playa Boundary
- BLM and SITLA Lease Boundary
- Sevier Playa Potash Project Water Resources Area of Interest

N

0 4.5 9 Miles

1:500,000

Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

Figure 2-2
Project Vicinity
SEVIER PLAYA POTASH PROJECT

MXD Name: WMP Fig 2-2 Project Vicinity 190214 | Date Saved: 2/14/2019 12:09:39 PM

2.3 Previous Investigations

CPM began monitoring groundwater beneath and adjacent to the Sevier Playa in 2011 with the installation of a monitoring well network, refurbishment of existing wells, performance of hydrologic testing, and monitoring of groundwater levels and water quality. This effort was expanded in 2012 to include monitoring of discharge and water quality in the Sevier River.

Whetstone (2017) prepared a summary of publicly-available and site-specific data for the playa available through 2013 as well as select data through 2015. Norwest Corporation (Norwest), now Stantec Consulting Services, Inc. (Stantec), subsequently prepared a Technical Memorandum (Norwest 2018) summarizing additional data collected from 2014 through 2016 that were not included in the Whetstone (2017) report. These data provide a good basic understanding of surface and groundwater quality and quantity in the area of the playa.

The State of Utah classifies surface and groundwater in UAC Title R317 based on quality and intended use. As noted in R317-6, groundwater in the state is classified as follows:

- Class I – Includes Class IA (Pristine), Class IB (Irreplaceable), and Class IC (Ecologically Important) groundwater. Groundwater is categorized as Class IA if the Total Dissolved Solids ("TDS") concentration is less than 500 milligrams per liter ("mg/L") and no contaminant concentration exceeds the standards provided in Appendix A of this plan. Class IB and Class IC groundwater are classified based on use rather than quality.
- Class II – Groundwater of a quality sufficient for human consumption. The TDS concentration of this water is between 500 and 3,000 mg/L, and no constituent concentration may exceed the standards provided in Appendix A of this plan.
- Class III – Limited Use groundwater. This classification is reserved for groundwater with a TDS concentration between 3,000 and 10,000 mg/L or where the concentration of one or more of the contaminants listed in Appendix A exceeds the associated standard.
- Class IV – Saline groundwater. The TDS concentration of this class of groundwater is greater than 10,000 mg/L.

UAC Title R317-2 classifies surface water based on location and Beneficial Use. According to R317-2-13.6, the Sevier River from the Sevier Playa upstream to Gunnison Bend Reservoir (located about 27 miles northeast of the northern end of the Sevier Playa) is classified for protection of the following uses:

- Class 2B – Infrequent primary contact for recreation as well as secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water (such as wading, hunting, and fishing);

- Class 3C – Non-game fisheries and aquatic life, including the necessary organisms in their food chain; and
- Class 4 – Agricultural uses including irrigation of crops and stock watering.

Appendix A provides a list of the water-quality standards for these classifications of surface water as contained in UAC Title R317-2-14.

The data from Whetstone (2017) and Norwest (2018) provide an understanding of the quality and quantity of surface and groundwater in and around the playa. From these data, the State classification and condition of waters in and around the playa can be identified. Based on the data collected to date, surface and groundwater resources within and adjacent to the Sevier Playa can be summarized as follows:

2.3.1 Surface Water

- Under current water use conditions, the majority of the Sevier River flow is diverted upstream from the playa for various beneficial uses. As a result, flows in the lower Sevier River toward the playa are infrequent and consist primarily of irrigation return flows. Infrequent flooding occurs, generally resulting from snowmelt during high precipitation years.
- Runoff from the ephemeral watersheds surrounding the playa is typically lost to infiltration and evaporation as it flows downstream toward the playa. Only during high-intensity precipitation or substantial snowmelt events does runoff reach the playa from these ephemeral watersheds.
- During high flow years, the flow in the Sevier River below Conks Dam (located about 22 miles northeast of the northern end of the Sevier Playa) occasionally exceeds channel capacity. During normal years, the Sevier River is typically dry below Conks Dam except for a 6-mile reach above Crafts Lake which, based on mapping by the U.S. Geological Survey, flows perennially.
- During years when surface flow exists within the lower Sevier River, the quality of this surface water is relatively poor, with TDS concentrations often exceeding 3,000 mg/L. This water tends to be a well-buffered sodium-chloride type. The highest TDS concentrations typically occur in late fall and winter (October through March) with occasional secondary peaks in April or May. The TDS concentration of the river water is typically greater than the surface water agricultural standard (Class 4) of 1,200 mg/L at monitoring points closest to the playa.
- Water in the lower Sevier River sporadically exceeds state surface water quality standards listed in UAC Title R317-2 for cadmium, lead, mercury, selenium, silver, zinc, and pH.

2.3.2 Groundwater

- Groundwater within the area of interest occurs in three hydrostratigraphic units: the playa groundwater system, the alluvial/colluvial groundwater system, and the regional bedrock groundwater system.
- The playa groundwater system occurs in playa sediments that consist generally of very fine-grained clays with local, discontinuous interbeds of silts, sands, and gravel that extend laterally into the playa sediments from the mountain ranges on both sides of the playa. The production zone for the Project is generally considered to be the upper 90 to 95 feet of playa sediments. Below this depth, the playa sediments are typically hard and dry.
- The alluvial/colluvial groundwater system occurs in sediments on slopes adjacent to the playa. These sediments consist of interbedded sand, silt, and clay of variable composition and thickness. The alluvial/colluvial sediments often interbed with the playa sediments near the edges of the playa.
- The regional bedrock groundwater system occurs in the Prospect Mountain Quartzite in the Cricket Mountains east of the playa, the Notch Peak Limestone in the House Range/Black Hills west of the playa, and either the Prospect Mountain Quartzite or Mutual Formation on the south. Structurally, the playa formed in a depression created by down-dropped faulting where the sediments collected.
- Groundwater quality in the aquifers within the area of interest ranges from Class I near the ridges of the adjacent mountains to Class IV adjacent to and within the playa groundwater system.
- Within the regional bedrock system, groundwater flows beneath the playa generally from east to west in the area of interest. Within the alluvial/colluvial system, groundwater recharges the regional bedrock system and flows toward to the playa.
- Whetstone (2017) and Norwest (2018) interpreted differently the extent to which alluvial/colluvial groundwater on the west side of the playa flows toward the playa and the degree of interaction between the playa and regional bedrock groundwater systems. It is anticipated that data collected under the SAP/QAPP will assist in better defining these systems.
- Well testing has determined that groundwater flow velocities within the area of interest are relatively high in the regional bedrock system, moderate in the alluvial/ colluvial strata, and very low in the clayey playa deposits.
- The groundwater chemistry of the regional bedrock system varies depending on the formation, ranging from a sodium-chloride water type to a calcium-bicarbonate to calcium-chloride water type. Whetstone (2017) pointed out that groundwater in the

regional bedrock system meets state Class I water quality standards in the area of interest.

- Alluvial/colluvial aquifers in the area of interest have groundwater chemistry of a sodium-chloride to a sodium-sulfate water type. Groundwater samples collected from the unconsolidated deposits typically meet the numerical groundwater standards listed in Appendix A, with the exception of fluoride, arsenic, and pH. These waters are generally categorized as Class III waters.
- Groundwater within the playa sediments is a sodium-chloride water type. Due to TDS concentrations above 10,000 mg/L, these waters are categorized as Class IV under the state standards.

2.4 Scoping Meeting

Multiple meetings have been held between CPM and BLM as well as CPM and UDWQ to discuss the scope and content of this SAP/QAPP. As a result of those discussions, Norwest (2017) submitted a 50% Framework Water Monitoring Plan to BLM on November 10, 2017. That document consisted of a draft Sampling and Analysis Plan as well as a Quality Assurance Project Plan. BLM and its contractors (ENValue and Whetstone Associates) provided comments on that plan on December 6, 2017.

CPM then held a meeting with BLM on April 17, 2018, to further discuss the scope of the document that would be needed to meet the requirements of the federal lease Special Stipulations. Dan Hall, of UDWQ, attended a portion of the meeting to discuss UDWQ's position on the scope that they require. This SAP/QAPP is intended to address that combined scope.

2.5 Geological/Meteorological Information

2.5.1 Geology

A good summary of the geology of the area of interest is provided by Whetstone (2017). As indicated therein, the Sevier Playa is located in an east-dipping structural graben between the House Range and Cricket Mountains. Little is known of the playa sediments below a depth of 975 feet (the greatest depth to which a borehole has been drilled from the playa surface). However, based on data collected from a gravity survey of the area, Case and Cook (1979) estimated that up to 4,600 feet of "alluvium and/or volcanics" may exist beneath the east edge of the playa.

The Sevier Playa is a terminal hydrologic basin, having no exterior drainage. Given this condition, mineral-rich brine exists within the playa sediments. This brine consists of the mineral salts that exist naturally in the playa groundwater. The playa sediments that contain the brine are composed primarily of clay and marl (carbonate-rich clay).

Consistent with borehole logs from Gwynn (2006) and Wilberg (1991), discontinuous stringers of coarse alluvial/colluvial sediments have been found to extend laterally into the playa sediments. These alluvial/colluvial deposits generally grade from coarser grained to finer grained with interbedded distance into the playa.

Cambrian to Ordovician-age limestone, dolomite, and quartzite underlie the area of interest (Hintze and Davis 2003). The shallowest of these bedrock layers consist of the Notch Peak Formation, which crops out in the House Range west of the playa, and the Prospect Mountain Quartzite, which crops out in the Cricket Mountains east of playa.

2.5.2 Meteorology

The climate of the area of interest is semi-arid. Data downloaded from the Western Regional Climate Center indicate that the average annual precipitation at Delta, Utah is 7.89 inches, with an average annual maximum temperature of 65.7°F and an average annual minimum temperature of 34.5°F. At Milford, Utah, the average annual precipitation is reported to be 9.03 inches, with an average annual maximum temperature of 65.5°F and an average annual minimum temperature of 33.3°F. In both cases, March, April, May, and October are typically the wettest months while June and July are typically the driest months.

2.6 Impact on Human Health and/or the Environment

Given the remoteness of the Project area, the lack of anthropological beneficial use of potentially-impacted surface and groundwater in the area of interest (other than for the future production of minerals under the Project), and the innocuous nature of the minerals that would be produced, no impacts to human health are anticipated from operation of the Project. However, impacts to the environment may occur if TDS concentrations in surface or groundwater are elevated by Project operations above levels that are considered safe for wildlife and agricultural (i.e., stock watering) purposes.

3 PROJECT AND DATA QUALITY OBJECTIVES

3.1 Project Task and Problem Definition

The intent of this SAP/QAPP is to collect the necessary data to meet the requirements of a Groundwater Discharge Permit from UDWQ and the requirements of federal lease Special Stipulations 8 and 13. UDWQ rules require an assessment of groundwater quality in the uppermost aquifer that may be impacted by a project. UDWQ personnel have determined that aquifer to be the alluvial/colluvial groundwater system at the edge of the playa. The BLM stipulations require that monitoring be conducted not only in the alluvial/colluvial groundwater system but also in the regional bedrock groundwater system.

CPM understands that, under Special Stipulation 8, it would be responsible to replace any water resources (with baseline TDS concentrations of less than 10,000 mg/L) “that are lost or adversely affected (quality or quantity)” by Project operations (see Section 1.1). The determination of whether a water resource has been “adversely affected” would be made through statistical comparisons of data collected during the baseline period with that collected during the Project operational period, as further described herein. Thus, once the baseline database is established and accepted by BLM, that database would be used to assess the data collected during operational monitoring and to evaluate potential Project-related impacts to surface and groundwater resources within the area of interest.

CPM also understands that the baseline data would be compared to operational monitoring data to determine compliance with state regulations through both direct standards comparison and trend analysis. If Project-caused impacts are determined to have occurred, CPM would work with the UDWQ and BLM to develop acceptable measures to reduce impacts and replace impacted water sources as appropriate.

Based on the above, the purposes of the SAP/QAPP are to:

- Collect baseline surface and groundwater data within the area of interest;
- Develop a valid set of water quality and quantity data under natural, pre-Project conditions;
- Monitor water sources within the area of interest during operational of the Project to document future water quality and quantity conditions; and
- Develop a valid data set that would allow a determination to be made of whether or not operation of the Project results in changes to the quality or quantity of water in surface resources or in the alluvial/colluvial or regional bedrock groundwater systems that require future mitigation actions.

To date, work associated with the Project has focused on resource evaluation and environmental monitoring. No site development or full-scale mineral production has occurred.

As noted in Section 2.3, surface water within the area of interest is categorized under UDWQ regulations as Beneficial Use Class 2B, Class 3C, and Class 4. Therefore, constituents of potential concern in surface water within the area of interest include pH and the metals and inorganic constituents that are regulated under Utah Administrative Code ("UAC") Title R317-2. These analytes are listed in Table 3-1. Hexavalent chromium and biochemical oxygen demand are not included in this table due to holding time restrictions that cannot be met because of site remoteness. Additional parameters that are not regulated under the Utah surface-water regulations have been added to Table 3-1, including total suspended solids ("TSS"), specific conductance, various forms of alkalinity, and major cations and anions. Concentrations of these additional analytes would be used by CPM to assist in data interpretation and validation, as discussed in Sections 3.3 and 3.5. During the baseline monitoring period, surface-water samples will be analyzed for the list of constituents presented in Table 3-1.

As also indicated in Section 2.3, groundwater in the area of interest is categorized as Class IA, II, III, and IV water, depending on its location. Therefore, constituents of potential concern in groundwater within the area of interest include pH as well as the metals and inorganic constituents that are regulated under UAC Title R317-6. These analytes are presented in Table 3-2. As is the case with surface water, additional analytes that are not regulated under the Utah groundwater regulations have been added to Table 3-2 to assist in data interpretation and validation, as discussed in Sections 3.3 and 3.5. During the baseline monitoring period, groundwater samples will be analyzed for the list of constituents presented in Table 3-2.

The focus of this SAP/QAPP is currently the collection of baseline hydrologic data to supplement existing data and gain a better understanding of spatial and temporal variations in surface and groundwater quality and quantity within the area of interest. During the Project operational period, the focus of monitoring would shift to determining whether hydrologic impacts have occurred in the area of interest as a result of Project activities. If experience indicates that future changes to the SAP/QAPP are appropriate for the Project operational period, CPM would recommend modifications to the SAP/QAPP. For instance, if certain parameters have not been detected during the baseline monitoring period and nothing about Project operations suggests that these analytes may be affected by future operations, CPM may request that these parameters be dropped from the analytical lists contained in Tables 3-1 and 3-2. Such recommendations would be submitted to BLM and UDWQ for approval as part of an annual report (see Section 3.5.3) before implementing any changes.

Table 3-1 Surface Water Analytes

Parameter	Basis	Lowest Standard Class 1, 2, 3, or 4	Analysis Method	Method Detection Limit	Practical Quantification Limit	Preservative	Min Sample Volume
Specific Conductance (µmhos/cm)	Dissolved	--	Field	10	10	Field (none)	
pH (s.u.)	--	6.5-8.5	Field	0.1	0.1	Field (none)	
Cation-Anion Balance	Dissolved	--	Manual				
TDS (measured) (mg/L)	Dissolved	--	2540 C-2011	2.82	10	None (4oC)	125 ml
TDS (calculated)	Dissolved	--	Manual				
pH (s.u.)	Dissolved		9040C			None (4oC)	250ml
Alkalinity, total (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, carbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, bicarbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, hydroxide (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Chloride (mg/L)	Dissolved	--	9056A	0.0519	1	None (4oC)	125 ml
Fluoride (mg/L)	Dissolved	4.0	9056A	0.0099	0.1	None (4oC)	
Sulfate (mg/L)	Dissolved	--	9056A	0.0774	5	None (4oC)	
Nitrate+Nitrite as nitrogen (mg/L)	Dissolved	10.0	353.2	0.0197	0.1	H2SO4	250ml
Phosphorous (mg/L)	Dissolved	--	365.4	0.035	0.1	H2SO4	
Aluminum (mg/L)	Dissolved	--	6020A	0.100	0.2	None (4oC)	250 ml
Arsenic (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Barium (mg/L)	Dissolved	2.0	6020A	0.0050	0.005	None (4oC)	
Beryllium (mg/L)	Dissolved	0.004	6020A	0.0020	0.002	None (4oC)	
Boron (mg/L)	Dissolved		6010B	0.200		None (4oC)	
Cadmium (mg/L)	Dissolved	0.005[a]	6020A	0.001	0.002	None (4oC)	
Calcium (mg/L)	Dissolved	--	6020A	1.0	1	None (4oC)	
Chromium (mg/L)	Dissolved	0.231[a]	6020A	0.0020	0.01	None (4oC)	
Copper (mg/L)	Dissolved	1.3[a]	6020A	0.0050	0.01	None (4oC)	
Iron (mg/L)	Dissolved	--	6020A	0.100	0.1	None (4oC)	
Lead (mg/L)	Dissolved	0.015	6020A	0.0020	0.005	None (4oC)	
Magnesium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Mercury (mg/L)	Dissolved	0.002	7470A	0.00020	0.0002	None (4oC)	
Potassium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Selenium (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Sodium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	

[a]Standard is a function of hardness

Note: Parameter units are consistent across rows except where noted.

Table 3-2 Groundwater Analytes

Parameter	Basis	Lowest Standard Class 1, 2, 3, or 4	Analysis Method	Method Detection Limit	Practical Quantification Limit	Preservative	Min Sample Volume
Specific Conductance (µmhos/cm)	Dissolved	--	Field	10	10	Field (none)	
pH (s.u.)	--	6.5-8.5	Field	0.1	0.1	Field (none)	
Cation-Anion Balance	Dissolved	--	Manual				
TDS (measured) (mg/L)	Dissolved	--	2540 C-2011	2.82	10	None (4oC)	125 ml
TDS (calculated)	Dissolved	--	Manual				
pH (s.u.)	Dissolved		9040C			None (4oC)	250ml
Alkalinity, total (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, carbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, bicarbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, hydroxide (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Chloride (mg/L)	Dissolved	--	9056A	0.0519	1	None (4oC)	125 ml
Fluoride (mg/L)	Dissolved	4.0	9056A	0.0099	0.1	None (4oC)	
Sulfate (mg/L)	Dissolved	--	9056A	0.0774	5	None (4oC)	
Nitrate+Nitrite as nitrogen (mg/L)	Dissolved	10.0	353.2	0.0197	0.1	H2SO4	250ml
Phosphorous (mg/L)	Dissolved	--	365.4	0.035	0.1	H2SO4	
Aluminum (mg/L)	Dissolved	--	6020A	0.100	0.2	None (4oC)	250 ml
Arsenic (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Barium (mg/L)	Dissolved	2.0	6020A	0.0050	0.005	None (4oC)	
Beryllium (mg/L)	Dissolved	0.004	6020A	0.0020	0.002	None (4oC)	
Boron (mg/L)	Dissolved		6010B	0.200		None (4oC)	
Cadmium (mg/L)	Dissolved	0.005	6020A	0.001	0.002	None (4oC)	
Calcium (mg/L)	Dissolved	--	6020A	1.0	1	None (4oC)	
Chromium (mg/L)	Dissolved	0.231	6020A	0.0020	0.01	None (4oC)	
Copper (mg/L)	Dissolved	1.3	6020A	0.0050	0.01	None (4oC)	
Iron (mg/L)	Dissolved	--	6020A	0.100	0.1	None (4oC)	
Lead (mg/L)	Dissolved	0.015	6020A	0.0020	0.005	None (4oC)	
Magnesium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Mercury (mg/L)	Dissolved	0.002	7470A	0.00020	0.0002	None (4oC)	
Potassium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Selenium (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Sodium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	

Note: Parameter units are consistent across rows except where noted.

Following the collection and validation of baseline data, the purposes of hydrologic monitoring during the operational period would be to:

- Monitor hydrologic resources within the area of interest including, but not limited to, changes in surface water, meteoric precipitation, groundwater, wetlands, and ditches and
- Determine the impacts, if any, to existing water right holders, wetlands, surface water, and groundwater as a result of Project operations.

3.2 Data Quality Objectives

EPA guidance identifies seven elements that should be addressed when developing DQOs for a project (EPA 2006). These elements consist of the following:

1. State the problem
2. Identify the goals of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data.

These elements are described in more detail below.

3.2.1 Problem Statement

In order to comply with the requirements of UDWQ and BLM, CPM will determine baseline surface and groundwater conditions (quantity and quality) within the area of interest. These data will be necessary to determine whether or not operation of the Project is in compliance with a future UDWQ Groundwater Discharge Permit and Special Stipulations 8 and 13 of the federal leases.

The conceptual hydrologic model of the area of interest is described generally in Section 2.3 of this document. In summary, this model consists of the following:

- Surface water within the area of interest is regulated by the State of Utah for infrequent contact recreational use, non-game fisheries and aquatic life, and agricultural use.
- Much of the surface water in the Sevier River upstream from the Sevier Playa is beneficially used before it reaches the playa, except during periods of above-normal precipitation.

- No substantial surface runoff occurs to the playa from adjacent slopes due to the ephemeral nature of those watersheds.
- The beneficial use of groundwater within the area of interest is regulated by the State of Utah as a function of the baseline quality of that groundwater.
- Groundwater within the area of interest occurs in playa sediments, alluvial/colluvial sediments, and bedrock. The classification of this groundwater, under rules promulgated by UDWQ, varies substantially within the area of interest due primarily to a wide range of natural TDS concentrations.
- The degree of interaction between the groundwater systems within the area of interest is not fully defined.

The planning team, decision makers, and data users associated with this effort are presented in Section 1.4. CPM has committed the necessary resources to implement this SAP/QAPP in a manner that satisfies the data needs of the Project as well as the appropriate governmental agencies (primarily UDWQ and BLM). CPM desires to begin data collection under this SAP/QAPP as soon as practical following approval of the SAP/QAPP.

3.2.2 Study Goals

Study questions and alternative actions help establish study goals. The key study questions associated with the SAP/QAPP are:

- What spatial and temporal variability naturally exists in the quality and quantity of surface and ground water within the area of interest?
- What is the degree of interaction between the playa groundwater system, the alluvial/colluvial groundwater system, and the regional bedrock groundwater system within the area of interest?

Two alternative actions exist to address these study questions:

- Monitor the quality and quantity of surface and groundwater within the area of interest to provide data that, when combined with historic information, will result in a better understanding of seasonal variations in and the degree of interaction between hydrologic systems in the vicinity of the proposed Project, or
- Take no action.

The no-action alternative will not address either of the study questions. Therefore, the decision statement and goal of the SAP/QAPP is to develop a valid set of surface and groundwater quality and quantity data under natural, pre-Project conditions. These data will then be evaluated, along with historic CPM and publicly-available data from the area of interest, to define baseline conditions and to provide a better understanding of the degree to which groundwater systems interact within the area of interest. These data would also be used during the operational period to determine whether or not operation of the Project has impacted local water resources to the extent that mitigation actions are needed.

3.2.3 Information Inputs

A substantial amount of hydrologic, geologic, and other environmental and resource data has been collected within the area of interest. These data have been generated from investigations conducted by public entities (most notably the U.S. Geological Survey), by CPM, and by prior investigators of the mineral reserves associated with the Sevier Playa.

This historic database has resulted in the formulation of a conceptual model of surface and groundwater conditions within the area of interest. These historic data will be reviewed to validate their usefulness. Historic data that are determined to be valid will be used in future decision-making. Historic data that are determined to not be valid will be appropriately flagged.

The historic database is not sufficient to fully address the study questions contained in Section 3.2.2. Additional surface and groundwater quality and quantity data will be required to properly address those study questions. Tables 3-1 and 3-2 provide a list of the parameters that will be monitored on a routine basis during the baseline data-collection period. The methods that will be used to collect the routine data and address the study questions are outlined in Sections 4 through 6 of this SAP/QAPP.

As indicated previously in this SAP/QAPP, the baseline data would serve as a point of comparison to determine if operation of the Project has adversely impacted surface and groundwater resources within the area of interest. The action levels against which the baseline data would be compared are detailed in federal lease Special Stipulations 8 and 13 and in the Groundwater Quality Discharge Permit that would be issued by UDWQ.

3.2.4 Study Boundaries

The spatial boundary in which the SAP/QAPP will be implemented is defined as the area of interest shown in Figure 4-1. A description of the extent of these boundaries is provided in Section 2.1.

The goal of monitoring during the baseline data-collection period will be to develop a statistically-valid database that adequately describes pre-Project hydrologic conditions. To that end, data will be collected quarterly during the baseline period to assess seasonal variations in hydrologic conditions within the area of interest.

It is currently anticipated that Project construction would begin in the autumn of 2019. Since baseline monitoring under this Plan began in September 2018, this will allow monitoring during at least five quarterly events prior to the start of construction. The U.S. Environmental Protection Agency (2009) recommends that a minimum of eight to ten independent baseline observations be collected before running most statistical tests. Thus, the period of baseline data collection will likely extend beyond the start of Project construction. This is not considered problematic for the following reasons:

1. CPM began collecting hydrologic data from the playa area in 2011. These data, which must still be validated, will likely contribute to the baseline database.
2. Given the typical hydraulic conductivities discussed in Section 2.4, it is estimated that average linear groundwater velocities in the Playa hydrostratigraphic unit ("HSU") are substantially less than 1 ft/yr. As a result, any impacts to groundwater in the Alluvial/Colluvial and Regional Bedrock HSUs caused by Project construction on the playa would not be observable for a period of several years. Thus, data collected during the one or two years following the onset of construction from monitoring wells in the Alluvial/Colluvial and Regional Bedrock HSUs would still be indicative of baseline conditions.
3. Only one water supply well would be drilled initially, and this well would be pumped only intermittently during the baseline sampling period as Project facilities are being constructed. This well (and the other three eventual water supply wells) would be drilled approximately 3 miles south of the processing facility area and 3.5 miles south of the playa. As a result, it is unlikely that the radius of influence associated with intermittent pumping of the one initial well would extend to the playa.
4. As a terminal basin, no surface water flows out of the playa. Furthermore, the inflow of Project-related recharge water to the playa would not occur until at least one year after construction begins. Thus, data collected from the Sevier River monitoring locations following the beginning of construction would still be indicative of baseline conditions.

Given these circumstances, it is concluded that enough data will be available to assess baseline conditions, even if some of these data are collected following the startup of some construction operations. Monitoring of water resources within the area of interest during the operation period of the Project would be defined following a review of the baseline data.

Locations within the area of interest that will be monitored are discussed in Section 4. Sampling units from which data will be collected consist of the Sevier River and monitoring wells completed in the playa, alluvial/colluvial and regional bedrock groundwater systems. A limited number of samples have also been collected from springs in the general vicinity of the playa and may be collected from those sources in the future. Future decisions regarding the need for impact mitigation, if any, would be made based on data collected from the location(s) of impact.

Three practical constraints exist with respect to implementation of the SAP/QAPP: (1) weather conditions (e.g., freezing temperatures, difficult or unsafe site access, etc.), (2) access permission from private landowners in the case of certain springs that may be monitored, and (3) vandalism of monitoring locations. If conditions are such that collection of data from a specific location during a particular sampling event is not feasible, these conditions would be documented and provided to UDWQ and BLM.

3.2.5 Approach to Data Analytics

Analyses of environmental data often assume that the data follow a normal distribution. While this may be the case for water quality and quantity data collected from the area of interest during the baseline period, it is inappropriate to make that assumption prior to the generation of additional data.

Following the collection of baseline data, all data will be subject to the data validation process discussed in Section 3.4. All valid data that are collected under this SAP/QAPP will be evaluated to provide a set of statistics that are appropriate to the data distribution. For this evaluation, the data will be grouped by individual monitoring point as well as within sampling units (e.g., all wells completed in the alluvial/colluvial groundwater system, all samples collected from the Sevier River, etc.).

It is currently anticipated that the data will be evaluated using ProUCL[1], a statistical data-evaluation software package developed by the EPA, or another appropriate data evaluation package. ProUCL calculates basic statistics (e.g., means, median, standard deviation, etc.) as well as statistical intervals, single and two sample hypothesis tests, analysis of variance, regression, trend evaluation, outlier, and goodness-of-fit tests. It also provides graphical analyses, including probability plots, histograms, box plots, and line/trend plots.

[1] https://www.epa.gov/land-research/proucl-software

Data collected during the operational period would be compared with the baseline data to determine if Project operations have impacted water resources within the area of interest. It is currently anticipated that these comparisons would be made using ProUCL and an approach that is applicable to the data statistical distribution. Comparisons would be made against the applicable UDWQ surface and groundwater quality standards and the federal lease TDS concentration limitation of <10,000 mg/L. If impacts are determined to have occurred, then CPM would take appropriate action in consultation with UDWQ or BLM, depending on the standard or limitation against which the impact has been determined.

3.2.6 Performance or Acceptance Criteria

All data collected during the baseline and operational periods would undergo review and validation, as indicated in Section 3.4. All valid data collected during the baseline and operational periods would be accepted. Data that are not considered valid would be appropriately flagged.

3.2.7 Selected Sampling Design

Sampling under this SAP/QAPP would be performed as indicated in Sections 4 through 6. The sampling design was selected to provide additional baseline data as well as data to determine whether future impacts, if any, occur to water resources within the area of interest due to operation of the Project.

3.3 Measurement Quality Objectives

MQOs are used to determine the viability and usability of field and laboratory data. MQOs are defined by the criteria established for the following data quality indicators (“DQIs”):

1. Accuracy
2. Precision
3. Sensitivity
4. Comparability
5. Completeness
6. Representativeness

MQOs represent the “acceptance criteria” for the DQI attributes and are set based on the equipment used in field sampling and laboratory analyses. These DQIs and their associated acceptance goals are summarized in Table 3-3 and discussed below.

Table 3-3 Data Quality Indicators Measurement Performance Criteria

Parameter	Method Quality Indicator Goal	Quality Control Sample and/or Activity
Accuracy/Bias	Laboratory Control Sample ("LCS") spiked result is >80% and <120% of spiked amount. Laboratory Matrix Spike ("LMS") result is >75% and <125% of spiked amount.	Paired limit trend charts documenting LCS and LMS sample results included in Quality Control Summary ("QCS") of each Pace Laboratory report. QC data outside the paired line limits require consultation with laboratory. Summary report on data usability provided with each data validation summary.
Precision	Field Duplicate Relative Percent Difference ("RPD") of 25% for samples with a TDS concentration of $\leq$3,000 mg/L and 35% for samples with a TDS concentration of >3,000 mg/L. Laboratory RPD of 20% or less for Laboratory Control Sample Duplicates ("LCSD") and RPD of 30% or less for Laboratory Matrix Spike Duplicates ("LMSD") 20%.	Trend Charts documenting LCSD and LMSD sample results included in QCS of each Pace laboratory report. QC data outside the paired line limits require consultation with laboratory. Summary report on data usability provided with each data validation summary
Sensitivity	1) Laboratory ability to detect a compound above zero with 99% confidence and provide method (or minimum) detection limit ("MDL") above the documented cleanup level, if applicable. 2) Continuing Calibration Verification Standards ("CCVs") are analyzed at a frequency determined by the analytical method.	1) Determine the matrix specific MDL using EPA Revision 2, December 2016. 2) Evaluate Initial Calibration Value ("ICV") and CCV % recovery values outside calibration actions based on Method applicable guidelines. Provide trend charts if applicable.
Comparability	Pace Laboratory National Environmental Laboratory Accreditation Program ("NELAP") certification # 6157585858 which requires them to routinely participate in performance tests to ensure the comparability of their data to results from other laboratories.	Use only NELAP accredited analytical laboratories for sample analysis.
Completeness	95% or higher completeness	% Completeness = Number of Valid Data Points/Number of Expected Data Points)*100.
Representativeness	Sampling procedure is consistent between sampling events.	Sampling Analysis Plan ("SAP") techniques and procedures are adhered to and performed using the same techniques and equipment and performed in the same sequence each sampling event.

Notes
The closer the spiked results are to the true value coupled with high precision means higher accuracy and lower bias.
The smaller the RPD the better. High precision and high accuracy means low bias.
The RPD acceptance cutoff limit of 3,000 mg/L was selected to be inclusive of groundwater categorized by UDWQ as Class I and Class II groundwater.

3.3.1 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy measures how close QC results are to the "true "value. To measure accuracy, the laboratory introduces a known concentration of Compound X into the QC sample. The QC sample is then analyzed to determine the concentration of Compound X. The QC result (amount recovered) is then compared against the "true" value to determine how close the laboratory recovery is to "true". The assessment of accuracy is usually expressed as percent recovery as shown by the following equation:

$$\text{Percent Recovery} = \frac{(C2-C1)x\ 100\%}{CO}$$

Where:

C0 = amount of analyte added to the sample matrix;
C1 = amount of analyte present in the un-spiked sample matrix (equal to zero for the standard matrix); and
C2 = amount of spiked material recovered in the analysis.

The amount of an analyte spiked into a field sample matrix is specified by the laboratory QC program. For data evaluation purposes, the accuracy MQO of this SAP/QAPP is to obtain the following percent recovery:

- Laboratory Control Sample (LCS) spiked result is >80% and <120% of spiked amount. Laboratory Matrix Spike (LMS) result is >75% and <125% of spiked amount.

Results outside of these limits may be qualified as "estimated."

Trend Charts documenting LCS and LMS sample results are included in QCS of each Pace report. The closer the spiked results are to the true value coupled with high precision means higher accuracy and lower bias.

3.3.2 Precision

Precision is a measure of the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform internally. This indicator is used to evaluate the variability related to sample collection and handling as well as laboratory sample handling and analysis procedures.

Precision will be determined by analyzing field, laboratory, and matrix spike/matrix spike duplicate ("MS/MSD") samples. A field (or "blind") duplicate is a sample collected in the field from the same location and matrix at the same time as the original using the same sample collection and handling procedures but labeled with a different sample number.

Blind duplicates will be collected in the field at a rate of 10 percent of the total number of samples collected (or portion thereof) from each matrix (i.e., surface water or groundwater).

A laboratory duplicate is a laboratory split of a submitted field sample. A MS/MSD sample is a field-collected and -designated sample used by the laboratory to spike with a known concentration of a compound and then split and analyzed for the original compound. These samples will be collected in the field at a rate of one MS/MSD sample for every 20 field samples (i.e., at a 5% collection rate), thus allowing the laboratory to run MS/MSD analyses at a rate of 5% of their analyses. Field-collected MS/MSD samples are labeled as such. Thus, the laboratory will be notified which field MS/MSD samples are available for laboratory MS/MSD batch QAQC analysis.

The precision of the field and analytical data will be determined by calculating the relative percent difference between the value reported for the original sample and the value reported for the duplicate sample as follows:

$$RPD = \frac{|(C2-C1)\ x\ 100\%|}{((C2+C1)/2)}$$

Where:

RPD = relative percent difference
C1 = analyte concentration in the original sample; and
C2 = analyte concentration in the sample duplicate.

The precision MQO goal for the SAP/QAPP is to obtain duplicate data that demonstrate a Relative Percent Difference ("RPD") of 20% or less for LCSDs and an RPD of 30% or less for LMSDs. The MQO goal for field duplicate data is an RPD of less than 25% for samples with a TDS concentration of less than or equal to 3,000 mg/L and an RPD of less than 35% for samples with a TDS concentration of greater than 3,000 mg/L. This TDS limit was selected to be equivalent to the UDWQ Class I/Class II standard.

The smaller the RPD between the original and duplicate samples the higher precision and accuracy and lower the bias. Trend charts documenting the LCSD and LMSD sample results included in Quality Control Summary of each Pace report will be used to identify results over time that are outside the precision MQO goals outlined above. Results outside these limits may be qualified as "estimated."

It should be noted that RPDs outside of the above ranges often occur when dealing with low concentrations that are near the method detection limit, particularly when the TDS concentration is high (as will often be the case for this project). Thus, professional judgment will be exercised when designating a result as “estimated” based on the precision MQO.

3.3.3 Sensitivity

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Sensitivity is addressed through the selection of appropriate analytical methods and instrumentation as well as through the use of matrix spike, laboratory control, and continued calibration verification samples.

Sensitivity is initially addressed using standards, prepared at specified concentrations, to calibrate and define the quantitative response relationship of the instrument to the analytes of interest. Instrument calibration is also performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method. Continued CCV is an approach used to verify the initial calibration of an instrument during its use in an analytical method. CCVs are implemented in the laboratory at a frequency determined by the analytical method.

The sensitivity of laboratory analyses is a function of the MDL and the practical quantitation limit (“PQL”). The MDL represents the minimum concentration of an analyte that can be measured above the instrument background noise. Thus, when MDLs are used as reporting limits, the laboratory is indicating that the analyte is not present at or above the value given. It may be present at a lower concentration but cannot be "seen" by the instrument.

The PQL is the minimum concentration of an analyte that can be measured within specified limits of precision and accuracy. This limit is determined by the laboratory based on interference that is naturally present in the sample (e.g., high salinity may require dilution of the sample which may affect the ability of the laboratory to accurately determine the magnitude of analytes that are present in low concentration).

The sensitivity MQO goals for the SAP/QAPP are as follows (except as affected by high salinity which may constrain laboratory procedures):

- Laboratory ability to detect a compound above zero with 99% confidence and provide MDLs above the documented regulatory standard, if applicable.
- CCV Standards analyzed at a frequency determined by the analytical method.
- PQLs less than or equal to 10 times the associated MDL for analytes without a regulatory standard.

The laboratory will provide CCV data for each laboratory report and these data will be compared to MOQ goals and, if necessary, trend charts will be evaluated to document the degree of adherence to the MQO.

3.3.4 Comparability

Comparability is a qualitative measure of the confidence with which one data set can be compared to another. It is currently anticipated that samples for the same analytes will be analyzed by the same laboratory throughout implementation of this SAP/QAPP. The field methods to collect the samples during baseline evaluation will be same as those used for long-term operational monitoring. The field personnel will use and follow prescribed standard operating procedures. Each of these factors will increase the comparability of the resulting data.

Pace is accredited through the NELAP. This program requires Pace to routinely participate in performance tests to ensure the comparability of their data to results from other laboratories. The Pace NELAP certification number is 6157585858.

As indicated in Section 5.1, Pace is also certified by the State of Utah. Compliance with the standards established by the State of Utah and NELAP provides the primary comparability check on the laboratory data.

3.3.5 Completeness

Completeness is a measure of the amount of valid data obtained from a sampling event, expressed as a percentage of the number of valid measurements that were planned to be collected during that sampling event. Analytical completeness will be assessed by comparing the total number of valid analytical results to the number of planned analyses.

Completeness is determined by:

$$C = \frac{P1\ x\ 100\%}{PO}$$

Where:

C = completeness (%)
P0 = total number of valid data points planned, and
P1 = number of actual valid data points.

The completeness MQO for the SAP/QAPP is 95 percent or higher.

The completeness of the analyses will also be checked by calculating the total dissolved solids content as a sum of the individual constituents (after mathematically converting alkalinity [as $CaCO_3$] to carbonate and bicarbonate) and comparing this value to the laboratory-measured TDS concentration. The ionic charge balance error will also be calculated by comparing the molar-equivalent concentrations of the major cations (primarily calcium, magnesium, potassium, and sodium) with the molar-equivalent concentrations of the major anions (primarily alkalinity, chloride, and sulfate). These calculations will be performed using dissolved constituents only. The MOQ goals for these calculated values are:

- Calculated TDS concentration within $\pm$20% of the measured TDS concentration.
- Total cation molar-equivalent concentration within $\pm$10% of the total anion molar-equivalent concentration.

Hem (1985) notes that the accuracy of the above comparisons can be problematic in water with high dissolved solids contents (such as will likely occur with many of the samples that will be collected under this SAP/QAPP). However, Hem (1985) also indicates that these comparisons tend to be relatively consistent at individual locations, even if they fall outside of typical ranges.

3.3.6 Representativeness

Representativeness is the degree to which data accurately and precisely represent the population. Representativeness is usually considered a qualitative term that does not lend itself to direct measurement. However, including it in the MQO is meant to re-enforce the goal of confirming that measurements are made and physical samples are collected in a manner that appropriately reflects actual conditions. This is addressed primarily in the sample design through the selection of sampling sites and procedures that reflect the SAP/QAPP goals and environment being sampled. For instance, under the low-flow well sampling method, the intake for each low-flow pump will be located within the screen interval determined by field testing to be the dominant inflow zone (see Section 6.4.2.1). Furthermore, the procedure of purging until the field parameters stabilize presumably ensures that fluid samples are representative of the aquifer waters. Similarly, for the no-purge (in-situ equipment) groundwater sampling method, the sample bottles will be located within a zone that has been evaluated by down-well flow measurements to indicate that the waters within the casing interval occupied by the in-situ sampling equipment are representative of the waters within the aquifer (see Section 6.4.2.2).

Representativeness is ensured in the laboratory through: (1) the proper handling and storage of samples, and (2) analysis within the specified holding times so that the material analyzed reflects the material collected as accurately as possible. Sample integrity can then be documented with the following procedures:

- Laboratory preparation of field preservation vials;
- Proper sample handling (i.e.., CoC); and
- Evaluating holding times and condition of samples on arrival at the laboratory.

Proper procedures will minimize the potential for alterations of the samples and ensure that samples received by the laboratory are representative of those at the site.

3.4 Data Review and Validation

The analytical laboratory will be responsible to review each data package prior to release for validation. CPM will independently review the laboratory data package as part of the data validation process outlined in Appendix D of the Water Monitoring Plan (Stantec, 2019), of which this SAP/QAPP is a part. At a minimum, the following reviews must be performed by the laboratory:

- Peer review of the data by a qualified analyst;
- Review of the reported data and deviations by a technical supervisor or data coordinator; and,
- QA officer review of 10% of the data.

Field teams will note any field-related quality problems in the logbook. QA reports will be provided to the MTM whenever field quality problems are encountered. In addition, a third-party entity under contract to CPM will review all field and laboratory data and validate those data. This review will involve the following:

- Sample holding times to ensure that they meet applicable requirements;
- Initial and continuing calibration of field instrumentation;
- Results of field blank analyses;
- Results of duplicate analyses;
- Sample handling and storage procedures; and
- Completeness of field documentation.

Data validation is performed to assess the degree to which sampling and analytical methods have generated consistent, reliable, and accurate data. Section 3.3 and Table 3-3 present the criteria for deciding the degree to which the data have met predetermined measurement quality objectives. Data that do not meet MQOs will be flagged. Results that are less than the reporting limits but exceed the method detection limits will be qualified as estimates and used in calculations as a detected value. All corrections, notions, and flagged comments will be added to the Project database.

Data validation reports will be provided to the MTM by the QAO. These reports will include a discussion of any significant quality problems that were observed and their effect on the use of the data. Quality issues identified by the field team, laboratory, and data validation specialist will be incorporated into the data evaluation report(s) submitted to the PM, UDWQ, and BLM. If significant problems are encountered, the MTM will report these issues along with the results of the necessary response actions to the PM, UDWQ, and BLM.

3.4.1 Response Actions

Response actions will be implemented on a case-by-case basis to correct quality problems. All personnel involved in the implementation of the SAP/QAPP are responsible for discovering QA problems or deficiencies in their areas of responsibility. Any such deficiencies will be reported to the Quality Assurance Officer as soon as possible after discovery. The QAO will report the issue to the PM and will have authority to stop sampling work until the issue is corrected. The PM, in consultation with the CPM Quality Assurance Officer, will prepare QA response actions in cooperation with personnel in the area where the deficiency was found.

The corrective action process has two components that must be addressed: (1) resolve the immediate problem, and (2) prevent future occurrences of the problem. It is the responsibility of the PM to ensure that both components are addressed, and to finalize the action necessary to achieve resolution.

Results of the following QA activities may also initiate corrective actions:

- Performance audits;
- Systems audits; and
- Failure to adhere to the approved SAP/QAPP.

3.4.2 Reconciliation with User Requirements

The DQIs listed in Section 3.3 will be evaluated at the end of each sampling event. The potential need for adjustments or corrective action to keep measurement systems in control will be evaluated and discussed with the BLM and UDWQ, as necessary.

Data validation reports prepared by CPM will include an evaluation of the usability of the data. Precision, accuracy, representativeness, completeness, and comparability will be evaluated and compared with the Project DQOs by the MTM, in consultation with the QAO and PM, as each data set is received. At the completion of each year, an annual assessment of data usability and compliance with the DQOs will be conducted and documented in the annual report.

3.5 Data Management

Data from both the surface water and groundwater monitoring efforts will be used to describe the water resources in the area of interest. Using ProUCL or other appropriate statistical evaluation packages, the data will be evaluated for confidence intervals, the presence of outliers, determination of appropriate distributions for statistical analysis, and preparation of summary statistics and evaluation of non-detect data. The data may also be plotted graphically (e.g., time series plots, histograms, box-whisker plots, etc.) and using tri-linear diagrams of water quality as needed to support data interpretation. These values and graphs will then be used as a comparison with future data to determine if impacts have occurred.

3.5.1 Statistical Data Analysis

Groundwater chemistry can vary with time under non-equilibrium groundwater conditions if the flow field is altered. Reversals of the flow direction near a well could cause abrupt changes in the water chemistry (Fetter 1980). Therefore, a primary purpose of the groundwater sampling program is to detect statistically significant changes in groundwater chemistry from baseline conditions following construction and start-up of Project operations.

Statistical evaluations of baseline vs. operational datasets would be performed as outlined in Section 3.2.5. The precise methods that would be used in these comparative analyses would be determined once the baseline data have been collected, reviewed, and validated and their statistical distribution(s) has been determined.

3.5.2 Data Management Process

CPM will incorporate the collected laboratory and field data into a relational database. Laboratory data will be transferred to CPM electronically, thereby minimizing the potential for data entry errors. Data Reporting

Following receipt of analytical reports from the laboratories for each sampling round, a third-party entity under contract to CPM will validate the data as outlined in Section 3.4. Copies of the validated data will be provided electronically to BLM and UDWQ within 45 days of receiving all data associated with a sampling event. Each data submittal will include a statistical evaluation of the data as outlined above. If this evaluation indicates that Project operations have adversely impacted water resources, the quarterly data submittal would include recommendations for impact verification and/or mitigation.

CPM will prepare annual reports detailing the results of the surface and groundwater monitoring completed for the prior year. Copies of these reports will be provided electronically to UDWQ and BLM before the end of the first quarter of the following year. The annual reports will include tabulated field and laboratory results. These annual data and all previous monitoring data will be included in the database for documentary and comparative purposes and can be supplied to UDWQ or BLM, if required.

Data interpretation may include appropriate plots of iso-concentration contours for selected constituents, graphs that show concentrations of selected parameters over time, comparisons to relevant water quality standards, updated surface and groundwater analytical tables, summary statistics, and a description of data validation. Report appendices will include copies of pertinent field notes, laboratory analytical results, QC data, data validation, summary statistics, well records, well testing data, water level data, field water quality measurements, and other field measurements such as transducer data and rating curves, as applicable. Given the probable voluminous nature of the laboratory analytical reports, these will be provided only in electronic format.

Also, the reports will include recommended steps for optimization of sampling and analysis efforts (when applicable) and a discussion on any identified impacts to surface or groundwater resources. If exceedances of standards or significant changes in conditions identified during the year suggest that Project operations are affecting local water resources, specific actions taken or anticipated following such exceedances would be summarized and recommendations for further activities would be provided. These may include additional sampling, review of sampling protocols, changes to the operational monitoring plan, or other recommendations to mitigate observed negative impacts to water resources.

3.6 Assessment Oversight

The CPM Quality Assurance Officer will oversee implementation of the SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the Quality Assurance Officer include:

- Provide independent QA oversight during implementation of the SAP/QAPP;
- Review log books, CoC forms, and laboratory analytical reports to determine if data meet the requirements of the SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate MQOs;
- Report data quality issues, quality control concerns, and data non-conformance to established standards to the CPM project manager;

- Periodically review the sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the SAP/QAPP; and
  Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the SAP/QAPP and follow up to ensure that those corrective actions are implemented.

4 SAMPLING DESIGN AND RATIONALE

As noted in Section 3.1, one of the primary purposes of the SAP/QAPP is to collect sufficient, validated baseline surface and groundwater data to define natural, pre-Project conditions and to allow future determinations to be made of whether or not operation of the Project results in changes to the quality or quantity of surface or groundwater within the area of interest. To accomplish this, selected surface water locations together with existing and new wells will be monitored.

4.1 Groundwater

In developing the proposed SAP/QAPP groundwater monitoring network, existing wells in the area were evaluated for their adequacy to provide acceptable data. An assessment was also made of the need to drill and complete new monitoring wells to provide additional information. Based on this evaluation, it is proposed that 32 wells (16 existing and 16 proposed) be used to assess baseline groundwater conditions under this SAP/QAPP. The selected existing and new wells to be included in the monitoring network represent the regional bedrock, alluvial/colluvial, and playa groundwater systems within the area of interest.

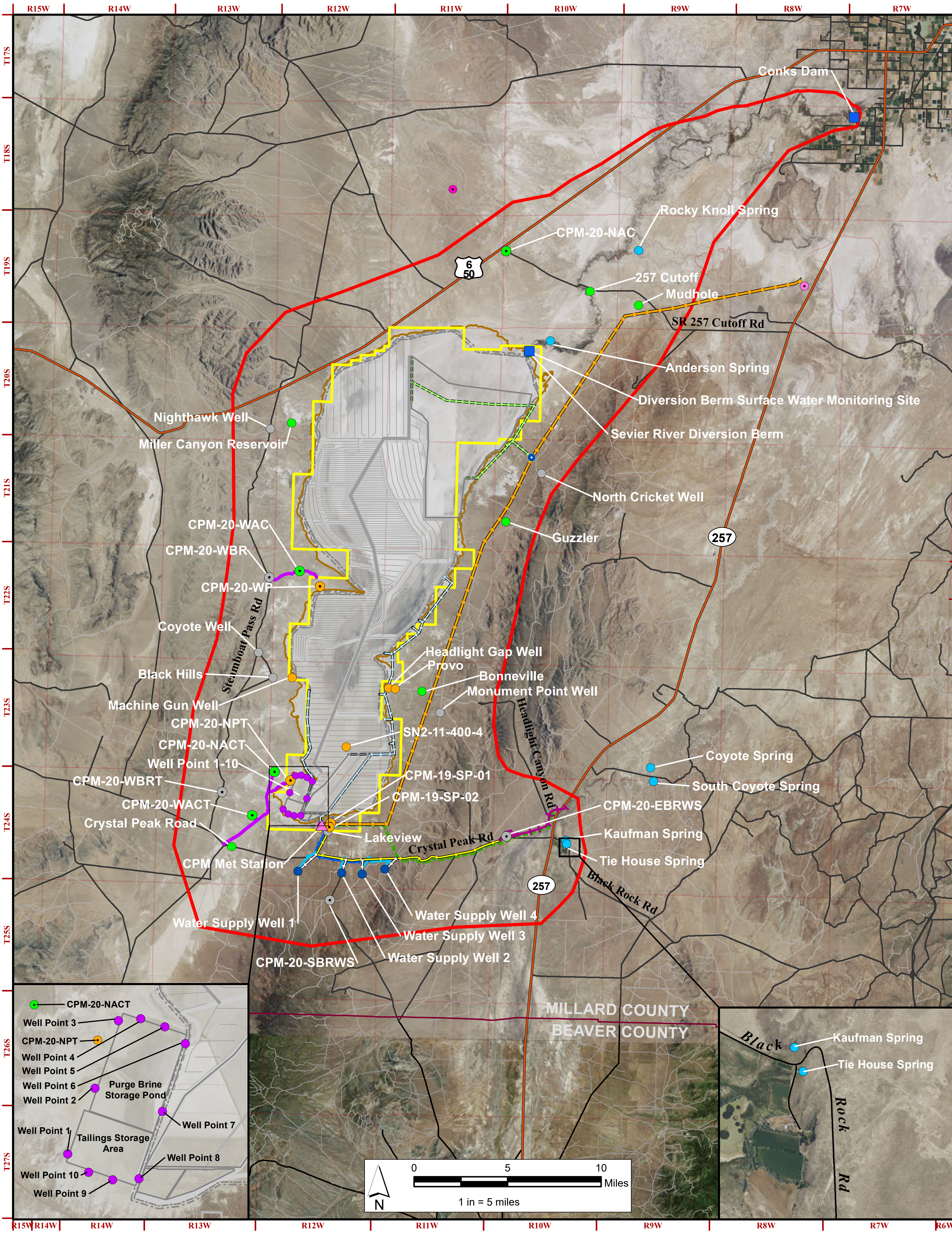
Groundwater monitoring efforts will consist of measuring groundwater levels and collecting groundwater quality samples at each of the wells listed in Table 4-1 and shown on Figure 4-1. Sampling of groundwater issuing from springs is discussed in Section 4.1.3 of this document. Sample collection dates will be selected to represent seasonal variations in groundwater conditions. The wells to be monitored are described below.

Table 4-1 Baseline Groundwater Monitoring Sites

Well ID	Ownership	Latitude (NAD83) Decimal degree	Longitude (NAD83) Decimal degree	Casing Elevation (ft AMSL)	Total Depth (ft BTOC)	Diameter (inch)	Screen (ft BTOC)	Screen Length (ft)	Depth to Sample Intake (ft BTOC)	Measuring Point Stick Up (ft)	Boring Construction Log	Single Well Drawdown Test	Max Flow and Drawdown (SW)	Suitable for Low Purge		Suitable for No Purge
														Yes/No	Why	
Playa Wells (Existing)																
SN2-11-400-4	Crystal Peak Minerals	38.7835250	-113.174497	4527.38	497	4	497-347	150	406-411		Yes	No	NA	Yes	Previous Field Data	Yes
Machine Gun	USGS	38.8361191	-113.2298862	4531.54	102	2	100-95	5	101-104		Yes	No	NA	Yes	Yes, purge record	Yes
Headlight Gap	USGS	38.8296586	-113.1341471	4549.94	207	2	210-207	3	207-210		Yes	No	NA	Yes	Purge Record	Yes
Provo	Crystal Peak Minerals	38.8291203	-113.1274863	4575.75	460	4	460-260	200	270-276		Yes	Yes	1 GPM 67'	Yes	Drawdown Test	Yes
Playa Wells (Proposed)																
CPM-20-WP	Crystal Peak Minerals	38.9070000	-113.204567	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-NPT	Crystal Peak Minerals	38.756441	-113.231382	-	-	4	-	-	-		-	-	-	-	-	-
CPM-19-SP-01	Crystal Peak Minerals	38.726343	-113.192944	-	-	4	-	-	-		-	-	-	-	-	-
CPM-19-SP-02	Crystal Peak Minerals	38.723402	-113.191879	-	-	4	-	-	-		-	-	-	-	-	-
Alluvial Colluvial Wells (Existing)																
257 Cutoff	Crystal Peak Minerals	39.1405648	-112.9426389	4552.84	60	4	60-45	15	50-56		Yes	Yes	1.75 GPM 22.80'	Yes	Drawdown Test	Yes
Bonneville	Crystal Peak Minerals	38.8279350	-113.1010343	4772.15	315	4	310-210	100	215-221		Yes	Yes	0.53 GPM 97.77'	**Questionable**	Drawdown Test	Yes
Crystal Peak Road	USGS	38.7040571	-113.2856608	4623.94	195	2	195-177	18	185-188		Yes	No	NA	Yes	High Turbidity	Yes
Guzzler	Crystal Peak Minerals	38.9605644	-113.0213739	4966.81	425	4	425-325	100	385-389		Yes	Yes	4 GPM 18'	Yes	Drawdown Test	Yes
Miller Canyon Reservoir	Crystal Peak Minerals	39.0332852	-113.2365813	4699.22	315	4	315-245	70	272-278		Yes	Yes	10 GPM 7'	Yes	Drawdown Test	Yes
Mudhole	BLM	39.1305575	-112.8943545	4559.56	503	8	338-365	27	370-373		No	Yes	37 GPM 7.8'	Yes	Drawdown Test	Yes
Alluvial/Colluvial Wells (Proposed)																
CPM-20-NAC	Crystal Peak Minerals	39.1700167	-113.0271333	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-WAC	Crystal Peak Minerals	38.9186167	-113.224933	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-WACT	Crystal Peak Minerals	38.7232486	-113.250747	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-NACT	Crystal Peak Minerals	38.762242	-113.244973	-	-	4	-	-	-		-	-	-	-	-	-

Well ID	Ownership	Latitude (NAD83) Decimal degree	Longitude (NAD83) Decimal degree	Casing Elevation (ft AMSL)	Total Depth (ft BTOC)	Diameter (inch)	Screen (ft BTOC)	Screen Length (ft)	Depth to Sample Intake (ft BTOC)	Boring Construction Log	Single Well Drawdown Test	Max Flow and Drawdown (SW)	Suitable for Low Purge		Suitable for No Purge
													Yes/No	Why	
Bedrock Wells (Existing)															
Black Hills	BLM	38.8356642	-113.2488075	4638.12	560	6	?	?	540-543	No	Yes	18 GPM 19'	Yes	Drawdown Test	Yes
Coyote	Crystal Peak Minerals	38.8550295	-113.2637821	4784.27	765	5	760-560	200	705-711	Yes	Yes	55 GPM 40'	Yes	Drawdown Test	Yes
Lakeview	BLM	38.7175450	-113.1909711	4590.11	532	6	125-70 and 500-420	80	94-100	Yes	Yes	26 GPM 2'	Yes	Drawdown Test	Yes
Monument Point	Crystal Peak Minerals	38.8115229	-113.0825462	4891.3	1215	5	1210-1030	180	1155-1161	Yes	Yes	54 GPM 96'	Yes	Drawdown Test	Yes
Nighthawk	Crystal Peak Minerals	39.0284436	-113.2573385	4804.36	780	5	780-580	200	608-614	Yes	Yes	45 GPM 74'	Yes	Drawdown Test	Yes
North Cricket	Crystal Peak Minerals	38.9987550	-112.9872956	5083.78	780	5	780-580	200	661-667	Yes	Yes	36 GPM 3'	Yes	Drawdown Test	Yes
Bedrock Wells (Proposed)															
CPM-20-WBR	Crystal Peak Minerals	38.9129333	-113.255050	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-WBRT	Crystal Peak Minerals	38.748624	-113.250783	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-SBRWS	Crystal Peak Minerals	38.66426	-113.18734	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-EBRWS	Crystal Peak Minerals	38.71673	-113.01396	-	-	4	-	-	-	-	-	-	-	-	-
Water Supply 1	Crystal Peak Minerals	38.6861005	-113.2194244	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 2	Crystal Peak Minerals	38.6857800	-113.1761975	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 3	Crystal Peak Minerals	38.6850996	-113.1557851	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 4	Crystal Peak Minerals	38.6895652	-113.1334771	-	-	8	-	-	-	-	-	-	-	-	-
Springs from Which Samples Were Previously Collected															
Anderson Spring	BLM	39.101146	-112.982398	-	-	-	-	-	-	-	-	-	-	-	-
Rocky Knoll Spring	BLM	39.172633	-112.896757	-	-	-	-	-	-	-	-	-	-	-	-
Coyote Spring	Rasmuson	38.683521	-112.877867	-	-	-	-	-	-	-	-	-	-	-	-
South Coyote Spring	BLM	38.674192	-112.871611	-	-	-	-	-	-	-	-	-	-	-	-
Springs from Which Samples May be Collected															
Tie Fork Spring	Kaufman	38.7110271	-112.9541065	-	-	-	-	-	-	-	-	-	-	-	-
Kaufman Spring	Kaufman	38.7129352	-112.9560873	-	-	-	-	-	-	-	-	-	-	-	-
Sevier River															
Below Conks Dam	N/A	39.278949	-112.683078	-	-	-	-	-	-	-	-	-	-	-	-
At Diversion Structure	N/A	39.092431	-113.002535	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1. AMSL = Above mean sea level
2. BOTC = Below top of casing



Existing and Proposed Proposed Project Features

- Existing Playa Aquifer Well
- Proposed Playa Aquifer Well
- Existing Alluvial/Colluvial Aquifer Well
- Proposed Alluvial/Colluvial Aquifer Well
- Existing Bedrock Aquifer Well
- Proposed Bedrock Aquifer Well
- Proposed Well Point Location
- Proposed Water Supply Well
- Surface Water Monitoring Site
- Spring
- Proposed Sevier River Diversion Berm
- Sevier Playa Potash Project Water Resources Area of Interest
- BLM/SITLA Lease Boundary
- Access Road - Off-Lease
- Proposed 69-kV Power and Communication Line
- Proposed 25-kV Power Line
- Proposed 12.47-kV Power Line
- Proposed 12.47-kV Power and Communication Line
- Proposed 12.47-kV Power Line Spur
- Proposed Rail Spur and Access Corridor
- Proposed Rail Loadout Facility
- Proposed Natural Gas Pipeline
- Proposed Communication Tower
- Proposed Substation
- Meteorological Station
- Proposed Water Supply Pipeline
- Proposed Water Supply Pipeline Spur

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018, 2019;
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2016

NO.	DATE	REVISION	BY	APVD
4	2/15/2019	Revised based on comments		
3	10/15/2018	Revised based on comments		
2	7/18/2018	Revised based on comments		
1	6/19/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN	DR	CHK	APVD

FIGURE 4-1

Sevier Playa Potash Project
Surface and Groundwater
Monitoring Network
SAP-QAPP

DATE: 4/11/2019 SCALE: 1:318,859

CRYSTAL PEAK MINERALS INC.

D:\GIS\Peak Minerals\Operational Monitoring Plan\WMP Fig 4-1 - SAP_QAPP_190411.mxd4/11/2019 5:01:07 PM

4.1.1 Existing Wells

In selecting the existing wells to be included in the monitoring network, prior sampling data were reviewed. In reviewing field logs associated with prior well sampling in the general area of the Project, it was apparent that some of the wells may have yielded unreliable data (e.g., field water-quality measurements that did not stabilize during well purging and/or the well being pumped dry during purging). Therefore, it was decided that existing wells used for baseline and operational groundwater monitoring should meet the following criteria where feasible:

- The well construction details are known, including screen intervals;
- The well can be purged using EPA (2017) low-flow purging methods, resulting in: (1) no more than 0.3 foot of drawdown during purging (or stabilized drawdown if greater than 0.3 foot), and (2) static water levels that are above the screen interval at the time of sampling; and
- The well diameter can accommodate sampling system equipment and provide a sufficient volume of water to allow for the analysis of original and duplicate samples.

Based on these criteria, 16 existing wells were chosen for the SAP/QAPP groundwater well monitoring network (see Table 4-1 and Figure 4-1). Four of the existing wells to be monitored under the SAP/QAPP are located within or at the perimeter of the Sevier Playa (Playa Wells). These consist of:

- SN2-11-400-4;
- Provo Well;
- Headlight Gap Well; and
- Machine Gun Well.

These wells were selected as representative of the elevation and quality of groundwater in the playa groundwater system both at depth and along the edge of the playa.

The following six existing wells were selected to monitor the alluvial/colluvial groundwater system:

- 257 Cutoff Well as an indicator of groundwater near the point at which the Sevier River flows into the playa;
- Guzzler Well, Mudhole Well, and Bonneville Well as indicators of groundwater upgradient from the playa; and

- Crystal Peak Road Well and Miller Canyon Reservoir Well as being potentially downgradient from the playa.

These wells were selected as representative of the elevation and quality of the alluvial/colluvial groundwater system adjacent to the playa.

The following six existing wells completed in the regional bedrock groundwater system are included in the SAP/QAPP:

- Coyote Well, Nighthawk Well, and Black Hills Well on the west (downgradient) side of the playa;
- Monument Point Well and North Cricket Well on the east (upgradient) side of the playa; and
- Lakeview Well on the south (upgradient) side of playa.

These wells were selected as representative of the elevation and quality of the regional bedrock groundwater system near the playa.

The data from these wells will aid in developing a representative baseline dataset and provide means to evaluate potential changes to these zones, if any, following the onset of Project operations.

Concerns have been raised that several of the wells proposed for monitoring are older wells completed with steel casing that may influence the quality of groundwater obtained from those wells. Specifically, the Black Hills, Lakeview, and Mudhole wells were completed with steel casing. CPM acknowledges this concern. Summarizing the work of others, Llopis (1991) stated that groundwater samples collected from steel-cased wells tend to contain elevated concentrations of cadmium, chromium, copper, iron, manganese, and zinc. Of these constituents, cadmium, chromium, and copper are included on the groundwater analytical list provided in Table 3-2. However, proper well purging and sampling should minimize those influences. Furthermore, under passive sampling, the samplers are to be located within well sections that, in theory, are representative of the aquifer groundwater. Salinity is of greater concern at this time than individual metallic ions and the effect of the slightly elevated metal concentrations will be minimal relative to the concentrations of TDS and the primary parameters that comprise TDS. Therefore, given the concern, care will be taken during evaluations of baseline metals data collected from wells that are cased with steel to determine if such data should be flagged due to potential interaction with the casing.

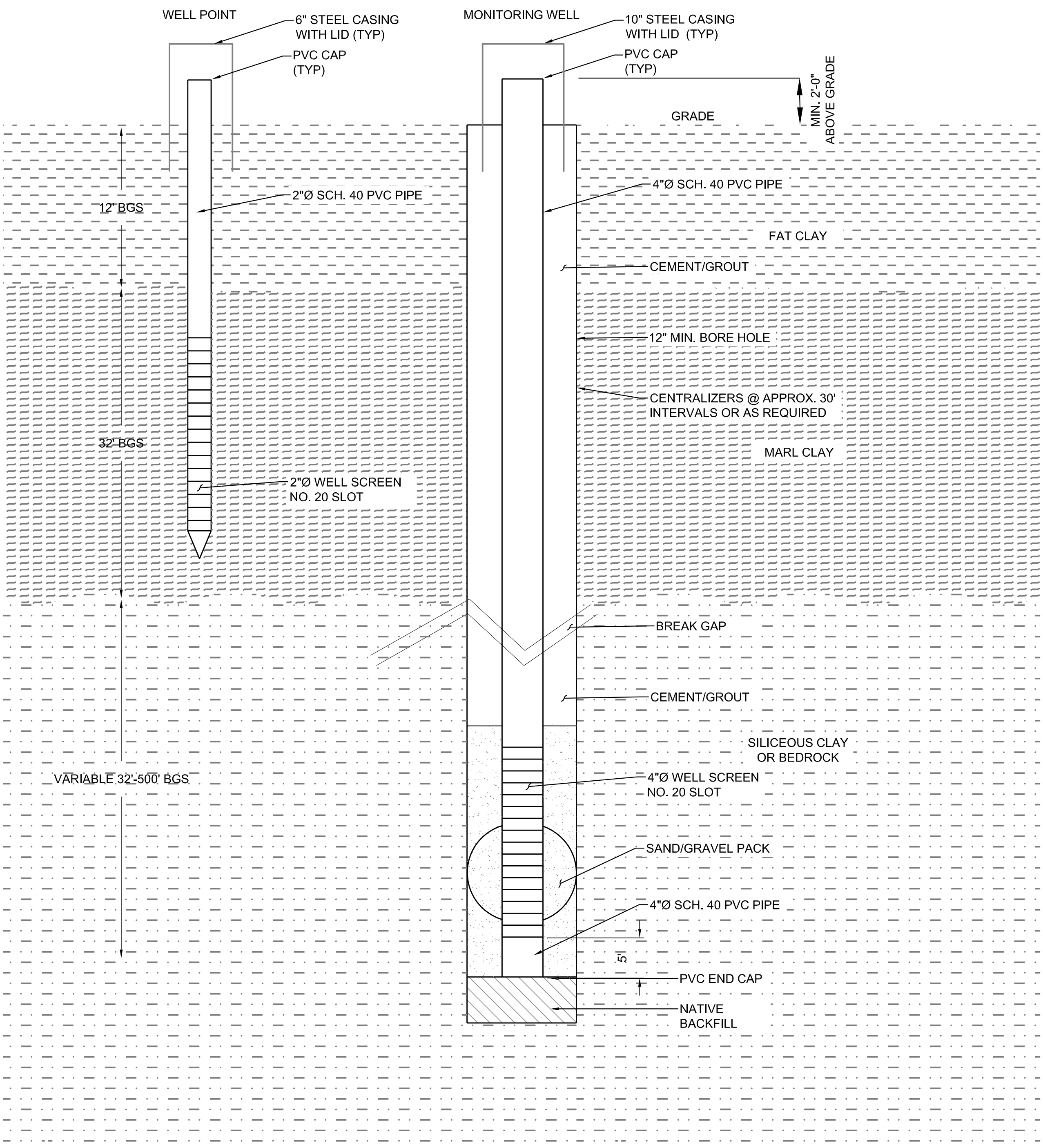
4.1.2 Proposed Wells

In addition to the existing wells, 16 wells (including the Project water supply wells) would be drilled and completed by CPM to add to the monitoring well network (see Table 4-1 and Figure 4-1). Figure 4-2 presents the typical completion detail for these wells. These wells would be drilled using reverse rotary and/or sonic drilling methods. Efforts would be made to drill these holes with air; however, if borehole stability becomes an issue, a combination of air and foam would be used to maintain the hole. Final depths of these wells would be determined based on field geology at the time of drilling.

One new replacement well is proposed on the north end of the playa to replace the UDOT-2 well. Three new wells are proposed to provide additional information along the west side of the playa between Coyote well to the south and Nighthawk well to the north. Four new wells are proposed to monitor potential changes to groundwater levels and chemistry, if any, due to activities in the Waste Product Storage Area (“WPSA”). Four new wells would be drilled to supply water to the Processing Facility. Two wells are proposed to monitor the upgradient effects of the water supply wells. The remaining two new wells are proposed along the south end of the playa to monitor potential water level and quality changes resulting from water supply pumping (see Figure 4-1).

The monitoring wells are proposed to be single well completions and would consist of an 8-inch diameter borehole completed with 4-inch diameter threaded polyvinyl chloride (“PVC”) casing. For wells shallower than 300 feet, the casings would be Schedule 40 PVC. For wells deeper than 300 feet, casings would consist of Schedule 80 PVC. Centralizers would be used to center the casings within the borehole.

Monitoring well construction (shown in Figure 4-2) would consist of a 4-inch diameter casing with an end cap on a section of blank casing that extends at least 5 feet below the screen, a section of well screen, and a section of blank casing extending to a point at least 1 foot above the ground surface with a slip-on cap. Graded sand would be installed as a filter pack in the completion zone surrounding the lower solid casing and well screen to a level at least 5 feet above the top of the screen. Bentonite grout would be tremied into the annular space from the top of the filter pack to 5 feet below the ground surface and cement grout would be placed from the top of the bentonite to the ground surface. A steel protective casing with a locking lid would be installed over the PVC casing, extending at least 3 feet into the cement grout and 2 feet above ground surface. The PVC casing and cap would be adjusted/cut to fit below the top of the steel protective casing before the steel casing is set.



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NO.	DATE	REVISION	BY	APVD
0	10-2-18	INITIAL SUBMITTAL	TJS	GG

DSGN	DR	CHK	APVD
TJS	TJS	RR	GG

FIGURE 4-2

Sevier Playa Potash Project
Monitoring Well Completions
Typical Detail

DATE: 10/2/2018
FILE: Figure 4-2 Typical Monitoring Well Detail
SCALE: NTS

NORWEST CORPORATION

In addition, CPM would install 10 well points around the perimeter of the WPSA as noted on Figure 4-1. These well points would be installed using direct-push methods to depths that extend at least 10 feet into the marl clay zone that serves as the uppermost aquifer in the playa sediments. The purpose of these well points would be to monitor the elevation and quality of groundwater immediately adjacent to the WPSA.

Using 3.25-inch diameter hollow push rods, each well point would be completed with 2-inch diameter threaded PVC casing, with 5 feet of PVC screen at the bottom of the casing string. Graded sand would be installed as a filter pack in the annular space between the borehole wall and the casing string, with the remainder of this space completed as indicated above.

Following drilling and completion, each new monitoring well and well point would be developed by surging, bailing, and/or pumping to ensure that water sampled from the wells in the future is representative of the adjacent natural groundwater. Development of the wells and well points would be conducted for 6 hours or until the water retrieved is visually clear and has stabilized with respect to pH, temperature, and specific conductance.

4.1.2.1 Proposed West Wells

Three proposed wells would be installed on the west side of the area of interest near Needle Point as shown on Figure 4-1. These wells would be completed in the three groundwater systems of interest: CPM-20-WBR in the regional bedrock groundwater system, CPM-20-WAC in the alluvial/colluvial groundwater system, and CPM-20-WP in the playa groundwater system. These wells would consist of single-level completions and would be used for water level monitoring and groundwater quality sampling.

4.1.2.2 Proposed Waste Product Storage Facility Wells

The future location of the WPSA, which consists of the Purge Brine Storage Ponds and the Tailings Storage Area, is shown on Figure 4-1. Several investigators with the U.S. Geological Survey, of which Gardner et al. (2011) is just one example, have shown that groundwater in the regional bedrock aquifer flows to the west-northwest beneath the Sevier Playa. Assuming similar flow directions in the alluvial/colluvial groundwater system at the future WPSA, wells would be installed to monitor areas downgradient from that area. CPM-20-NACT and CPM-20-WACT would be completed in alluvial/colluvial sediments, CPM-20-NPT would be completed in the Marl Clay Zone of the playa sediments, and CPM-20-WBRT would be completed in the regional bedrock groundwater system. These new monitoring wells would be used to assess groundwater conditions in the vicinity of the WPSA.

These wells would be monitored to detect potential water levels changes, potential movement of the high concentration brines, and potential changes to the groundwater chemistry of the area, if any, in response to tailings and purge brine storage. These wells would be completed in the same manner as the single-level completion wells discussed above.

4.1.2.3 PROPOSED WATER SUPPLY WELLS

CPM plans to drill and install four water supply wells into the regional bedrock aquifer on BLM and SITLA land, approximately 5.5 miles south of the proposed processing facility area (see Figure 4-1). Information regarding the geology at the site of the proposed water supply wells is available from a 750-foot deep test hole (CWTW-1) that was completed by CPM to assess potential water quality and sustainable discharge rates (CH2M Hill, 2012). It is currently anticipated that these wells would not be drilled until after the start of facility construction. The drilling program is planned to be phased, with one well being drilled in year 1 and the other wells drilled at later dates as water demand increases. Six months prior to the anticipated start date, the final work plan for well drilling and installation, including planned construction details, would be prepared and submitted to BLM and UDWQ under separate cover.

These four wells, when completed, would also be used to monitor the groundwater quality of the bedrock aquifer. Since the wells will be producing on a regular basis, the water produced would be representative of the water within the aquifer. Therefore, a sampling port/tap would be installed on the water line from the well(s) to the processing facility to collect samples from the wells during operation. Additionally, the water levels would be monitored in each production well to assess the impact of pumping from each of the wells.

Additionally, two monitoring wells would be installed south and east of the water supply wells to monitoring the upgradient affects. Well CPM-20-SBRWS would be located south of the water supply wells to assess the drawdown toward the south. Well CPM-20-EBRWS would be installed near the rail loadout to assess the drawdown from the water supply wells to the east.

4.1.2.4 PROPOSED SOUTH-END WELLS

CPM plans to drill and install two single-level water monitoring wells (CPM-19-SP-01 and CPM-19-SP-02) to supplement data obtained from the playa groundwater system via the Dike Access Well. The two new wells will be installed along a line perpendicular to the edge of the playa toward the proposed water supply wells to assess the influence of long-term pumping of the water supply wells on the playa groundwater system, if any, and potential movement of brines toward the water supply wells. These wells will consist of 4-inch diameter screen and casing.

4.1.2.5 PROPOSED WELL POINTS

CPM plans to install ten single-level well points around the perimeter of the WPSA to supplement data obtained from the remainder of the groundwater monitoring network in that area. The well points would be monitored primarily for water levels and specific conductance to determine whether leakage is occurring from the WPSA. As 2-inch dimeter well points, these wells can also be sampled for a broader suite of analytes if deemed necessary.

4.1.2.5 PROPOSED UDOT WELL REPLACEMENT

An existing well, known as UDOT 2 and located north of the playa northeast of the intersection of US Highway 6/50 and the 257 Cutoff Road, has partially filled with sediment, making sampling difficult and data interpretation problematic. A replacement well (CPM-20-NAC) would be installed at the intersection of US Highway 6/50 and the 257 Cutoff Road to monitor groundwater conditions in the alluvial/colluvial sediments upgradient from the playa. This well would be a single-level completion consisting of 4-inch diameter screen and casing.

4.1.3 Springs

Four springs shown on Figure 4-1 may be monitored during the baseline and Project operational periods. These springs consist of Rocky Knoll and Anderson Springs to the north as well as Kaufman Spring and Tie House Spring to the south.

Anderson Spring is a groundwater seep that exists in the bottom of the Sevier River channel near the river’s terminus into the playa. There was no discernable flow at this location during a prior attempt to sample Anderson Spring. During periods when the Sevier River flows at that location, Anderson Spring would not be accessible for sampling.

Phreatophytes have invaded the area of Rocky Knoll Spring, which currently exists as a slight seep with no observable flow. This spring may be sampled if sufficient water is available.

Kaufman Spring and Tie House Spring exist in an adjacent basin southeast of the playa. Although a hydrogeologic connection between these springs and the playa is unlikely (Summers 2018), they may be monitored during the baseline and/or operational periods to provide a general indication of near-surface groundwater in that area if access permission from the private landowner can be obtained. Additional information regarding these springs is provided in the companion Water Monitoring Plan (Norwest 2019a).

A fence has been installed around Rocky Knoll Spring, generally precluding its use by wildlife or livestock. The remaining springs are currently used by wildlife and for stock watering. If monitored, indications of recent wildlife or livestock usage of the springs at the time of sampling would be noted in the field logbook. Since flow measurements may mobilize sediments and cause disturbances in the water, any water quality samples collected from the springs will be done before measuring the flow. If monitored, flow data and water quality samples would be collected from the springs following procedures outlined in Section 4.2.

4.2 Surface Water

The purpose of surface water monitoring would be to document the quality and quantity of surface inflows to the playa. This would be accomplished using the surface water sampling points on the Sevier River shown on Figure 4-1. The samples will be collected below Conks Dam and at the Diversion Structure. Data collected from below Conks Dam will provide information concerning the quality and quantity of water that is released to the lower Sevier River. Data collected from the Diversion Structure site will allow an assessment of the quantity and quality of water that flows onto the playa.

Flow data and water quality samples will be collected from the surface water sampling locations during the baseline sampling period. Sample collection dates will be selected to represent seasonal variations in flow and water quality. Discharge measurements will be collected using methods outlined in Section 6.3.2. Surface water quality samples will be collected as indicated in Section 6.3.1.

It is likely that the depth of surface flow at the time of each monitoring event will be variable, ranging from dry channels to fast moving water. Safety will be a primary concern when conducting monitoring activities at surface water stations. Any safety-driven deviations from the standard monitoring methods outlined in Section 6 (e.g., swift water that may preclude access to the center of the channel for flow measurements and sample collection) will be noted in the field log books.

5 REQUESTS FOR ANALYSES

5.1 Analysis Narrative

Field samples collected during the implementation of this SAP/QAPP will be analyzed for the constituents listed in Tables 3-1 and 3-2. These tables also indicate the analytical methods that will be used by the laboratory. Clean sample containers of appropriate volumes will be obtained from the analytical laboratory. If preservatives other than ice are required, these preservatives will be supplied by the laboratory.

Analyses for the constituents listed in Tables 3-1 and 3-2 will be performed by Pace in Mt. Juliet, Tennessee. Pace is accredited through the NELAP and is certified in Utah (No. 6157585858) to analyze samples for wastewater, drinking water, RCRA, USTs, and air quality. Pace is also certified by the Utah Public Health Laboratory for environmental analyses.

Samples for laboratory analyses will be collected in laboratory-supplied containers immediately following field analyses and filtering. Laboratory analyses are detailed on Tables 3-1 and 3-2. Analytical methods were selected to achieve method detection limits that are no greater than the applicable standard. All analyses will be performed using EPA- and/or UDWQ-approved analytical methods. It is currently anticipated that standard turn-around times will be requested for all analytical results. The collection of field QC samples (i.e., blanks and duplicates) is discussed in Section 10. These samples will be analyzed in the same manner as all other field samples.

UDWQ rules indicate that the standards for the class of water need to be adjusted based on hardness of the waters (R317-2-14, Utah DEQ May 1, 2018). The majority of the waters occurring in the lower Sevier drainage have a hardness of 400 mg/L or more, based on both the data in the Whetstone (2017) report and the 2016 water quality data collected by UDWQ in the general region surrounding the Project. After adjusting for the hardness, the metals standards increase from the values shown in the Utah Groundwater Protection Standards to the following:

- Cadmium – >400mg/L hardness, 1-hour acute value 0.008 mg/L.
- Chromium III- >400 mg/L hardness, 1-hour acute value 1.773 mg/L.
- Copper - >400 mg/L hardness, 1-hour acute value 0.050 mg/L.
- Lead - >400 mg/L hardness, 1-hour acute value 0.281 mg/L.
- Silver - >400 mg/L hardness, 1-hour acute value 0.035 mg/L.

The laboratory MDL for these metals meet the adjusted values based on water hardness. The aluminum standard, footnote 6 of Table 2.14.2 in R317-2-14, Utah DEQ May 1, 2018, indicates that, for sites with pH over 7 and hardness over 50, the standard to be used is 0.75 mg/L. Thus, the 0.1

mg/L reporting limit is also sufficient for aluminum. Additionally, antimony will be analyzed by Pace to meet the 0.006 mg/L standard for Utah groundwater.

Mercury analyses for surface waters are scheduled to be analyzed by Pace to meet the UDWQ standard of 1.2E-5 mg/L. It is anticipated that the naturally high salinity of many of the water samples collected under this SAP/QAPP will cause analytical interference. In those cases, it is typical for the laboratory to dilute the sample, thereby resulting in a higher practical quantitation limit. Pending sample interference due to high salinity, the reporting limit will be 0.5 nanograms per liter or 5.0E-7 mg/L. If sample interference occurs, the reporting limit will be raised.

5.2 Analytical Laboratory

As noted in Section 5.1, analyses for the constituents listed in Tables 3-1 and 3-2 will be performed by Pace. Pace has an internal QA program that has been approved by the National Environmental Laboratory Accredited Program and the State of Utah. A copy of this QA program is provided in Appendix B. CPM understands and agrees to the MQOs that are presented in the Pace QA program and that will be used by Pace for this Project.

6 FIELD METHODS AND PROCEDURES

The purposes of the SAP/QAPP, outlined in Section 3.1, will be accomplished through the collection of surface and groundwater samples from the locations shown on Figure 4-1. This chapter presents a discussion of the field sampling methods and procedures that will be used to accomplish the goals of the SAP/QAPP. Information regarding sample tracking and shipping is provided in Section 7.

Sampling methods used during implementation of the SAP/QAPP will adhere to the sampling, analytical, and data QA/QC procedures outlined herein. These procedures accord with the UDWQ Water Quality Assessment Guidance (UDWQ, 2010) and UDWQ's field procedures described in the DWQ Monitoring Plan Manual (UDWQ, 2006). All samples will be collected and properly preserved so that they are delivered to the laboratory and tested within the holding times required by the applicable EPA analytical method. Personnel involved in sampling will wear clean, disposable gloves that are donned prior to the collection of each sample, thereby minimizing the potential for cross-contamination between samples.

Sampling and field data collection will occur as detailed in the SOPs provided in Appendix C. Summaries of those procedures are presented below. The following summaries are presented to be consistent with EPA guidance for the preparation of the SAP/QAPP documents. Where conflicts exist between the following summaries and the SOPs, the SOPs will govern.

6.1 Monitoring Frequency

Monitoring of surface and groundwater under this SAP/QAPP will be conducted quarterly to assess seasonal variations in hydrologic conditions within the area of interest. Once the initial baseline validity assessment is complete, a report will be prepared and submitted to UDWQ and BLM to present a summary of data collected and justify the valid baseline data set. On-going monitoring throughout the life of the Project would then be used to evaluate potential impacts, if any, from Project operations and to assess conditions for reclamation and closure of the site. Based on the data collected, the report may include recommendations on adjustments to the SAP/QAPP regarding the sampling points and analyte list to better monitor the potential impacts from future Project operations.

6.2 Field Equipment

6.2.1 List of Equipment

Equipment that will be used in the field during the collection of surface and groundwater samples is listed in Table 6-1. Some of the field instrumentation may be combined into a single piece of equipment (e.g., through the use of multi-parameter instruments).

Manufacturer's information on the recommended equipment described in Table 6-1 is included in Appendix D. Portions of field equipment that will contact the water to be sampled will be rinsed in distilled water prior to use at the next sample location, thereby minimizing the potential for cross contamination.

Table 6-1 Equipment List

Field Equipment	Manufacture Specification
Water Level Monitoring	
Solinst 101 P7 Laser marked 1/100-foot increments PVDF tape	https://www.solinst.com/products/level-measurement-devices/water-level-meters.php
Solinst Levelogger Edge 3001 conductivity, water level and temperature	https://www.solinst.com/products/dataloggers-and-telemetry/3001-levelogger-series/levelogger-edge/datasheet/
Solinst Barologger Edge absolute pressure, W Data Wizard	https://www.solinst.com/products/data/3001.pdf
Surface Water Flow	
USGS Top Setting Wading Rod, 0.2, 0.6 and 0.8 depth settings	http://rickly.com/usgs-topset-wading-rod-1-2m/
USGS Type AA Current Meter, Price-type	http://rickly.com/usgs-type-aa-current-meter/
Groundwater Sampling	
Snap Sampler, QED Environmental Systems, Inc.	https://www.snapsampler.com/
Geotech 1.66x36 inch Bladder Pumps	http://www.geotechenv.com/pdf/ground_water_sampling_equipment/geotech_bladder_pumps.pdf
Geotech BP Controller 300/500 pounds per square inch ("PSI")	http://www.geotechenv.com/pdf/ground_water_sampling_equipment/bp_controller.pdf
Groundwater/Surface Water Field Meter	
YSI EXO Multimeter Platform	https://www.ysi.com/EXO-HH
YSI EXO1 Multiparameter Sonde, SC/Temp, pH, DO, Turbidity	https://www.ysi.com/EXO1?EXO1-Water-Quality-Sonde-89
YSI EXO1 Flow Cell	https://www.ysi.com/Accessory/id-599080/EXO1-and-ProDSS-Flow-Cell
Geotech Portable Turbidity Meter (Option 2)	http://www.geotechenv.com/pdf/water_quality/geotech_turbidity_meter.pdf

6.2.2 Calibration of Field Equipment

All instruments and equipment used during sampling and analysis will be operated, calibrated, and maintained in accordance with the manufacturers' recommendations, as well as criteria set forth in the applicable analytical methodology references. Documentation of all routine and special maintenance and calibration information will be maintained in a logbook and will be available for review by authorized agency representatives upon request.

Most field equipment used during site monitoring is factory calibrated. Equipment that is not factory calibrated will be calibrated each day prior to collecting field data. Calibration and operation of all equipment used for collection of samples and field parameters will conform to the respective manufacturer's specifications. Instrument calibrations and calibration checks will be recorded daily in a log book and on Forms B and C of Appendix E.

The YSI meter listed in Table 6-1 measures several different water parameters. The calibration of this instrument will be performed as follows:

- Calibration of the pH meter will be performed to pH standards (4, 7, or 10 standard units) bracketing the actual field measured value with a post-calibration check using an alternate pH standard to ensure that the meter is reading within 5% of the standard.
- The specific conductance meter will be calibrated to one of four standards (1,413, 4,000, 6,000, or 10,000 microSiemens per centimeter [µS/cm]) with a post-calibration check using an alternate salinity standard to ensure that the meter is reading within 5% of the standard.
- Dissolved oxygen will be calibrated using the barometric pressure method outlined by the manufacturer.
- The turbidity meter will be calibrated to 0.02, 20, 100, and 800 NTU. Turbidity measurements will be made using a separate turbidimeter and not the flow-through cell used for groundwater sampling.

6.3 Surface Water Sampling

The collection of samples from the Sevier River will start at the downstream-most location and progress upstream. The river conditions and field parameters will be logged on the Surface Water Sample Form C in Appendix E. Flow measurements within the channel will likely mobilize sediments and cause disturbances in the water; therefore, river water quality samples will be collected before flow measurements.

6.3.1 Surface Water Quality Sample Collection

Surface-water samples will be collected from the locations shown in Figure 4-1. The samples will be taken from flowing, not stagnant water. Sample collection bottles will be labeled and transported to the river edge in a sample caddy and remain sealed until the water sample is collected. Depending on site conditions, samples will be collected by use of a sampling pole or by wading into the river. The samples will be collected upstream of the sampling pole location or wading personnel to avoid disturbance of the sampled water. Samples will be collected directly into sample bottles to which no preservatives have been added. In this case, the sample collection bottle will be rinsed a minimum of three times with river water before collecting the sample.

Sample bottles that contain an added preservative will be filled from a rinsed bottle that does not contain a preservative, thereby avoiding the loss of the preservative. These bottles will be filled at least to the neck of the bottle, but not overflowing, before capping.

All surface-water samples will be considered grab samples. Sample collection bottles will be immersed mouth down below the water surface to approximately one-third the depth of the stream flow if the flow depth is sufficient. With the lid removed, the bottle will be pulled up through the water column at a rate that would fill the bottle from a vertical section of the stream, the purpose being be to collect water from different depths in the stream. If the flow depth is insufficient to submerge the bottle, care will be taken to avoid the introduction of bottom sediment into the sample during collection. The sample cap will then be replaced, and the sample bottle placed in the sample caddy.

Samples requiring analyses of dissolved constituents (as noted in Table 3-1) will be field filtered using a 0.45-micron filter to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. The filtered water samples will be transferred from the filter directly into the appropriate sample containers with a preservative (if required) and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container.

Field parameters for temperature, pH, specific conductance, turbidity, and dissolved oxygen will be collected in the flowing water and recorded. Surface water samples will be chilled and processed for shipment to the laboratory. Sample management and custody will be performed following procedures in Section 7.

6.3.2 Surface Water Flow Measurement

Streamflow measurements will be collected using a current meter or other appropriate method approved by the U.S. Geological Survey (Buchanan and Somers, 1969). Once sufficient data are available, rating curves will be developed for each channel location, thereby allowing stage-gauge readings to provide future estimates of flow based on the rating curve. Flow and cross-section data will be collected to represent those periods when flow stage varies between high and low to aid in developing a more accurate rating curve for each stream station.

Absolute pressure transducers will be installed at each surface-water sample location shown on Figure 4-1 to determine the stage at these stations during periods when samplers are not in the field. In both cases, a pressure transducer will be placed inside a section of vertical

PVC casing secured to a vertical T-post and staff gage. These transducers will be programmed to collect water levels at a minimum of once per hour.

During each sampling event, the river stage will be recorded from the staff gauge at each station and data from the pressure transducers will be downloaded. Flow measurements will be recorded on the Surface Water Sample Form C in Appendix E. The transducer level readings will be adjusted for barometric pressure changes and compared with the manual stage readings to ensure appropriate correlation.

The pressure transducer readings and staff gauge heights described above will be used to develop rating curves. These curves will be used to estimate the river flow without having to physically measure the channel area and flow velocity at the time of each stage reading. The rating curves will be developed from a log-log plot of stage and discharge data (Kennedy, 1984), which generates a straight-line equation in the following form:

$$Q=P(G-e)b$$

Where: Q = discharge (cfs)

P = the intercept equal to Q when (G-e) is equal to 1.0
G = the river stage (feet)
e = a constant that, when subtracted from G, would result in a straight line on a log-log plot of Q vs. (G-e); the default value of “e” is zero and is adjusted if initial log-log plot shows curvature
b = the slope of linear trend line on log-log plot

The rating curve will be considered accurate over the range of manually-measured flows if the correlation coefficients (R^2) of the rating curve is greater than 0.8. The rating curves will allow the generation of daily flow records at both gauging stations for duration of the Project.

6.4 Groundwater Sampling

6.4.1 Groundwater Level Measurement

The wells identified in Table 4-1 will be used to monitor groundwater levels in the bedrock, alluvial/colluvial, and playa groundwater systems. These data will consist of manual water level measurements during sampling events to monitor trends in groundwater levels during baseline and operational periods.

Manual water level measurements will be collected using electronic water-level indicators, with the probe tape marked in 0.01-foot increments. All wells will be sounded for depth to water from the top of casing prior to purging. Field water-level indicators will be calibrated according to manufacturer's recommendations before each field sampling event. Field meter probes will be decontaminated before and after use at each well by rinsing with distilled water.

In addition to manual water-level measurements, pressure transducers will be installed in bedrock wells Black Hills, Coyote, Monument Point, Nighthawk and North Cricket and alluvial/colluvial wells Mudhole to the north of the playa and Lakeview on the south end of the playa. Data will be collected from these pressure transducers at a minimum rate of twice each day. The purpose of the pressure transducer measurements is to identify regional daily trends in water levels over time.

When analyzing barometric data, it is important to keep in mind that storm events commonly reduce total atmospheric pressure by about 1.7% from pre-existing high-pressure conditions (1.7% converts to approximately 0.6 feet or 0.2 meters of water level equivalent barometric fluctuation).

The Solinst Levelogger (20 PSI) series of water level dataloggers that will be used measure absolute pressure. Thus, when in water, they measure the total head of water plus the barometric pressure. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used to correct data collected from the pressure transducers installed on the north half of the playa. A second Barologger will be installed at Monument Point well and used to correct data collected from pressure transducers installed on the south half of the playa.

The algorithms programmed into the Barologger are strictly for use in air, making this instrument extremely accurate. The barometric data are then used, along with software Data Wizard, to compensate the Levelogger data and provide true water level readings. To increase the accuracy of barometric compensation data, the Barologgers and pressure transducers will be programmed with the same recording times.

Each transducer will be checked annually to verify its accuracy. This procedure will include raising the transducer to the top of the water surface while monitoring the pressure/head reading. When it measures zero, the cable will be marked. The transducer will then be lowered to depths of 5, 25, and 100 feet below the water surface and the pressure/head readings will be recorded. If these match the actual values, within the accuracy of the transducer, the transducer will be deemed acceptable and will continue in service. If not, the transducer will be replaced and returned for calibration and service.

Data from the transducers will be downloaded during each field sampling event. These data will be stored on a USB flash drive and then transferred to the central database for review, data verification, and analysis.

6.4.2 Groundwater Quality Sampling

It is currently anticipated that samples will be collected from the monitoring wells using low-flow purge and sampling methods or passive sampling methods as discussed further below. In either case, down-well flow testing will be conducted prior to the initial sampling round in order to select a representative depth from which samples will be collected from the wells.

6.4.2.1 DOWN-WELL FLOW TESTING

Low flow and passive groundwater sampling methods are not recommended for wells with long screens unless the Project team has a good understanding of the zones of inflow to the screen segments. Therefore, prior to use of these proposed sampling protocols, down-well flow tests were conducted, thereby determining the flow zones within the monitoring wells. The testing also assisted in understanding the relationship of groundwater flow between zones within the same groundwater system and provided information regarding interaction between groundwater systems within the area of interest.

Down-well flow testing was conducted in selected wells by Colog of Lakewood Colorado between the dates of June 4-22, 2018. The following wells were tested:

- Playa well SN2-11-400-4.
- Alluvial/colluvial wells 257 Cutoff, Bonneville, Crystal Peak Road, Guzzler, Lakeview, Headlight Gap, Machine Gun, Miller Canyon Reservoir, Mudhole and Provo.
- Bedrock wells Black Hills, Coyote, Monument Point, Nighthawk and North Cricket.

These 16 wells were logged to evaluate the vertical distribution of flow into and out of the wells for the purpose of locating sampling equipment in the wells. The screen interval showing the highest inflow of water will be the zone from which samples will be collected during each sampling event.

Each well was video logged first to determine the location of the well screen. In a few cases, the well screen interval determined by video logging did not match the well driller’s log. Table 3-1 will be updated for accurate screen intervals in the first annual report after this evaluation is complete. This updated information will also be presented in the baseline report.

The down-well flow testing method involves fluid-column conductivity logging over time after the in-situ fluid column has been replaced with environmentally safe deionized water. Finite difference modeling routines are used to determine zones where formation water is entering the well and to calculate aquifer permeability. Zones of in-flow, no-flow or very low flows are calculated throughout the well screen interval. Table 4-1 will be updated in the first annual report after completion of the down-well flow testing with the sampling depth selected for each well. This updated information will also be presented in the baseline report. Published field studies demonstrate that the technique has achieved better low-flow resolution than that reported with other flow measurement techniques (Vernon et al., 1993, reported in EPA CLU-IN, accessed 2018).

Well SN2-11-400-4, located within the playa, was flow tested using a Corehole Dynamic Flowmeter ("CDFM") because the equipment used to test the other wells could not be deployed to the playa surface. Data collection with a CDFM is based on Faraday's Law of Induction: voltage induced by a conductor moving at right angles through a magnetic field is directly proportional to the velocity of the moving conductor. Although the CDFM results are not as detailed and specific as the method used by Colog, interval(s) of higher flow into the well were still identified and will be used to set the sampling equipment depth and update Table 4-1.

At this time, CPM does not anticipate re-testing the wells unless there are noted obstructions in the wells within the sampling intervals that are suspected to potentially change the in-flow depth interval.

6.4.2.2 IN-SITU SAMPLING METHOD

CPM plans to use the ISS method for collecting groundwater quality samples in wells greater than 2-inch diameter, excluding wells equipped with dedicated submersible pumps (Black Hills, Lakeview, and Mudhole wells). Because the ISS sample volume in a 2-inch diameter well is insufficient to collect a duplicate of the full analytical suite shown on Table 3-2, low-flow sampling will be used in 2-inch diameter wells and is described in the subsequent section.

The wells that comprise the SAP/QAPP groundwater monitoring network vary in depth, diameter, and lithology surrounding the screen intervals. Review of previous sampling purge logs shows inconsistencies in purge procedures, apparently in response to individual well characteristics. Most notable are the numbers of wells that go dry when attempting a standard three-well volume purge.

Studies conducted in the 1990s demonstrated that purging of multiple well volumes of groundwater was not necessary to collect representative samples of the groundwater (Powell and Puls 1993; Barcelona et al. 1994; Puls and Barcelona 1996). These studies and others ushered in the low-flow purging method as a replacement to the multiple volumes purging. Robin and Gillham (1987) and Powell and Puls (1993) continued their investigations into low-flow purging and demonstrated that no purging was required as long as the sample device was set in the well screen at a depth where adequate well water exchange was occurring naturally (determined for this Project through down-well flow testing). Puls and Barcelona (1996) indicate that passive sample collection may be more appropriate for obtaining a representative sample in low-permeability and fractured flow formations than standard sampling protocols.

Recent testing and verification of ISS devices can be found in numerous documents including Britt (2006), Interstate Technology and Regulatory Council (“ITRC”) (2007), Parsons (2005), Parker and Mulherin (2007), and the current American Society of Testing Materials (“ASTM”) Standard Guide for Selection of Passive Techniques for Sampling Groundwater Monitoring Wells [ASTM D7929-14] (ASTM, 2014). The benefit of an ISS device is that the sampler is left in the well to equilibrate with the flow through the well screen, which minimizes the alteration of the groundwater sample through purging. This removes some of the sources of variability in water quality data due to differences in sampling personnel, sampling procedures, and equipment (EPA, 2005; Britt et al. 2010).

ASTM D7929-14 states that ISS sampling methods should consider sampler design, ability of the sampler to collect the target contaminants, well construction (including well diameter, screen and filter pack length), vertical and horizontal flow patterns within the well, and the constituents of concern. Passive ISS samplers are particularly well suited for conditions where active sampling methods can be problematic, such as those demonstrated in the purge logs from prior well sampling activities in the area of interest (CH2M, 2013). These conditions can include low-yield formations, where excessive drawdown is unavoidable even at low flow rates or where low-turbidity samples are needed but cannot be obtained using other sampling methods, such as with a bailer or a pump (ASTM D7929-14).

ITRC (2007) encourage the appropriate use of passive sampler technologies in new groundwater monitoring programs and as a replacement for existing high-volume purge sampling systems. The benefits stated by the ITRC (2007) include the following:

- Relatively easy to use;
- Reduces field-sampling variability, resulting in more reproducible data;
- Decreases field labor and project management costs for long-term monitoring;
- Allows rapid field sample collection;
- Allows sampling of the same interval in the well;
- Practical for use where access is difficult or where discretion is desirable;
- Can be deployed in series to provide a vertical chemical profile;
- Can be deployed in most wells; and
- Has no depth limit.

ISS sampling imparts the least degree of differential influence of any of these factors from one sampling event to the next through elimination of variations in sampling procedures and sample handling. Using an ISS system, the focus shifts from the sampling process to interpretation of time-series data. The ISS system will be a dedicated system to reduce field sampling variability but can be removed temporarily to allow use of the well for other purposes. If, for any reason, the ISS system is not functioning correctly in any of the wells, the backup sampling method would be low-flow purge (EPA, 2017).

For the ISS method, CPM proposes to use the Snap Sampler® ISS sampling method. With this system, sample bottles are suspended on a cable at an appropriate depth within the well screen (determined from the down-well flow testing described in Section 6.4.2.1) and allowed to set for a minimum of one week prior to sampling. A minimum of 460 ml of groundwater is required for the analyte list shown on Table 3-2. In 4-inch diameter wells and larger, 2,100 ml of groundwater can be collected using a total of six Snap Sampler bottles. Therefore, sufficient water will be available to allow the collection of the original sample as well as a duplicate or MS/MSD sample from any 4-inch diameter well or larger.

At the time of sampling, the lids on the bottles are triggered closed, thereby sealing the sample. The cable is then withdrawn, and the sample bottles are brought to the ground surface. An appropriate volume of unfiltered groundwater will be transferred into a separate container for field testing of pH and specific conductance. Aliquots of groundwater will be field filtered through a 0.45-micron disposable filter into appropriate laboratory supplied containers. Laboratory supplied preservative will be added to the appropriate sample containers.

Following sample collection, the Snap Sampler bottles will be cleaned using a bristle brush and Liquinox™ or an equivalent non-phosphate detergent, then rinsed with tap water and distilled water. The bottles will be drip-dried (under a paper towel or other cover to preclude dust impacts), after which they will be placed back onto the cable and lowered back into the well. The bottles will be dedicated to an individual well. A standard operating procedure is included in Attachment C.

The sample ID, sample date and time, field parameters, required analyses and sample volume will be recorded on the Groundwater Sample Log Form B (Appendix E). Sample management and shipping will occur in accordance with the procedures in Section 7.

6.4.2.3 LOW-FLOW SAMPLING METHOD

Low flow purge methods will be used in 2-inch diameter wells including Machine Gun, Crystal Peak Road and Headlight Gap and BLM wells with previously-installed submersible pumps (i.e., Black Hills, Lakeview, and Mudhole). Low-flow sampling methods will generally follow procedures recommended by the EPA (2017).

The low-flow wells identified above were down-well flow tested and sample depths are presented on Table 4-1. CPM acknowledges that EPA (2017) recommends that the low flow procedure is preferentially applicable to wells with a well screen length no more than 10 feet and a static water level above the well screen. However, the EPA recommendation assumed that the dominant groundwater inflow interval to a well was not known. Furthermore, Kaminski (2010) recommends that the purge location should relate to the saturated thickness of the monitored zone and preferential pathways rather than an arbitrary screen length (Kaminski 2010).

Low flow purging will be performed using Geotech bladder pumps capable of installation in 2-inch diameter casing and larger. These bladder pumps can operate at depths up to 1,000 feet with true low flow capability for less agitation. Bladder pumps will be installed in accordance with the manufacturer’s instructions and are planned to be a dedicated installation for each well. The pumps will be controlled by the Geotech 300 PSI Controller with accurate microprocessor-controlled fill/discharge timers to sustain low flow sampling techniques. The 300 PSI controller can operate the pumps to sampling depths of 690 feet. The depth at which the pumps are installed are identified on Table 4-1 (determined by the down-well testing described in Section 6.4.2.1), with samples collected from the primary zone of groundwater flow through the well screen.

Tubing from the pump will be connected to a flow-through cell in which dissolved oxygen, specific conductance, temperature, and pH will be monitored until these parameters stabilize for three consecutive readings taken at 5-minute intervals. Turbidity measurements will be collected from water diverted at a bypass valve installed before the flow through cell. The water samples for turbidity will be collected in separate sample cells and analyzed using a turbidimeter. Stable water quality parameter measurements indicate representative sampling is obtainable. Stabilization will be considered complete when the following is achieved (EPA 2017):

- Dissolved Oxygen (“DO”): $\pm$10 percent for values > 0.5 mg/L; if three values are < 0.5 mg/L the water is considered stabilized.
- pH: $\pm$ 0.1 unit.
- Specific Conductance (“SC”): $\pm$3 percent.
- Temperature: $\pm$3 percent.
- Turbidity: $\pm$10% for values greater than 5 Nephelometric Turbidity Units (“NTU”); if three turbidity values are less than 5 NTUs, consider the values as stabilized.

There is some concern over the stabilization of field parameters based on previous sampling logs. If field parameters do not stabilize even with adjustments to purge rates, and/or the drawdown in the well is surpassing the preferred quantity of 0.3 foot, field personnel will document the lack of stabilization and stop the purge process. Further, once the required purge volume is obtained (as discussed below), the purge process will not extend past one-half hour. If such steps are taken, they will be noted in the field log and the data will be appropriately qualified.

The discharge from the flow-through cell will be directed to a five-gallon bucket to determine the total volume purged (including that which is collected for turbidity measurements). During pumping, the flow rate will be monitored using a 250-ml graduated cylinder while drawdown in the well is measured. The goal is to purge the well at a rate that produces less than 0.3 foot of drawdown. The final purge volume must be greater than the stabilized drawdown volume plus the pump’s tubing volume.

Once the field parameters stabilize and the minimum total volume of purge water has been verified by the amount of water collected in the bucket, the water will be sampled. The tubing will be disconnected from the flow-through cell and each bottle will be filled from that tubing.

Samples intended to provide concentrations of dissolved constituents (Table 3-2) will be field filtered using a 0.45-micron filter to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. Groundwater samples will be transferred from the filter directly into the appropriate sample containers with a preservative and stored on ice until they are processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container.

Sample containers will be supplied by the analytical laboratory. Commercially available, pre-cleaned jars will be used. The laboratory will be responsible for maintaining a record of certification from the suppliers. Preservatives (if needed) would be added to the sample bottles before filling to reduce the time the sample is handled and open to the atmosphere.

The sample ID, sample date and time, field parameters, required analyses and sample volume will be recorded on the Groundwater Sample Log Form B (Appendix E). The sample management and shipping will occur in accordance with the procedures in Section 7.

At wells where a duplicate sample is to be collected, all bottles designated for a particular analysis for both sample designations will be filled sequentially before bottles for another analysis are filled. In the filling sequence for duplicate samples, bottles with the two different sample designations will alternate. Groundwater samples will be transferred directly into the appropriate sample containers with preservative, if required, chilled if appropriate, and processed for shipment to the laboratory.

6.4.3 Spring Sampling

If springs are monitored in the future, flow measurements will be collected if feasible and the spring water will be sampled if present. Given the intermittent nature of the springs as well as land owner accessibility issues, spring monitoring locations may change as more information becomes available.

If the flow is too low to allow the use of a current meter to measure the discharge rate, the flow velocity will be estimated using the float method or other approach recommended by Buchanan and Somers (1969).

In order to avoid potential disturbances caused by flow measurement, water quality samples will be collected from the springs before measuring the flow. Field measurements of temperature, pH, SC, turbidity, and DO will be collected and recorded during each sampling event. The spring samples and field measurements will be logged on the Surface Water Sample Form C (Appendix E). Sample management and shipping would follow procedures in Section 7. The samples will be analyzed for the constituents listed in Table 3-1.

6.5 Decontamination Procedures

Sampling equipment that comes into contact with water at another source will be decontaminated in accordance with SOP 2 in Appendix C. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

7 SAMPLE CONTAINERS, PRESERVATION, PACKAGING, AND SHIPPING

7.1 Water Sample Containers

The number and type of sample containers are listed in Tables 3-1 and 3-2. The containers will be pre-cleaned and preservatives, if required, will be added to the containers in the field. All samples will be chilled to 4°C $\pm$ 2°C immediately upon collection and labeling. Additional information regarding sample preservation and analysis is provided in Sections 5.1.1 (surface water) and 5.1.2 (groundwater).

7.2 Packaging and Shipping

Glass sample bottles will be individually placed inside a protective bubble wrap container to minimize the potential for breakage during shipment. All sample containers will be placed inside a sealable plastic bag that is placed inside a strong-outside shipping container (e.g., a cooler). Ice will be added to the cooler and empty space in the cooler will be filled with bubble wrap if necessary, to prevent movement and breakage of the sample containers during shipment.

A properly completed CoC form for the samples in the cooler will be placed inside a separate plastic bag, sealed, and taped to the inside lid of the cooler. Security seals will be signed and placed over the lip of the cooler lid. This seal with be secured to the lid with packing tape. The cooler will be shipped directly to Pace via an overnight service.

8 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting environmental samples, the sampling team will generate different types of waste that may include the following:

- Used sampling gloves,
- Disposable sampling equipment,
- Decontamination fluids,
- Purged groundwater and excess groundwater collected for sample container filling.

Used sampling gloves and disposable equipment will be placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill.

Decontamination fluids that will be generated in the sampling event will consist of tap water containing a non-phosphate detergent, distilled or deionized water, and residual (innocuous) contaminants. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area and will, therefore, be poured onto the ground.

Purged groundwater will be disposed by pouring onto the ground adjacent to the sampled well.

9 SAMPLE DOCUMENTATION

9.1 Field Documentation

Field documentation serves as the primary foundation for all field data that will be used to evaluate conditions within the area of interest. Care will be taken to ensure that all field documentation is accurate, legible, and written in indelible black or blue ink. No pencils or erasures will be used. Incorrect entries in field books, logs, or on forms that need to be corrected will be crossed out with one line, initialed, and dated. Skipped pages or blank sections at the end of a page will be crossed out with an "X" covering the entire page or blank section. "No Further Entries," initials, and date will be written by the person crossing out the section or page. The responsible field team member will write his/her signature, date, and time after the day's last entry.

9.1.1 Field Logbooks

The field logbook will be a bound, weatherproof book with numbered pages and will serve primarily as a summary of the activities carried out during the fieldwork. The logbook will be signed by the field personnel at the end of the daily entry. All entries will be made in indelible black or blue ink. The field forms (Appendix E, Forms A through C), will contain the documentation for sampling activities and will be referenced in the logbook each day, including an indication of which form(s) were used.

Field logbooks will document the following:

- Date;
- Time of important events;
- Purpose and objective of field work;
- Health and safety issues;
- Personnel and subcontractors on job site and time spent on the site;
- Summary of what was completed/performed;
- Type of sampling equipment used;
- Field instrument readings and calibration;
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.);
- Preliminary sample descriptions (e.g., clear or turbid water);
- Sample preservation;
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and CoC form numbers;
- Shipping arrangements (overnight air bill number);

- Name(s) of recipient laboratory(ies);
- Problems encountered and corrective action taken;
- Deviations from the sampling plan and reason for the deviations; and
- List of forms completed (i.e., Forms A through C).

Electronic field logs (i.e., using a tablet or laptop computer) may also be used to capture the above information.

9.1.2 Photographs

Photographs will be taken of the sample locations and at other areas of interest to document conditions during each sampling event. Documentation of a photograph is crucial to verify that it represents an existing situation. The following information concerning photographs will be noted in the logbook:

- Date, time, and location photograph was taken - in format mm/dd/yyyy – hh:mm;
- Weather conditions;
- Description of photograph;
- Reasons photograph was taken;
- Sequential number of the photograph; and
- Orientation direction when the photograph was taken.

After the photos are downloaded, the information recorded in the field logbook will be summarized in captions in the digital photo log.

9.2 Sample Labeling

All sample containers will be labeled (pre-printed by laboratory or sampling team) using waterproof labels and ink with the following information written on the labels:

- Client or project name;
- Sample identification number;
- Date and time of collection - in format mm/dd/yyyy – hh:mm;
- Requested analysis; and
- Container type and type of preservation used (chemicals added).

Field information concerning water samples will be listed on the appropriate forms contained in Appendix E.

9.3 Sample Chain-Of-Custody Forms

Chain-of-custody ("CoC") is used to ensure that samples shipped from the field and data resulting from laboratory analysis are credible and defensible. CoC begins at the time and point of sample collection. Documentation of sample possession and CoC is provided using sample labels and CoC forms.

All sample shipments for analyses will be accompanied by a CoC form. A copy of the form is found in Appendix F. Form(s) will be completed and sent with the samples in each cooler.

Information listed on the CoC includes:

- Sample ID;
- Project name, location, and number;
- Sampling dates and times;
- Name of sampling technician(s);
- Media being tested for each sample;
- Number of containers per sample;
- Signature of person relinquishing and receiving custody;
- Requested analyses for each sample; and
- Special requirements/comments for project or analysis.

The CoC form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of the sampling team leader. The sampling team leader or designee will sign the CoC form in the "relinquished by" box and note the date, time, and air bill number.

The field person relinquishing the samples will keep one copy of each CoC form and send the remaining copies with the samples. As noted in Section 7.2, the CoC form will be sealed in a waterproof plastic bag and taped to the inside lid of the shipping container (cooler).

10 QUALITY CONTROL

Quality assurance and quality control ("QA/QC") are critical components of every monitoring program. QA/QC requirements for CPM's monitoring activities are intended to ensure that data collected meet the Project and data quality objectives discussed in Section 3. Quality assurance planning helps ensure that the Project DQOs are met. Quality control samples ensure that procedures and actions are conducted correctly.

10.1 Field Quality Control

QC samples to be collected in the field are briefly described below.

10.1.1 Blind Duplicates

A blind duplicate sample is a duplicate of an original sample collected at the same time and location as the original sample. Blind duplicate water samples are collected in immediate succession, using identical sampling techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned a unique identification number in the field such that they cannot be identified as duplicates by laboratory personnel (i.e., the samples are submitted "blind").

When collecting blind duplicate water samples, bottles representing the original sample and the blind duplicate, with the two different sample identification numbers, will alternate in the filling sequence. Bottles for one type of analysis will be filled before bottles for the next analysis are filled. Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix.

Blind duplicate sample results are used to assess precision of the overall sample collection and analysis process, as noted in Section 3.3.1. Blind duplicate surface and groundwater samples will be collected at a minimum frequency of one duplicate for every 10 regular samples, or portion thereof, with at least one duplicate for each matrix (i.e., surface water and groundwater).

10.1.2 Field Blanks

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during sampling due to contamination from sample containers or from environmental conditions (e.g., dust). Field blank samples will be obtained by pouring deionized water into a sampling container at the sampling point, leaving the lid off during sampling at that location. The field blanks that are collected will be analyzed for metals.

One field blank will be collected each time a blind duplicate sample is collected. The field blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number will be assigned to each field blank sample, and it will be submitted blind to the laboratory.

10.1.3 Temperature Blanks

For each sample container that is shipped or transported on ice to an analytical laboratory, a 40-ml or larger glass or polyethylene container will be included that is marked “temperature blank.” This blank will contain deionized or distilled water and will be used by the laboratory to check the temperature of samples upon receipt.

10.2 Laboratory Quality Control Samples

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of laboratory glassware and reagents. Each type of laboratory-based QC sample will be analyzed at a rate of 5% or one per batch (a batch is a group of up to 20 samples analyzed together), whichever is more frequent.

10.2.1 Method Blank

A method blank is a sample generated in the laboratory consisting of reagent-grade water that is taken through the entire sample preparation and analysis with the field samples. It is used to monitor for contamination that may be introduced into the samples during processing within the laboratory. Evaluation criteria are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.2 Laboratory Duplicate

A laboratory duplicate consists of an aliquot of a field sample that is taken from the same container as the initial field sample and prepared and analyzed with the field sample. Laboratory duplicates are used to monitor the precision (in terms of RPD) of the analytical process. In conjunction with blind duplicates, the sampling precision can then be inferred. Criteria for laboratory duplicates are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.3 Laboratory Control Sample

A LCS consists of a laboratory-generated sample that contains the analytes of interest at known concentrations. It may be prepared by the laboratory or purchased from an outside source. The LCS is taken through the same preparation and analytical procedures as the field samples. Analyte recoveries indicate the accuracy of the analytical system. LCSs and matrix spikes (“MS”) together allow the overall accuracy of the sampling and analytical process to be determined. Criteria for LCS evaluation are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.4 MS/MS Duplicates

MS/MSDs are used to assess the effect of the sample matrix on analyte recovery. Both the MS and the MSD consist of an aliquot of a field sample to which the laboratory adds a known concentration of the analyte(s) of interest. An unspiked aliquot is also analyzed, and the percent recovery for the spiked sample is calculated.

The sample(s) chosen for MS/MSDs should be representative of the sample matrix but should not contain excessive concentrations of analytes or interfering substances. MS/MSDs will be analyzed at a frequency of one MS/MSD per 20 or fewer samples for each matrix and each sampling event.

Analysis of MS/MSDs requires collection of a sufficient volume of sample to accommodate the number of aliquots to be analyzed. The laboratory will be informed of the number of MS/MSD samples to be collected to ensure that a sufficient number of samples contained are filled for the analyses. The laboratory will also be alerted as to which sample is to be used for MS/MSD analysis by a notation on the sample container label and the CoC record or packing list.

When collecting water samples that will be the subject of MS/MSD analyses, bottles for each type of analysis will alternate in the filling sequence. Bottles for one type of analysis will be filled before bottles for the next analysis are filled. Control limits for MS/MSDs are provided in the source methods and in the laboratory quality assurance manuals provided in Appendix B.

11 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When possible, the QA Officer will be notified and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12 FIELD HEALTH AND SAFETY PROCEDURES

All field activities associated with the SAP/QAPP will be performed in accordance with the most recent edition of the CPM Site Safety Plan.

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APPENDIX A

WATER QUALITY CRITERIA

(Included as Attachments to the PDF Document)

SURFACE WATER STANDARDS

Standards for the quality of surface waters of the State are contained in UAC R317-2. The water quality standards are intended to protect Utah's waters and improve the quality for beneficial uses, including drinking water, fish and aquatic life, wildlife, agricultural, industrial, and recreational uses. The recognized classes of surface waters of the State are as follows:

Class 1 -- Protected for use as a raw water source for domestic water systems.

> Class 1C -- Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water

Class 2 -- Protected for recreational use and aesthetics.

> Class 2A -- Protected for frequent primary contact recreation where there is a high likelihood of ingestion of water or a high degree of bodily contact with the water. Examples include, but are not limited to, swimming, rafting, kayaking, diving, and water skiing.
>
> Class 2B -- Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.

Class 3 -- Protected for use by aquatic wildlife.

> Class 3A -- Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
>
> Class 3B -- Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
>
> Class 3C -- Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
>
> Class 3D -- Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
>
> Class 3E -- Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.

Class 4 -- Protected for agricultural uses including irrigation of crops and stock watering.

Class 5 waters represent a special class reserved for the Great Salt Lake. Individual bodies of water and reaches of flowing water are classified in R317-13 using the above categories.

GROUNDWATER CLASSES

Numerical groundwater quality standards for Utah are defined in UAC R317-6. Protection levels for groundwater are assigned in UAC R317-6-3, using a six-tier classification system based on existing use and background concentrations of TDS and other regulated constituents. The recognized classes of groundwater are as follows:

Class IA: Pristine Groundwater – Class IA groundwaters have less than 500 mg/L TDS. Concentrations of other constituents are less than the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class IB: Irreplaceable Groundwater – Class IB groundwaters are sources for community public drinking water systems for which no reliable supply of comparable quality and quantity is available because of economic or institutional constraints.

Class IC: Ecologically Important Groundwater – Class IC groundwaters are sources of groundwater discharge that are important to the continued existence of wildlife habitat.

Class II: Drinking Water Quality Groundwater – Class II groundwaters have TDS concentrations between 500 and 3,000 mg/L. Concentrations of other constituents that are less than the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class III: Limited Use Groundwater – Class III groundwaters have TDS concentrations between 3,000 and 10,000 mg/L. Concentrations of other constituents that exceed the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class IV: Saline Groundwater – Class IV groundwaters have TDS concentrations greater than 10,000 mg/L.

APPENDIX B

LABORATORY QA/QC PROGRAM

(Included as Attachments to the PDF Document)

Data Packages at a Glance

	Client Report Style	Cover Page	Narrative	Basic QC	Surrogates	Internal Standards	Calibration Summaries	Raw Data	TRRP R Report	TRRP S Report
QC2 (LIMS)	ESC			■	■					
QC2MOD	ESC			■	■	■				
QC2MODCN	ESC		■	■	■	■				
QC2MODCN-AZ *	ESC	■	■	■	■	■				
QC2VAP	ESC		■	■	■	■				
QCAZ *	DPP	■	■	■	■	■				
QCTX	ESC			■					■	
QCTX-S	ESC			■					■	■
QC3	ESC	■	■	■	■	■	■			
QC4	ESC	■	■	■	■	■	■	■		

Basic QC includes:

Blanks
Duplicates
LCS/D
MS/D

*** Includes AZ state qualifiers on QC pages**

Level 2 “LIMS” Data Package (also “Auto-QC2”)

1. Analytical Results
2. Method Blanks
3. Duplicates
4. Laboratory Control Samples
5. Matrix / Matrix Spike Duplicates

Surrogates are included where applicable

Level 2 "MOD" Data Package

1. Analytical Results
2. Wet – Chemical Data
    2.1. Quality Control Data
        2.1.1. Method Blanks
        2.1.2. Laboratory Control Samples
        2.1.3. Duplicates
        2.1.4. Matrix / Matrix Spike Duplicates
3. Inorganic Data
    3.1. Quality Control Data
        3.1.1. Method Blanks
        3.1.2. Laboratory Control Samples
        3.1.3. Duplicates
        3.1.4. Matrix Spike / Matrix Spike Duplicates
4. GC Volatiles Data
    4.1. Quality Control Data
        4.1.1. Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Surrogate Summaries
        4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC/MS Volatiles Data
    5.1. Quality Control Data
        5.1.1. Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Surrogate Summaries
        5.1.4. Matrix Spike / Matrix Spike Duplicates
        5.1.5. Internal Standard Response and Retention Time Summaries
6. GC Semi-volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 “MODCN” Data Package

1. SDG Narrative
2. Analytical Results
3. Wet – Chemical Data
    - 3.1. Quality Control Data
        - 3.1.1. Method Blanks
        - 3.1.2. Laboratory Control Samples
        - 3.1.3. Duplicates
        - 3.1.4. Matrix / Matrix Spike Duplicates
4. Inorganic Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC Volatiles Data
    - 5.1. Quality Control Data
        - 5.1.1. Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Surrogate Summaries
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC/MS Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates
        - 6.1.5. Internal Standard Response and Retention Time Summaries
7. GC Semi-volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Surrogate Summaries
        - 7.1.4. Matrix Spike / Matrix Spike Duplicates

8. GC/MS Semi-volatiles Data
    8.1. Quality Control Data
        8.1.1. Blanks
        8.1.2. Laboratory Control Samples
        8.1.3. Surrogate Summaries
        8.1.4. Matrix Spike / Matrix Spike Duplicates
        8.1.5. Internal Standard Response and Retention Time Summaries
9. HPLC Data
    9.1. Quality Control Data
        9.1.1. Blanks
        9.1.2. Laboratory Control Samples
        9.1.3. Surrogate Summaries
        9.1.4. Matrix Spike / Matrix Spike Duplicates
10. GC/ECD Pesticide / Aroclor Data
    10.1. Quality Control Data
        10.1.1. Blanks
        10.1.2. Laboratory Control Samples
        10.1.3. Surrogate Summaries
        10.1.4. Matrix Spike / Matrix Spike Duplicates
11. Chain of Custody

Level 2 "VAP" Data Package

1. SDG Narrative
2. Analytical Results
3. Wet – Chemical Data
    3.1. Quality Control Data
        3.1.1. Method Blanks
        3.1.2. Laboratory Control Samples
        3.1.3. Duplicates
        3.1.4. Matrix / Matrix Spike Duplicates
4. Inorganic Data
    4.1. Quality Control Data
        4.1.1. Method Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Duplicates
        4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC Volatiles Data
    5.1. Quality Control Data
        5.1.1. Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Surrogate Summaries
        5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC/MS Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates
        6.1.5. Internal Standard Response and Retention Time Summaries
7. GC Semi-volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Surrogate Summaries
        7.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 "AZ" Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results with AZ qualifiers
4. Wet – Chemical Data
    4.1. Quality Control Data
        4.1.1. Method Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Duplicates
        4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    5.1. Quality Control Data
        5.1.1. Method Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Duplicates
        5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates
7. GC/MS Volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Surrogate Summaries
        7.1.4. Matrix Spike / Matrix Spike Duplicates
        7.1.5. Internal Standard Response and Retention Time Summaries
8. GC Semi-volatiles Data
    8.1. Quality Control Data
        8.1.1. Blanks
        8.1.2. Laboratory Control Samples
        8.1.3. Surrogate Summaries
        8.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 "TX" Data Package

1. Cover Page
2. TRRP Reports
3. Analytical Results (MDL Format)
4. Wet – Chemical Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    - 5.1. Quality Control Data
        - 5.1.1. Method Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Duplicates
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Matrix Spike / Matrix Spike Duplicates
7. GC/MS Volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Matrix Spike / Matrix Spike Duplicates
8. GC Semi-volatiles Data
    - 8.1. Quality Control Data
        - 8.1.1. Blanks
        - 8.1.2. Laboratory Control Samples
        - 8.1.3. Matrix Spike / Matrix Spike Duplicates
9. GC/MS Semi-volatiles Data
    - 9.1. Quality Control Data
        - 9.1.1. Blanks
        - 9.1.2. Laboratory Control Samples
        - 9.1.3. Matrix Spike / Matrix Spike Duplicates

10. HPLC Data
    10.1. Quality Control Data
        10.1.1. Blanks
        10.1.2. Laboratory Control Samples
        10.1.3. Matrix Spike / Matrix Spike Duplicates
11. GC/ECD Pesticide / Aroclor Data
    11.1. Quality Control Data
        11.1.1. Blanks
        11.1.2. Laboratory Control Samples
        11.1.3. Matrix Spike / Matrix Spike Duplicates
12. Chain of Custody

Level 3 Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results
4. Wet – Chemical Data
    4.1. Quality Control Data
        4.1.1. Method Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Duplicates
        4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    5.1. Quality Control Data
        5.1.1. Method Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Duplicates
        5.1.4. Matrix Spike / Matrix Spike Duplicates
        5.1.5. Initial and Continuing Calibration Verifications
        5.1.6. Initial and Continuing Calibration Blanks
        5.1.7. ICP Runlog
6. GC Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates
        6.1.5. Calibration Verification Summaries
7. GC/MS Volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Surrogate Summaries
        7.1.4. Matrix Spike / Matrix Spike Duplicates
        7.1.5. Initial and Continuing Calibration Verifications
        7.1.6. Internal Standard Response and Retention Time Summaries

8. GC Semi-volatiles Data
    - 8.1. Quality Control Data
        - 8.1.1. Blanks
        - 8.1.2. Laboratory Control Samples
        - 8.1.3. Surrogate Summaries
        - 8.1.4. Matrix Spike / Matrix Spike Duplicates
        - 8.1.5. Calibration Verification Summaries

9. GC/MS Semi-volatiles Data
    - 9.1. Quality Control Data
        - 9.1.1. Blanks
        - 9.1.2. Laboratory Control Samples
        - 9.1.3. Surrogate Summaries
        - 9.1.4. Matrix Spike / Matrix Spike Duplicates
        - 9.1.5. Initial and Continuing Calibration Verifications
        - 9.1.6. Internal Standard Response and Retention Time Summaries

10. HPLC Data
    - 10.1. Quality Control Data
        - 10.1.1. Blanks
        - 10.1.2. Laboratory Control Samples
        - 10.1.3. Surrogate Summaries
        - 10.1.4. Matrix Spike / Matrix Spike Duplicates
        - 10.1.5. Initial and Continuing Calibration Summaries

11. GC/ECD Pesticide / Aroclor Data
    - 11.1. Quality Control Data
        - 11.1.1. Blanks
        - 11.1.2. Laboratory Control Samples
        - 11.1.3. Surrogate Summaries
        - 11.1.4. Matrix Spike / Matrix Spike Duplicates
        - 11.1.5. Calibration Verification Summaries

12. Chain of Custody

13. Login Confirmation

Level 4 Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results
4. Wet – Chemical Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix / Matrix Spike Duplicates
        - 4.1.5. Method Blank Summaries
    - 4.2. Raw Data
        - 4.2.1. Instrument Run Data with Bookmarks
            - 4.2.1.1. Continuing Calibration Reports
            - 4.2.1.2. Samples
            - 4.2.1.3. Blanks
            - 4.2.1.4. Laboratory Control Samples
            - 4.2.1.5. Duplicates
            - 4.2.1.6. Matrix Spikes
5. Inorganic Data
    - 5.1. Quality Control Data
        - 5.1.1. Method Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Duplicates
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
        - 5.1.5. Method Blank Summaries
        - 5.1.6. Initial and Continuing Calibration Verifications
        - 5.1.7. Initial and Continuing Calibration Blanks
        - 5.1.8. ICP Interference Check Samples
        - 5.1.9. ICP Runlog
    - 5.2. Raw Data
        - 5.2.1. Digestion Logs
        - 5.2.2. Instrument Run Data with Bookmarks
            - 5.2.2.1. Samples
            - 5.2.2.2. Blanks
            - 5.2.2.3. Laboratory Control Samples
            - 5.2.2.4. Duplicates
            - 5.2.2.5. Matrix Spikes

6. GC Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates
        6.1.5. Method Blank Summaries
        6.1.6. Calibration Verification Summaries
    6.2. Raw Data
        6.2.1. Pages from Instrument Run Data with Bookmarks
            6.2.1.1. Injection Logs (not bookmarked)
            6.2.1.2. Calibration Verification Data
            6.2.1.3. Sample Data
            6.2.1.4. Blank Data
            6.2.1.5. Laboratory Control Sample Data
            6.2.1.6. Matrix Spike Data
            6.2.1.7. Calibration Curve Data
7. GC/MS Volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Surrogate Summaries
        7.1.4. Matrix Spike / Matrix Spike Duplicates
        7.1.5. Method Blank Summaries
        7.1.6. Instrument Performance Summaries
        7.1.7. Relative Response Factor Summaries
        7.1.8. Initial and Continuing Calibration Verifications
        7.1.9. Internal Standard Response and Retention Time Summaries
    7.2. Raw Data
        7.2.1. Pages from Instrument Run Data with Bookmarks
            7.2.1.1. Injection Logs (not bookmarked)
            7.2.1.2. Initial and Continuing Calibration Data
            7.2.1.3. Sample Data
            7.2.1.4. Blank Data
            7.2.1.5. Laboratory Control Sample Data
            7.2.1.6. Matrix Spike Data
            7.2.1.7. BFB Tune Data
            7.2.1.8. Calibration Curve Data

8. GC Semi-volatiles Data
    8.1. Quality Control Data
        8.1.1. Blanks
        8.1.2. Laboratory Control Samples
        8.1.3. Surrogate Summaries
        8.1.4. Matrix Spike / Matrix Spike Duplicates
        8.1.5. Method Blank Summaries
        8.1.6. Calibration Verification Summaries
    8.2. Raw Data
        8.2.1. Pages from Instrument Run Data with Bookmarks
            8.2.1.1. Extraction Logs
            8.2.1.2. Injection Logs (not bookmarked)
            8.2.1.3. Calibration Verification Data
            8.2.1.4. Sample Data
            8.2.1.5. Blank Data
            8.2.1.6. Laboratory Control Sample Data
            8.2.1.7. Matrix Spike Data
            8.2.1.8. Calibration Curve Data
9. GC/MS Semi-volatiles Data
    9.1. Quality Control Data
        9.1.1. Blanks
        9.1.2. Laboratory Control Samples
        9.1.3. Surrogate Summaries
        9.1.4. Matrix Spike / Matrix Spike Duplicates
        9.1.5. Method Blank Summaries
        9.1.6. Instrument Performance Summaries
        9.1.7. Relative Response Factor Summaries
        9.1.8. Initial and Continuing Calibration Verifications
        9.1.9. Internal Standard Response and Retention Time Summaries

- 9.2. Raw Data
  - 9.2.1. Pages from Instrument Run Data with Bookmarks
    - 9.2.1.1. Extraction Logs
    - 9.2.1.2. Injection Logs (not bookmarked)
    - 9.2.1.3. Initial and Continuing Calibration Data
    - 9.2.1.4. Sample Data
    - 9.2.1.5. Blank Data
    - 9.2.1.6. Laboratory Control Sample Data
    - 9.2.1.7. Matrix Spike Data
    - 9.2.1.8. DFTPP Tune Data
    - 9.2.1.9. Calibration Curve Data

10. HPLC Data
  - 10.1. Quality Control Data
    - 10.1.1. Blanks
    - 10.1.2. Laboratory Control Samples
    - 10.1.3. Surrogate Summaries
    - 10.1.4. Matrix Spike / Matrix Spike Duplicates
    - 10.1.5. Method Blank Summaries
    - 10.1.6. Initial and Continuing Calibration Summaries
  - 10.2. Raw Data
    - 10.2.1. Pages from Instrument Run Data with Bookmarks
      - 10.2.1.1. Extraction Logs
      - 10.2.1.2. Initial and Continuing Calibration Data
      - 10.2.1.3. Sample Data
      - 10.2.1.4. Blank Data
      - 10.2.1.5. Laboratory Control Sample Data
      - 10.2.1.6. Matrix Spike Data
      - 10.2.1.7. Calibration Curve Data

11. GC/ECD Pesticide / Aroclor Data
    11.1. Quality Control Data
        11.1.1. Blanks
        11.1.2. Laboratory Control Samples
        11.1.3. Surrogate Summaries
        11.1.4. Matrix Spike / Matrix Spike Duplicates
        11.1.5. Method Blank Summaries
        11.1.6. Retention Time Summaries
        11.1.7. Calibration Verification Summaries
    11.2. Raw Data
        11.2.1. Pages from Instrument Run Data with Bookmarks
            11.2.1.1. Extraction Logs
            11.2.1.2. Injection Logs (not bookmarked)
            11.2.1.3. Calibration Verification Data
            11.2.1.4. Sample Data
            11.2.1.5. Blank Data
            11.2.1.6. Laboratory Control Sample Data
            11.2.1.7. Matrix Spike Data
            11.2.1.8. Calibration Curve Data
12. Chain of Custody
13. Login Confirmation

Stantec

APPENDIX C

STANDARD OPERATING PROCEDURES

(Included as Attachments to the PDF Document)

SOP 1
Well Gauging

Groundwater Well Gauging

One person should measure the fluid levels in every well during each sampling event to avoid potential errors caused by different people reading depth off the fluid level tape. Verify that all the wells are vented to the atmosphere prior to measurement to maintain water equilibration.

Manual Well Gauging Procedure

Measurements of water levels in the wells using an electronic sounder will be performed as follows:

1) Open the well and determine where the top-of-casing elevation survey point is located. This is usually a “v” notch in the casing or a mark on the casing.
2) Know the previous water level measurement and control the rate of decent at least 30 feet above the last known depth to water so the meter encounters the water gently.
3) The sounder is lowered down the well gently until the lead probe contacts water and sounds with a “beep”. The sounder should not enter the water abruptly since this may cause hydrologic disturbance prior to sampling.
4) The depth to water is read off the graduated tape with reference to the surveyed point on the top-of-casing.
5) Record the measurement on the Well Gauging Form A.
6) Remove the sounder from the well.
7) Decontaminate the sounder following procedures in SOP 3.

Pressure Transducer

A dedicated pressure transducer (PT) will record water levels in the bedrock wells and select alluvial/colluvial wells twice a day. The purpose of the pressure transducer measurements is to identify regional daily trends in water levels over time. The transducer data will be downloaded once a quarter during the groundwater gauging events.

Pressure Transducer Set up and Operation

A 1-inch diameter PT pipe will be installed in each well from top-of-casing to 30 feet below the average depth-to-water. The purpose for the pipe is keep the PT cable away from the Insitu Sampling System (ISS) cable which will suspend the ISS sample bottles at a specified depth in the well screen. The PT pipe will be securely docked at the well head.

A 20 PSI absolute pressure PT will be installed approximately 20 feet below the average depth-to-water of each well. The correction for atmospheric changes on the ground surface will be accomplished using a Barologger. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used for the PTs installed in wells on the north half of the playa. A second Barologger will installed at Monument Point well and used for PTs installed on the south half of the playa. The PT installed in wells will be set at a depth of approximately 20 feet below top-of-casing. The depth of the pressure transducer will be manually checked twice per year by attaching the Solinst water level meter electronic probe at the same level as the PT measurement reference. The pressure transducer reference depth will be recorded each time it is checked in the log book.

SOP 2
In-situ Sampling System (Snap Sampler)
Low Flow Purge Method (Bladder Pump)

In-situ Sampling System

The goal of this groundwater sampling program is to minimize changes in groundwater chemistry during the sample collection and handling procedures that can distort the physical sample in a manner that may not provide representative samples each time. Under the In-Situ Sampling System (ISS) method, the sample bottles are dedicated inside the well at the screen interval determined by Hydrophysical logging to be the dominate flow area into the well. Once the trigger has closed, the sample is sealed from potential atmosphere changes to the integrity of the sample.

1. Deployment

The procedure for deployment of the Snap Samplers is presented below:

1) Measure the depth-to-water following SOP 1.
2) The Snap Samplers will be installed at a depth well below the groundwater surface so measuring depth-to-water will not influence sample integrity.
3) Turn the translucent (PFA) vial cap on each end of the bottle slightly to release the O-ring.
4) Insert the bottle into the upper end of the sampler as shown in Figure 1.

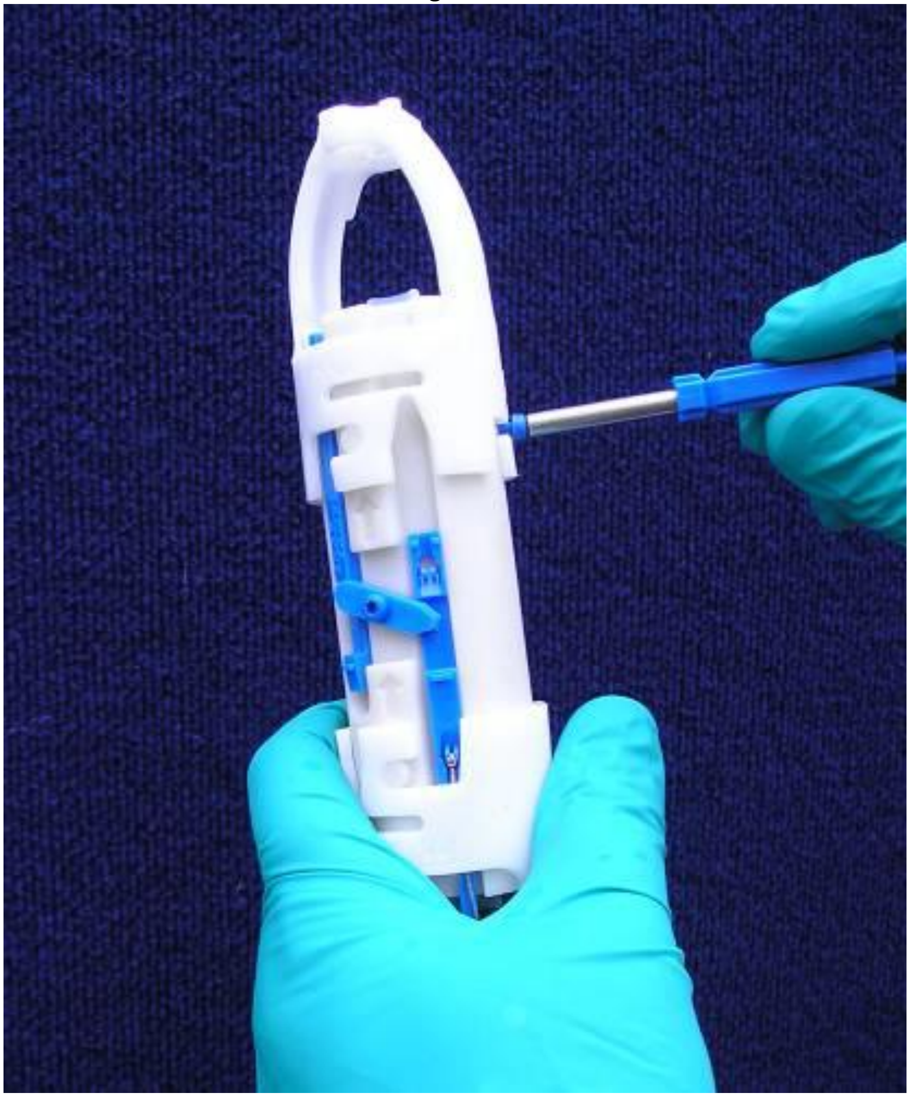
Figure 1

5) Place the sampler connector onto each end of the sampler; turn clockwise to align the set pins/screw shown in Figure 2.

Figure 2

6) Gently tighten the set screw with the Snap Driver Tool (Figure 3).

Figure 3

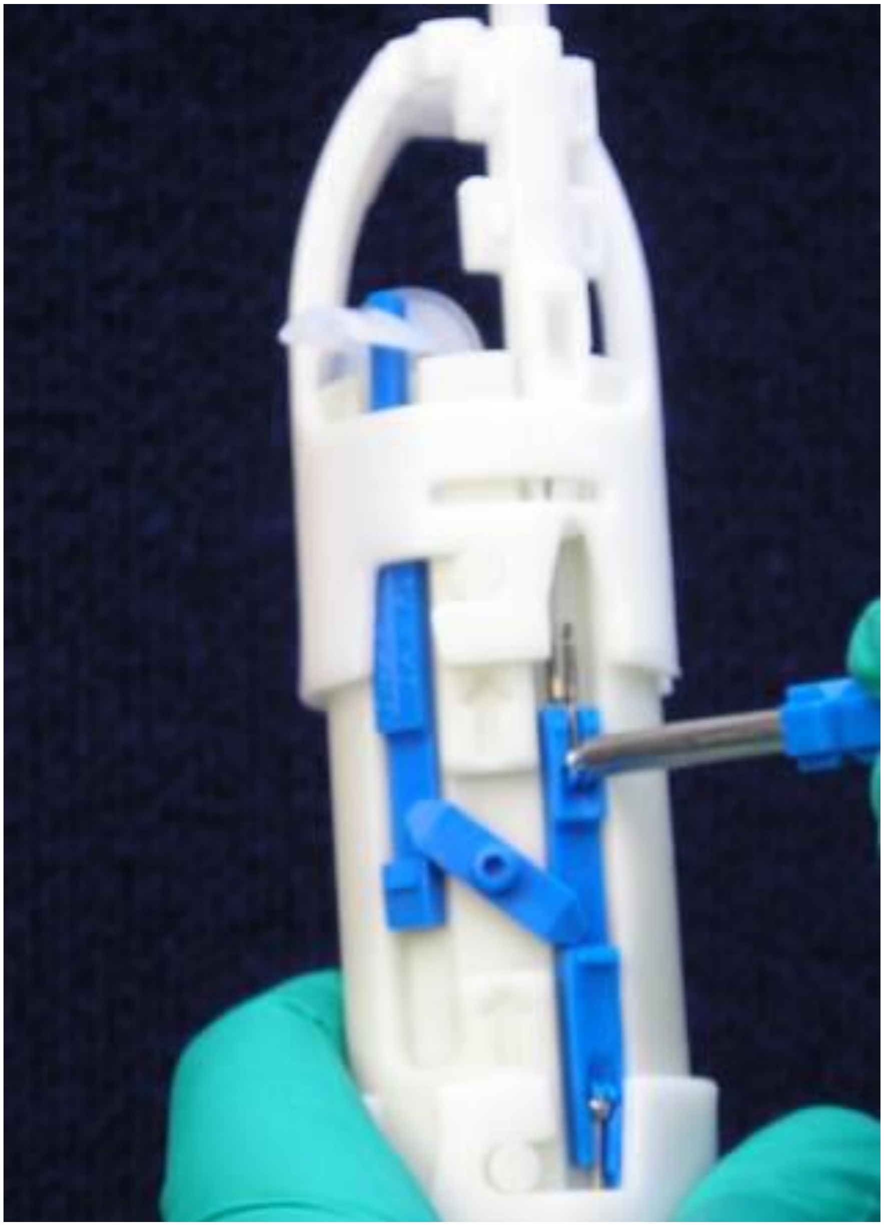


7) Pivot the vial cap (Snap Cap) into its seat with the Snap driver. Push the retainer pin up through the lower hole in the vial cap. Repeat for all Snap Caps (Figure 4). If an O-ring should dislodge from its seat during setting, remove the sample bottle and carefully replace it in the O-ring groove; repeat setting procedure.

Figure 4

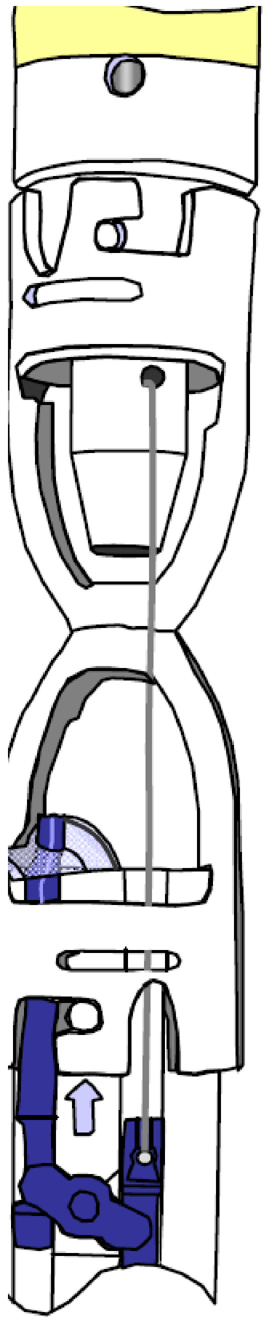
8) For the manual trigger, feed ball-fitting end of trigger cable through lower release pin groove; click tube fitting into connector and press in the ball fitting to attach lower release pin (Figure 5).

Figure 5



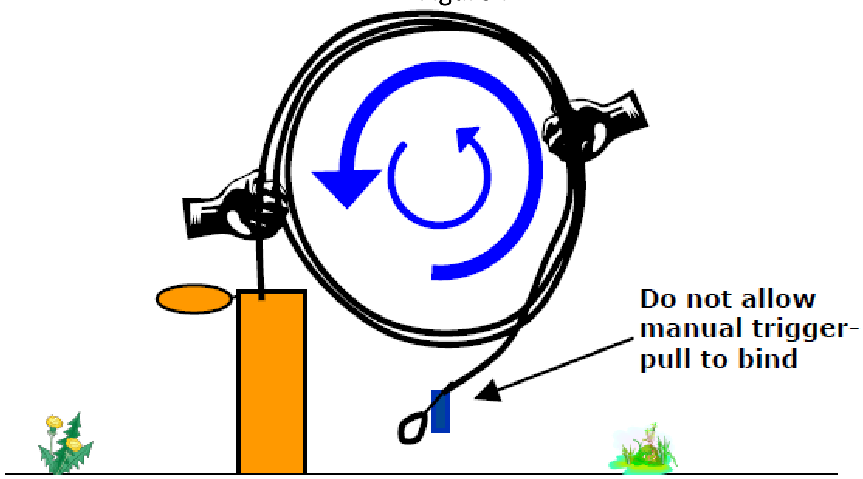
9) For pneumatic trigger, attach the wireline from the plunger (Figure 6).

Figure 6



10) Deploy the samplers to the depth with the trigger cable/tubing and attach to the well head docking station (Figure 7).

Figure 7



11) Additional Snap Samplers can be deployed in series with the single trigger.
12) The Snap Samplers can be deployed for extended periods. No upper bound for sampler deployment has been found.

2. Sample Collection

When deployment is completed, the Snap Sampler bottles will set in the well for a minimum of 2-weeks to equilibrate with the groundwater flow into the well. To collect the sample, the manual or pneumatic trigger at the wellhead is activated. The sample bottles are then retrieved to the surface. Loosen the retainer screw and turn the connector piece to free the sample bottles. The bottom connector piece does not need to be disassembled to remove the bottles.

The water in the Snap Samplers will be field filter as necessary to fill the laboratory prepared sample bottles. The water samples will be filtered through an in-line 0.45 micron filter that is connected to a peristaltic pump with ¼-inch diameter polyethylene tubing. The required filtered sample bottles will be filled at the wellhead. Water from one of the Snap Sample bottles will remain unfiltered and used to measure field parameters Dissolved Oxygen (DO), specific conductance (SC), pH, temperature and turbidity.

The sample ID, sample date and time, required analyses and sample volume are all recorded on the Groundwater Sample Log Form B. Fill out the removable adhesive label according to SOP 4 and attach to the laboratory supplied sample bottles. Fill out the chain-of-custody according to SOP 4, place each bottle in a pre-labeled zip-lock baggie, place the bottles in the shipping cooler and place the chain-of-custody form in a waterproof plastic bag taped to the inside lid of the shipping cooler.

Any water from the Snap Samplers not used for laboratory analyses can be discharged to the ground surface. Clean the Snap Sampler bottles according to SOP 3 and reattach the Snap Sampler bottles to the wireline and redeployed back into the well for the next quarterly sampling event. This procedure significantly reduces the labor and equipment required to collect quarterly groundwater samples.

Low Flow Purge

This SOP provides a description of field procedures related to collection of groundwater samples using the low flow purge method (USEPA, 2017) with two exceptions. The well screen is not limited to 10 feet and field measurements of DO, specific conductance and pH are the primary parameters to stabilize.

1. Calibrate the field multi meter.
2. Calibration of pH meters shall be performed to pH standards (4, 7, or 10 standard units) bracketing the actual field measured value.
3. The specific conductivity meter shall be calibrated to one of three standards, 2,000, 6,000, or 10,000 micro Siemens per centimeter (mS/cm), whichever is closer to the field measured value.
4. Dissolved oxygen is calibrated using the barometric pressure method outlined by the manufacturer.
5. Turbidity calibration is performed using 2-point values of 3 and 7 NTUs.
6. Record the field calibration on the Groundwater Sample Form B.
7. The dedicated bladder pump is set at the pre-determined screen interval where inflow the well was determined using the Hydrophysical logging method.
8. Measurements of DO, SC, temperature, pH, will occur by way of probes that are installed in a clear flow through cell.
9. Turbidity measurements are collected from water diverted at a bypass valve installed before the flow through cell. The water samples for turbidity are collected in separate 25 mm x 60 mm round sample cells and analyzed using the HACH 2100Q turbidimeter.
10. The pumps flow rate will be set to an approximate flow rate of between 100-200 milliliters per minute (mL/min).
11. The flow rate will be adjusted for long pulses of water, so one pump cycle will deliver a minimum of 40 mL of water as recommended by USEPA (USEPA, 2017).
12. Purge groundwater from the monitoring well into a bucket to observe water color and clarity
13. Record the drawdown in the well, adjust the pump to maintain less than 0.3 feet of drawdown.
14. If the drawdown goes below 0.3 feet but then stabilizes, continue to purge the well until field parameters stabilize.
15. The final purge volume must be greater than the stabilized drawdown volume plus the pumps tubing volume. If the drawdown exceeds 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level and add the volume of water in the pump tubing. This combined total volume of water must be purged before sample collection.
16. Record DO, SC, pH, temperature and turbidity at a frequency of 5 minute intervals. Stabilization is considered to be achieved when three consecutive readings are within the following limits:
    - DO - 10% for values greater than 0.5 mg/L; if three DO values are less than 0.5 mg/L, consider the values stable;
    - Specific conductance 3%;
    - pH +- 0.2 unit;
    - Temperature +- 3%; and
    - Turbidity 10% for values greater than 5 NTU, if three turbidity values are less than 5 NTU consider the values stable.
17. There is some concern over the stabilization of turbidity based on previous sampling logs. If DO, pH and SC have stabilized but turbidity has not, and the drawdown in the well is surpassing the preferred distance of 0.3 feet, field personnel have the option to document the lack of stabilization of turbidity and stop the purge process based on the stabilization of DO, pH and SC.
18. Remove the tubing from the flow through cell and attach the discharge tubing to an in-line 0.45 micron filter. DO NOT SAMPLE FROM THE FLOW THROUGH CELL.
19. Collect all filtered samples directly into laboratory supplied sample container and add the

laboratory color coded preservative to the appropriate sample containers.

20. Collect all non-filtered samples directly into laboratory supplied sample container.
21. Record the sample information on the Groundwater Sample Form B and chain-of-custody.
22. Purge water in the bucket can be discharged to the ground surface.
23. Decontaminate the flow through cell according to procedures in SOP 3.

SOP 3
Decontamination

Decontamination of Sampling Equipment

Sampling equipment that comes in contact with surface water and groundwater will be decontaminated between each sample location by using a three bucket wash and rinse system. The procedure is as follows:

- Wash the equipment in bucket one using low-phosphate detergent and tap water,
- Triple rinse the equipment with tap water into bucket two, and
- Rinse the equipment with deionized/distilled water into bucket three.
- Allow the sampling equipment to air dry and then place equipment inside a clean, disposable protective case or bag before proceeding to the next sampling point.

The Snap Sampler bottles will be cleaned after each sampling event using a three bucket wash and rinse system. The procedure is as follows:

- Wash the bottles in bucket one that is only used for Snap Sampler bottles using low-phosphate detergent and tap water,
- Triple rinse the Snap Sampler bottles with tap water into bucket two, and
- Rinse the Snap Sampler bottles with deionized water into bucket three.

Immediately replace the Snap Samplers in the well by attaching to the wire line and lowering back down the well to the sampling interval. Do not let the Snap Samplers air dry.

Drilling Equipment

All down hole drilling equipment and associated tools will be pressure-washed between boreholes. Pipe racks or similar will be used to elevate the drilling equipment (e.g., rods and augers) during pressure washing. Wash water can be dispensed to the ground surface.

SOP 4
Sample Management and Chain-of-Custody

Introduction

This section describes sample handling and shipping documentation requirements to ensure the integrity of the samples collected and submitted to the laboratory for analysis, and to provide the laboratory with instructions for the analytical services required. The following general procedures are summarized in this section:

- Sample labeling,
- Sample packaging and shipping, and
- Chain-of-custody.

Sample Labeling

All sample containers will be labeled using waterproof ink with the following information on labels:
Client or project name,

- Sample identification number,
- Date and time of collection,
- Requested analysis, and
- Container type and type of preservation used.

All groundwater samples collected each day are to be documented in the Log Book, and on the Groundwater Sample Form A. Duplicate samples will be labeled with a "D" after the fictitious well ID, and recorded in the Log Book with the correct well ID from which it was collected.

Sample Packaging and Shipping

The following procedures apply to all groundwater samples packed for transport to the laboratory:

1. Place each glass sample bottle into an individual laboratory supplied bubble wrap bag. Plastic bottles do not need to be placed inside protective bubble wrap.
2. The bottles are then placed into a 1-liter sealable baggie and labeled on the outside of the baggie with the sample name, date, and sample time. This is performed to verify the sample during preparation of the chain of custody, and to assist the laboratory personnel at the log in procedure at the laboratory.
3. Place bubble wraps on the inside bottom of the cooler.
4. Line the cooler with a laboratory supplied 6-millimeter thick clear plastic bag (plastic bag) that extends above the cooler at least 18-inches so the bag can be sealed with a zip-tie strap.
5. Place the samples inside the plastic bag and pack the plastic bag with the contents of one bag of crushed ice. Spread the ice evenly over the entire contents of the plastic bag. Zip tie the plastic bag shut.
6. Place the completed chain of custody inside a 1-liter sealable baggie and tape the baggie to the inside lid of the cooler.
7. Remove any expired shipping label for the cooler. Place the laboratory supplied overnight priority shipping label on the cooler. Remove the copy receipt of the shipping label and attach it to the copy of the chain-of-custody that is inside the cooler.
8. Attach two signed custody seals over the cooler lid where it seals to the body of the cooler. Tape the cooler shut by wrapping shipping tape around the cooler lid and base and over the custody seals at least two layers thick.
9. Ship the coolers using Federal Express or United Parcel Service only from a distribution location

that is staffed by company personnel. No shipping cooler is ever to be left unattended at a drop location.

Chain-of-Custody

Chain-of-custody is a mechanism employed to ensure that data resulting from laboratory analysis are credible and defensible. Chain-of-custody begins at the time and point of sample collection. Documentation of sample possession and chain-of-custody is provided by the use of sample labels and chain-of-custody forms.

The chain-of-custody record will be initiated in the field and will accompany samples during shipment to the laboratory. The chain-of-custody record allows transfer of custody of a sample or group of samples in the field to any laboratory. Information listed on the chain-of-custody includes:

1. Sample Identification;
2. Project name, location, and number;
3. Sampling dates and times;
4. Name of sampling technician(s);
5. Media being tested for each sample;
6. Number of containers per sample;
7. Signature of person relinquishing and receiving custody;
8. Requested analyses for each sample; and
9. Special requirements/comments for project or analysis.

The sampler relinquishing the samples will keep one copy of the chain-of-custody forms and send the original and remaining copies with the samples. The chain-of-custody form shall be sealed in a waterproof plastic bag and placed inside the shipping container.

SOP 5
Surface Water Flow and Sampling Procedures

Introduction

The collection of samples from the Sevier River will start at the downstream-most location and progress upstream. The river conditions and field parameters will be logged on the Surface Water Sample Form C in Attachment E. Flow measurements within the channel will likely mobilize sediments and cause disturbances in the water; therefore, river water quality samples will be collected before flow measurements.

Surface Water Sampling

Sample bottles will be transported to the river edge in a sample caddy and remain sealed until the water sample is collected. Depending on site conditions, samples will be collected by use of a sampling pole or by wading into the river. The samples will be collected upstream of the sampling pole location or wading personnel to avoid disturbance of the sampled water. Samples will be collected directly into sample bottles to which no preservatives have been added. In this case, the sample collection bottle will be rinsed a minimum of three times with river water before collecting the sample.

Sample bottles that contain an added preservative will be filled from a rinsed bottle that does not contain a preservative, thereby avoiding the loss of the preservative. These bottles will be filled at least to the neck of the bottle, but not overflowing, before capping.

1. Sample collection bottles will be immersed mouth down below the water surface to approximately one-third the depth of the stream flow if the flow depth is sufficient.
2. With the lid removed, the bottle will be pulled up through the water column at a rate that would fill the bottle from a vertical section of the stream, the purpose being be to collect water from different depths in the stream. If the flow depth is insufficient to submerge the bottle, care will be taken to avoid the introduction of bottom sediment into the sample during near surface water collection.
3. The sample cap will then be replaced and the sample bottle placed in the sample caddy. The sample caddy will be carried away from the river for sample preparation and labeling.
4. Samples requiring analyses of dissolved constituents (as noted in Table 3-1) will be field filtered by transferring the sample to the laboratory supplied containers using a peristaltic pump. The field collected sample will be pumped through ¼-inch diameter polyethylene tubing through an in-line 0.45-micron filter into the laboratory supplied sample containers. When transferring samples, care will be taken not to touch the filter to the sample container.
5. Laboratory supplied color coded preservative (color on preservative matches color label on sample container) will be added to the appropriate containers.
6. Field parameters for dissolved oxygen (DO), specific conductance (SC), pH, temperature and turbidity will be measured in the field. Rinse a 100 ml wide mouth sample bottle at least three times from the water being sampled. Fill a 100 ml sample bottle approximately ½ full and place the DO, SC, temperature and pH probes in the sample bottle.
7. Collect a second 100 ml aliquot of the surface water using the same procedure as described in #6 above to measure turbidity. Transfer the aliquot into the 25 mm x 60 mm round turbidity sample bottle and place in the turbidity meter for measurement.
8. Label the surface water samples, complete the chain-of-custody form, and pack the samples for shipment to the laboratory following the procedures in SOP 4.

Surface Water Flow

Streamflow measurements will be collected using a current meter or other appropriate method approved by the U.S. Geological Survey (Buchanan and Somers, 1969). Once sufficient data are available, rating curves will be developed for each channel location, thereby allowing stage-gauge readings to provide future estimates of flow based on the rating curve. Flow and cross-section data will be collected at least quarterly and more frequently (i.e., monthly) if possible during those periods when flow stage varies between high and low to aid in developing a more accurate rating curve for each stream station. the general procedures are as follows:

1. Install a 10 PSI absolute pressure PT at each surface-water sample location shown on Figure 4-1.
2. Install a vertical T- post in the center of the river channel during a time when the river is dry.
3. Secure a staff gauge with visible one-tenth foot markers and at least five feet total markings on the T- post. The 0-foot depth corresponds to the bottom of the river bed.
4. Place the PT inside a section of vertical PVC casing secured to the T-post and staff gage.
5. The transducers will be programmed to collect water levels at a minimum of twice per day.
6. The correction for atmospheric changes on the ground surface will be accomplished using a Barologger. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used for the PTs installed on the north half of the playa. A second Barologger will be installed at Monument Point well and used for PTs installed on the south half of the playa.
7. During quarterly monitoring, recorded the river depth from the staff gauge at each station and download the data from the PT installed inside the 2-inch pipe attached to the T-post.
8. Record the data on the Surface Water Sample Form C in Attachment E.
9. Download the barometric pressure data from the Barologger stations quarterly when collecting surface water and groundwater samples.
10. Correct the PT level readings for barometric pressure changes and compare with the manual stage readings to ensure appropriate correlation.

The pressure transducer readings and staff gauge heights described above will be used to develop rating curves. These curves will be used to estimate the river flow without having to physically measure the channel area and flow velocity at the time of each stage reading. The rating curves will be developed from a log-log plot of stage and discharge data (Kennedy, 1984), which generates a straight-line equation in the following form:

$$Q=P(G-e)^b$$

Where: Q is discharge (cfs) from

P is the intercept equal to Q when (G-e) is equal to 1.0

G is the river stage (feet)

e is a constant that when subtracted from G, will result in a straight line on log-log plot of Q vs. (G-e); the default value is zero and is adjusted if initial log-log plot shows curvature

b is the slope of linear trend line on log-log plot

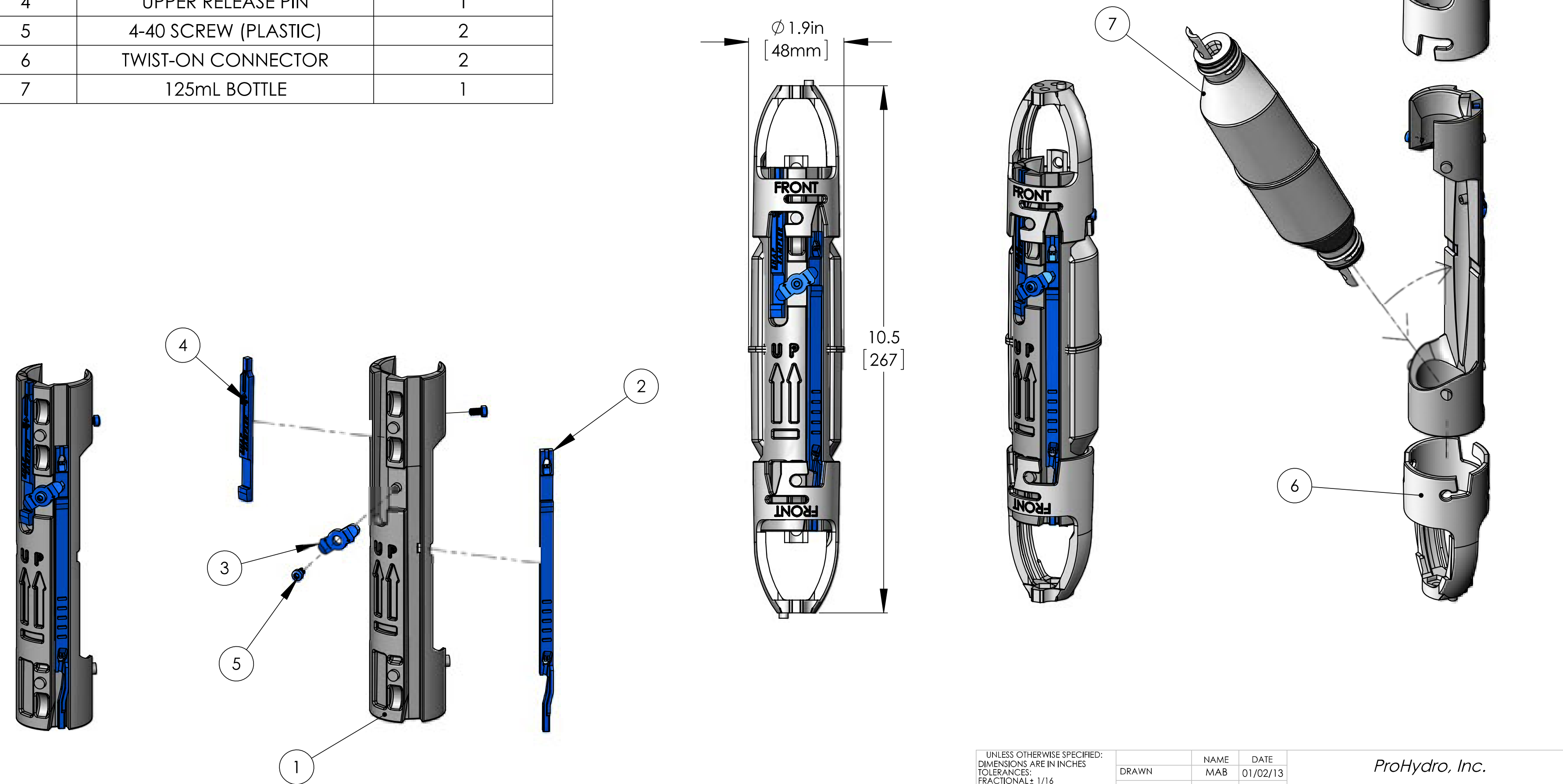
The pressure transducer data will be used with the rating curves to produce a relatively daily flow record at both gauging stations for duration of the Project.

APPENDIX D

FIELD EQUIPMENT SPECIFICATIONS

(Included as Attachments to the PDF Document)

ITEM NO.	DESCRIPTION	STACKED/QTY.
1	125mL/350mL SAMPLER BODY	1
2	LOWER RELEASE PIN (LONG)	1
3	RELEASE PIN LEVER	1
4	UPPER RELEASE PIN	1
5	4-40 SCREW (PLASTIC)	2
6	TWIST-ON CONNECTOR	2
7	125mL BOTTLE	1



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: 1° TWO PLACE DECIMAL ± 0.01 THREE PLACE DECIMAL ± 0.005		NAME	DATE
	DRAWN	MAB	01/02/13
	CHECKED		
	ENG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER: ASME Y14.5-2009	MFG APPR.		
	Q.A.		
MATERIAL	COMMENTS: 1in [25.4mm]		
FINISH			
DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL

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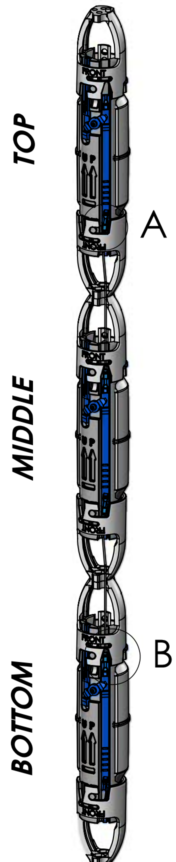
TITLE:
125mL SNAP SAMPLER

SIZE	PART NO.	REV
B		

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 2

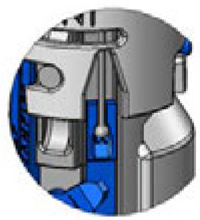
ITEM NO.	DESCRIPTION	QTY.
1	BALL END CONNECTOR (PLASTIC)	2
2	BALL END CONNECTOR (S.S.)	2
3	125mL SNAP SAMPLER	3
4	SCREW (PLASTIC)	4
5	HEX NUT (PLASTIC)	4



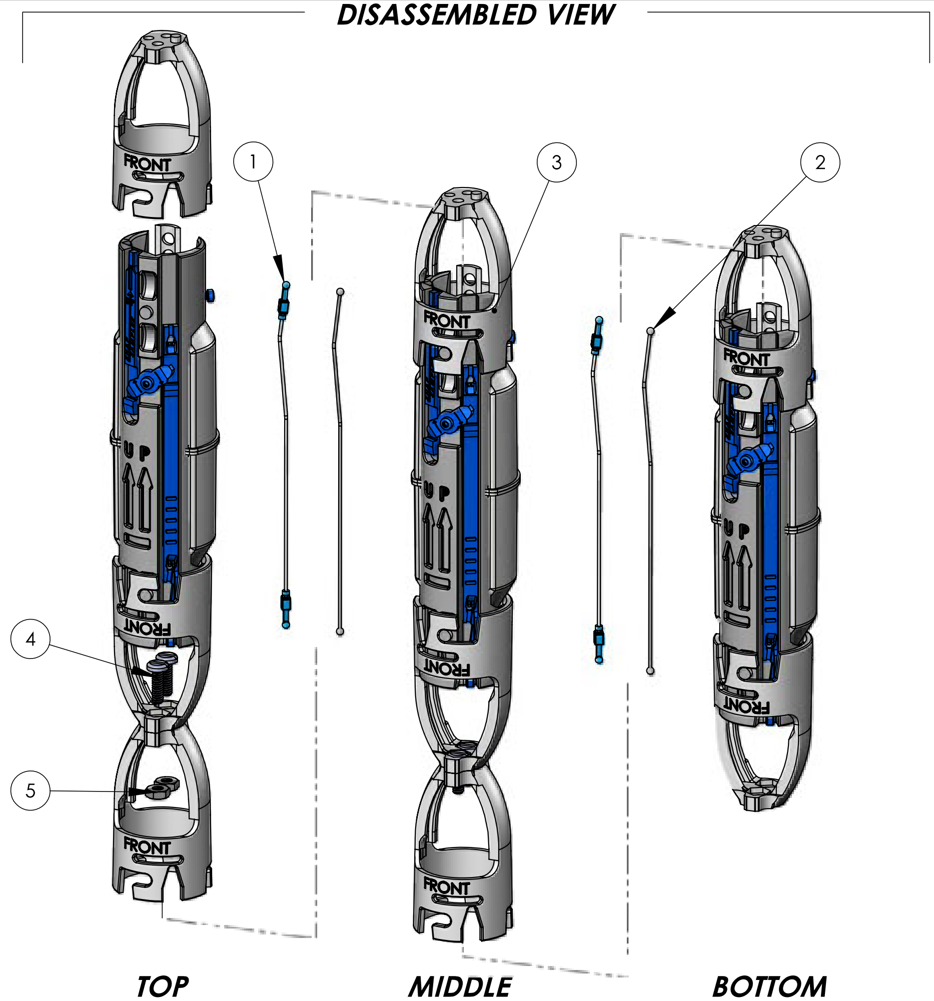
DETAIL A
PLASTIC CONNECTOR
CABLE INSERTION

DETAIL A'
S.S. CONNECTOR
CABLE INSERTION

DETAIL B
PLASTIC CONNECTOR
CABLE INSERTION



DETAIL B'
S.S. CONNECTOR
CABLE INSERTION



NOTE:

- 40mL AND 125mL SNAP SAMPLERS ARE INTERCHANGEABLE AND CAN BE ASSEMBLED IN ANY COMBINATION UP TO 6 IN SERIES.
- EITHER CABLE CONNECTOR(S) (PLASTIC OR STAINLESS STEEL) CAN BE USED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/16
ANGULAR: 1°
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ± 0.005
INTERPRET GEOMETRIC TOLERANCING PER:
ASME Y14.5-2009
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	MAB	01/02/13
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
1in
[25.4mm]

ProHydro, Inc.

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TITLE:
125mL SNAP SAMPLER

SIZE B | PART NO. | REV

SCALE: 1:2 | WEIGHT: | SHEET 2 OF 2

GO TO GEOTEC

geotech

Bladder Pump Controller

Geotech BP Controller 300/500 PSI

The simple-to-use Bladder Pump (BP) Controller (300 or 500 PSI) utilizes accurate microprocessor-controlled fill/discharge timers to sustain true low-flow sampling techniques. Both Controllers are equipped with high-pressure valves and fine resolution regulators that can perform in deep-well applications.

The Geotech BP Controller universally connects to any bladder pump system using simple quick-connect adapters.

FEATURES

- **Designed for durable, trouble-free operation**
- **High pressure operation for greater depths**
- **Multiple power input options**
- **Microprocessor controlled timers for accuracy**
- **Internal over-pressure protection**
- **Battery over-draw protection**
- **Water Level Meter compatibility for well draw-down**
- **Intuitive user controls and status indicator**
- **Accessories cavity for easy portability**
- **Included:** Air-In and Air-Out Hoses, AC Power Supply, DC Power Cord and Clip Adapter, Geotech Drawstring Bag, Carry Case

BP Controller 300 PSI with optional draw-down control for low-flow sampling

SPECIFICATIONS

	300 PSI	500 PSI
Performance		
Operating Depth	0-690 feet (210 m)	0 -1000 feet (0-305 m)
Input Air Pressure	Up to 300 psi (20.5 bar)	100 to 500 psi (34 bar)
FILL Timer Range	5 - 120 seconds	5 - 180 seconds
DISCHARGE Timer Range	5 - 120 seconds	5 - 180 seconds
Timer Resolution	2 seconds	2 seconds
Timer Accuracy	±2 seconds	±3 seconds
12V 8Ah Battery Life	1,300 cycles @ 30 sec. timers	50,000 cycles
Internal Battery/Life	External only	(2x) 9V/30,000 cycles
Environmental		
Operating Temperature	32°-158°F (0°-70°C)	32°-158°F (0°-70°C)
Storage Temperature	-40°-185°F (-20°-85°C)	-40°-185°F (-20°-85°C)
Physical		
Enclosure	7" x 16" x 12" (18 x 41 x 30.5 cm)	7" x 19" x 14" (18 x 48 x 35 cm)
Weight	15 lbs. (6.8 kg)	25 lbs. (11.4 kg)
Enclosure Material	Structural resin	Structural resin
Input Power		
External Battery	10.5-13.8V DC	10.5-26V DC
AC	90-240V AC*	90-240V AC*
Line Frequency	45-65 Hz	45-65 Hz
Maximum Power	15 Watts	15 Watts pulse for 50mS

*International AC Power Plug Adapters available (UK, AUS, EURO)

CE

Geotech BP Controller 500 PSI

Geotech BP Controller 300 PSI

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bp_controller.qxp 12/16/15

Levelogger® Edge

Model 3001

The Levelogger Edge records highly accurate groundwater and surface water level and temperature measurements. It combines a pressure sensor, temperature detector, 10-year lithium battery, and datalogger, sealed within a 7/8" x 6.25" (22 mm x 159 mm) stainless steel housing with Titanium based PVD coating.

The Levelogger Edge measures absolute pressure using a Hastelloy pressure sensor, offering excellent durability and reliability. Combined with the Titanium based PVD coating, both elements have high corrosion resistance in harsh environments, allowing stable readings in extreme pressure and temperature conditions. The Hastelloy sensor can withstand 2 times over-pressure without permanent damage.

The Levelogger Edge features a wide temperature compensated pressure range (0 to 50°C, -10 to 50°C for Barologger Edge), and rapid thermal response time. The Levelogger Edge has high resolution and an accuracy of 0.05% FS. The convenient Barologger Edge provides the easiest and most accurate method of barometric compensation.

Applications

- Aquifer characterization: pumping tests, slug tests, etc.
- Watershed, drainage basin and recharge monitoring
- Stream gauging, lake and reservoir management
- Harbour and tidal fluctuation measurement
- Wetlands and stormwater run-off monitoring
- Water supply and tank level measurement
- Mine water and landfill leachate management
- Long-term water level monitoring in wells, surface water bodies and seawater environments

Fast communication and downloading speeds with a high speed Optical Reader

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Features

- 0.05% FS Accuracy
- Corrosion resistant Titanium based PVD coating
- Robust Hastelloy pressure sensor
- Accurate temperature compensation
- Memory for up to 120,000 readings
- Basic and advanced data compensation options

The Levelogger Edge has a battery life of 10 years based on a 1-minute sampling rate. It has FRAM memory for 40,000 sets of data points – or up to 120,000 using the compressed linear sampling option.

The Levelogger Edge uses a Faraday cage design, which protects against power surges or electrical spikes caused by lightning. Its durable maintenance-free design, high accuracy and stability, make the Levelogger Edge the most reliable instrument for long-term, continuous water level recording.

Flexible Communication

Levelogger PC Software is streamlined, making it easy to program dataloggers, and to view and compensate data, in the office or in the field. The software has useful programming options, including compressed and repeat sampling, and future start/stop. Data compensation has been simplified, and allows multiple data files to be barometrically compensated at once.

The extremely intuitive Solinst Levelogger App, and Levelogger App Interface on your in-field Leveloggers, creates a Bluetooth® connection between your Leveloggers and smart device. Also an option, the DataGrabber is a field-ready, USB data transfer unit designed specifically for the Levelogger Series.

Remote monitoring options include the LevelSender, a simple and compact device that fits right in a 2" well, STS Telemetry Systems, and RRL Remote Radio Link. In addition, Levelogger Series dataloggers are SDI-12 compatible.

Levelogger Setup

Programming Leveloggers is extremely intuitive. Simply connect to a PC using an Optical Reader or PC Interface Cable. All in one screen fill in your project information and sampling regime. Templates of settings can be saved for easy re-use.

The Levelogger time may be synchronized to the computer clock. There are options for immediate start or future start and stop times. The percentage battery life remaining and the amount of free memory are indicated on the settings screen.

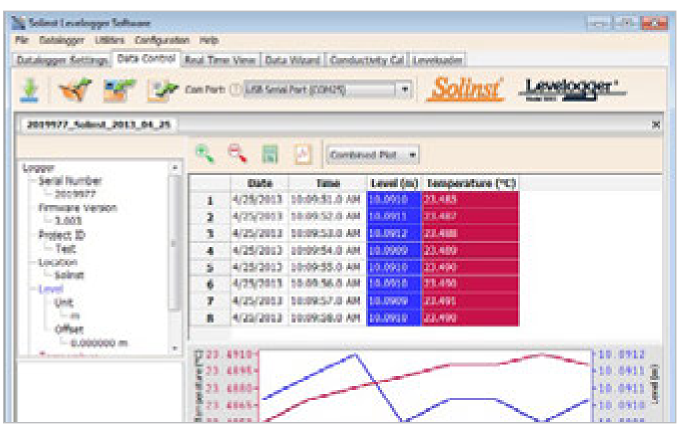
Leveloggers can also be programmed with a sampling regime and start/stop times using the Solinst Levelogger App on your smart device.

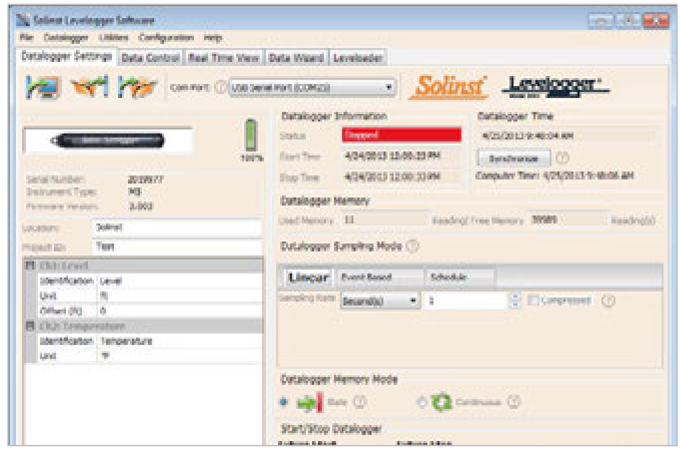
Convenient Sampling Options

Leveloggers can be programmed with linear, event-based, or a user-selectable sampling schedule. Linear sampling can be set from 1/8 second to 99 hours. The Levelogger Edge can be programmed with compressed linear sampling, which increases memory from 40,000 to up to 120,000 readings.

Event-based sampling can be set to record when the level changes by a selected threshold. Readings are checked at the selected time interval, but only recorded in memory if the condition has been met. A default reading is taken every 24 hours if no "event" occurs.

The Schedule option allows up to 30 schedule items, each with its own sampling rate and duration. For convenience, there is an option to automatically repeat the schedule.





Levelogger Edge Settings Software Windows

Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon. There are multiple options for downloading data, including 'Append Data' and 'All Data'. The software also allows immediate viewing of the data in graph or table format using the 'Real Time View' tab.

The level data is automatically compensated for temperature, and the temperature data is also downloaded. Barometric compensation of Levelogger data is performed using the Data Wizard, which can also be used to input manual data adjustments, elevation, offsets, density, and adjust for Barometric efficiency.

The software allows easy export of the data into a spreadsheet or database for further processing.

The Solinst Levelogger App also allows you to view and save real-time, or logged data right on your smart device.

Helpful Utilities

The 'Self-Test Diagnostic Utility' can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required.

A firmware upgrade will be available from time to time, to allow upgrading of the Levelogger Edge, as new features are added.

Solinst Levelogger App & Levelogger App Interface

The Levelogger App Interface uses Bluetooth® technology to connect your Levelogger to your smart device. With the Solinst Levelogger App, you can download data, view real-time data, and program your Leveloggers. Data can be e-mailed from your smart device directly to your office (see Model 3001 Levelogger App & Interface data sheets).

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Standard Cable Deployment

Leveloggers may be suspended on a stainless steel wireline or Kevlar® cord. This is a very inexpensive method of deployment, and if in a well, allows the Levelogger to be easily locked out of sight and inaccessible. Solinst offers stainless steel wireline assemblies and Kevlar cord assemblies in a variety of lengths.

Solinst 3001 Well Cap Assembly

The 2" Locking Well Caps are designed for both standard and Direct Read Cable deployment options.

The well cap has a convenient eyelet for suspending Leveloggers using wireline or Kevlar cord. The Well Cap insert has two openings to accommodate Direct Read Cables for both a Levelogger and Barologger. Adaptors are available to fit 4" wells.

The cap is vented to equalize atmospheric pressure in the well. It slips over the casing, and the cap can be secured using a lock with a 3/8" (9.5 mm) shackle diameter.

Levelogger 2" Locking Well Cap Installations (see Well Caps data sheet for more details)

Direct Read Cables

When it is desired to get real-time data and communicate with Leveloggers without removal from the water, they can be deployed using Direct Read Cables. This allows viewing of the data, downloading and/or programming in the field using a portable computer, DataGrabber, or the Solinst Levelogger App and Interface.

Leveloggers can also be connected to an SDI-12 datalogger using the Solinst SDI-12 Interface Cable attached to a Direct Read Cable.

Cable Specifications

Direct Read Cables are available for attachment to any Levelogger in lengths up to 1500 ft. The 1/8" dia. (3.175 mm) coaxial cable has an outer polyethylene (MDPE) jacket for strength and durability. The stranded stainless steel conductor gives non-stretch accuracy.

Barologger and Levelogger installed in Well Using Direct Read Cables

Accurate Barometric Compensation

The Levelogger Edge measures absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters, centimeters, psi, kPa, or bar.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger Edge, avoiding time lag in the compensation.

The Barologger is set above high water level in one location on site. One Barologger can be used to compensate all Leveloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

The Levelogger Software Data Compensation Wizard automatically produces compensated data files using the synchronized data files from the Barologger and Leveloggers on site.

The Barologger Edge uses pressure algorithms based on air rather than water pressure, giving superior accuracy.

The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Barologger Edge records atmospheric pressure in psi, kPa, or mbar. When compensating submerged Levelogger Edge, Gold or Junior data, Levelogger Software Version 4 can recognize the type of Levelogger and compensate using the same units found in the submerged data file (Levelogger Gold and Junior measure in feet, meters, or centimeters). This makes the Barologger Edge backwards compatible.

Synchronize & Streamline Your Barometric Compensation Efforts, Across Your Entire Site

® Kevlar is a registered trademark of DuPont Corp.

Levelogger Edge Specifications

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy:	± 0.05% FS (Barologger Edge: ± 0.05 kPa)
Stability of Readings:	Superior, low noise
Units of Measure:	m, cm, ft., psi, kPa, bar, °C. °F (Barologger Edge: psi, kPa, mbar, °C, °F)
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0° to 50°C (Barologger Edge: -10 to +50°C)
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
Battery Life:	10 Years - based on 1 reading/minute
Clock Accuracy:	± 1 minute/year (-20°C to 80°C)
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	40,000 readings FRAM memory, or up to 120,000 using linear data compression
Memory Mode:	Slate and Continuous
Communication:	Optical Infrared Interface. Conversion to RS-232, USB, SDI-12. Serial at 9600 bps, 38,400 bps with USB
Size:	7/8" x 6.25" (22 mm x 159 mm)
Weight:	4.6 oz. (129 grams)
Corrosion Resistance:	Titanium based PVD coating
Other Wetted Materials:	Delrin®, Viton®, 316L stainless steel, Hastelloy, Titanium based PVD coating
Sampling Modes:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	1/8 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius)

Models	Full Scale (FS)	Accuracy
Barologger	Air only	± 0.05 kPa
M5	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)
M10	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)
M20	20 m (65.6 ft.)	± 1 cm (0.032 ft.)
M30	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)
M100	100 m (328.1 ft.)	± 5 cm (0.164 ft.)
M200	200 m (656.2 ft.)	± 10 cm (0.328 ft.)

Low Cost Datalogging: See Levelogger Junior Edge Data Sheet.
Vented Dataloggers: See LevelVent and AquaVent Data Sheets.
Conductivity Datalogging: See LTC Levelogger Edge Data Sheet

DataGrabber™

The DataGrabber is a field-ready data transfer device that allows you to copy data from a Levelogger, onto a USB flash drive key.

The DataGrabber is compact and very easy to transport. It connects to the top end of a Levelogger's Direct Read Cable, or an Adaptor is available to allow direct connection to a Levelogger.

One push-button is used to download all of the data in a Levelogger's memory to a USB device plugged into the DataGrabber. A convenient LED light indicates the operation of the DataGrabber. The data in the Levelogger memory is not erased, and logging is not interrupted if the Levelogger is still running. The DataGrabber uses its own replaceable 9V battery.

LevelSender Telemetry

The LevelSender is a simple, low cost telemetry system designed to send data from Leveloggers in the field, to your smart device and PC database via cellular communication.

Initial set up is done through a user-friendly software wizard at the Home Station. There is two-way communication between the LevelSender and Home Station, allowing remote updates.

Each LevelSender device has a single port to connect one Levelogger with an optional splitter that allows the connection of a Barologger.

LevelSender stations are compact in design, which allows them to be discreetly installed inside a 2" (50 mm) well (see Model 9500 data sheet).

STS Telemetry

The STS Telemetry System provides an efficient method to send Levelogger data from the field to your desktop. Cellular communication options give the flexibility to suit any project. STS Systems are designed to save costs by enabling the self-management of data. Alarm notification, remote firmware upgrades and diagnostic reporting make system maintenance simple (see Model 9100/9200 data sheet).

RRL Telemetry

The RRL Remote Radio Link is ideal for short range applications up to 20 miles or 30 km; distances can be increased by using radios as relay stations. Ideal for creating closed-loop monitoring networks using Leveloggers (see Model 9100/9200 data sheet).

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Overview

Includes flowcell, 3/8 inch and 1/4 inch fittings, lubricant and instructions.

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GO TO GEOTEC

Bladder Pumps, Groundwater Sampling

Geotech Bladder Pumps

Together with the USGS, Geotech designed the original bladder pump for groundwater quality and pollution monitoring. Geotech Bladder Pumps can pump from as deep as 1000 feet (305 meters) with minimal agitation for the best representative samples.

FEATURES

- **True low flow capability for less agitation**
- **Proprietary resin grade virgin PTFE bladder for long life**
- **Constructed of #316 SS for durability**
- **Dedicated or portable turnkey systems**
- **Robust screened intake extends bladder life**
- **Optional Drop-Tube assembly available for sampling from greater depths**
- **Limited lifetime warranty on dedicated stainless steel systems**
- **Compatible with the Geocontrol PRO and BP Controller units**

BLADDER PUMP MODELS

A. 1.66, 36" (4 cm, 91 cm)
Made from SS for maximum durability. Highest volume rate for a low flow pump. For 2" (5 cm) wells or larger. Available in High Pressure and Low Pressure models to meet site specic requirements.

B. 1.66, 18" (4 cm, 46 cm)
The same as above but for lower pump volume requirements.

C. .850, 18" (2.2 cm, 46 cm)
Made from high-grade SS for maximum durability.
Extra slim design provides excellent performance for its size.

D. .675, 18" (1.7 cm, 46 cm)
Our smallest bladder pump, fits in any well .75" (1.9 cm) or larger. Made with the same polished stainless steel as our other top-of-the-line pumps.

A. B. C. D.

SPECIFICATIONS

	1.66, 36"	1.66, 18"	.850, 18"	.675, 18"
Pump Housing	316 SS	316 SS	316 SS	316 SS
Bladder Material	Virgin PTFE	Virgin PTFE	Virgin PTFE	Virgin PTFE
O.D.	1.66" (4.2 cm)	1.66" (4.2 cm)	.850" (2.2 cm)	.675" (1.7 cm)
Length w/Screen	38" (96.5 cm)	20" (51 cm)	18 5/8" (47.3 cm)	18 3/4" (47.6 cm)
Weight	5.5 lbs. (2.5 kg)	3.5 lbs. (1.6 kg)	1.1 lbs. (.5 kg)	.83 lbs. (.4 kg)
Volume / Cycle	22 oz. (650 ml)	11 oz. (325 ml)	.9 oz. (29 ml)	.5 oz. (15 ml)
Min. Well I.D.	2" (50 mm)	2" (50 mm)	1.00" (2.5 mm)	.75" (1.9 mm)
Operating Pressure				
Low Pressure BP:	10-125 psi (.7-8.6 bar)	10-125 psi (.7-8.6 bar)	100 psi (6.9 bar)	100 psi (6.9 bar)
High Pressure BP:	10-500 psi (.7-34 bar)	10-500 psi (.7-34 bar)	N/A	N/A
Min. Operating Pressure	5 psi (.34 bar) ash*	5 psi (.34 bar) ash*	5 psi (.3 bar) ash*	5 psi (.3 bar) ash*
Maximum Depth				
Low Pressure BP:	290' (88 m)	290' (88 m)	200' (61 m)	200' (61 m)
High Pressure BP:	1000' (305 m)	1000' (305 m)	N/A	N/A
Air Line (ID x OD)				
Low Pressure BP:	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)
High Pressure BP:	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	N/A	N/A
Discharge Line (ID x OD)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)

*ash = above static head

CALL GEOTECH TODAY (800) 833-7958

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue • Denver, Colorado 80205
(303) 320-4764 • **(800) 833-7958** • FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

BP Controller
300 PSI

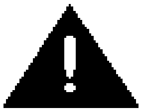
Installation and Operation Manual

Rev 1/21/2017 Part # 11150362

Table of Contents

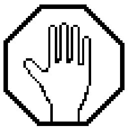
DOCUMENTATION CONVENTIONS

This document uses the following conventions to present information:



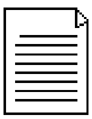
WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

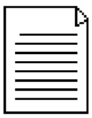


NOTE

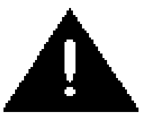
A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

In order to ensure that your Controller has a long service life and operates properly, adhere to the cautions below and read this manual before use.

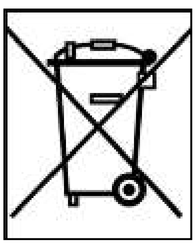
- Disconnect from power source when not in use.
- Controller power input source must not exceed maximum ratings.
- Controller must be wired to a negative ground system.
- Controller may not operate properly with excess wiring not supplied by manufacturer.
- Avoid spraying fluid directly at controller.
- Never submerge controller.
- Avoid pulling on wires to unplug controller wiring.
- Avoid using controller with obvious physical damage.
- To prevent controller damage, avoid dropping controller.



The BP Controller 300PSI cannot be made dangerous or unsafe because of failure due to EMC interference.



Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.



Notice for consumers in Europe:
This symbol indicates that this product is to be collected separately.

The following apply only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.

For more information, contact the seller or the local authorities in charge of waste management.

Section 1: System Description

Function and Theory

The Bladder Pump (BP) Controller 300 PSI is a high-pressure pump controller that uses advanced electronic logic to control gentle low-flow sampling. Equipped with a high-pressure solenoid activated valve and self-relieving regulator, the BP Controller can purge depths down to 690’ (210m).

This controller connects to any Bladder Pump (BP) system with the use of simple push-to-connect hose adapters. The two timers are adjusted to set the amount of time that the pump pressurizes (discharge cycle) and depressurizes (fill cycle). During the discharge cycle, the pump pressurizes squeezes the bladder, forcing the sample through the center discharge line. During the fill cycle, the compressed pump now exhausts through the controller vent allowing the pump to fill again, hydrostatically.

A user-friendly interface visually communicates operating status of the controller, as well as informing the user of low battery conditions. The BP Controller is compatible with Water Level Meter equipment by connecting a drawdown cable.

System Components

The control panel is mounted inside a heavy-duty case for ease of mobility and long-term durability. Accessories for the BP Controller consist of high-pressure AIR IN (from supply) and AIR OUT (to pump) hoses, and an AC and DC Power Cord.

Air Connections

The couplings on the AIR IN and AIR OUT Hose Assembilies are Push-to-Connect fittings; press the socket onto the plug until a ‘click’ is heard. It should be a secure fit which can not be pulled off when tugged. To remove the coupling, push down on the socket’s jacket and the connection will ‘pop’ out (see Figure 1-1).

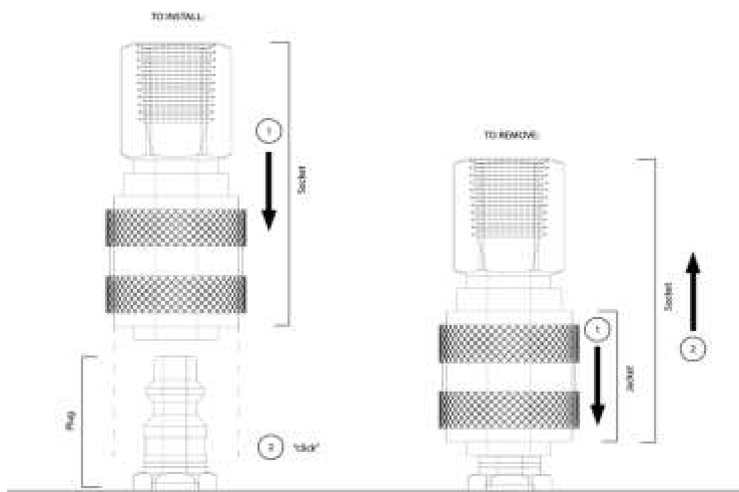
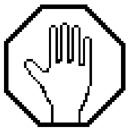


Figure 1-1: Push-to-Connect fitting

Section 2: System Installation



The BP Controller requires dry, moisture free air.
Disregarding this caution can increase the likelihood of unnecessary maintenance.

Power Source

Determine your power source, either 115 VAC or 12 VDC. Power connects are on the side of the control panel.

If using Water Level Meter Equipment, connect a drawdown cable to the ‘AUX INPUT’.

Selecting an Air Source

Air consumption depends on the volume of tubing and the size of deployed Bladder Pump. Follow the general guidelines and examples below to calculate the air consumption for specific sampling configurations.

Volume of Tubing

	TUBING LENGTH				
TUBE I.D.	1 ft./ 0.3 m	10 ft./ 3 m	50 ft./ 15 m	100 ft./ 30 m	690 ft./ 210 m
0.17 in/ 0.43 cm	0.3 in^3/ 5 cm^3	3 in^3/ 50 cm^3	15 in^3/ 246 cm^3	30 in^3/ 492 cm^3	207 in^3/ 3392 cm^3
0.25 in/ 0.64 cm	0.6 in^3/ 10 cm^3	6 in^3/ 100 cm^3	30 in^3/ 492 cm^3	60 in^3/ 984 cm^3	414 in^3/ 6784 cm^3
0.5 in/ 1.2 cm	2.4 in^3/ 39 cm^3	24 in^3/ 393 cm^3	120 in^3/ 1967 cm^3	240 in^3/ 3933 cm^3	1656 in^3/ 27137 cm^3

Volume of Bladder Pumps

1.66 BP LENGTH	VOLUME
18 in/ 46 cm	39 in^3/ 640 cm^3
36 in/ 91 cm	78 in^3/ 1278 cm^3

Calculation guideline:

Volume of Tubing (in^3/cm)
+ Volume of Bladder Pump (in^3/cm^3)
= Air Consumption per cycle (in^3/cm^3)

Example (use metric units when applicable):

When using an 18” bladder pump and 0.17” I.D. tubing, what size compressor is recommended to purge a sample 200’ deep?

Step 1: Determine air consumption per cycle.
In this case the 1.66 BP 18” pump is used with 200’ of 0.17” I.D. tubing.

Volume of tubing = 30 in^3 * 2 = **60 in^3**
Volume of pump = **39 in^3**
Total air consumption per cycle = 60 in^3 + 39 in^3 = **99 in^3**

Step 2: Determine air consumption per hour.
Assuming the pump cycles no more than 6 times per minute, we can estimate maximum air consumption per hour.

99 in^3/cycle * 6 cycles/min * 60min/hour = **35,640 in^3/hour** or 21 ft^3/hour

When using an air compressor use one reserve tank to ensure proper air supply to the pump. When using a Nitrogen Tank, see Figure 2-1 for Nitrogen Tank Volume vs. Bladder Pump consumption.

Determining PSI

Determine the air pressure needed to operate the Bladder Pump based on the length of the air supply line to the pump (well depth).
Use this simplified formula:

0.5 PSI (per foot) + 10 PSI (to account for tubing friction) = required PSI
0.12 bar (per meter) + 0.7 bar (to account for tubing friction) = required bar

Example (use metric units when applicable:

For a pump 400’ away from the air source

(400’ * 0.5 PSI) + 10 = **210 PSI**

As mentioned above, the additional 10 PSI (0.7 bar) is to account for the pump itself and friction loss along the airline tubing. When the length of the airline is 50’ (15m) or less, there is no need for the additional pressure.

To determine minimum operating pressures for the specific Bladder Pump model you are using, consult the pump’s specifications. Typically, the minimum operating pressure will be 5 PSI (0.4 bar) above static head.

The formulas stated above are not absolute, and are meant to provide baseline information.

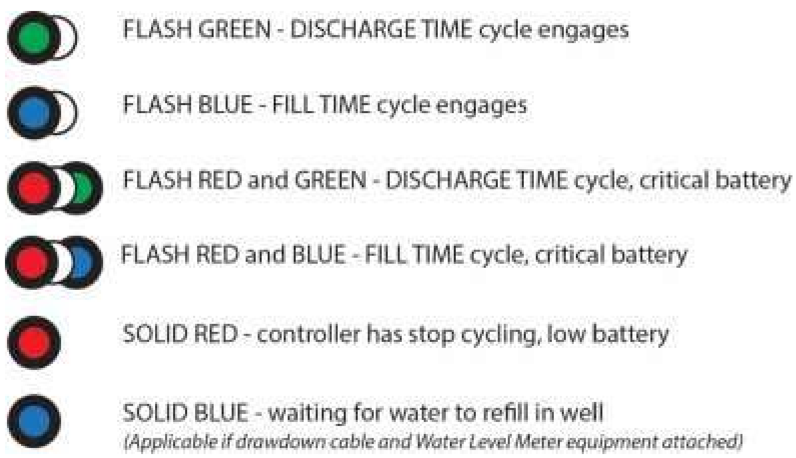
General Operating Definitions

The BP Controller interface utilizes ‘FILL TIME’ and ‘DISCHARGE TIME’ to identify the alternating timed air cycles. The ‘STATUS’ light will indicate the current cycle or error code.

FILL TIME – During this cycle, the controller is exhausting compressed air from the BP system (tubing and pump) to allow hydrostatic fill of liquid within the pump.

DISCHARGE TIME – During this cycle, the controller is routing compressed air into the BP and squeezing the flexible bladder, which then displaces liquid up the discharge line.

STATUS – The LED on the control panel will visually communicate the status of the sampling system:



Battery Overdraw Protection

The controller is designed to stop cycling if there is a potential for battery overdraw, as an overdrawn battery cannot be recharged and reused.

- A flashing red LED will indicate that your power source is in a critically low condition.
- A solid red LED will indicate that the controller has stop cycling to help protect against battery overdraw.

Operating Battery Voltage	11.7V to 14V
Critically Low Battery Voltage	11V to 11.6V
Low Battery Voltage	below 11V
*Recharge Voltage required to re-engage	12.8V

**If the controller’s power source is connected to a solar panel for battery recharge, the battery will have to be recharged to 12.8V or above before the controller will continue cycling.*

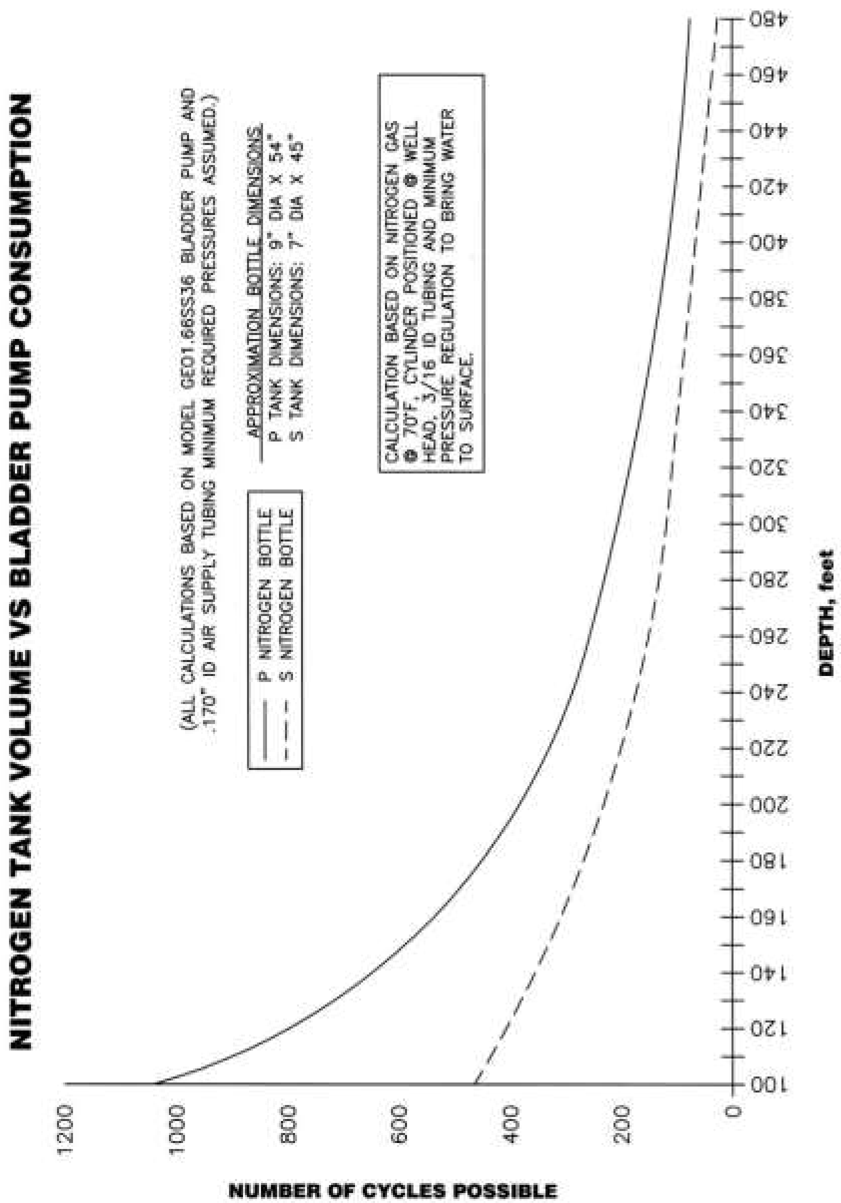


Figure 2-1: Nitrogen tank volume vs. Bladder Pump consumption

Section 3: System Operation

The BP Controller 300 PSI has a *Normally Closed* valve. Therefore, if power is disconnected from the unit, the controller will automatically stop the flow of air. This helps to protect the integrity of the bladder and protects against draining the air source.

Quick Start Guide

1. Connect Power Supply to side of controller (see *Section 2* ‘Power Source’).

2. Connect drawdown cable to Water Level Meter equipment (if applicable).

3. Set FILL TIME and DISCHARGE TIME knobs to approximately 30 seconds.
   - *A low cycle time limits the amount of initial pressurized air entering the pump, so as not to collapse the bladder.*

4. Flip BP Controller power switch to the ON position.
   - *After about 30 seconds, there should be* a distinct ‘click’ when the solenoid *valve shifts.*
   - *If the controller only cycles once and then displays a red light, there is not sufficient power from the battery. See* Section 5: System Troubleshooting *for more information.*

5. Connect ‘AIR OUT’ hose socket to the ‘AIR OUT’ plug on the control panel (1/4” coupling size). Connect the other end of the ‘AIR OUT’ hose to the pump airline on the wellhead (1/4” quick-connect fitting).
   See Section 1 ‘System Components’ *for details on the air connection couplings.*

6. Connect the unpressurized ‘AIR IN’ hose socket to the ‘AIR IN’ plus on the control panel (3/8” coupling size). Connect the other end of the ‘AIR IN’ hose to the regulated air supply (compressor, bottle, tank, etc.)

The controller has an imbedded safety relief valve, which will exhaust compressed air that enters the system in excess of 350PSI (24 bar). To reset the relief valve and allow air through the controller, incoming air must be regulated to 300PSI (20.7 bar) or below.

7. Adjust the air source to the appropriate PSI (MAXIMUM: 300PSI/20.7 bar). See ‘Determining PSI’ in *Section 2*).

8. Adjust the FILL TIME and DISCHARGE TIME based on pump and well specifications (see ‘Adjusting Cycle Timers’ in *Section 3* for guidelines).
   a. Let controller cycle until fluid starts pumping from discharge tubing.
   b. Adjust DISCHARGE TIME so that the air supply turns off when fluid stops flowing from tubing.
   c. Adjust FILL TIME to desired setting that allows pump to hydrostatically fill.

9. When pumping is complete, turn off air supply (exhaust excess air if applicable) and flip BP Controller power switch to the OFF position.

10. Use caution when disconnecting hoses, as the system may be slightly pressurized. Hoses and power adapters are stored in the accessory bag.

Water Level Meter Compatibility

A connected Water Level Meter is used to control drawdown in the well, and when installed correctly will cause the BP Controller to cycle only when the Water Level Meter probe is submerged. The probe should be positioned at or above the pump's head.

The Water Level Meter with drawdown feature connects to the BP Controller through the "AUX INPUT" terminal.

Once connected, the probe of the Water Level Meter must be submerged in water to initiate the drawdown logic. If the Water Level Meter is accidently disconnected, the BP Controller will enter a "Waiting for Water" status.

The BP Controller must be power cycled to exit Water Level Meter mode.

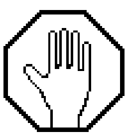
Follow the Water Level Meter's Installation and Operation Manual for additional information.

Adjusting Cycle Timers

The FILL TIME and DISCHARGE TIME knobs have a large diameter for maximum resolution. The timers have a range from 5-120 seconds.

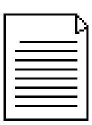
Adjust DISCHARGE TIME knob to approximately 10 seconds, and adjust FILL TIME knob to approximately 30 seconds. A 30 second exhaust cycle (FILL TIME) will be enough time to hydrostatically fill a bladder at approximately 100' (30.5m) deep.

The DISCHARGE TIME cycle can be adjusted by watching the sample line. When a steady stream of water stops during the cycle (STATUS light = green), set the DISCHARGE TIME back about five seconds.



DO NOT OVER PRESSURIZE (EXCESS DISCHARGE TIME) as this will cause excessive bladder wear.

Once the DISCHARGE TIME is adjusted, measure the volume of the sample and adjust the FILL TIME back about one second. Let the pump cycle a few times after each modification before adjusting again. Measure the volume of sample to make sure it is not decreasing. Continue to reduce the FILL TIME until the sample volume decreases. A decrease in sample volume indicates that the exhaust cycle (FILL TIME) is not long enough for the pump bladder to fill to its maximum capacity. Add one second to the FILL TIME at this point to make sure the maximum volume in the bladder is achieved.



Discharge and Fill times will vary depending on the depth of well and size of airline tubing. It may take a few cycles to see fluid as the pump fills the discharge tubing incrementally.

The following Fill cycle time guidelines are based on a 0.5” (1.3 cm) I.D. airline tube:

TYPE	DEPTH	DISCHARGE TIME
Standard Sampling	up to 172’ / 52m	0-30 seconds
Deep Well Sampling	up to 345’/ 105m	0-60 seconds
Max. Depth Sampling	up to 690’/ 210m	0-120 seconds

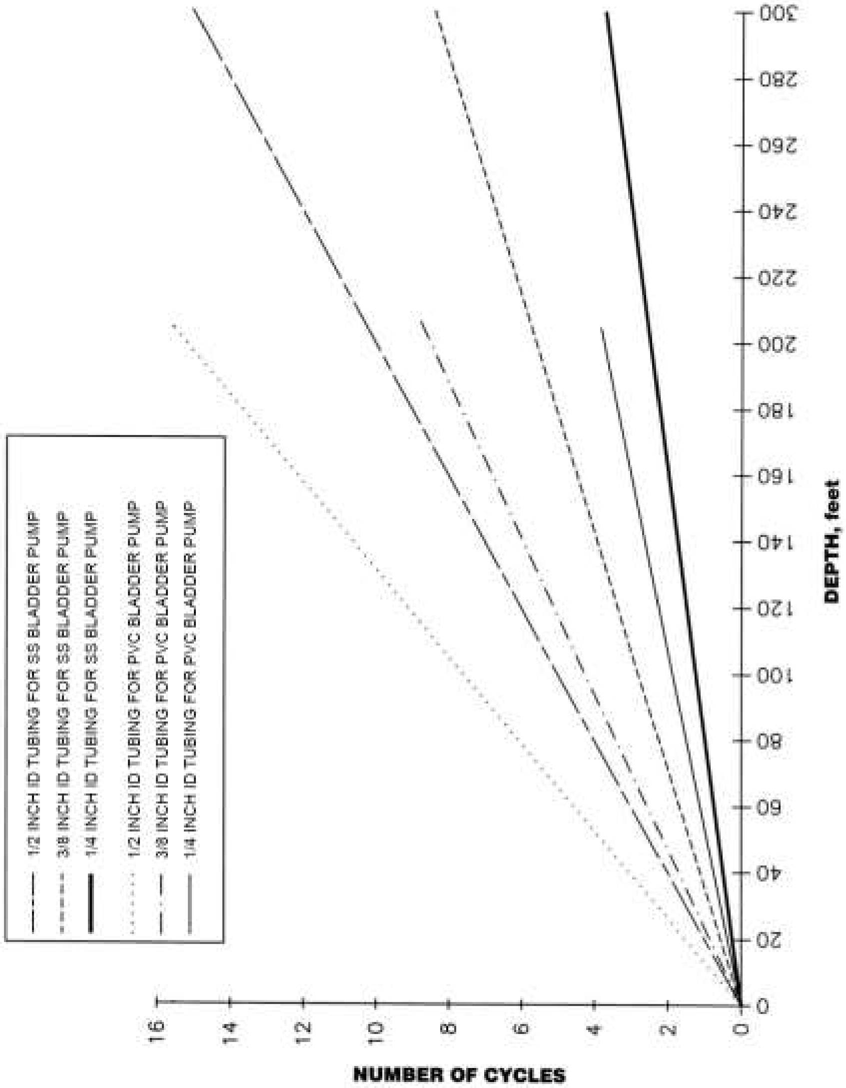


Figure 3-2: Cycles vs. Depth

Section 4: System Maintenance

The BP Controller does not require a regular maintenance program; however, proper care will ensure reliability.

As stated in installation and operation, this unit requires dry, moisture-free air. To disregard will increase the likelihood of unnecessary maintenance or hardware replacement.

To keep your BP Controller reliable, follow these simple guidelines:

- Do not drop your BP Controller.
- Do not immerse your BP Controller.
- Do not subject your BP Controller to poor power supplies.
- Do not subject your BP Controller to extreme heat or cold when in use.

Controller

Keep your BP Controller clean and dry. In the event that the controller is subjected to significant splashing or immersion, discontinue use and wipe the unit down immediately with a clean dry cloth.

Let the controller dry out in between uses by opening the heavy-duty case. When closed the heavy-duty case has a waterproof seal and will trap in unattended water.

Power Cords

Always replace a kinked or damaged power cord.

Air Connections

When build up is present, clean the AIR IN and AIR OUT coupling connections using a phosphate-free cleaning detergent and water solution.

Solenoid

Qualified personnel may clean the solenoid. The following procedure outlines how to disassemble and clean a stuck solenoid piston:

1) Remove power source and all air connections.
2) Remove the four (4) scews holding the control panel faceplate to the heavy-duty case.
3) Lift the control panel faceplate from the heavy-duty case and turn it over to expose controller components.

4) Locate the solenoid. See Figure 4-1.

Figure 4-1: Solenoid

5) Using a 3/32 Alan Wrench, remove the two retaining screws on the solenoid faceplate.

6) Remove the spring, bushing, and piston.

Figure 4-2: Removing Solenoid Parts

Figure 4-3: Solenoid Parts

7) Clean the piston and piston cavity with a lint-free cloth.

8) Lubricate the piston using a silicon based or aerosol lubricant.
Do not over lubricate.

9) Using the end of a cotton swab, (or a thin, solid object) push the pin on the inside of the piston cavity to ensure the pin functions.

10) On the coil side of the solenoid, verify that the piston will easily move by depressing the silver button on the end of the solenoid.
    Repeat 2-3 times to ensure the button functions.

Figure 4-4: Silver button on solenoid

11) Reassemble the solenoid by inserting the piston, bushing, and spring.

12) Compress the spring with the solenoid faceplate and refasten the two retaining screws.

13) Reattach the control panel faceplate to the heavy-duty case.

14) Reconnect the power and airlines. Resume operation.

Section 5: System Troubleshooting

Problem: Unit will not turn on.

Solution:
- Check power source and cables for damage.
- If using a battery, see Section 2, 'Battery Overdraw Protection'.
- If using DC, verify that you have a 12 VDC power source. If on AC, verify that you are getting a consistent 115 VAC current.

Problem: Unit turns on but cycles rapidly, no pumping.

Solution:

- Discharge and Fill times not set correctly.
- Check and adjust Discharge and Fill cycle times (i.e., if discharge time too long and fill time too short, or discharge time too short). Review *Section 3*: *System Operation* for correct cycle times.

Problem: Turns on, cycles correctly but does not pump water.

Solutions:

- Check for tubing kinks.
- Pressure may be too low, check the gauge. Calculate based on 0.5 PSI per foot (.1 bar per meter) of head and add 10 PSI (.7 bar) for friction.
- Increase FILL TIME. The pump needs to depressurize to allow pump to fill.
- Solenoid may have moisture or debris build-up. See *Section 4: System Maintenance.*

Problem: Unit was working, but stopped cycling.

Solutions:

- Check power source.
- If using a battery, see *Section 2,* 'Battery Overdraw Protection'.
- If power source is good, check air source.
- Ensure the air source is using clean, dry air.

For further assistance contact Geotech at 1-800-833-7958.

Section 6: System Specifications

Model: BP Controller, 300 PSI

Maximum Ratings

Input DC Power Source	0.5-13.8 VDC
DC Current Draw	0.5 Amps
DC Input Surge Current	<50 Amps
Input AC Power Source	105-130 VAC
AC Current Draw	0.1 Amps
AC Input Surge Current	<15 Amps
Input AC Line Frequency	45-65 Hz
Maximum Power	15 Watts

Performance

Operating Air Pressure	10 - 300 PSI (20.5 bar)
Max. Air Input	350 PSI (24 bar)
Operating Depth	0-690' (0-210m)
DISCHARGE Timer Range	10 to 120 seconds
FILL Timer Range	10 to 120 seconds
Minimum Timer Value	*5 seconds (Discharge & Fill)
Timer Resolution	1 second, between 10 – 120 seconds
Timer Accuracy	± 2 seconds

*5 second minimum timer value with timer dial set between 0 and 10 seconds.

Battery Performance

12V 8AH Battery Life	1300 cycles, 20 Hours @ 30 sec FILL & DISCHARGE timers (70°F)

Environmental

Operating Temperature Range	32° – 158°F (0-70º C)
Storage Temperature Range	-4° – 185°F (-20° to 85º C)
Position Effect	0.10% change at any angle
Vibration	No change after 10G RMS 20 to 2000 Hz
Shock	No change after 50Gs for 11minutes
EMI Emissions	Class A

Physical

Enclosure	7" x 16" x 12" (18cm x 41cm x 30.5cm)
Enclosure Material	Structural resin
Weight	15 lbs (6.8 kg)

Section 7: System Schematics

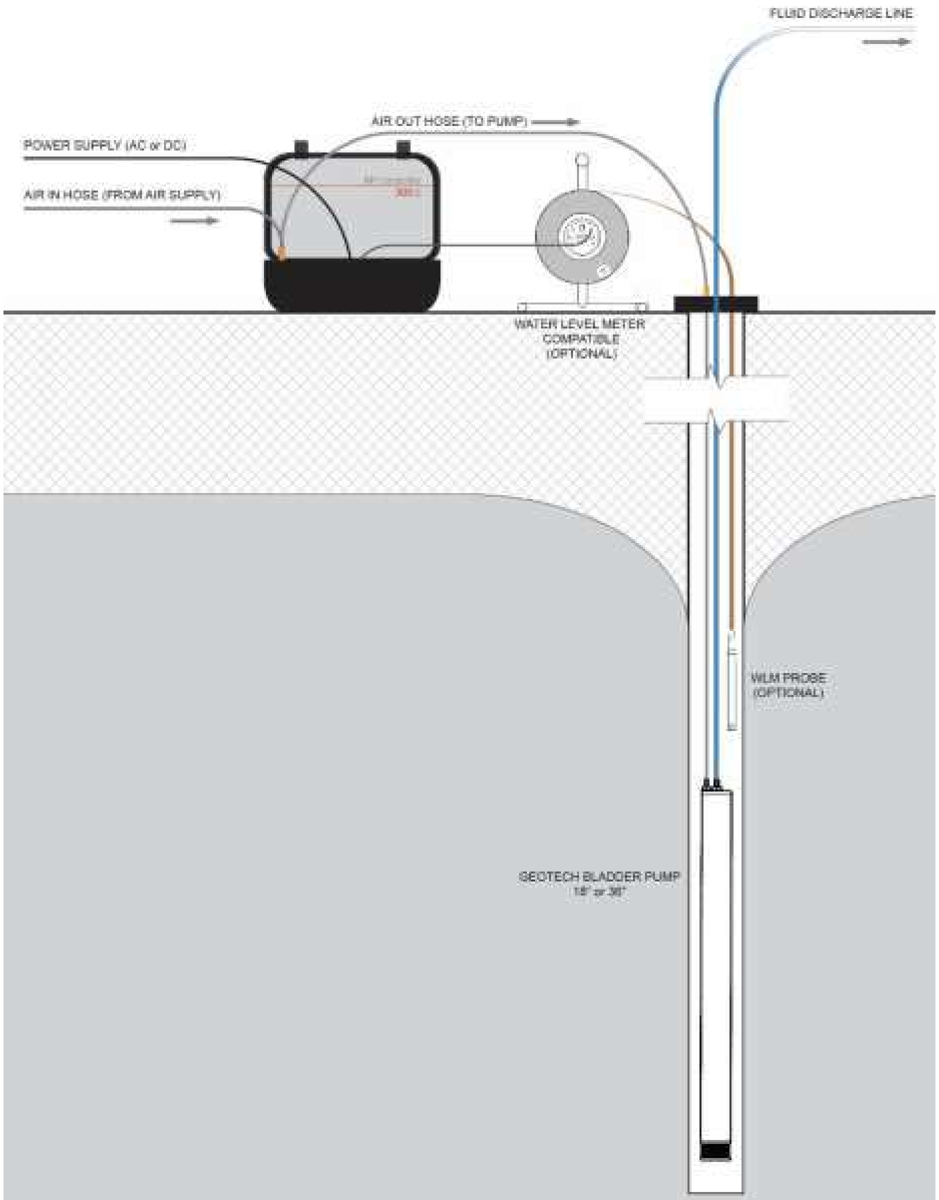


Figure 7-1: Site Schematic

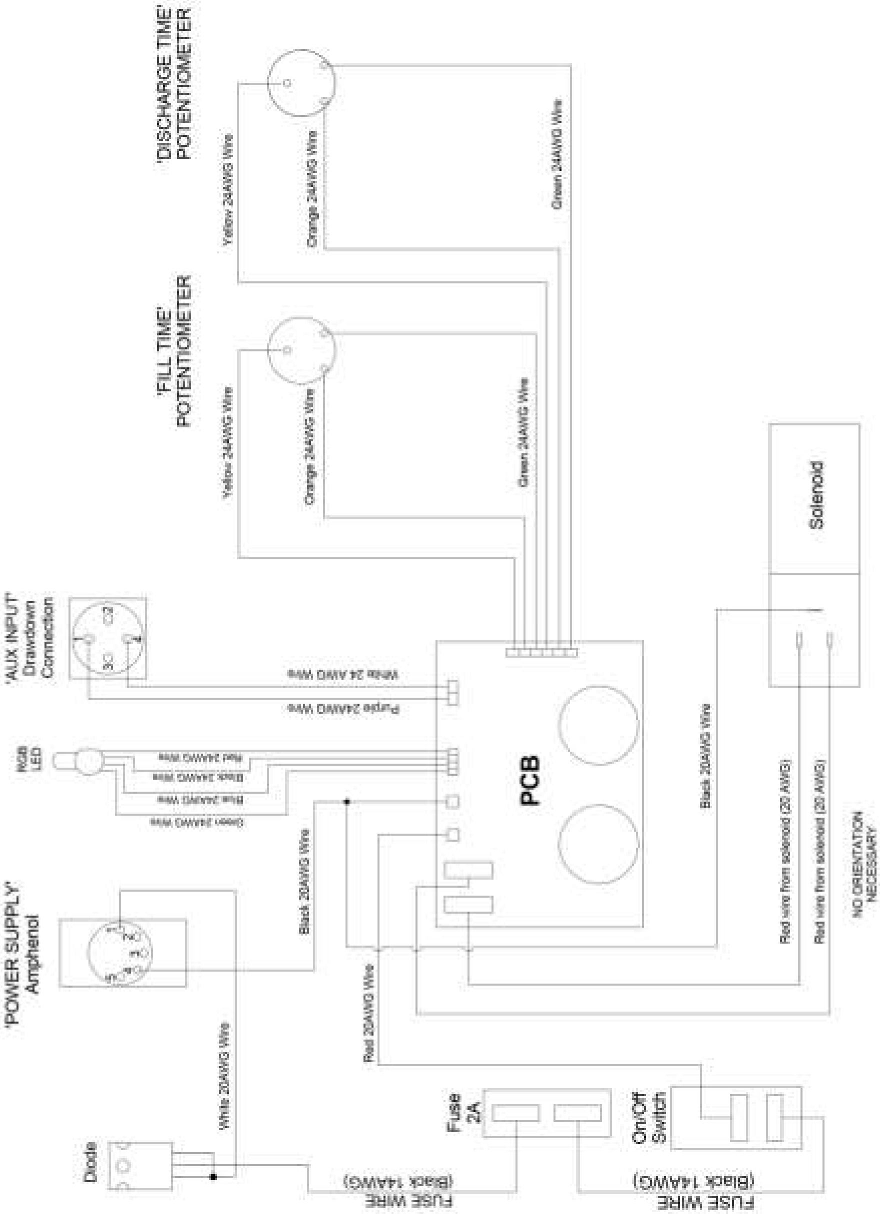


Figure 7-2: Wiring Diagram

Section 8: Parts and Accessories

<u>**Part Number**</u>	<u>**Part Description**</u>

Main Components

81150042	BP, CONTROLLER, 300PSI, CE
51150064	ASSY, POWER SUPPLY, BP CONTR, CE BP CONTROLLER 300PSI
57500008	ASSY, POWER CORD, DC W/ AMP
51150074	ASSY, HOSE, AIR IN, BP CONTROLLER 300PSI
51150075	ASSY, HOSE, AIR OUT, BP CONTROLLER 300PSI
11150362	MANUAL, BP CONTROLLER, 300PSI, CE
11150360	FUSE, 2A/32V, BLADE
51150076	ASSY, PCB, BP CONTROLLER 300PSI, POTTED
51150134	BAG, ACCESSORY, BPC

Power Cord Adapters

11150367	AC ADAPTER, PLUG-IN, US, 15W/30W
11150368	AC ADAPTER, PLUG-IN, EURO, 15W/30W
11150369	AC ADAPTER, PLUG-IN, UK, 15W/30W
11150370	AC ADAPTER, PLUG-IN, AUS, 15W/30W

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Initial Release	9/12/13
-	Updated Wiring Diagram – SP	10/9/13
-	Added to Section 6: Battery Life Information - SP	10/30/13
-	Updated Section 8: Parts & Accessories descriptions to match sales database – SP	11/18/13
-	Updated wiring diagram, add header to EC Declaration of Conformity – SP	1/22/14
Project 1392	Added metric where missing, added NC information, edited timer specifications, updated wiring diagram – SP	4/2/14
-	Updated back page info & EC Declaration of Conformity, SP	1/13/14
2005	Instruction steps for maintaining solenoid, minor style edits, SR	11/21/16

NOTES

NOTES

NOTES

EC Declaration of Conformity

Manufacturer:

Geotech Environmental Equipment, Inc.
2650 E 40th Avenue
Denver, CO 80205

Declares that the following products,

Product Name: BP (Bladder Pump) Controller 300PSI

Model(s): 81150042

Year of manufacture: 2013

Conform to the principle safety objectives of 2006/95/EC Low Voltage Directive (LVD) by application of the following standards:

EN 61010-1: 2010

Year of affixation of the CE Marking: 2013

Conform to the protection requirements of 2004/108/EC Electromagnetic Compatibility (EMC) by application of the following standards:

EN 61000-6-1: 2007
EN 61000-6-3: 2012
EN 61326-1: 2013, emissions Class A

EMC conformity established 09/01/2013.

Production control follows the ISO 9001:2008 regulations and includes required safety routine tests.

This declaration issued under the sole responsibility of Geotech Environmental Equipment, Inc.

Joseph Leonard

Joe Leonard
Product Development

Serial number ________________

The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: ________________

Serial Number: ________________

Date of Purchase: ________________

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

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Printed in the United States of America

Portable Turbidity Meter

Installation and Operation Manual

Rev 06/15/2017 Part # 22100045

Table of Contents

DOCUMENTATION CONVENTIONS

This uses the following conventions to present information:

WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.

CAUTION

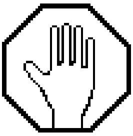
A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

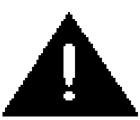
General Information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.



In order to ensure your Turbidity Meter has a long service life and operates properly, adhere to the following cautions and read this manual before use.

- **Disconnect from power source when not in use.**
- **Power input source must not exceed maximum ratings.**
- **Equipment must be wired to a negative ground system.**
- **Equipment may not operate properly with excess wiring not supplied by manufacturer.**
- **Avoid spraying fluid directly at equipment.**
- **Never submerge equipment.**
- **Avoid pulling on wires to unplug equipment wiring.**
- **Avoid using equipment with obvious physical damage.**
- **To prevent equipment damage, avoid dropping it.**



WARNING

Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.

Notice for consumers in Europe:

This symbol indicates that this product is to be collected separately.

The following applies only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.
- For more information, contact the seller or the local authorities in charge of waste management.

Section 1: System Description

Function and Theory

Geotech's Portable Turbidity Meter offers great precision, repeatability and ease of use in a low cost extremely robust portable/laboratory instrument. Data points from field sample events can be stored to memory and transferred to computer or other storage device.

Turbidity Meters provide fluid clarity insight by shining light onto a sample and measuring the amount of light scattered by suspended particles in the fluid.

The Geotech Portable Turbidity Meter has two light source models to fulfill specific customer and site requirements:

Model GTW: White Light source, compliant to US EPA method 180.1
Model GTI: Infrared light source, compliant to ISO 7027 standards

Instrument Features

- Sample chamber with lid
- Data port/ power supply (serial output, USB to Mini-B cable not included)
- Sealed battery compartment (4x AA batteries)
- IP67 Seal for extension into hazardous environments
- Digital display and navigation keypad

System Components

- Economy carry case included, optional custom foam cut case available
- Lint-free cleaning cloth
- 2 sample vials
- Primary Calibration Standards: 0.10, 20, 100, 800 NTU

Figure 1-1: Instrument Features

Section 2: System Installation & Navigation

Install the battery

1. With a small Phillips screwdriver, remove the battery cover (located on the backside of the instrument).
    - Take care to keep the small screws and washers safe when removing the battery cover.
2. Install four (4) AA alkaline or nickel metal hydride (NiMH) batteries.
    - Make sure that batteries are installed in the correct orientation.
3. Replace the battery cover.
    - For optimal seal, we recommend using a torque screwdriver set to 4N-m.

Figure 2-1: Replacing the batteries

Sample Vial Handling

Handle calibration and sample vials by caps only. Any scratches on the vials will compromise accurate turbidity readings.

When placing the vials into the instrument, ensure that the white line on the sample vial is aligned with the black arrow on the bottom edge of the instrument's sample chamber.

The sample vials must be very clean while calibrating or doing field readings; no debris or fingerprints should be visible on the glass. Use a soft cleaning cloth to ensure clarity before each measurement. Do no store samples and vial in extreme temperatures or direct sunlight.

Figure 2-2: Sample chamber

User Interface

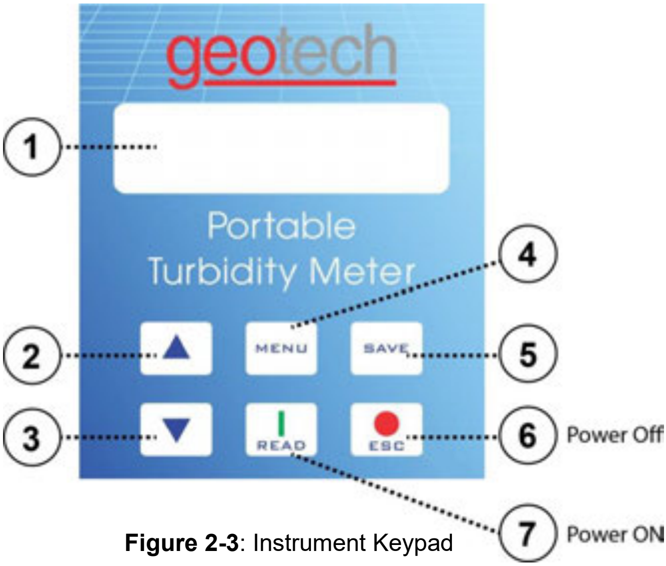


Figure 2-3: Instrument Keypad

1. **DISPLAY**

   Displays readings, diagnostics, and operational data.

2. **UP ARROW (▲)**
   Scroll through menus, enter numbers and letters

3. **DOWN ARROW (▼)**
   Scroll through menus, enter numbers and letters

4. **MENU**
   Enters into main menu function, selects options to configure the instrument, select analysis, and moves cursor to the right.

5. **SAVE**
   Store Selections and data, saves the result to be USB transferred and selects the parameters.

6. **ESC/OFF**
   Powers off the instrument (hold for 3 seconds), aborts operations, return to the previous screen.

7. **READ/ON**
   Powers on the instrument (hold for 3 seconds), confirms options, initiates sample reading, moves cursor to the left.

Section 3: System Operation

3.1 Quick Start Guide

To turn ON unit: press and hold the **READ** button for 3 seconds.

To turn OFF unit: press and hold the **ESC** button for 3 seconds.

Figure 3-1: Read (ON/Enter) ESC (OFF/Back)

Basic Operation

1. Turn instrument on by pressing **READ** for 3 seconds.
    a. Once through the welcome screens, the unit will automatically begin reading a sample.
    b. See *Section 3.2.2: Calibrate* if Calibration is required.

2. Rinse the inside of each sample vial three times with the sample to be tested.

3. Completely fill sample vial with sample, then dry and clean the outside of vial.
    - Handle vial by the cap.

4. Align white mark on vial with arrow on bottom of sample chamber.
    - See “Sample Vial Handling” in *Section 2: System Installation & Navigation* for details.

5. Close the sample chamber cap.

6. Press **READ** button again to take sample, NTU reading will appear after status bar is complete.

7. Press **SAVE** button to mark reading, “M” will flash for 3 seconds in upper left corner of display.

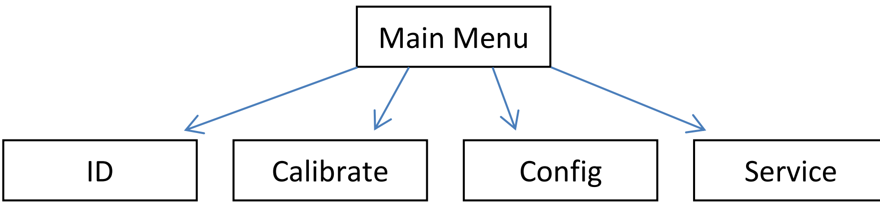
Figure 3-1: Basic Operation

3.2 Menu Navigation

The Geotech Portable Turbidity Meter has several configuration capabilities. The menu structure is easy and simple to operate, please follow the steps below to configure the unit according to your needs.

To Enter Main Menu: With instrument turned on, press **MENU** key for 3 seconds to enter the Menu Function. You will see the following screen:

Using ▲ or ▼ the user can navigate between the main menu functions. When you reach the desired menu or function press **READ** to enter, or **ESC** to go back to the previous screen.



The four main sub menus are listed below:

- ID - Access the user identification function
- Calibrate - Access the calibration functions
- Config - Access the configuration functions
- Service - Access the service functions (only for certified technicians)

The fifth menu item is “Back” – when selected will navigate to the ready-to-sample screen.

Please reference the following pages for an explanation of instrument configuration and menu navigation. See section *3.4: Menu Structure* for an overview of the complete menu structure.

3.2.1 ID (Identification)

From the main menu, use the ▲ or ▼ keys select the ID function, then press **READ** to enter that submenu.

Sample

Use the ▲ or ▼ keys to set sample number from 0-99. Use the **READ** or **SAVE** button to set the sample number and exit to the ID menu.

User

Use the ▲ or ▼ keys to set user number from 0-99. Use the **READ** or **SAVE** button to set the user number and exit to the ID menu.

3.2.2 Calibrate

From the main menu, use the ▲ or ▼ keys select the Calibrate function, then press **READ** to enter that submenu.

The Standard vials must be thoroughly cleaned before each measurement, using a lint-free cloth.

Guided Cal.

The complete calibration procedure, as outlined below, should be performed by the user according to required quality and maintenance programs.

1. Gather the four (4) calibration sample vials with formula standards of <0.10 (i.e. 0.02), 20.0, 100, 800 NTU (or stabilized primary standards in the same concentrations).
   - Ensure each vial is cleaned with a soft cloth.

2. Hold **MENU** button for 3 seconds until the main menu is displayed.

3. Scroll through the menu using the ▲ or ▼ keys until “Calibrate” is displayed.

4. Press the **READ** button to enter into the calibration menu.

5. Select “Guided Cal” and follow the scrolling prompts on the screen.
   - Before placing each vial into the sample chamber, gently invert the vial to ensure a homogeneous mix.

6. Once done calibrating to the four standards, the instrument will return to the calibration menu.

7. Press the **ESC** key twice to navigate to the ready-to-sample screen.

Free Cal.

Free Calibration allows for a single calibration point. For many users, this single point calibration will be sufficient for routine work.

1. Follow steps 1-3 from “Guided Cal” above.

2. Select “Free Cal”

3. On the “Cal. Auto” screen, there will be a value displayed from the previous calibration. Place one of the calibration standards into the sample chamber.

4. Press READ button and wait for result.

5. If necessary use ▲ or ▼ keys to change the displayed value for this standard to match its label, press and hold **SAVE** for 3 seconds.
   - "Saving" will be displayed.

6. After the value is saved, the display returns to the "Calibrate" menu.

7. Recalibrate against the same standard for better accuracy, or perform the “Guided Cal” routine.

NOTE 1: If an error message displays, check the standards and repeat the previous steps.

NOTE 2: After the calibration, perform standard readings for verification, and if needed repeat the calibration procedure.

3.2.3 Config (Configuration)

From the main menu, use the ▲ or ▼ keys select the Config function, then press **READ** to enter that submenu.

Time/Date

When inside this configuration you can change ***Time*** and ***Date***.

Use **MENU/READ** to move the cursor right/left and ▲ or ▼ keys to adjust the numbers as desired. Press and hold **SAVE** for 3 seconds to store the data, or **ESC** to return to the previous menu without saving any changes.

Display

When inside this configuration you can set and change Contrast, Backlight Time and Backlight Brightness (Time and Contrast only on instruments with Backlight optional installed), use ▲ or ▼ to select between the options and **READ** to enter it or **ESC** to go back to the previous menu.

Contrast

Using ▲ or ▼, you can change the contrast to the desired level: 00-30. When done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Backlight Time

From 0 up to 60 minutes of backlight on.

Using ▲ or ▼ change the time to the desired backlight time, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Backlight Level

From 0 up to 100 (intensity level).

Using ▲ or ▼ change the level to the desired, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Partial Res.

Using ▲ or ▼ to choose Yes or No.

Big Number

Using ▲ or ▼ to choose Yes or No to show the large number displayed on the Auto screen.

Instrument

When inside this configuration you can set Auto off, Readings, Color compensation, curves, fast settling, Sampling, ID, Calibration interval, personalization, patrimony, use ▲

or ▼ to select between the options and **READ** to enter it or **ESC** to go back to the previous menu.

Auto off

The Auto off function shall be activated to save the batteries; it can be configured to turn the unit off after 0 to 60 minutes of inactivity.

Using ▲ or ▼ change the time to the desired level, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

NOTE: When the time is in 0 minutes the auto off will not be operational.

Auto Reading

The Auto reading function can be activated from 1 to 250 seconds; this will set the time between readings.

NOTE: If you configure the Auto reading for 5 seconds the unit will make readings every 5 seconds until it is turned off.

Using ▲ or ▼ change the desired time between readings, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Color Compensation

The instrument can compensate for the color of the sample for a more accurate reading.

A password is required to access this feature. Default password is **9999.** Input password and hold **SAVE** for 3 seconds to proceed.

Using ▲ or ▼ select Yes or No, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

NOTE: When activated (Yes selected) “C” will appear in the upper right corner of the display in the reading mode screen.

Test Curves

You can define which curves will appear in the curve selection menu (when you press and release the Menu key).

Press **ESC** to remove the * icon from the curves you don´t want and **READ** to put the * icon in the ones you want.

Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Measure Mode/ Fast Settling

When selected, instrument will take a snapshot of the sample and display the immediate reading before particles settle in the vial (for high solids samples).

Using ▲ or ▼ select yes or no, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Sample

This function can be used to set the number of readings the unit will take to calculate the average and present it as a measurement in the display. Number of samples ranges from 8-100.

1. User ID

Here you can set up user names/passwords and when they shall be requested by the unit.

Edit

To create users and its passwords:

- Choose the user number between 00 and 50 , press **READ**
- Choose a name for this user using ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Name can be a maximum of thirteen (13) characters.
- You will see “PIN:” on the Display, use ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Pin must be four (4) characters.
- Press and Hold **ESC for 3 seconds** to return to the previous menu.

Request

To define when the user ID and password will be required:

- Choose between the following options using ▲ or ▼, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Always	– ID and password will be request at every measurement.
On Start	– ID and password will be request at Instrument Start Up.
MEMO	– ID and password will be request when **SAVE** is pressed.
Previous	**–** ID and password will not be requested, the previous user informed will be assigned for all operations.
No	– ID and password will not be requested.

2. Sample ID

Here you can set up sample names /passwords and when they shall be requested by the unit.

Edit

To create sample names and their passwords:

- Choose the user number between 00 and 50, press **READ**
- Choose a name for this sample using ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.
- Press and Hold **ESC for 3 seconds** to return to the previous menu.

Request

To define when the sample name will be required:

- Choose between the following options using ▲ or ▼, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Always –Sample name will be request at every measurement.
On Start –Sample name will be request at Instrument Start Up.
MEMO –Sample name will be request when **SAVE** is pressed.
Previous –Sample name will not be requested, the previous user informed will be assigned for all operations.
No –Sample name will not be request.

Schedule Cal.

Access this function to set up the time (Days/hours) before calibration is requested.

A password is required to access this feature. Default password is **9999.** Input password and hold **SAVE** for 3 seconds to proceed.

F.Scale

- Choose the number of days and hours before the calibration warning graph will appear on the display using ▲ or ▼ and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

NOTE: When the calibration schedule is programmed, a graph will be displayed in the upper right corner during measurements, when the calibration date arrives, a bar will appear in the graph and a Calibration warning will be displayed.

Customize

Use ▲ or ▼ and **MENU/READ** (send the cursor to the right/left) to set an ID for the unit, press and hold **SAVE** for 3 seconds to store the data. ID must be four (4) characters.

Tag Number

Use ▲ or ▼ and **MENU/READ** (send the cursor to the right/left) to set an ID number for the unit, press and hold **SAVE** for 3 seconds to store the data. ID must be four (4) characters.

Language

Use ▲ or ▼ to select the desired language from the list below, press and hold **SAVE** for 3 seconds to store the data.

- US – English
- ES – Spanish
- BR – Portuguese

Communication

Use ▲ or ▼ to select between Eco Result or Log Transmit and **READ** to enter it or **ESC** to go back to the previous menu.

Eco Result

In this mode, the measurement displayed is sent to the USB port. You can select to send all measurements only part of them.

Using ▲ or ▼ select Auto, Manual and Off, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

- Auto – Sends all measurements to the USB (when they are performed)
- Manual – Sends measurements that are selected (**SAVE** pressed during on measurement mode)
- Off – No measurement will be sent to the USB

Log Transmit

Here you can select 4 ways to send the instrument measurement log

Using ▲ or ▼ select between, New Mark, All Mark, New, All, Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Auto - Sends all measurements to the USB (when they are performed)

Manual - Sends measurements that are selected (**SAVE** pressed during on measurement mode)

Off - No measurement will be sent to the USB

NOTE: When the time is in 0 minutes the instrument will not be shut off.

Serial Baud

Sets the data rate in bits for data transmission.

Options include: 57600, 38400, 19200, and 9600. Default/suggested configuration is 19200bits/sec. Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Header

Select Yes or No to display header. Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

CSV Separator

Determines character to be placed in between spaces. Select a symbol then press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

User Test

The instrument allows users to calibrate a user curve.

NOTE: When user curve is calibrated, the instrument performance might change due to standard and procedures adopted, factory calibrated curve is made with 100% traceable standards and reference materials in controlled environment, use it in order to have full confidence in instrument performance.

Security/Password

Here you can set up the security level and password for the Calibration, configuration and service functions.

The Factory pre-saved password is 9999, if this is required during configuration or operation use ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

ID

Here you will assign a security level and password to access all the ID functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level

Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password

Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Password must be four (4) characters.

Calibration
Here you will assign a security level and password to access all the calibration functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

Config.
Here you will assign a security level and password to access all the Configurable functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

Service
Here you will assign a security level and password to access all the service functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

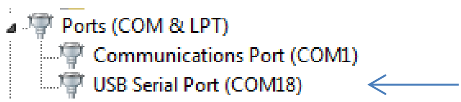
Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

3.3 USB Connection

1. Plug the unit into the computer; wait for device driver to download. Device connection is successful if an additional COM port is recognized in the Device Manager.

2. Identify a communication port for the connection, look in the computer's Device Manager (example: COM2, COM18).

If unsure of which communication port, disconnect and then reconnect the Turbidity Meter while Device Manager is open and notice which new communication/USB serial port opens, look under "Ports (COM & LPT)".



3. Open a serial terminal connection to access the saved data.

   Serial terminal programs are available to download from the internet. For example, "PuTTY" or "TeraTerm" are two serial terminal programs which are quick and free to download, and simple to use.

4. Configure the serial terminal interface as follows:

Parameter	**Value**
Speed	19200 bits/sec (baud rate)
Data bits	8
Parity	None
Stop Bits	1
Flow Control	None

5. To transmit the Data use the menu structure diagram (*see Section 3.4*) to navigate to Service > Datalog > Log Transmit.

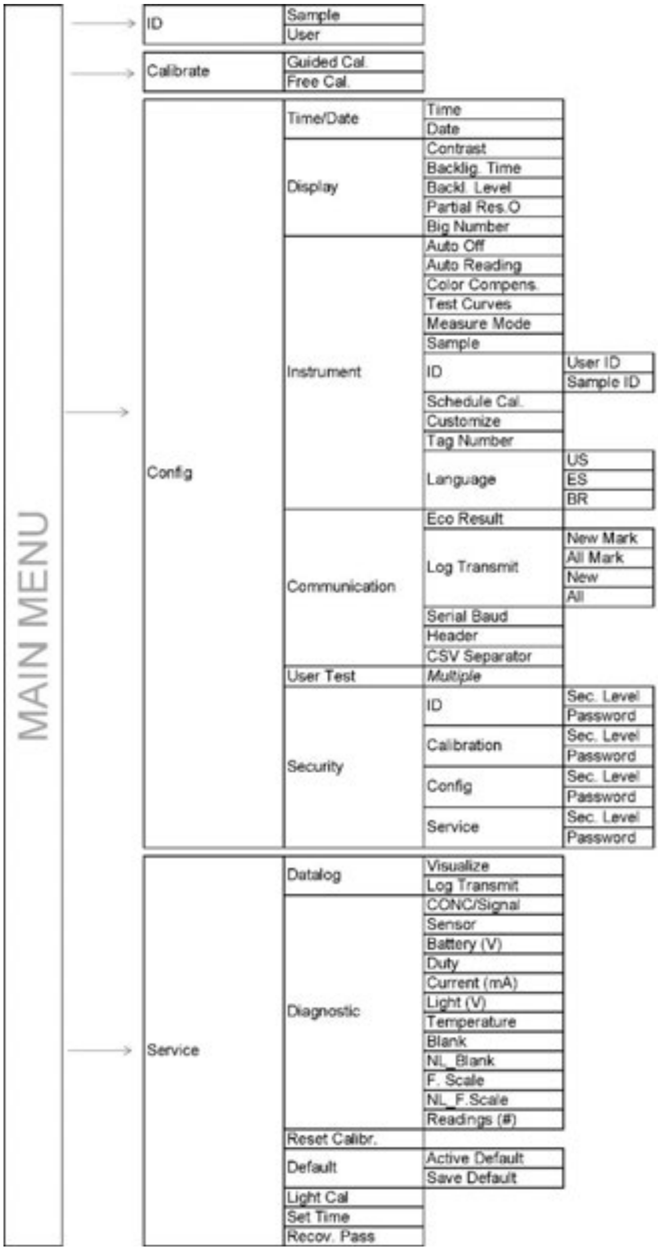
The display will read, "Wait…" and the serial terminal on the computer will begin the data log transfer. The data output could be copied and pasted into a data processing program, such as MS Excel or Word (comma delineated import).

Note: Some variables will appear in the data collected,

"M": Marked
"D": Point where the data has already being transmitted
"E": Clock not adjusted in last transmission

3.4 Menu Structure

Use the “**READ**” button to enter into a sub menu, use the “**ESC**” button to exit a sub menu.



Section 4: System Maintenance

The Geotech Portable Turbidity Meter is designed to be a low-maintenance lab instrument that can be used in the field.

General cleaning guidelines:

- Use a soft cloth with mild soap and warm water to clean the unit.
- Clean and dry the sample chamber to ensure no water droplets accumulate on the lens, as this can affect the accuracy of turbidity readings.

Per each use:

- Keep unit clean and free of debris when traveling - build up on sample chamber lenses could permanently damage the instrument
- Calibrate before each use to ensure good data

Seasonal use:

- Keep unit clean and free of debris when storing - build up on lenses could permanently damage the instrument
- Remove batteries when storing long term
- Ensure a complete calibration is conducted when bringing unit out of storage

Calibration Solutions:

- Avoid exposing calibration standards to extreme temperatures. Do not store below the freezing point, or above 122 °F (55°C)

Section 5: System Troubleshooting

Problem: Unit will not turn on.

Solution:

- No power to unit:
    - Check that batteries are installed and in the correct orientation (+/- polarity)

Problem: Cannot get accurate readings on control samples.

Solution:

- Recalibrate unit
- Clean lenses inside sample chamber to ensure a clear read
- Clean outside of bottles
- Check the expiration date on the calibration standards. Expired standards will result in an inaccurate reading.

If these troubleshooting guidelines have not resolved the problem, contact Geotech Environmental Equipment at 1-800-833-7958.

Section 6: System Specifications

Measurement Method	Nephelometric
Regulatory	EPA method 180.1 (GTW)
	ISO method 7027 (GTI)
Light Source	EPA - White light Tungsten (GTW)
	ISO - 860nm LED (GTI)
Range	0 to 1000 NTU (FNU)
Accuracy	±2% of reading plus stray light
Repeatability	±1% of reading, or 0.01 NTU (FNU), whichever is greater
Resolution	0.01 NTU on lowest range
Stray Light	<0.02 NTU (FNU)
Signal Averaging	Selectable On/Off (programmable from 8 to 100 readings/ 4 to 27 seconds)
Detector	Silicon photocell
Reading Modes	Fast Settling, automatic, manual reading, EBC
Data Logger	1000 Data Sets
Download	Standard USB, no special software required
Languages	English, Spanish, Portuguese
Power	4 AA Alkaline batteries
	USB 5VDC/500mA
Operating Temperature	32 to 122°F (0 to 50°C)
Storage Conditions	-40 to 140°F (-40 to 60°C), instrument only
Instrument Enclosure Rating	IP67 with lid open or closed
Sample Required	0.473 oz. (14 ml)
Sample Vials	2.55 x 0.94 in. (65 x 24 mm)
Dimensions	4.48 x 7.79 x 3.26 in. (114 x 198 x 83 mm)
Weight	1.09 lb. (496 g) without batteries
	1.28 lb. (585 g) with 4 AA alkaline batteries
Warranty	2 year

Section 7: Parts and Accessories

Part Number	Qty	Part Description
82100003	1	TURBIDITY METER,0-1000NTU,GEOTECH,CALKIT,FIELD CASE
82100005	1	TURBIDITY METER,0-1000NTU,GEOTECH,CALKIT, ECO CASE
52100003	1	CASE,FIELD,TURBIDITY
52100000	1	CAL KIT,TURBIDITY,GEOTECH(.1, 20, 100, 800 NTU)
22100046	.5	VIAL,TURBIDITY,4PK
22100048	1	CLOTH,LINT FREE,TURBIDITY
PPE041006	4	BATTERY, 1.5V, SIZE AA, EACH
22100045	1	MANUAL, PORTABLE TURBIDITY METER,GEOTECH
*22100049	1	CASE,ECONOMY,TURBIDITY
*52100004	1	COMM CABLE,USB,TURBIDITY

**Indicates optional accessories.*

For additional information, please call Geotech Environmental Equipment at:
1-800-833-7958

Document Revisions		
EDCF #	**Description**	**Rev/Date**
-	Release, SP	07/07/2016
Project #1496	Updated graphics, additional user instructions, StellaR, SP	06/08/2017

NOTES

NOTES

EC Declaration of Conformity

Manufacturer:

Geotech Environmental Equipment, Inc.
2650 E 40th Avenue
Denver, CO 80205

Declares that the following products,

Product Name: Geotech Portable Turbidity Meter

Model(s): Portable Turbidity Meter, White Light (GTW)
Portable Turbidity Meter, Infrared Light (GTI)

Year of manufacture: 2017

Conform to the principle safety objectives of 2006/95/EC Low Voltage Directive by application of the following standards:

EN 61010-1: 2010

Year of affixation of the CE Marking: 2017

Conform to the protection requirements of 2004/108/EC Electromagnetic Compatibility (EMC) by application of the following standards:

EN 61000-6-1: 2007
EN 61000-6-3: 2012
EN 61326-1: 2013

EMC conformity established 5/24/2017

Production control follows the ISO 9001:2008 regulations and includes required safety routine tests.

This declaration issued under the sole responsibility of Geotech Environmental Equipment, Inc.

Joseph Leonard

Joe Leonard
Product Development

Serial number ________________

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Release, SP	07/07/2016
Project #1496	Added Declaration of Conformity, general updates to images and menu descriptions, SB	05/26/2017
Project#1496	Updated parts list, updated menu navigation, StellaR	6/15/2017

The Warranty

For a period of two (2) years from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: ________________

Serial Number: ________________

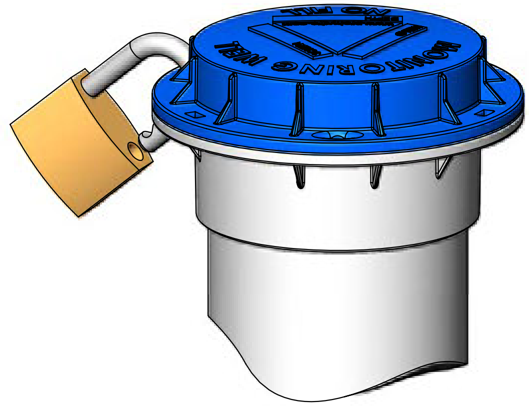
Date of Purchase: ________________

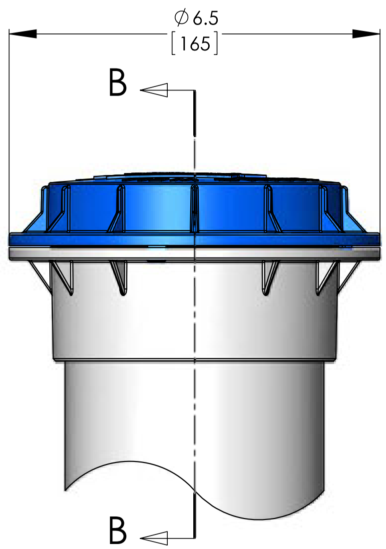
Equipment Decontamination

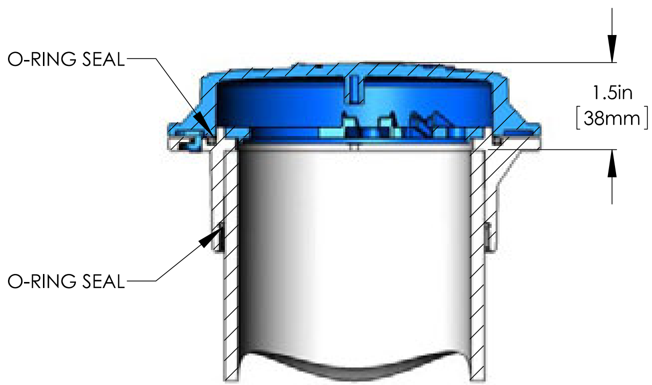
Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● **(800) 833-7958** ● FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

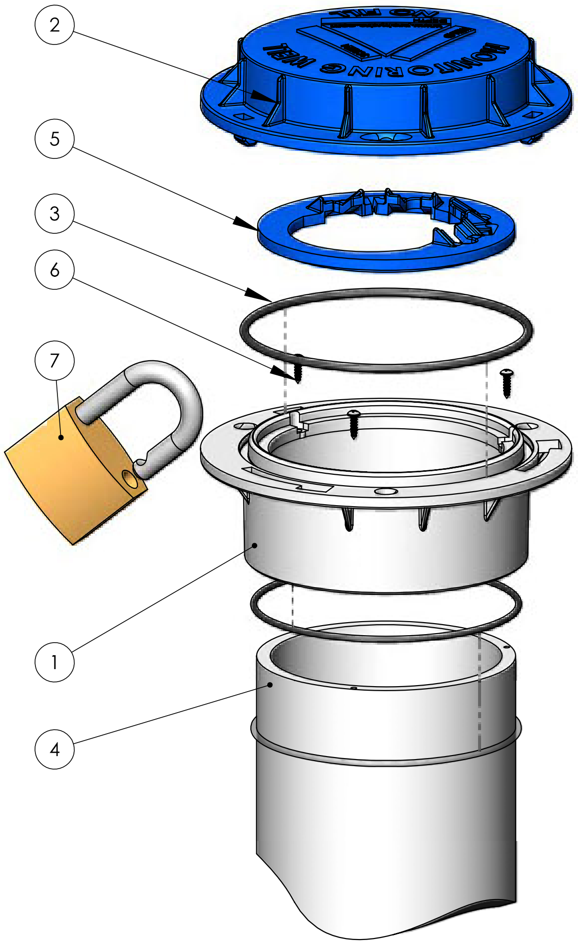
ITEM NO.	DESCRIPTION	QTY.
1	4" WELL DOCK BASE	1
2	4" WELL DOCK CAP	1
3	VITON O-RING	2
4	4" WELL RISER PIPE	1
5	4" WELL DOCK EQUIPMENT SUPPORT RING	1
6	410 SS SCREW (MAGNETIC)	3
7	PADLOCK (EXAMPLE; NOT INCLUDED)	1







SECTION B-B



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/16
ANGULAR: 1°
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ± 0.005
INTERPRET GEOMETRIC TOLERANCING PER:
ASME Y14.5-2009
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	MAB	01/02/13
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
1in
[25.4mm]

ProHydro, Inc.

MADE IN THE USA | 585-385-0023 | www.prohydro.com

TITLE:
4" WELL CAP ASSEMBLY

SIZE B | PART NO. | REV

SCALE: 1:2 | WEIGHT: | SHEET 2 OF 2

Levelogger® Edge

Model 3001

The Levelogger Edge records highly accurate groundwater and surface water level and temperature measurements. It combines a pressure sensor, temperature detector, 10-year lithium battery, and datalogger, sealed within a 7/8" x 6.25" (22 mm x 159 mm) stainless steel housing with Titanium based PVD coating.

The Levelogger Edge measures absolute pressure using a Hastelloy pressure sensor, offering excellent durability and reliability. Combined with the Titanium based PVD coating, both elements have high corrosion resistance in harsh environments, allowing stable readings in extreme pressure and temperature conditions. The Hastelloy sensor can withstand 2 times over-pressure without permanent damage.

The Levelogger Edge features a wide temperature compensated pressure range (0 to 50°C, -10 to 50°C for Barologger Edge), and rapid thermal response time. The Levelogger Edge has high resolution and an accuracy of 0.05% FS. The convenient Barologger Edge provides the easiest and most accurate method of barometric compensation.

Features

- 0.05% FS Accuracy
- Corrosion resistant Titanium based PVD coating
- Robust Hastelloy pressure sensor
- Accurate temperature compensation
- Memory for up to 120,000 readings
- Basic and advanced data compensation options

Applications

- Aquifer characterization: pumping tests, slug tests, etc.
- Watershed, drainage basin and recharge monitoring
- Stream gauging, lake and reservoir management
- Harbour and tidal fluctuation measurement
- Wetlands and stormwater run-off monitoring
- Water supply and tank level measurement
- Mine water and landfill leachate management
- Long-term water level monitoring in wells, surface water bodies and seawater environments

The Levelogger Edge has a battery life of 10 years based on a 1-minute sampling rate. It has FRAM memory for 40,000 sets of data points – or up to 120,000 using the compressed linear sampling option.

The Levelogger Edge uses a Faraday cage design, which protects against power surges or electrical spikes caused by lightning. Its durable maintenance-free design, high accuracy and stability, make the Levelogger Edge the most reliable instrument for long-term, continuous water level recording.

Fast communication and downloading speeds with a high speed Optical Reader

Flexible Communication

Levelogger PC Software is streamlined, making it easy to program dataloggers, and to view and compensate data, in the office or in the field. The software has useful programming options, including compressed and repeat sampling, and future start/stop. Data compensation has been simplified, and allows multiple data files to be barometrically compensated at once.

The extremely intuitive Solinst Levelogger App, and Levelogger App Interface on your in-field Leveloggers, creates a Bluetooth® connection between your Leveloggers and smart device. Also an option, the DataGrabber is a field-ready, USB data transfer unit designed specifically for the Levelogger Series.

Remote monitoring options include the LevelSender, a simple and compact device that fits right in a 2" well, STS Telemetry Systems, and RRL Remote Radio Link. In addition, Levelogger Series dataloggers are SDI-12 compatible.

Levelogger Setup

Programming Leveloggers is extremely intuitive. Simply connect to a PC using an Optical Reader or PC Interface Cable. All in one screen fill in your project information and sampling regime. Templates of settings can be saved for easy re-use.

The Levelogger time may be synchronized to the computer clock. There are options for immediate start or future start and stop times. The percentage battery life remaining and the amount of free memory are indicated on the settings screen.

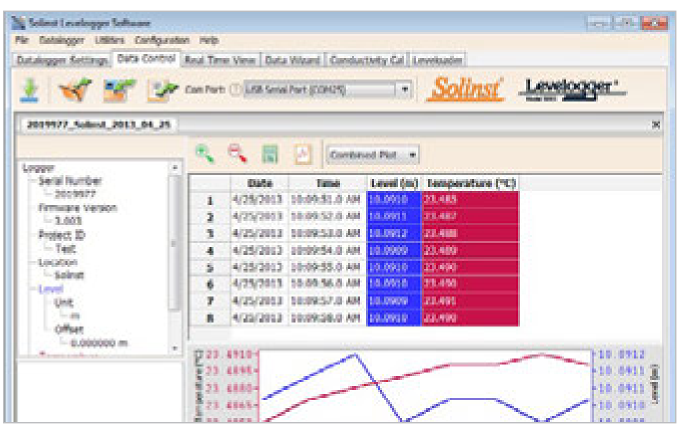
Leveloggers can also be programmed with a sampling regime and start/stop times using the Solinst Levelogger App on your smart device.

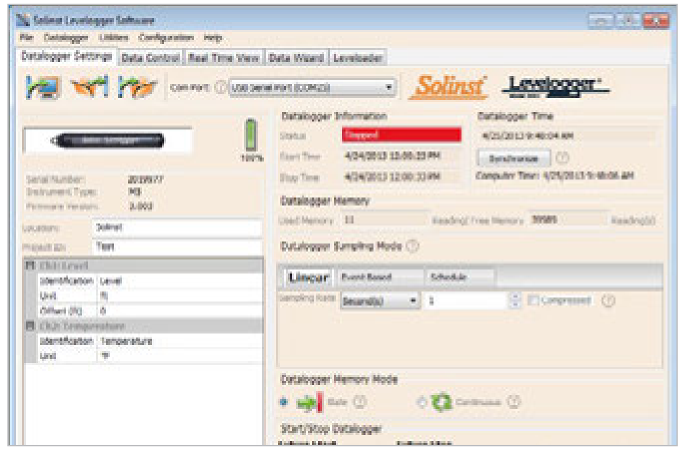
Convenient Sampling Options

Leveloggers can be programmed with linear, event-based, or a user-selectable sampling schedule. Linear sampling can be set from 1/8 second to 99 hours. The Levelogger Edge can be programmed with compressed linear sampling, which increases memory from 40,000 to up to 120,000 readings.

Event-based sampling can be set to record when the level changes by a selected threshold. Readings are checked at the selected time interval, but only recorded in memory if the condition has been met. A default reading is taken every 24 hours if no "event" occurs.

The Schedule option allows up to 30 schedule items, each with its own sampling rate and duration. For convenience, there is an option to automatically repeat the schedule.





Levelogger Edge Settings Software Windows

Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon. There are multiple options for downloading data, including 'Append Data' and 'All Data'. The software also allows immediate viewing of the data in graph or table format using the 'Real Time View' tab.

The level data is automatically compensated for temperature, and the temperature data is also downloaded. Barometric compensation of Levelogger data is performed using the Data Wizard, which can also be used to input manual data adjustments, elevation, offsets, density, and adjust for Barometric efficiency.

The software allows easy export of the data into a spreadsheet or database for further processing.

The Solinst Levelogger App also allows you to view and save real-time, or logged data right on your smart device.

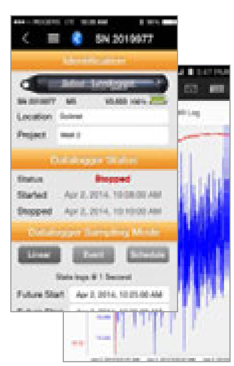
Helpful Utilities

The 'Self-Test Diagnostic Utility' can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required.

A firmware upgrade will be available from time to time, to allow upgrading of the Levelogger Edge, as new features are added.

Solinst Levelogger App & Levelogger App Interface

The Levelogger App Interface uses Bluetooth® technology to connect your Levelogger to your smart device. With the Solinst Levelogger App, you can download data, view real-time data, and program your Leveloggers. Data can be e-mailed from your smart device directly to your office (see Model 3001 Levelogger App & Interface data sheets).



Download on the App Store

GET IT ON Google play

Standard Cable Deployment

Leveloggers may be suspended on a stainless steel wireline or Kevlar® cord. This is a very inexpensive method of deployment, and if in a well, allows the Levelogger to be easily locked out of sight and inaccessible. Solinst offers stainless steel wireline assemblies and Kevlar cord assemblies in a variety of lengths.

Solinst 3001 Well Cap Assembly

The 2" Locking Well Caps are designed for both standard and Direct Read Cable deployment options.

The well cap has a convenient eyelet for suspending Leveloggers using wireline or Kevlar cord. The Well Cap insert has two openings to accommodate Direct Read Cables for both a Levelogger and Barologger. Adaptors are available to fit 4" wells.

The cap is vented to equalize atmospheric pressure in the well. It slips over the casing, and the cap can be secured using a lock with a 3/8" (9.5 mm) shackle diameter.

Levelogger 2" Locking Well Cap Installations (see Well Caps data sheet for more details)

Direct Read Cables

When it is desired to get real-time data and communicate with Leveloggers without removal from the water, they can be deployed using Direct Read Cables. This allows viewing of the data, downloading and/or programming in the field using a portable computer, DataGrabber, or the Solinst Levelogger App and Interface.

Leveloggers can also be connected to an SDI-12 datalogger using the Solinst SDI-12 Interface Cable attached to a Direct Read Cable.

Cable Specifications

Direct Read Cables are available for attachment to any Levelogger in lengths up to 1500 ft. The 1/8" dia. (3.175 mm) coaxial cable has an outer polyethylene (MDPE) jacket for strength and durability. The stranded stainless steel conductor gives non-stretch accuracy.

Barologger and Levelogger installed in Well Using Direct Read Cables

Accurate Barometric Compensation

The Levelogger Edge measures absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters, centimeters, psi, kPa, or bar.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger Edge, avoiding time lag in the compensation.

The Barologger is set above high water level in one location on site. One Barologger can be used to compensate all Leveloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

The Levelogger Software Data Compensation Wizard automatically produces compensated data files using the synchronized data files from the Barologger and Leveloggers on site.

The Barologger Edge uses pressure algorithms based on air rather than water pressure, giving superior accuracy.

The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Barologger Edge records atmospheric pressure in psi, kPa, or mbar. When compensating submerged Levelogger Edge, Gold or Junior data, Levelogger Software Version 4 can recognize the type of Levelogger and compensate using the same units found in the submerged data file (Levelogger Gold and Junior measure in feet, meters, or centimeters). This makes the Barologger Edge backwards compatible.

Synchronize & Streamline Your Barometric Compensation Efforts, Across Your Entire Site

® Kevlar is a registered trademark of DuPont Corp.

Levelogger Edge Specifications

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy:	± 0.05% FS (Barologger Edge: ± 0.05 kPa)
Stability of Readings:	Superior, low noise
Units of Measure:	m, cm, ft., psi, kPa, bar, °C. °F (Barologger Edge: psi, kPa, mbar, °C, °F)
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0° to 50°C (Barologger Edge: -10 to +50°C)
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
Battery Life:	10 Years - based on 1 reading/minute
Clock Accuracy:	± 1 minute/year (-20°C to 80°C)
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	40,000 readings FRAM memory, or up to 120,000 using linear data compression
Memory Mode:	Slate and Continuous
Communication:	Optical Infrared Interface. Conversion to RS-232, USB, SDI-12. Serial at 9600 bps, 38,400 bps with USB
Size:	7/8" x 6.25" (22 mm x 159 mm)
Weight:	4.6 oz. (129 grams)
Corrosion Resistance:	Titanium based PVD coating
Other Wetted Materials:	Delrin®, Viton®, 316L stainless steel, Hastelloy, Titanium based PVD coating
Sampling Modes:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	1/8 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius)

Models	Full Scale (FS)	Accuracy
Barologger	Air only	± 0.05 kPa
M5	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)
M10	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)
M20	20 m (65.6 ft.)	± 1 cm (0.032 ft.)
M30	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)
M100	100 m (328.1 ft.)	± 5 cm (0.164 ft.)
M200	200 m (656.2 ft.)	± 10 cm (0.328 ft.)

Low Cost Datalogging: See Levelogger Junior Edge Data Sheet.
Vented Dataloggers: See LevelVent and AquaVent Data Sheets.
Conductivity Datalogging: See LTC Levelogger Edge Data Sheet

DataGrabber™

The DataGrabber is a field-ready data transfer device that allows you to copy data from a Levelogger, onto a USB flash drive key.

The DataGrabber is compact and very easy to transport. It connects to the top end of a Levelogger's Direct Read Cable, or an Adaptor is available to allow direct connection to a Levelogger.

One push-button is used to download all of the data in a Levelogger's memory to a USB device plugged into the DataGrabber. A convenient LED light indicates the operation of the DataGrabber. The data in the Levelogger memory is not erased, and logging is not interrupted if the Levelogger is still running. The DataGrabber uses its own replaceable 9V battery.

LevelSender Telemetry

The LevelSender is a simple, low cost telemetry system designed to send data from Leveloggers in the field, to your smart device and PC database via cellular communication.

Initial set up is done through a user-friendly software wizard at the Home Station. There is two-way communication between the LevelSender and Home Station, allowing remote updates.

Each LevelSender device has a single port to connect one Levelogger with an optional splitter that allows the connection of a Barologger.

LevelSender stations are compact in design, which allows them to be discreetly installed inside a 2" (50 mm) well (see Model 9500 data sheet).

STS Telemetry

The STS Telemetry System provides an efficient method to send Levelogger data from the field to your desktop. Cellular communication options give the flexibility to suit any project. STS Systems are designed to save costs by enabling the self-management of data. Alarm notification, remote firmware upgrades and diagnostic reporting make system maintenance simple (see Model 9100/9200 data sheet).

RRL Telemetry

The RRL Remote Radio Link is ideal for short range applications up to 20 miles or 30 km; distances can be increased by using radios as relay stations. Ideal for creating closed-loop monitoring networks using Leveloggers (see Model 9100/9200 data sheet).

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™DataGrabber is a trademark of Solinst Canada Ltd.

Printed in Canada
April 26, 2018

For further information contact: Solinst Canada Ltd.
Fax: +1 (905) 873-1992; (800) 516-9081 Tel: +1 (905) 873-2255; (800) 661-2023
35 Todd Road, Georgetown, Ontario Canada L7G 4R8
Web Site: www.solinst.com E-mail: instruments@solinst.com

USGS TopSet Wading Rod, 1.2m

Price:	Item No.:	Weight:
$400.00	105-008	6.00 LBS

Quantity: 1 ADD TO CART

Add to Wish List

Click the button below to add the USGS TopSet Wading Rod, 1.2m to your wish list.

ADD TO WISH LIST

Pin it

Product Overview

The standard USGS Top Setting Wading Rod is intended for use with the Type AA and pygmy current meters. It is designed for measuring shallow streams, with the standard English rod marked in feet and tenths and comes in 4, 6 and 8-foot long models. The standard metric rod marked in centimeter increments with a length of 1.2 meters. These wading rods also are available in lengths (up to 10 feet or 3 meters long) as desired by the customer. The anodized aluminum handle has an integral scale to indicate the correct setting of the current meter at the 0.2, 0.6 and 0.8- depth settings, which corresponds to the conventional two- position method. This unit permits convenient setting of the current meter at the proper depth. It allows the hydrologist to quickly set the meter at the correct depth without bringing the meter out of the water. The depth of the water is read on the graduated hex main rod. When the round setting rod is adjusted to the depth of the water, the current meter is automatically positioned for the 0.6-depth method (0.4-depth position up from the streambed). Setting the unit to half the water depth will place the meter at the 0.2-depth up from the streambed. Conversely, setting the unit to twice the water depth will place the meter at the 0.8-depth position up from the streambed. The latter two positions correspond to the conventional two-position method. The electrical lead to the current meter is supplied, and a standard plug is fitted into the handle to accept the leads from a headphone, counter or AquaCalc 5000. The commonly used two prong connector can also be supplied as required. All parts are made of stainless steel, anodized aluminum and brass.

Vernier Setting	Actual Current Meter Position
Exact Water Depth	0.4 up from the streambed
Twice Water Depth	0.2 up from the streambed
1/2 Water Depth	0.8 up from the streambed

Wading Rod, TopSet, 1.2m

Accessories

USGS TopSet Wading Rod, 8ft
$470.00

Electronic TopSet Wading Rod, 1.2m
$430.00

USGS TopSet Wading Rod, 2.4m
$490.00

AquaRod TopSet Wading Rod, 1.2m
$470.00

Rickly
IMAGE COMING SOON

Breakdown TopSet Wading Rod, 1.2m
$455.00

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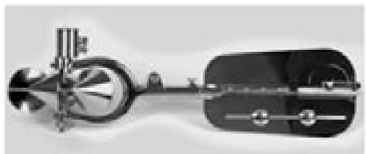
- Stage Measurement
- Aquatic Sampling
- Meteorological Instruments
- Sample Analysis Instrumentation
- Surveying & Mapping Equipment
- Water Quality Instruments
- Soil Science
- Groundwater Monitoring
- Acoustic Doppler Current Profiler (ADCP)
- Bathymetric & Topographic Survey System

Home | Stream Gaging Equipment | Current Meters | USGS Type AA Current Meters | USGS Type AA Current Meter



USGS Type AA Current Meter

Price:	Item No.:	Weight:
$795.00	101-001	8.00 LBS

Quantity:
1 ADD TO CART

Add to Wish List

Click the button below to add the USGS Type AA Current Meter to your wish list.

ADD TO WISH LIST

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Product Overview | Product Videos

The USGS Type AA current meter is commonly known as the Price-type current meter. This current meter is suspended in the water using a cable with sounding weight or wading rod (taking the tail section off) and will accurately measure streamflow velocities from 0.1 to 25 feet per second (0.025 to 7.6 meters per second). The main features of this meter are the uniquely designed bucket wheel shaft bearings and the two post contact chamber. The bucket wheel has six conical shaped cups, is five inches (12.7 cm) in diameter and rotates on a vertical axis inside the yoke. The tungsten carbide bearings for the bucket wheel shaft are located in deeply recessed inverted cups. When the meter is in use, these cups become air chambers and the entrapped air effectively excludes water and silt from the bearing surfaces giving extremely low starting velocities and minimal friction in the bearings.

The contact chamber houses a penta gear and two binding posts, each having a fine platinum alloy contact wire. One wire makes contact with the bucket wheel shaft once during every revolution; the other is used when fast velocities are encountered, and makes contact with the penta gear once during every five revolutions of the bucket wheel.

Each current meter is provided with a U.S. Geological Survey approved standard rating table to convert bucket revolutions to stream velocity in either English units (feet per second) or metric units (meters per second), spare parts, instrument oil, cleaning cloth, screwdriver and an instrument case with a water tight o-ring seal that floats if dropped in the water and provides proper protection of the meter during transportation and storage.

The meter is made from brass and stainless steel and all exposed surfaces are chrome plated for corrosion-free service. The standard Type AA was designed for use with all of the counters as well as the AquaCalc 5000 Digital Flow Computer. No conversion kits or replacement contact chambers are necessary to use the latest digital technology with this meter.

Accessories

USGS TopSet Wading Rod, 4ft
$380.00

AquaCalc 5000 Computer
$2,000.00

Headphone, Two Ear
$70.00

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Multiparameter Sondes

3

EXO Handheld Display

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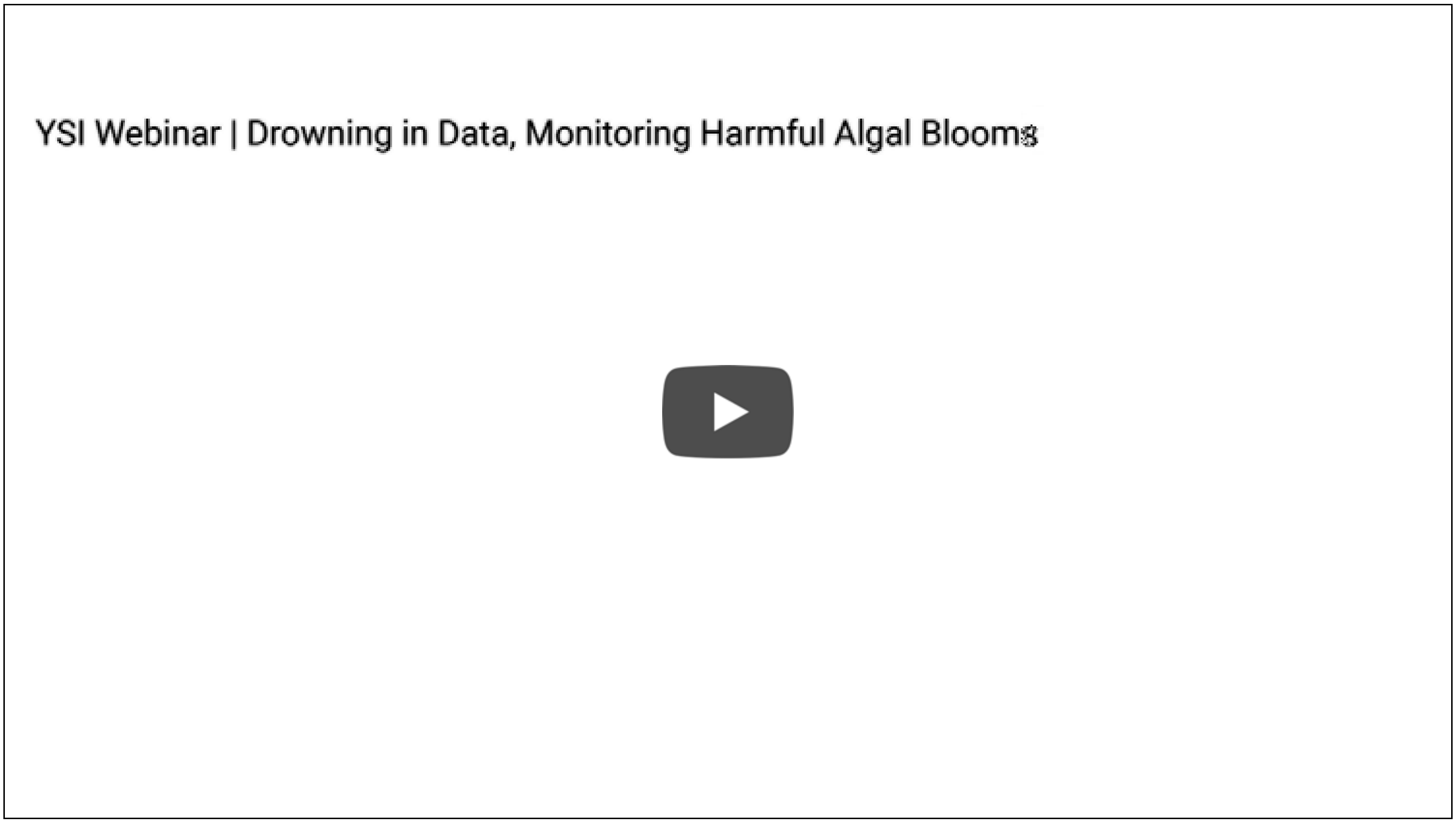
EXO Multiparameter Sondes



EXO advanced water quality monitoring platform for continuous field water quality measurements in challenging conditions.

Price: Request Pricing

SKU: 599960

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Enhanced interface for the EXO platform

In water quality monitoring, instruments must hold up to harsh conditions. Rain or shine, sleet or snow, your equipment needs to keep up with you.

Download the EXO Handheld Operation Mini-Manual (https://www.ysi.com/File%20Library/Documents/Manuals/E117-EXO-Handheld-Operation-Mini-Manual.pdf)

Overview

Specifications

Autostable:	Yes
Cable Options:	Any EXO field cable

Certifications:	CEC, CE; RoHS; IP-67; WEEE; FCC; UN Part III, Section 38.3, Test methods for lithium-ion batteries (Class 9)
Connector:	Wet-mate connectors
Desktop Software Compatible:	KOR software for the EXO platform
Equipment used with:	Any EXO Sonde
GPS:	Yes
Graphic Display:	Graphic display with detailed help menus and auto-sized dashboard text based on number of sensors
Keypad:	Yes
Languages:	German, English, Spanish, Italian, Norwegian, Traditional Chinese, French, Simplified Chinese, Japanese, Portuguese
Logging Capabilities:	> 100,000 data sets with single point or continuous logging with autostability option
Operating Temperature:	0 to 50 °C (32 to 122 °F)
Power:	Rechargeable lithium-ion battery pack provides ~48 hours if powering the handheld only and ~20 hours if powering the handheld, sonde and four sensors; battery recharge time is ~9 hours with the AC power adapter. The instrument can also be powered via AC or external power pack though the USB port.
Sampling:	Yes
Size:	Instrument: 8.3 cm width x 21.6 cm length x 5.6 cm depth (3.27 in x 8.5 in x 2.21 in)
Storage Temperature:	0 to 45 °C (32 to 113 °F) with battery installed; 0 to 60 °C (32 to 140 °F) without battery installed. Note: Storing Li-Ion batteries in cool environments will help extend their lifespan.
User Calibratable:	Yes, 400 detailed calibration records can be stored and are available to view, download and print for traceability.
Warranty:	3-year handheld; 1-year Li-ion battery pack
Waterproof:	Floats, IP-67
Weight:	Weight with Battery, 567 grams (1.25 lbs)

Video

Application Notes

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() () ()

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You may also need

(/EXO2)

EXO2 Multiparameter Sonde (/EXO2)

7-Port Multiparameter Water Quality Sonde

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(/EXO1)

EXO1 Multiparameter Sonde (/EXO1)

4-port Multiparameter Water Quality Sonde

Request Pricing

(/Product/id-599040/EXO-Field-Cable)

EXO Field Cable (/Product/id-59904 /EXO-Field-Cable)

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Multiparameter Sondes

EXO1 Multiparameter Sonde

(javascript:void(0)) (/ProductImages//9be4f2de-0a91-455f-886a-eff7ffe3a89f/images/YSI-EXO1-Sonde.jpg) (javascript:void(0))

EXO - State-of-the-art Water Quality Monitoring Platform

Live Chat

EXO, a state-of-the-art water quality monitoring platform, is designed to address the many challenges of collecting accurate field data in the natural environment. In this video you will learn about the EXO sondes and EXO's innovative features, including: Universal smart sensors; Expansive and high-performance sensor suite; and Extremely rugged design for deeper depths and longer deployments.

Price: Request Pricing

Option: EXO1 Sonde, No Depth, 4 Sensor Ports

SKU: 599501-00

Request a Quote (/request-a-quote)

4-Port Multiparameter Water Quality Sonde

Instrument Only. Cables, probes/sensors, and accessories sold separately.

Overview

Specifications

Depth / Pressure Rating / Limit:	0 to 250 m (0 to 820 ft)
Desktop Software Compatible:	KOR for EXO
Flow Cell:	Yes

Languages:	Chinese, German, Japanese, French, Spanish, English
Logging Capabilities:	Yes
Medium:	Fresh, sea or polluted water
Memory:	>1,000,000 logged readings, 512 MB total memory
Multiparameter:	Yes
Operating Temperature:	-5 to +50°C
Power:	2 Alkaline Batteries
Sampling:	Yes
Smart Sensors / Ports:	Yes
Storage Temperature:	-20 to +80°C
Unit of Measure:	Parameter Dependent
User Calibratable:	Yes
Waterproof:	Yes

EXO1 Specifications	
Battery Life	90 days*
Communications	Computer Interface: Bluetooth wireless technology (between sonde and handheld or computer with KOR software), USB Output Options: USB with signal output adapter (SOA); RS-232 & SDI-12 with DCP-SOA.
Diameter	4.70 cm (1.85 in)
Length	64.77 cm (25.50 in)
Peripheral Ports	1 power communication port
Sample Rate	Up to 4 Hz
Sensor Ports	4
Warranty: 3 mos	Replaceable reagent modules for ammonium, chloride, and nitrate
Warranty: 1 yr	Optical DO membranes and replaceable reagent modules for pH and pH/ORP
Warranty: 2 yrs	Cables; sonde bulkheads; handheld; conductivity, temperature, depth, and optical sensors; electronics base for pH, pH/ORP, ammonium, chloride, and nitrate sensors; and accessories
Weight	1.42 kg (3.15 lbs)

*Typically 90 days at 20°C at 15-minute logging interval; temperature/conducti turbidity sensors installed on EXO1. Battery life is heavily dependent on sensor configuration.

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Ammonium *(freshwater only)*	Ammonium Sensor *Ammonia with pH sensor* SKU: 599710 (/Product/id-599710 /EXO-Ammonium-Smart-Sensor)	0 to 200 mg/L (0 to 30°C)	±10% of reading or 2 mg/L-N, w.i.g.	T63<30 sec	0.01 mg/L
Barometric Pressure	Integral Barometer	375 to 825 mmHg	±1.5 mmHg from 0 to 50°C	-	0.1 mmHg
Blue-green Algae, Phycocyanin	Total Algae Sensor SKU: 599102-01 (/Product /id-599102-01/EXO-Total-Algae-PC-Smart-Sensor)	0 to 100 µg/L; 0 to 100 RFU;	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 100 µg/mL BGA-PC equivalents	T63<2 sec	0.01 µg/L; 0.01 RFU
Blue-green Algae, Phycoerythrin	Total Algae Sensor SKU: 599103-01 (/Product /id-599103-01/EXO-Total-Algae-PE-Smart-Sensor)	0 to 280 µg/L; 0 to 100 RFU;	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 280 µg/mL BGA-PE equivalents	T63<2 sec	0.01 µg/L; 0.01 RFU
Chloride *(freshwater only)*	Chloride Sensor SKU: 599711 (/Product/id-599711 /EXO-Chloride-Smart-Sensor)	0 to 18000 mg/L-Cl (0 to 30°C)	±15% of reading or 5 mg/L-Cl, w.i.g.	T63<30 sec	0.01 mg/L
Chlorophyll	Total Algae Sensor SKU: 599102-01 (/Product /id-599102-01/EXO-Total-Algae-PC-Smart-Sensor), 599103-01 (/Product/id-599103-01/EXO-Total-Algae-PE-Smart-Sensor)	0 to 400 µg/L Chl; 0 to 100 RFU	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 400 µg/L Chl *a* equivalents	T63<2 sec	0.01 µg/L Chl; 0.01 RFU
Conductivity[1]	Conductivity / Temperature Sensor SKU: 599870 (https://www.ysi.com /Product/id-599870/EXO-Conductivity--Temperature-Smart-Sensor)	0 to 200 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading	T63<2 sec	0.0001 to 0.01 mS/cm (range dependent)

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Depth - 10 m	Integral, Non-vented Depth Sensor[3]	0 to 10 m (0 to 33 ft)	±0.04% FS (±0.004 m or ±0.013 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Depth - 100 m	Integral, Non-vented Depth Sensor[3]	0 to 100 m (0 to 328 ft)	±0.04% FS (±0.04 m or ±0.13 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Depth - 250 m	Integral, Non-vented Depth Sensor[3]	0 to 250 m (0 to 820 ft)	±0.04% FS (±0.10 m or ±0.33 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Dissolved Oxygen, % air saturation	Optical Dissolved Oxygen Sensor SKU: 599100-01 (/Product/id-599100-01/EXO-Optical-Dissolved-Oxygen-Smart-Sensor)	0 to 500% air saturation	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading [4]	T63<5 sec[5]	0.1% air saturation
Dissolved Oxygen, mg/L	Optical Dissolved Oxygen Sensor SKU: 599100-01 (/Product/id-599100-01/EXO-Optical-Dissolved-Oxygen-Smart-Sensor)	0 to 50 mg/L	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading [4]	T63<5 sec[5]	0.01 mg/L
fDOM *(CDOM)*	fDOM Sensor SKU: 599104-01 (/Product/id-599104-01/EXO-fDOM-Smart-Sensor)	0 to 300 ppb Quinine Sulfate equivalents (QSU)	Linearity: R2 > 0.999 for serial dilution of 300 ppb QS solution Detection Limit: 0.07 ppb QSU	T63<2 sec	0.01 ppb QSU
Level, Vented - 10 m	Integral Vented Level Sensor	0 to 10 m (0 to 33 ft)	±0.03% FS (±0.003 m or ±0.010 ft)	T63<2 sec	0.001 m (0.001 ft)
Nitrate *(freshwater only)*	Nitrate Sensor SKU: 599709 (/Product/id-599709/EXO-Nitrate-Smart-Sensor)	0 to 200 mg/L-N (0 to 30°C)	±10% of reading or 2 mg/L-N, w.i.g.	T63<30 sec	0.01 mg/L

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
pH	pH Sensor SKU:599701 guarded (/Product/id-599701/EXO-pH-Smart-Sensor), 599702 unguarded (/Product/id-599702/EXO-pH-Smart-Sensor) pH/ORP Sensor SKU:599705 guarded (/Product/id-599705/EXO-pH--ORP-Smart-Sensor), 599706 unguarded (https://www.ysi.com/Product/id-599706/EXO-pH--ORP-Smart-Sensor)	0 to 14 units	±0.1 pH units within ±10°C of calibration temp; ±0.2 pH units for entire temp range[7]	T63<3 sec[8]	0.01 units
ORP	pH/ORP Sensor SKU:599705 guarded (/Product/id-599705/EXO-pH--ORP-Smart-Sensor), 599706 unguarded (https://www.ysi.com/Product/id-599706/EXO-pH--ORP-Smart-Sensor)	-999 to 999 mV	±20 mV in Redox standard solution	T63<5 sec[6]	0.1 mV
Temperature	Conductivity / Temperature Sensor SKU: 599870 (https://www.ysi.com/Product/id-599870/EXO-Conductivity--Temperature-Smart-Sensor)	-5 to 35°C 35 to 50°C	±0.01°C[2] ±0.05°C[2]	T63<1 sec	0.001 °C
Turbidity[9]	Turbidity Sensor SKU: 599101-01 (/Product/id-599101-01/EXO_Turbidity_Smart_Sensor)	0 to 4000 FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, w.i.g.; 1000 to 4000 FNU: ±5% of reading[10]	T63<2 sec	0 to 999 FNU = 0.01 FNU; 1000 to 4000 FNU = 0.1 FNU
Salinity	Calculated from Conductivity and Temperature[11]	0 to 70 ppt	±1.0% of reading or 0.1 ppt, w.i.g.	T63<2 sec	0.01 ppt
Specific Conductance	Calculated from Conductivity and Temperature[11]	0 to 200 mS/cm	±0.5% of reading or .001 mS/cm, w.i.g.	-	0.001, 0.01, 0.1 mS/cm (auto-scaling)

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Total Dissolved Solids (TDS)	Calculated from Conductivity and Temperature[11]	0 to 100,000 mg/L Cal constant range 0.30 to 1.00 (0.64 default)	Not Specified	-	Variable
Total Suspended Solids (TSS)	Calculated from Turbidity and user reference samples	0 to 1500 mg/L	Not specified	T63<2 sec	Variable

**Specifications indicate typical performance and are subject to change. All sensors have a depth rating to 250 m (820 ft), except shallow and medium depth sensors, ammonium, chloride, and nitrate. Accuracy specification is attained immediately following calibration under controlled and stable environmental conditions. Performance in the natural environment may vary from quoted specification.
w.i.g. = whichever is greater

EXO sensors are not compatible with YSI 6-Series sondes, sensors, or handheld.

[1]Outputs of specific conductance (conductivity corrected to 25°C) and total dissolved solids are also provided. See Calculated Parameters and footnote 11.
[2] Temperature accuracy traceable to NIST standards
[3]Accuracy specifications apply to conductivity levels of 0 to 100,000 µS/cm.
[4] Relative to calibration gases
[5] When transferred from air-saturated water to stirred deaerated water
[6] When transferred from water-saturated air to Zobell solution
[7]Within the environmental pH range of pH 4 to pH 10.
[8]On transfer from water-saturated air to rapidly stirred air-saturated water at a specific conductance of 800 µS/cm at 20°C; T63<5 seconds on transfer from water-saturated air to slowly-stirred air-saturated water.
[9] Calibration: 1-, 2-, or 3-point, user-selectable
[10] Performance based on 3-point calibration done with YSI AMCO-AEPA standards of 0, 124, and 1010 FNU. The same type of standard must be used for all calibration points.
[11] Values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (Ed. 1989).

Xenoy is a trademark of SABIC Innovative Plastics IP BV.

EXO Bluetooth modules comply with Part 15C of FCC Rules and have FCC, CE Mark and C-tick approval. Bluetooth-type approvals and regulations can be country specific. Check local laws and regulations to insure that the use of wireless products purchased from Xylem are in full compliance.

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APPENDIX E

FIELD FORMS

(Included as Attachments to the PDF Document)

Johnston Leigh Inc.

Page ______ of ______

Date: __________ Project No. __________ Field Geo/Eng __________
Client: __________ Project __________ Location __________

Personnel On Site:

Name	Employer	PPE Level	Time On	Time Off

Weather Conditions: __________
Temperature __________ Wind Direction: __________ Wind Speed: __________

Tasks to be completed: __________

Personal Protective Equipment

Initial to document PPE used:

Fire Retardant Coverall __________
Gloves (type) __________
Boots __________
Respirator __________
Hearing Protection __________
Hard hat __________
Eye Protection __________
Cartridge Type __________

Monitoring Equipment

Indicate Manufacture and Model:

Water Level Meter __________
Peristaltic Pump __________
PID __________
Barologger __________
Pressure Transducer __________
Water Meter __________

Calibration

Indicate Standards Used and Meter Calibration Response

pH Standards __________
Conductivity Standards __________
Turbidity Standards __________

Time/Duration/Description of Daily Activities/Events

Johnston Leigh Inc.

Continue on Reverse Side if Needed

Page ____ of ____

Time/Duration/Description of Daily Activities/Events

Johnston Leigh Inc.

Well Gauging Form A
Freshwater Baseline Monitoring

	Well	Well Acronym	Time	Date	Depth to Groundwater	Constructed Well Depth	Screen Interval	Depth Snap Sampler	Depth Low Flow Pump	Pressure Transducer Depth
	Date:									
	Weather conditions:									
					(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
	Playa Perimeter Wells									
1	Headlight Gap (HLG)	HLG							207-210	
2	Provo (PRO)	PRO				460.00	260-460	270-276		
3	SN2-11-400-4 (SN2)	SN2				497	347-497	406-411		
4	Machine Gun (MCG)	MCG				102	98-102		101-104	
	Playa Perimeter Well									
	Alluvial/Colluvium Wells									
5	257 Cutoff	257				60	45-60	50-56		
6	Mudhole	MUD				503.00	338-365		370-370	30
7	Guzzler	GUZ				425.00	325-425	385-389		
8	Bonneville	BON				315.00	210-310	215-221		
9	Black Rock	BKR				250.00	50-84			
10	Miller Canyon Reservoir	MCR				315.00	245-315	272-278		
11	Crystal Peak Road	CPR				195.00	177-195		185-188	
12	Lakeview	LKV				532.00	420-500	94-100		130
	Tailings West									
	Tailings North									
	Bedrock Wells									
13	North Cricket	NCT				780.00	580-780	661-667		550
14	Monument Point	MNP				1215.00	1030-1210	1155-1161		350
15	Nighthawk	NTH				780.00	580-780	608-614		410
16	Coyote	CYT				765.00	560-760	705-711		400
17	Black Hills	BKH				560.00			540-543	230
	Bedrock 1 West									
	Water Supply 1									
	Water Supply 1									
	Water Supply 1									
	Water Supply 1									

Johnston Leigh Inc.

Well: ______ Date: ______ Sampler: ______
Weather: ______ Purge Method: Circle One ISS Low Flow
DTW: ______ Boring Dia: ______ Well Dia: ______ Well Depth: ______ Screen Interval: ______
Snap Sampler Depth: ______ Low Flow Pump Depth: ______

ISS Method

Sample Depth Interval: ______ # Snap Bottles: ______ Snap Bottles Volume: ______
Snap Trigger Pressure: Snap Trigger Time:

Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Appearance

Sample Time:	
Sample ID:	
Blind Dup:	

No. Laboratory Containers: ______
125 ml Anions - No Preservative: ______
250 ml Dissolved Metals - No Preservative: ______
250 ml N02, N03, Phosphorus - H2SO4 preservative: ______
250 ml TDS, Mercury, SC - No Preservative: ______
pH, Alkalinity - No Preservative: ______

Low Flow Method

Purge Calculator ______ X ______ + ______ = ______
Tubing Length (ft) × Tubing DF + Stable SW Volume (ml) = Purge Volume (ml)

Tubing Diameter Factors (DF)	3/8" =	9.84 ml/ft	1/2" =	38 ml/ft	5/8" =	60ml/ft	
Stable SW Volume ml:	2" well =	617.46 ml/ft	4" well=	2467.80 ml/ft	5" well=	3859.15 ml/ft	6" well= 5557.18 ml/ft

Time	Purge Rate	Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Fill - Discharge time		Drawdown (SW) (ft)
							Fill	Discharge	

No. Laboratory Containers: ______
125 ml Anions - No Preservative: ______
250 ml Dissolved Metals - No Preservative: ______
250 ml N02, N03, Phosphorus - H2SO4 preservative: ______
250 ml TDS, Mercury, SC - No Preservative: ______
pH, Alkalinity - No Preservative: ______

Sample Time:	
Sample ID:	
Blind Dup:	

Ship Date: ______

Ship to: Pace Laboratory
12065 LeBanon Pike
Mount Juliet, TN 37122
(615) 758-5858

If field parameters do not stabilize within 30 minutes after purge volume has been removed, record the final measurement and collect groundwater sample.

Sampler Signature: ______

Johnston Leigh Inc.

Form C
Surface Water Sample Log
Sevier Playa Potash Project

Location: ____________________ Date: __________ Sampler: ____________________

Weather: ____

Wading Stick Used: ____________________ Flow Meter Used: ____________________

Sketch Cross Section Area of Measurment Area

Flow 0.2

Flow 0.6

Flow 0.8

Ave Flow

Average Flow Cross Section Area: ____________________

Bucket Flow Rate: 1st __________ 2nd __________ 3rd __________ Average: __________

Field Measurments:

Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Appearance	Notes

Ship Date: ____________________

Ship To: Pace Laboratory
12065 LeBanon Pike
Mount Juliet, TN 37122
(615) 758-5858

Sample Time
Sample ID:

Sampler Signature: ____

APPENDIX F

CHAIN-OF-CUSTODY FORMS

(Included as Attachments to the PDF Document)

Billing Information:

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to:

Email To:

Project Description:

City/State Collected:

Phone:
Fax:

Client Project #

Lab Project #

L #

Table #

Collected by (print):

Site/Facility ID #

P.O. #

Acctnum:

Template:

Prelogin:

TSR:

PB:

Shipped Via:

Collected by (signature):

Immediately Packed on Ice N ____ Y ____

Rush? (Lab MUST Be Notified)

____ Same Day ____ Five Day
____ Next Day ____ 5 Day (Rad Only)
____ Two Day ____ 10 Day (Rad Only)
____ Three Day

Quote #

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs											Remarks	Sample # (lab only)

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other________

Remarks:

pH ______ Temp ________

Flow ______ Other ________

Samples returned via:
__ UPS __ FedEx __ Courier __ ______

Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: __Y __N
Bottles arrive intact: __Y __N
Correct bottles used: __Y __N
Sufficient volume sent: __Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Temp: °C Bottles Received:	If preservation required by Login: Date/Time
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	Hold: Condition: NCF / OK

ATTACHMENT D

Example Data Validation Summary

To: ***
From: ***
Date: ***
Subject: Data Validation Summary for *** Sampling Event

Stations Not Sampled

- The pump in well MW-A was pulled for repair.

Receiving Temperatures

- Receiving temperatures for all samples were between 0 °C and 6 °C, with none frozen. Given that all receiving temperatures were within the desired range, no Extended Qualifiers were assigned by XYZ Laboratory.

Cooler ID	Receiving Temperature (ºC)	Laboratory Batch	Sample ID
1234	4.0	ABC1-01	MW-B
		ABC1-02	MW-C
5678	4.6	ABC3-01	MW-D
9101	2.5	ABC4-01	MW-E
		ABC4-02	MW-F
1213	0.6	ABC6-01	MW-G
		ABC6-02	MW-H
1415	4.2	ABC7-01	MW-I

Holding Times

- All samples were analyzed past holding time for lab pH. Samples flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-B, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-C, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-D, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.

Sample ID	Parameter	Received	Analyzed	Lab Extended Qualifier
MW-H	pH, Lab	1 Day 21 Hrs	2 Day 15 Hrs	
MW-B	pH, Lab	1 Day 19 Hrs	4 Day 0 Hrs	
MW-C	pH, Lab	2 Day 0 Hrs	2 Day 17 Hrs	
MW-D	pH, Lab	1 Day 23 Hrs	3 Day 13 Hrs	
MW-E	pH, Lab	1 Day 22 Hrs	3 Day 13 Hrs	
MW-F	pH, Lab	1 Day 18 Hrs	3 Day 8 Hrs	
MW-G	pH, Lab	1 Day 2 Hrs	2 Day 16 Hrs	
MW-B	Turbidity, Lab	1 Day 19 Hrs	2 Day 21 Hrs	HE
MW-C	Turbidity, Lab	2 Day 0 Hrs	2 Day 2 Hrs	H3
MW-D	Turbidity, Lab	1 Day 23 Hrs	2 Day 0 Hrs	HE

Original and Duplicate Sample

- **Radiologic**
  - All original and duplicate pairs had intersecting error bands.

Station	Parameter	Original	Duplicate
MW-G	Gross alpha, total	4.8±3.2	5.4±3.5
	Gross beta, total	10±3.6	12±4
	Radium 226, total	0.19±0.1	0.28±0.09
	Radium 228, total	0.63±0.65	2.1±1.2

- **RPDs**
  - Total iron had an RPD of 40.0%; however, both results were detected below the PQL, therefore no Validation Flag assigned for total iron.
  - Dissolved iron had an RPD of 40.0%; however, both results were detected below the PQL, therefore no Validation Flag assigned for dissolved iron.
  - Dissolved zinc had an RPD of 40.0%. One result was non-detect and the other result was detected below the PQL. A qualifier cutoff value (QCV) was calculated at 5 times the detected value. All results in the batch detected below the QCV (MW-C, MW-D, MW-H) were flagged as estimated (‘J’).
  - All other parameters were non-detect for original and duplicate samples or had an RPD less than 25%.

TDS Ratio

- Sample collected from well MW-E had a TDS ratio of 1.31.
- All other TDS ratios were within range of >0.80 and <1.20.

Sample ID	Sample	Parameter	Value	Result
MW-I	Original	TDS ratio, measured/calculated	1.09	Normal
MW-B	Original	TDS ratio, measured/calculated	1.03	Normal
MW-C	Original	TDS ratio, measured/calculated	0.99	Normal
MW-D	Original	TDS ratio, measured/calculated	1.04	Normal
MW-E	Original	TDS ratio, measured/calculated	1.31	High
MW-F	Duplicate	TDS ratio, measured/calculated	1.04	Normal
MW-G	Original	TDS ratio, measured/calculated	1.02	Normal
MW-H	Original	TDS ratio, measured/calculated	0.97	Normal

Cation-Anion Balance

- All samples had a cation-anion balance of less than five percent.

Sample ID	Sample	Parameter	Value (%)	Result
MW-I	Original	Cation-Anion Balance	0.00	Normal
MW-B	Original	Cation-Anion Balance	2.90	Normal
MW-C	Original	Cation-Anion Balance	2.90	Normal
MW-D	Original	Cation-Anion Balance	1.30	Normal
MW-E	Original	Cation-Anion Balance	3.00	Normal
MW-F	Duplicate	Cation-Anion Balance	0.00	Normal
MW-G	Original	Cation-Anion Balance	1.60	Normal
MW-H	Original	Cation-Anion Balance	1.10	Normal

	Original (MW-G)			Duplicate (MW-I)			
	Result	MDL	PQL	Result	MDL	PQL	RPD
Major Ions and Solution Parameters							
pH, lab	8.5	0.1	0.1	8.5	0.1	0.1	0.0%
Total alkalinity	400	2	20	400	2	20	0.0%
Bicarbonate alkalinity	375	2	20	372	2	20	0.8%
Carbonate alkalinity	24.2	2	20	28.2	2	20	15.3%
Hydroxide alkalinity	<2	2	20	<2	2	20	0.0%
Hardness	70	0.2	5	69	0.2	5	1.4%
Calcium, dissolved	15.5	0.1	0.5	15.3	0.1	0.5	1.3%
Magnesium, dissolved	7.6	0.2	1	7.4	0.2	1	2.7%
Sodium, dissolved	182	0.2	1	179	0.2	1	1.7%
Potassium, dissolved	7	0.2	1	6.9	0.2	1	1.4%
Chloride	13.0	0.5	2.5	13.0	0.5	2.5	0.0%
Fluoride	3.01	0.05	0.25	3.01	0.05	0.25	0.0%
Bromide	<0.05	0.05	0.25	<0.05	0.05	0.25	0.0%
Sulfate	44.0	0.5	2.5	44.1	0.5	2.5	0.2%
TDS, filterable @ 180C	526	10	20	532	10	20	1.1%
Nutrients							
Nitrate/nitrite	0.27	0.02	0.1	0.27	0.02	0.1	0.0%
Ammonia	0.74	0.05	0.2	0.75	0.05	0.2	1.3%
Phosphorus, dissolved	<0.02	0.02	0.05	<0.02	0.02	0.05	0.0%
Phosphorus, total	<0.02	0.02	0.05	<0.02	0.02	0.05	0.0%
Dissolved Metals							
Aluminum	<0.03	0.03	0.2	<0.03	0.03	0.2	0.0%
Antimony	<0.0004	0.0004	0.002	<0.0004	0.0004	0.002	0.0%
Arsenic	0.0388	0.0002	0.001	0.0393	0.0002	0.001	1.3%
Barium	0.124	0.003	0.02	0.123	0.003	0.02	0.8%
Beryllium	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Boron	2.35	0.01	0.05	2.30	0.01	0.05	2.2%
Cadmium	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Chromium	<0.0005	0.0005	0.002	<0.0005	0.0005	0.002	0.0%
Copper	<0.0005	0.0005	0.003	<0.0005	0.0005	0.003	0.0%
Iron	0.03	0.02	0.05	0.02	0.02	0.05	**40.0%**
Lead	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Manganese	0.0988	0.0005	0.003	0.0994	0.0005	0.003	0.6%
Mercury	<0.0002	0.0002	0.001	<0.0002	0.0002	0.001	0.0%
Molybdenum	<0.02	0.02	0.1	0.02	0.02	0.1	0.0%
Nickel	<0.008	0.008	0.04	<0.008	0.008	0.04	0.0%
Selenium	<0.0001	0.0001	0.0003	<0.0001	0.0001	0.0003	0.0%
Silver	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Thallium	0.0001	0.0001	0.0005	0.0001	0.0001	0.0005	0.0%
Uranium	0.0006	0.0001	0.0005	0.0006	0.0001	0.0005	0.0%
Vanadium	0.0110	0.0002	0.001	0.0111	0.0002	0.001	0.9%
Zinc	0.003	0.002	0.005	<0.002	0.002	0.005	**40.0%**
Total Metals							
Aluminum	<0.03	0.03	0.2	<0.03	0.03	0.2	0.0%
Antimony	<0.0004	0.0004	0.002	<0.0004	0.0004	0.002	0.0%
Arsenic	0.0397	0.0002	0.001	0.0426	0.0002	0.001	7.0%
Barium	0.124	0.003	0.02	0.124	0.003	0.02	0.0%
Beryllium	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Boron	2.30	0.01	0.05	2.31	0.01	0.05	0.4%
Cadmium	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Chromium	<0.0005	0.0005	0.002	<0.0005	0.0005	0.002	0.0%
Copper	<0.0005	0.0005	0.003	<0.0005	0.0005	0.003	0.0%
Iron	0.02	0.02	0.05	0.03	0.02	0.05	**40.0%**
Lead	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Manganese	0.0998	0.0005	0.003	0.1004	0.0005	0.003	0.6%
Mercury	<0.0002	0.0002	0.001	<0.0002	0.0002	0.001	0.0%
Molybdenum	<0.02	0.02	0.1	<0.02	0.02	0.1	0.0%
Nickel	<0.008	0.008	0.04	<0.008	0.008	0.04	0.0%
Selenium	<0.0001	0.0001	0.0003	<0.0001	0.0001	0.0003	0.0%
Silver	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Thallium	0.0001	0.0001	0.0005	0.0001	0.0001	0.0005	0.0%
Uranium	0.0006	0.0001	0.0005	0.0006	0.0001	0.0005	0.0%
Vanadium	0.0125	0.0002	0.001	0.0137	0.0002	0.001	9.2%
Zinc	<0.002	0.002	0.005	<0.002	0.002	0.005	0.0%

Extended Qualifiers with Validation Flags

- No extended qualifiers required validation.

Results Exceeding Standards

- MW-D
  - Dissolved aluminum exceeded Federal SMCL Groundwater Standards.
  - Total aluminum exceeded State Groundwater Secondary Standards.
  - Total iron exceeded State Groundwater Secondary Standards.
- MW-F
  - Lab pH exceeded State Groundwater Secondary Standards.
  - Total dissolved solids exceeded State Groundwater Secondary Standards.
  - Dissolved arsenic exceeded Federal MCL Standards.
  - Dissolved manganese exceeded State Groundwater Secondary Standards.
  - Total arsenic exceeded Federal MCL Standards.
  - Total manganese exceeded State Groundwater Secondary Standards.
- MW-H
  - Lab pH exceeded State Groundwater Secondary Standards.
  - Dissolved arsenic exceeded Federal MCL Standards.
  - Total arsenic exceeded Federal MCL Standards.

Station Name	Units	Federal MCL Groundwater Standards	Federal SMCL Groundwater Standards	State Groundwater Secondary Standards	MW-D	MW-F	MW-H
Major Ions and Solution Parameters							
pH, lab	s.u.		6.5-8.5	6.5-8.5		**8.5**	**8.5**
TDS, filterable @ 180C	mg/l		500	500		**526**	
Dissolved Metals							
Aluminum	mg/l		0.05	0.2	**0.05**		
Arsenic	mg/l	0.01				**0.0388**	**0.0186**
Manganese	mg/l		0.05	0.05		**0.0988**	
Total Metals							
Aluminum	mg/l		0.05	0.2	**0.33**		
Arsenic	mg/l	0.01				**0.0397**	**0.0188**
Iron	mg/l		0.3	0.3	**0.36**		
Manganese	mg/l		0.05	0.05		**0.0998**	