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## Technical Memorandum

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

### 1.0 Introduction

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

*Application Vol. 1, February 2009, states “Waste rock will be managed by monitoring potentially acid generating (PAG) and non-acid generating (NAG) materials and placing materials in designated areas.” It further states, “Because waste rock will be placed by segregating materials based on acid generating potential and testing results by source type and Waste Rock Storage Area will achieve greater engineering control potential compared to a typical unsegregated waste rock pile.”*

*Please provide the following:*

- a) *A detailed work plan for segregating potentially acid generating materials, including method of sampling, frequency of sampling, and what triggers or activates segregation and testing procedures;*

*For characterizing waste rock to determine if the material is non-acid generating. Rosemont is referred to the guidelines specified under CHARACTERIZATION OF TAILING, SPENT ORE AND WASTE ROCK contained in the Arizona Mining BADCT Guidance Manual.*

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

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

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

## **2.0 General Project Information**

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

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

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

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

**Table 1 Summary of Rosemont Waste Rock Types and Tonnages**

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

### 3.0 Summary of Material Classification

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

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

#### 3.1 Net Neutralization Potential (NNP)

The ANP and the AGP are expressed in units of tons of calcium carbonate (CaCO<sub>3</sub>) per kiloton of rock (tons CaCO<sub>3</sub>/kton rock). The difference between the ANP and AGP is defined as the net neutralization potential (NNP) (NNP = ANP-AGP).

In general, a sample would be acid-generating if it has a significant amount of sulfur or sulfide minerals or if its net neutralization potential (NNP) was less than zero (0); however, the risk of acid rock drainage (ARD) has been found to be highest for samples with NNP values less than -20 tons CaCO<sub>3</sub>/kton rock and is low when the NNP is greater than +20 tons CaCO<sub>3</sub>/kton rock (Price, 1997).

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

- If the NNP is less than -20 tons CaCO<sub>3</sub>/kton ( $NNP \leq -20$ ), then the sample is acid generating;
- If the NNP is between -20 and +20 ( $-20 < NNP < +20$ ), then the sample is potentially acid generating; and
- If the NNP is greater than +20 ( $NNP > +20$ ), then the sample is considered non-acid generating.

If NNP is less than -20 tons of CaCO<sub>3</sub>/kton, it can be considered acid generating. Between -20 and +20, the potential exists for the waste rock to be acid generating. The more positive the NNP, the lower is the risk for the waste rock to be acid generating. When the NNP is above +20, the material can generally be considered non-acid generating. Prediction of the acid generating potential when the NNP is between +20 and -20 tons of CaCO<sub>3</sub>/kton of sample is more difficult due to uncertainty in analysis and conversion factors.

### **3.2 Neutralization Potential Ratio**

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

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

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

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

### **3.3 Waste Rock Sampling**

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

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

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

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

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

### **4.0 Waste Rock Segregation Plan**

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

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



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

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

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

#### **4.1 Rock Inspection and Classification**

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

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

#### **4.2 Type Monitoring**

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



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

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

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

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

## REFERENCES

Arizona Department of Environmental Quality (ADEQ) (2004). *Arizona Mining Best Available Demonstrated Control Technology (BADCT) Guidance Manual*. Aquifer Protection Program. Publication TB-04-01.

Hem, J.D. (1985). *Study and Interpretation of the Chemical Characteristics of Natural Water*. USGS Water Supply Paper 2254. US Government. Print Office. Washington DC 263 pgs.

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Smith, A. and J.B. Barton Bridges, (1991). *Some Consideration in the Prediction and Control of Acid Mine Drainage Impact on Groundwater from Mining in North America*. Proceedings of the EPPIC Water Symposium. May 16-17, 1991, Johannesburg, South Africa.

Tetra Tech (2009). *Aquifer Protection Permit (APP) Application*. Prepared for Rosemont Copper Company. Report Dated February 2009.

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