

Memorandum - DRAFT

To:	Dale Ortman, P.E.	Date:	July 30, 2010
cc:	Tom Furgason, SWCA Cori Hoag, SRK File	From:	Vladimir Ugorets, Ph.D. Larry Cope, M.S. Mike Sieber, P.E.
Subject:	Technical Review of Hydrogeologic Framework Model (Tetra Tech, 2010)	Project #:	183101/1800

This memorandum provides a technical review of the Technical Memorandum, *Hydrogeologic Framework Model* (Tetra Tech, 2010) dated July 9, 2010. This review was undertaken and the Technical Memorandum prepared at the request of SWCA and the Coronado National Forest, in accordance with a Statement of Work and Request for Cost Estimate from Mr. Dale Ortman dated July 18, 2020. This memorandum was prepared by Vladimir Ugorets, Larry Cope, and Mike Sieber of SRK Consulting (U.S.), Inc. (SRK).

1 Description of Hydrogeologic Framework Model

The hydrogeologic framework model was constructed using Mining Visualization System and hydrogeologic data at 200-foot intervals between 5,400 and 2,400 feet above mean sea level (amsl). These horizontal slices, representing the subsurface hydrogeologic units, were developed by Montgomery & Associates (M&A, 2009) and were created from a combination of publically available surface geology maps, borehole lithology data, and cross sections. The geologic formations were grouped into ten (10) hydrogeologic units, based on their age and material properties as follows:

1. Quaternary and Recent alluvium (Qal)
2. Late Tertiary to Early Quaternary basin-fill deposits - higher permeability (QTg)
3. Late Tertiary to Early Quaternary basin-fill deposits - lower permeability (QTg1)
4. Late Tertiary to Early Quaternary basin-fill deposits - lowest permeability (QTg2)
5. Early to Mid-Tertiary sedimentary and volcanic units (Pantano Formation - Tsp)
6. Upper Cretaceous and Early Tertiary intrusive rocks (Kti)
7. Upper Cretaceous volcanic rocks (Kti)
8. Lower Cretaceous sedimentary units (Bisbee Group – Ksd)
9. Paleozoic sedimentary and metamorphic formations (Pz)
10. Precambrian igneous and metamorphic (pCb)

The process used by Tetra Tech to transform the two-dimensional data sets into the three-dimensional block model consisted of three steps: (1) data sampling, (2) hydrogeologic unit interpretation, and (3) consistency check. The steps are described in detail in their technical memorandum.

The developed regional groundwater flow model has a telescoping grid in plain view, with the grid ranging from a cell width of 800 feet at the model domain edges to a cell width of 200 feet in the vicinity of the pit. Vertically, the grid was constructed using a total of 20 horizontal model layers with consistent thicknesses. Flow model layers intersecting the pit were assigned a cell thickness of

approximately 150 feet and model cells above and below the pit were assigned thicknesses between 200 and 430 feet. The uppermost elevation of the flow model was placed at an elevation of 5,500 feet amsl, and the base of the model was placed at an elevation of 1,000 feet amsl.

2 SRK Conclusions

SRK concludes that:

1. The geologically based approach used in the Hydrogeologic Framework Model by Tetra Tech is reasonable and is an accepted practice for groundwater modeling of mine dewatering projects. The geology incorporated into the numerical model matches the geology slice at 3,600 ft elevation (Figure 1) and cross sections A-A' and B-B' (Figures 5 and 6, respectively).
2. The 10 hydrogeologic zones with individual sets of hydraulic parameters look reasonable. It should be noted that SRK did not find a description of these parameters in the reviewed document. But in as much as it presents a concept for modeling, we expect the parameters will be described and defended in subsequent documents.
3. Proposed grid discretization (telescoping in plan view and detailed in cross section, shown in Figure 3) is considered adequate for the required predictive simulations and corresponds to standards in 3-D numerical groundwater modeling.

3 Reviewer Qualifications

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