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DRAFT TECHNICAL MEMORANDUM

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

Date: March 25, 2015

Subject: **Proposed Copper Flat open pit reclamation plan and inputs for evaluating water quality predictions**

John Shomaker & Associates, Inc. (JSAI) prepared this technical memorandum to outline the approach to performing water-quality predictions for the proposed Copper Flat open pit after reclamation.

Reclaimed open pit water quality predictions are needed to demonstrate to the New Mexico Environment Department (NMED) that surface water quality standards will be met. The existing Copper Flat Mine Open Pit currently contains water that is considered an unclassified perennial water of the state subject to surface water quality standards (20.6.4 NMAC) for the default uses related to primary contact, warmwater aquatic life, livestock, and wildlife habitat. A Use Attainability Analysis (UAA) for warmwater aquatic life is currently in progress, and the initial results indicate naturally-occurring elevated concentrations of manganese and zinc from evapo-concentrated groundwater inflow prevent the attainment of aquatic life uses. Therefore, the applicable NMED surface water standards are yet to be determined.

Concepts of the open pit reclamation plan have been discussed with the New Mexico Mining and Minerals Division, but the details have yet to be formalized in the Mine Operation and Reclamation Plan (MORP). A map of the proposed open pit with reclamation areas is presented as Figure 1. The proposed open pit reclamation plan includes the following details:

1. During mining operations, pressure grouting areas of significant sulfide mineralization and rock fracturing in the pit walls and on the pit benches. This will minimize contact of meteoric water with sulfide masses and will limit infiltration on the benches within the open pit. The purpose of this reclamation

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53

measure is to reduce the potential for temporary acid wall seep occurrences (as experienced with the existing pit).

2. Reclaimed watershed area surrounding open pit to minimize infiltration and promote vegetative growth. This proposed reclamation measure will create a store and release cover and minimize infiltration of stormwater around the pit perimeter and limit water–rock interaction in the upper pit walls

3. Rapid fill with groundwater from Copper Flat supply wells within the range of the model predicted steady-state water-level elevation (4,860 to 4,900 ft amsl). Rapid filling is proposed to occur within 6 months and require 2,600 ac-ft of fresh alkaline groundwater. Rapid fill will dilute solutes derived from water-rock interaction, submerge walls and benches to limit the exposure of sulfide minerals to oxygen, stabilize pit water quality, and create steady state condition for a hydraulic sink. Starting water chemistry will resemble 98 percent supply well water and 2 percent storm-water runoff from pit shell.

4. Reclaim haul road within open pit by installing storm-water conveyance system along haul road, erosion control features, compacted caliche base on exposed haul road area, and seeding where appropriate. Conveyed storm water is expected to have chemistry similar to historical data from SWQ-1.

Model-Predicted Water Budgets

JSAI has already run the Copper Flat groundwater flow model to calculate the water budget for the rapid fill scenario. The model simulated pumping 2,202 ac-ft from the supply wells in the first 6 months of mine closure. Rapid fill stops when the 4,900 ft water elevation is achieved. Water budget for the end of the rapid fill event is summarized in Table 1. The pit volume at the end of rapid fill is over 95 percent well water.

Table 1. Proposed open pit water budget at the end of rapid fill to 4,900 ft elevation

Component	ac-ft	percent of water budget
Input		
Well water pumped to pit	2,202.2	95.4
Groundwater inflow	13.3	0.6
Watershed runoff	1.6	0.1
Pit shell runoff	14.7	0.6
Direct precipitation	8.0	0.3
output		
Evaporation from water surface	-68.8	3.0
Resulting pit volume	2,171.0	

After 100 years the pit water level declines from 4,900 to about 4,860 as a result of evaporation exceeding inputs until steady state is achieved. The water budget for 100 years after rapid fill is summarized in Table 2. Runoff from the reclaimed watershed and the haul road portion of the pit shell should have water quality similar to the results from SWQ-1 (background surface water) in the BDR.

Table 2. Proposed open pit water budget 100 years after rapid fill to 4,900 ft elevation

Component	ac-ft	percent of water budget
Input		
Well water pumped to pit	0	0.0
Groundwater inflow	3,828.1	37.0
Watershed runoff	430.4	4.0
Pit shell runoff	3,936.3	38.0
Direct precipitation	2,181.5	21.0
output		
Evaporation from water surface	-11,266.9	108.0
Change in pit volume	-909.7	

Chemistry of Rapid Fill Water

A detailed laboratory analysis of water from NMCC production wells was performed during the pumping tests conducted in December 2012. The water quality results are summarized in Table 3. Groundwater from the production wells is sodium bicarbonate type with low Total Dissolved Solids (TDS).

Reclaimed Areas

The proposed open pit and receiving watershed totals 230 acres (see watershed area on Fig. 1). The proposed open pit facility includes 160 acres of the 230 acre total area. The open pit facility can also be considered the pit shell as defined in Tables 1 and 2. Proposed reclaimed areas and pit water surface (after rapid fill) will include 47 percent of the pit shell area. The remaining 53 percent of the pit shell area will be stabilized pit walls and benches left in place without reclamation.

Runoff chemistry from the reclaimed haul road, pit rim, and receiving watershed is best represented by the background water quality results from SWQ-1, and runoff chemistry from the exposed pit walls and benches is best representative of the water-rock interaction analysis described in the SRK pit geochemistry model. A summary of SWQ water quality data is presented as Table 5.

Table 3. Summary of water quality results from PW-1 and PW-3 combined

Constituent	unit	result
pH	standard	7.89
Specific conductance	uS/cm	400
TDS	mg/L	249
Total organic carbon (TOC)	mg/L	0.23
Total alkalinity	mg/L as $CaCO_3$	140
bicarbonate	mg/L as $CaCO_3$	140
sulfate	mg/L	18
chloride	mg/L	25
fluoride	mg/L	0.78
nitrate (as N)	mg/L	0.49
calcium	mg/L	26
magnesium	mg/L	2.2
sodium	mg/L	52
potassium	mg/L	2.9
silicon	mg/L	16
aluminum	mg/L	0.0109
arsenic	mg/L	0.0020
barium	mg/L	0.013
boron	mg/L	0.071
cadmium	mg/L	<0.001
chromium	mg/L	0.0025
cobalt	mg/L	0.0020
copper	mg/L	0.00033
iron	mg/L	0.081
lead	mg/L	0.000024
manganese	mg/L	0.17
mercury	mg/L	0.00002
molybdenum	mg/L	0.0020
nickel	mg/L	0.00022
selenium	mg/L	0.0009
thallium	mg/L	0.000012
uranium	mg/L	0.0025
vanadium	mg/L	0.0080
zinc	mg/L	0.020

Table 4. Summary of areas within proposed open pit watershed and facility

Component	area (acres)	% total area
Open pit receiving watershed	70	
Open pit facility	160	100
Reclaimed pit rim	32	20
Reclaimed haul road	21	13
benches and walls	85	53
Water body	22	14

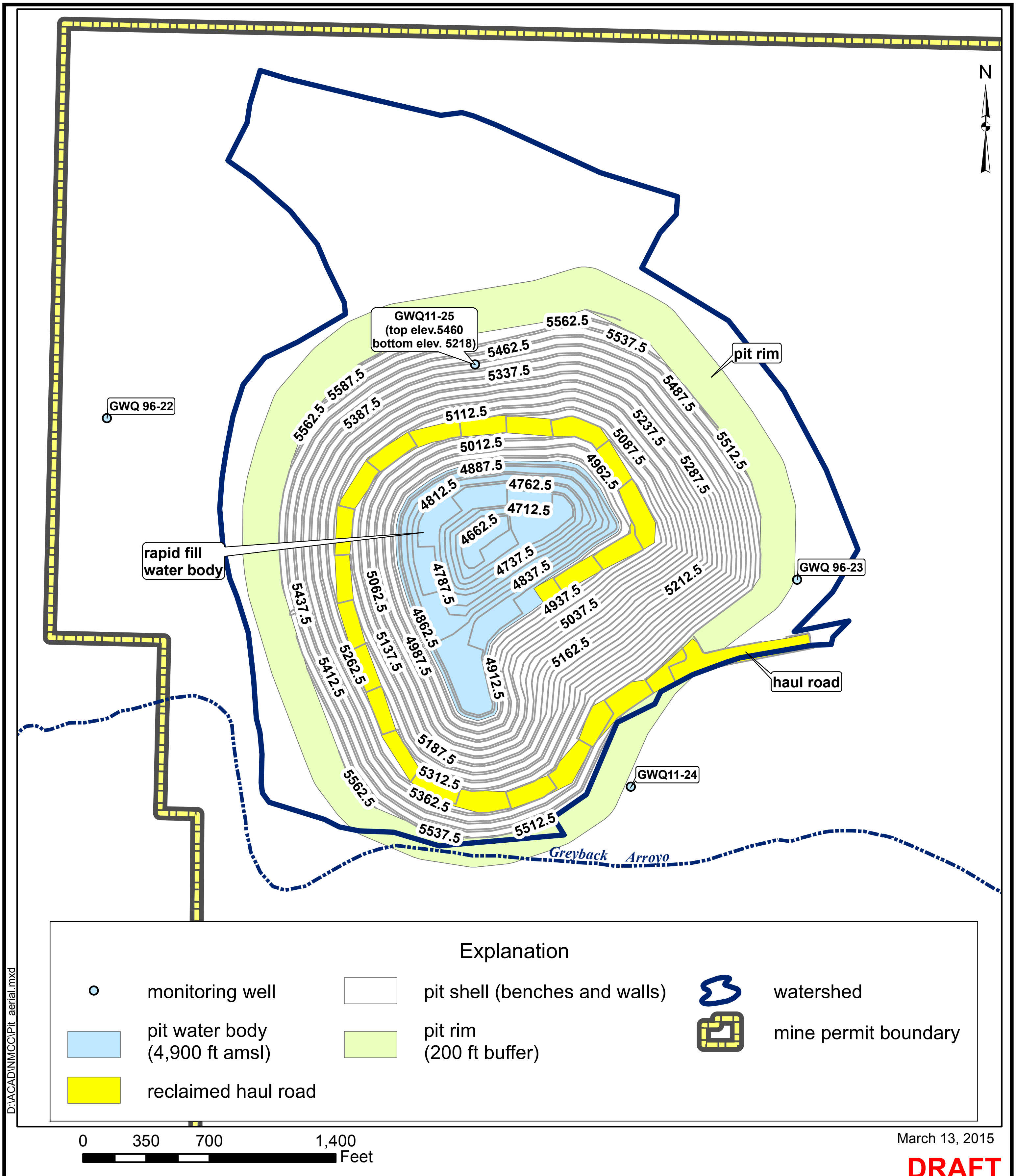
Table 5. Summary of water quality results from SWQ-1

Constituent	unit	result
pH	standard	8.3
TDS	mg/L	615
Total alkalinity	mg/L as $CaCO_3$	360
bicarbonate	mg/L as $CaCO_3$	430
sulfate	mg/L	261
chloride	mg/L	30
fluoride	mg/L	0.3
nitrate (as N)	mg/L	2.5
calcium	mg/L	109
magnesium	mg/L	36
sodium	mg/L	107
potassium	mg/L	1.8
aluminum	mg/L	<0.1
arsenic	mg/L	<0.005
barium	mg/L	<0.5
boron	mg/L	0.02
cadmium	mg/L	<0.002
chromium	mg/L	<0.02
cobalt	mg/L	<0.05
copper	mg/L	<0.01
iron	mg/L	<0.05
lead	mg/L	<0.02
manganese	mg/L	<0.02
mercury	mg/L	<0.001
molybdenum	mg/L	<0.02
selenium	mg/L	<0.005
zinc	mg/L	<0.01

Water Quality Prediction Scenarios

JSAI recommends performing the following water quality prediction scenarios:

1. Base case scenario with no reclamation and no rapid fill. SRK has already evaluated this scenario.
2. Reclamation scenario with reclaimed areas and rapid fill as above. The SRK geochemical model inputs for rapid fill and runoff can be obtained from the JSAI water model results and water quality data presented in Tables 3 and 5.
3. Same as scenario 2, but use the JSAI model to perform a mixing analysis that incudes source terms and effects of evapo-concentration but no chemical reactions.



Map of proposed NMCC Copper Flat Open Pit facility.

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