Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico

Report Prepared for

THEMAC Resources Group Ltd.

Report Prepared by

SRK Consulting (U.S.), Inc.
SRK Project Number 191000.03
May 2018

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THEMAC Resources Group Ltd.

4253 Montgomery Boulevard NE, Suite 130,
Albuquerque, NM 87109

SRK Consulting (U.S.), Inc.

5250 Neil Road
Suite 300
Reno, NV 89502
e-mail: reno@srk.com
website: www.srk.com

Tel: (775) 828-6800
Fax: (775) 828-6820

SRK Project Number 191000.03

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Authors:
Ruth Griffiths, EurGeol, CGeol, PhD
Senior Consultant (Geochemistry)

Amy Prestia, MSc, P.G.
Principal Consultant (Geochemistry)

Peer Reviewed by:
Eur. Geol. Rob Bowell PhD, CChem, CGeol
Corporate Consultant (Geochemistry)

Executive Summary

SRK Consulting (SRK) has undertaken a predictive geochemical modeling exercise to assess future pit lake chemistry associated with the Copper Flat Project, New Mexico and to compare this to existing pit lake water quality. This work has been undertaken on behalf of New Mexico Copper Corporation (NMCC – a subsidiary of THEMAC Resources Group Ltd. [THEMAC]) to demonstrate compliance with New Mexico Mining Act regulations "Performance and Reclamation Standards for New Mining Operations" at 19.10.6.603 NMAC, applicable to the future pit water body, specifically that:

- The operations must be planned and conducted to minimize change in the hydrologic balance in both the permit and potentially affected areas; and
- Reclamation must result in a hydrologic balance similar to pre-mining conditions.

The work also forms part of the geochemical characterization study to assess the Acid Rock Drainage and Metal Leaching (ARDML) potential of the Project.

The Copper Flat Project is a porphyry copper-molybdenum deposit located on the western margin of the Rio Grande Rift. The deposit also contains minor, but potentially recoverable, gold and silver mineralization. The deposit is hosted by a quartz monzonite stock that intrudes a sequence of andesitic volcanic rocks.

Preliminary pit lake predictions for the Project were presented in the SRK December 2014 report entitled *'Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico'*, which was presented to Regulatory authorities to generate discussion and input. A number of modifications and refinements have been made to the pit lake models since this report was submitted, including:

- Incorporation of the Feasibility Study geologic block model;
- Incorporation of the current open pit design, which is detailed in the 2017 Mine Operation and Reclamation Plan (2017 MORP pit);
- Refinement of the pit wall composition to include delineation of material types by primary lithology, oxidation and mineralized versus weakly-mineralized material;
- Refinement of humidity cell test (HCT) inputs to include separate source terms for major and trace elements, reflecting the different processes that control their release;
- Refinement of mineral equilibrium phases based on predicted chemistry;
- Refinement of the water balance to use a reduced annual evaporation rate of 50 inches and to include a separate runoff term for reclaimed areas in the pit and the open pit watershed;
- Revisions to the groundwater chemistry inputs; and
- Incorporation of pit management and reclamation measures; including rapid fill of the pit and reclamation of the pit haul road and other areas within the pit and the pit watershed.

The objective of the report is to provide an analysis that demonstrates that future pit lake water quality results in a water body with similar chemistry to that of pre-mining conditions upon implementation of the reclamation actions proposed by NMCC in its MORP and Reclamation Plan, including rapid-fill of the open pit after closure of the mine.

Geochemical predictions were developed for three scenarios, including: (i) a calibration model for the existing pit lake; (ii) a natural fill model for the future unreclaimed pit; and (iii) a rapid fill model for the future reclaimed pit. Rapid fill has been proposed as the water quality component of NMCC's reclamation strategy for the future pit lake. It will include filling the pit with 2,200 acre-feet of good quality water from the production water supply wells during the first six months of groundwater recovery and pit infilling.

This report describes the approach taken for the revised pit lake predictive modeling effort, details the assumptions made, and presents the results of the revised pit lake geochemical predictions.

Model Calibration

The results of the existing pit lake model show good calibration of constituents, demonstrating water quality can be predicted with a good degree of accuracy for the future pit lake. The baseline water quality data utilized in the calibration model are data for existing water quality chemistry in the pit lake between 2010 and 2013. This is a subset of the entire baseline data generated between 1998 and July 2017. The full data set was utilized in comparing existing water quality chemistry to projected future water quality of the pit lake in discussed in Sections 5 and 6.

Unreclaimed Fill Scenario

In the unreclaimed pit scenario, allowing the pit to fill naturally will result in the pit walls and benches being exposed over a much longer period of time, i.e., approximately 150 years, before the pit lake reaches hydrologic equilibrium. In this scenario, the proposed future Copper Flat open pit is expected to be seasonally stratified but otherwise well-mixed, oxygenated and not acidic. Waters are predicted to be moderately alkaline (pH 7.9 – 8.2), primarily due to the buffering capacity of the inflowing groundwater. During the early stages of pit infilling (i.e., the first six months post-closure), removal/flushing of soluble salts will occur through precipitation contacting the pit walls and is likely to result in a spike in boron, lead, mercury, manganese, molybdenum, nickel, selenium, vanadium, zinc and sulfate in the early pit lake. The effects of this initial flush will be dissipated by inflowing groundwater and precipitation, and pit lake chemistry will then evolve over time, with some parameters increasing in concentration as a result of evaporation effects. This is similar to the trends observed in the existing pit lake where elemental concentrations have increased since the start of pit infilling in response to evapoconcentration.

A comparison of predicted pit lake water chemistry for the unreclaimed fill scenario to chemistry measured in the existing pit lake between 1989 and 2017 demonstrates that the concentrations of the majority of constituents are comparable to existing concentrations, and therefore water quality of the future pit lake is expected to be similar to existing pit lake water quality.

Reclaimed Fill Scenario

Rapidly refilling the pit with water from the water supply wells during the first six months post-closure will result in a better initial water quality within the pit lake due to the good quality of the water that will be used. The long-term result is that the effects of evapoconcentration are not as pronounced as the pit lake reaches hydrogeologic equilibrium, and predicted concentrations of many major ions and trace elements will remain lower than in the unreclaimed fill scenario. This is particularly the case for constituents such as boron, sulfate and chloride, which are strongly influenced by evaporation effects and are predicted to be much lower in concentration for the rapid fill scenario compared to the natural fill scenario. In addition, the rapid fill will also quickly submerge walls and benches within six months and thus limit the exposure of sulfide minerals to oxygen, which will reduce trace element release into the pit lake. By contrast, the unreclaimed fill scenario allows the pit to fill naturally and results in the pit walls and benches being exposed over a much longer period of time, i.e., approximately 150 years, before the pit lake reaches hydrologic equilibrium. A comparison of predicted pit lake chemistry for the reclaimed pit rapid fill scenario to chemistry measured in the existing pit lake between 1989 and 2017 demonstrates that concentrations of the majority of predicted constituent concentrations are comparable to existing concentrations and therefore, water quality of the future pit lake is expected to be similar to existing pit lake water quality.

Conclusion

Based on the model results presented herein, the changes to the hydrologic balance of the future pit water body that will form post-mining will be nil or minimal and the water quality will be very similar to that of the existing pit lake. The existing pit lake at Copper Flat is an artificial water body created as a result of mineral extraction with little or limited ability to sustain aquatic life (Aquatic Consultants, Inc. 2014). The post-mining water body is anticipated to be similar to the existing pit lake and is not expected to be conductive to providing aquatic habitat or supporting fish life.

This geochemical modeling report demonstrates that the mine pit reclamation proposed for the Copper Flat mine that is outlined in Section 3.1.8 of this report meets the water quality similarity requirements of 19.10.6.603 NMAC.

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1 Introduction

1.1 Purpose and Scope

SRK Consulting, Inc. (SRK) has undertaken a geochemical modeling assessment on behalf of New Mexico Copper Corporation (NMCC – a subsidiary of THEMAC Resources Group Ltd. [THEMAC]) to predict future pit lake chemistry associated with the Copper Flat Project (the Project), New Mexico. The purpose of the assessment is to evaluate the future environmental impacts of the Project as required by the New Mexico Mining Act and State environmental regulations. The work forms part of the geochemical characterization study to assess the Acid Rock Drainage and Metal Leaching (ARDML) potential of the Project.

Preliminary pit lake model results were presented in the December 18, 2014 report entitled *'Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico'* (SRK, 2014a). The purpose of this preliminary report was to outline the methodology for the pit lake modeling in order to seek feedback from the agencies, and to present the initial results of the pit lake modeling. Since this preliminary report was submitted, a number of modifications and refinements have been made to the pit lake models, including:

- Incorporation of the Feasibility Study geologic block model;
- Incorporation of the current open pit design, which is detailed in the 2017 Mine Operation and Reclamation Plan (2017 MORP pit);
- Refinement of the pit wall composition to include delineation of material types by primary lithology, oxidation and mineralized versus non-mineralized material;
- Refinement of humidity cell test (HCT) inputs to include separate source terms for major and trace elements, reflecting the different processes that control their release;
- Refinement of mineral equilibrium phases based on predicted chemistry;
- Refinement of the water balance to use a reduced annual evaporation rate of 50 inches and to include a separate runoff term for reclaimed areas in the pit and the open pit watershed;
- Revisions to the groundwater chemistry inputs; and
- Incorporation of pit reclamation measures, including rapid fill of the pit and reclamation of the pit haul road and other areas within the pit and the pit watershed.

This final report describes the approach taken for the revised pit lake predictive modeling effort, details the assumptions made, and presents the final results of the revised pit lake geochemical predictions.

Applicable standards to the post-mining Copper Flat pit lake are contained in the New Mexico Mining and Minerals Division (MMD) regulations administered under the Mining Act. Specifically, the performance and reclamation standards require that reclamation must result in a hydrologic balance similar to pre-mining conditions. With respect to water quality in the pit lake, post mining water quality must be similar to baseline pre-mining water quality in the pit lake. The model results presented herein have been compared to pre-mining baseline water quality of the existing pit lake.

1.2 Background

The Copper Flat Project is a porphyry copper/molybdenum deposit located in the Hillsboro Mining District in South Central New Mexico, in Sierra County located approximately 150 miles south of Albuquerque, New Mexico and approximately 20 miles southwest of Truth or Consequences, New Mexico straight-line distances). Access from Truth or Consequences is by 24 miles of paved highway and 3 miles of all-weather gravel road. The Copper Flat Project location is shown in Figure 1-1.

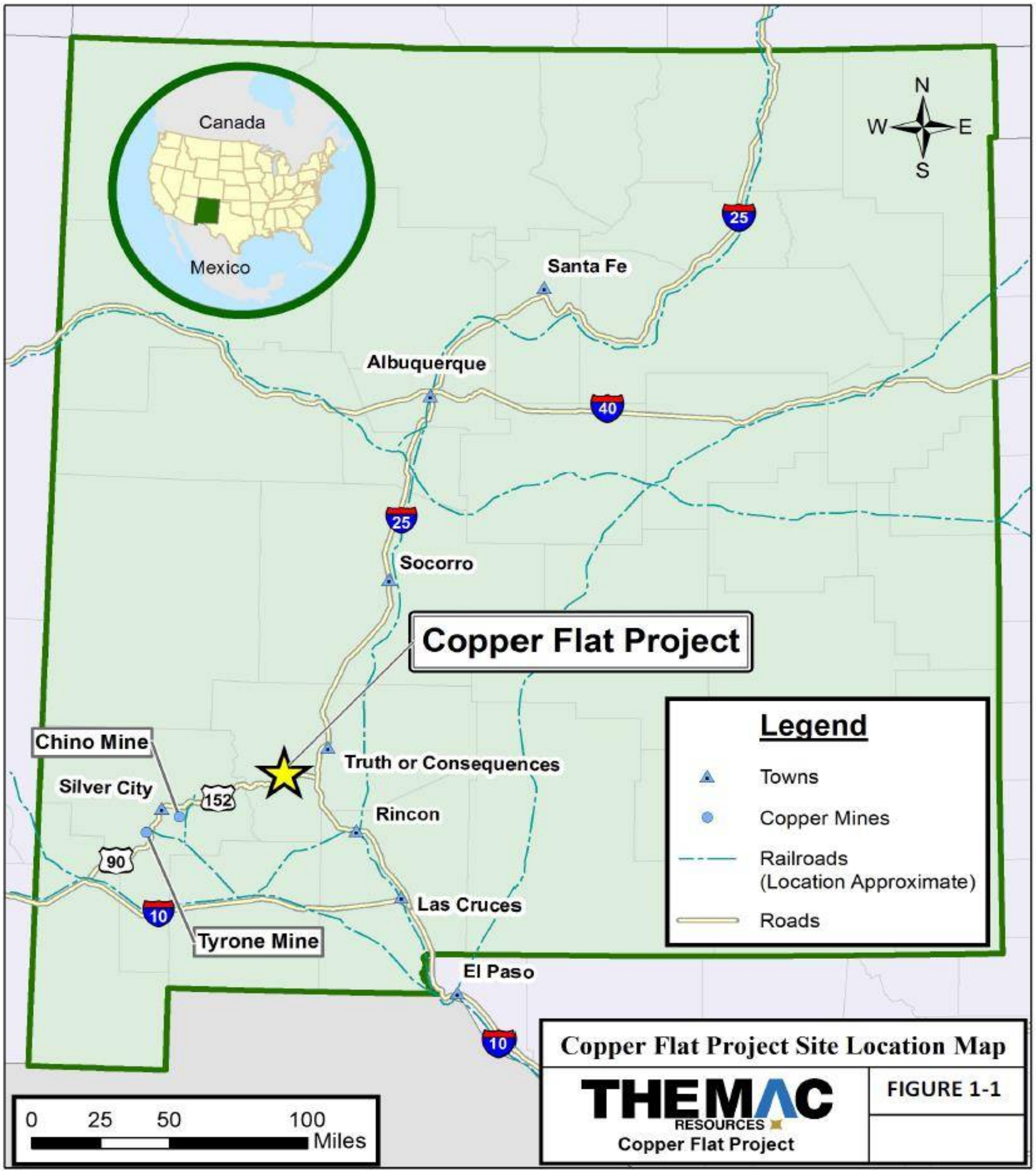

Figure 1-1: Project Location

1.2.1 Climate

The regional climate is high desert, and is generally hot with a July average of 76°F (record maximum 107°F), and January average of 39°F (record minimum 1°F). The area is generally dry with about 13 inches of average annual precipitation, which occurs mostly as rainfall during July to September.

Winters are cold and dry. Snowfall is possible from October through April, but more typically occurring between December and February. The average annual total is 8 inches of snowfall. Prevailing wind direction is predominantly from the west, and secondarily from the north, and averages 10 to 15 miles per hour. Wind speeds in excess of 50 mph may occur as major storms pass through the area.

1.2.2 Prior Mining Operations

Mining activities in the Hillsboro Mining District began in the late-1800s. Gold was mined from shafts and adits at Copper Flat and from placer workings developed along drainages to the east and southwest of Black and Animas Peaks. Gold mining was further developed during the early 1900s and continued until World War II. Today, small scale placer mining continues. Copper exploration began in the 1950s and continued to the early 1980s, when Quintana Minerals Corporation defined 60 Mt of reserves sufficient to operate for a 11-year mine life at an extraction rate of 15,000 tons of ore per day (tpd). Operations included the development of the open pit, waste rock stockpiles, TSF and other mine disturbances observed today, but mining stopped after three months due to low metal prices. Mine buildings and equipment were dismantled in 1985; however structural foundations, power lines, water wells, and in-ground infrastructure were left in-place for a future restart. During the 1990s, plans to reopen the mine were considered. Existing surface disturbances and facilities in the Project area include the following:

- A pit with a small pit lake;
- Waste rock stockpiles (WRSP);
- A 115-kilovolt power line from the Caballo Substation to the mine site;
- Production wellfield and 20-inch pipeline from the wellfield to the mine site;
- A diversion channel collecting stormwater from west and south of the pit and diverting unimpacted flows down Grayback wash;
- A diversion channel collecting stormwater from north of the pit and diverting unimpacted flows to the east;
- Existing concrete foundations and structures including:
    - Primary crusher structure and stacking conveyor tunnel
    - Coarse ore reclaim tunnel
    - Concentrator building foundation
    - Truck shop foundation
    - Administration building foundation
    - Concentrate storage foundation
    - Mine office and change house foundation.
- Site grading and roads; and
- A tailings storage facility (TSF) containing approximately 1.4 Mt of tailings from the Quintana mining operation.

1.2.3 Mine Plan

The proposed Project consists of an open pit mine, flotation mill, tailings storage facility, waste rock stockpiles and ancillary facilities. During the mine life, the proposed Project is expected to produce approximately 113 million tons of copper ore and 45 million tons of waste rock. Ore extraction will take place by conventional truck and loader methods using 25-foot high benches. Backfilling of the pit will not take place during or after mining.

Beneficiation will be achieved through the use of a conventional concentrator using standard crushing, grinding and flotation technologies. The operation is designed to recover copper, molybdenum, gold, and silver into separate copper and molybdenum concentrates. The nominal ore throughput rate is 30,000 tpd and an operational life of 11 to 12 years is currently projected. The proposed layout of the mine facilities is shown in Figure 1-2. The current pit configuration is modified from the pit design developed for the Copper Flat Feasibility Study (FS) published in November 2013 (M3, 2013) and matches the pit design presented in the 2017 MORP (THEMAC, 2017a).

EWRSP = EXISTING WASTE ROCK STOCKPILE
WRSP = WASTE ROCK STOCKPILE

SITE PLAN
SCALE: 1:500

DO NOT SCALE 11x17 DRAWINGS

PRELIMINARY
FOR AGENCY REVIEW

THEMAC RESOURCES

REFERENCES		REFERENCES	
DWG. NO.	TITLE	DWG. NO.	TITLE

REVISIONS						REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

SCALE: 1" = 500'		DATE
DESIGNED BY	SAM	DEC12
DRAWN BY	SAM	DEC12
CHECKED BY	TDL	JAN13
PROJECT MGR	RKZ	
CLIENT APPR.		

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SITE GENERAL
CIVIL
PROJECT AREA
PROPOSED SITE PLAN

JOB NO. M3 PN-120085
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FIGURE 1-2
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1.2.4 Geology and Mineralization

The following description of geology and mineralization is from the Copper Flat Feasibility Study (FS) published in November 2013 (M3, 2013). The Copper Flat Project is a porphyry copper-molybdenum deposit located on the western margin of the Rio Grande Rift. The deposit also contains recoverable, gold and silver. The deposit is hosted by a small quartz monzonite stock having a porphyritic texture that intrudes a sequence of andesitic volcanic rocks of similar age covering an area approximately 4 miles in diameter.

Regional Geology

The Copper Flat Project lies within the Mexican Highlands portion of the Basin and Range Physiographic Province. The Project is located in the Hillsboro Mining District in the Las Animas Hills, which are part of the Animas Uplift, a horst on the western edge of the Rio Grande valley. The Animas Uplift is separated from the Rio Grande by nearly 20 miles of Santa Fe Group alluvial sediments, referred to as the Palomas Basin of the Rio Grande valley. To the west of the Animas Uplift is the Warm Springs valley, a graben that parallels the Rio Grande valley. Further west, the Black Mountains form the backbone of the Continental Divide, rising to about 9,000 feet above sea level. The regional geology is discussed in more detail in the *Baseline Data Report for the Copper Flat Mine* (BDR) (INTERA, 2012). The focus of this report is on the local and Copper Flat ore body geology.

Basement rocks in the area consist of Precambrian granite and Paleozoic and Mesozoic sandstones, shales, limestones, and evaporites. Sedimentary units that crop out within the Animas Uplift include the Ordovician Montoya Limestone, the Silurian Fusselman Dolomite, and the Devonian Percha Shale. The Cretaceous-age Laramide orogeny, which was characterized by the intrusion of magma associated with the subduction of the Farallon plate beneath the North American plate, affected this region between 75 and 50 million years ago (Ma). Volcanic activity during the late Cretaceous and Tertiary periods resulted in localized flows, dikes, and intrusive bodies, some of which were associated with the development of the nearby Tertiary Emory and Good Sight-Cedar Hills calderas. Later basaltic flows resulted from the tectonic activity associated with the formation of the Rio Grande rift. Tertiary and Quaternary alluvial sediments of the Santa Fe Group and more recent valley fill overlie the older Paleozoic and Mesozoic units in the area.

Local Geology

The district geology described below is modified from McLemore et al. (2000) and Raugust (2003). The predominant geologic feature of the Hillsboro Mining District is the Cretaceous Copper Flat stratovolcano, a circular body of Cretaceous andesite that is 4 miles in diameter (Figure 1-3). The Hillsboro Mining District comprises the Las Animas Hills, a low range formed by the Animas Hills horst at the western edge of the Rio Grande Rift. Faults that bound the Animas Hills horst are related to the tectonic activity of the Miocene-age Rio Grande Rift (Dunn, 1982). Due to the difference in ages and in spite of its close proximity, there is no known connection between the Rio Grande rift and the Copper Flat volcanic/intrusive complex. The Copper Flat volcanic/intrusive complex has been interpreted as an eroded stratovolcano based on the presence of agglomerate and flow band textures in some of the andesite (Richards, 2003).

The Copper Flat Quartz Monzonite (CFQM) intrudes the core of the volcanic complex. The CFQM stock has a surface expression of approximately 0.4 mi^2 and has been dated by the argon-argon (40Ar/39Ar) techniques to be 74.93 ±0.66 million years old (McLemore et al., 2000). The surrounding andesite has also been dated using argon-argon techniques to be 75.4 ±3.5 million years old (McLemore et al., 2000).

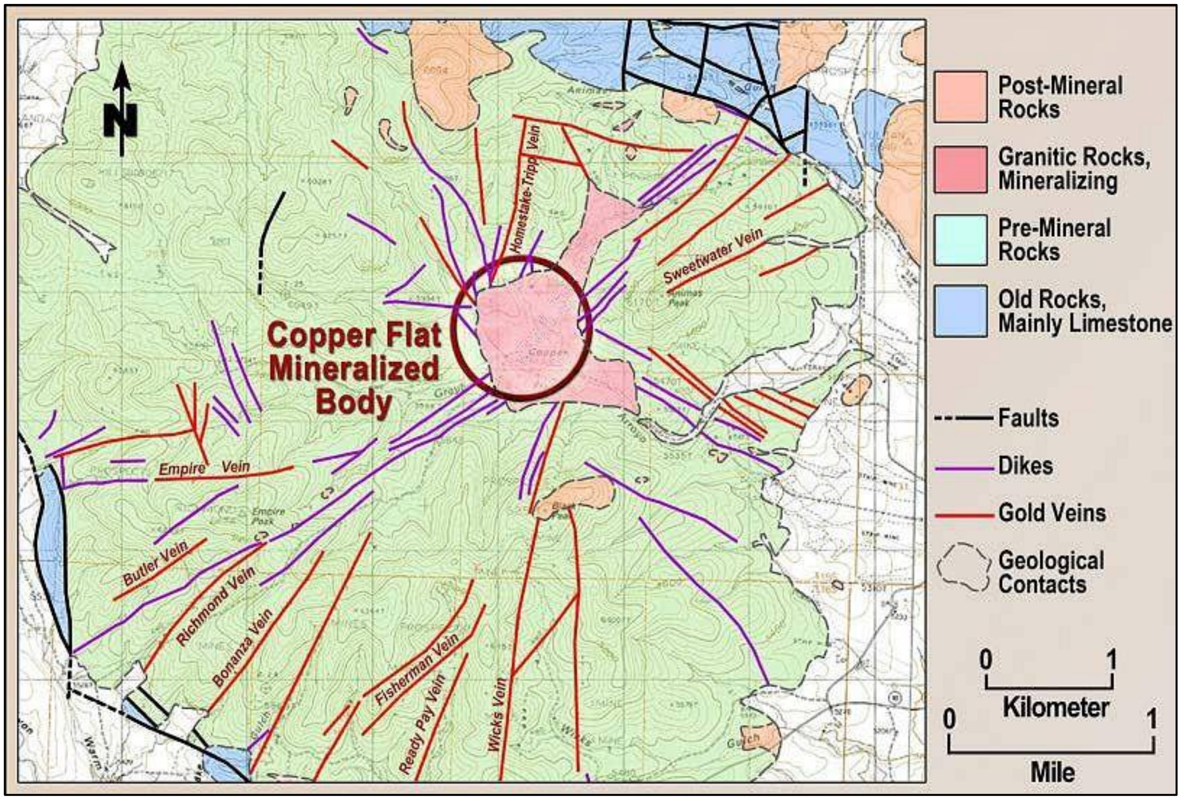


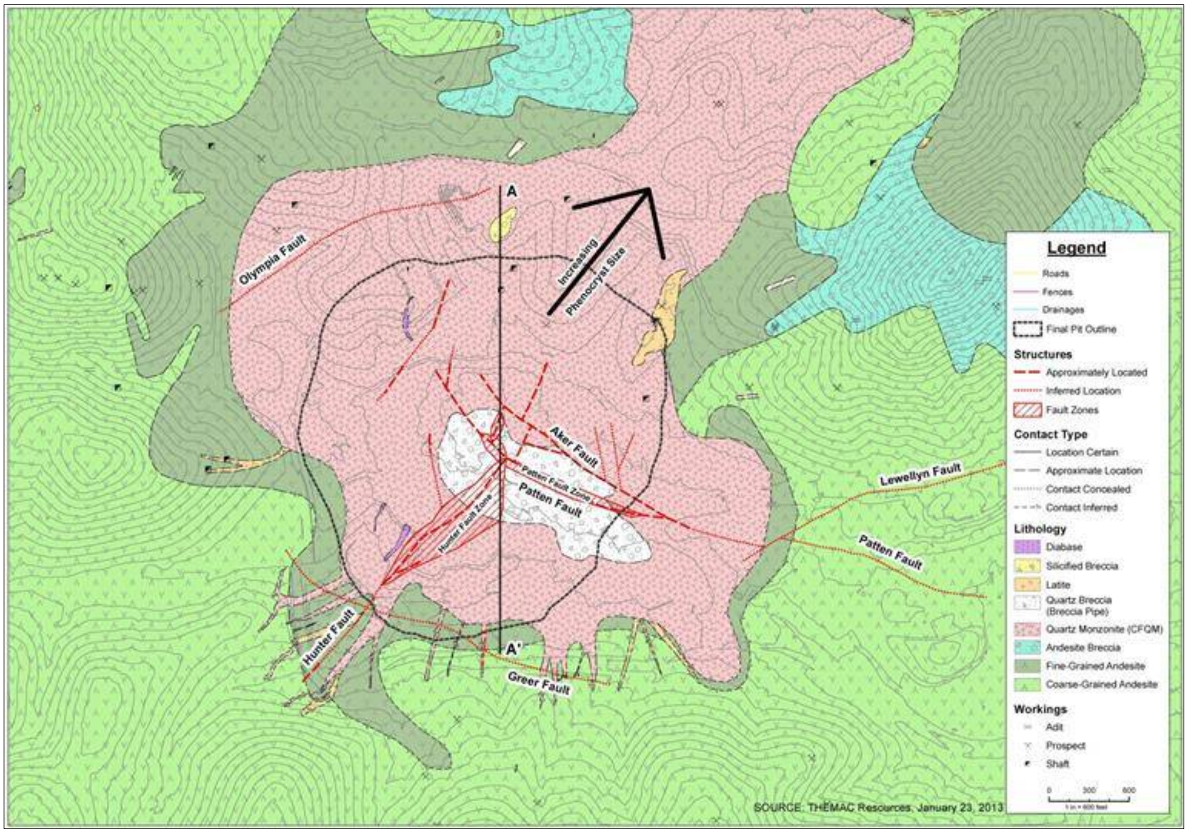
Figure 1-3: Geology of the Copper Flat Mine (Dunn, 1982)

Geology of the Copper Flat Orebody

The Copper Flat andesite is generally fine-grained with phenocrysts of plagioclase (andesine) and amphibole in a groundmass of plagioclase and potassium feldspar and rare quartz. Some agglomerates or flow breccias are locally present, but the andesite is generally massive. Magnetite is commonly associated with the mafic phenocrysts, and accessory apatite is commonly found.

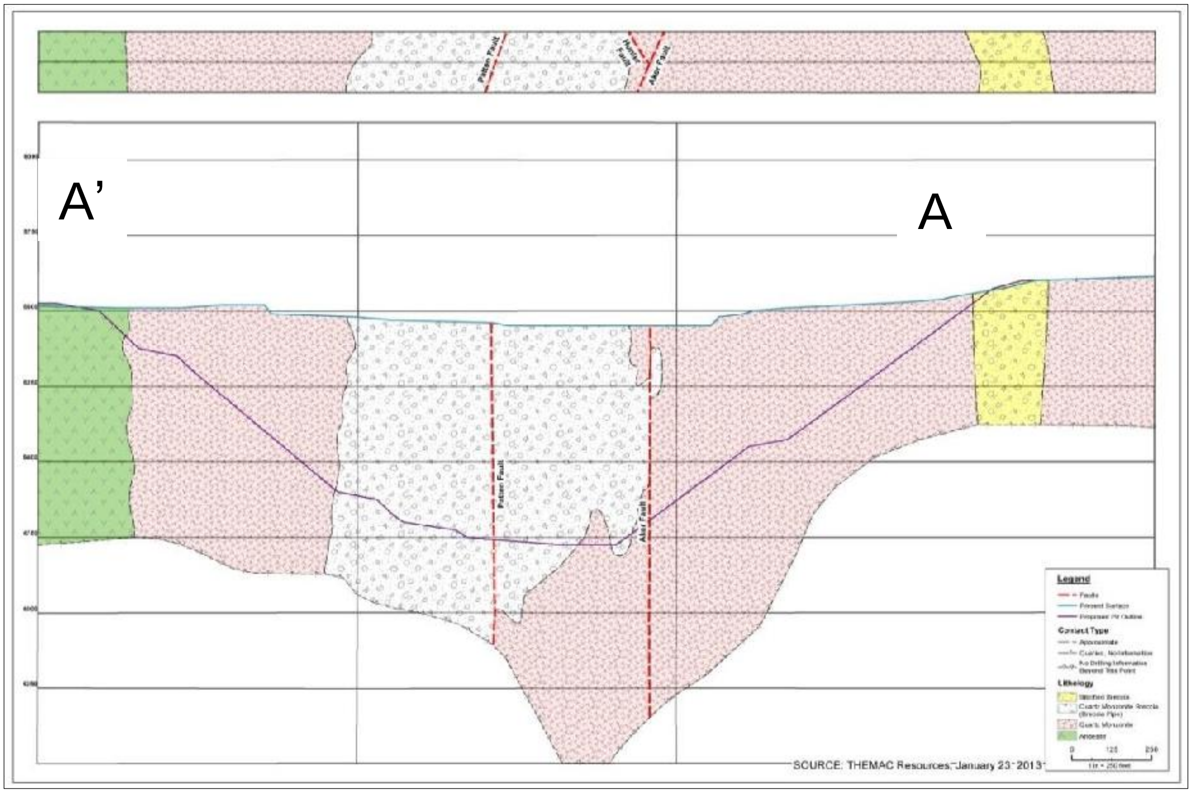
Although the depth of erosion is uncertain, the center of the stratovolcano was eroded to form a topographic low. To the east of the site, this andesite body is in fault contact with Santa Fe Group sediments, which are at least 2,000 feet thick in the immediate Copper Flat area and thickening to the east. Near-vertical faults characterize the contacts on the remaining perimeter of the andesite body; these faults juxtapose the andesite with Paleozoic sedimentary rocks. Historical drill holes indicate the andesite is locally more than 3,000 feet thick. This feature, combined with the concentric fault pattern, indicate that the local geology represents a deeply eroded Cretaceous-age volcanic complex. A detailed geologic map of the Copper Flat orebody is provided in Figure 1-4 and a south-north geologic cross section through the Copper Flat orebody is provided in Figure 1-5.

Copper Flat Quartz Monzonite (CFQM) intrudes the core of the volcanic complex. Sulfide mineralization is present as veinlets and disseminations in the CFQM, but is most strongly developed in and adjacent to the west end of a steeply dipping breccia pipe that is centrally located within the CFQM stock and elongated in the northwest-southeast direction (Figure 1-5).



SOURCE: THEMAC Resources, January 23, 2013

Figure 1-4: Detailed Geologic Map of the Copper Flat Orebody (M3, 2013)



SOURCE: THEMAC Resources, January 23, 2013

Figure 1-5: Geologic Cross Section through the Copper Flat Orebody (M3, 2013)

Lithology

The CFQM intruded into the center of the andesite sequence at the intersection of two principal structures that trend respectively N50°W and N20°E. The CFQM is an irregular-shaped stock underlying a surface area of approximately 0.40 square miles and has been dated to approximately 75 Ma. In the few exposures in which the CFQM is in contact with the andesite, the andesite shows no obvious signs of contact metamorphism. The CFQM is a medium- to coarse-grained, holocrystalline porphyry composed primarily of potassium feldspar, plagioclase, hornblende, and biotite; trace amounts of magnetite, apatite, zircon, and rutile are also present, along with localized mineralized zones containing pyrite, chalcopyrite, and molybdenite. About 15 percent of the monzonite is quartz, which occurs both as small phenocrysts and as part of the groundmass; however, quartz is absent in some parts of the stock.

Numerous dikes, some of which are more than a mile in length and mostly of latite composition, radiate from and cut the CFQM stock. Most of the dikes trend to the northeast or northwest and represent late stage differentiation of the CFQM stock. Diabase has been mapped in contact with the CFQM at Copper Flat. Immediately south of the quartz monzonite, the andesite is coarse-grained, perhaps indicating a shallow intrusive phase. An irregular mass of andesite breccia along the northwestern contact of the quartz monzonite contains potassium feldspar phenocrysts and andesitic rock fragments in a matrix of sericite with minor quartz. This may represent a pyroclastic unit. Magnetite, chlorite, epidote, and accessory apatite are also present in the andesite breccia.

Structure

Three principal structural zones are present at Copper Flat, the most prominent of which is a northeast-striking fault that trends N 20°-40°E that includes the Hunter and parallel faults or the Hunter fault zone. In addition, west-northwest striking zones of structural weakness (N50°-70°W) are marked by the Patten and Greer faults, and east-northeast striking zones are marked by the Olympia and Lewellyn faults. All faults have a near-vertical dip; the Hunter fault system dips 80°W, the Patten dips approximately 70°S-80°S, and both the Olympia and Lewellyn fault systems dip between 80°S and 90°S. These three major fault zones appear to have been established prior to the emplacement of the CFQM and controlled subsequent igneous events and in the case of the Patten and Hunter controlled mineralization.

As previously stated, the CFQM emplacement is largely controlled by the three structural zones. The southern contact parallels and is cut by the Greer fault, although the contact is cut by the fault, and the southeastern and northwestern contacts are roughly parallel to the Olympia and Lewellyn faults, respectively. The CFQM stock is principally elongated along the Patten fault, as well as along the Hunter fault zone.

Although latite dikes strike in all the three principal fracture directions, most of the dikes strike northeast. The northeast trending fault zones contain a high proportion of wet gouge, often with no recognizable rock fragments. Reportedly in underground exposures the material comprising the Hunter fault zone has the same consistency as wet concrete and has been observed to flow in underground headings. Based on recent drilling the Patten fault consists of a mixture of breccia and gouge. However, the material in the east-northeast fault zones contains only highly broken rock and minor gouge. The width of individual structures in all three systems varies along strike from less than a foot to nearly 25 feet in the Patten fault east of the Project. Despite intense brecciation, the total displacement along the faults does not appear to exceed a few tens of feet. At the western edge of the CFQM intrusion, a younger porphyritic dike was emplaced in a fault that offsets an early latite dike, indicating that fault movement occurred during the time that dikes were being emplaced.

Post-dike movement is evident in all the three principal fault zones, and both the Hunter and Patten fault systems show signs of definite post-mineral movement. Fault movement has smeared sulfide deposits and offset the breccia pipe as well as the zones within the breccia pipe. Post-mineral movement along faults has resulted in wide, strongly brecciated fault zones. Some of the post-mineral dikes have been emplaced within these fault zones.

NMCC has mapped the pit area and diversion cuts in detail at 1 inch equals 40 feet (1:480) and has examined the pre- and post-mineral stress orientations in the andesite and CFQM. Findings indicate no significant difference in the stress fields before and after mineralization. During NMCC's mapping efforts, the Greer and Olympia previously mapped fault locations could not be verified; therefore, these faults were labeled as inferred.

Mineralization

The CFQM hosts mineralization dominated by pyrite and chalcopyrite with subsidiary molybdenite, minor bornite and recoverable amounts of gold and silver. The mineralization is focused along intersecting northeast- and northwest-trending faults, and these intersections may have originally controlled emplacement of the CFQM.

Although copper occurs almost exclusively as chalcopyrite locally accompanied by trace amounts of bornite, minor amounts of chalcocite and copper oxide minerals are locally present near the surface and along fractures. The supergene enrichment typical of many porphyry copper deposits in the Southwest is virtually non-existent at Copper Flat. During the early mining days, a 20 to 50-foot leached oxide zone existed over the ore body, but this material was stripped during the mining activities that occurred in the early 1980s. Most of the remaining ore is unoxidized and consists primarily of chalcopyrite and pyrite with some molybdenite and locally traces of bornite, galena and sphalerite. Recently completed mineralogical studies indicate that fine grained disseminated chalcopyrite is often inter grown with pyrite and occurs interstitial to silicate minerals. Deposition of chalcopyrite and molybdenite (76.2 Ma) occurred within the same mineralizing event as the pyrite.

Sulfide mineralization is present as veinlets and disseminations in the CFQM, but is most strongly developed in and adjacent to the west end of a steeply dipping breccia pipe, that is centrally located within the CFQM stock and elongated in the northwest-southeast direction roughly along, but south of the Patten fault. The sulfide mineralization first formed in narrow veinlets and as disseminations in the quartz monzonite with weakly developed sericitic alteration. This stage of mineralization was followed by the formation of the breccia pipe with the introduction of coarse "clotty" pyrite and chalcopyrite along with veinlet controlled molybdenite and milky quartz, and the development of strong potassic alteration.

The breccia pipe, which can best be described as a crackle breccia, consists largely of subangular fragments of mineralized CFQM, with locally abundant mineralized latite where dikes exposed in the CFQM projected into the brecciated zone that range in size from an inch to several inches in diameter. Andesite occurs only as mixed fragments partially in contact with intrusive CFQM and appears to represent the brecciation of relatively unaltered andesite xenoliths in the CFQM. The matrix contains varying proportions of quartz, biotite (phlogopite), potassium feldspar, pyrite, and chalcopyrite, with magnetite, molybdenite, fluorite, anhydrite, and calcite locally common. Apatite is a common accessory mineral. Breccia fragments are rimmed with either biotite or potassium feldspar, and the quartz and sulfide minerals have generally formed in the center of the matrix.

Two types of breccia within the quartz monzonite breccia pipe have been identified as distinguishable units based on the dominant mineral filling the matrix between clasts. Recent drilling has shown that the two breccia types, biotite breccia and feldspar breccia, grade into one another as well as with the CFQM. Interestingly, from a recovery perspective, metallurgical testing has shown that the mineralization behaves virtually the same irrespective of the lithology.

The total sulfide content ranges from 1 percent (by volume) in the eastern part of the breccia pipe and the surrounding CFQM to 5 percent in the CFQM to the south, north, and west. Sulfide content is highly variable within the breccia, with portions in the western part of the breccia containing as much as 20 percent sulfide minerals. The strongest copper mineralization is concentrated in the western half of the breccia pipe and in the adjoining stockwork veined CFQM in the vicinity of the intersection of the Patten fault and the Hunter fault zone. Sulfide mineralization is concentrated in the CFQM and breccia pipe, and drops significantly at the andesite contact. Minor pyrite mineralization extends into the andesite along the pre-mineral dikes and in quartz-pyrite-bearing structures, some of which were historically prospected for gold.

Molybdenite occurs in some steeply dipping quartz veins or as thin coatings on fractures. Minor sphalerite and galena are present in both carbonate and quartz veinlets in the CFQM stock. Preliminary 2011 evaluations of the mineralization at Copper Flat indicate that copper mineralization concentrates and trends along the N50°W structural influences, whereas the molybdenum, gold and silver appear to favor a N10°-20°E trend.

1.2.5 Hydrology

Hydrological information pertaining to the Copper Flat Project has been summarized from the Baseline Data Report (INTERA, 2012) and is provided herein to provide a context for the pit lake modeling. The mine permit area is located in the Lower Rio Grande watershed, which includes approximately 5,000 square miles in Catron, Socorro, Sierra, and Doña Ana Counties and is dominated by the Rio Grande and its tributaries as well as the two large reservoirs of Elephant Butte and Caballo. Numerous tributaries drain into the Rio Grande from the west, but none contribute perennial flow to the Rio Grande. The mine permit area is drained by ephemeral streams (arroyos) within the Greenhorn Arroyo Drainage Basin. The Greenhorn Arroyo Drainage Basin is composed of Greenhorn Arroyo, Grayback Arroyo, and Hunkidori Gulch. The Grayback Arroyo passes through the permitted mine area and is diverted around the existing mine pit. Drainages within this watershed are ephemeral, flowing in response to heavy or sustained precipitation events. Water quality data for the Greyback Arroyo are summarized in Table 1-1.

Table 1-1: Summary of Hydrochemical Information in the Grayback Arroyo (INTERA, 2012)

Details	pH (s.u.)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Min	7.42	0.71	11	78
Max	7.92	130	2,900	4,500

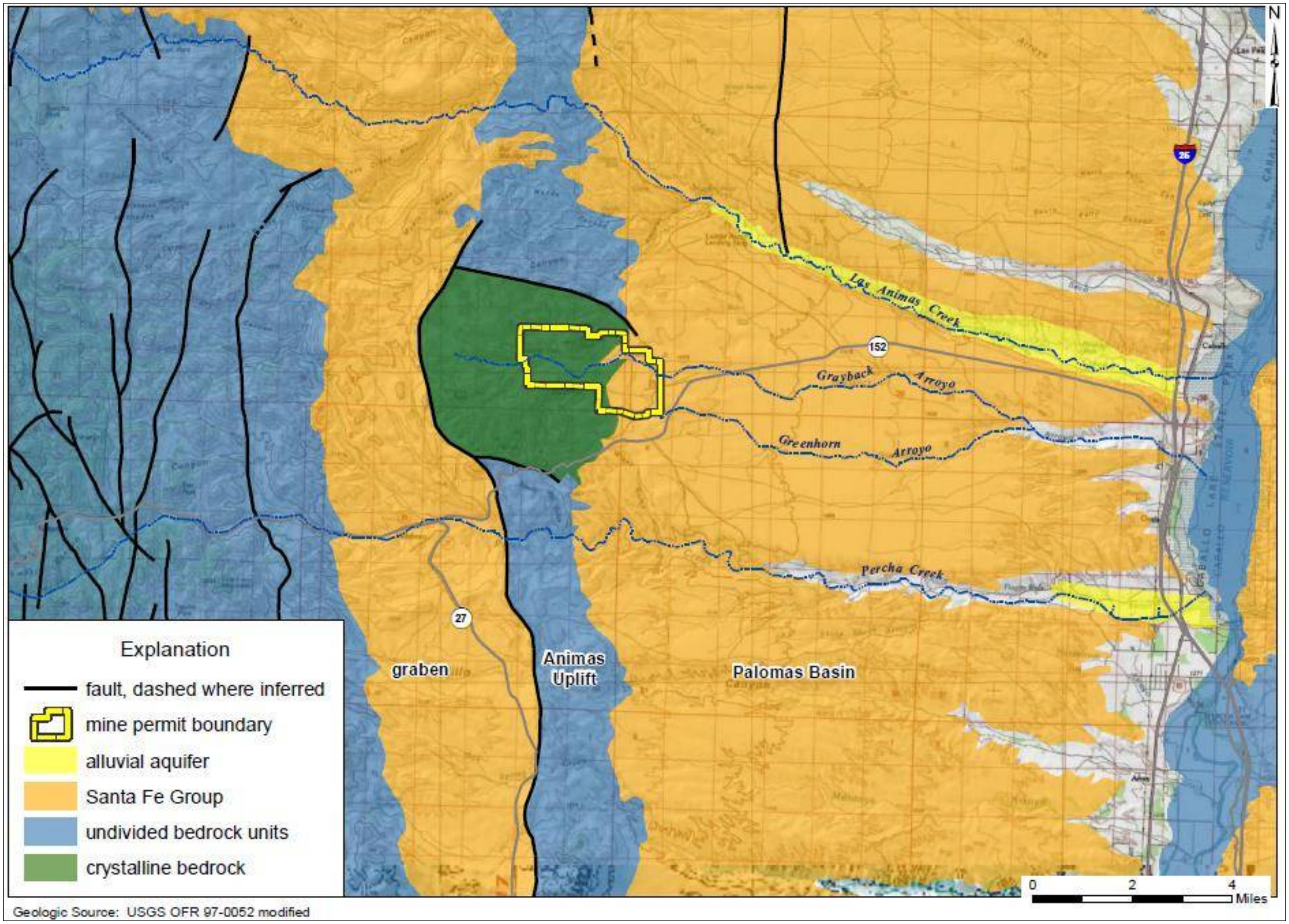
Surface waters in the Grayback Arroyo are typically characterized by higher major ion and trace element concentrations, with sulfate concentrations up to 2,900 mg/L and TDS up to 4,500 mg/L.

1.2.6 Hydrogeology

Hydrogeological information pertaining to the Copper Flat Project has been summarized from the Baseline Data Report (INTERA, 2012) and is provided herein. This report identifies three aquifers within the Copper Flat Project area (Figure 1-6) including:

1. Crystalline bedrock aquifer;
2. Santa Fe Group aquifer; and
3. Quaternary alluvial aquifer.

Details of these aquifers are provided below.



Geologic Source: USGS OFR 97-0052 modified

Figure 1-6: Map Showing Location of Crystalline Bedrock, Santa Fe Group Sediments and Alluvial Aquifer Zones (INTERA, 2012)

1. ***Crystalline Bedrock Aquifer:*** Groundwater is present within the crystalline volcanic rocks (quartz monzonite and andesite) that constitute much of the western portion of the mine permit area. Though the rocks themselves have practically no inter-granular permeability, faulting and jointing of the monzonite have created locally permeable zones through which water can move. Groundwater flow is generally from west to east, with the exception of the area surrounding the pit lake, which behaves as an evaporative sink. The permeability of the andesite is extremely low (<0.003 feet/day), whereas the permeability of the monzonite rocks averages 0.1 feet/day due to localized secondary porosity from fracturing. Groundwater in the Crystalline Bedrock Aquifer is characterized by moderately alkaline pH (~8 s.u.) and can generally be classed as sodium / calcium plus bicarbonate (Na / Ca + HCO_3) type waters based on their major ion signature (Figure 1-7).
2. ***Santa Fe Group Aquifer:*** Overlying and adjacent to the crystalline bedrock aquifer is the Santa Fe Group Aquifer system, which receives recharge from precipitation. The aquifer is located approximately 1 mile downgradient of the existing pit lake, and the low hydraulic conductivity of the andesite limits cross formational flow. The sediments of the Santa Fe Group are stratified, contain a wide variety of grain sizes, and, in general, dip to the east. The direction of groundwater flow is from west to east and the groundwater elevation contours indicate groundwater flows from the andesite to the alluvium and Santa Fe Group sediments. Groundwater in the Santa Fe Group Aquifer is characterized by circum-neutral to moderately alkaline pH (7 – 8 s.u.) and can generally be grouped into the calcium plus bicarbonate (Ca + HCO_3) or calcium plus sulfate (Ca + SO_4) hydrochemical facies based on major ion chemistry (Figure 1-7). The sulfate signature of some of the groundwater samples is associated with wells within the Santa Fe Group Aquifer near the existing TSF, which are known to be influenced by a sulfate plume from the historic tailings.
3. ***Quaternary Alluvial Aquifer:*** This aquifer is comprised of channel and floodplain gravels, sands and silts and represents the uppermost aquifer in the vicinity of the Copper Flat Project. The alluvial aquifer is typically recharged by infiltration of rainfall.

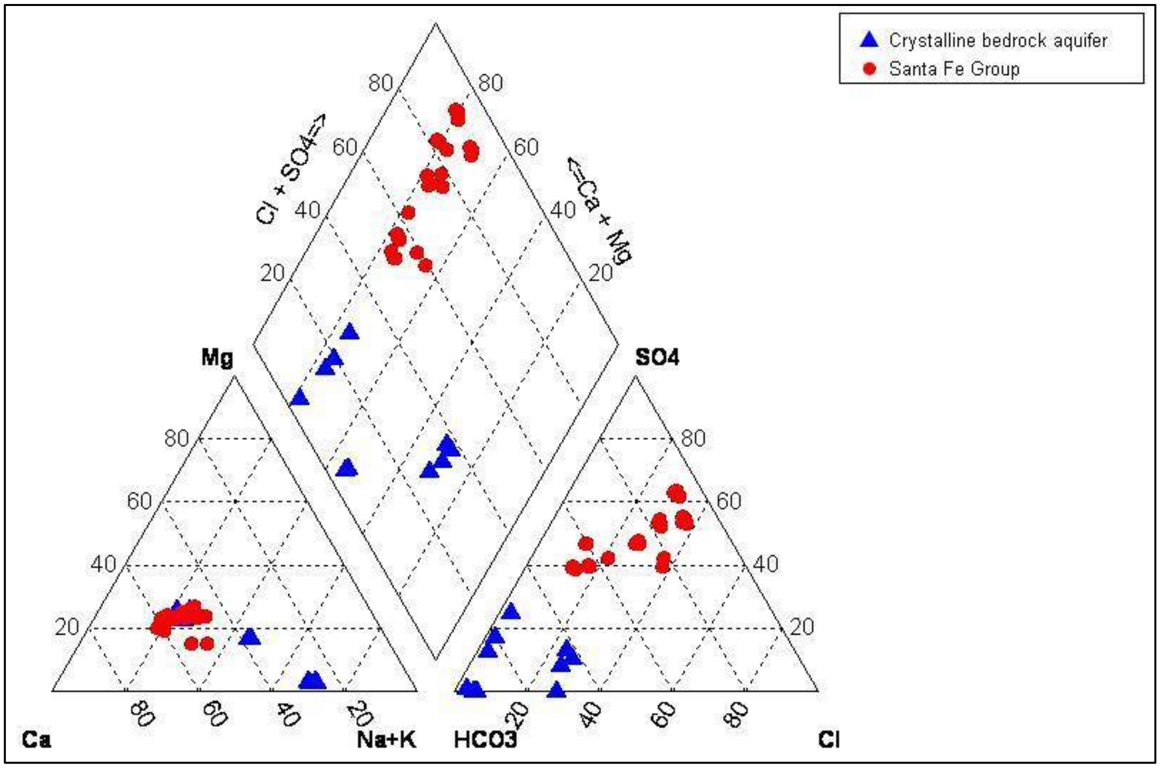


Figure 1-7: Piper Plot of Major Ion Chemistry of Groundwater in the Mine Permit Area (analyses from 2010 and 2011 only)

1.2.7 Existing Pit Lake

Beginning in the late 1980s, a pit lake formed in the existing pit. This lake represents an artificial water body that has formed in a man-made void. The surface area of the pit lake was approximately 13.8 acres at its maximum extent, but the lake has subsequently reduced in size as a result of evaporation and limited precipitation (i.e., drought conditions). A recent evaluation by John Shomaker and Associates (JSAI, who have been assisting THEMAC with site management of water resources) indicates that the pit lake currently covers an area of approximately 5.2 acres and contains approximately 70 acre-feet of water (NMCC estimate, 2015). Bathymetric measurements carried out as part of the INTERA (2012) baseline data collection program indicate that the depth of the existing pit lake varies between 10 and 35 feet. Water levels are typically highest in the winter month of January and lowest in the summer month of July. The analytical results do not indicate the presence of a chemocline or any chemical stratification in the lake. However, the temperature profiles for the winter and summer sampling showed a greater than 1ºC per meter change, indicating the presence of a seasonal thermocline. The pit currently represents a hydraulic sink, with evaporation from the lake surface exceeding groundwater inflow, precipitation and surface runon (M3, 2012).

Monitoring of the existing pit lake water quality has taken place periodically between 1989 and present, with a total of 57 samples being collected for analysis. Monitoring took place on at least an annual basis between 1989 and 1997, with 26 samples collected during this period. The monitoring program was then re-established in 2010 as part of the INTERA (2012) baseline data collection program, which included collection of samples from the deepest part of the pit lake in September 2010, January 2011, April 2011 and July 2011. JSAI collected four quarters of additional data in 2013 as part of the Stage 1 abatement investigation (JSAI, 2014a). Monitoring of pit lake water quality is ongoing, with NMCC collecting three samples in 2014, two samples in 2015, 13 samples in 2016 and two samples to date in 2017.

The results of the existing pit lake monitoring are summarized in Table 1-2 and time-series plots of key parameters are provided in Appendix A. This demonstrates that the pH of the pit lake waters has been variable over the period of record, ranging from a minimum of pH 3.6 to a maximum of pH 8.3. In general, the pit lake waters are circum-neutral (average of pH 6.5); any periodic decreases in pH (for example between March and October 1992, June 2008 and June 2015 [Figure 1-10]) are associated with periodic Acid Wall Seep (AWS) events. Concentrations of sulfate, chloride, TDS, manganese, magnesium, cobalt, fluoride, sodium and potassium have increased between 1989 and 2017 (Appendix A). In particular, evapoconcentration effects have increased the concentrations of sulfate and chloride (Figure 1-8), resulting in supersaturation of pit lake waters and subsequent precipitation of salts (primarily gypsum) around the rim of the existing pit lake. These precipitated solids form a thick crust on the pit walls (Figure 1-11).

Copper concentrations in the open pit are influenced by AWS events (Figure 1-9). The elevated copper concentrations observed in 2010 are naturally mitigated to below analytical detection limits by 2011. This demonstrates that pit lake chemistry is temporally variable, with copper concentrations varying from below analytical detection limits up to a maximum of 26.5 mg/L.

Temperature and dissolved oxygen profiles for the existing pit lake (INTERA, 2012, Aquatic Consultants, 2014) show the pit water is not significantly stratified. The water stays well oxygenated for the entire depth for each season (6 to 8 mg/L dissolved oxygen). Thermal stratification requires a 1^{o}C change in temperature per meter (Wetzel, 2001), which can occur in the summer months as the upper water column heats up and the lower water column remains cool, and well oxygenated. Figure 1-12 also shows that there is no depth-dependent variation in key chemical constituents (pH, TDS, copper, iron, zinc, manganese). This supports the assumption that the current pit lake is not stratified and that no chemocline exists.

A biological assessment of the pit lake was performed by Aquatic Consultants, Inc. (Aquatic Consultants, 2014, Appendix J) as part of the baseline data gathering effort to determine if aquatic life was present in the existing pit lake. While some algae were identified in the waters, no zooplankton, macroinvertebrates and no fish species were recovered during sampling, indicating the pit lake does not provide a suitable aquatic habitat. The biological assessment in conjunction with the other information provided in this section demonstrates that the existing pit lake is an artificial water body created as a result of mineral extraction with little or limited ability to sustain aquatic life and should not be equated to conditions that may be encountered in natural lakes.

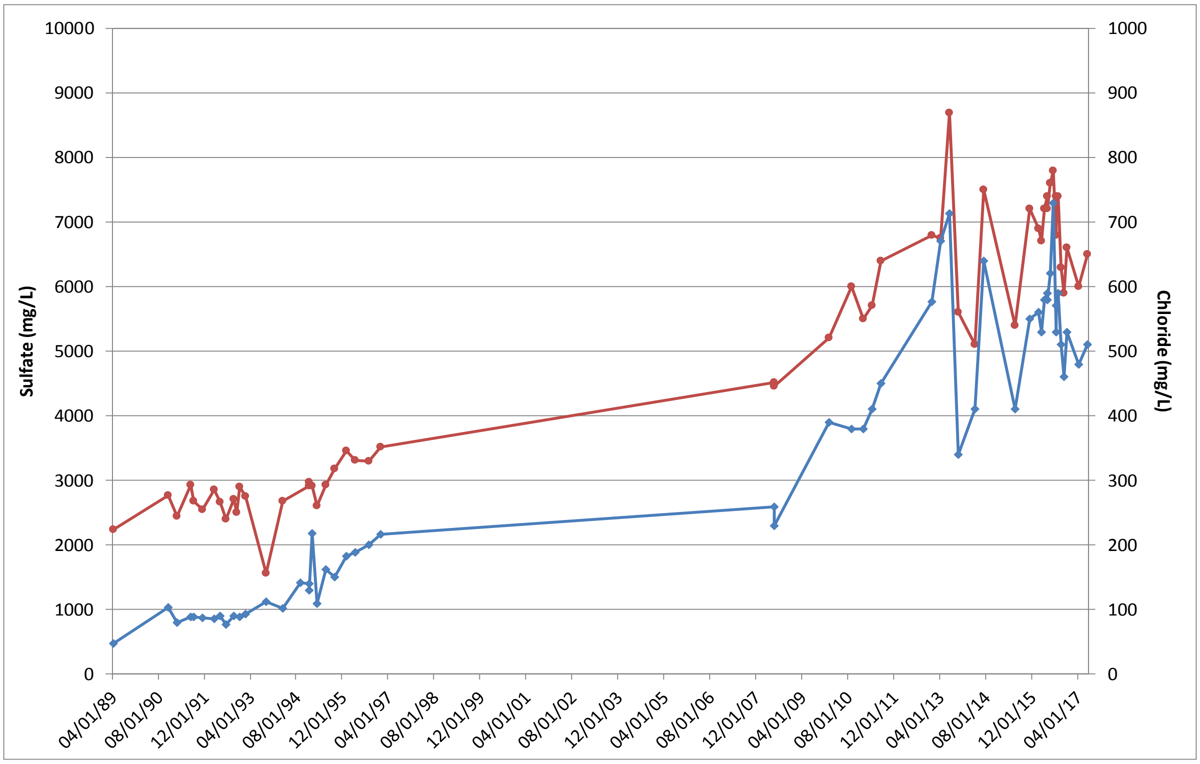


Figure 1-8: Plot of Sulfate and Chloride Concentrations in Existing Pit Lake

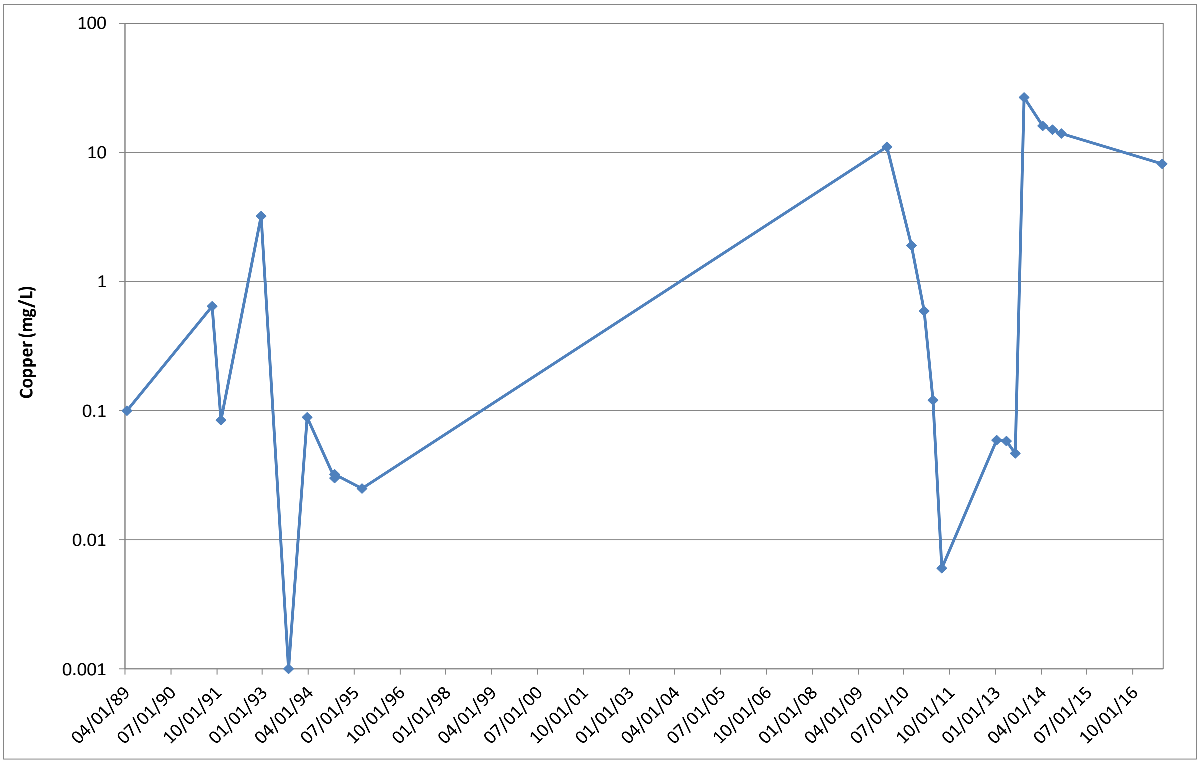


Figure 1-9: Plot of Copper Concentrations in Existing Pit Lake

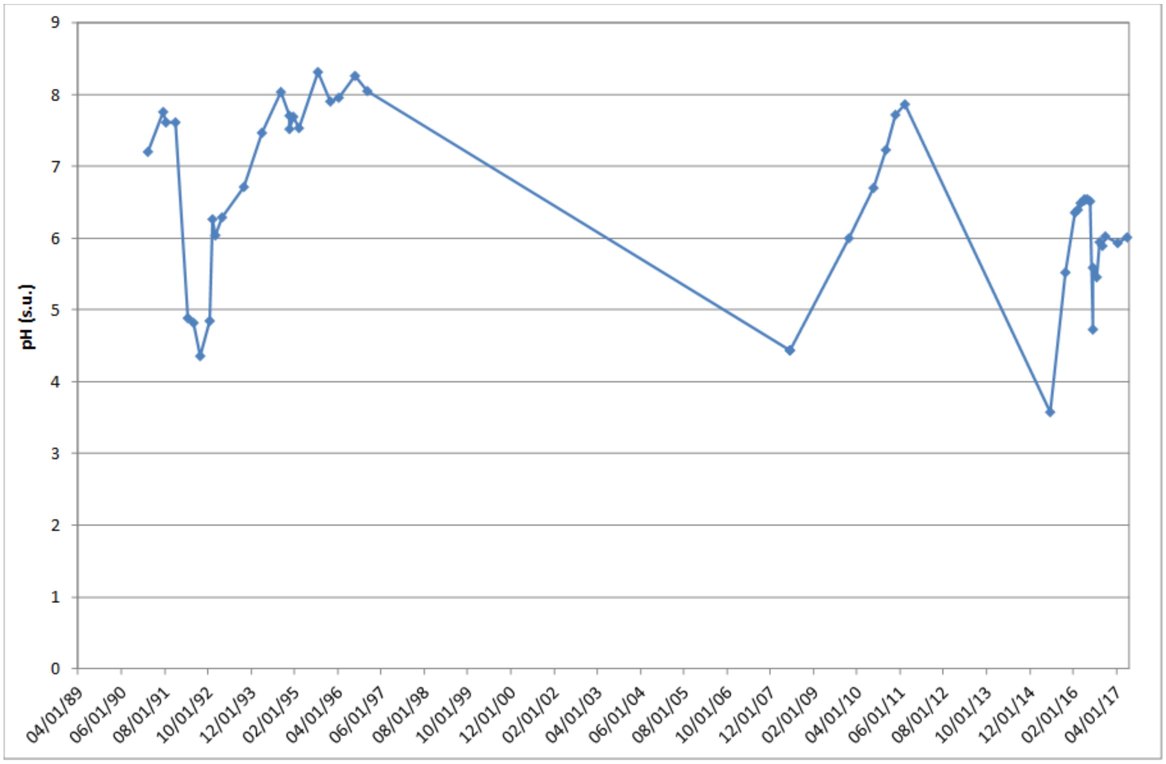


Figure 1-10: Plot of pH in Existing Pit Lake

Figure 1-11: Precipitated Salts around Rim of Existing Pit Lake

Table 1-2: Existing Pit Lake Chemistry (1989 – 2017)

Parameter	Units	n	Average	Minimum	Maximum
pH	s.u.	47	6.5	3.6	8.3
TDS	mg/L	56	7,538	2,711	14,800
Bicarbonate	mg/L	37	40.4	<3	122
Sulfate	mg/L	55	4,803	1,566	8,690
Chloride	mg/L	55	332	47.3	730
Fluoride	mg/L	33	19.2	4.8	34
Calcium	mg/L	37	550	455	684
Magnesium	mg/L	37	698	43	1,120
Sodium	mg/L	37	888	165	1,400
Potassium	mg/L	37	32.1	11	60.6
Aluminum	mg/L	33	10.4	<0.02	82.6
Antimony	mg/L	7	<0.001*		
Arsenic	mg/L	10	0.004	<0.001	0.006
Boron	mg/L	9	0.14	<0.1	0.2
Cadmium	mg/L	35	0.05	<0.005	0.1
Chromium	mg/L	11	0.03	<0.006	0.1
Cobalt	mg/L	32	0.29	<0.05	0.49
Copper	mg/L	22	4.44	0.001	26.5
Iron	mg/L	11	0.2	<0.02	1.3
Lead	mg/L	11	0.02	<0.005	0.1
Manganese	mg/L	35	34.8	0.02	59
Mercury	mg/L	10	0.0005	<0.0002	0.001
Molybdenum	mg/L	9	0.04	0.015	0.1
Nickel	mg/L	9	0.06	0.039	0.1
Selenium	mg/L	34	0.028	<0.001	0.25
Silver	mg/L	12	0.026	<0.005	0.1
Thallium	mg/L	8	0.0045	<0.001	0.005
Uranium	mg/L	4	0.11	0.11	0.12
Vanadium	mg/L	4	0.1	<0.05	0.25
Zinc	mg/L	33	5.4	0.01	9
Total Dissolved Solids	mg/L	56	7,538	2,711	14,800

n	*Number of samples*
*	*Indicates parameter was uniformly below analytical detection limits in pit lake water over monitoring period, but detection limit was variable. Concentration shown in table represents lower limit of analytical detection.*

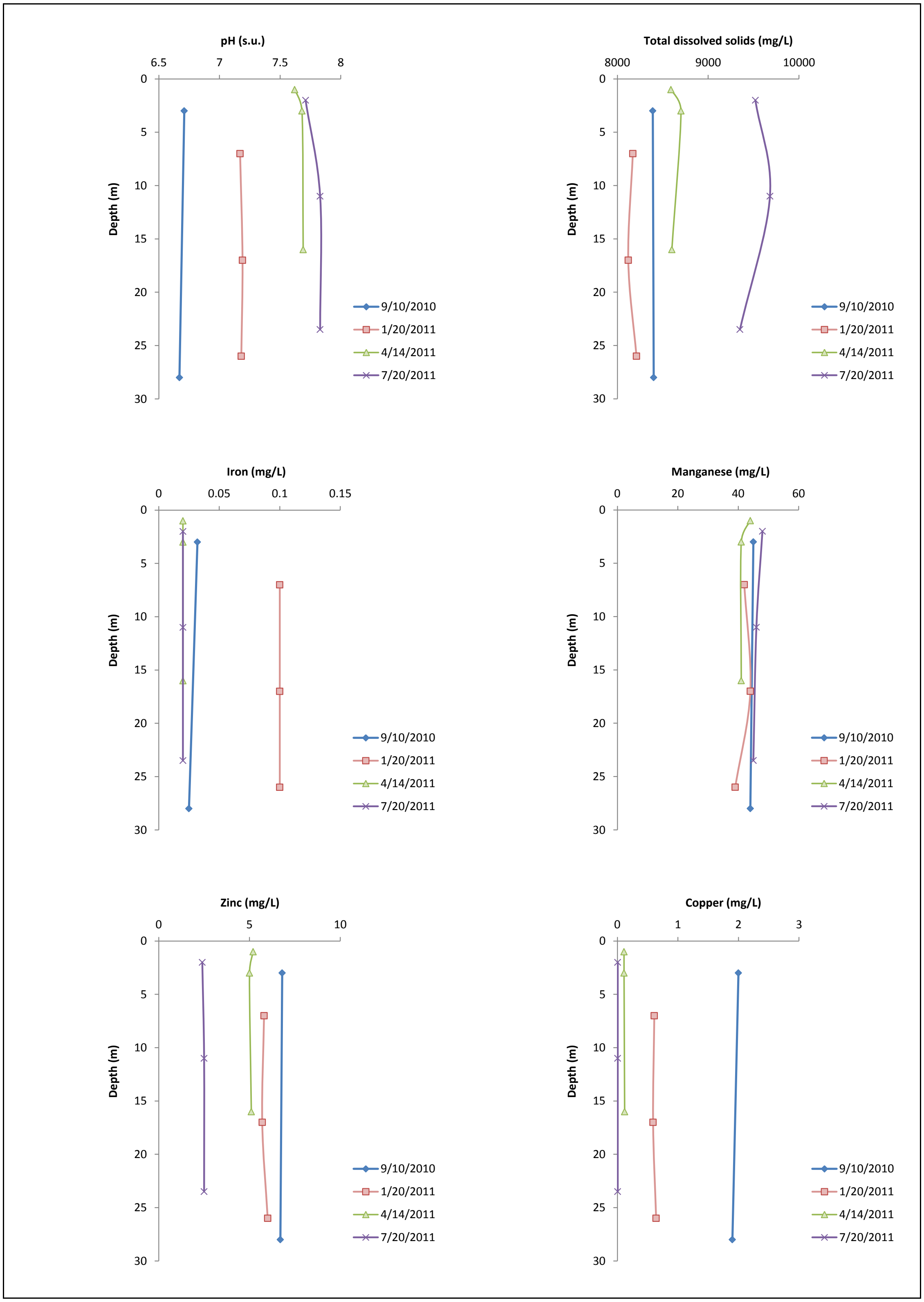


Figure 1-12: Depth Profiles of Key Constituents in Existing Pit Lake

2 Geochemical Characterization Testwork Summary

SRK has conducted a geochemical characterization program for the Copper Flat Project, which has included the testing of 91 waste rock samples, 41 samples representative of low grade ore and 11 samples of tailings material to investigate the potential for ARDML generation. The results of this program are presented in the *Geochemical Characterization Report for the Copper Flat Project, New Mexico* (SRK, 2012) and the main findings are summarized below.

Waste rock and ore sample intervals were selected from both exploration core holes drilled within the proposed pit boundaries in 2009, 2010 and 2011 and from the surface of existing WRSPs and pit walls on site. Samples were selected to represent the range of waste rock and ore material types that will be encountered during future mining. Tailings samples were collected from the metallurgical program and from the existing (historic) TSF on site. The static test methods used for the geochemical characterization program include multi-element analysis using four-acid digest and ICP-MS analysis, modified Sobek Acid Base Accounting (ABA), Net Acid Generation (NAG) test and the ASTM E2242-13 Meteoric Water Mobility Procedure (MWMP; ASTM, 2013). These static tests were selected to address total acid generation or neutralization potential of the samples and concentration of constituents in leachates derived from the material. However, these static tests do not consider the temporal variations that may occur in leachate chemistry as a result of long-term changes in oxidation, dissolution and desorption reaction rates. To address these factors, kinetic testing was also carried out as part of the geochemical characterization program and includes 32 humidity cell tests (HCTs) conducted on samples of waste rock, ore and tailings according to the ASTM D-5744-96 methodology (ASTM, 1996).

The results of the characterization program demonstrate that the acid generating potential of the Copper Flat waste rock is generally low and is largely dependent on the sulfide mineral content, with sulfide concentrations varying from less than analytical detection limits to a maximum of 2.52 wt%. The static testwork results indicate that the transitional waste material (i.e. mixed sulfide/oxide) is likely to be potentially acid forming based on a generally higher sulfide mineral content and the presence of secondary oxide minerals that formed as a result of supergene weathering. In contrast, the diabase, andesite and tailings are likely to be non-acid forming materials. The main material type for the Project consists of sulfide (i.e., non-oxidized) Quartz Monzonite and Breccia, which typically exhibited either non-acid forming characteristics or a low potential for acid generation. This is related to the encapsulation of sulfide minerals in a quartz matrix or occasionally in potassium feldspar. In addition, the sulfide minerals in the Copper Flat deposit are crystalline and often coarse grained and as such have slow weathering reaction kinetics. It is likely that the Copper Flat materials will offer limited silicate buffering (neutralizing) capacity; although this is unlikely to be high magnitude, it may modify/buffer pH in the near neutral range.

The Copper Flat waste rock and ore materials were found to be enriched in copper, sulfur and selenium in whole rock chemistry, which relates to the primary mineralization (predominantly chalcopyrite - $CuFeS_2$). Silver, arsenic, cadmium, molybdenum, lead, thallium, uranium, tungsten, and zinc were also found to be enriched in one or more material types, with the greatest levels of enrichment occurring in the sulfide and transitional ore material types. Many of these elements are typically associated with copper porphyry deposits, which explain their enrichment in the Copper Flat materials (and more specifically in the ore grade samples). The diabase and andesite material types typically showed much lower levels of elemental enrichment, which is likely related to the lack of primary mineralization in these lithological units.

MWMP tests were conducted on a total of 49 waste rock and tailings samples to provide an indication of elemental mobility and metal(loid) release from the Copper Flat materials during meteoric rinsing. Metal mobility and release was also assessed from the results of the HCT program, the results of which are summarized in Appendix B. In general, metal leaching from the Copper Flat materials was found to be low and the majority of leachates generated during the MWMP and HCT test programs could be classed as near-neutral, low-metal waters. However, several of the grab samples of transitional material collected from historic waste rock stockpiles produced acidic leachates and showed the potential for higher metal release than observed for the unoxidized sulfide materials. The higher release of acidity and metals from the transitional material likely represents the flushing of soluble acidic sulfate salts from the material surface that were produced by the prolonged weathering (over geological time) of the material.

3 Pit Lake Modeling

3.1 Summary of Modifications to Pit Lake Models since submittal of SRK (2014a) Preliminary Report

A number of modifications and refinements have been made to the Copper Flat pit lake models since the preliminary Pit Lake Geochemical Modeling Report was submitted in December 2014 (SRK, 2014a). These are detailed in Sections 3.1.1 to 3.1.8 below and are summarized in Table 3-1 at the end of this section.

3.1.1 Incorporation of Current Geologic Block Model

The revised models presented herein use the FS geologic block model to calculate the exposed surface areas of each lithology in the final pit walls. The FS block model represents the most up-to-date geological classification for the Project. Using the FS geologic block model results in minor changes to the relative proportions of each lithology that will be exposed in the final pit walls. In addition, the FS block model groups the biotite breccia and quartz feldspar breccia units together.

3.1.2 Incorporation of Current Pit Design

The revised models presented herein use the current pit design. The current pit design was developed along with the FS block model during the feasibility study and then modified to limit the future pit water body to private property with an expanded bench at the 4900 elevation in the NW corner of the pit (Figure 3-1). The current open pit design is detailed in the 2017 Mine Operation and Reclamation Plan (THEMAC, 2017a).

3.1.3 Refinement of Pit Wall Composition

The revised models include differentiation of the pit walls into mineralized and weakly to non-mineralized material, using a copper grade of 0.164% to differentiate between the two. This differentiation was used in addition to the lithology and oxidation classifications that were used in the original pit lake models (SRK, 2014a). The rationale for this refinement was based on a more in-depth review of the humidity cell chemistry data (see Appendix B), which showed that the release of certain parameters is greater from the mineralized material compared to weakly or non-mineralized material. As such, the source terms for these materials were defined separately. The redefinition and refinement of materials types within the pit walls provides a more representative calibration of existing pit lake conditions as described in Section 4 below.

3.1.4 Refinement of HCT Inputs

The revised models use different HCT inputs for trace elements and major ions to represent the different geochemical processes that control their release. An average of all weeks of humidity cell data were used for major ions (calcium, magnesium, sodium, potassium, aluminum, iron, manganese, chloride, sulfate, fluoride, bicarbonate) and an average of steady-state humidity cell data (i.e. minus the first 20 weeks of testing) were used for trace elements (silver, arsenic, boron, barium, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium, uranium, vanadium and zinc). The main driver for this change in the input of HCT data was based around the improved calibration to existing conditions obtained by using the different sources of data. The results indicate that soluble salts are important in the input of major elements to the existing lake and, as such, all weeks of humidity cell data are needed for a valid prediction. By contrast, the release of trace elements is predominantly associated with longer term weathering processes, possibly sulfide oxidation and as a result the initial HCT flush concentrations were not included in the source term chemistry. Consequently, a closer calibration between predicted and observed chemistry in the existing pit lake is achieved using this ‘mixed’ approach to humidity cell chemistry as described in Section 4.

3.1.5 Refinement of Mineral Equilibrium Phases

Minor modifications have been made to the mineral equilibrium phases specified in the PHREEQC model input file. This refinement was based on mineral phases that were observed to be close to saturation in the preliminary outputs to the refined model.

3.1.6 Refinement of Water Balance

Since submission of the December 2014 preliminary pit lake modeling report, JSAI has refined the pit lake water balance for the future pit lake to reflect an evaporation rate of 50 inches per year, compared to the 64 inch evaporation rate used previously. This refinement was based on the relationship between maximum ET (ET_0), meteorological parameters including temperature, relatively humidity and wind speed, and geographical parameters including altitude, latitude and time of year. Further details are provided in Appendix C.

In addition to the revised evaporation rate, the water balance and geochemical models were revised to reflect post-reclamation conditions for the proposed open pit and surface drainage area as presented in the 2017 MORP (THEMAC, 2017a) and summarized herein. The revised geochemical model includes separate source terms for reclaimed and unreclaimed areas of the pit and receiving watershed. Stormwater sourced from reclaimed pit areas is expected to have a chemistry similar to background surface water quality from SWQ-1.

Further details of how runoff coefficients were defined are provided in Appendix G.

3.1.7 Revisions to Groundwater Chemistry Inputs

JSAI developed a revised groundwater input chemistry from the available historic data. JSAI used the water quality database, well construction data and groundwater flow model results to determine the most representative groundwater flow chemistry to the existing and future open pits. Further details on how the groundwater chemistry inputs were refined are provided in Appendix D.

3.1.8 Incorporation of Pit Reclamation Measures

NMCC has developed a Mine Reclamation Plan for the Copper Flat Project (THEMAC, 2017a, THEMAC, 2017b, Golder, 2017). Pit reclamation aspects included in the MORP are:

- Reclamation of the pit haul road;
- Reclamation of the expanded section of the 4900 catch bench;
- Reclamation of benches at the crest of the pit; and
- Rapid fill of the open pit with fresh water from the production water supply wells after mining to create a pit lake with water surface at the 4987 feet elevation.

These reclamation measures are described in the following sections.

Pit Haul Road and Pit Bottom

The open pit will be mined in benches over a 12 year period to create a terraced pit wall (Figure 3-1). Access into the open pit during mining will be via a 90 foot wide haul road constructed in the pit wall as mining advances. After mining, the haul road from pit crest to pit bottom will be covered with a suitable reclamation material. In addition, several benches at the bottom of the pit will also be covered in a similar manner before pit flooding occurs (Figure 3-2). The section of haul road above the final pit lake water surface will be prepared for revegetation as described in the MORP (JSAI, 2017a).

The reclaimed haul road will be used to convey stormwater to the bottom of the pit in a controlled manner. A system of surface water conveyance channels will be constructed around the pit crest to intercept and direct stormwater to the bottom of the pit through an engineered stormwater channel that is constructed in the alignment of the pit haul road.

Expanded 4900 Catch Bench

The 4900 elevation catch bench will be expanded to approximately 2 acres in size in the northwest corner of the pit (Figure 3-1). The surface of this catch bench will remain above water after rapid-fill is complete and the pit lake is established. The catch bench surface will be ripped and a growth media cover placed. The covered area will be revegetated.

Pit Crest

The upper benches of the pit shell will be laid back at an approximate 2:1 slope angle at the end of the mine operations to accommodate revegetation. The reclaimed benches will be blended into the surrounding reclaimed pit perimeter area described in the MORP. Revegetation will be accomplished by ripping the area and a growth media cover placed and re-contoured to blend with reclamation of the pit perimeter area and revegetated as described in the MORP.

Rapid Fill

After mining, the pit will be filled with fresh water coming from the mine freshwater production wells to rapidly create a pit lake (rapid fill). The rapid fill will begin immediately after mining and will be completed in approximately six months. The rapid fill requires pumping 2,200 acre-feet into the pit and will fill the pit to the 4894 ft elevation (JSAI 2017b).

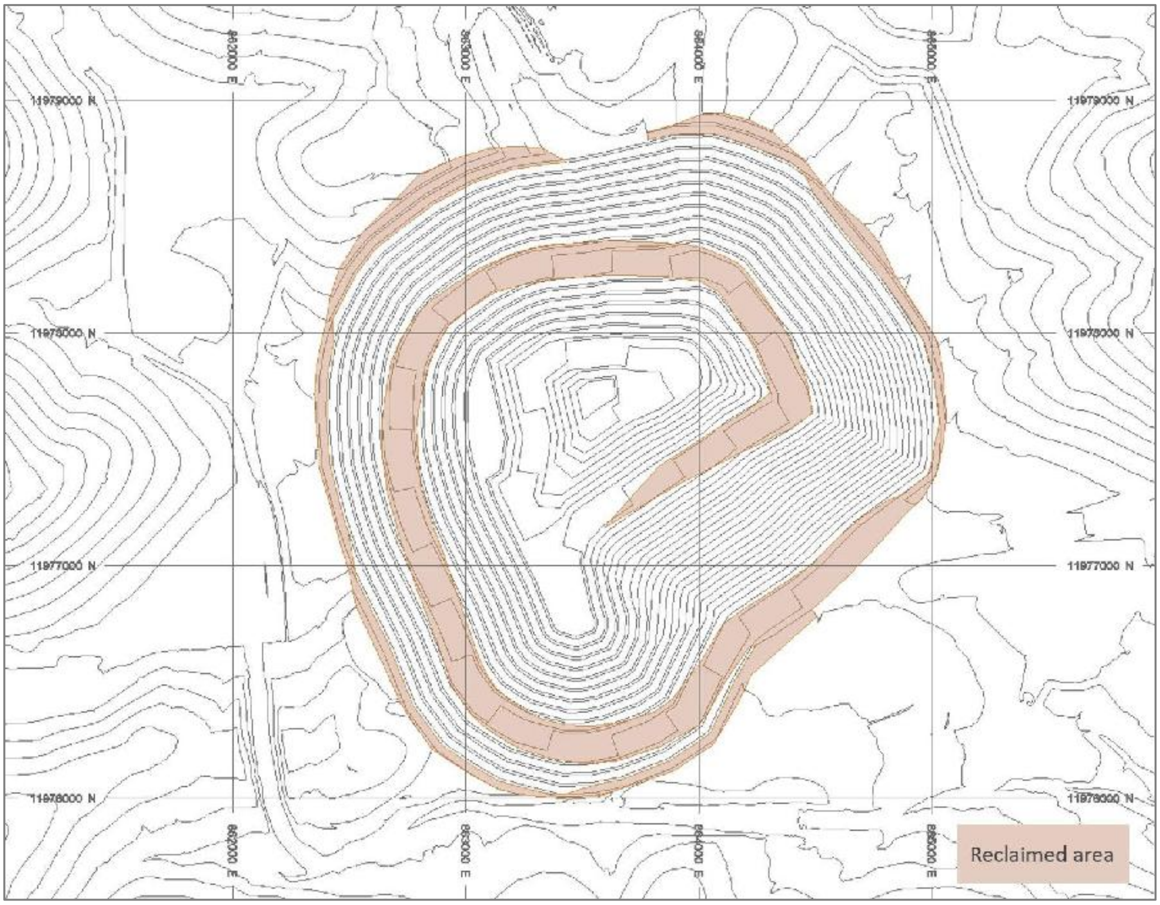


Figure 3-1: 2017 MORP Pit Showing Expanded 4900 Catch Bench and Pit Surfaces Scheduled for Cover

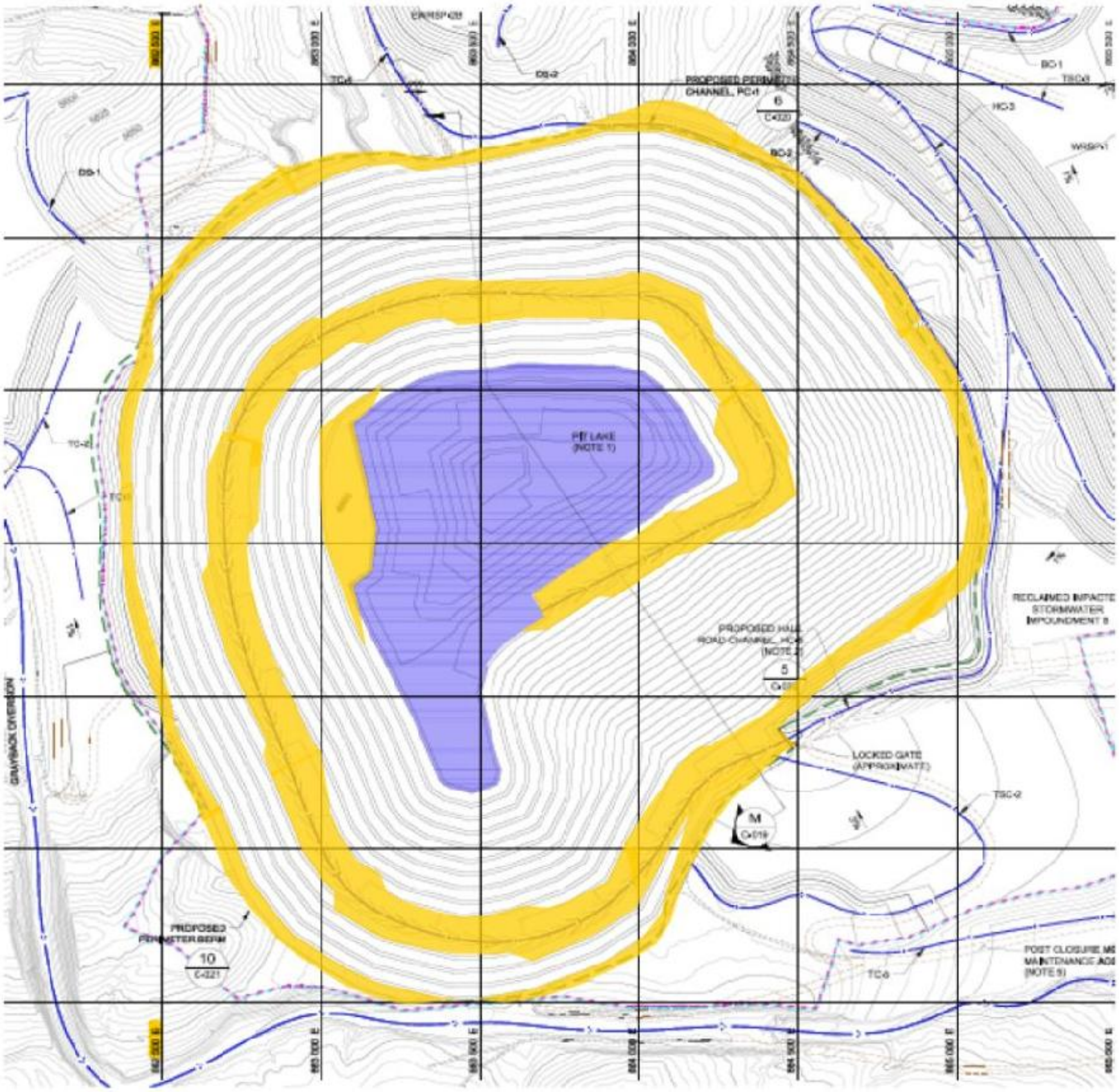


Figure 3-2: 2017 MORP Pit Showing Reclaimed Pit with Pit Lake

Table 3-1: Summary of Modifications to Pit Lake Models since Submittal of Preliminary SRK (2014a) Report

Component	Changed from (SRK, 2014a)	Changed to (current)
Geologic block model	PFS block model	FS block model
Pit shell	PFS pit shell	2017 MORP Pit
Pit wall composition	Delineated based on lithology and oxidation only	Delineated based on lithology, oxidation and mineralized versus weakly/non-mineralized
Source terms/HCT inputs	An average of all weeks of HCT data were used to develop source terms for each material type	Separate source terms were developed for major ions and trace elements. • **Major ions** (Ca, Mg, Na, K, Al, Fe, Mn, Cl, SO_4, F, HCO_3): used an average of all weeks of HCT data • **Trace elements** (Ag, As, B, Ba, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se, U, V, Zn): used steady-state HCT chemistry (i.e., minus the first 20 weeks of testing).
Mineral equilibrium phases	Alunite, Ag_2Se, albite, anhydrite, azurite, barite, boehmite, brochantite, brucite, calcite, chrysotile, Cr_2O_3, diaspore, epsomite, ferrihydrite, fluoride, gypsum, gibbsite, gummite, kaolinite, magnesite, malachite, mirabilite, otavite, pyromorphite, rhodochrosite, rutherfordine, schoepite, sepiolite, SiO_2; tenorite, U_3O_8, UO_3, $UO_2(OH)_2$	Minor modifications were made to the equilibrium phases based on the predicted geochemical conditions. • **Phases added:** $CaMoO_4$, $CaSeO_3{:}2H_2O$, $CdMoO_4$, Cr2O3, $CuMoO_4$, Cu_2Se, $Mg_3(PO_4)_2$, $MnSeO_3$, $NiMoO_4$, $Ni(OH)_2$, $Ni_3(AsO_4)_2{:}8H_2O$, $PbMoO_4$, SbO_2, $ZnMoO_4$. • **Phases removed:** boehmite, diaspore, gibbsite, magnesite, malachite, pyromorphite, rhodochrosite, tenorite.
Water balance	Evaporation rate of 64 inches.	Evaporation rate of 50 inches. Separate water balance terms were also developed for run-off from reclaimed surfaces in the pit and pit catchment.
Groundwater chemistry	Average of data for wells GWQ96-22A, GWQ96-22B, GWQ96-23A, GWQ96-22B, GWQ11-24B and GWQ11-25B.	Average of data for wells GWQ96-22A, GWQ96-22B, GWQ96-23A, GWQ96-22B and GWQ11-24B. Different groundwater inputs were also developed for the current and future pits according to the relative contribution of flow from the Quartz Monzonite and Andesite units.
Pit reclamation	None	Haul road will be reclaimed and revegetated, pit shell crest and expanded 4900 catch bench will be revegetated. Pit void will be rapidly filled with water from water supply wells.

3.2 General Pit Lake Modeling Approach

The results of the geochemical characterization testwork have been coupled with site-specific hydrologic, hydrogeologic and mine plan information to develop geochemical predictions of pit lake water quality for the Copper Flat Project. Geochemical predictions have been developed for three scenarios, including:

(i) Calibration model for the existing pit lake;

(ii) Natural fill model for the future unreclaimed pit; and

(iii) Rapid fill model for the future reclaimed pit.

The conceptual models, inputs and assumptions for each of these model scenarios are presented in Sections 4, 5 and 6. The general approach to the modeling is provided in Sections 3.4 to 3.10 below.

Water chemistry predictions were made using the USGS code PHREEQC (Parkhurst and Appelo, 2010), which has been rigorously tested and is the industry standard for pit lake, waste rock dump and tailings facility geochemical predictions. The approach used herein is consistent with the industry-standard approach for modeling pit lake chemistry. Comparable approaches are reported in Tempel et al. (2000), Eary (1998) and Castendyk and Webster-Brown (2007).

The PHREEQC software uses thermodynamic equilibrium chemistry and solubility calculations to determine the residual concentration of mixing of solutions, allowing for mineral precipitation and attenuation of solutes through sorption reactions with specified mineral surface area. Furthermore, dissolution and oxidation can also be factored into the model to account for reaction with solid mineral phases which can be declared in the model in finite quantities. The resulting model output predicts not only the concentration of modeled elements but also the speciation of the aqueous solutes and the potential saturation indices of minerals of constituent components. This allows a geochemist to interpret trends in water quality data and to predict the resulting chemistry of the mixing reactions. These results are then compared to environmental and ecological risk water quality criteria to determine if a potential impact will result from the mineral-solute reactions. If appropriate, these data can also inform the development of mitigation strategies.

Data used as inputs to the models were derived from the following sources:

- Geological and mine planning information from the Baseline Data Report (INTERA, 2012), Feasibility Study (M3, 2013), the FS geologic block model, and the 2017 MORP (THEMAC, 2017a);
- Hydrologic and hydrogeologic information from the JSAI pit lake water balances developed for the three model scenarios;
- Geochemical data from laboratory humidity cell tests performed on representative mineralized and non-mineralized materials and then scaled to field conditions. These data were utilized to provide source term data for chemical leaching of exposed rock in the pit walls;
- Precipitation chemistry data from long-term monitoring at the Gila Cliff Dwellings National Monument meteorological station, New Mexico (NADP, 2012);
- Groundwater chemistry data from the groundwater monitoring program; and
- Published thermodynamic data provided with USGS PHREEQC and updated with additional sorption data for arsenic and manganese species.

These data were used to develop representative conceptual hydrogeochemical models for the three model scenarios.

3.3 Model Logic and Coding

The conceptual models developed for the Copper Flat pit lake were translated into numerical models using a geochemical thermodynamic equilibrium code and several limiting and simplifying assumptions. The Copper Flat models used a modified version of the minteq.v4 thermodynamic database supplied with the v3.3.12.12704 version of PHREEQC (released May 10th 2017). This database is widely used for geochemical modeling and was selected for this study because it includes the full range of elements for consideration in this water quality prediction as well as key sorption reactions for iron oxyhydroxides. The database was modified to include sorption data for arsenic and manganese species.

The PHREEQC model consists of several components including the input data file, the thermodynamic database, the executable code and the output file. The input file consists of a series of logic statements and commands that define each of the components of the system and explains how these components interact. The input file is read by the executable code and commands are executed in a stepwise manner. Influent component waters were speciated and mixed to generate a series of intermediate waters, solid phases, and adsorbed phases. Selected outputs are specified and parceled out to various output files for analysis of results.

A logic flow diagram for the structure of the input code is provided in Figure 3-3 and discussed below. The PHREEQC input code is provided in Appendix H.

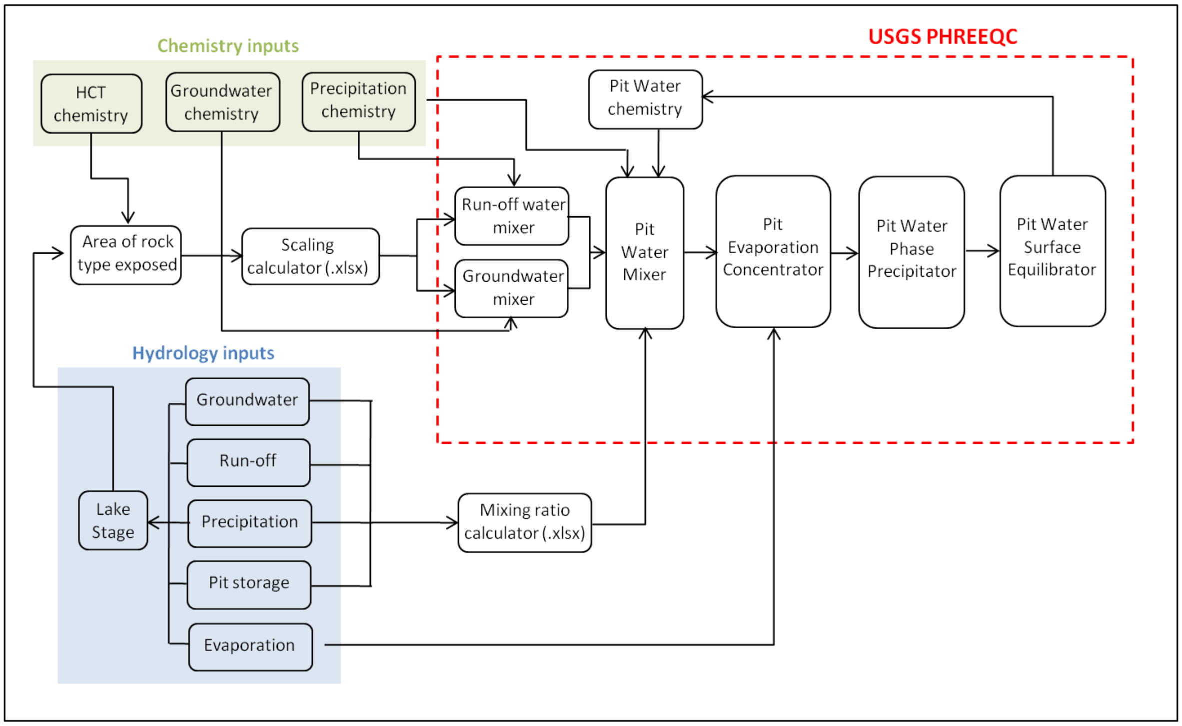


Figure 3-3: Copper Flat Pit Lake Model Execution Mechanics

The steps in the modeling process include the following items:

1. Define run-off water input specific to each exposed rock type. The run-off solution chemistries are comprised of scaled kinetic test cell leachate concentrations for each material type. These leachates are scaled to the water:rock ratio from the cell to the field based on the estimated presence of fractures in the wallrock and the thickness of the reaction rind.
2. Define the run-off solution mixing ratios. Mixing ratios are based on the amount of each material type that is sub-aerially exposed in the pit high wall at each time step.
3. Define the groundwater input. Groundwater chemistry is based on a mass addition function that combines the existing mass found within the groundwater with the mass of solute (per unit surface area and rock mass) released in the kinetic tests for specific material types exposed in the final pit walls. This is scaled to the water:rock ratio from the cell to the field, based on the estimated thickness of the reaction rind within the fractured wallrock.
4. Define groundwater solution mixing ratios based on the exposed surface area for each material type within the pit wall below the pit lake surface (i.e., within the submerged pit wallrock). As with the run-off mixing ratio, this ratio is dependent on the pit lake elevation and changes at each simulated time step.
5. Define precipitation water chemistry based on representative chemical analyses of rainwater.
6. Perform a master mixing calculation where run-off waters, groundwater, atmospheric precipitation and existing pit lake waters are mixed in ratios defined by the site-wide water balance for each time step.
7. Evapoconcentration. The resulting pit water is concentrated by a factor equivalent to the calculated evapoconcentration determined by the site-wide water balance for each determined time step. A fixed percentage of water is removed as a reverse titration of water. At the end of each titration, the volume of water is readjusted to one liter.
8. Equilibrate and precipitate. Once mixed, the model is equilibrated with atmospheric gases and select mineral phases are allowed to precipitate at the calculated pH, with pE fixed at a subatmospheric value equal to 12 minus pH. This represents a transitional equilibrium between mixed pit lake water and the atmosphere and is the most likely scenario based on the conceptual model.
9. Calculate sorption. After mineral precipitation, trace elements were allowed to adsorb onto iron oxyhydroxides (i.e., ferrihydrite). The total mass of ferrihydrite is equivalent to the mass predicted to be generated during the previous reaction step. This assumption is conservative in that it does not account for sorption to other minerals such as aluminum oxide or clay, or to iron oxides present in the pit wallrock.
10. Save chemistry for the next time step. At the end of each time step, the predicted pit water chemistry is exported to a spreadsheet for analysis.
11. The model was terminated after sufficient iterations to simulate water quality over a 100-year filling period.

3.4 Mineral and Gas Phase Equilibration

For the purpose of the Copper Flat geochemical models, it was assumed that any run-off, groundwater and precipitation entering the pit would mix evenly and completely. Under these circumstances the solutes in these waters will react with each other and may form chemical precipitates if the concentrations and geochemical conditions (Eh, pH, pCO_2, pO_2, and ionic strength) allow super saturation to occur. The geochemical models required the specification of a number of equilibrium phases that were allowed to precipitate if they become oversaturated. The suite of minerals chosen was based on the geology and mineralization of the deposit and an understanding of the types of minerals commonly observed in waste rock leachates.

The relative saturation of all minerals was calculated by comparing the calculated concentration of dissolved ionic pairs with their theoretical thermodynamic limit. Where these values were equal, the saturation index was zero and the solution was said to be at equilibrium with that mineral. At equilibrium, any amount of the mineral that dissolves will precipitate to maintain the relative solute: mineral balance. The target saturation index was set to zero and the minerals that were allowed to form in the geochemical model are given in Table 3-2. These precipitates will sink to the bottom of the pit lake and be removed from future chemical interactions as a sediment layer accumulates on the pit bottom. The precipitated mineral phases are unlikely to re-dissolve unless the pH or redox conditions of the pit lake change substantially. As such, the model assumes that precipitated mineral phases are removed from the system and that subsequent re-dissolution of these phases does not occur. Sulfide mineral reactions are already accounted for in the model because HCT data were used as inputs. The HCT test provides an estimate of long-term accelerated rates of elemental release as a result of oxidation reactions, including sulfide mineral oxidation. Kinetic data for sulfide mineral phases are also limited, with data generally being limited to silicate mineral phases. Further, in evaluating long term changes to water chemistry it is reasonable to assume thermodynamic equilibrium will be attained by the system and as such the approach taken in this study is valid.

Table 3-2: Equilibrium Phases Included in the Pit Lake Geochemical Model

Equilibrium phase*	Ideal formula	Rationale for inclusion in PHREEQC model
Alunite	$KAl_3(SO_4)_2(OH)_6$	Mineral observed at Copper Flat (SRK, 1996; 1997)
Barite	$BaSO_4$	Primary control on barium at neutral to alkaline pH (Eary, 1999). Mineral observed in Copper Flat mineralogical study (SRK, 2014b)
Brochantite	$Cu_4^{2+}(SO_4)(OH)_6$	Primary control on copper at neutral to alkaline pH (Eary, 1999). Mineral observed at Copper Flat (SRK, 1996; 1997).
Calcite	$CaCO_3$	Primary control on alkalinity at neutral to alkaline pH (Eary, 1999). Mineral observed at Copper Flat (SRK, 1996; 1997)
Ferrihydrite	$5Fe_2O_3.9H_2O$	Major control on iron chemistry and on the sorption of trace elements within pit lakes. Thermodynamic properties well defined (Dzombak and Morel, 1990).
Fluorite	CaF_2	Primary control on fluoride (Eary, 1999). Mineral observed in Copper Flat mineralogical study (SRK, 2014b)
Gypsum	$CaSO_4.2H_2O$	Primary control on sulfate (Eary, 1999). Observed in significant quantities around existing pit lake (SRK, 1996; 1997; 2014b).
Mirabilite	$NaSO_4.10H_2O$	Mineral observed at Copper Flat (SRK, 1996; 1997)

3.5 Adsorption

In solution, trace element concentrations are mostly controlled by adsorption onto common mineral phases or are removed from solution through a process of co-precipitation. The Copper Flat pit lake models assumed that trace metals may be removed from solution via sorption onto freshly generated mineral precipitates such as iron oxides. Sorption is likely to represent an important metal removal mechanism at circum-neutral to moderately alkaline pH, with many metal ions sorbing more effectively under these pH conditions. Ferrihydrite ($5Fe_2O_3.9H_2O$) was selected as a sorption surface because it is a common sorption substrate in oxygenated natural waters and because the trace element sorption thermodynamic properties of these reactions are well defined by numerous empirical studies. Adsorption of soluble phases to hydrous ferric oxides (HFO) is highly pH dependent as is the solubility of HFO itself. Below a pH of around 4.5, only minimal sorption of most dissolved metal species is observed (Stumm and Morgan, 1996). The mass of ferrihydrite used in the models was assumed to be identical to the mass of the mineral phase ferrihydrite precipitated in the previous model reaction step and is controlled by the chemistry of the system. The model assumes that the ferrihydrite is characterized by both strong (HFO_s) and weak (HFO_w) surface adsorption sites. In order to be consistent with the properties of ferrihydrite published by Dzombak and Morel (1990) the geochemical models assumed a surface site density of 0.2 moles of weak sites and 0.005 moles of strong sites per mole of ferrihydrite. Because the future pit lake predictions start from time zero (i.e., cessation of mining), there will be no prior pit lake in the void at that point. Any HFO/ferrihydrite will therefore originate from the precipitation of oversaturated mineral phases that develop upon solution mixing.

As with mineral phase precipitation, the adsorbed mass of trace elements removed through this mechanism is assumed in the conceptual model to be permanently removed from the system following incorporation and co-precipitation with the HFO phase. In the case of a major shift in pH or redox conditions, it is possible that material adsorbed to the HFO surface may be released. However, based on the HCT results available to date, a major shift in pH conditions is not likely.

3.6 Evapoconcentration

The Copper Flat pit lake is an evaporative sink, both in its current state and under future post-operational conditions (JSAI, 2017b). There will be no outflow to groundwater and the only mechanism of water loss will be through direct evaporation from the pit lake surface. As such, solutes within the pit lake will evapoconcentrate and the only mechanism for removing solutes is the formation and settling of chemical precipitates and the adsorption of trace elements onto these particulates.

3.7 Treatment of Analytical Reporting Limits

The Copper Flat pit lake models incorporate groundwater and humidity cell data that have been collected over extended periods of time, including both detectable elemental concentrations and constituent concentrations that may be below analytical reporting limits (ARL). The treatment of analytical reporting limits within the geochemical model has important implications for the model results, particularly where the data are scaled to address the difference in solid:liquid ratio between the laboratory-scale test and field conditions.

When analysis of the humidity cell leachates identified certain elements to be below the ARL, the reporting limit was adjusted to 10% of the reported limit for the purpose of calculating the average release rate for the model input. Where a constituent was consistently below the ARL throughout the course of the humidity cell testwork, the constituent was excluded from the model input for that material type to limit overstating constituent concentrations that may arise as an artifact of the modeling exercise from the scaling of humidity cell data to field conditions or from equilibration of groundwater source data that are below ARLs.

Nitrate was excluded from the geochemical predictions due to the lack of mineralogical controls in PHREEQC code. The exemption of nitrate is supported by the data as this parameter is consistently below the ARL in both the humidity cell effluent leachates and the groundwater surrounding the pit. Nitrate is also below the ARL in the existing pit lake, supporting the assumption that this parameter is unlikely to be a problem during future operations.

3.8 Model Assumptions and Limitations

The pit water quality predictions presented herein are considered the best representation of likely future water quality associated with the Copper Flat pit lake. However, it is recognized that there are a number of assumptions and limitations associated with the predictive calculations including:

- The models have been developed using site-specific geochemical, hydrochemical, geological, hydrogeological and mine plan information. Therefore, changes in operational decisions may result in a change in the future pit lake water quality at Copper Flat.
- The models assume that groundwater and surface water input chemistry can be simulated using laboratory kinetic (humidity cell) leachate chemistries, which are appropriately scaled to field conditions. The reactive surface area, ratio of water-to-rock and flushing rates in laboratory tests are different from actual field conditions. Grain size is smaller in the kinetic and static test cells and the resulting surface area for reactivity is greater that field conditions. The laboratory test cells are operated at a higher water-to-rock ratio than would be expected in the field and are flushed more frequently, so that mineral-water reaction rates are enhanced. Because the future Copper Flat pit does not yet exist, field scale parameters cannot be measured, so scaling relies on published estimates of future groundwater flux and fracture density. These estimates and assumptions are supported by the geochemical model for the existing pit (Section 4), which shows good calibration to current conditions.
- Modeling was limited to predicting water quality within the pit lake for a 100-year time period. This length of time is not intended to imply that the pit lake geochemistry or hydrogeology for the natural fill scenario will achieve steady-state, hydrogeochemical equilibrium at 100-years.
- The models rely on an external database of thermodynamic constants for mineral phase precipitates and sorbed surface complexes. These thermodynamic constants are valid at 25ºC and 1 atmosphere of pressure. The models do not consider the effects associated with the formation and precipitation of mineral species other than those specified. Due to kinetic constraints, a portion of the potentially oversaturated mineral phases will not actually precipitate. A select suite of minerals is therefore specified that are allowed to precipitate, based on relevance for the environment in question, site-specific knowledge, experience in evaluating kinetic constraints and relevance of key phases for given styles of mineralization, and literature

review (Eary, 1999). The nature of the thermodynamic databases means that the constants for all major elements and a large number of trace elements are well understood and have been rigorously tested and verified. However, constants for certain parameters (for example vanadium, boron and nitrate) are not as well understood. As such, the mineralogical controls on these elements in PHREEQC are poorly defined, which may affect their precipitation (i.e., removal) from solution in the predictive calculations.

- The models assume atmospheric equilibrium with oxygen and carbon dioxide gas, with pH + pE equal to 12 (based on calculations by Baas-Becking et al., 1960 to define stability limits of natural waters).
- The models are limited to thermodynamic equilibrium reactions and do not simulate the effects of reaction kinetics and rates.
- The models are limited to inorganic reactions and do not take into account the complexities associated with biologically mediated reactions.

None of these limitations affect the ability to use model as intended, which is to assess potential future pit lake chemistry and evaluate the future environmental impacts of the Project.

3.9 Analysis of Model Input Variability

The various parameters that have been used as data inputs for the pit lake geochemical model have been assessed to determine their relative significance in influencing the model results. For the purpose of this exercise, each parameter has been assigned a qualitative value based on the degree to which it influences the final predicted solution chemistry:

- “Minor” represents less than 1% control on the final model output;
- “Moderate” represents between 1% and 10% control on the final model output; and
- “Significant” represents between 10% and 50% control on the final model output.

The results of this exercise are displayed in Table 3-3.

Table 3-3: Analysis of Pit Lake Model Input Variability

Category	Parameter	Assumptions / data used in model	Source	Control on final model results*
Hydrogeologic information	Pit lake water balances	Water balances provided by JSAI for the three model scenarios, including water elevation and surface area, groundwater inflows, direct precipitation, run-off and evaporation data.	JSAI, 2017	Significant. The water balances define the mixing ratios for the PHREEQC input solutions.
Chemical inputs	Groundwater chemistry	Baseline groundwater chemistry data from the ongoing monitoring program: average of data for wells GWQ96-22A, GWQ96-22B, GWQ96-23A, GWQ96-22B and GWQ11-24B.	INTERA, 2012; JSAI, 2017a	Significant during the early years post-closure when groundwater is likely to represent the dominant solution input to the pit lake.
	Precipitation chemistry	Averaged precipitation chemistry from Gila Cliff Dwelling National Monument Meteorological Station (1985-2011)	NADP, 2012	Minor. The precipitation chemistry represents a near-pure solution chemistry. In the absence of site-specific data, published precipitation chemistry from this meteorological station in New Mexico is the best representation of precipitation chemistry in the area.
	HCT chemistry	Averaged HCT chemistry from the HCT programs.	SRK 2012; 2014b	Significant. The solutions generated by the HCT programs represent the main chemical inputs for the pit wall source terms.
	Water Supply well chemistry (rapid fill model only)	Groundwater quality data from water supply wells PW-1 and PW-3	JSAI, 2017c	Significant. The water supply well chemistry represents the largest solution contributor to the pit lake during the first six months of filling.
Geological information	Pit wall surface area and lithologic composition	Pit wall surface areas were calculated for each simulated time step using the geologic block model and 2017 MORP pit	SRK/ NMCC	Significant. The lithological composition of the pit wall defines the mixing ratios for the PHREEQC input solutions.
Geochemical model assumptions	Mass of pit wall rock available for reaction	Mass of future pit wall available for reaction was calculated assuming an oxidized rind of 0.04 feet thickness and a fractured zone of 1 feet thickness (with 10% fractures).	SRK/ NMCC	Moderate. The values were assigned based on communication with NMCC regarding future blasting practices for the Project and are considered a conservative estimate and are consistent with industry practice.
	Equilibrium/mineral phases	The equilibrium/mineral phases listed in Table 3-2 were used as input to the models	SRK	Moderate. Mineral precipitation will influence final solution chemistry. Equilibrium phases were selected based on knowledge of site-specific geologic and mineralogic conditions and were then verified and refined by calibrating with the existing pit lake chemistry.

* Minor: <1%
Moderate: 1 - 10%
Significant: 10 - 50%

3.10 Comparative Guidelines

The standards that apply to the post-mining Copper Flat pit water body are contained in the regulations MMD administers under the Mining Act; specifically “Performance and Reclamation Standards for New Mining Operations” at 19.10.6.603 NMAC. These MMD standards require that the pit water body comply to the following performance standard:

- Operations must be planned and conducted to minimize change in the hydrologic balance in both the permit and potentially affected areas; and
- Reclamation must result in a hydrologic balance similar to pre-mining conditions.

MMD must determine that the NMCC mine operating and reclamation plan complies with these standards before a mining permit can be issued. The mine plan must take into account the site-specific characteristics of the mining operation and the site in meeting the standards and requirements. The MMD regulations require that the permit area be reclaimed to a self-sustaining ecosystem appropriate for the life zone of the surrounding area following closure unless conflicting with the approved post-mining land use. Specifically, NMAC 19.10.6.603.C.(4), Hydrologic Balance states that the performance and reclamation standards identified in this subsection require that, if not in conflict with the approved post-mining land use, reclamation must result in a hydrologic balance similar to pre-mining conditions.

Section 19.10.6.602.D.(13)(g)(v) of the regulations identifies the environmental baseline information required to establish pre-mining conditions and outlines the hydrologic and water quality data requirements for baseline data.

There are several site-specific factors to consider regarding the Copper Flat Project in determining what standards apply. First, the existing pit water body is and the future pit water body will be fully confined to private land. The two-acre catch bench at the 4900 ft amsl elevation of the pit ensures that the future pit lake remains on private property. The pit is and will be a hydraulic evaporative sink in the future, and, as such, is not a flow-through system (INTERA, 2012; JSAI, 2017b). As a result of being confined to private land and remaining a hydrologic sink, the current and future pit water body will not be a water of the state and the surface water standards the NMED Surface Water Quality Bureau (SWQB) administers will not apply to the pit water. Because the pit is and will be a hydraulic evaporative sink in the future, NMED Groundwater Quality Bureau (GWQB) standards are also not applicable to the future pit water body.

Therefore, the applicable standard for the future pit water body as provided by the MMD regulations will be “similarity”, NMCC must demonstrate that post-mining hydrologic conditions, i.e., the post-mining hydrologic balance is similar to the pre-mining hydrologic conditions. The MMD regulations do not contain a definition of “hydrologic balance”. Nonetheless, Section 19.10.6.602.D.(13)(g)(v) requires that a determination be made of the probable hydrologic consequences of the operation and reclamation, including water quality. These two regulatory requirements are interpreted to require the NMCC demonstrate that that the water quality of the future pit lake be similar to that of the pre-mining pit water quality and, thus, allow NMCC to demonstrate that the water quality hydrologic consequence is nil.

This report provides the required demonstration as to the similarity of the future pit lake water quality to present pit lake water quality. In this report, the pit lake predictive model results are compared to existing pit lake water quality to demonstrate that the anticipated post-mining water quality of the future pit is similar to pre-mining pit water body quality present at Copper Flat today.

In addition, the existing pit water body has been previously studied by Aquatic Consultants, Inc. (Aquatic Consultants, 2014) and it has been determined that the environment within the existing water body does not reflect a natural lake environment. There are no fish in the existing pit water body and water quality reflects the mineralized nature of the surrounding pit walls. When mining is complete, the pit water body will re-form; the NMCC reclamation and closure plan is designed to leave the future pit water body in a condition similar to its current condition.

4 Existing Pit Calibration Model

Numerical predictions have been undertaken to model the current (i.e., existing) pit lake chemistry in order to calibrate and verify the future pit lake geochemical predictions. A water balance for the existing pit was provided to SRK by JSAI and this was coupled with the results of the HCT testwork and data relating to the existing pit wall geology to carry out numerical simulations of water quality in the existing pit lake.

4.1 Conceptual Model

A conceptual model for the existing pit lake at Copper Flat is provided in Figure 4-1. The inputs to the model are discussed in Sections 4.2 to 4.5 below.

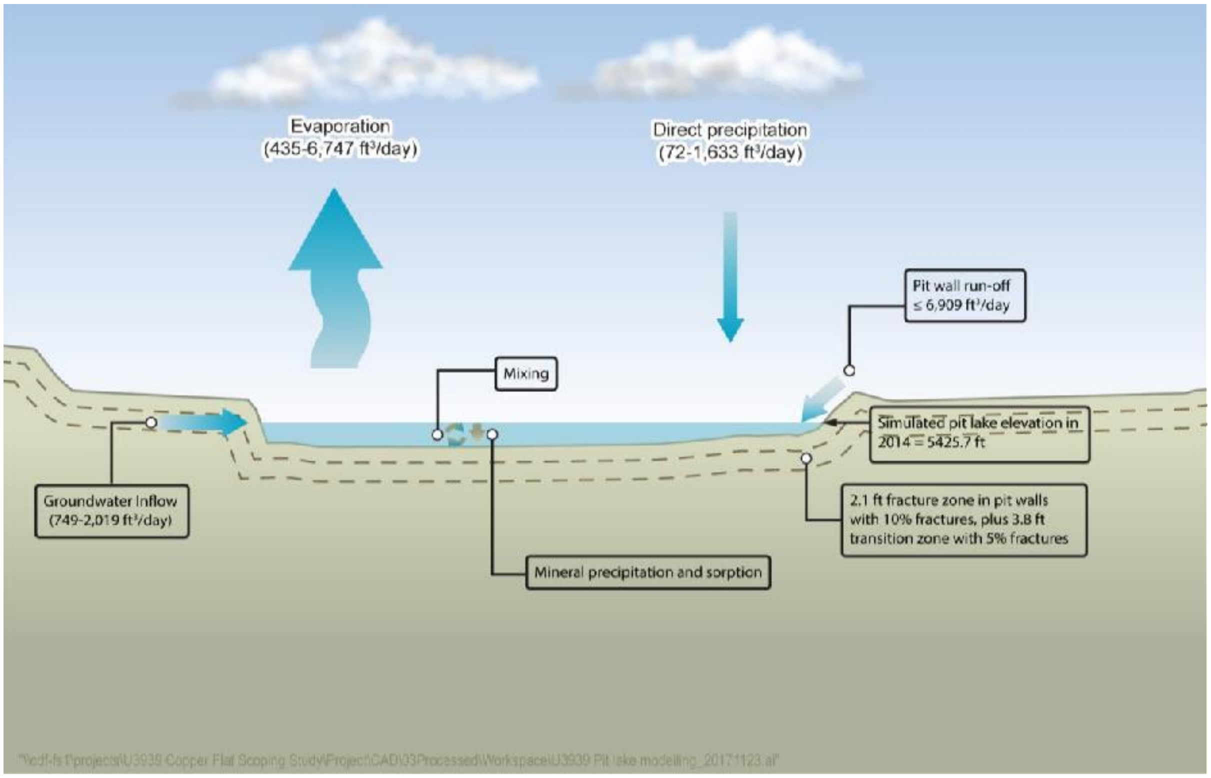


Figure 4-1: Existing Pit Conceptual Model

4.2 Pit Wall Surface Areas

The proportional surface areas of the main material types that are exposed in the existing pit walls have been calculated from the FS geologic block model. Material types have been delineated based on primary lithology, oxidation (redox) and mineralization (i.e., mineralized versus weakly/non-mineralized).

The three-dimensional surface areas used as input to the existing pit model are provided in Table 4-1 and are illustrated in Figure 4-2. This demonstrates that mineralized, oxidized quartz monzonite represents the dominant material type exposed in the existing pit walls.

Table 4-1: Pit Wall Surface Areas used in Existing Pit (Calibration) Model

Mineralization	Rock Type	Redox	Three-dimensional surface area	
			Square feet	%
Weakly/non-mineralized	Biotite Breccia	Oxide	88,213	8.5
		Sulfide (non-ox.)	5,073	0.5
	Quartz Monzonite	Oxide	171,155	16.5
		Sulfide (non-ox.)	27,011	2.6
Mineralized	Biotite Breccia	Oxide	118,474	11.4
		Sulfide (non-ox.)	153,348	14.8
	Quartz Monzonite	Oxide	291,547	28.1
		Sulfide (non-ox.)	184,085	17.1
		Total	**1,038,906**	**100%**

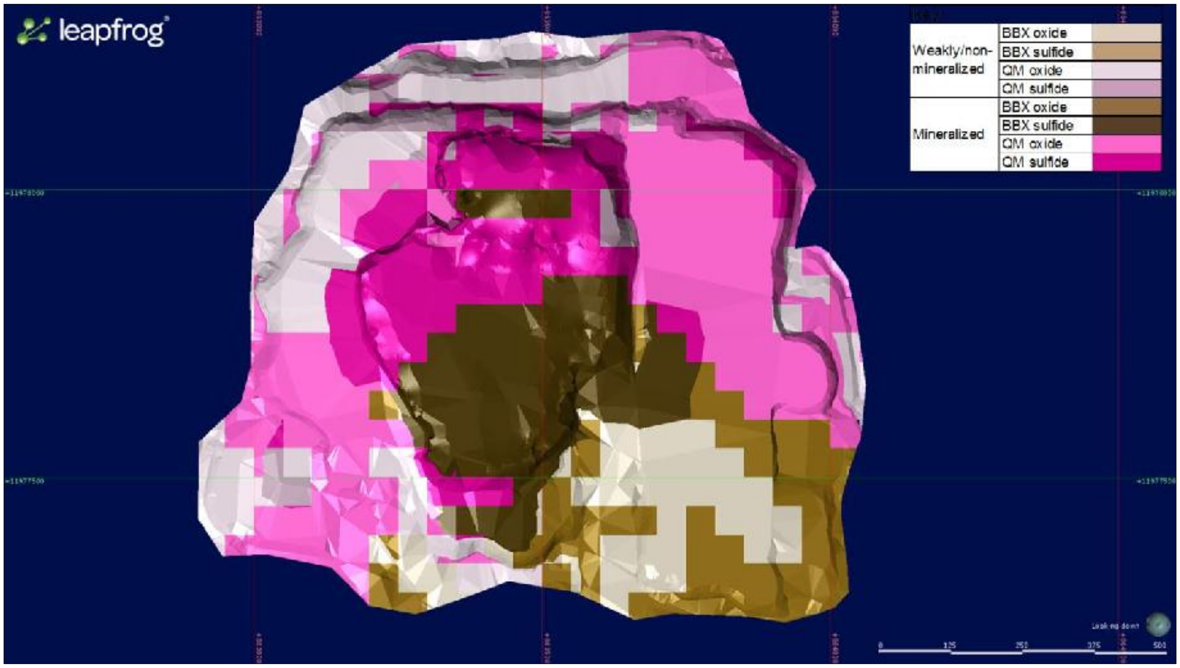


Figure 4-2: Material Types Exposed in Existing Pit (Calibration) Model

4.3 Calculation of Pit Wall Rock Available for Leaching

During Quintana's operations, the existing pit at Copper Flat did not reach its final configuration and the pit walls were not prepared using pre-split drilling and smooth wall blasting. Therefore, the existing pit wall has significantly deeper fracturing than predicted for the future final pit wall from the proposed operation. The literature demonstrates that open pit wall blast damage for granite, granodiorite and quartz monzonite rocks extends 2 to 4 ft in depth when assessing effects from production type blasting (e.g., Carroll and Scott, 1966; Siskind and Fumanti, 1974; Kelsall et al., 1984) (Appendix F).

For the existing pit lake scenario, an estimate of the reactive rind thickness is provided by results from a U.S. Bureau of Mines experimental study on fracturing produced in the vicinity of large-diameter blast holes in Lithonia granite (Siskind and Fumanti, 1974). From this study, a fractured zone ('fracture zone') was identified that extends approximately 2 feet into the pit wall and a second zone ('transition zone') characterized by a lesser degree of fracturing extends from approximately 2 to 4 feet (Figure 4-3). Oxygen infiltration extends no further than the predicted depth of fracturing of 2 feet, and that the percent of the rim rock mass fractured during mining will range from 10% within the fracture zone to 5% within the transition zone. This estimate of fracturing is supported by Atchison (1968). An oxidized rind of 0.04 feet thickness has also been assumed in the pit walls. This scenario is considered a conservative input of pit wall fracturing based on the information provided in Appendix F.

Using these assumptions for the fracture zone, transition zone and oxidized rind, the reactive mass (R_m) of each material type in the pit wall was calculated as:

$$R_m = (S \times F_{FZ} \times L_{FZ} \times D) + (S \times F_{TZ} \times L_{TZ} \times D) + (S \times L_{OR} \times D)$$

Where:

S is the three-dimensional pit wall surface area of the given material type in square meters (defined by the geological block model; see Table 4-1);

F_{FZ} is the fracture density in the fracture zone (10%);

L_{FZ} is the thickness of the fracture zone in meters (0.64m);

F_{TZ} is the fracture density in the transition zone (5%);

L_{TZ} is the thickness of the transition zone in meters (1.16m);

L_{OR} is the thickness of the oxidized rind in meters (0.012m);

D is the rock density in kg/m^3 (2700 kg/m^3, Young and Olhoeft, 1976).

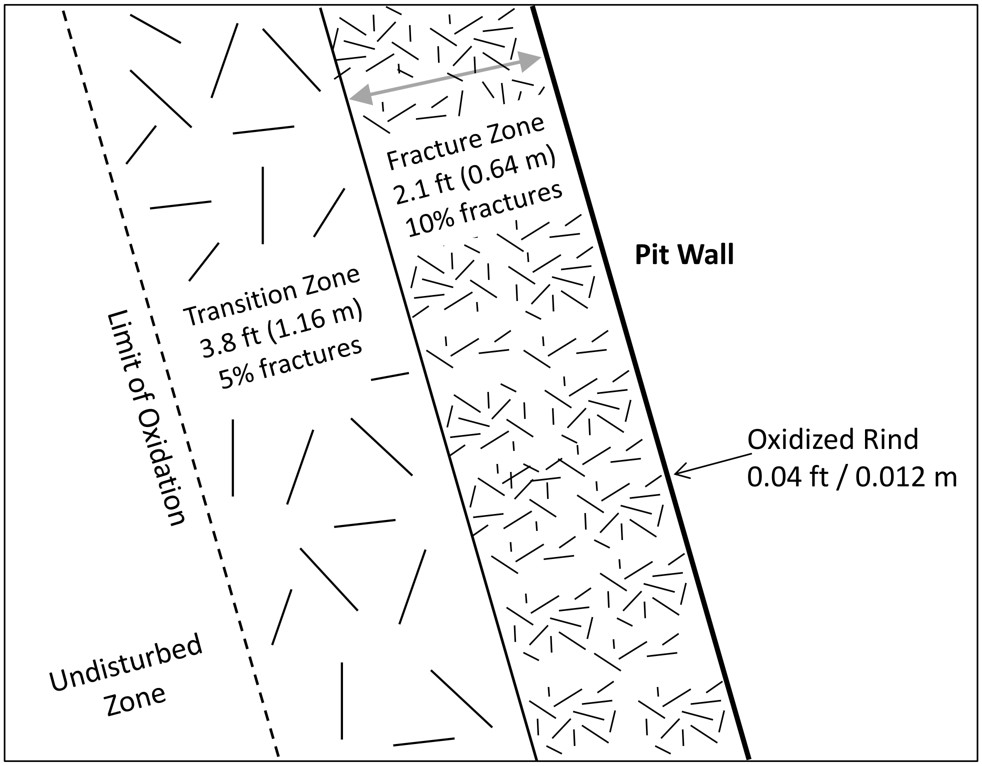


Figure 4-3: Existing Pit Wall Conceptual Model

4.4 Water Balance

A pit lake water balance for the existing pit lake was provided to SRK by JSAI. The water balance data used in the existing pit lake predictions are summarized in Figure 4-4 and Figure 4-5 below.

Figure 4-4 shows the simulated pit lake elevation with time and Figure 4-5 shows the simulated inflows and outflows to the existing pit.

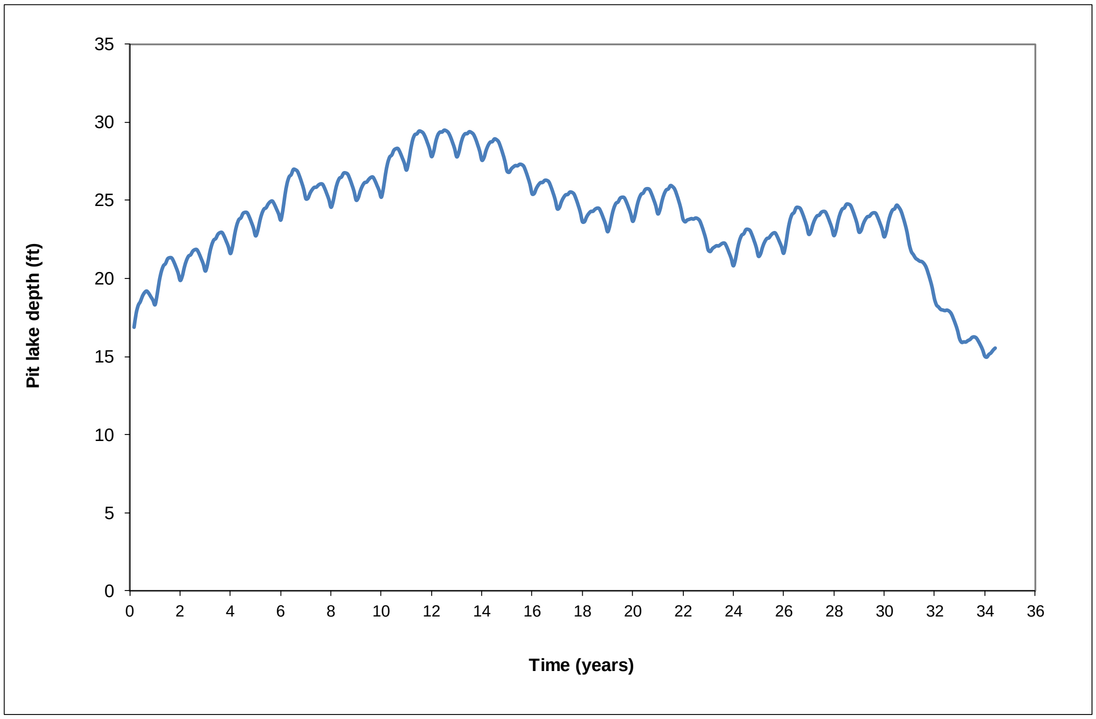


Figure 4-4: Simulated Water Level for the Existing Pit Lake

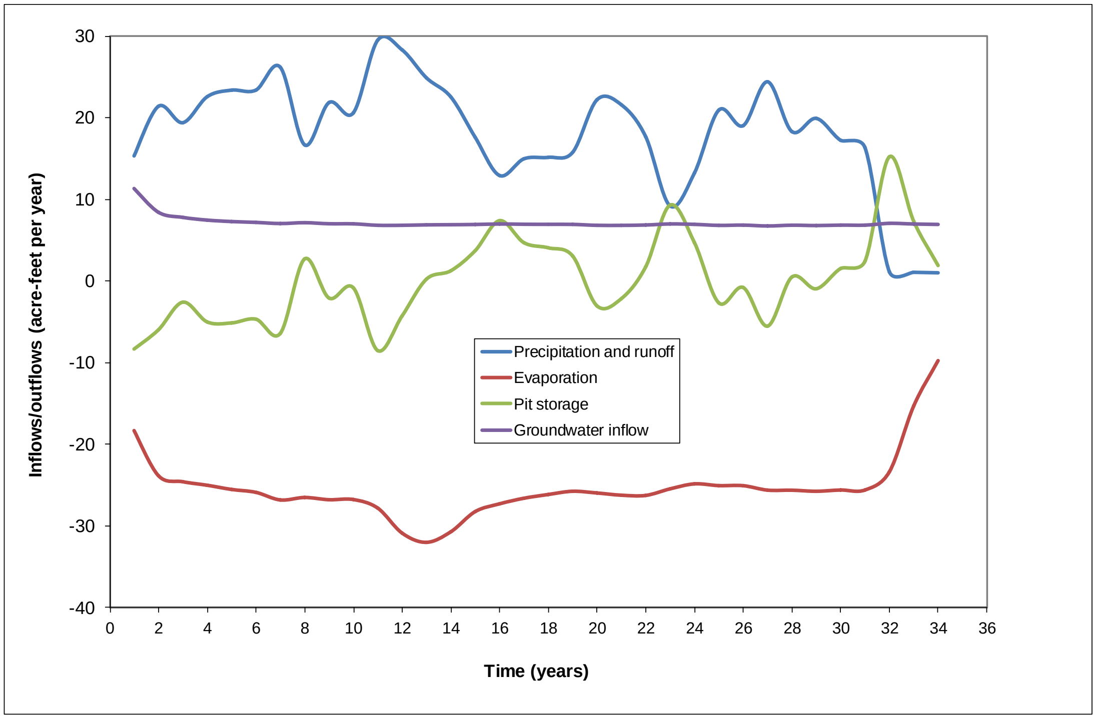
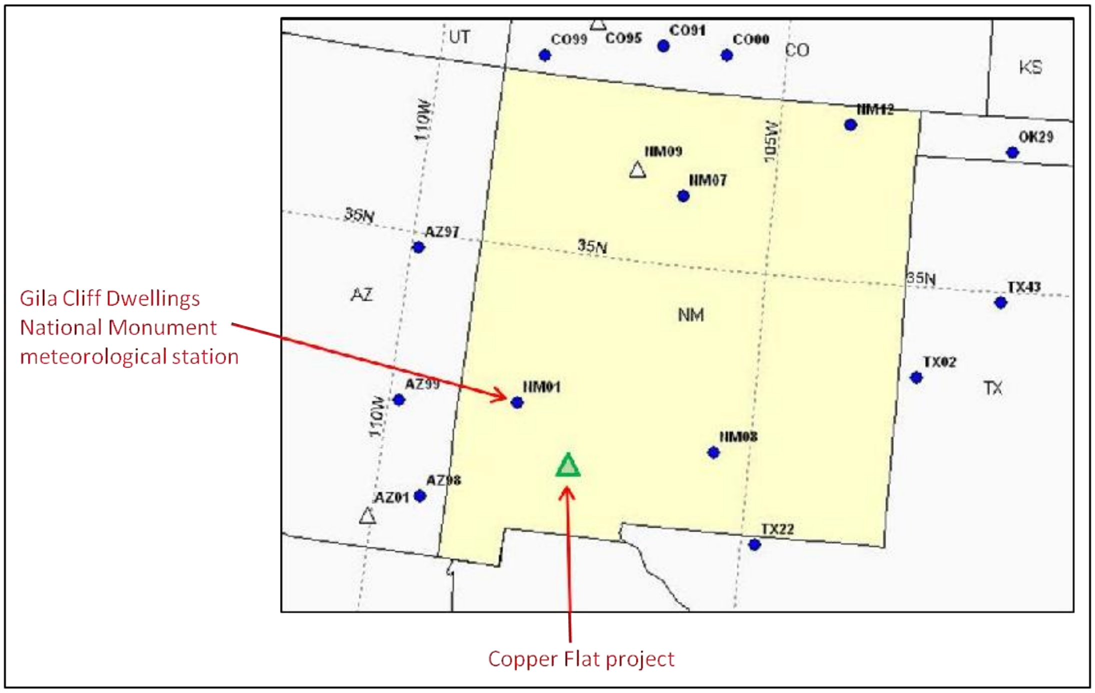


Figure 4-5: Existing Pit Lake Inflows/Outflows

4.5 Solution Inputs

4.5.1 Precipitation Chemistry

The primary wall rock lixiviant for the pit high walls in both the existing pit and the future pit is assumed to be rainwater (i.e. meteoric precipitation). Representative precipitation chemistry data were obtained from monthly monitoring carried out between 1985 and 2011 at the Gila Cliff Dwellings National Monument meteorological station, Catron County, New Mexico (NADP, 2012) (Figure 4-6). In the absence of any site-specific precipitation chemistry, this is considered the most representative precipitation chemistry available for use in both the existing and future pit lake models.



Gila Cliff Dwellings National Monument meteorological station

Copper Flat project

Figure 4-6: Location of Gila Cliff Dwellings National Monument Meteorological Station

4.5.2 Groundwater Chemistry

Representative groundwater chemistry data for the existing pit lake model were obtained from the historical data compiled by JSAI and NMCC. There are four sets of piezometers surrounding the existing pit that have been sampled, with two piezometer sets representing groundwater in the andesite (GWQ96-22[A,B] and GWQ96-23[A,B]), and two in the quartz monzonite (GWQ11-24[A,B] and GWQ11-25[A,B]). GWQ96-23(A,B) is located at the transition between andesite and quartz monzonite; however the water quality is similar to GWQ96-22(A,B) and indicative of andesite.

The results from wells GWQ96-22(A,B), GWQ96-23(A,B), GWQ11-24(B) and GWQ11-25(B) were averaged and used as input to the existing pit lake geochemical model (Table 4-2). Wells GWQ11-24A and GWQ11-25A were not used in the model input as they may have been affected by oxidation of sulfides in fractures during well development and may not be representative of groundwater reporting to the open pit. Furthermore, GWQ11-25A represents a localized and isolated fracture system recharged by oxygenated meteoric water that is not connected to the open pit (JSAI, 2017a). For these reasons, data from GWQ11-24(A) and GWQ11-25(A) were not considered as part of the groundwater inflow to the existing pit.

Further information on how the groundwater chemistry data were derived is provided in the JSAI technical memorandum in Appendix D.

4.5.3 Wall Rock Chemistry

Source term solutions for material types exposed in the existing pit walls at Copper Flat were developed from the results of site-specific HCT testing conducted as part of the SRK (2012) geochemical characterization program that were scaled to field conditions. The application of a scaling factor is necessary because laboratory tests are operated at a higher water-to-rock ratio than would be expected in the field, meaning that mineral-water reaction rates are enhanced in the laboratory. The scaling factor is based on site-specific information relating to the pit water balance, geological model, pit wall fracturing and wall rock density.

The reactive mass (R_m) of pit wall rock available for chemical weathering reactions in both the unsaturated high wall and the submerged pit wall was calculated using the methodology outlined in Section 4.3. The reactive mass for each material type was coupled with the pit water balance to determine the changes in run-off and groundwater chemistry as any water that interacts with the pit walls migrates through the reactive fracture zones. This is demonstrated by the equation below:

$$C_i = \frac{r_i . R_m}{Q}$$

Where:

C_i represents the predicted concentration (in mg/L) of element i;

r_i represents the average release rate of element i in mg/kg/week in the humidity cell tests;

R_m indicates the pit wall reactive mass in kg; and

Q represents either the rate of groundwater inflow into the pit or the rate of pit wall run-off in L/week.

The modified chemistry of the precipitation from these pit rim reactions was then used as the source term contribution to the pit. Separate source terms were developed for each of the material types exposed in the current pit walls (see Table 4-1).

Different HCT inputs were used for trace elements and major ions to represent the different geochemical processes that control their release. Soluble salts are important in the input of major elements to the existing lake and, as such, all weeks of humidity cell data are needed for a valid prediction. By contrast, the release of trace elements is predominantly associated with longer term weathering processes, possibly sulfide oxidation and as a result the initial HCT flush information does not contribute sufficiently. As such, an average of all weeks of humidity cell data were used for major ions (calcium, magnesium, sodium, potassium, aluminum, iron, manganese, chloride, sulfate, fluoride, bicarbonate) and an average of steady-state humidity cell data (i.e., minus the first 20 weeks of testing) were used for trace elements (silver, arsenic, boron, barium, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium, uranium, vanadium and zinc).

The solutions used as inputs to the geochemical model are provided in Table 4-2.

Table 4-2: Groundwater, Wall Rock and Precipitation Chemistry used as Input to the Existing Pit Model

Parameter		Units	Precipitation chemistry	Groundwater chemistry	Wall rock chemistry							
					Mineralized				Weakly/non-mineralized			
					Biotite breccia oxide	Biotite breccia sulfide	Quartz Monzonite oxide	Quartz Monzonite sulfide	Biotite breccia oxide	Biotite breccia sulfide	Quartz Monzonite oxide	Quartz Monzonite sulfide
			Gila Cliff Dwellings National Monument meteorological station	*Average of wells GWQ96-22(A,B), GWQ96-23(A,B), GWQ11-24(B) and GWQ11-25(B).*	*Average of HCT SRK 0854*	*Average of HCTs 604767, 604787, 604811, 604854, 604862, 604867 and 605033*	*Average of HCT SRK 0867*	*Average of HCTs 604652, 604606, 604653, 604656 and 604669*	*Average of HCT SRK 0872*	*Average of HCTs 604811, 604854, 604862, 604867 and 605033*	*Average of HCT 604569*	*Average of HCTs 604673 and 605153*
pH	pH	s.u	4.93	6.91	5.22	7.86	6.9	7.95	6.51	7.91	7.85	5.74
HCO_3	Bicarbonate	mg/L		316	0.47	45	9.27	38.2	6.4	54.9	22.6	12.3
Ag	Silver	mg/L		0.009	-	-	-	-	-	-	-	-
Al	Aluminum	mg/L		0.12	0.39	0.005	0.07	0.008	0.08	0.006	0.03	0.04
As	Arsenic	mg/L		0.0023	0.0011	0.00034	-	-	0.00095	0.00025	0.00025	-
B	Boron	mg/L		0.136	-	0.005	0.0047	0.0049	-	0.0049	0.005	0.005
Ba	Barium	mg/L		0.089	0.012	0.0091	0.0075	0.012	0.01	0.0062	0.0005	0.035
Ca	Calcium	mg/L	0.21	336	14.1	24.1	25.9	19.5	27.8	28	9.05	6.32
Cd	Cadmium	mg/L		0.001	0.0013	-	0.00005	-	0.00008	-	0.00005	0.00034
Co	Cobalt	mg/L		0.01	0.0009	-	0.0005	-	0.0005	-	-	-
Cr	Chromium	mg/L		0.0066	-	-	-	-	-	-	0.00025	-
Cu	Copper	mg/L		0.0037	18.2	0.0085	0.0056	-	0.0034	0.013	0.0025	0.38
F	Fluoride	mg/L		4.6	0.25	1.09	0.56	0.81	0.33	1.2	0.74	0.43
Fe	Iron	mg/L		1.48	0.7	0.001	0.1	0.001	0.1	0.001	0.001	0.004
Hg	Mercury	mg/L		0.000002	-	-	-	-	-	-	-	0.00002
K	Potassium	mg/L	0.03	4.39	1.42	3.75	1.08	3.84	0.48	4.43	2.5	1.84
Mg	Magnesium	mg/L	0.02	57.8	1.44	3.97	2.24	3.51	1.16	4	2.54	0.98
Mn	Manganese	mg/L		2.47	0.32	0.07	0.47	0.13	0.18	0.04	0.04	0.02
Mo	Molybdenum	mg/L		0.0119	-	0.0052	0.0051	0.0074	0.079	0.0056	0.0005	0.002
Na	Sodium	mg/L	0.08	115	0.61	2.41	0.93	3.46	0.45	2.6	3.23	1.69
Ni	Nickel	mg/L		0.0125	0.0005	-	0.0005	-	0.0005	-	0.0005	-
Pb	Lead	mg/L		0.0025	0.0034	-	-	0.00012	0.00012	-	0.00012	0.0016
Sb	Antimony	mg/L		0.0009	-	-	0.003	-	0.00051	-	-	-
Se	Selenium	mg/L		0.0022	0.00023	0.00031	0.00024	0.00032	0.00024	0.00035	0.00025	0.00025
U	Uranium	mg/L		0.0015	0.0013	0.0033	0.0005	0.0012	0.0013	0.0017	0.0005	0.0046
V	Vanadium	mg/L		0.0009	0.0005	0.001	0.0005	0.0005	0.0005	0.0015	0.0005	0.0005
Zn	Zinc	mg/L		0.08	0.088	0.0027	0.0016	0.0046	0.0013	0.0014	0.0023	0.015
SO_4	Sulfate	mg/L	0.86	954	99.6	44.5	72.3	38.7	74.4	47.3	21.6	14.9
Cl	Chloride	mg/L	0.12	34	0.69	1.3	0.74	2.17	0.6	1.34	1.07	0.71

- Indicates parameter was uniformly below ARLs in the HCT effluent leachates and was excluded from the PHREEQC model input for the specified material type

4.6 Results

The results of the existing pit calculations are shown in Table 4-3. This shows predicated pit lake chemistry in 2014 (i.e., the final point in the simulated water balance). The predicted chemistry has been compared to average measured chemistry in the existing pit lake between 2010 and 2013 and also the range of chemistry observed during this time period. The PHREEQC model only predicts chemistry at a fixed point in time and does not account for seasonal or longer-term variations in chemistry that may occur. As such, comparison of predicted pit lake chemistry to the range of measured chemistry is likely a more reliable indicator of the accuracy of the model in predicting future chemical conditions.

The model results show good calibration for pH, bicarbonate, calcium, aluminum, cobalt, chromium, copper, mercury, manganese, sodium, nickel, selenium, uranium, zinc and TDS. Predicted concentrations of these constituents are within the range of chemistry measured in the existing pit lake between 2010 and 2013. This demonstrates that they can be predicted with a good degree of accuracy for the future pit lake. In comparison, a few constituents are either positively or negatively-biased in the pit lake calibration model.

Boron, potassium, molybdenum and antimony are overestimated by the PHREEQC model. This likely relates to a combination of factors, including: evapoconcentration effects within the PHREEQC model and a lack of appropriate mineralogical controls in the minteq thermodynamic code. This means the geochemical mechanisms that are responsible for removal of these constituents from solution in the existing pit lake (e.g., adsorption only clays or precipitation of mineralogical phases that are not included in the minteq database) are not accounted for in the PHREEQC geochemical model. This lack of appropriate mineralogical controls in the thermodynamic code prevents these elements from precipitating (i.e. be removed from solution) within the model, thus resulting in predicted concentrations of these constituents being artificially increased over time. This is a limitation of the minteq thermodynamic database, which is discussed further in Section 3.8.

By contrast, concentrations of arsenic, barium, cadmium, fluoride and iron are slightly underestimated by the PHREEQC model. For iron, this underestimate likely relates to the fact that PHREEQC reports only truly dissolved phases. It is possible that iron in the existing pit lake may exist in the form of fine-grained colloids that pass through a 0.45 µm filter, which explains the high measured concentrations of iron in the existing pit lake. This has implications for arsenic concentrations due to the strong affinity of arsenic for Fe-oxyhydroxides (Bowell, 1994). The model predicts that arsenic concentrations will primarily be controlled by adsorption onto Fe-oxyhydroxides, therefore any underestimate in iron concentrations and/or Fe-oxyhydroxide precipitation by the model will affect the predicted arsenic chemistry. Furthermore, the calculations assume thermodynamic equilibrium and it may be that speciation of arsenic in the lake is more complex than predicted and adsorption of arsenic onto Fe-oxyhydroxide may be affected as a result.

For fluoride and barium, the lower concentrations predicted by the model may relate to the over-estimation of precipitation for mineral phases that control the chemistry of these constituents (i.e., fluorite and barite for fluoride and barium, respectively). Although both of these minerals have been observed around the existing pit lake at Copper Flat (SRK, 2014b) and are likely to form based on the predicted chemistry, the model may overestimate the mass of these minerals that will precipitate (i.e. be removed from solution), resulting in lower predicted concentrations.

Despite these minor differences in predicted and measured concentrations for a small number of parameters, the existing pit lake model shows that the majority of parameters can be predicted with a good degree of accuracy for the future pit lake.

Table 4-3: Existing Pit (Calibration) Model Results

Parameter		Units	Average measured chemistry in existing pit lake (2010 - 2013)	Range of measured chemistry in existing pit lake (2010 - 2013)	PHREEQC predicted chemistry for existing pit lake
pH	**pH**	s.u.	7.30	6.0 – 7.9	7.94
pe	**pe**	s.u.	-	-	4.84
HCO_3	**Bicarbonate**	mg/L	49.7	<20 – 123	37.9
Ag	**Silver**	mg/L	<0.005	<0.005	0.012
Al	**Aluminium**	mg/L	4.58	<0.02 – 82.6	0.02
As	**Arsenic**	mg/L	0.003	<0.001 – 0.0077	0.0012
B	**Boron**	mg/L	0.17	0.13 – 0.19	0.85
Ba	**Barium**	mg/L	0.012	<0.01 – 0.014	0.003
Ca	**Calcium**	mg/L	567	453 – 670	461
Cd	**Cadmium**	mg/L	0.055	0.038 – 0.064	0.03
Co	**Cobalt**	mg/L	0.29	0.049 – 0.49	0.06
Cr	**Chromium**	mg/L	<0.006	<0.006	0.0015
Cu	**Copper**	mg/L	2.21	<0.006 – 26.5	0.03
F	**Fluoride**	mg/L	18.4	15 – 29.8	4.74
Fe	**Iron**	mg/L	0.12	<0.02 – 1.3	0.0001
Hg	**Mercury**	mg/L	<0.0002	<0.0002	0.0002
K	**Potassium**	mg/L	33	24 – 49	397
Mg	**Magnesium**	mg/L	720	570 – 1120	524
Mn	**Manganese**	mg/L	41	28 - 48	38.7
Mo	**Molybdenum**	mg/L	0.02	<0.015 – 0.025	1.66
Na	**Sodium**	mg/L	871	604 – 1400	923
Ni	**Nickel**	mg/L	0.058	0.039 – 0.069	0.06
Pb	**Lead**	mg/L	0.011	<0.005 – 0.026	0.019
Sb	**Antimony**	mg/L	<0.001	<0.001	0.13
Se	**Selenium**	mg/L	0.027	0.013 – 0.059	0.034
U	**Uranium**	mg/L	0.12	0.11 – 0.12	0.14
V	**Vanadium**	mg/L	<0.05	<0.05	0.020
Zn	**Zinc**	mg/L	4.29	0.78 – 7.36	2.05
SO_4	**Sulfate**	mg/L	6,128	5,200 – 8,690	5,302
Cl	**Chloride**	mg/L	451	340 – 714	224
TDS	**Total Dissolved Solids**	mg/L	9,188	7,770 – 14,800	7,918

5 Unreclaimed Pit Model with Natural Fill

5.1 Conceptual Model

The unreclaimed model assumes that dewatering will occur during mining operations and limited water will pond within the pit itself. At the end of open pit mining operations, dewatering will cease and a pit lake will ultimately form by natural refill as a result of inflow of groundwater into the pit, direct precipitation onto the pit lake, run-off from the pit walls and runoff from the open pit surface drainage area. Predictions of future pit lake chemistry for this scenario were made at selected time intervals (beginning when the pit lake starts to fill after mining and dewatering operations cease). Water quality predictions were made for the time periods of 0.5, 1, 2, 5, 10, 25, 50, 75, and 100 years after the start of pit lake formation. These predictions were based on mass load mixing of waters from different sources and allowing the resulting mix to establish thermodynamic equilibrium under imposed conditions by dissolving or precipitating specified solids, with attenuation of trace elements through sorption reactions.

A conceptual geochemical model was developed for the unreclaimed pit model from a review of background and site-specific data in addition to experience with similar projects. The conceptual model is provided in Figure 5-1 and the inputs to the model are discussed in Sections 5.2 to 5.5, below.

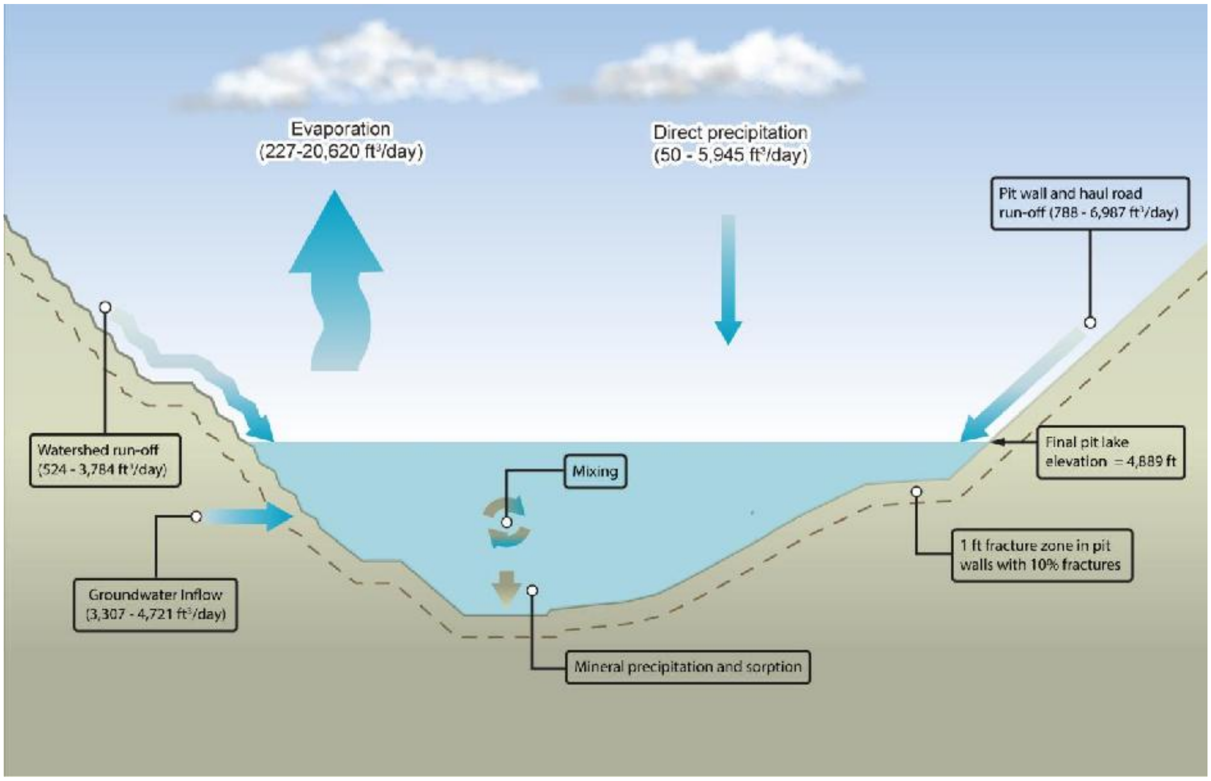


Figure 5-1: Conceptual Model for Unreclaimed Pit with Natural Fill

5.2 Pit Wall Surface Areas

The proportional surface areas of the main material types that will be exposed in the final walls of the unreclaimed pit have been calculated from the FS geologic block model and pit shell with expanded 4900 catch bench. The block model was used to calculate the three-dimensional surface area of each material type that will be exposed in the pit wall both above and below the water level as pit filling progresses. Three-dimensional surface areas were calculated for each of the modeled time steps (i.e., for 0.5, 1, 2, 5, 10, 25, 50, 75 and 100 years after the start of pit lake formation). Material types were delineated based on primary lithology, oxidation (redox) and mineralization (i.e., mineralized versus weakly/non-mineralized).

The three-dimensional surface areas of each material type in the unreclaimed pit at the end of mine life are provided in Table 5-1 and are illustrated in Figure 5-2. This demonstrates that unoxidized Quartz Monzonite will represent the dominant material type that will be exposed in the final walls of the unreclaimed pit.

Table 5-1: Three-dimensional Surface Areas of Pit Wall Rock Material Types for Final Unreclaimed Pit

Mineralization	Rock Type	Redox	Three-dimensional surface area	
			Square feet	%
Weakly/non-mineralized	Andesite	Oxide	4,150	0.05%
		Sulfide (non-ox.)	171,177	2.2%
	Biotite Breccia	Oxide	13,856	0.2%
		Sulfide (non-ox.)	340,496	4.4%
	Quartz Monzonite	Oxide	12,826	0.2%
		Sulfide (non-ox.)	2,823,022	36.3%
	Coarse Crystalline Porphyry	Oxide	8,874	0.1%
		Sulfide (non-ox.)	705,534	9.1%
Mineralized	Biotite Breccia	Sulfide (non-ox.)	813,861	10.5%
	Quartz Monzonite	Oxide	1,768	0.02%
		Sulfide (non-ox.)	2,543,813	32.7%
	Coarse Crystalline Porphyry	Oxide	77	0.001%
		Sulfide (non-ox.)	335,045	4.3%
		Total	**7,774,501**	**100%**

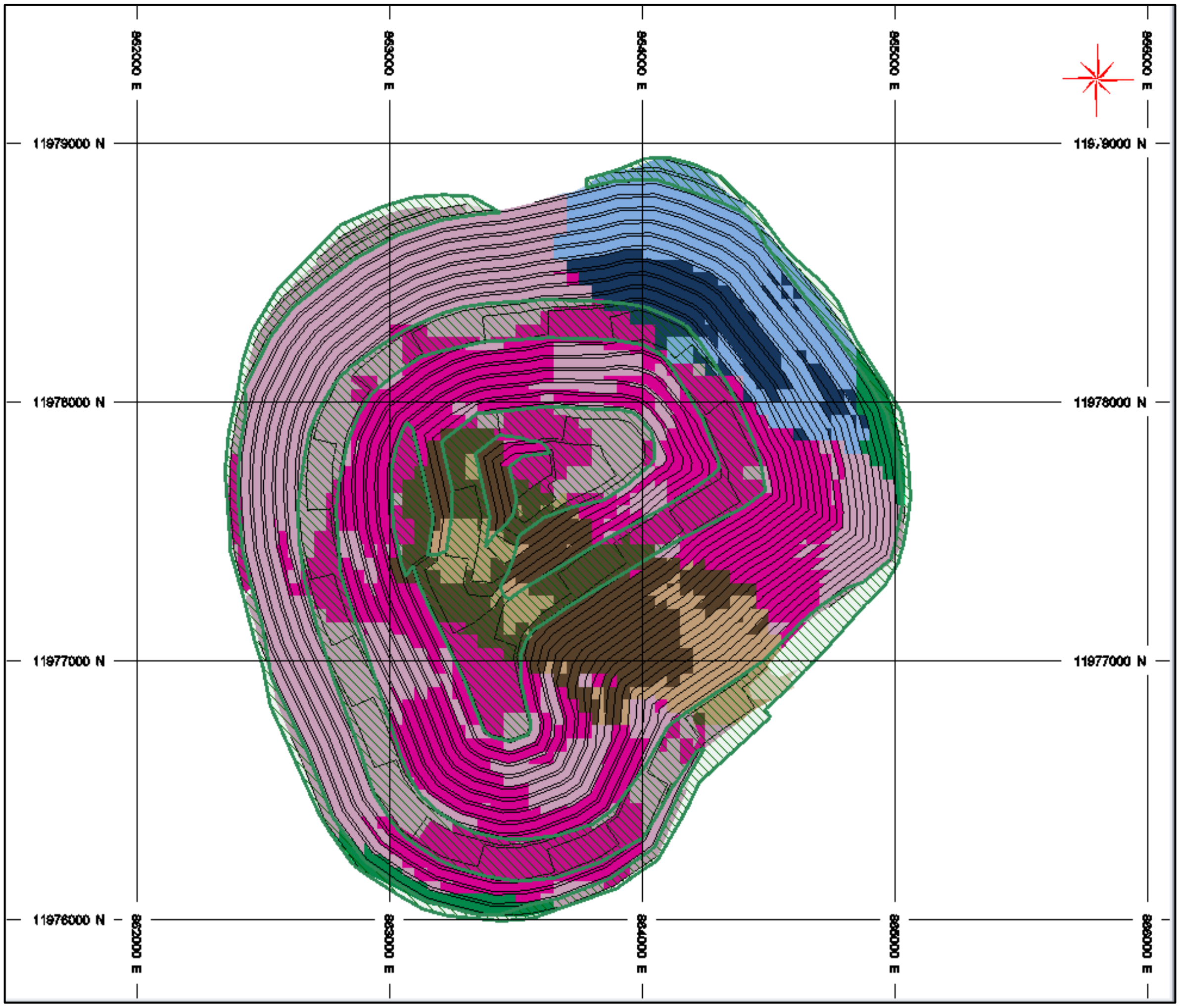


Figure 5-2: Exposed Material Types in Final Walls of Unreclaimed Pit

5.3 Calculation of Pit Wall Rock Available for Leaching

During the period of dewatering the pit walls will be exposed to oxygenated conditions and will weather to form secondary minerals, including soluble salts. As the pit wall re-saturates during rebound of the groundwater table, soluble salts and other weathering products will dissolve into the ambient groundwater that drains into the pit. In addition, dissolution of these soluble salts by run-off waters in the unsaturated high wall of the pit may occur. In order that laboratory leach data can be used to determine the mass release of solutes under field leaching conditions, it was necessary to determine the total reactive mass (R_m) of material available for leaching in the pit walls based on the exposed surface areas of each lithology in both the unsaturated high wall and in the submerged pit walls. The reactive mass will be dependent on the density of the pit wall rocks, the density of any fractures produced by blasting, and the depth to which this fracturing penetrates in the pit walls.

Several studies have evaluated the density and thickness of pit wall fracturing caused by blasting (e.g., Carroll and Scott, 1966; Siskind and Fumanti, 1974; Kelsall et al., 1984; Molebatsi et al., 2009). A detailed summary of this research is presented in Appendix F. This demonstrates that the depth of pit wall fracturing is found to be variable between 1 and 16 feet.

An estimate of the reactive mass in the future pit high wall at Copper Flat was made based on the review of the published information on pit wall fracturing (Appendix F) and from site-specific information provided by NMCC. Future blasting practices at Copper Flat will include pre-split drilling and smooth wall blasting to protect final pit walls, which is considered best practice for geotechnical stability and will effectively reduce fracturing within the final pit walls. Kelsall et al. (1984) studied blasting effects in granite and basalt wall rock and found that blasting enhances permeability by approximately 10 times near the blast face. However, the extent of blast effects is generally limited to <1m (<3.3ft), and as little as 0.3m (1ft) when using low-charge blast methods. Given that the future blasting techniques at Copper Flat will include protective measures such as smooth wall blasting at the final pit wall and that the pit wall composition (i.e., quartz monzonite) will be similar to the granitic material studied in Kelsall et al. (1984), a 1 foot thickness of reactive rock in the pit walls has been assumed for the purpose of the future pit lake model. It is assumed that fracturing in this zone will average 10% (Siskind and Fumanti, 1974; Kelsall et al., 1984). This assumption (i.e., 10% fractures) is considered conservative because the rock comprising the proposed pit shell has low fracture permeability and the limited natural fractures are mineralized (quartz and calcite are common minerals in fractures).

In addition to the fracture zone described above, mineralogy work carried out by SRK on humidity cell tests for previous projects indicates particles generally show water infiltration and products of reactivity up to 0.04 feet into the individual rock fragments. Therefore an oxidized rind of 0.04 feet (0.012 m) thickness has also been assumed on the surface of the pit walls (Figure 5-3).

Using these assumptions for the fracture zone and oxidized rind, the reactive mass (R_m) of each material type in the pit wall was calculated as:

$$R_m = (S \times F_{FZ} \times L_{FZ} \times D) + (S \times L_{OR} \times D)$$

Where:

S is the three-dimensional pit wall surface area of a given material type in square meters (defined by the geological block model; see Table 3-1);

F_{FZ} is the fracture density in the fracture zone (10%);

L_{FZ} is the thickness of the fracture zone in meters (0.3m);

L_{OR} is the thickness of the oxidized rind in meters (0.012m);

D is the rock density in kg/m^3 (2700 kg/m^3, Young and Olhoeft, 1976).

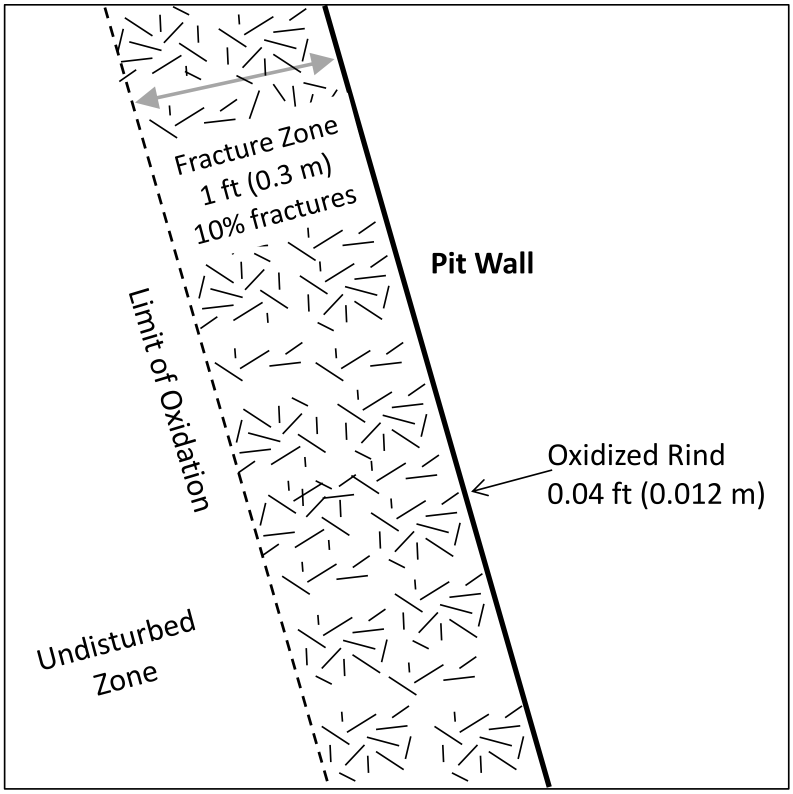


Figure 5-3: Future Pit Wall Conceptual Model

5.4 Water Balance

A pit lake water balance for the unreclaimed pit model was developed by JSAI; details of the groundwater flow model are presented in JSAI (2014b). The post-mining pit water levels and water balance for this scenario were simulated assuming the 2017 MORP pit geometry with expanded 4900 catch bench and watershed shown in Figure 3-1. The model assumes that upon cessation of mining, pumping will cease in and around the pit, allowing the pit to naturally refill over a number of years.

The water balance for the unreclaimed pit natural fill model is based on the following inputs/assumptions from JSAI (JSAI, 2014b; JSAI, 2015a; JSAI, 2017b):

- The primary solution inputs to the pit are assumed to be groundwater inflow, direct precipitation onto the high walls of the pit and run-off from the pit walls, haul road and receiving watershed;
- Evaporation will represent the dominant solution loss;
- The annual average precipitation rate is 12.5 inches per year; and
- The pit lake evaporation rate is 50 inches per year (JSAI, 2015a).

The JSAI water balance projects that the final pit lake elevation for the unreclaimed pit model will be 4,897 ft. The resulting lake will cover an area of approximately 20.7 acres with a depth of approximately 247 ft. The final pit water balance will be approximately 93 acre-feet per year, comprising 57 acre-feet of precipitation and run-off and 36 acre-feet per year of groundwater inflow.

The future pit will be a hydrologic sink, capturing groundwater flowing from all directions (INTERA, 2012; JSAI, 2017b). Surface water from within the footprint of the pit and runoff from the open pit surface drainage area will also be captured. Even with the surface water inflows, the pit will be a hydraulic sink with evaporation rates greatly exceeding precipitation and groundwater inflows on an annual basis (JSAI, 2017b). It is expected that the water levels of the lake will fluctuate seasonally by a few feet depending on precipitation and evaporation rates; rising during periods of lower evaporation (winter months) and decreasing during summer months.

The pit lake filling curve for the unreclaimed pit model is shown in Figure 4-4 and the various inputs/outputs to the pit are shown in Figure 5-5.

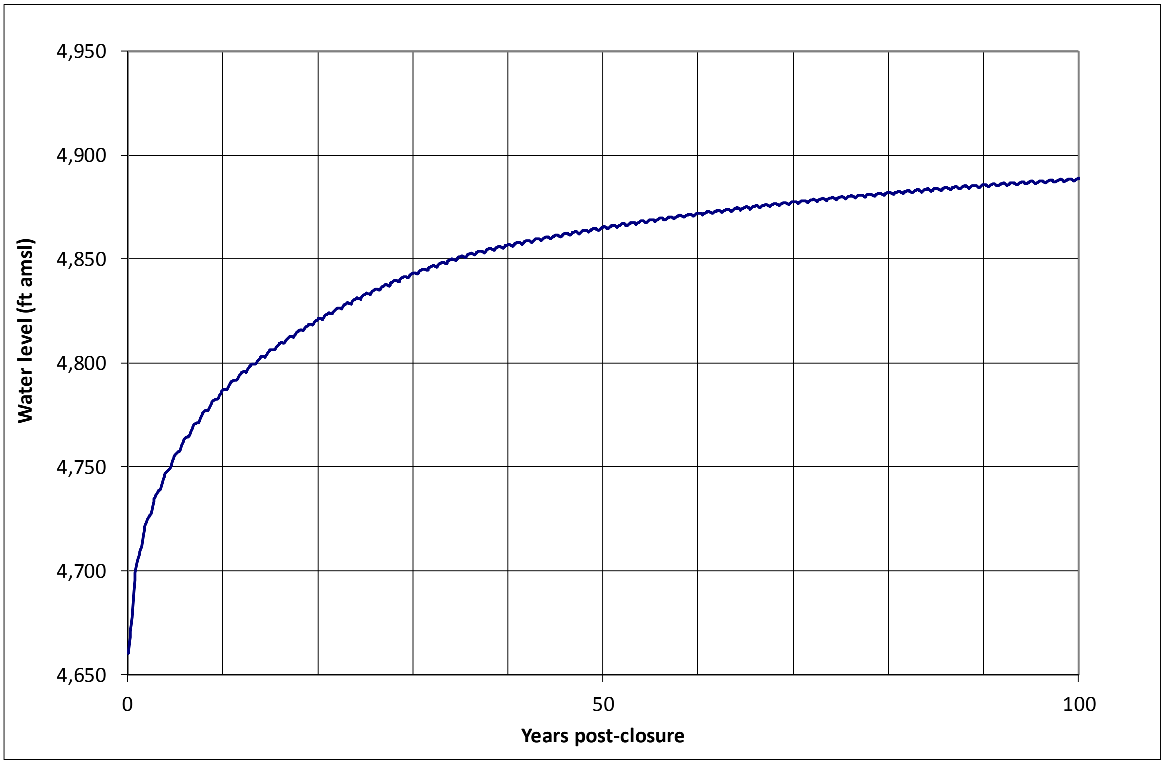


Figure 5-4: Pit Lake Elevation Curve for Unreclaimed Pit Model (source: JSAI)

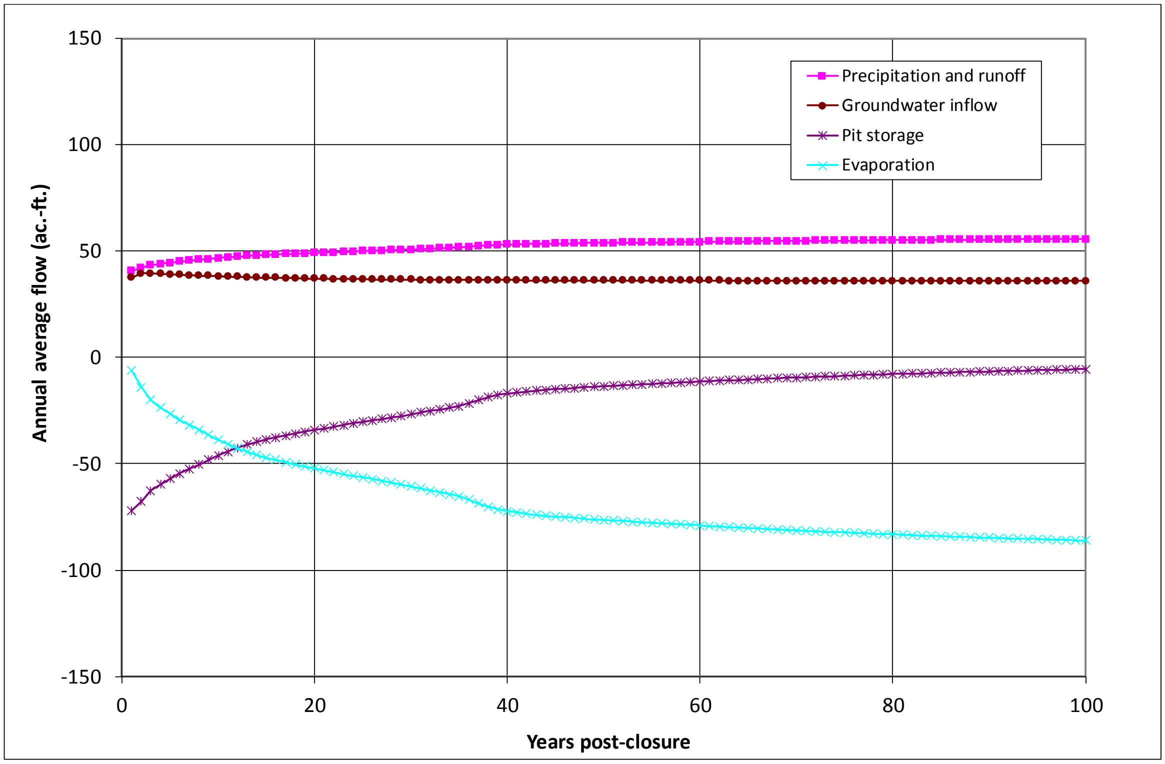


Figure 5-5: Pit Lake Flux for Unreclaimed Pit Model (source: JSAI)

5.5 Solution Inputs

5.5.1 Precipitation Chemistry

As with the existing pit model, the primary wall rock lixiviant for the future pit high walls is assumed to be precipitation. Representative precipitation chemistry data were obtained from monthly monitoring carried out between 1985 and 2011 at the Gila Cliff Dwellings National Monument meteorological station, Catron County, New Mexico (NADP, 2012) (Figure 4-6, Table 5-2).

5.5.2 Groundwater Chemistry

Representative groundwater chemistry data for the future pit lake model were obtained from the historical data compiled by JSAI and NMCC. Based on the current mine plan, a large proportion of the quartz monzonite is removed by mining and the remaining quartz monzonite is dewatered. Groundwater reporting to the future pit is therefore likely to be representative of the andesite rock. Based on this assumption, data from wells GWQ96-22(A), GWQ96-22(B) GWQ96-23(A) and GWQ96-23(B) were used as input to the future pit lake geochemical model.

Further information on how the groundwater chemistry data were derived is provided in the JSAI technical memorandum in Appendix D. The groundwater chemistry used as input to the unreclaimed pit model is presented in Table 5-2.

5.5.3 Wall Rock Chemistry

As with the existing pit model, source term solutions for the future pit lake were developed from the results of site-specific HCT testing conducted as part of the SRK (2012) geochemical characterization program and scaled to field conditions. The HCT testwork results were used to develop separate source terms for each material type that will be exposed in the final pit wall (see Table 5-1). The method used to scale the laboratory HCT data to field conditions was identical to that described in Section 4.5.3 and was based on site-specific information relating to the pit water balance, geological model, pit wall fracturing and wall rock density.

As with the existing pit lake model, different HCT inputs were used for trace elements and major ions to represent the different geochemical processes that control their release. An average of all weeks of humidity cell data were used for major ions (calcium, magnesium, sodium, potassium, aluminum, iron, manganese, chloride, sulfate, fluoride, bicarbonate) and an average of steady-state humidity cell data (i.e., minus the first 20 weeks of testing) were used for trace elements (silver, arsenic, boron, barium, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium, uranium, vanadium and zinc).

The solutions used as inputs to the geochemical model are provided in Table 5-2. In order to maintain charge balance, the solutions were balanced by adjusting the concentration of a conservative ion (either chloride or sodium) which have a low potential to influence model outcome.

Table 5-2: Groundwater, Wall Rock, Haul Road and Precipitation Chemistry used as Input to the Unreclaimed Pit Model

Parameter		Units	Precipitation chemistry	Groundwater chemistry	Haul road and watershed run-off chemistry	Wall Rock Chemistry												
						Mineralized					Weakly/non-mineralized							
						Biotite breccia sulfide	Quartz Monzonite oxide	Quartz Monzonite sulfide	Coarse Crystalline Porphyry oxide	Coarse Crystalline Porphyry sulfide	Andesite oxide	Andesite sulfide	Biotite breccia oxide	Biotite breccia sulfide	Quartz Monzonite oxide	Quartz Monzonite sulfide	Coarse Crystalline Porphyry oxide	Coarse Crystalline Porphyry sulfide
			Gila Cliff Dwellings National Monument meteorological station	*Average of wells GWQ96-22(A,B) and GWQ96-23(A,B)*	*Average of SWQ-1*	*Average of HCTs 604767, 604787, 604811, 604854, 604862, 604867 and 605033*	*Average of HCT SRK 0867*	*Average of HCTs 604652, 604606, 604653, 604656 and 604669*	*Average of HCT CF-11-02 (0-27)*	*Average of HCT CF-11-02 (367-408)*	*Average of HCTs SRK 0864 and SRK 0866*	*Average of HCTs SRK 0864 and SRK 0866*	*Average of HCTs SRK 0872 and SRK 0854*	*Average of HCTs 604811, 604854, 604862, 604867 and 605033*	*Average of HCTs SRK 0858 604569*	*Average of HCTs 604673 and 605153*	*Average of HCT CF-11-02 (0-27)*	*Average of HCT CF-11-02 (367-408)*
pH	pH	s.u	4.93	7.85	8.3	7.86	6.90	7.95	7.92	7.74	7.32	7.32	5.50	7.91	2.99	5.74	7.92	7.74
HCO_3	Bicarbonate	mg/L		408	430	45.0	9.27	38.2	30.1	19.9	10.6	10.6	3.44	54.9	N/A	12.2	30.1	19.9
Ag	Silver	mg/L		0.009		-	-	-	-	-	-	-	-	-	-	-	-	-
Al	Aluminum	mg/L		0.029		0.0046	0.070	0.0078	0.019	0.050	0.0090	0.0090	0.237	0.0059	2.96	0.037	0.019	0.050
As	Arsenic	mg/L		0.0023		0.00034	-	-	-	-	-	-	0.0010	0.00025	0.00036	-	-	-
B	Boron	mg/L		0.136	0.02	0.0050	0.0047	0.0049	0.0049	0.0048	-	-	-	0.0049	0.018	0.0050	0.0049	0.0048
Ba	Barium	mg/L		0.089		0.0091	0.0075	0.012	0.00049	0.0028	0.0033	0.0033	0.011	0.0062	0.0021	0.035	0.00049	0.0028
Ca	Calcium	mg/L	0.21	85.8	109	24.1	25.9	19.5	9.95	7.36	8.36	8.36	20.9	28.0	9.59	6.32	9.95	7.36
Cd	Cadmium	mg/L		0.0008		-	4.72E-05	-	-	-	-	-	0.00068	-	0.0014	0.00034	-	-
Co	Cobalt	mg/L		0.008		-	0.00047	-	-	-	-	-	0.00070	-	0.015	-	-	-
Cr	Chromium	mg/L		0.0066		-	-	-	-	-	-	-	-	-	0.0056	-	-	-
Cu	Copper	mg/L		0.0061		0.0085	0.0056	-	-	0.0049	-	-	9.11	0.013	2.41	0.384	-	0.0049
F	Fluoride	mg/L		2.1	0.3	1.09	0.558	0.807	0.820	0.548	0.425	0.425	0.289	1.20	1.98	0.432	0.820	0.548
Fe	Iron	mg/L		1.48		0.00069	0.099	0.00087	0.0025	0.0022	0.0014	0.0014	0.400	0.00074	6.75	0.0039	0.0025	0.0022
Hg	Mercury	mg/L		0.000002		-	-	4.91E-06	9.97E-06	4.83E-06	-	-	-	-	-	1.62E-05	9.97E-06	4.83E-06
K	Potassium	mg/L	0.03	2.96	1.80	3.75	1.08	3.84	2.18	1.70	0.974	0.974	0.950	4.43	1.66	1.84	2.18	1.70
Mg	Magnesium	mg/L	0.02	19.3	36.0	3.97	2.24	3.51	1.74	0.570	1.27	1.27	1.30	4.00	1.64	0.978	1.74	0.570
Mn	Manganese	mg/L		0.66		0.072	0.468	0.130	0.019	0.0094	0.0095	0.0095	0.248	0.043	0.125	0.018	0.019	0.0094
Mo	Molybdenum	mg/L		0.012		0.0052	0.0051	0.0074	0.00049	0.00048	0.00046	0.00046	0.040	0.0056	0.0018	0.0020	0.00049	0.00048
Na	Sodium	mg/L	0.08	119	107	2.41	0.932	3.46	2.31	2.04	1.71	1.71	0.530	2.60	1.98	1.69	2.31	2.04
Ni	Nickel	mg/L		0.0125		-	0.00047	-	-	-	-	-	0.00047	-	0.0018	-	-	-
Pb	Lead	mg/L		0.0025		-	-	-	0.00012	0.00012	0.00012	-	0.0018	-	0.0019	0.0016	0.00012	0.00012
Sb	Antimony	mg/L		0.0009		0.00012	0.0030	0.00012	-	-	-	-	0.00040	0.00012	-	-	-	-
Se	Selenium	mg/L		0.0015		0.00031	0.00024	0.00032	0.00024	0.00024	0.00023	0.00023	0.00024	0.00035	0.00023	0.00025	0.00024	0.00024
U	Uranium	mg/L		0.0015		0.0033	0.00047	0.0012	0.0024	0.0024	-	-	0.0013	0.0017	0.0051	0.0046	0.0024	0.0024
V	Vanadium	mg/L		0.0009		0.0010	0.00047	0.00049	0.00049	-	0.00046	0.00046	0.00047	0.0015	0.0018	0.00050	0.00049	-
Zn	Zinc	mg/L		0.03		0.0027	0.0016	0.0046	-	-	-	-	0.045	0.0014	0.017	0.015	-	-
SO_4	Sulfate	mg/L	0.86	84	261	44.5	72.3	38.7	12.1	7.66	20.3	20.3	87.0	47.3	89.1	14.9	12.1	7.66
Cl	Chloride	mg/L	0.12	49	30	1.30	0.739	2.17	0.999	1.37	0.708	0.708	0.647	1.34	1.26	0.711	0.999	1.37

- Indicates parameter was uniformly below ARLs in the HCT effluent leachates and was excluded from the PHREEQC model input for the specified material type

5.6 Potential for Future Pit Lake Stratification

The existing Copper Flat pit lake contained approximately 70 acre feet of water in 2014 (NMCC estimate). The water surface measures 5.2 acres with an average diameter of 537 feet (Figure 8-8in INTERA, 2012). The average depth is approximately 13 feet deep and the maximum depth is 35 feet (INTERA, 2012), which results in a relative depth (RD) of 7%. Samples taken from various depths of the existing pit lake demonstrate that the pit lake is homogeneous and no stratification exists (SRK, 1996, INTERA, 2012, Aquatic Consultants Inc., 2014). Baseline data from the existing pit water body provides evidence that a thermocline develops in the summer and mixing occurs in the winter (INTERA, 2012). A chemocline does not appear to develop, and the water body remains oxygenated (DO = 6 to 9 mg/L) throughout the full water column year-round with similar chemistry throughout the lake (see JSAI, 2014c, Appendix F). Based on elevation and latitude, the Copper Flat open pit water body is classified as a warm monomitic type lake (Wetzel, 2001). A warm monomitic lake mixes freely once a year in the winter assuming the temperature is above 4°C. However, wind effects and water body geometry can have an effect on the magnitude and frequency of mixing (Castendyk, 2009).

Mine pit lakes can develop vertical density stratification that may be seasonal or permanent. The density of water is a function of both its temperature and its salinity or total dissolved solids (TDS) content. Freshwater is most dense at a temperature of about 4^{o}C. At a given temperature, water density increases with increasing TDS. As TDS increases, the temperature of the maximum density of water also decreases (Atkins et al., 1997; Parshley and Bowell, 2003).

Long-term (multi-year) or permanent density stratification can occur if a lake has a significant vertical variation in TDS due to large differences in the TDS of various source waters to the lake and/or to processes in the lake that increase the TDS. This in turn affects the density of the deeper water. For example, if a lake contains enough organic matter to deplete oxygen in the hypolimnion, then during the summer, ferric hydroxide that precipitates at the surface will sink, become reduced, and dissolve in the basal anoxic water, raising the TDS content and the density of the bottom water.

Water in the hypolimnion will generally become anoxic and will continuously dissolve any ferric hydroxide precipitates falling into it from above. This process further increases the TDS of the hypolimnion and strengthens the density gradient between it and the overlying layer, perpetuating the stratification. Sulfidization in the hypolimnion will lead to natural attenuation of metals and metalloids as well as sulfur. Few studies reporting site-specific limnological data have been published to date (Atkins et al., 1997; Parshley and Bowell, 2003). For Copper Flat, the presence of solute material that will modify pit lake chemistry (i.e., sulfide minerals and gypsum) will likely prevent permanent chemical stratification or layering of the lake. This was validated in the 1990s from depth sampling of the pit lake at Copper Flat (SRK, 1996), and in 2010 and 2011 from baseline data collection (INTERA, 2012). The results from this study demonstrated that the current pit lake is homogeneous and no stratification exists. Temperature and dissolved oxygen profiles for the existing pit lake (INTERA, 2012, Aquatic Consultants Inc., 2014) show the pit water is not significantly stratified. The water stays well oxygenated for the entire depth for each season (6 to 8 mg/L). Thermal stratification requires a 1^{o}C change in temperature per meter (Wetzel, 2001), which can occur in the summer months as the upper water column heats up and the lower water column remains cool, and well oxygenated.

When established, the future Copper Flat pit lake will contain approximately 2,300 acre feet of water. The water surface is projected to measure 22 acres with an average diameter of 1,105 feet. The average depth will be approximately 105 feet and the maximum depth will be 247 feet, which results in a relative depth (RD) of 22% (JSAI Pit Water Balance, 2017).

The 23% RD for the future Copper Flat pit lake is greater than the average value of 2% for natural lakes and suggests the lake may stratify. Such stratification may result in oxidizing conditions in the upper portions of the lake and more chemically reducing (oxygen-deprived) conditions at depth. However, this stratification is likely to be temporary and influenced by seasonal changes. A prerequisite for permanent stratification is that precipitation plus runoff is greater than evaporation during the summer months when the water body is potentially undergoing temporary thermal stratification (Jewell, 2009). This is not the case at Copper Flat, where annual evaporation from the pit lake (100 acre-feet per year) will greatly exceed precipitation plus run-off (63 acre-feet per year). As such, permanent stratification is unlikely for the current and future Copper Flat pit lake. Consequently, in keeping with many pit lakes in arid regions there is a lower potential for stratification than a single relative depth metric would imply (Jewell, 2009).

Jewell (2009) evaluated six permanently stratified and eight seasonally stratified open pit lakes, and concludes that permanently stratified lakes have vertical density contrast greater than 0.0005 g/cm^3 and a Wedderburn number greater than 1. The Wedderburn number considers thermocline depth, maximum lake length, water density, and wind speed. Jewell (2009) failed to note that most permanently-stratified open pit lakes receive AWS inputs and have resulting acidic water at the surface. A summary table of existing open pit water bodies and their characteristics is presented in Table 5-3.

The future Copper Flat open pit lake is expected to be well mixed, oxygenated, and not acidic, although seasonal stratification may occur. Relative depth does not appear to govern the conditions for creating a permanently stratified open pit water body; however acidic water and higher latitude are key conditions for creating permanent stratification. In addition, another related control is the total dissolved solids or salinity which will also exert control over the density or buoyancy of the mine pit lake. At Copper Flat, direct surface water inputs to the existing lake over time are unlikely to be significant and therefore the potential for turnover is less.

Stratification within the pit lake has implications for redox conditions, mineral solubility and sorption reactions. The pit lake model results presented herein assume the pit lake will be fully mixed. A number of studies on deep mine pit lakes, including Summer Camp Pit in Nevada (Parshley and Bowell, 2003) and unpublished reports on Lone Tree Mines, Yerrington mine and the Robinson Mining District, also in Nevada, have demonstrated the tendency for incomplete seasonal overturn.

Based on observations of the current Copper Flat pit lake, the development of a metal-rich brine in the hypolimnion of the future pit lake is unlikely. The conditions for this are summarized in Castendyk (2009). Rather, the future pit lake is expected to be mixed and well oxygenated because: (i) the existing and future pit lake can be classified as monomictic with frequent or continuous periods of circulation with no ice cover in the winter; and (ii) the existing and future pit lake can also be characterized as oligotrophic, i.e., having little to no nutrient input and organic production, with dissolved oxygen content regulated largely by physical processes.

While stratification of an open pit water body has implications for water chemistry at depth, particularly in terms of redox changes, the near surface waters of the future Copper Flat pit lake are expected to remain oxidizing. These near surface waters are considered the most critical from a perspective of potential ecological risks associated with the lake, reduced water quality that may develop at depth is less important since the proposed Copper Flat pit will remain a terminal sink post closure.

Table 5-3: Summary of open pit water bodies and stratification characteristics (JSAI, 2014c)

Open pit	Location	Effective length (ft)	Maximum depth (ft)	Relative depth (%)	Thermocline depth (ft)	Acidic
Permanently stratified						
Brenda	British Colombia	2,296	492	21	39	No
Spenceville	California	253	50	20	13	Yes
Berkeley	Montana	5,900	426	7	23	Yes
Seasonally stratified and well mixed						
Humbolt	Nevada	944	137	15	8	No
Blackhawk	Utah	492	na	na	33	No
Blowout	Utah	656	230	35	39	No
Colosseum	California	482	157	33	na	No
Cunningham	New Mexico	407	90	22	20	No
Copper Flat (existing)**	New Mexico	537	35	7	20	No*
Copper Flat (proposed)***	New Mexico	1105	247	22	TBD	No
Yerington	Nevada	5,412	400	13	49	No

* Predominantly circum-neutral with the development of occasional temporary acidity

** Updated from JSAI (2014c) to reflect Baseline Data Report (INTERA, 2012)

*** Updated from JSAI (2014c) to reflect current pit water balance and mine plan

TBD – to be determined

5.7 Results

The predicted pit lake chemistry for the unreclaimed pit model is summarized in Table 5-4 and illustrated in Figure 5-6 to Figure 5-19 for selected parameters. These show predicted pit lake chemistry at each of the modeled time steps (i.e., 0.5, 1, 2, 5, 10, 25, 50, 75 and 100 years post-closure). In each case, the predicted pit lake chemistry is compared to the chemistry measured in the existing pit lake between 1989 and 2017. The full PHREEQC output file is provided in Appendix I, which shows precipitating and dissolving mineral species at each time step as part of the mass transfer calculations.

Pit lake waters for the unreclaimed pit are predicted to be moderately alkaline (pH 7.9– 8.2) with a magnesium plus sulfate ($Mg + SO_4$) major ion signature. During the early stages of pit infilling (i.e., the first six months post-closure), the prediction is that an early flush will occur in boron, lead, mercury, manganese, molybdenum, nickel, selenium, vanadium, zinc and sulfate. This initial flush occurs due to dissolution of soluble sulfate salts that will have developed on the pit walls during the life of mine. This initial flush is only observed for the natural fill model, but the effects are dissipated in the rapid fill model (Section 6) and no initial flush is observed.

Inflowing groundwater and direct precipitation on the pit lake surface will then provide some dilution and the effects of this initial flush will be dissipated. Following this initial flush, pit lake waters are predicted to evolve over time, with increasing concentrations of chloride, sulfate, TDS and trace elements owing to the effects of evapoconcentration. This is similar to the trends observed in the existing pit lake, where elemental concentrations (particularly boron, cadmium, fluoride, magnesium, manganese, sodium and sulfate) have increased over time. The macrochemistry ($Ng\text{-}Na\text{-}SO_4$) changes are reflected in the Piper plot in Figure 5-19, which shows a progressive change in pit lake major ion chemistry post-closure, with waters becoming increasingly dominated by sulfate and magnesium over time. However, pH remains moderately alkaline throughout pit infilling.

Pit lake chemistry is likely to be dominated by groundwater chemistry plus evapoconcentration effects. Over time, the groundwater contribution will decrease slightly as the pit lake is established. Both adsorption and secondary mineral precipitation are likely to be the major controls on trace element chemistry. Mineral precipitation processes are shown to be the dominant control on major ion chemistry. For example, sulfate concentrations are controlled by the precipitation of gypsum, alunite, barite, mirabilite and brochantite. Calcium and fluoride concentrations are controlled by the precipitation of fluorite, iron concentrations are controlled by the precipitation of ferrihydrite, potassium and aluminum concentrations are controlled by the precipitation of alunite, copper is controlled by the precipitation of brochantite and sodium is controlled by the precipitation of mirabilite. In comparison, trace element concentrations (including arsenic, antimony, cadmium, copper, chromium, lead, manganese, nickel, molybdenum, selenium and zinc) are shown to be controlled primarily by adsorption onto ferrihydrite.

Pit lake waters for the unreclaimed pit are predicted to be ‘near-neutral, low-metal’ waters for years zero (i.e., end of mine life) to year 50, based on pH values between 7.9 and 8.2 and total Ficklin metal concentrations[1] less than 1 mg/L (Figure 5-18). The effects of evapoconcentration are predicted to result in increasing metal concentrations, with pit lake waters being classed as ‘near-neutral, high metal’ from year 75 onwards (Figure 5-18).

A comparison of predicted pit lake chemistry to chemistry measured in the existing pit lake between 1989 and 2017 demonstrates that concentrations of the majority of constituents are either comparable to or less than existing concentrations. In particular, predicted concentrations of arsenic, cadmium, copper, cobalt, chromium, fluoride, lead, manganese, nickel, zinc and sulfate in the future unmitigated

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[1] Ficklin metals are the base metals copper, cobalt, cadmium, lead, nickel and zinc (Ficklin et al., 1992)

pit are lower than those observed in the existing pit lake at Copper Flat. This relates to a number of factors, including:

- The future pit walls will be prepared using pre-split drilling and smooth wall blasting, which will reduce the depth of fracturing and oxidation, and consequently reduce solute loading to the pit lake;
- The future pit walls will contain less mineralized material than the existing Copper Flat pit, which will also reduce solute loading to the pit lake;
- The future pit walls will contain less transitional material than the existing Copper Flat pit, that is the source of the AWS events; and
- The dominant groundwater flow into the future pit will originate from the Andesite, which is typically characterized by lower constituent concentrations than the Quartz Monzonite groundwater (JSAI, 2017a).

The only constituents that are predicted to be higher in the future pit lake compared to the existing pit lake are boron, molybdenum, potassium and antimony. From the calibration model (Section 3.10) these constituents are known to be over-predicted by PHREEQC, and therefore the predicted concentrations of boron, molybdenum, potassium and antimony presented in Table 5-4 are likely to be an overestimate.

Table 5-4: Unreclaimed Pit Model Results

Parameter		Units	*Measured Chemistry in Existing Pit (1989 - 2017)*			Predicted Future Chemistry (Years Post-Closure)								
			Average	*Minimum*	*Maximum*	**0.5**	**1**	**2**	**5**	**10**	**25**	**50**	**75**	**100**
pH	**pH**	s.u.	*6.5*	*3.6*	*8.3*	8.2	8.1	8.1	8.0	8.0	8.0	7.9	7.9	7.9
HCO_3	**Bicarbonate**	mg/L	*40.4*	*<3*	*122*	54.8	45.5	42.7	40.6	39.4	37.3	35.3	33.9	34.7
Al	**Aluminium**	mg/L	*10.4*	*<0.02*	*82.6*	0.06	0.10	0.10	0.11	0.12	0.13	0.16	0.18	0.16
As	**Arsenic**	mg/L	*0.004*	*<0.001*	*0.006*	2.23E-04	1.47E-04	1.47E-04	1.46E-04	1.41E-04	1.36E-04	1.49E-04	1.71E-04	1.94E-04
B	**Boron**	mg/L	*0.14*	*<0.1*	*0.2*	0.44	0.30	0.31	0.34	0.38	0.49	0.67	0.85	1.04
Ca	**Calcium**	mg/L	*550*	*455*	*684*	99.8	127	150	177	202	262	360	460	489
Cd	**Cadmium**	mg/L	*0.05*	*<0.005*	*0.1*	0.0093	0.0064	0.0066	0.0072	0.0080	0.0103	0.0140	0.018	0.022
Co	**Cobalt**	mg/L	*0.29*	*<0.05*	*0.49*	0.008	0.005	0.006	0.006	0.007	0.009	0.01	0.02	0.02
Cr	**Chromium**	mg/L	*0.03*	*<0.006*	*0.1*	4.82E-04	4.80E-04	6.52E-04	9.35E-04	1.20E-03	1.73E-03	2.55E-03	3.34E-03	4.12E-03
Cu	**Copper**	mg/L	*4.44*	*0.001*	*26.5*	0.012	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
F	**Fluoride**	mg/L	*19.2*	*4.8*	*34*	3.30	3.02	3.34	3.83	4.25	4.11	4.00	3.94	4.16
Fe	**Iron**	mg/L	*0.2*	*<0.02*	*1.3*	4.64E-05	4.88E-05	5.03E-05	5.18E-05	5.30E-05	5.55E-05	5.88E-05	6.17E-05	6.20E-05
Hg	**Mercury**	mg/L	*0.0005*	*<0.0002*	*0.001*	0.0006	0.0004	0.0004	0.0004	0.0005	0.0006	0.0008	0.0011	0.0013
K	**Potassium**	mg/L	*32.1*	*11.0*	*60.6*	192	131	135	148	166	212	290	372	453
Mg	**Magnesium**	mg/L	*698*	*43*	*1,120*	171	121	125	136	152	194	266	341	416
Mn	**Manganese**	mg/L	*34.8*	*0.02*	*59.0*	4.66	3.19	3.30	3.62	4.04	5.15	7.04	9.02	11.00
Mo	**Molybdenum**	mg/L	*0.04*	*0.015*	*0.1*	0.29	0.20	0.20	0.22	0.25	0.32	0.44	0.56	0.68
Na	**Sodium**	mg/L	*888*	*165*	*1,400*	278	202	210	230	257	326	445	570	694
Ni	**Nickel**	mg/L	*0.06*	*0.039*	*0.1*	0.009	0.007	0.007	0.008	0.009	0.011	0.015	0.019	0.022
Pb	**Lead**	mg/L	*0.02*	*<0.005*	*0.1*	0.0082	0.0068	0.0073	0.0083	0.0094	0.0123	0.017	0.0220	0.0270
Sb	**Antimony**	mg/L	*<0.001**			0.005	0.003	0.003	0.004	0.004	0.005	0.007	0.009	0.011
Se	**Selenium**	mg/L	*0.028*	*<0.001*	*0.25*	0.019	0.013	0.013	0.014	0.016	0.020	0.027	0.034	0.042
U	**Uranium**	mg/L	*0.11*	*0.11*	*0.12*	0.114	0.078	0.080	0.09	0.10	0.13	0.17	0.22	0.27
V	**Vanadium**	mg/L	*0.1*	*<0.05*	*0.25*	0.0033	0.0025	0.0026	0.0027	0.0027	0.0028	0.0032	0.0038	0.004
Zn	**Zinc**	mg/L	*5.4*	*0.01*	*9*	0.52	0.36	0.37	0.40	0.45	0.58	0.79	1.01	1.23
SO_4	**Sulfate**	mg/L	*4,803*	*1,566*	*8,690*	1,505	1,196	1,284	1,441	1,626	2,096	2,887	3,708	4,353
Cl	**Chloride**	mg/L	*332*	*47.3*	*730*	135	95.6	99.1	109	121	154	210	269	328
TDS	**Total Dissolved Solids**	mg/L	*7,538*	*2,711*	*14,800*	2,447	1,926	2,053	2,291	2,573	3,293	4,507	5,770	6,786

* *Indicates parameter was uniformly below analytical detection limits in pit lake water over monitoring period, but detection limit was variable. Concentration shown in table represents lower limit of analytical detection.*

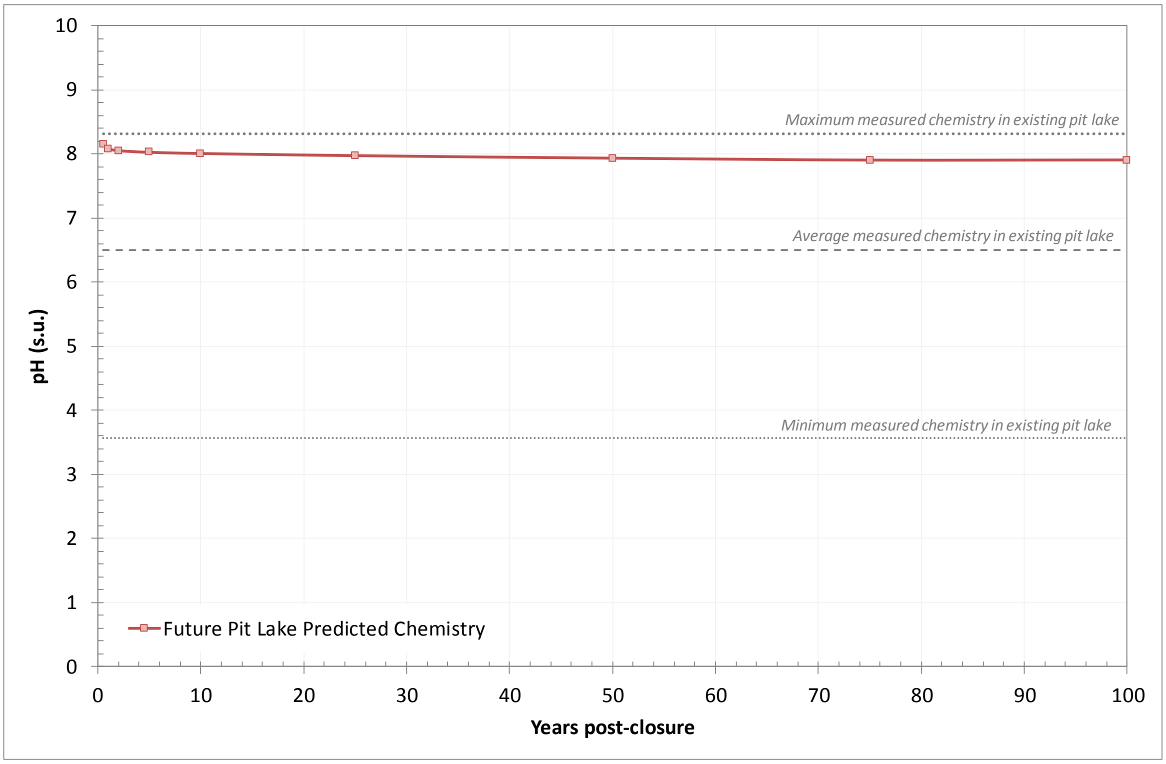

Figure 5-6: **Time-series Plot of Predicted pH for the Unreclaimed Pit Model**

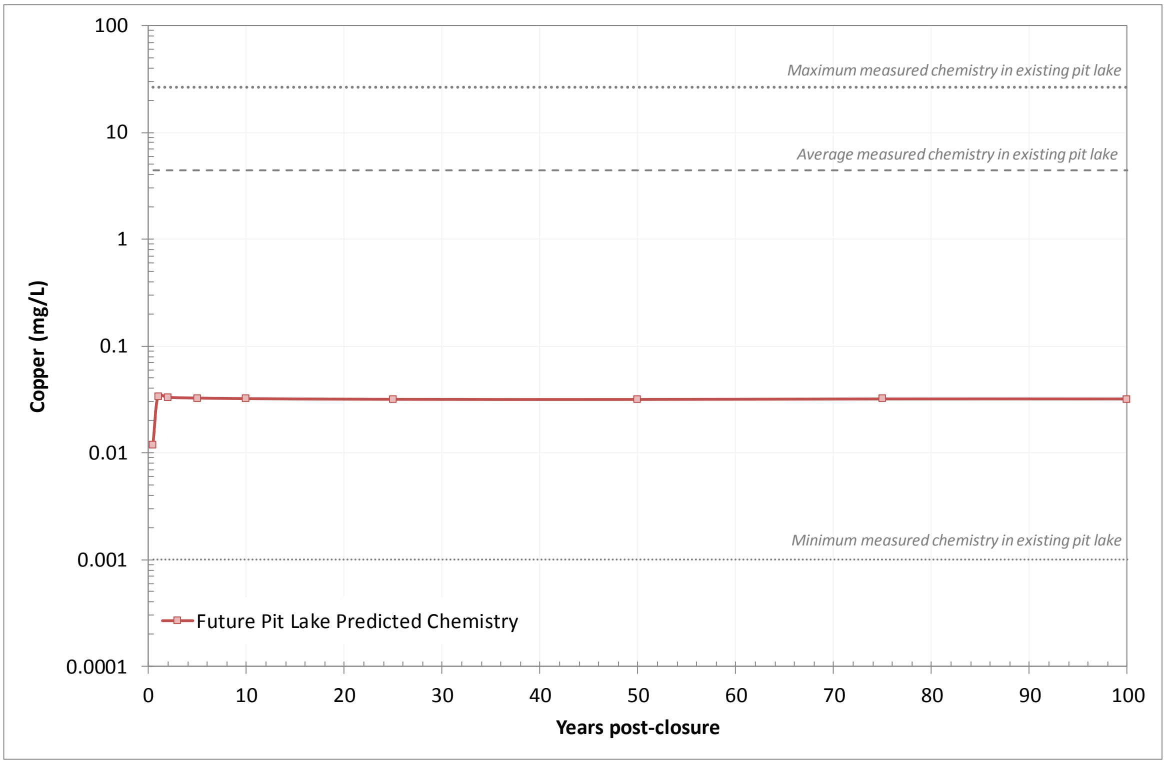

Figure 5-7: **Time-series Plot of Predicted Copper for the Unreclaimed Pit Model**

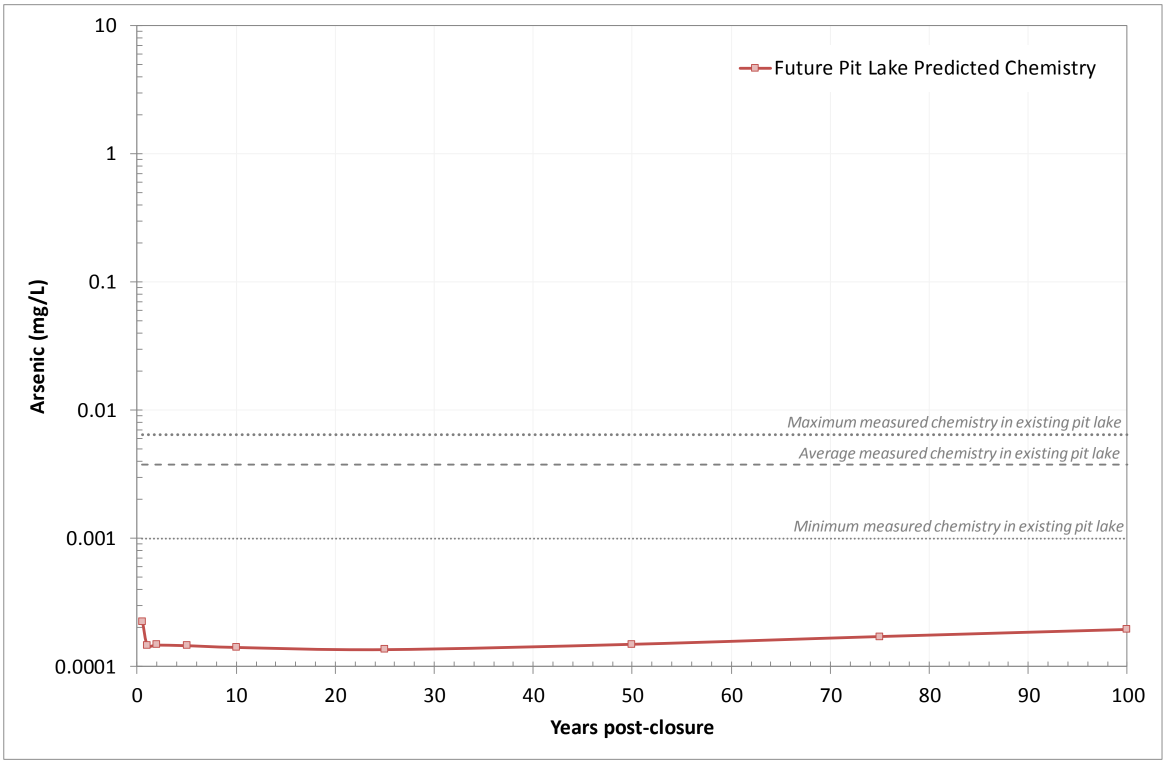

Figure 5-8: Time-series Plot of Predicted Arsenic for the Unreclaimed Pit Model

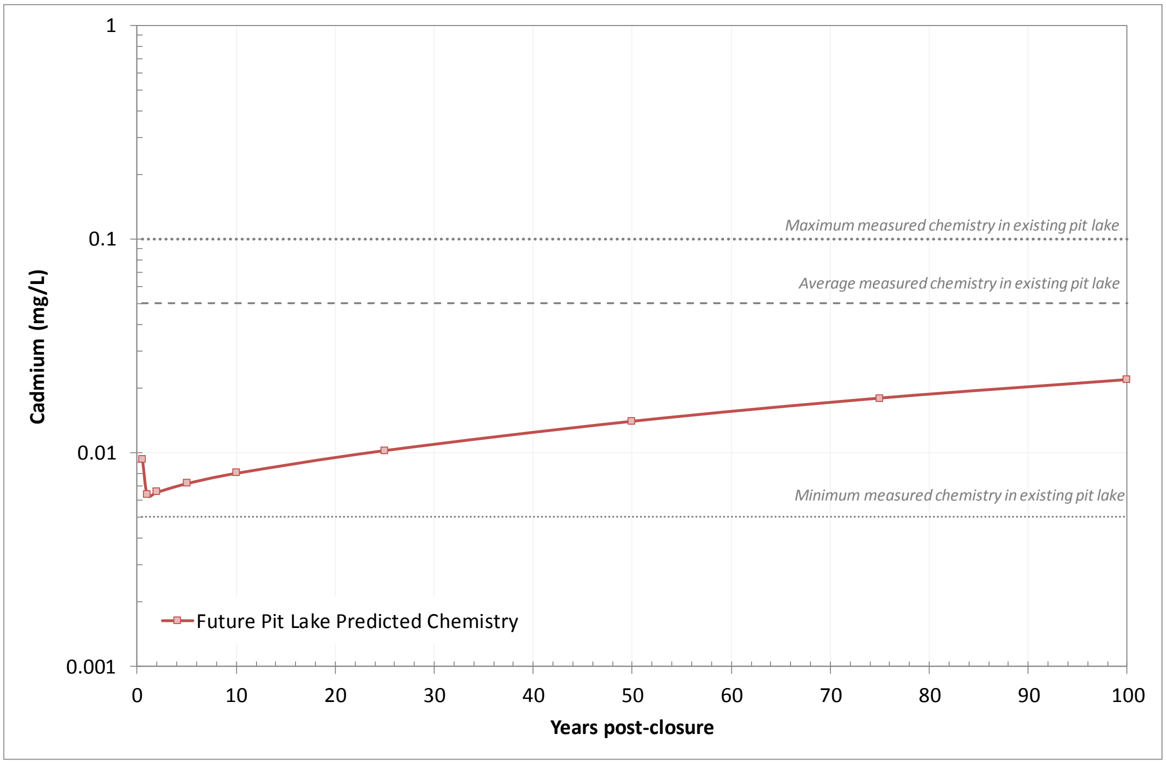

Figure 5-9: Time-series Plot of Predicted Cadmium for the Unreclaimed Pit Model

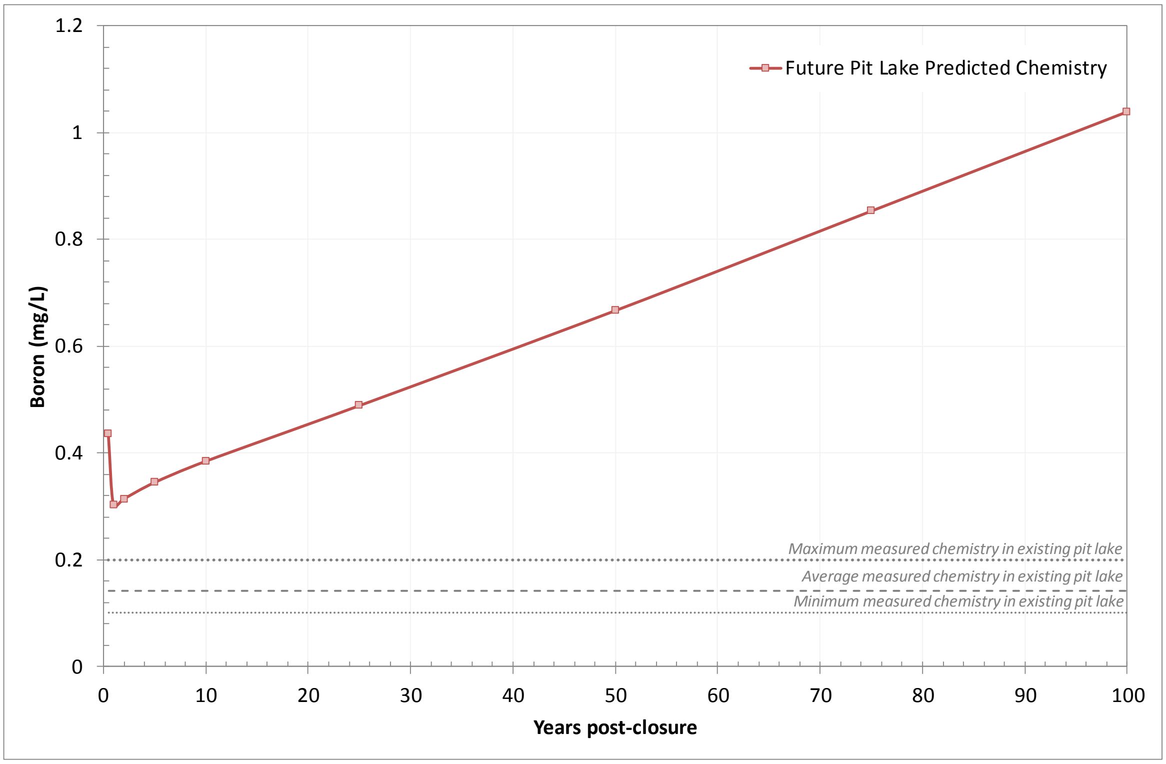

Figure 5-10: Time-series Plot of Predicted Boron for the Unreclaimed Pit Model

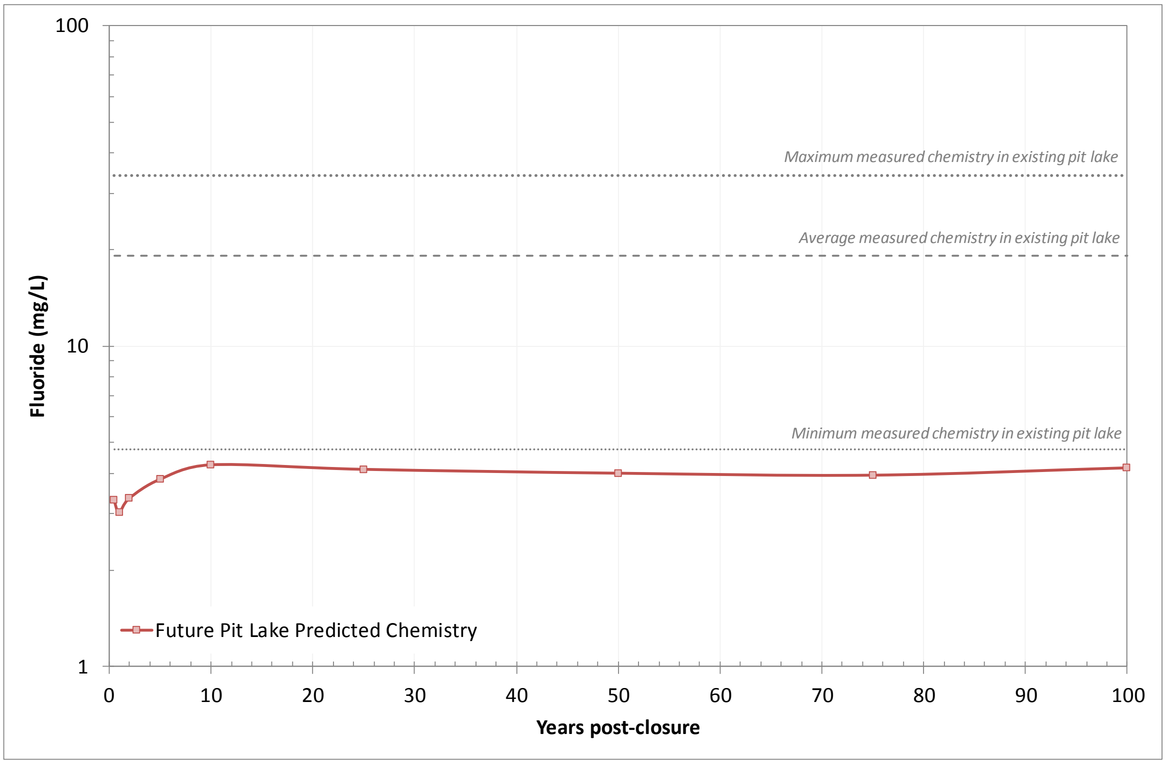

Figure 5-11: Time-series Plot of Predicted Fluoride for the Unreclaimed Pit Model

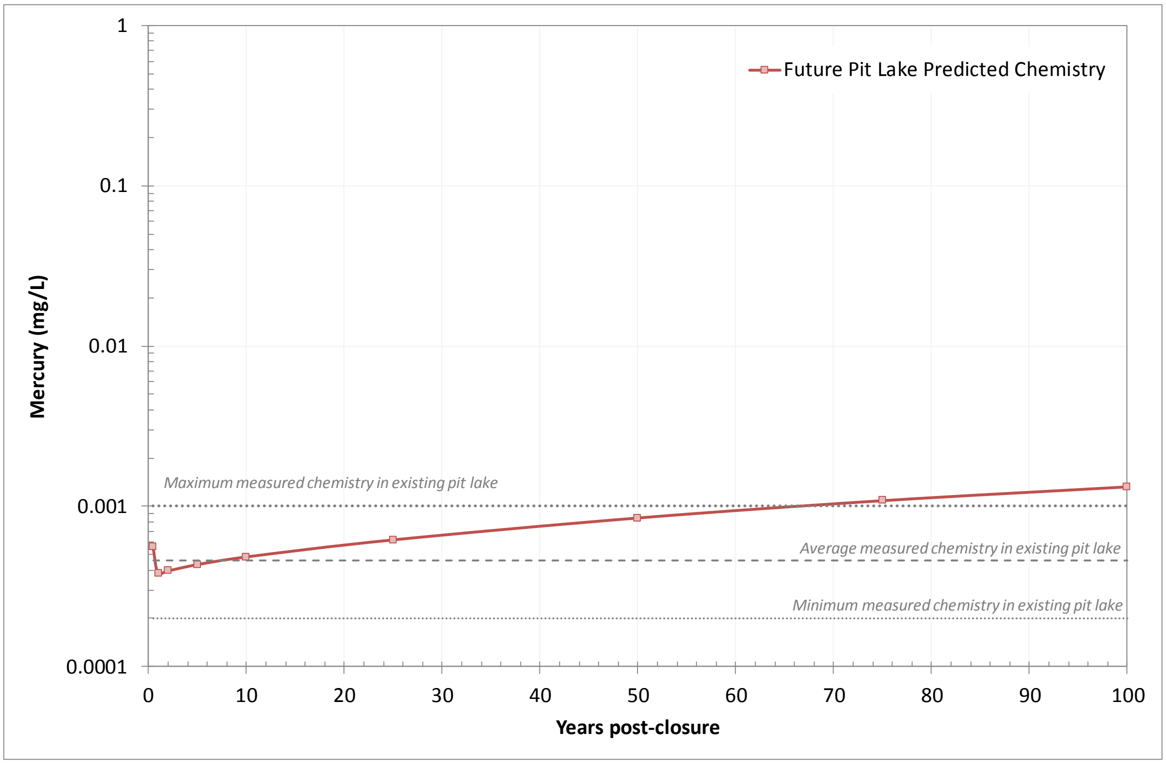

Figure 5-12: Time-series Plot of Predicted Mercury for the Unreclaimed Pit Model

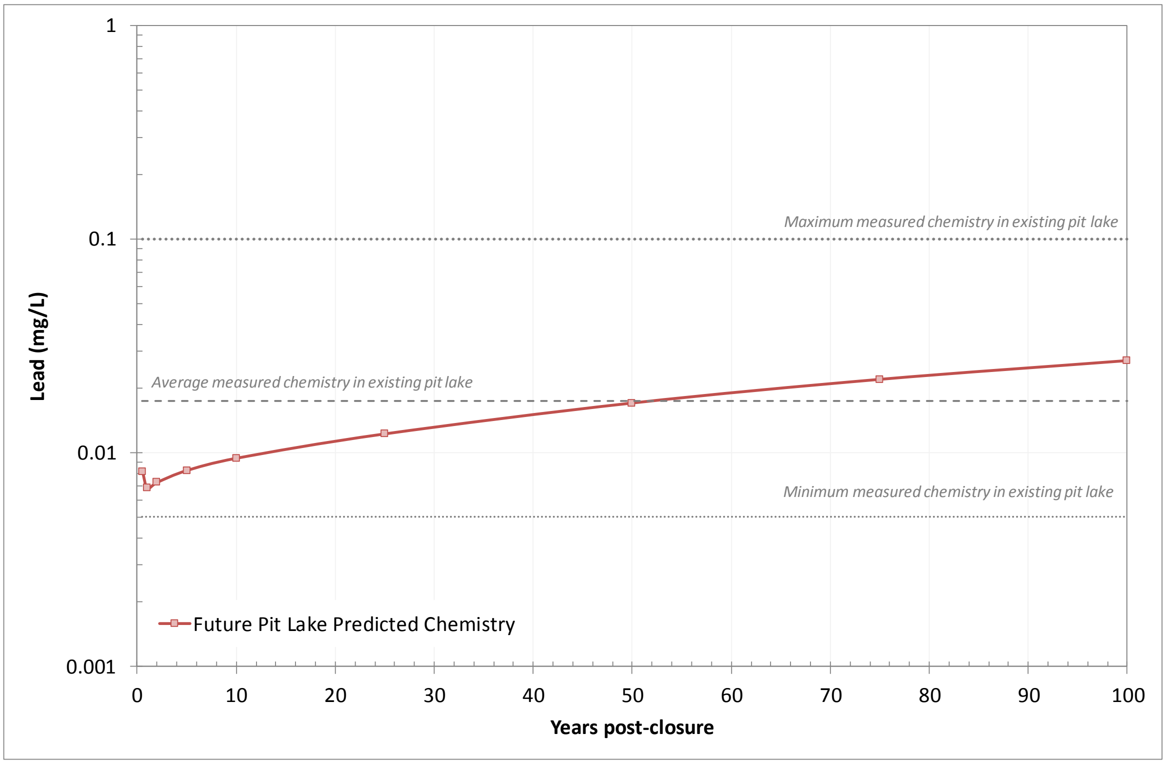

Figure 5-13: Time-series Plot of Predicted Lead for the Unreclaimed Pit Model

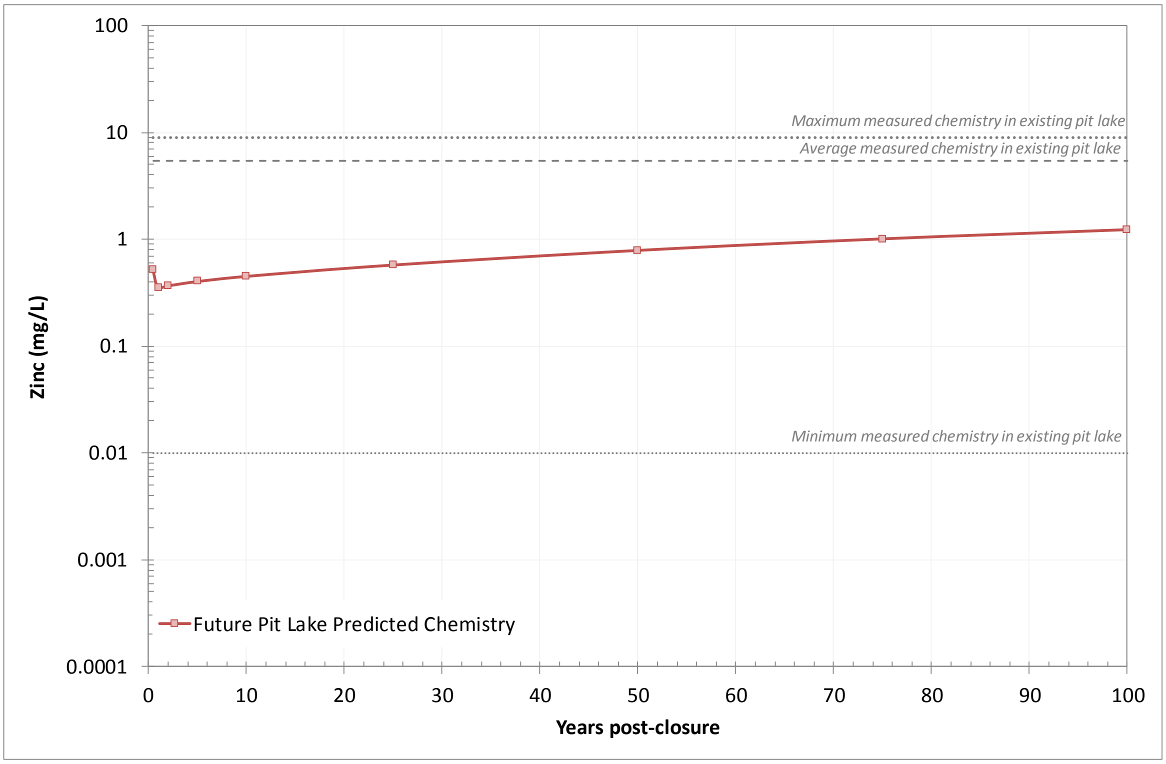

Figure 5-14: Time-series Plot of Predicted Zinc for the Unreclaimed Pit Model

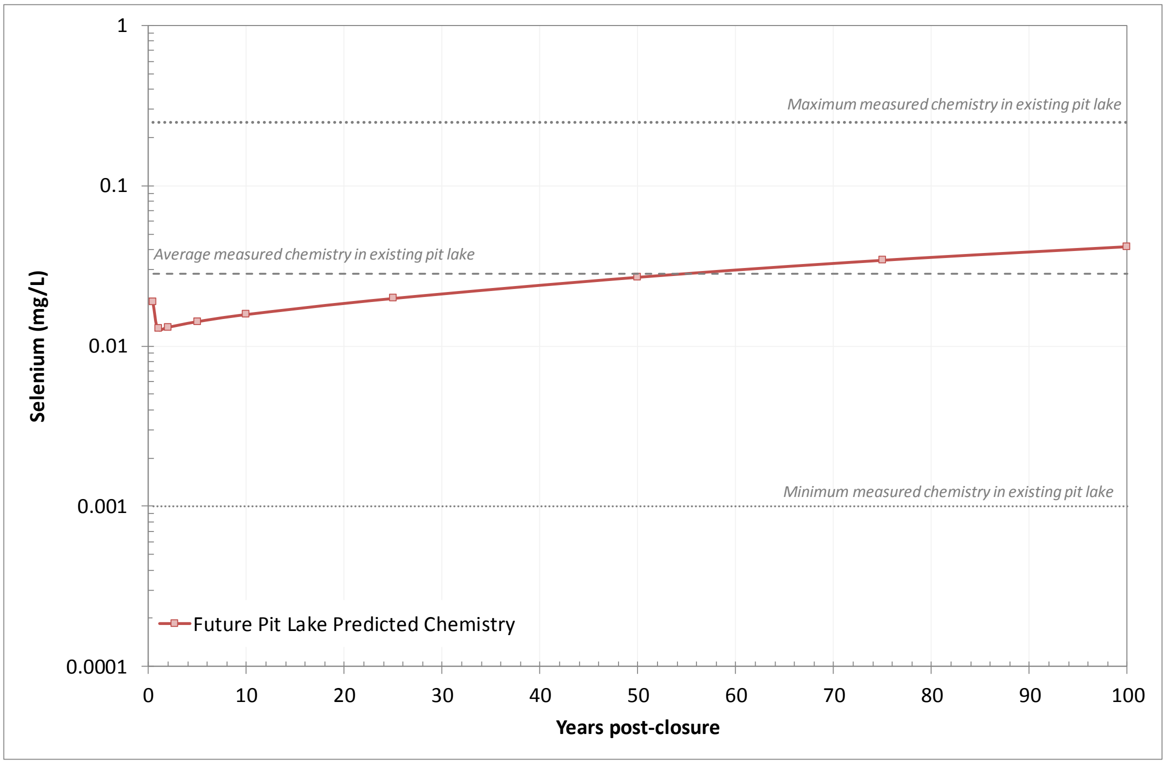

Figure 5-15: Time-series Plot of Predicted Selenium for the Unreclaimed Pit Model

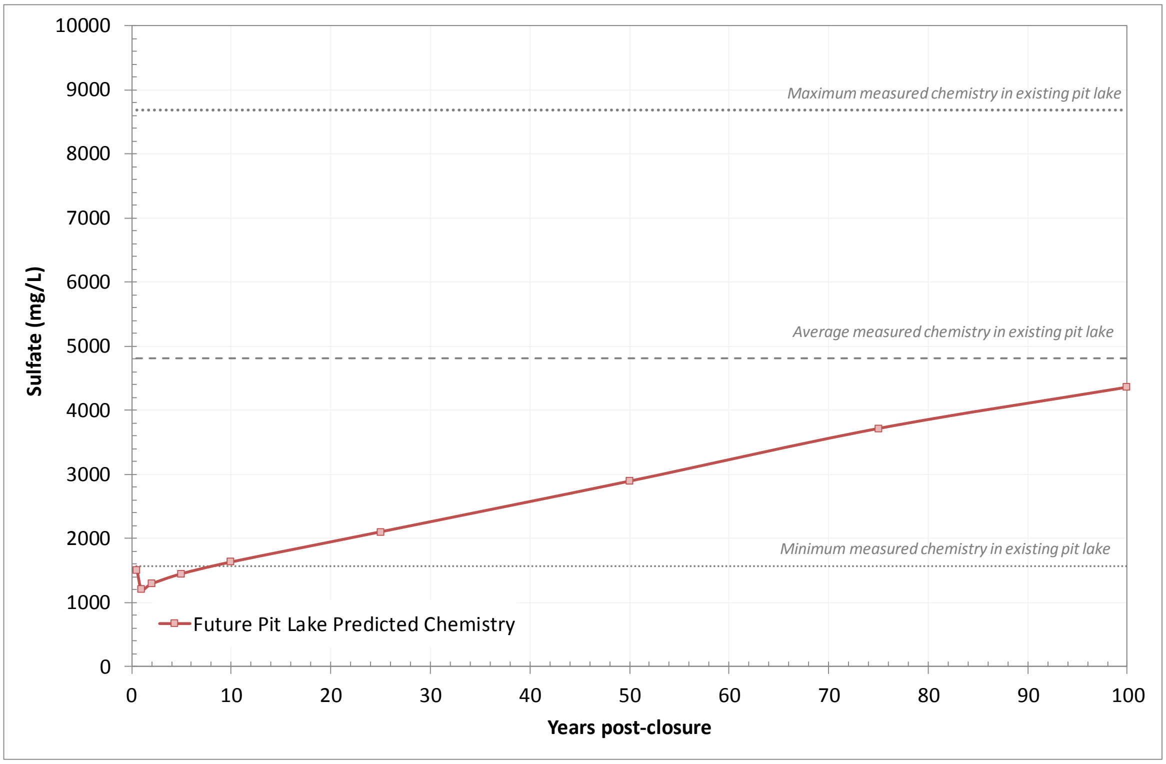

Figure 5-16: Time-series Plot of Predicted Sulfate for the Unreclaimed Pit Model

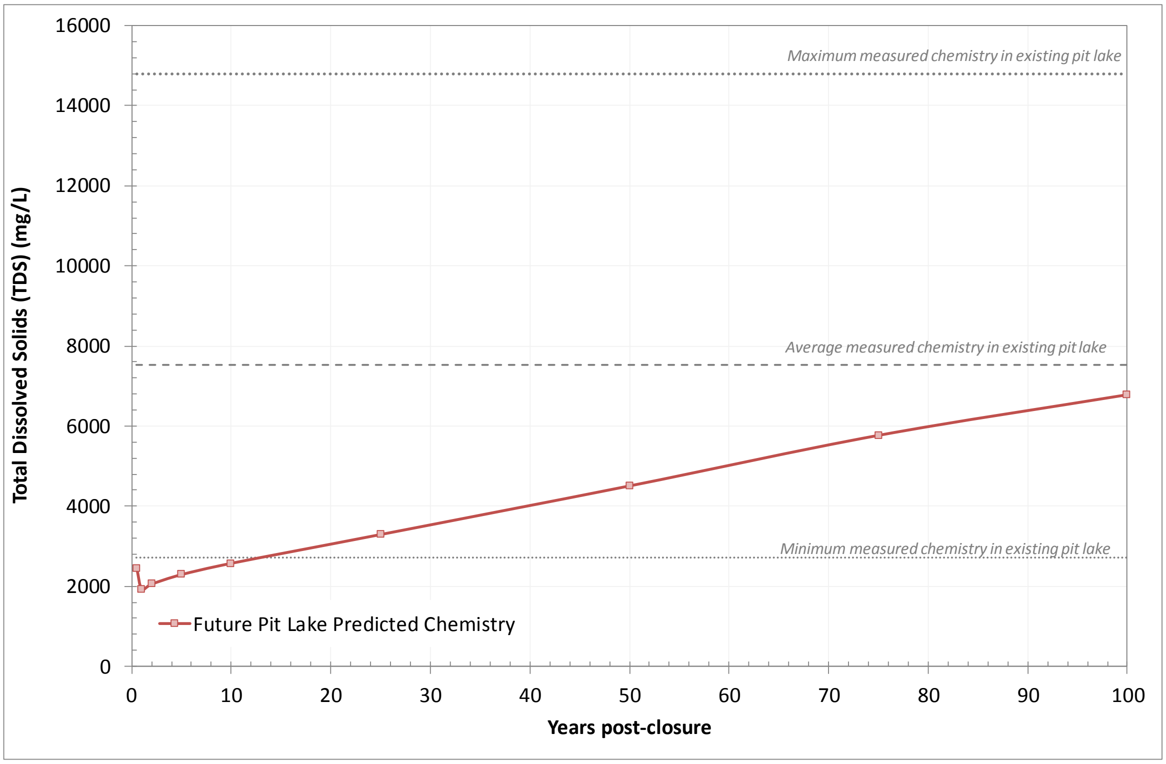

Figure 5-17: Time-series Plot of Predicted TDS for the Unreclaimed Pit Model

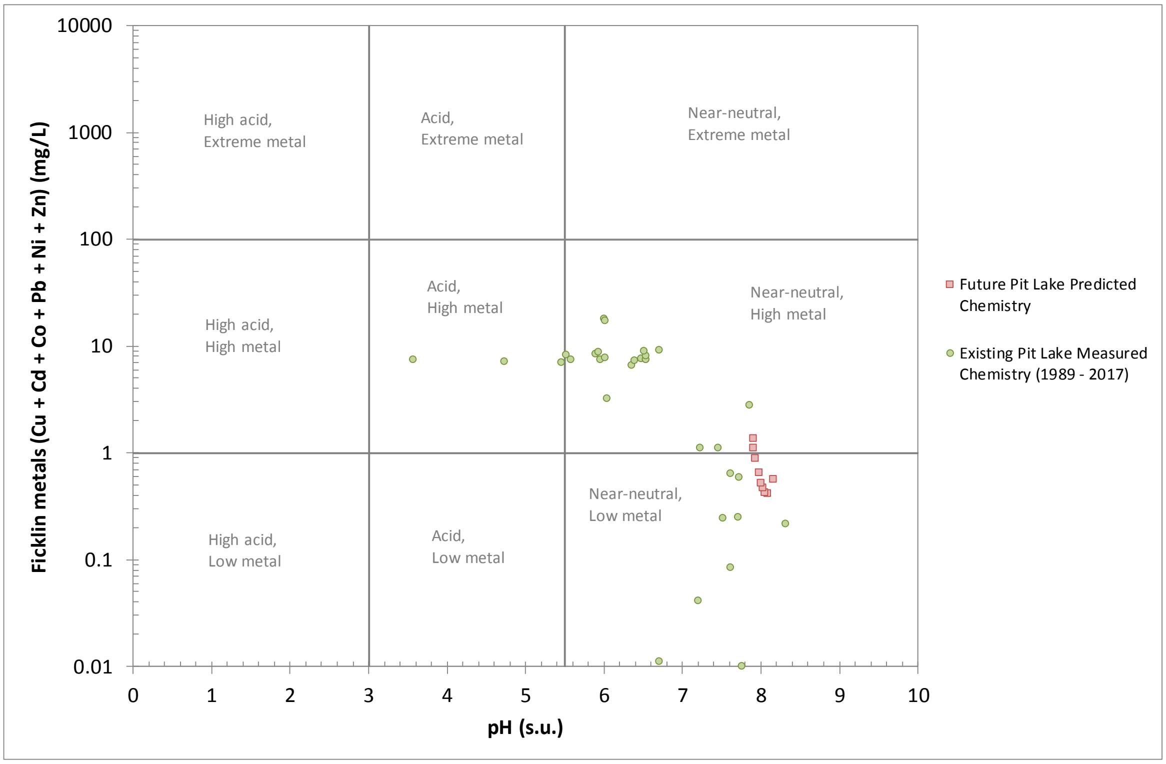

Figure 5-18: Ficklin Plot for the Unreclaimed Pit Model

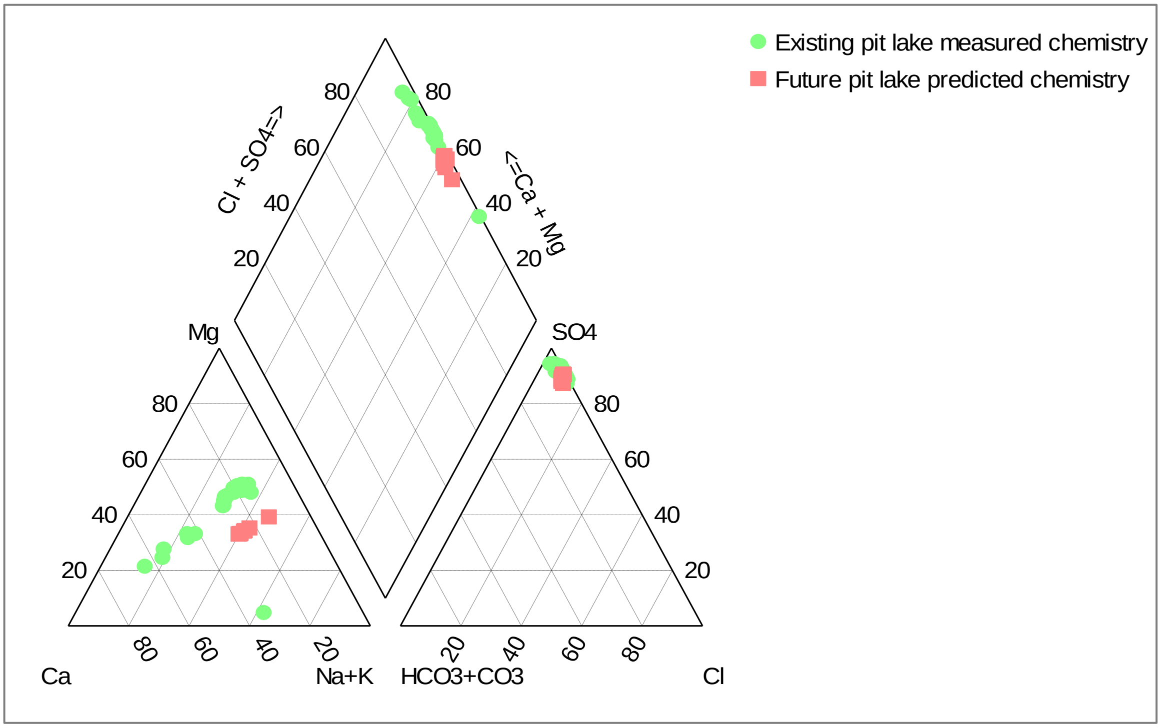

Figure 5-19: Piper Plot of Predicted Major Ion Chemistry for the Unreclaimed Pit Model

6 Reclaimed Pit Model with Rapid Fill

6.1 Conceptual Model

Rapid fill has been proposed as a reclamation strategy for the future pit and will dilute solutes derived from water-rock interaction. Rapid fill will quickly submerge walls and benches to limit the exposure of sulfide minerals to oxygen, and will reduce the effects of evapoconcentration over time. To assess the effects of initial rapid fill on predicted pit lake chemistry for the future pit, an alternative model has been run. This alternative fills the pit with 2,200 acre-feet from the water supply wells during the six months of pit filling. Rapid fill stops when the 4,897 ft water elevation is achieved. Additional reclamation activities for this scenario includes reclamation of the haul road, the expanded section of the 4900-catch bench and the pit shell crest (see Section 3.1.8).

Water quality predictions for this scenario were made for time periods of 0.5, 1, 2, 5, 10, 25, 50, 75, and, 100 years after the start of pit lake formation. A conceptual model for the reclaimed pit rapid fill scenario is presented in Figure 6-1 and inputs to the model are discussed in Sections 6.2 to 6.5.

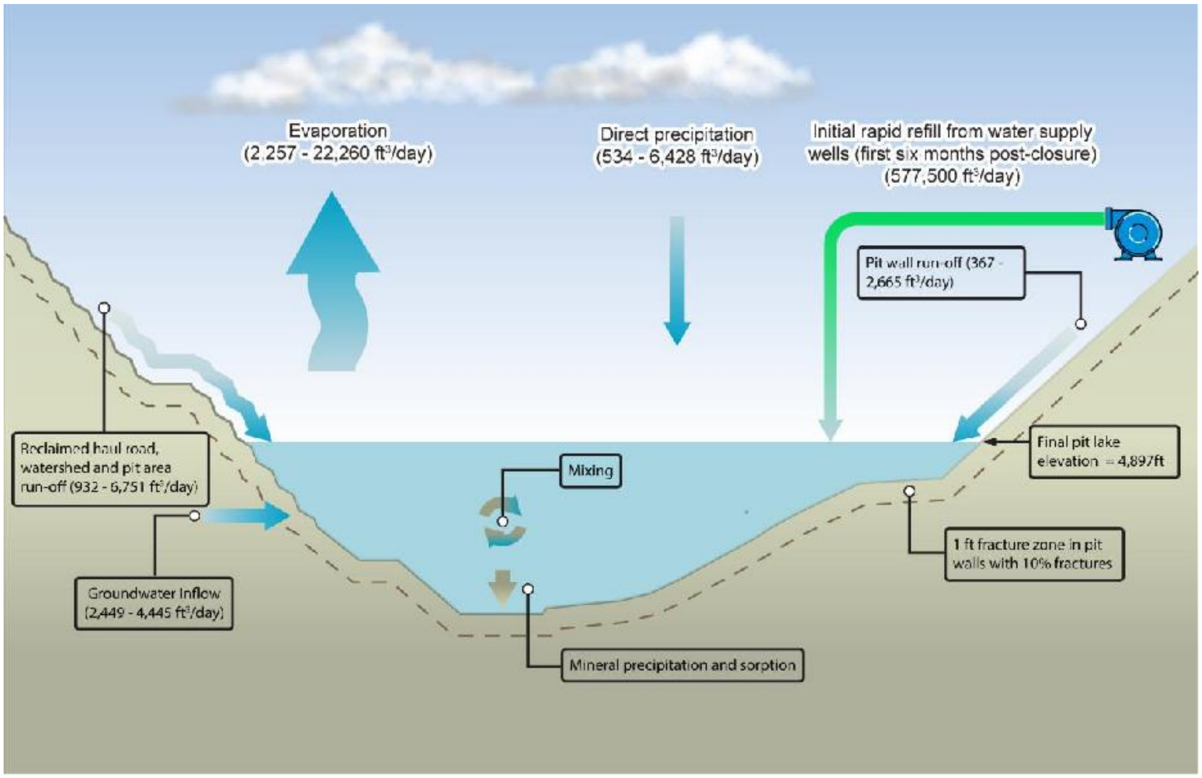

Figure 6-1: Conceptual Model for Reclaimed Pit with Rapid Fill

6.2 Pit Wall Surface Areas

The proportional surface areas of the main material types that will be exposed in the final walls of the reclaimed pit have been calculated from the FS geologic block model and the 2017 MORP pit. The block model was used to calculate the three-dimensional surface area of each material type that will be exposed in the pit wall both above and below the water level as pit filling progresses. Three-dimensional surface areas were calculated for each of the modeled time steps (i.e., for 0.5, 1, 2, 5, 10, 25, 50, 75 and 100 years after the start of pit lake formation). Material types were delineated based on primary lithology, oxidation (redox) and mineralization (i.e., mineralized versus weakly/non-mineralized). Areas proposed for cover and reclamation are excluded from the exposed surface areas.

The three-dimensional surface areas of each material type in the reclaimed pit at the end of mine life are provided in Table 6-1 and are illustrated in Figure 6-2. This demonstrates that unoxidized Quartz Monzonite will represent the dominant material type that will be exposed in the final walls of the reclaimed pit.

Table 6-1: Three-dimensional Surface Areas of Pit Wall Rock Material Types for Final Reclaimed Pit

Mineralization	Rock Type	Redox	Three-dimensional surface area	
			Square feet	%
Weakly/non-mineralized	Andesite	Oxide	41	0.001%
		Sulfide (non-ox.)	118,926	1.5%
	Biotite Breccia	Oxide	434	0.01%
		Sulfide (non-ox.)	300,158	3.9%
	Quartz Monzonite	Oxide	236	0.003%
		Sulfide (non-ox.)	2,165,968	27.9%
	Coarse Crystalline Porphyry	Oxide	790	0.01%
		Sulfide (non-ox.)	596,808	7.7%
Mineralized	Biotite Breccia	Sulfide (non-ox.)	787,435	10.1%
	Quartz Monzonite	Oxide	0	0%
		Sulfide (non-ox.)	1,993,567	25.6%
	Coarse Crystalline Porphyry	Oxide	0	0%
		Sulfide (non-ox.)	302,134	3.9%
Reclaimed area (above water level)			1,508,004	19.4%
Total			**7,774,501**	**100%**

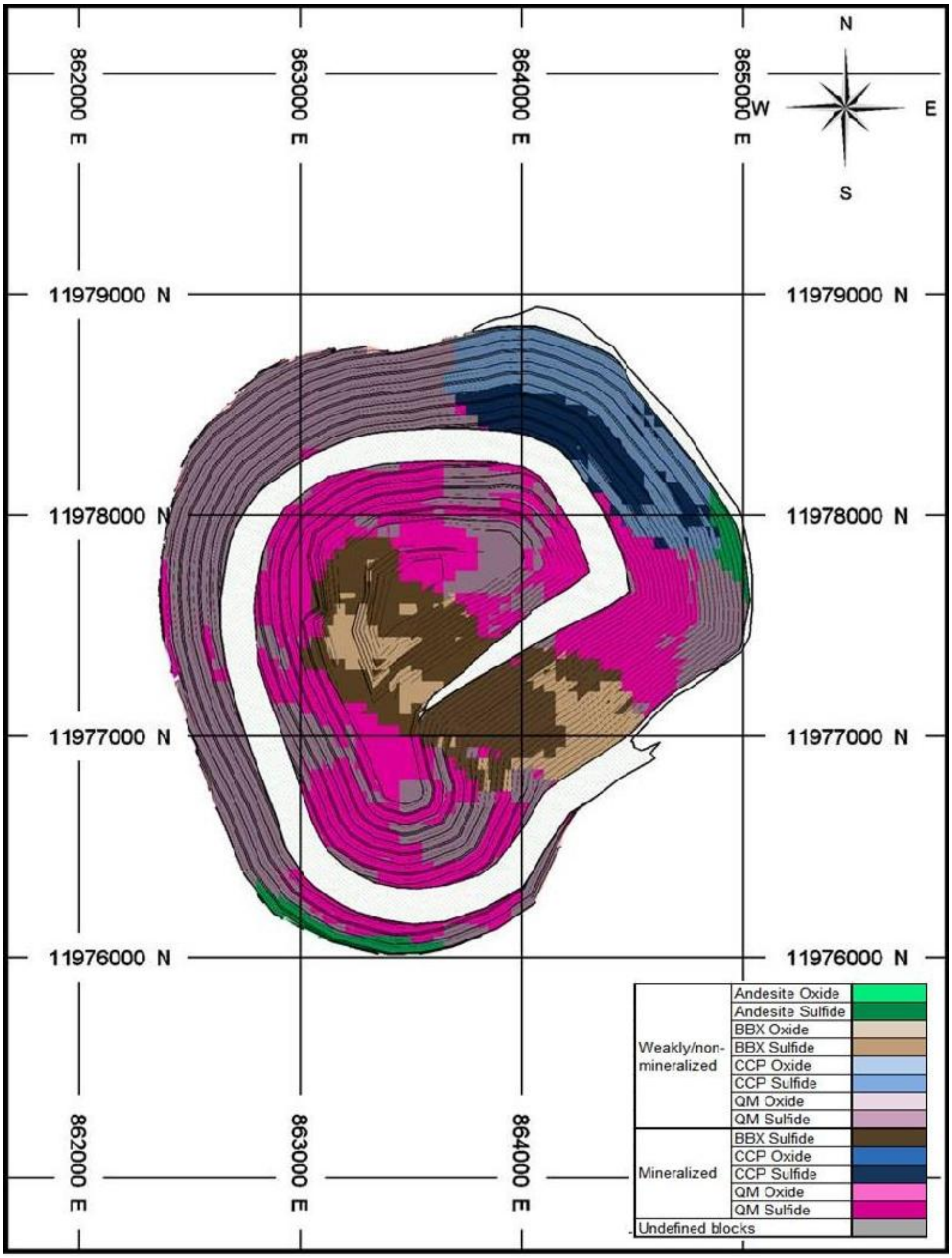

Figure 6-2: Exposed Material Types in Final Walls of the Reclaimed Pit

6.3 Calculation of Pit Wall Rock Available for Leaching

The blasting techniques that will be used for the reclaimed pit will be identical to those for the unreclaimed pit model. As such, a 1 foot thickness of reactive rock in the pit walls has also been assumed for the reclaimed pit model (Siskind and Fumanti, 1974; Kelsall et al., 1984). The method used to calculate the mass of pit wall available for leaching was identical to that used for the unreclaimed pit model (Section 5.3).

6.4 Water Balance

A pit lake water balance for the reclaimed pit model with rapid fill has been developed by JSAI and is based on the following inputs/assumptions (JSAI, 2017):

- The pit will be filled with 2,200 acre-feet from the water supply wells during the six months of pit infilling;
- Rapid fill stops when the 4,897 ft water elevation is achieved;
- Evaporation will represent the dominant solution loss; and
- The pit lake evaporation rate is 50 inches per year.

As with the unreclaimed pit model, the pit lake for the reclaimed pit model will also be a hydrologic sink. The pit lake filling curve is shown in Figure 6-3 and the various inputs/outputs to the pit are shown in Figure 6-4.

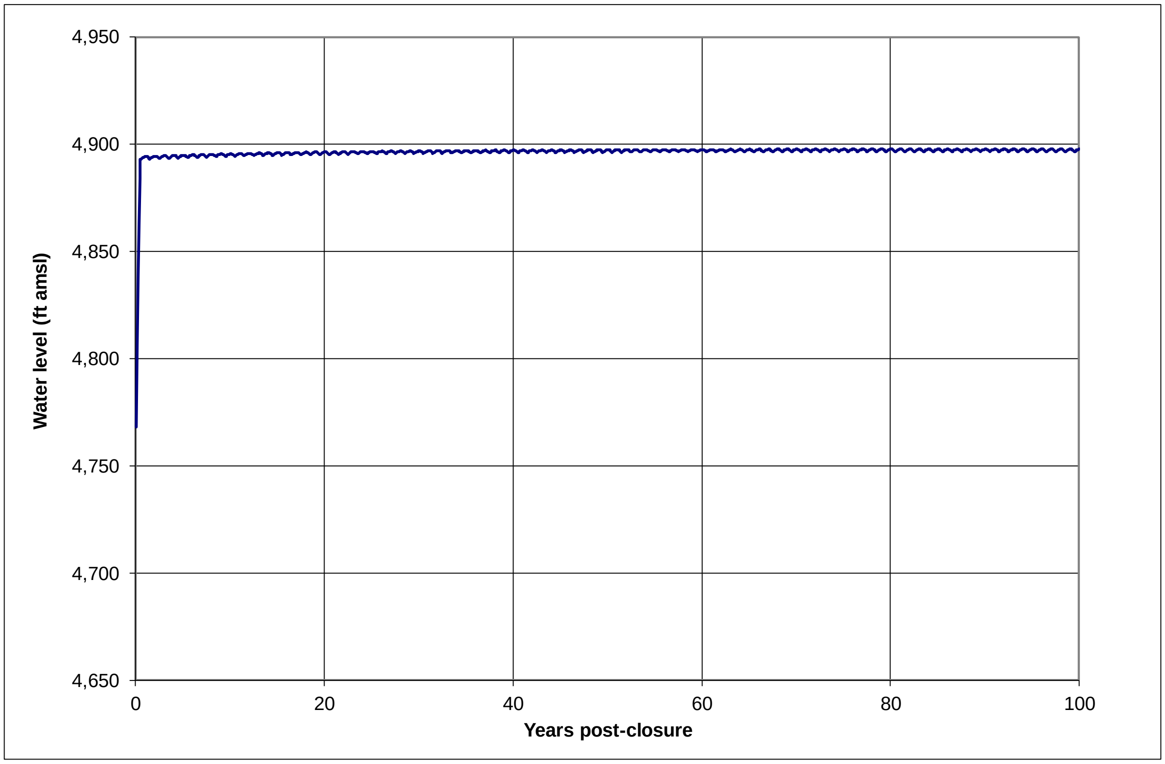

Figure 6-3: Pit Lake Elevation Curve for Reclaimed Pit Model with Rapid Fill

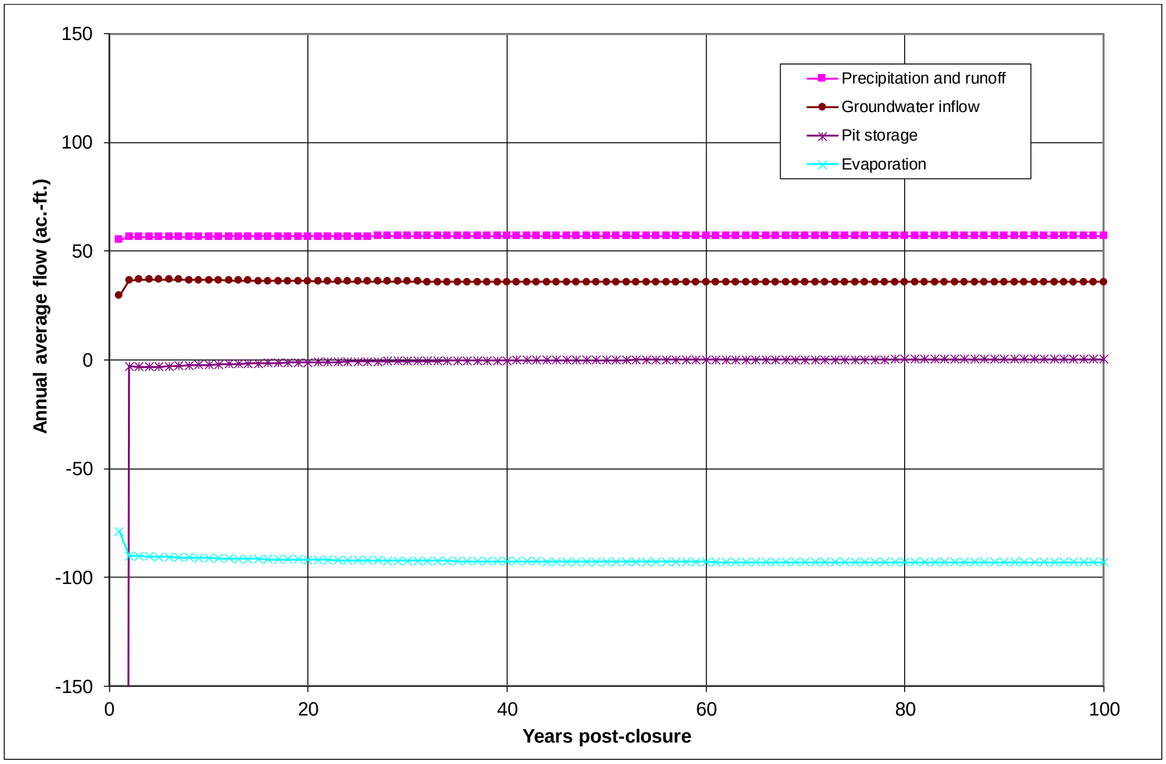

Figure 6-4: **Pit Lake Flux for Reclaimed Pit Model with Rapid Fill**

6.5 Solution Inputs

6.5.1 Precipitation Chemistry

As with the existing pit model (Section 4) and unreclaimed pit model (Section 5), the primary wall rock lixiviant for the pit high walls in the reclaimed pit model is assumed to be precipitation. Representative precipitation chemistry data were obtained from monthly monitoring carried out between 1985 and 2011 at the Gila Cliff Dwellings National Monument meteorological station, Catron County, New Mexico (NADP, 2012).

6.5.2 Groundwater Chemistry

Following the initial rapid fill with water from the supply wells, groundwater will continue to enter the pit. The groundwater chemistry used for the reclaimed pit model was identical to that used for the unreclaimed pit model (Section 5.5.2, Table 5-2).

6.5.3 Wall Rock Chemistry

The pit shell and exposed wall rocks for the reclaimed pit model will be identical to those in the unreclaimed model. As such, the same wall rock source terms were used in the model (Section 5.5.3, Table 5-2).

6.5.4 Water Supply Well Chemistry

Water used to rapidly fill the pit is represented by hydrochemical data from water supply wells PW-1 and PW-3 (Table 6-2; JSAI, 2017c; Appendix E).

Table 6-2: Water Supply Well Chemistry for PW-1 and PW-3 used to Represent Rapid Fill Water Quality in the Reclaimed Pit Model

Parameter		Units	Average Chemistry for PW-1 and PW-3
pH	pH	s.u.	8.03
HCO_3	Bicarbonate	mg/L	135
Ag	Silver	mg/L	<0.005*
Al	Aluminum	mg/L	<0.02*
As	Arsenic	mg/L	0.005
B	Boron	mg/L	0.08
Ba	Barium	mg/L	0.009
Be	Beryllium	mg/L	<0.002*
Ca	Calcium	mg/L	28
Cd	Cadmium	mg/L	<0.002*
Cl	Chloride	mg/L	41
Co	Cobalt	mg/L	<0.006*
Cu	Copper	mg/L	<0.006*
Cr	Chromium	mg/L	0.006
F	Fluoride	mg/L	1.45
Fe	Iron	mg/L	0.053
Hg	Mercury	mg/L	<0.0002*
K	Potassium	mg/L	3.35
Mg	Magnesium	mg/L	2.05
Mn	Manganese	mg/L	0.0025
Mo	Molybdenum	mg/L	<0.008*
Na	Sodium	mg/L	69.5
Ni	Nickel	mg/L	<0.01*
Pb	Lead	mg/L	<0.005*
SO_4	Sulfate	mg/L	27
Se	Selenium	mg/L	<0.001*
Si	Silica	mg/L	19
U	Uranium	mg/L	0.0023
V	Vanadium	mg/L	<0.05*
Tl	Thallium	mg/L	<0.001
Zn	Zinc	mg/L	0.023

* Parameters below analytical detection limits were not included in the input to the PHREEQC model

6.5.5 Reclaimed Surface Chemistry

At closure, several areas of the pit will be reclaimed. Water quality associated with run-off from these areas is therefore likely to have a different chemical composition from the rest of the pit walls. As such, the water balance provided by JSAI includes a separate input to the water balance for the reclaimed areas and receiving watershed. Conveyed stormwater is expected to have a chemistry similar to background surface water quality from SWQ-1 (Table 6-3; JSAI, 2015b).

Table 6-3: Water Supply Well Chemistry for SWQ-1 used to Represent reclaimed pit Run-off Water Quality in the Reclaimed Pit Model

Parameter		Units	Average Chemistry for SWQ-1
pH	pH	s.u.	8.3
HCO_3	Bicarbonate	mg/L	430
Al	Aluminum	mg/L	<0.1*
As	Arsenic	mg/L	<0.005*
B	Boron	mg/L	0.02
Ba	Barium	mg/L	<0.5*
Ca	Calcium	mg/L	109
Cd	Cadmium	mg/L	<0.002*
Cl	Chloride	mg/L	30
Co	Cobalt	mg/L	<0.05*
Cu	Copper	mg/L	<0.01*
Cr	Chromium	mg/L	<0.02*
F	Fluoride	mg/L	0.3
Fe	Iron	mg/L	<0.05*
Hg	Mercury	mg/L	<0.001*
K	Potassium	mg/L	1.8
Mg	Magnesium	mg/L	36
Mn	Manganese	mg/L	<0.02*
Mo	Molybdenum	mg/L	<0.02*
Na	Sodium	mg/L	107
Pb	Lead	mg/L	<0.02*
Se	Selenium	mg/L	<0.005*
SO_4	Sulfate	mg/L	261
Zn	Zinc	mg/L	<0.01*

* Parameters below analytical detection limits were not included in the input to the PHREEQC model

6.6 Results

The predicted pit lake chemistry for the reclaimed pit model is summarized in Table 6-4 and illustrated in Figure 6-5 to Figure 6-18 for selected parameters. These show predicted pit lake chemistry at each of the modeled time steps (i.e., 0.5, 1, 2, 5, 10, 25, 50, 75 and 100 years post-closure) compared to water quality in the existing pit lake. The full PHREEQC output file is provided in Appendix I, which shows precipitating and dissolving mineral species at each time step as part of the mass transfer calculations.

As with the unreclaimed pit model, pit lake waters for the reclaimed pit model are predicted to be moderately alkaline (pH 8.0 – 8.4) with a predominantly sodium + chloride/sulfate (Na + SO_4/Cl) major ion signature (Figure 6-18). Rapidly filling the pit with the water supply wells during the first six months post-closure results in a more dilute initial water chemistry with a sodium-chloride (Na+Cl) signature. The result is that the effects of evapoconcentration are not as pronounced as the pit lake reaches hydrogeologic equilibrium, and predicted concentrations of many major ions and trace elements at 100 years remain lower than if natural fill were used. This is particularly the case for constituents such as boron, sulfate and chloride, which are strongly influenced by evaporation effects and are predicted to be much lower in concentration for the rapid fill scenario compared to the natural fill scenario. The rapid fill will also quickly submerge walls and benches to limit the exposure of sulfide minerals to oxygen, which will reduce trace element release into the pit lake.

As with the unreclaimed model, concentrations of the majority of constituents are either comparable to or less than concentrations in the existing pit lake at Copper Flat. Pit lake waters for the reclaimed pit model are predicted to be ‘near-neutral, low-metal’ waters based on pH values between 8.0 and 8.4 and total Ficklin metal concentrations less than 1 mg/L (Figure 6-17). Ficklin metal concentrations are predicted to evolve and increase over time as a result of evapoconcentration effects. This evolution in chemistry is similar to the trends observed in the existing pit lake and reflects the environment or climate control rather than one related to mining; however, for the future reclaimed pit, water chemistry is predicted to remain in the ‘near-neutral, low-metal’ classification for all modeled time steps as the metal-releasing material will not be exposed.

Table 6-4: Reclaimed Pit Model Results

Parameter		Units	*Measured Chemistry in Existing Pit (1989 - 2017)*			Predicted Future Chemistry (Years Post-Closure)								
			Average	*Minimum*	*Maximum*	0.5	1	2	5	10	25	50	75	100
pH	**pH**	s.u.	*6.5*	*3.6*	*8.3*	8.4	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0
HCO_3	**Bicarbonate**	mg/L	*40.4*	*<3*	*122*	84.7	82.5	80.3	74.9	68.3	57.7	50.2	46.8	44.6
Al	**Aluminium**	mg/L	*10.4*	*<0.02*	*82.6*	0.0003	0.001	0.002	0.005	0.01	0.03	0.05	0.08	0.10
As	**Arsenic**	mg/L	*0.004*	*<0.001*	*0.006*	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005
B	**Boron**	mg/L	*0.14*	*<0.1*	*0.2*	0.08	0.09	0.10	0.12	0.16	0.28	0.49	0.69	0.89
Ca	**Calcium**	mg/L	*550*	*455*	*684*	13.0	14.3	16.2	22.1	32.6	66.7	126.4	185	244
Cd	**Cadmium**	mg/L	*0.05*	*<0.005*	*0.1*	0.00008	0.00016	0.0003	0.0008	0.0016	0.0039	0.0077	0.012	0.015
Co	**Cobalt**	mg/L	*0.29*	*<0.05*	*0.49*	0.00005	0.0001	0.0002	0.0006	0.001	0.003	0.006	0.010	0.013
Cr	**Chromium**	mg/L	*0.03*	*<0.006*	*0.1*	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.008	0.009
Cu	**Copper**	mg/L	*4.44*	*0.001*	*26.5*	0.002	0.01	0.02	0.05	0.05	0.04	0.03	0.03	0.03
F	**Fluoride**	mg/L	*19.2*	*4.8*	*34*	1.49	1.52	1.61	1.86	2.28	3.50	5.53	5.38	5.29
Fe	**Iron**	mg/L	*0.2*	*<0.02*	*1.3*	3.93E-05	3.95E-05	3.97E-05	4.04E-05	4.15E-05	4.44E-05	4.81E-05	5.08E-05	5.31E-05
Hg	**Mercury**	mg/L	*0.0005*	*<0.0002*	*0.001*	0.000005	0.00001	0.00002	0.00005	0.0001	0.0002	0.0005	0.0007	0.0009
K	**Potassium**	mg/L	*32.1*	*11.0*	*60.6*	5.16	6.88	10.4	20.9	38.2	89.5	174	259	344
Mg	**Magnesium**	mg/L	*698*	*43*	*1,120*	3.70	5.52	9.03	19.5	36.7	87.6	172	256	340
Mn	**Manganese**	mg/L	*34.8*	*0.02*	*59.0*	0.04	0.09	0.17	0.43	0.85	2.09	4.14	6.19	8.23
Mo	**Molybdenum**	mg/L	*0.04*	*0.015*	*0.1*	0.003	0.005	0.01	0.03	0.05	0.13	0.25	0.38	0.50
Na	**Sodium**	mg/L	*888*	*165*	*1,400*	72.8	75.3	81.5	99.7	130	219	368	517	665
Ni	**Nickel**	mg/L	*0.06*	*0.039*	*0.1*	0.0001	0.0002	0.000	0.001	0.002	0.005	0.010	0.015	0.020
Pb	**Lead**	mg/L	*0.02*	*<0.005*	*0.1*	0.0002	0.0004	0.0009	0.0024	0.0049	0.012	0.024	0.037	0.049
Sb	**Antimony**	mg/L	*<0.001**			0.00004	0.0001	0.0002	0.0004	0.001	0.002	0.004	0.006	0.008
Se	**Selenium**	mg/L	*0.028*	*<0.001*	*0.25*	0.0002	0.0003	0.001	0.002	0.003	0.008	0.017	0.025	0.033
U	**Uranium**	mg/L	*0.11*	*0.11*	*0.12*	0.002	0.003	0.005	0.01	0.02	0.05	0.10	0.15	0.20
V	**Vanadium**	mg/L	*0.1*	*<0.05*	*0.25*	0.0001	0.0003	0.0007	0.002	0.004	0.009	0.02	0.03	0.04
Zn	**Zinc**	mg/L	*5.4*	*0.01*	*9*	0.03	0.03	0.04	0.07	0.11	0.25	0.47	0.70	0.92
SO_4	**Sulfate**	mg/L	*4,803*	*1,566*	*8,690*	42.0	60.5	94.1	194	358	845	1,651	2,455	3,258
Cl	**Chloride**	mg/L	*332*	*47.3*	*730*	66.6	67.3	69.9	77.9	91.0	130	196	262	327
TDS	**Total Dissolved Solids**	mg/L	*7,538*	*2,711*	*14,800*	290	314	363	511	759	1,503	2,749	3,995	5,239

* *Indicates parameter was uniformly below analytical detection limits in pit lake water over monitoring period, but detection limit was variable. Concentration shown in table represents lower limit of analytical detection.*

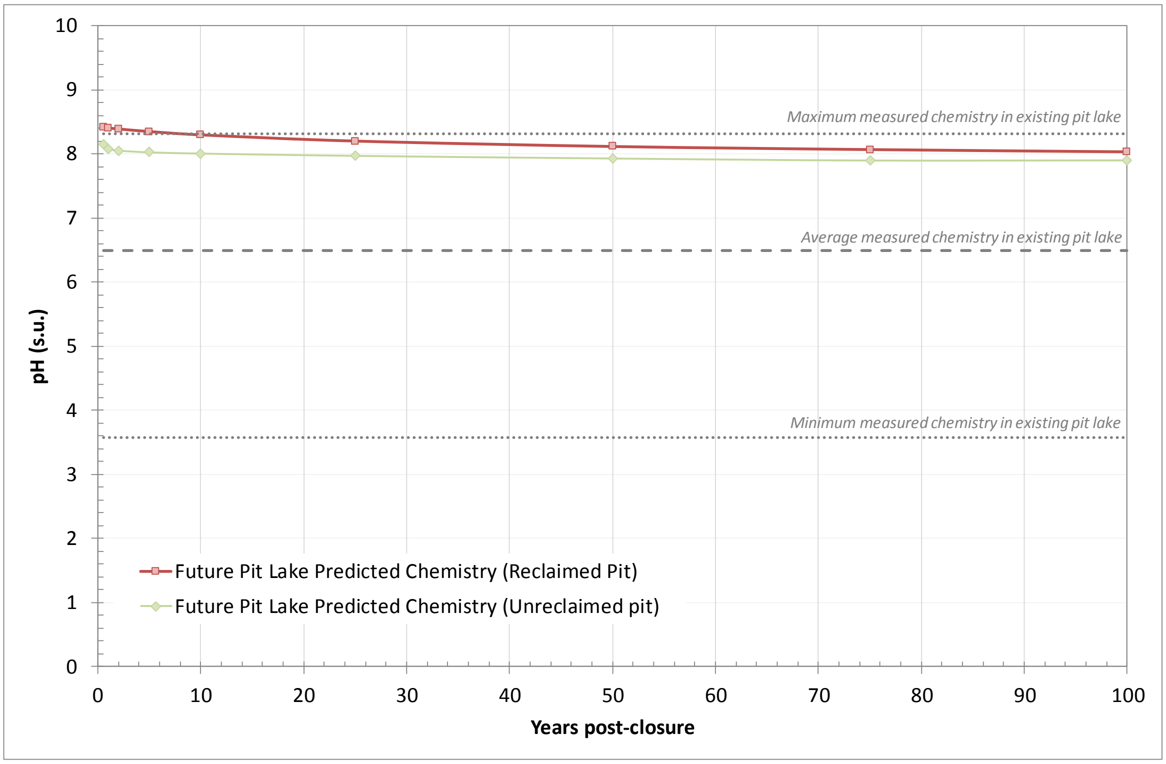

Figure 6-5: Time-series Plot of Predicted pH for the Reclaimed Pit Model

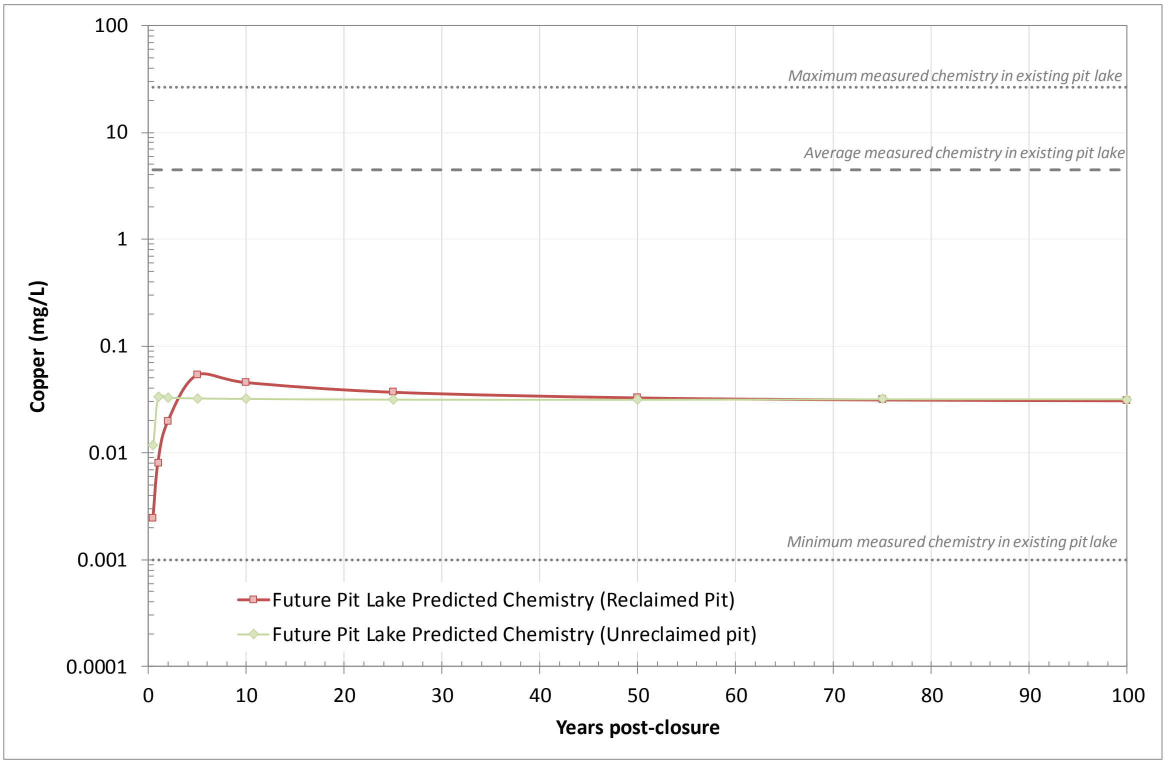

Figure 6-6: Time-series Plot of Predicted Copper for the Reclaimed Pit Model

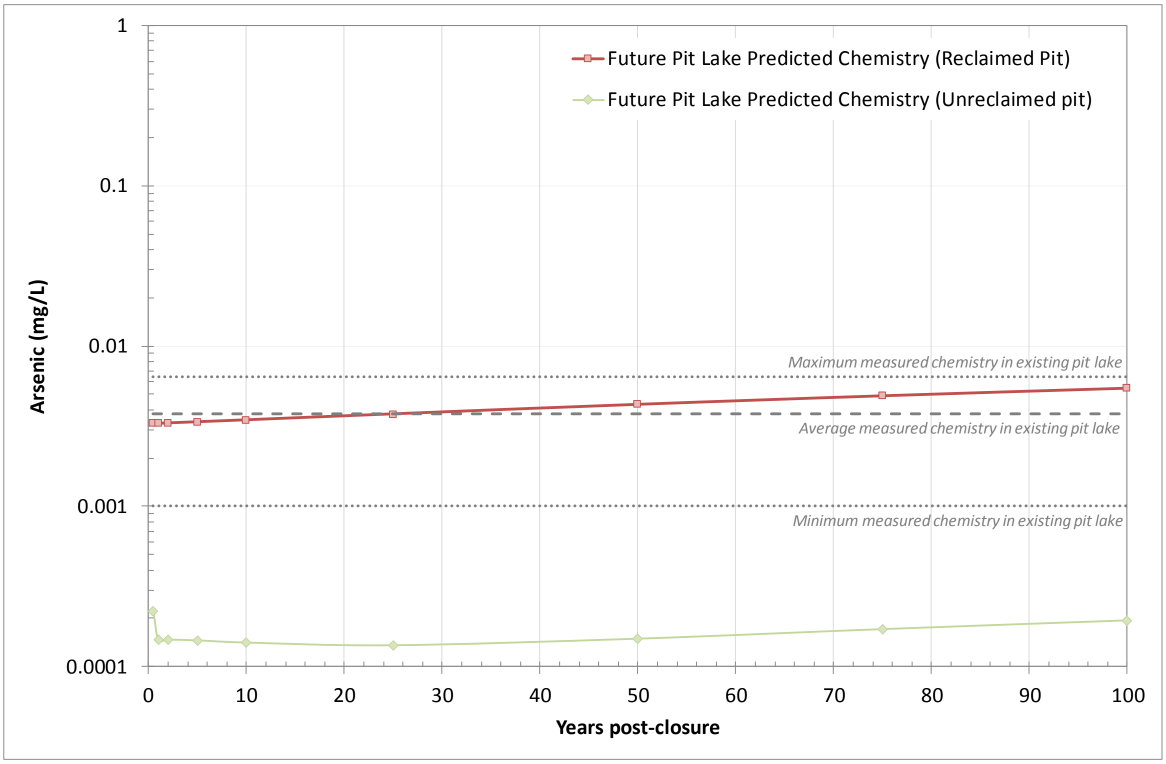

Figure 6-7: Time-series Plot of Predicted Arsenic for the Reclaimed Pit Model

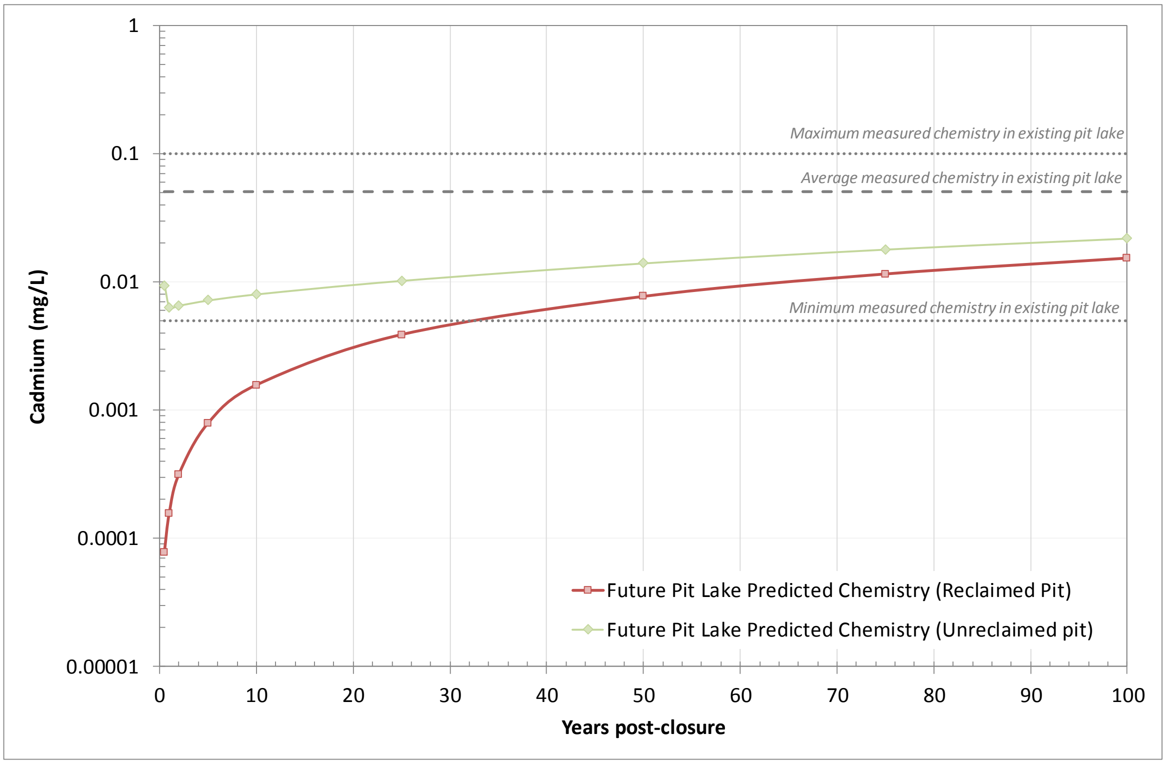

Figure 6-8: Time-series Plot of Predicted Cadmium for the Reclaimed Pit Model

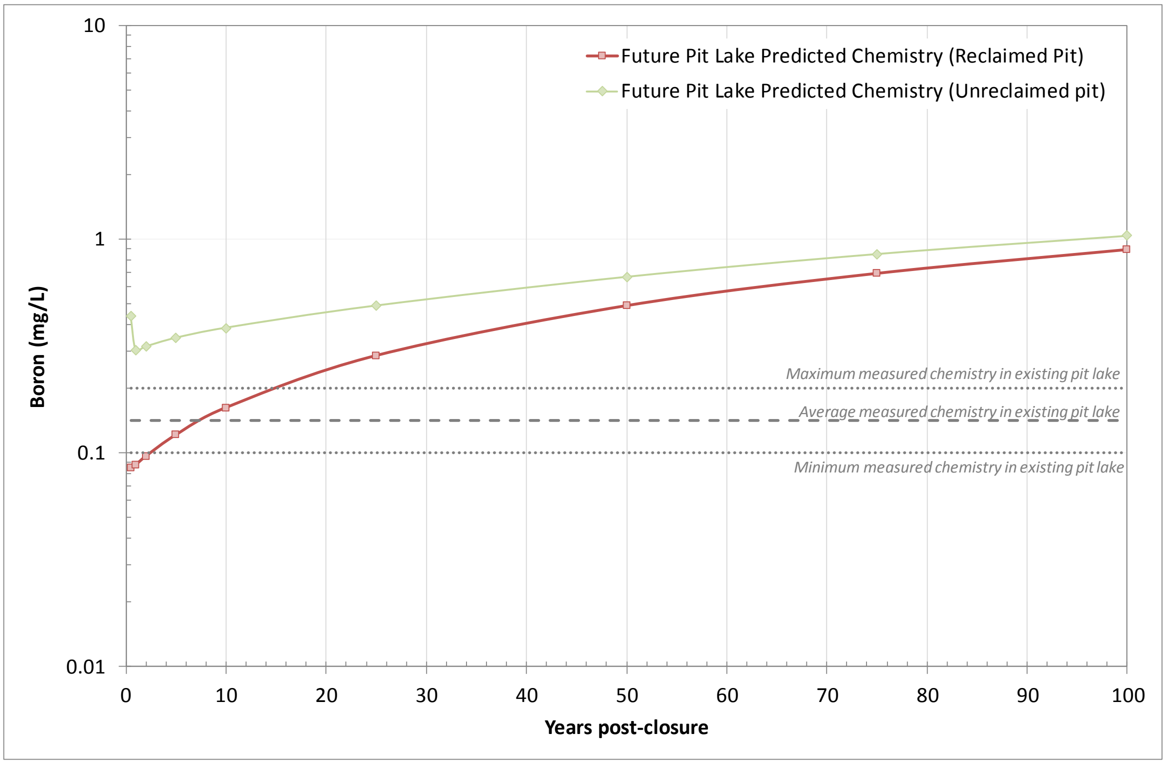

Figure 6-9: Time-series Plot of Predicted Boron for the Reclaimed Pit Model

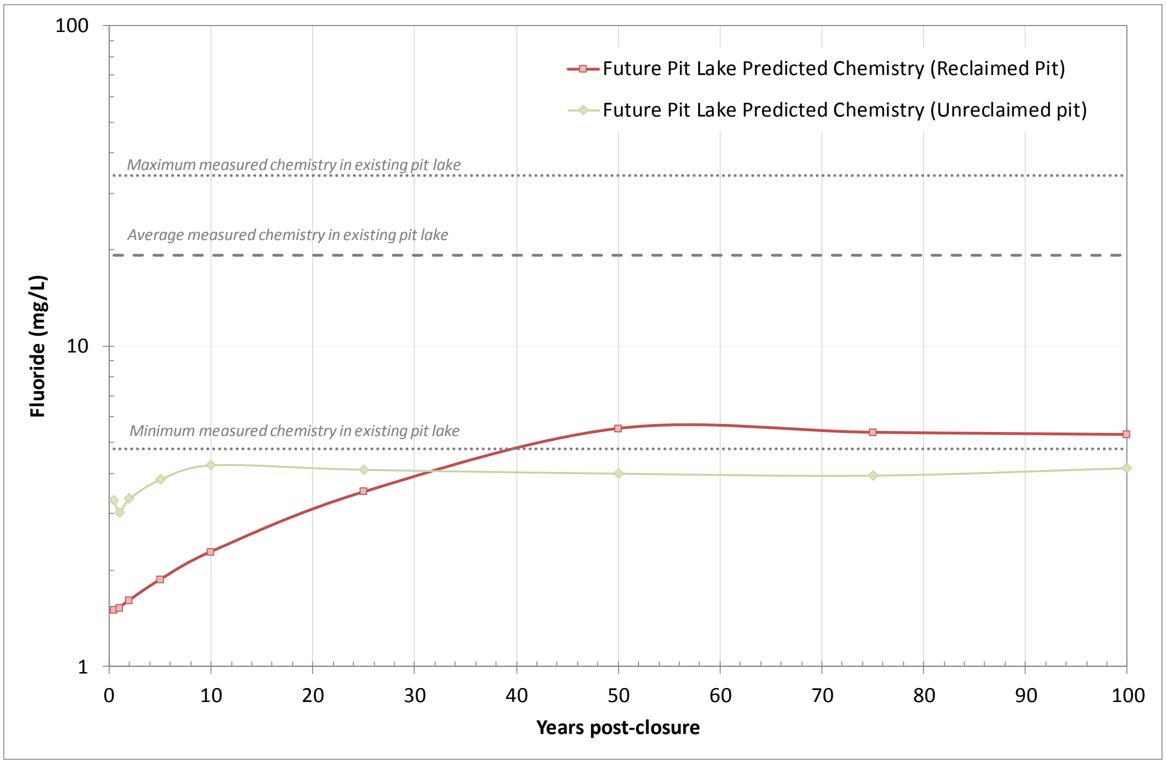

Figure 6-10: Time-series Plot of Predicted Fluoride for the Reclaimed Pit Model

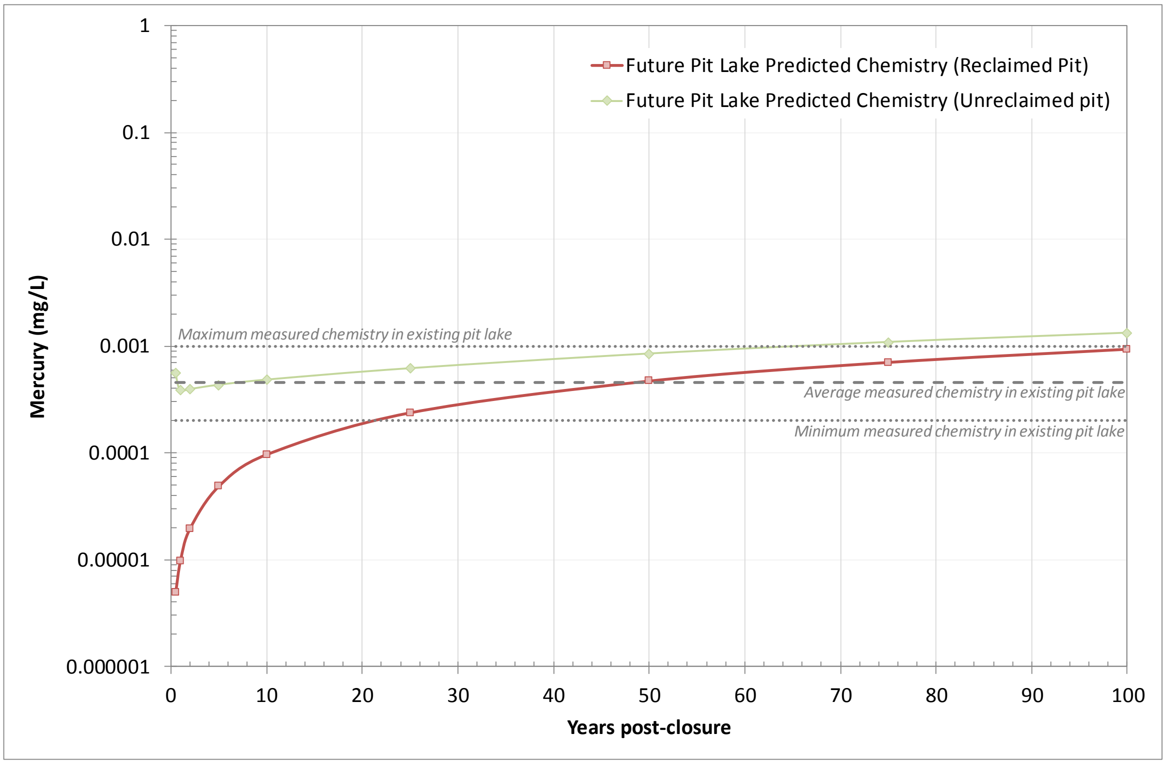

Figure 6-11: Time-series Plot of Predicted Mercury for the Reclaimed Pit Model

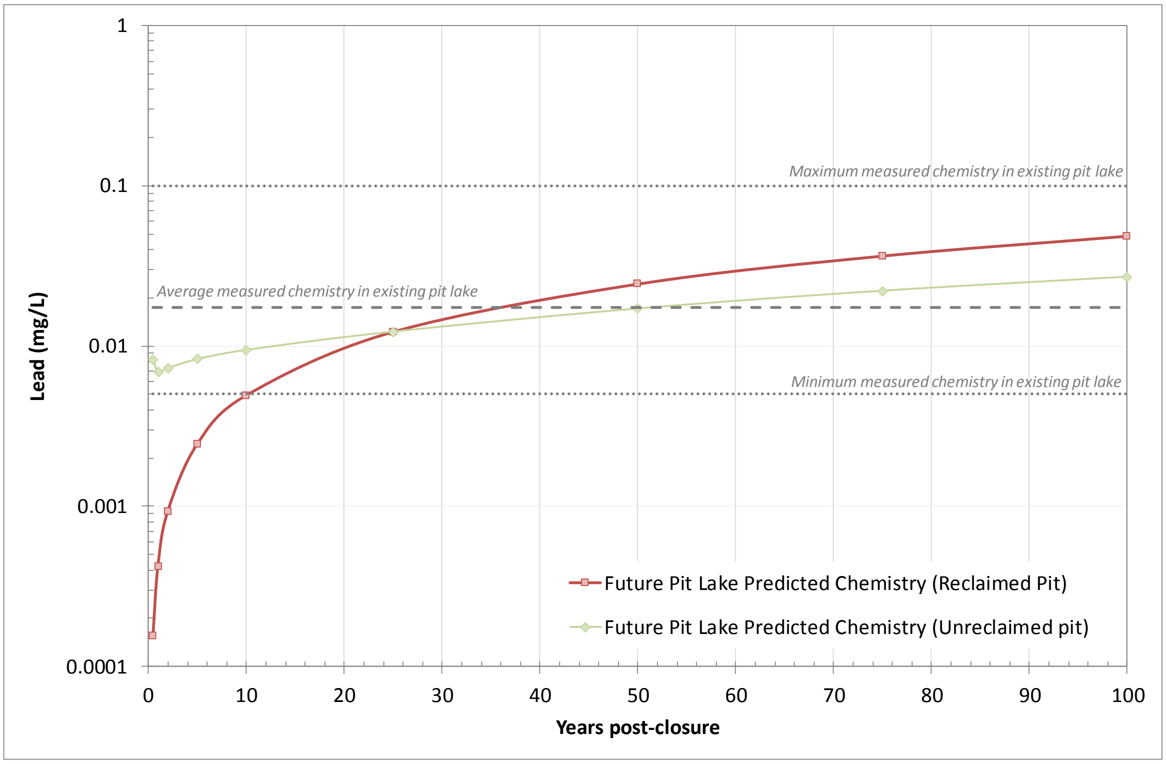

Figure 6-12: Time-series Plot of Predicted Lead for the Reclaimed Pit Model

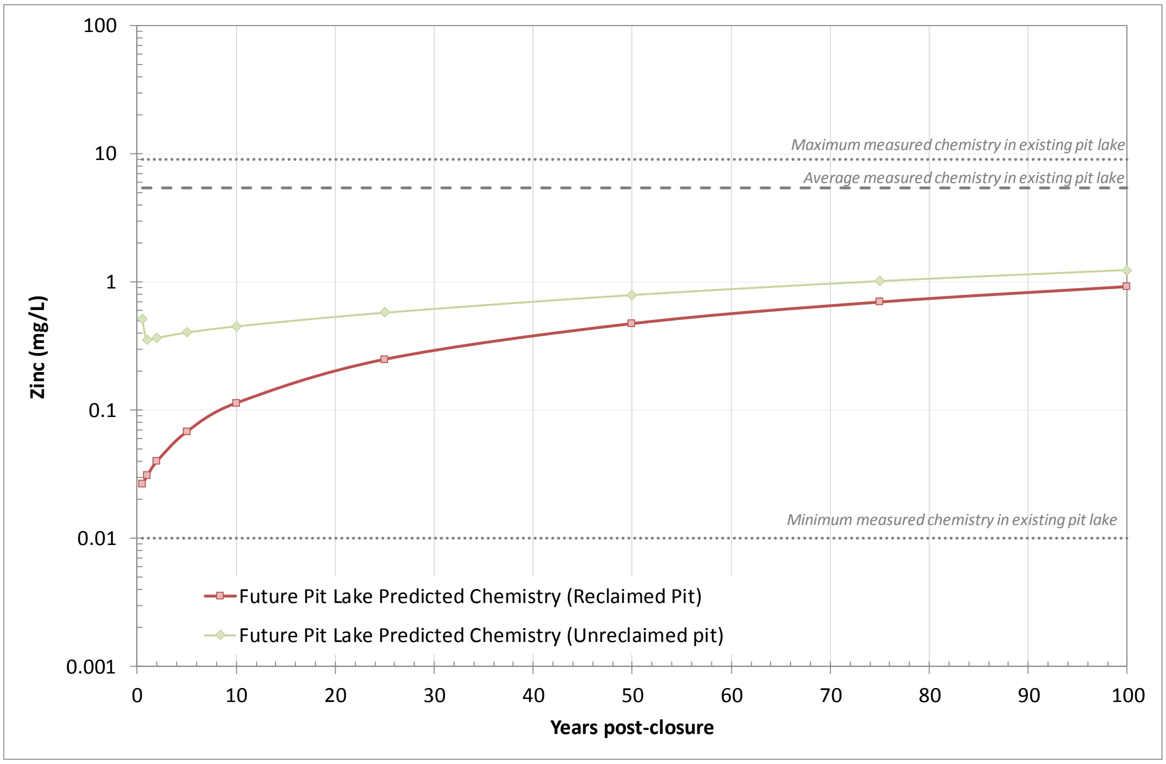

Figure 6-13: Time-series Plot of Predicted Zinc for the Reclaimed Pit Model

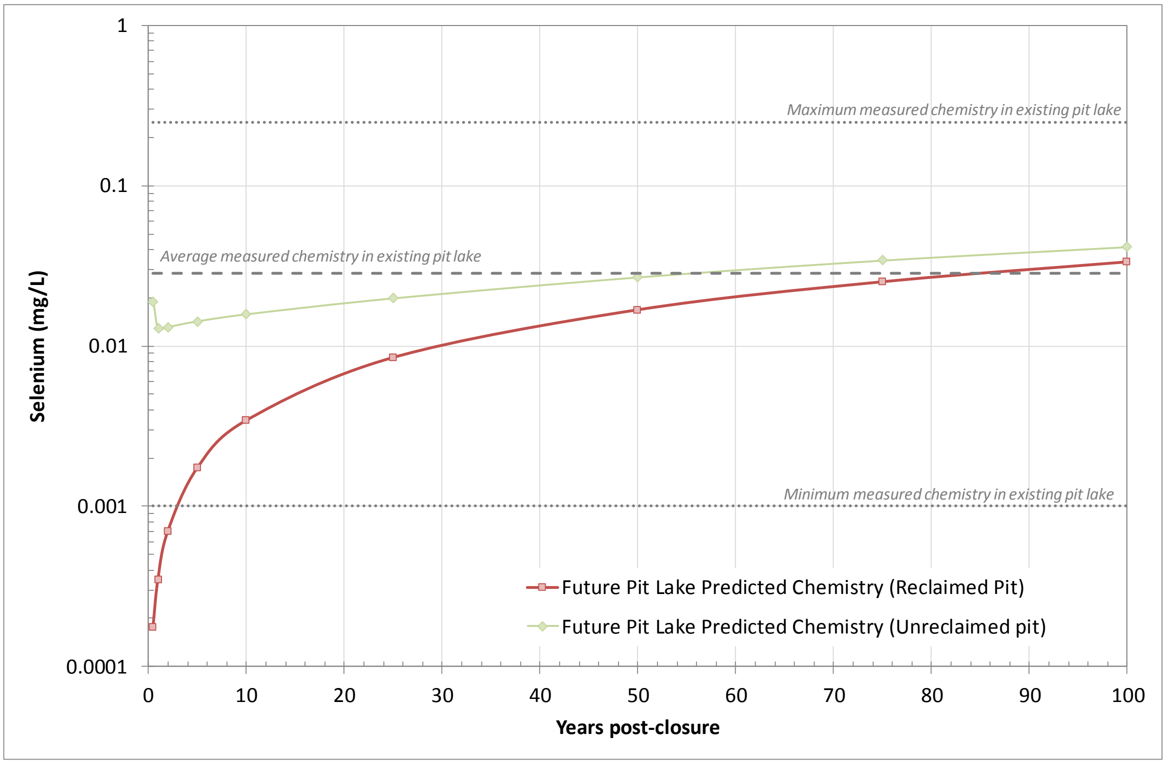

Figure 6-14: Time-series Plot of Predicted Selenium for the Reclaimed Pit Model

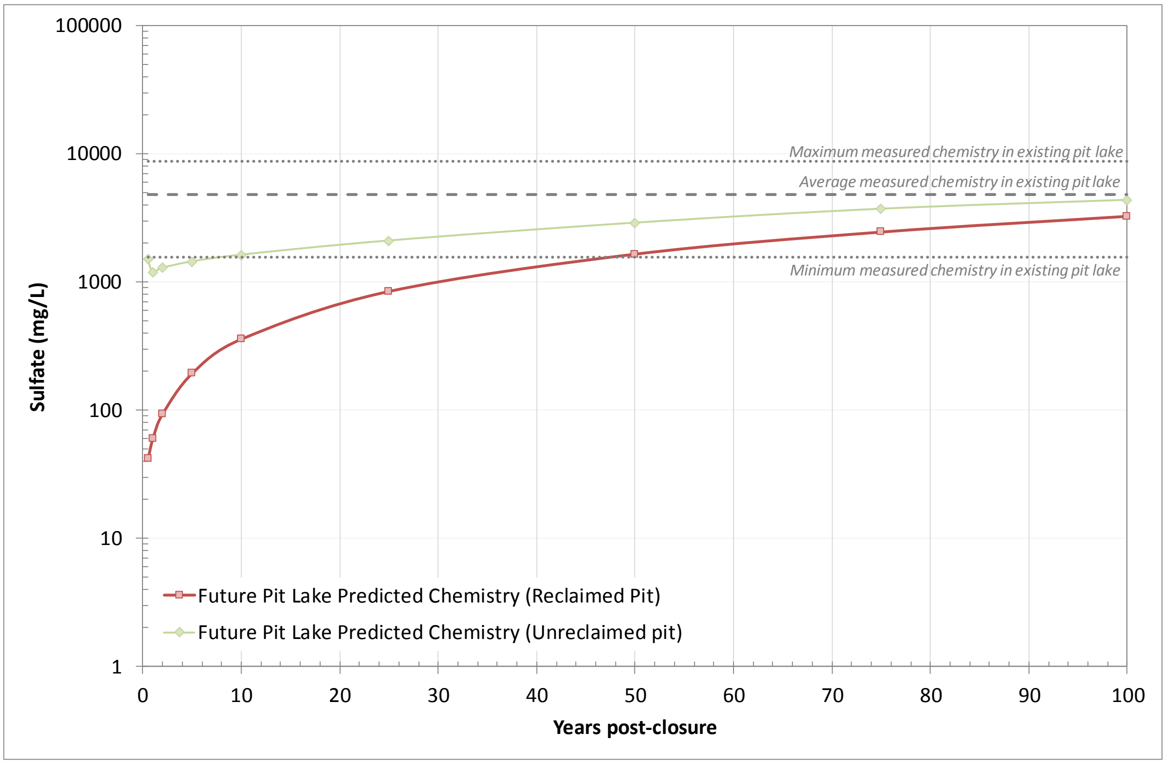

Figure 6-15: **Time-series Plot of Predicted Sulfate for the for the Reclaimed Pit Model**

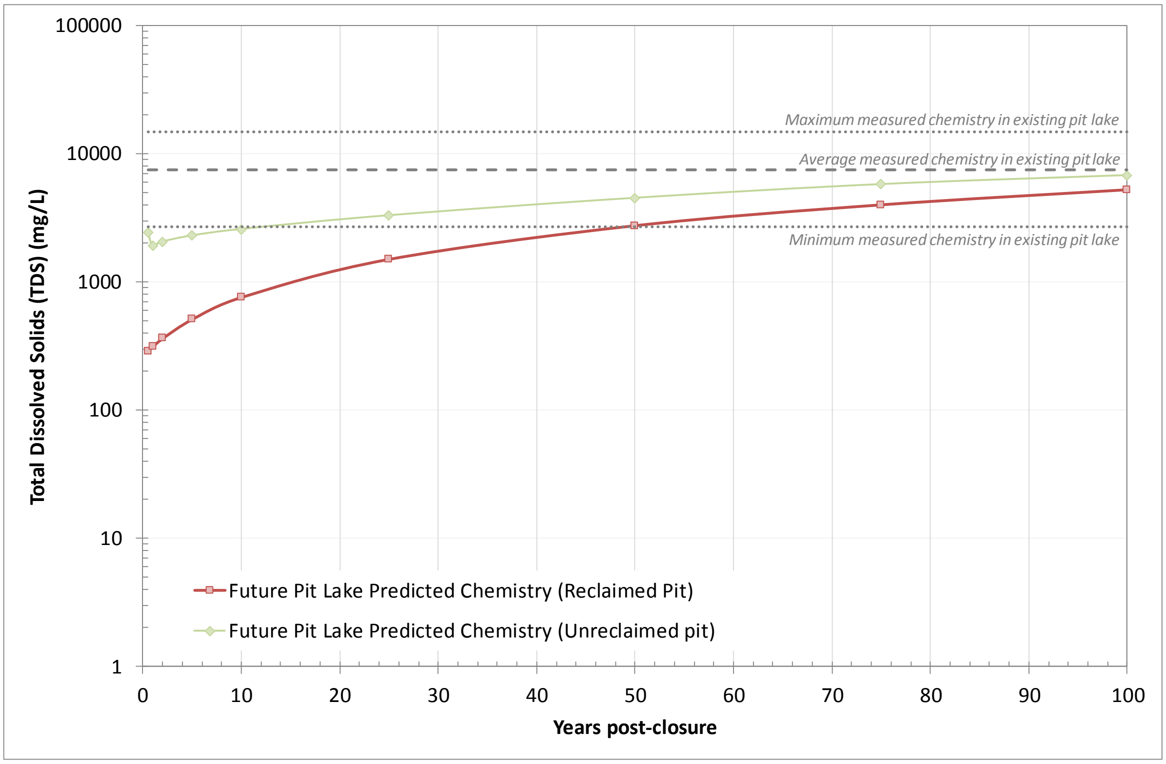

Figure 6-16: **Time-series Plot of Predicted TDS for the for the Reclaimed Pit Model**

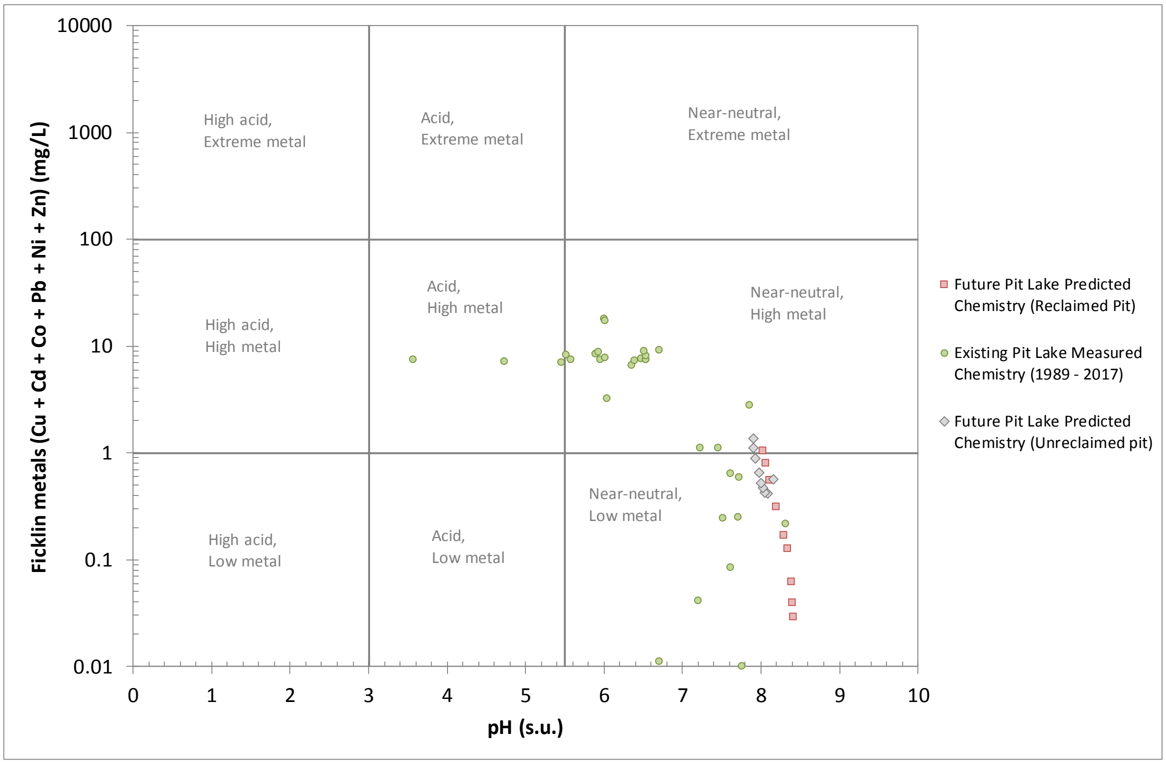

Figure 6-17: Ficklin Plot for the Reclaimed Pit Model

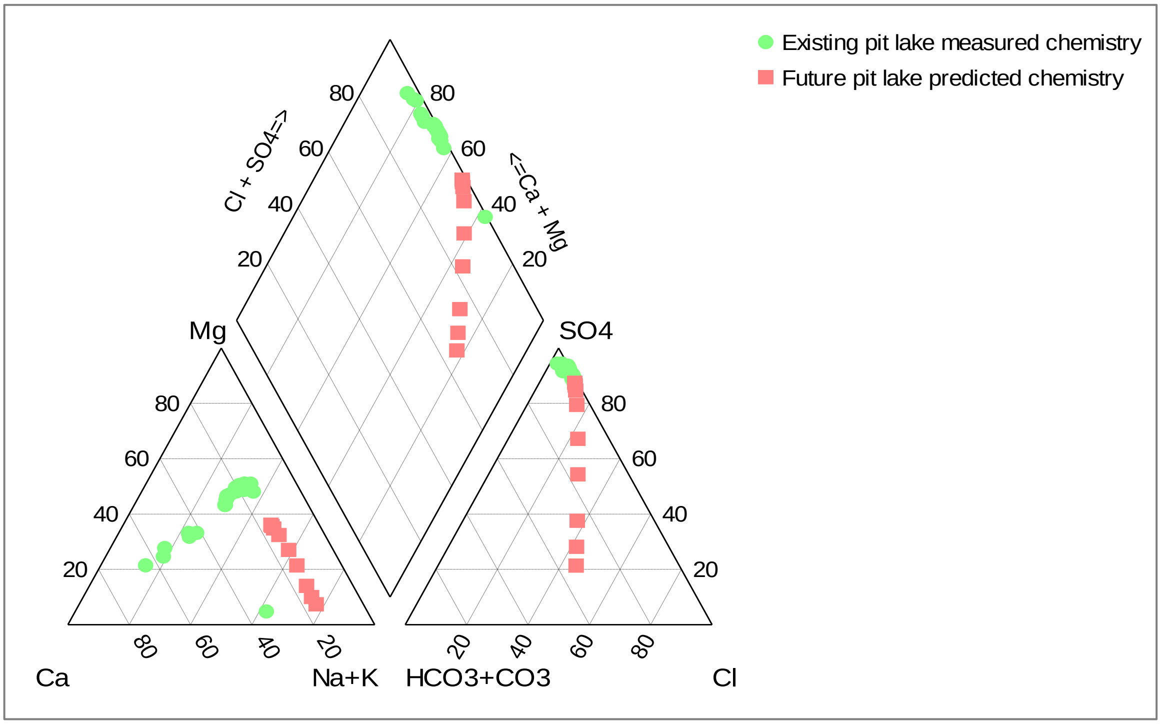

Figure 6-18: Piper Plot of Predicted Major Ion Chemistry for the Reclaimed Pit Model

7 Summary and Conclusions

SRK has undertaken a predictive geochemical modeling exercise to assess potential future pit lake chemistry associated with the Copper Flat Project in New Mexico and to compare this to the chemistry of the existing pit lake. The objective of this model and report is to provide the analysis that demonstrates that future pit lake water quality results in a hydrologic balance similar to that of pre-mining conditions upon implementation of the reclamation actions proposed by NMCC in its MORP and Reclamation Plan, including rapid fill of the open pit after closure of the mine.

Geochemical predictions were developed for three scenarios, including: (i) a calibration model for the existing pit lake; (ii) a natural fill model for the future unreclaimed pit; and (iii) a rapid fill model for the future reclaimed pit. Rapid fill has been proposed as the water component of NMCC's reclamation strategy for the future pit lake. It will include filling the pit with 2,200 acre-feet of good quality water from the production water supply wells during the first six months of groundwater recovery and pit infilling.

7.1 Model Calibration

The results of the existing pit lake model show good calibration for pH, bicarbonate, calcium, aluminum, cobalt, chromium, copper, mercury, manganese, sodium, nickel, selenium, uranium, zinc and TDS, demonstrating these constituents can be predicted with a good degree of accuracy for the future pit lake. The baseline water quality data utilized in the calibration model are data for existing water quality chemistry in the pit lake between 2010 and 2013, as discussed in Section 4. Model calibration was performed as part of the preliminary pit lake model results presented in the December 2014 report (SRK, 2014a). This is a subset of the entire baseline data generated between 1998 and July 2017. The full data set was utilized in comparing existing water quality chemistry to projected future water quality of the pit lake, as discussed in Sections 5 and 6.

7.2 Unreclaimed Fill Scenario

For the unreclaimed fill scenario, allowing the pit to fill naturally will result in the pit walls and benches being exposed over a much longer period of time, i.e., approximately 150 years, before the pit lake reaches hydrologic equilibrium. In the unreclaimed fill scenario, the proposed future Copper Flat open pit is expected to be seasonally stratified but otherwise well-mixed, oxygenated and not acidic. Waters are predicted to be moderately alkaline (pH 7.9 – 8.2), primarily due to the buffering capacity of the inflowing groundwater. During the early stages of pit infilling (i.e., the first six months post-closure), removal/flushing of soluble salts from the pit walls is likely to result in a flush in boron, lead, mercury, manganese, molybdenum, nickel, selenium, vanadium, zinc and sulfate in the early pit lake. The effects of this initial flush will be dissipated by inflowing groundwater and precipitation, and pit lake chemistry will then evolve over time, with some parameters increasing in concentration as a result of evapoconcentration effects. This is similar to the trends observed in the existing pit lake where elemental concentrations have increased since the start of pit infilling. However, the mineralized material to be mined and the future pit walls will be prepared using pre-split drilling and smooth wall blasting. This will reduce the depth of fracturing and oxidation and consequently reduce solute loading to the future pit lake.

A comparison of predicted pit lake water chemistry for the unreclaimed fill scenario to chemistry measured in the existing pit lake between 1989 and 2017 demonstrates that the predicted concentrations of the majority of constituents are comparable to existing concentrations.

7.3 Reclaimed Fill Scenario

Rapidly filling the pit with water from the production supply wells during the first six months post-closure will result in a better initial water quality within the pit lake due to the good quality of the water that will be used. The long-term result is that the effects of evapoconcentration will not be as pronounced as the pit lake reaches hydrogeologic equilibrium. Predicted concentrations of many major ions and trace elements remain lower in the reclaimed fill scenario. This is the case for constituents such as boron, sulfate and chloride, which are strongly influenced by evaporation effects and are predicted to be much lower in concentration for the reclaimed pit rapid fill scenario compared to the unreclaimed pit natural fill scenario. In addition, the rapid fill will also quickly submerge walls and benches to limit the exposure of sulfide minerals to oxygen, which will reduce trace element release into the pit lake. By contrast, the unreclaimed fill scenario allows the pit to fill naturally and results in the pit walls and benches being exposed over a much longer period of time, i.e., approximately 150 years, before the pit lake reaches hydrologic equilibrium. As is the case in the unreclaimed fill scenario, the mineralized material to be mined and the future pit walls will be prepared using pre-split drilling and smooth wall blasting, which will also reduce the depth of fracturing and oxidation and consequently reduce solute loading to the pit lake.

A comparison of predicted pit lake chemistry for the reclaimed pit rapid fill scenario to chemistry measured in the existing pit lake between 1989 and 2017 demonstrates that concentrations of the majority of predicted constituent concentrations are either comparable to or less than concentrations in the existing pit lake.

7.4 Conclusions

Standards applicable to the post-mining Copper Flat pit lake are contained in the New Mexico Mining and Minerals Division (MMD) regulations administered under the Mining Act. Specifically, the performance and reclamation standards require that reclamation must result in a hydrologic balance similar to pre-mining conditions. With respect to water quality in the pit lake, post mining water quality must be similar to baseline pre-mining water quality in the pit lake. The predictive geochemical model results presented herein have been compared to pre-mining baseline water quality of the existing pit lake, which has been in existence for more than 35 years.

Based on the model results presented herein, the changes to the hydrologic balance of the future pit water body that will form post-mining will be nil or minimal, and the water quality will be very similar to that of the existing pit lake. As noted above, the existing pit lake at Copper Flat is an artificial water body created as a result of mineral extraction that has little or limited ability to sustain aquatic life (Aquatic Consultants, Inc. 2014). The post-mining water body is anticipated to be similar to the existing pit lake and is not expected to be conductive to providing aquatic habitat or supporting fish life.

This report demonstrates that implementation of either the unreclaimed fill or reclaimed fill scenario will provide compliance with water quality requirements discussed in Section 3.10 above. However, the reclaimed fill scenario leads to improved water quality during the modeled period. In addition, the overall performance and reclamation standards and requirements of the Mining Act regulations set forth additional standards, beyond those which are the subject of analysis in this report. In this regard, NMCC has committed to the reclamation plan as described in the MORP, including the pit reclamation measures outlined in Section 3.1.8 of this report.

Prepared by

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RGriffiths

Ruth Griffiths EurGeol, CGeol, PhD
Senior Consultant (Geochemistry)

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Amy Prestia, M.Sc., P.G.
Principal Consultant (Geochemistry)

Reviewed by

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RBowell

Eur. Geol. Rob Bowell PhD, CChem, CGeol
Corporate Consultant (Geochemistry)

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Appendix A – Time-Series Plots of Existing Pit Lake Chemistry

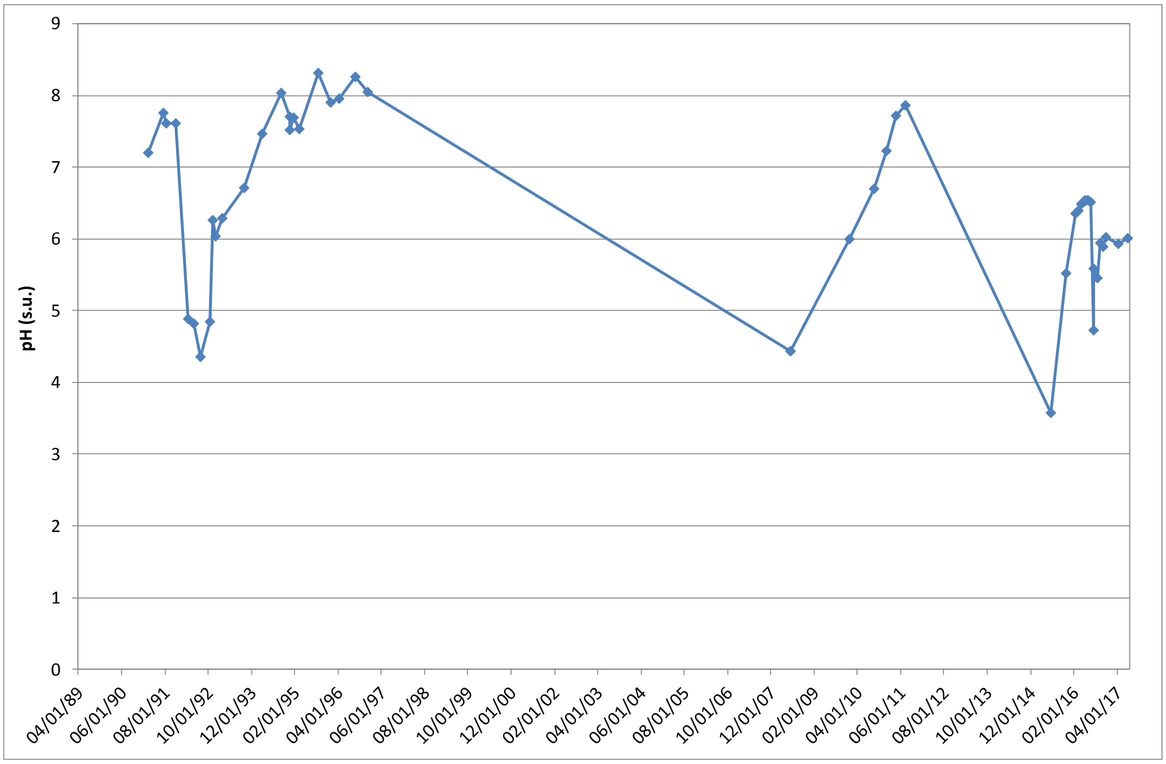

Figure A-1: pH Trends in Existing Pit Lake

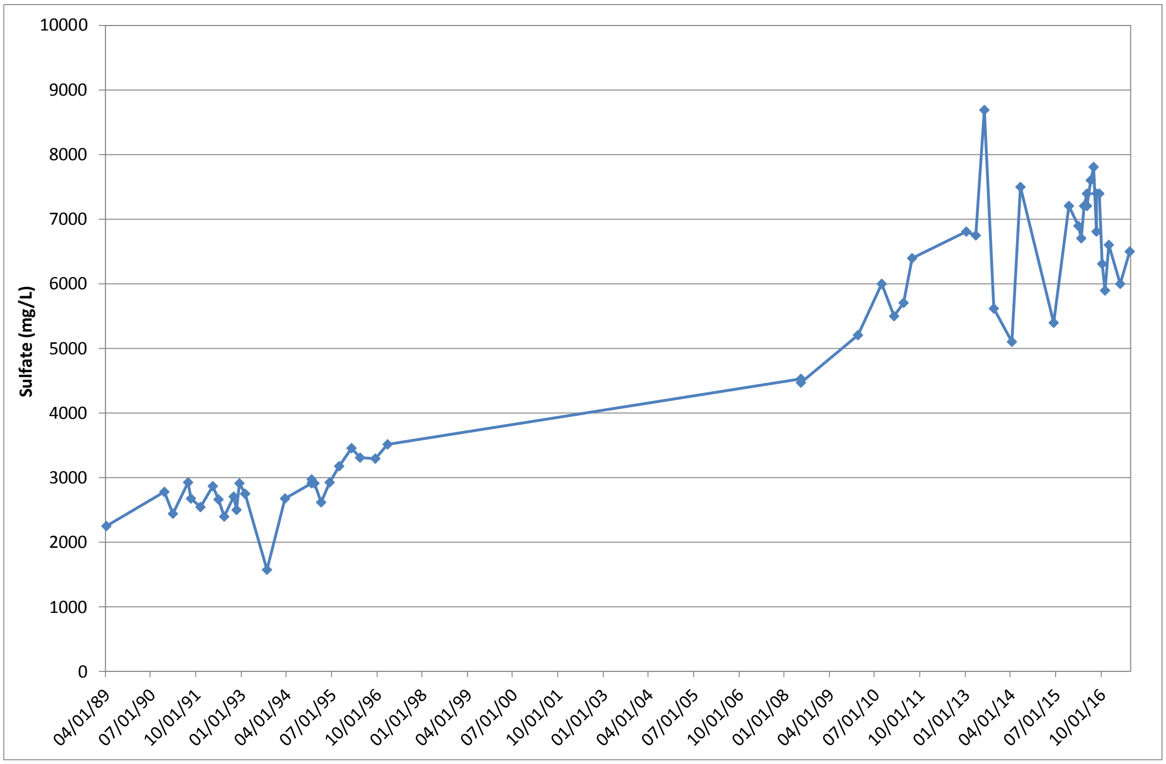

Figure A-2: Sulfate Trends in Existing Pit Lake

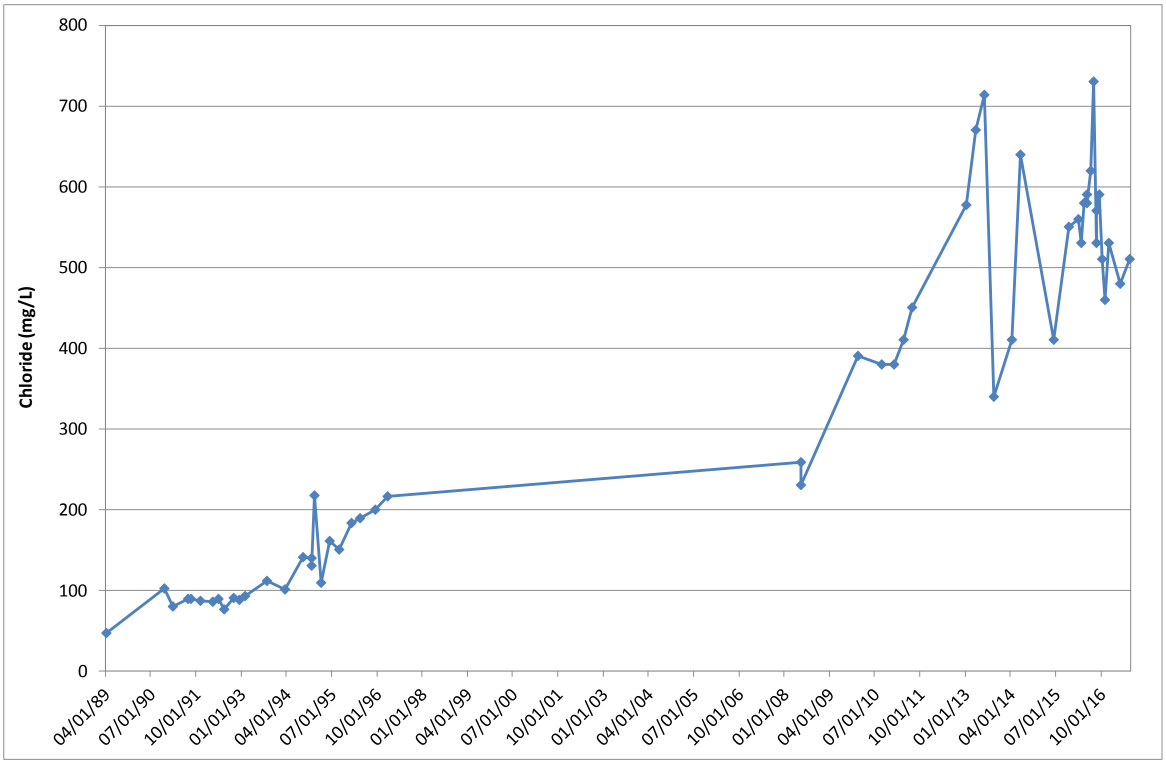

Figure A-3: Chloride Trends in Existing Pit Lake

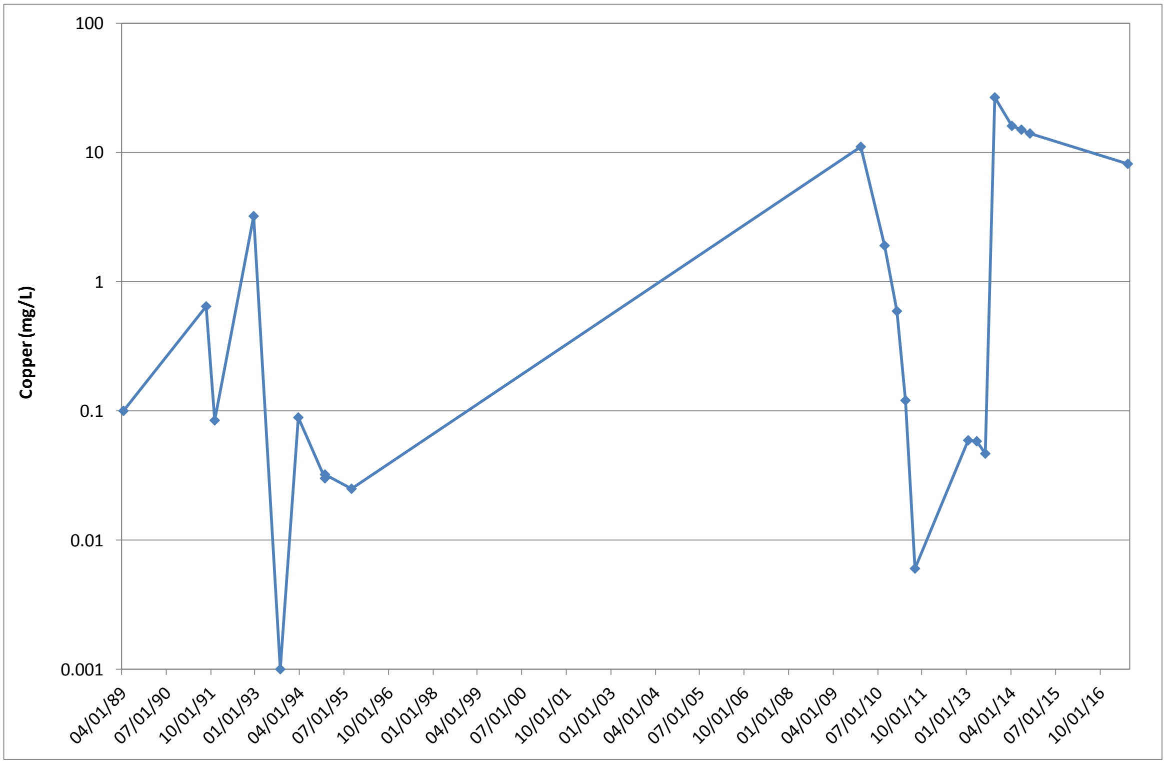

Figure A-4: Copper Trends in Existing Pit Lake

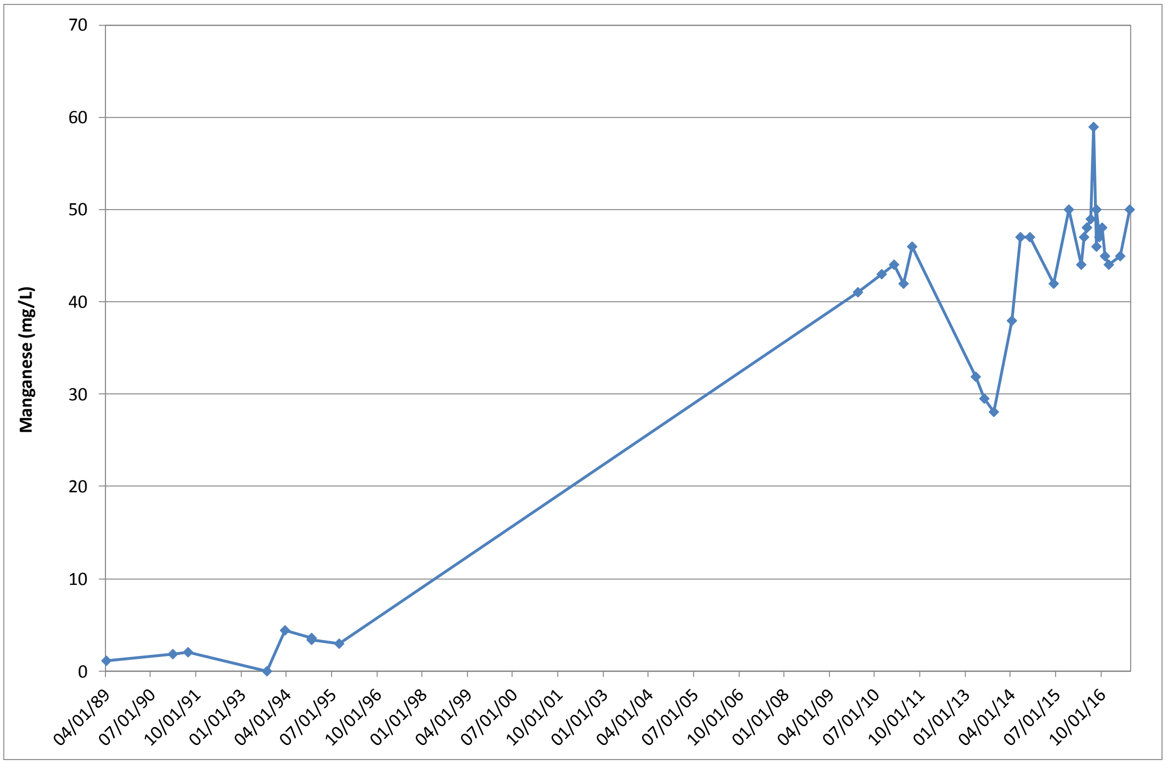

Figure A-5: Manganese Trends in Existing Pit Lake

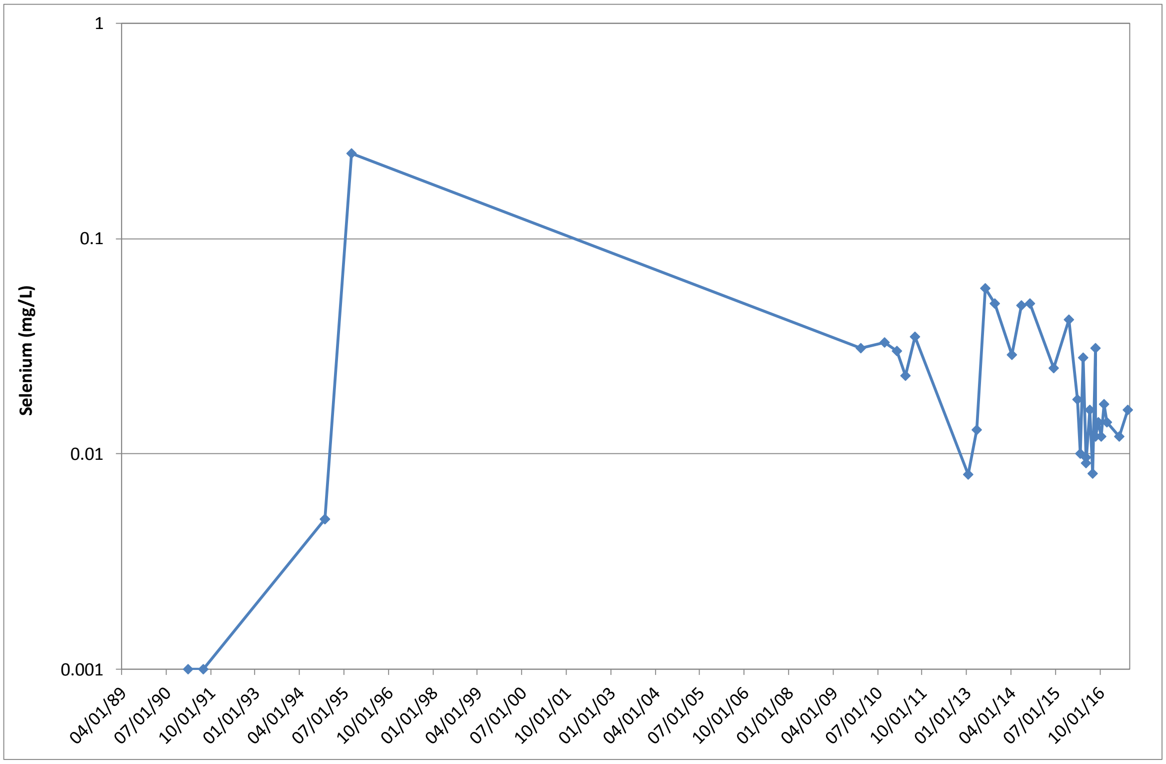

Figure A-6: Selenium Trends in Existing Pit Lake

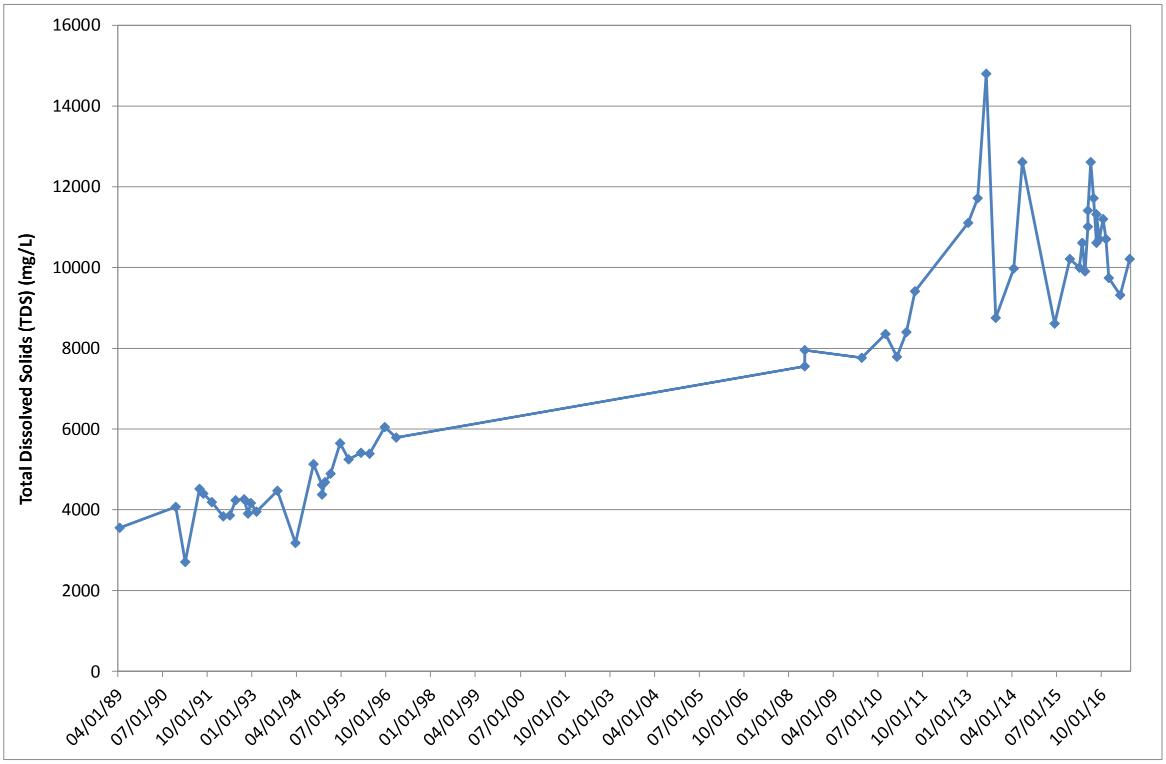

Figure A-7: TDS Trends in Existing Pit Lake

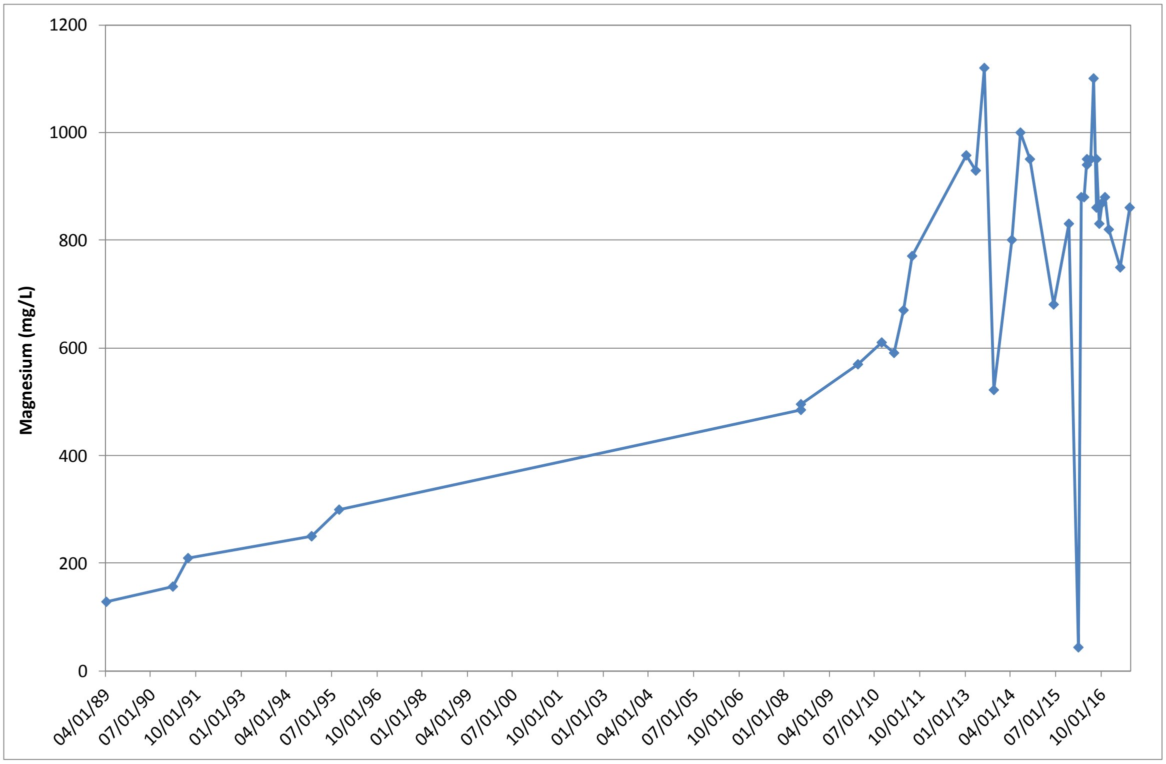

Figure A-8: Magnesium Trends in Existing Pit Lake

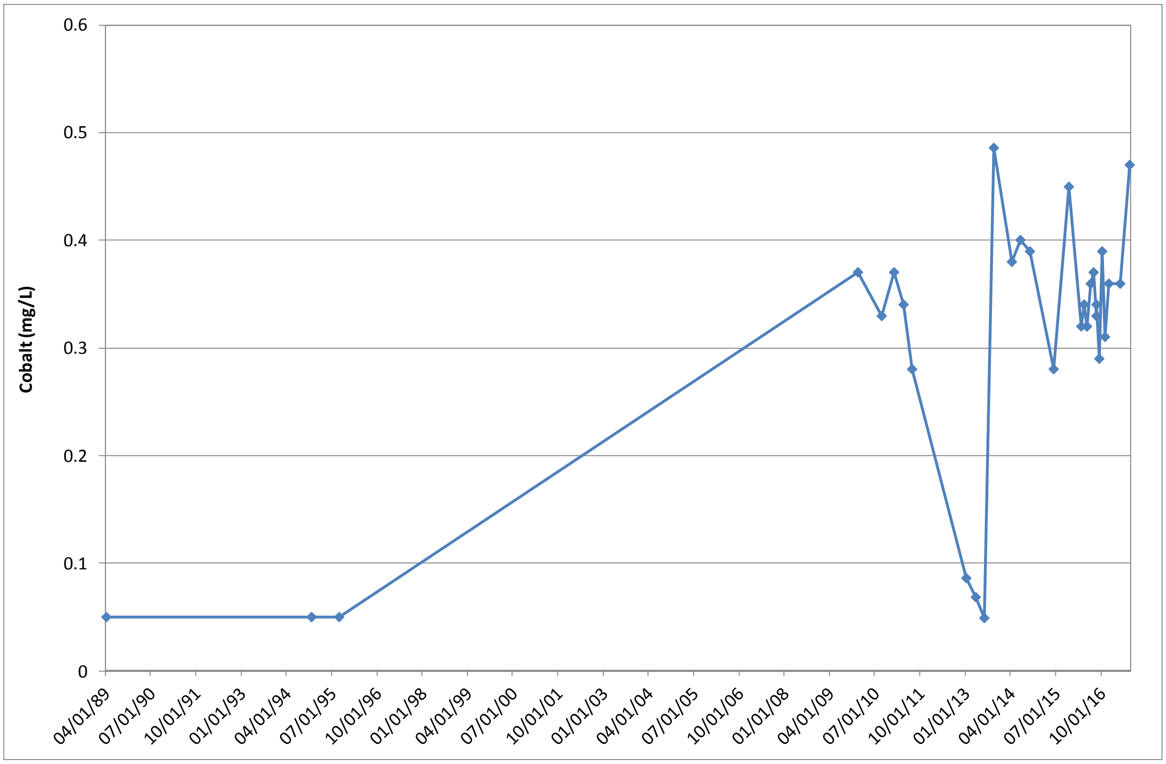

Figure A-9: Cobalt Trends in Existing Pit Lake

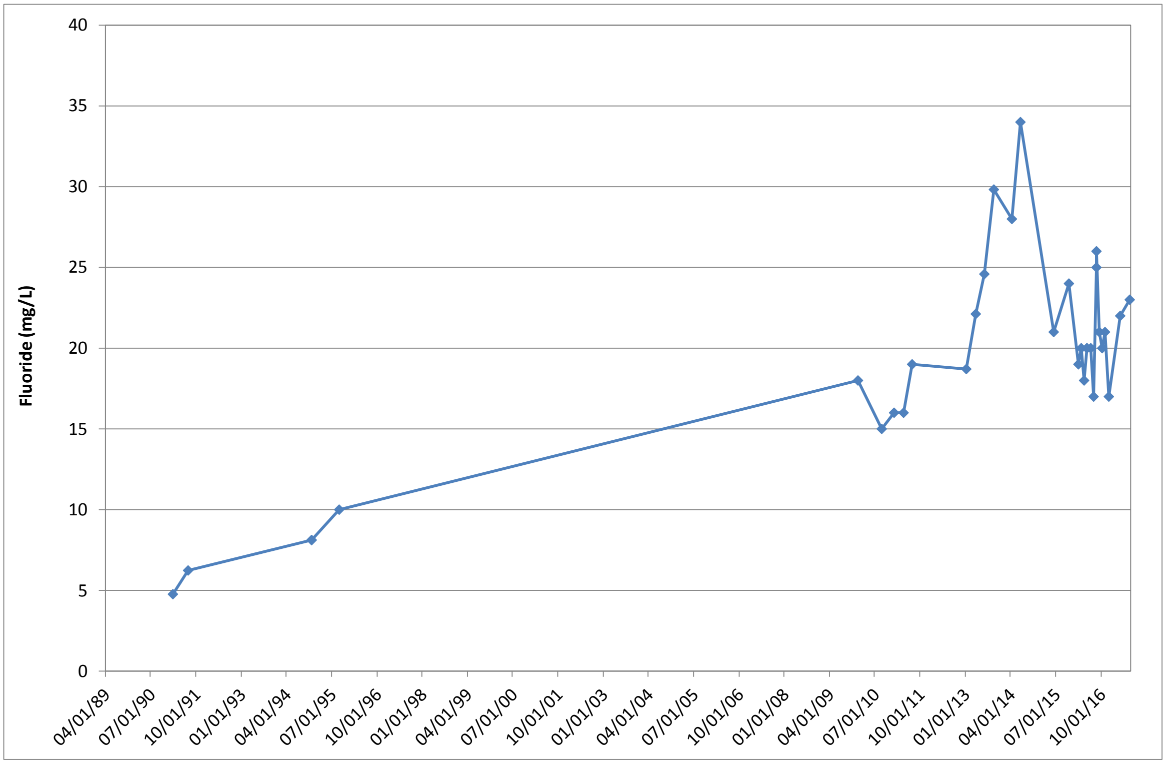

Figure A-10: Fluoride Trends in Existing Pit Lake

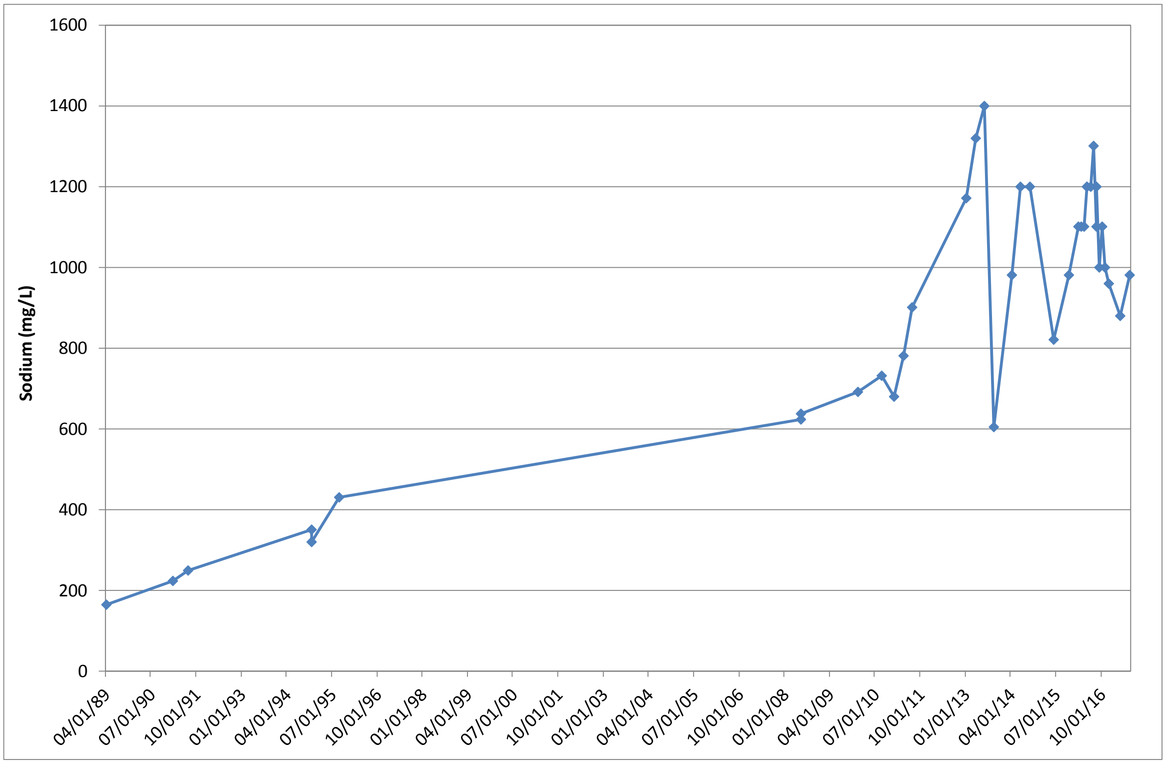

Figure A-11: Sodium Trends in Existing Pit Lake

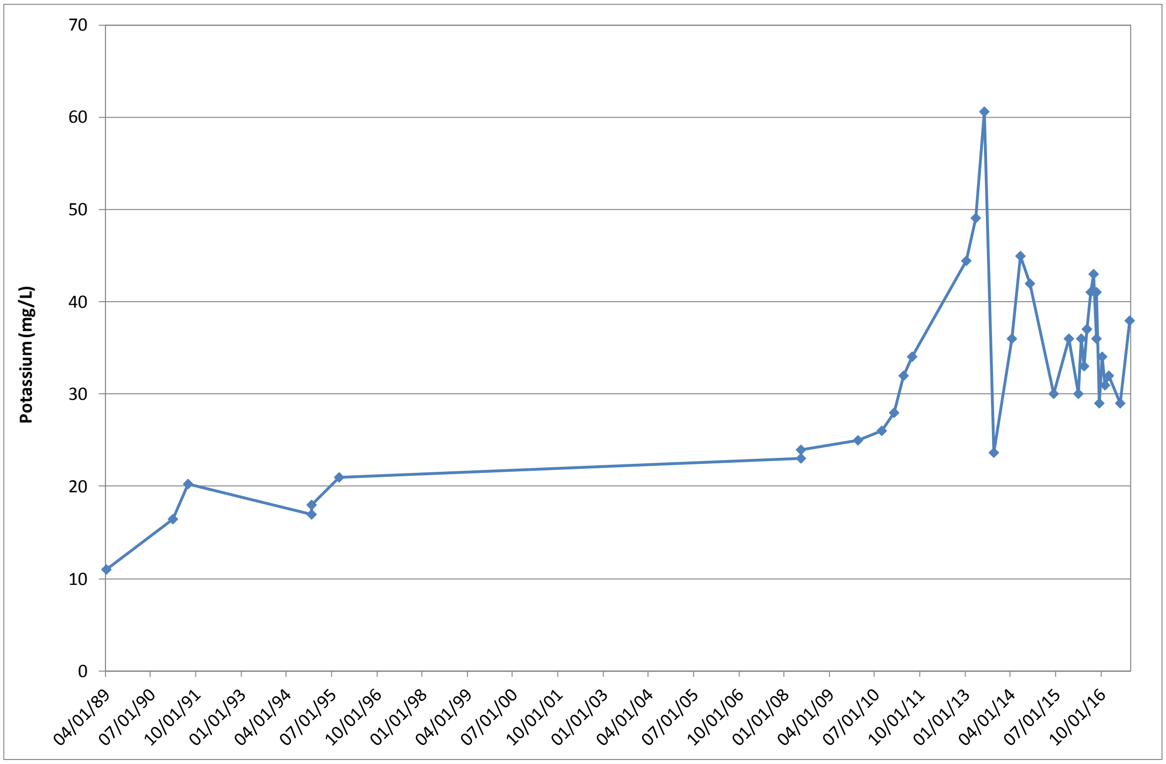

Figure A-12: Potassium Trends in Existing Pit Lake

Appendix B – Humidity Cell Elemental Release Rate Graphs

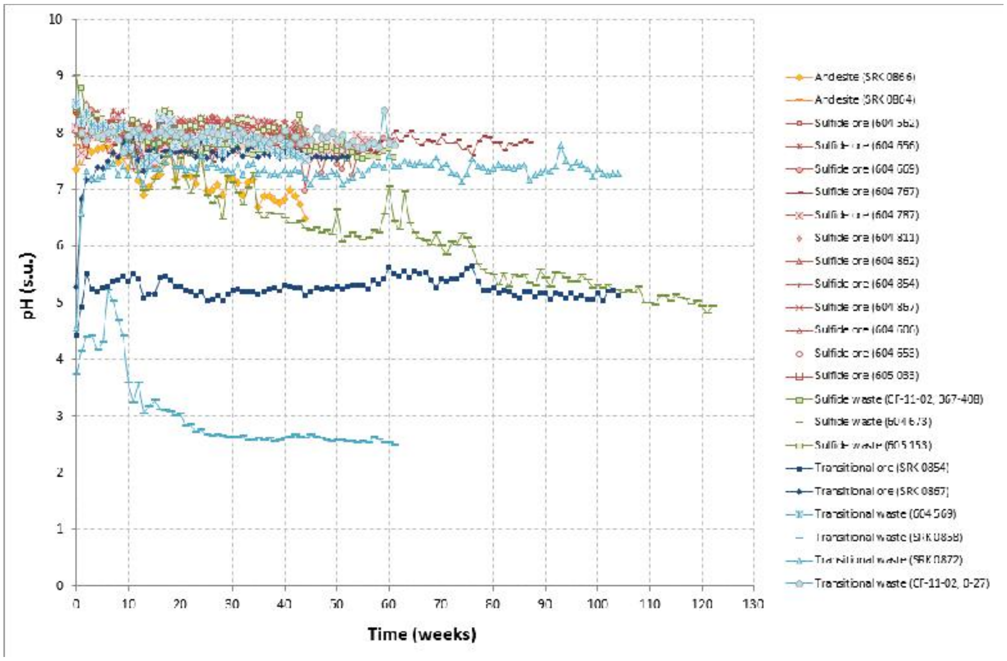

Figure B-1: Humidity Cell Effluent pH

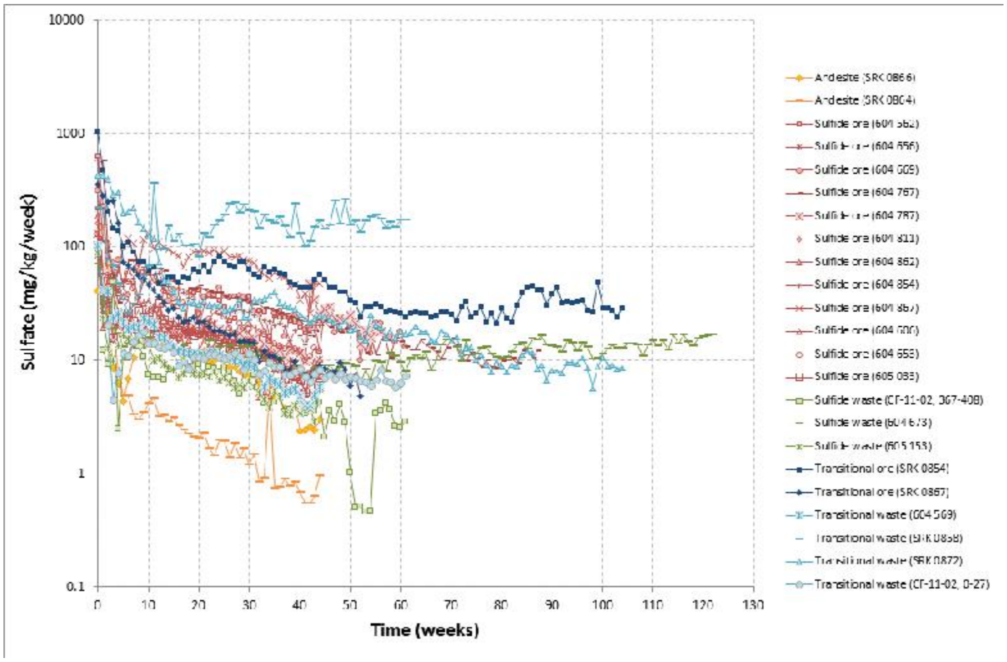

Figure B-2: Humidity Cell Effluent Sulfate

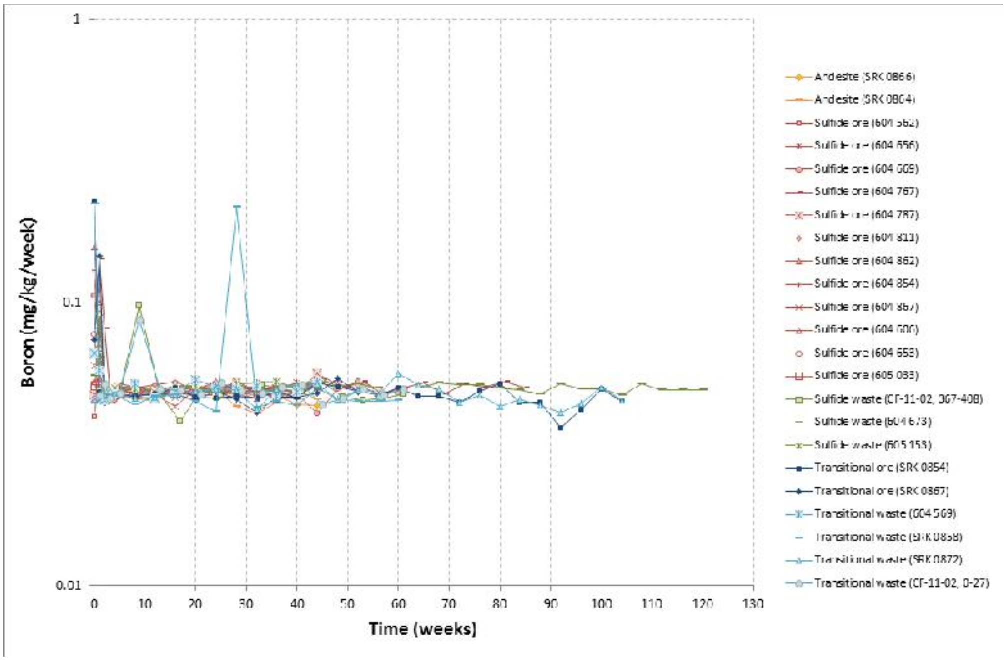

Figure B-3: Humidity Cell Effluent Boron

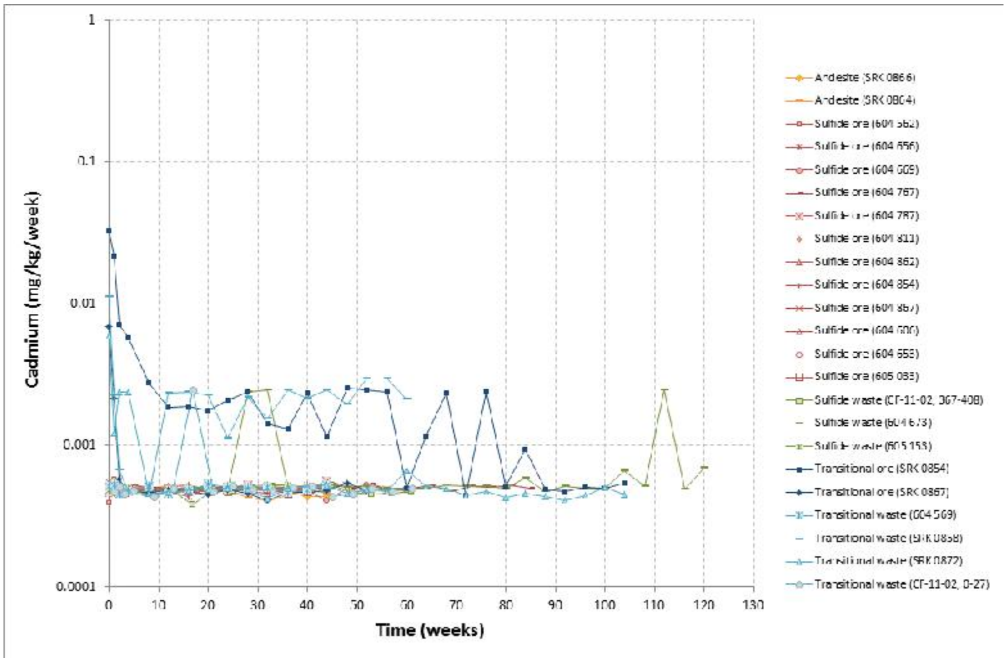

Figure B-4: Humidity Cell Effluent Cadmium

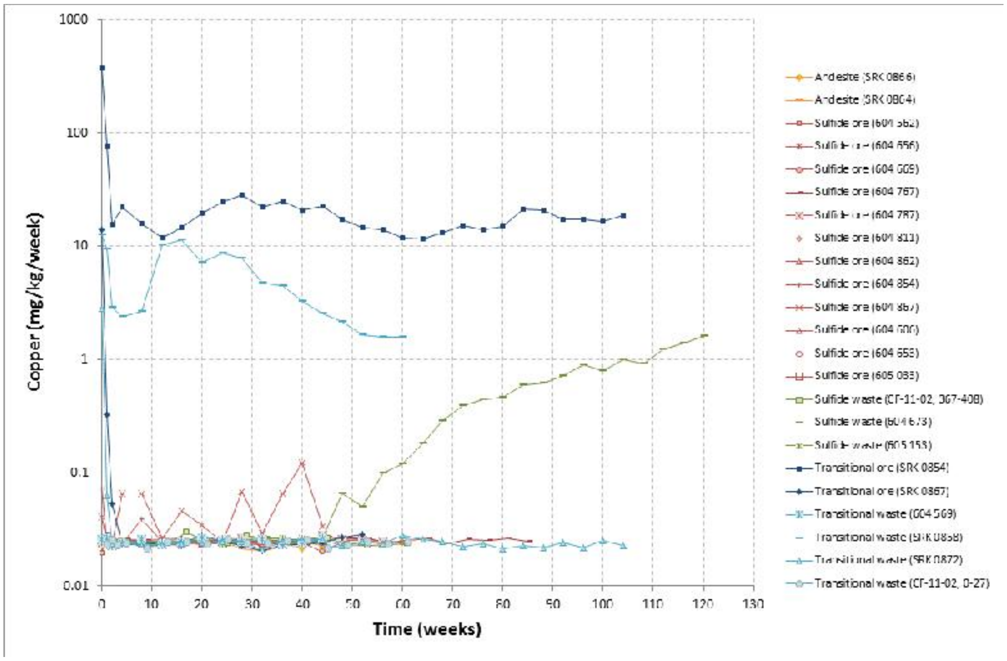

Figure B-5: Humidity Cell Effluent Copper

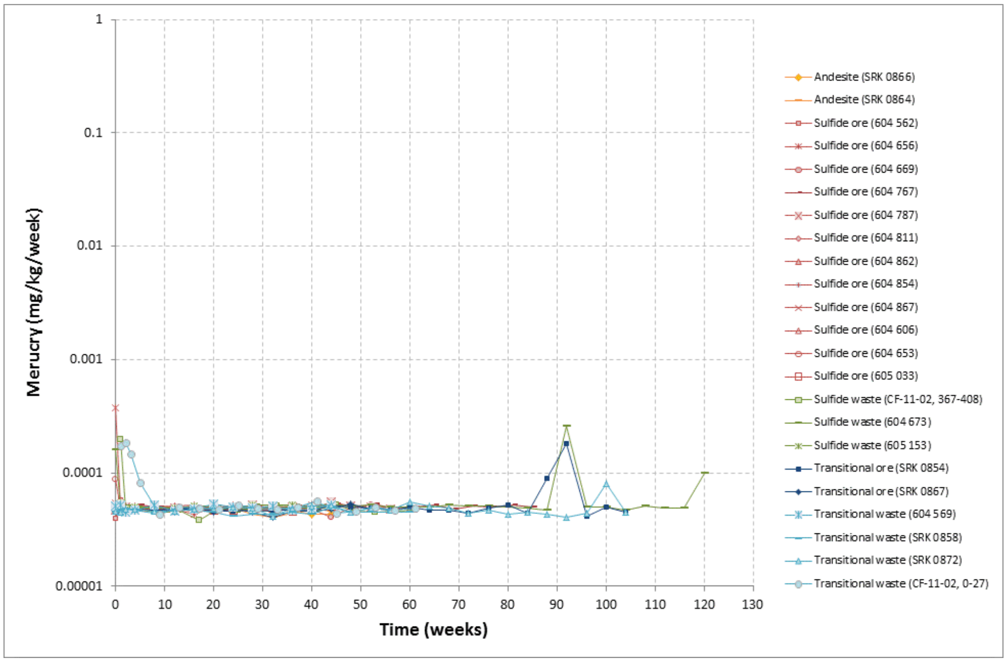

Figure B-6: Humidity Cell Effluent Mercury

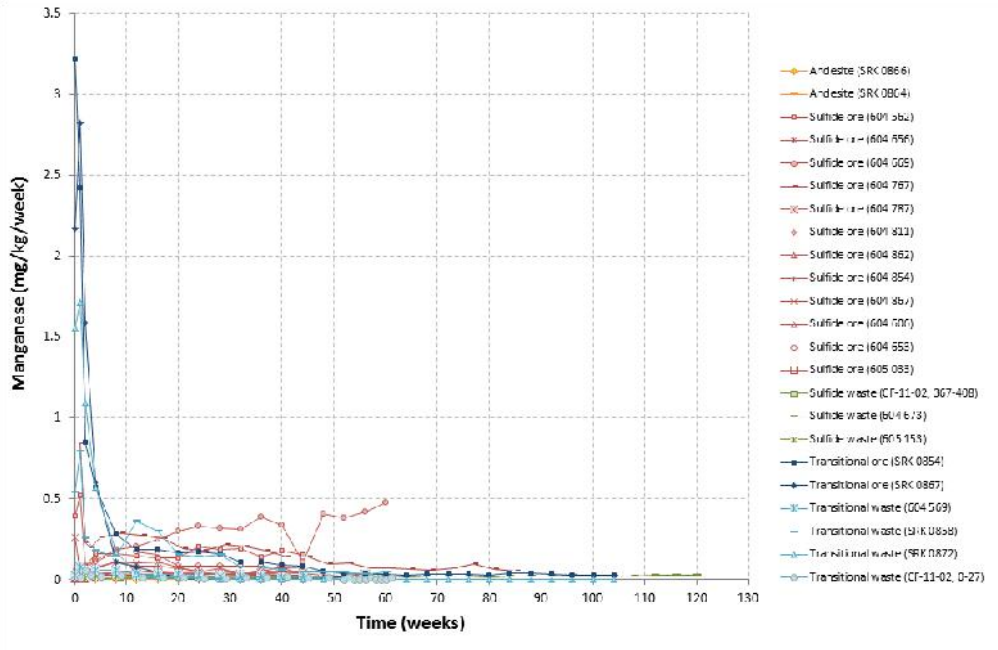

Figure B-7: Humidity Cell Effluent Manganese

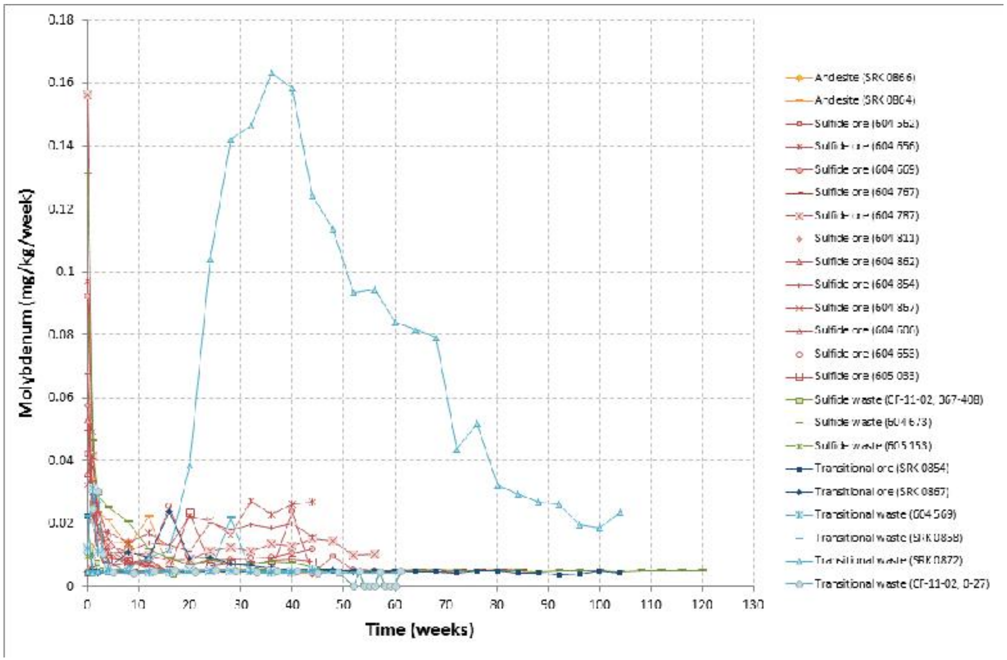

Figure B-8: Humidity Cell Effluent Molybdenum

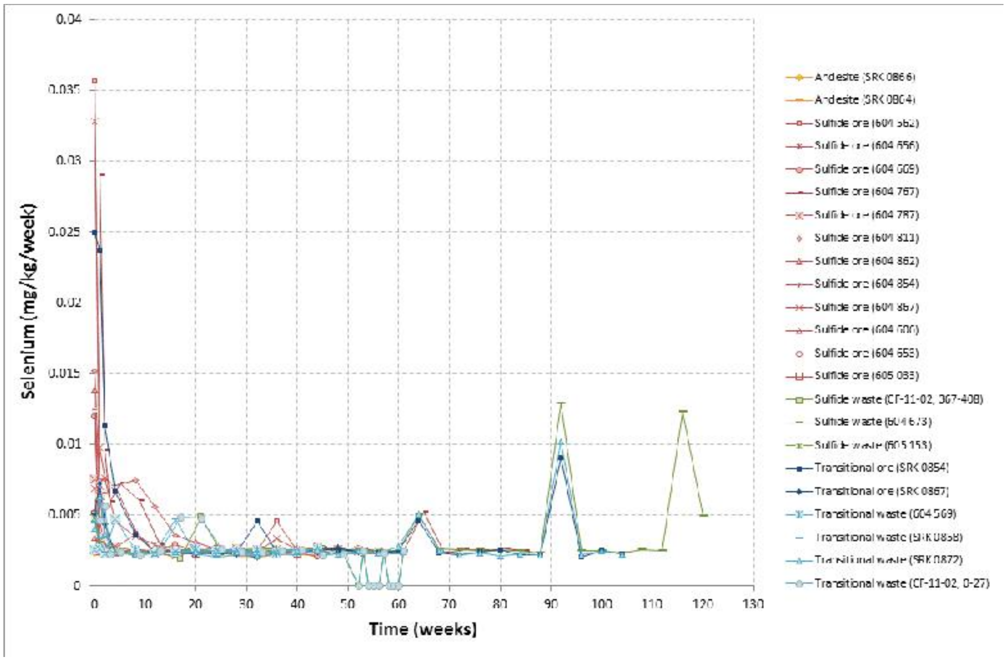

Figure B-9: Humidity Cell Effluent Selenium

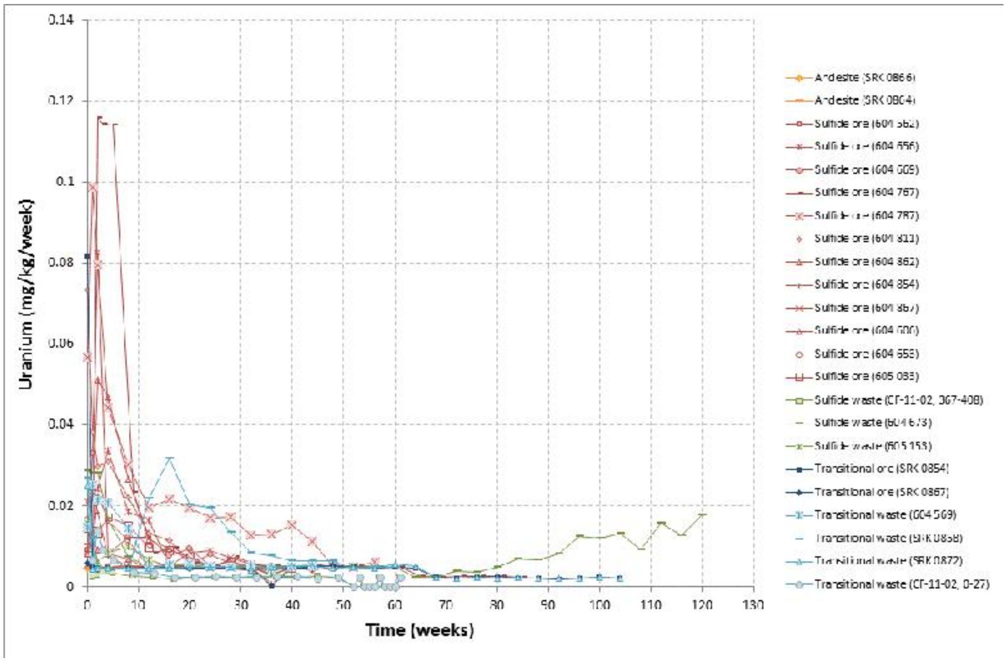

Figure B-10: Humidity Cell Effluent Uranium

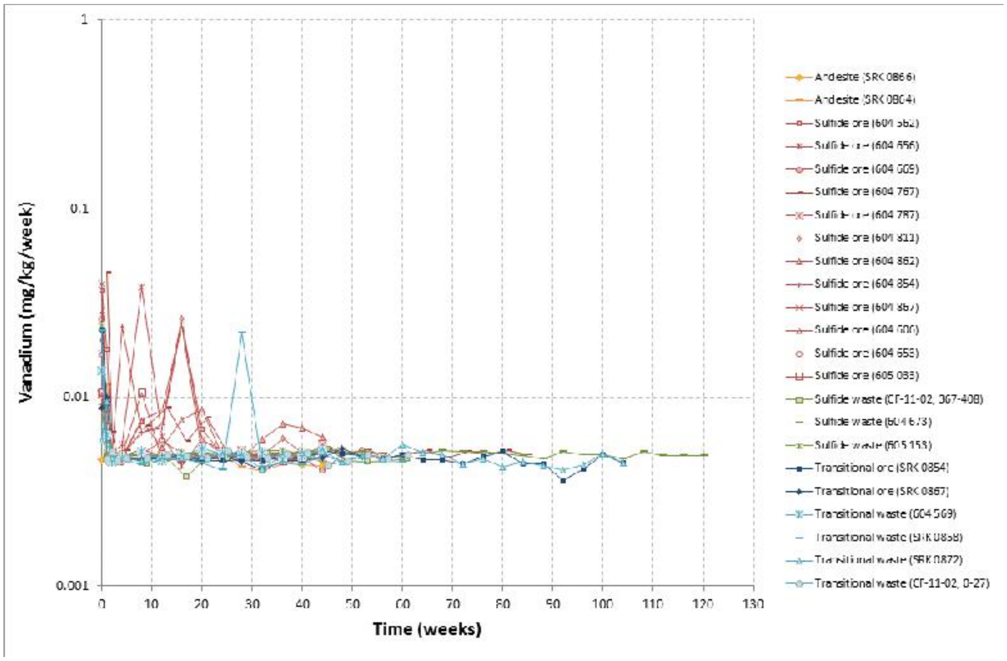

Figure B-11: Humidity Cell Effluent Vanadium

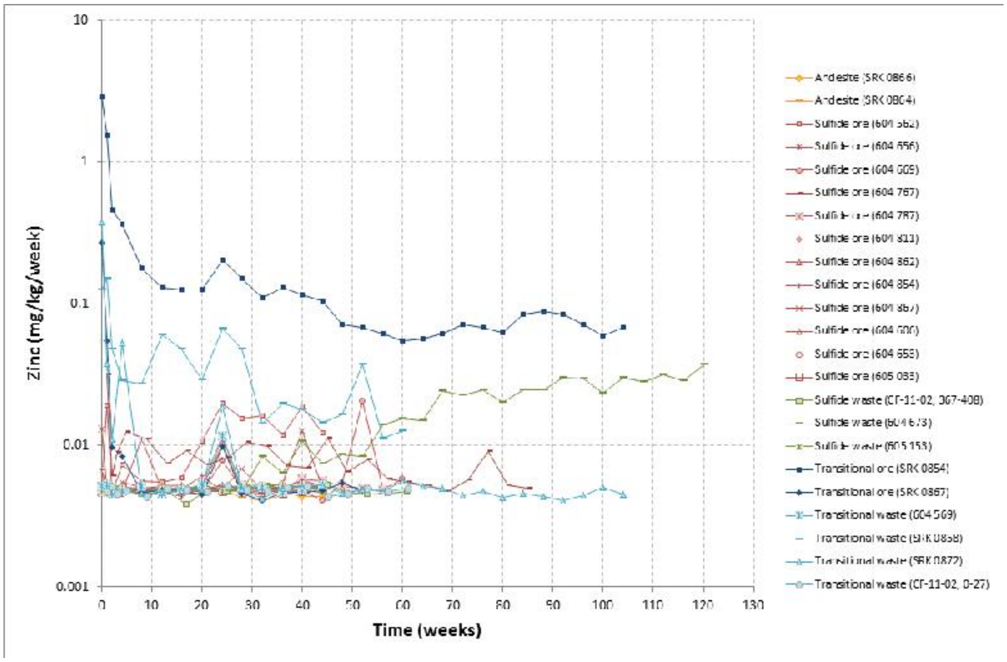

Figure B-12: Humidity Cell Effluent Zinc

Appendix C – JSAI Evaporation Rate Technical Memorandum

JOHN SHOMAKER & ASSOCIATES, INC.
WATER-RESOURCE AND ENVIRONMENTAL CONSULTANTS
2611 BROADBENT PARKWAY NE
ALBUQUERQUE, NM 87107
505-345-3407; 505-345-9920 FAX
www.shomaker.com

TECHNICAL MEMORANDUM

To: Steve Raugust, JS Raugust Consulting
Jeff Smith, New Mexico Copper Corporation

From: Steven T. Finch, Jr., Principal Hydrogeologist-Geochemist, JSAI
Annie McCoy, Senior Hydrogeologist, JSAI

Date: September 1, 2015

Subject: **Estimated evaporation rate for future Copper Flat open pit**

As discussed in the Copper Flat Project groundwater-flow model report (JSAI, 2014), potential evapotranspiration (ET), or the maximum evaporation and plant transpiration that can occur given full availability of water, is a function of geographical and climatic conditions, and is commonly estimated using the Penman-Monteith equations (Monteith, 1965). These relate maximum ET (ET_0) to meteorological parameters including temperature, relative humidity and wind speed, and to geographical parameters (altitude, latitude, and time of year). Annual ET_0 computed from results at Hillsboro meteorological station is about 60 in./yr, which compares well to previous estimates (SRK, 1997) of 65 in./yr of potential evaporation, and 64.6 in./yr estimated as 74 percent (an accepted conversion factor for the region (NOAA, 1982) between pan evaporation and evaporation from a normal open water surface) of Copper Flat pan evaporation. Actual evaporation or ET is less, depending on sun and wind exposure, ground conditions, and availability of water.

If ET_0 is estimated to be 60 to 65 in./yr at the rim of the ultimate Copper Flat open pit (where the prior land surface intersects the open pit), ET_0 will be somewhat less at the bottom of the ultimate open pit due to the fact that the bottom of the pit will have less exposure to sun and wind compared to the rim.

To estimate ET_0 for the bottom of the ultimate Copper Flat open pit, the duration of sunlight at analogous established open pits was evaluated using the "sunlight across the landscape" tool in Google Earth, for the date April 29, 2015. April is a month with close-to-average duration of sunlight (as are the months of March, September, and October; Dunne and Leopold, 1978). Table 1 presents a summary of hours of sunlight for analogous pits ranging in depth from 300 to 1,400 ft.

Table 1. Summary of hours of sunlight for selected open pits in New Mexico and California, April 29, 2015

pit	rim elevation, ft amsl	bottom elevation, ft amsl	sunlight at rim, hours	sunlight at bottom, hours	bottom / rim sunlight ratio
Cobre pit, SW NM	6,800	6,300	6:30 to 19:30 = 13 hours	9:30 to 18:30 = 9 hours	0.69
Santa Rita pit, SW NM	6,600	5,200	7:00 to 19:50 = 12.5 hours	9:30 to 16:30 = 7 hours	0.56
Tyrone main pit, SW NM	6,200	4,900	6:30 to 19:30 = 13 hours	8:30 to 17:30 = 9 hours	0.69
CHMRP pit, N. NM	7,100	6,800	7:30 to 19:30 = 12 hours	8:45 to 16:00 = 7.25 hours	0.60
Colosseum pit, S. CA	5,800	5,400	8:00 to 19:00 = 11 hours	9:00 to 16:00 = 7 hours	0.64
average			**12.3 hours**	**7.85 hours**	**0.64**

CHMRP – Cunningham Hill Mine Reclamation Project
ft amsl – feet above mean sea level
SW – southwest
N. – north
S. – south

Pan evaporation data were collected at the Cunningham Hill Mine Reclamation Project (CHMRP), near the rim of the open pit in June 2000, and at the bottom of the pit between April and July 2011 (JSAI, 2011). Pan evaporation was higher at the rim, despite higher summer precipitation in 2001 compared to 2011. The pan evaporation data were interpreted to represent an average evaporation rate of about 60 in./yr at the rim, and 54 in./yr at the bottom.

CHMRP evaporation data were used for an upper bound of 90 percent, in terms of percentage of evaporation at the rim that represents actual evaporation at the bottom of the pit, and the average sunlight ratio presented in Table 1 was used for a lower bound of 64 percent. For the ultimate Copper Flat open pit, actual evaporation at the bottom of the pit was assumed to be 50 in./yr, which is 77 to 83 percent of ET_0 values 60 to 65 in./yr estimated at the rim.

The estimate of 50 in./yr evaporation for the ultimate Copper Flat open pit is also in close agreement with the estimate of open water evaporation of 53 in./yr for the North Mine Area (Santa Rita pit) at Chino Mine in southwestern New Mexico (Golder, 2005).

STF:AMM

Enc: References

References

Dunne, T., and Leopold, L.B., 1978, Water in environmental planning: W.H. Freeman and Company, New York, 818 p.

[Golder] Golder Associates, Inc., 2005, Report on North Mine Area groundwater flow model: Chino Mine, New Mexico: consultant's report prepared for Chino Mines Company, January 13, 2005, 64 p. plus tables, figures, and appendices.

[JSAI] John Shomaker & Associates, Inc., 2011, Update and recalibration of groundwater-flow and solute-transport model for predicting potential effects from the Cunningham Hill Mine Open Pit, Santa Fe County, New Mexico: consultant's report prepared for LAC Minerals (USA) LLC, June 27, 2011, 29 p. plus figures and appendices.

[JSAI] John Shomaker & Associates, Inc., 2014, Model of groundwater flow in the Animas Uplift and Palomas Basin, Copper Flat Project, Sierra County, New Mexico: consultant's report prepared for New Mexico Copper Corporation, August 15, 2014, 89 p. plus figures and appendices.

Monteith, J.L., 1965, Evaporation and environment: Symp. Soc. Exp. Biol. 19, 205-224 obtained from Forest Hydrology and Watershed Management - Hydrologie Forestiere et Amenagement des Bassins Hydrologiques (Proceedings of the Vancouver Symposium, August 1987, Actes du Co11oque de Vancouver, Aout 1987): IAHS-AISH Publication No. 167, 1987, pp. 319–327.

[NOAA] National Oceanic and Atmospheric Administration, 1982, Evaporation atlas for the contiguous 48 United States: NOAA Technical Report NWS 33.

[SRK] Steffen Robertson and Kirsten, Inc., 1997, Copper Flat Mine compilation of pit lake studies: consultant's report prepared by Steffen Robertson and Kirsten, Inc. prepared for Alta Gold Co., December 1997.

Appendix D – JSAI Groundwater Chemistry Technical Memorandum

TECHNICAL MEMORANDUM

To: Jeff Smith, New Mexico Copper Corporation jsmith@themacresourcesgroup.com

From: Steve Finch, Principal Hydrogeologist-Geochemist

Date: September 26, 2017

Subject: Copper Flat open pit area groundwater chemistry data and application to SRK geochemistry model

John Shomaker & Associates, Inc. (JSAI) has evaluated the water quality data regarding Copper Flat open pit influent groundwater chemistry in order to assist SRK with completion of the open pit geochemistry model. All historical data and the Stage 1 abatement data were compiled and reported in JSAI (2014). JSAI used the water quality database, well construction data, and groundwater flow model results to determine the most representative groundwater flow chemistry to the existing and future open pits.

Groundwater quality data for the open pit area come from wells GWQ96-22(A,B), GWQ96-23(A,B), GWQ11-24(A,B), and GWQ11-25(A,B). Monitoring wells GWQ96-22(A,B) and GWQ96(A,B) represents groundwater in the andesite, where monitoring wells GWQ11-24(A) represents groundwater in the quartz monzonite ore body, and GWQ11-24(B) and GWQ11-25(B) represent parts of the quartz monzonite with lower grade of the ore body. Piezometers GWQ11-24(A) and GWQ11-25(A) may have been affected by oxidation of sulfides in fractures during well development, and not representative of groundwater reporting to the open pit. Further analysis of GWQ11-25(A) provided evidence that it represents a localized and isolated fracture system recharged by oxygenated meteoric water that is not connected to the open pit (JSAI, 2014).

Existing Open Pit Influent Groundwater Chemistry

Table 1 is a summary of groundwater chemistry potentially influencing the existing open pit. Individual samples with values less than detection limits were assigned a value of one-half the detection limit. Results for selenium, mercury, and vanadium were evaluated for the lowest possible detection limit. Not all of the constituents analyzed in the baseline data report were analyzed as part of the Stage 1 abatement investigation, so results for GWQ11-24(A,B) and GWQ11-25(A,B) are limited by the Stage 1 constituent list (see Table 1).

Future Post-Mining Open Pit Influent Groundwater Chemistry

Based on the mining plan, a good portion of the quartz monzonite is removed by mining and the remaining quartz monzonite is dewatered. The groundwater flow model simulates localized dewatering rates and volumes (JSAI, 2014a). Groundwater representative of the andesite rocks reports to the future pit, and all of the groundwater in the quartz monzonite surrounding the future pit is dewatered during mining and replaced with groundwater from the surrounding andesite (JSAI, 2014a). The calculated volume of groundwater in the quartz monzonite is removed and flushed three times by inflow of groundwater representative of andesite. A volume of 500 acre feet is calculated to be dewatered during mining of the proposed open pit of which 165 ac-ft represents groundwater stored in quartz monzonite.

A summary of groundwater chemistry potentially influencing the future open pit during post mining conditions is listed in Table 1. Groundwater chemistry representative of the future pit was determined by using data representative of the andesite rocks (column A). These “Column A” sample results represent groundwater from the andesite rocks after dewatering and mining to create the future pit.

Attachments

Table 1. Summary of groundwater chemistry for Copper Flat open pit area

References

JSAI, 2014, Results of first year of Stage 1 investigation at the Copper Flat Mine Site, Hillsboro, New Mexico: Consultant’s report prepared by Steven T. Finch of John Shomaker & Associates, Inc. for New Mexico Copper Corporation.

[JSAI] John Shomaker & Associates, Inc., 2014a, Model of groundwater flow in the Animas Uplift and Palomas Basin, Copper Flat Project, Sierra County, New Mexico: consultant’s report prepared for New Mexico Copper Corporation, August 15, 2014, 89 p. plus figures and appendices.

Table 1. Summary of Copper Flat open pit influent groundwater chemistry

		Column:	A	B	C	AVERAGE A-C	
parameter	**parameter name**	**unit**	**Groundwater chemistry (average of samples collected from wells GWQ96-22(A,B), GWQ96-23(A,B) between 1996 and 2013)**	**GWQ11-24B 2013 average**	**GWQ11-25B 2013 average**	**Blended Groundwater chemistry representative of inflow to current open pit[b]**	**Groundwater chemistry representative of inflow to future open pit**
pH	pH	s.u	7.85	6.44	6.45	6.91	7.85
HCO3	bicarbonate	mg/L	408	191	350	316.3	408
Ag	silver	mg/L	0.009	nm	nm	0.009	0.009
Al	aluminum	mg/L	0.029	0.013	0.308	0.12	0.029
As	arsenic	mg/L	0.0023	nm	nm	0.0023	0.0023
B	boron	mg/L	0.136	nm	nm	0.136	0.136
Ba	barium	mg/L	0.089	nm	nm	0.089	0.089
Ca	calcium	mg/L	85.8	442	481	336	85.8
Cd	cadmium	mg/L	0.0008	0.001	0.001	0.001	0.0008
Co	cobalt	mg/L	0.008	0.017	0.004	0.010	0.008
Cr	chromium	mg/L	0.0066	nm	nm	0.0066	0.0066
Cu	copper	mg/L	0.0061	0.0024	0.0026	0.0	0.0061
F	fluoride	mg/L	2.1	3.80	7.90	4.60	2.1
Fe	iron	mg/L	1.48	nm	nm	1.48	1.48
Hg	mercury[a]	mg/L	0.000002	nm	nm	0.000002	0.000002
K	potassium	mg/L	2.96	6.2	4	4.4	2.96
Mg	magnessium	mg/L	19.3	79	75	57.8	19.3
Mn	manganese	mg/L	0.66	3.5	3.25	2.47	0.66
Mo	molybdenum	mg/L	0.012	nm	nm	0.0119	0.012
Na	sodium	mg/L	119	94	131	114.5	119
Ni	nickel	mg/L	0.0125	nm	nm	0.0125	0.0125
Pb	lead	mg/L	0.0025	nm	nm	0.0025	0.0025
Sb	antimony	mg/L	0.0009	nm	nm	0.0009	0.0009
Se	selenium	mg/L	0.0015	0.0024	0.0028	0.0022	0.0015
U	uranium	mg/L	0.0015	nm	nm	0.0015	0.0015
V	vanadium[a]	mg/L	0.0009	nm	nm	0.0009	0.0009
Zn	zinc	mg/L	0.03	0.18	0.02	0.08	0.03
SO4	sulfate	mg/L	84	1408	1370	954	84
Cl	chloride	mg/L	49	27	27	34	49
TDS	total dissolved solids	mg/L	649	2,440	2,540	1,876	649

notes:

nm = not measured

[a] = results from sample analyzed for low detection limits for SRK geochemical model (samples collected July 10, 2013)

Appendix E – Water Supply Well Chemistry

Production Well Water Quality Samples				
Parameter		**PW1 May 1, 2012**	**PW3 May 3, 2012**	**Average**
pH	pH	8.02	8.03	8.025
HCO_3	Bicarbonate	150	120	135
Al	Aluminum	nd	nd	nd
As	Arsenic	0.0033	0.0074	0.00535
B	Boron	0.065	0.095	0.0800
Ba	Barium	0.011	0.0078	0.0094
Ca	Calcium	36	20	28
Cl	Chloride	32	50	41
Cu	Copper	nd	nd	nd
Cr	Chromium	nd	0.006	0.006
F	Fluoride	1	1.9	1.45
Fe	Iron	0.04	0.065	0.0525
Hg	Mercury	nd	nd	nd
K	Potassium	3.4	3.3	3.35
Mg	Magnesium	3.1	1	2.05
Mn	Manganese	0.0024	0.0026	0.0025
Mo	Molybdenum	nd	nd	nd
Na	Sodium	58	81	69.5
Ni	Nickel	nd	nd	nd
Pb	Lead	nd	nd	nd
SO_4	Sulfate	28	26	27
Se	Selenium	nd	nd	nd
Si	Silica	17	21	19
U	Uranium	0.0032	0.0013	0.00225
V	Vanadium	nd	nd	nd
Tl	Thallium	nd	nd	nd
Zn	Zinc	0.024	0.021	0.0225

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 14, 2012

Katie Emmer
New Mexico Copper Corp
2425 San Pedro Dr NE Ste 100
Albuquerque, New Mexico 87109
TEL: (505) 400-7925
FAX

RE: Cu Flat OrderNo.: 1205076

Dear Katie Emmer:

Hall Environmental Analysis Laboratory received 1 sample(s) on 5/2/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1205076**
Date Reported: **5/14/2012**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: New Mexico Copper Corp
Project: Cu Flat
Lab ID: 1205076-001
Matrix: AQUEOUS
Client Sample ID: PW-1
Collection Date: 5/1/2012 2:00:00 PM
Received Date: 5/2/2012 7:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						Analyst: **BRM**
Fluoride	1.0	0.10		mg/L	1	5/2/2012 12:52:03 PM
Chloride	32	10		mg/L	20	5/2/2012 1:03:17 PM
Nitrogen, Nitrite (As N)	ND	0.10		mg/L	1	5/2/2012 12:52:03 PM
Nitrogen, Nitrate (As N)	0.59	0.10		mg/L	1	5/2/2012 12:52:03 PM
Sulfate	28	0.50		mg/L	1	5/2/2012 12:52:03 PM
EPA METHOD 200.7: DISSOLVED METALS						Analyst: **ELS**
Aluminum	ND	0.020		mg/L	1	5/8/2012 8:02:55 AM
Barium	0.011	0.0020		mg/L	1	5/8/2012 8:02:55 AM
Beryllium	ND	0.0020		mg/L	1	5/8/2012 8:02:55 AM
Boron	0.065	0.040		mg/L	1	5/9/2012 8:36:51 AM
Cadmium	ND	0.0020		mg/L	1	5/8/2012 8:02:55 AM
Calcium	36	1.0		mg/L	1	5/9/2012 8:36:51 AM
Chromium	ND	0.0060		mg/L	1	5/8/2012 8:02:55 AM
Cobalt	ND	0.0060		mg/L	1	5/8/2012 8:02:55 AM
Copper	ND	0.0060		mg/L	1	5/8/2012 8:02:55 AM
Iron	0.040	0.020		mg/L	1	5/9/2012 8:36:51 AM
Lead	ND	0.0050		mg/L	1	5/8/2012 8:02:55 AM
Magnesium	3.1	1.0		mg/L	1	5/9/2012 8:36:51 AM
Manganese	0.0024	0.0020		mg/L	1	5/8/2012 8:02:55 AM
Molybdenum	ND	0.0080		mg/L	1	5/8/2012 8:02:55 AM
Nickel	ND	0.010		mg/L	1	5/8/2012 8:02:55 AM
Potassium	3.4	1.0		mg/L	1	5/9/2012 8:36:51 AM
Silicon	17	0.40		mg/L	5	5/8/2012 8:06:09 AM
Silver	ND	0.0050		mg/L	1	5/8/2012 8:02:55 AM
Sodium	58	1.0		mg/L	1	5/9/2012 8:36:51 AM
Vanadium	ND	0.050		mg/L	1	5/8/2012 8:02:55 AM
Zinc	0.024	0.010		mg/L	1	5/8/2012 8:02:55 AM
EPA 200.8: DISSOLVED METALS						Analyst: **SNV**
Antimony	ND	0.0010		mg/L	1	5/8/2012 1:15:26 PM
Arsenic	0.0033	0.0010		mg/L	1	5/8/2012 1:15:26 PM
Selenium	ND	0.0010		mg/L	1	5/10/2012 2:28:58 PM
Thallium	ND	0.0010		mg/L	1	5/8/2012 1:15:26 PM
Uranium	0.0032	0.0010		mg/L	1	5/10/2012 2:28:58 PM
EPA METHOD 245.1: MERCURY						Analyst: **ELS**
Mercury	ND	0.00020		mg/L	1	5/9/2012 11:59:45 AM
SM2340B: HARDNESS						Analyst: **ELS**
Hardness (As CaCO3)	100	6.6		mg/L	1	5/9/2012
EPA 120.1: SPECIFIC CONDUCTANCE						Analyst: **DBD**
Conductivity	450	0.010		µmhos/cm	1	5/7/2012 12:31:49 PM

Qualifiers:				
	*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **5/14/2012**

CLIENT: New Mexico Copper Corp
Project: Cu Flat
Lab ID: 1205076-001
Matrix: AQUEOUS
Client Sample ID: PW-1
Collection Date: 5/1/2012 2:00:00 PM
Received Date: 5/2/2012 7:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
SM4500-H+B: PH						Analyst: **JLF**
pH	8.02	1.68	H	pH units	1	5/3/2012 1:22:52 PM
SM2320B: ALKALINITY						Analyst: **JLF**
Bicarbonate (As CaCO3)	150	20		mg/L CaCO3	1	5/3/2012 1:22:52 PM
Carbonate (As CaCO3)	ND	2.0		mg/L CaCO3	1	5/3/2012 1:22:52 PM
Total Alkalinity (as CaCO3)	150	20		mg/L CaCO3	1	5/3/2012 1:22:52 PM
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **KS**
Total Dissolved Solids	294	20.0		mg/L	1	5/8/2012 3:12:00 PM
SM 2540D: TSS						Analyst: **KS**
Suspended Solids	ND	4.0		mg/L	1	5/3/2012 5:30:00 PM

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	120503026
Address:	4901 HAWKINS NE SUITE D	**Project Name:**	1205076
	ALBUQUERQUE, NM 87109		
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	120503026-001	**Sampling Date**	5/1/2012	**Date/Time Received**	5/3/2012	12:24 PM
Client Sample ID	1205076-001D / PW-1	**Sampling Time**	2:00 PM	**Extraction Date**		
Matrix	Water	**Sample Location**				
Comments						

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Cyanide	ND	mg/L	0.01	5/11/2012	CRW	EPA 335.4	

Authorized Signature

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

QC SUMMARY REPORT

WO#: **1205076**

Hall Environmental Analysis Laboratory, Inc.

14-May-12

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **PBW** Batch ID: **R2622** RunNo: **2622**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **72991** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	ND	0.020								
Barium	ND	0.0020								
Beryllium	ND	0.0020								
Cadmium	ND	0.0020								
Chromium	ND	0.0060								
Cobalt	ND	0.0060								
Copper	ND	0.0060								
Lead	ND	0.0050								
Manganese	ND	0.0020								
Molybdenum	ND	0.0080								
Nickel	ND	0.010								
Silicon	ND	0.080								
Silver	ND	0.0050								
Vanadium	ND	0.050								
Zinc	ND	0.010								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **LCSW** Batch ID: **R2622** RunNo: **2622**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **72992** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.52	0.020	0.5000	0	105	85	115			
Barium	0.49	0.0020	0.5000	0	98.9	85	115			
Beryllium	0.52	0.0020	0.5000	0	103	85	115			
Cadmium	0.50	0.0020	0.5000	0	99.2	85	115			
Chromium	0.49	0.0060	0.5000	0	98.5	85	115			
Cobalt	0.47	0.0060	0.5000	0	94.9	85	115			
Copper	0.50	0.0060	0.5000	0	99.9	85	115			
Lead	0.50	0.0050	0.5000	0	99.3	85	115			
Manganese	0.48	0.0020	0.5000	0	96.9	85	115			
Molybdenum	0.49	0.0080	0.5000	0.002030	98.4	85	115			
Nickel	0.47	0.010	0.5000	0	93.9	85	115			
Silicon	2.6	0.080	2.500	0	104	85	115			
Silver	0.094	0.0050	0.1000	0	94.1	85	115			
Vanadium	0.52	0.050	0.5000	0	104	85	115			
Zinc	0.50	0.010	0.5000	0	101	85	115			

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2622** RunNo: **2622**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **73030** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2622** RunNo: **2622**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **73030** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.54	0.020	0.5000	0	107	70	130			
Barium	0.52	0.0020	0.5000	0.02182	98.9	70	130			
Zinc	0.54	0.010	0.5000	0.03785	101	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2622** RunNo: **2622**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **73031** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.53	0.020	0.5000	0	106	70	130	1.33	20	
Barium	0.51	0.0020	0.5000	0.02182	97.2	70	130	1.71	20	
Zinc	0.53	0.010	0.5000	0.03785	98.0	70	130	2.48	20	

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74182** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Potassium	56	1.0	50.00	4.808	102	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74183** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Potassium	57	1.0	50.00	4.808	104	70	130	2.44	20	

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74185** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron	4.5	0.10	2.500	2.034	99.6	70	130			
Magnesium	390	5.0	250.0	124.9	107	70	130			
Sodium	460	5.0	250.0	192.5	107	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74186** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron	4.6	0.10	2.500	2.034	101	70	130	1.03	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74186** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Magnesium	390	5.0	250.0	124.9	106	70	130	0.684	20	
Sodium	460	5.0	250.0	192.5	106	70	130	0.966	20	

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **PBW** Batch ID: **R2670** RunNo: **2670**

Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74215** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	ND	0.040								
Calcium	ND	1.0								
Iron	ND	0.020								
Magnesium	ND	1.0								
Potassium	ND	1.0								
Sodium	ND	1.0								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **LCSW** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74216** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.51	0.040	0.5000	0	101	85	115			
Calcium	54	1.0	50.00	0	107	85	115			
Iron	0.47	0.020	0.5000	0.004190	93.2	85	115			
Magnesium	54	1.0	50.00	0	109	85	115			
Potassium	53	1.0	50.00	0	106	85	115			
Sodium	54	1.0	50.00	0	107	85	115			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID **LCS** SampType: **LCS** TestCode: **EPA 200.8: Dissolved Metals**
Client ID: **LCSW** Batch ID: **R2629** RunNo: **2629**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **73283** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.023	0.0010	0.02500	0	92.8	85	115			
Arsenic	0.023	0.0010	0.02500	0	93.1	85	115			
Thallium	0.023	0.0010	0.02500	0	92.9	85	115			

Sample ID **MB** SampType: **MBLK** TestCode: **EPA 200.8: Dissolved Metals**
Client ID: **PBW** Batch ID: **R2629** RunNo: **2629**
Prep Date: Analysis Date: **5/8/2012** SeqNo: **73284** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	ND	0.0010								
Arsenic	ND	0.0010								
Thallium	ND	0.0010								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA 200.8: Dissolved Metals**
Client ID: **LCSW** Batch ID: **R2708** RunNo: **2708**
Prep Date: Analysis Date: **5/10/2012** SeqNo: **75447** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Selenium	0.026	0.0010	0.02500	0	104	85	115			
Uranium	0.025	0.0010	0.02500	0	99.2	85	115			

Sample ID **MB** SampType: **MBLK** TestCode: **EPA 200.8: Dissolved Metals**
Client ID: **PBW** Batch ID: **R2708** RunNo: **2708**
Prep Date: Analysis Date: **5/10/2012** SeqNo: **75448** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Selenium	ND	0.0010								
Uranium	ND	0.0010								

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **MB-1862** SampType: **MBLK** TestCode: **EPA Method 245.1: Mercury**

Client ID: **PBW** Batch ID: **1862** RunNo: **2669**

Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74223** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.00020								

Sample ID **LCS-1862** SampType: **LCS** TestCode: **EPA Method 245.1: Mercury**

Client ID: **LCSW** Batch ID: **1862** RunNo: **2669**

Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74224** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.4	80	120			

Sample ID **1204854-004AMS** SampType: **MS** TestCode: **EPA Method 245.1: Mercury**

Client ID: **BatchQC** Batch ID: **1862** RunNo: **2669**

Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74226** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.2	75	125			

Sample ID **1204854-004AMSD** SampType: **MSD** TestCode: **EPA Method 245.1: Mercury**

Client ID: **BatchQC** Batch ID: **1862** RunNo: **2669**

Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74227** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.1	75	125	0.0957	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70797** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Chloride	ND	0.50								
Nitrogen, Nitrite (As N)	ND	0.10								
Nitrogen, Nitrate (As N)	ND	0.10								
Sulfate	ND	0.50								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70798** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.47	0.10	0.5000	0	93.8	90	110			
Chloride	4.6	0.50	5.000	0	92.9	90	110			
Nitrogen, Nitrite (As N)	0.93	0.10	1.000	0	92.9	90	110			
Nitrogen, Nitrate (As N)	2.4	0.10	2.500	0	97.4	90	110			
Sulfate	9.5	0.50	10.00	0	94.8	90	110			

Sample ID **1205075-001BMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70800** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.68	0.10	0.5000	0.1911	98.1	72.9	113			
Nitrogen, Nitrite (As N)	1.0	0.10	1.000	0	101	77.6	111			
Nitrogen, Nitrate (As N)	2.5	0.10	2.500	0	99.9	82.8	116			

Sample ID **1205075-001BMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70801** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.65	0.10	0.5000	0.1911	90.9	72.9	113	5.39	20	
Nitrogen, Nitrite (As N)	0.90	0.10	1.000	0	90.2	77.6	111	10.8	20	
Nitrogen, Nitrate (As N)	2.3	0.10	2.500	0	91.3	82.8	116	8.94	20	

Sample ID **1205079-001AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70809** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrite (As N)	1.3	0.10	1.000	0	127	77.6	111			S
Nitrogen, Nitrate (As N)	2.4	0.10	2.500	0	97.8	82.8	116			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205079-001AMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70810** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrite (As N)	1.2	0.10	1.000	0	122	77.6	111	4.14	20	S
Nitrogen, Nitrate (As N)	2.4	0.10	2.500	0	95.5	82.8	116	2.38	20	

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70849** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Chloride	ND	0.50								
Nitrogen, Nitrite (As N)	ND	0.10								
Nitrogen, Nitrate (As N)	ND	0.10								
Sulfate	ND	0.50								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70850** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.50	0.10	0.5000	0	99.0	90	110			
Chloride	4.7	0.50	5.000	0	94.2	90	110			
Nitrogen, Nitrite (As N)	0.98	0.10	1.000	0	98.0	90	110			
Nitrogen, Nitrate (As N)	2.5	0.10	2.500	0	98.3	90	110			
Sulfate	9.6	0.50	10.00	0	95.7	90	110			

Sample ID **1205066-002AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70852** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	1.1	0.10	0.5000	0.5616	101	72.9	113			
Nitrogen, Nitrite (As N)	0.93	0.10	1.000	0	92.7	77.6	111			
Nitrogen, Nitrate (As N)	3.3	0.10	2.500	0.5059	111	82.8	116			
Sulfate	48	0.50	10.00	36.66	113	80.5	119			

Sample ID **1205066-002AMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2544** RunNo: **2544**
Prep Date: Analysis Date: **5/2/2012** SeqNo: **70853** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	1.0	0.10	0.5000	0.5616	93.8	72.9	113	3.52	20	
Nitrogen, Nitrite (As N)	0.79	0.10	1.000	0	78.5	77.6	111	16.5	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**1205066-002AMSD**	SampType:	**MSD**	TestCode:	**EPA Method 300.0: Anions**
Client ID:	**BatchQC**	Batch ID:	**R2544**	RunNo:	**2544**
Prep Date:		Analysis Date:	**5/2/2012**	SeqNo:	**70853** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrate (As N)	3.0	0.10	2.500	0.5059	98.7	82.8	116	10.2	20	
Sulfate	47	0.50	10.00	36.66	101	80.5	119	2.50	20	

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**1205170-001D**	SampType:	**DUP**	TestCode:	**EPA 120.1: Specific Conductance**
Client ID:	**BatchQC**	Batch ID:	**R2646**	RunNo:	**2646**
Prep Date:		Analysis Date:	**5/7/2012**	SeqNo:	**73516** Units: **µmhos/cm**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Conductivity	610	0.010						0	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205005-001A DUP**		SampType: **DUP**		TestCode: **SM4500-H+B: pH**						
Client ID: **BatchQC**		Batch ID: **R2560**		RunNo: **2560**						
Prep Date:		Analysis Date: **5/3/2012**		SeqNo: **71363**		Units: **pH units**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	3.92	1.68						0.762		H

Sample ID **1205120-001B DUP**		SampType: **DUP**		TestCode: **SM4500-H+B: pH**						
Client ID: **BatchQC**		Batch ID: **R2560**		RunNo: **2560**						
Prep Date:		Analysis Date: **5/3/2012**		SeqNo: **71373**		Units: **pH units**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	7.73	1.68						0.645		H

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**1205005-001A MS**	SampType:	**MS**	TestCode:	**SM2320B: Alkalinity**
Client ID:	**BatchQC**	Batch ID:	**R2560**	RunNo:	**2560**
Prep Date:		Analysis Date:	**5/3/2012**	SeqNo:	**71221** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	ND	20	80.00	0	0	62.6	110			S

Sample ID	**1205005-001A MSD**	SampType:	**MSD**	TestCode:	**SM2320B: Alkalinity**
Client ID:	**BatchQC**	Batch ID:	**R2560**	RunNo:	**2560**
Prep Date:		Analysis Date:	**5/3/2012**	SeqNo:	**71222** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	ND	20	80.00	0	0	59.9	111	0	10	S

Sample ID	**1205120-001B MS**	SampType:	**MS**	TestCode:	**SM2320B: Alkalinity**
Client ID:	**BatchQC**	Batch ID:	**R2560**	RunNo:	**2560**
Prep Date:		Analysis Date:	**5/3/2012**	SeqNo:	**71242** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	360	20	80.00	299.4	70.9	62.6	110			

Sample ID	**1205120-001B MSD**	SampType:	**MSD**	TestCode:	**SM2320B: Alkalinity**
Client ID:	**BatchQC**	Batch ID:	**R2560**	RunNo:	**2560**
Prep Date:		Analysis Date:	**5/3/2012**	SeqNo:	**71243** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	350	20	80.00	299.4	67.1	59.9	111	0.869	10	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **MB-1832**	SampType: **MBLK**	TestCode: **SM2540C MOD: Total Dissolved Solids**	
Client ID: **PBW**	Batch ID: **1832**	RunNo: **2634**	
Prep Date: **5/7/2012**	Analysis Date: **5/8/2012**	SeqNo: **73329**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	ND	20.0								

Sample ID **LCS-1832**	SampType: **LCS**	TestCode: **SM2540C MOD: Total Dissolved Solids**	
Client ID: **LCSW**	Batch ID: **1832**	RunNo: **2634**	
Prep Date: **5/7/2012**	Analysis Date: **5/8/2012**	SeqNo: **73330**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	1,020	20.0	1,000	0	102	80	120			

Sample ID **1205078-002GMS**	SampType: **MS**	TestCode: **SM2540C MOD: Total Dissolved Solids**	
Client ID: **BatchQC**	Batch ID: **1832**	RunNo: **2634**	
Prep Date: **5/7/2012**	Analysis Date: **5/8/2012**	SeqNo: **73337**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	4,890	20.0	1,000	3,791	110	80	120			

Sample ID **1205078-002GMSD**	SampType: **MSD**	TestCode: **SM2540C MOD: Total Dissolved Solids**	
Client ID: **BatchQC**	Batch ID: **1832**	RunNo: **2634**	
Prep Date: **5/7/2012**	Analysis Date: **5/8/2012**	SeqNo: **73338**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	4,930	20.0	1,000	3,791	114	80	120	0.733	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205076**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **MB-1800**		SampType: **MBLK**			TestCode: **SM 2540D: TSS**					
Client ID: **PBW**		Batch ID: **1800**			RunNo: **2570**					
Prep Date: **5/3/2012**		Analysis Date: **5/3/2012**			SeqNo: **71656**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	ND	4.0								

Sample ID **LCS-1800**		SampType: **LCS**			TestCode: **SM 2540D: TSS**					
Client ID: **LCSW**		Batch ID: **1800**			RunNo: **2570**					
Prep Date: **5/3/2012**		Analysis Date: **5/3/2012**			SeqNo: **71657**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	93	4.0	96.60	0	96.3	82.9	110			

Sample ID **1205034-001BDUP**		SampType: **DUP**			TestCode: **SM 2540D: TSS**					
Client ID: **BatchQC**		Batch ID: **1800**			RunNo: **2570**					
Prep Date: **5/3/2012**		Analysis Date: **5/3/2012**			SeqNo: **71663**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	ND	4.0						0	15	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laborator
4901 Hawkins NE
Albuquerque, NM 8710
TEL: 505-345-3975 FAX: 505-345-410
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: NEW MEXICO COPPER CORP Work Order Number: 1205076

Received by/date: AT 05/02/12

Logged By: **Anne Thorne** 5/2/2012 7:30:00 AM

Completed By: **Anne Thorne** 5/2/2012

Reviewed By: AT 05/02/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Client

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? Yes ☑ No ☐
(Note discrepancies on chain of custody)
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? Yes ☑ No ☐
(If no, notify customer for authorization.)

\# of preserved bottles checked → for pH: 1
(<2 or >12 unless noted)
Adjusted?
Checked by: AT 05/02/12

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.4	Good	Not Present			

Chain-of-Custody Record

Client: New Mexico Copper Corp

Mailing Address: 2425 San Pedro Dr NE
Suite 100, ABQ NM

Phone #: 505.400.7925

email or Fax#:

QA/QC Package:
☐ Standard ☐ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____

☐ EDD (Type) ____

Turn-Around Time:
☐ Standard ☒ Rush Need Results by May 11 via email

Project Name: CuFlat

Project #: Production Well Sampling

Project Manager: Katie Emmer

Sampler: CMC

On Ice: ☒ Yes ☐ No

Sample Temperature: 3.4°

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1205076	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	see enclosed list				Air Bubbles (Y or N)
5.1.12	1400	H_2O	PW-1	500		-001												X				
				125	H_2SO_4	-001																
				125	HNO_3 + filter	-001																
				500	HNO_3	-001																
				500	NaOH	-001																

Date:	Time:	Relinquished by:	Received by:	Date	Time
5/1/12	14:30			May 1 2012	14:30
5/2/12	07:50			05/02/12	0730

Remarks:
Please email results to: Katie Emmer
kemmer@themacresourcesgroup.com
Please add Hardness, per Katie. 5/3

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

NM Copper
May 1, 2012

Table 9-3
Analytical Parameters and Analysis Methods for Groundwater Samples

Analytical Parameter	Analysis Method	Lab Detection Limit (mg/L unless noted)
Anions		
Fluoride	EPA Method 300.0	0.1
Chloride	EPA Method 300.0	0.1
Nitrogen, Nitrite (as N)	EPA Method 300.0	0.1
Nitrogen, Nitrate (as N)	EPA Method 300.0	0.1
Sulfate	EPA Method 300.0	0.5
Dissolved Metals		
Aluminum	EPA Method 200.7	0.02
Antimony	EPA Method 200.8	0.005
Arsenic	EPA Method 200.8	0.02
Barium	EPA Method 200.7	0.002
Beryllium	EPA Method 200.7	0.002
Boron	EPA Method 200.7	0.04
Cadmium	EPA Method 200.7	0.002
Calcium	EPA Method 200.7	0.50
Chromium	EPA Method 200.7	0.006
Cobalt	EPA Method 200.7	0.006
Copper	EPA Method 200.7	0.0003
Iron	EPA Method 200.7	0.02
Lead	EPA Method 200.7	0.005
Magnesium	EPA Method 200.7	0.50
Manganese	EPA Method 200.7	0.002
Mercury	EPA Method 7470 CVAA	0.0002
Molybdenum	EPA Method 200.7	0.008
Nickel	EPA Method 200.7	0.01
Potassium	EPA Method 200.7	1.0
Selenium	EPA Method 200.8	0.02
Silicon	EPA Method 200.7	0.08
Silver	EPA Method 200.7	0.005
Sodium	EPA Method 200.7	0.5

NM Copper
May 1, 2012

Analytical Parameter	Analysis Method	Lab Detection Limit (mg/L unless noted)
Thallium	EPA Method 200.7	0.01
~~Titanium~~	~~EPA Method 200.7~~	~~0.005~~
Uranium	EPA Method 200.8	0.01
Vanadium	EPA Method 200.7	0.005
Zinc	EPA Method 200.7	0.005
Solids		
Total Suspended Solids (TSS)	SM 2540D	1.0 µg/L
Total Dissolved Solids (TDS)	SM 2540C	10
Alkalinity		
Alkalinity, total (as $CaCO_3$)	SM 2320B	20
Carbonate	SM 2320B	20
Bicarbonate	SM 2320B	20
Other		
pH	150.1	12.45
Specific Conductance	120.1	0.01 µS/cm
Cyanide	Kelada-01	0.005

Note: NA = not applicable as sample will not be analyzed for a given parameter.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 14, 2012

Katie Emmer

New Mexico Copper Corp
2425 San Pedro Dr NE Ste 100
Albuquerque, New Mexico 87109
TEL: (505) 400-7925
FAX

RE: Cu Flat OrderNo.: 1205153

Dear Katie Emmer:

Hall Environmental Analysis Laboratory received 1 sample(s) on 5/3/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1205153**
Date Reported: **5/14/2012**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: New Mexico Copper Corp
Project: Cu Flat
Lab ID: 1205153-001
Matrix: AQUEOUS

Client Sample ID: PW-3
Collection Date: 5/2/2012 2:30:00 PM
Received Date: 5/3/2012 8:35:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						Analyst: **BRM**
Fluoride	1.9	0.10		mg/L	1	5/3/2012 12:04:13 PM
Chloride	50	10		mg/L	20	5/3/2012 12:41:28 PM
Nitrogen, Nitrite (As N)	ND	0.10		mg/L	1	5/3/2012 12:04:13 PM
Nitrogen, Nitrate (As N)	0.70	0.10		mg/L	1	5/3/2012 12:04:13 PM
Sulfate	26	0.50		mg/L	1	5/3/2012 12:04:13 PM
EPA METHOD 200.7: DISSOLVED METALS						Analyst: **ELS**
Aluminum	ND	0.020		mg/L	1	5/8/2012 8:09:23 AM
Barium	0.0078	0.0020		mg/L	1	5/8/2012 8:09:23 AM
Beryllium	ND	0.0020		mg/L	1	5/8/2012 8:09:23 AM
Boron	0.095	0.040		mg/L	1	5/9/2012 8:40:03 AM
Cadmium	ND	0.0020		mg/L	1	5/8/2012 8:09:23 AM
Calcium	20	1.0		mg/L	1	5/9/2012 8:40:03 AM
Chromium	0.0060	0.0060		mg/L	1	5/8/2012 8:09:23 AM
Cobalt	ND	0.0060		mg/L	1	5/8/2012 8:09:23 AM
Copper	ND	0.0060		mg/L	1	5/8/2012 8:09:23 AM
Iron	0.065	0.020		mg/L	1	5/9/2012 8:40:03 AM
Lead	ND	0.0050		mg/L	1	5/8/2012 8:09:23 AM
Magnesium	1.0	1.0		mg/L	1	5/9/2012 8:40:03 AM
Manganese	0.0026	0.0020		mg/L	1	5/8/2012 8:09:23 AM
Molybdenum	ND	0.0080		mg/L	1	5/8/2012 8:09:23 AM
Nickel	ND	0.010		mg/L	1	5/8/2012 8:09:23 AM
Potassium	3.3	1.0		mg/L	1	5/9/2012 8:40:03 AM
Silicon	21	0.40		mg/L	5	5/8/2012 8:12:46 AM
Silver	ND	0.0050		mg/L	1	5/8/2012 8:09:23 AM
Sodium	81	1.0		mg/L	1	5/9/2012 8:40:03 AM
Vanadium	ND	0.050		mg/L	1	5/8/2012 8:09:23 AM
Zinc	0.021	0.010		mg/L	1	5/8/2012 8:09:23 AM
EPA 200.8: DISSOLVED METALS						Analyst: **SNV**
Antimony	ND	0.0010		mg/L	1	5/8/2012 1:19:22 PM
Arsenic	0.0074	0.0010		mg/L	1	5/8/2012 1:19:22 PM
Selenium	ND	0.0010		mg/L	1	5/10/2012 2:32:54 PM
Thallium	ND	0.0010		mg/L	1	5/8/2012 1:19:22 PM
Uranium	0.0013	0.0010		mg/L	1	5/10/2012 2:32:54 PM
EPA METHOD 245.1: MERCURY						Analyst: **ELS**
Mercury	ND	0.00020		mg/L	1	5/9/2012 12:01:31 PM
SM2340B: HARDNESS						Analyst: **ELS**
Hardness (As CaCO3)	53	6.6		mg/L	1	5/9/2012
EPA 120.1: SPECIFIC CONDUCTANCE						Analyst: **DBD**
Conductivity	460	0.010		µmhos/cm	1	5/7/2012 12:36:13 PM

Qualifiers:				
	*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **5/14/2012**

CLIENT:	New Mexico Copper Corp	**Client Sample ID:**	PW-3
Project:	Cu Flat	**Collection Date:**	5/2/2012 2:30:00 PM
Lab ID:	1205153-001 **Matrix:** AQUEOUS	**Received Date:**	5/3/2012 8:35:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
SM4500-H+B: PH						Analyst: **JLF**
pH	8.03	1.68	H	pH units	1	5/3/2012 5:14:04 PM
SM2320B: ALKALINITY						Analyst: **JLF**
Bicarbonate (As CaCO3)	120	20		mg/L CaCO3	1	5/3/2012 5:14:04 PM
Carbonate (As CaCO3)	ND	2.0		mg/L CaCO3	1	5/3/2012 5:14:04 PM
Total Alkalinity (as CaCO3)	120	20		mg/L CaCO3	1	5/3/2012 5:14:04 PM
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **KS**
Total Dissolved Solids	303	20.0		mg/L	1	5/8/2012 3:12:00 PM
SM 2540D: TSS						Analyst: **KS**
Suspended Solids	ND	4.0		mg/L	1	5/4/2012 4:36:00 PM

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	120504004
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	1205153
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	120504004-001	**Sampling Date**	5/2/2012	**Date/Time Received**	5/4/2012 10:18 AM
Client Sample ID	1205153-001D / PW-3	**Sampling Time**	2:30 PM		
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Cyanide	ND	mg/L	0.01	5/8/2012	CRW	EPA 335.4	

Authorized Signature John W. Codd

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID	**MB**	SampType:	**MBLK**	TestCode:	**EPA Method 200.7: Dissolved Metals**
Client ID:	**PBW**	Batch ID:	**R2622**	RunNo:	**2622**
Prep Date:		Analysis Date:	**5/8/2012**	SeqNo:	**72991** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	ND	0.020								
Barium	ND	0.0020								
Beryllium	ND	0.0020								
Cadmium	ND	0.0020								
Chromium	ND	0.0060								
Cobalt	ND	0.0060								
Copper	ND	0.0060								
Lead	ND	0.0050								
Manganese	ND	0.0020								
Molybdenum	ND	0.0080								
Nickel	ND	0.010								
Silicon	ND	0.080								
Silver	ND	0.0050								
Vanadium	ND	0.050								
Zinc	ND	0.010								

Sample ID	**LCS**	SampType:	**LCS**	TestCode:	**EPA Method 200.7: Dissolved Metals**
Client ID:	**LCSW**	Batch ID:	**R2622**	RunNo:	**2622**
Prep Date:		Analysis Date:	**5/8/2012**	SeqNo:	**72992** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.52	0.020	0.5000	0	105	85	115			
Barium	0.49	0.0020	0.5000	0	98.9	85	115			
Beryllium	0.52	0.0020	0.5000	0	103	85	115			
Cadmium	0.50	0.0020	0.5000	0	99.2	85	115			
Chromium	0.49	0.0060	0.5000	0	98.5	85	115			
Cobalt	0.47	0.0060	0.5000	0	94.9	85	115			
Copper	0.50	0.0060	0.5000	0	99.9	85	115			
Lead	0.50	0.0050	0.5000	0	99.3	85	115			
Manganese	0.48	0.0020	0.5000	0	96.9	85	115			
Molybdenum	0.49	0.0080	0.5000	0.002030	98.4	85	115			
Nickel	0.47	0.010	0.5000	0	93.9	85	115			
Silicon	2.6	0.080	2.500	0	104	85	115			
Silver	0.094	0.0050	0.1000	0	94.1	85	115			
Vanadium	0.52	0.050	0.5000	0	104	85	115			
Zinc	0.50	0.010	0.5000	0	101	85	115			

Sample ID	**1205193-005EMS**	SampType:	**MS**	TestCode:	**EPA Method 200.7: Dissolved Metals**
Client ID:	**BatchQC**	Batch ID:	**R2622**	RunNo:	**2622**
Prep Date:		Analysis Date:	**5/8/2012**	SeqNo:	**73030** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2622** RunNo: **2622**

Prep Date: Analysis Date: **5/8/2012** SeqNo: **73030** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.54	0.020	0.5000	0	107	70	130			
Barium	0.52	0.0020	0.5000	0.02182	98.9	70	130			
Zinc	0.54	0.010	0.5000	0.03785	101	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2622** RunNo: **2622**

Prep Date: Analysis Date: **5/8/2012** SeqNo: **73031** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.53	0.020	0.5000	0	106	70	130	1.33	20	
Barium	0.51	0.0020	0.5000	0.02182	97.2	70	130	1.71	20	
Zinc	0.53	0.010	0.5000	0.03785	98.0	70	130	2.48	20	

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74182** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Potassium	56	1.0	50.00	4.808	102	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74183** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Potassium	57	1.0	50.00	4.808	104	70	130	2.44	20	

Sample ID **1205193-005EMS** SampType: **MS** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74185** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron	4.5	0.10	2.500	2.034	99.6	70	130			
Magnesium	390	5.0	250.0	124.9	107	70	130			
Sodium	460	5.0	250.0	192.5	107	70	130			

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**

Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**

Prep Date: Analysis Date: **5/9/2012** SeqNo: **74186** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron	4.6	0.10	2.500	2.034	101	70	130	1.03	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205193-005EMSD** SampType: **MSD** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **BatchQC** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74186** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Magnesium	390	5.0	250.0	124.9	106	70	130	0.684	20	
Sodium	460	5.0	250.0	192.5	106	70	130	0.966	20	

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **PBW** Batch ID: **R2670** RunNo: **2670**
Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74215** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	ND	0.040								
Calcium	ND	1.0								
Iron	ND	0.020								
Magnesium	ND	1.0								
Potassium	ND	1.0								
Sodium	ND	1.0								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 200.7: Dissolved Metals**
Client ID: **LCSW** Batch ID: **R2670** RunNo: **2670**
Prep Date: Analysis Date: **5/9/2012** SeqNo: **74216** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.51	0.040	0.5000	0	101	85	115			
Calcium	54	1.0	50.00	0	107	85	115			
Iron	0.47	0.020	0.5000	0.004190	93.2	85	115			
Magnesium	54	1.0	50.00	0	109	85	115			
Potassium	53	1.0	50.00	0	106	85	115			
Sodium	54	1.0	50.00	0	107	85	115			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**
14-May-12

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID	**LCS**	SampType:	**LCS**	TestCode:	**EPA 200.8: Dissolved Metals**
Client ID:	**LCSW**	Batch ID:	**R2629**	RunNo:	**2629**
Prep Date:		Analysis Date:	**5/8/2012**	SeqNo:	**73283** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.023	0.0010	0.02500	0	92.8	85	115			
Arsenic	0.023	0.0010	0.02500	0	93.1	85	115			
Thallium	0.023	0.0010	0.02500	0	92.9	85	115			

Sample ID	**MB**	SampType:	**MBLK**	TestCode:	**EPA 200.8: Dissolved Metals**
Client ID:	**PBW**	Batch ID:	**R2629**	RunNo:	**2629**
Prep Date:		Analysis Date:	**5/8/2012**	SeqNo:	**73284** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	ND	0.0010								
Arsenic	ND	0.0010								
Thallium	ND	0.0010								

Sample ID	**LCS**	SampType:	**LCS**	TestCode:	**EPA 200.8: Dissolved Metals**
Client ID:	**LCSW**	Batch ID:	**R2708**	RunNo:	**2708**
Prep Date:		Analysis Date:	**5/10/2012**	SeqNo:	**75447** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Selenium	0.026	0.0010	0.02500	0	104	85	115			
Uranium	0.025	0.0010	0.02500	0	99.2	85	115			

Sample ID	**MB**	SampType:	**MBLK**	TestCode:	**EPA 200.8: Dissolved Metals**
Client ID:	**PBW**	Batch ID:	**R2708**	RunNo:	**2708**
Prep Date:		Analysis Date:	**5/10/2012**	SeqNo:	**75448** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Selenium	ND	0.0010								
Uranium	ND	0.0010								

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **MB-1862** SampType: **MBLK** TestCode: **EPA Method 245.1: Mercury**
Client ID: **PBW** Batch ID: **1862** RunNo: **2669**
Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74223** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.00020								

Sample ID **LCS-1862** SampType: **LCS** TestCode: **EPA Method 245.1: Mercury**
Client ID: **LCSW** Batch ID: **1862** RunNo: **2669**
Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74224** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.4	80	120			

Sample ID **1204854-004AMS** SampType: **MS** TestCode: **EPA Method 245.1: Mercury**
Client ID: **BatchQC** Batch ID: **1862** RunNo: **2669**
Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74226** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.2	75	125			

Sample ID **1204854-004AMSD** SampType: **MSD** TestCode: **EPA Method 245.1: Mercury**
Client ID: **BatchQC** Batch ID: **1862** RunNo: **2669**
Prep Date: **5/9/2012** Analysis Date: **5/9/2012** SeqNo: **74227** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0049	0.00020	0.005000	0	97.1	75	125	0.0957	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71254** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Chloride	ND	0.50								
Nitrogen, Nitrite (As N)	ND	0.10								
Nitrogen, Nitrate (As N)	ND	0.10								
Sulfate	ND	0.50								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71255** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.48	0.10	0.5000	0	95.5	90	110			
Chloride	4.8	0.50	5.000	0	96.2	90	110			
Nitrogen, Nitrite (As N)	0.98	0.10	1.000	0	98.2	90	110			
Nitrogen, Nitrate (As N)	2.5	0.10	2.500	0	101	90	110			
Sulfate	9.8	0.50	10.00	0	97.5	90	110			

Sample ID **1205153-001AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **PW-3** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71257** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	2.4	0.10	0.5000	1.941	84.8	72.9	113			
Nitrogen, Nitrite (As N)	0.96	0.10	1.000	0	96.5	77.6	111			
Nitrogen, Nitrate (As N)	3.3	0.10	2.500	0.7031	102	82.8	116			
Sulfate	37	0.50	10.00	26.34	106	80.5	119			

Sample ID **1205153-001AMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **PW-3** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71258** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	2.4	0.10	0.5000	1.941	84.1	72.9	113	0.155	20	
Nitrogen, Nitrite (As N)	0.92	0.10	1.000	0	92.4	77.6	111	4.30	20	
Nitrogen, Nitrate (As N)	3.1	0.10	2.500	0.7031	97.9	82.8	116	3.36	20	
Sulfate	37	0.50	10.00	26.34	102	80.5	119	1.04	20	

Sample ID **1205167-005AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71285** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205167-005AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71285** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrite (As N)	0.94	0.10	1.000	0	94.4	77.6	111			

Sample ID **1205167-005AMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71286** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrite (As N)	0.94	0.10	1.000	0	94.4	77.6	111	0.0232	20	

Sample ID **MB** SampType: **MBLK** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/4/2012** SeqNo: **71314** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Chloride	ND	0.50								
Nitrogen, Nitrite (As N)	ND	0.10								
Nitrogen, Nitrate (As N)	ND	0.10								
Sulfate	ND	0.50								

Sample ID **LCS** SampType: **LCS** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/4/2012** SeqNo: **71315** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.51	0.10	0.5000	0	101	90	110			
Chloride	4.7	0.50	5.000	0	93.9	90	110			
Nitrogen, Nitrite (As N)	0.96	0.10	1.000	0	96.1	90	110			
Nitrogen, Nitrate (As N)	2.5	0.10	2.500	0	98.0	90	110			
Sulfate	9.5	0.50	10.00	0	94.7	90	110			

Sample ID **1205174-001BMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **BatchQC** Batch ID: **R2561** RunNo: **2561**
Prep Date: Analysis Date: **5/4/2012** SeqNo: **71317** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	1.4	0.10	0.5000	0.9876	91.1	72.9	113			
Chloride	14	0.50	5.000	8.329	103	78	107			
Nitrogen, Nitrite (As N)	0.96	0.10	1.000	0	95.8	77.6	111			
Nitrogen, Nitrate (As N)	6.0	0.10	2.500	3.372	106	82.8	116			
Sulfate	45	0.50	10.00	35.20	102	80.5	119			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**1205174-001BMSD**	SampType:	**MSD**	TestCode:	**EPA Method 300.0: Anions**
Client ID:	**BatchQC**	Batch ID:	**R2561**	RunNo:	**2561**
Prep Date:		Analysis Date:	**5/4/2012**	SeqNo:	**71318** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	1.4	0.10	0.5000	0.9876	90.1	72.9	113	0.330	20	
Chloride	13	0.50	5.000	8.329	103	78	107	0.0337	20	
Nitrogen, Nitrite (As N)	0.96	0.10	1.000	0	95.7	77.6	111	0.0653	20	
Nitrogen, Nitrate (As N)	6.0	0.10	2.500	3.372	106	82.8	116	0.00611	20	
Sulfate	45	0.50	10.00	35.20	101	80.5	119	0.199	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**1205170-001D**	SampType:	**DUP**	TestCode:	**EPA 120.1: Specific Conductance**	
Client ID:	**BatchQC**	Batch ID:	**R2646**	RunNo:	**2646**	
Prep Date:		Analysis Date:	**5/7/2012**	SeqNo:	**73516**	Units: **µmhos/cm**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Conductivity	610	0.010						0	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID **1205005-001A DUP** SampType: **DUP** TestCode: **SM4500-H+B: pH**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71363** Units: **pH units**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	3.92	1.68						0.762		H

Sample ID **1205120-001B DUP** SampType: **DUP** TestCode: **SM4500-H+B: pH**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71373** Units: **pH units**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	7.73	1.68						0.645		H

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**
14-May-12

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID **1205005-001A MS** SampType: **MS** TestCode: **SM2320B: Alkalinity**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71221** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	ND	20	80.00	0	0	62.6	110			S

Sample ID **1205005-001A MSD** SampType: **MSD** TestCode: **SM2320B: Alkalinity**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71222** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	ND	20	80.00	0	0	59.9	111	0	10	S

Sample ID **1205120-001B MS** SampType: **MS** TestCode: **SM2320B: Alkalinity**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71242** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	360	20	80.00	299.4	70.9	62.6	110			

Sample ID **1205120-001B MSD** SampType: **MSD** TestCode: **SM2320B: Alkalinity**
Client ID: **BatchQC** Batch ID: **R2560** RunNo: **2560**
Prep Date: Analysis Date: **5/3/2012** SeqNo: **71243** Units: **mg/L CaCO3**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	350	20	80.00	299.4	67.1	59.9	111	0.869	10	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp
Project: Cu Flat

Sample ID	**MB-1832**	SampType:	**MBLK**	TestCode:	**SM2540C MOD: Total Dissolved Solids**
Client ID:	**PBW**	Batch ID:	**1832**	RunNo:	**2634**
Prep Date:	**5/7/2012**	Analysis Date:	**5/8/2012**	SeqNo:	**73329** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	ND	20.0								

Sample ID	**LCS-1832**	SampType:	**LCS**	TestCode:	**SM2540C MOD: Total Dissolved Solids**
Client ID:	**LCSW**	Batch ID:	**1832**	RunNo:	**2634**
Prep Date:	**5/7/2012**	Analysis Date:	**5/8/2012**	SeqNo:	**73330** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	1,020	20.0	1,000	0	102	80	120			

Sample ID	**1205078-002GMS**	SampType:	**MS**	TestCode:	**SM2540C MOD: Total Dissolved Solids**
Client ID:	**BatchQC**	Batch ID:	**1832**	RunNo:	**2634**
Prep Date:	**5/7/2012**	Analysis Date:	**5/8/2012**	SeqNo:	**73337** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	4,890	20.0	1,000	3,791	110	80	120			

Sample ID	**1205078-002GMSD**	SampType:	**MSD**	TestCode:	**SM2540C MOD: Total Dissolved Solids**
Client ID:	**BatchQC**	Batch ID:	**1832**	RunNo:	**2634**
Prep Date:	**5/7/2012**	Analysis Date:	**5/8/2012**	SeqNo:	**73338** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	4,930	20.0	1,000	3,791	114	80	120	0.733	20	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205153**

14-May-12

Client: New Mexico Copper Corp

Project: Cu Flat

Sample ID	**MB-1808**	SampType:	**MBLK**	TestCode:	**SM 2540D: TSS**
Client ID:	**PBW**	Batch ID:	**1808**	RunNo:	**2606**
Prep Date:	**5/4/2012**	Analysis Date:	**5/4/2012**	SeqNo:	**72551** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	ND	4.0								

Sample ID	**LCS-1808**	SampType:	**LCS**	TestCode:	**SM 2540D: TSS**
Client ID:	**LCSW**	Batch ID:	**1808**	RunNo:	**2606**
Prep Date:	**5/4/2012**	Analysis Date:	**5/4/2012**	SeqNo:	**72552** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	94	4.0	96.60	0	97.3	82.9	110			

Sample ID	**1205122-001BDUP**	SampType:	**DUP**	TestCode:	**SM 2540D: TSS**
Client ID:	**BatchQC**	Batch ID:	**1808**	RunNo:	**2606**
Prep Date:	**5/4/2012**	Analysis Date:	**5/4/2012**	SeqNo:	**72556** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Suspended Solids	ND	4.0						0	15	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laborator
4901 Hawkins NE
Albuquerque, NM 8710
TEL: 505-345-3975 FAX: 505-345-410
Website: www.hallenvironmental.con

Sample Log-In Check List

Client Name: NEW MEXICO COPPER CORP Work Order Number: 1205153
Received by/date: AT 05/03/12
Logged By: **Anne Thorne** 5/3/2012 8:35:00 AM
Completed By: **Anne Thorne** 5/3/2012
Reviewed By: AT 05/03/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Client

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

\# of preserved bottles checked for pH: 3 /
(<2 or [✓ >12] unless noted)
Adjusted?
Checked by: AT 05/03/12

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.6	Good	Not Present			

Chain-of-Custody Record

Client: NMCC

Mailing Address: 2425 San Pedro NE Ste 100
Albuquerque, NM

Phone #: 505-400-7925

email or Fax#:

QA/QC Package:
☐ Standard ☐ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____________

☐ EDD (Type) ____________

Turn-Around Time: Need Results
☐ Standard ☒ Rush May 11

Project Name: Cu Flat

Project #: Production Well Sampling

Project Manager: Katie Emmer

Sampler: CMC

On Ice ☒ Yes ☐ No

Sample Temperature 1.6°

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1205153	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	See attached list				Air Bubbles (Y or N)
5-2-12	14:30	H_2O	PW-3	500	none	-001																
				125	H_2SO_4	-001																
				125	HNO_3 & filter	-001																
				500	HNO_3	-001																
				500	NaOH	-001																

Date: 5-3-12	Time: 8:35	Relinquished by:	Received by:	Date 05/03/12	Time 0835
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: Please add Hardness per Andy of Katie 5/3
Need Results by May 11
Please email to: Kemmer@themacresourcegroup.com

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Table 9-3
Analytical Parameters and Analysis Methods for Groundwater Samples

Analytical Parameter	Analysis Method	Lab Detection Limit (mg/L unless noted)
Anions		
Fluoride	EPA Method 300.0	0.1
Chloride	EPA Method 300.0	0.1
Nitrogen, Nitrite (as N)	EPA Method 300.0	0.1
Nitrogen, Nitrate (as N)	EPA Method 300.0	0.1
Sulfate	EPA Method 300.0	0.5
Dissolved Metals		
Aluminum	EPA Method 200.7	0.02
Antimony	EPA Method 200.8	0.005
Arsenic	EPA Method 200.8	0.02
Barium	EPA Method 200.7	0.002
Beryllium	EPA Method 200.7	0.002
Boron	EPA Method 200.7	0.04
Cadmium	EPA Method 200.7	0.002
Calcium	EPA Method 200.7	0.50
Chromium	EPA Method 200.7	0.006
Cobalt	EPA Method 200.7	0.006
Copper	EPA Method 200.7	0.0003
Iron	EPA Method 200.7	0.02
Lead	EPA Method 200.7	0.005
Magnesium	EPA Method 200.7	0.50
Manganese	EPA Method 200.7	0.002
Mercury	EPA Method 7470 CVAA	0.0002
Molybdenum	EPA Method 200.7	0.008
Nickel	EPA Method 200.7	0.01
Potassium	EPA Method 200.7	1.0
Selenium	EPA Method 200.8	0.02
Silicon	EPA Method 200.7	0.08
Silver	EPA Method 200.7	0.005
Sodium	EPA Method 200.7	0.5

Analytical Parameter	Analysis Method	Lab Detection Limit (mg/L unless noted)
Thallium	EPA Method 200.7	0.01
~~Titanium~~	~~EPA Method 200.7~~	~~0.005~~
Uranium	EPA Method 200.8	0.01
Vanadium	EPA Method 200.7	0.005
Zinc	EPA Method 200.7	0.005
Solids		
Total Suspended Solids (TSS)	SM 2540D	1.0 µg/L
Total Dissolved Solids (TDS)	SM 2540C	10
Alkalinity		
Alkalinity, total (as $CaCO_3$)	SM 2320B	20
Carbonate	SM 2320B	20
Bicarbonate	SM 2320B	20
Other		
pH	150.1	12.45
Specific Conductance	120.1	0.01 µS/cm
Cyanide	Kelada-01	0.005

Note: NA = not applicable as sample will not be analyzed for a given parameter.

Appendix F – JSAI Review of Methods and Assumptions for Predicting Open Pit Water Quality

JOHN SHOMAKER & ASSOCIATES, INC.
WATER-RESOURCE AND ENVIRONMENTAL CONSULTANTS
2611 BROADBENT PARKWAY NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 345-3407, FAX (505) 345-9920
www.shomaker.com

TECHNICAL MEMORANDUM

To: Steve Raugust, New Mexico Copper Corporation
Katie Emmer, New Mexico Copper Corporation

From: Steven T. Finch, Jr., Principal Hydrogeologist-Geochemist, JSAI

Date: December 17, 2014

Subject: Review of methods and assumptions for predicting open pit water quality, Copper Flat Project, New Mexico

New Mexico Copper Corporation (NMCC) is in the process of obtaining a mining permit for the Copper Flat property near Hillsboro, New Mexico. To determine if the proposed Copper Flat open-pit water would meet New Mexico Water Quality Control Commission (NMWQCC) standards for stock and wildlife use, SRK (2013) prepared a report titled *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico*. The SRK (2013) geochemical model incorporated the water model developed by JSAI (2013). Reviewers of the SRK (2013) report have raised questions about the following issues:

1. More detail is needed to validate the assumption of 10-percent average fracture density in the pit walls and the amount of wall rock available for leaching.
2. More detail is needed to demonstrate that the proposed open pit water body will be well mixed, remain oxygenated, and not chemically stratify.
3. The geochemical model needs to be calibrated to chloride concentrations in the existing open pit to make sure the effects of evaporation are accounted for.

This Technical Memorandum consists of three sections for addressing the issues listed above. Sections 1.0 and 2.0 compare the SRK (2013) approach and assumptions to other open pit geochemical investigations, Section 3.0 presents calibration and sensitivity analysis results of the water model (JSAI, 2013) to historical water-quality data from the existing open pit, and Section 4.0 is a summary of findings.

1.0 REVIEW OF OPEN PIT WALL-ROCK STUDIES

1.1 SRK (2013) Copper Flat Model

SRK (2013) used different conceptual models of wall rock available for leaching: one for the existing and one for the future Copper Flat open pit. The difference is due to the blasting technique; the existing pit was mined in 1982 using production blasting similar to the blasting effects analyzed by Siskind and Fumanti (1974), and the proposed pit would be mined using presplit drilling and smooth wall blasting practices. The two conceptual models are summarized below.

1.1.1 Existing Open Pit

For the existing Copper Flat open pit, SRK (2013) estimated 10-percent fracturing in the first 2 ft of open pit wall rock (crushed zone) and 5-percent fracturing for a 3.8-ft-thick transition zone. The limit of oxidation and depth to undisturbed rock was assumed to be about 6 ft behind the pit wall (see fig. 3-9; SRK, 2013). A reactive rim of 0.04 ft around the fractures was assumed for the rock in the pit walls (based on HCT results).

Quintana Minerals only used production blasting to create the existing pit. Production blasting uses large widely-spaced explosive charges that are designed to fragment a large amount of *burden* (the rock that lies between the existing slope face and the blast hole). Production blasting is the most efficient way to remove large rock burdens, but it typically creates radial fractures around the blast hole and back break (fractures that extend into the final slope face), which reduce the strength of the remaining rock mass and increase its susceptibility to slope raveling and rock fall.

1.1.2 Proposed Open Pit

For the future Copper Flat open pit, SRK (2013) estimated fracturing is 10 percent of rock volume for the first 1 ft of open pit wall rock (crushed zone), with no transition zone between the crushed zone and undisturbed zone (see fig. 3-3; SRK, 2013). The open pit wall rock approximate 1 ft from the surface was assumed to be the limit of oxidation and the depth to undisturbed rock (see fig. 3-9, SRK, 2013). A reactive rim of 0.04 ft around the fractures was assumed for the rock in the pit walls. The 1-ft crushed zone and no transition zone represent presplit drilling and smooth wall blasting practices. Presplit holes are blasted before production blasts. Procedure uses small diameter holes at close spacing and lightly loaded with distributed charges. Presplit holes protect the final pit wall cut by producing a fracture plane along the final slope face that fractures from production blasts cannot pass.

1.1.3 Rock Mass Available for Leaching

For both scenarios, water flow is assumed to be mobile in the crushed zone and oxidized rind. The calculation of reactive mass was based on an average rock density of 169 lb/ft^3 (2,700 kg/m^3).

Chemistry of open pit run-off, for each pit wall material type, is estimated from scaled kinetic test cell (HCT) leachate concentrations. Average HCT solute concentrations are scaled up based on the pit wall water-rock ratio, and computed based on the estimated degree of fracturing and thickness of the reactive rind (SRK, 2013; p. 30).

1.2 Review of Pit Wall Fracturing References

1.2.1 Blasting Effects

Siskind and Fumanti (1974), a key reference used by SRK (2013), studied the fracturing produced in the vicinity of large-diameter blast holes (production blasting) in Lithonia Granite. The purpose of the Siskind and Fumanti (1974) study was to evaluate the use of production blasting to increase permeability for in-situ mining, where the amount of fracturing between holes is intended to be maximized for economic efficiency. A severely fractured zone was found to extend approximately 25 inches (64 cm) from the center of the 6-1/2-inch (16.5 cm) blast holes. A second zone, characterized by a lesser degree of fracturing, extended from 25 to 45 inches (64 to 114 cm). Beyond 45 inches (114 cm), the rock was undamaged. Carroll and Scott (1966) evaluated blasting effects on quartz monzonite and granodiorite (Climax Stock near Mercury, Nevada) and found that production blasting created an altered zone 0 to 8 ft in depth, and blast damage 2 to 4 ft in depth.

Kelsall and others (1984) found that in granite and basalt blasting enhanced permeability by about 10 times near the blast face, but the extent of blast effects were generally limited to <3.3 ft (<1 m), and possibly as little as 1 ft (0.3 m) when using low-charge blast methods.

It is important to note that granite, granodiorite, and quartz monzonite are similar intrusive rocks with similar rock properties. The primary difference is the quartz and feldspar content. The quartz monzonite at Copper Flat is therefore analogous to the granite and granodiorite in the blasting studies cited above. The Siskind and Fumanti (1974) study cites physical properties of the Lithonia Granite. Recent physical properties or the principal rock types of the Copper Flat Ore are presented in a 2013 report prepared by Mine Design Engineering of Kingston, Ontario, Canada for THEMAC Resources (Mine Design, 2013). The Mine Design report (2013) was prepared for the purposes of engineering the future pit walls for geotechnical stability. Table 1 presents a comparison of selected physical properties Lithonia Granite to the Copper Flat Quartz Monzonite and Quartz Monzonite Breccia.

Figure 1 presents the Copper Flat pit outline (Pre-Feasibility Study; PFS) from the 2013 Mine Design report, which shows the major rock types, their distribution, and the locations of the geotechnical drill holes where the samples from Table 1 were collected. From information presented in Mine Design (2013), and other available information, the Definitive Feasibility Study (DFS) pit geometry was developed. For geochemical characterization purposes, the PFS pit is very similar to the DFS Pit (SRK, 2014).

Table 1. Summary of the physical properties of the Lithonia Granite with Copper Flat Quartz Monzonite (QM) and Quartz Monzonite Breccia (QMBX)

Laboratory Analysis	Lithonia Granite (Tested by prevous investigators)	Lithonia Granite (Tested by authors at H-100 control hole)	QM (Average Values)	QM (Maximum Values)	QM (Minimum Values)	QMBX (Average Values)	QMBX (Maximum Values)	QMBX (Minimum Values)
Specific Gravity	2.63	-	2.68	-	-	2.57	-	-
Density (lb/ft^3)	164	-	167	-	-	160	-	-
Tensile Strength (lb/in^2)	450	-	2,132	3,075	493	1,247	1,697	653
Compressive Strength (lb/in^2)	30,000	28,000	18,490	29,400	11,810	6,614	6,614	6,614
Young's Modulus (lb/in^2)	3,000,000	6,400,000	5,018,000	6,135,000	3,626,000	2,973,000	2,973,000	2,973,000
Poisson's Ratio	0.26	-	0.10	0.09	0.11	0.12	0.12	0.12

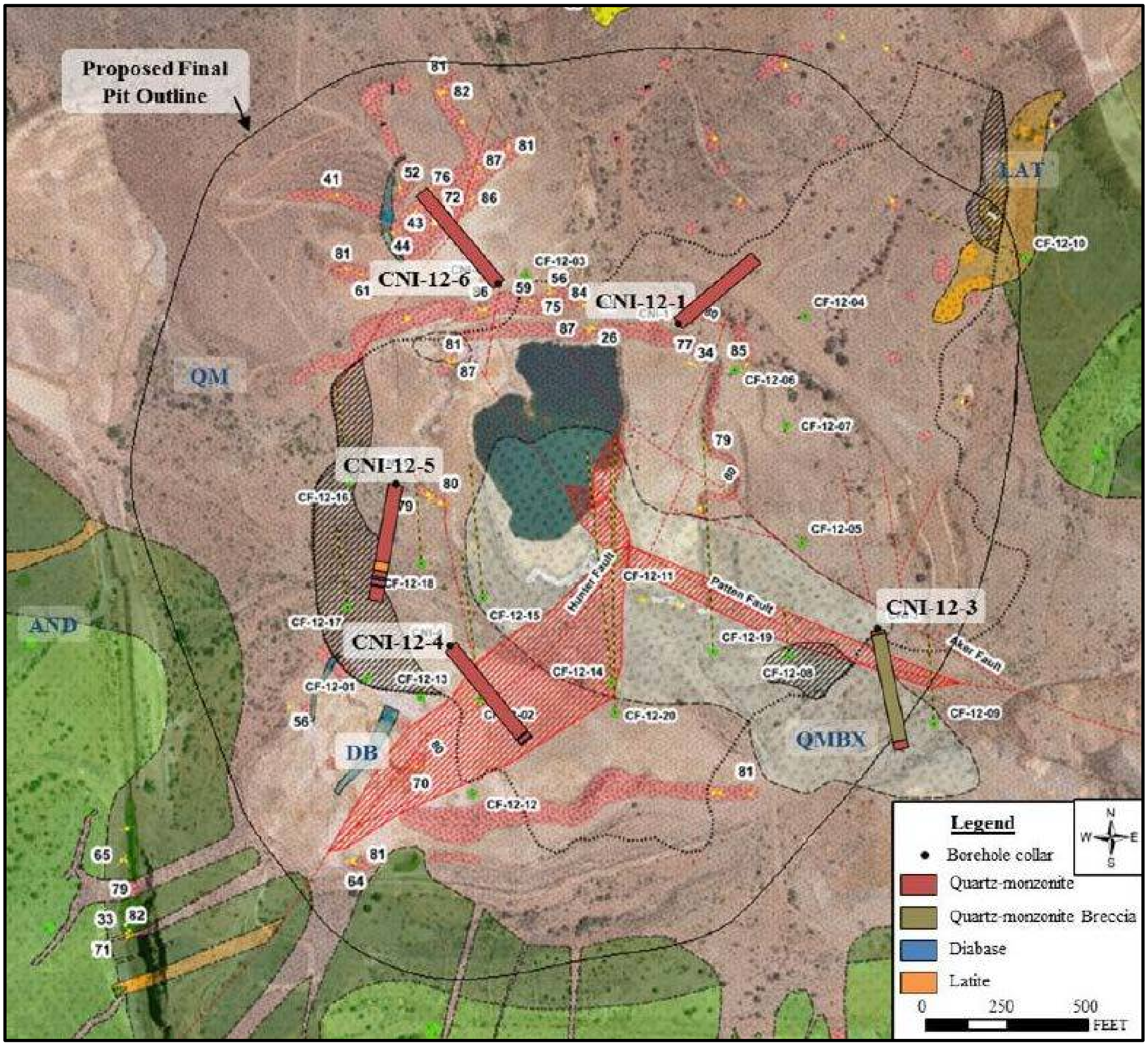

Figure 1. Geotechnical drill hole locations and the Pre-Feasibility Study pit outline (Mine Design, 2013).

1.2.2 Fracture Permeability

Molebatsi and others (2009) noted that many open-pit mines are located in fractured rock systems where water flow paths are complex and difficult to predict. These flow paths are typically controlled by a small subset of fractures that are permeable and interconnected. Most models of flow in fractured rock systems are based on a network of interconnected fractures that are all assumed to be permeable. However, this assumption is rarely observed in natural rocks where a significant number of the fractures within a connected cluster may be impermeable.

Field observations have shown that only a small proportion of fractures contribute to the overall flow, resulting in a complex and heterogeneous flow system. Up to 20 percent of the total number of fractures may contribute to overall flow (Bear et al., 1993). Although fracture connectivity has been used to explain heterogeneous phenomena (de Marsily, 1985), it is likely that additional aspects such as the effect of partial or total closure of individual fractures could further increase flow heterogeneity and tortuosity. Effectively impermeable fractures that (although mappable) will not conduct flow will thus need to be excluded from the conductive fracture cluster.

Not discussed in detail by Molebatsi and others (2009) is the rock type and mineralization of fractures, degree of fracturing, hydraulic conductivity in comparison to fracture density, and specific yield of rock. Obviously, fractured rock with low hydraulic conductivity would have more impermeable fractures than high hydraulic conductivity fractured rock that effectively behaves as a porous medium.

1.3 Other Open-Pit Geochemical Models

1.3.1 URS (2009) Little Rock Mine Post-Closure Pit Lake Model

The Little Rock open pit mine is located near Silver City, New Mexico, and is currently operating. URS (2009) assumed that a mixture of the in-situ field leaching tests and the HCT leachates represents the pit wall runoff. For the most likely case, an equal-weight mixture of the mean in-field leachate results, week-0 HCT results, and HCT results from the first 4-week idle period was used to represent run-on from the exposed pit walls above the pit lake. URS (2009) assumed: 1) rock samples collected within 100 ft of the final pit wall are representative of the exposed wall rock, and 2) a combination of the in-situ field leachates and the HCT leachates mimics weathering of pit wall rock. There is no discussion of blasting effects or increased fracture density on leaching of wall rock.

1.3.2 Tetra Tech (2010) Rosemont Copper Project

The Rosemont Copper project is located in southeastern Arizona. For simulating the initial flushing of blast-fractured pit walls, Tetra Tech (2010) used the first rinse from the HCTs to represent the chemical source terms. The HCT concentrations were generally higher than from the Synthetic Precipitation Leaching Procedure (SPLP) results, which generally correspond to rock that has had more time to weather before contacting water.

The near-surface wall rock of the anticipated ultimate pit shell is expected to be affected by blasting. An initial chemical flushing of the blast-affected pit wall rock was incorporated into the pit lake model. The near-pit wall rock is anticipated to have altered hydraulic properties and increased fracture density as a result of blasting and the extraction of surrounding rock. An increase in the porosity and specific yield (3 to 15 percent) of the near-surface wall rock is expected. The blast-affected wall rock was considered to extend for a distance of six (6) ft behind the ultimate pit wall; there was no basis provided for this assumption.

Where available, the chemical source terms used for flushing of the blast-affected wall rock for each formation were developed using the averaged first-rinse HCT data. Scaling of HCT data was not considered. For formations without HCT data, the concentrations of major cations and anions derived from SPLP tests were multiplied by a factor of three (3) and the trace metals were multiplied by a factor of two (2). Three (3) pore volumes of the blast-affected wall rock were considered in the model for the initial flush, after which standard groundwater inflow chemistry was assumed.

1.3.3 Schafer (2007) Betze Pit Lake Water Quality Predictions

Schafer (2007) estimated the thickness of the weathered zone behind the pit wall by applying the approximate analytical solution (shrinking core model) derived by Davis and others (1986). The shrinking core model considers that particle size and the reactive core shrink simultaneously; therefore, sulfide oxidation rates decrease over time. A porosity of 2 percent was used to represent the highwall, while the rate of interparticle diffusion was determined from historical humidity cell tests. The rate of interparticle diffusion was calculated using the Millington Quirk equation (Jury et al., 1991). For portions of the highwall with relatively low sulfide levels, oxygen can penetrate nearly 16.4 ft (5 m) after 400 years, while the depth of oxygen penetration is closer to 9.8 ft (3 m) after 400 years for higher sulfide zones. The overall average thickness of the oxidized wall rock was estimated to be 9.8 ft (3 m).

1.3.4 Schafer (2010) Dee Pit Lake, Arturo Mine

Schafer (2010) assumes the thickness of a weathered highwall increases with increasing exposure to oxidation. The thickness of the weathered zone was estimated for the Dee pit lakes by applying the approximate analytical solution derived by Davis and others (1986). A porosity of 3 percent was used to represent the highwall. Other data needed to calibrate the Davis and others (1986) equations were determined from pyrite weathering rates observed in humidity cell tests. The rate of interparticle diffusion was calculated using the Millington Quirk equation (Jury et al., 1991). For portions of the highwall with relatively low sulfide levels, oxygen can penetrate over 15 ft (5 m) after 400 years, while the depth of oxygen penetration is closer to 10 ft (3 m) after 400 years for higher sulfide zones (see Fig. 2 below).

1.3.5 Adrian Brown (1997) Cunningham Hill Mine Open Pit

A water model and geochemical model were coupled to predict open pit water quality. The model was calibrated to existing water levels and water-quality data (alkalinity, calcium, and sulfate). Inputs from existing acid wall seepage (AWS) were used to simulate open pit water-rock interactions. The water-quality model was simply a mixing model if open pit water quality remained under-saturated with respect to gypsum.

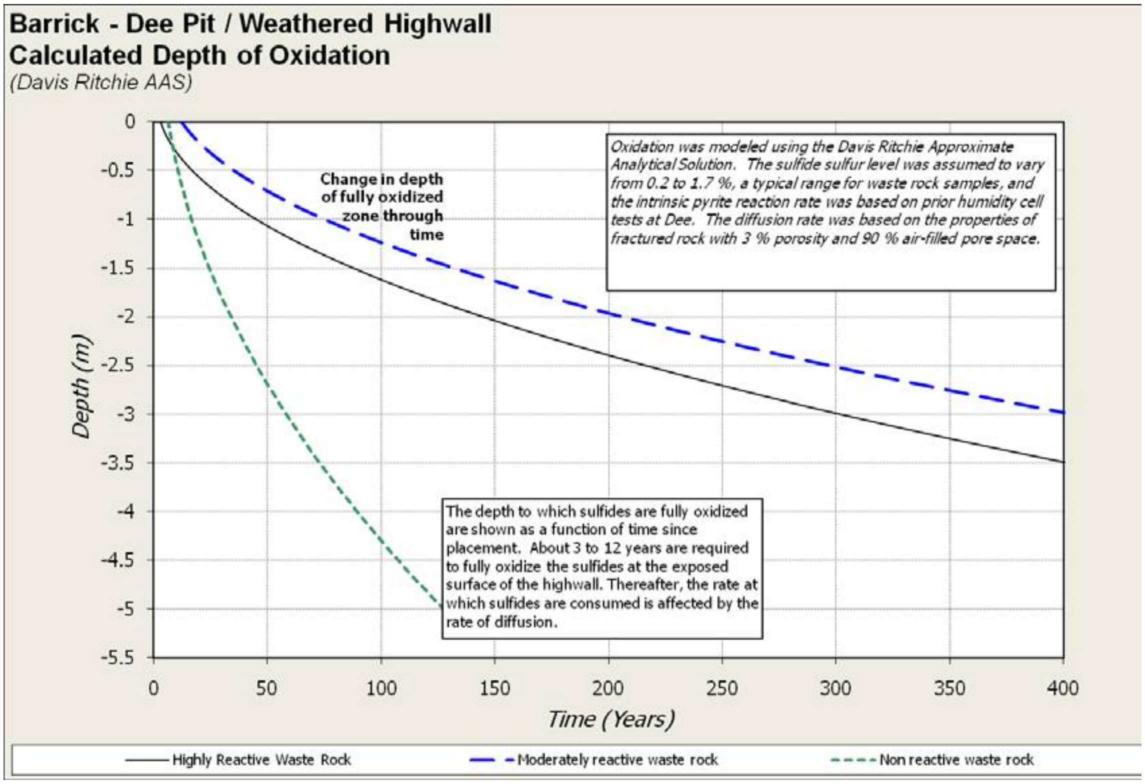

Figure 2. Graph showing depth of oxygen penetration based on the Davis and others (1986) approximate analytical solution (Schafer (2010) Fig. 13).

A groundwater flow and solute transport model of the open pit and surrounding groundwater system was developed by JSAI (1999), and later updated and recalibrated by JSAI (2011). It was demonstrated that the open pit general chemistry is more influenced by water budget components (mixing) than by mineral precipitation reactions.

1.3.6 Kempton and Atkins (2009)

Kempton and Atkins (2009) provide a review of methods for predicting water quality in open pits where sulfide oxidation is a major source term. Shrinking core models have been demonstrated to effectively simulate conditions in uniform materials, such as tailings. However, it is difficult to evaluate accuracy in the more heterogeneous pit benches and walls.

Kempton and Atkins (2009) evaluated a method for direct measurement of sulfide oxidation rates in mine pit benches by sealing a drape-chamber apparatus to the surface. They found that application of this method to benches and waste rock have not found the measured oxidation rates to be meaningfully correlated to sulfide sulfur, presence of surface rubble, moisture conditions, or carbonate content of the underlying rock. This suggests that physical processes such as blast-induced wall rock porosity and depth of pit-wall oxidation were more important than chemical processes. It was noted that fracturing is lower in competent rock, such as granite, and that careful blasting can reduce fracturing. Kempton and Atkins (2009) concluded that reliable comparisons of model-simulated versus observed pit lake water quality are needed to accurately assess model capabilities; this is exactly what SRK (2013) has done.

1.4 Discussion

Geochemical models for predicting open pit water quality are commonly most sensitive to the water budget components and the calculated solute contributions from sulfide oxidation. Open pit water-quality models with the least accurate predictions have under-estimated the potential for sulfide oxidation in wall rock and poorly represented water budget components (Kuipers and others, 2006). One reason for inaccurate water quality predictions is the lack of historical data for model calibration; most projects do not have an existing open pit water body with good time-series data. In contrast, the proposed Copper Flat open pit geochemical and groundwater flow model is calibrated to an existing open pit water body with 30 years of data.

Open pit wall blast damage for granite, granodiorite, and quartz monzonite rocks extends 2 to 4 ft in depth when assessing effects from production type blasting (Carroll and Scott, 1966; Siskind and Fumanti, 1974; and Kelsall and others, 1984).

Kelsall and others (1984) found that production blasting enhances permeability by about 10 times near the blast face. Molebatsi and others (2009) indicate that a small percentage (<20 percent) of the total fractures will contribute to permeability of the system. Typically, fractured rock groundwater systems are assumed to have a specific yield of less than 5 percent, and commonly less than 1 percent. The calibrated Copper Flat groundwater flow model simulates a specific yield of 0.001 (0.1 percent) in the quartz monzonite. If blast fracturing increased the effective porosity (specific yield) by an order of magnitude, the specific yield of the blast zone would be 1 percent. The 5 to 10 percent fracture density used by SRK (2013) can be considered conservative given the properties of the open pit wall rock estimated from the calibrated groundwater flow model.

A summary of the case studies reviewed is presented in Table 2. SRK (2013) is the only open pit water-quality model that includes blasting effects in the pit walls, scaled HCT data, and calibration to existing pit water chemistry.

Table 2. Summary of open pit water-quality prediction studies

reference	open pit	pit wall fracture assumptions	sulfide oxidation model	calibration to existing pit
SRK (2013)	Copper Flat	5 - 10 % fracture density (porosity) with depth based on blasting method; ranging from 1 to 6 ft	based on scaled HCT data	yes
Adrian Brown (1997)	Cunningham Hill	used measured acid wall seepage (AWS) data	used measured AWS data	yes
URS (2009)	Little Rock	none	based on HCT data	no
Tetra Tech (2010)	Rosemont	3 to 6% porosity, 6 ft depth	based on HCT data	no
Schafer (2007)	Betze	2 % porosity with oxidation depth increasing with time; 10 to 16 ft after 400 years	shrinking core model	no
Schafer (2010)	Dee	3 % porosity with oxidation depth increasing with time; 10 to 15 ft after 400 years	shrinking core model	no

2.0 STRATIFICATION OF OPEN PIT WATER BODIES

SRK (2013) concluded the proposed Copper Flat pit will not stratify, and will remain oxygenated. The proposed Copper Flat open pit water body will have a maximum depth of approximately 200 ft with a maximum surface area of about 22 acres.

2.1 Overview

Based on elevation and latitude, the Copper Flat open pit water body is classified as a warm monomitic type lake (Wetzel, 2001; fig 6-7). A warm monomitic lake mixes freely once a year in the winter at or above 4 °C. However, wind effects and water body geometry can have an effect on the degree and frequency of mixing. Baseline data (INTERA, 2012) from the existing pit water body provides evidence that a thermocline develops in the summer and mixing occurs in the winter. A chemocline does not develop, and the water body remains oxygenated (dissolved oxygen = 6 to 9 mg/L) throughout the full water column year-round. The existing open pit water body has an area of about 5 acres, maximum depth of 30 ft, and length of about 460 ft.

The relative depth (RD) of the predicted Copper Flat open pit water body at the maximum pit water stage is approximately 18 percent. RD relates the maximum depth of a lake (Z) to the width (d). Assuming an approximately circular lake, the width is a function of surface area (A) and can be determined from:

$$d = 2(A/\pi)^{\wedge}0.5$$

The percent RD is defined as:

$$RD = (Z/d)*100 \text{ percent}$$

The estimated RD of 18 percent is considerably greater than 5 percent, which typically suggests that the lake is likely to stratify. Such stratification may result in oxidizing conditions in the upper portions of the lake and more chemically reducing (oxygen-deprived) conditions at depth. However, pit lakes that form in arid regions are unlikely to stratify, relative to lakes that form in cooler, wetter climates (Jewell, 2009). A prerequisite for permanent stratification is that precipitation plus runoff is greater than evaporation during the summer months when the water body is potentially undergoing temporary thermal stratification (Jewell, 2009).

While stratification of an open pit water body has implications for water quality at depth, the near-surface waters will remain oxidized. These near-surface waters are considered the most important from an open pit water-quality perspective given the potential ecological risks associated with them. The water quality at depth is less important given the expected terminal nature of the open pit water body.

2.2 Case Studies

Jewell (2009) evaluated six permanently-stratified and eight open pit lakes with seasonal thermocline, and concludes that permanently stratified lakes have vertical density contrast greater than 0.0005 g/cm^3 and a Wedderburn number greater than 1. The Wedderburn number considers thermocline depth, maximum lake length, water density, and wind speed. Jewell (2009) failed to note that most permanently-stratified open pit lakes receive AWS inputs and have acidic water. A summary table of existing open pit water bodies and their characteristics is presented in Table 3.

Table 3. Summary of open pit water bodies and stratification characteristics

open pit	location	effective length (ft)	maximum depth (ft)	relative depth (percent)	thermocline depth (ft)	acidic
permanently stratified						
Brenda	B.C.	2,296	492	21	39	no
Spenceville	California	253	50	20	13	yes
Berkeley	Montana	5,900	426	7	23	yes
Seasonal thermocline and well mixed						
Humbolt	Nevada	944	137	15	8	no
Blackhawk	Utah	492	na	na	33	no
Blowout	Utah	656	230	35	39	no
Colosseum	California	482	157	33	na	no
Cunningham Hill	NM	407	90	22	20	no
Copper Flat (existing)	NM	537	30	6	20	no[1]
Copper Flat (proposed)	NM	1,105	200	18	TBD	no
Yerington	Nevada	5,412	400	13	49	no

[1] there have been temporary acidic conditions where the pit water naturally neutralizes over time

TBD - to be determined

2.3 Discussion

The proposed Copper Flat open pit is expected to have a seasonal thermocline, be well mixed, oxygenated, and not acidic. Relative depth does not appear to govern the conditions for creating a permanently stratified open pit water body; however, acidic water and higher latitude are key conditions for creating permanent stratification.

3.0 COPPER FLAT OPEN PIT WATER MODEL

The Copper Flat open pit and groundwater flow model (water model) developed by JSAI (2013) was calibrated to water levels, water budgets, and hydraulic properties. The water model was used by SRK (2013) in the geochemical model. The JSAI (2013) water model was an interim version that was finalized in 2014, but the pit water balance did not change.

The water model is used here to address calibration to the Copper Flat open pit evaporation. Evaporation accounts for all of the outflow from the open pit water body; however, the water model only simulates average climate conditions. Figures 3 through 5 illustrate the model-simulated effects of evaporation on total dissolved solids, (TDS), sulfate, and chloride concentrations in the open pit when considering mixing without mineral precipitation.

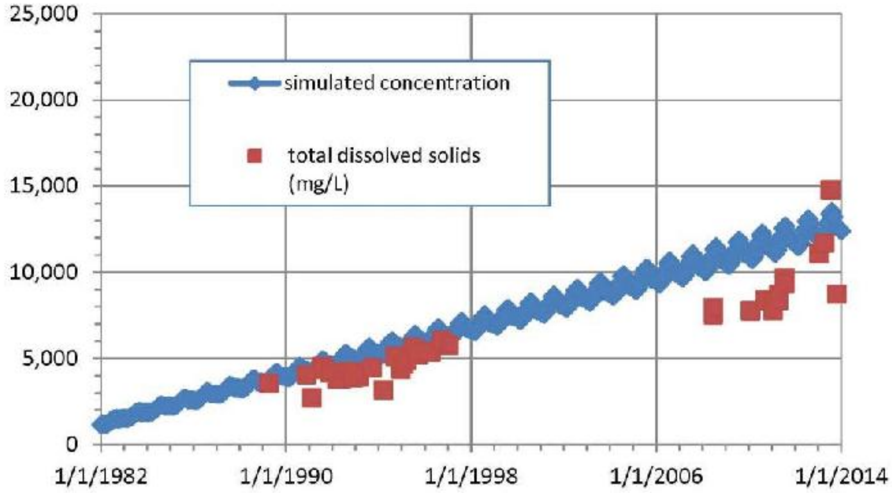

Figure 3. Graph showing water-model simulated and measured TDS concentrations for the Copper Flat open pit water body.

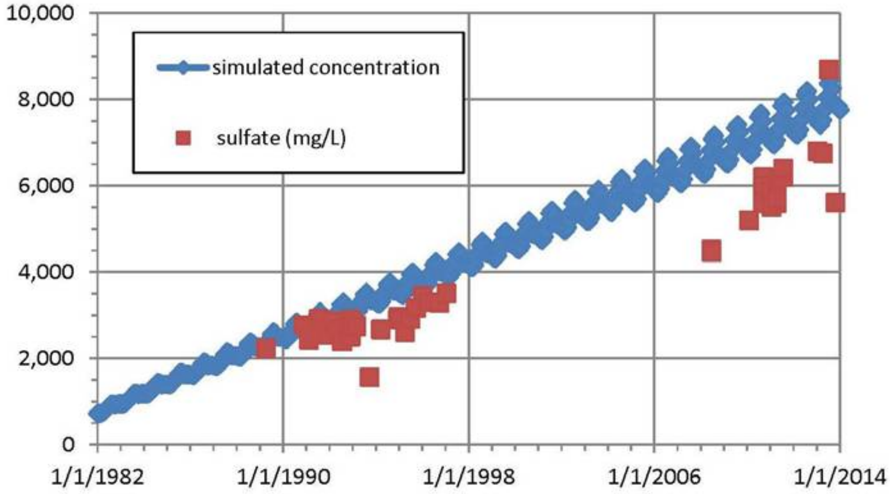

Figure 4. Graph showing water-model simulated and measured sulfate concentrations for the Copper Flat open pit water body.

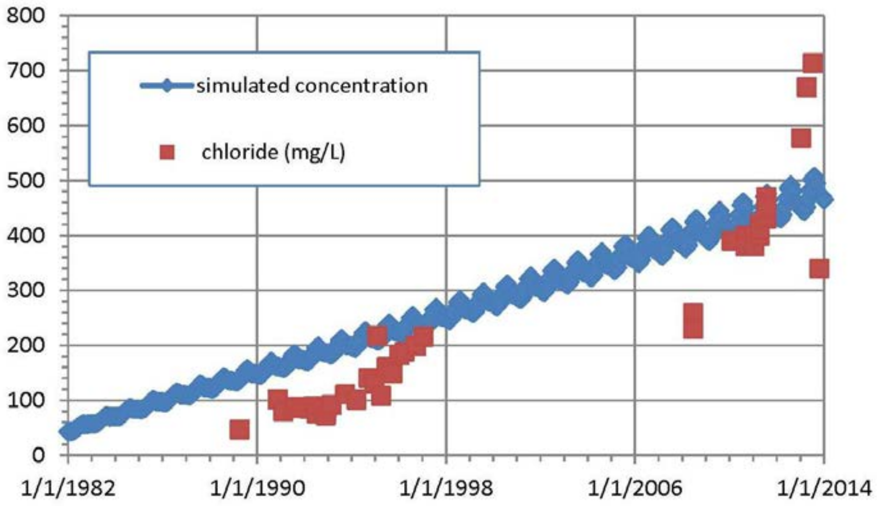

Figure 5. Graph showing water-model simulated and measured chloride concentrations for the Copper Flat open pit water body.

Data collected during 2013 show the evapo-concentration effects of extreme drought with concentrations well above the model-simulated concentrations, but 4th quarter 2013 concentrations were well below the model-simulated concentrations, due to a heavy monsoon period (Figs. 3 through 5). The model appears to reasonably simulate the average climate conditions.

SRK (2013) calibration of the geochemical model to existing pit conditions was performed for the 2011 dataset. The geochemical model considers mixing from the water model and mineral precipitation reactions. The geochemical model calibrates to TDS and sulfate better than the water model with mixing alone, but the water model calibrates better to chloride concentrations than the geochemical model (Table 4). The effects of evaporation are reasonably calibrated in the water model and reflected in the geochemical model.

Table 4. Comparison of water-model and geochemical-model simulated TDS, chloride, and sulfate concentrations to measured concentrations, Copper Flat open pit

constituent	2010-2011 measured range (mg/L)	geochemical-model results (mg/L)	water-model results (mg/L)
total dissolved solids (TDS)	7,770 to 9,410	7,751	11,621
sulfate	5,200 to 6,400	5,152	7,263
chloride	380 to 470	235	436

mg/L - milligrams per liter

4.0 SUMMARY OF FINDINGS

In summary, SRK (2013) assumptions used for reactive wall thickness and fracture density for the existing and proposed future pit are reasonable and supported by detailed studies pertaining to blasting effects on quartz monzonite rocks cited in Section 1.0. SRK (2013) used fracture-density results reflective of production blasting for the existing Quintana pit walls, and fracture density results reflective of low-charge blasting methods for the future open pit. Sensitivity of model results to fracture density and reactive wall thickness is reflected in these two simulations.

Out of the case studies reviewed (Table 2), SRK (2013) is the only open pit water quality model that considers blasting effects in the pit walls, scaled HCT data, and calibration to existing pit water chemistry. Calibration of the water model and geochemical model to existing data strengthens the ability to accurately predict future conditions.

Relative depth does not appear to govern the conditions for creating a permanently stratified open pit water body; however, significant acidic water inputs and higher latitude are key conditions for creating permanent stratification. The proposed Copper Flat open pit is expected to be seasonally stratified (thermocline only), well mixed, oxygenated, and not acidic. Baseline data from profiles in the existing pit at Copper Flat support the conclusion that the proposed pit will be well mixed and oxygenated.

Using the water model to simulate mixing and evapoconcentration effects on chloride, sulfate, and TDS demonstrates that the water model is calibrated to the effects of evaporation. The results in Table 4 compare simulated evapoconcentration with no mineral precipitation (water model only) to simulated evapoconcentration with mineral precipitation (water model and geochemical model). This comparison of model results to historical data is a sensitivity analysis that shows that the water and geochemical models are well calibrated to effects of evaporation.

The SRK (2013) geochemical model is representative of expected conditions at Copper Flat, and presents the best technical approach for predicting water quality at the future Copper Flat open pit.

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Appendix G – JSAI Future Pit Water Balance

JSAI

TECHNICAL MEMORANDUM

To: Jeff Smith, New Mexico Copper Corporation jsmith@themacresourcesgroup.com

From: Steve Finch, Principal Hydrogeologist-Geochemist
Michael A. Jones, Principal Hydrologist

Date: September 25, 2017

Subject: Post reclamation open pit surface area storm-water runoff calculations, Copper Flat Project, New Mexico Copper Corporation

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John Shomaker & Associates, Inc. (JSAI) developed and calibrated a groundwater flow model for the New Mexico Copper Corporation (NMCC) Copper Flat project (JSAI, 2014), which included the proposed Copper Flat open pit. The model was calibrated to historical and current conditions at the Copper Flat Open Pit, and used to predict effects of the proposed mining plan.

The purpose of this technical memorandum is to establish storm-water runoff coefficients and watershed areas representative of the post-mining reclamation of the proposed Copper Flat Open Pit Surface Drainage Area (OPSDA). The post-mining OPSDA and watershed areas discussed in this memo are shown on Figure 1.

After reclamation, there will be three areas with different runoff coefficients inside the OPSDA:

1. Reclaimed watershed area surrounding the open pit;
2. Reclaimed sections of the Open Pit shell; and
3. Un-Reclaimed sections of the Open Pit shell.

Curve numbers for the different areas shown on Figure 1 and listed in Table 1 were derived from the NRCS Part 630 Hydrology National Engineering Handbook. The curve number equation (from NRCS, 2004) and precipitation statistics from the Hillsboro station were used to develop the assigned runoff coefficients presented in Table 1.

Post mining OPSDA reclamation will include re-contouring, placement of cover materials, and revegetation. As described in the NMCC Baseline Data Report, cover materials will resemble sandy to silty loam representative of Hydrologic Soil Group B (NRCS, 2009).

The hydrologic conditions of the reclaimed OPSDA will be classified as poor to fair, resembling desert shrub with less than 40 percent vegetative cover (NRCS, 2004). A Curve Number of 75 is representative of Desert Shrub landscape, Hydrologic Soil Group B, and less than 40 percent vegetative cover (NRCS, 2004; table 9-1).

Table 1. Summary of corresponding Curve Number and assigned Runoff Coefficient for sub-regions within the reclaimed Copper Flat Open Pit Surface Drainage Area

sub-region name	corresponding Curve Number	assigned Runoff Coefficient
Reclaimed OPSDA	75	0.071
Reclaimed Pit Shell	90	0.303
Un-Reclaimed Pit Shell	80	0.126

The reclaimed pit shell includes the haul road and potentially other accessible areas. Reclaimed surface is expected to resemble improved dirt road, and have a corresponding runoff curve number of 90 (NRCS, 2004; table 9-1).

The un-reclaimed pit shell was assigned a runoff curve number of 80, which has been derived from water balance studies for other open pits, such as the Cunningham Hill Mine Reclamation Project (JSAI, 2012).

Precipitation statistics were used with the runoff curve number to calculate the runoff coefficient presented in Table 1. Surface-water runoff is calculated from daily precipitation data, and soil conditions represented by a runoff curve number (NRCS, 2004a). Runoff is estimated using the following equations:

$$Ia = S*0.2$$

$$S = (1{,}000/CN)-10$$

$$Q = \frac{(P-Ia)^2}{(P-Ia)+S}$$

where,

Ia equals the initial abstraction including surface storage, interception by vegetation and infiltration prior to runoff, in inches depth over the drainage area.

S equals the potential maximum retention of water by the soil in equivalent inches depth over the drainage area.

CN equals the runoff curve number

P equals the accumulated rainfall in inches depth over the drainage area

Q equals the accumulate volume of runoff in inches depth over the drainage area

The runoff equations (above) are used to calculate the average annual runoff for the period of record from the Hillsboro Station. An example for Curve Number equal 90 is presented in Table 2. The calculated average annual runoff for period of record is divided by the average annual precipitation for period of record (12.5 in./yr) to derive the runoff coefficient.

Table 2. Summary of Hillsboro Station precipitation statistics and calculated runoff used to derive runoff coefficient for reclaimed pit shell area (CN=90)

Range in daily precipitation events	No. of daily precipitation events within range for period of record*	Average number of precipitation events per year for period of record	average magnitude of precipitation event for range (in.)	P-Ia for CN =90	runoff per average event for range (in.)	average runoff per year (in.)
>3	3	0.031	3.29	3.070	2.86	0.090
2 - 3	21	0.219	2.31	2.090	1.89	0.414
1 - 2	168	1.752	1.32	1.100	0.92	1.606
0.5 - 1	490	5.109	0.7	0.480	0.33	1.682
					sum	3.79
Runoff coefficient (CN=90) = (3.79 in)/(12.5 in) = 0.303						

* Hillsboro station period of record equals 95.9 years or 35,037 days with average annual precipitation of 12.5 inches per year

Attachments

Figure 1. Map showing post-mining watershed areas for the Copper Flat Open Pit Drainage Area.

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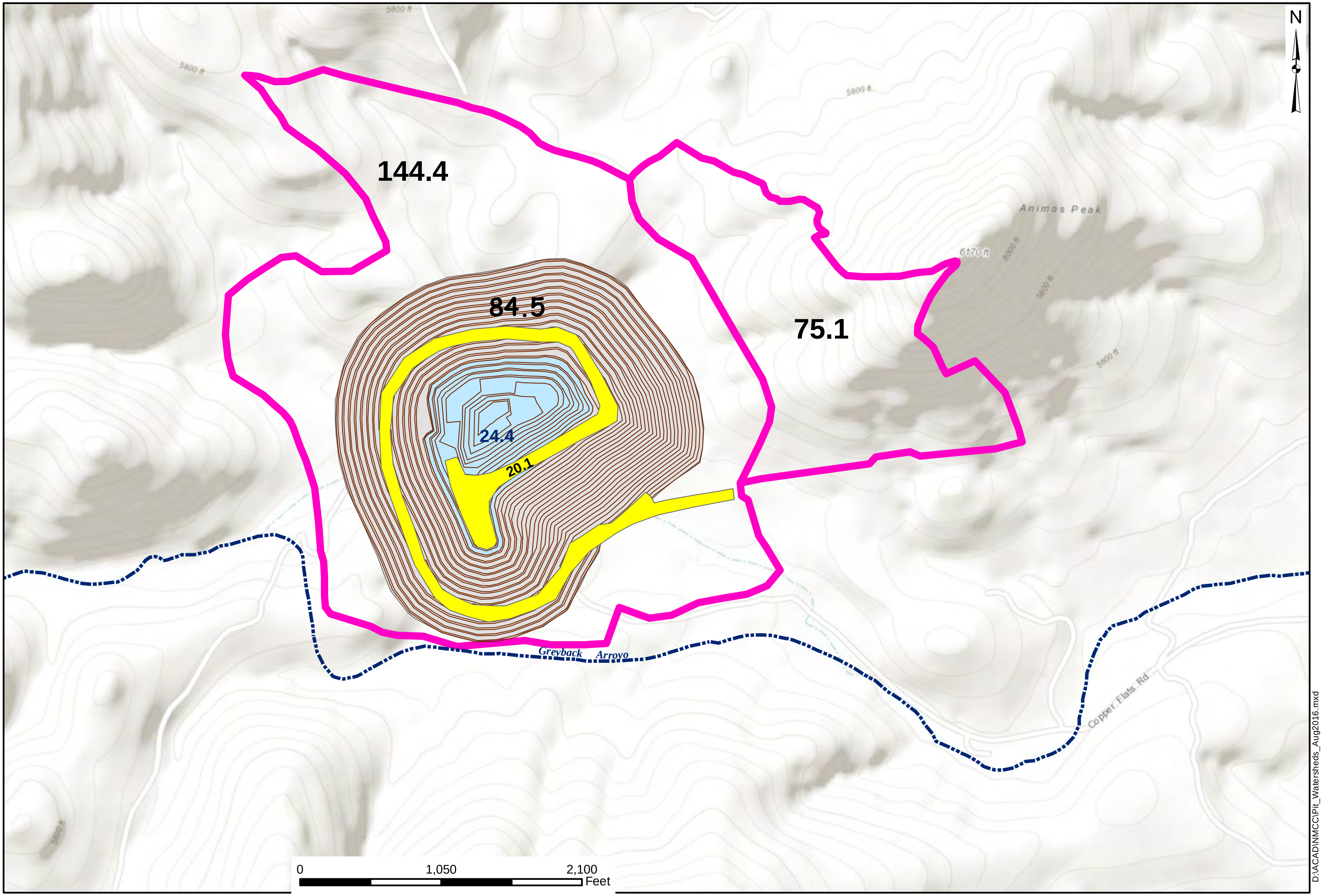

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Figure 1. Map showing post-mining watershed areas for the Copper Flat Open Pit Drainage Area.

JSAI Pit Water Balance
Summary Statistics

		Pit Model	
Parameter	**Units**	**Un Reclaimed**	**Reclaimed**
Model Date		Jun 2017	Jul 2017
Pit Fill Method		Natural Fill	Rapid Fill
Total Pit Watershed	Acres	314	314
Watershed Ex-Pit	Acres	185	185
Watershed In-Pit	Acres	129	129
Pit Reclaimed Surfaces	Acres	0	46
Pit Unreclaimed Surfaces	Acres	0	83
Pit Lake Surface Area at Static Level	Acres	22	22
Annual Precipiation Rate	Inches	12	12
Annual Evaporation Rate	Inches	50	50
Runoff Coefficient, Ex-Pit Watershed		0.071	0.071
Runoff Coefficient, In-Pit Watershed Reclaimed		0.303	0.303
Runoff Coefficient, In-Pit Watershed Unreclaimed		0.126	0.126
Fresh Water Fill	Acre-Feet	0	2,201
Pit Lake Annual Evaporation @ Static Level	Acre-Feet	91	92
Annual Groundwater Inflow	Acre-Feet	36	36
Annual Stormwater Inflow, Total Watershed	Acre-Feet	54	57
Annual Stormwater Inflow, Ex-Pit	Acre-Feet	14	14
Annual Stormwater Inflow, In-Pit	Acre-Feet	41	43
Pit Lake Volume at Static Level	Acre-Feet	2,278	2,286
Pit Lake Depth at Static Level	Feet	247	248
Pit Lake Surface Elevation at Static Level	Feet AMSL	4,897	4,898

Appendix H – PHREEQC Input Files (electronic)

Appendix H(i) – Existing pit calibration model

Appendix J – Aquatic Consultants Inc. Biological Assessment of the Existing Copper Flat Pit Lake

Copper Flat Mine

Biological Assessment
November 2014

AquaticConsultants Inc.

"Your Lake & Stream Experts"

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METHODS

All samples were collected and field measurements were completed on 06 November 2014. All testing was conducted by Aquatic Consulting & Testing, Inc. (Arizona Laboratory License No. AZ0004). Measurements and samples were collected from three locations (coordinates shown below) except where otherwise described.

Location 1:	N 32º58'11.97"	W 107º32'03.52"
Location 2:	N 32º58'15.24"	W 107º32'03.08"
Location 3:	N 32º58'14.48"	W 107º32'00.80"

Light transmission was measured using an Apogee MQ300 quantum meter and remote sensor. Transparency was measured using a standard Secchi Disk.

Temperature and oxygen profiles were measured using a YSI Model 550A dissolved oxygen meter with remote sensor. Light extinction coefficient was calculated using the quantum meter data and the following formula:

Light extinction coefficient $k = (\ln I_o - \ln I_d) \times 1/z$

Where k = extinction coefficient
I_o = light intensity at surface
I_d=light intensity at depth umhol/m^2/s [or uE]
Z= depth (m)

Water samples were collected from a depth of 0.5 meter at the three sampling locations and composited into a single sample. Depth-integrated samples were not required because the water was not vertically stratified. Sample preservation and chemical analyses were performed using EPA or APHA (Standard Methods) procedures licensed by Arizona Department of Health Services. Specific test methods are referenced in the attached laboratory reports. Algae identification and counts were made using a Nikon Diaphot phase/contrast inverted microscope. Samples were concentrated using an Utermohl settling chamber. Identifications were made using the following taxonomic references:

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Zooplankton was collected using an 80-um Wisconsin plankton net. A vertical tow from the bottom to top of the water column was made at each location and combined to produce a composite. At the laboratory, the concentrated sample volume was measured and recorded, an aliquot was transferred to a counting chamber, and the sub-sample was observed using a dissecting microscope. Zooplankton forms were identified and counted.

Benthic (sediment) samples were collected with a stainless steel Ponar dredge. The sediment was hand sorted and screened in the laboratory to retrieve and isolate macroinvertebrates. Particle size analysis was conducted using an ATM Arrow shaker equipped with stacked U.S. standard sieves.

Fish sampling was conducted using an 18’ Smith-Root Electro-fishing Boat. Running Direct Current (DC) at 15 pulses per second. Percent of range selected was 40% with output at approximately 200 volts. Pulse width at 40% produced a pulse duration of 2.4 milliseconds. Electro-fishing amperage was between 8 and 10. Electro-fishing effort was continuous at 1800 seconds during daylight and 1800 seconds after dark. Additionally, three experimental mesh gill nets were deployed for 21 hours over night. Two sets were shoreline sets and one in the middle of the pit. Each net was 120ft long and made up of six monofilament 20ft sections with the following mesh sizes ½”, 1”,1 ½”, 2”, 2 ½”, and 3”.

RESULTS AND DISCUSSION

Physical Conditions

Stratification

Temperature and oxygen profiles are presented below. Water temperature measurements varied from 12.6 to 13.7 C and dissolved oxygen concentrations ranged from 8.9 to 9.4 mg/L. At the time of sampling, the pit water was vertically mixed. The greatest change in temperature with depth occurred at Location 2, with a change of only 0.7 C from top to bottom (7.5 m) of the water column. Accordingly, dissolved oxygen was essentially unchanged through the water column at each location, with only a 0.2 mg/L maximum change from surface to pit bottom. Raw data and profiles are presented in Figure 1.

The temperature and oxygen data, aside from other limiting factors, indicate the water should be supportive of a warm water or possibly a cold water fishery (summertime profiles were not available).

Transparency and Solar Radiation

The Secchi disk depth was approximately 4.0 m. PAR measurements indicated penetration through the entire water column. Approximately 110 umhol/m2/s PAR was available at the pit bottom (extinction coefficient 0.35). Sufficient light existed to support a phytoplankton population. Light intensity at the pit bottom was similar to the recommended light intensity for algae cultures (Lavens and Sorgeloos 1996) and possibly benthic algae, although the minimum light requirement for benthic algae is poorly understood (Stevenson et al 1996). Light extinction data and graph are presented in Figure 2.

Sedimentation and Substrate Type

The amount of compacted sediment on the pit bottom ranged from 4 to 6 inches, with up to a 20-inch covering of iron floc. The sediment contained a very low (0.21%) organic carbon concentration, but did contain organic nitrogen (2160 mg/kg) and phosphorus (880 mg/kg). These data indicate that benthic algae or even submerged rooted macrophytes could only exist in areas where the iron floc was limited (littoral zone).

Seive analysis (see Figure 3) indicated that all particles were less than 1.18 mm and 89 percent was finer than 0.6 mm. The sediment is classified as silt (all particles less than 2 mm). The silt provides little to no substrate for diversity in a macroinvertebrate population.

The sieve analysis is presented on the following page. Sediment chemistry data are presented as part of laboratory report package presented at the end of the narrative.

Nutrients

Low nutrient concentrations, typical of oligotrophic lakes, were measured. An available N:P ratio of 3:1 was found. Because of the low pH (4.6 SU) and reported (Hall Environmental Analysis Laboratory) acidity of the water (180 mg/L as $CaCO_3$), bicarbonate and carbonate ions would be essentially absent (Geller et al.). Sufficient inorganic carbon would be available to algae through the equilibrium reactions of absorbed atmospheric carbon dioxide and carbonic acid (University of Montana).

Biologically-available phosphorus (0.018 mg/L phosphate-P), nitrogen (0.24 mg/L NO_3-N and 0.03 NH_3-N) would be adequate to support a modest phytoplankton population. This projection was supported by the very low chlorophyll-a concentration measurement of 0.8 ug/L. At measured pH, no ammonia toxicity could exist. The low pH would be detrimental to cyanobacteria (blue-green algae growth, but not eukaryotic algae species (Brock 1973). The complete water quality report is provided at the end of the report narrative.

Biological Conditions

The pit waters contained a depauperate algal assemblage composed of only six genera of algae. The six consisted of the diatoms (Bacillariophyta) *Diatoma*, *Cymbella*, *Synedra,* and *Navicula*; the cryptomonad, *Cryptomonas*; and the blue-green (Cyanophtya) alga *Chroococcus*. *Cryptomonas* was the dominant organism and is common in cold, acidic waters (Holopaenin 1992; Ojala and Jones 1993). Diatoms have also been found in a number of acidic environments, especially where high concentrations of iron exist as in some pit water environments (Nicola 2000). *Chroococcus* has been reported to dominate acidified Canadian lakes (Seckbach 2007). The total cell count was 603 cells per mL. However, many of the diatoms were frustules only (no protoplasm or chlorophyll observed), suggesting that these were dead and settling cells. The viable cell count is estimated at 312 cells/mL. The algae composition is summarized below (Table 1).

Table 1. Algae composition of Copper Flat pit water 11/06/14

Genus	Division/ form	Count per mL	Percent Comp.
Diatoma	Bacillariophyta (diatom) unicell	22	3.7
Cryptomonas	Cryptophyta (cryptophytes) flagellate	223	37.0
Cymbella	Bacillariophyta (diatom) unicell	34	5.6
Synedra	Bacillariophyta (diatom) unicell	212	35.2
Navicula	Bacillariophyta (diatom) unicell	22	3.7
Chroococcus	Cyanophyta (blue-green) colony	89	14.8

Sediment samples, primarily in the littoral zone, contained diatom frustules (most void of protoplasm or chlorophyll) and a very small number of *Hormidium* (Chlorophyta) filaments. *Hormidium* grows in acid environments as low as pH 3.5 and is least susceptible to copper and zinc toxicity at the pH range of 3.5 to 4.0 SU (Hargraves and Whitton 1976).

No zooplankton were recovered from multiple vertical tows at each location.

No macroinvertebrates were recovered from the sediment.

No fish species were recovered from either electro-fishing or gill nets.

A very small stand (20 sq ft) of cattail (*Typha* sp.) was found along the lake edge, in the dampened soil. No floating or submerged macrophytes were present.

Integrated Conditions and Biological Integrity

Because of the limited variety of organisms recovered from the sampling activities, only a few basic indices were calculated to characterize the pit water. The indices typically characterize the pit water as oligotrophic, with insignificant amounts of organic pollution, but with one or more other water quality variables reducing productivity.

*Carlson Trophic Index (*Carlson 1976) uses chlorophyll-a, transparency and phosphorus concentration to quantitatively categorize the status of a lake ranging from oligotrophic (unproductive) to highly eutrophic (productive). The range of TSI was 28-69. Transparency and chlorophyll were indicative of an oligotrophic lake, but total phosphorus was characteristic of a eutrophic lake.

Nygaard Trophic Index (Nygaard 1976) proposed five indices to evaluate the organic pollution of water bodies based on the tolerance of various groups of planktonic algae occurring in them. These indices include Cyanophycean or Myxophycean index Chlorophycean index Bacillariophycean or Myxophycean index, Chlorophycean index, Bacillariophycean index, Euglenophycean index and a combination of these called compound coefficient index. Because of the paucity of phytoplankton, only the diatom index was appropriate. The Index value was 0, indicating oligotrophic conditions.

Palmer Organic pollution Index (Person 1989). The metric evaluates the degree of organic pollution based on pollution tolerance of key algal genera. The pit water score was 5 indicating minimal or no organic pollution, or that another variable is interfering with algae growth.

CONCLUSION

The collected and historic data demonstrate that the pit waters do not and cannot support a balanced ecosystem. Higher aquatic life forms are absent because of likely chemical toxicity, lack of suitable habitat, and lack of food resources.

The pH of the water is below the range (6.5 to 9.0 SU) typically considered supportive of aquatic ecosystems (EPA 1986). pH has been considered the most important determinant of water quality in a pit environment (Miller 2002), impacting divalent metals solubility and creating toxicity. Groundwater interaction with the walls and surrounding host rock of the pit create oxidation reactions that release sulfate, acid, and metals into the lake. Copper Flat Pit water pH (4.6 SU) is well below the typical tolerance range of most aquatic organisms and the copper concentration (18 mg/L) is well above minimum phytotoxic concentrations.

Although adequate light and some nutrients are available, there is a paucity of primary producers in the pit water. Without available food, zooplankton species are essentially absent. A high concentration of copper in the water and low pH appear likely factors limiting algal growth and survival.

Macroinvertebrates are absent, including those typically considered tolerant of pollution. Habitat availability and diversity is limited. Most of the pit bottom and edge is composed of fine particulates; rocks and rubble are essentially absent. Organic matter is limited. The layer of precipitated iron covering a layer extremely fine silt is not suitable habitat for most benthic organisms. Food reserves for shredders and scrapers is highly limited, as the depauperate and sparse periphyton consisted of a single species of filamentous algae.

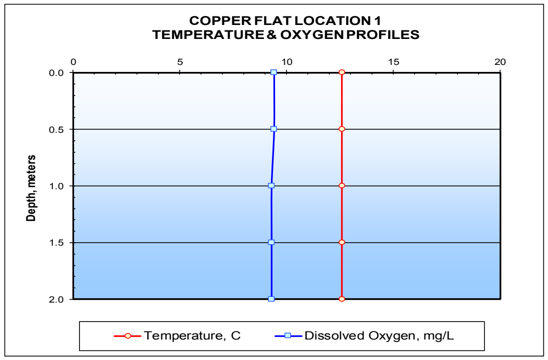
FIGURE 1

Copper Flat - 11/06/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 1

Depth, m	Temp, C	O2, mg/L
0.0	12.6	9.4
0.5	12.6	9.4
1.0	12.6	9.3
1.5	12.6	9.3
2.0	12.6	9.3

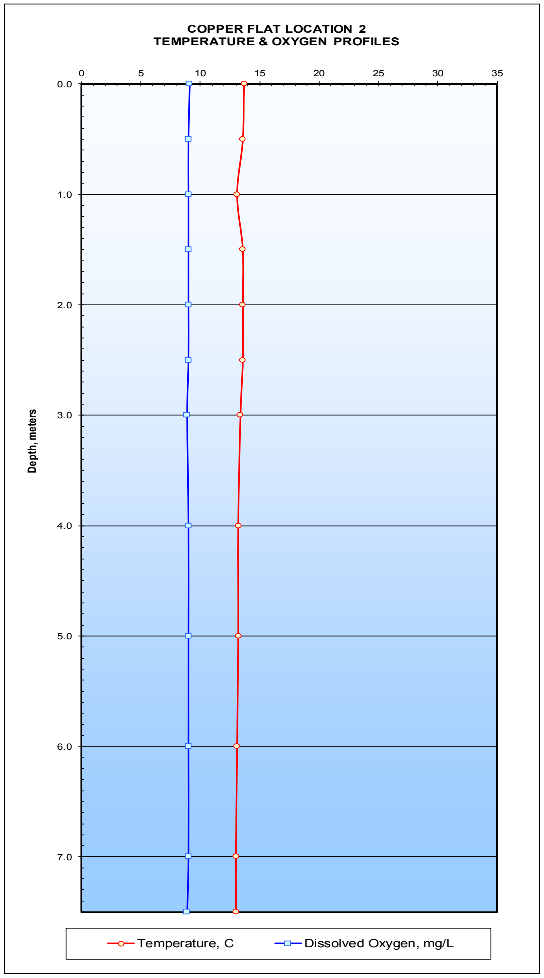


Copper Flat - 11/06/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 2

Depth, m	Temp, C	O2, mg/L
0.0	13.7	9.1
0.5	13.6	9.0
1.0	13.1	9.0
1.5	13.6	9.0
2.0	13.6	9.0
2.5	13.6	9.0
3.0	13.4	8.9
4.0	13.2	9.0
5.0	13.2	9.0
6.0	13.1	9.0
7.0	13.0	9.0
7.5	13.0	8.9



Copper Flat - 11/06/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 3

Depth, m	Temp, C	O2, mg/L
0.0	13.6	9.1
0.5	13.6	9.0
1.0	13.6	9.0
1.5	13.6	8.9
2.0	13.5	9.0
2.5	13.4	9.0
3.0	13.4	9.0
3.5	13.2	9.0
4.0	13.2	9.0

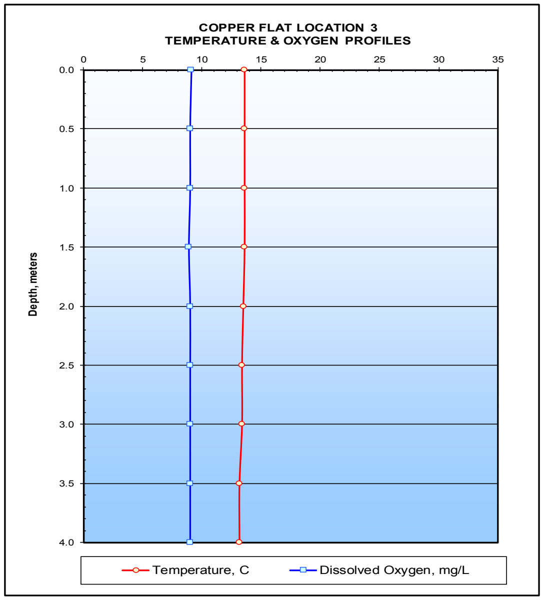


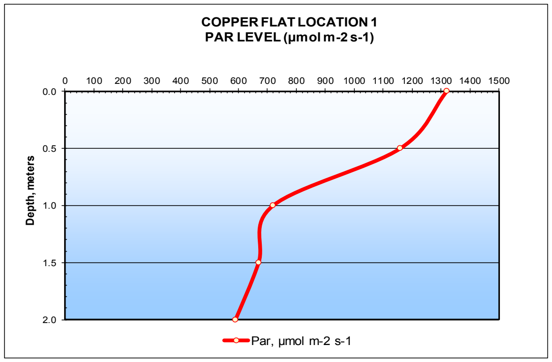
FIGURE 2

Copper Flat - 11/6/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 1

Depth, m	Par, µmol m-2 s-1
0.0	1320.0
0.5	1160.0
1.0	720.0
1.5	670.0
2.0	590.0

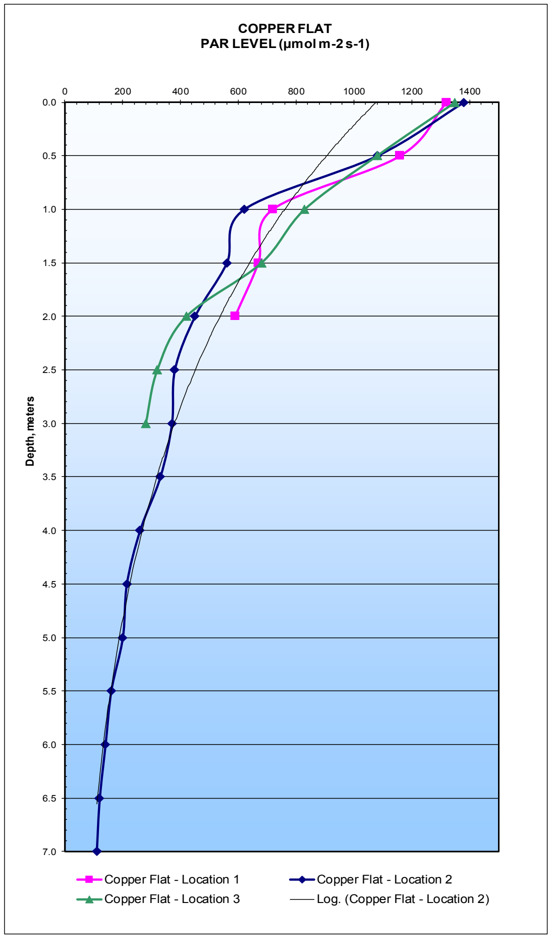


Copper Flat - 11/6/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 2

Depth, m	Par, µmol m-2 s-1
0.0	1380.0
0.5	1080.0
1.0	620.0
1.5	560.0
2.0	450.0
2.5	380.0
3.0	370.0
3.5	330.0
4.0	260.0
4.5	214.0
5.0	200.0
5.5	160.0
6.0	140
6.5	120
7.0	110



Copper Flat - 11/6/14

Aquatic Consulting & Testing, Inc.

Copper Flat - Location 3

Depth, m	Par, µmol m-2 s-1
0.0	1350.0
0.5	1080.0
1.0	830.0
1.5	680.0
2.0	420.0
2.5	320.0
3.0	280.0

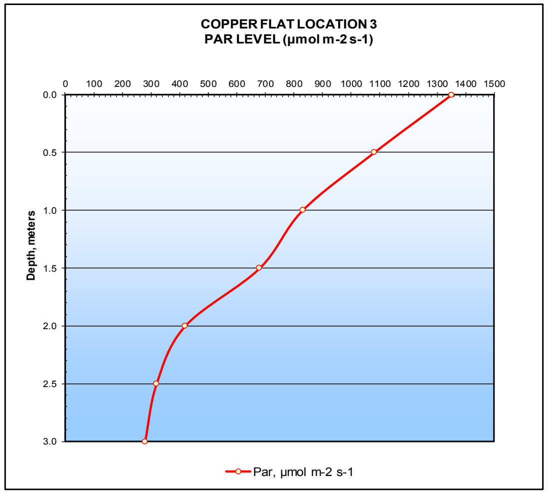
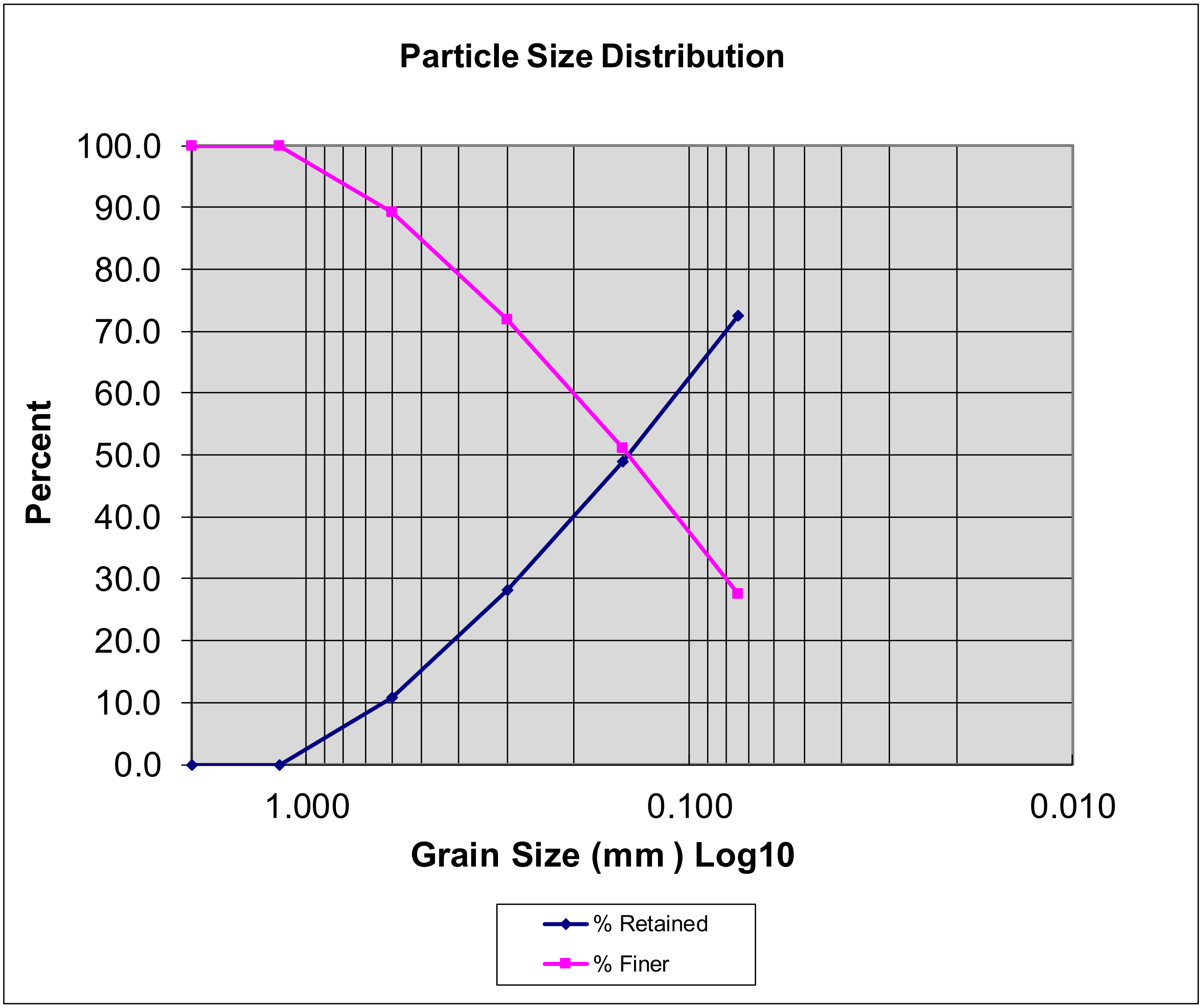


FIGURE 3

Laboratory ID: **BW10543**
Client ID: **Aquatic Consultants - Copper Flat New Mexico**

Mesh Size	Nominal Opening (inches)	Grain Size (mm)	Grams retained	Each sieve % Retained	Cumulative % Retained	% Finer
8	0.0937	2.360	0	0.0	0.0	100.0
10	0.0787	2.000	0	0.0	0.0	100.0
16	0.0469	1.180	0	0.0	0.0	100.0
30	0.0234	0.600	34.52	10.8	10.8	89.2
50	0.0117	0.300	55.01	17.3	28.1	71.9
100	0.0059	0.150	66.72	20.9	49.0	51.0
200	0.0029	0.075	74.76	23.5	72.5	27.5
	<0.0029		87.64	27.5	100.0	0.0



AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1610
Tempe, Arizona 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: Aquatic Consultants
4421 Irving Blvd. NW
Albuquerque, NM 87114

Date Submitted: 11/07/14
Date Reported: 12/02/14

Attn: Paul Cassidy

Project: Copper Flat

RESULTS

Client ID: H2O Comp. Loc 1-3
ACT Lab No.: SW10542

Sample Type: Surface Water
Sample Time: 11/06/14 14:30

	Analysis Date				
Parameter	Start	End	Method No.	Result	Unit
Total Organic Carbon	11/24/14	11/24/14	SM 5310 C	0.7	mg/L
Algae Count	12/01/14	12/01/14	SM 10200 F	See Attached	cells/mL
Algae Identification	12/01/14	12/01/14		See Attached	
Chl/Pheo Ratio	11/25/14	11/25/14	SM10200 H	1.14	
Chlorophyll a	11/25/14	11/25/14	SM10200 H	0.80	ug/L
Pheophytin a	11/25/14	11/25/14	SM10200 H	3.12	ug/L
Zooplankton	11/20/14	11/20/14	SM10200 G	<10.	#/cu. meter
Oxygen, Dissolved Field	11/06/14	11/06/14	SM4500 O G	9.0	mg/L as O2
pH, Field	11/06/14	11/06/14	SM4500H+ B	4.6	SU
Secchi Disk Depth	11/06/14	11/06/14	NALMS	4.0	meters
Temperature, Field	11/06/14	11/06/14	SM2550 B	13.6	C
Ammonia - N	11/20/14	11/20/14	SM4500NH3 D	0.03	mg/L as N
Nitrate + Nitrite - N	11/26/14	11/26/14	SM4500NO3 E	0.24	mg/L as N
Phosphate, ortho	11/07/14	11/07/14	365.3	0.018 *	mg/L as P
Phosphorus, Total	11/25/14	11/25/14	365.3	0.087	mg/L as P
Total Inorganic Carbon	11/24/14	11/24/14	SM 5310 C	0.9	mg/L
Total Kjeldahl Nitrogen	11/20/14	11/20/14	SMNorg C,NH3 C/D	0.3	mg/L as N

* R12=RPD/RSD exceeded the method acceptance limit. Result <5 times the PQL.

RESULTS

Client ID: Sed Comp. Loc 1-3
ACT Lab No.: BW10543

Sample Type: Sediment
Sample Time: 11/06/14 14:30

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Soil TOC	11/19/14	11/19/14	WalkleyBlack	0.21	% Org-C
Sieve Test	11/25/14	11/25/14	ASTM	See Attached	
Kjeldahl Nitrogen - Soil	11/19/14	11/19/14	SM4500NorgC mod.	2160.	mg/kg as N
Nitrate + Nitrite - N	11/18/14	11/18/14	SM4500NO3E mod.	<1.	mg/kg as N
Phosphorus, Total	11/23/14	11/24/14	365.3 mod.	550. *	mg/kg as P
Total Solids	11/10/14	11/14/14	SM2540 G	10.8	%

* R8-Sample RPD exceeded the method acceptance limit.

Client ID: Sed Floc
ACT Lab No.: BW10544

Sample Type: Sediment
Sample Time: 11/06/14 14:30

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Microscopic Identification	12/01/14	12/01/14		See Attached	

Reviewed by
Frederick A. Amalfi, Ph.D.
Laboratory Director

AQUA CONSULTING & TESTING, INC.
1525 W. University Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

PWS ID #

PAGE ___ OF ___

Client Name: Aquatic Consultants, Inc.
Address: Street
City, State, Zip
Phone:
Fax:
Contact: Paul Cassidy
Sampler Signature: SPH

PO# Copper Flat
Project
Remarks:

SAMPLE ID	SAMPLE Date	SAMPLE Time	AM/PM	SAMPLE TYPE	Chemistry: Metals (See Below)	☐ TDS ☐ TSS ☒ TS per ☐ SETT ☐ TVS ☐ VSS	☐ O+G ☐ TPHC ☐ MBAS ☐ CN ☐ Sulfide	☐ BOD ☐ COD ☐ New Source	☒ Tot.P ☐ O-PO4 ☒ Diss. P	☒ Nitrate + Nitrite ☐ Nitrite	☒ TKN ☒ Ammonia	~~☐ THMs ☐ HAAS~~ TOC, IOC	☐ Phenol ☐ 420.1 ☐ 625 ☐ 8270	~~☐ 8260 ☐ BTEX~~ TKN, Nitrate, TP	☐ Perchlorate ☐ Radio ☐ Asbestos	Biology: Total Coliform ☐ P/A ☐ Colilert ☐ MPN	~~☐ E. Coli ☐ Fecal Strep~~ TOC (w-B)	Fecal Coliform ☐ MPN ☐ MF	☒ MICRO SCOPE ID	~~☐ Plate Count ☐ Biotoxins~~ Particle Size	F-(pH, DO, T, SDE)	Biomon: ~~☐ Acute ☐ Chronic~~ Periphyton	~~☐ AMUET (SWMD)~~ Macroinvert ID	Chl a, Algae ID, Etc.	Zoop.	Na2S2O3	H2SO4	HNO3	NONE	~~NaOH~~ Lugols	NaOH/ZnAc	Laboratory Number
H2O Comp. Loc F5	11/6/14	1430	PM	SW					X	X	X	X		X							X			X	X		1		5	2		BW-10542
Sed Comp. Loc-F3	↓	1430		Sed		X								X,			X			X			X						1			43
Sed. Floc		1430		Sed															X										1			44
Edge Periphyton	↓	1540		Solid																jm	~~X~~	X							1			45

Metals: ☐ Al ☐ Sb ☐ As ☐ Ba ☐ Be ☐ B ☐ Cd ☐ Ca ☐ Cr ☐ Co ☐ Cu ☐ Au ☐ Fe ☐ Pb ☐ Mg ☐ Mn ☐ Hg ☐ Mo ☐ Ni ☐ Se ☐ Ag ☐ Na
☐ Sr ☐ Tl ☐ Sn ☐ Ti ☐ V ☐ Zn

[ ] TOTAL [ ] DISSOLVED [ ] SDWA [ ] TCLP [ ] RCRA

Sample Types: DW, GW, SW, WW, AQ, Soil, Sludge or Solid

Sample Receiving: MLO
Intact: X Yes ___ No
Temp: 15°C Auth Init: ______
Pres: 1 Yes/V 10 No/Lab
Sterile: ___ Yes X No
Total # containers: 11

1. Relinquished By: P. H
Date: 11/7/14 Time: 1507 AM/PM
1. Received By: T Johnson
Date: 11-7-14 Time: 15:07 AM/PM

2. Relinquished By:
Date: Time: AM/PM
2. Received By:
Date: Time: AM/PM

3. Relinquished By:
Date: Time: AM/PM
3. Received By:
Date: Time: AM/PM

Attn: Your signature on this document authorizes analysis regardless of sample condition at time of submittal

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsible parties on the form and failure to do so does not constitute justification for non-payment.

White-Laboratory Yellow-Report Pink-Client

Sample delivery group #: -023