cover of phreatophyte plants and an associated decrease in ET of ground water, as reflected in the estimated water budget changes listed in Tables 3.2-19 and 3.2-20.

Table 3.2-19: Estimated Change in Annual Ground Water Budgets in Final Year of Project (2099) Under the Slower, Longer Project Alternative, Relative to the No Action Alternative[1]

Budget Component	Antelope Valley	Diamond Valley	Kobeh Valley	Pine Valley (within the HSA)	Entire HSA
Change in Ground Water Inflow[2] (afy)					
Precipitation Recharge	0	0	0	0	0
Subsurface Inflow[4]	0	36 (52 from Pine Valley and -16 from Kobeh Valley)	205 (7 from Monitor Valley, 36 from Antelope Valley, and 162 from Pine Valley)	0	7 (from Monitor Valley to Kobeh Valley)
Net Change in Total Inflow	**0**	36	**205**	**0**	7
Change in Ground Water Outflow[2] (afy)					
Evapotranspiration[3]	-23	-72	-3,300	-25	-3,420
Net Ground Water Pumping	0	0	11,300	0	11,300
Subsurface Outflow[4]	36 (to Kobeh Valley)	0	16 (to Diamond Valley)	214 (52 to Diamond Valley and 162 to Kobeh Valley)	0
Net Change in Total Outflow	**13**	**-72**	**7,984**	**189**	**7,880**

[1] Estimation based on sources of data and methods described in Interflow (2011), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4]Source: Interflow (2011), Table 1.

Table 3.2-20: Estimated Change in Annual Ground Water Budgets 50 Years Post-Project (2149) Under the Slower, Longer Project Alternative, Relative to the No Action Alternative[1]

Budget Component	Antelope Valley	Diamond Valley	Kobeh Valley	Pine Valley (within the HSA)	Entire HSA
Change in Ground Water Inflow[2] (afy)					
Precipitation Recharge	0	0	0	0	0
Subsurface Inflow[4]	0	39 (35 from Pine Valley and 4 from Kobeh Valley)	171 (17 from Monitor Valley, 31 from Antelope Valley, and 123 from Pine Valley)	0	17 (from Monitor Valley to Kobeh Valley)
Net Change in Total Inflow	**0**	39	**171**	**0**	**17**
Change in Ground Water Outflow[2] (afy)					
Evapotranspiration[3,4]	-27	-117	-1,764	-49	-1,957

Budget Component	Antelope Valley	Diamond Valley	Kobeh Valley	Pine Valley (within the HSA)	Entire HSA
Net Ground Water Pumping	0	0	0	0	0
Subsurface Outflow[4]	31 (to Kobeh Valley)	0	4 (to Diamond Valley)	157 (35 to Diamond Valley, -1 to North Pine Valley, and 123 to Kobeh Valley)	-1
Net Change in Total Outflow	**4**	**-117**	**-1,760**	**108**	**-1958**

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Interflow (2011), Table 1.

In the final year of operations under the Slower, Longer Project Alternative (2099), the estimated available ground water in Diamond Valley is predicted to be reduced by 72 afy as a result of open pit dewatering and KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-11). An increase in subsurface inflow to Diamond Valley of 36 afy (52 afy from Pine Valley and a decrease of 16 afy from Kobeh Valley) is also predicted to occur as a result of open pit dewatering (since the pit is mostly located within the Diamond Valley basin). Fifty years after the end of operations under the Slower, Longer Project Alternative (2149), the estimated available ground water in Diamond Valley is predicted to be reduced by 117 afy as a result of pit-lake capture and previous KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-12). In 2149, a predicted increase in subsurface inflow to Diamond Valley of 39 afy (35 afy from Pine Valley and 4 afy from Kobeh Valley) results from pit-lake capture. The predicted mine-related reduction in available ground water in Diamond Valley within 50 years post-Project under the Slower, Longer Project Alternative (up to 117 afy) is minor (0.2 percent) in comparison to the estimated consumptive use of ground water for agricultural purposes in Diamond Valley (55,800 afy) in 2009.

The quantity of ground water leaving the HSA by subsurface flow and discharging into northern Pine Valley (the only location of subsurface outflow from the HSA) is not predicted to change significantly as a result of mine dewatering and KVCWF pumping.

- **Impact 3.2.3.7-4:** Ground water flow modeling indicates that there could be up to approximately 25 percent decrease in **ET** of ground water in Kobeh Valley due to **a change in** phreatophyte **composition and percent cover** resulting from temporary mine-induced drawdown.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

- **Impact 3.2.3.7-5:** Ground water flow modeling indicates that there could be a time-varying net change (decrease or increase) in the available ground water in Diamond

Valley that is due solely to effects of the Slower, Longer Project Alternative by the end of mining and milling operations and for at least 50 years post-Project; however, the magnitude of the predicted changes are less than 0.2 percent, compared to the overall ground water budget for Diamond Valley.

Significance of the Impact: The impact is not considered significant.

No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

Consumptive Losses

Potential impacts to water resources in the HSA resulting from long-term consumptive use of ground water under the Slower, Longer Project Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.7-6:** Consumptive use of water during mining and milling operations would support a beneficial use and would not be expected to adversely impact water resources, and EML would have adequate water rights to cover the consumptive use. Long-term consumptive use of ground water by evaporation from the pit lake surface is predicted to be approximately 100 gpm (161 afy) and would continue in perpetuity. This consumptive loss would occur under the Slower, Longer Project Alternative (and the Proposed Action), and so represents a negative impact compared to the No Action Alternative. The 161 afy is less than 0.1 percent of the combined water budget for the Kobeh and Diamond Valleys.

  Significance of the Impact: Impacts during mining and milling operations are less than significant. After those operations cease, direct impacts of pit lake evaporation do not result in significant impacts.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

Potential Impacts Due to Subsidence

The basis for this potential impact and the assessment methodology are similar to those described for the Proposed Action in Section 3.2.3.3.2; therefore, they will not be repeated here. The numerical model shows that under the Slower, Longer Project Alternative, subsidence of up to approximately 1.5 feet would occur in the northern part of the KVCWF area (Figure 3.2.33). The projected lateral extent of subsidence greater than one-half-foot is approximately four miles in radius and is centered on the northern part of the well field area. There is no other predicted land subsidence due to the effects of mine pit dewatering or KVCWF pumping under the Slower, Longer Project Alternative within the HSA.

Potential for Changes to Aquifer Productivity

The greatest potential for permanent deformation would occur in the finer grained sediments (clays and silty clays) that are not the primary water-bearing materials in the basin-fill aquifer of

Kobeh Valley. The result would be a slight loss in aquifer interbed storage, but no noticeable loss in aquifer productivity of water supply wells. Thus, the potential impacts to the aquifer due to subsidence under the Slower, Longer Project Alternative, if any, would be localized and are not considered significant.

- **Impact 3.2.3.7-7:** A small change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately four miles quasi-radially from the center of subsidence effects in the northern part of the KVCWF area, and a maximum subsidence of approximately 1.5 feet is projected in a small part of that central area. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer.

  Significance of the Impact: The potential for the Kobeh Valley basin-fill aquifer to transmit or store water is not expected to be significantly impacted.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

Potential for Significant Land Surface Alteration

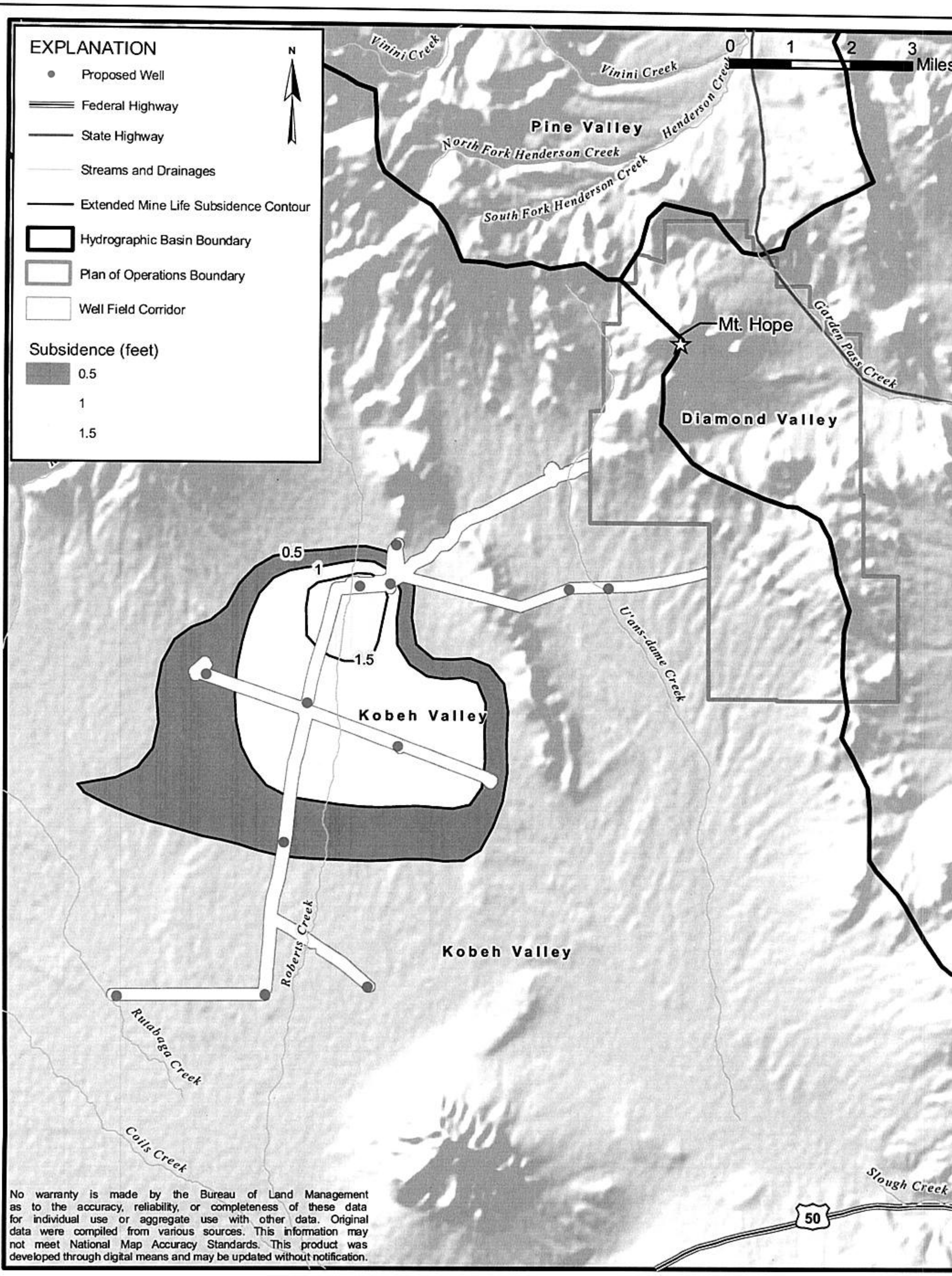
Potential impacts to ground surface conditions (fissuring or alteration of drainage patterns) resulting from dewatering-induced land subsidence under the Slower, Longer Project Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.7-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for uncontained process fluids or chemical or hydrocarbon releases. Capture of surface runoff by fissures, may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.

  Significance of the Impact: The impact would be significant if fissure gullies formed.

- **Mitigation Measure 3.2.3.7-8:** EML would be responsible for specifically monitoring for fissure gully development. If fissure gullies form, they would be filled in with clean, coarse-grained alluvium, with the intent of providing a rapid means of dissipation for any surface water entering the fissure, thereby reducing the propagation of the fissure through continued erosion. The fill material then would be seeded with a BLM-approved seed mix.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.7-8 would be effective at mitigating the fissures that develop. Any residual effects of fissure development would be fully mitigated during the life of the Project.



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 08/06/2012

FILE NAME: p1635_Fig3-2-33_ExtendedAlt_SubsidenceKobehValley.mxd

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Slower, Longer Project Alternative Predicted Subsidence in Year 88 (2099), Relative to 2009 Conditions

Figure 3.2.33

3.3 Water Resources - Water Quality

3.3.1 Regulatory Framework

The NDEP requires compliance with National Pollution Discharge Elimination System (NPDES) permits related to discharge to waters of the U.S. of wastewater to surface waters from discharge points such as tailings piles and wastewater ponds, as well as with NPDES permits related to discharge to waters of the U.S. of storm water runoff. NDEP also requires that discharges into subsurface waters be controlled if the potential for contamination of ground water supplies exist. In such instances a State of Nevada zero-discharge permit is required.

The Nevada Water Pollution Control Law provides the state the authority to maintain water quality for public use, wildlife, existing industries, agriculture, and the economic development of the site. The NDEP defines waters of the state to include surface water courses, waterways, drainage systems, and underground water. The Nevada Water Pollution Control Law also gives the State Environmental Commission authority to require controls on diffuse sources of pollutants, if these sources have the potential to degrade the quality of the waters of the state. The EPA has also granted Nevada authority to enforce **DWS** established under the Safe Drinking Water Act.

The State of Nevada classifies surface water bodies into four classes; Class A, Class B, Class C, and Class D. Each class has associated water quality standards. Class A waters include waters or portions of waters located in areas of little human habitation, no industrial development or intensive agriculture and where the watershed is relatively undisturbed by man's activity. The beneficial uses of Class A waters are municipal or domestic supply, or both, with treatment by disinfection only, aquatic life, propagation of wildlife, irrigation, watering of livestock, recreation including contact with the water and recreation not involving contact with the water. Class B waters include waters or portions of waters that are located in areas of light or moderate human habitation, little industrial development, light-to-moderate agricultural development, and where the watershed is only moderately influenced by man's activity. The beneficial uses of Class B water are municipal or domestic supply, or both, with treatment by disinfection and filtration only, irrigation, watering of livestock, aquatic life and propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply. Class C waters include waters or portions of waters that are located in areas of moderate-to-urban human habitation, where industrial development is present in moderate amounts, agricultural practices are intensive, and where the watershed is considerably altered by man's activity. The beneficial uses of Class C water are municipal or domestic supply, or both, following complete treatment, irrigation, watering of livestock, aquatic life, propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply. Class D waters include waters or portions of waters located in areas of urban development, highly industrialized or intensively used for agriculture or a combination of all the above and where effluent sources include a multiplicity of waste discharges from the highly altered watershed. The beneficial uses of Class D waters are recreation not involving contact with the water, aquatic life, propagation of wildlife, irrigation, watering of livestock, and industrial supply, except for food processing purposes.

Roberts Creek and its tributaries are Class A water bodies from the headwaters to the reservoir and Class B water bodies below the reservoir. Denay Creek and its tributaries from the headwaters to Tonkin Reservoir and the Reservoir itself are Class A water bodies. Denay Creek below Tonkin Reservoir is a Class B water body. J.D. ponds are Class C water bodies. These water bodies have aquatic life, livestock, recreation, irrigation, and other beneficial uses. All other perennial streams in the vicinity of the Project Area are unclassified.

The applicable surface water and ground water quality standards for inorganic compounds in Nevada are summarized in Table 3.3-1. These standards are based both on aquatic toxicity criteria and the proposed use of the water.

3.3.2 Affected Environment

3.3.2.1 Study Methods

Water Resources - Water Quality information, descriptions, and data are based on technical reports addressing geochemistry and pit water quality that were prepared for EML. The reports include the Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report (SRK 2008d) and the Mount Hope Project Final Pit Lake Geochemistry Report (SWS 2010).

3.3.2.2 Existing Conditions

3.3.2.2.1 Surface Water Quality

Surface water from springs and perennial streams in the Mount Hope area is generally of good quality, i.e., meeting all Nevada water quality standards at most locations (SRK 2008d). The locations where water quality standards are not met tend to fall into one of four general categories:

1. Waters that have elevated TDS, SO_4, or pH. In xeric environments, some locations have water that has undergone extensive evaporation. This evaporation leads to elevated levels of TDS and SO_4, as well as elevated pH;
2. Spring waters with elevated Mn or Fe. Mn and Fe are naturally mobile under the reducing conditions of most ground water; therefore, their concentrations would be higher, often exceeding regulatory standards. However, when these waters emanate into the oxidizing conditions found in surface waters, the Fe and Mn in these waters would rapidly precipitate;
3. Anomalous elevated metals in a single sample. At three locations, metals are found above regulatory limits for a single sample. All other samples at these locations are below regulatory limits and usually below detection; and
4. The Zinc Adit. At the Mount Hope mine site there is water emanating from the Zinc Adit. Prior to discharge from the adit, this water migrates through the zones of mineralization in the Mount Hope ore deposit where propylitically altered rock, enriched with sulfide minerals and trace elements, provides the water with its unique chemical signature. This mineralized material would be removed through the development of the open pit under the Proposed Action. In addition, the source of the water discharging from the adit and the adit itself would be removed.

3.3.2.2.2 Ground Water Quality

The applicable ground water quality standards for inorganic compounds in Nevada is summarized in Table 3.3-1 under the Maximum Contaminate Levels (MCLs) column. These standards are based both on aquatic toxicity criteria and the proposed use of the water, and with the exception of the aquatic life standards are the same for surface water.

Similar to the surface water in the vicinity of Mount Hope, ground water is generally of good quality. Similar to the spring data, there are some elevated levels of Mn, and elevated pH over the standard of 8.5.

Near the ore deposit, reducing conditions created by the presence of sulfides in the ore result in water from wells commonly exceeding regulatory standards for Fe and Mn, with several wells also having elevated TDS and SO_4. Well IGM-169 has elevated levels of fluoride, Al, and As present in its water, likely related to the abundant sulfide mineralization observed in the drill cuttings from the well. These reported data are from an open borehole as opposed to the standard method of obtaining data from a completed monitoring well. The pH of IGM-169 is unusual in that it has values below the NDEP standard of 6.5 to 8.5; however, the pH values generally ranged from 6.8 to 7.2 in the remainder of the sample sites. This well is located in the upper propylitic alteration zone of the ore deposit, where this type of chemistry signature in the water would be expected.

Table 3.3-1: Standards for Toxic Materials Applicable to Designated Waters

Chemical	Maximum Contaminate Levels (mg/L)	Aquatic Water Quality Micrograms per liter (µg/L)	Irrigation (µg/L)	Watering Livestock (µg/L)
Aluminum	0.2	-	-	-
Antimony	0.006	-	-	-
Arsenic	0.010	-	100[b]	200[c]
Arsenic (III)	-	-	-	-
1-hour average	-	342[a,e]	-	-
96-hour average	-	180[a,e]	-	-
Barium	2	-	-	-
Beryllium	0.004	-	100[b]	-
hardness≤75mg/L	-	-	-	-
hardness≥=75mg/L	-	-	-	-
Boron	-	-	750[a]	5,000[c]
Cadmium	0.005	-	10[d]	50[c]
1-hour average	-	0.85 exp {1.128In(H)-3.828][a,e]	-	-
96-hour average	-	0.85 exp {0.7852In(h)-3.490}[a,e]	-	-
Chromium (total)	0.1	-	100[c]	1,000[c]
Chromium (VI)	-	-	-	-
1-hour average	-	15[a,e]	-	-
96-hour average	-	10[a,e]	-	-
Chromium (III)	-	-	-	-
1-hour average	-	0.85 exp {0.8190In(H)+3.688}[a,e]		-
96-hour average	-	0.85 exp {0.8190In(H)+1.561}[a,e]		-
Copper	1.0	-	200[c]	500[c]
1-hour average	-	0.85 exp{0.9422In(H)-1.464}[a,e]	-	-

Chemical	Maximum Contaminate Levels (mg/L)	Aquatic Water Quality Micrograms per liter (µg/L)	Irrigation (µg/L)	Watering Livestock (µg/L)
96-hour average	-	0.85 exp {0.8545In(H)-1.465}[a,e]	-	-
1-hour average	-	22[a]	-	-
Cyanide	0.2	-	-	-
96-hour average	-	5.2[a]	-	-
Fluoride	0.14	-	1,000[c]	2,000[c]
Iron	0.3	1,000[a]	5,000[c]	-
Lead	0.015	-	5,000[c]	100[c]
1-hour average	-	0.50 exp {1.273In(H)-1.460}[a,e]	-	-
96-hour average	-	0.25 exp {1.273In(H)-4.705}[a,e]	-	-
Manganese	0.05	-	200[c]	-
Mercury	0.002	-	-	10[c]
1-hour average	-	2.0[a,e]	-	-
96-hour average	-	0.012[a]	-	-
Molybdenum	-	19[d]	-	-
Nickel	-	-	200[c]	-
1-hour average	-	0.85 exp {0.8460In(H)+3.3612}[a,e]		-
96-hour average	-	0.85 exp {0.8460In(H)+1.1645}[a,e]		-
Selenium	0.05	-	20[c]	50[c]
1-hour average	-	20[a]	-	-
96-hour average	-	5.0[a]	-	-
Silver	0.1	0.85 exp {1.72In(H)-6.52}[a,e]	-	-
Sulfate	250	-	-	-
Sulfide (Undissociated hydrogen sulfide)	-	2[a]	-	-
Thallium (Tl)	0.002	-	-	-
Zinc	5	-	2,000[c]	25,000[c]
1-hour average	-	0.85 exp {0.8473In(H)+0.8604}[a,e]		-
96-hour average	-	0.85 exp {0.8473In(H)+0.7614}[a,e]		-

1 Single concentration limits and 24-hour average concentration limits must not be exceeded. One-hour average and 96-hour average concentration limits may be exceeded only once every three years. See reference a.
2 Hardness is expressed as mg/L calcium carbonate.
3 If a criterion is less than the detection limit of a method that is acceptable to the division, laboratory results which show that the substance was not detected would be deemed to show compliance with the standard unless other information indicates that the substance may be present.
4 If a standard does not exist for each designated beneficial use, a person who plans to discharge waste must demonstrate that no adverse effect would occur to a designated beneficial use. If the discharge of a substance would lower the quality of the water, a person who plans to discharge waste must meet the requirements of NRS 445A.565.
5 The standards for metals are expressed as total recoverable, unless otherwise noted.
a EPA, Pub. No. EPA 440/5-86-001, Quality Criteria for Water (Gold Book) (1986).
b EPA, Pub. No. EPA 440/9-76-023, Quality Criteria for Water (Red Book) (1976).
c National Academy of Sciences, Water Quality Criteria **1972** (Blue Book) **(1973)**.
d California State Water Resources Control Board, Regulation of Agricultural Drainage to the San Joaquin River: Appendix D, Water Quality Criteria (March 1988 revision).
e This standard applies to the dissolved fraction. (Added to NAC by Environmental Commission, eff. 9-13-85; A 9-25-90; 7-5-94; A 11-29-95).

Source: NAC 445A.144, which states, "except as otherwise provided in this section, the following standards for toxic materials are applicable to the waters specified in NAC 445A.123 to 445A.127, inclusive, and NAC 445A.145 to 445A.225, inclusive". If the standards are exceeded at a site and are not economically controllable, the commission would review and adjust the standards for the site.

Overall, the ground water from within the ore deposit and from the surrounding area has relatively high levels of alkalinity (generally over 100 mg/L calcium carbonate [$CaCO_3$]) and somewhat elevated levels of SO_4 (generally over 100 mg/L as SO_4, ranging up to 1,000 mg/L as SO_4). These waters generally fall into the classification as calcium bicarbonate to calcium sulfate waters. **The samples of ground water from the Project Area consistently exceeded the Nevada reference values for Mn, with values that range from 0.0076 to 25 mg/L. Less frequent exceedances, but still numerous, were Fe, Al, pH, SO4, TDS, and F (SRK 2008a).**

3.3.2.2.3 Waste Rock Characterization

Characterization Assessment Plan

Ore and waste rock from the Mount Hope deposit has been extensively characterized by SRK (2008d). The Waste Rock Report presents a detailed scheme for characterizing waste rock that incorporates whole rock analysis, ABA, MWMP testing, NAG testing, mineralogical characterization, and HCTs (Figure 3.3.1).

As a porphyry sulfide ore body, the deposit has very low levels of sulfide while having almost no carbonate to neutralize any acid that the low levels of sulfide may generate. Therefore, the characterization of waste rock focuses on determining the threshold at which sulfide overcomes the acid generating capacity of the rock and causes water quality issues.

Whole Rock Analyses

Whole rock analyses were conducted on 250 samples from the Mount Hope deposit using induced coupled plasma-mass spectrometry (ICP-MS). Due to the very nature of an orebody, there were observed enrichments in several elements, including silver (Ag), As, Cd, Mo, S, Sb, Se, Sn, and Zn throughout the orebody. In general, the enrichment was correlated more with the degree of enrichment than the lithology type. In the outer phyllic and argillic alteration halos, Th, Pb, and Cu are also present. The highest degree of elemental enrichment is observed in the skarn mineralization on the east side of the proposed open pit, which is associated with Zn sulfide replacement mineralization. The enriched Zn zone is where previous mining occurred during the 1940s. The skarn zone is also enriched in beryllium (Be), Fe, Pb, Sn, Mn, and S. Whole rock analyses did not analyze for fluorine (F) as an element, due to the limitations of the digestion method, (dissolving samples in hydrofluoric acid). However, mineralogical analysis indicated that elevated levels of fluorite are present in the skarn, potassic, and biotite alteration zones.

Mineralogic Analyses

Mineralogic analyses of the deposit have been conducted by SRK (2008d) and many other exploration programs. The key findings show that there is very little carbonate present (except in the outer propylitic alteration zone) in the deposit. Molybdenite and pyrite (PAG sulfides) are present in the main ore zone; however, in comparatively low concentrations.

Static Testing

Static testing included MWMP, ABA, and NAG testing.

Meteoric Water Mobility Procedure Test Results

MWMP testing was conducted on 137 samples. MWMP testing provides an indication of whether rocks would leach constituents. However with sulfide-bearing materials, the results of the MWMP testing provide only an initial indication of the potential release of metals. Subsequent sulfide oxidation in a ore deposit, for which the MWMP test is not designed, would release additional constituents. As there is little oxidation in the deposit, MWMP testing primarily guided the selection of additional samples. MWMP testing did indicate that some samples (primarily from the phyllic, argillic, and silicic alteration types) generated several metals (including Al, Cu, Cd, Fe, Mn, and Zn) at elevated levels and low pH (less than 6.5).

Acid Base Accounting Test Results

ABA testing was also conducted on 137 core samples and 1,546 pulp samples using the modified Sobek method (Lawrence and Wang 1997). In short, this method measures the amount of sulfide and SO_4 present in the rock using LECO analyses, and total inorganic **carbon** (C) by a titration method. The S and C values are then converted to acid equivalence to assess whether the rock has the potential to generate acid.

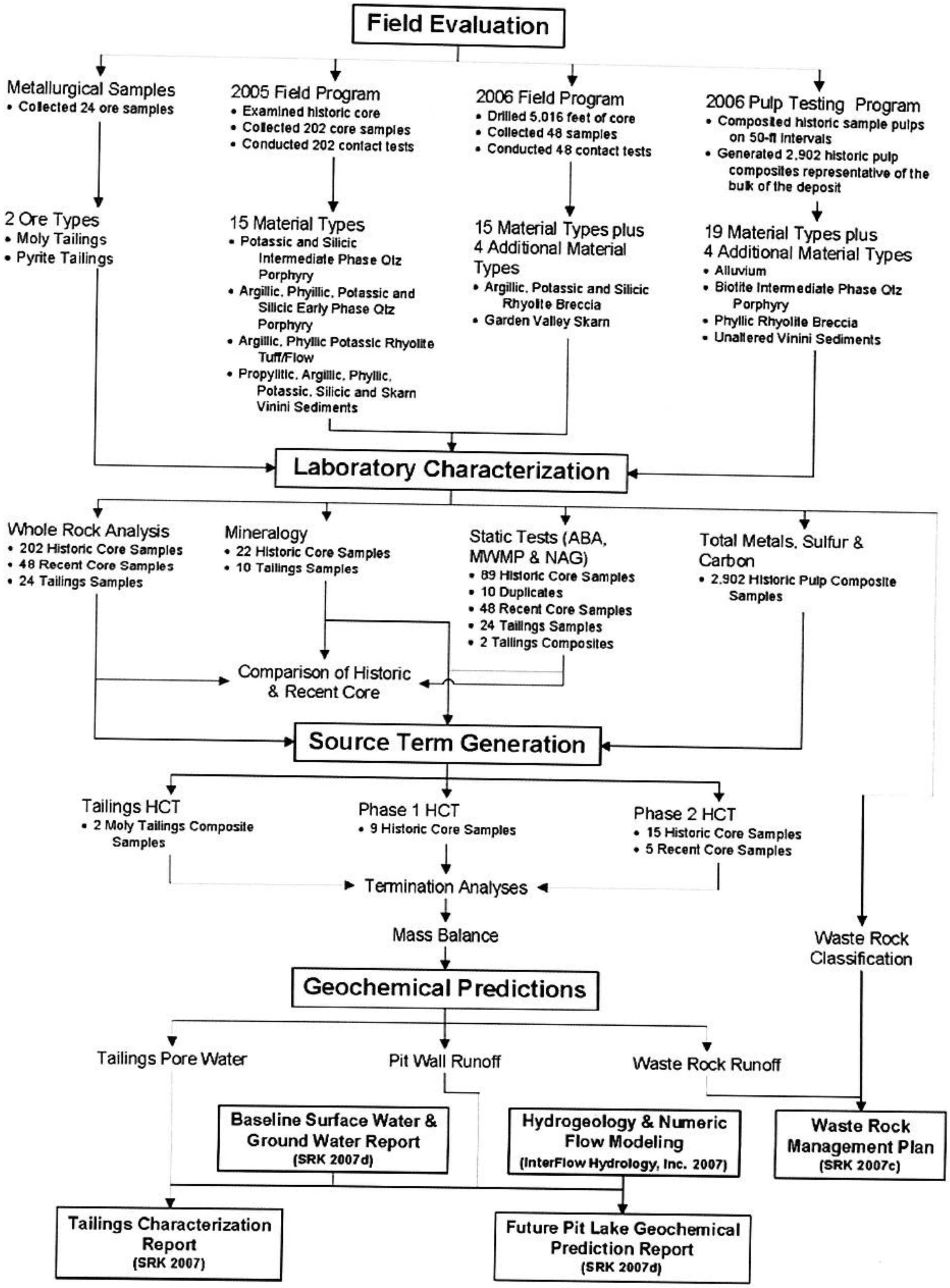
The method for calculating the acidification potential (AP) is based on the stoichiometry of the reaction of pyrite and the amount of sulfide S is multiplied by a coefficient to convert the value to an equivalent amount of acidity in terms of tons $CaCO_3$/1,000 tons (Ktons) rock to give the equivalent amount of acid the rock can generate. Similarly, based on the amount of inorganic C measured in the rock, the carbonate is converted to an equivalent neutralizing potential of $CaCO_3$ presented also in tons $CaCO_3$/Ktons rock to give the neutralization potential (NP).

The net neutralization potential (NNP) is the AP subtracted from the NP: NNP=NP-AP.

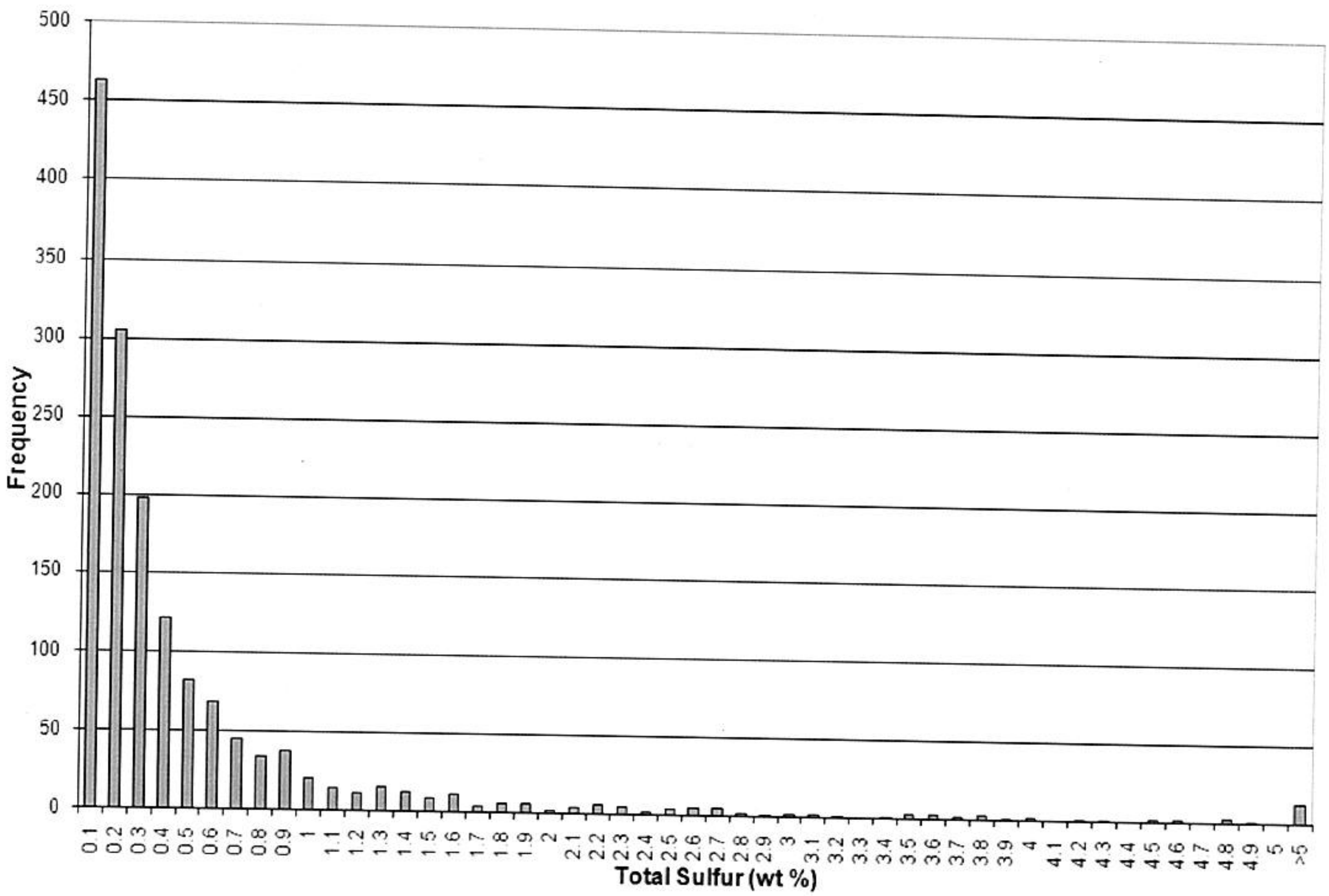
If the NNP is negative, there is more AGP than neutralizing potential, and the rock has the potential to generate acid. If the NNP is positive, the rock likely has an excess of neutralization capacity. There is an assumed stoichiometry of reactions that does not always strictly apply to all minerals because there is uncertainty associated with these measurements. Kinetic factors may affect the generation or consumption of acid. NNP results are characterized as three groups:

- If NNP is greater than 20 tons $CaCO_3$/Ktons, the rock is net neutralizing;
- If the NNP is between 20 and -20 tons $CaCO_3$/Ktons, the rock is assumed to have an uncertain or weak AGP; and
- If the NNP is less than -20, the rock is characterized as strongly acidic.

The AP and NP results from the deposit representative of the ore deposit geology and alteration types. Histograms of total S (Figure 3.3.2) and total C (Figure 3.3.3) indicate that both sulfide (with the majority of the samples below 0.3 percent sulfide) and carbonate (with the majority of the samples also below 0.3 percent) are very low in the ore and waste rock. Many samples have very low sulfide and carbonate values; therefore, a plot of NNP versus sulfide S (Figure 3.3.4) shows that most samples are very close to zero, with a tail of acid generating samples trailing off at sulfide S values greater than 0.5 percent. Therefore, the majority of the samples at Mount Hope have an NNP value between -20 and 20 tons $CaCO_3$/Ktons rock, which is within the uncertain range for the NP.



BATTLE MOUNTAIN DISTRICT OFFICE Mount Lewis Field Office 50 Bastian Road Battle Mountain, Nevada 89820	BUREAU OF LAND MANAGEMENT MOUNT HOPE PROJECT	DRAWING TITLE: **Characterization Program Flow Diagram**	**Figure 3.3.1**
DESIGN: EMLLC · DRAWN: GSL · REVIEWED: RFD			
CHECKED: - · APPROVED: RFD · DATE: 07/29/2011			
FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd			



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 07/29/2011
FILE NAME p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd		

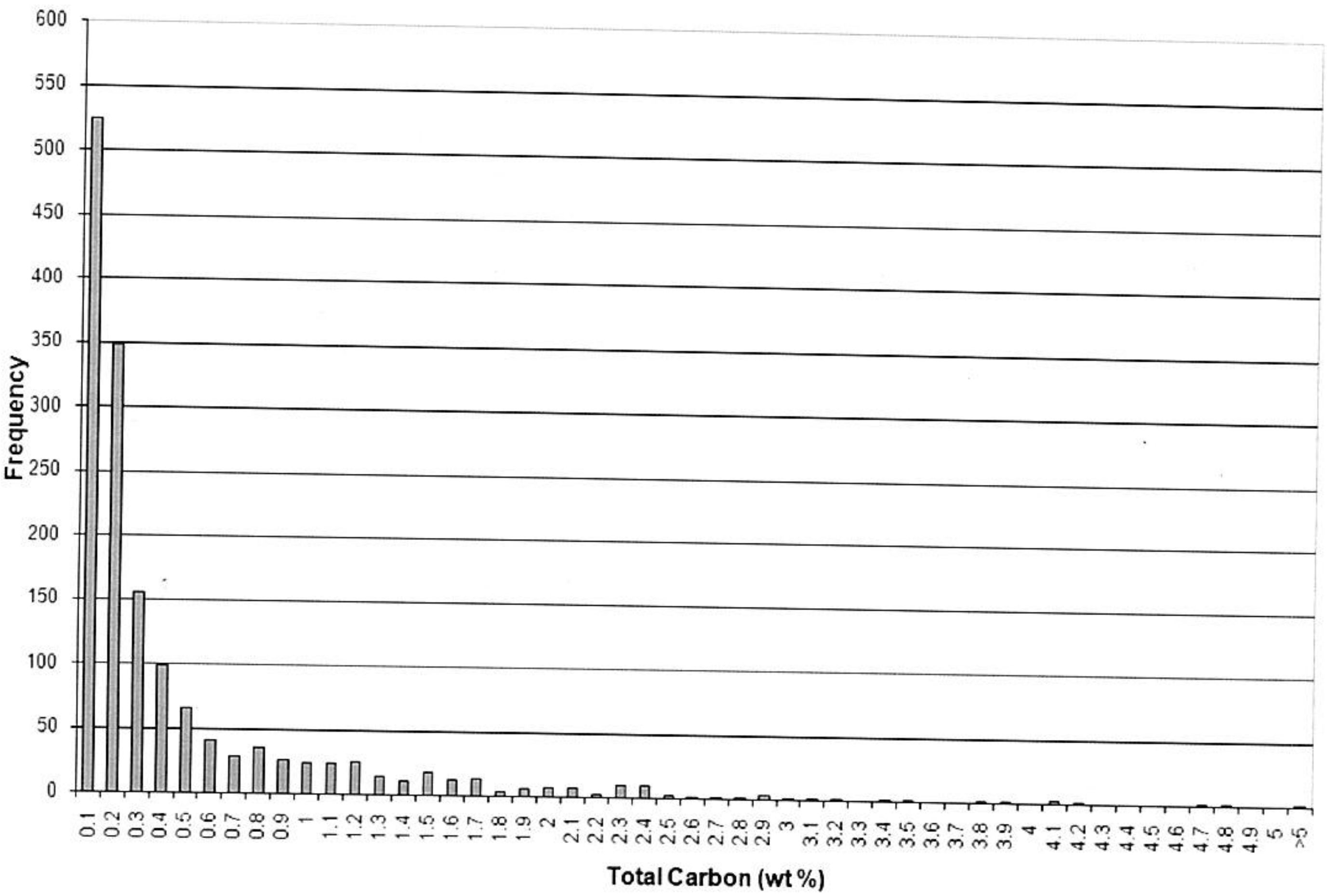
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Total Sulfur Histogram for Mount Hope Waste Rock Samples

Figure 3.3.2



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN	EMLLC	DRAWN	GSL	REVIEWED	RFD
CHECKED	-	APPROVED	RFD	DATE	07/29/2011
FILE NAME	p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd				

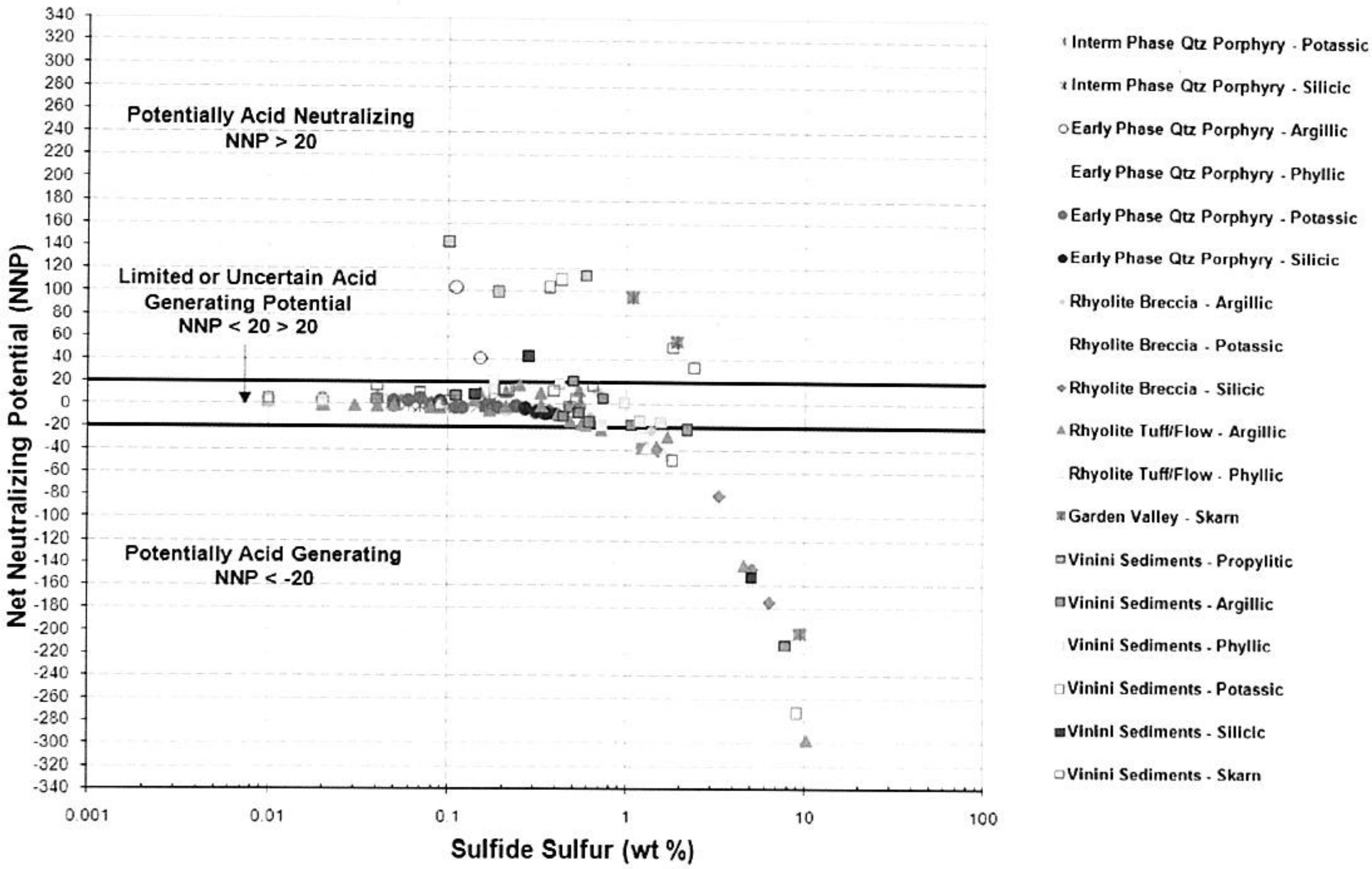
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Total Carbon Histogram for Mount Hope Waste Rock Samples

Figure 3.3.3



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 07/29/2011
FILE NAME p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Net Neutralization Potential Versus Sulfide

Figure 3.3.4

Net Acid Generation Testing

NAG testing is a peroxide digestion of samples using the method of Miller et al. (1997). The peroxide in this digestion would oxidize the sulfide minerals in the samples, generating acid. If inadequate neutralization is present in the rock material, the final NAG effluent would be acidic. It is a test that determines how much acid a sample would generate, the test does not assess the neutralization potential of a material. NAG test results fall into three separate categories, based on both the pH and the total acidity of the NAG effluent:

- Highly acid generating samples with a pH of less than 4 and acidity greater than ten kilograms (kg) H_2SO_4 per ton of rock;
- Lower capacity acid generating samples with a pH less than 4 and an acidity less than ten kg H_2SO_4 per ton of rock; and
- Non acid forming materials with a pH greater than 4.

NAG testing is a quick, reliable means to gain insight into the true acid generating capacity of a sample. In many ways, NAG testing is a reasonable worst-case scenario for acid generation for a sample, as the test achieves nearly complete oxidation of the sulfide minerals, a situation that rarely occurs in field settings.

The results of the NAG testing are shown in Figure 3.3.5. This figure shows the final NAG acid generation plotted against the NAG pH. The results of this testing show a bimodal distribution of results with a hockey-stick shaped plot. Tests having a pH greater than 4 and having low levels of acid generation plot on a flat line above pH 4; samples with a final NAG pH greater than 4 have a linear uptick in acidity as the pH decreases. Figure 3.3.6 shows the NAG acidity plotted against total S in samples. The total S content of 0.3 percent appears to be a clear demarcation line. Samples with less than 0.5 percent S generate no NAG acidity.

Summary of Static Testing

The static testing protocols provide two independent indicators of acid generation, ABA testing and NAG testing. These results show that materials with greater than approximately 0.3 percent sulfide S are likely to generate acid material. Samples with less than 0.3 percent total S never generated substantial acid (greater than two kg H_2SO_4 per ton of material).

Kinetic Testing

As a standard practice in Nevada, the HCTs were conducted to characterize the long-term acid generation of deposit materials (SRK 2008d; SWS 2010). Twenty-nine humidity cells were run for at least 70 weeks to characterize the generation of acid over time. The HCTs were run in accordance with ASTM Method D-5744-96. The HCTs are repeatedly put through seven-day cycles. In the first two days deionized water is trickled over the samples. This is followed by two days of exposure to moist air and then followed by two days of dry air. On the seventh day, the samples are rinsed with distilled water, and a sample is collected for analysis. Samples are analyzed on a weekly basis for pH, SO_4, acidity, alkalinity, conductivity, Fe, and reduction potential (Eh) over the full 70 weeks.

The HCTs serve multiple purposes. At their most basic level, HCTs provide the most definitive indication of whether or not a specific sample would eventually generate acid. The secondary application of HCTs is to generate source terms for additional geochemical modeling to quantify how waste rock and pit wall materials would interact with the environment. It is common for the chemistry of an HCT to evolve over time. One common pattern seen in HCTs is a delayed onset of acid generation for several weeks and then the sample suddenly turns acidic. Conversely, some humidity cells react quickly and all the sulfide is consumed or where acid generation happens so quickly that no additional acid is generated after a few weeks and the sample eventually evolves to a circumneutral pH.

As previously stated, the first goal of HCTs is to determine if rocks would ultimately generate acid. In practice, these more rigorous kinetic tests support the detailed static testing program that these samples have undergone. The humidity cells provide excellent validation of any rock characterization assessment plan. If the acid base classification assessment plan is correct and protective of the environment (conservative), HCTs should not generate acid when ABA and NAG testing indicated that acid would not be generated.

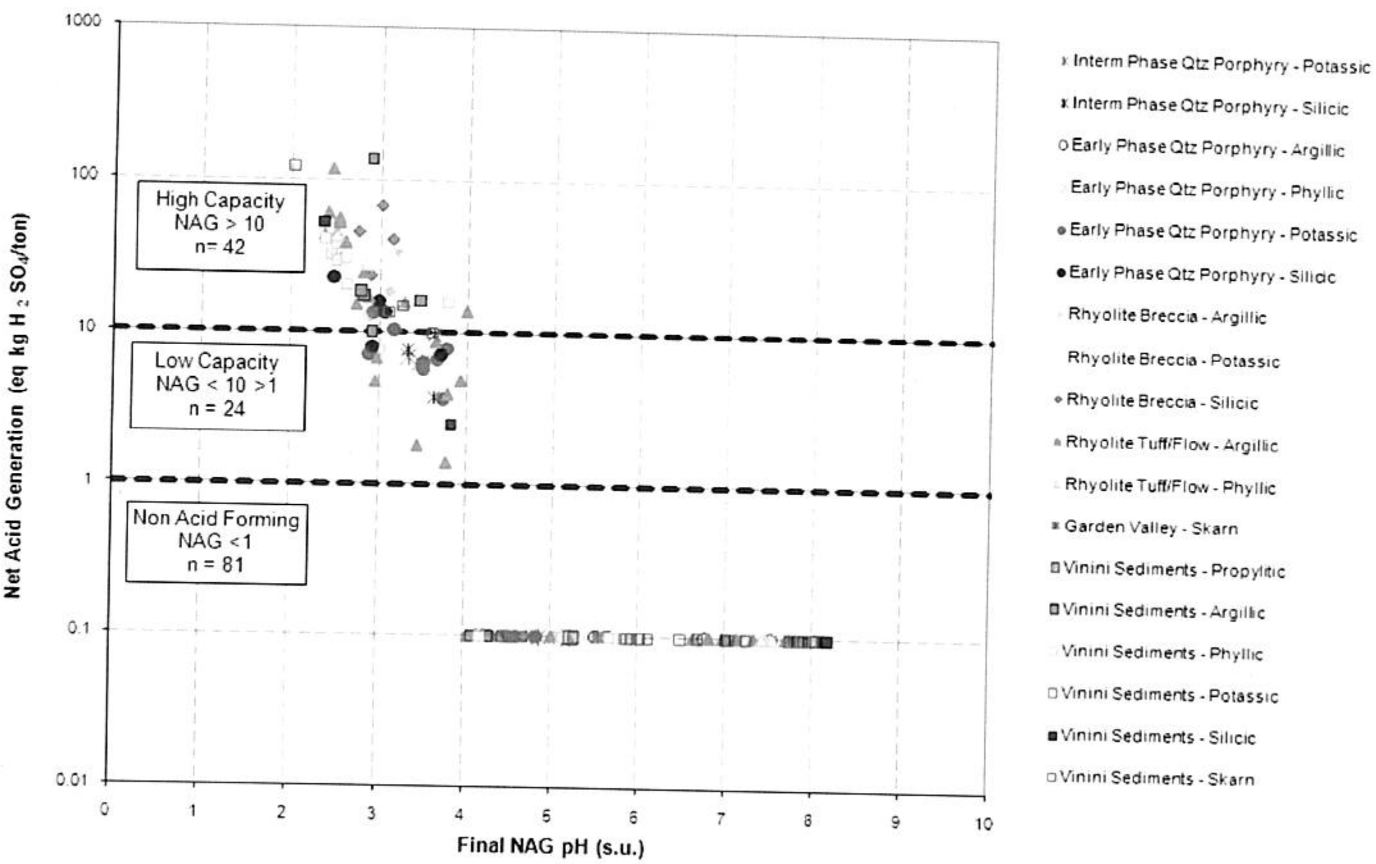
A comparison of the results of the HCTs to the static tests is presented in Table 3.3-2. Overall, 25 of the 29 cells have a behavior that comports with the predictions of the static testing. There are four samples (cells 9, 19, 26, and 30) for which either NAG or ABA static testing would predict that these samples would generate acid, but in fact, the HCTs did not. All samples that were predicted to be non-acid generating were found to be non-acid generating in the HCTs. These results are shown in Figures 3.3.7 and 3.3.8, which show that all samples that are below criteria identified in this study do not generate acid in HCTs. Overall, the HCTs are in excellent agreement with the static testing predictions. Where differences do arise between HCTs and static testing, the static testing tends to predict more acid generation than is found in HCTs.

Therefore, the static testing program appears to provide a conservative measure of whether or not a particular rock would generate acid.

HCT results also provide inputs into assessing the impacts to ground water and surface water quality from waste rock, tailings, and pit walls. The interpretation of the HCTs is discussed in detail in SRK 2008d and 2010. In short, the average concentrations of HCT effluents were used to provide baseline inputs to predict the water quality of waste rock drainage and pit lake water quality.

For some lithologic units, the HCT results show considerable variability within individual alteration and lithology types. For example, humidity cells 9, 18, and 31 are all from the Ordovician Vinni Formation with argillic alteration; however, all three cells have different pHs, and cells 18 and 31 are classified differently (18 as Non-PAG, 9 and 31 as PAG). Cells 18 and 31 both have similar levels of sulfide S (0.51 percent and 0.54 percent, respectively, and Cell 9 has a higher sulfide content of 2.41 percent). The observation of this amount of variability aids in the prediction of future environmental impacts at the mine, as it is important to understand this variability in assessing future effects.

Overall, the HCT effluents are generally stable and show no signs of becoming more acidic. Only one cell (Cell 6, a sample of potassic-altered Valmy Formation), showed any delayed onset of acid generation. The initial pH in the first week for Cell 6 was 3.2, but rose to pH 6.2 by week



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 08/03/2011

FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd

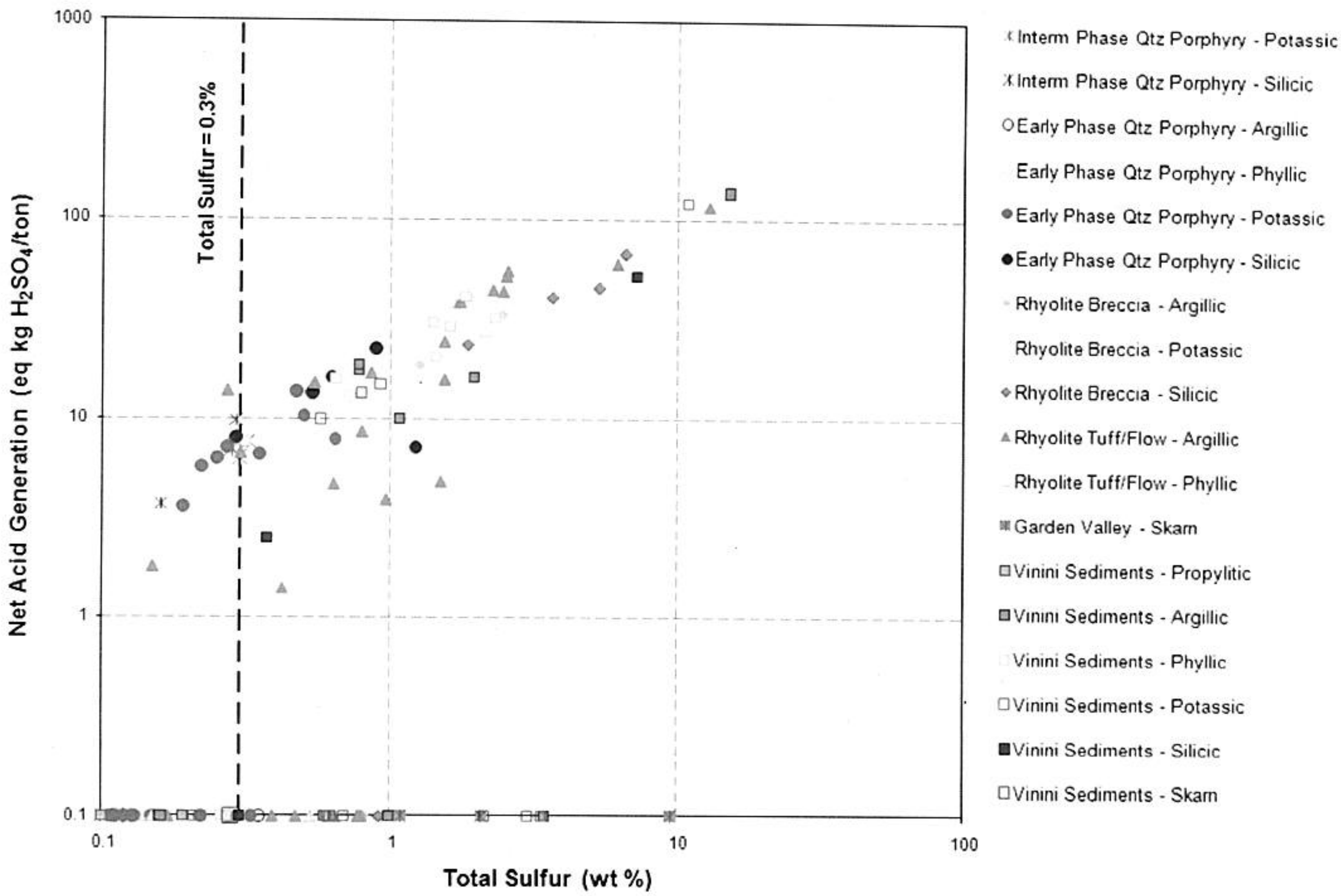
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Net Acid Generation Versus Net Acid Generation pH

Figure 3.3.5



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN	EMLLC	DRAWN	GSL	REVIEWED	RFD
CHECKED	-	APPROVED	RFD	DATE	07/29/2011
FILE NAME	p1535_Fig3-3-X_Geochem_8i11i_landscape.mxd				

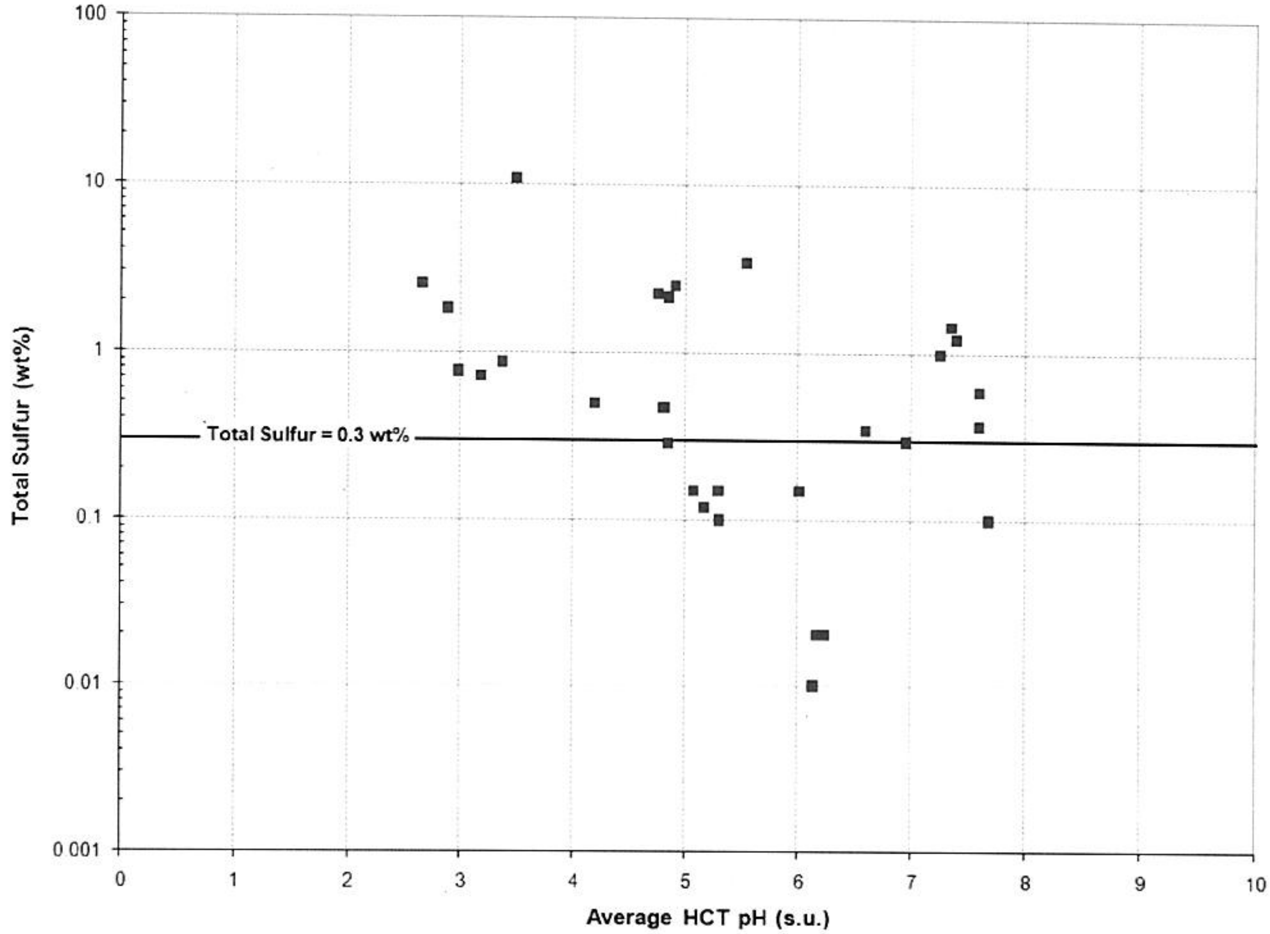
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Total Sulfur Versus Net Acid Generation

Figure 3.3.6



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 11/02/2011
FILE NAME p1635_Fig3-3-X_Geochem_8x11_landscape.mxd		

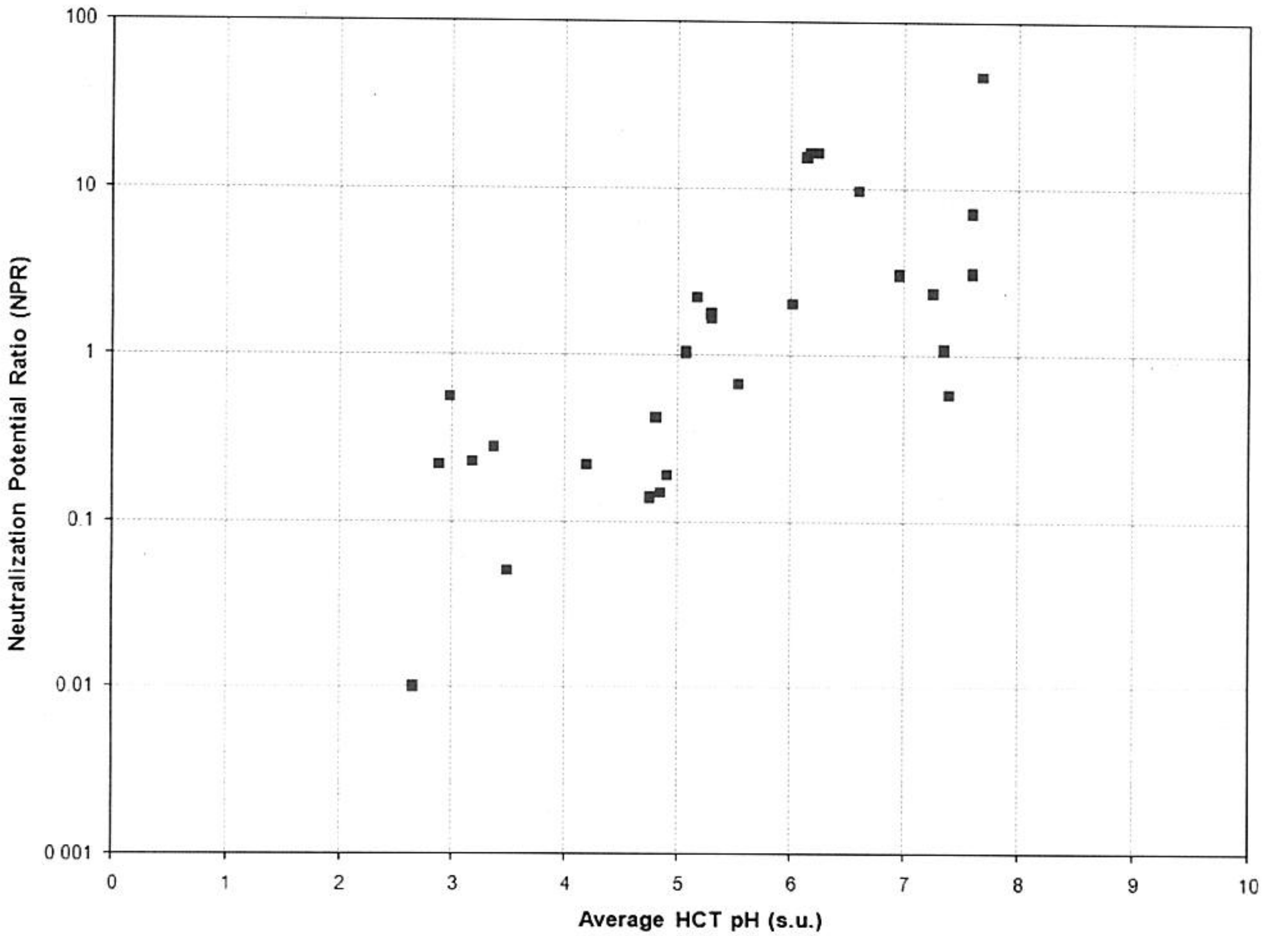
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Total Sulfur Plotted Against the Average Humidity Cell pH

Figure 3.3.7



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 11/02/2011
FILE NAME p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Neutralization Potential Ratio Plotted Against Average Humidity Cell pH

Figure 3.3.8

nine, then slowly dropped to below pH 3 by week 30 of the testing, remaining below pH 3 to the end of the test. Metals and other constituent concentrations are generally stable or drop in all cells by the end of the tests, indicating that the tests have likely captured all potential geochemical behavior of these materials in the field.

Table 3.3-2: Comparison of Humidity Cell Test Results to Static Test Results

Cell #	Material Type[2]	Acid Generation Prediction From ABA[1]	NAG Test Prediction[1]	Acid Generation Prediction From HCT	MWMP Constituents Above NDEP Values	HCT Constituents Above NDEP Values
1	Tmr - Ar	uncertain	Non-PAG	Non-PAG	None	pH
2	Tqp - Ar	Non-PAG	Non-PAG	Non-PAG	None	None
3	Tmr - Ar	PAG	PAG	PAG	Al, Cd, Cu, fluoride, Fe, Pb, Mn, Ni, pH, SO_4, Tl, Zn	Al, As, Cd, fluoride, Mn, Ni, pH, SO_4, Tl, Zn
4	Tmr - Ar	PAG	PAG	PAG	Mn, pH, Zn	pH, Al, Mn, Zn
5	Ov - Pot	Non-PAG	Non-PAG	Non-PAG	None	None
6	Ov - Pot	PAG	PAG	PAG	Al, As, Cd, Cu, Fe, Pb, Mn, Ni, pH, SO_4, Tl, Zn	Al, As, Sb, Cd, Cu, Fe, Mn, Ni, pH, SO_4, Tl, Zn
7	Tqp - Pot	PAG	PAG	PAG	Mn	Al. As, Cd, Cu, Fe, pH
8	Tfr - Ar	Non-PAG	Non-PAG	Non-PAG	None	pH
9	Ov - Ar	PAG	Non-PAG	Non-PAG	Al, Cd, Cu, Fe, Pb, Mn, Ni, pH, SO_4, Tl, Zn	Al, As, Cd, F, Mn, Ni, pH, SO_4, Zn
12	Ov - Si	Non-PAG	uncertain	Non-PAG	None	As
13	Tqpa - Si	PAG	PAG	PAG	Al, Cd, fluoride, Mn	Al, Cd, fluoride, Mn, pH
14	Tqp - Ph	PAG	PAG	PAG	Al, Cd, Cu, Fe, Pb, Mn, Ni, Tl, Zn	Al, Cd, Cu, fluoride, Fe, Pb, Mn, Ni, pH, SO_4, Tl, TDS, Zn
15	Tqp - Si	PAG	PAG	PAG	None	Al, As, Cd, Cu, fluoride, Fe, Pb, Mn, pH, Zn
16	Tqp - Ph	Non-PAG	Non-PAG	Non-PAG	None	Cd, fluoride, Mn
17	Tqp - Ar	Non-PAG	Non-PAG	Non-PAG	fluoride, Mn	fluoride, Mn
18	Ov - Ar	Uncertain	Non-PAG	Non-PAG	Mn	Mn
19	Ov - Ph	PAG	PAG	Non-PAG	None	Mn
20	Ov - Pr	Non-PAG	Non-PAG	Non-PAG	None	As, Mn
21	Ov - Pr	Non-PAG	Non-PAG	Non-PAG	Mn	As, Mn
22	Tqpa - Si	uncertain	Non-PAG	Non-PAG	None	Al, Cd, fluoride, Mn, Zn
23	Tqpa - Pot	uncertain	Non-PAG	Non-PAG	None	Al, F, Fe, Mn, pH

Cell #	Material Type[2]	Acid Generation Prediction From ABA[1]	NAG Test Prediction[1]	Acid Generation Prediction From HCT	MWMP Constituents Above NDEP Values	HCT Constituents Above NDEP Values
24	Ov - Ph	PAG	PAG	PAG	Al, Be, Cd, Fe, Pb, Mn, Ni, SO_4	Al, Be, Cd, Cu, Fe, Pb, Mn, Ni, pH, SO_4, TDS, Zn
25	Tmr - Ph	uncertain	Non-PAG	Non-PAG	Al, fluoride, Mn	Al, fluoride, Mn, pH, Tl, Zn
26	Tqp - Si	PAG	uncertain	Non-PAG	None	Mn
27	Tmr - Ar	PAG	PAG	PAG	Al, Sb, Be, Cd, Cu, fluoride, Pb, Mn, Ni, Se, SO_4, Tl TDS, Zn	Al, As, Be, Cd, Cu, fluoride, Fe, Pb, Mn, Ni, pH, Se, SO_4, Tl TDS, Zn
28	Tmr - Ph	PAG	PAG	PAG	Cd, Mn, Ni, Th, Zn	Al, Cd, Pb, Mn, Ni, pH SO_4, Tl TDS, Zn
29	Tqp - Pot	PAG	PAG	PAG	fluoride, Mn	Al, Cd, fluoride, Pb, Mn, pH
30	Tqp - Pot	PAG	Non-PAG	Non-PAG	Al, fluoride, Mn	Al, fluoride, Mn, pH
31	Ov - Ar	PAG	PAG	PAG	Cd	Al, Be, Cd, Cu, fluoride, Fe, Pb, Mn, Ni, pH, Th

[1] Criteria used for this assessment are based on the discussion above.
[2] Tmr - Rhyolite Flow/Tuff; Ar - Argillic; Tqp - Early Phase Quartz Porphyry; Ov - Vinini Sediments; Pot - Potassic; Tqpa - Intermediate Phase Quartz Porphyry; Si - Silicic; Ph - Phyllic

3.3.2.2.4 Geochemical Characterization of Waste Rock

The prediction of waste rock geochemical behavior for the Project as described in SRK (2007a) is based on commonly applied criteria for static test results. For the MWMP tests, leachate chemistry data were compared to the comparative standards provided in NDEP WPCP Form 0090 for Profile II constituents to determine those that could exceed the comparative standards, and to what degree, when meteoric water contacted these rocks under certain conditions.

The waste rock characterization program was initially used to identify the potential of Project waste rock material to generate acid or to leach deleterious metals (Table 3.3-3). The results of this program were then applied to define a set of criteria for waste rock classification that can be used during implementation of the WRMP that routes waste rock materials to the different WRDFs.

3.3.3 Environmental Consequences and Mitigation Measures

3.3.3.1 Significance Criteria

Criteria for assessing the significance of potential impacts to the quality of water resources in the Project Area are described below. Impacts to water quality resources are considered to be significant if these criteria are predicted to occur as a result of the Proposed Action or the alternatives.

Table 3.3-3: Waste Characterization Summary

Rock Type	Primary Alteration	Percentage of Total Waste Based on Mine Model	Percentage of Waste Based on Mine Model		Percentage of Waste Based on the 1,546 Pulp Samples			MWMP Constituents Above NDEP Comparative Standards[c]
			Percent LPAG[1]/ Non-PAG	Percent PAG	Percent Non-PAG	Percent LPAG	Percent PAG	
Undefined	Undefined	0.6	73	27	NA	NA	NA	NA
Alluvium	NA	–[a]	–[a]	–[a]	100	0	0	--
Intermediate Phase Quartz Porphyry	Undefined	0.6	98	2	NA	NA	NA	NA
	Potassic	1.1	84	16	71	0	29	None
	Biotite	0.1	100	0	29	29	43	--
	Silicic	1.1	75	25	17	4	78	Cd, Mn
Early Phase Quartz Porphyry	Undefined	6.0	94	6	NA	NA	NA	NA
	Argillic	2.3	82	18	43	0	57	F, Mn
	Phyllic	0.1	10	90	74	1	25	Al, Cd, Cu, Fe, Mn, Pb, Th, pH (<6.5)
	Potassic	12.7	91	9	81	1	18	F, Mn
	Silicic	1.2	98	2	54	0	46	Mn
Rhyolite	Undefined	10.0	60	40	NA	NA	NA	NA
	Argillic	22.9	53	47	68	1	31	Al, Cd, Fe, Mn, Zn, pH (<6.5)
	Phyllic	0.6	30	70	51	2	47	Al, Cd, Mn, Zn
	Potassic	3.5	79	21	79	0	21	--
Vinini Formation Sediments	Undefined	20.5	80	20	NA	NA	NA	NA
	Propylitic	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]	pH (<8.5)
	Argillic	2.9	56	44	70	0	30	Al, As, Cd, Cu, F, Fe, Mn, Ni, Pb, pH (<6.5)
	Phyllic	1.6	66	34	61	8	32	Al, F, Mn
	Potassic/Hornfels	12.1	89	11	71	7	22	Al, F, Mn
	Silicic[5]	0.1	100	0	60	0	40	Al, Cd, Cu, Fe, Mn, Nickel (Ni), Pb, Th, Zn, SO_4, TDS, pH (<6.5)
Totals		**100**	**74**	**26**	**67**	**3**	**30**	
			100		**100**			

NA = Not Applicable
– Indicates no data are available
[1]Limited Potentially Acid Generating (LPAG)
[a]Alluvium comprises an insignificant amount of the total waste rock and was not included in the calculation of waste rock volumes.
[b]Even though waste rock with propylitic alteration would be extracted from the open pit, the volume of this material type cannot be estimated because propylitic alteration was not recognized and documented in past exploration drill logs and as a result cannot be defined as a distinct alteration type in the current mine model.
[c]Determined from a statistical analysis of the data as described in SRK (2007a)

3.3.3.1.1 Surface Water Quality

- Release of mining-related contaminants such as cyanide, or metals such as As and Pb, into drainages by spills or flooding that results in soil or sediment contamination in excess of the NDEP standards specified at NAC 445A.2272.1.(c) or release of fuels and lubricants into drainages resulting in soil contamination exceeding the NDEP guidance level (100 milligrams [mg] per kg [mg/kg] of total petroleum hydrocarbons [TPH]).

- A discharge or change in water quality that results in an exceedance of the applicable water quality standards presented in Table 3.3-1 or specified in NAC 445A.453, or NDEP standards for aquatic life, irrigation, or livestock or potential beneficial uses in perennial streams, springs, seeps, and the post-mining pit lake.

3.3.3.1.2 Ground Water Quality

- Degradation of natural ground water quality by chemicals such that concentrations exceed applicable water quality standards, or render water unsuitable for other existing or potential beneficial uses. For ground water that does not meet applicable water quality standards for baseline conditions, degradation would be considered significant where a change in water quality would render the water unsuitable for an existing or potential beneficial use. This criterion is based on NAC 445A.424.

- Degradation of natural soil chemistry by cyanide, trace metals, or other compounds such that concentrations exceed NDEP guidance levels. NDEP guidance levels for soils are based on results of MWMP testing that are ten times the DWS for each compound. This guidance is designed to protect ground water from contamination by leachate from overlying soils.

3.3.3.2 Assessment Methodology

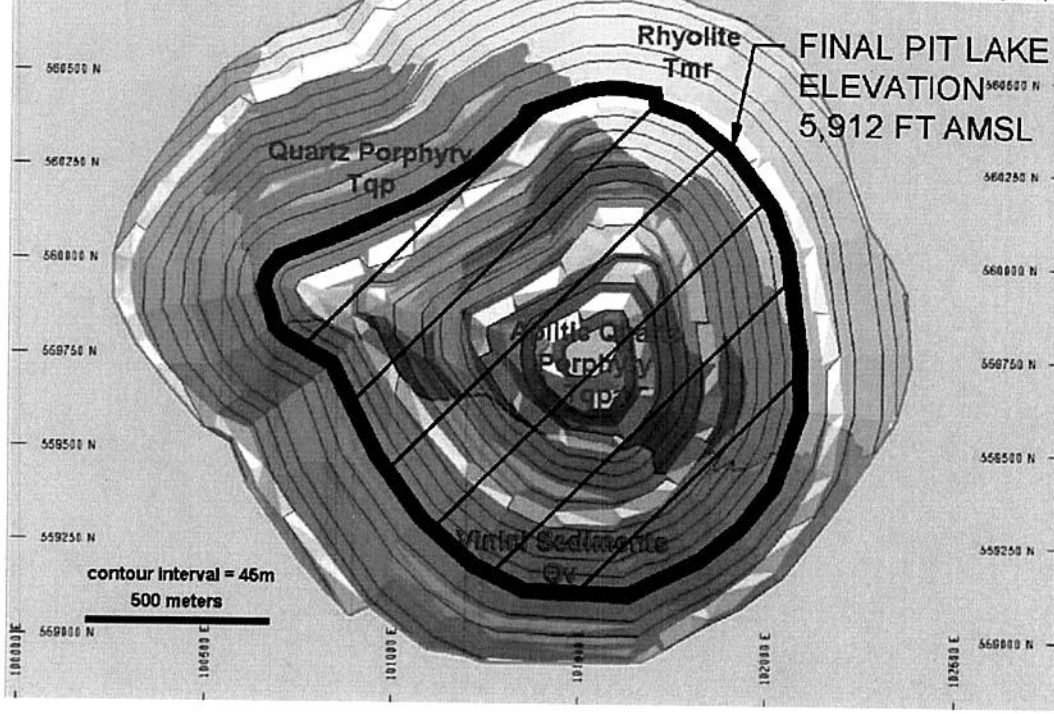
3.3.3.2.1 Pit Lake Water Quality

Pit lake water quality was assessed in a study by SWS (2010). The model is based on pit infilling data, the ABA and HC data, the chemistry of the local and regional ground water, and the characteristics of the final open pit shell.

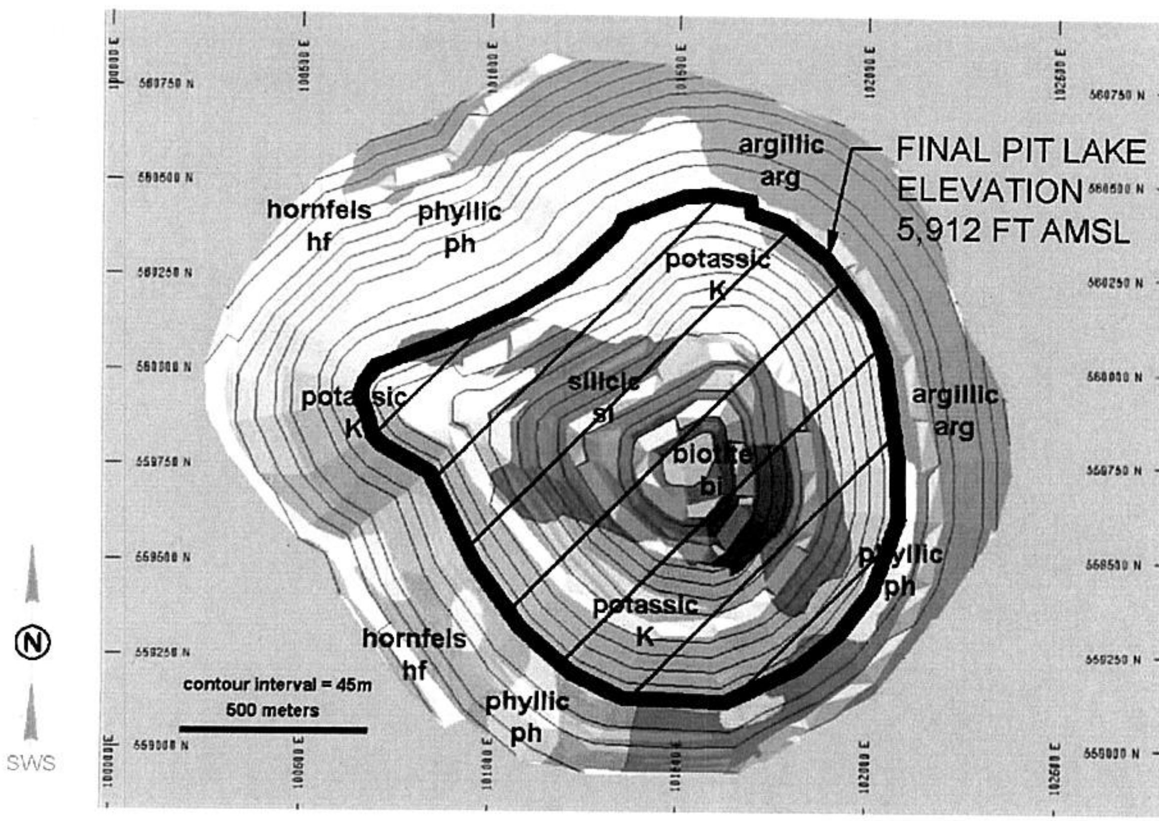
The pit lake water quality assessment (SWS 2010) used as its base the distribution of lithologic units, alteration types, and ABA characteristics in the open pit shell developed by SRK (2008d) (Figures 3.3.9 and 3.3.10). This model was developed using Mintec's Mine Site software, based on the data set of over 1,500 pulp samples with ABA results. There were little sampling data from some of the pit wall areas because of the relatively cylindrical nature of the orebody. Where there was a lack of data, a nearest neighbor approach was used to conservatively assign the ABA characteristics of the pit wall. The choice of extrapolating to the pit wall from the core of the ore deposit is believed to be conservative, as the geologic work on the orebody indicates that mineralization becomes more diffuse at the fringes of the deposit, making a lower potential for acid generating material in these areas.

The HCT data, ground water quality data, and ground water inflow data have been discussed in depth in other sections of this document. The data flow of the pit lake study is represented in Figure 3.3.11. The base model uses average humidity cell effluent concentrations to calculate the release of materials from the pit wall due to surface runoff and ground water infilling to the open pit. Assumptions underlying this loading include consideration of the damage to the wall rock due to mining, blasting and surface sloughing of materials. For the base case pit lake model, a scaling factor to account for differences in laboratory and field reaction rates was not incorporated into the model (although it was incorporated into sensitivity analyses). Typically, laboratory reaction rates occur one to three orders of magnitude faster than field reaction rates

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

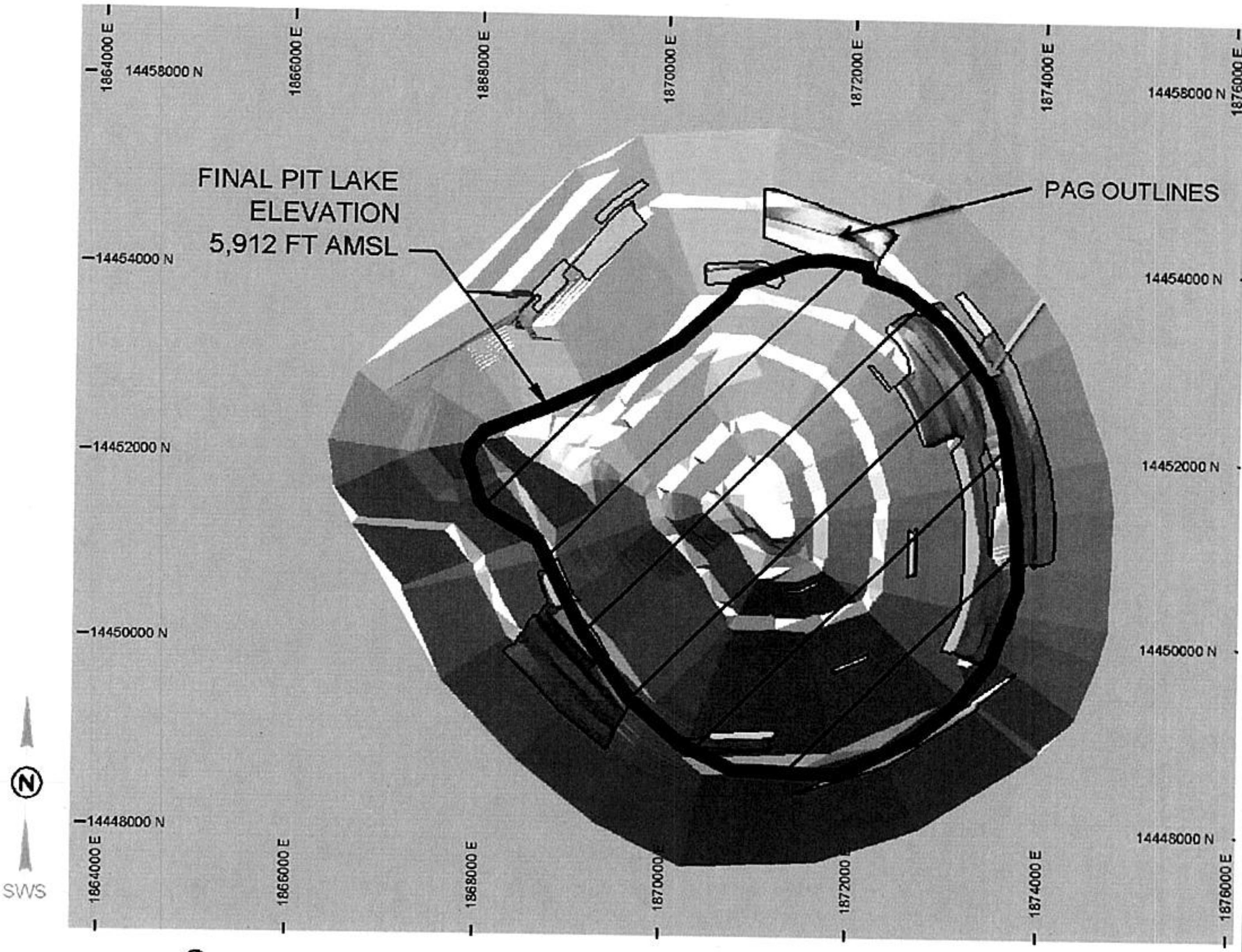


Final Pit Alteration Assemblages



PIT LAKE

BATTLE MOUNTAIN DISTRICT OFFICE Mount Lewis Field Office 50 Bastian Road Battle Mountain, Nevada 89820	BUREAU OF LAND MANAGEMENT MOUNT HOPE PROJECT	DRAWING TITLE:	**Final Pit Wall Lithologies and Alteration Assemblages in the Mount Hope Pit**
DESIGN: EMLLC; DRAWN: GSL; REVIEWED: RFD			
CHECKED: -; APPROVED: RFD; DATE: 05/09/2011			
FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd			**Figure 3.3.9**

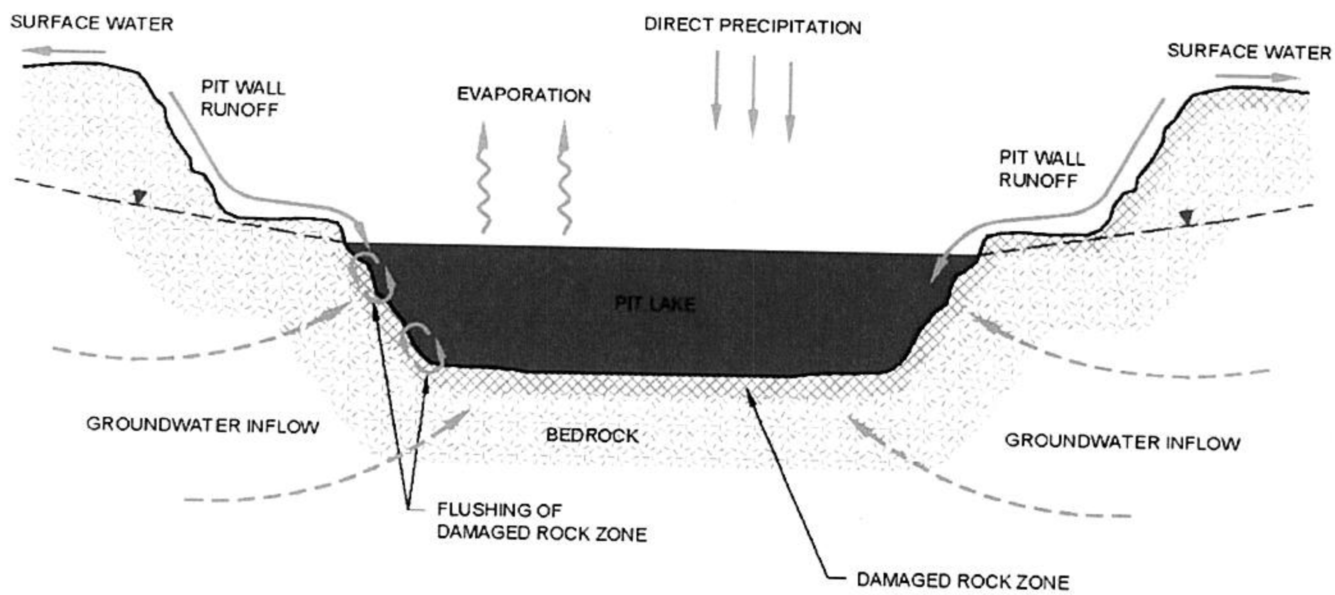


PIT LAKE

PAG MATERIAL (PROJECTED) ON PIT WALLS

PAG: POTENTIALLY-ACID GENERATING (SRK, 2009a)

	BATTLE MOUNTAIN DISTRICT OFFICE Mount Lewis Field Office 50 Bastian Road Battle Mountain, Nevada 89820 DESIGN: EMLLC DRAWN: GSL REVIEWED: RFD CHECKED: - APPROVED: RFD DATE: 09/22/2011 FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd	BUREAU OF LAND MANAGEMENT MOUNT HOPE PROJECT	DRAWING TITLE: PAG Material (Projected) in the Final Open Pit Shell Figure 3.3.10



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 05/09/2011
FILE NAME p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE

Conceptual Model of the Mount Hope Pit Lake

Figure 3.3.11

(Sverdrup and Warfvinge 1995; Drever and Clow 1995; Li et al. 2008). Incorporating this factor would result in less loading to the lake and an overall improvement in the predicted water quality. Additional information on the pit lake water quality assessment is presented in detail in SWS (2010).

3.3.3.2.2 Waste Rock Draindown Water Quality

The water quality of drainage from waste rock is estimated from the results of HCTs. In the mine plan (SWS 2010), average HCT effluents are scaled based on estimates of waste volumes from different formations in the mine plan (SWS 2010). Similar to the pit lake water quality issue, these concentrations are not adjusted for differences in laboratory and field reaction rates.

3.3.3.2.3 Tailings Draindown Water Quality

Results of HCTs of tailings material indicate that draindown water from tailings would have a circumneutral pH (between 7 and 7.4) and may contain several regulated ground water constituents at elevated levels, including As, Al, Sb, fluoride, and Mo (SRK 2008d). Metals concentrations in actual field settings are expected to be lower than the laboratory values due to the slower rates of field processes (Sverdrup and Warfvinge 1995) and the inhibited oxidation of tailings in the inundated conditions of the tailings ponds.

3.3.3.3 Proposed Action

3.3.3.3.1 Surface Water Quality Impacts

The Project would require the alteration or diversion of existing natural drainages and washes that contain surface flow during the infrequent periods of high rainfall and snowmelt. The planned storm water diversion structures would be designed to divert flows of a 100-year, 24-hour storm event from the unnamed drainages upstream of the facilities. The tailings facilities are designed to contain a 100-year, 24-hour storm event in addition to normal process fluids. Surface disturbance generally increases the potential for erosion; therefore, sediment from increased erosion may be transported to and accumulate in the local surface drainages. During mine operations, standard erosion prevention and maintenance procedures (see Section 2.1.1**4.11**) would reduce impacts to less than significant levels based on the significance criteria outlined in Section 3.3.3.1.

Small drainages affected by roads and small facility structures would be returned to their natural condition during reclamation. Permanent drainage alterations around the open pit, WRDFs, and the South TSF would consist of open channels and berms. Such features would be left in place and reclaimed using vegetation or rock lining for stability and elimination of long-term maintenance under post-closure conditions. In addition, the tops of the two TSFs would be designed with a concave surface creating an evaporation basin or playa to retain and evaporate the average monthly precipitation and the 100-year, 24-hour storm event. This design is intended to ensure the long-term integrity of the TSF closure. The North TSF has been designed without an upstream diversion structure. As a result, there would be a potential for substantial storm water run-on that could exceed the design capacity of the North TSF evaporation basin and cause over topping of the structure and erosion of the reclaimed surfaces.

- **Impact 3.3.3.3-1:** There would be a moderate to high potential for impacts to surface water quality due to erosion and possible breaching of the North TSF under the Proposed Action.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.3-1:** EML would submit a North TSF upstream diversion structure design. This design would be of sufficient capacity to divert run-on from the North TSF so that the current evaporate pond design would be sufficient to contain the designed storm events. The design would be submitted to the BLM 24 months prior to the anticipated start of construction. The BLM would approve the design prior to the commencement of construction.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.3-1 would be effective at preventing erosion and possible breaching of the North TSF. The design would be based on an engineering evaluation of the topography and design precipitation event (24 hour-100 year event) as required by the NDEP so that the design event would effectively be conveyed away from the North TSF.

There is a potential impact to the flow of Roberts Creek resulting from mine-related ground water drawdown under the Proposed Action. A decrease in the flow of Roberts Creek could result in an inability to meet the beneficial uses outlined for a Class A surface water body.

- **Impact 3.3.3.3-2:** The ground water drawdown is predicted to be greater than ten feet for the perennial stream segments of Roberts Creek for varying periods of time up to at least 400 years after the end of mining and milling operations.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.3-2:** The measures outlined under Mitigation Measure 3.2.3.3-2 would address the potential reduced flows outlined in the impact.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.3-2 would be effective at preventing degradation of water quality in Roberts Creek. The mitigation measure would restore flows to the creek, which would remove the underlying cause of this potential impact.

3.3.3.3.2 Ground Water Quality Impacts

The Proposed Action includes the lining of the PAG WRDF (see Section 2.1.3.1) with the following: 1) a 12-inch thick engineered subgrade (1×10^{-5} cm/sec saturated hydraulic conductivity) and a five-foot thick **non-PAG** base layer for the foundation of the facility; 2) perforated collecting piping with geomembrane under the pipe to promote drainage from the base of the facility to a collection channel at the toe of the facility; 3) diversion channels to route upgradient surface water runoff away from the facility; 4) geomembrane-lined collection channel to route runoff and infiltration into a PAG/low-grade ore storm water collection ponds (Phase 1 and Phase 2); and 5) geomembrane-lined storm water collection ponds (Phase 1 and Phase 2) to capture surface water runoff and infiltration from the facilities. In general, HCT and MWMP testing of non-acid generating materials has found the effluent from these materials to be generally benign. For non-acid generating materials, elevated pH, Mn, and SO_4 are sometimes observed. However, the average chemistry from the non-acid generating materials only exceeds water quality criteria for Al (0.87 mg/L) and Mn (1.47 mg/L). Under the circumneutral pH conditions of the draindown, Al would be expected to precipitate (Lindsay 1979). Mn **values are** already found at levels **above regulatory standards (0.0076 to 25 mg/L) in ground water beneath the site and the levels in the potential seepage would be similar to the existing water quality values beneath the site**. Therefore, the Mn in the draindown would not degrade ground water beneath the non-acid generating waste rock piles. No ground water impacts are anticipated from the disposal of potentially acid generating material as this material would be underlain by a constructed compacted liner preventing leachate loading to ground water.

Each TSF would consist of the following components: impoundment; tailings conveyance and distribution system; reclaim recovery systems; and tailings draindown recovery systems (Figure 2.1.15). Figure 2.1.5 shows the locations of the North and South TSFs. The tailings production rate would range from approximately 21 to 23 million tpy for the 44 years of operation. The combined storage capacity of the TSFs is approximately 966 million dry tons.

The South TSF would have a capacity of approximately 790 million tons, which would equate to approximately 36 years of production. The South TSF would be constructed once the North TSF facility reaches capacity at Year 36, to contain 176 million tons, which would equate to approximately eight years of production.

The TSF embankment foundation and impoundment basin would be lined using a 60 mil (0.06 inch) LLDPE geomembrane, with a K value of 1×10^{-11}cm/s to provide fluid containment. This level of containment exceeds that required by the State of Nevada under NAC 445A.437 for facilities with ground water in excess of 100 feet.

As previously discussed, the water quality of the tailings and PAG waste rock draindown would exceed water quality standards for many constituents. To address this potential water quality impact, both the tailings facility and the PAG waste rock facility would be underlain by liners, and drainage from these facilities collected and managed. This planned management would prevent these low-quality waters from degrading either surface or ground water quality.

Upon closure, both the tailings and the PAG WRDF would be capped and revegetated to reduce the amount of infiltration to these facilities. Water draining from these facilities would continue to be managed through the use of evaporation cells.

Based on the ore and waste rock characteristics, the arid conditions of the mine site limit the amount of infiltration and using the Proposed Action management of mine wastes, the impacts to water quality from stockpiled ore and waste rock are considered less than significant based on the significance criteria outlined in Section 3.3.3.1.

- **Impact 3.3.3.3-3:** There would be a low potential for impacts to ground water quality due to drainage from tailings impoundments and waste rock piles under the Proposed Action.

  Significance of the Impact: The impact is not considered significant.

No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.3.3.3.3 Pit Lake Water Quality Impacts

The pit lake that is anticipated to form in the open pit is expected to fill slowly (Figure 3.3.12), and would be 900 feet deep at 200 years after the end of mining. Overall, the lake is predicted to have a slightly alkaline pH (approximately 7.7) and a moderate alkalinity (approximately 60 mg/L $CaCO_3$) (Figure 3.3.13). As most metals associated with ARD are less mobile at these pH values, overall the water is predicted to be of good quality (Table 3.3-3). Of constituents that are regulated by the State of Nevada, fluoride, SO_4 (Figure 3.3.14), Cd, Mn (Figure 3.3.15), Sb, and Zn (Figure 3.3.16) are expected to be near or above Nevada reference standards and EPA drinking water MCLs Table 3.3-3 water quality criteria (Table 3.3-1).

Initial pit lake water quality is predicted to be good and would meet Nevada enforceable DWS. As evaporation from the lake surface concentrates the dissolved minerals, some water quality constituent concentrations would be predicted to increase over time relative to baseline concentrations and to exceed the present Nevada water quality standards (see Table 3.3-1). The pit lake would be a water of the State of Nevada, and applicable water quality standards would depend on the present and potential beneficial uses of the lake. Access to the open pit by humans and livestock would be restricted. The lake is not intended to be a drinking water source for humans or livestock or to be used for recreational purposes. Therefore, standards to protect these beneficial uses would not be directly applicable. Aquatic standards would also not be applicable since EML does not plan to have the pit lake stocked with fish. This approach is consistent with NAC 445A.429. Exposure to terrestrial and avian wildlife species is discussed in Section 3.23.3.

- **Impact 3.3.3.3-4:** There would be a low potential for impacts to ground water quality due to the formation of a ground water sink in the open pit under the Proposed Action.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

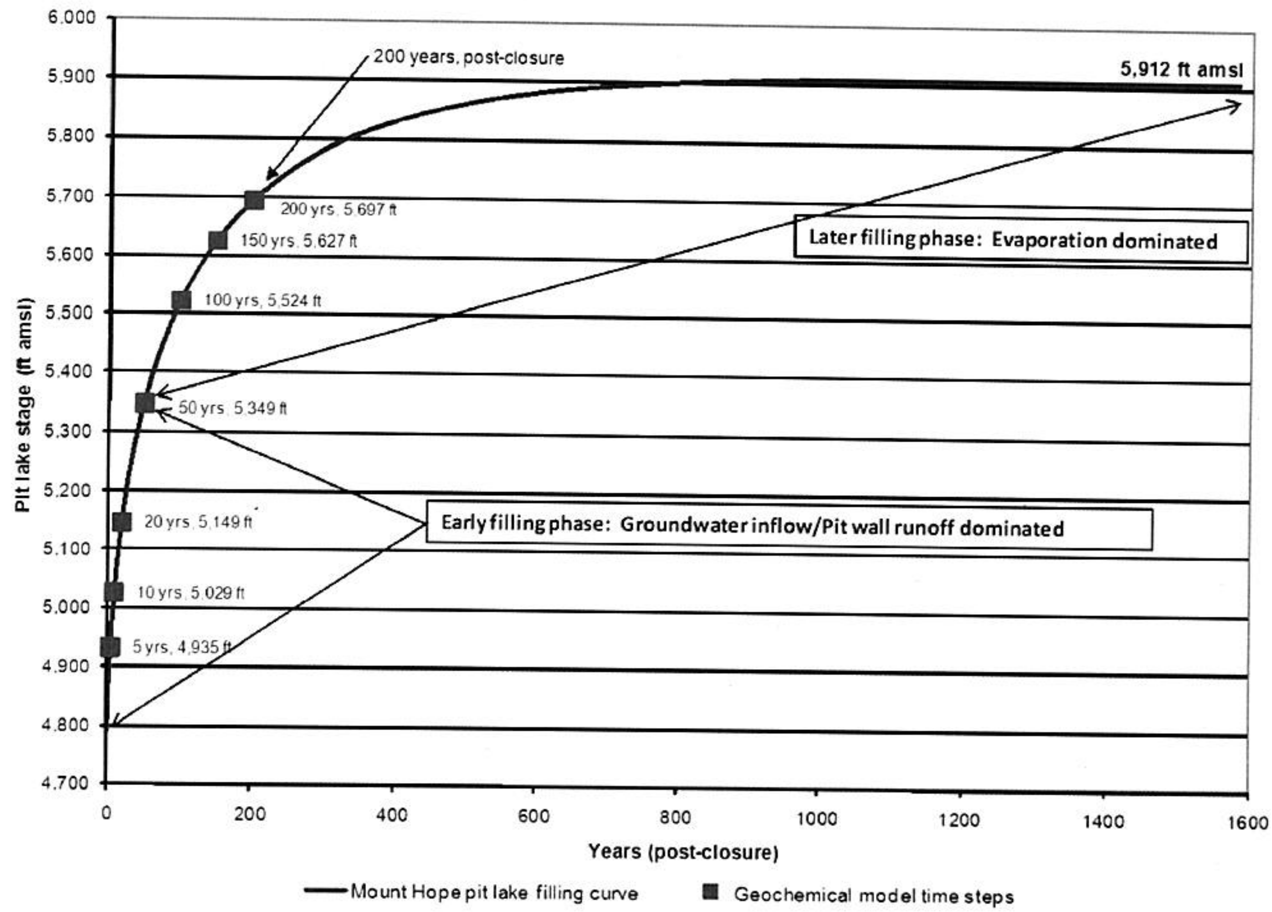
3.3.3.4 <u>No Action Alternative</u>

Implementation of the No Action Alternative is not expected to impact either surface or ground water quality. As there would be no change in the flow regime and no additional pumping, ground water quality is not expected to change. Surface water quality with regard to suspended solids is anticipated to improve as roads and drill sites are reclaimed.

3.3.3.5 <u>Partial Backfill Alternative</u>

3.3.3.5.1 Surface Water Quality Impacts

The Project would require the alteration or diversion of existing natural drainages and washes that contain surface flow during the infrequent periods of high rainfall and snowmelt. The planned storm water diversion structure has been designed to divert flows of a 100-year, 24-hour storm event from the unnamed drainages upstream of the facilities. The tailings facilities would



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN EMLLC	DRAWN GSL	REVIEWED RFD
CHECKED -	APPROVED RFD	DATE 05/09/2011
FILE NAME p1635_Fig3-3-X_Geochem_8i11i_landscape.mxd		

BUREAU OF LAND MANAGEMENT

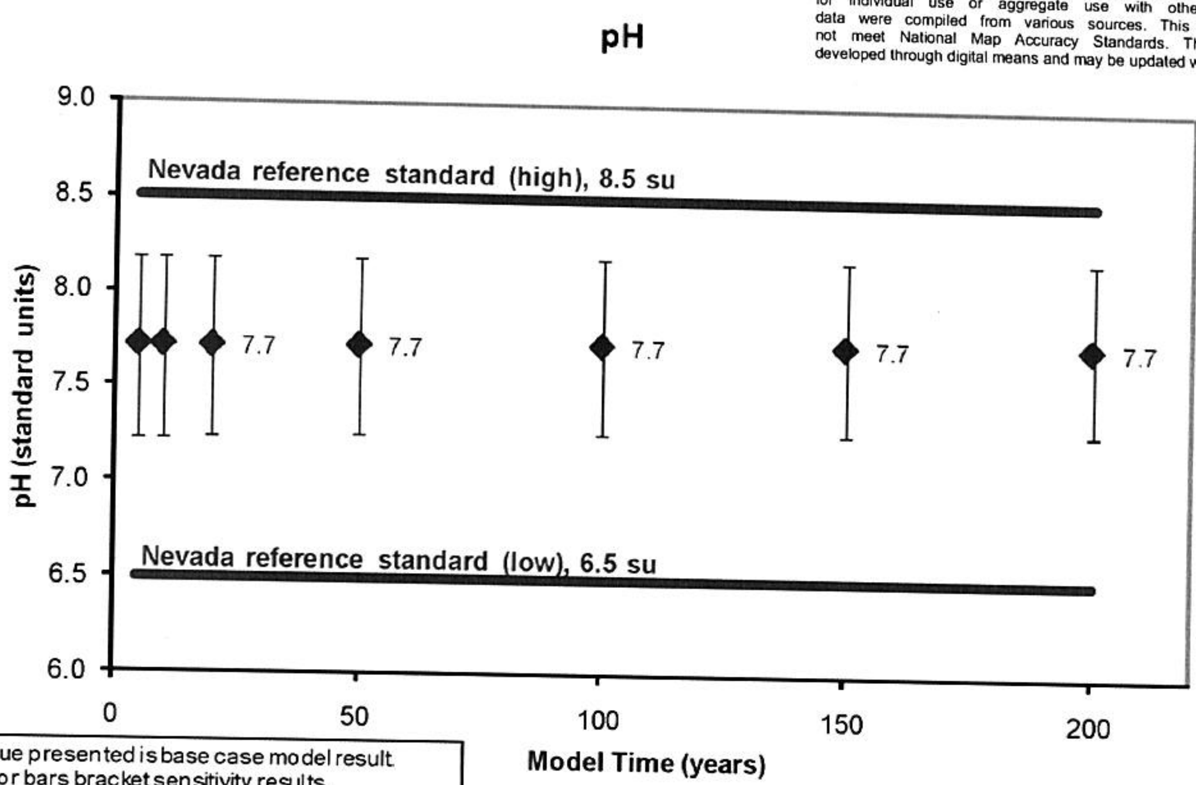
MOUNT HOPE PROJECT

DRAWING TITLE

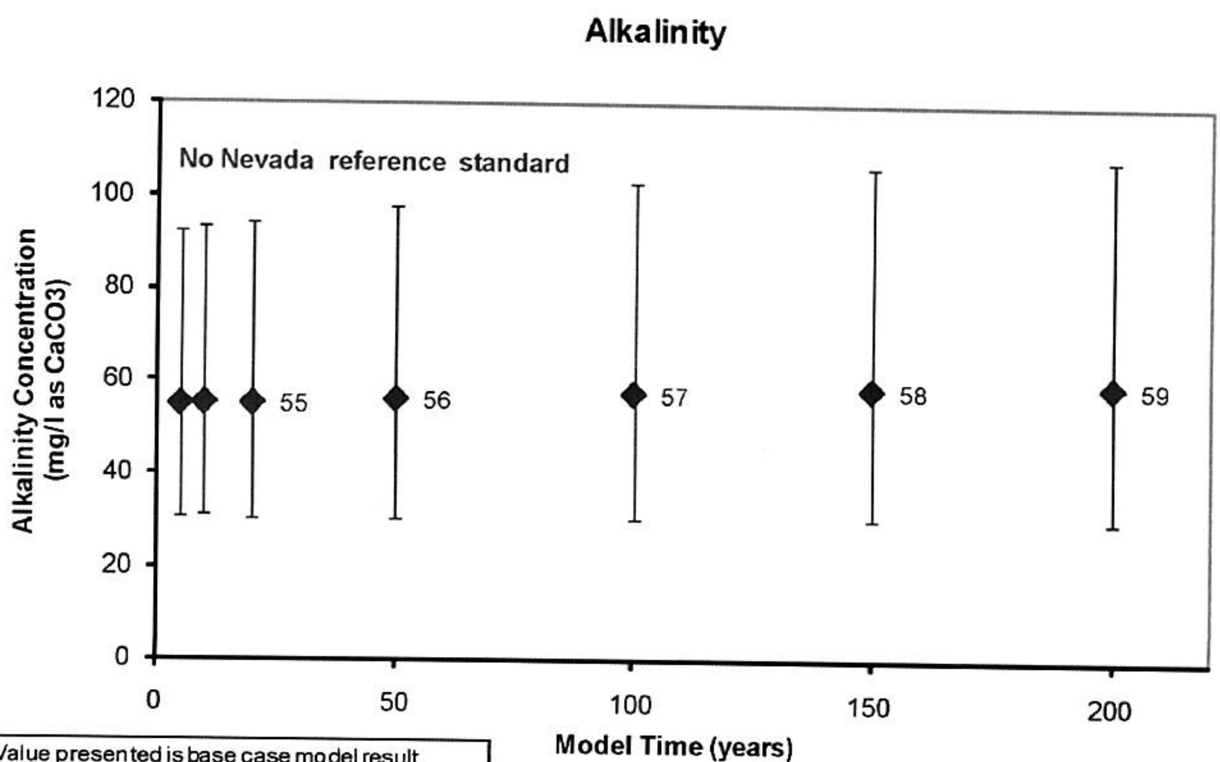
Projected Pit Lake Filling Curve of the Mount Hope Pit Lake

Figure 3.3.12

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.



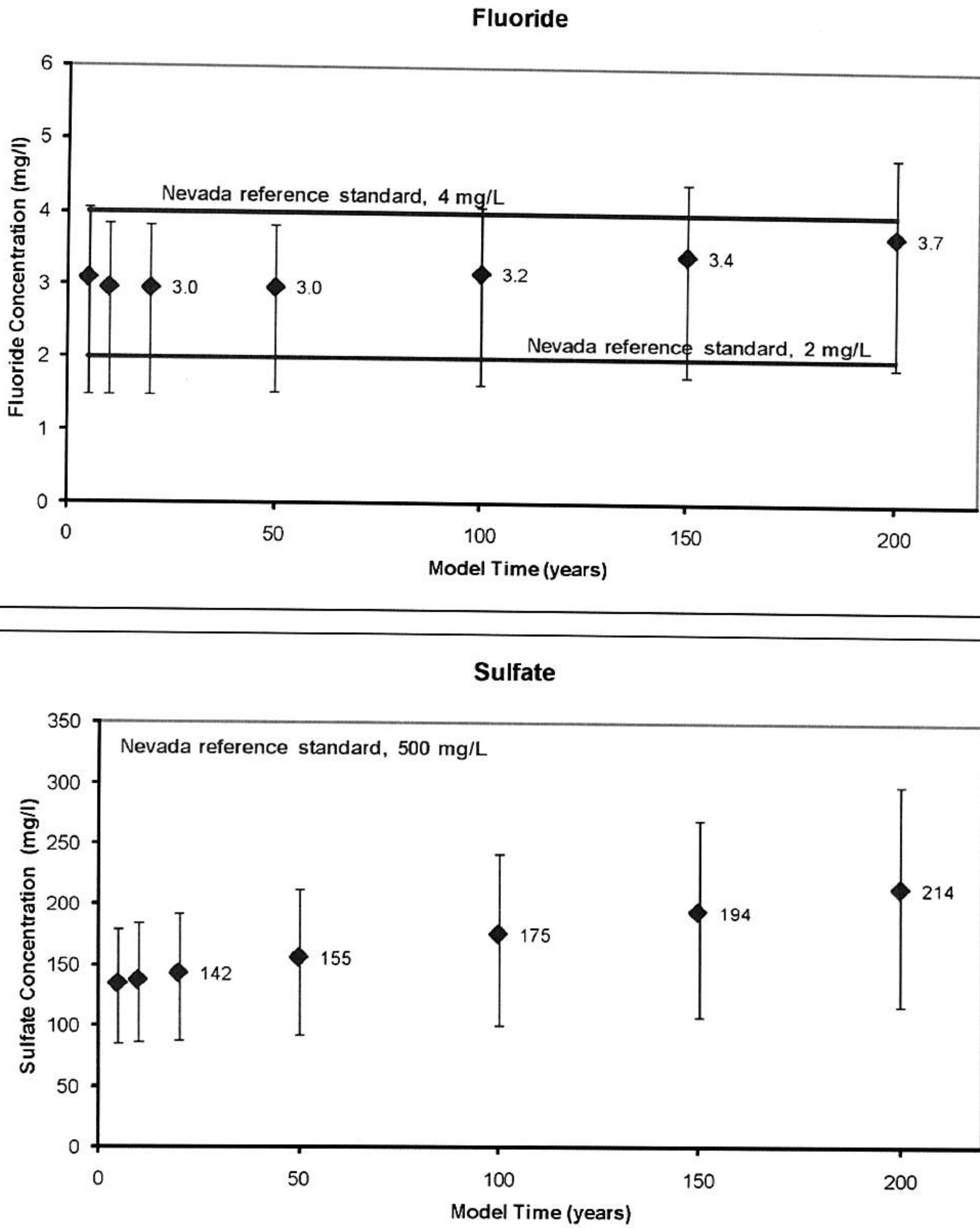
Value presented is base case model result.
Error bars bracket sensitivity results.



Value presented is base case model result.
Error bars bracket sensitivity results.

BATTLE MOUNTAIN DISTRICT OFFICE Mount Lewis Field Office 50 Bastian Road Battle Mountain, Nevada 89820 DESIGN: EMLLC DRAWN: GSL REVIEWED: RFD CHECKED: - APPROVED: RFD DATE: 05/09/2011 FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd	BUREAU OF LAND MANAGEMENT MOUNT HOPE PROJECT	DRAWING TITLE: **Projected pH and Alkalinity in the Pit Lake (SWS 2010)** **Figure 3.3.13**

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 09/22/2011
FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

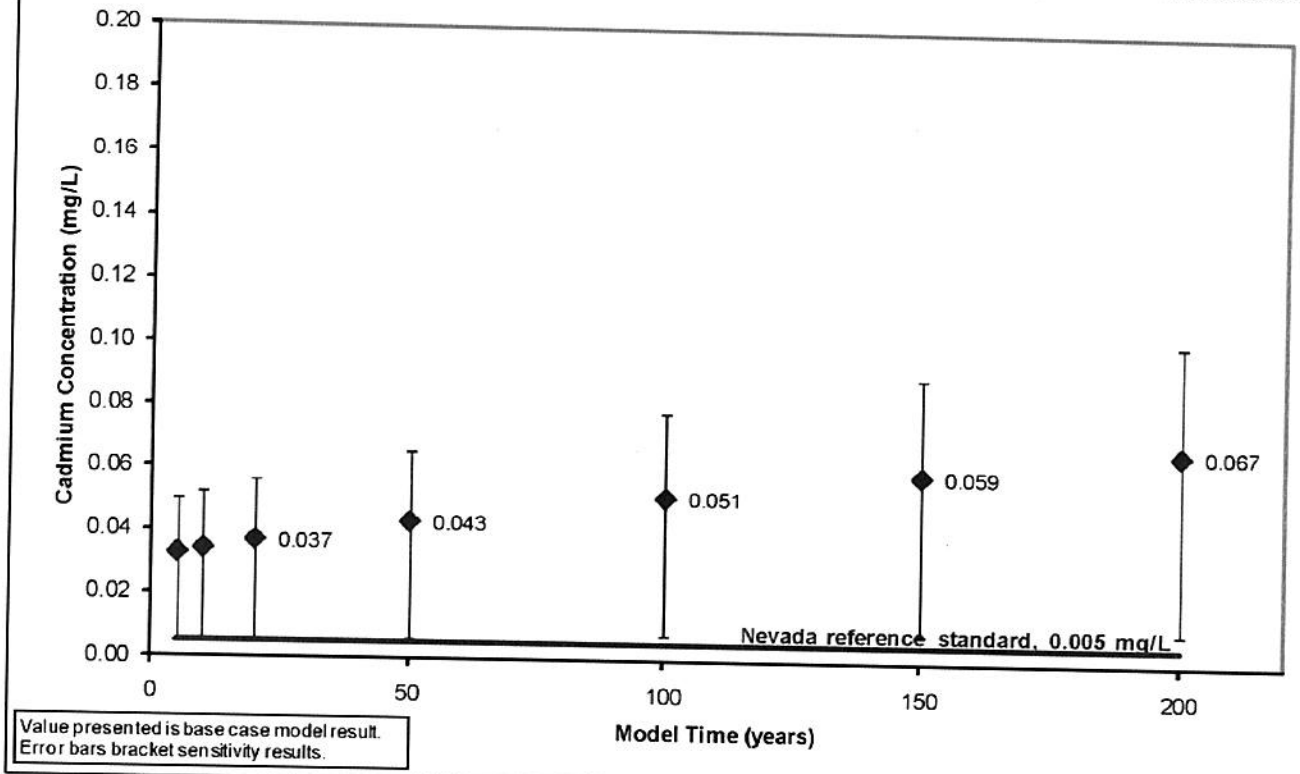
DRAWING TITLE:

Projected Fluoride and Sulfate in the Mount Hope Pit Lake (SWS 2010)

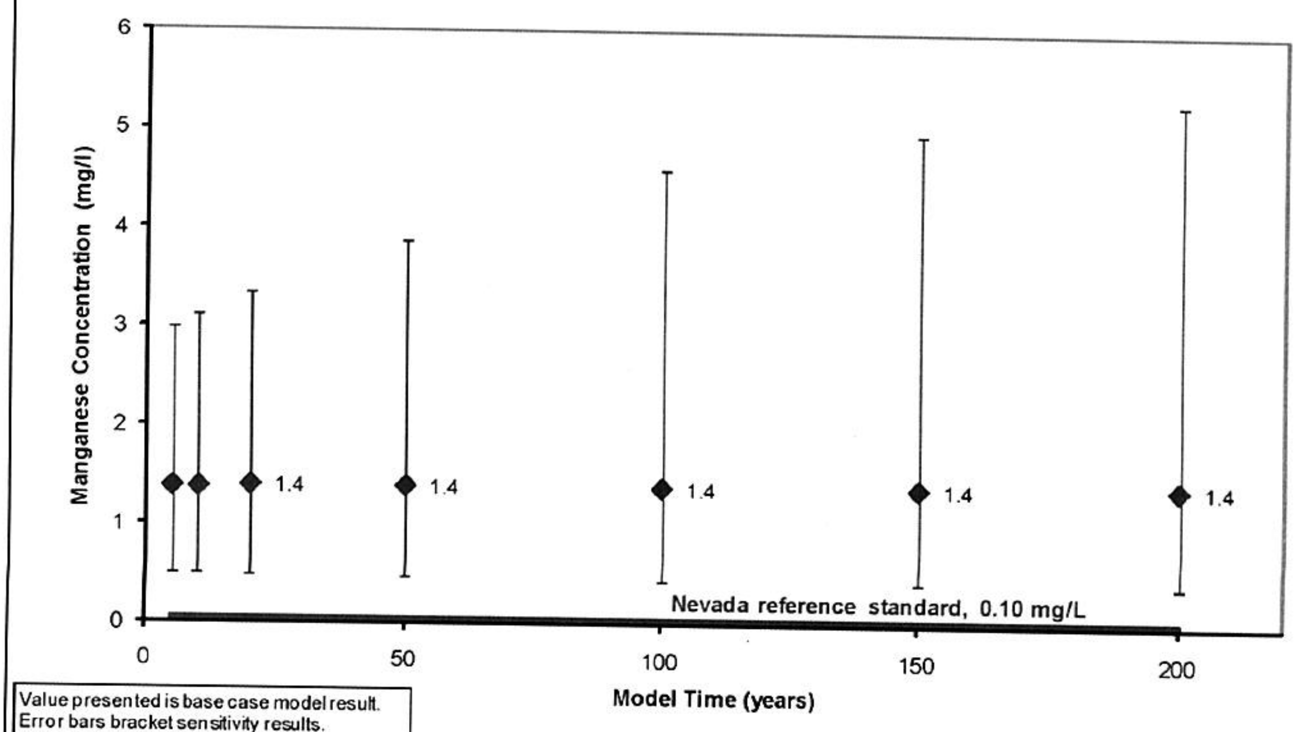
Figure 3.3.14

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

Cadmium



Manganese



BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 09/22/2011
FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd		

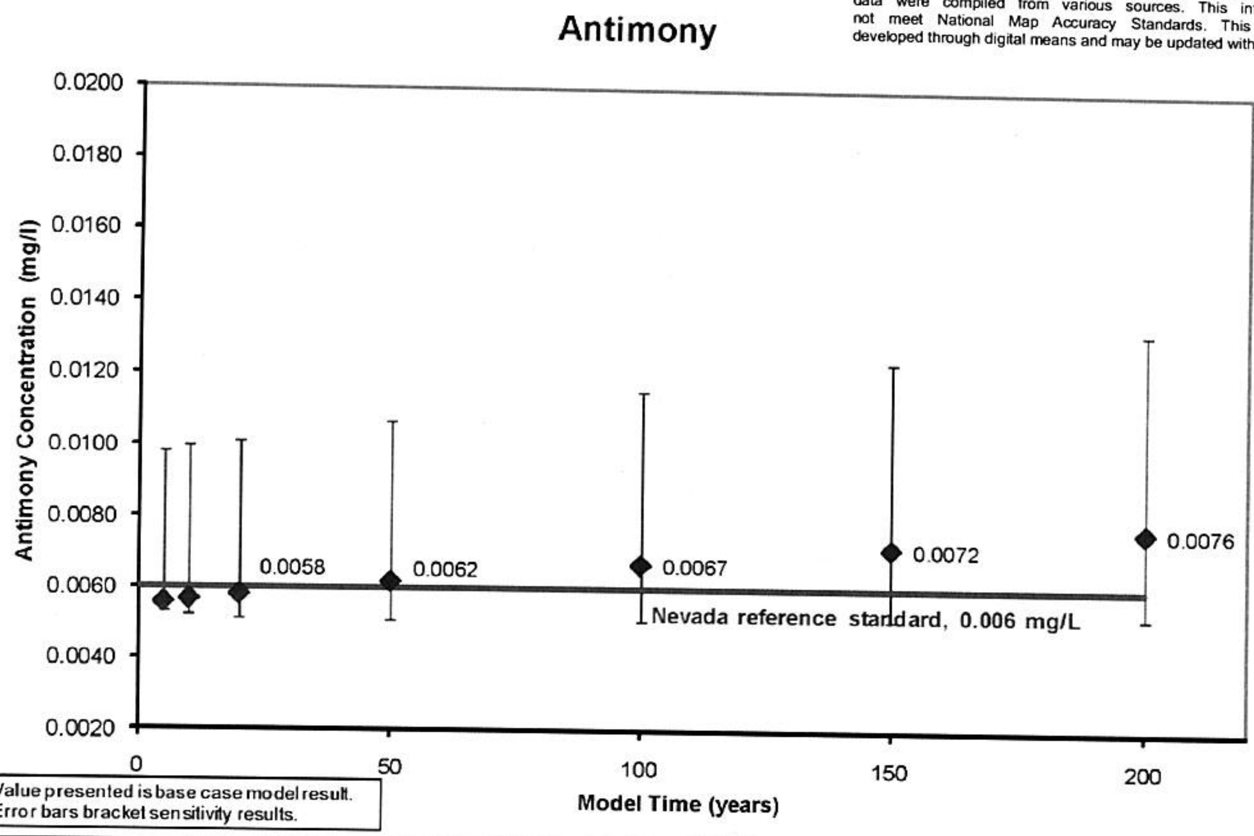
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

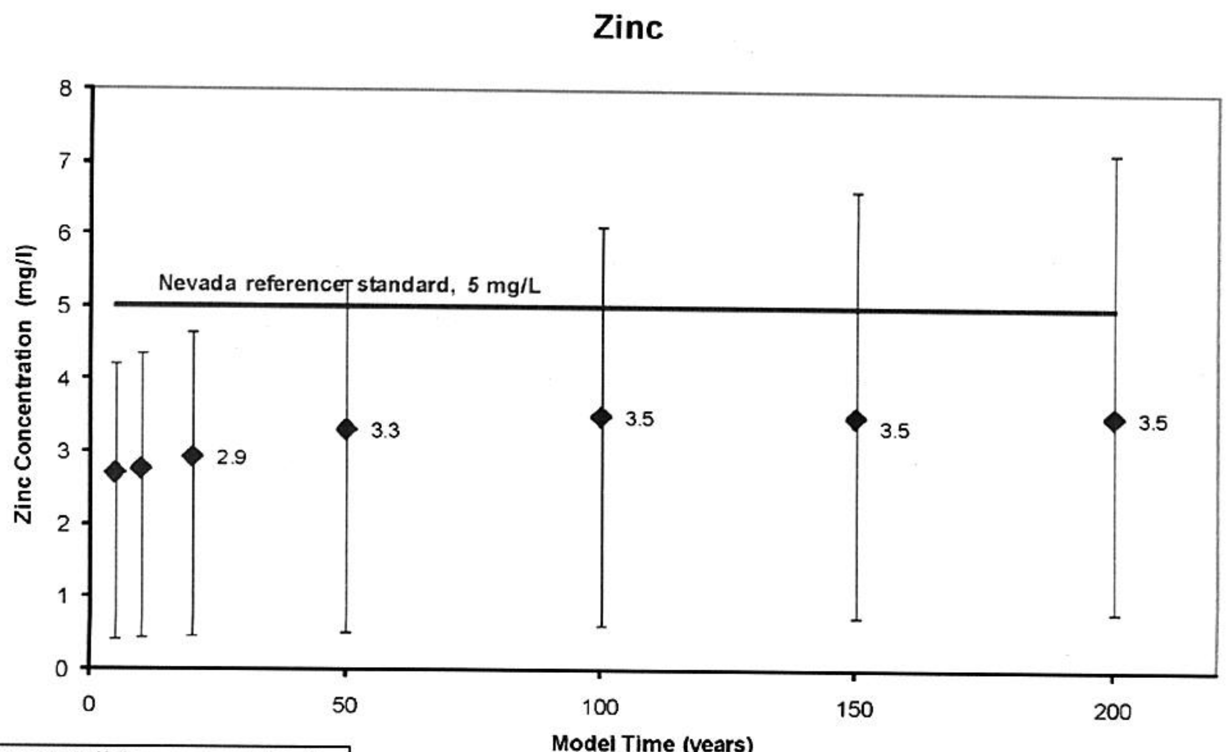
DRAWING TITLE:

Projected Cadmium and Manganese in the Mount Hope Pit Lake (SWS 2010)

Figure 3.3.15



Value presented is base case model result.
Error bars bracket sensitivity results.



Value presented is base case model result.
Error bars bracket sensitivity results.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 09/22/2011
FILE NAME: p1635_Fig3-3-X_Geochem_8i11i_portrait.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Projected Antimony and Zinc in the Mount Hope Pit Lake

Figure 3.3.16

Table 3.3-3: Mount Hope Predicted Pit Lake Water Quality Results

Parameter/Analyte	Nevada Reference Standards	USEPA Drinking Water MCLs	Pit Lake (Time)						
			5 years	10 years	20 years	50 years	100 years	150 years	200 years
pH, standard units	**6.5 - 8.5***	**6.5 - 8.5***	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Major Ions									
Alkalinity, as $CaCO_3$	**ns**	**ns**	55	55	55	56	57	58	59
Chloride	**400***	**250***	8.2	8.3	8.4	8.8	9.5	10.1	10.8
Fluoride	**4.0 (2.0*)**	**4.0 (2.0*)**	3.1	3.0	3.0	3.0	3.2	3.4	3.7
Nitrate, As N	**10**	**10**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus	**ns**	**ns**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sulfate, as SO_4^{2-}	**500***	**250***	134	136	142	155	175	194	214
Calcium	**ns**	**ns**	46	46	47	50	54	58	62
Magnesium	**150***	**ns**	7.3	7.4	7.6	8.1	8.9	9.6	10.4
Potassium	**ns**	**ns**	4.5	4.6	4.7	5.1	5.7	6.3	6.8
Sodium	**ns**	**ns**	26	27	28	30	34	38	42
Metals/Metaloids									
Aluminum	**0.2***	**0.05 - 0.2***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Antimony	**0.006**	**0.006**	0.0056	0.0057	0.0058	0.0062	0.0067	0.0072	0.0076
Arsenic	**0.01**	**0.01**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Barium	**2**	**2**	0.014	0.014	0.013	0.012	0.011	0.011	0.010
Beryllium	**0.004**	**0.004**	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bismuth	**ns**	**ns**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	**ns**	**ns**	<0.05	<0.05	<0.05	<0.05	0.053	0.059	0.065
Cadmium	**0.005**	**0.005**	0.033	0.034	0.037	0.043	0.051	0.059	0.067
Chromium	**0.1**	**0.1**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	**ns**	**ns**	0.009	0.009	0.010	0.011	0.013	0.014	0.016
Copper	**1.0* (1.3**)**	**1.0* (1.3**)**	0.015	0.0149	0.016	0.016	0.018	0.018	0.018

Parameter/Analyte	Nevada Reference Standards	USEPA Drinking Water MCLs	Pit Lake (Time)						
			5 years	10 years	20 years	50 years	100 years	150 years	200 years
Iron	**0.6***	**0.3***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	**0.015****	**0.015****	0.00045	0.00043	0.00045	0.00048	0.00051	0.00052	0.00053
Lithium	**ns**	**ns**	0.0042	0.0045	0.0048	0.0057	0.0069	0.0079	0.0090
Manganese	**0.10***	**0.05***	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Mercury	**0.002**	**0.002**	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	**ns**	**ns**	0.074	0.078	0.083	0.094	0.11	0.12	0.13
Nickel	**0.1**	**ns**	0.023	0.023	0.025	0.028	0.034	0.038	0.043
Selenium	**0.05**	**0.05**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	**0.1***	**0.1***	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Strontium	**ns**	**ns**	0.22	0.22	0.22	0.23	0.24	0.26	0.28
Thallium	**0.002**	**0.002**	0.00055	0.00056	0.00058	0.00063	0.00069	0.00075	0.00083
Tin	**ns**	**ns**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	**ns**	**ns**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc	**5.0***	**5***	2.7	2.7	2.9	3.3	3.5	3.5	3.5

STANDARDS PRESENTED ARE NOT APPLICABLE TO THE PIT LAKE WATER. FOR REFERENCE PURPOSES ONLY.

Nevada Reference Standards are based on Nevada primary and secondary **DWS**, action levels, and beneficial use standards.
* Based on secondary standards. ** Based on Pb and Cu action levels. ns - no standards.
Exceedances of a Nevada Reference Standards are highlighted.
All concentrations are in mg/L, unless otherwise noted.
< Analyte concentration result is below typical analytical detection limits. The value shown is the detection limit.

be designed to contain a 100-year, 24-hour storm event in addition to normal process fluids. Surface disturbance generally causes an increase in erosion, therefore, sediment from increased erosion may be transported to and accumulate in the local surface drainages. During mine operations, standard erosion prevention and maintenance procedures (see Section 2.1.15) would reduce impacts to less than significant levels.

Small drainages affected by roads and small facility structures would be returned to their natural condition during reclamation. Permanent drainage alterations around the open pit, WRDFs, and the South TSF would consist of open channels and berms. Such features would be left in place and reclaimed using revegetation or rock lining for stability and elimination of long-term maintenance under post-closure conditions. In addition, the tops of the two TSFs would be designed with a concave surface creating an evaporation basin or playa to retain and evaporate the average monthly precipitation and the 100-year, 24-hour storm event. This design is intended to ensure the long-term integrity of the TSF closure. The North TSF has been designed without an upstream diversion structure. As a result, there would be a potential for substantial storm water run-on that could exceed the design capacity of the North TSF evaporation basin and cause over topping of the structure and erosion of the reclaimed surfaces.

- **Impact 3.3.3.5-1:** There would be a moderate to high potential for impacts to surface water quality due to erosion and possible breaching of the North TSF under the Partial Backfill Alternative.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.5-1:** EML would submit a North TSF upstream diversion structure design. This design would be of sufficient capacity to divert run-on from the North TSF so that the current evaporate pond design would sufficient to contain the designed storm events. The design would be submitted to the BLM 24 months prior to the anticipated start of construction. The BLM would approve the design prior to the commencement of construction.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.5-1 would be effective preventing erosion and possible breaching of the North TSF. The design would be based on an engineering evaluation of the topography and design precipitation event (24 hour-100 year event) as required by the NDEP so that the design event would effectively be conveyed away from the North TSF.

- **Impact 3.3.3.5-2:** The ground water drawdown is predicted to be more than ten feet for the perennial stream segments of Roberts Creek for varying periods of time up to at least 400 years after the end of mining and milling operations.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.5-2:** The measures outlined under Mitigation Measure 3.2.3.5-2 would address the potential reduced flows outlined in the impact.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.5-2 would be effective at preventing degradation of water quality in

Roberts Creek. The mitigation measure would restore flows to the creek, which would remove the underlying cause of this potential impact.

3.3.3.5.2 Ground Water Quality Impacts

Under the Partial Backfill Alternative, ground water quality impacts from tailings and waste rock draindown would be expected to be similar to those under the pit lake alternative.

- **Impact 3.3.3.5-3:** There would be a low potential for impacts to ground water quality due to drainage from tailings impoundments and waste rock piles under the Partial Backfill Alternative.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.3.3.5.3 Pit Lake Water Quality Impacts

Under the Partial Backfill Alternative, the ground water quality within the pit backfill would be anticipated to be impacted by waste materials (Non-PAG) deposited in the open pit and from infiltrating the runoff from pit walls. This poor-quality water could flow from the confines of the former pit shell into the surrounding ground water, degrading waters of the state. Assuming that non-acid generating materials are placed in the open pit, the ground water entrained within the backfill would contain elevated levels of constituents observed in HCT draindown (Mn, SO_4, pH), as well as constituents found in runoff from the pit walls (including Cd, fluoride, and Mn) (SWS 2010). While a specific water balance has not been developed for the ground water entrained in the backfill, it is expected that this water quality would exceed Nevada **DWS** for the above listed constituents.

Under the Partial Backfill Alternative, the modeling conducted by InTerraLogic (2011) was designed to predict the composition of future pore water quality in the backfilled open pit. The results for the post-closure period, just prior to the point of well-defined ground water throughflow (approximately 210 years) are presented in Table 3.3-4. At the point of throughflow, the pH of the open pit backfill pore water is predicted to be circum-neutral, at a pH of approximately 6.8. Sulfate concentrations are low or below analytical detection; however, concentrations of fluoride, Sb, Cd, and Mn are predicted to be present above the Nevada Reference values (Table 3.3-4).

Table 3.3-4: Partial Backfill Alternative Predicted Pore Water Quality Results

Parameter/Analyte	Nevada Reference Standards (mg/L)	Backfill Pore Water Quality at 210 Years (mg/L)
pH, standard units	6.5 – 8.5*	6.8
Major Ions		
Alkalinity, as CaCO3	ns	64
Chloride	400*	12
Fluoride	4.0 (2.0*)	3.8
Nitrate, as N	10	<0.05

Parameter/Analyte	Nevada Reference Standards (mg/L)	Backfill Pore Water Quality at 210 Years (mg/L)
Phosphorus	ns	<0.05
Sulfate, as SO_4^{2-}	500*	177
Calcium	ns	53
Magnesium	150*	9.3
Potassium	ns	11
Sodium	ns	37
Metals/Metaloids		
Aluminum	0.2*	0.044
Antimony	0.006	0.0061
Arsenic	0.01	<0.0005
Barium	2	0.012
Beryllium	0.004	<0.0002
Bismuth	ns	<0.001
Boron	ns	0.11
Cadmium	0.005	0.037
Chromium	0.1	<0.001
Cobalt	ns	0.0083
Copper	1.0* (1.3**)	0.032
Iron	0.6*	0.57
Lead	0.015**	0.00028
Lithium	ns	0.0082
Manganese	0.10*	2.1
Mercury	0.002	<0.0002
Molybdenum	ns	0.36
Nickel	0.1	0.026
Selenium	0.05	0.0018
Silver	0.1*	<0.005
Strontium	ns	0.22
Thallium	0.002	0.0060
Tin	ns	0.0023
Titanium	ns	<0.001
Vanadium	ns	0.012
Zinc	5.0*	2.8

ns = no standard; * = based on secondary standard; ** = based Pb and Cu action levels.
Exceedances of the Nevada Reference Standards are highlighted.

Over the long term, water would continue to move through the backfill and into the downgradient ground water system (Diamond Valley). The chemistry of this throughflow water would gradually evolve as the readily-soluble chemical mass in the backfill is rinsed out. Eventually the throughflow water would resemble a mixture of the upgradient ground water, percolation of precipitation through the backfill, and open pit wall runoff, **which would exceed Nevada DWS.**

- **Impact 3.3.3.5-4:** It is expected that the ground water flowing from backfill material would exceed Nevada **DWS** under the Partial Backfill Alternative.

  Significance of the Impact: The impacts to ground water quality under the Partial Backfill Alternative would be significant.

- **Mitigation Measure 3.3.3.5-4:** Mitigation for this impact would require the removal of sufficient backfill material for the formation of an evaporative ground water sink.

Implementation of this mitigation would be otherwise inconsistent with the reasoning for selecting this alternative.

Residual Impact: Based on the assumption that the mitigation would not be implemented, the residual impact of the Partial Backfill Alternative on ground water quality would be the long-term degradation of the ground waters of the state.

3.3.3.6 Off-Site Transfer of Ore Concentrate for Processing Alternative

3.3.3.6.1 Surface Water Quality Impacts

Under the Off-Site Transfer of Ore Concentrate for Processing Alternative, surface water quality impacts would be similar to the Proposed Action.

- **Impact 3.3.3.6-1:** There would be a moderate to high potential for impacts to surface water quality due to erosion and possible breaching of the North TSF under the Off-Site Transfer of Ore Concentrate for Processing Alternative.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.6-1:** EML would submit a North TSF upstream diversion structure design. This design would be of sufficient capacity to divert run-on from the North TSF so that the current evaporate pond design would be sufficient to contain the designed storm events. The design would be submitted to the BLM 24 months prior to the anticipated start of construction. The BLM would approve the design prior to the commencement of construction.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.6-1 would be effective at preventing erosion and possible breaching of the North TSF. The design would be based on an engineering evaluation of the topography and design precipitation event (24 hour-100 year event) as required by the NDEP so that the design event would effectively be conveyed away from the North TSF. With the implementation of the mitigation measure, the residual impact of the Off-Site Transfer of Ore Concentrate for Processing Alternative would be limited to natural erosion processes.

- **Impact 3.3.3.6-2:** The ground water drawdown is predicted to be more than ten feet for the perennial stream segments of Roberts Creek for varying periods of time up to at least 400 years after the end of mining and milling operations.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.6-2:** The measures outlined under Mitigation Measure 3.2.3.3-2 would address the potential reduced flows outlined in the impact.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.6-2 would be effective at preventing degradation of water quality in Roberts Creek. The mitigation measure would restore flows to the creek, which would remove the underlying cause of this potential impact.

3.3.3.6.2 Ground Water Quality Impacts

Under the Off-Site Transfer of Ore Concentrate for Processing Alternative ground water quality impacts would be indistinguishable from the Proposed Action.

- **Impact 3.3.3.6-3:** There would be a low potential for impacts to ground water quality due to drainage from tailings impoundments and waste rock piles under the Off-Site Transfer of Ore Concentrate for Processing Alternative.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.3.3.6.3 Pit Lake Water Quality Impacts

Under the Off-Site Transfer of Ore Concentrate for Processing Alternative pit lake water quality impacts would be indistinguishable from the Proposed Action.

- **Impact 3.3.3.6-4:** There would be a low potential for impacts to ground water quality due to the formation of a ground water sink in the open pit under the Off-Site Transfer of Ore Concentrate for Processing Alternative.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.3.3.7 <u>Slower, Longer Project Alternative</u>

3.3.3.7.1 Surface Water Quality Impacts

Under the Slower, Longer Project Alternative, surface water quality impacts would be similar to the Proposed Action; however, the timing of those potential impacts could differ due to the extended operating time frames for this alternative.

- **Impact 3.3.3.7-1:** There would be a moderate to high potential for impacts to surface water quality due to erosion and possible breaching of the North TSF under the Slower, Longer Project Alternative.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.7-1:** EML would submit a North TSF upstream diversion structure design. This design would be of sufficient capacity to divert run-on from the North TSF so that the current evaporate pond design would be sufficient to contain the designed storm events. The design would be submitted to the BLM 24 months prior to the anticipated start of construction. The BLM would approve the design prior to the commencement of construction.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.7-1 would be effective at preventing erosion and possible breaching of the North TSF. The design would be based on an engineering evaluation of the topography and design precipitation event (24 hour-100 year event) as required by the NDEP so that the design event would effectively be conveyed away from the North TSF.
  With the implementation of the mitigation measure, the residual impact of the Slower, Longer Project Alternative would be limited to natural erosion processes.

- **Impact 3.3.3.7-2:** The ground water drawdown is predicted to be more than ten feet for the perennial stream segments of Roberts Creek for varying periods of time up to at least 400 years after the end of mining and milling operations.

  Significance of the Impact: The impact is considered potentially significant.

- **Mitigation Measure 3.3.3.7-2:** The measures outlined under Mitigation Measure 3.2.3.7-2 would address the potential reduced flows outlined in the impact.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.3.3.7-2 would be effective at preventing degradation of water quality in Roberts Creek. The mitigation measure would restore flows to the creek, which would remove the underlying cause of this potential impact.

3.3.3.7.2 Ground Water Quality Impacts

Under the Slower, Longer Project Alternative ground water quality impacts would be indistinguishable from the Proposed Action; however, the timing of those potential impacts could differ due to the extended operating time frames for this alternative.

- **Impact 3.3.3.7-3:**There would be a low potential for impacts to ground water quality due to drainage from tailings impoundments and WRDFs under the Slower, Longer Project Alternative.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.3.3.7.3 Pit Lake Water Quality Impacts

Under the Slower, Longer Project Alternative pit lake water quality impacts would be indistinguishable from the Proposed Action.

- **Impact 3.3.3.7-4:** There would be a low potential for impacts to ground water quality due to the formation of a ground water sink in the open pit under the Slower, Longer Project Alternative.

  Significance of the Impact: The impact is not considered significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

The Mount Hope **Final** EIS **is** continued in Volume II.

3.4 Geology and Mineral Resources

3.4.1 Regulatory Framework

The U.S. Congress established the right to access and develop mineral resources on open lands administered by the Federal Government under the 1872 General Mining Law. This law has been amended many times since its passage; however, the underlying right to access and develop minerals has remained in the General Mining Law. Limitations on the development of minerals under the General Mining Law have been established by the U.S. Congress in their passage of the various environmental laws (i.e., CWA, Clean Air Act [CAA], Endangered Species Act [ESA], etc.). The BLM has been charged by the U.S. Congress with the management of activities on public lands under the General Mining Law. The BLM implements this management through regulations at 43 CFR 3809.

The U.S. Congress has passed two laws that establish the policy for the development of mineral resources in the U.S. These acts are the MMPA and the Materials and Minerals Policy Research and Development Act of 1980. Congress declared that the national mineral policy is "...to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, (2) the orderly and economic development of domestic resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security, and environmental needs ...". The 1980 Act reiterates these statements from the 1970 act.

The NDWR has safety requirements for water impoundment facilities of a size that are covered under the regulations at NAC 535.010 through 535.420. These regulations address how impoundments are designed, constructed, operated, and inspected.

Construction of mine facilities is regulated by standards of the Uniform Building Code (UBC). Eureka County currently uses the 2003 version of the International Building Code. The seismic zone designation throughout Eureka County is zone 3 on a scale ranging from 1 (indicating less damage expected) to 4 (indicating the most damage expected). Seismic activity in the vicinity of the Project Area is discussed under Section 3.4.2.4.10. Eureka County does not have specific regulations for building construction.

3.4.2 Affected Environment

3.4.2.1 Study Methods

The geology in the Project Area has been studied in detail by numerous geologic investigators. A comprehensive map of Eureka County was compiled in 1967 and is included in Geology and Mineral Resources of Eureka County, Nevada (Roberts et al.1967). The geology in the area has recently been researched and the structural setting reinterpreted (Crafford 2007) as part of the process of compiling a new geologic map for the entire State of Nevada. Crafford (2007) has described the various geologic units in context of sedimentary rocks and assemblages. Local, in depth studies of the Project Area have been ongoing since the deposit at Mount Hope was discovered. Current studies by EML geologists concur with the descriptions formulated by geologists formerly working at the Project. The following section describes the geology of the Project Area and the Mount Hope deposit. The geologic information in this section is summarized primarily from the paper written by Westra and Riedell (1996) and published in the

Geological Society of Nevada's 1996 Geology and Ore Deposits of the American Cordillera, Symposium Proceedings. Crafford's (2007) interpretations have been noted where appropriate.

3.4.2.2 Existing Conditions

The Project is located in the central Great Basin section of the Basin and Range Physiographic Province. Block faulting in the area has resulted in generally north south trending topography. Structural deformation has resulted in a series of valleys separated by mountain ranges.

3.4.2.3 Regional Geology

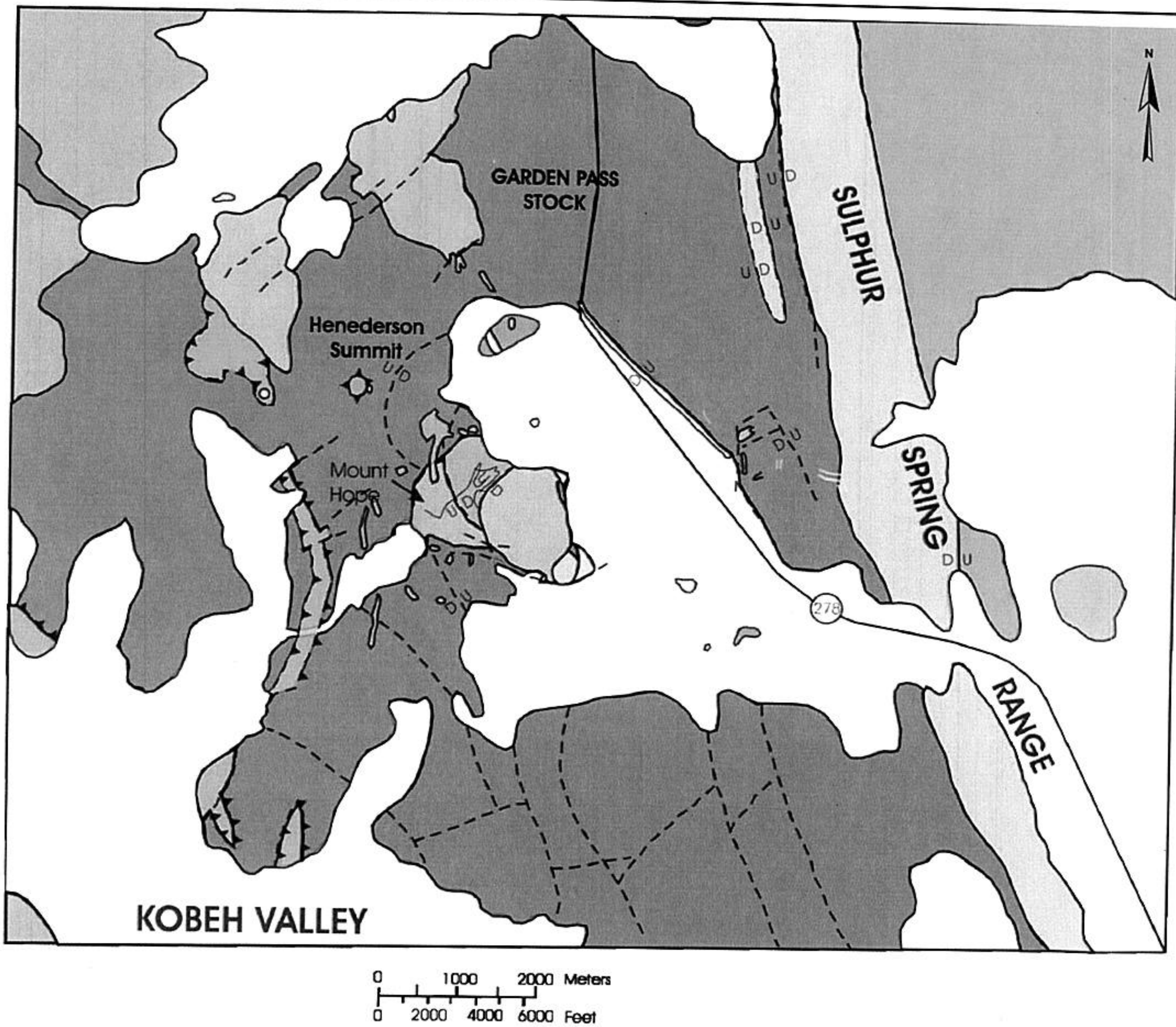
Mount Hope is situated near the leading edge of the Roberts Mountains thrust. East vergent thrusting placed a basinal sedimentary and volcanic ("Western") assemblage on top of coeval, predominantly shelf sequence carbonate rocks ("Eastern" assemblage) during the Devonian-Mississippian Antler orogeny (process of mountain building). Western assemblage mudstones, cherts, sandy limestones, sandstones, and conglomerates of the Ordovician Vinini Formation underlie most of the Project Area. Figures 3.4.1, 3.4.2, and 3.4.3 show the geology and stratigraphy of the area.

Eastern assemblage shelf sequence rocks, including the Silurian Lone Mountain Dolomite and Devonian Nevada Formation, are exposed along the eastern side of the Sulphur Spring Range. Several fault bounded exposures of dolomite and limestone of the Nevada and Devils Gate Formations lie west of Mount Hope. These have been interpreted as windows through the Roberts Mountains thrust; fault slices of lower plate material caught up in the upper plate; tectonic slides structurally interlayered with and overlying the Vinini Formation, emplaced during early Cretaceous (?)[1] gravity sliding; or lower plate blocks rotated and juxtaposed against Vinini Formation rocks by Oligocene or younger extensional faults. Previous mapping and drilling indicate that the carbonate blocks both overlie and are interleaved within the Vinini Formation, and are in turn overlain by tuffs related to the Mount Hope igneous complex. Crafford (2007) has reinterpreted and recategorized early mapped units into assemblages such as Slope Assemblage, Basin Assemblage, and others. These assemblages formed under varying circumstances and then were involved in complex structural events, which destroyed the original stratigraphic sequence making it very difficult to determine or interpret underlying and overlying strata and the age of those strata. This is a key component to the discussion of paleontology in Section 3.5.

During the Antler orogeny, an elongate foreland basin formed at the toe of the allochthon. This basin was filled with a post-orogenic coarse clastic "Overlap" assemblage representing detritus eroded off the Antler highlands. In the Mount Hope area, the Overlap assemblage is represented by Permian limestone, conglomerate, and shale of the Garden Valley Formation, exposed in the Sulphur Spring Range and at the southeastern contact of the Mount Hope igneous complex. Intermittent orogenic movement during the late Paleozoic and Mesozoic resulted in folding and thrust faulting of the Overlap assemblage and underlying formations.

The leading edge of the Roberts Mountains thrust is not exposed in the Mount Hope area; however, the distribution of Western and Eastern assemblage rocks indicates that the trace of the

[1] The use of "(?)" is a standard practices when stating uncertain geologic ages.



QUATERNARY

Alluvium

TERTIARY

Basalt flows

Dacite porphyry

Quartz porphyry

Rhyolite ash flow tuffs and vent breccias

PERMIAN

Garden Valley Formation - limestone, sandstone, conglomerate, shale

ORDOVICIAN TO DEVONIAN

Miogeosynclinal Carbonates and Clastics - Includes Eureka Quartzite, Lone Mountain and Nevada Dolomites, and Devils Gate Limestone

ORDOVICIAN

Vinini Formation - chert, siltstone, shale, limestone, quartzite

SYMBOLS

Contact

U/D Normal fault, showing displacement

Thrust fault

SOURCE: Westra and Riedell (1996) published in the Geological Society of Nevada's 1996 Geology and Ore Deposits of the American Cordillera

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN:	EMLLC	DRAWN:	GSL	REVIEWED:	RFD
CHECKED:	-	APPROVED:	RFD	DATE:	05/02/2011
FILE NAME:	p1635_Fig3-4-X_Geology.mxd				

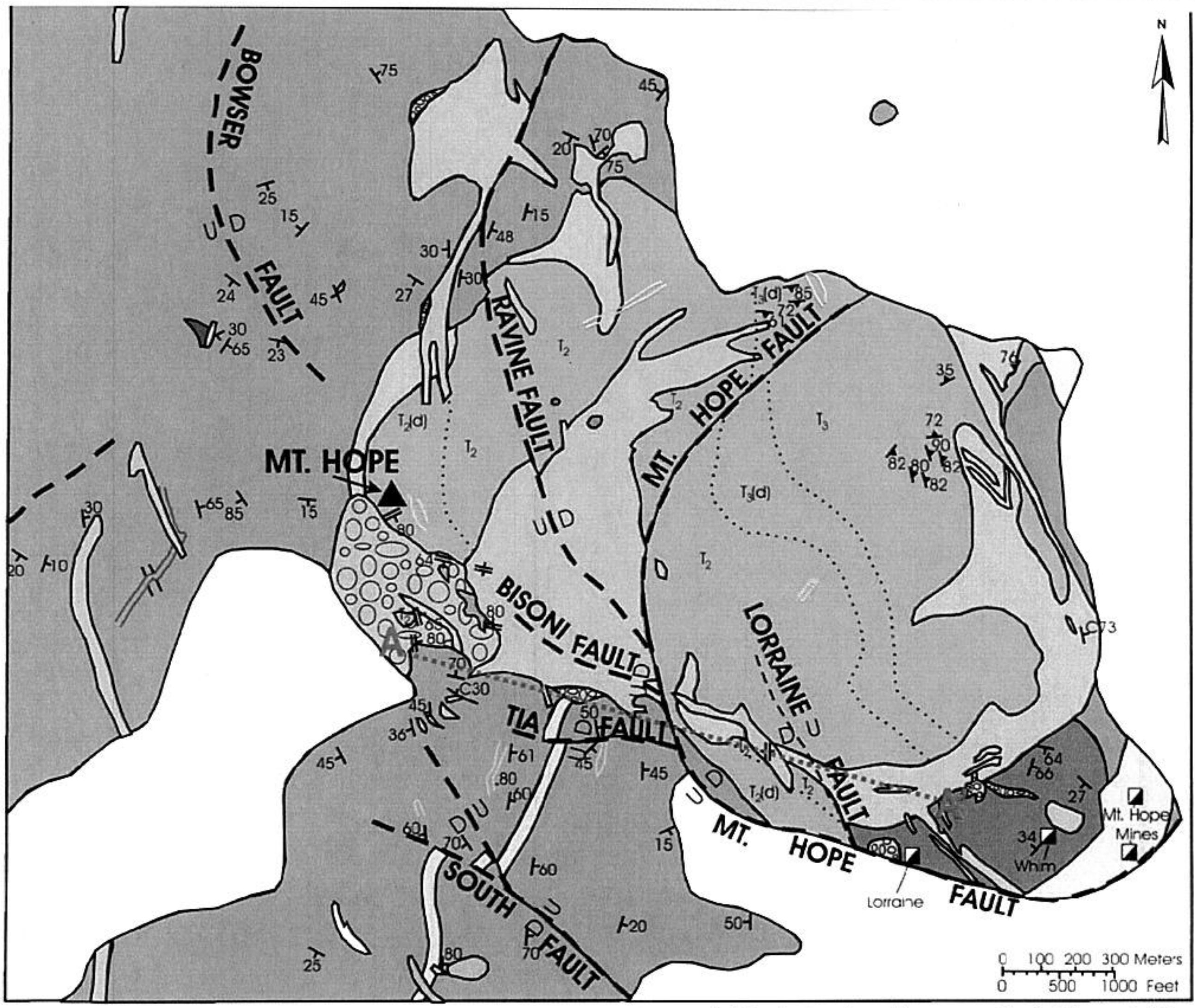
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

General Geology of the Mount Hope Area, Nevada

Figure 3.4.1



A-A' indicates line of cross section in Figure 3.4.3.

QUATERNARY

- Alluvium

TERTIARY

- Dacite porphyry
- Quartz porphyry breccia (age uncertain)
- Quartz porphyry
- Quartz porphyry border phase
- Rhyolite vent breccia
- Quartz-eye tuff (age uncertain)
- Mt. Hope Tuff - cooling units designated T_1, T_2, and T_3 from oldest to youngest. Density welded zones indicated by (d). T, undivided Mt. Hope Tuff (T_3, T_2(d), T_2, T_1(d), T_1)
- Biotite quartz monzonite porphyry (age uncertain)

PERMIAN

- Garden Valley Formation

ORDOVICIAN

Vinini Formation

- Chert, argillite, quartzite, minor limestone
- Limestone, with subordinate clastic sediments

SYMBOLS

- C30 — Contact: mapped, approximate, inferred, showing dip
- Contact between cooling and welding unit in tuff
- D/U — Normal fault, showing displacement
- 65 — Strike and dip of beds
- 30 — Strike and dip of eutaxitic foliation
- 80 — Strike and dip of sheeted quartz vein sheet
- Mine workings

SOURCE: Westra and Riedell (1996) published in the Geological Society of Nevada's 1996 Geology and Ore Deposits of the American Cordillera

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 05/02/2011
FILE NAME: p1635_Fig3-4-X_Geology.mxd		

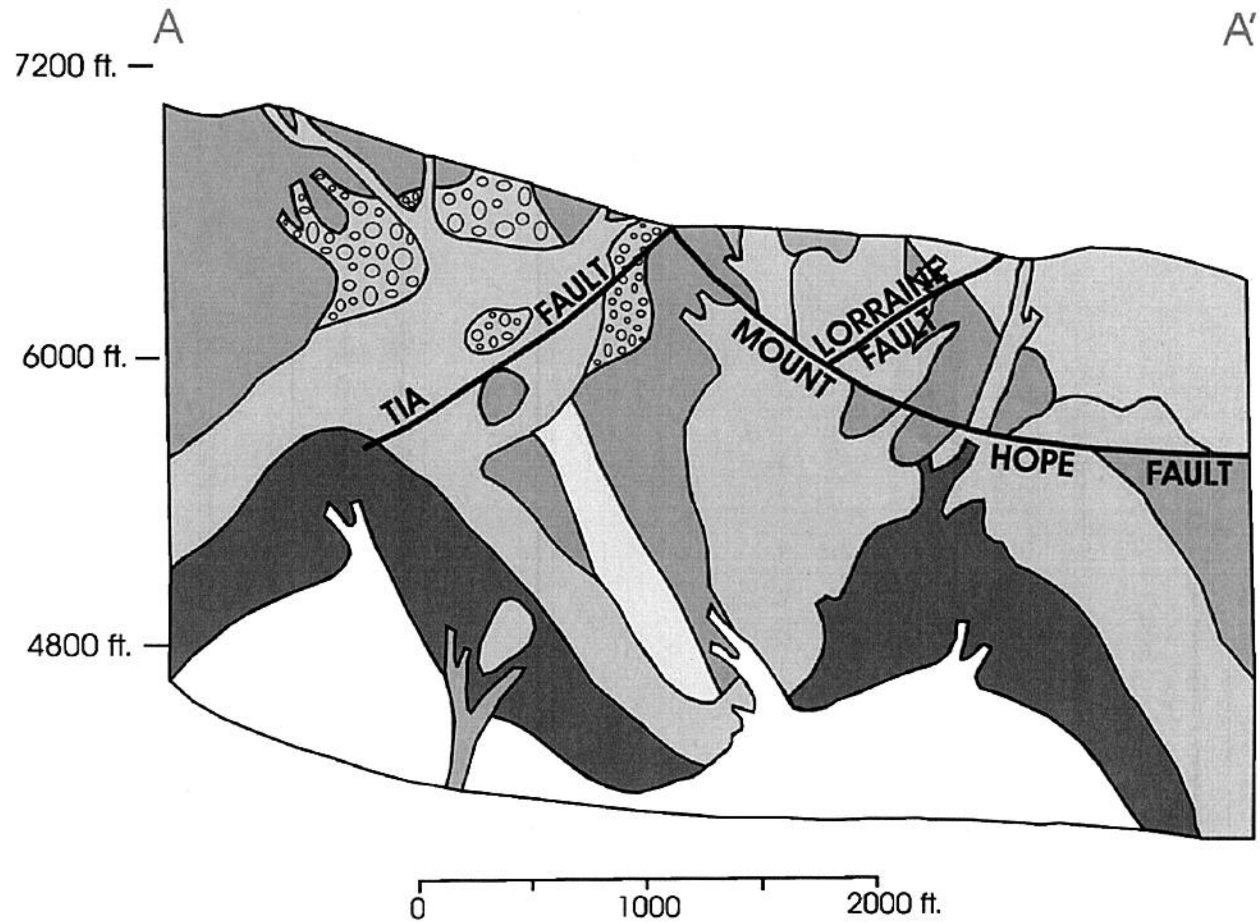
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Geologic Map of the Mount Hope Area

Figure 3.4.2



TERTIARY

- Fine-grained granite
- Coarse-grained quartz porphyry
- Apilitic quartz porphyry
- Quartz porphyries
- Quartz porphyry border phase
- Rhyolite vent breccia
- Mount Hope Tuff

ORDOVICIAN

VININI FORMATION

- Chert, argillite, quartzite, minor limestone
- Limestone, with subordinate clastic sediments

SOURCE: Westra and Riedell (1996) published in the Geological Society of Nevada's 1996 Geology and Ore Deposits of the American Cordillera

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

DESIGN: EMLLC	DRAWN: GSL	REVIEWED: RFD
CHECKED: -	APPROVED: RFD	DATE: 05/02/2011
FILE NAME: p1635_Fig3-4-X_Geology.mxd		

BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Geologic Cross Section

Figure 3.4.3

thrust is concealed beneath the Garden Valley Formation in the Sulphur Spring Range or is faulted out by the structure bounding the range to the east. Drilling in the vicinity of the Mount Hope complex, to a depth of 2,888 feet, has failed to intercept lower plate carbonate rocks.

During the Eocene and Oligocene, extensive andesitic and rhyolitic magmatism occurred within a broad east northeast trending belt that extended from central Nevada to north central Utah. Felsic magmas crystallized as small hypabyssal plugs at Mount Hope and Garden Pass and as rhyolitic ash flows at Mount Hope and in the Henderson Summit area. Unconsolidated to poorly consolidated late Tertiary and Quaternary gravel, sand, and silt fill valleys formed by Basin and Range block faulting.

3.4.2.4 Geology of the Mount Hope Area

3.4.2.4.1 Paleozoic Sedimentary Rocks

Crafford (2007) divides the rock units in the Project Area into two separate assemblages: 1) the Slope assemblage that contains Ordovician through Lower Mississippian rocks; and 2) units in the Basin assemblage that include Upper Cambrian through Devonian rocks.

The Devonian-Ordovician Vinini Formation is widely exposed south and west of the Mount Hope igneous complex. Thin to medium bedded shale, siltstone, chert, and conglomerate predominate; quartzite and sandy limestone are also present. One thin but persistent sandy limestone unit divides the section into a lower sequence of dominantly argillaceous rocks, cropping out to the west, and a chert and quartzite rich upper unit to the east. The limestone bed dips and thickens eastwardly and may correlate with skarn present in the deep subsurface.

Along the southeast side of the Mount Hope complex, the basal limestone unit of the Permian Garden Valley Formation has been preserved in a small asymmetrical syncline. It overlies Vinini Formation in an unconformable or possibly thrust contact.

3.4.2.4.2 Garden Pass Quartz Porphyry

The Garden Pass stock is located 2.5 miles north of Mount Hope and consists largely of unaltered rhyolitic quartz porphyry, similar to the main phase quartz porphyry of the Mount Hope complex.

3.4.2.4.3 The Mount Hope Igneous Complex

The Mount Hope Igneous Complex consists of rhyolitic and subordinate rhyodacitic to dacitic intrusive and extrusive phases and thus represents a subvolcanic erosion level of a mid-Tertiary eruptive center. Welded rhyolite tuffs are distinguished by the presence of shard structures and variable amounts of coarse pumice. These rocks probably formed from localized ash flows erupted from the complex. Rhyolite vent breccias are rich in lithic fragments but lack pumice and glass shards, and form steeply dipping ring dikes along the margins of the complex. Quartz porphyries occur both as autoliths in and as dikes cross cutting the rhyolite tuffs and vent breccias and must, therefore, predate and postdate the latter rock types.

Rhyolite tuffs: The most extensive ash flow unit, the informally named variably welded Mount Hope tuff, is characterized by 25 to 40 percent small angular phenocrysts, Vinini siltstone, and pumice in a devitrified groundmass of fine crystalline quartz and K-feldspar (potassium feldspar). The texture of the tuffs contrasts with that of porphyries and pumice fragments due to the fracturing of crystals during ash flow eruption and dissipation of fine ash out of the top of the eruptive cloud, resulting in the higher phenocryst content in the tuffs.

Rhyolite vent breccias: The southeastern and northwestern contacts of the Mount Hope complex are marked by ring dikes of rhyolite vent breccia that cut all units of Mount Hope tuff. The breccias have broken crystals similar to those in the Mount Hope tuff, but contain fewer phenocrysts, larger and more abundant lithic fragments, and neither shards nor pumice. Angular fragments of early quartz porphyry and Vinini siltstone, quartzite, and hornfels are included.

Quartz porphyries: Intrusive rhyolitic quartz porphyries contain subhedral to euhedral (or rarely broken) quartz, K-feldspar, and plagioclase phenocrysts in groundmasses of allotriomorphic granular texture and varying grain size. Early quartz porphyry, presently known only from autoliths in rhyolite tuffs and vent breccias, is the only known quartz porphyry phase that predates these units. Autoliths of early quartz porphyry are most common in rhyolite vent breccia along the eastern and southeastern edges of the complex, suggesting that a mass of early quartz porphyry may occur in the subsurface in this area. No reliable macroscopic or petrographic criteria distinguish this rock type from the quartz porphyries that postdate the eruptive episode.

A minimum of four post-eruptive quartz porphyry phases together constitute an irregular intrusive mass that cuts both Mount Hope tuff and rhyolite vent breccia. From margin to core, the quartz porphyry phases become successively younger and have progressively coarser groundmasses. The discontinuous rind of the porphyry pluton, exposed primarily along the southwestern contact zone, consists of a chilled border phase. An extremely fine grained groundmass, common broken phenocrysts, and numerous xenoliths of Vinini hornfels distinguish this unit from the later porphyries. Main phase quartz porphyry, the most widespread intrusive phase at the surface, forms an irregular stock of somewhat variable texture and numerous dikes cutting the Vinini Formation.

With increasing depth, the quartz porphyry grades into or is cut by aplitic quartz porphyry characterized by distinctly coarser aplitic groundmass. Only rarely do dikes of aplitic quartz porphyry intrude overlying quartz porphyry. The core of the igneous complex consists of a heterogeneous mass of granite porphyries and coarse grained quartz porphyries. A contact breccia, with fragments of quartz porphyries and Vinini hornfels and skarn, locally separates the granite porphyry with a quartz K-feldspar oligoclase groundmass of grains. The finer grained groundmass of the coarse grained quartz porphyry in the core of the stock may be the result of pressure quenching during brecciation of the granite border zone.

Other related intrusive units are volumetrically insignificant. Fine grained granite or aplite forms rare dikes cutting all quartz porphyry phases. Small hydrothermal quartz porphyry breccias with matrices of silicified rock flour have been mapped northeast and south southeast of the summit of Mount Hope.

Intermediate rocks: Dikes of rhyodacitic to dacitic composition crop out north, east and west of the Mount Hope Complex. It is uncertain whether these rocks represent more mafic products of the Mount Hope magma chamber or different magmas altogether. Rare dikes of biotite quartz monzonite porphyry cut Vinini Formation west of the complex and are cut in turn by dikes of quartz porphyry. Dacite porphyry occurs as dikes on the lower slopes north and east of Mount

Hope and shows no crosscutting relationships with the rhyolitic units of the complex; however, this porphyry is affected by hydrothermal alteration.

Age of the Mount Hope Complex: Radiometric age dates range from 26 to 49 million years ago (Ma) and are markedly discordant for individual units. Wide spans in potassium argon and fission track dates have been reported from other porphyry Mo deposits but are now considered suspect due to probable resetting at lower temperatures. Current interpretation of these data, with consideration given to differences in the quality of samples is that the age of all the rhyolitic units is about 38 Ma based on clustering of ages in the 36 to 40 Ma range. Dacite porphyries exhibit peripheral alteration and mineralization consistent with their spatial position in the system but yield anomalously younger 30 to 33 Ma ages. Based on geologic relationships, it is inferred that the dacite porphyry is approximately the same age as the rhyolitic rocks.

3.4.2.4.4 Structural Development During the Emplacement of Mount Hope Igneous Complex

The thickness and distribution of the Mount Hope tuff in the subsurface and the highly variable and locally steep dips of eutaxitic foliation suggest that ash flow eruptions were accomplished by cauldron subsidence. The actual cauldron bounding structures have not been observed either in outcrop or drill core because they were largely to completely filled with rhyolite vent breccia. Subsidence is inferred, however, because the ring dikes of rhyolite vent breccia juxtapose outcropping Paleozoic sedimentary rocks on their outer sides against substantial thicknesses of Mount Hope tuff overlying downdropped Paleozoic rocks on their inner sides. Map patterns of rhyolite vent breccia suggest two cauldrons formed.

The western cauldron, approximately 3,300 feet in diameter, is outlined by the partial ring dike northwest and north northeast of the summit of Mount Hope. This ring fracture system juxtaposes a 1,000-foot thick section of the lower cooling unit of the Mount Hope tuff against Vinini Formation. The restricted distribution of this cooling unit indicates that eruption and accumulation were almost entirely confined to this small western cauldron.

The ring dike of rhyolite vent breccia that borders the complex on the eastern side was emplaced along a structure that juxtaposed the middle and upper cooling units against Paleozoic rocks to the east and south. The ring dike partially outlines a cauldron approximately 900 feet across, comprising the eastern half of the complex. Both middle and upper tuff units ponded in, and probably erupted from, this eastern cauldron. At least 1,150 feet of subsidence is inferred. The outflow facies of the middle cooling unit has been preserved in the Henderson Summit area and in widely scattered small erosional remnants. The Bowser fault, northwest of Mount Hope, forms a broad semi-circular structure that may define a yet larger subsidence area.

3.4.2.4.5 Postmineral Structures

Several fault zones can be traced between drill holes in the subsurface. Offsets in zones of alteration and mineralization indicate that significant postmineral normal movement took place along these structures. Locally strong pyrite and molybdenite mineralization within these zones may provide evidence for some premineral history. Two sets of faults occur: 1) high angle structures trending west northwest and 2) moderate to high angle ring shaped structures that truncate the earlier set.

The west northwest trending Bisoni and Tia faults cut the southwestern edge of the complex and adjacent Vinini Formation. The faults dip 60 to 70° in a northerly direction. The Mount Hope fault terminates these structures to the east. Offsets of Mo zones along these faults suggest postmineral movement of less than 330 feet.

The Mount Hope fault has been well defined by drilling and is a listric fault with easterly dips of 55° at the surface and 30 to 35° at depth. In plain view, the fault is spoon shaped, opening to the northeast, which suggests that displacement was in a north 65° east direction. Normal movement estimated at 650 to 800 feet placed argillic alteration on top of better grade Mo mineralization in the footwall.

The Lorraine fault appears to dip southwesterly at a moderate angle. It is restricted to the hanging wall of, and may be an antithetic normal fault related to, the Mount Hope Fault. The listric Ravine fault only occurs in the footwall of the Mount Hope fault. The Ravine fault is nearly vertical at the surface, but flattens with increasing depth to a moderate easterly dip.

Map patterns suggest that cooling units of the Mount Hope tuff dip gently northeast, although attitudes of compaction foliation are far less regular. Miocene basalts exposed in the Roberts Mountains also dip gently east suggesting that Basin and Range block faulting tilted the Mount Hope area between ten and 20° east following mineralization.

3.4.2.4.6 Alteration and Minor Element Distribution

Hydrothermal alteration and mineralization affect nearly all of the Mount Hope complex and a wide area of adjacent sedimentary rocks. Patterns of alteration and metal zoning are well developed. Mapping and petrographic study allow correlation of alteration effects in igneous rocks with those in the Vinini Formation. Regardless of host, such effects are classified into weak argillic propylitic, argillic, potassic phyllic, potassic, high silica, and biotite alteration zones, arranged from periphery to core of the hydrothermal system.

Weak Argillic Propylitic Alteration: Weak argillic and propylitic assemblages characterize the outermost zone of the Mount Hope hydrothermal system. In quartz porphyry, plagioclase is partly replaced by kaolinite and sericite. The more calcium rich dacite porphyry commonly exhibits propylitic assemblages, with aggregates of epidote, carbonates, and clays replacing plagioclase. Thermal metamorphism of Vinini argillites extends up to 2,000 feet from the contact with the Mount Hope complex and produced hornfels with blocky fracturing but no megascopic mineral changes. Local structurally controlled argillized zones, with carbonates, chlorite, and sulfides, extend outward into unaltered Vinini siltstones and shales.

Argillic Alteration: Argillic assemblages are widespread and especially well developed in Mount Hope tuff and rhyolite vent breccia in the hanging wall of the Mount Hope fault. Montmorillonite, kaolinite, mixed layer illite/montmorillonite, and minor calcite and sericite/illite completely replace plagioclase. K-feldspar is fresh to weakly "dusted" by clays and sericite. Vinini hornfels within the argillic zone contains quartz, sericite and disseminated pyrite. Closer to the center of the hydrothermal system, but still within the argillic zone, hydrothermal or contact metamorphic biotite imparts a distinctive chocolate brown color to the hornfels. Minor amounts of pyrite or pyrrhotite are present. Limestone of the Garden Valley Formation formed marble with isolated pods and lenses of skarn containing garnet, pyroxene, tremolite, epidote, fluorite, and retrograde clays, carbonates, chlorite, and biotite. Silicate veins are rare to absent in most rock types, although sparse hairline quartz veinlets cut more competent rocks such as the densely welded tuffs. Disseminated grains and thin veinlets of pyrite increase with depth. Discontinuous veinlets containing sphalerite, pyrrhotite, or rarely galena are also common.

Low Mo (less than 20 parts per million [ppm]) and F (less than 500 ppm) values characterize the argillic zone. Highly anomalous Pb, Zn, Ag, and Mn form distinct haloes largely within the argillic zone, above and peripheral to molybdenite ore. In cross section, anomalous Pb and Ag values occur above and outside a strongly developed Zn and Mn halo. The historic Mount Hope mine exploited the high grade Zn-rich mineralization formed where this halo intersected reactive limestones of the Garden Valley Formation. Intense orbicular alteration and the highest total sulfide concentrations generally overlap with strong Zn mineralization. Cu and Sn values increase with depth in the argillic zone, but commonly peak in the underlying potassic phyllic zone.

Potassic Phyllic Alteration: Early potassic alteration with overprinted sericite forms a discontinuous zone between the potassic core and the peripheral argillic zone. This region, termed the potassic phyllic zone, is best developed in quartz porphyries and Vinini hornfels along the southern and southwestern sides of the complex. Throughout the exposed potassic phyllic zone, quartz veinlets commonly occur in near vertical sheeted sets that appear to form radial and annular patterns centered on the exposed potassic core. The potassic phyllic zone averages only one to two weight percent sulfides, mostly pyrite and molybdenite, with pyrrhotite also present in Vinini hornfels.

A rapid increase in Mo content takes place within the potassic phyllic zone. No more than 500 to 650 feet separate the 0.01 percent and the 0.1 percent Mo contours in most drill holes. Chalcopyrite bearing veinlets are also common in this zone and, where exposed to weathering, may give rise to a zone of weak chalcocite enrichment. Sn is commonly found in high concentrations. The highest F values straddle the transition between potassic phyllic and underlying potassic alteration, directly above the Mo ore zone. Fluorite occurs in veinlets and in xenomorphic aggregates replacing the porphyry groundmass and some K-feldspar phenocrysts. No topaz has yet been recognized. F is preferentially concentrated in sedimentary rocks of the Vinini Formation, and a very strong surface F anomaly occurs along the contact with the main quartz porphyry phase.

Potassic Alteration: A zone of potassic alteration represents the exposed core of the hydrothermal system and widens considerably with depth, extending easterly in the footwall of the Mount Hope fault. Potassic altered quartz porphyries consist largely of quartz, K-feldspar, and minor fluorite, and show a striking enrichment in potassium. Hydrothermal K-feldspar replaces plagioclase and floods in the groundmass. Green to yellow sericite and kaolinite, in turn, replace relict and some K-feldspathized plagioclase. Fluorite locally replaces groundmass grains and K-feldspar phenocrysts. Recrystallization of argillite formed brown hornfels containing quartz, biotite, K-feldspar, plagioclase, and minor sericite. Calcareous sedimentary rocks formed skarns containing garnet, diopside, and retrograde actinolite, hornblende, chlorite, and biotite. Some quartz veins in the calcareous rocks have envelopes of hydrothermal K-feldspar which postdate formation of the garnet skarn.

A well developed stockwork of quartz ± fluorite ± K-feldspar ± molybdenite veinlets cuts quartz porphyries and Vinini hornfels and is largely confined to the potassic zone. Vein density ranges from four to 30 volume percent of the rock. In the Vinini Formation, K-feldspar is more common in veinlets, and haloes of dark brown biotite or pale tan grey K-feldspar surround the quartz veins. Parallel vein walls, dilation of earlier structures, and offsets of earlier by later veins all indicate that open fracture filling was the dominant mechanism of vein formation. The potassic zone averages less than one percent pyrite plus molybdenite, and outcrops contain only sparse limonites.

Potassic alteration is approximately coextensive with the surface Mo anomaly and with ore grade Mo mineralization at depth. Anomalous **W** concentrations commonly occur within the deeper part of the potassic zone. The highest **W** values occur in biotite and calc-silicate hornfels of the Vinini Formation with scheelite being the dominant W mineral.

High Silica Alteration: A gradual increase in barren granular hydrothermal silica with depth marks the transition into zones of high silica alteration. In igneous rocks, high silica zones contain in excess of 30 volume percent hydrothermal quartz in veins and irregular replacements. Locally, massive silica has obliterated all igneous textures. In addition to quartz, these high silica zones contain minor carbonates, chlorite, and pyrite, but fluorite is conspicuously absent. Quartz produced by silica flooding is coarser grained than quartz occurring in stockwork veins. Petrographic study suggests that silica flooding began with suturing of strained quartz phenocrysts, forming mosaics that grew outward and coalesced into patches of granular silica. In Vinini hornfels, vein quartz increases only slightly in the high silica zone, but veinlets are less regular and nebulous patches of silica flooding are more common than in the overlying potassic zone.

Patches of silica flooding consistently appear to cut quartz molybdenite ± fluorite veinlets in drill core, in some instances assimilating remnants of mineralized fractures as "ghost" molybdenite. Such relationships suggest that silicic alteration formed somewhat later than the bulk of molybdenite mineralization.

A slight increase in pyrite content accompanies the transition from potassic to high silica alteration. Magnetite, absent from higher levels of the system, averages up to 0.5 weight percent in veinlets with quartz, biotite, chlorite, and pyrite. Traces of arsenopyrite and hematite have been noted, and Pb and Zn are locally anomalous. A significant increase in sericite, kaolinite, and calcite after relict feldspars occurs 160 to 330 feet below the top of the high silica zone and overlaps into the underlying biotite zone.

Biotite Alteration: A zone characterized by magmatic and hydrothermal biotite occurs in the subsurface in granite porphyry and coarse grained quartz porphyry. Aggregates of hydrothermal biotite with retrograde chlorite and sericite occupy magmatic biotite sites. Primary biotite and oligoclase become more abundant with increasing depth. Widely spaced high angle quartz calcite veins are common. A thin zone of low-grade Mo and W mineralization generally occurs near the top of the biotite zone.

3.4.2.4.7 Nature and Habit of Molybdenite Mineralization

Molybdenite mineralization at Mount Hope occurs in a stockwork of fractures and veinlets. Disseminated molybdenite, although present, is very rare. The bulk of mineralization occurs in four types of veinlets: 1) quartz molybdenite veinlets (comprising 75 percent of ore) range from 0.1 to five millimeters (mm) in thickness and generally contain molybdenite crystals averaging one mm in the longest dimension; 2) coarse quartz molybdenite veins (ten percent of ore) are five to 20 mm thick and are lined with rich clusters of molybdenite crystals averaging 0.08 mm across. Such veins are most common in Vinini Formation; 3) blue quartz veins (ten percent of ore) are three to ten mm thick and bluish gray in color, imparted by sparse grains of molybdenite averaging 0.05 mm across. These veins are most common in the deeper part of the system; and 4) molybdenite "paint" (five percent of ore) refers to thin films of molybdenite, commonly smeared and slickensided, on fractures devoid of quartz.

3.4.2.4.8 Vein Paragenesis

The age relations between various vein types at Mount Hope are complex. Detailed core logging and petrographic studies suggest the following generalized sequence: 1) early barren quartz ± K-feldspar ± fluorite veins; 2) quartz fluorite molybdenite ± K-feldspar veins; 3) quartz molybdenite ± fluorite veins; 4) blue quartz veins; 5) granular silica associated with the formation of high silica zones; 6) quartz sericite pyrite ± chlorite ± fluorite veinlets (shallow); quartz pyrite ± magnetite ± biotite ± chlorite veinlets (deep); 7) molybdenite "paint" on fractures; and 8) late fractures lined with pyrite, clay or carbonate. Pervasive early potassic alteration affected all quartz porphyries, hornfels of the Vinini Formation, and possibly Mount Hope tuff. Related vein types 1 and 2 cut potassic altered porphyries and Vinini Formation but are rare in the tuffs. Molybdenite bearing quartz veins, types 2 through 4, formed during the transition from potassic to high silica alteration. These veins appear to become thicker and leaner in molybdenite with time and increasing depth, and culminate in the patches of barren granular quartz comprising the high silica assemblage. Weakly developed phyllic alteration, represented by vein type 6, cut potassic and high silica alteration. Argillic alteration may by superimposed on potassic altered Mount Hope tuff and extends well beyond the earlier potassic zone.

3.4.2.4.9 Local Geologic Structures

Three Quaternary age faults have been mapped within ten miles of the Project Area. There is a discontinuous and vaguely defined group of faults that extend southeast from approximately four miles west of Mount Hope to three miles northwest of Mount Whistler, on the southeastern flank of the Roberts Mountains. These are short faults where bedrock is found against Quaternary pediment slope deposits (Lidke 2000). There is evidence along the zone for at least one faulting event that is no older than early Pleistocene in age.

Another group of faults strikes north and is located in the Garden Valley area immediately north of the Project Area. These faults trend north and appear to down drop Quaternary deposits of the Garden Valley against Paleozoic and Tertiary bedrock of the Roberts Mountains and Sulphur Springs Range, which border the western and eastern flank of the valley, respectively (Lidke 2000). There is evidence for Quaternary movement along these faults, but no estimates of offset amounts for these faults have been reported.

Approximately ten miles southwest of Mount Hope is a northwest striking fault that follows the southwestern flank of the Roberts Mountains. It is a major range front fault that appears to extend farther southeast as a prominent scarp on pediment slope deposits of the northern part of the Kobeh Valley (Lidke 2000). Along the southwestern flank of the Roberts Mountains, the fault has a down to the southwest stratigraphic offset that juxtaposes Paleozoic bedrock against Quaternary pediment slope deposits (Lidke 2000). Evidence of latest movement is Holocene in age.

None of these faults have been studied in detail and very little is known about their nature, character and movement history, and there is no record of recent movement along these faults.

3.4.2.4.10 Seismicity

Although the Project is in a seismically active region of the country, it is not located within Nevada's major seismic belts. A search of the UNR Seismological Laboratory database revealed that from 1872 to 2008, there have been 364 recorded earthquakes greater than 3.0 within 100 miles of the site; 40 recorded earthquakes greater than 3.0 within 50 miles of the site, and zero recorded earthquakes greater than 3.0 within ten miles of the Project Area. Most of the earthquake activity in the last 156 years has been 100 miles west of the Project Area.

Table 3.4-1 indicates that 89 percent of the earthquakes within 100 miles of the site and 98 percent of the earthquakes within 50 miles of the site have been below 5.0 in magnitude. The highest magnitude earthquakes were 7.2 and 7.8 and were located approximately 100 miles southwest and 90 miles northwest, respectively. The highest magnitude earthquake (5.5) closest to the Project Area, was recorded on April 2, 1875, approximately 26 miles to the southeast. There have been no earthquakes recorded with a magnitude greater than 3.5 within ten miles of the proposed site since record keeping began in 1852.

Table 3.4-1: Seismic Events (>3.0) Recorded Near the Project Area Between 1872 and 2008

Local Magnitude	Number within 100 Miles	Number within 50 Miles	Number within 10 miles
>7.0	2	0	0
6.0 - 6.9	3	0	0
5.0 - 5.9	36	1	0
4.0 - 4.9	207	19	0
3.0 - 3.9	116	20	0

Assessment of the seismic hazards at Mount Hope was conducted using seismic models available from the USGS. One assessment tool models the occurrence of a seismic event within a 30 mile radius of the site within the next 50 years. Another calculates the peak acceleration caused by a seismic event in the next 50 years.

The USGS model indicated that the probability of a magnitude 5.0 quake occurring within 30 miles of the site in the next 50 years is between 0.4 and 0.5. The probability of a magnitude 6.0 quake occurring within 30 miles of the site in the next 50 years is between 0.10 and 0.15. The probability of an earthquake greater than a 7.0 occurring within 30 miles of the site in the next 50 years is between 0.005 and 0.01. The probability of an earthquake greater than 8.0 occurring within 30 miles of the area in the next 50 years is essentially zero.

In order to evaluate the force on a building during an earthquake, peak acceleration can be calculated for an area. During an earthquake ground acceleration varies with time. Peak acceleration can be calculated with a two percent and ten percent probability of exceedance in 50 years. An exceedance of two percent was used because it is the most conservative amount. The analysis was completed so that there is a two percent chance that the ground acceleration would be exceeded in a 50 year time period. For the Project, the percentage is calculated between 20 and 30 percent. A percentage of 20 to 30 percent calculated for the Project Area indicates that if there is an earthquake within the next 50 years, then it would result in negligible damage to buildings of good design and construction.

3.4.2.4.11 Mineral Resources

The Mount Hope deposit is a classic Mo porphyry, similar in type to the Climax deposit in Colorado. This type of deposit has well zoned molybdenite mineralization where many intersecting small veins of molybdenite form a stockwork in an altered quartz monzonite porphyry. Similar to other porphyry-type ore deposits, the ore is low-grade but the ore body is very large. EML is focused on the economic Mo mineralization in the deposit; however, based on drilling results and the presence of other mineralization in the district such as W, Ag, gold (Au), Pb, Zn, and Cu that are present in the pit walls adjacent to and distal from the open pit, EML would evaluate these additional mineral resources in the future (**Independent Mining Consultants** [IMC] 2005). The Mount Hope deposit contains a nearly 1.0 billion ton molybdenite ore body that would produce approximately 1.1 billion pounds of recoverable Mo during its 44-year lifetime. **Approximately** 2.7 billion tons of ore and waste rock would be excavated from the open pit with an ore to waste ratio of 1:1.6. A single open pit would result from the phased mining. The ultimate pit depth would be approximately 2,600 feet **bgs** at an elevation of approximately 4,700 feet amsl.

Exxon in 1988, in one of their last diamond drill holes, encountered significant widths of good grade Zn mineralization. The drill hole encountered two zones: one zone from 128 to 272 feet in depth, 144 feet assayed 9.1 percent Zn; and one zone from 423 to 472 feed in depth, 49 feet assayed 9.3 percent Zn. Recent analyses determined that the mineralization represents a skarn zone between sediments and quartz porphyry. The mineralization in this hole is approximately 300 feet north and generally along trend of the Zn mineralization in the original Mount Hope underground Zn mine. As long as a mile of strike length remains open and unexplored. The zone is outside the limits of the planned Mo open pit. The original underground workings developed a high-grade Zn zone; however, there was no follow up to determine the full extent of the deposit after the Mo deposit was discovered in 1978.

3.4.3 Environmental Consequences and Mitigation Measures

Major issues related to geology and minerals include the following: a) geologic hazards created or magnified by Project development; b) failure of, or damage to, critical facilities caused by seismically induced ground shaking; and c) exclusion of future mineral resource availability caused by the placement of facilities (tailings or waste rock storage areas, etc.).

3.4.3.1 Significance Criteria

Adverse impacts to geology and minerals would be significant if the proposed action or alternatives resulted in any of the following:

- Impacts to the facility site or design caused by geologic hazards, including landslides and catastrophic slope failures or ground subsidence;
- Structural damage or failure of a facility caused by seismic loading from earthquakes; or
- Restriction on the current or future extraction of known mineral resources.

3.4.3.2 Assessment Methodology

Impacts of the Proposed Action and Project Alternatives were assessed based on review of reports prepared in support of the Project, review of the Project baseline characterization reports (SRK 2006), review of the Plan for the Project (EML 2006), and review of the Proposed Action. The significance of the impacts was evaluated based on the significance criteria listed above. Stability analysis of the Project waste rock dumps was analyzed in the Waste Rock Disposal and Low Grade Ore Storage Facilities Design Report (SWC 2008a). Stability analyses for the Project storage and tailings facilities are included in the South and North Tailings Storage Facilities Located in Kobeh Valley Design Report (SWC 2008b).

Waste Rock Disposal Facilities

Slope stability analyses for the WRDFs were conducted in support of the permitting level design. These analyses required the selection of strength parameters from the geotechnical work performed to date and from experience on projects similar to the Project. The slope stability analyses examined the stability of the proposed WRDFs and the LGO Stockpile under both static and seismic loading conditions.

Slope stability analyses were completed for five cross sections developed from ultimate facility configurations under the Proposed Action. Detailed information can be found in SWC's reports (2008a and 2008b), which can be viewed during normal office hours at the MLFO. For this study, all stability analyses were conducted using SLIDE V5.0 (RocScience 2007), which analyzes the stability of slopes using the limit equilibrium method. The limit equilibrium method of analysis used to find the critical circular and wedge type failure surfaces was the Spencer Method. The Spencer Method satisfies both moment and force equilibrium. The program automatically iterates through a variety of potential failure surfaces, calculates the safety factor for static and pseudostatic conditions for each surface according to Spencer's Method, and selects the surface with the minimum factor of safety commonly referred to as the critical failure surface. Specific input requirements of the SLIDE program include geometric profiles, material properties (moist unit weight, saturated unit weight, effective cohesion, and effective friction angle) and a phreatic surface profile.

Stability analyses were conducted under both static and seismic loading conditions. An earthquake event having a 1,100-year return period with a four percent probability of exceedance occurring during the 45-year operation life is considered appropriate for design of the waste rock facilities at Mount Hope. Peak horizontal ground accelerations (PHGA) were determined to be 0.15 gravity (g) and 0.23g for firm rock (Sb) and soil (Sc) respectively. For slope stability analyses, a design horizontal ground acceleration equal to two thirds of the PHGA is considered conservative for deep rotational failures (Hynes and Franklin 1984); therefore, a value of 0.15g was conservatively selected for analyzing WRDFs and the LGO Stockpile both on firm rock and soil. The complete hazard analysis is described in detail in SWC (2008b).

Strength parameters were established based on laboratory testing to date and SWC's experience with similar projects. The waste rock materials contained within all three facilities were considered to be predominantly comprised of competent, relatively durable rock based on comparatively shallow overburden depths of soil overlying bedrock within the ultimate pit limit. Results of the slope stability analyses performed on the waste rock facilities and LGO Stockpile are presented in Table 3.4-2.

Stability analyses were completed for the South TSF at the ultimate crest elevation of 6,710 feet and at the mid-life crest elevation of 6,525 feet under both static and seismic loading conditions. Since the TSF is sited in a somewhat remote area, the tailings embankment was classified as a "large dam significant hazard" in accordance with Nevada Dam Safety Guidelines. Under this classification, a dam is considered a significant hazard if its failure carries a low potential for loss of life but could cause an appreciable economic loss.

Table 3.4-2: Summary of Stability Analyses Results for the Waste Rock Disposal Facilities and the Low-Grade Ore Stockpile

Location	Section	Static Factor of Safety (Circular/Wedge)	Pseudostatic Factor of Safety (Circular/Wedge)
Non-PAG WRDF	1	2.0/2.0	1.3/1.3
	2	2.0/2.0	1.3/1.3
PAG WRDF	3	2.0/2.0	1.3/1.4
	4	2.0/2.1	1.4/1.4
Low-Grade Ore Stockpile	5	1.7/1.7	1.2/1.2

Tailings Storage Facilities

Similar to the WRDF analyses, the TSFs were analyzed using SLIDE V5.0 (RocScience 2007) using the Spencer Method. Static analyses were conducted with no applied horizontal forces, while pseudostatic analyses modeled design seismic conditions by incorporating a constant horizontal force. The embankment section selected for analysis is composed of foundation soil, cycloned sand, slimes, rockfill (toe drain), starter dam material, and smooth and textured LLDPE geomembrane liner. The material properties used for the slope stability analysis were established based on the geotechnical investigation and laboratory testing performed to date, from work completed on other projects similar in nature, area specific experience, and published data from previous studies. The nonlinear shear strength envelope was determined from Shear Interface Testing (SWC 2008b).

The distribution of head and predicted phreatic level within the facility were modeled using a finite element method seepage model embedded within the SLIDE V5.0 program. The facility cross section was modeled under steady state conditions with the probable maximum flood pond level. The phreatic surface model is considered a worst case scenario where the underdrain system is not functional, and the operating pool is at the permitted maximum freeboard level. The modeled phreatic surface is considered to be conservative because it is anticipated that the underdrain system would function as designed and the cycloned sand embankment would remain unsaturated. In addition, the supernatant reclaim pond would be maintained a considerable distance from the crest of the TSF; however, at a minimum, the reclaim pond should be maintained 1,500 feet from the TSF crest during extreme flood conditions. The TSF cross section was modeled as having a uniform conductivity in all directions (isotropic) for all material types. The hydraulic conductivities for the materials overlying the geomembrane liner were selected from laboratory data and experience with similar material on other projects. Hydraulic conductivities used in the finite element model are summarized in SWC (2008b). Results of the stability analyses for the cross sections under consideration are shown in Table 3.4-3.

Table 3.4-3: Results of Slope Stability Analyses for the Tailings Storage Facilities

Section	Type of Failure Modeled	Static Factor of Safety
Ultimate TSF	Circular	2.2
	Block	1.5
18-year (mid-life) TSF	Circular	2.0
	Block	1.5

3.4.3.3 Proposed Action

3.4.3.3.1 Mineral Resources

Direct impacts of the Proposed Action on geologic and mineral resources would result in excavation of **approximately** 2.7 billion tons of ore and waste rock from the open pit with an ore to waste ratio of 1:1.6. This equates to 1.0 billion tons of ore that would be processed. A total of 1.1 billion pounds of Mo would be shipped off site and the remainder of the material would be sent to the two tailings facilities. A total of 1.7 billion tons of waste rock would be stored in WRDFs immediately adjacent to the open pit.

The placement of the WRDFs immediately adjacent to the open pit could limit the future development of mineral resources located in the pit walls adjacent to the open pit, should those potential mineral resources be amenable to development through open pit mining methods; however, there is not sufficient reasonably available geologic and resource information to more definitively address this potential impact.

- **Impact 3.4.3.3-1:** Implementation of the Proposed Action would result in resource extraction and production of 1.1 billion pounds of Mo.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals. However, the impact is economically significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

- **Impact 3.4.3.3-2:** Implementation of the Proposed Action would result in the extraction of waste rock that would be placed adjacent to the open pit and limit the future development of the identified Zn mineralization located to the north of the open pit.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals, because a known Zn mineralization has not been sufficiently defined and potentially could be developed using underground mining techniques.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.4.3.3.2 Geological Hazards

The USGS model indicated that the probability of a magnitude 5.0 quake occurring within 30 miles of the site in the next 50 years is between 0.4 and 0.5. The probability of a magnitude

6.0 quake occurring within 30 miles of the site in the next 50 years is between 0.10 and 0.15. The probability of an earthquake greater than a 7.0 occurring within 30 miles of the site in the next 50 years is between 0.005 and 0.01. The probability of an earthquake greater than 8.0 occurring within 30 miles of the area in the next 50 years is essentially zero.

Seismic events could result in slope failures or structural damage to mine facilities due to an earthquake event having a 1,100-year return period with a four percent probability of exceedance during the operational life of the Project. Based on the results from SWC's analyses (2008a), which indicate a safety factor of 1.7 to 2.0, the WRDFs and Low-Grade Ore Stockpile are stable for all conditions analyzed.

For a water impoundment facility, which is the standard to which the embankment is designed, the desired minimum static factor of safety required by the NDWR is typically 1.4 for static conditions. Based on the results from SWC's analyses of the TSFs (2008b), the proposed facility is stable under static loading conditions since the computed values (1.5 to 2.2) exceed the prescriptive factors of safety; therefore, there would be no impacts associated with geologic hazards.

3.4.3.3.3 Residual Impacts

The potential residual impacts to geology and mineral resources from the Proposed Action are an irreversible and irretrievable commitment of mineral resources through the removal of 1.1 billion pounds of Mo from the mined materials.

3.4.3.4 No Action Alternative

3.4.3.4.1 Mineral Resources

As a result of the No Action Alternative, none of the impacts to the mineral resources generated by the Proposed Action or any other alternative would occur; therefore, implementation of the No Action Alternative would restrict the development of a known mineral resource and not allow the removal of 1.1 billion pounds of Mo from the materials that would have been mined.

- **Impact 3.4.3.4-1:** A known mineral resource with 1.1 billion pounds of recoverable Mo would not be developed due to implementation of the No Action Alternative.

  Significance of the Impact: This impact is considered significant; however, no mitigation measures appear feasible.

3.4.3.4.2 Geological Hazards

The No Action Alternative would result in no impacts from geologic hazards associated with the Proposed Action. Impacts associated with normal earth dynamics (i.e., earthquakes) could occur but could not be predicted.

3.4.3.4.3 Residual Impacts

Under the No Action Alternative, residual adverse impacts to mineral resources would not occur because the known mineral resource would not be developed; however, this impact is not irreversible or irretrievable.

3.4.3.5 Partial Backfill Alternative

3.4.3.5.1 Mineral Resources

Implementation of the Partial Backfill Alternative would result in potential impacts that are similar to those outlined under the Proposed Action.

Direct impacts of the Partial Backfill Alternative on geologic and mineral resources would result in excavation of **approximately** 2.7 billion tons of ore and waste rock from the open pit with an ore to waste ratio of 1:1.6. This equates to 1.0 billion tons of ore that would be processed. A total of 1.1 billion pounds of Mo would be shipped off site, and the remainder of the material would be sent to the two tailings facilities. A total of 1.7 billion tons of waste rock would be stored in WRDFs immediately adjacent to the open pit, and then there would be the placement of 1.24 billion tons of this mined waste rock back into the open pit.

The placement of a majority of the waste rock back into the open pit, as well as the placement of the remaining WRDF immediately adjacent to the open pit could limit the future development of mineral resources located in the pit walls adjacent to the open pit should those mineral resources be amenable to development through open pit mining methods. This alternative would have impacts similar to the impacts of the Proposed Action. In addition, the placement of the waste rock back into the open pit would limit the future development of a mineral resource (see Section 3.4.2.4.11) that would be amenable to development through underground mining methods; however, there is not sufficient reasonably available geologic and resource information to more definitively address this potential impact.

- **Impact 3.4.3.5-1:** Implementation of the Partial Backfill Alternative would result in resource extraction and production of 1.1 billion pounds of Mo.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals. However, the impact is economically significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

- **Impact 3.4.3.5-2:** Implementation of the Partial Backfill Alternative would result in the extraction of waste rock that would be placed adjacent to the open pit and then replaced within the open pit, thus limiting the future development of the identified Zn mineralization located to the north of the open pit to a degree that is greater than under the Proposed Action.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals, because a known Zn mineralization has not been sufficiently defined and potentially could be developed using underground mining techniques.

No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.4.3.5.2 Geological Hazards

The potential geological hazards impacts from the Partial Backfill Alternative would be the same as those discussed under the Proposed Action.

3.4.3.5.3 Residual Impacts

The potential residual impacts to geology and mineral resources from the Partial Backfill Alternative are an irreversible and irretrievable commitment of mineral resources through the removal of 1.1 billion pounds of Mo from the mined materials.

3.4.3.6 Off-Site Transfer of Ore Concentrate for Processing Alternative

3.4.3.6.1 Mineral Resources

The potential impacts to geology and mineral resources from the Off-Site Transfer of Ore Concentrate for Processing Alternative are an irreversible and irretrievable commitment of mineral resources through the removal of 1.1 billion pounds of Mo from the mined materials.

- **Impact 3.4.3.6-1:** Implementation of the Proposed Action would result in resource extraction and production of 1.1 billion pounds of Mo.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals. However, the impact is economically significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

- **Impact 3.4.3.6-2:** Implementation of the Proposed Action would result in the extraction of waste rock that would be placed adjacent to the open pit and limit the future development of the identified Zn mineralization located to the north of the open pit.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals, because a known Zn mineralization has not been sufficiently defined and potentially could be developed using underground mining techniques.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.4.3.6.2 Geological Hazards

The potential geological hazards impacts from the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as those discussed under the Proposed Action.

3.4.3.6.3 Residual Impacts

The potential residual impacts to geology and mineral resources from the Off-Site Transfer of Ore Concentrate for Processing Alternative are an irreversible and irretrievable commitment of mineral resources through the removal of 1.1 billion pounds of Mo for the mined materials.

3.4.3.7 Slower, Longer Project Alternative

3.4.3.7.1 Mineral Resources

Impacts to mineral resources from the Slower, Longer Project Alternative are expected to be similar to impacts from the Proposed Action; however, impacts from the Slower, Longer Project Alternative would occur over a period approximately twice as long in duration compared to the Proposed Action.

- **Impact 3.4.3.7-1:** Implementation of the Slower, Longer Project Alternative would result in resource extraction and production of 1.1 billion pounds of Mo.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals. However, the impact is economically significant.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

- **Impact 3.4.3.7-2:** Implementation of the Slower, Longer Project Alternative would result in the extraction of waste rock that would be placed adjacent to the open pit and limit the future development of the identified Zn mineralization located to the north of the open pit.

  Significance of the Impact: This is not considered a potentially significant impact to geology and minerals, because a known Zn mineralization has not been sufficiently defined and potentially could be developed using underground mining techniques.

  No mitigation is proposed for this impact; see Section 3.1.1 for a general discussion of significance and the development of mitigation measures.

3.4.3.7.2 Geological Hazards

The potential geological hazards impacts from the Slower, Longer Project Alternative would be the same as those discussed under the Proposed Action.

3.4.3.7.3 Residual Impacts

The potential residual impacts to geology and mineral resources from the Slower, Longer Project Alternative are an irreversible and irretrievable commitment of mineral resources through the removal of 1.1 billion pounds of Mo for the mined materials.

3.5 Paleontology

3.5.1 Regulatory Framework

On March 30, 2009, Paleontological Resource Protection Act (PRPA) became law when President Barack Obama signed the Omnibus Public Land Management Act (OPLMA) of 2009, Public Law 111-011. Public Law 111-011, Title VI, Subtitle D on Paleontological Resources Preservation **(PRP)** (123 Stat. 1172; 16 U.S.C. 470aaa) requires the Secretaries of the Interior and Agriculture to manage and protect paleontological resources on federal land using scientific principles and expertise. The OPLMA-PRP includes specific provisions addressing management of these resources by the BLM, NPS, Bureau of Reclamation, U.S. Fish and Wildlife Service (USFWS), and U.S. Forest Service (USFS).

The BLM manages paleontological resources under a number of federal laws including: FLPMA Sections 310 and 302(b), which directs the BLM to manage public lands to protect the quality of scientific and other values; 43 CFR 8365.1-5, which prohibits the willful disturbance, removal, and destruction of scientific resources or natural objects; 43 CFR 3622, which regulates the amount of petrified wood that can be collected for personal noncommercial purposes without a permit; and 43 CFR 3809.420 (b)(8), which stipulates that a mining operator "shall not knowingly disturb, alter, injure, or destroy any scientifically important paleontological remains or any historical or archaeological site, structure, building or object on Federal lands."

IM No. 2008-009, effective October 15, 2007, defines the BLM classification system for paleontological resources on public lands. The classification system is based on the potential for the occurrence of significant paleontological resources in a geologic unit and the associated risk for impacts to the resource based on federal management actions. This classification system for paleontological resources is intended to provide a more uniform tool to assess potential occurrences of paleontological resources and evaluate possible impacts. The system uses geologic units as base data, which are more readily available to all users, and is intended to be applied in broad approach for planning efforts, and as an intermediate step in evaluating specific projects.

The descriptions for the classes used in the Potential Fossil Yield Classification (PFYC) system are intended to serve as guidelines rather than strict definitions. Knowledge of the geology and the paleontological potential for individual units or preservational conditions should be considered when determining the appropriate class assignment.

In addition, IM No. 2009-011, effective October 10, 2008, provides guidelines for assessing potential impacts to paleontological resources in order to determine mitigation steps for federal actions on public lands under the FLPMA and the NEPA. These guidelines also apply where a federal action impacts split estate lands. This IM provides for field survey and monitoring procedures to help minimize impacts to paleontological resources from federal actions in cases where it is determined that significant paleontological resources would be adversely affected by a federal action.

These two IMs, along with the PFYC system, provide guidance for the assessment of potential impacts to paleontological resources, field survey and monitoring procedures, and recommended mitigation measures that protect paleontological resources impacted by federal actions.

It is the policy of the BLM that potential impacts from federal actions on public lands, including land tenure adjustments, be identified and assessed, and proper mitigation actions be implemented when necessary to protect scientifically significant paleontological resources. This policy also applies to federal actions impacting split estate lands and is subject to the right of landowners to preclude evaluation and mitigation of paleontological resources on their land. The removal of a significant paleontological resource from public lands requires a Paleontological Resources Use permit for collection. Significant paleontological resources collected from public lands are federal property and must be deposited in an approved repository. Paleontological resources collected from split estate lands are the property of the surface estate owner, and their disposition would be in accordance with the surface agreement between the landowner and the permittee.

Surface disturbing activities may cause direct adverse impacts to paleontological resources through the damage or destruction of fossils or loss of valuable scientific information by the disturbance of the stratigraphic context in which fossils are found. Indirect adverse impacts may be created by increased accessibility to important paleontological resources, leading to looting or vandalism. Land tenure adjustments may result in the loss of significant paleontological resources to the public if paleontological resources pass from public ownership. Generally, the Project proponent is responsible for the cost of implementing mitigation measures, including the costs of investigation, salvage, and curation of paleontological resources.

3.5.2 Affected Environment

3.5.2.1 Study Methods

The Assessment of Potential Impacts to Paleontological Resources (IM No. 2008-009) was reviewed using the PFYC system, based on current geologic mapping, to determine if impacts to paleontological resources would occur. Based on scoping of the Proposed Action in regard to paleontological resources, if initial scoping identifies the possibility for adversely affecting paleontological resources, further analysis is necessary. Guidance indicates that if there would be no impact or potential impact based on the action, or the fossil resource may be impacted but is too deep to be recovered (e.g., deep well bore passing through a fossil formation) the Project file must be documented and no additional assessment is necessary.

3.5.2.2 Existing Conditions

The open pit, WRDFs, processing facilities, and a portion of the TSFs would be located in, on, or adjacent to the Mount Hope igneous complex, which consists of rhyolitic intrusive and extrusive rocks, and thus represents a subvolcanic erosion level of a mid-Tertiary eruptive center (see Section 3.4). The western cauldron, approximately 3,300 feet in diameter, is outlined by the partial ring dike northwest and north northeast of the summit of Mount Hope and juxtaposes a 1,000-foot thick section of the lower cooling unit of the Mount Hope tuff against Vinini Formation. There would be no fossils in the rhyolitic rocks because fossils do not occur in volcanic intrusive or extrusive rocks. The extensive and complicated faulting that has occurred would also preclude stratigraphic accuracy if fossils were encountered. These units would be considered as Class 1 - Very Low.

The Devonian-Ordovician Vinini Formation is widely exposed south and west of the Mount Hope igneous complex. Thin to medium bedded shale, siltstone, chert, and conglomerate