

Memorandum

To:	Chris Garrett, P.HGW.	Date:	July 18, 2012
Company:	SWCA	From:	Corolla Hoag, P.G. David Bird, P.G. Stephen Day, PGeo (BC, AB).
Copy to:	Dale Ortman, P.E.	Project #:	183101.02
Subject:	Rosemont Copper DEIS – Response to specific geochemistry modeling concerns from CNF		

This memorandum provides a technical response to concerns and questions by the Coronado National Forest (CNF) and compiled in SWCA memorandum *Request for Professional Opinion on Specific Geochemistry Modeling Concerns* (SWCA, 2012). This review was undertaken, and the Technical Memorandum prepared, at the request of SWCA and the CNF, in accordance with a *Statement of Work and Request for Cost Estimate* from Mr. Dale Ortman dated February 6, 2012. This memorandum was prepared by C. Hoag and D. Bird and reviewed by Stephen Day Principal Geochemist, SRK Consulting, Inc. (SRK). Selected sections were also reviewed by R. Bowell, Ph.D., Principal Geochemist of SRK.

The questions posed by CNF came from five sources listed below:

- Source A
 - Correspondence from Pima County dated 24 December 2009 transmitting a 2009 report by Dr. Ann Maest, Buka Environmental (Maest, 2009)
- Source B
 - Comments on the administrative Draft EIS from the U.S. Environmental Protection Agency (EPA, 2011)
- Source C
 - Comments from Maggie Baker, U.S. Forest Service, on various technical reports (Baker, 2011)
- Source D
 - Testimony of Dr. Tom Myers before the Arizona Power Plant and Transmission Line Siting Committee (dated 5 December 2011) (Myers, 2011), which incorporated his review of the geochemical pit lake model (dated 27 August 2010) (Myers, 2010).
- Source E
 - Internal CNF interdisciplinary team concerns stated in a data request letter by Jim Upchurch, CNF, to Rosemont Copper (CNF, 2011)

Complete references for these source documents, earlier SRK reports and technical memoranda, and external reports and published papers referenced in this SRK memorandum are provided in Section 7. The complete text of the CNF questions are presented in blue italicized text and the original numbering scheme is retained. A summary of work completed is provided in some sections as context for the responses to CNF questions or comments.

1 Tailings Geochemistry Samples

Various lab tests were conducted on nine samples of material that were described by Rosemont as being representative of the future tailings material. The results of the lab tests on these nine samples were then used in the geochemical modeling to predict the potential water quality of drainage from the dry-stack tailings

facility. Concerns were raised as to whether these nine samples were actually representative of the tailings material, and whether the number of samples was sufficient to represent the tailings material. (Source: A, C)

Summary of Work Completed by Rosemont

Geochemical testing was performed on ten tailings samples generated during bench-scale metallurgical test work by Rocky Mountain States R & D of Vail, Arizona – four in 2006-2008 and six in 2010 as shown in Table 1 and described by Tetra Tech (2010d). Geochemical test work was designed to follow Arizona Department of Environmental Quality (ADEQ) guidance for Tier #1 geochemical testing of mine waste materials (ADEQ, 2004b, Appendix B). The tests performed included acid base accounting (ABA), Net Acid Generation testing (NAG pH) (Stuart, 2005), total metals analysis, and Synthetic Precipitation Leaching Procedures (SPLP) (EPA Method 1312, EPA, 1994). Seven of the samples were additionally tested using the Meteoric Water Mobility Procedure (MWMP) (ASTM, 2002). Kinetic tests following ADEQ guidance for Tier #2 geochemical test work was also performed; these evaluations consisted of humidity cell tests (HCT), field column tests, and radiochemical analyses.

Eight of the 10 tailings samples tested consisted of single rock-formations comprising the five dominant sulfide ore types (88.8% of sulfide materials) to be extracted during the life-of-mine. The production tonnages and the percentages of sulfide material by weight are shown in Table 3 of Tetra Tech (2010d). Two samples were physical blends prepared with more than one rock type representing the spatial area of the first two mining phases and in the approximate proportion to the rock materials to be mined during these specific mining phases (Year 0-3 and Year 4-7) as shown in Table 2. The same selection process was used to prepare both single-rock and multi-rock samples. Split historic and recent drill core and recent core coarse rejects were selected by Tetra Tech from drillhole intervals of the desired rock type and copper grade from spatially and vertically representative locations within the life of mine pit or within the materials to be mined in a specified period (Tetra Tech 2009, 2010d).

To represent the final mine phase (Year 8-21), a physical tailings sample was not prepared. Instead, leachate results were calculated using the results from the single-formation SPLP and MWMP samples that were taken from the area of the production plan for Year 8-21 (Tetra Tech, 2010e). The results were proportionally mixed in the fate and transport model using computer code PHREEQC, according to the rock type percentages forecast to be mined during this period as documented in Table 5 of Tetra Tech (2010l) and recopied below in Table 2. This approach is not ideal. A tailings sample representing the material expected in the later part of the mine life should be prepared and tested during future metallurgical test work, and the results used to update the predictive calculations.

During the review of preliminary SPLP analyses, Tetra Tech discarded from further use the SPLP results for Tailings-May2006 because the reporting limits were not low enough to provide meaningful comparison with reference Arizona water quality standards. The ABA and whole rock analyses from this sample, however, are valid.

Sulfide-sulfur concentrations measured in the ten ABA tests ranged from <0.01% to 0.29% in nine of the ten samples with an average 0.11% sulfide-sulfur. The remaining sample (Epitaph) showed the highest sulfide-sulfur concentration of all the materials tested with 0.72% sulfide-sulfur content. SRK previously requested clarification from Tetra Tech on the source of soluble sulfate-sulfur in the samples representing pit wall rock and tailings samples (SRK, 2010c). The soluble sulfate-sulfur content was attributed to gypsum in the unmineralized rock and skarn units rather than to the potential presence of rapidly dissolving acid sulfate salts (Tetra Tech, 2010k). SRK concurs with this assessment as gypsum-rich marl is documented in the Epitaph Formation on site (Daffron and others, 2007) and elsewhere in southern Arizona (Creasey, 1967). Both anhydrite and gypsum were recorded by Montgomery & Associates (M&A) in the geology logs for the Rosemont pit monitoring wells (M&A, 2007; 2009a).

The Net Neutralizing Potential (NNP) for the ten tailings samples tested ranged from a low of 180 tons $\text{CaCO}_3/\text{kton}$ rock in the Colina sample to 539 tons $\text{CaCO}_3/\text{kton}$ rock in the Horquilla sample; the average NNP was 314 $\text{CaCO}_3/\text{kton}$. The ratio of neutralizing potential to acid generating potential (NP:AP) ranged from a low of approximately 18 in the Epitaph sample to 2210 in the Tailings-022807 sample. Using average value for both NP value in the numerator and the AP value in the denominator, the average NP:AP for the 10 samples was 60; this average value indicates the material has a high capacity for acid neutralization and extremely low to negligible potential for acid generation. The results demonstrate the materials as being non-acid generating according to the industry-standard criteria of non-acid generating materials having a NNP values greater than 20 tons $\text{CaCO}_3/\text{kton}$ rock and a NP:AP of greater than 3:1.

Table 1 Tailings samples - Rock composition and test work performed

Sample ID	Date Collected	Rock Unit Tested	ABA	NA G pH	Whole Rock	SPLP	MWMP	HCT
Tailings – May 2006	5/19/2006	Horquilla Ls	X		X	D		
Tailings - 022807	2/28/2007	Horquilla Ls	X	X	X	X		X
Tailings-05 June 2007	6/5/2007	Horquilla Ls	X	X	X	X	X	
Year 0-3 Tailings (composite)	7/2008	72.9% Horquilla 21.3% Earp 5.8% Escabrosa	X		X	X	X	X
Year 4-7 Composite	6/21/2010	50% Horquilla 28% Earp 18% Colina 4% Epitaph	X	X	X	X	X	
Horquilla	6/21/2010	Horquilla Ls	X	X	X	X		
Colina	7/8/2010	Colina Ls	X	X	X	X	X	
Epitaph	7/8/2010	Epitaph Fm.	X	X	X	X	X	
Earp	7/1/2010	Earp Fm.	X	X	X	X	X	
Escabrosa	7/1/2010	Escabrosa Ls	X	X	X	X	X	

Source: Modified from Tetra Tech, 2010d, Table 1.

D=Discarded as reporting limits were too high to compare results with reference Arizona Aquifer Water Quality Standards for trace metals.

Table 2 Tailings tonnages and sulfide ore rock types represented by composite tailings samples (Tetra Tech, 2010I, Table 5)

Rock Type	Tons of Tailings		% of Tailings		Tons of Tailings		% of Tailings	
	Years 0-3		Years 4-7		Years 8-21			
Mixed Horquilla	0	0	151	0	12209	3		
Sulfide Epitaph	86	0	2,804	3	45,105	13		
Sulfide Colina	21	0	11,011	10	68,188	19		
Sulfide Earp	9,051	11	26,043	24	55,959	16		
Sulfide Horquilla	51,061	63	56,793	52	39,043	39		
Sulfide Escabrosa	4,082	5	1,222	1	14,506	4		
Sulfide Other	17,219	21	12,237	11	18,663	5		
Total Ore	81,520	15	110,261	20	353,673	65		

Notes: Tonnages and percentages listed in Tetra Tech's November 23, 2010 memorandum (2010I) changed slightly to those listed in 2012 by Geochemical Solutions but the changes are not material.

1.1 Question 1a and Response

Did SRK find that the rock types of the nine samples used for the geochemical modeling of the tailings facility were adequate to represent the geologic character of the future tailings material?

In SRK's professional opinion, Tetra Tech demonstrated that the rock types selected to represent the tailings samples were adequate to represent the geologic character of the future tailings material. Although limited in number, the tailings samples do include materials that are geologically representative of the future materials. Additional tailings samples would only be minimally more geologically representative because of the large numbers of core intervals used and the wide spatial and vertical distribution of materials included in the original tailings samples.

The ore composite materials were chosen by Tetra Tech and Rosemont to represent the five dominant sulfide rock types comprising 88.8% of the rock types expected to be mined, processed, and deposited in the tailings facility according to Rosemont's mine plan by year (Table 1, Tetra Tech, 2010d; Table 1 of Geochemical Solutions, 2012). Geologic representativeness was achieved by selecting historic and recent drill core and

recent drill core coarse rejects from numerous drillholes intervals located within the shape of the ultimate proposed open pit. Itemized by drillhole name, footage below surface, and rock type, the selected intervals adequately represent the vertical and lateral variability of the dominant host rocks and mineralization types within the mixed oxide-sulfide and sulfide portions of the deposit (Tetra Tech 2010d, Attachments A through C). For example as shown in Table 3, the single Epitaph tailings sample is a composite of 150 different core intervals from 17 drillholes comprising the Epitaph Formation at various pit locations and depths.

Ten tailings samples, prepared from numerous core sample intervals, were processed by Mountain States R & D of Vail, Arizona, and were subsequently geochemically tested¹. The samples have usable analyses as follows: ten ABA and total metals analyses, nine SPLP leachate analyses, seven MWMP leachate analyses, and two 35-week HCT results. The HCTs were run to the minimum number of weeks to assess release rates. SRK recommends confirmatory HCTs and additional test work be performed during future operations or closure planning investigations when actual tailings materials are available to test. The leachate quality designated for Years 8-21 in the tailings fate and transport model was derived by calculating a representative chemistry based on chemistry generated from single-formation tailings samples and then mixed in proportions appropriate to the percentages of each formation planned to be mined during this period as shown in Table 2.

Table 3 Drillholes and core reject intervals used in the tailings samples

Sample ID	Rock Unit Tested	# Drill Holes	# Intervals Sampled	%Samples Relative to Rock Type %
Tailings – May 2006	Horquilla	1	Core and coarse rejects from 3 intervals representing 414 ft	100%
Tailings - 022807	Horquilla			100%
Tailings - 05June2007	Horquilla			100%
Year 0-3 Tailings (composite)	72.9% Horquilla	11	99	71.2%
	21.3% Earp	7	31	22.3%
	5.8% Escabrosa	2	9	6.5%
Year 4-7 Composite	50% Horquilla	17	28	49.1%
	28% Earp	8	15	26.3%
	18% Colina	6	10	17.5%
	4% Epitaph	4	4	7%
Horquilla	Horquilla	27	150	100%
Colina	Colina	15	140	100%
Epitaph	Epitaph	17	150	100%
Earp	Earp	29	147	100%
Escabrosa	Escabrosa	15	150	100%

Source: Compiled from Tetra Tech, 2010d Attachments B and C.

1.2 Question 1b and Response

Were nine samples an adequate number to adequately represent the future tailings material?

Tetra Tech has proposed that the ten samples were an adequate number to represent the future tailings material because of the large number of individual core intervals included in the samples. Tetra Tech's memoranda on sample selection method (Tetra Tech, 2010d; 2010h) provides evidence to confirm that the samples selected are representative of predicted future materials to be mined, processed, and disposed of as tailings.

The samples were prepared to represent the dominant materials mined during the life of mine as documented in mine production tables provided in Tetra Tech's reports (2010d; 2010h). For example, four single-formation samples (40% of the ten samples) were tested on the Horquilla Formation, which is estimated to be approximately 47% of the material mined during the life of mine and the majority of material mined during the first 7 years (Tetra Tech, 2010d). In SRK's opinion, although the number of tailings samples prepared and analyzed is extremely limited, the materials used in the samples do appear to be spatially and vertically

¹ Note the level of geological descriptive documentation for six samples prepared in 2010 is more detailed than that prepared for the four samples from 2006-2007.

representative of the materials to be extracted during the life of mine based on the itemization of drill core intervals and depths and the mapped sample locations.

1.3 Question 1c and Response

What is the possibility that mineralogical differences within a formation (like the Horquilla) could result in areas of problematic water quality?

Local mineralogical differences within a particular formation can result in potentially elevated, naturally occurring concentrations of specific groundwater constituents in contact with local facies of any particular formation. Local variability within a deposit is typically blended by mining and metallurgical processes. In SRK's professional opinion, the effect of mineralogical variability within a formation was adequately addressed during Tetra Tech's geochemical test work program. They evaluated the chemistry of all site formations (total metals analysis, ABA), using hundreds of individual core samples to represent the vertical and lateral variability in mineral constituents for each formation.

1.4 Question 1d and Response

Is there a need for mineralogical detail of the tailings samples to determine the potential for areas of problematic water quality to occur?

Mineralogical detail is essential site knowledge needed to interpret geochemical test work and assess the potential for soluble constituents, such as sulfate and mineral salts, to be created during weathering of the tailings. This type of detailed mineralogy, however, provides the most realistic and reliable data only after there are actual tailings to test. In SRK's opinion, the test work (ABA, SPLP, MWMP, HCT) conducted to date on the simulated tailings samples is adequate to predict whether there should be concerns about problematic water quality resulting from weathering of the tailings.

General Comments on Rock Type Mineralogy

Mineralogical review and identification is an important step to understand the characteristics of the materials tested including waste, oxide/sulfide ore, and tailings materials. This helps to assess the rate of mineral reactions that could occur based on deposit-specific and sample-specific information such as mineral species present and their respective grain sizes. For example, minerals with a small grain size have greater surface area and typically react more quickly. Mineral species such as quartz and orthoclase formed at low crystallization temperatures are very stable at the low temperature environment found at Earth's surface. Minerals such as olivine, calcium plagioclase, and amphibole, which were formed at high crystallization temperatures, typically react/weather quickly when exposed to the surface conditions. Mineralogical studies also typically provide information on secondary oxide and sulfide minerals and mineral salts, if present, that may potentially be readily flushed out and influence water quality in contact with these minerals. For example, precipitated salts such as melanterite [FeS₄·7H₂O] and jarosite [KFe₃³⁺(SO₄)₂(OH)₆] are potential sources of acidity when they are re-solubilized (ASTM, 1996).

Mineralogical Information Available about Rosemont Deposit

General mineralogical characteristics of the host rocks and ore found at in the Rosemont area was provided to Tetra Tech by Rosemont geologists familiar with the deposit geology; this orientation occurred during Tetra Tech's initial field investigations (Vector, 2006). Tetra Tech personnel examined the deposit geology in drill core and in the available surface outcrops and prospect pits. Mineralogical documentation of the samples tested by Tetra Tech includes rock type and is further designated as waste, oxide ore, sulfide ore, and tailings according to copper grades. No specific environmental mineralogical analysis was completed for this study. It is recommended that mineralogical test work be undertaken during future operations to support closure planning.

During various reviews, SRK requested clarification from Tetra Tech on the mineral species present in the host rocks and those precipitated during mineralization and metasomatism, hydrothermal alteration, and subsequent oxidation through exposure on pit walls, and in contact with pit lake water (SRK, 2011a; 2011b; 2011c). SRK's questions focused on ensuring that Tetra Tech had identified minerals relevant to the interpretation of the test results and inclusion as source terms in the geochemical models. Tetra Tech addressed these comments and questions in their memoranda and in oral comments (i.e. conference call on May 5, 2011) (Tetra Tech, 2010k; 2010l).

The mineralogical assemblages found on site in the host rocks, mineralized skarn, and hydrothermally altered

rocks are documented in a number of sources (Drewes, 1971; Anzalone, 1995; McNew, 1981; Daffron and others, 2007). The host rocks (i.e. non-mineralized Horquilla, Colina, etc.) have well understood ranges of concentration in basic rock-forming constituents (calcite, quartz, feldspar, etc.) characteristic of unmineralized limestone, dolomite, and sandstone. Mineralized samples contain a variety of rock-forming minerals such as quartz, calcite, gypsum, as well as calcsilicates and metal (sulfide, oxide, silicate, and carbonate) constituents in skarn and mineralized intrusive rocks. These mineralization characteristics (type, size, distribution, association) and relative mineral percentages have been documented in the literature and are typically recorded by the site geologists and geologists at nearby similar deposits in southern Arizona.

Tailings Mineralogy

Detailed mineralogy on the tailings samples typically provides the percentages of the sulfide minerals (pyrite, residual copper sulfides) present (perhaps by size fractions), and the relationship of sulfides and the associated non-sulfide gangue minerals. The latter item includes an assessment of the degree of encapsulation of the residual sulfides (i.e. those sulfides not concentrated and removed during processing) by resistant minerals such as highly stable quartz or potassium feldspar. This helps to estimate how much of the residual sulfide is in ready contact with the atmosphere and could potentially weather and react to generate acidity and metals. Sulfides that are encapsulated by minerals with low chemical reactivity are not readily accessible to the atmosphere. The encapsulated portion of the sulfide content is therefore essentially inert. Weathering of occluded sulfides will occur only after the breakdown and dissolution of the inert encapsulating mineral.

Tetra Tech has documented the rock type for the simulated tailings materials and that the intervals used had pre-processing head grades between the 0.2% total copper (sulfide cutoff grade) and 1% total copper. Lacking in the Tetra Tech sample documentation are specifics on the percentage of sulfides and associated gangue minerals present (i.e. calcite, quartz, garnet, etc.) in the samples sent for metallurgical test work and subsequent environmental analysis. The descriptions were apparently not compiled by Tetra Tech because the dominant rock types are overwhelmingly alkaline (limestone, marble, limey sand/siltstone, skarn), and the trace mineral constituents were not expected to change the net neutralizing capacity of the tailings materials.

1.5 Question 1e and Response

Does the use of compositing of acid-generating and non-acid generating rock types for the tailings samples under represent the potential for areas of problematic water quality to occur?

The range of water quality results (high and low) expected at a site or in a single rock formation is not as well understood when more than one rock type is tested in a single sample. A composite sample provides results based on a blended composition that may mask the high or low peaks produced by individual samples of the rock type.

In the Rosemont test work, however, 80 percent of the samples tested were single-formation samples and the rock types by mass are dominantly alkaline. Two mass-weighted composite samples were prepared to reflect the proportional mass of rock types mined during production Years 0-3 and 4-7. In SRK's professional opinion, the use of compositing to prepare these two multi-rock tailings samples does not under represent the potential for areas of problematic water quality to occur because the samples were composited according to the characteristics and proportions of rock types to be mined.

Compositing Test Samples with Respect to Production Procedures

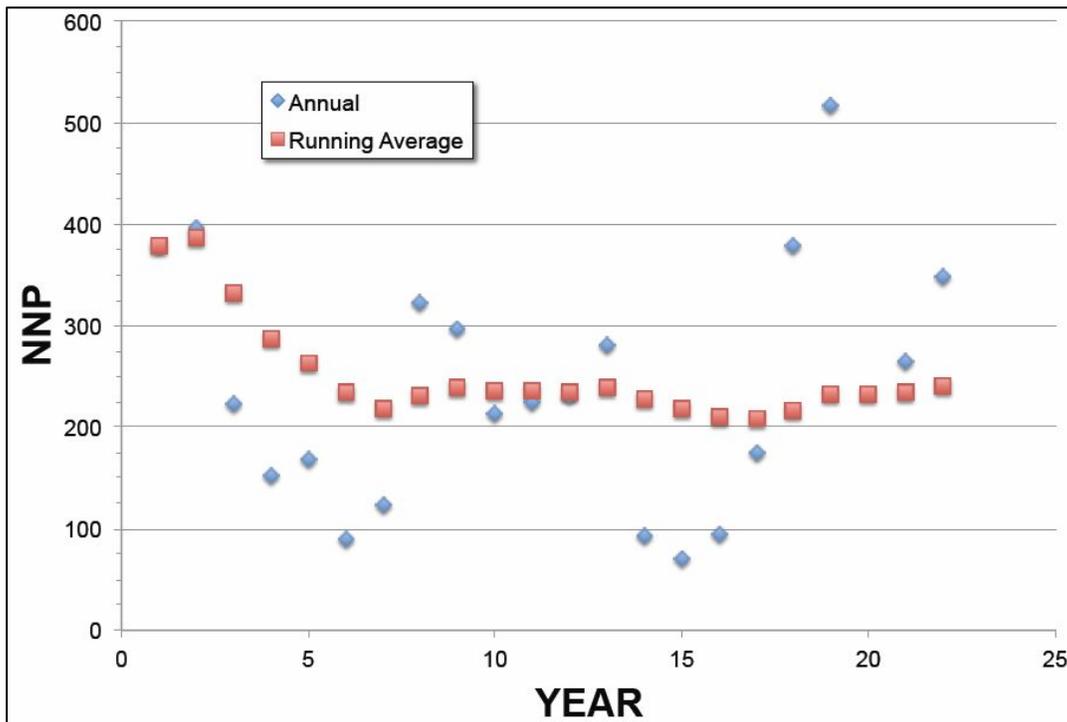
Preparation of a composite sample that reflects the proportional mass of materials to be excavated during different production years is a valid approach to understand the physical and chemical properties of those materials. Mine operations typically are designed on 50-foot bench heights that commonly intersect multiple rock types on a single bench elevation. On a daily basis, shovels will be stationed in different areas of the expanding pit and will mine different rock formations. The shovel is likely to intercept two rock units in a single pass of the bucket depending on what rocks are exposed in a particular bench face. Rock from different parts of the pit will be transported to the primary crusher where blending will occur on a truck-by-truck basis before the material is taken for secondary crushing, processing, and tailings disposal.

What is mined and ultimately placed on the Dry Stack Tailings facility will represent a well-homogenized blend of materials each day. Any potentially acid-generating, single-formation material (i.e. Bolsa Quartzite) deposited on the Dry Stack Tailings facility in a thin layer will be overwhelmed in volume by the blended acid-neutralizing rock types mined from different areas of the pit and placed on the Dry Stack Tailings on a daily basis.

Summary of Results

As mentioned in Section 1, the average NP:AP for the ten tailings samples (representing 88.8% of the sulfide material to be mined) was 60 CaCO₃/kton rock. This value supports the NNP determination that the average, blended material has a high capacity for acid neutralization and extremely low to negligible potential for acid generation. The criteria of NNP values greater than 20 tons CaCO₃/kton rock and a NP:AP greater than 3:1 confirm the Rosemont material is not acid generating. Select Rosemont sulfide ore, primarily the Bolsa (~0.2% of sulfide materials mined) and Epitaph (~9% of materials mined) have the potential to generate acid or uncertain potential to generate acid, respectively. These minor ore constituents will be blended with and overwhelmed by the mass of dominantly net neutralizing materials, especially the Horquilla Limestone.

While not directly relevant to results for the tailings samples, Geochemical Solutions of Loveland, Colorado recently prepared a graph showing the weighted annual Net Neutralizing Potential (NNP) in the waste rock and the running average (Figure 1) respect to the of waste rock expected to be produced during the life of the Rosemont mine (Geochemical Solutions, 2012). The weighted annual averages were calculated by using the percentage of each rock type by mass to be mined each year and the average NNP documented for each rock type. During the life of mine, the annual NNP maintains a value of greater than 75 CaCO₃/kton rock, which demonstrates a high capacity to neutralize acid and a low potential to generate acidity according to geochemistry research guidance. SRK has not seen a graph similar to that shown in Figure 1 for the anticipated NNP for tailings materials by production year. A graph such as the one prepared for waste rock would be helpful for CNF to understand the range of expected NNP values and expected running average NNP on an annual basis for tailings materials.



Source: Geochemical Solutions, 2012. Note that materials with a NNP>20 are considered to have high capacity for neutralizing acid.

Figure 1 Weighted annual NNP and running average NNP of waste rock produced during life of mine

2 Tailings Geochemistry Samples

A variety of characterization tests were run on representative rock samples, including humidity cells (16 samples representing 4 lithologies), acid-base accounting (226 samples representing 17 lithologies), Synthetic Precipitation Leaching Procedure (67 samples representing 14 lithologies), Meteoric Water Mobility Procedure (23 samples representing 8 lithologies), and column tests. Concerns have been raised about specific components of these characterization tests.

2.1 Question 2a and Response

It has been suggested that humidity cell tests reflect oxygenated conditions, and that this may not represent the eventual situation in the tailings facility at the site. Do the humidity cell tests conducted adequately reflect the conditions expected to occur in a dry-stack tailings facility? (Source: A)

In SRK's opinion, humidity cell data would be expected to be useful for calculations of overall oxidation rates for a heap or dry stack tailings facility. A humidity cell is operated to provide an estimate of the rate of oxidation under oxygenated conditions and should provide a reasonable indication of the oxidation rate of tailings that have a low degree of saturation where oxygen (O₂) is present at measurable concentrations. In the case where diffusion is the dominant oxygen transport mechanism and the rate the oxidation is typical of sulfide-bearing tailings, oxygen may be limited to the near-surface material with decreasing oxygen concentrations at depth. Similar to oxygen concentrations often measured in conventional tailings, oxygen concentration may be very low (essentially zero) deep in a dry stack tailings facility and therefore the oxidation rate approaches zero.

SRK is not aware of any studies that correlate direct oxygen measurements in a dry stack tailings with oxygen levels maintained in a humidity cell test. Dry stack tailings have a low degree of saturation and therefore may be expected to have higher oxygen contents than measured in conventional tailings facility.

2.1.1 Oxygenated Conditions in Dry Stack Tailings

SRK is not aware of published data on the direct measurement of oxygen concentrations in dry stack tailings. There are published studies on O₂ concentrations in dewatered conventional tailings, waste rock dumps, and heap leach piles, so the following comments will rely on these data. Oxygenated conditions similar to that found in the atmosphere at the elevation of a tailings facility are typically measured within the top 10 ft of a dewatered tailings impoundment, but well-oxygenated conditions have been measured to 40 ft below unsaturated impoundment surfaces. The concentration of O₂ decreases with depth below surface and with increasing distance inward from the tailings embankment. Concentrations may also show seasonal O₂ changes or fluctuations in the upper oxygenated portions of the facility.

The decrease in O₂ content with depth has been noted locally by SRK in oxygen measurements taken on the closed, dewatered San Manuel tailings (six conventional tailings facilities deactivated between 1971 and 1999). The top 10 to 40 ft were found to be oxygenated (~21%-18% O₂) with steadily decreasing oxygen concentrations with depth. At 60 to 100 ft below surface, oxygen concentrations ranged from approximately 10% to 2% O₂ (SRK, 2005b). Example graphs of O₂ concentration versus depth from two of the closed tailings facilities are shown in Figure 2 and Figure 3.

Based on AMEC's moisture content test work and the manufacturer's specifications of the filtration equipment, AMEC has estimated that the moisture content in the as-placed Dry Stack Tailings at Rosemont will be 15-18%, which will subsequently drain down to a field capacity of 11% (AMEC, 2009, p. 24). At these low degrees of saturation, depth of penetration of oxygen into the tailings will most likely be limited by the intrinsic oxidation rate of the tailings and the dominant gas transport mechanism. The intrinsic oxidation rate is the rate of oxygen consumption on a per volume (or per mass) basis in the conditions to which the material is subjected. For tailings, with a 1% sulfide-sulfur content, this oxidation rate might be 5×10^{-7} kg(O₂)/m³/s or higher. This rate is high compared with most waste rock dumps.

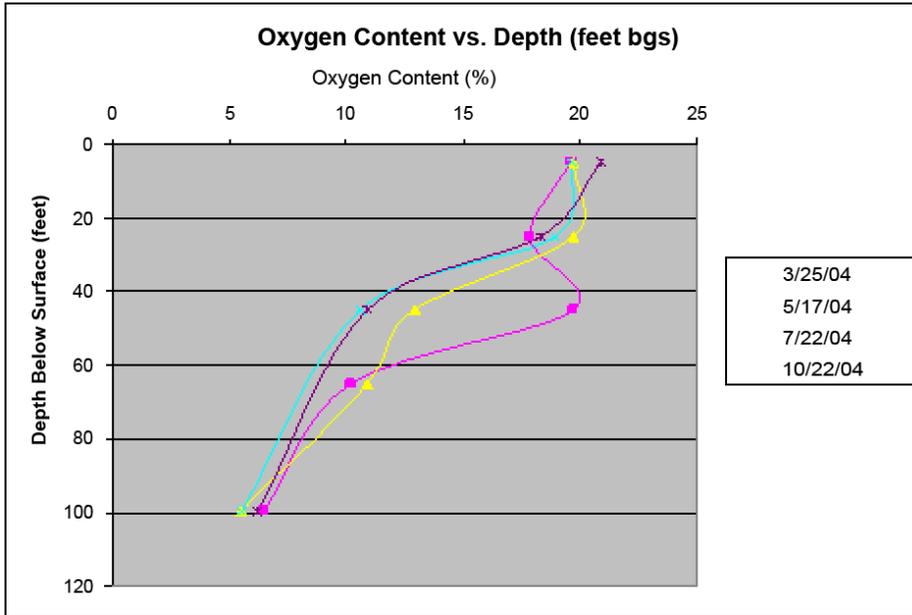
The oxygen transport mechanisms will be diffusion and possibly convection and advection. The diffusion supply of oxygen is inevitable. Typically, if convection and advection are significant, the oxygen concentration would be expected to increase in the outer regions of the tailings, but could also be increased away from edges. The distribution of oxygen by convection and advection is generally dependent on the geometry of the waste structure and the driving forces for gas transport. Given that the dry stacking method produces a configuration similar to a dry heap leach pad and that the system has low bulk density and high intrinsic permeability, convection and advection are possible although perhaps unlikely.

2.1.2 Humidity Cell Test Method

A humidity cell test (HCT) that is conducted as prescribed in the current standardized HCT methodology (ASTM D5744-07) will be well-oxygenated under Option A if the protocols are followed; Option B allows control of oxygen influx. Tetra Tech (2007) followed the procedure that was current at the time the 2007 testing was begun (ASTM D5744-96, reapproved in 2001).

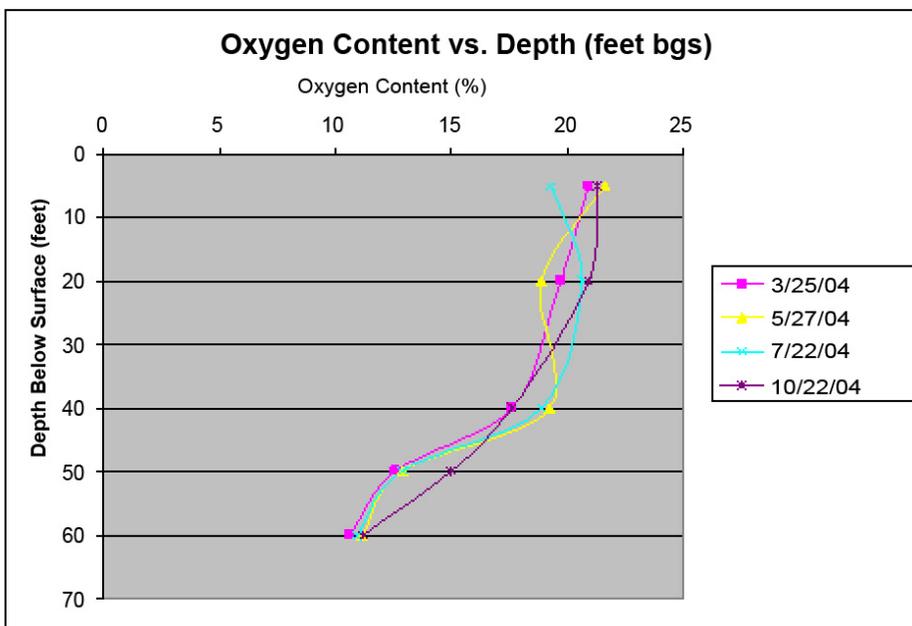
It must be emphasized that the purpose of an HCT is not to simulate precisely the site specific conditions. As

stated in Section 1.1 of the HCT test description, an HCT test is designed to: 1) enhance reaction-product transport in the aqueous leach of a solid material sample and 2) to measure rates of weathering-product mass release. The methodology also states that the test method “is not intended to provide leachates that are identical to the actual leachate produced from a solid material in the field or to produce leachates to be used as the sole basis of engineering design”(Section 1.6) and “is not intended to simulate site-specific leaching conditions” (Section 1.7). It is the job of the geochemist to analyze the data generated from relatively short-term tests such as HCTs, and extrapolate those data to the actual field conditions that will endure for much longer.



Source: SRK, 2005b. Measurements were taken in 2004 from oxygen monitor well in beach of a conventional tailings facility decommissioned in 1999 (6 years of dewatering).

Figure 2 Oxygen concentration versus depth – Monitor hole in tailings facility inactive after 1999



Source: SRK, 2005b. Measurements were taken in 2004 from beach of a conventional tailings facility that was inactive after 1971. Cover (4" soil on top) and revegetation were completed in 1991 (minimum 13 years of dewatering).

Figure 3 Oxygen concentration versus depth – Monitor hole in tailings facility inactive after 1971

2.2 Question 2b and Response

Humidity cell tests were run for 25-35 weeks, with most running 35 weeks (14 out of 16 samples). Is this duration sufficient to provide adequate information to support the geochemical modeling conducted for the mine site? Please provide a rationale for your professional opinion. (Source: A, B, C, E)

It is SRK's opinion that it is acceptable to evaluate the data, report results, and conduct preliminary predictive modeling after HCT duration of 20 weeks provided that stable trends are apparent, with the caveat that predictions (as well as waste management strategies) are subject to revision as new data are generated. Kinetic tests are commonly run beyond what might be deemed adequate based on apparent stability at the 20-week or 35-week milestones. Numerous examples exist in the literature (Herrell and others, 2009; Howell and others, 2006; Maest and Kuipers, 2005; Scharer and others, 2000; Morin and Hutt, 1999; Day, 1994; Ziemkiewicz and Meek, 1994; Ferguson and Morin, 1991) that describe HCT data that display apparent stability over 20-40 weeks, but turn more acidic as testing continues. The transition to acidic condition in the large majority of cases is predictable using acid-base accounting data. The number of deposits in the case studies mentioned above that are analogous to the Rosemont setting (carbonate-hosted, ~10% intrusive present, low-sulfide content) is limited. For the Rosemont samples, the probability of acidic leachate being produced is considered to be very low, but metals will still be mobilized under the expected alkaline conditions.

2.3 Question 2c and Response

Taken as a whole, are the number, type, and distribution of samples for the humidity cell and other characterization tests (ABA, SPLP, MWMP) sufficient to provide adequate information to support the site specific geochemical modeling conducted for the mine site and considering specific lithologies such as those that are known to be acid generating? (Source: A, C)

Tetra Tech has argued in their memoranda that the number, types, and distribution of samples for the humidity cell and other characterization tests were sufficient to provide adequate information to support the site-specific geochemical modeling including various sensitivity analyses. In SRK's professional opinion, the test work and geochemical modeling performed to date are sufficient to provide adequate information to support the pre-mine geochemical models. Additional test work and modeling prior to operations will not change the outcome of the models prepared to date. Confirmatory test work and modeling are recommended during operations when Rosemont initiates investigations for their final closure design plans. This testing and modeling would use the chemistry and material properties of the mined materials including the waste facilities, pit wall, and process solution.

The dominant rock types to be mined are strongly alkaline and show no potential to generate acid or show uncertain potential according to industry standard guidance. The acid-generating rock type identified by Tetra Tech is the andesite within Willow Canyon Formation, which is primarily to be placed in the Waste Rock Storage Area or on a lined Heap Leach Pad. The Bolsa Quartzite has potential to generate acid and will be a minor component of both the Dry Stack Tailings and the Waste Rock Storage Area. The andesite and Bolsa Quartzite constitute approximately 2.4% and 0.2%, respectively, of the ore to be mined during the 20-year mine life and approximately 4% and 1.9%, respectively, of the waste rock (Table 3, Tetra Tech, 2010d). The acid-generating materials will be crushed and blended with acid neutralizing materials during mining, processing, and placement on the Dry Stack Tailings facility. A *Waste Rock Segregation Plan* is in place to identify and encapsulate acid-generating materials with acid-neutralizing materials on the Waste Rock Storage Area (Tetra Tech, 2010g).

3 Release of Arsenic

A concern was raised that "based on the geochemistry evaluations there is significant evidence of risk or release of arsenic in leachates from waste rock or tailings." It is unclear the reason for these concerns, given that geochemical modeling for tailings, waste rock, and heap leach all are below aquifer water quality standards. (Source: B)

The seepage and infiltration models indicate seepage from the Dry Stack Tailings will occur over a long period as the residual pore water drains down. The average quantity of seepage for the Dry Stack Tailings facility is estimated to be approximately 8.4 gpm or (0.0074 gallons per acre). Geochemical modeling of seepage quality from the Dry Stack Tailings predicts the arsenic concentrations will be not be detected above typical analytical limits (i.e. <0.003 to <0.01 mg/L) (Tetra Tech, 2010e). Seepage from the Waste Rock Storage Area is expected to be *de minimus*. If seepage, however, does occur from the Waste Rock Storage Area, elevated arsenic

concentrations are predicted (0.013 mg/L). The untreated Heap draindown is predicted to have arsenic concentrations that fall below both the reference Arizona AWQS of 0.05 mg/L and the reference federal maximum contaminant level (MCL) of 0.01 mg/L As. The residual Heap closure draindown will be collected in double-lined ponds and treated and will not be discharged (Tetra Tech, 2010b).

Provided below is a summary of the site characterization information related to arsenic-bearing minerals and groundwater concentrations and arsenic results by test work test work and modeling performed for each facility.

3.1 Site Characterization – Mineralogy and Groundwater

The sections below will provide some information on the site mineralogy and ambient groundwater quality with respect to arsenic.

3.1.1 Arsenic-bearing Minerals in Rosemont Deposit

The arsenic-bearing minerals at the site have not been studied in detail. Arsenic does not appear to be clearly associated with other trace elements so it could be present as sulfide or sulfosalt minerals (arsenopyrite, tetrahedrite-tennantite), oxide minerals, or perhaps in clay minerals found in the overlying sedimentary formations similar to reports for Cenozoic lakebeds elsewhere in southern Arizona (Spencer, 2002). Arsenopyrite (FeAsS) is noted in porphyry copper and contact metamorphic deposits and is associated with galena, sphalerite, pyrite, chalcopyrite, silver, and tetrahedrite. The background geological information provided by Daffron and others (2007), however, indicates arsenic-bearing minerals, such as arsenopyrite, are not common at site.

Tetrahedrite, a copper antimony sulfosalt $(\text{Cu,Fe})_{12}\text{Sb}_4\text{S}_{13}$, was “*positively identified in a few places and probably is more abundant due to the difficulty in identifying very small grains megascopically*” (i.e. visual identification through core logging) (Daffron and others, 2007). Tetrahedrite is actually a solid solution mineral with the copper arsenic sulfosalt tennantite $(\text{Cu,Fe})_{12}\text{As}_4\text{S}_{13}$ and therefore could contain arsenic.

In a review of the whole rock geochemistry, antimony concentrations are relatively low and do not support presence of tetrahedrite, hence it is possible arsenic is present as tennantite. Pyrite occurs at Rosemont and may also host arsenic. In the oxidized zones of the deposit, any sulfides and arsenic-bearing sulfosalts will oxidize to yield iron (ferric) oxyhydroxides and sulfate. Arsenic will be oxidized to arsenate and will likely co-precipitate with the ferric oxyhydroxides.

Based on perusal of the whole rock geochemical database, arsenic concentrations do not vary widely. Tailings arsenic concentrations tended to be in the 10 to 30 mg/kg range. Wider variation was noted in the ore feed samples used to prepare the composites (maximum measured was 74 mg/kg) but this represents only modest enrichment with respect to global average values of 1 to 13 mg/kg, depending on rock type (Price 1997). Arsenic concentrations do not appear to be correlated with sulfide content, which does not allow conclusions to be drawn about the mineralogical host. It is possible that at these relatively low concentrations, arsenic is occurring in association with iron oxides and carbonates although the sulfide association cannot be ruled out.

Under non-acidic conditions (expected to prevail at Rosemont), arsenic occurs aqueously as arsenate. Being a positively charged ion, this possibly leads to arsenic being relatively more mobile compared to heavy elements occurring as cations which favor acidic conditions. An important consideration for arsenic is also the presence of iron. As the ratio of iron to arsenic increases under leaching conditions, arsenic concentrations decrease for a given pH value. The differences can span orders of magnitude. For example, if arsenopyrite is the source of arsenic and iron (Fe/As =1 on a molar basis), dissolved arsenic concentrations can exceed 10 mg/L. As the Fe/As ratio falls below 5 (which is expected where the main hosts are pyrite and ferric oxyhydroxides) dissolved arsenic concentrations can be below 0.1 mg/L at near neutral pH.

Based on the current understanding of arsenic mineralogy (i.e. relatively low arsenic concentrations associated with minerals having high Fe/As ratio), arsenic is generally expected to leach at relatively low concentrations. The potential for localized elevated leaching may be associated with oxidation of tetrahedrite-tennantite although the antimony and arsenic concentrations do not indicate this mineral is abundant.

3.1.2 Site Groundwater Quality

Elevated naturally occurring arsenic concentrations have been documented in groundwater sampled in the Rosemont area and elsewhere in southern Arizona. The background groundwater analyses of pit monitor wells and springs on the Rosemont area measured concentrations ranging from 0.0003 mg/L arsenic to a maximum

of 0.28 mg/L As with a mean concentration of 0.0073 mg/L (see Tetra Tech, 2010e, p. 80, based on report by M&A, 2009a). The mean background groundwater concentration used in the fate and transport model was 0.0073 mg/L (0.0097 95% upper confidence level), which is below the reference federal MCL and Arizona AWQS.

3.2 Summary of Geochemical Test Work - Arsenic

3.2.1 Total Metals Analyses

The arsenic content in the ore feed samples for the tailings material was extensively analyzed during the geochemical test work program. Although tailings are not soil materials per se, they are ground to the particle size of typical soil material. The total metals in these materials can be compared for reference purposes with Arizona non-residential soil remediation levels² (NRSRL). The NRSRLs are designed to assess potential impacts to groundwater from impacted soils during remedial actions. The NRSRL for arsenic is 10 mg/kg, which means any soil exceeding this arsenic concentration is not directly suitable for non-residential uses. As noted above, a number of the individual core and coarse reject samples comprising the Rosemont ore feed used to prepare the tailings samples measured arsenic concentrations in excess of 10 mg/kg. The maximum arsenic measured in an ore feed composite sample was 74 mg/kg. The tailings samples ranged from 5.3 mg/kg As for Earp Formation to a high of 28.7 mg/kg As for Epitaph. The Colina, Epitaph, Escabrosa, Horquilla, and Tailings Year 0-3 tailings samples had total arsenic values that exceed the 10 mg/kg NRSRL, all of which confirms that arsenic-bearing minerals do occur at Rosemont (see Attachment 3, Table A.3 of Tetra Tech, 2010l).

ADEQ has developed screening criteria termed the minimum Groundwater Protection Levels (GPLs), which are compared to total metals concentrations in the soil. The GPLs are published in the *Screening Method to Determine Soil Concentrations Protective of Groundwater Quality* (ADEQ, 1996). They are characterized in the guidance document as being a worst case, theoretical correlation between total metals concentrations in soils and the concentration of the leachable fraction of the metals from those soils. Therefore, soils with mean concentrations of metals below the minimum GPLs would not be expected to leach contaminants at concentrations that would impact groundwater above the AWQSs. The GPL for arsenic is 290 mg/kg. None of the individual ore feed samples or the 10 tailings samples analyzed during the geochemical test work were measured with arsenic concentrations higher than 74 mg/kg arsenic found in a single ore feed sample. By this worst-case theoretical correlation basis, tailings solids material is not expected to generate arsenic concentrations that would exceed the reference AWQS of 0.05 mg/L.

3.2.2 MWMP and SPLP Analyses

In a review of the hundreds of MWMP and SPLP leachate results from geochemical test work, SRK noted low levels of leachable arsenic but nothing elevated above the reference AWQS of 0.5 mg/L. A small proportion (18 out of 109 samples) showed concentrations above the reference federal arsenic MCL (0.01 mg/L). The SPLP results on two tailings samples (Tailings-022807 and Tailings-05 June 2007) were non-detects for arsenic. This may not be relevant as tailings are rinsed thoroughly during metallurgical test work, and therefore leachable concentrations in the test results are expected to be low.

3.2.3 Humidity Cell Tests

ABA test work indicated that andesite waste rock is likely to generate acid and that a number of other rock types (arkose, Bolsa, Earp, quartz monzonite) have uncertain or moderate potential to generate acid. These rock types warranted additional study through kinetic testing (humidity cells) (Tetra Tech, 2007).

HCTs were conducted for 35 weeks on 14 samples of the dominant waste rock types by mass (andesite, arkose, and Earp) (Tetra Tech, 2007, p. 13). The humidity cell tests were performed in accordance with industry standardized test procedures (ASTM, 1996). Analyses by inductively coupled plasma mass spectrometry (ICP/MS) were conducted on the leachate every fifth week. Most metals were less than their detection level in the HCT leachates, although measurable levels of copper, manganese, arsenic, and selenium were found in some samples (Tetra Tech, 2007, p. 14). None of the leachate samples contained arsenic at levels above the reference AWQS limit of 0.05 mg/L, although some of the samples of leachate from mineralized arkose exceeded the reference federal MCL of 0.1 mg/L. The arsenic in the leachate from arkose samples ranged

² Specified in Arizona Administrative Code R-18-7-205

between 0.0162 to 0.047 mg/L (Tetra Tech, 2007, Appendix A, Table 8).

The humidity cell kinetic testing on two tailings samples showed three leachate results during the 20 weeks of analysis for which concentrations were greater than the reference primary MCL of 0.01 mg/L As, but were lower than the reference Arizona AWQS (0.05 mg/L). These results were not used in the starting solutions for the Dry Stack Tailings fate and transport model. The HCT results do not provide a direct indication of overall groundwater quality beneath the tailings, but generally indicate low levels of leachable arsenic.

3.2.4 Field Column Tests

Samples from six field column test results were collected for 22 weeks (with field parameters collected for four additional weeks) from materials shown to have likely and uncertain acid generating potential. The materials tested included three samples of andesite and three composite blends containing varying amounts of pyrite (<1% to 1%). The decreasing pH in the leachate through week 26 indicated the material was reacting. Decreasing pH enhances arsenic attenuation, but it may not be relevant in low-sulfide materials. Arsenic was confirmed to be non-detect or leaching at concentrations below reference federal MCL of 0.01 mg/L from all samples for eight of the 11 samples taken over a 22-week period. The method reporting limits were too high on weeks 11, 13, and 15 (0.0300 mg/L, 0.075 mg/L, and 0.015 mg/L, respectively) to evaluate the concentration of arsenic with respect to reference water quality standards. The samples taken in the following weeks (17, 99, 22) with low method reporting limits, however, were all non-detects or very low concentrations below reference arsenic MCL with the exception of the week 19 sample for Composite-1 (0.012 mg/L As). The tests were terminated because the fine material fractions of the column samples started to cement together, which prevented proper drainage (Tetra Tech, 2010l).

The low concentrations of arsenic in field column test leachates provided the strongest indication that arsenic has low leachability from site materials and confirms the low leachable concentrations observed in high liquid to solid ratio tests such as SPLP and MWMP. It appears likely that arsenic is either present in minerals that dissolve at low rates, or is associated with elevated Fe/As ratios that limit arsenic solubility.

3.3 Summary of Model Predictions

3.3.1 Dry Stack Tailings Facility

The fate and transport results (Tetra Tech, 2010c; 2010e; 2010l) predicted non-detects for arsenic in the Dry Stack Tailings seepage water quality as shown in Table 4 as a result of low concentrations observed in SPLP, MWMP, and humidity cell leachates. Uncertainty remains about arsenic concentrations in Dry Stack contact waters due to the lack of test work performed at lower liquid to solid ratios. Other constituents that are regulated with an AWQS or federal MCLs are not predicted to exceed their applicable numeric standard. Some constituents, however, such as magnesium, sulfate, potassium, fluoride, total dissolved solids, molybdenum, and selenium, are predicted to be elevated in the tailings seepage with respect to the mean background concentrations for the site groundwater.

3.3.2 Waste Rock Storage Facility Model

The geochemical model for the Waste Rock Storage Facility was constructed as a simple mixing of the starting solutions, which simulated water contacting the proportional material in the Waste Rock Storage facility. The averages of the results of the SPLP or MWMP testing were used to characterize the starting solutions. Starting solutions of samples from the Abrigo, Earp, Epitaph, and Concha formations were below the reference federal MCL of 0.01 mg/L As concentration. Samples of arkose, andesite, Horquilla, and Tertiary gravels were slightly elevated above 0.01 mg/L. Arsenic in samples of the Bolsa, Colina, Escabrosa, Gance, and quartz monzonite porphyry were not detected in the total element analyses, so were not included in modeling (Tetra Tech, 2010e). None of the starting solutions in the fate and transport model of the Waste Rock Storage Area were above the reference Arizona AWQS of 0.05 mg/L As.

The results of the infiltration and seepage model indicated that water is not expected to flow from the Waste Rock Storage facility, as a result of the high evaporation rate and low infiltration rate (Tetra Tech, 2010e, p. 78). The results of the mixing model suggested that, if seepage were to develop from the Waste Rock Storage Area, it would have concentrations of 0.013 mg/L As. This is below the reference AWQS of 0.05 mg/L, but slightly above the reference federal MCL of 0.01 mg/L (Tetra Tech, 2010e, p. 80).

3.3.3 Heap Leach Facility Model

The starting solutions in the fate and transport model of the Heap Leach facility were proportional to the tons

of arkose, andesite, and quartz monzonite to be placed on the facility and mixed with dilute sulfuric acid (0.5%) to represent the leached materials. Individual starting solutions included a high of 0.0135 mg/L As for arkose (63% of mass), 0.0039 mg/L As for andesite (16% of mass), to non-detect values for quartz monzonite (21% of mass). The model results for arsenic in the Heap seepage is 0.008 mg/L, which is below reference federal MCL of 0.01 mg/L and the reference AWQS. The modeled results for As include three treatment scenarios: seepage without treatment, seepage through crushed limestone, and seepage through engineered biological system (Tetra Tech, 2010e, p. 83).

Draindown of process solution and infiltration and storm water runoff from the surface of the Heap Leach Facility will be collected in the PLS Pond during operations and the draindown period. The facility will be closed per prescriptive BADCT guidance (ADEQ, 2004a) (Tetra Tech, 2010e, p. 82 and Appendix D). Water treatment is proposed to be a two-stage process (increasing the pH in treatment stage 1 and then reducing sulfate in an engineered biological system in stage 2). Although no exceedance of arsenic is anticipated, the draindown solution is predicted to exceed the AWQS for cadmium, nickel, and selenium and will not be discharged.

Table 4 Fate and transport model – Arsenic seepage concentration

Facility	Modeled As seepage concentration (mg/L)	Comparison of leachate water quality against reference water quality standards (mg/L)
Dry stack tailings	Non-Detect	Will not exceed AWQS (0.05) or federal MCL (0.01)
Waste Rock Storage Area	0.013 (if seepage occurs)	Will not exceed AWQS (0.05) Exceeds the federal primary MCL (0.01)
Heap Leach Facility	0.008	Will not exceed AWQS (0.05) or federal MCL (0.01)
Background characterization	Actual Arsenic concentration (mg/L)	Comparison against Reference AWQS
Groundwater & seeps at site	Range 0.0003 to 0.28 mg/L Mean 0.0073 mg/L	12 site characterization wells and 3 springs exceed AWQS (0.05) or federal MCL (0.01)

Source: Tetra Tech, 2010i

3.4 Question 3a and Response

Based on review of the geochemical evaluations as a whole, is there a risk of arsenic concentrations in leachate from tailings or seepage from waste rock that is not adequately represented in the current geochemical modeling?

Based on review of the Rosemont geochemical evaluations as a whole, the predicted concentrations in leachate from tailings or seepage from waste rock appear to be adequately represented in the current geochemical modeling. The geochemical evaluations predict that leachate volume from tailings is not expected to cause an exceedance of a reference water quality standard for arsenic. There is a low risk that seepage from waste rock would occur. If seepage occurs, it is predicted to contain an arsenic concentration below the AWQS of 0.05 mg/L but potentially elevated with respect to the reference federal MCL of 0.01 mg/L As.

3.4.1 General Comments

Estimating potential field impacts based on the results of geochemical test work and predictive modeling has been refined over many years, but is not an exact or absolute science despite improvements in modeling codes and regulatory guidance to assist site evaluations. Sources of uncertainty potentially exist as related to the quality of the data gathered, seasonal/operational variability in site conditions versus assumed model inputs, variations in predictive software model codes used, differences based on sensitivity analyses performed, and other factors.

A review of actual versus predicted water quality in a number of mining facility case studies by Kuipers and others (2006) highlighted shortcomings in the success rate for prediction of acid mine drainage and metal drainage. The review considered 25 case studies from various types of operations (underground, open pit), host rock geology, commodities, waste disposal methods, and climate conditions. Their conclusions indicate that caution and a conservative (rather than overly optimistic) approach are warranted. The case studies, however,

have limited application to Rosemont because they do not include similar deposits, particularly with respect to commodity, limestone-dominant host rocks, mining and waste disposal methods, climate conditions, or modern environmental requirements and test methods³. It can be argued that the case studies selected by Kuipers and others (2006) did not adequately address shortcomings of predictions in situations where carbonate buffering could bring pH values to 8 to 9.

The above caveat suggests that even the most experienced geochemist and thorough program may have the potential to under-predict or over-predict potential impacts related to the presence of a specific constituent. Nonetheless, the geochemist must make a decision based on the data and results at hand – especially when there is a proposed project lacking existing facilities (i.e. open pit, pit wall, pit lake, tailings, or waste rock dump) or actual process solutions.

Prediction uncertainty is reduced, however, by having:

- A thorough understanding of site geology, mineralogy, hydrogeology,
- Good conceptual models (such as site water balance, regional numerical groundwater flow, surface water flow, pit lake recovery/water quality) for both operations and post-closure scenarios,
- Field data collection that matches the range of the material types to be mined/processed (and approximate proportions),
- Geochemical tests completed by more than one approach including both static and kinetic analyses, and
- Mitigation strategies based on a range of potential values derived through sensitivity analyses.

In general, SRK finds that the project documents indicate that these aspects have been considered in support of the pre-mine geochemical modeling at Rosemont. In SRK's opinion, the Rosemont waste storage and Heap facility designs will reduce seepage to the best extent possible during operations. Strong quality assurance/quality control documentation implemented during construction (to ensure the facility is built as designed), consistent use of Best Management Practices to eliminate and/or capture seepage, and frequent routine operational monitoring and maintenance will provide the best practical insurance to monitor and address seepage that occurs in greater quantities or concentrations than expected. Most important as a contingency, the design of the project allows for centralized capture of a dominant portion of any seepage water that occurs in the Open Pit watershed.

3.5 Question 3b and Response

Is there a need for further sampling or analysis to evaluate the need for arsenic contamination from the operation?

SRK believes that the potential for arsenic contamination related to the Rosemont operation has been evaluated sufficiently at this stage. Further sampling or testing will not reduce prediction uncertainty. Quarterly groundwater monitoring and reporting for arsenic is listed as a compliance requirement of the draft Aquifer Protection Permit (APP) for seven Point-of-Compliance wells. SRK recommends confirmatory analyses on the tailings and waste materials, construction of on-site field tests to evaluate leachates and testing of derived leachates after operations commence. These operational confirmatory analyses will likely be needed to prepare detailed closure designs at a later phase in the mining life cycle.

³ Note: The 25 case studies in Kuipers and others (2006) are dominantly gold/silver mines in host rocks and climate conditions that are not similar to the proposed Rosemont operation. Even the two Arizona case studies – Bagdad Cu-Mo porphyry (dominantly igneous and metamorphic host rocks) and Ray Cu porphyry (dominantly igneous and diabase host rocks) are not directly analogous to the low-sulfide, limestone-skarn hosted Cu-Mo deposit at Rosemont. Bagdad and Ray operations have unlined leach dumps. Rosemont has proposed building a heap leach facility with 6 inches of compacted bedding soil, a sodium bentonite GCL with low permeability (1 x 10⁻⁶ cm/sec), a 60-mil linear low-density polyethylene liner above the GCL, and a leak collection recovery system. Bagdad and Ray have conventional tailings facilities; Rosemont has proposed a Dry Stack Tailings Facility with 15-18% moisture content. Both Bagdad and Ray have waste rock dumps located within their open pit watersheds similar to what has been proposed for Rosemont. Ray is authorized to use low-sulfide, inert waste to rock armor the Elder Gulch tailings facility. Rosemont is proposing to use inert waste rock to place on the outer surfaces of the Rosemont Ridge Landform (Tetra Tech, 2010a). SRK is not aware that Bagdad or Ray has a PAG/non-PAG waste rock management plan similar to Rosemont's proposed management plan (Tetra Tech, 2010g), but Rosemont's plan is similar to ones in effect at other copper mines such as Pinto Valley in Gila County and the Robinson Mine in Nevada.

4 Sample Mineralogy

Concerns have been raised that full mineralogical analysis (i.e., minerals present, oxidation type of minerals, grade of minerals) has not been conducted on the rock samples used to support the geochemical modeling. (Source: A, C, E)

Concern about the lack of detailed mineralogy on specific samples was previously expressed by SRK in review comments about the test work and source terms for model inputs (SRK, 2010a, 2010b; 2010c; 2011a; 2011b; 2011c). The concerns have been addressed by Tetra Tech in a number of response memoranda and in discussions with them during a conference call held with Tetra Tech, SRK, and CNF personnel. Detailed mineralogy was not performed and the mineralogy documentation on the samples is brief. Tetra Tech, however, did have access to information related to oxidation state (oxide, sulfide zone), rock type, copper grade, and the general characteristics of host rocks, ore, and waste materials during their geochemical test program. A general mineralogical description by formation is available from the literature for the Rosemont deposit (Anzalone, 1995; McNew, 1981; Daffron and others, 2007).

4.1 Question 4a and Response

Based on the materials reviewed by SRK, was mineralogical analysis conducted by Rosemont?

Formal detailed mineralogy analysis consisting of petrographic thin sections, X-ray diffraction, scanning electron microscope, or other laboratory method was not performed by Tetra Tech on the samples selected for geochemical analysis or on the tailings samples. Although outside laboratory work was not performed on representative sample intervals, sufficient deposit mineralogy data were reviewed for the geochemical analysis to provide a meaningful framework for analysis.

Rock and mineral characteristics such as general geology, geomorphology, deposit ore/gangue/host types, basin-fill and older sedimentary cover units, and representative drill core specimens were reviewed with Rosemont geologists on site during Tetra Tech's preliminary field investigations (Vector, 2006). Compilation of the existing mineralogy and geology data by Tetra Tech in various compilation reports is limited to designating the drillhole name, drillhole sample interval, footage depth, and rock type. The rock samples were initially segregated by whether they represented tailings (sulfide) or heap leach (oxide) waste rock (sulfide) according to established grade cutoffs of 0.1% total copper for oxide waste and 0.2% total copper for sulfide waste (Tetra Tech, 2010h).

4.2 Question 4b and Response

Would the availability of mineralogical analysis be likely to change the results of the geochemical modeling?

Availability of mineralogical analysis would add confidence in the results of the geochemical models and may well assist in providing realistic constraints on saturated mineral phases expressed in the model, but would likely not appreciably change the results and conclusions of the geochemical models. In SRK's opinion, the general geological characteristics and mineralogy of the deposit is understood, but the mineralogy of the samples tested is not well reported in Tetra Tech's reports.

The mineralogy data would have been helpful to assess the predictions related to the Dry Stack Tailings and Heap Leach facilities. A formal mineralogy review for tailings would have included the percentages of the dominant mineral constituents of the samples, grain sizes of potentially acid-neutralizing or acid-generating minerals, and observations about encapsulation. This proved helpful in the geochemical assessment at the closed San Manuel tailings facility where the majority of the residual pyrite was determined by mineralogical analysis to be encapsulated by inert quartz and feldspar and is therefore not readily available to oxidize (SRK, 2005a). A formal mineralogy review on post-leach residues derived from a column leach test on the proposed Heap materials would have identified potential soluble secondary salts and precipitates in the metallurgical test-simulated spent Heap material.

5 Parameters & Approach for Pit Lake Model

Concerns were raised specifically by Dr. Tom Myers (Attachment D) concerning the parameters and approach used for the pit lake model. The following questions arise directly from Dr. Myers' review of the Tetra Tech pit lake model.

5.1 Question 5a and Response

Dr. Myers indicates that the model ignores the chemical loading resulting from precipitation that percolates through the pit walls to the groundwater table or to the pit lake.

Tetra Tech's approach assumed that 20% to 40% of the precipitation will come into contact with the pit walls, the exact percentage of which depends on the extent of pit wall exposure during the refilling of the Pit Lake. Tetra Tech's rationale was described as follows: "Much of the precipitation falling on the pit walls will pond in depressions (such as on haul roads) and evaporate, or will infiltrate into the blast altered rock zone of the ultimate pit walls." Since Tetra Tech included infiltration into the pit walls and benches as a possible component in the hydrologic balance, the prediction does include an estimation of the water quality of this component.

5.1.1 Response to Question 5a(i)

Is there a need for an approach to account for this source of chemical loading? If not, why not?

In SRK's opinion, omitting this source will underestimate the chemical loading predicted from these zones, so there is a need to account for it. Tetra Tech's statement that much of the precipitation falling on the pit walls will infiltrate indicates that this source component is accounted for in the model. This component will likely acquire a chemical loading signature that is very similar to the pit wall runoff. Thus the geochemical aspect of the predictive modeling of this source can mimic that of the pit wall runoff, with commensurate scaling based on the estimated infiltration rate.

5.1.2 Response to 5a(ii)

If so, how significantly would that parameter affect the results of the pit lake model?

Addition of this source component would result in a proportional increase of chemical loading to the pit lake over that generated by the pit wall runoff model. The geochemistry of that parameter is assumed to be very similar to the pit wall runoff. Pit Wall Runoff (R) = Precip (P) – Evap (E) – Infiltration (I), so given that the exposed surfaces of pit walls and benches can be highly fractured and amenable to infiltration, accounting for (I) has the potential to add a loading component to the model. The most significant overall component, however, is the chemical loading associated with inflowing groundwater.

5.2 Question 5b and Responses

The groundwater inflow chemistry was estimated based on average chemistry from eight monitoring wells. Dr. Myers indicates that this approach is erroneous as it does not account for variations in water quality by geologic formation.

Summary of Work Completed by Rosemont

In order to address this comment, one must first understand the data, hydrogeological context, and method used to assign average groundwater inflow chemistry in the Pit Lake Predictive Model. A summary is provided below with respect to field data collected from the pit monitor wells (formations intercepted, water quality samples), formations expected in the ultimate open pit, and the consolidation of geologic units into hydrogeologic zones within the numerical groundwater flow model.

Well Installation in Future Pit Wall Area: In 2007-2008, Montgomery & Associates (M&A) installed eight observation/monitor wells (PC-1 through PC-8) located in the area surrounding and immediately adjacent to the ultimate extent of the proposed open pit. The wells are screened in the major formations expected in the future pit wall. Well construction details, geologic and downhole geophysical logs, water levels, and water quality data were presented in two M&A reports dated September 6, 2007 and February 26, 2009. Table 5 summarizes the well screen intervals, rock types intercepted (footage and percent relative to the specific well), and static water levels for monitor wells PC-1 through PC-8. Water quality samples were taken by M&A at the end of aquifer pump tests from both isolated sub-intervals and from the entire screened interval.

The relative proportions of rock types expected to be exposed in the proposed ultimate pit wall is presented in Table 6 (from Table B-1 of Tetra Tech, 2010i) and depicted in Figure 4. For comparison purposes, footages for each rock type intercepted in the individual pit monitor wells and tabulated for all the wells are also shown in Table 6.

Water Quality Sampling: The background groundwater quality results collected from PC-1 through PC-8 during the pump tests is presented in the M&A well data compilation reports (2007; 2009a). SRK compared

the M&A analyses (Tables 6, 7, 8 in M&A, 2009a) with the averaged water quality values reported by Tetra Tech to represent groundwater inflow chemistry (see Table 4.01, Tetra Tech, 2010i). Laboratory results indicate the water ranges from calcium-bicarbonate water to a calcium-sulfate water type. These wells are not water quality compliance wells, but the chemistry can be compared for reference purposes only to various numeric standards. With respect to reference water quality standards, there were no exceedances of an Arizona AQWS in the water quality analyses for the constituents analyzed. There was one exceedance in a reference EPA drinking water MCL for arsenic as measured in one of the three samples taken from artesian well PC-2. There were a number of exceedances in several wells including PC-2 with reference to EPA National secondary drinking water standards (i.e. sulfate, TDS, manganese, iron).

Unit Consolidation: Based on a review of pump test data and other aquifer data for the various formations, Tetra Tech consolidated the geologic formations into eight hydrogeologic zones in their regional numerical groundwater flow model (see Table 4-1 Tetra Tech, 2010h, p. 26). Within the immediate pit area, the consolidated rock units in the model are represented by four hydrogeologic zones (Qtg2, Ksd, PZ_Pit, and PCb) and model layers 3 (highest) through 14 (deepest). The Qtg2 zone comprises Quaternary-Tertiary unconsolidated and cemented basin-fill (also informally known as Gila Conglomerate). The Ksd zone includes Lower Cretaceous Bisbee Group sedimentary units (Willow Canyon Formation and the Glance Conglomerate). The Willow Canyon Formation includes interlayers of cemented gravel, sandstone, siltstone and some andesite flows. The PZ zone comprises the Paleozoic sedimentary formations including contact metamorphosed and metasomatized sedimentary formations in the immediate pit area. The Pz zone is locally designated as “Pz_Pit” in the immediate pit area. Pz-Pit zone dips to the west honoring the geometry of the steeply east-dipping quartzite, shale, and limestone formations. The PCb zone includes Precambrian crystalline basement rocks including the Continental Granodiorite and the Pinal Schist.

Assigning Hydraulic Properties: Tetra Tech assigned initial and final (calibrated) vertical and horizontal hydraulic conductivity values (K in ft/day) to each zone; the values vary by two orders of magnitude between Ksd and Pz (Table 6-3, Tetra Tech, 2010h). These zonal K values were kept constant in the respective zones assigned to layers 3 through 14. The relation of rock formations screened in the pit monitor wells with respect to the model zone designations is shown in Table 6. Final calibrated horizontal and vertical K values for the model zones are shown in Table 7.

Assessing Groundwater Inflow Chemistry: To calculate groundwater inflow chemistry for the pit lake model, Tetra Tech reported that they used averaged the water quality results taken from the eight pit monitor wells (Section 4.1, Tetra Tech, 2010i). The average input values are listed in Table 4.01 (Tetra Tech, 2010i). The maximum number of samples per constituent was 24; 20 samples were analyzed for radiochemicals. No details are provided in Section 4.1 on the methodology of the calculation such as the treatment of non-detect values, treatment of values falling between the minimum detection limit and practical quantification limit, treatment of radium 226+228 results (these have a mean value with standard deviation specified), the treatment of apparent outliers, or if any model zone-specific weighting was used. All constituents were evidently used in the calculation with equal weighting.

SRK Cross Check on Calculated Average Groundwater Inflow Values

SRK randomly selected 18 out of 31 parameters listed in Table 4.01 of Tetra Tech’s report *Geochemical Pit Lake Predictive Model–Revision 1* (2010i) to verify that the average values used by Tetra Tech were correctly calculated based on the groundwater analyses for the pit monitoring well as reported by M&A (2009a) in Tables 6, 7, and 8. SRK used all values including apparent outliers; non-detect values were used as-is (e.g. 0.01 mg/L was used for a non-detect value of <0.01 mg/L instead of one-half the value or other nil value). Of the 18 average values randomly checked, the percent difference in calculation for eight⁴ out of 17 constituents was less than 5%; a 5-10% difference was noted in three constituents⁵. Seven constituents⁶ had a percent difference in calculation ranging from 13.4% to 198%; this latter category primarily included constituents with multiple non-detect values for constituents with very low concentrations (see Table 8).

Some additional clarification from Tetra Tech would be helpful to document and verify their procedures to calculate an average input value. It appears that their average inflow concentrations (where different from

⁴ Ca, Cu, Mg, NO₃/NO₂ as N, Ra226+Ra228, Se, Na, U

⁵ As, F, SO₄

⁶ Ba, Fe, Pb, Mn, Mo, K, Zn

SRK's calculation by more than 5%) are higher than those calculated by SRK using all analyses in an averaged (non-weighted) calculation. The concentrations appear to be higher (more conservative with respect to potential elevated constituents) than calculated by straight average. Another method was likely used, but method details were not provided.

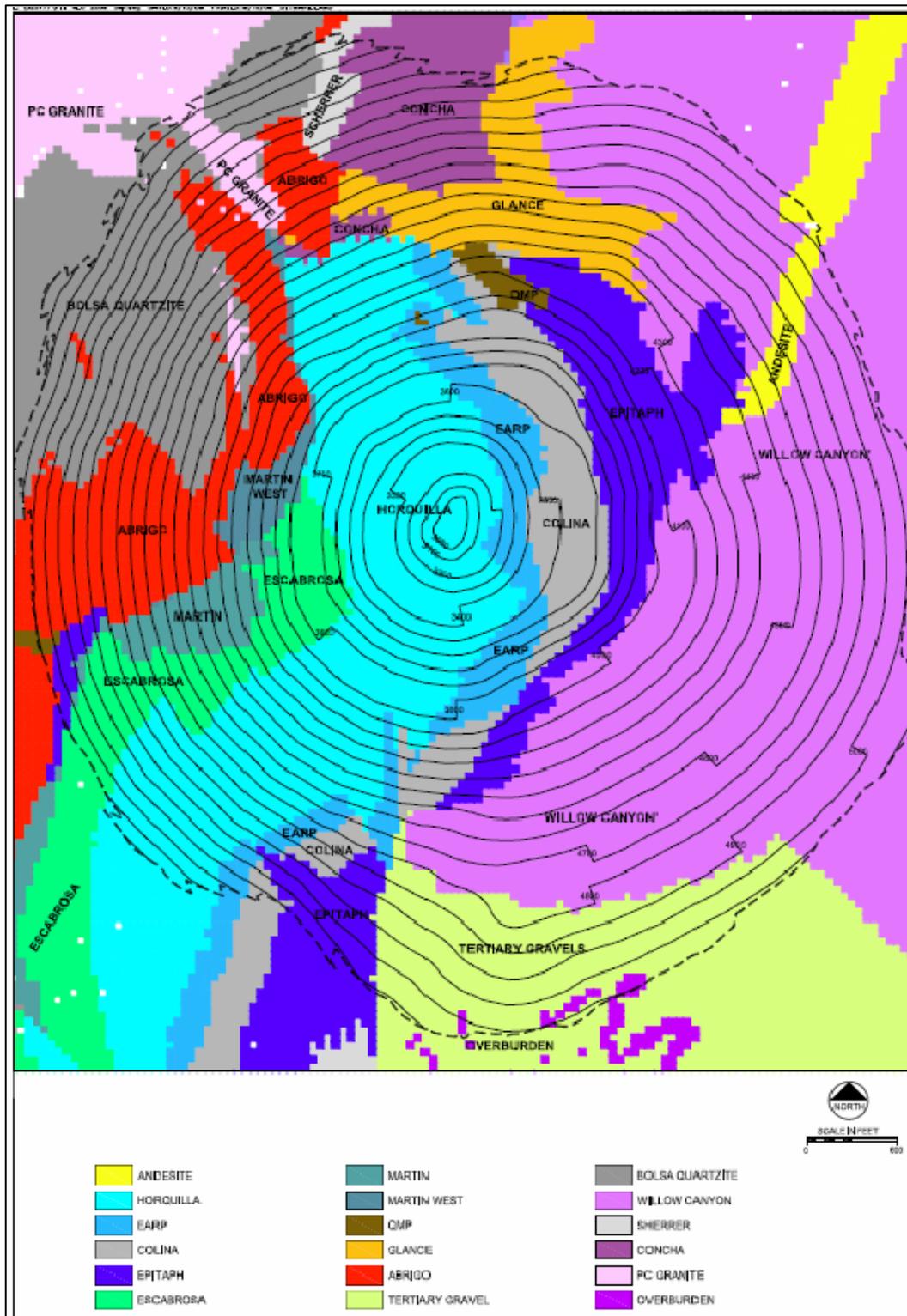


Figure 4 Proportions of exposed rock in ultimate pit wall (Tetra Tech, 2010i, Table 4.01)

Table 5 Summary of pit wall monitor wells

Well ID	Screen Interval (ft.)	Lithological Unit	Lithology ft. (%)	TT Hydrogeo Model Zone	Measured DTW (ft. bgs)
PC-1	200-1,020 ft.	Willow Canyon Fm. 40-1,020 ft.	820 ft. (100%)	Ksd	123.60 ft.
PC-2	200-1,503 ft.	Willow Canyon Fm 200-820 ft. Epitaph Fm. 820-1,503 ft.	620 ft. (48%) 683 ft. (52%)	Ksd Pz	+17 ft.
PC-3	200-1,360 ft.	Gila Conglomerate 200-410 ft. Willow Canyon 410-1,360 ft.	210 ft. (18%) 950 ft. (82%)	Qtg2 Ksd	146.81
PC-4	200-1,500 ft.	Gila Conglomerate 200-590 ft. Willow Canyon 590-1,500 ft.	390 ft. (30%) 910 ft. (70%)	Qtg2 Ksd	120.66 ft.
PC-5	109-901 ft. 946-1,477 ft. 1,530-2,001 ft.	Willow Canyon Fm 109-925 ft. Glance Conglomerate 925-1,060 ft. Scherrer Fm. 1,060-1,490 ft. Epitaph Fm w/ intermingled Colima Ls 1,490-2,001 ft.	816 ft. (43%) 135 ft. (7%) 430 ft. (23%) 511 ft. (27%)	Ksd Ksd Pz Pz	+1 ft.
PC-6	220-485 ft. 525-969 ft. 1,013-1,464 ft. 1,509-2,000 ft.	Concha Lm. 220-500 ft. Epitaph Fm. 500-2,000 ft.	280 ft. (16%) 1,500 ft. (84%)	Pz Pz	210 ft.
PC-7	109-569 ft. 620-878 ft. 920-1,402 ft. 1,447-1,988 ft.	Willow Canyon Fm. 109-240 ft. Glance Conglomerate 240-500 ft. Epitaph Fm. 500-620 ft. Horquilla Ls. 620-1,988 ft.	131 ft. (7%) 260 ft. (14%) 120 ft. (6%) 1,368 ft. (73%)	Ksd Ksd Pz Pz	290 ft.
PC-8	197-794 ft. 860-1,890 ft. 1,962-2,205 ft.	Escabrosa Ls/Martin Fm. 197-830 ft. Abrigo Fm 830-1,940 ft. Bolsa Quartzite 1,940-2,150 ft. Granodiorite 2,150-2,205 ft.	633 ft. (32%) 1,110 ft. (55%) 210 ft. (10%) 55 ft. (3%)	Pz Pz Pz PCb	194 ft.

Source: M&A (2007; 2009a) for geologic formation screened in wells PC-1 through PC-8.

Table 6 Summary of formations projected in exposed areas of the pit wall (sorted by majority percentages) vs. screened by pit monitor wells.

Rock Formation	%Exposed Area in Pit Wall	%Rock Screened in Wells	Footage of Rock Type in Each Well								Total Rock Type Footage in Wells
			PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8	
Willow Canyon Fm, Arkose	29.3	35.0	820	620	950	910	816		131		4,247
Horquilla Limestone	16.0	11.3							1,368		1,368
Bolsa Quartzite	8.1	1.7								210	210
Abrigo Formation	7.5	9.1								1,110	1,110
Epitaph Formation	7.4	19.0		683				1500	120		2,303
Tertiary Gravel (Gila Cgl)	6.4	4.9			210	390					600
Colina Limestone	4.8	4.2					511				511
Earp Formation	4.0	0.0									0
Glance Conglomerate	3.8	3.3					135		260		395
Escabrosa Limestone	3.8	5.2								633	633
Concha	2.9	2.3						280			280
Martin Formation	2.5	0.0									0
Precambrian Granodiorite	1.0	0.5								55	55
Willow Canyon Fm Andesite	0.9	0.0									0
Scherrer Formation	0.6	3.5					430				430
Quartz Monzonite Porphyry	0.5	0.0									0
Overburden	0.2	0.0									0
Total Footage											12,142

Source: Reports by Tetra Tech (2010i), Table B1 for percentages of geologic formations exposed in the pit wall and Montgomery & Associates (2007; 2009a) for geologic formation screened in wells PC-1 through PC-8.

Table 7 Number of samples taken per well per model zone

Model Zone Within Pit	Final Horiz K	Final Vert K	Number of Samples taken from Pit Monitor Well							
	(ft/day)	(ft/day)	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8
Qtg2	1.31×10^{-2}	6.56×10^{-4}			--	1				
Ksd	6.56×10^{-2}	4.92×10^{-3}	1	--	--		--			
Pz_Pit	X 3.28×10^{-4} Y 3.28×10^{-3}	3.28×10^{-3}		--			1	4	3	3
PCb	2.38×10^{-3}	2.38×10^{-3}								--
Mixed Qtg/Ksd					1	1				
Mixed Ksd/Pz				3			5		1	

Source: Sample numbers are from Table 6 of M&A (2009a). Final calibrated K values are from Table 6-3 of Tetra Tech (2010j). Mixed rock formations indicate the sample was pumped from entire well, not taken from an isolated interval representing a single formation. Notes: Shading means that the zone is hydrogeologic model zone is not present in the particular well.

-- = formation in a sample represents two model zones owing to long screen length intercepting more than one formation.

Table 8 Calculation comparison for selected constituents – Groundwater quality PC-1 through PC-8 and average used for Pit Lake inflow model

Montgomery & Associates, 2009a, Phase 2 Groundwater Investigation & Monitoring, Groundwater Quality from PC-1 through PC-8, Tables 6, 7, 8																			
Well/Sample ID	As (mg/L)	Ba (mg/L)	Ca (mg/L)	Cu	F- (mg/L)	Fe (mg/L)	Pb (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO3/NO2 as N	K (mg/L)	Ra226+228 (pCi/L)	Se (mg/L)	Na (mg/L)	SO4- (mg/ U (mg/L)	Zn (mg/L)		
PC-1	0.0028	0.015	82.2	0.01	0.8	0.02	0.0002	9.5	0.46	0.03	0.69	1.9	1.62	0.0018	10.7	30	0.0016	0.35	
PC-2	0.0154	0.01	87	0.01	1.2	0.02	0.0001	20.6	0.053	0.13	0.38	2.6	2.31	0.0044	20.3	170	0.004	0.39	
PC-2	0.0078	0.013	72.5	0.01	1.5	0.49	0.0001	20.3	0.014	0.19	0.16	2.2	1.40	0.0028	12	110	0.006	0.01	
PC-2	0.0018	0.013	68.2	0.01	2	0.21	0.0003	19.1	0.084	0.16	0.02	2.2	0.87	0.0011	12.1	109	0.0095	3.34	
PC-3	0.0038	0.058	192	0.01	1.2	0.43	0.0001	33.4	0.671	0.13	0.09	5	1.18	0.0006	56.3	610	0.0159	0.56	
PC-4	0.0023	0.183	59.6	0.01	0.4	0.96	0.0002	17.9	0.565	0.03	0.63	4.1	3.69	0.0006	32.9	50	0.0064	0.61	
PC-5	0.004	0.01	72	0.01	0.7	0.15	0.0001	10.7	0.007	0.07	0.48	1.6	1.22	0.0014	6.4	42.2	0.0016	0.01	
PC-5-922-UP	0.0032	0.01	72.3	0.01	0.8	0.33	0.0001	10.8	0.009	0.07	0.55	1.6	1.51	0.0017	6.5	34.2	0.0013	0.01	
PC-5-1516-LP	0.0017	0.03	162	0.01	1	0.21	0.0001	15.9	0.114	0.63	0.03	3.8	1.79	0.0019	186	824	0.0092	0.01	
PC-5	0.0063	0.006	71.9	0.02	0.9	0.02	0.0012	10.5	0.005	0.07	0.54	1.8	NA	0.0014	6.3	37.9	0.0013	0.01	
PC-5	0.0051	0.008	75.5	0.02	0.8	0.02	0.0009	11.1	0.007	0.05	0.55	1.6	NA	0.0018	7.6	37	0.0012	0.01	
PC-5	0.0062	0.003	72.7	0.04	0.8	0.02	0.0012	10.5	0.005	0.08	0.57	1.6	NA	0.0011	6.5	38.1	0.0013	0.01	
PC-5	0.0054	0.014	77.9	0.02	0.8	0.02	0.0006	11.3	0.006	0.07	0.55	1.8	NA	0.0017	7.6	38.5	0.0014	0.01	
PC-6	0.0014	0.028	204	0.01	0.7	0.84	0.0004	21.9	0.101	0.07	0.65	3.5	0.87	0.0018	30.5	441	0.0049	0.01	
PC-6-522-UP	0.0009	0.028	194	0.01	0.7	0.5	0.0003	21.1	0.099	0.07	0.65	3.1	1.68	0.0017	30	425	0.0046	0.01	
PC-6-1002-MP	0.0008	0.026	209	0.02	1	1.12	0.0001	22.4	0.116	0.07	0.61	3.2	1.61	0.0013	33.5	444	0.0056	0.01	
PC-6-1502-LP	0.0008	0.026	203	0.02	0.7	1.37	0.0001	20.7	0.172	0.07	0.67	3.4	1.71	0.0015	34	457	0.0038	0.03	
PC-7	0.0011	0.019	184	0.01	1	0.52	0.0001	33	0.109	0.07	0.37	3.2	0.44	0.0041	24.3	447	0.0032	0.01	
PC-7 602-UP	0.0014	0.021	195	0.02	0.9	0.4	0.0001	32.8	0.095	0.09	0.28	3.6	1.21	0.0034	22	513	0.0027	0.01	
PC-7 902-MP	0.0014	0.017	245	0.01	0.9	0.51	0.0001	42.5	0.094	0.11	0.21	4	0.63	0.0055	23.2	710	0.0031	0.02	
PC-7 1422-LP	0.0011	0.012	359	0.01	0.9	1.2	0.0007	61.5	0.006	0.09	0.12	4.8	1.08	0.0039	28.5	1090	0.0031	0.05	
PC-8	0.0022	0.024	61.8	0.01	0.6	0.06	0.0001	11.5	0.019	0.01	1.79	2.1	2.76	0.0019	8.9	7	0.0029	0.07	
PC-8 863-UP	0.0018	0.019	60.4	0.01	0.6	0.11	0.0001	11.4	0.019	0.01	0.37	2.2	2.21	0.0018	9	7.1	0.003	0.07	
PC-8 1930-LP	0.0023	0.02	59.4	0.01	0.6	0.03	0.0001	11.3	0.005	0.01	0.34	2.2	1.33	0.0017	7.9	3.7	0.003	0.16	
TT average	0.0037	0.042	131.0	0.01	0.85	0.554	0.00092	20.5	0.174	0.121	0.49	3.17	1.58	0.00212	26	300	0.00419	0.694	
SRK average	0.0034	0.026	130.9	0.01	0.90	0.398	0.00031	20.5	0.118	0.10	0.47	2.80	1.56	0.00212	26	278	0.00419	0.241	
Diff	0.0003	0.016	0.1	0.00	-0.05	0.156	0.00061	0.01	0.056	0.022	0.02	0.37	0.02	0.00000	0.0417	22	0.0000	0.4532	
%Diff	9.63	64.44	0.1	0.00	-5.12	39.08	198.38	0.06	47.302	22.02	4.07	13.38	1.54	-0.04	0.16	7.85	-0.04	188.17	
Below Dection Limit, Actual value is less than this amount																			
Between MDL and PQL																			
Similar concentration detected in blank																			
Looks like an outlier but was sampled in mineralized skarn																			

5.2.1 Response to Question 5b(i)

Was the Tetra Tech approach of using average chemistry results reasonable?

The approach is not ideal but provides a broad estimate given the number of water quality samples, well screen construction (screens spanning more than one model zone in three wells), location of the samples with respect to the proposed ultimate pit wall, and the spatial geometry of the steeply dipping formations (and resulting model zones).

The well locations and screening of the wells at various depths was designed to enable M&A to establish the aquifer properties and collect water quality samples that reasonably represent the spatial and vertical variability expected in the area surrounding the proposed open pit. The proportion of rock types in the screened intervals (Table 6) generally matches the proportion of rock types and hydrogeologic model zones expected in the ultimate pit wall (Figure 4). Most of the rock types represented with a higher percentage representation in the pit walls also have a higher percentage representation in the screened portion of the wells adjacent to the ultimate pit wall.

The water quality does show some variability by well location and rock type but the statistical significance is difficult to assess based on the 24 samples and the fact that three wells are screened in more than one formation. One might be tempted to discard at least one sample⁷ collected from PC-2 based on its apparent outlier status relative to other samples collected from the same formation in the same well. Discarding an apparent outlier is not justified, however, if the value can be linked to a specific geological or mineralogical observation noted in the well cuttings or based on a documented mineralogical or chemical characteristic about a particular formation. According to the geology log for PC-2, the screened interval intercepted a mineralized skarn horizon in the Epitaph Formation with chalcopyrite noted in several intervals. Sphalerite (ZnS) and possibly arsenopyrite or tennantite were also likely present (“dark metallic mineral” noted in several log intervals) causing the elevated zinc concentration measured in the single sample and elevated arsenic measured in another. Discarding these particular samples would have not have been a valid approach and would have inaccurately depressed the average value used for inflow chemistry expected in the immediate pit area.

Assigning a representative groundwater inflow chemistry to hydrogeologic zones in a pit lake predictive model could be done in a number of ways including using an arithmetic average of a number of blended samples or by using a weighted average that assigns greater or lesser influence to the water quality from a particular geologic formation or model zone based on the aquifer properties of that zone, lake refill stage, and the hydraulic head adjacent to and beneath the pit. The latter approach would likely work best if there were numerous samples taken per formation allowing one to generate a high-confidence mean value (after discarding apparent outliers if needed). Using chemistry based on only one or two samples from a specific formation and then heavily weighting the influence of that particular formation may generate a non-representative inflow chemistry by giving too much confidence to the limited number of samples.

Tetra Tech’s regional numerical groundwater flow model and pit lake predictive model did take into account aquifer properties of the model zones including the final calibrated horizontal and vertical K values as summarized in Table 7. The horizontal conductivity of Qtg2 and Ksd are similar to each other but are 1-2 orders of magnitude greater than that modeled for Pz_Pit and PCb. The vertical conductivity values for Ksd, Pz_Pit, and PCb are very similar to each other but are an order of magnitude greater than that seen in Qtg2. Tetra Tech may have been able to assign chemistry to each model zone based on a weighting factor derived from the differences in horizontal and vertical conductivity properties or lake fill stage, but once again, using a limited number of samples taken over long screen intervals would likely generate less accurate water quality estimates than using a more conservative estimate based on an average concentration from 24 samples – some of which were elevated relative to the bulk of samples.

Ultimately, the method chosen should reflect the site-specific geometry of the geologic formations or resulting consolidated model zones. Based on the configuration of the steeply geologic formations at Rosemont, two model zones (Pz_Pit, and Ksd) will dominate the rock types exposed in the ultimate pit wall and will influence water chemistry throughout the duration of the pit lake refilling period. Water inflow attributed to Pz_Pit (exposed over roughly 65% of pit wall) will occur throughout the entire water level recovery period because of

⁷ The 3.34 mg/L Zn measured in PC-2 (July 25, 2008) is highly anomalous with respect to other PC-2 samples and all other samples but reflects base metal mineralization noted in a skarn interval.

the steeply dipping nature of the zone intersecting the pit wall from pit rim to pit floor. Ksd is not present in the deepest, most constricted portion of the ultimate pit, but is present in roughly 30% of the pit wall and will contribute inflow during a significant portion of the recovery period. One model zone (Pcb) will likely be only very minor contributor as formation exposure (1%) is limited to the upper benches on the northwest portion of the pit and a portion is above the water table.

In consideration of the steeply dipping model zones, the number of water quality samples, the relative proportion of samples from formations in the monitor wells that match the proportion of rock formations in the pit walls, generally similar hydraulic properties of the formations, and the use of some anomalously high values relative to the majority of analyses for a particular parameter, SRK believes that using the average concentrations from all the samples collected will generate a slightly higher average inflow concentration than would be produced by a weighted approach. With respect to trace elements such as arsenic and a number of cations/anions this will produce a more conservative estimate of the potential inflow groundwater quality because many of the analyses show concentrations that are below detection.

5.2.2 Response to 5b(ii)

If not, how significantly would accounting for geochemistry by formation affect the results of the pit lake model?

Table 6 in M&A (2009a) shows sulfate concentrations in the water quality samples range from 7 mg/L to 1,090 mg/L. Values less than 400 mg/L were reported in basin-fill and older sedimentary formations (Qtg, Ksd) while values greater than 400 mg/L were from water quality samples taken in the Pz_Pit zone (mineralized, oxide and sulfide skarn samples). The averaging method can potentially downplay the concentration used in a model for formations with relatively degraded water quality. Conversely, formations with relative good water quality can be given greater weight than hydrologic parameters would dictate. Assessing the method to assign water quality by formation/model zone should take into account the site-specific geometry and aquifer properties of the model zones otherwise a potential fatal flaw can be made in model setup.

The geochemical composition of a particular formation could be insignificant in terms of pit lake contribution if hydraulic conductivity is miniscule and the formation has little probability of contributing any significant inflow. To provide the highest level of validity, the inflow should be staged in temporal increments to account for the specific formations that discharge water to the pit at specific stages of pit inflow. Except for unusual circumstances, a filling pit lake will be expected to respond to the rebounding cone of depression and fill due to inflow from the bottom of the pit upward, while at the same time experiencing some contribution from wallrock/bench runoff due to periodic precipitation. Groundwater seepage through pit wallrocks above the water table will likely be negligible.

In the case of the Rosemont pit lake predictive model, the water quality from the two major model zones (Ksd, Pz_Pit) will be contributed near equally throughout the pit refilling stage owing to the steeply dipping nature of the geologic formations and broadly similar aquifer properties of the model zones. Groundwater inflow from the other two model zones (PCb and Qtb2) will have very low influence on the pit lake chemistry owing to low exposure in the pit walls (~7.4% total). The averaging method using water quality samples primarily sampled from the Ksd and Pz_Pit zones is therefore not an unreasonable approach.

5.3 Question 5c and Responses

Dr. Myers indicates that groundwater inflow chemistry would change as it flows through the altered near-pit zone, due to increased fracture density/surface area and oxygen availability to sulfide mineralization in the wall rock.

Concerns about inflow chemistry changing as groundwater flows from distal areas into the intensely fractured skin of the open pit were addressed in Tetra Tech's revised 2010 predictive Pit Lake model (Tetra Tech, 2010i; 2010k). SRK previously reviewed the geological characterization of the future pit wall, modeling assumptions used in the original and revised Pit Lake models, analyses used in the model inputs, and host/ore mineral species assumed to be present in the pit wall, mineral species assumed to be present in the Pit Lake as interaction occurs with the pit walls (SRK, 2010c; 2011b; 2011c). Additional questions were posed about the chemical loading attributed to increased fracture density in the outer bench faces, scaling the SPLP results to reflect field conditions, the effect of fines in blast residue, mechanisms for attenuation in the pit walls of either acidity or metals, and potential geochemical reactions between the refilling lake and the pit walls. Tetra Tech's technical memorandum (2010k) succinctly summarizes the responses to SRK questions and changes made in

Revision 1 to the predictive model. The questions were previously answered to SRK's satisfaction in Tetra Tech's response memoranda and in oral discussion with Tetra Tech, SRK, and CNF personnel (conference call on March 10, 2011). These questions, assumptions, and responses are summarized below.

Summary of Tetra Tech's Pit Lake Model Assumptions Related to Pit Wall Conditions

Groundwater inflow was a significant component of the Pit Lake water balance in the February 2010 predictive model and the updated November 2010 model (Tetra Tech, 2010i). The original Pit Lake model used the numerical groundwater model prepared by Montgomery & Associates (2009b). The inflow volume in the revised dynamic systems model was based on the results of the 3-D numerical flow model completed by Tetra Tech (Tetra Tech, 2010j).

A brief summary is provided below as directly excerpted from Tetra Tech's memo (2010k) discussing their treatment of various issues related to inflow chemistry through the pit wall and blasted zone in the revised Pit Lake model. These responses were provided to answer questions posed previously by SRK, some of which are similar to those posed by Dr. Myers.

Clarification on minerals present with respect to calculation of acid potential and use of Sobek Neutralization Potential method

Minerals such as pyrite and gypsum were confirmed to be present and siderite was confirmed to be absent based on site observations and published reports. Gypsum has slower dissolution rates than acid-producing jarosite. Siderite, a ferrous carbonate, does not contribute to acid neutralization owing to the release of ferrous iron, which commonly oxidizes and reacts with water to create acidity. Use of Sobek NP calculation method is appropriate.

Effect of blasting on release of mineral components

ABA, MWMP, SPLP, and HCT testing is all done on finely ground rock potentially resembling the finely ground blast fines. In the revised model, the HCT data from the initial week were used to address the contribution of chemical mass from the pit wall benches owing to fines and accumulated water soluble salts that are rinsed from the pit walls by runoff, groundwater inflow, and the recovering Pit Lake. Concentrations in HCT leachates from the initial week are typically elevated relative to concentrations measured in the following weeks.

Configuration of broken rock in the pit walls

The revised model incorporated the presence of a damaged rock zone. The zone of enhanced fracturing was estimated as 6 ft in depth, with an average porosity of 9% (varied between 2% and 15%).

Role of oxidation, dissolution, and water-rock interaction leading to leaching of potential contaminants

SPLP test results were used as they were consistent with long-term HCT results (or sometimes more concentrated) (Tetra Tech, 2011). For the initial rinsing, the initial results from the HCT results were used to simulate wallrock that has considerable time to weather without periodic rinsing. SPLP results were used where HCT results were unavailable. SPLP results, however, were increased 3-fold for major constituents and 2-fold for minor/trace constituents as documented in *Rosemont SPLP Usage for Pit Wall Runoff* (Tetra Tech, 2010h).

Attenuation of acidity or metal loading

As a conservative measure, the revised model incorporated no provision for attenuation of acidity or metals by the pit walls.

Effect of pit wall submergence

The revised model included a term for chemical loading owing to submergence of pit walls. It included a damaged rock zone 6-ft thick with a fracture void space of 9-10%.

Reactions between Pit Lake and pit walls

Tetra Tech did not make any adjustment to the model based the reasoning that the water to rock ratio is very large (~500:1) and the chemical mass derived from such a large ratio is low relative to mass derived from the inflowing groundwater and flushing of pit walls and damaged rock zone.

5.3.1 Response to Question 5c(i)

Is there a need for an approach to account for this source of chemical loading? If not why not?

In SRK's opinion, this source of chemical loading was adequately addressed in Tetra Tech's 2010 revised Pit Lake model (2010i) and response memo (2010k) as described above in Section 5.3. It is also SRK's opinion that, after inundation and submergence in the Pit Lake, the enhanced reactivity of this zone will not be a factor.

Exposed pit wallrock and benches represent a unique geochemical environment with characteristics such as increased fracture density, enhanced availability of oxygen, and secondary minerals that could enhance chemical loading to the pit runoff component. This environment must be accounted for in the predictive model. Fracture density adjacent to blast zones can exceed that of the undisturbed rock by more than an order of magnitude and can extend to depths up to several feet into the bench face and presents more surfaces for reactions and formation of secondary minerals. Tetra Tech addressed the unique aspects of this zone through changes in porosity, varying input chemistries (sensitivity analyses), and arbitrary doubling and tripling concentrations of leachate analyses used as the basis for the starting solutions.

5.3.2 Response to 5c(ii)

If so, how significantly would that parameter affect the results of the pit lake model?

The altered near-pit zone has the potential to possess a rock-water ratio that is more than an order of magnitude greater than undisturbed rock. Combined with increased oxygen availability that can both enhance oxidation and promote formation of secondary salts, this near-pit environment presents opportunities for increases in chemical loading that can only be determined through experimentation. The dominant chemistry impacting the Pit Lake water quality is the chemistry of inflowing groundwater.

5.4 Question 5d and Responses

Dr. Myers indicates that as drawdown occurs during mine life, previously saturated pore spaces will fill with air, increasing the potential for oxidation. After mine life, these pore spaces re-fill with water causing oxidation products to be leached to the forming pit lake, with a "first flush" occurring during initial pit lake formation that will greatly affect water chemistry.

This comment refers to the dewatered rock in the pit cone of depression. The groundwater inflow component used in the Pit Lake predictive model consisted of water quality analyses from the adjacent pit monitoring wells, but the chemistry remobilized from refilling pore spaces was not specifically addressed by Tetra Tech. First flush chemistry was simulated in Tetra Tech's revised model by using analyses from the initial week of HCT testing and from SPLP analyses where HCT results were unavailable. The SPLP results for major cations/anions were increased 2-fold relative to laboratory results and increased 3-fold for minor/trace metals (Tetra Tech, 2010i; 2010k). The increase was applied to the blast face area only, not applied to the specific potential sources of loading.

5.4.1 Response to Question 5d(i)

Is there a need for an approach to account for this source of chemical loading? If not, why not?

The concentrations of metals in the secondary mineral salts precipitated in previously saturated (then dry) pore spaces are expected to provide a contribution to the Pit Lake chemistry. Failure to address this source represents a potential shortcoming in the model predictions, due to the likely formation of secondary metal sulfates, silicates, or oxides in the previously saturated pore spaces. The formation, mobility, and solubility of these types of secondary minerals is well documented, having been "noted since early antiquity" (Jambor and others, 2000), and it is well established that these minerals can have a significant impact on water quality (Dagenhart, 1980; Olyphant and others, 1991; Bayless and Olyphant, 1993; Keith and Runnells, 1998, Keith and others, 1999).

Practically, however, it is nearly impossible to quantify this component reliably because there is a wide range in possible conditions that could be considered and there are no monitoring data that can inform the modeling. Precipitation of gypsum, caliche, and clay minerals will also occur during the desaturation phase plugging up the pore spaces and thereby reducing the generation of additional mineral salts.

To address this uncertainty, batch or column leach testing can be formed once there are weathered pit wall materials to evaluate the potential loading from this component, but with a specified set of moisture and other parameters geared toward simulating that environment. Ultimately this uncertainty can be addressed by

monitoring collection points within the Pit Lake; the Pit Lake is predicted to be a terminal sink with inward hydraulic gradient and can be and treated if needed.

5.4.2 Response to 5d(ii)

If so, how significantly would that parameter affect the results of the pit lake model?

In the opinion of SRK, omission of this source of loading could have an effect on the overall chemical loading of the system, most notably owing to flushing in the early stages of pit infilling as the drawdown in the surrounding groundwater recovers. As mentioned in Section 5.4.1, however, it is nearly impossible to quantify this component reliably especially in a pre-mine condition. Precipitation of clay and gypsum will also occur in the desaturated pores thereby reducing the available space to form additional mineral salts. There is no meaningful monitoring data or test work that can inform the modeling at this time. The outcome of any testwork to assess the importance of this component may not be valid and is not likely to change the outcome of overall predictive model.

5.5 Question 5e and Responses

Dr. Myers indicates that the laboratory tests used to support the pit lake model were on unweathered rock samples, whereas weathering increases surface area and potential reaction rates.

Test work was primarily performed on drill core and coarse core rejects rather than on weathered rock outcrops exposed in trenches, underground drifts, or a pre-existing open pit. According to the tabulation of samples IDs in the various reports, however, Tetra Tech did use historic drill core from predecessor companies (estimated by SRK to be 20-30 years old) in addition to recent core materials drilled by Augusta Resource. The historic core was likely not appreciably weathered in comparison with rock left unprotected in the elements, but is weathered relative to the fresh, unsplit drill core.

General Comments

Weathering does increase surface area by opening and enlarging small joints and cracks in the rock, which can potentially affect reaction rates in the mineral species located on the jointed, broken surfaces in contact with the atmosphere. The jointed surface may contain minerals constituting the native host rock only (i.e. limestone, siltstone) or contain a mix of host rock plus disseminated blebs, films, or veinlets of quartz, calcite, gypsum/anhydrite, hypogene minerals (iron/copper/molybdenum sulfides), supergene minerals (iron/copper oxides, silicates, carbonates), and/or clay minerals.

Outcrops in Arizona typically show a reddish-colored near-surface rind indicating the surface rocks are weathered in the top few feet and that the contained trace minerals such as biotite, amphibole, specular hematite, or pyrite have been oxidized. Oxidation related to hydrothermal alteration and supergene enrichment of copper deposits is a more pervasive and intensive process owing to elevated percentages of associated gangue pyrite and other sulfide minerals. At many deposits, the effects related to supergene oxidation typically extend tens to hundreds of feet below the top of bedrock in an irregular blanket that broadly mimics the geometry of the top of bedrock. The Oxide zone can be offset along faults to deeper levels or can extend along a limited width deep into the Sulfide zone along the hangingwall of a major fault. The Oxide zone at Rosemont is deeply buried on the east side of the proposed pit but is typically less than 50 to 200 feet in thickness. Development of the proposed pit will indeed expose a portion of the previously buried sulfide materials to the atmosphere and oxidize a percentage of this material as exposed in the ultimate pit walls.

5.5.1 Response to Question 5e(i)

Was the Tetra Tech approach of using unweathered sample results reasonable?

Tetra Tech provided a demonstration that the sample selection method was reasonable and follows industry standard methods for a “greenfields” site that lacks a surface exposure of a weathering related to the development of an historic open pit. SRK acknowledges that sampling of weathered exposures comparable to the eventual pit walls would have been preferred but such exposures are not present at the site. Split samples from recent core, recent coarse core rejects, and from historic core (~20-30 years old) located within 50 feet of the ultimate pit wall were used in the analysis. Ore and waste grade samples representative of vertical and spatial differences throughout the deposit are not available for testing other than through the use of drill core.

5.5.2 Response to 5e(ii)

If not, how significantly would accounting for weathering affect the results of the pit lake model?

The effects of weathering and blasting damage were incorporated into the revised Pit Lake model (Tetra Tech, 2010i; 2010k).

In their predictive Pit Lake model, Tetra Tech addressed the chemical mass loading of minerals such as soluble salts located on weathered pit surfaces by increasing the porosity in a thickness assumed to be blast-impacted adjacent to mined areas. Short-term leach tests and HCT results were used to assess the potential for release of various constituents from different rock types and to develop source terms for chemical loading to the pit lake from the pit wall runoff. With respect to the initial flushing of blast-impacted pit walls, averaged HCT data were used to simulate the chemical source term for Willow Canyon andesite and arkose, and for the Bolsa and Earp formations. Tetra Tech used SPLP test data to represent formations lacking HCT results. In a conservative approach, however, the SPLP concentrations of major cations and anions were tripled and the concentrations for trace metals were doubled relative to actual average results (Tetra Tech, 2010i). Low, average, and elevated chemical loading simulations were performed during sensitivity analyses (Tetra Tech, 2010i).

5.6 Question 5f and Responses

Dr. Myers raises concerns about the potential for stratification of the lake to occur, which were largely dismissed by Tetra Tech, and indicates that stratification should be included in the model.

Tetra Tech states that stratification of the pit lake will be unlikely based on information presented in Jewell (2009) suggesting that lakes in arid regions are unlikely to stratify due to the limited availability of freshwater that might induce a density gradient in the pit. The lake was modeled as an oxidized system, allowing the oxidation of iron, the formation of hydrous ferric oxides, and the adsorption of arsenic and other chemical species (Tetra Tech, 2010k). Tetra Tech also states that if stratification does occur, the near surface waters will remain oxidizing and it is the near-surface waters that are the most important with respect to ecological risks. Tetra Tech also states that the lake will be perpetually terminal (permanent inward hydraulic gradient) with no discharge, stating that “*water quality at depth is less important given the expected terminal nature of the pit lake.*” Therefore, no consideration was given to possible groundwater effects due to pit lake stratification and seepage.

5.6.1 Response to Question 5f(i)

Was the Tetra Tech dismissal of the possibility of stratification reasonable? Why or why not?

In SRK’s opinion, some stratification may occur, even in an arid climate. Tetra Tech relies on a conclusion in Jewell (2009) that lakes in arid regions are unlikely to stratify. However, that same publication concludes that determination of the key variables that will control stratification, by way of detailed water balance studies, is “not straightforward,” implying the existence of substantial uncertainty in such determinations. Tetra Tech’s assumption that the Pit Lake will be forever terminal with no potential for discharge is based on water balance studies and groundwater models that incorporate those uncertainties.

As an example of the expected chemical insignificance of stratification, Tetra Tech illustrates an array of modeling simulations that predict a range of values for arsenic. It is SRK’s opinion that this may be an oversimplification because of the potentially complex geochemical environment that could ensue in the pit lake due to stratification. Future calibration predictions should include sensitivity analyses on lake stratification incorporating a range of redox conditions to assess reductive dissolution, desorption, and other potentialities, in the event that predictions of zero discharge prove inaccurate. It is unlikely the pre-mine geochemical modeling results would change significantly as a result of incorporating impacts related to stratification.

5.6.2 Response to 5f(ii)

If not, how significantly would accounting for stratification affect the results of the pit lake model?

Stratification, whether seasonal or permanent, introduces additional complexity to the pit lake chemical dynamics. A stratified lake with oxidizing conditions near surface and reducing conditions at depth calls into play a broader range of factors such as chemical reactions, speciation, phase stabilities, etc., and greater ranges in the solubility and mobility of critical elements and phases. There are various concerns with stratification, one of the greatest being that under oxidizing conditions processes such as sorption, precipitation, or co-precipitation can store metals in solid phases, but if the redox conditions turn more reducing the solids may

destabilize, causing rapid release of the stored metals at potentially greater concentrations than existed in the inflowing groundwater.

With that caveat, it is unlikely that pit lake stratification would significantly impact the overall modeling results or predicted results. For reference purposes only, Table 9 presents the predicted water quality of the Pit Lake geochemical model under four scenarios in comparison to various reference water quality standards. The standards chosen include:

- Arizona Aquifer Water Quality Standards (relevant to groundwater);
- EPA National Primary Drinking Water Standards Maximum Contaminant Level (MCL) (relevant to drinking water); and
- EPA National Secondary Drinking Water Standards (relevant to drinking water).

Table 9 Pit Lake model results – Comparison of results under 4 scenarios to ambient groundwater and various reference water quality standards

Parameter (mg/L)	AWQS	National Primary Standard MCL	National Secondary Standard	Ambient Ground Water	Low Chemical Loading Scenario	Avg. Chemical Loading Scenario	Elevated Chemical Loading Scenario	Avg. Chemical Loading w. Bolsa HCT Data
Ca				131	89.9	99.8	107.7	100.7
Mg				20.5	22.7	25.7	30.1	25.6
Na				26	31.9	35.9	38.6	35.3
K				3.17	5.1	5.7	6.3	5.4
SO ₄			250	300	330.6	374.1	518.5	375.8
Cl			250	8.36	9.9	11.1	12.5	11.1
F	4	4	2.0	0.85	1.1	1.2	1.4	1.2
HCO ₃				187	37.3	36.2	37.0	36.0
Ag			0.10	NA	0.004	0.004	0.005	0.004
Al			0.05 to 0.2	<0.03	0.158	0.197	0.26	0.357
As	0.05	0.01		0.0037	0.004	0.005	0.000	0.003
Sb	0.006	0.006		<0.0004	0.003	0.003	0.003	0.003
Ba	2	2		0.042	0.000	0.000	0.009	0.000
Be	0.004	0.004		<0.0001	0.001	0.001	0.001	0.001
Cd	0.005	0.005		<0.0001	0.002	0.002	0.002	0.002
Cr	0.1	0.1		<0.01	0.004	0.005	0.005	0.005
Cu			1	<0.01	0.004	0.004	0.005	0.163
Fe			0.3	0.554	0.000	0.000	0.000	0.000
Pb	0.05	0.05		0.00092	0.004	0.015	0.017	0.015
Hg	0.002	0.002		<0.0002	0.002	0.001	0.000	0.000
Mn			0.05	0.174	0.229	0.255	0.243	0.254
Mo				0.121	0.137	0.150	0.192	0.154
Ni	0.1	0.1		<0.01	0.005	0.006	0.007	0.01
Se	0.05	0.05		0.00212	0.013	0.014	0.016	0.014
Tl	0.002	0.002		NA	0.005	0.006	0.007	0.006
U		0.03		0.00419	0.005	0.006	0.006	0.006
Zn			5	0.694	0.745	0.847	0.959	0.862
TDS			500	581	527	589	751	590
pH			6.5 to 8.5	7.6/8.2	8.1	8	8	8

Source: Table 7.01, Tetra Tech, 2010i, 200-year simulation results.

Notes per explanation in Tetra Tech, 2010i: All results in mg/L except for pH. Low, average, and elevated chemical loading scenarios were established using SPLP data for the pit wall rock based upon TDS to establish a sense of low, average, and elevated total chemical loading simulations.

Values reported as zero were not calculated to be present at concentrations reported to three decimal places.

Highlighted rows correspond to chemical constituents that were always below detection limits in laboratory leaching tests.

Net positive values are shown due to the use of one-half detection limit values.

Two regional numerical flow models have been prepared for the site, both of which indicate the Pit Lake will maintain inward hydraulic gradient and be a terminal sink in perpetuity. Water in the deeper (potentially reduced) portion of the lake is not anticipated to leave the pit bottom. The Pit Lake predictive model predicts no exceedances of AWQS. The future Pit Lake water is not planned to be used for drinking water. In comparison to drinking water standards, however, there are no expected exceedances of a primary MCL. In comparison with secondary drinking water standards, the future Pit Lake will have elevated sulfate, manganese, and TDS. The average ambient groundwater quality currently exceeds secondary drinking water standards for sulfate, iron, manganese, and TDS.

6 SRK Questions and Recommendations

SRK asked these additional questions and/or made these recommendations in this memo:

- Section 1, Page 2 Recalibration test work for future closure planning is recommended once actual tailings, waste rock, pit wall, and leach materials are available and baseline water quality has been established in the Points of Compliance wells. Additional humidity cells and controlled site leach tests should be run during operations to improve reliance of predictions for closure. These should be operated until steady state constituent release can be demonstrated that the results incorporated into updated geochemical prediction models. Geochemical modeling inputs should incorporate humidity cell and on site test work results on mined and weathered materials rather than SPLP/MWMP on drill core where ever possible.
- Section 1.5, Page 7 Is a graph available of the weighted annual NP, AP, NP/AP, and NNP and a running average NP, AP, NP/AP, and NNP of tailings material for the life-of-mine? The graph prepared for waste rock (see Figure 1, Geochemical Solutions, 2012) was helpful in establishing the range of NNP values seen on an annual basis during the life of mine and confirming the data suggesting the waste material is unlikely to produce acidic drainage. This type of graph for tailings materials life-of-mine would establish the variability including minimum NNP values expected for life of operation.
- Section 2.3, Page 10 Additional tailings test work is recommended in the future to represent the tailings material mined in the final production years (Years 8-21). These results would be used to replace the simulated leachate results used in the Dry Stack Tailings fate and transport model.
- Section 5.2, Page 18 Could Tetra Tech provide additional clarification on the actual water quality samples used and on the calculations used to generate the averaged groundwater chemistry input for the Pit Lake Predictive Model?
- SRK requests one clarification about the pH of the tailings seepage as shown in Table 6.9 of Tetra Tech's *Infiltration, Seepage, Fate and transport Modeling Report – Revision 1* (2010e). The fate and transport model for the Dry Stack Tailings predicts seepage will have a pH of 5.87. A quick survey of information available to SRK on tailings water quality at two sites in Arizona indicates pore water and seepage water concentrations at these facilities range from pH values of 5.1 to 9.5. The majority of the analyses were alkaline (7.3 to 8.5 pH). Both of these tailings facilities contain dominantly igneous and/or metamorphic host rocks rather than the carbonate rock types as present at Rosemont. Could Tetra Tech please confirm that the Dry Stack Tailings seepage, as predicted by the fate and transport model, is expected to be slightly acidic?

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