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Memorandum

To: Kathy Arnold

From: David Krizek

Doc #: 057/11/15.3.2

Subject: **Response to SRK Pit Lake Comments**

Date: May 13, 2011

In response to the May 5, 2011 Technical Memorandum prepared by SRK Consulting (SRK) titled *Rosemont Pit Lake Geochemistry, Action Items for Tetra Tech and SRK, Phone Conference Call of March 10, 2011*, I have prepared this response. Action items summarized under Section 2.1 of the SRK memorandum, and directed at Tetra Tech, were as follows:

- Inputs to predictions of pit lake and waste rock dump pore water concentrations include the chemistry assigned to rock contact water. SRK requested that Tetra Tech prepare and include in the report (Tetra Tech, 2010b) a summary table which would describe for each chemical parameter modeled the minerals assumed to be controlling concentrations, the assumed concentrations and the source of the assumed concentration (e.g. scale up concentration, testwork, theoretical value). Where a testwork value was adopted directly, SRK would like to understand the rationale for adopting the value. **(Section 1.0)**
- Check with Rosemont to confirm that scheduling was considered in the waste rock plan. **(Section 2.0)**
- Prepare and include in the report a table or graph showing that waste rock material arrives in sequence. **(Section 2.0)**
- Write a couple paragraphs for inclusion in the report to document that non-PAG rock will be on the outside of the waste rock disposal unit and will be exposed, and that waste material will be identified and mixed in via encapsulation for the life of the mine. **(Section 3.0)**

It should be noted that most of these comments are not related to the pit lake study, but to general issues related to waste rock placement. There also appear to be errors made when referencing documents.

SRK's May 5th memo is provided as Attachment 1. Rosemont also received another review memorandum by SRK titled *Technical Review of (Tetra Tech, 2010b), Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Project*, dated March 31, 2011. There were no action items in this memorandum. For reference, this memo is provided in Attachment 2.

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A Bridge to a Sustainable Future.

Memorandum

To: Beverly Everson

Cc: Chris Garrett

From: Kathy Arnold

Doc #: 052/11 – 15.3.2

Subject: **Transmittal of Technical Memoranda**

Date: May 13, 2011

Rosemont Copper is transmitting the attached memoranda responding to the March 10, 2011 SRK review that was submitted to Rosemont on April 25, 2011.

- *Response to SRK Pit Lake Comments*, Rosemont memorandum dated May 13, 2011
- *Rosemont Scaling of SPLP Source Terms*, Tetra Tech memorandum dated May 13, 2011 (Attachment 3)
- *Rosemont Waste Rock Segregation Plan – Revision 1*, Tetra Tech memorandum dated January 25, 2011 (Attachment 4)

This memorandum is being transmitted in electronic form via email only. Please let me know if you require additional hardcopy versions of this document.

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1.0 SOURCE TERM SUMMARY

Tetra Tech prepared a Technical Memorandum titled *Rosemont Scaling of SPLP Source Terms* (dated May 13, 2011) that discussed the use of Synthetic Precipitation Leaching Procedure (SPLP) data versus humidity cell test (HCT) results. This memorandum is provided in Attachment 3.

2.0 WASTE ROCK SCHEDULE

The block model used to develop the mine plan has an identifier for potentially acid generating (PAG) materials. The table below summarizes the occurrence of PAG materials identified in the block model per pit phase.

PIT PHASE	TOTAL WASTE ROCK (ktons)	PAG WASTE ROCK (ktons)	PAG WASTE (%)
1	120,651	244	0.20
2	85,368	294	0.34
3	97,205	3,966	4.08
4	107,533	12,296	11.43
5	110,954	8,864	7.99
6	479,066	12,271	2.56
7	12,271	110	0.05
TOTALS	**1,231,465**	**38,045**	**3.1**

Of the total 1,231,465,000 tons of waste rock, only 38,046,000 tons has been identified as PAG. This amounts to about three (3) percent of the total waste rock tonnage. As noted on the table, only minor amounts of PAG material are generated during the first two pit phases. These waste rock materials will mainly used for constructing the underdrains, perimeter berms, and the dry stack buttress. Due to the minor amount (0.25%) of PAG materials in these pit phases, these materials will be incorporated with the other rock types with a high neutralizing potential.

3.0 WASTE ROCK SEGREGATION PLAN

A Technical Memorandum was prepared by Tetra Tech titled *Rosemont Waste Rock Segregation Plan – Revision 1* dated January 25, 2011. This plan outlines the anticipated approach to testing and managing PAG materials. This memorandum is provided in Attachment 4.

There is no plan to update any of the reports with the wording contained within this memorandum.

Attachment 1

SRK Technical Memorandum titled

Rosemont Pit Lake Geochemistry

Action Items for Tetra Tech and SRK,

Phone Conference Call of March 10, 2011

(Dated May 5, 2011)

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Memo

To:	Dale Ortman, P.E.	**Date:**	May 5, 2011
Copy to:	Cori Hoag, R.G. Chris Garrett, SWCA	**From:**	Stephen Day, P. Geo. Claudia Stone, R.G.
Subject:	Rosemont Pit Lake Geochemistry Action Items for Tetra Tech and SRK, Phone Conference Call of March 10, 2011	**Project #:**	183101/2300

Pursuant to a request by Mr. Dale Ortman, following is a request for Action Items that were developed during a phone conference call between Tetra Tech and SRK Consulting (SRK) on March 10, 2011. A summary of SRK technical model reviews, undertaken to date, precedes the list of Action Items.

1 Infiltration, Seepage, Fate and Transport Modeling Report (Tetra Tech, 2010a)

All issues regarding infiltration, seepage, fate and transport modeling (Tetra Tech, 2010) have been resolved. The draft final Technical Review Memoranda prepared by SRK were submitted to SWCA on February 14, 2011 (SRK, 2011a, infiltration and seepage modeling) and April 14, 2011 (SRK, 2011b, fate and transport geochemical modeling).

2 Geochemical Pit Lake Predictive Model, Revision 1 (Tetra Tech, 2010b)

All modeling issues regarding the pit lake water balance and the dynamic system model integration, as they relate to the pit lake predictive model (Tetra Tech, 2010) have been resolved. The draft final Technical Review Memorandum was submitted to SWCA on March 31, 2011 (SRK, 2011c). The present request for Action Items covers only the geochemical modeling of the pit lake.

2.1 Action Items—Tetra Tech

- Inputs to predictions of pit lake and waste rock dump pore water concentrations include the chemistry assigned to rock contact water. SRK requested that Tetra Tech prepare and include in the report (Tetra Tech, 2010b) a summary table which would describe for each chemical parameter modeled the minerals assumed to be controlling concentrations, the assumed concentrations and the source of the assumed concentration (e.g. scale up concentration, testwork, theoretical value). Where a testwork value was adopted directly, SRK would like to understand the rationale for adopting the value
- Check with Rosemont to confirm that scheduling was considered with the waste rock plan.
- Prepare and include in the report a table or graph showing that waste rock material arrives in sequence.
- Write a couple paragraphs for inclusion in the report to document that non-PAG rock will be on the outside of the waste rock disposal unit and will be exposed, and that waste material will be identified and mixed in via encapsulation for the life of the mine.

2.2 Action Items—SRK

- Review Tetra Tech's memo on the issue of selecting source terms.

3 References

SRK Consulting, 2011a, Technical Review of *Infiltration, Seepage, Fate and Transport Modeling Report– Revision 1 - Part 1 Infiltration and Seepage Model Components:* unpublished technical review memorandum prepared for SWCA and Coronado National Forest, February 14, 2011, 5 p.

_____ 2011b, Technical Review of *Infiltration, Seepage, Fate and Transport Modeling Report – Revision 1, Part 2 Geochemical Fate and Transport Modeling*: unpublished technical review memorandum prepared for SWCA and Coronado National Forest, April 14, 2011, 12 p.

_____ 2011c, Technical Review of *Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Project:* unpublished technical review memorandum prepared for SWCA and Coronado National Forest, March 31, 2011, 4 p.

Tetra Tech, 2010a, Infiltration, seepage, fate and transport modeling report, Revision 1, Rosemont Copper Project: unpublished report prepared for Rosemont Copper Company, Tetra Tech Project No. 114-320884, August 2010, 482 p.

_____ 2010b, Geochemical pit lake predictive model, Revision 1, Rosemont Copper Project: unpublished report prepared for Rosemont Copper Company, Tetra Tech Project No. 114-320884, November 2010, 116 p.

Attachment 2
SRK Technical Memorandum titled
Technical Review of (Tetra Tech, 2010b) Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Company
(March 31, 2011)

SRK Consulting
Engineers and Scientists

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Technical Memorandum

To:	Dale Ortman, P.E.	**Date:**	March 31, 2011
cc:	Tom Furgason, SWCA Cori Hoag, SRK File, SRK	**From:**	Vladimir Ugorets, PhD, SRK
		Reviewed by:	Corolla Hoag, R.G., SRK
Subject:	Technical Review of (Tetra Tech, 2010b) *Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Project*	**Project #:**	183101/2300

This memorandum provides a technical review of the report, *Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Project, Revision 1* (Tetra Tech, 2010b). This review was undertaken, and the Technical Memorandum prepared, at the request of SWCA and the Coronado National Forest, in accordance with a Statement of Work and Request for Cost Estimate from Mr. Dale Ortman dated December 2, 2010. This memorandum was prepared by Vladimir Ugorets SRK Consulting, Inc. (SRK), and reviewed by Corolla K Hoag, SRK.

Additional supporting Tetra Tech documents (regional groundwater flow model (Tetra Tech, 2010d) and Tetra Tech's response (Tetra Tech, 2010c) to comments on the February 2010 geochemical pit lake model report (Tetra Tech, 2010a) made by SRK (SRK, 2010)) also were reviewed as background for preparing this memorandum.

The comments in the present review are grouped into two topics: (1) pit lake water balance and (2) dynamic system model (DSM) integration. Final review of the geochemical modeling will be provided under separate cover.

In the present review of the revised geochemical pit lake model, SRK is of the opinion that all inconsistencies in the pit water balance that existed in the Tetra Tech (2010a) report and cited in the SRK (2010) Technical Review Memorandum were appropriately adjusted in the revised version of the geochemistry pit lake model (Tetra Tech, 2010b). SRK is further of the opinion that the modeling results appear to be reasonable for this study. SRK has no further comments or questions regarding the pit lake model.

1 Pit Lake Water Balance

Components of the post-mining pit lake water balance include groundwater inflow and outflow, direct precipitation, pit wall runoff, and evaporation, as described below.

1.1 Groundwater Inflow

Tetra Tech (2010b) used groundwater inflow to the pit lake from the results of the 3-D numerical modeling completed by Tetra Tech (2010d). It should be noted that the initial version of the Tetra Tech (2010a) geochemical pit lake predictive model (2010a) was based on the 2009 Montgomery & Associates regional groundwater flow model.

Groundwater inflow is a significant component of the pit lake water balance and depends on hydraulic heads adjacent to and below the pit, the lake stage, and the hydraulic properties of the surrounding country rock. The pit lake stage depends on the depth, size, and geometry of the final pit configuration, and on the other components of the pit lake water balance. Finally, groundwater inflows into the pit lake and lake stage depend on pre-mining hydrogeological conditions and the rate and duration of pit dewatering. They can be evaluated by numerical groundwater modeling iteratively, considering and varying all components of the water balance listed above.

1.2 Groundwater Outflow

The Tetra Tech assumption, that groundwater outflow from the pit lake equals zero, is based on their 2010 modeling results (Tetra Tech, 2010d). These results predicted the pit lake to be a permanent hydrologic sink. SRK agrees with this assumption.

1.3 Direct Precipitation

Average monthly precipitation data of 17.37 inches per year (in/yr) were taken from the NOAA Nogales station, due to the limited duration of the data record at the Rosemont site (since 2006). The data from both stations closely correspond (where data from the Rosemont site are available).

The initial pit lake geochemistry evaluation (Tetra Tech, 2010a) used average monthly precipitation data of 22.2 in/yr taken from the Santa Rita Experimental Range (SRER) at an elevation 4,300 feet above mean sea level (amsl), 8 miles to the southwest of the project. Tetra Tech (2010b) reported they replaced precipitation data from the SRER station with the Nogales station data because of the close data correlation and because Nogales is the closest station to Rosemont that includes more than 50 years of continuous data even though the NOAA Nogales station is located at an elevation only 3,560 feet amsl versus an elevation of 5,350 feet amsl at the mine site.

It should be noted that regardless of why the precipitation stations were changed, SRK is of the opinion that the use of 17.37 in/yr precipitation is a more conservative assumption to evaluate pit lake infilling and the impact to the groundwater system during the post-mining conditions. The data from both stations closely correspond to the Rosemont site station.

1.4 Pit Wall and Upgradient Drainage Runoff

Pit wall runoff was simulated using a fraction of the precipitation that ultimately reaches the pit lake. This fraction was assumed to be 30 percent (reasonable, in SRK's opinion) and applied to the area of exposed pit walls above the pit lake elevation.

Tetra Tech considered the areas above the 5,100 feet amsl boundary of the pit as upgradient catchment areas. Runoff from these areas will reach the pit walls from the unbermed drainages or as sheet flows.

1.5 Evaporation

Tetra Tech estimated a pan evaporation rate of 71.52 in/year. The value was derived from data from the Nogales station, adjusted to the Rosemont site, based on a linear trend with each station elevation. The monthly average projected pan evaporation data were converted to a lake evaporation rate using a coefficient 0.7. SRK considers a lake evaporation of 50 in/year as very reasonable for this study.

SRK is of the opinion, that all inconsistencies in the pit water balance that existed in the Tetra Tech (2010a) report and cited in the SRK (2010) Technical Review Memorandum were appropriately adjusted in the revised version of the geochemistry pit lake model (Tetra Tech, 2010b).

2 Dynamic System Model (DSM) Integration

The DSM computer model for the proposed Rosemont mine pit lake was developed in GoldSimTM to simulate the hydrologic water balance and the mixing of chemical loads from the different components of the water balance (e.g. groundwater inflow, pit wall runoff, precipitation). The DSM outputs from the predictive simulations were used as inputs to a final simulation model using PHEEQC.

The DSM includes both stochastic (variable) and deterministic (fixed) parameters. The stochastic parameters were used to assess the uncertainty in the predictions due to the data and analytical constraints and the natural variability in the input parameters (such as precipitation, pit wall runoff, and lake evaporation). Groundwater inflow to the pit was assumed to be a deterministic parameter and was incorporated into the model by a simplified relationship between groundwater inflow and lake stage. This relationship was developed on the basis of outputs from the post-mining predictions made by the numerical groundwater flow model (Tetra Tech, 2010d).

It should be noted that Tetra Tech improved the description of the used DSM model in the revised version of predictive geochemical model report by illustrating differences in simulation by groundwater flow and DSM models:

a) Groundwater inflow to pit lake vs. lake stage (Illustration 5.01), and
b) Components of pit lake balance and lake stage over time.

The DSM model confirms that a lake will form in the open pit upon cessation of mining in all cases of the variability of the used stochastic elements. Modeling results indicate that the pit lake elevation after 1,000 years can be varied from 4,095 feet amsl to 4,488 feet amsl (5^{th} and 95^{th} percentiles values, respectively) with a mean value of 4,287 feet amsl. The modeling results appear to be reasonable for this study.

3 References

SRK Consulting, 2010, Technical Review of Tetra Tech, 2010 *Geochemical pit lake predictive model*, Rosemont Copper Project: unpublished technical memorandum prepared for SWCA, May 3, 2010, 11 p.

Tetra Tech, 2010a, Geochemical pit lake predictive model, Rosemont Copper Project: unpublished report prepared for Rosemont Copper, Tetra Tech Project No. 114-320777, February 2010, 33 p., 6 appendices.

_____, 2010b, Geochemical pit lake predictive model, Revision 1, Rosemont Copper Project: unpublished report prepared for Rosemont Copper Company, Tetra Tech Project No. 114-320884, November 2010, 43 p., _ appendices.

_____, 2010c, Response to comments on February 2010 *Geochemical Pit Lake Model Report*: unpublished technical memorandum prepared by Mark Williamson for Rosemont Copper, Doc. No. 266/10-320884-5.3, November 16, 2010, 12p plus 5 attachments.

_____, 2010d, Regional groundwater flow model, Rosemont Copper Project: Report prepared for Rosemont Copper, Tetra Tech Project No. 114-320874, November 2010, 118p, appendices.

Vector Arizona, 2006, Preliminary report and phase 1 sampling and analysis plan: unpublished technical memorandum by K. Arnold, Vector, Arizona to J. Sturgess, Augusta Resource Corporation, July 26, 2006, 7 p.

4 Reviewer Qualifications

The Senior Reviewer, Vladimir Ugorets, Ph.D., is a Principal Hydrogeologist with SRK Consulting in Lakewood, Colorado. Dr. Ugorets has more than 31 years of professional experience in hydrogeology, developing and implementing groundwater flow and solute-transport models related to mine dewatering, groundwater contamination, and water resource development. Dr. Ugorets' areas of expertise are in design and optimization of extraction-injection well fields, development of conceptual and numerical groundwater flow and solute-transport models, and dewatering optimization for open-pit, underground and in-situ recovery mines. Dr. Ugorets was directly responsible for reviewing the hydrogeology of the pit lake predictive model.

Attachment 3
Tetra Tech Technical Memorandum titled
Rosemont Scaling of SPLP Source Terms
(Dated May 13, 2011)

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Technical Memorandum

To:	Kathy Arnold	**From:**	Mark A. Williamson
Company:	Rosemont Copper Company	**Date:**	May 13, 2011
Re:	Rosemont Scaling of SPLP Source Terms	**Project #:**	112/11-320884-5.3
CC:	David Krizek, P.E. (Rosemont); Paul Ridlen, P.E. (Tetra Tech)		

1.0 Introduction

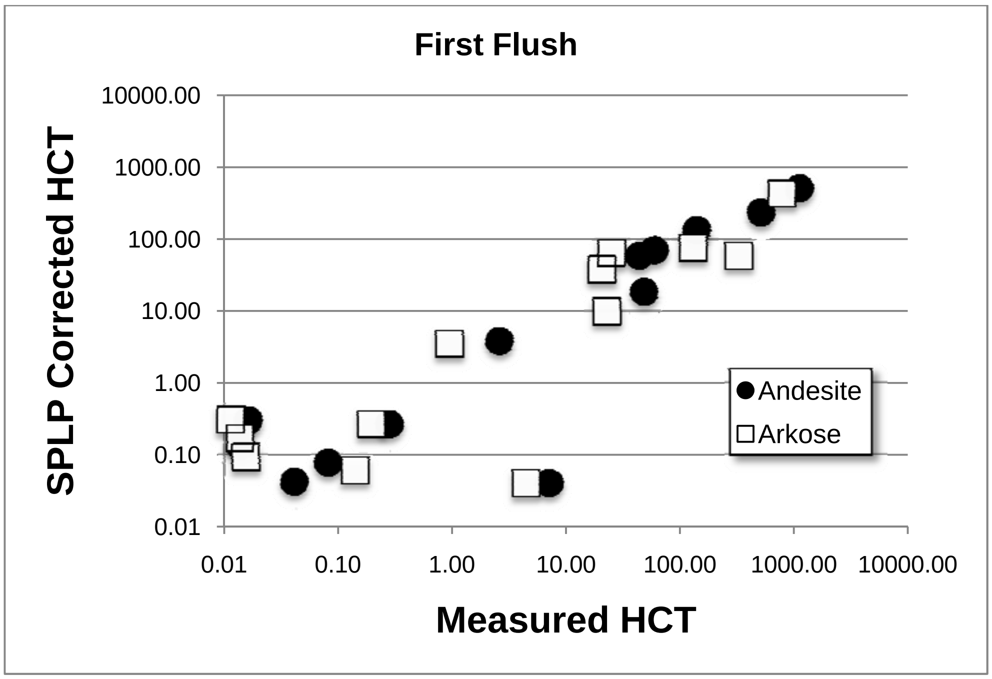
Review comments on the pit lake, including the waste rock and tailings seepage models, have indicated a concern about scaling the results of laboratory leaching tests. That is, should the SPLP laboratory tests with a 20-to-1 water-to-rock ratio (W:R) be adjusted to more closely reflect the lower W:R that may dominate field conditions? Review comments regarding the pit lake geochemical model indicate a reluctance to use Synthetic Precipitation Leaching Procedure (SPLP) results to represent pit wall runoff chemistry. Rather, the use of other testing methods that have water:rock testing ratios lower than the SPLP 20:1 ratio are preferred. Tests such as humidity cell testing (HCT) and the meteoric water mobility procedure (MWMP) are cited as more appropriate. This topic has been given much thought and I am not convinced that scaling of SPLP results would result in any meaningful change in the model results obtained to date. By meaningful, I refer to a change in model results that would affect either the selection of a preferred alternative in the Rosemont Environmental Impact Statement (EIS) or affect the selection and design of mitigation alternatives. With respect to meeting the objectives of the EIS, models are not intended to provide detailed guarantees of performance (as would be the case for specific discharge permits), but to disclose reasonable and expected eventualities. Below I have laid out several considerations regarding this topic with the goal of reconciling this issue and documenting the extent that the inclusion, or exclusion, of scaling might affect projected model results.

Water:Rock Ratio

The concentration of a chemical constituent in water that contacts rock, either in a laboratory test or under field conditions, is often, but not always, related to the proportion of water relative to the rock. In general, the higher the W:R ratio, the lower the concentration expected. Under field conditions, the W:R ratio is low in waste rock, but may not be for pit wall rinsing during the brief, infrequent and substantial rainfall events that may be associated with the Rosemont site. These rainfall events will likely result in rapid wetting, rapid runoff of water, and rapid drying, which is characteristic of the arid conditions in the southwestern U.S.

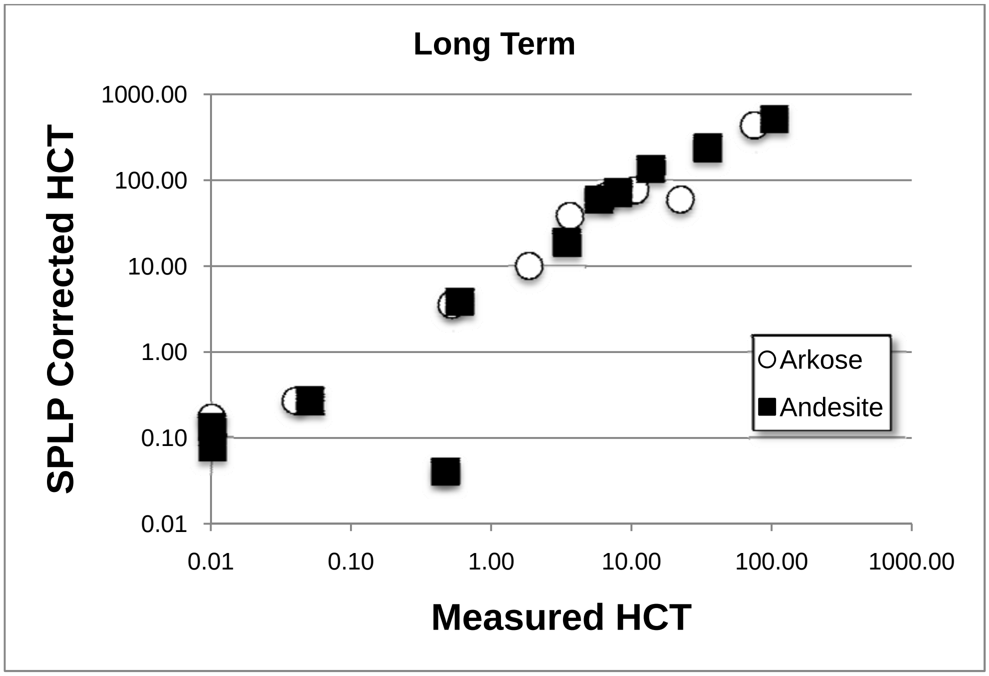
I have compared average SPLP test results with the average first flush of humidity cell tests (HCT), since they are both rinsing equivalent rock, only using different W:R ratio. The W:R ratio for SPLP is 20:1 and for HCT is 1.5:1. So, SPLP results can be scaled to HCT by simply dividing SPLP concentrations by 13.3. Mathematically scaling the SPLP to represent a more concentrated HCT condition results is generally good agreement with actual HCT results for major chemical species (Illustration 1). However, when the same scaling is applied to trace constituents, the scaling correction performs poorly, significantly over estimating concentrations. Nonetheless, the first-flush HCT data (i.e., scaled SPLP) was used to simulate flushing of the blast zone of pit walls on recharging by groundwater.

Illustration 1 First flush HCT compared to scaled SPLP



Scaling of long-term HCT results clearly fails for both major and trace constituents (Illustration 2), as SPLP results are commonly *higher* than the long-term HCT values (see my earlier memo regarding SPLP usage titled *Rosemont SPLP Usage for Pit Wall Runoff* [Tetra Tech, October 26, 2010]). Thus, in instances where one might consider long-term HCT measurements suitable (e.g., rinsing of pit walls by short-term, sparse rain events at Rosemont), the current use of SPLP results actually introduces an environmentally-protective bias. The concentrations of constituents in the SPLP results are consistently higher than in the HCT results. For the pit-lake model, the net effect between the use of either is relatively small. This is because rainfall is infrequent and the resulting chemical loading to the projected pit lake is limited relative to the chemical mass from recharging groundwater.

Illustration 2 Long-term HCT compared to scaled SPLP



The net effect on predictive modeling related to waste rock and the pit lake is discussed below.

Field vs. Laboratory Comparisons

The SRK review team for the EIS provided an example of chemical data for actual field W:R contact solutions (although not at the Rosemont site) compared with laboratory test data. The results of that comparison make it fairly clear that scaling of laboratory SPLP, MWMP, and humidity cell test results, need to be scaled for *acid conditions.* For alkaline conditions, the agreement between lab and field is much more consistent (although variable). The result is that under alkaline conditions, SPLP test results appear to be reasonable to use, particularly when a reasonable number of measurements for a particular rock material are available.

The illustrations in the reference provided by the SRK review team show that, for alkaline field drainage, MWMP measurements:

- generally, but not always, under- predict sulfate,
- are consistent with iron,
- are higher for arsenic, and
- are slightly low for zinc, but generally consistent.

The under-prediction of sulfate is likely tied to the weathering of pyrite, which does not substantially occur in MWMP tests. However, in the absence of appreciable pyrite, in a rock anticipated to produce alkaline drainage (e.g., Rosemont rock), the agreement with respect to sulfate is likely better.

These results suggest that SPLP data for major species (sulfate) might be scaled to provide a closer agreement with field solutions and that scaling of trace constituents (arsenic and zinc) should *not* be scaled. This is consistent with the discussion above comparing SPLP test results for Rosemont rock with first-flush data from HCT tests.

The majority of the waste rock at Rosemont is anticipated to be alkaline (Tetra Tech 2007, Illustration 3.2), with some, but not all, samples of andesite and arkose displaying uncertain character with respect to the formation of low pH drainage. Additional Net Acid Generation (NAG) pH testing (Tetra Tech 2007, Illustration 3.3) further refines waste rock characterization to indicate that even for arkose and andesite, only a very minimal amount of these materials (3 samples of 178 samples of waste rock) can be anticipated to produce low pH drainage. These samples are expected to be associated with limited local occurrences of material containing pyrite at the higher concentrations observed at Rosemont. Therefore, on the basis of these tests any potential drainage from the Rosemont mine is anticipated to be alkaline and that, per the SRK- supplied reference, MWMP results provide a reasonable estimate of source-term water quality.

Despite having a higher W:R ratio than the MWMP (at 1:1), the SPLP (at 20:1) produces test results for Rosemont rock that were consistent with the MWMP. Thus, it would appear that the use of SPLP results is a reasonable representation of the anticipated alkaline conditions for the projected Rosemont rock.

Pragmatic Effects on Predictive Modeling

Ultimately, the discussion of scaling is applied to predictive modeling. Does scaling SPLP test results lead to a better, more reliable model results? With respect to EIS evaluation, in which the objective is to disclose reasonable and expected outcomes, does scaling of the currently used SPLP source terms lead to a different conclusion? As discussed below, I believe the answer is “no”, that scaling will not change the expected outcomes.

Pit Lake
For the pit lake, the W:R ratio applies to leaching of the blasted-rock zone along the ultimate pit surface as groundwater recharges the pit, and to rinsing of pit walls during the infrequent rain events at the Rosemont Project site.

As noted above, the blast zone of the ultimate pit surface was modeled using the first-flush HCT results when available. If first-flush HCT were not available, SPLP data for major constituents was scaled to twice their value, and trace constituents to three times the SPLP value. Pit wall runoff, consistent with the above discussion, was simulated using SPLP results.

The bulk pit lake is predicted to geochemically evolve to a body of water that is saturated with calcium carbonate (calcite), calcium sulfate (gypsum), and atmospheric carbon dioxide, at an alkaline pH. Model calculations indicate that many years (hundreds) will be required to reach this condition. Trace constituents will, like major constituents, also build up over time and scaling will accelerate this process.

Scaling the SPLP tests will not affect this modeled eventual outcome. It can only accelerate the time that it takes to reach such a condition. The time required will still be very long and the disclosure of the likely and expected conditions for the lake's bulk character will remain unchanged. Given the uncertainty associated with such things as weather (temperature, rain patterns), there would appear to little improvement in model resolution with scaling of SPLP leaching test results. Nonetheless, for the pit lake, we have attempted to scale SPLP results.

Waste Rock

Modeling of potential seepage from the waste rock storage area used un-scaled SPLP when MWMP results were not available. While it is true that the W:R ratio in waste rock will be significantly higher than in SPLP tests, scaling SPLP would have no effect at all on the results of waste rock modeling since the waste rock storage area was shown not to produce seepage.

Attachment 4

Tetra Tech Technical Memorandum titled

Rosemont Waste Rock Segregation Plan – Revision 1

(Dated January 25, 2011)

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Technical Memorandum

To:	Kathy Arnold	**From:**	David Krizek
Company:	Rosemont Copper Company	**Date:**	January 25, 2011
Re:	Rosemont Waste Rock Segregation Plan – Revision 1	**Doc #:**	010/10-320877-5.3
CC:	Amy Hudson (Tetra Tech)		

1.0 Introduction

A Technical Memorandum titled *Rosemont Waste Rock Segregation Plan* (Tetra Tech, 2010) was prepared in response to the April 14, 2010 *Comprehensive Request for Additional Information* from the Arizona Department of Environmental Quality (ADEQ) to Rosemont Copper Company (Rosemont). This request is part of the aquifer protection permit (APP) application (Tetra Tech, 2009) submitted to ADEQ in February 2009 associated with the proposed Rosemont Copper Project (Project) in Pima County, Arizona. Specifically, Tetra Tech (2010) was developed to answer item no. 30a on page 13 of 18 of the April 14, 2010 request for information:

> *Application Vol. 1, February 2009, states "Waste rock will be managed by monitoring potentially acid generating (PAG) and non-acid generating (NAG) materials and placing materials in designated areas." It further states, "Because waste rock will be placed by segregating materials based on acid generating potential and testing results by source type and Waste Rock Storage Area will achieve greater engineering control potential compared to a typical unsegregated waste rock pile."*
>
> *Please provide the following:*
>
> *a) A detailed work plan for segregating potentially acid generating materials, including method of sampling, frequency of sampling, and what triggers or activates segregation and testing procedures;*
>
> *For characterizing waste rock to determine if the material is non-acid generating. Rosemont is referred to the guidelines specified under CHARACTERIZATION OF TAILING, SPENT ORE AND WASTE ROCK contained in the Arizona Mining BADCT Guidance Manual.*

An updated Technical Memorandum titled *Rosemont Waste Rock Segregation Plan – Revision 1* was prepared in response to additional comments received by Rosemont Copper Company in a letter from ADEQ titled *Incomplete Response to Technical Deficiencies* (dated December 3, 2010). Specifically this Technical Memorandum responds to Additional ADEQ's Comment #13 on page 25 of 34 of the December 3, 2010 letter:

> *Rosemont's proposed frequency of ABA testing on at least two random samples per week up to a maximum of 10 samples during one month and conduct quarterly Synthetic*

Precipitation Leaching Procedure, EPA Method 1312, on samples used as buttress or drain materials, is rather general and imprecise. ADEQ recommends that Rosemont should develop a more comprehensive plan to ensure segregation of potentially acid generating material using ABA testing and Synthetic Precipitation Leaching Procedure. Please submit a copy of the comprehensive plan for segregating potentially acid generating material.

2.0 General Project Information

The Project will include both sulfide and oxide ore mining and processing activities. Throughout active mining operations, grade control sampling and analysis will be performed as part of the overall mining process to control plant operations, to verify metals recovery, and to ensure proper segregation of materials.

Oxide ore will be placed on a lined heap leach pad and leached with dilute sulfuric acid. Sulfide ore will be processed in the milling and flotation circuit, with concentrate being shipped off-site for further processing. Tailings will be stored in the Dry Stack Tailings Facility. Waste rock, depending upon its type and characterization, will be placed in the Waste Rock Storage Area, used as buttress material for the Dry Stack Tailings, screening berms for the Waste Rock Storage Area, or used for various fill requirements.

Table 1 identifies the rock types, anticipated material tonnages, and the percentage of that rock type compared to the total anticipated waste rock volume. These tonnages are based on the current P673 pit configuration. Table 1 also lists some of the geochemical characterization tests previously performed on the various waste rock types. Analyses performed included Acid Base Accounting (ABA), net acid generation pH test (NAG pH), whole rock analysis, Synthetic Precipitation Leaching Procedure (SPLP), and Meteoric Water Mobility Procedure (MWMP).

Based on Table 1, approximately 1.2 billion tons of waste rock will be mined from the proposed Rosemont open pit. Mining rates vary but could be up to about 375,000 tons per day, with an average rate of about 210,000 tons per day.

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Table 1 Summary of Rosemont Waste Rock Types and Tonnages

Rock Type	Tons of Material	Percent of Material (by weight)	No. of ABA/NAG pH Tests	No. of SPLP Tests	No. of MWMP Tests
Arkose	546,336,000	44.38%	55	8	8
Tertiary Gravel	141,227,000	11.47%	5	0	0
Abrigo	113,815,000	9.24%	6	5	0
Horquilla	87,141,000	7.08%	26	8	2
Glance	80,841,000	6.57%	4	0	0
Andesite	49,118,000	3.99%	38	4	6
Concha	34,107,000	2.77%	6	1	1
Martin	32,304,000	2.62%	7	4	0
Earp	29,577,000	2.40%	14	6	0
Epitaph	27,150,000	2.21%	16	6	0
Escabrosa	22,859,000	1.86%	10	4	0
Bolsa	23,447,000	1.90%	13	6	0
Colina	16,145,000	1.31%	11	4	0
Quartz Monzonite Porphyry	13,047,000	1.06%	9	2	1
Scherrer	8,524,000	0.69%	0	0	0
Pre-Cambrian Granodiorite	4,203,000	0.34%	0	0	0
Undefined	941,000	0.08%	0	0	0
Overburden	391,000	0.03%	6	2	2
Total Amounts	**1,231,173,000**	**100%**	**226**	**60**	**20**

3.0 Summary of Material Classification

As referenced in Section 1, the non-acid generating nature of the material will be based on the section in the Arizona Best Available Demonstrated Control Technology (BADCT) Guidance Manual (ADEQ, 2004) titled Characterization of Tailing, Spent Ore, and Waste Rock (Part A of Appendix B).

ABA analyses previously conducted for the waste rock samples evaluated the potential of the waste rock to generate acid based on Part A: Characterization of Tailing, Spent Ore and Waste Rock of Appendix B of the Arizona Mining BADCT Guidance Manual (ADEQ, 2004). The ABA analyses included a determination of the sulfur content, acid neutralization potential (ANP), and the acid generating potential (AGP) of the waste rock. The sulfur and sulfide content indicates the likelihood of whether the rock type may be acid generating. There are two (2) methods for evaluating ABA analysis results: the net neutralization potential and the neutralization potential ratio.

3.1 Net Neutralization Potential (NNP)

The ANP and the AGP are expressed in units of tons of calcium carbonate ($CaCO_3$) per kiloton of rock (tons $CaCO_3$/kton rock). The difference between the ANP and AGP is defined as the net neutralization potential (NNP) (NNP = ANP-AGP).

In general, a sample would be acid-generating if it has a significant amount of sulfur or sulfide minerals or if its net neutralization potential (NNP) was less than zero (0); however, the risk of acid rock drainage (ARD) has been found to be highest for samples with NNP values less than -20 tons $CaCO_3$/kton rock and is low when the NNP is greater than +20 tons $CaCO_3$/kton rock (Price, 1997).

Appendix B of the BADCT Manual (ADEQ, 2004) provides the following guidance:

- If the NNP is less than –20 tons $CaCO_3$/kton (NNP ≤ –20), then the sample is acid generating;
- If the NNP is between –20 and +20 (–20 < NNP < +20), then the sample is potentially acid generating; and
- If the NNP is greater than +20 (NNP > +20), then the sample is considered non-acid generating.

If NNP is less than -20 tons of $CaCO_3$/kton, it can be considered acid generating. Between -20 and +20, the potential exists for the waste rock to be acid generating. The more positive the NNP, the lower is the risk for the waste rock to be acid generating. When the NNP is above +20, the material can generally be considered non-acid generating. Prediction of the acid generating potential when the NNP is between +20 and -20 tons of $CaCO_3$/kton of sample is more difficult due to uncertainty in analysis and conversion factors.

3.2 Neutralization Potential Ratio

The ratio of ANP to AGP, the neutralization potential ratio (NPR) (NPR = ANP/AGP), can also be used to assess risk of developing acidic rock drainage (ARD). An NPR greater than 3 is thought to have a low ARD risk while samples with an NPR less than one (1) have a high ARD risk (Price, 1997).

The BADCT manual (ADEQ, 2004) provides the following guidance for evaluating the NPR:

- If the ratio is less than or equal to one (1) (ANP/AGP ≤ 1), the sample is likely to be acid generating;
- If the ratio is greater than one (1) but less than three (3), then the sample is potentially acid generating; and
- If the ratio is equal to or greater than three (3) to one (1) (ANP/AGP ≥ 3), then the sample is considered non-acid generating.

Ratios of ANP/AGP can also be used to assess the acid generation potential. An ANP/AGP ratio of 1:1 is equivalent to an NNP of zero (0). If the ratio of a sample's neutralization potential and acid production potential is greater than 3:1, then there is a low risk for acid drainage to develop. For samples with a NPR between 1:1 and 3:1, the uncertainty increases. As a result, additional testing is usually necessary using kinetic test methods as described under the Tire #2 protocols (ADEQ, 2004). Samples with a ratio of 1:1 or less are more likely to generate acid (Smith and Barton-Bridges, 1991).

3.3 Waste Rock Sampling

A total of 226 waste rock samples have been tested to date to evaluate the acid generating and acid neutralizing potential of the material. Based on previous characterization work, twelve (12) of the 226 waste rock samples analyzed for NPR were identified as being likely acid generating;

- Five (5) of 38 samples of Andesite had NPRs indicating that were likely acid generating;
- One (1) of 55 Arkose samples had an NPR indicating that the sample was likely acid generating; and
- The remaining potentially acid generating samples included five (5) Bolsa and one (1) Abrigo sample.

In summary, twelve (12) samples from Andesite, Arkose, Bolsa, Earp, and Qmp rock types had NPR ranges that indicated that the rock types were moderate or uncertain acid generation potential.

The NNPs for the 226 samples indicated that only one (1) sample of Andesite was likely acid generating, and approximately 51 samples of Abrigo, Andesite, Arkose, Bolsa, Earp, overburden, and Qmp, contained NNPs indicative of the type being moderately acid generating or uncertain. Most of these 51 samples were from Andesite, Arkose, and Qmp rock types.

Based on this information, very little of the waste rock at Rosemont has the potential to generate acidic conditions. Therefore, sampling and analysis of waste rock during operation will target specific rock types as well as incorporate an overall characterization plan. The plan would be designed to provide verification of the expected behavior of the materials that have been defined through the previous characterization program.

4.0 Waste Rock Segregation Plan

In general, the plan to segregate acid generating waste rock will be based on observations, sampling, and characterization of samples completed during mining operations. The operational sampling will be compared to prior to testing to verify the expected behavior of the material. Although specific material testing frequencies were not provided, the Global Acid Rock Drainage Guide (GARD) developed by the International Network for Acid Prevention (INAP, 2008) was reviewed and used to develop the plan outlined herein.

During the mining operations, drilling will be completed on 50-foot benches. Variations in lithology and mineralogy/geology, as well as degree and extent of fracturing, will be evaluated by a Rosemont Copper geologist or trained technician. Composites from the drill holes will be assayed as needed to characterize the material as waste rock, oxide ore, or sulfide ore. If waste rock material is identified and determined to be in one of, or include one of, the units (i.e., Andesite, Arkose, etc.) that have been identified as potentially acid generating, sampling and testing of the composite drill hole samples will be targeted to isolate the area within the blast zone that would require special handling. Although any material identified as waste rock will be subject to the operational testing program, the focus will be on those materials previously identified as uncertain or likely to generate acid.

Characterization of these samples will include Acid Base Accounting (ABA) or net acid generation pH test (NAG pH). The degree of sulfide and oxide mineralization would be determined as part of the aforementioned characterization. The data collected through the operational testing program will be added to the existing geochemical database. The full characterization database would be reviewed weekly to ensure the expected behavior of the material, and the characterization of the lithologies, are updated as necessary.

Decisions for segregation, particularly of any potentially acid generating waste rock, will be based on the results of the previous characterization program. Non-acid generating waste rock will be preferentially placed in the east and south haul roads, screening berms, dry stack tailings buttresses and exterior haul roads, drain fills, permanent diversion crossings, the crusher haul road, as leach pad cover, and any other exterior surface. Acid generating waste rock will be placed to the interior of the Waste Rock Storage Area and possibly mixed (comingled) with non-acid generating waste rock. Additionally, potentially acid generating waste rock will not be placed immediately below within 50 feet of areas designated for water management ponds that are part of the final landform. Potentially acid generating material placed with the interior of the Waste Rock Storage Area will also not be placed in areas subject to water conveyance, etc.

Specific waste rock segregation requirements will be detailed in operating plans that will be modified as appropriate. In general, however, these plans will include Rock Inspection and Classification, and Rock Type Monitoring as specified below.

4.1 Rock Inspection and Classification

As described above, drilling will be completed on 50-foot benches. Variations in lithology and mineralogy/geology, as well as degree and extent of fracturing, will be evaluated by the geologist or trained technician. Composites from the drill holes will be assayed as needed to characterize the material as waste rock, oxide ore, or sulfide ore. If waste rock material is identified and determined to be one of, or include one of, the units (i.e., Andesite, Arkose, etc.) that have been identified as potentially acid generating, sampling and testing of the composite drill hole samples will be targeted to isolate the area within the blast zone that would require special handling. The composite samples will be characterized using either ABA or NAG pH testing. Fizz testing with dilute hydrochloric acid (HCl) will also be conducted on the drill hole cuttings to help target samples collecting for ABA or NAG pH testing.

Both testing records and waste rock placement decisions shall be maintained, including the personnel involved in the decision, the testing or review involved, and if the rock was determined to be acid generating or not. Placement of the material should also be verified. The records shall be maintained on site and available for inspection.

4.2 Type Monitoring

In addition to the testing targeting specific lithologic units described in Section 4.1, ABA tests shall be completed at an on-site lab (when constructed) on at least two (2) random samples per week or one (1) sample per approximate 250,000 tons of waste rock material mined, whichever is more frequent. Sample selection will be distributed based on the rock types/lithologies encountered during the sampling period/increment.

These random samples will not be selected based on lithology and will be used to verify previous characterization work. ABA testing includes a measurement of the Acid Neutralization Potential (ANP) and the Acid Generating Potential (AGP) of the waste rock.

SPLP (Synthetic Precipitation Leaching Potential EPA Method 1312) shall be completed at the on-site lab when constructed on samples used as outer berm/buttress or drain materials to confirm that these materials are non-acid generating and have limited reactivity.

For waste rock materials used in the flow-through drains, one (1) SPLP sample shall be taken per blast zone or one (1) sample per 250,000 tons, whichever is less.

All geochemical testing records will be maintained on-site either in hardcopy or electronic form.

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