phelps dodge Tyrone, Inc. P. O. Drawer 571, Tyrone, New Mexico 88065 • (505) 538-5331

July 25, 2005

Via Federal Express

Mr. Clint Marshall
New Mexico Environment Department
Mining Environmental Compliance Section
P.O. Box 26110
Santa Fe, New Mexico 87502

Dear Mr. Marshall:

Re: Phelps Dodge Tyrone, Inc., DP-1341 Condition 83
Work Plan for Additional Groundwater Modeling Analysis
to Supplement the Existing Tyrone Mine Pit Lake Formation Model

Attached are three hardcopies of the Phelps Dodge Tyrone, Inc. (Tyrone) proposed work plan and implementation schedule required pursuant to Condition 83 of DP-1341, which were sent to your attention by Daniel B. Stephens and Associates via Federal Express. An electronic copy of the subject work plan was emailed to you and Mary Ann Menetrey.

Tyrone apologizes for the over due work plan. Should you have questions or comments please contact Mr. Mike Jaworski at (505) 538-7181.

Very truly yours,

Ned Hall

E. L. (Ned) Hall
Environment, Land & Water, Manager
New Mexico Operations

ELH: mj
Attachment
20050725-100

c Mary Ann Menetrey, NMED
Keith Ehlert, NMED
Holland Shepherd, MMD
David Ohori, MMD

Work Plan for Additional Groundwater Modeling Analysis to Supplement the Existing Tyrone Mine Pit Lake Formation Model DP-1341 Condition 83

Prepared for **Phelps Dodge Tyrone, Inc.**
Tyrone, New Mexico

July 25, 2005

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

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Work Plan for Additional Groundwater Modeling Analysis to Supplement the Existing Tyrone Mine Pit Lake Formation Model DP-1341 Condition 83

1. Introduction

On April 8, 2003, the New Mexico Environment Department (NMED) issued discharge permit (DP) 1341 to Phelps Dodge Tyrone, Inc. (PDTI) in its letter to Phelps Dodge New Mexico Operations (NMED, 2003). Section III of the permit requires PDTI to conduct scientific studies of the Tyrone Mine (Tyrone) and mine closure actions as a condition of compliance. Daniel B. Stephens & Associates, Inc. (DBS&A), in conjunction with PDTI, has prepared this work plan describing PDTI's proposed supplemental study that fulfills the requirements of DP-1341 Condition 83, which states that:

> Tyrone shall perform a study to supplement the existing Pit Lake Formation Model submitted January 22, 1999. In accordance with the schedule approved under Condition 74, Tyrone shall submit to NMED for approval a work plan, including an implementation schedule, for a study to supplement the existing Pit Lake Formation Model submitted January 22, 1999. The study shall address the comment letter from NMED regarding the Tyrone Mine Pit Lake formation study and the Pit Lake water Quality Modeling dated January 30, 2001.

This work plan addresses the proposed methodology for updating the Tyrone Mine Pit Lake Formation Model (pit lake model). Applicable background information on the groundwater conditions at Tyrone and a summary of related reports and supporting studies for closure and closeout are presented in Section 2. Section 3 presents key requirements outlined in the January 30, 2003 NMED comment letter. Section 4 describes the proposed approach to model enhancement and refinement. The proposed implementation and reporting schedule is presented in Section 5.

2. Background

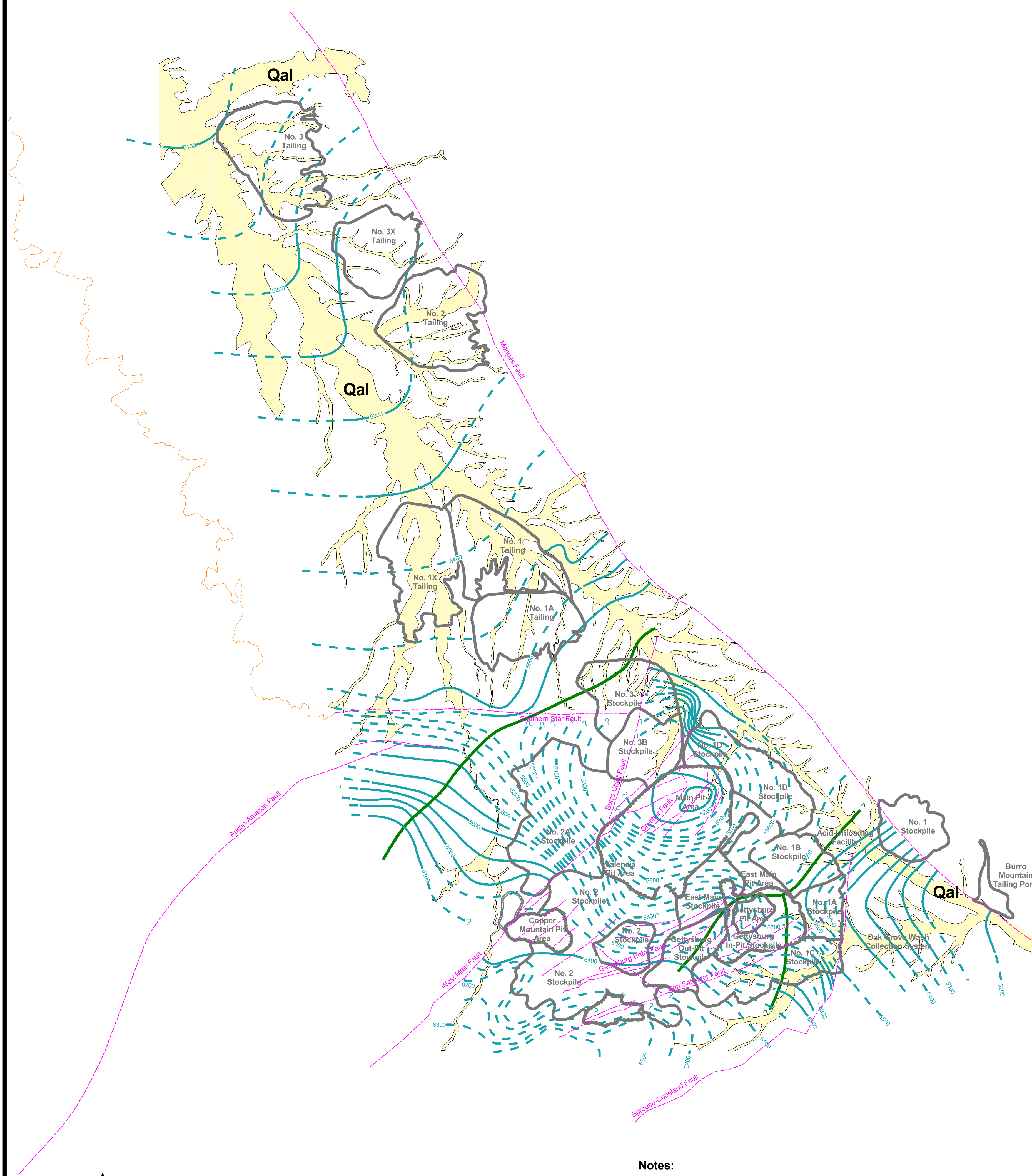
The Tyrone Mine is an open-pit copper mine located just off State Highway 90 approximately 10 miles southwest of Silver City in Grant County, New Mexico. The general layout of the existing mining facilities and regional groundwater conditions at Tyrone are shown in Figure 1. The current mine setting and other background information regarding mine closure/closeout is provided in the report *End of Year 2001 through Year 2006 Closure/Closeout Plan* (CCP) (M3, 2001), which is partially incorporated in the NMED's Supplemental Discharge Permit for Closure DP-1341 and the Mining and Minerals Division (MMD) Permit Revision 01-1 to Permit No. GR010RE.

To support the CCP, baseline and closure design-related studies were conducted to ensure that groundwater, surface water, and air quality standards are met after mining ceases and that effective reclamation and use of disturbed land are conducted in accordance with the requirements of the NMMA and Rules 69 36-1 to 69-36-20 (NMSA, 1978). The intent of the baseline supporting studies needed to fulfill these requirements was first described in the original CCP, *Closure/Closeout Plan, Tyrone Mine* (DBS&A, 1997c), was updated in the *Revised Closure/Closeout Plan, Tyrone Mine* (RCCP) (DBS&A, 1999b), and was revised again in the most recent CCP (M3, 2001). The most relevant supporting studies that provide data to be used in this study are summarized in Sections 2.1 through 2.4.

2.1 Preliminary and Supplemental Groundwater Studies

The following is a summary of the information presented in the *Preliminary Site-Wide Groundwater Study, Tyrone Mine Closure/Closeout* (PGWS) (DBS&A, 1997a) and the *Supplemental Groundwater Study, Tyrone Closure/Closeout* (SGWS) (DBS&A, 1997b). These reports document DBS&A's 1997 site-wide groundwater study at Tyrone, performed in support of the development of a mine closure/closeout plan. The objectives of the study were to:

- Compile historical and current data
- Identify surface water, perched water, and groundwater that may be impacted by mobilized constituents of concern (COCs)



Notes:

1. Water level elevation data are from the third quarter of 2001, except wells LRW-4, LRW-7, 6-2R, GLD-2A, MPWM-1, MPWM-2, MPWM-3, P-8A (May - June 2001), and MPWM-6 (Oct 2001).

2. The water level elevation within the Main Pit was approximately 5,142 feet msl during the third quarter of 2001.

Explanation

- Fault
- Contact between Upper Gila Conglomerate and Igneous Rock
- Facility outlines
- Qal — Alluvium (Holocene); unconsolidated poorly sorted gravel, sand, and silt
- Water level elevation contour (ft msl), dashed where approximate (contour interval 50 ft)
- Approximate groundwater divide

phelps dodge Tyrone Inc.

TYRONE DP-1341 CONDITION 83

Mine Facilities and Regional Aquifer Water Level Elevations

Figure 1

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- Evaluate the geochemical and hydrogeologic characteristics of these waters

- Correlate potential source areas with surface water or groundwater that could be affected by releases of COCs

- Develop conceptual hydrogeologic models for three mine units (Mangas Valley Tailing Unit, Mine/Stockpile Unit, and East Mine Unit-East Side Area)

Both the PGWS and SGWS are comprehensive reports, presenting an abundance of hydrogeologic information regarding Tyrone. This summary provides an overview of the content of each report, and describes the general hydrogeology at the mine.

The PGWS described the sources and methodology used to compile existing data into a database. Data sources included Tyrone Mine Environmental Department files, NMED DP files, drillers' logs, USGS documents, and various letters referencing sample locations. This information was then applied to identify data gaps and develop preliminary hydrogeologic models for tailing ponds and stockpiles. The report provided comprehensive descriptions of the physiographic setting, land use history, geology, surface water, groundwater, previous environmental investigations, and facility operations at the mine.

The SGWS expanded on the hydrogeologic evaluation presented in the PGWS. It fills in several of the data gaps identified in the PGWS, provides conceptual hydrogeologic models for the three mine units, documents screening level water balances and pit lake water level recovery analyses, provides an evaluation of water quality, and recommends additional work elements to fill remaining data gaps. The summary below provides general hydrogeologic characteristics for the Tyrone Mine based on information presented in the PGWS and SGWS. More detailed and specific information related to each of the three mine units can be found in Section 4.5 of the SGWS, which presents conceptual hydrogeologic models for each of the mine units.

As part of the site-wide groundwater study, hydraulic parameter estimates and data from aquifer and permeameter tests were critically evaluated; where appropriate, the data were reanalyzed to establish a representative set of hydraulic parameters for different hydrostratigraphic units at

Tyrone. The identified hydrostratigraphic units consist of intrusive igneous rocks (Precambrian granite and Tertiary quartz monzonite), Tertiary/Quaternary Gila Conglomerate, and Quaternary alluvium. The SGWS provided representative hydraulic parameter estimates for the three hydrostratigraphic units, which are summarized individually below.

The primary intrusive igneous rocks at Tyrone are Precambrian granite and Tertiary quartz monzonite, which occur primarily in the Mine/Stockpile Unit. Groundwater flow within these rocks appears to be governed by secondary permeability (joints, fractures, and faults). Hydraulic conductivity estimates range from 8.20×10^{-5} centimeters per second (cm/s) (0.232 feet per day [ft/day]) to 5.06×10^{-3} cm/s (14.3 ft/day), with a geometric mean of 8.86×10^{-4} cm/s (2.51 ft/day). Because the permeability values measured at individual wells are indicative of the permeability of specific fracture zones, they are likely substantially greater than large aquifer-scale "bulk" permeability values that incorporate the entire volume of porous media (i.e., both fractured and unfractured rock). The mean values for storativity and specific yield are 9.50×10^{-3} and 1.54×10^{-2}, respectively.

The Tertiary/Quaternary Gila Conglomerate is an unconsolidated to semiconsolidated sedimentary deposit present in the Mangas Valley Tailing Unit, the East Mine Unit-East Side Area, and along the northern and eastern boundaries of the Mine/Stockpile Unit. The Gila Conglomerate discussed in the PGWS and SGWS also includes younger bolson fill. Hydraulic conductivity estimates for the unit range from 6.44×10^{-4} cm/s (1.83 ft/day) to 1.23×10^{-2} cm/s (34.9 ft/day), with a geometric mean of 2.56×10^{-3} cm/s (7.26 ft/day). The mean storativity is 2.74×10^{-2} and the estimated specific yield is 7.68×10^{-2}.

Quaternary alluvium is present within all three Tyrone Mine units and may contain perched water (e.g., Deadman Canyon and Oak Grove Wash) or regional groundwater (e.g., Mangas Valley). Hydraulic conductivity estimates range from 3.05×10^{-3} cm/s (8.65 ft/day) to 2.21×10^{-1} cm/s (626 ft/day), with a geometric mean of 3.47×10^{-2} cm/s (98.4 ft/day). The mean storativity is 0.10 and the estimated specific yield is 0.27.

As part of the site-wide groundwater study, groundwater contour maps were developed and used to describe regional groundwater flow conditions for individual mine units and to assess temporal groundwater flow changes. Maps were created from compiled data for the years

1982, 1986, 1990, 1996, and 1997. A pre-surface mining groundwater contour map was developed from 1954 to 1958 water level data presented in Trauger (1972). These maps indicate that groundwater flow within the Mine/Stockpile Unit is primarily controlled by lithology, topography, the depth and location of the open pits that intersect groundwater, and geologic structures (joints, fractures, and faults).

Before surface mining, groundwater flow was either to the northwest into the Gila-San Francisco underground basin or toward the southeast into the Mimbres Valley underground basin. The divide separating these two underground basins was nearly coincident with the Continental Divide. Since surface mining began, groundwater flow conditions have changed due to dewatering activities. Dewatering of the regional aquifer likely began with pumping from the Burro Chief shaft during the late 1970s, and continued with pumping from the Main and Gettysburg Pits from the early 1980s to the present time (DBS&A, 1997a). Now, capture zones are associated with dewatering activities in the Main, Gettysburg, and Copper Mountain Pits. Groundwater not captured through dewatering either flows toward the Gila-San Francisco underground basin northwest of the mine, or toward the Mimbres Valley underground basin southeast of the mine.

2.2 Pit Lake Modeling Studies

The *Tyrone Pit Lake Formation Modeling Report* (DBS&A, 1999a) was submitted to MMD and NMED on January 22, 1999. The primary objectives of the groundwater flow modeling study were to:

- Estimate the post-closure recovery period of water levels in the mine pits and surrounding aquifers, and project the post-closure steady-state pit lake(s) surface elevation(s)
- Examine the potential for pit lake outflows
- Evaluate the potential interactions of pit lake(s) with other mine facilities, hydrologic features, and geologic structures

- Provide supporting groundwater flow information for the pit lake water quality study

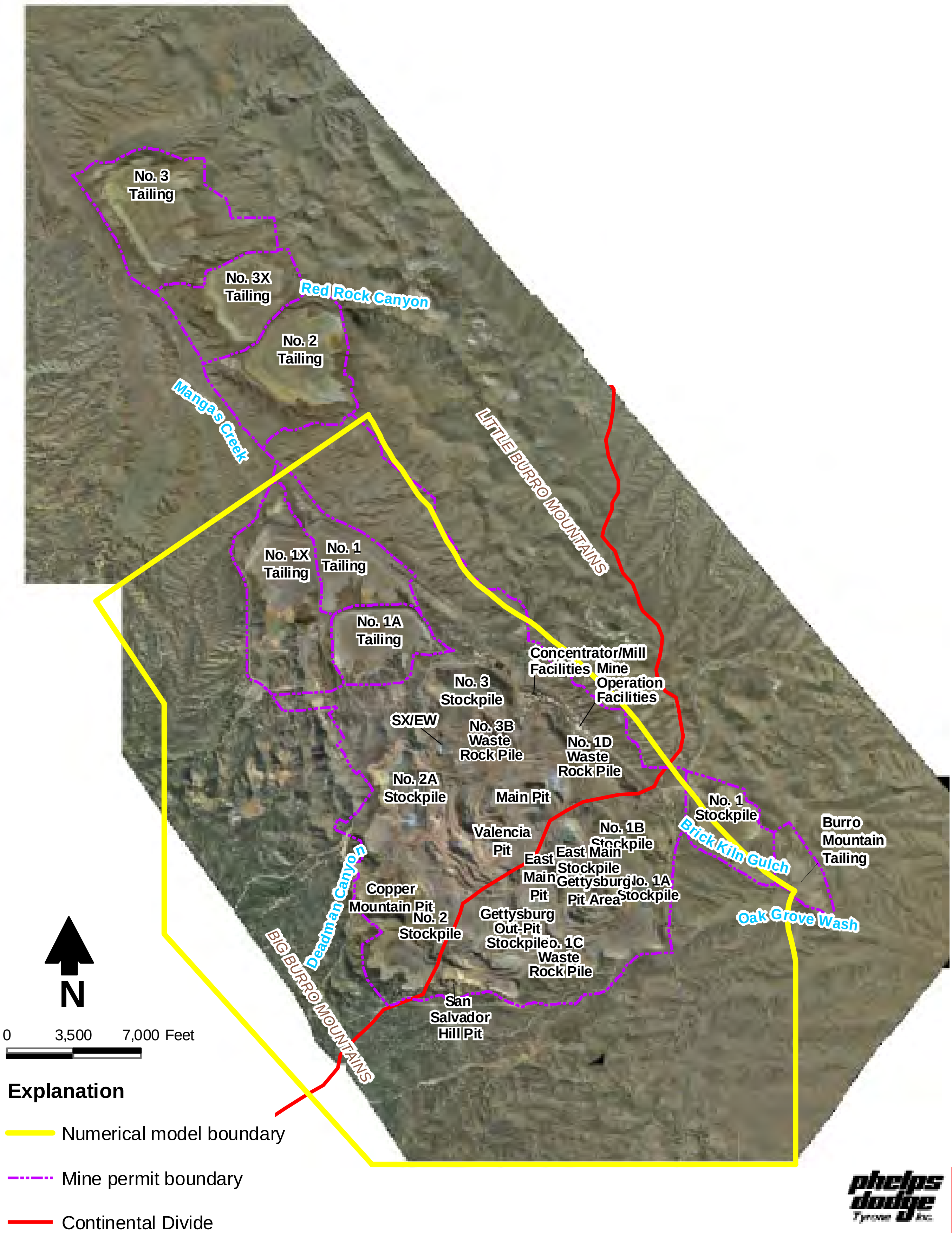
The modeling study focused primarily on the regional groundwater flow regime in the Mine/Stockpile Unit area; however, portions of the East Mine Unit and the Mangas Valley Tailing Unit are also included within the model boundaries. The model was based on the 1998 mine configuration and was used to simulate both steady-state (current) and transient (future) conditions. The extent of the pit lake model is provided in Figure 2.

The report presents the results of (1) a review of available hydrologic and geologic data, (2) the formulation of a comprehensive, conceptual hydrogeologic model of the Tyrone Mine/Stockpile Unit, and (3) the construction and calibration of a numerical groundwater flow model designed to simulate post-closure regional groundwater conditions at Tyrone. The model was successfully calibrated to the 1998 groundwater flow regime, assuming quasi-steady-state conditions. Predictive simulations were also included in this study, but were submitted as an addendum to the modeling report on June 18, 1999 (DBS&A, 1999c).

The predictive simulation results indicate that the regional aquifer in the Mine/Stockpile Unit will approach a long-term steady-state condition within 100 years of cessation of pit dewatering activities. If the pits are then allowed to fill, the model predicted that the final lake stage levels at the Main and Gettysburg Pits are expected to be approximately 5,605 and 5,940 feet above mean sea level (msl), respectively. In addition, the model predicted that these pit lakes would become temporary storage systems in less than 50 years, allowing for a portion of the stored water to flow northwest from the Main Pit area into the Gila-San Francisco basin and for a smaller portion to flow southeast from the Gettysburg Pit area toward the Mimbres Valley basin.

A detailed pit lake model sensitivity analysis and verification study are provided in DBS&A (2002). In that document, model sensitivity runs were documented for the following model input parameters or changes to model construction:

- Hydraulic conductivity
- Storage coefficient
- Reduced hydraulic conductivity with depth
- Addition of a fourth model layer beneath the Main Pit



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TYRONE DP-1341 CONDITION 83

Existing Pit Lake Formation Model Domain

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Figure 2

- Enhanced recharge from the No. 3 stockpile area
- Model boundary influx
- Interceptor well pumping rates

A model verification study for a 40-month period from July 1998 through October 2001 is also provided in DBS&A (2002). The purpose of the verification study was to evaluate the predictive capability of the pit lake model by simulating the pit lake level using observed pit pumping rates and weather data to develop model inputs. For the 40-month period evaluated, the pit lake model was able to simulate the observed Main Pit water levels quite well.

2.3 Discharge Plan Monitoring Reports

The results of selected DP investigations will also be used in this study. These reports provide important results of seepage investigations and fluid level and water quality monitoring at the No. 3 stockpile, Deadman Canyon and East Side areas. Some of the DP investigations have been summarized in the RCCP and the PGWS (DBS&A, 1999b and 1997a). The most significant groundwater impacts identified by these investigations are pregnant leach solution (PLS) seepage sources below active stockpile leach systems, which have resulted in perched seepage migration in alluvium-filled drainage channels beyond the stockpile boundaries.

At the No. 3 stockpile, perched seepage reached the regional water table, resulting in water quality impacts in the regional aquifer. Water quality impacts from PLS seepage to the regional aquifer in the East Side area have occurred at a number of locations west of the Sprouse-Copeland Fault near the toe of the No. 1 stockpile complex (Figure 1). West of the Sprouse-Copeland Fault, regional monitor wells generally meet standards, but elevated levels of sulfate and total dissolved solids (TDS) have been observed in some wells in this area (e.g. MB-27). Also some regional wells (e.g., MB-29 and MB-42) have recently exceeded standards, although it is not known if the exceedences will continue. At both mine locations, remedial pumping systems and PLS collection structures (interceptor well systems, interceptor/barrier trenches, and high-density polyethylene [HDPE]-lined ponds) have been constructed and are operating to capture and remove the vast majority of perched seepage and prevent impacts to the regional aquifer. Additional collection systems at the No. 3 stockpile remove impacted water from the regional aquifer as close to the source as possible.

Figure 1, generally indicative of the present-day groundwater flow regime, indicates that much of the basal seepage from stockpiles that reaches regional groundwater does so within the area of the open-pit capture zones created by present-day pit dewatering operations. The particle tracking results provided in the report *Prediction of Impact on Water Quality, Tyrone Mine* (DBS&A, 2000) confirm the general capture zone shown in Figure 1. This report (along with the groundwater modeling reports) also showed that if pit dewatering were not maintained after closure, then outflow conditions could exist in the Main and Gettysburg Pits, and stockpile seepage would, in all likelihood, not be contained by the pits.

The containment of impacted perched water zones is the objective of ongoing investigations and mitigation activities being conducted by PDTI. Impacted groundwater is intercepted using toe collection ponds, cut-off trenches, and pump-back well systems installed by PDTI.

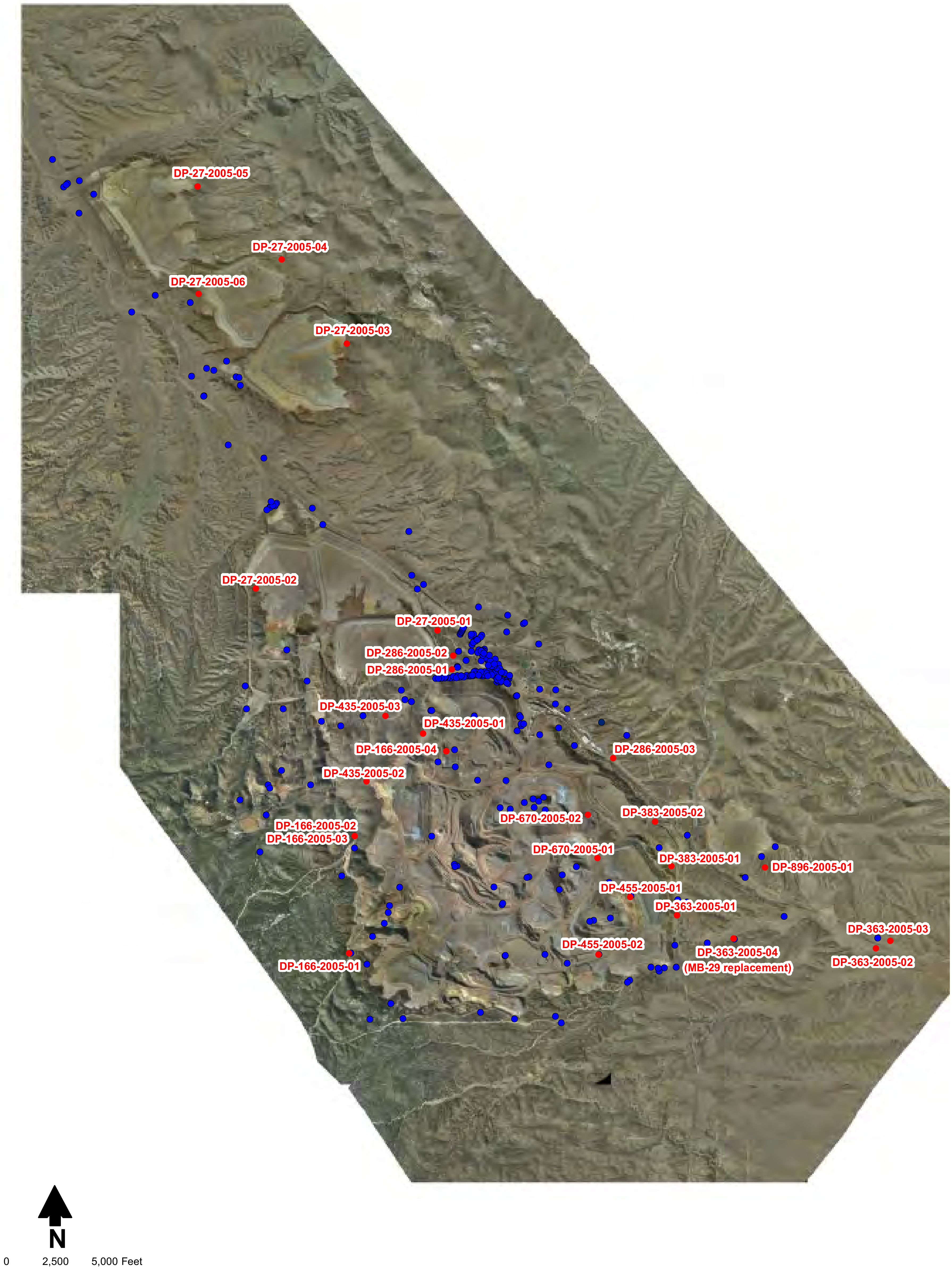
2.4 2005 Monitor Well Installation and Hydraulic Testing

A major program to construct additional monitor wells (24 regional wells and 2 alluvial) at Tyrone is nearing completion (Figure 3). The new wells were completed due to requirements under DP-1341 Condition 82 (Groundwater Study), DP-1341 Condition 34 (Abatement Plan), the DP-27 Settlement Agreement, and operational DPs 166, 286, 363, 383, 435, 455, and 670. Water levels and water quality analyses will be available from all of these wells, and hydraulic properties will be tested at some well locations. These newly collected data will be used in conjunction with other existing data to guide revisions and updates to the pit lake model.

3. NMED Comment Letter

Condition 83 requires that supplements to the pit lake model include the requirements and conditions outlined in the NMED comment letter dated January 30, 2001 (Appendix A). On page 3 of the NMED comment letter, six items are enumerated as requirements for model refinements, as follows:

1. Better justification or adjustments to boundary conditions
2. A reduction in hydraulic conductivity of the southern zone



Explanation

- New monitor well
- Existing regional monitor well

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TYRONE DP-1341 CONDITION 83
New Monitor Wells to be Installed at Tyrone During 2005

Figure 3

5. Addition of a lower layer below the Main Pit in the model
6. Improved estimates of enhanced recharge
7. A sensitivity analysis of key hydraulic zones and model inputs
8. A transient calibration

Of these six items, two (Nos. 2 and 5) have already been completed and are provided in DBS&A (2002). Sensitivity analyses that evaluated the effects of (1) addition of a fourth model layer beneath the Main Pit, (2) changes to boundary influx, and (3) changes to the rate of enhanced recharge are also presented in DBS&A (2002). The results of these sensitivity analyses will be used to assist with construction and calibration of the updated pit lake formation model. It is anticipated that the updated model will be sufficiently different from the existing model to require that an updated sensitivity analysis be performed.

4. Technical Approach

Enhancements and modifications that will be made to the existing pit lake model are grouped into the following seven categories that form an overall outline for the model development process. Depending on the results of a given task, the modified model may or may not closely resemble the existing model, although substantial variations from the existing model framework are not anticipated at this point.

4.1 Conceptual Model Evaluation and Construct

The conceptual model of groundwater flow at Tyrone that serves as the basis of the existing pit lake model will be reevaluated in general as part of DP-1341 Condition 82, and in particular as it relates to construction and calibration of the pit lake model as part of this task. The conceptual model of groundwater flow at the mine will serve as the fundamental basis for construction of the numerical model. At this time, significant differences from the current conceptual model of groundwater flow at Tyrone are not anticipated. If review of the existing and newly collected data (Section 2.4) indicates that significant modifications to the current conceptual model are warranted, proposed changes and updates will be discussed with NMED prior to proceeding with the subsequent stages of model construction.

4.2 Determination of Boundary Conditions and Model Input Parameters

Initial model input parameters will be determined from previous and ongoing technical studies, the existing pit lake model, and possibly additional analyses conducted as part of this study. For example, independent estimates of groundwater recharge will be derived from previous work conducted by John Shomaker & Associates, Inc. (JSAI, 2005) as part of Condition 86 of DP-1340 (Chino), or through application of a similar mass-balance (rainfall-runoff) approach. Initial model input parameters will be adjusted as required and appropriate during the model calibration process (Section 4.4).

4.3 Model Grid Construction

The existing model grid may need adjustment if alternate boundary locations are selected, or possibly for computational reasons. The same model grid orientation (northwest-southeast) will be maintained so that the computational grid remains aligned with major geological structural features (e.g., faults). Also, as is the case in the current model, fine grid spacing will be maintained in the vicinity of the Main and Gettysburg Pits to facilitate model convergence and mass balance. The model may also be extended to incorporate additional portions of the Mangas Valley and Lower Oak Grove Wash.

The current model consists of three layers in the vertical dimension. The updated model will either (1) consist of at least four model layers, as required by the NMED comment letter, or (2) incorporate the effects of deep groundwater beneath the Main Pit through application of an appropriate boundary condition. Implementation of the second option would require the approval of NMED.

4.4 Model Calibration

Model calibration will be conducted by comparing simulated hydraulic head at specified times and locations to observed hydraulic heads from monitor wells; comparisons will be conducted using plots of observed versus simulated hydraulic head at specified times (45-degree plots), as well as comparison of simulated and observed hydraulic head at specified locations through time (hydrographs). Specific monitor wells that have sufficient well construction and water level history information will be selected for the model calibration. In addition, the locations of dry monitor wells will be considered to assist with simulation of the expansion of the combined pit cones of depression through time. The model calibration will also consider the estimated volumes of groundwater inflows to the Main, Gettysburg, and Copper Mountain Pits.

One of the requirements of Condition 83 is that a transient model calibration (as opposed to steady-state) be conducted. Conceptually, there are at least two ways to conduct the transient model calibration:

- ***Option A*** - Simulate development of the cone of depression beginning during the late 1970s with pumping from the Burro Chief shaft and then the Main and Gettysburg Pits; note that this option requires “reconstruction” of pit excavation through time. Initial conditions for this option would be obtained from a predevelopment steady-state model calibration.

- ***Option B*** - Select a time period that is after the late 1970s, and read observed water levels into the model as initial conditions.

Option A is very complex because the history of mine pit excavation since the late 1970s would have to be compiled and implemented into the model, at least in a general sense. It is possible that sufficient information does not exist to appropriately implement this option. Option B would be substantially easier to implement, but the accuracy of the approach and the simulation results are dependent upon the number of observed hydraulic head values within the model domain. Final selection of the transient calibration approach will be made during the study and submitted to NMED for approval.

Model calibration will be conducted using the standard iterative approach, automated methods, or a combination of these two techniques. Either the MODFLOW-Surfact (HydroGeoLogic, 1999) or MODFLOW 2000 (Harbaugh et al., 2000) computer codes will be applied. The existing pit lake model was constructed using the MODFLOW-Surfact code because it allows for the resaturation of previously dry model cells (cells where the simulated water level is below the bottom of the cell). This capability is critical for the predictive pit lake filling scenarios. If automated calibration methods are applied, the PEST code (Doherty, 2000) may be used as well.

4.5 Sensitivity Analysis

Sensitivity analyses for the most significant model input parameters will be conducted through adjusting the selected parameter input value (e.g., hydraulic conductivity) and rerunning the model calibration to evaluate the effects on simulation results. Through this process, the most sensitive model parameters (those that lead to the greatest change in simulation results caused by the smallest changes to input values) will be identified. If an inverse method is applied to achieve model calibration, model parameter sensitivity information will be automatically generated as part of the calibration process.

4.6 Predictive Simulations

Predictive simulations similar to those completed using the existing model will be conducted using the updated pit lake model. The first predictive simulation will consider the prediction of pit lake development through time under closure/closeout conditions where the pit lakes are not pumped down. The purpose of this simulation is to reevaluate the previous simulation result where formation of a flow-through pit lake (as opposed to a terminal pit lake) was predicted by the current model. Additional simulations may consider predictive scenarios where the pit lakes are maintained as sumps as required under DP-1341, and scenarios where one or more of the pits that intersect regional groundwater are entirely or partially backfilled with adjacent stockpile material. Other planned or potential changes to the configuration of mine facilities that could significantly influence regional groundwater flow will be considered and incorporated into the predictive simulations as appropriate. Specific predictive simulations that are required or useful will be determined in conjunction with Tyrone staff and other Tyrone consultants working on the Feasibility Study (DP-1341 Condition 89), as well as NMED.

4.7 Documentation

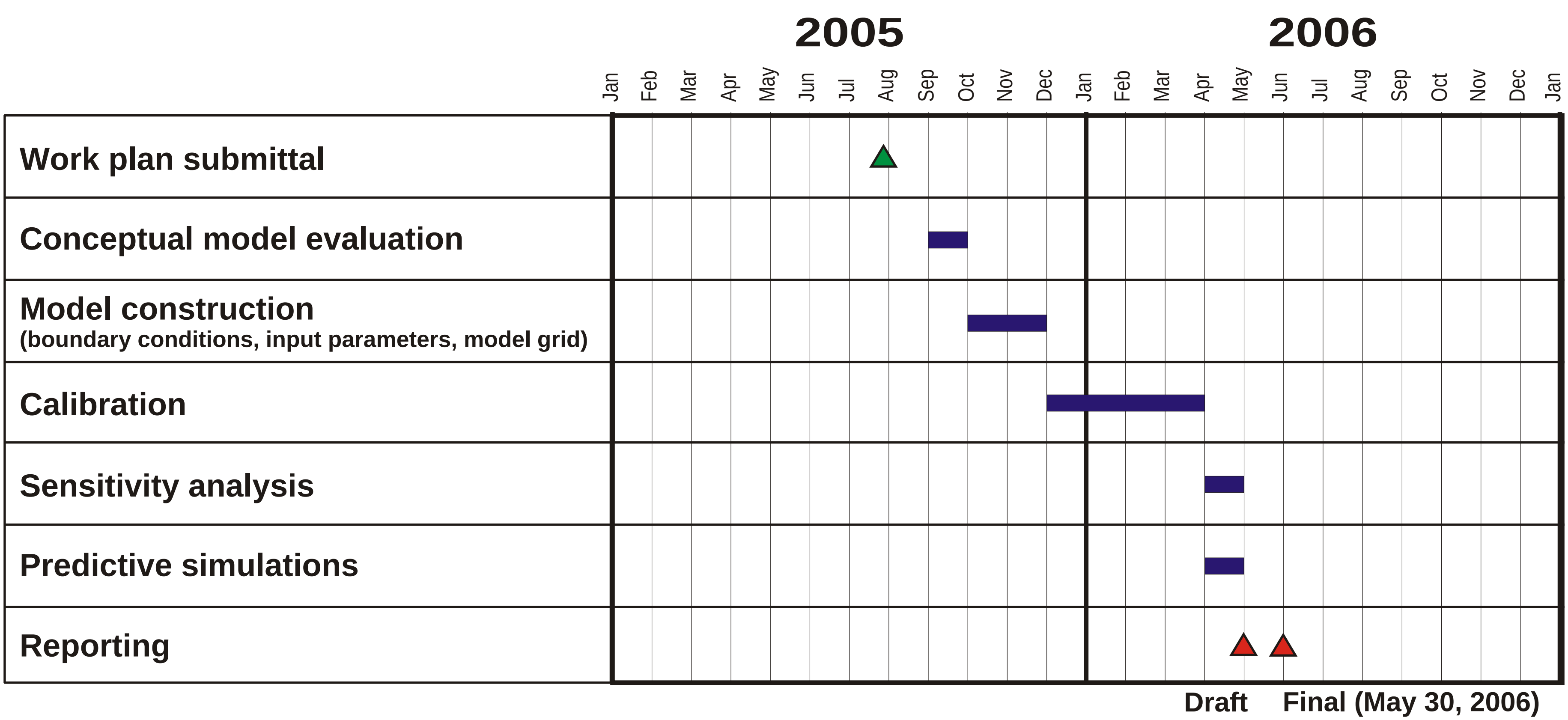
Results of the tasks described in Sections 4.1 through 4.6 will be documented in a completion report submitted to NMED for comment. NMED comments on the draft report will be considered and a final completion report will be submitted.

5. Study Implementation and Reporting Schedule

Figure 4 presents PDTI's proposed implementation schedule and report deliverable dates. Results of the modeling study will be documented in a draft report that will be provided to NMED for comment. The report will include:

- A statement of the model purpose
- A description of the conceptual model on which the numerical model will be based
- A description of the model calibration approach and results
- An overview of all model input parameters
- Model sensitivity analysis
- Updated predictive pit lake formation scenarios

Upon review and approval of the draft report by NMED, a final report will be produced.



phelps dodge Tyrone Inc.

TYRONE DP-1341 CONDITION 83

Project Time Line

Figure 4

Daniel B. Stephens & Associates, Inc.

7-21-05

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Appendix A

NMED Comment Letter

State of New Mexico
ENVIRONMENT DEPARTMENT
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1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502
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GARY E. JOHNSON
GOVERNOR

PETER MAGGIORE
Secretary
PAUL R. RITZMA
Deputy Secretary

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January 30, 2001

Mr. Robert I. Pennington, President
Phelps Dodge Tyrone, Inc
P.O. Drawer 571
Tyrone, New Mexico 88065

RE: MECS AND THIRD PARTY COMMENTS ON TYRONE MINE PIT LAKE FORMATION STUDY AND PIT LAKE WATER QUALITY MODELING.

Dear Mr. Pennington:

The Mining Environmental Compliance Section (MECS) of the New Mexico Environment Department (NMED) has completed its review of the *Tyrone Pit Lake Formation Modeling Work Plan*, dated June 30, 1998; *Tyrone Pit Lake Formation Modeling Report*, January 22, 1999; *Addendum to the Pit Lake Formation Modeling Report: Predictive Pit Filling Simulation Results*, June 18, 1999; *Correction Letter to the Tyrone Pit Lake Formation Modeling Results*, September 29, 1999; *Tyrone Pit Lake Water Quality Modeling Work Plan*, October 30, 1998; *Preliminary Pit Lake Water Quality Modeling Tyrone Mine*, March 31, 1999; and, *Pit Lake Water Quality Modeling Tyrone Mine*, February 29, 2000. The MECS review consisted of an internal evaluation and third party review conducted by Hydrologic Consultants, Inc (HCI). HCI reviewed the above reports and other supporting documents. The ground water flow modeling reports were produced by Daniel B. Stephens and Associates, Inc (DBS&A); the geochemical modeling reports by SARB Consulting, Inc (SARB). Enclosed with this letter are two copies of the HCI final report.

The remainder of this letter contains MECS comments on the ground water flow and geochemical modeling and, based on MECS's and HCI's review, additional work MECS requires. The NMED Surface Water Quality Bureau (SWQB) has reviewed the referenced reports and concurs with the MECS comments in this letter. Additional SWQB comments are included at the end of this letter. The following issues must be clarified and schedules for future work submitted before the discharge permit application can be deemed technically complete pursuant to 20 NMAC 6.2 3109.A and prior to providing the environmental determination pursuant to the New Mexico Mining Act.

TYRONE MINE PIT LAKE FORMATION MODEL

MECS has had strong reservations regarding the pit lake formation model and has made these reservations known to Phelps Dodge Tyrone, Inc. (PDTI) and DBS&A at several meetings. PDTI's argument against these reservations has been that no additional work is necessary because the model is conservative, i.e. the model predicts the worst-case scenario of the pit lake becoming a flow-through system. HCI agrees with this assertion. Based on the third party review, MECS is now satisfied by this assertion for *only* the existing pit lake formation model. Due to the many issues discussed below, until the existing pit lake formation model is refined to the satisfaction of MECS, MECS will not support the use of the pit lake formation model with any other study or report, including the *Prediction of Impact on Water Quality, Tyrone Mine* and the Gettysburg Pit Pumpback Containment System Study.

1. **Main Pit's Simulated Cone of Depression.** The Main Pit, the central focus of the model, has a very poorly reconstructed cone of depression. Well P8-A has nearly 287 feet of excess water in the model. Wells SXMW01, SXMW02, and SXMW03, which are dry in reality, show a modeled excess of at least 239, 253, and 209 feet of water respectively.

2. **Enhanced Recharge.** MECS believes that the enhanced recharge (water that infiltrates to ground water) applied to the No. 2C and 3 Stockpiles is questionable and results in the excess water levels in certain wells. HCI discovered that the enhanced recharge applied to the No. 2C and 3 Stockpiles amounts to nearly *19 feet per year.*

3. **Constant Head Boundaries.** Constant head boundaries can supply or remove an unlimited amount of water from a model. MECS and HCI believe that independent calculations should be performed to estimate what the ground water flux through the model should be.

4. **Southern 20 ft/day Unit.** MECS believes that the large southern unit of igneous rock was improperly given a hydraulic conductivity of 20 ft/day, allowing too great a ground water flux to move through the model. 20 ft/day is higher than the alluvium in the model and about two orders of magnitude greater than all other igneous rock in the model. DBS&A have stated that 20 ft/day was necessary for calibration purposes. After examining the sensitivity runs, HCI does not believe this to be true; a lower hydraulic conductivity resulted in an equally good calibration and a lower and more believable ground water flux.

5. **Calibration.** Because of the items discussed above, MECS does not believe that the model is actually calibrated. Calibration logs were not kept which is a standard procedure. When discussing the Southern 20 ft/day Unit, HCI states, "Since no logs were kept of model

calibration, it is hard to have confidence that a thorough calibration attempt was made.

6. **Sensitivity Analysis.** The "sensitivity analysis" performed on the model consisted of only two new model runs on only the southern unit. MECS does not consider this to be a sensitivity analysis. HCI states, "Generally a sensitivity analysis is performed on several of the most important components in a ground-water model."

7. **Layer Below Bottom of Main Pit.** The bottom of the Main Pit is essentially at the bottom of the model. MECS and HCI maintain that an additional layer is needed below the Main Pit to allow for vertical movement of ground water into the pit.

8. **Steady State Assumption.** After reviewing hydrographs of water levels across the site, HCI found more wells with a downward trend than wells with a constant water level; therefore, it does not appear to HCI that the model domain is at steady state.

FUTURE DIRECTION FOR PIT LAKE FORMATION MODEL

Based on MECS's and HCI's third party review, MECS will require, at a minimum, future modeling refinement to include the following:

1. Better justification or adjustments to boundary conditions;
2. A reduction in hydraulic conductivity of the southern zone;
3. Addition of a lower layer in the model;
4. Improved estimates of enhanced recharge;
5. A sensitivity analysis of key hydraulic zones and model inputs; and,
6. A transient calibration.

The above list is not inclusive; MECS will seek other more detailed changes. MECS understands that it is not feasible to remodel the Tyrone Mine ground water system in a manner that adequately addresses the above issues prior to discharge permit modification to incorporate the closure/closeout plan; however, in order for a closure plan to be approved and for an environmental determination to be provided, PDTI must submit a proposal with a schedule detailing how the issues will be addressed in a defensible, technically sound manner that incorporates MECS and HCI comments. The PDTI proposal and schedule will be incorporated as part of the Tyrone Mine closure plan. MECS requests that PDTI submit the proposal and schedule for future model refinement within 45 days of receipt of this letter.

PIT LAKE WATER QUALITY MODELING, TYRONE MINE

Based upon HCI's third party review, MECS is mostly satisfied with the pit lake water quality model produced by SARB and believes that the prediction is largely conservative. As discussed in HCI's report (p.15), MECS will not accept the reaction path modeling performed by SARB. Due to HCI's opinion that iron concentrations predicted for the Main Pit are likely low due to goethite selected as a precipitate, MECS requests iron concentrations for the Main Pit without goethite precipitation be submitted within 30 days of receipt of this letter.

As a result of the third party review, MECS has few technical comments on the pit lake water quality modeling reports; however, MECS does have concerns regarding the presentation of these reports. Review of the reports was very difficult. There are many instances of contradictory sentences, graphs not matching tables, and sentences or captions not matching tables or graphs. Extremely small graphs with tens of data points made interpretation impossible. Evidently the preliminary report was used as a starting point for the final report. Changes were made to the modeling process taken between the reports; unfortunately, the final report's sections from the preliminary report were not modified to reflect this change. HCI mentions (p.16) how the report discusses using the EQ3NR/EQ6 model although it was never used. HCI goes on to state, "The report should be rewritten to better reflect the actual procedure used to predict the composition of the pit lake."

MECS believes it is the responsibility of both PDTI and SARB to review any documents prior to submittal to the state agencies. It is difficult to have confidence in technical work that is presented in a confusing, unorganized manner. Please ensure that all future submittals are complete, organized, and have been reviewed prior to submittal. Future documents that are confusing and unorganized will be returned to PDTI for changes prior to technical review.

FUTURE DIRECTION FOR PIT LAKE WATER QUALITY MODELING

Based on HCI's recommendation and MECS concerns about the confusing nature of the documents and providing an understandable public record, MECS requests that a supplemental report be prepared and submitted, providing an overview to the water quality modeling. This report should include figures and tables of sufficient size that the effort to include them provides some benefit. This report should contain the results of model runs for the Main Pit's iron concentration if goethite is not allowed to precipitate. In addition, please include information to clarify the comments below.

1. On page 15 of the *Pit Lake Water Quality Modeling Tyrone Mine (PLWQMTM)* states that simulated ground water inflow to the Gettysburg Pit is 329.6 gallons per minute (gpm). However, on page 29 of the *Tyrone Pit Lake Formation Modeling Report* submitted January 22, 1999, the simulated ground water inflow to the Gettysburg Pit is reported as 392.6 gpm and recent discussions have placed the value at 417 gpm. Please check which figure was used in the geochemical modeling.

2. On page 29 of the *PLWQMTM*, the caption for Table 4-1 states, "*The table gives the average, maximum, and minimum analyzed values…*" However, the table itself only reports the

average values. Please resubmit the table with the maximum and minimum values included.

3. Figure 4.6 on page 36 seems in error. The data point labeled "avg. PLS" has a higher SO_4/Na ration than any of the three individual PLS data points. Please clarify.

4. On page 38, Section 4.2.5.1 states, "*Two of these zones (I and II) contain major fractures where visible water enters the pit.*" However, the Zone Division Map of Appendix E shows the fracture seeps (MPS-1, MPB-2S, and MPB-3S) in Zones I and V. Please clarify.

5. Table 4-4 on page 42 contains conflicts with the Zone Division Map. Please clarify.

6. On page 42, Section 4.2.5.4 discusses the reference wells used in the study; however, all the wells are not mentioned. Please discuss the remaining wells. Starting on page 44, the reference well element concentrations are plotted; however, all the wells are not included. Please graph the element concentrations for all the wells.

7. In addition to the reference well element concentration plots, Appendix A provides the same water quality data in tabular form. While reviewing the *Preliminary Pit Lake Water Quality Modeling* report, MECS discovered the plots and tables were in major disagreement. MECS informally notified PDTI of this disagreement. Later, the *Pit Lake Water Quality Modeling* report was submitted and MECS found that while some of the errors were resolved, many still exist. For example, well 6-3R still contains contradictions over sodium, nickel, zinc, fluorine, and potassium. Please recheck all data and submit corrected plots and tables that are in total agreement. Please recheck which data were used in model calculations.

8. Table 4-3 on page 41 is in disagreement with the reference well element concentration plots on pages 44 to 55 and the tables in Appendix A. For example, Table 4-3 shows well TWS-8 with 8 samples from 1997-98. The element concentration plot on page 50 and Appendix show many more samples from 1986-98. Please place Table 4-3, the element concentration plots, and Appendix A in total agreement.

9. The tables in Appendix A do not include all the reference wells used in the modeling effort and include a well not used in the modeling effort. When Appendix A is resubmitted, please make it inclusive of all the wells, and only the wells used in the modeling effort.

SWQB COMMENTS

SWQB policy considers mine pit lakes to be "waters of the state", subject to the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC; 10/12/2000) as applied to the water's designated uses. All impoundments at mine sites are non-classified waters, although discharges from these impoundments may potentially impact classified receiving waters. Determination of whether standards are expected to be met can be made on a case-by-case basis, dependant on the current status of the mining operation, the pit lakes' active or abandoned condition, and in consideration of proposed or active closure plans. In all instances it is intended that permanent impoundment pit lakes remaining on the mine site following completion of all other reclamation activities will be considered waters of the state and *must be* in compliance with water quality standards.

Please submit clarification to the items above concerning the water quality modeling within 30 days of letter receipt.

If you have any questions regarding the above, please contact me at (505) 827-0652.

Sincerely,

Mark Phillip
Mining Environmental Compliance Section
Ground Water Quality Bureau

Cc: Mary Ann Menetrey, HPM, MECS
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