Great
Basin
Resource
Watch

Working with Communities to Protect Their Land, Air, and Water

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June 23, 2018

Via email

Matthew Schulenberg
Division of Environmental Protection
Bureau of Mining Regulation and Reclamation
901 South Stewart Street, Room 4001
Carson City, Nevada 90701-5249

RE: Mt Hope Project, Water Pollution Control Permit NEV2008106 renewal

Dear Mr. Schulenberg,

Great Basin Resource Watch (GBRW) has reviewed the permit, fact sheet, and various background materials related to the Mt. Hope Project, and does not support this permit renewal. GBRW anticipates significant toxic drainage at this site with an insufficient plan to arrest the problem, which will result in violations of Nevada Law.

GBRW concurs with the following statements from the U.S. Environmental Protection Agency (EPA):

> "The proposed project would consume up to 11,300 acre feet per year of groundwater, resulting in a 10 foot drawdown contour encompassing an area likely in excess of 200 square miles [Using Google Earth Pro and Figure 3.2.19 of the Draft EIS, EPA found that the maximum draw-down area approximates a polygon with an area of over 200 square miles, which is greater than the surface area of Lake Tahoe (http://tahoe.usgs.gov/facts.html)]. The FEIS predicts potential adverse impacts to 22 perennial springs and 7.7 miles of perennial stream segments. Impacts associated with the drawdown of groundwater table levels in Kobeh Valley are anticipated to persist for over 100 years, while those associated with the mine's dewatering operation will persist for well over 400 years. Unless these impacts are mitigated for the duration that they occur, the project may result in the loss of miles of perennial waters essential for wildlife, livestock, and human use.
>
> The FEIS states that drain-down solutions from the tailings storage facilities are expected to contain aluminum, antimony, cadmium, fluoride, manganese, molybdenum, and sulfate concentrations that exceed water quality standards, and will become acidic over time. Waste rock seepage will contain high concentrations of aluminum, arsenic, cadmium, fluoride, manganese, nickel, zinc, copper, iron, lead, beryllium, thallium, selenium, sulfate, and total dissolved solids. If tailings and waste rock disposal facilities, fluid collection systems, and

> evapotranspiration cells are not properly managed over the long-term, the project could result in significant and long-term degradation of surface water and/or groundwater quality, as well as wildlife exposure to these waters."[1]

SITE MONITORING

GBRW acknowledges that NDEP added seven monitoring wells from the originally proposed monitoring scheme of 2012. However, the draft permit[2] describes the locations of these wells in a general way, and contains the following as a schedule of compliance: "The work plan must include a map(s) showing mine facilities, updated groundwater potentiometric surface contours, and proposed well locations, plus proposed well parameters and a provision for drill oversight and field screen depth determination by a qualified geologist or hydrologist." GBRW and the general public cannot fully evaluate the efficacy of the monitoring plan without the details. If Eureka Moly, LLC cannot supply these details as part of its renewal, then the monitoring plan cannot be validated and the permit should be withdrawn.

Despite the addition of monitoring wells GBRW still finds the number of wells to be insufficient and insists that the following be added:

1. At least three additional monitoring wells that screen across the water table should be constructed along the southern boundary of the non-PAG waste rock dump west of IGM-157.
2. LGO (low grade ore) Stockpile Monitoring: a couple of shallower wells that screen any water levels in the alluvium are necessary. Well SCP-1 should be constructed to span the water table if there is a phreatic aquifer in the area; the permit should specify these construction details.
3. At least three new monitoring wells east of the PAG waste rock dump with depth to screen chosen based on the presence of a water table aquifer and the presence of fracture flow zones at depth, as in the wells east of the LGO stockpile.

The remainder of this section largely contains our analysis from 2012. GBRW includes this analysis as it contains details of where and how monitoring wells should be installed. Much of the hydrological analysis of the monitoring plan contained in these comments was extracted from a technical memorandum by Myers prepared for GBRW.[3]

Basis for Critique of Monitoring Plan

A basic concept underlying the preparation of a groundwater monitoring plan is that a conceptual model for contaminant flow from a potential source be established. This means estimating the flow paths in the vicinity of the mine. The original application includes maps which show pre-mine groundwater contours and one that shows general flow paths among the three nearby basins. There are no detailed flow paths prepared or presented for the area near the pit where the waste facilities will be although they can be discerned from the contour map. The conceptual model must also consider potential dispersion of contaminants along the flow path; this was not presented in the studies prepared for this application. At a mine for which dewatering may change the groundwater contours, the flow paths may change. Although the Fact Sheet notes the pit lake will be terminal, meaning that it will capture flow, it does not address the contaminants flowing toward the pit; the applicant does not

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[1] U.S. Environmental Protection Agency, *Mount Hope Project Draft Environmental Impact Statement (EIS), Eureka County, Nevada*

[2] Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation, "Water Pollution Control Permit, Mount Hope Project Permit No. NEV2008106 (Renewal 2018, Revision 00). (p. 2)

[3] Myers, Tom, "Technical Memorandum, Review of the Water Pollution Permit NEV2008106, Mt Hope Mine," October 24, 2012.

apparently rely on this capture to avoid monitoring for contaminants. NDEP should require the applicant to determine a "discharge influence area" so that it is known from where leakage from waste facilities would be able to move downgradient and not toward the pit; such an analysis would depend on time because the capture zone may change. This information would make the selection of monitoring well locations more efficient; it does not make sense to monitor an area that will be quickly drawndown so as to be dry or from which the contaminants will be drawn toward the pit or dewatering wells.

The general groundwater flow paths near the proposed mine is away from the mine toward the three nearby valleys because of the mine's location near the intersection of the topographic divides among the valleys; Figure 1 shows that the crest of the groundwater divide is just north of the pit and that the flow direction under the PAG waste rock dump and the low-grade-ore stockpile (east of the pit) is to the east. The groundwater crest lies just northeast of the proposed tailings impoundment, so the flow

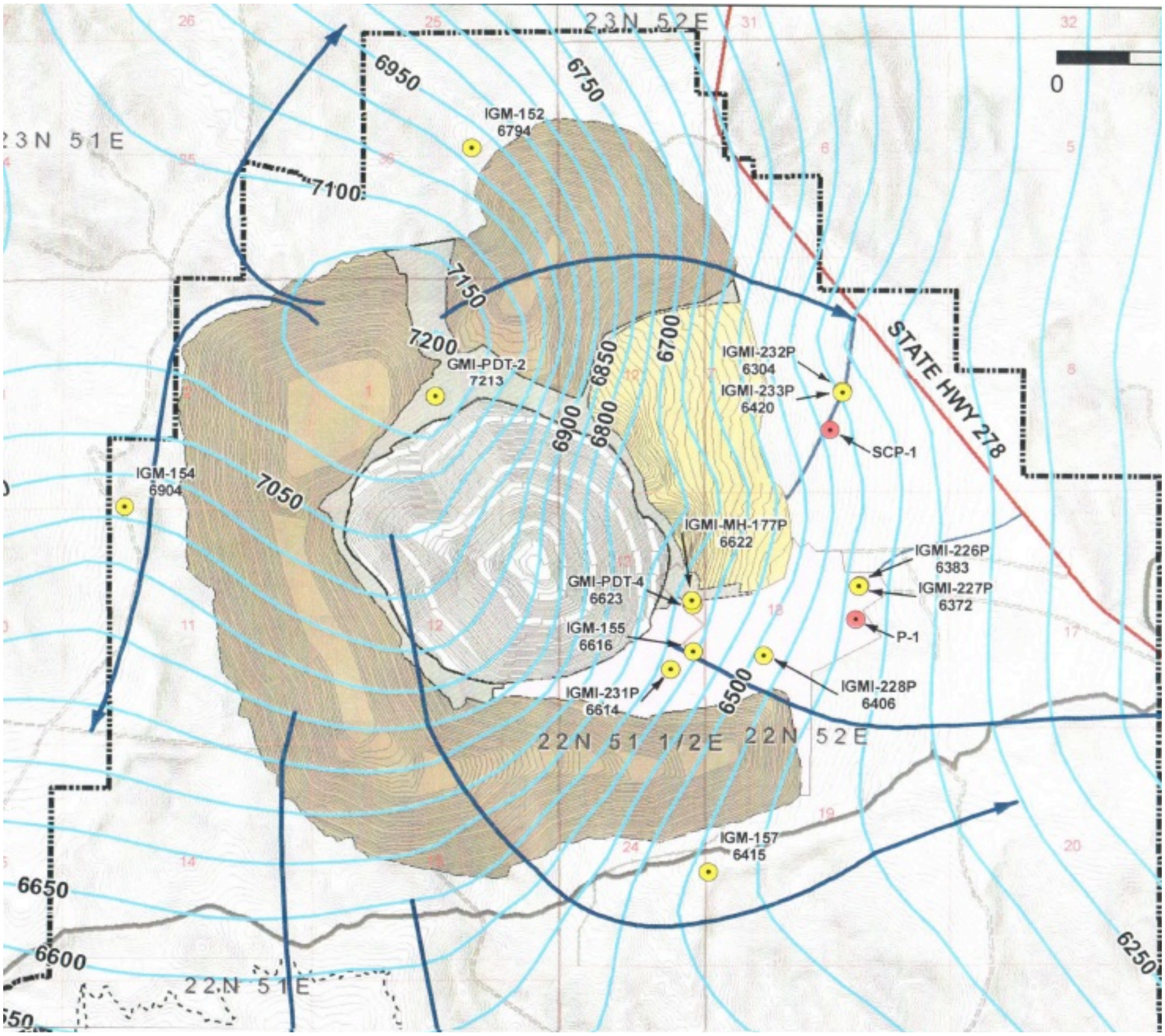

Figure 1: Snapshot from WPCP (2012) application Figure II-9 showing proposed monitoring

across the tailings impoundment is to the southwest (Figure 2). The following consideration of the monitoring well locations relies on flow paths as described here.

Non-PAG (not potentially acid generating) Waste Disposal Facility Monitoring

Discharge from the Non-PAG waste rock disposal facility (WRDF) is expected to be of low quality in some cases requiring treatment and has the potential to degrade groundwater. This can be seen from the Table 3.3-2 in the final EIS that shows elevated levels of aluminum, manganese, and fluoride for the meteoric water mobility procedure (MWMP), and in addition arsenic and zinc for the humidity cell tests.[4] Unlike other facilities within the project, no specific permeability conditions are applicable to the Non-PAG WRDF base, so there is a high potential for toxic leachate to enter groundwater. Thus, both the design and monitoring of the Non-PAG WRDF are essential to ensure that groundwater degradation does not occur.

The draft permit specifies the monitoring wells associated with different mine components (section I.D (10).) The Non-PAG WRDF encircles the pit to the west and south (Figure 1). The draft permit states that well GMI-PDT-2 is upgradient of the facility; Figure 1 shows that that this well is existing and that a flow arrow through the well would be toward the pit, not under the waste rock dump. Well IGM-154 is considered downgradient but lies west of the dump and the flow path through it both up- and downgradient would not go under the dump. Well IGM-157 is on the southeast corner of the dump at a point where a flowpath would extend under the dump. At best, well IGM-157 is the only one that, based on its location, is properly located to monitor flowpaths that could actually transport contaminants from the waste rock dump. Even if IGM-154 is on a proper flowpath (it is not), it is separated from IGM-157 by several miles; a huge contaminant plume could advect south and southeast from the waste rock between the monitoring wells without being detected. It is essential that at least three additional monitoring wells that screen across the water table be constructed along the southern boundary of the Non-PAG waste rock dump west of IGM-157.

LGO (low grade ore) Stockpile Monitoring

LGO stockpile lies east of the pit. The draft permit specifies that monitoring well SCP-1, IGMI-232P, and IGMI-233P are downgradient monitoring wells. Figure 1 confirms that all three lie on flow paths which flow beneath the stockpile. However, the IGMI wells appear to be at the same point. Well logs show these are both deep wells screened far below the water table. IGMI 232-P is screened from 1018 to 998 feet below ground surface (bgs) in shale with static water level at 763 ft bgs while IGMI 233-P is screened from 568 to 548 feet bgs in tuft with static water level at 85 ft bgs. Neither report indicates where water was first encountered nor are there geophysical logs in the application with which to determine saturated levels. These wells are apparently monitoring fracture zones in the respective lithologies. There is no discussion of how the monitoring depth was chosen, but it is reasonable based on the fractures and the dip of the formations that monitoring at this depth is warranted. However, a couple of shallower wells that screen any water levels in the alluvium are necessary. Well SCP-1 should be constructed to span the water table if there is a phreatic aquifer in the area; the permit should specify these construction details.

PAG Waste Rock Disposal Facility (PAG WRDF) Monitoring

Wells IGM-152, -226P, and -227P are all called downgradient monitoring wells for the PAG WRDF. The latter two are east of the southernmost end of the LGO stockpile and not downgradient of the PAG WRDF. IGM-152 is northwest of the PAG WRDF (Figure 1) and the groundwater contours

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[4] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (Table 3.3-2, p. 3-207)

show that a flowpath intersecting this well would not be underneath the PAG WRDF. The wells as shown on Figure 1 and specified in the draft permit will not monitor the PAG WRDF. Basically, this permit will allow the PAG waste rock to not be monitored. NDEP should specify at least three new monitoring wells east of the PAG WRDF with depth to screen chosen based on the presence of a water table aquifer and the presence of fracture flow zones at depth, as in the wells east of the LGO stockpile.

The Wells IGM-226P and -227P lie east of the milling facility and the LGO stockpile, and are probably good wells for monitoring those facilities. The assemblage of up- and downgradient wells, including the two specified for the PAG WRDF, at the mill facilities are probably sufficient. They are well spaced laterally and vertically. However, well IGMI-MY-177P is not useful because the screen is too long; it spans 110 to 270 feet bgs, which allows dilution to minimize the observed concentrations.

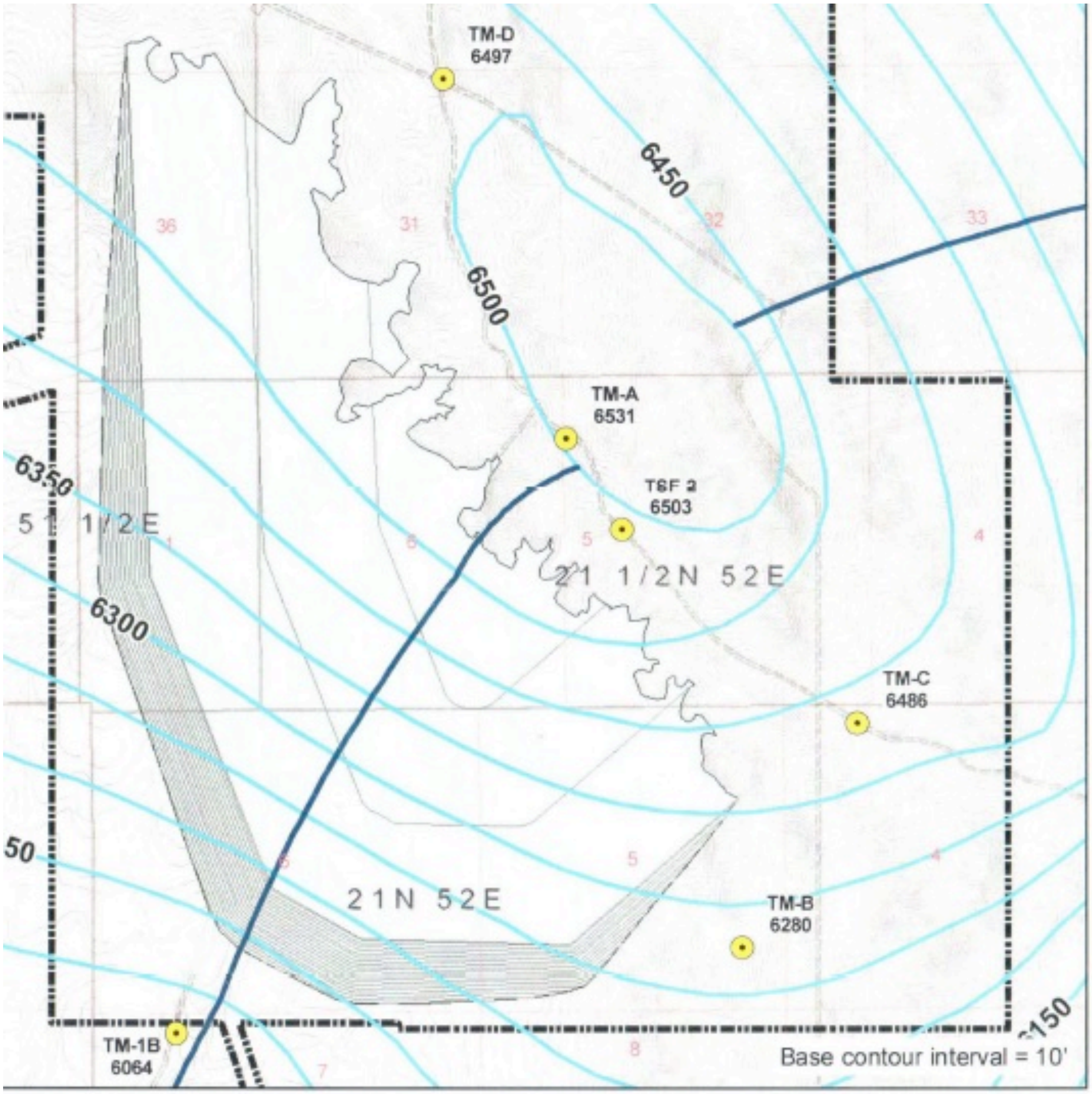

Figure 2: Snapshot from WPCP application (2012) Figure II-9 showing proposed monitoring wells and groundwater contours near the tailings impoundment. The yellow wells have already been constructed.

Tailings Impoundment Monitoring

The tailings impoundment would be south of the pit. It lies southwest of the groundwater divide, therefore the groundwater flow will be to the southwest under the facility (Figure 2). The original draft permit indicates that four upgradient and two downgradient wells will be used to monitor this site.

Figure 2 shows clearly that well TM-B is cross-gradient from the facility, although the original draft permit refers to it as one of the two downgradient wells. A flowpath through this well would pass just east of the easternmost portion of the facility, therefore this well is not useful for monitoring contaminants from the tailings impoundment. Wells TM-D, TM-A, and TSF-2 appear to be adequate upgradient monitoring wells, but well TM-C is also too far east; a flowpath through TM-C would miss the tailings impoundment by a quarter mile.

The original draft permit therefore has just three adequate upgradient wells and one downgradient well. Because of the size of the impoundment and the potential contamination from leaky tailings, it is obvious there should be at least four additional monitoring wells downgradient from the tailings facility. Two should lie between TM-1B and TM-B and two should lie on a line between TM-1B and the number 6300 on the contour space about 1/3rd mile north from TM-1B.

Table II: 3-2 in Volume 2 of the applications (2012) shows the well depths for wells near the tailings impoundments are very deep, with four of five wells 1000 or more feet deep. According to the well logs, however, they are screened at much shallower depths, in the order of hundreds of feet. Assuming the description of drill holes near the site is accurate, with no groundwater encountered in the upper 100 feet, the screen depths for the monitoring wells is appropriate. The required new wells should have similar screen depths.

General Monitoring Well Requirements

The original draft permit specifies that if a well is dry or fluid is not otherwise accessible, they should just record "dry". However, the permit should specify what is to be done if the well goes permanently dry. The pit will require dewatering which will lower the water table in the nearby vicinity. It may be possible to argue that the pit will capture any contaminants so that monitoring wells become unimportant near the pit. NDEP should require profile 1 sampling of any dewatering wells for the same reason they require monitoring wells and to characterize the water that will become inflow to the pit after dewatering. If dewatering wells are not used, the permit should specify that inflow to the pit be sampled.

The permit must also establish sampling procedures, otherwise the methods used for sampling the wells may not be consistent and may not meet industry standards. Part II.E does not provide sufficient detail. For example, what are the requirements for purging the well prior to drawing a sample? What about taking field blanks? If indeed there is a standard, the permit should at least reference it.

Summary of Monitoring Well Requirements

The permit apparently utilizes existing wells for monitoring as much as possible. However, as shown here, several proposed monitoring wells do not lie on a flow path from near a potential source of contaminants; monitoring them would be wasteful. Because the applicant did not consider the conceptual flow model when constructing some of these wells, additional wells are needed if this facility is to be adequately monitored.

There are no monitoring wells downgradient from the bulk of the Non-PAG WRDF. At least three additional monitoring wells that screen across the water table should be constructed along the southern boundary of the Non-PAG WRDF west of IGM-157. The PAG WRDF has no monitoring wells at all, because two of the proposed wells are actually east of the LGO stockpile and the other is northwest of the facility and not on a flowpath beneath it. NDEP should specify at least three new monitoring wells east of the PAG WRDF with depth to screen chosen based on the presence of a water table aquifer and the presence of fracture flow zones at depth. The LGO stockpile has two deep monitoring wells, so the currently planned-for third well should be shallower, sampling the water table aquifer if possible.

At least two of the proposed wells at the tailings impoundment are not on a flow pathway that could transport contaminants from the facility. Only one downgradient well is currently proposed (because the other in the draft permit is not actually downgradient). It is essential that NDEP require at least four additional monitoring wells constructed as specified above.

Pit Lake Monitoring

The draft permit contains requirements for monitoring water in the pit lake, but is not clear about monitoring of groundwater around the pit lake. The periodic updates to the pit lake model should include any current groundwater data that pertains to inputs for the modeling process. It appears as though a few of the proposed monitoring wells, which are on the periphery of the pit may serve this purpose in part. In addition dewatering wells could also be used here; however, GBRW could not find the locations of those wells. The permit needs to indicate which wells would be used for this purpose and what data is to be obtained from them for model updates.

GBRW remains concerned that a flow-through condition could exist at some point during the filling of the pit lake. The analysis presented in the Mount Hope Environmental Impact Statement (FEIS) claims that at "all times during the simulated recovery period … , including a final equilibrium, the hydraulic gradients are inward toward the pit in all directions, indicating that the pit consistently acts as a hydraulic sink during and after mine closure"[5]. The pre-mine groundwater levels sloped several hundred feet across the proposed pit lake, which suggests the natural water levels on up- and down-gradient sides of the pit differ significantly. Because of the steep gradient in the area, it is possible that more rapid recovery in some areas may allow the pit lake to recover more quickly than the water table on all sides and at all level; simply considering the top of the water table is insufficient to predict whether the pit will always be a sink.

The groundwater inflow portion of the pit lake volume is initially small although the pit lake level recovers almost 550 feet in the first 50 years[6]. Most of the simulated pit lake recovery is due to the pit wall runoff rate exceeding the groundwater inflow rate for the first 400 years.[6] This could only occur if the groundwater levels around the pit recover slowly. It is therefore reasonable that the pit lake is above the groundwater level on one or more sides of the pit.

To better prove the consistent "sink" nature of the pit, Montgomery et al should add simulated monitoring wells around the pit to monitor the water levels in each model layer both at and at a small distance from the pit lake wall. Detailed consideration of the monitoring well hydrographs should provide evidence that the pit will be a sink or show that it is not. Additionally, it is essential to consider that fractures and preferential flow paths not currently known or simulated in the model could affect the hydraulic gradients around the pit, especially on a local basis.

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[5] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (p. 3-3115)

[6] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (Figure 3.3.12)

GBRW is aware that the Bureau of Land Management disagrees with our suggestion of the potential for flow-though conditions; however, appropriate monitoring of groundwater surrounding the open pit should be part of the monitoring plan to assure that groundwater is not being degraded.

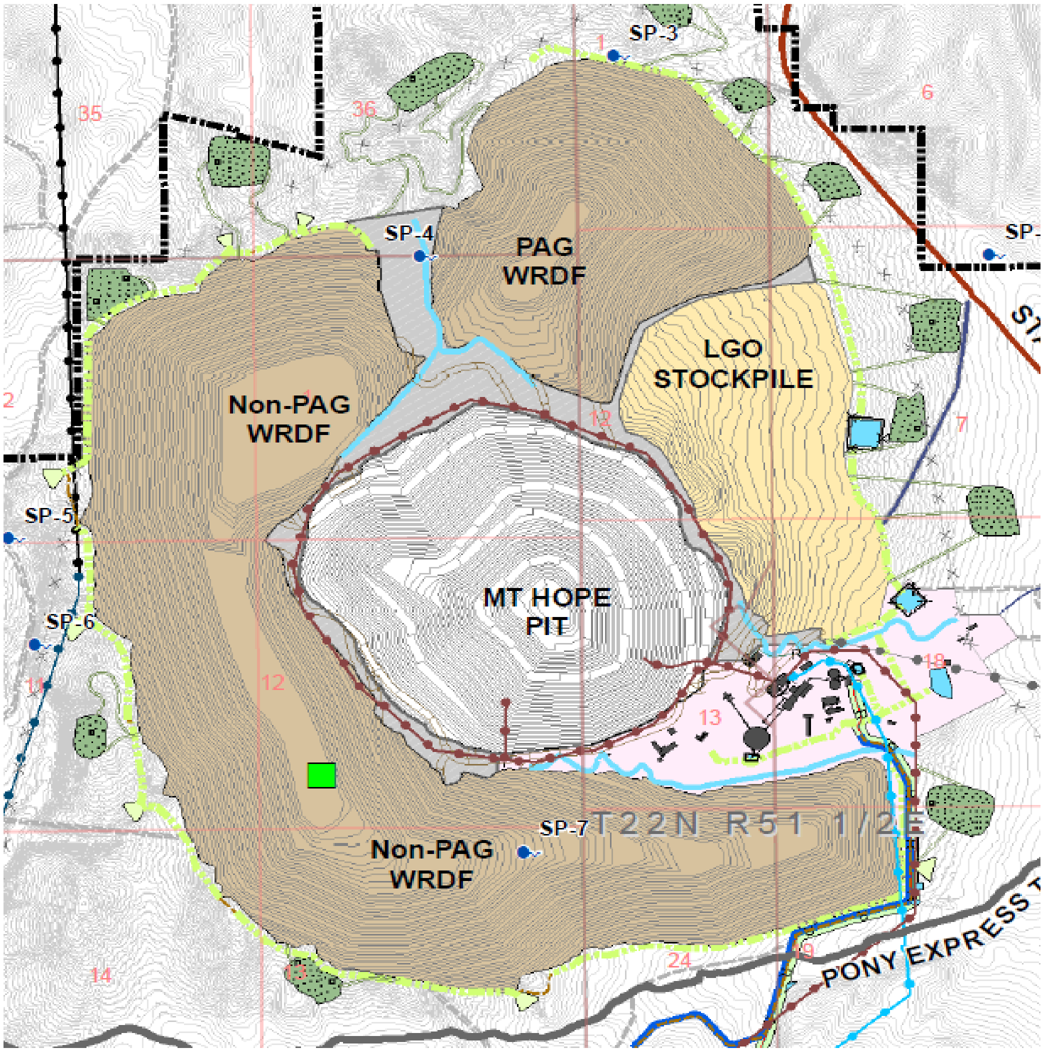

Figure 3: Diversion channel and ponds near the proposed pit, from FEIS figure 2.1.5

WASTE ROCK MANAGMENT

Geochemical Characterization

Key to prediction of future water quality at mine site is judicious and sufficient sampling of the various rock types and alterations. The bare minimum for characterization as cited in an EPA review[7] is 1 sample per million tons of rock, which Eureka Moly LLC (EML) approximately achieves. According to the mine plan 1,750 million tons of waste rock is anticipated[8], so the minimum would be on the order of 1,750 samples, and in total EML appears to have based waste rock characterization on 1,844

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[7] U.S. Environmental Protection Agency, "Technical Document Acid Mine Drainage Prediction," EPA530-R-94-036, December 1994,. (p. 11)

[8] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement (NV063-EIS07-019),* October, 2012 (p. 2-24)

samples from 1,545 "historic" pulp samples, 250 historic core samples, and 48 recent core samples (It was not clear to GBRW from the report whether kinetic testing used samples from the 1,844 or additional samples).[9] The EPA review article cites other expert sampling opinions; 1 for every 20,000 tons (Gene Farmer, US Forest Service), 1, for every 40,000 tons (British Columbia AMD Task Force. Extrapolating in a linear fashion from these opinions EML would have needed to collect from 40,000 to 70,000 samples, roughly 20 to 40 times as many as were collected. Although, EPA does not indicate whether a linear extrapolation is appropriate, GBRW acknowledges that such an estimate may be overly conservative. In a more recent review of predicting water quality at mine sites, Maest and Kuipers recommend the following[10]:

Table 1

Mass of Each Separate Rock Type (tonnes)	Minimum Number of Samples
<10,000	3
<100,000	8
<1,000,000	26
10,000,000	80

Using this prescription adapted from Price and Errington 1994,[11] yields a similar sampling rate as indicated from Farmer and the BC AMD task force. In view of these reviews and our opinion of the potential for acid drainage and poor water quality that has occurred at other mines in Nevada GBRW does not see the sampling rate for the Mt. Hope Project to be sufficient. The most glaring example of this is that paucity of potential pit wall samples that were used for the pit lake water quality analysis, as indicated in the FEIS *"There were little sampling data from some of the pit wall areas because of the relatively cylindrical nature of the orebody."* [12] Regardless of whether the approach to the pit lake model is justified, this statement clearly indicates how incompletely the sampling was done. EML was relying on samples that were taken 30-40 years earlier, where the mine plan was likely to have been much different that the current plan. These "pulp" samples appear to have been largely from the periphery of the ore body as part of those early explorations when resource evaluation was the primary goal. GBRW recognizes that these samples are useful; however, we are skeptical that they and the additional recent samples have been sufficient to fully understand PAG versus Non-PAG breakdown and ultimately water management plan and closure of the site.

BLM in response to GBRW draft EIS comments refers to the BCATF recommendations and stated that, "According to this method, the recommended minimum number of samples should be 25 for a 1 million ton geologic unit and the maximum number of samples recommended by the BCATF is 500."[13] A more current, 2009, analysis[14] to which the BCATF refers, cites the same table that GBRW used in the FEIS comments (Table I above) as the recommended starting point for sampling rate. It is also

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[9] General Moly Inc., "Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report," January 28, 2008, (pp. 4-2 – 4-3)

[10] Maest, A.S., Kuipers, J.R., Travers, C.L., and Atkins, D.A., 2005. Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art (p. 22)

[11] Price, W. and Errington, J, 1994. ARD Policy for Mine Sites in British Columbia. Presented at International Land Reclamation and Mine Drainage Conference and the Third International Conference on the Abatement of Acid Drainage, Pittsburgh, PA,. (p. 287)

[12] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement (NV063-EIS07-019),* October, 2012. (p. 3-212)

[13] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement (NV063-EIS07-019),* October, 2012. (Vol. III, p. 331)

[14] Price, William A., "Prediction Manual for Drainage Chemistry for Sulphidic Geologic Materials," CANMET – Mining and Mineral Sciences Laboritories, Smithers, British Columbia, V0J 2N0, December 2009.

recommended that, "…the final sampling frequency be determined site specifically based on the variability of critical parameters, prediction objectives and required."[15] There is no mention of a 500 maximum number of samples; perhaps that was the previous thinking.

In addition to the overall number of samples is the matter of sufficient samplings of rock types and alterations. In Table 2 below GBRW has compared the sampling for the primary alterations of rock types (based on Table 3.3-3 of the FEIS, p. 3-209) deduced from Table 4.1 of Waste Rock and Pit Wall Rock Characterization Report, 2008, with recommended sampling for the same tonnage based on Table 1 above. We have provided two methods of estimating the number of samples needed shown in the two columns under the column heading, "Approximate Number of Samples required based on Maest and Kuipersi." The left and right columns use a linear and non-linear respectively interpolation and extrapolation from Table I. It is likely the best reasonable conservative estimate of the sampling rate lies in between these two estimates, with the non-linear approach underestimating, and the linear approach overestimating for large tonnages. Note that some rock types are on the order of hundreds of millions of tons, so extrapolation needs to be cautiously done, since it extends well beyond the basis for the model. In general, based on this analysis the overall sampling should be from ~3,600 - ~ 14,000 (non-linear to linear) compared to the 1,844 samples actually used, and sampling under each rock type/primary alteration with a few exceptions is also fewer than recommended. GBRW also notes that as rock strata is subdivided further into various alterations, etc, the number of samples recommended increases.

GBRW does not expect that EML would match the "generic" sampling rate that we have discussed here, and we recognize variation from such recommendations based on field mineralogy with other quick and simple tests, but the deviation from recommended is sufficiently wide and typically leans towards fewer than recommended sampling. In our view, the number of samples used for geochemical characterization probably should have been 2-4 times what was actually used. GBRW is concerned that this is a symptom of cutting costs at the expense of proper assessment of environmental impacts.

According to the waste rock analysis from other static and kinetic testing 27 percent of the waste rock has been classified as PAG. The FEIS and supporting documents indicate that the Mt. Hope deposit and surrounding waste rock is low sulfide and poor in neutralizing capacity. GBRW has noted that many of the rock types/alterations were listed as giving variable result from humidity cell tests (HCT).[16] The discussion of the humidity cell tests describes this variability, which typically involves a discrepancy involving only 2 or 3 test runs. This again underscores the need for additional sampling and analysis to get more of a statistical sense of what to expect from the various rock types/alterations. Overall, GBRW does not trust that EML has captured the correct breakdown of PAG versus Non-PAG for this site. We are concerned that as the mine develops more PAG material will be uncovered, and thus the current analysis would underestimate the affect on water quality and need to long-term treatment to avoid degrading waters of the State.

The site is purported to be low sulfide as stated in the FEIS, and could very likely be underestimating the potential for acid generation. In fact the "low sulfide" is based on an average content in the pit volume, and there were tests that indicated some very high sulfide content. Thus, there will be portions of the waste rock that are likely to be very acid generating, and even low sulfide portions could produce acid drainage in exceedence of Nevada regulations. For example, samples from the Duluth Complex in

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[15] Price, William A., "Prediction Manual for Drainage Chemistry for Sulphidic Geologic Materials," CANMET – Mining and Mineral Sciences Laboritories, Smithers, British Columbia, V0J 2N0, December 2009. (p. 8-8)

[16] General Moly Inc., "Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report," January 28, 2008,. (p. 8-2, Table 8.1)

northeastern Minnesota with low sulfur content, 0.41 to 0.71%, and low buffering capacity were shown to produce pH values from 4.8-5.3.[17] Even at the Lone Tree mine site in Nevada, where there exists significant carbonate deposits, and thus significantly greater neutralizing capacity the pit lake has become very acidic with no end in sight. GBRW does not trust the estimation and acid generating potential at the site, and is concerned that the belief of low sulfide (on the average) has created a false perception within federal land managers and state agencies.

Table 2: Waste Rock Sampling Frequency

Rock type	Primary alteration (over 25% PAG highlighted)	Percentage of Total Waste Based on Mine Model	Waste Rock Tonnage x 10^6	Approximate Number of Samples required based on Maest and Kuipers[ii]		Number of Samples used[1]
				Linear	Non-linear	
Undefined	Undefined	0.6	10.5	80	82	unknown[2]
Intermediate Phase Quartz Porphyry	Undefined	0.6	10.5	80	82	unknown[2]
	Potassic	1.1	19.3	160	110	28
	Biotite	0.1	1.75	40	34	7
	Silicic	1.1	19.3	160	110	54
Early Phase Quartz Porphyry	Undefined	6	105	800	254	unknown[2]
	Argillic	2.3	40.3	325	159	60
	Phyllic	0.1	1.75	40	34	109
	Potassic	12.7	222	1770	366	299
	Silicic	1.2	21	160	115	36
Rhyolite	Undefined	10	175	1400	326	unknown[2]
	Argillic	22.9	401	3200	489	466
	Phyllic	0.6	10.5	85	82	107
	Potassic	3.5	61.3	490	195	34
Vinini Formation Sediments	Undefined	20.5	359	2870	463	unknown[2]
	Argillic	2.9	50.8	406	178	68
	Phyllic	1.6	28	224	132	156
	Potassic	12.1	212	1690	358	343
	Silicic	0.1	1.75	40	34	15

[1] Estimated from Table 4-1 Waste Rock and Pit Wall Rock Characterization Report, 2008. It was unclear to GBRW how this category translated to categories that appeared in Table 4-1 of the Waste Rock and Pit Wall Rock Characterization Report, 2008.

[ii] The left column is the estimate determined by linear interpolation extrapolation from Table I, and the right column used a linear fit to a power function based on the table values:

$$\text{Number of samples} = 25.94 \cdot (\text{millions of tons})^{0.49}, r^2 = .9986$$

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[17] Maest, A.S., Kuipers, J.R., Travers, C.L., and Atkins, D.A., 2005. Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art. (p. 28)

Overall, GBRW recommends that NDEP require EML to conduct further sampling and analysis especially for those portions of the pit that are not well represented by the existing sampling such as much of the pit wall vicinity. This is needed to minimize the uncertainly regarding acid generation and the potential need for long-term treatment, so that impacts can be optimally determined and mitigation and best management practices can be developed.

Waste Rock Management Plan

1. *The Potentially Acid Generating Waste Rock Facility will be a long-term source of acidic leachate to bedrock groundwater and the storm water collection ponds.*

The data available[18], despite being sparse, do indicate a significant potential for acid generation, but with very little neutralizing capacity. For example, Figure 3.3.5 (FEIS, Figure 4 below), Net Acid Generation Versus Net Acid Generation pH, shows that 29% of the samples to be net acid generating and another 16% in the questionable category, so the conservative approach would be to assume that 45% or almost half could be acid forming to various extents.

Thus, GBRW foresees significant acid drainage from and a potentially larger footprint for the PAG WRDF. A larger footprint could be very problematic, since the existing footprint is dangerously close to two springs, SP-4 and SP-3. Cleary, EML is also anticipating some acid drainage by installing a drainage system at the bottom of the PAG WRDF to collect substandard water. What is not in the management plan is a discussion of the possibility of long-term treatment (possibly in perpetuity) of acidic drainage. This scenario needs to be addressed in the renewal application. EML needs to amend the management plan to evaluate long-term treatment of acid mine drainage including a credible estimation of the timeframe for treatment and potential increased treatment costs (current bonding model does not include this possibility to our knowledge).

By its design, the PAG WRDF will contain ~0.45 billion tons of net-acid generating rock[19] where the "PAG" classification is based on material containing >0.3 % sulfur and the demonstrated production of acidic leachate in empirical oxidative weathering tests (i.e., the rock produced a leachate with pH < 4.5, and leached > 10 kg H_2SO_4 / ton rock).[20] In addition, this formation of acidic conditions is associated with increased concentrations of dissolved heavy metals, including cadmium, copper, lead, nickel, and zinc.[21] The problem is that the design for the PAG WRDF will not prevent atmospheric oxygen from diffusing into the facility, and will not prevent water from percolating through the cover and the underlying PAG waste. As a result, the PAG WRDF will discharge acidic metal-laden leachate to groundwater and/or surface seeps for centuries to millennia as it weathers into the future.

Regarding oxidation and associated acid production, the proposed PAG WRDF includes a 24-inch thick "store-and-release cover constructed of salvaged growth media" placed on the top and sides slopes.[22] This type of soil cover remains unsaturated by design, and such soil covers with aerated pore

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[18] Such as Figures 3.3.4 to 3.3.8 in the final EIS.

[19] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. (Section 4.2.2 Waste Rock Schedule, p. 26)

[20] SRK, Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report. Prepared for General Moly. Prepared by SRK consultants, January 28, 2008. (Figure 6-13: Sulfide Sulfur vs. NAG, p. 6-19)

[21] SRK, Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report. Prepared for General Moly. Prepared by SRK consultants, January 28, 2008. (Figure 6-1 Ficklin Diagram)

[22] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. SRK 2009. (Chapter 9 Reclamation and Closure, p. 43)

spaces will not reduce the diffusion and/or advection of oxygen into the underlying waste rock enough to appreciably stop oxidation and the associated release of sulfate, acidity, and metals.

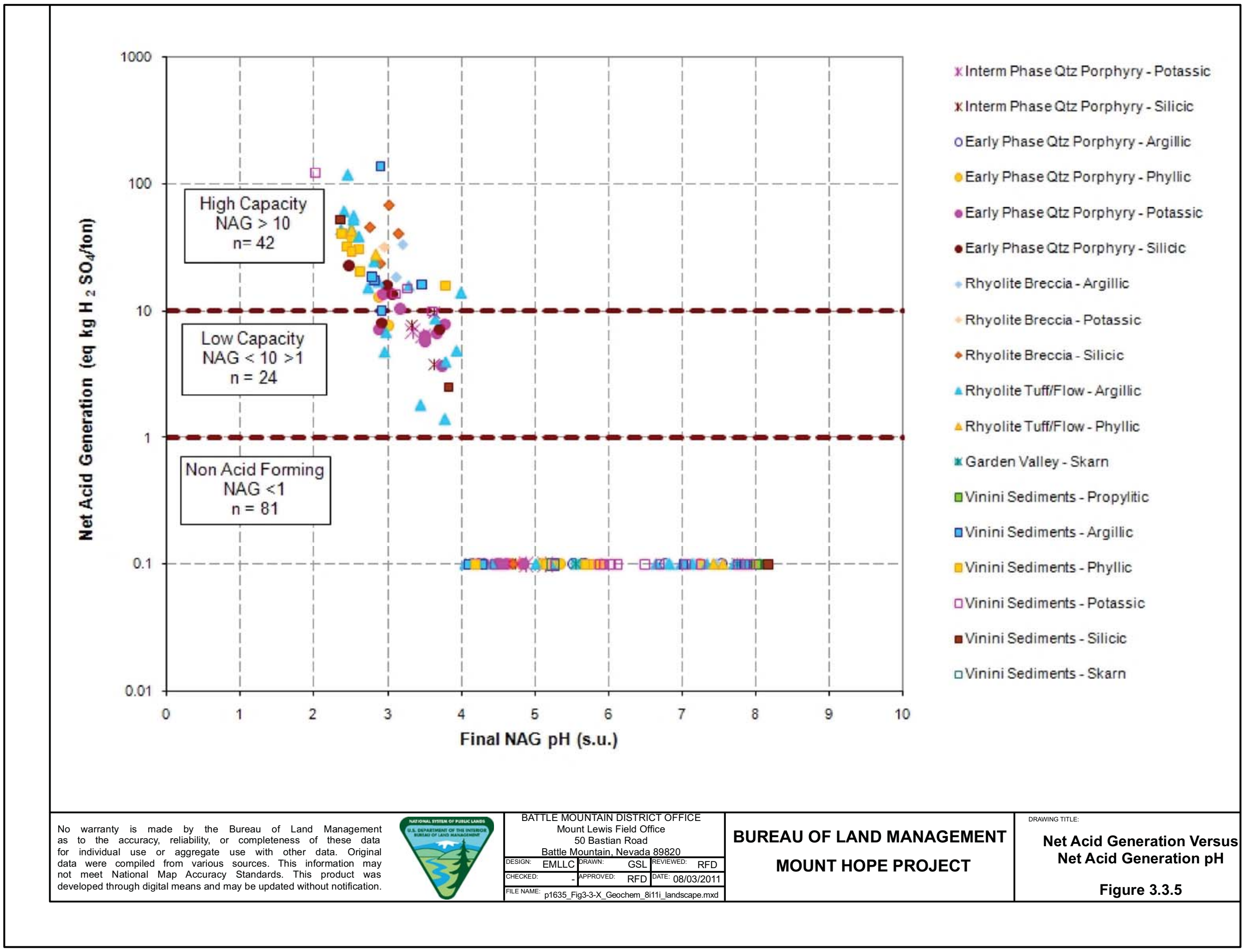

Figure 4. Graph extracted from the Mt. Hope FEIS.

Regarding water infiltration, the current proposed cover (a working version that may be modified before closure) is designed to remove most water by evapotranspiration, but will not prevent some water flow through the PAG waste rock. The design "is based on infiltration modeling using the HYDROUS-1D computer code," where in selecting "the saturated and unsaturated parameter values, the model used hydraulic testing data from the Golden Butte Mine," (based on it's similar grain size distribution to that of onsite soils). Parameters from an analog site were used because "at this stage of the planning process, site specific hydrogeologic parameters are not required and are typically reserved for detailed cover modeling for inclusion in a final closure design."[23]

In order to estimate a high but reasonable value for "net infiltration" (i.e., the flux of water the flows out the base of the evapotranspiration layer, which is thus the flux that passes through the PAG waste rock), the base-case simulation that assumed that the wettest year on record was repeated for three

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[23] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. SRK 2009. (Section 5.3 Cover Material Testing and Design, p. 37)

consecutive years. The 24-inch cover was proposed because model results indicated that "the majority of the infiltration reduction is achieved with a 24-inch thick alluvial cover.) Results of this 3-year simulation indicated that net-infiltration through the 24-inch cover would be $2.6x10^3$ cm/day, or ~2.5% of mean annual precipitation (an average flow rate of 12 gallons per minute from the entire 610 acre PAG WRDF design footprint.[24]

The waste rock management plan refers to this water-balance simulation of the waste-rock cover as "conservative," by which they mean that because it is has assumed sequential wetter than average years, it has probably overestimated the actual future long-term infiltration through the proposed cover. The overriding point, however, is that long-term water flux through any vegetated store-and-release cover can not be estimated reliably using historic climatic patterns because the future climate expected in the upcoming decades and centuries is poorly constrained. Thus, the PAG WRDF is not designed to stop water or oxygen from reaching waste, and closure planning needs to *assume that the facility will discharge acidic leachate.*

As important, the proposed cover, even if it is successful at reducing average net-infiltration to 2.5% of precipitation, may have little effect on reducing the load of pollutants to surface seeps or groundwater. This is because in acidic pore waters, many of the chemical effects that cap solute concentrations, such as mineral solubility and metal adsorption to mineral surfaces, are reduced or eliminated. That is, acid and metals are solubilized by the rate of oxidation, not the water flow, so that absent a cap on the dissolved concentrations, as water flow decreases, pollutant concentrations just increase proportionally and the load remains the same. The limited effectiveness of reducing water flow in PAG waste was identified over 20 years ago in field studies of net acid-generating waste, where researches noted that the neutralization capacity will eventually be exhausted, after which "the load exiting the base of the dump... will be independent of the rate water infiltrates."[25]

The waste rock management plan acknowledges the possibility of perpetual capture and management of acidic leachate from the PAG WRDF, with removal by evaporation, i.e.:

> "If seepage occurs in the long term, the flow rate would be at levels that are low enough for the solution to be removed by evaporation. In the unlikely case that seepage occurs, the stormwater pond could be converted into an evaporation and/or evapotranspiration cell to manage long term flow from the PAG WRDF. The cell would be designed and constructed to limit the access and exposure of wildlife to potential seepage."[26]

This above acknowledgement of "the unlikely case that seepage occurs" needs to be changed so that closure planning and associated bonding for the PAG WRDF explicitly assume the need to provide perpetual care of acidic seepage. The Mt. Hope project proposes to launch into the long-term future a 450-million ton pile of waste rock that will undoubtedly contain acidic pore water. The waste rock management plan has used sensible modeling to approximate the unsaturated flow through the proposed store-and-release cover under current conditions. However, given the uncertainties in future temperatures, surface-vegetation type, soil-cover integrity and continuity, and the frequency, intensity, and annual amount of precipitation, the PAG WRDF is virtually certain to produce intermittent or

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[24] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. SRK 2009. (Section 5.3 Cover Material Testing and Design, p. 38)

[25] Ritchie, A.I.M., "Rates of mechanisms that govern pollutant generation from pyritic wastes," In Environmental geochemistry of sulfide oxidation. Alpers and Blowes (eds.), Am. Chem. Soc., 1994, Washington, DC.

[26] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. (Section 9.1.1 PAG Waste Rock Disposal Facility, p. 43).

continuous discharge of acidic metal-bearing to the underlying groundwater and surface capture system. Mt. Hope Mine planning needs to incorporate an explicit acknowledgement of this condition of long-term future management, and provide a reliable funding based on quantitative estimates for what is essentially perpetual care.

2. The basal layers in the proposed PAG WRDF design will not prevent acidic leached from percolating down through the bottom of the facility and into the underlying bedrock water table below.

Two design features are included to reduce unsaturated flow out of the base of the WRDF:

- "A 12-inch thick engineered subgrade ($1x10^{-5}$ cm/sec) and a five-foot thick NAG base layer for the foundation of the facility"; and
- "Six-inch diameter corrugated perforated polyethylene (CPeP) 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." [27]

Regarding the perforated polyethylene drain pipes, these appear to be designed to capture water from rock placed under much wetter conditions. While this design should work to capture saturated or near-saturated water that flows down from the area directly above the drain pipes or underlying geomembrane layer, unsaturated flow that is outside of the drain liners will pass on into the 12-inch compacted low-permeability drain layer.

Regarding the "12-inch compacted low-permeability base layer," the design hydraulic conductivity of this layer, $1x10^{-5}$ cm/s, is too high to impede the expected flow of acidic leachate from the PAG WRDF. Specifically, results of the example simulation of net infiltration through the PAG WRDF cover over a 3-year period that assumes repeated wet years indicated a water flux of $2.6x10^{-3}$ cm/d (which equals $3.8x10^{-8}$ cm/s, or 0.37 inches/yr).[28] Thus, the hydraulic conductivity of the low-permeability base layer ($1x10^{-5}$ cm/s) is ~330 times higher than would be required to transmit the expected flux of water through the PAG WRDF ($3.8x10^{-8}$ cm/s). That is, there is no reason to expect that the compacted low-permeability base layer under the proposed PAG WRDF would alter at all the downward flow of acidic water as it percolates through the waste.

3. The PAG Waste Rock Management Plan needs to acknowledge that the onset of acidic seepage may be delayed for years to decades, but that it is then expected to be a long-term condition.

The Mt. Hope Mine Waste Rock Management Plan states that the calculated rate of water discharge from the PAG WRDF "assumes that any water that infiltrates through the cover would report as drainage to the toe of the waste rock facility. In reality, a significant volume of water would be retained as moisture within the waste rock."[29]

This indicates short-term thinking to a long-term condition. Indeed, waste rock facilities in semi-arid climates typically do not immediately produce discharge from toe-seeps or out the base of the facility. This is because the hydraulic conductivity of waste rock decreases with decreasing moisture content. Under semi-arid conditions, waste rock facilities generally show a wetting front, with wetter conditions

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[27] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. (Section 5.1.2 PAG Waste Rock Disposal Facility, p. 34, and Figure 7B Post-Reclamation WRDF Cross Section).

[28] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. (Section 5.3 Cover Material Testing and Design, p.38).

[29] SRK, "Revised Mount Hope Project Waste Rock Management Plan," Prepared for Eureka Moly, LLC, October 2009. (section 5.3 Cover Material Testing and Design, p. 38).

near the surface recharge-zone, and dryer conditions below the wetting front. But eventually, the wetting front reaches the base of the waste rock, and beyond this time, the water discharged from the base of the facility approximately equals the net-infiltration into the facility from above. (An intuitive way to think of unsaturated water flow in waste rock is that the rock "wets up" until the unsaturated hydraulic conductivity is equal to the net infiltration rate. Thus, in a waste rock pile that receives 1 inch per year net infiltration, it will reach a steady state condition, and measuring the average moisture content in the rock would indicate the amount of saturation required to produce a hydraulic conductivity of 1 inch per year.) This is another example of where the Mt. Hope waste rock management plans implies, incorrectly, that the PAG WRDF will probably not be a perpetual source of acidic leachate. In fact, the proposed PAG waste rock would transmit some water through the vegetated cover, would be subaerial and thus produce acidic pore water as it reacts with atmospheric oxygen, and is effectively unlimed, so that it will be a long-term source of acidic leachate to surface seeps and underlying groundwater. A plan to perpetually capture and evaporate the seepage could work, but this needs to describe in detail the financial and institutional mechanisms that will be required to maintain this perpetual water management system.

The risk to the nearby community and environment from acid mine drainage is likely to be greatly underestimated at Mt. Hope. The Rain Mine site just a bit north and west of Mt Hope has been producing acidic drainage for over 20 years. At the Rain Mine precipitation levels are comparable to the Mt. Hope area and the problematic waste rock dump at Rain is much smaller than the PAG WRDF proposed for Mt. Hope. Thus, the PAG WRDF is likely to capture much more water, and will likely be a larger footprint that proposed (see arguments above). In terms of reclamation, the two-foot cover is probably not sufficient to prevent infiltration and acid drainage, and at volumes much greater than at the Rain site. GBRW strongly recommends a thicker cover to decrease infiltration further.

We also note that there is discussion in the waste rock management plan[30] to encapsulate PAG material with neutralizing material or develop layers of neutralizing rock between PAG rock. This would seem a reasonable best practice. The management plan needs to be amended to discuss this as a mitigation measure and how this kind of procedure would be achieved. Again, GBRW is concerned if there is a false confidence – overly optimistic perspective on how the site will evolve. Once the waste rock facility is built the region is stuck with it, and adaptive management will be limited as to how to handle unexpected consequences. It is better to implement best practices when there is a luxury of options than after the fact.

4. The footprints of the waste rock facilities needs to be changed to avoid close proximity and covering of springs.

The PAG WRDF is very close to two springs on the north side and another on the west side. Clearly there are not a lot of options for waste rock placement, but EML should develop ways to avoid these springs to a much greater extent. Most likely the springs will be negatively affected by dewatering (unless they are from perched aquifers), and could become dry for a number of years. In general GBRW us very concerned about the proximity of the PAG WRDF to these water sources.

GBRW does not support the covering of the spring on the southwest corner of the site with the Non-PAG WRDF. Even though an engineered conduit is to be arranged to channel spring seepage away from the facility it still represents a loss of the natural outlet of the spring. In general, covering a spring can have seriously harmful consequences in the future. After mining has ended and EML walks away the conduit is likely to collapse, eventually, and then the spring is lost or worst metal leaching occurs, enhanced if an acid drainage develops. Optimally the waste rock facility should be redesigned to avoid

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[30] EML., "Revised Mount Hope Project Waste Rock Management Plan Report," October, 2009.

the spring. If not redesigned ELM should analyze the possibility of the conduit collapse and resulting impacts, and add to the waste rock management plan modified to include mitigation for this scenario.

Based on an examination of groundwater contours and surface level contours the depth to groundwater under the PAG WRDF is roughly 100 to 120 feet below the surface where the PAG WRDF is planned, and that difference will widen as dewatering occurs. Even so, GBRW is concerned that the one foot compacted layer base is not a sufficient barrier especially since acid drainage is likely (in our view). Over the long-term the drainage system may partially fail and acidic drainage would find its way into the unsaturated zone and eventually the groundwater especially as the water level recovers post dewatering.

Overall, we recommend that NDEP require EML to reevaluate the design of the PAG WRDF to include neutralizing component, sufficiency of the base layer to act as a barrier, and judicious groundwater monitoring around the waste rock and tailings facilities.

PIT LAKE

Pit Lake Model

The pit lake water quality model used to predict pit lake water quality follows the physical model of previous pit lake estimates in that it assumes that the contributions to pit lake water quality will reflect the rain/snow runoff from the pit walls as well as oxidation of the pit wall surface, plus reactions in the pit lake and evaporative processes. This model has sometimes been referred to as the "rind" model and has been commonly used in Nevada for predicting of pit lake water quality. The key component in question for this physical model is the depth of reaction of air with the oxidizable components in the pit walls. This physical model has failed for the two recent pit lakes formed in Nevada, Cove and Lone Tree pit lakes, in that it has substantially underpredicted the primary indicator of oxidation (sulfate) by at least a factor of 5, and probably a much higher underprediction in the case of Lone Tree since it has gone acidic and required over 70,000 tons of lime to neutralize the pit lake. Neither pit lake was expected to exceed the solubility product of gypsum, and both have exceeded that solubility product.

The problem with the rind model is that it fails to recognize that the amount of surface exposed to air in the dewatered cone of depression is very much larger than the thin layer of the surface of the pit lake, which is what is generally assumed in this model. Quite simply, when water is removed from an aquifer, and the water table is lowered by 2250 ft (and recovers in 200 years by 1800 ft)[31] water is replaced with air in the cone of depression. That air contains 20% oxygen, and it is reasonable to assume that all of the oxygen that comes in contact with oxidizable surfaces will react. Thus, it is legitimate (using conservative estimates) to calculate the amount of pyrite oxidation to form sulfuric acid simply by determining the amount of air that is drawn into the aquifer, and assuming that this oxygen reacts with pyrite to form sulfuric acid. Not all of it will contact with pyrite, but even making an assumption that half of the oxygen is available for production of sulfate, the amount of oxidation will show that much higher concentrations of sulfate are ultimately rinsed into the pit lake.

In the extreme case, that all of the water pumped from the surrounding aquifers (about 500,000 acre-feet) is replaced with air, and when those surfaces drain into the pit, the amount of sulfate delivered is about 7-10 gm/L of sulfate in the water rinsed into the pit lake (assuming 100,000 acre-feet (AF) in the

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[31] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement (NV063-EIS07-019),* October, 2012. (Figure 3.2.27 - Projected Ground Water Level in Center of Pit Backfill)

pit lake). At a minimum, the pit lake will receive at least 100,000 AF of water, and thus 100,000 AF of air, and this equates to approximately 1.4-2.0 gm/L (1,400-20,000 mg/L) of sulfate in the pit lake, not even taking into account the meteoric water rinsing the pit walls. This very simple analysis has at least (and probably much more) validity than the complex assumptions in the Mt. Hope pit lake model, which have not been verified. This is in addition to the amount of sulfate predicted in the pit lake model, where the sulfate concentration is 200 mg/L at 200 years, and 142 mg/L at 20 years. Under any circumstances, the physical aspects of this rind model fail with the realization that air is not diffusively transported into the wall rock; it is advectively transported when water is removed, creating a partial vacuum that is relieved by drawing in air.

Models for both Lone Tree and Cove pit lakes predicted low amounts of sulfate, but both are gypsum saturated as of 8 years ago, and Lone Tree pit lake has gone acidic twice, and required large amounts of lime to bring the pH to circumneutral status. Thus, the rind models of these two pit lakes have failed to predict water quality in the pit lake by a large margin. If the model cannot predict the sulfate concentrations, it is not predicting the amount of oxidation that occurs do to removal of the water.

The critical component is sulfate, and provides a lower estimate of the amount of oxidation that will occur. To our knowledge, there is no example of a pit lake in Nevada that contains pyrite, low neutralization ability, underground filling of the pit and a sulfate concentration that is less than 1000 mg/L. Thus, the Mt. Hope pit lake model is probably of no value in predicting if this water will present a risk to avian or terrestrial wildlife. It should be entirely redone, with more realistic assumptions, and discussions on why the "rind" model failed at Cove and Lone Tree. The discussion in the pit lake modeling report refers to previous work on pit lake modeling, but the critical component to determine is why both Lone Tree and Cove have much greater amounts of sulfate in the pit lakes than predicted.

If the amount of oxidation of pyrite is not correct, then effectively all of the other constituents (particularly the metals) will not be accurately predicted. Consequently, any risk assessment regarding the impact on terrestrial or avian wildlife are invalid also.

Additionally, the rock in the walls does not appear to have much carbonate/neutralization ability, and a clear question exists as to whether the sulfuric acid formed will be neutralized. And, whatever neutralization capability exists may become covered with iron/manganese precipitates, which can reduce the buffering capacity in the that rock, and allow the acidic water to drain into the pit lake. It is difficult, if not impossible, to accurately predict how much acidity will drain into the pit lake, but there are compelling reasons to believe that the current pit lake model is not a reflection of what will happen. The core issue, however, is that air will be convectively transported wherever water has been removed. Those oxidation products will be rinsed into the lake, and the places where pyrite exists, the amount of acidity generated could potentially be very high.

NDEP needs to require the evaluation of the following questions:

1. What happens when water is removed from an aquifer regarding the volume that it used to fill?
2. Assuming it is air, how much sulfate will be produced if a realistic assumption is made that over 44 years, all of the oxygen in that air is consumed by pyrite oxidation?
3. What will happen to those soluble products as the cone of depression recovers and water enters the pit lake?
4. Why did the models for Lone Tree and Cove fail to predict water quality in those pit lakes, and what does that mean for the Mt. Hope pit lake.

Analysis of Pit Lake Model Study

1. The assumed thickness of the "Damaged Rock Zone" (DRZ) in the pit walls in the pit lake model (1.8 m) is lower than measured in other hard-rock metal mines by a factor of ~360% to 850%.

The Mt. Hope Mine pit lake model estimates the volume of rock available to oxidize and then leach into to the lake as the product of the area exposed in the pit by mining and the assumed thickness of the "Damaged Rock Zone" (DRZ).[32] This DRZ thickness was assumed to be 1.8 m (~5.9 ft), which was drawn from a study of measured fracturing in the blast face of agranite mine.[33] But the Mt. Hope mine is not granite, and this assumed depth of reactive wall rock of 5.9 ft is several times smaller than has been measured in the wall rock of open-pit metal mines.

Specifically, an EPA study that measured permeability in blast-face wall rock at the Golden Sunlight Mine (Montana) found iron staining (indicative of active oxidation) to a depth of ~10 ft, a rind of high-permeability rock to a depth of ~20 ft, and propagation of blast fracturing to a depth of 54 ft from the face.[34] A horizontal well study of the Betze Screamer Pit in Nevada, USA estimated pit-wall reaction-zone depth by measuring pore-space oxygen concentrations in the first 49 ft from sulfide pit-wall faces.[35] Oxygen measurements were made in ten horizontal holes in pit faces. The holes were completed as gas wells (casing collar annular space was packed with inert wadding to seal out oxygen), equilibrated for 5 months, then sampled for oxygen by pulling gas from perforated intervals after isolation with packers. The core indicated an average fracture spacing of 0.1 m, and evidence of oxidation at 10 to 20 ft from the face. Further, results found some oxygen gas remained in wall rock fractures to a depth of 49 ft in most holes, suggesting active oxygen flux to at least this depth. Collectively, these studies indicated that the thickness of enhanced permeable in metal-mine wall rock can be 20 ft, and that oxygen can penetrate to a depth of at least 49 ft into sulfide-bearing wall rock.

Thus, the Mount Hope pit lake water quality model has almost certainly *underestimated* the thickness of the enhanced-permeability wall rock, and thus the mass of wall rock available to leach solutes to the pit lake, by a factor of ~3.4 (i.e., 20 ft / 5.9 ft), and possibly by a factor as high as 8.3 (i.e., 49 ft/5.9 ft).

2. The pit-lake water quality model algorithm contains an error that produces a systematic underestimate in the calculated load of solutes released from sulfide-bearing wall rock and to the lake.

In overview, the error can be explained thus: Sulfide minerals present in the exposed mine wall rock (both PAG and NAG material) will oxidize over time. To a first approximation, the amount of oxidation that occurs in a wall rock zone, and thus the mass of associated pollutants (sulfate, acidity, and solubilized metals) is approximately proportional to the duration that the rock is exposed to the atmosphere. Longer duration of wall-rock exposure to air = more

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[32] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Section 3.2.2 Pit wall runoff/submergence, p 15)

[33] Siskind, D.E., and R.R. Fumanti. "Blast-produced fractures in Lithonia granite." U.S. Bureau of Mines., Report of investigations 7901. 1974, U.S. Department of the Interior Library.

[34] McClosky, L., R. Wilmoth, J. LeFever, and D. Jordan, "Evaluation of technologies to prevent acid mine drainage generation from open pit highwalls," In: Proceedings of the 6th International Conference on Acid Rock Drainage, Cairns, Australia, 14-17 July, 2003, pp. 541-547.
(see also: https://www.epa.gov/sites/production/files/2015-09/documents/minewaste-tech-prevent-acid-mine-drainage.pdf)

[35] Radian, "Predicted water quality in the Betze-Screamer pit lake," Prepared for Barrick Goldstrike Mines, Inc., Elko, NV. Prepared by Radian International. 1997.

pollutants released. In semi-arid climates like Mt. Hope, solutes build up in pore water between rain and snow events. These solute concentrations in acidic pore water (i.e., the conditions expected in the PAG rock) can become very high—thousands to tends-of-thousands of mg/L - until it is flushed by meteoric water into the lake. The mass of pollutants <u>released</u> from sulfide wall rock thus depends on the duration over which the rock is exposed to the atmosphere; but at which this accumulated pollutant mass is <u>loaded</u> to pit lake depends on when the wall rock is flushed with meteoric water.

The error in the Slumberger 2010 pit lake model arises because it does not consider the duration over which the wall rock is exposed to the atmosphere when calculating wall rock loads to the pit lake. Instead, it assumes that the <u>concentration</u> of solutes in leachate from sulfide-bearing wall rock is <u>constant</u>, regardless of how long the wall rock has been oxidizing since the previous flushing event.

The following is a more detailed description of this error, tied to the text in the pit lake water quality report: [36]

> "Various methods exist for correlating weathering/oxidation time in an HCT test (in weeks) to actual weathering rates in the field (on the order of several to 100s of years)."

This identifies the problem of linking short-duration kinetic tests to estimate pollutant released over much longer durations of time.

> "Phase I Mount Hope HCTs were run for 57-70 cycles (weeks), and Phase II HCT data through 67 weeks were available."

The duration of kinetic tests was much less than the duration of oxidation under field conditions.

> "HCT leachate chemistry, averaged throughout the duration of the testing cycles, was used for modeling and the data are presented in appendix C."

The above sentence describes the disconnect: the model does not consider the rate component of the kinetic test, such as to calculate the average rate of release over time [e.g., mg SO_4/kg-rock/week], which could then be multiplied by the duration of wall rock exposure to indicated total release of a solute over a model time step, (e.g., [weeks] × [mg SO_4/kg-rock/week] = [mg SO_4/kg-rock]). Instead, the model assumes that the concentration in leachate is independent of the duration over which the wall rock has been exposed to the atmosphere.

The authors of the Pit Lake Geochemistry report are aware of this disconnect at some level, e.g.,

> "Humidity cells are not designed to predict field chemistry, but rather to optimize the rates of oxidation reactions and to compare the relative kinetics of acid generation and neutralizing process."[37]

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[36] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Section 3.3.2, p. 15)

[37] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Section 3.4 Laboratory to Field Scaling Calculations, p. 18).

But the pit lake model then contradicts directly the above statement, and applies directly the laboratory humidity cell leachate composition to calculate the "field chemistry," in this case, the leachate concentration in effluent from wall rock.

Finally, although the pit lake model report does acknowledge the effect of solute accumulation in pore water, the description of how the pore-water accumulation effect into the lake water quality model contains three "red flags" that suggest strongly the conceptual errors in the model design. From the description of how the pit-lake model developers attempted to incorporate the effect of higher solute release from PAG rock: "Weekly HCT [concentration] data were averaged (arithmetic) over the entire testing cycles, and were used to estimate runoff and flushing chemistry . . . This approach accounts for the higher concentrations associated with first flush (early time), as well as the potential of high concentrations in the late time for some acid-generating material types."[38]

- Red flag #1: The model prediction for the pit lake composition thus depends on the "first flush" composition measured in humidity cells. But in a sulfide-bearing rock, the first flush humidity cell composition is an entirely arbitrary parameter that depends on the duration that the sample happened to be stored, the conditions of storage before humidity cell testing began, and the water-to-rock ratio used in the humidity cell test. Thus, the model solute load depends on the arbitrary and unquantified storage history of samples prior to a laboratory test.
- Red flag #2: The model does not explicitly incorporate the duration that wall rock is exposed to the atmosphere and associated amount of sulfide that oxidized when it estimates solute leaching from wall rock. Instead, the model relies on this arbitrary "first flush" composition from a laboratory test to provide a quantitative estimate for the amount of acid solute that built up in rock in model simulation steps that ranged from 5 to 50 years in duration.
- Red flag #3: There is no indication that the model tracks mass balance of sulfide minerals in wall rock (e.g., the initial mass of sulfur in each wall rock zone before mining, and the mass lost during the model simulation).

The net effect of using an average concentration measured in 1-week duration laboratory humidity cell tests to estimate the solute release from multi-year exposure of wall rock to field oxidation has very probably introduced a systematic underestimate of pollutant loading to the Mt. Hope mine pit lake.

3. The Mount Hope Mine pit-lake model report does not provide a clear description of how much rock us included when calculating the water: rock ratio in the surface runoff.

The pit lake model description of how solute loading from wall rock is added to the Mt. Hope pit lake includes the following:

> "Pit wall runoff chemistry was weighted as a function of exposed, plan-view surface area above the pit lake elevation; and pit wall submergence chemistry is a function of actual or 3-D exposed areas below the pit lake elevation. . . . The resultant chemistry of runoff/submergence water reporting to the pit is then calculated as the weighted sum of

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[38] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Section 3.3.2, Pit wall runoff/submergence, p. 15)

each water type associate with each exposed material type."[39]

Questions to be addressed:

a) Are the solute concentrations in runoff of meteoric water from each litho-chemical wall rock zone simply assumed to be equal to the average composition measured in humidity cell effluents from these materials? If so, then as described in point 2 above, this model approach ignores the effect of increasing solute released from sulfide-bearing wall rock in proportion to the duration over which it is exposed to the atmosphere.

b) Is runoff over wall rock assumed to also interact with the 1.8 m thick Damaged Rock Zone (DRZ)? If so, the report should state this clearly. Without this information, there is no way to calculate a mass balance on sulfate and metals leached from the reactive sulfide-bearing wall rock.

4. *The pit lake model needs to include a mass balance accounting for solutes leached from reactive wall rock to the mine pit lake.*

A mass balance would indicate, for example, what fraction of the total sulfur and leachable metals in each section of sulfide-bearing wall rock zones (PAG and NAG wall-rock) is leached to the pit lake. This type of mass-balance tracking on pollution loading is a fundamental component in chemical modeling, and needs to be included in the Mt. Hope model.

5. *A simple calculation suggests that the Mt. Hope pit lake water quality model has underestimated the concentration of dissolved sulfate in future pit lake.*

Following is a simple comparison calculation that estimates the concentration of sulfate expected in the Mt. Hope pit lake at year 50 after infilling begins based only on the load of sulfate from inflowing groundwater and leaching from PAG wall rock above the lake. This is a rough calculation, conducted to provide a completely independent comparison of whether the pit lake model provides a reasonable estimate of sulfate in the lake.

For this comparison, we make the simple assumption that the average rate of sulfate released from the Mt. Hope Mine PAG wall is 1 kg $SO_4/m^2/year$, which is on the low end of measured and modeled values for wall rock oxidation at other Nevada mines, e.g.:

- ~3.7 kg $SO_4/m^2/yr$ (model of siltstone at 50 years after mining, initial rock sulfide S =0.93%; Radian 1997)
- ~4.5 kg $SO_4/m^2/yr$ (model of siliceous siltstone at 50 years after mining, initial sulfide S = 0.62%; Fennemore et al., 1998).
- ~0.5 kg $SO_4/m^2/yr$ (model siliceous siltstone with fractures at 50 years after mining, initial sulfide S = 0.62%; Fennemore et al., 1998)
- 2.1 kg $SO_4/m^2/year$ (average of 14 measured rates at 14 locations on pit benches, where rock sulfide S ranged from 0.4 to 6.18 %; Exponent 2000).

The modeling estimates in the above studies all assume that the oxidation rates are limited by oxygen diffusion using various formulations of a "shrinking core" model of reactive sulfide S in rock fragment. Thus, the model estimates for oxidation rates were higher than the above values

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[39] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Section 3.3.2, p. 16 & 17)

initially, and decrease over time to the values listed above at year 50, with the decrease reflecting the increase in distance that oxygen must diffuse before reaching the reactive sulfide S.

Given:

Time after filling begins: **50 years.**
(Arbitrarily selection for this comparison).

Volume of the lake at year 50: 1.1x10^9 ft^3 (=**3.11x10^{10} L**)
(Slumberger, April 2010, Final Pit Lake Geochemistry Report, Mount Hope Project, Table 3.1, p. 12):

Surface area of PAG pit wall rock exposed above lake at year 50: 118.7 Acres (=**480,362 m^2**); (sum of 9 PAG wall rock zones in the Mount Hope pit, Slumberger, 2010, Table 2.1 Final pit wall material type percentages, p. 10).

Total groundwater inflow to the lake over the first 50 years of infilling: 7.55x10^8 ft^3 (=**2.14x10^{10}L**)
(Slumberger, 2010, Table 3.2 Time step summaries of water balance flow volumes and percentages.)

Sulfate concentration in groundwater: **119.75 mg/L SO_4**
(Average of 4 wells around the proposed Mount Hope Mine pit, Slumberger, 2010, Appendix D Mount Hope Groundwater Date Used in Modeling.)

Results:

Sulfate concentration in the Mount Hope pit lake at year 50 due to only to groundwater:

$$\frac{118.75[\text{mg/L } SO_4^{2-} \text{ in G.W. inflow}] \times 2.14\cdot 10^{10} \text{ L [Volume G.W. inflow to Yr 50]}}{3.11\cdot 10^{10} \text{ L [Volume lake at Yr 50]}} = 82 \text{ mg/L } SO_4^{2-}$$

Sulfate leached from PAG wall rock and into the Mount Hope pit lake over the first 50 years that the lake fills:

$$480{,}362\ [\text{m}^2 \text{ of PAG wall rock above the pit lake at year 50}] \times 50 \text{ years}$$
$$\times\ 1\ [\text{kg } SO_4^{2-} \text{kg/m}^2\text{yr}] \text{ x } 1.0\cdot 10^6\ [\text{mg } SO_4^{2-}/\text{kg } SO_4^{2-}] = 2.4\cdot 10^{13} \text{ mg } SO_4^{2-}$$

Concentration of sulfate in the Mt. Hope lake at year 50 due only to PAG wall rock:

$$\frac{2.4\cdot 10^{13} \text{ mg } SO_4^{2-}}{3.11\cdot 10^{10} \text{ L lake water}} = 770. \text{ mg/L } SO_4^{2-}$$

Total calculated sulfate concentration in the lake at year 50 after filling begins:

$$770.\ [\text{mg/L } SO_4^{2-} \text{ from PAG rock}] + 82\ [\text{mg/L from groundwater}] = 852 \text{ mg/L } SO_4^{2-}$$

For comparison, the estimated SO_4^{2-} concentration in the Mt. Hope pit lake at year 50 predicted by the model[40] is 155 mg/L, or ~18% as high as the concentration estimated by a simple comparison. That is, the Slumberger model predicts lake sulfate that is low by a factor of ~5.5, or 550%.

This comparison suggests strongly that the Mt. Hope pit-lake water quality analysis (Slumberger 2010) probably underestimates the sulfate concentration that will exist in the pit lake, and thus also underestimates the concentrations of metals, metalloids, and acidity that humidity cell tests demonstrate are released from PAG wall rock along with the sulfate.

In response, the closure management planning and associated financial bond to fund should, at a minimum:

- Enhance the pit-lake water quality model so that it includes more comprehensive analysis of true uncertainty and thereby better identify the reasonable range in possible future lake water quality;
- Incorporate these more realistic (and thus larger) ranges for water-quality prediction uncertainty into ecological risk assessments of future lake water quality;
- Update lake management plans and associated bond amounts so that they incorporate proven technical options to mitigate the effects of acute or chronic ecological toxicity that may form in the short-term (i.e., in the first 5 years after formation of the pit lake begins) as well as long-term (beyond 100-years).
- Include an adaptive management plan for perpetual care of the pit lake that includes evaluation of future options for long-term options that could eventually provide passive and perpetual "walk-away" remediation of the lake, such as slow but complete backfilling with benign waste rock.

Pit Lake Water Quality

As mentioned above GBRW is not convinced that sufficient sampling was performed in the geochemical evaluation of the project. In addition to our concern regarding the underlying conceptual model of the pit lake evolution is the lack of sufficient data to extrapolate water quality in time. The FEIS states that little sampling data was available from expected pit wall material. In justification the final EIS states, *"There were little sampling data from some of the pit wall areas because of the relatively cylindrical nature of the orebody* (p. 3-315). This statement leaves GBRW to question how well PAG rock areas on the final pit surface are estimated as shown in Figure 3.3.10 of the FEIS, and to what extent these areas are expected to be acid generating. The Waste Rock and Pit Wall report clarifies the situation by stating, *"… because this PAG shape is based on data from historic assay pulps from the Exxon drill holes, approximately 30% of the pit material is undefined with respect to acid generating potential. For these undefined areas, the PAG shape had to be extrapolated to the edge of the final proposed pit."*[41] The results are presented in Table 9.1 indicating that about 14.5% of the final pit wall is PAG rock.[42] It appears as though the 30% "undefined" material pertains largely from material associated with the pit wall, since the historic samples were primarily to determine the nature of the resource. Therefore, GBRW suspects that characterization of material associated with final pit wall amount to very few actual samples as indicated in the FEIS. The FEIS goes on to state, "*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*

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[40] Slumberger, "Final Pit Lake Geochemistry Report, Mount Hope Project," Prepared for Eureka Moly, LLC, Prepared by Slumberger Water Services, Denver, CO. April 2010. (Table 6.1 Mt. Hope Predicted Pit Lake Water Quality Results)

[41] SRK, "Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report," Prepared for General Moly, Inc., January 2008. (p. 9-12)

[42] General Moly Inc., "Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report," January 28, 2008, (p. 9-12 to 14, Table 9.1)

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." [43] As far as the extrapolation using the nearest neighbor approach from the ore body sample data as being conservative, GBRW does not agree. There is nothing more conservative than the real data. Even if the pit lake model is conceptually correct, there does not appear to be enough actual data to predict with any confidence the water quality in the pit lake.

Even given the overly optimistic analysis of the pit lake there are still expected exceedences in Nevada water quality standards, in cadmium, manganese, fluoride, and antimony with cadmium at 10 times the Nevada reference standard. Based on data presented in section 3.3.2.2.2 Ground Water Quality of the FEIS it does seem as though groundwater entering the pit lake will be degraded, certainly for cadmium and possibly other constituents as well. Thus, "good quality" groundwater will become poor quality surface water.

The Pit Lake will Violate Nevada Law

Nevada regulations, NAC 445A.429(3) require that "Bodies of water which are a result of mine pits penetrating the water table must not create an impoundment which; (a) Has the potential to degrade groundwaters of the State or (b) Has the potential to affect adversely the health of human, terrestrial, or avian life." Therefore, under Nevada Water Pollution Control Law, mine operations must not create a pit lake that have the potential to adversely the health of human, terrestrial, or avian life.

The pit lake analysis presented in the WPCP application and the FEIS even taken at face value does show that the pit lake will contain elevated constituents. The FEIS found that the initial pit lake water quality is predicted to meet Nevada water quality standards. However, as evaporation form the pit lake concentrates dissolves minerals, some water quality constituents concentrations are predicted to increase relative to baseline conditions and to exceed Nevada water quality standards.[44] Similarly, the Fact Sheet (p 26) states that "concentrations of antimony, cadmium, and manganese are predicted to be above Profile I reference values."

A Screening-Level Ecological Risk Assessment (SLERA) was prepared using the results of the pit lake study for water quality. (Fact Sheet, p. 26). The Fact Sheet finds: "The SLERA results indicate the overall ecological risk to livestock and wildlife that might inhabit the site or could use the pit lake as a drinking water source is considered to be low. Given the low risks identified, mitigation of the Mount Hope Project pit lake does not appear to be necessary at the time."

The WPCP NEV2008106, therefore, allows a "low-risk" of ecological harm to livestock and wildlife as a result of drinking the pit lake water. Any risk, even if low, indicates a *potential* of adverse effects on terrestrial or avian life. The Fact Sheet, the SLERA, and the final EIS all conclude that terrestrial or avian life may be affected by the concentration of toxic materials or ecological risks presented in the pit lake. NAC 445A.429(3) prescribes a mandate that a mine operation "must not" create a pit lake that have the "potential to adversely the health of human, terrestrial, or avian life."

Despite NDEP's finding that there is a risk of adverse effects to the health of terrestrial or avian life, NDEP had issued and plans to renew WPCP NEV2008106 with insufficient monitoring or mitigation

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[43] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement (NV063-EIS07-019),* October, 2012. (p. 3-210)

[44] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (Section 3.3.3.3.3, p. 3-220)

measures to ensure that these effects do not occur. NDEP cannot permit EML to create an open pit mine that create and ecological risk, no matter how low the risk. NAC 445A.429(3) imposes a mandatory standard, and NDEP has no discretion to issue a permits that do not fully comply with that standard.

The term "groundwater" means "all subsurface water comprising the zone of saturation, including perched zones of saturation, which could produce usable water." NAC 445A.361. Here the Fact Sheet states that groundwater inflow will be the primary source of water for the formation of the pit lake (p. 25-26). Thus, the pit lake is composed of groundwater.

EML's application materials state: "A comparison of the maximum concentrations for groundwater to Nevada beneficial use standards, reveals that the groundwater within the area demonstrates wide range of beneficial uses. The majority of the groundwater locations can be used for municipal or domestic supply, watering of livestock and industrial uses."[45] "Domestic use means "culinary and household purposes." NRS 534.013. Culinary purposes include drinking water.

The FEIS makes the following finding: "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."[46] Therefore, NDEP is aware that drinking water quality groundwater will flow into the open pit, creating a pit lake. The groundwater will then become degraded because of evaporation from the pit, leaving the groundwater contaminants in higher concentrations. Additionally, pit wall material will influence the degradation of the pit lake as mentioned in the Fact Sheet (p. 25-26) by recognizing a "secondary influence" from the pit wall material.

Nothing in Nevada law states that groundwater ceases to be groundwater once it flows into a mine pit. Moreover, NDEP has not granted any exemption to EML under NAC 445A.424 that would allow EML to create a facility that will degrade groundwater. Good quality groundwater that meets drinking water quality standards will flow into the mine pit, creating a pit lake. Due to the mine facilities, that groundwater will then become degraded below applicable drinking water quality standards. That degradation is prohibited by Nevada's Water Pollution Control Law. The issuance and renewal of the WPCP, which allows EML to create the pit lake, is illegal.

GBRW submits that the hydrological analysis does not preclude the potential that the pit lake in the earlier years of filling will be flow through (see discussion above under MONITORING). If in fact flow-through is possible then there is also the potential of degrading groundwater, which is a violation of Nevada law.

CONCLUSIONS

GBRW considers the proposed Mt. Hope Mine a serious community and environmental risk to the region, and illegal under Nevada law. The amount of acid generating rock at the site is underestimated, which makes the waste rock management plan invalid at the outset. In addition, our analysis indicates considerable acidic discharge even if EML's waste rock characterization is correct. The time frame of

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[45] SRK, "Mount Hope Project Baseline Surface Water and Groundwater Repor," Prepared for General Moly. 2008. (p. 48)

[46] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (p. 3-220)

the discharge is expected to be long-term with no end date for treatment, perpetuity treatment. It is critical that Nevada does not allow a mine to be permitted where this potential for perpetuity treatment exists.

Groundwater monitoring is also likely to be inadequate to intercept all possible drainage containing elevated levels contaminants.

The pit lake analysis presented in the WPCP application and the FEIS even taken at face value does show that the pit lake will contain elevated constituents. The FEIS found that the initial pit lake water quality is predicted to meet Nevada water quality standards. However, as evaporation form the pit lake concentrates dissolves minerals, some water quality constituents concentrations are predicted to increase relative to baseline conditions and to exceed Nevada water quality standards.[47] Similarly, the Fact Sheet (p 26) states that "concentrations of antimony, cadmium, and manganese are predicted to be above Profile I reference values."

Assumptions contained in the pit lake development model are likely to be in error resulting and a significant underestimation of the constituent load in the pit lake. We have also pointed to evidence that supports a possible flow through characteristic in the earlier stages of pit lake filling, which would result in a violation of state law by degrading groundwater.

GBRW cannot at this time support WPCP NEV2008106. In our view the mine plan is poorly conceived and significant revisions will be needed to address the concerns raised here and avoid violations of Nevada state law.

Feel free to contact us if you need any clarifications or discuss any aspect of these comments.

Sincerely,

John Hadder

John Hadder,
Director, Great Basin Resource Watch

Bob Fulkerson,
Executive Director, Progressive leadership Alliance of Nevada.

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[47] U.S. Department of the Interior Bureau of Land Management, *Mount Hope Project Final Environmental Impact Statement*, NV063-EIS07-019, October 2012. (Section 3.3.3.3.3, p. 3-220)