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

April 12, 2005

Via Overnight Delivery

Mr. David Ohori
Reclamation Specialist
Mining Act Reclamation Program
Mining and Minerals Division
1220 South St. Francis Dr.
Santa Fe, New Mexico 87505

Dear Mr. Ohori:

Re: Phelps Dodge Tyrone, Inc., Affected Areas Study Proposal, Permit No. GR010RE

Phelps Dodge Tyrone, Inc. (Tyrone) hereby submits two hard copies of the Affected Areas Study required under Section L.3.of Revision 01-1 to Permit GR010RE dated April 12, 2004. The report provides an overview of areas affected by Tyrone mining operations, a summary of ongoing and proposed studies to characterize mining affects in those areas, and a schedule for completion of those studies that will fully meet the Mining and Minerals Division's Affected Areas Study requirements.

If you have any questions or comments, please contact Mr. Mike Jaworski at 505-538-7181.

Very truly yours,

Ned Hall

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

ELH:mj
Attachment
20050412-100

c Holland Shepherd

April 12, 2005

Mr. Michael Jaworski
Senior Environmental Engineer
Phelps Dodge Tyrone, Inc.
P.O. Drawer 571
Tyrone, New Mexico 88065

Re: Tyrone Mine Affected Areas Study Proposed Work Plan

Dear Mr. Jaworski:

Enclosed are two complete copies of the referenced document prepared by Daniel B. Stephens & Associates, Inc. on behalf of Phelps Dodge Tyrone, Inc. The Affected Areas Study is required under Section L.3 of Revision 01-1 to Mining and Minerals Division permit GR010RE.

Please call me at (505) 822-9400 or email me at nblandford@dbstephens.com if you have any questions.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

T. Neil Blandford

T. Neil Blandford
Vice President/Senior Hydrologist

TNB/rpf
Enclosures

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6020 Academy NE, Suite 100 505-822-9400
Albuquerque, NM 87109 FAX 505-822-8877

Affected Areas Study Work Plan

Tyrone Mine Facility

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

April 12, 2005

Daniel B. Stephens & Associates, Inc.

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

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1. Introduction

This proposed work plan for the Affected Areas Study (AAS) for the Tyrone Mine Facility has been prepared by Daniel B. Stephens & Associates, Inc. (DBS&A), on behalf of Phelps Dodge Tyrone Inc. (Tyrone), in accordance with Section L.3 of Permit Revision 01-1 to Permit No. GR010RE issued by the Mining and Minerals Division (MMD) of the New Mexico Energy, Minerals and Natural Resources Department.

The purpose of the AAS is to identify areas outside the MMD permit boundary that have been impacted by mining operations. Affected areas are defined as areas outside the MMD permit boundary where land surface, surface water, groundwater, or air resources are impacted by mining operations within the permitted boundary (Section 19.10.1.7.A.3 NMAC). For the AAS, an impact is defined as the presence of mine-derived constituent concentrations that are elevated from background levels and/or exceed regulatory standards. Elevated constituent concentrations will be evaluated on a case-by-case basis to determine if an affected area classification status is appropriate.

As summarized in this report, numerous environmental investigations have been conducted, are ongoing, or are proposed for the Tyrone Mine Facility. Several of these investigations address the effects of mining operations on the environment outside the MMD permit boundary, and therefore meet the data needs of the AAS. For instance, in April 2003, the New Mexico Environment Department (NMED) issued Tyrone a supplemental discharge permit (DP-1341) that provides site closure requirements. Some of the closure requirements address possible mining-related impacts outside the MMD permit boundary. This work plan summarizes previous, ongoing, and proposed investigations as they pertain to affected areas. Additionally, the work plan identifies areas where data are insufficient to determine if an area is affected (i.e., data gaps) and recommends additional investigations to fill these data gaps.

2. Site Background

This section provides an overview of the Tyrone Mine Facility. The discussion includes descriptions of the environmental setting, history of mine operations and facilities, and environmental permits.

2.1 Environmental Setting

The Tyrone Mine Facility is located approximately 10 miles south of Silver City, New Mexico on approximately 9,000 acres on the northeastern flanks of the Big Burro Mountains (Figures 1 and 2). The natural ground surface elevation at the Tyrone Mine Facility ranges from about 5,300 to 6,500 feet above mean sea level (msl). The Continental Divide crosses the Tyrone Mine Facility between the Big Burro and Little Burro Mountains.

The following sections present a general description of the climate, regional geology, hydrology, and groundwater quality in the vicinity of the Tyrone Mine Facility.

2.1.1 Climate

The climate in the area is semiarid, with annual evaporation exceeding annual precipitation. Average annual precipitation is approximately 16 inches, and average annual lake evaporation is approximately 64 inches (Trauger, 1972). Most of the precipitation falls during the monsoon season, July through October. Tyrone collects monthly precipitation data at five weather stations distributed across the Tyrone Mine Facility. Evaporation data are collected from Class A type evaporation pans located at the No. 1A leach stockpile, Nos. 1 and 3 tailing impoundments, and Bill Evans Lake. Average annual pan evaporation rates range from 86 inches (Bill Evans Lake) to 101 inches (No. 3 tailing impoundment) (DBS&A, 1999). Average daily maximum temperatures range from approximately 49°F in December to 86°F in June and July (DBS&A, 1999).

The vegetation is categorized as a desert scrub grassland in the area of the tailing impoundments, transitioning to a mixed-evergreen woodland at the higher elevations around the open pits and stockpiles.

2.1.2 Regional Geology

The Tyrone copper deposit generally occurs within a triangular area at the northeast end of the Big Burro Mountains; it is bounded by the Burro Chief Fault on the west, the Sprouse-Copeland Fault on the east, and multiple smaller unnamed faults on the south (Figure 3). The geology of the deposit and surrounding area has been summarized by DuHamel et al. (1995), Kolessar (1982), and Paige (1922).

The rocks that crop out in the Big Burro Mountains, the Mangas Valley, and the Little Burro Mountains range in age from Precambrian to Quaternary. The Big Burro Mountains are primarily composed of Precambrian Burro Mountain granite, which is part of a batholith that was subsequently intruded by the Tyrone laccolith nearly 56 million years ago (Kolessar, 1982). The Tyrone laccolith is composed of four principal stages of porphyry intrusions (DuHamel et al., 1995), collectively referred to as the Tertiary Quartz Monzonite of Tyrone.

Exposures of the predominantly sedimentary Cretaceous rocks are limited to the Little Burro Mountains. The Cretaceous units include the thin-bedded to massive Beartooth quartzite and the Colorado Formation, which is a sandy shale (Kolessar, 1982). Cretaceous and Tertiary volcanic rocks (primarily andesites and rhyolites), overlie the Cretaceous sedimentary units. The youngest rocks in the area are of Late Tertiary and Quaternary age, and consist mostly of sands, gravels and conglomerates. The Gila Conglomerate, the oldest of the younger sedimentary rocks, was deposited as bolson fill and as fan deposits derived from Late Tertiary and older uplifts. The youngest sedimentary units were deposited unconformably on Gila Conglomerate and as valley fill along present-day drainages.

The predominant geologic structures at and near Tyrone are sets of northeast- and northwest-trending faults (Figure 3). The Sprouse-Copeland Fault near Oak Grove Wash strikes north-south and is nearly vertical, with displacement on the order of hundreds of feet. This fault has juxtaposed upthrown Precambrian Burro Mountain granite against the Gila Conglomerate. The other major northeast-striking faults in the area are the Austin-Amazon Fault and the Burro Chief Fault, which forms the western limit of the Tyrone copper deposit (Kolessar, 1982). According to Hedlund (1978), these older faults are splayed and branched and have been intruded by rhyolite and quartz monzodiorite porphyry dikes in some sections. The Tyrone ore deposits are associated with these faults and intrusions.

The younger, northwest-trending fault system controls the current topography in the area of the Tyrone Mine Facility. The Mangas Fault strikes northwest-southeast with a dip of about 60 degrees southwest, and forms a prominent scarp on the Little Burro Mountains. The Mangas Fault has juxtaposed Gila Conglomerate and bolson fill against the older rocks of the Little Burro Mountains (Kolessar, 1982). The generally east-west trending Southern Star Fault juxtaposes Precambrian rocks of the Big Burro Mountain against Gila Conglomerate and bolson fill in the area south of the No. 1A tailing impoundment and beneath the No. 3 leach stockpile.

2.1.3 Hydrogeology

Three primary hydrostratigraphic units have been identified at Tyrone based on rock type and groundwater flow characteristics. The three hydrostratigraphic units are (1) intrusive igneous rocks (Precambrian granite and Tertiary quartz monzonite), (2) Tertiary/Quaternary Gila Conglomerate, and (3) Quaternary alluvium (DBS&A 1997a and 1997b). The intrusive igneous rocks occur primarily in the area of the mine. The Tertiary/Quaternary Gila Conglomerate is an unconsolidated to semiconsolidated sedimentary deposit present in Mangas Valley, the Oak Grove Wash/Brick Kiln Gulch area (i.e., East Side area), and along the northern and eastern boundaries of the mine. Quaternary alluvium is primarily present in drainages and may contain perched water (e.g., Deadman Canyon and Oak Grove Wash) or regional groundwater (e.g., Mangas Valley).

Figures 4 and 5 show regional groundwater level elevations for northern and southern portions of the Tyrone Mine Facility. In the Mangas Valley area, groundwater flows to the northwest (Figure 4). Regional groundwater flow in the vicinity of the open pits is controlled by mining dewatering. In the Oak Grove/Brick Kiln Gulch area, groundwater flows to the east-southeast (Figure 5).

The remainder of this section provides an overview of current groundwater quality at the Tyrone Mine Facility; the discussion is divided into separate sections for perched and regional groundwater. Contaminant levels in perched and regional groundwater are above numerical groundwater quality standards of 20.6.2.3103 NMAC for some constituents at various locations. Where impacted perched water exists due to fugitive pregnant leach solution (PLS), standards for most constituents tested (i.e., total dissolved solids [TDS], sulfate, aluminum, cadmium, cobalt, chromium, copper, fluoride, iron, manganese, nickel, and zinc) are present at concentrations above groundwater standards unless dilution has occurred due to mixing with natural waters. Impacted regional groundwater monitor wells generally have lower constituent concentrations than those observed in perched waters. Impacted regional wells often exhibit elevated concentrations of TDS, sulfate, and manganese. It is possible that manganese concentrations in groundwater in some areas of the Tyrone Mine Facility could be elevated or exceed standards due to natural background conditions.

2.1.3.1 Perched Groundwater Quality

Saturated conditions exist within a number of perched zones adjacent to leach stockpiles and upgradient of PLS collection facilities. These saturated conditions are an intrinsic component of the mine-for-leach operation conducted at the Tyrone Mine Facility, and the saturating fluid is PLS, which exceeds numerous groundwater quality standards. In three areas of the Tyrone Mine Facility, fugitive PLS has impacted perched water quality downgradient of PLS collections systems. These areas are the toe of the No. 3 leach stockpile, the Deadman Canyon area, and the Oak Grove Wash/Brick Kiln Gulch area.

Perched zones at the No. 3 leach stockpile consist of narrow north- to northeast-oriented natural drainage channels that contain unconsolidated alluvial sediments and extend outward from the base of the stockpile. Investigations at the stockpile have identified perched PLS seepage in 10 of the 11 existing drainage channels or “canyons”. To reduce the effects of PLS seepage on groundwater quality, a series of interceptor/barrier trenches have been installed in several of the canyons. Relatively small amounts of perched water not captured by the containment systems eventually mingle with regional groundwater, which is captured by regional pumping wells.

Fugitive PLS has impacted perched water quality in Deadman Canyon. Figure 6 shows the current extent of perched water and identifies perched zone monitor wells exceeding water quality standards in 2004. Seepage collection systems have been installed and source control measures implemented (i.e., removal of the United States Natural Resources Inc. [USNR] leach stockpile, a precipitation plant and an associated pond, and a portion of the No. 2A leach stockpile material) to limit PLS impacts. Seepage collection systems are located just downgradient of seeps emanating from the toe of the No. 2 and 2A leach stockpiles. Table 1 provides a comparison of perched zone water quality for an upgradient (TWS-35) and a downgradient (TWS-28) well in Deadman Canyon. Because water quality impacts extend outside the MMD permit boundary, the perched zone in Deadman Canyon is considered an affected area (Section 3.2).

Fugitive PLS has also impacted perched water quality beneath Brick Kiln Gulch and Oak Grove Wash (Figure 7). In this area, a zone of fugitive PLS mixed with natural water currently extends approximately 2 miles downgradient from the No. 1 leach stockpile. Table 1 provides perched zone water quality data for one of several monitor wells located in this area. Abatement activities have been successful in reducing perched zone extent, which was approximately 3.4 miles in 1996, and stopping the continued migration of impacted water down Lower Oak Grove Wash. Because the perched zone extends outside the MMD permit boundary and exceeds water quality standards, it is considered an affected area (Section 3.3).

2.1.3.2 Regional Groundwater Quality

Regional groundwater quality data for the most recent analyses conducted within 2003 to 2004 are illustrated in Figure 8; note that only wells that have water quality analyses within the 2003 to 2004 timeframe are illustrated on this figure. The figure shows monitor well locations where water quality exceeds groundwater standards. The majority of regional groundwater quality impacts are observed within the MMD permit boundary. Groundwater quality standards are exceeded at some locations outside the MMD permit boundary beneath Oak Grove Wash and in Deadman Canyon. These locations are considered affected areas (Sections 3.2, 3.3

and 3.4). Impacts to regional groundwater quality outside the MMD permit boundary appear to be relatively limited in horizontal extent, pending continued investigation and monitoring. Regional groundwater outside the MMD permit boundary in Mangas Valley meets groundwater quality standards.

2.1.4 Surface Water

Streams and washes in the vicinity of the Tyrone Mine Facility are ephemeral—they flow only after significant precipitation events. Because streams at the Tyrone Mine Facility are ephemeral, it is not anticipated that biological assessments will be used to assist with definition of the extent and magnitude of impacts to surface water. Major surface water features in the vicinity of the Tyrone Mine Facility include Mangas Creek, Deadman Canyon, Brick Kiln Gulch and Oak Grove Wash (Figure 2).

As required by the Tyrone Storm Water Pollution Prevention Plan (SWPPP), discharges from each of 17 representative outfalls (Table 6.1 in PDTI, 2003) are monitored visually on a quarterly basis. Visual observations include characteristics such as color, odor, clarity, presence of floating, settled or suspended solids, foam, oil sheen, or other indicators of stormwater pollution.

In addition, a series of routine sampling and analytical monitoring requirements exist for active copper ore mining and dressing facilities. To fulfill these requirements, 8 representative outfalls must be sampled twice a year for total suspended solids (TSS), turbidity, pH, hardness as calcium carbonate, and 13 metals (antimony, arsenic, beryllium, cadmium, copper, iron, lead, manganese, mercury, nickel , selenium, silver, and zinc). Once per quarter during year 2 and year 4 of monitoring, these 8 representative outfalls must also be sampled for TSS, nitrate plus nitrite as nitrogen, and chemical oxygen demand (COD). Also once per quarter during these monitoring years, 3 additional outfalls must be sampled for TSS, nitrate plus nitrite as nitrogen, and COD (Table 6.2 in PDTI, 2003).

Stormwater quality samples collected in 2002 from Oak Grove Wash and Deadman Canyon contained constituent concentrations above benchmark cutoff concentrations for copper, iron, manganese, lead, TSS, COD, and zinc (PDTI, 2003). Sampling of surface water in the Mangas Valley will be conducted under Condition 34 of the DP-27 Settlement Agreement and Stipulated Final Order; the Condition 34 water monitoring plan was submitted to NMED on December 12, 2003.

Interaction between surface water and groundwater occurs at the Tyrone Mine Facility in three ways:

- Infiltration of surface water to groundwater during and after storm events large enough to cause flows in the washes
- Discharge of groundwater to the surface at springs or seeps
- Discharge of groundwater to the Main, Gettysburg, and Copper Mountain Pits, which have been excavated to depths such that they intersect groundwater

A number of seeps and springs are monitored under existing operational discharge plans (DPs). Samples are analyzed for a variety of cations and anions (bicarbonate, carbonate, calcium, chloride, fluoride, magnesium, potassium, sodium, and sulfate), TDS, pH, and metals (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, and zinc).

Tyrone monitors a total of 8 seeps (Nos. 2, 3, 4, 5, 5E, 6, 8, and 1, designated as location TWS7) under DP-166, which covers the No. 2 leach system and Deadman Canyon. As of May and June 2004, Seep 5 was the only one that had intermittent flows, and the measured levels of some contaminants were above the groundwater quality standards. Deadman Canyon Spring and McCain Spring are sampled under DP-435, and water from the open pits is also sampled regularly under existing DPs.

2.2 History of Tyrone Mine Operations and Facilities

This section presents a brief history of mine operations and describes major mine facilities at Tyrone. These facilities include tailing impoundments, stockpiles, open pits, a mill and concentrator facility undergoing demolition, and a solution extraction/electrowinning (SX/EW) plant. Figure 2 identifies the facilities on a recent (February 2004) aerial photograph.

2.2.1 History of Operations

Phelps Dodge has mined copper in the Tyrone area since the early 1900s. Early mining was conducted underground, with ore concentrated in a mill located just east of the No. 1 leach stockpile, and tailing material deposited at the Burro Mountain tailing impoundment. In 1921, a drop in copper prices and lack of high-grade ore caused the underground mines to shut down. Limited leaching and precipitation operations occurred between 1921 and 1929 and intermittently between 1941 and 1950.

In 1967, Phelps Dodge began open-pit mining operations, installing a mill and concentrator along with other mine support facilities. The mill and concentrator operated between 1969 and 1992. Its operations consisted of the crushing and froth-flotation of ore to generate copper concentrate that was transported to the Phelps Dodge Hidalgo Smelter for final metallurgical processing. Tailing slurry was thickened, and tailing material subsequently deposited to six tailing impoundments located in the Mangas Valley.

In 1972, Phelps Dodge began limited stockpile leaching at the No. 1 stockpile, concurrent with the opening of a precipitation plant (Figure 2). The precipitation plant was closed in 1997. Copper matte from the precipitation plant was transported to either the Hurley or Hidalgo smelter for final metallurgical processing.

In 1984, Phelps Dodge expanded stockpile leaching operations and opened the SX/EW plant located just south of the No. 3 leach stockpile. Eight stockpiles have been permitted for leaching operations. They are the No. 1, No. 1A, No. 1B, No. 2, No. 2A, No. 3, Gettysburg, and East Main Pit stockpiles. Current mine operations consist of open-pit mining, stockpile leaching and SX/EW processing.

2.2.2 Mine Facilities

The northern portion of the mine area along Mangas Creek contains six inactive tailing impoundments: Nos. 1, 1A, 1X, 2, 3X, and 3 tailing impoundments. The tailing impoundments cover approximately 2,300 acres and contain approximately 304 million tons of processed mill tailings. Each of these impoundments will be reclaimed in accordance with the DP-27 Settlement Agreement and Stipulated Final Order (DP-27 Settlement Agreement) signed by Tyrone and NMED on October 15, 2003. Reclamation has been initiated on the No. 3X tailing impoundment.

South of the tailing impoundments are the primary mining operations. This area encompasses several open pits, leach ore stockpiles, waste rock piles, the SX/EW plant, PLS collection impoundments, seepage interception systems, stormwater detention impoundments, a maintenance and lubrication area, process solution pumping stations, process solution conveyance systems, former mill and concentrator facilities, the former precipitation plant area and acid unloading facility, and the Burro Mountain tailing impoundment.

The open pits at the Tyrone Mine Facility cover approximately 2,000 acres, and include the Main, West Main, Valencia, Gettysburg, Copper Mountain, South Rim, Savanna, and San Salvador Hill pits. The various leach ore stockpiles and waste rock piles at the Tyrone Mine Facility encompass approximately 2,800 acres and contain approximately 1.7 billion tons of rock deposited near and adjacent to the open pits. The leach ore stockpiles are the No. 1, No. 1A, No. 1B, No. 2, No. 2A, No. 3, East Main Pit, Gettysburg Out Pit, and Gettysburg In Pit stockpiles. The waste rock piles include the Nos. 1C, 1D, 3B, a portion of the 2B, the Savanna, and the Upper Main. A former leach ore stockpile leached by a previous operator, the USNR leach stockpile, was removed from the Deadman Canyon area and placed on the No. 2A leach stockpile in 2000. USNR conducted mining and leach operations in the Deadman Canyon area from about 1970 to 1976.

The SX/EW plant area encompasses approximately 51 acres. The SX/EW plant removes copper from PLS and reacidifies recycled and make-up water with sulfuric acid to produce raffinate for leaching. Raffinate is applied to the tops of the leach ore stockpiles using drip emitters, and it percolates through the stockpiles leaching copper and other minerals, and becomes PLS. PLS is captured at stockpile toes by collection systems and then pumped to the SX/EW plant.

2.3 Regulatory Background

Tyrone operates under MMD mine permit No. GR010RE, as well as nearly a dozen DPs issued by the NMED. Tyrone also operates under an SWPPP.

Discharges from mine facilities have been permitted under 10 operational groundwater DPs:

- Mangas Valley tailings (DP-27)
- No. 2 leach system and SX/EW plant (DP-166)
- No. 3 leach system (DP-286)
- No. 1A leach system (DP-363)
- No. 1B leach system (DP-383)
- No. 1C waste rock pile (DP-396)
- No. 2A leach system (DP-435)
- Gettysburg leach system (DP-455)
- East Main leach system (DP-670)
- Acid unloading facility area, the No. 1 leach ore stockpile, and the historical Burro Mountain tailing impoundment (DP-896)

Figure 9 shows the approximate boundaries of each DP. Under the operational DPs, Tyrone has installed and now operates many systems designed to capture and treat or limit the extent of mine discharges to surface water and groundwater. Tyrone also conducts ongoing corrective actions or abatement in certain portions of the Tyrone Mine Facility under some of the operational DPs and/or 20.6.2.1203 NMAC.

On April 8, 2003, the NMED issued Tyrone a supplemental discharge permit (DP-1341). This permit supplements the operational DPs listed above and provides additional requirements for site closure. The intent of the requirements is to prevent the exceedance of groundwater quality standards (Section 20.6.2.3103 NMAC) or presence of toxic pollutants in groundwater, and to ensure abatement of groundwater contamination. Several of these requirements address potential impacts outside the MMD permit boundary, and are therefore summarized in this work plan.

The Tyrone SWPPP identifies 63 outfalls for monitoring of stormwater that could flow into Mangas Wash, Deadman Canyon, or Oak Grove Wash (Section 2.1.4).

3. Affected Area Environmental Studies

Previous, ongoing, and proposed environmental investigations that address impacts or potential impacts outside the MMD permit boundary are presented in this section. More recent, ongoing, and proposed investigations are generally associated with DP-1341 closure requirements, specifically Condition 34 (Abatement Plan), Condition 82 (Supplemental Groundwater Study), Condition 84 (Assessment of No. 3 Tailing Spill Reclaimed Areas), and Condition 85 (Deposition of Tailing Transported by Wind or Water). These investigations are summarized as they pertain to previously identified or possible affected areas. Condition 89 of DP-1341 (Feasibility Study) may also be relevant to the AAS. However, this condition is not described in detail in this work plan because it does not involve the collection of new data that may influence the determination of affected areas, but rather is a study to evaluate closure alternatives for each facility to be closed and to determine whether the closure alternatives evaluated will ensure that the requirements of the Water Quality Act (WQA) and the New Mexico Water Quality Control Commission (NMWQCC) regulations are met.

Some of the previous environmental investigations have already identified affected areas or provide data that demonstrate that environmental media outside the MMD permit boundary are not impacted. Known affected areas occur within four general geographic areas: Mangas Valley, Deadman Canyon, Oak Grove Wash/Brick Kiln Gulch (East Side area), and Upper Oak Grove Wash (Figure 2).

3.1 Mangas Valley

Affected areas and potentially affected areas in the Mangas Valley are associated with six tailing impoundments located along the valley. Reclaimed areas from a 1980 tailing spill are recognized affected areas. Wind-blown transport and subsequent deposition of tailing material may impact soil and sediments outside the MMD permit boundary. Both the reclaimed areas and potential impacts from tailing deposition will be addressed as part of DP-1341 and are discussed below.

3.1.1 No. 3 Tailing Impoundment Tailing Spill

Affected areas in the Mangas Valley include reclaimed areas associated with an October 13, 1980 spill from the No. 3 tailing impoundment. The spill discharged approximately 2.6 million cubic yards of tailing material into the Mangas Valley. Tailing material was either contained in place or excavated and placed in multiple repositories. By July 1981, Tyrone had reclaimed the tailing spill by covering excavated areas and repositories with at least 18 inches of native cover material (i.e., surface soil, alluvium, or Gila Conglomerate) and then reseeding (DBS&A, 1997a and 1999). Tyrone discontinued tailing deposition at the No. 3 tailing impoundment after the 1980 spill. Figure 10 shows the locations of the reclaimed repository areas.

Between March 1999 and May 2001, an assessment of repository reclamation activities was conducted to demonstrate how these efforts were protective of groundwater and surface water quality (TTEMI, 2001). The assessment consisted of an evaluation of existing data and site surveys to verify the locations of reclaimed areas, identify groundwater and surface water sampling points, and examine reclaimed area conditions. The assessment also evaluated two years of DP-27 groundwater and surface water monitoring data.

The assessment identified individual tailing reclaimed areas and found reclamation efforts to be generally successful; covers showed little erosion and supported native vegetation (TTEMI, 2001). The assessment also demonstrated that the tailing release had not impacted groundwater quality, and that drainage off reclaimed areas was not affecting surface water quality. Groundwater analytical results met NMWQCC standards for groundwater quality, and except for an elevated copper concentration at FS-5 during a sampling event in 1992, surface water quality met NMWQCC water quality standards for livestock.

As part of DP-1341 Condition 84, Tyrone will update this previous assessment by further evaluating the success of reclamation activities performed after the October 1980 tailing spill. The purpose of the evaluation is to determine whether reclamation activities meet WQA and NMWQCC regulation requirements. In addition, DP-1341 Conditions 16 through 20 specify requirements for cover placement and revegetation of tailing material.

In 2004, Tyrone performed investigation activities to satisfy DP-1341 Condition 84 requirements. Tyrone will submit a report describing these investigation activities and evaluating reclamation success to NMED by April 29, 2005. Investigation activities performed in 2004 include the following (TTEMI, 2004a and 2004b; PDTI, 2004a and 2004b):

- A map showing tailing spill and repository locations was generated using a geographic positioning system (GPS) to accurately define reclaimed area extents. Figure 10 shows the delineation of spill areas and repositories based on this mapping effort.

- Boreholes were advanced through reclaimed area covers to facilitate measurement of cover thicknesses.

- Vegetation performance data were collected at reclaimed areas. The data consisted of species counts, canopy and basal covers, litter accumulation, and number of surface rock fragments.

- Groundwater quality samples were collected from DP-27 monitor wells (designated 13, 14, 15, 19, 37, 38, 44, 47 and G) and existing or former water supply wells within Mangas Valley (designated MS-2, MS-3, MS-4, MS-5, MS-8 and MS-10). The samples were submitted to a laboratory and analyzed according to DP-27 monitoring requirements, which include analysis of total dissolved metals and major anions.

- Groundwater levels were measured at the same wells from which water quality samples were collected except for water supply wells where casing access to groundwater is restricted. The water level measurements will be used to calculate groundwater elevations and to determine regional groundwater flow directions in the near vicinity of the reclaimed areas.

- Monitoring of surface water quality at two sample locations (designated FS-5 and FS-6) immediately downgradient of reclaimed repositories. These sample locations are part of a network of flow samplers located in Mangas Wash that facilitate surface water sampling following storm events.

The DP-1341 Condition 84 reclaimed area evaluation will also include an assessment of the upward migration of acidity into cover material from underlying tailings. This assessment will be accomplished by interpreting soil cover chemical and physical data collected in May 2001. These data were sent to NMED and MMD, but a formal interpretive report was not prepared at that time. Also as part of the DP-1341 Condition 84 investigations, the May 2001 soil cover data will be interpreted and reported.

In 2004, Tyrone initiated additional repository reclamation activities consisting of cover augmentation and surface drainage control. Before these reclamation activities were performed, photographs were taken to record preconstruction conditions. Photographs were also taken to document post-construction conditions. The photographs will be submitted in a Construction Quality Assurance (CQA) report to be submitted to NMED in the summer of 2005. This report will also include as-built drawings, final topographic contour maps, soil testing results, and a summary of reclamation activities. The CQA report is a requirement of DP-1341 Condition 18.

3.1.2 Investigation of Tailing Transport and Deposition Impacts

As part of DP-1341 Condition 85, Tyrone will identify, delineate, and abate any tailing deposition originating from water and wind erosion of the tailing impoundments in the Mangas Valley. Tyrone has submitted a work plan to the NMED that addresses tailing deposition (TTEMI, 2004b; PDTI, 2005). The scope of the work plan includes investigating possible tailing deposition outside the MMD permit boundary and assessing any resulting soil, surface water or groundwater impacts. The work is to be performed in 2005 and a final report submitted to NMED by February 15, 2006.

The objectives of the tailing deposition study are to (1) assess the extent of tailing deposition from water and wind erosion of the No. 1, 1A, 2, 3 and 3X tailing impoundments, (2) assess potential soil and stream sediment impacts from tailing deposition, and (3) evaluate the necessity for abatement and reclamation. The tailing deposition study includes the following tasks:

- The deposition of wind-blown tailings will be identified visually using aerial photographs and by performing site reconnaissance. If observed, tailing deposition will be mapped using GPS and the thickness will be measured. In addition, shallow soil samples will be collected every 50 feet along transects oriented in the same direction as prevailing winds (i.e. generally to southwest). The minimum number of transects for each tailing impoundment will vary between 3 and 7 depending on the impoundment.

- Tyrone will inspect major ephemeral streams of the watersheds that the tailing impoundments are located within to identify and map any tailing material transport from an impoundment by surface water. This assessment will be accomplished by examining stream deposits, incised channel walls, and shallow excavations for the presence of tailing material. In addition, approximately 30 stream sediment samples will be collected downstream of the tailing impoundments, including samples from Mangas Wash (Figure 11).

- Soil and stream sediment samples will be submitted to a laboratory for analysis of paste pH and electrical conductivity (EC). Sample results will be compared to background samples collected from exposed Gila Conglomerate to identify impacts from tailing deposition.

- If significant and continuous tailing deposits are observed, Tyrone will make recommendations for abatement and reclamation.

It is unlikely that groundwater quality has been impacted by the deposition of fugitive tailings due to large thickness of the vadose zone. Nonetheless, potential groundwater impacts will be investigated if distinct tailing deposits are observed. Surface water quality will be assessed under DP-1341 Condition 48.

In addition to the tailing impoundments located on the northern portion of the Tyrone Mine Facility, the Burro Mountain tailing impoundment is located at the southern end of the facility. The Burro Mountain tailing impoundment received tailing from the concentrator from 1916 to

1921. In 2002, the tailing was covered with a dust cap. In 2004, the tailing unit was reclaimed incorporating a 3-foot cover with stormwater management diversions and control features.

Waste rock and leach stockpiles are not expected to contribute significantly to possible air and soil/sediment impacts through surface water runoff and wind-blown transport. Containment and diversion structures installed at the toes of many of the stockpiles prevent runoff of PLS and stormwater. Stockpile material is generally gravel to boulder sized and not susceptible to wind-blown transport. Given the surface water runoff controls and no wind-blown transport mechanism, a deposition study associated with the waste rock and leach stockpiles is not proposed.

3.2 Deadman Canyon

Fugitive PLS or other seepage emanating from the Nos. 2 and No. 2A leach stockpiles are sources of perched zone impacts west of the MMD permit boundary in Deadman Canyon and in some of the alluvial channels east of the canyon. In addition, the former USNR leach stockpile contributed impacted water to this perched zone before Tyrone removed the stockpile in 2000.

To mitigate perched zone impacts, Tyrone has installed seepage collection systems and implemented source control measures. Seepage collection systems have been installed at seeps 2, 3, 4, 5E, 8, 9, and DC2-1 between 1997 and 1998. In 2000, Tyrone removed the USNR leach stockpile and portions of the No. 2A leach stockpile to areas of the No. 2 leach stockpile complex that overlie the eastern portion of the pre-mining drainage divide (HAI, 2001).

Water quality in the Deadman Canyon area is monitored under DP-166. Figure 6 shows perched zone monitor wells and water elevations; seep, spring and seepage collection system locations; and perched zone wells that exceed Section 20.6.2 NMAC groundwater quality standards. In 2004, sulfate and TDS concentrations exceeded groundwater quality standards at two perched zone monitor well locations outside the MMD permit boundary: TWS-37 and TWS-39; other constituents exceeding groundwater quality standards included aluminum, cobalt, copper, and manganese. Wells TWS-33 and TWS-34 exceeded the manganese standard. Perched zone water quality in Deadman Canyon fluctuates; between 1997 and 2004, TDS concentrations at TWS-39 varied from 250 to 1,670 milligrams per liter (mg/L).

In general, regional groundwater in Deadman Canyon meets groundwater quality standards, and shows minimal mining-related impacts. In 2004, TWS-8, located west of the MMD permit boundary, exceeded the groundwater standard for iron (Figure 8). TWS-9, also located outside the MMD permit boundary, meets groundwater quality standards. TDS concentrations in TWS-9 have been generally increasing through time. Well TWS-9 is open to the alluvium and the underlying bedrock.

As part of DP-1341 Condition 82, Tyrone will perform an additional groundwater study in the Deadman Canyon area (DBS&A, 2004). The study will address fluctuations in observed water quality related to changes in precipitation (HAI, 2001), the implementation of seepage control systems, the location and intensity of leach operations within the No. 2 leach stockpile complex, or some combination of all of these factors. The study will include detailed examination of water quality, precipitation records, raffinate application records, and water levels and water quality data collected from newly installed perched and regional groundwater monitor wells.

The extent of impacted perched water in Deadman Canyon is well known except in the downgradient (north) direction beyond TWS-28 and Seep 5, an area that is within the MMD permit boundary. A perched/regional aquifer well pair will be installed downgradient of TWS-28 and Seep 5 just within the MMD permit boundary. These wells are designated as DP-166-2005-02R (regional) and DP-166-2005-02S (perched) on Figures 6 and 8, respectively. A second perched zone well (designated as DP-166-2005-01) will be installed upgradient (south) of impacted water, near TWS-8 (Figure 8). Paste pH values will be collected on soil and sediment samples when these wells are drilled. In addition, well TWS-19 will be added to the DP-166 quarterly sampling and water level measurement schedule. Data collected from these wells will be used to better define the extent and magnitude of mining-related impacts in Deadman Canyon, and therefore support the AAS.

3.3 Oak Grove Wash/Brick Kiln Gulch (East Side area)

Fugitive PLS originating from the Nos. 1, 1A and 1B leach stockpiles and impacted seepage originating from the No. 1C waste rock pile have created perched zones of poor water quality beneath Brick Kiln Gulch and the upper and lower reaches of Oak Grove Wash along the southeastern boundary of the Tyrone Mine Facility (Figure 7). Perched PLS mixed with native water extends approximately 2 miles from the vicinity of the No. 1 leach stockpile. The historical extent of this perched PLS from the No. 1 leach stockpile was 3.4 miles when it was discovered in 1996. Perched PLS also exists in Upper Oak Grove Wash and extends approximately 0.25 mile from the toe of the No. 1A leach stockpile. As shown on Figure 7, zones of perched PLS extend outside the MMD permit boundary, and are therefore considered affected areas.

Abatement activities conducted under DP-363 and DP-383 were initiated in January 1999, and have reduced the extent of impacted perched water, especially in Upper Oak Grove Wash, where interceptor/barrier trenches have been installed within the wash and at the bases of the Nos. 1A and 1B leach stockpiles and the No. 1C waste rock pile. The interceptor/barrier trenches capture process and fugitive PLS and impacted seepage from precipitation. Effective seepage controls have not yet been implemented in Brick Kiln Gulch or the alluvial channels that emanate from underneath the No. 1 leach stockpile. Perched PLS is pumped from wells just downgradient of the confluence of Oak Grove Wash and Brick Kiln Gulch.

Regional groundwater in the Oak Grove Wash/Brick Kiln Gulch area exceeds Section 20.6.2 NMAC groundwater standards at three monitor well locations outside the MMD permit boundary: MB-28, MB-29, and MB-42 (Figure 8). In 2004, sulfate and TDS concentrations at MB-29 were 627 and 1,030 mg/L, respectively, only slightly above groundwater quality standards. At MB-28 and MB-42, only manganese was detected at concentrations above groundwater quality standards; historically sulfate and TDS concentrations at these two well locations have been below groundwater quality standards. A study will be conducted under DP-1341 Condition 34 to evaluate the extent of naturally occurring manganese in groundwater in this area.

Additional data collection is proposed for the Oak Grove Wash/Brick Kiln Gulch area as part of DP-1341 Conditions 34 and 82 (DBS&A, 2003 and 2004). Both vadose zone and regional groundwater investigations will be performed. The vadose zone investigation will consist of soil boring installation, sediment sampling and leach testing, and instrumentation at selected monitor wells, as described below:

- Soil borings will be installed at two investigation areas (Figure 7). The boring will be advanced to the bottom of PLS-impacted sediments or auger refusal. Cuttings will be collected at 5-foot intervals. Based on historical fluid levels in nearby wells, samples will be collected starting at the interval closest to but above the former PLS-free surface, continuing to the bottom of the boring. The samples will be leach tested to estimate water quality where saturated conditions occur due to recharge.

- To evaluate whether transient pulses of saturation occur within the perched zones, two existing (but currently dry) perched zone wells in the two investigation areas will be instrumented with continuous-recording pressure transducers. Wells will be selected that lie within or near the deepest portion of the former perched zone at each location. If pulses of transient saturation are observed, an attempt will be made to correspond the occurrences to known precipitation or snowmelt events.

The regional groundwater investigation will include the installation of three monitor wells: DP-363-2005-01, DP-363-2005-02, and DP-896-2005-01 (Figure 8). The collection of water quality data at these wells will assist in evaluating regional groundwater impacts outside the MMD permit boundary. Well DP-363-2005-02 will assist with characterization of deep groundwater in the area of OG-39, which is the current terminus of perched water (Figure 7). Well DP-363-2005-01 will assist with the determination of groundwater and contaminant flow paths in the vicinity of the Sprouse-Copeland Fault.

In addition to fugitive PLS impacts, approximately 1,000,000 gallons of PLS was released to Brick Kiln Gulch and Oak Grove Wash in December 1997 (DBS&A, 1999). The spill extended 4.5 miles and outside the MMD permit boundary. Tyrone abated the release by removing PLS and affected soils and sediments. Additional investigation of the release is not required because impacted sediments were removed from the drainages.

3.4 Upper Oak Grove Wash (South Side)

Regional groundwater outside the southern portion of the MMD permit boundary exceeds Section 20.6.2 NMAC groundwater quality standards (Figure 8). Water quality at the southern extent of the Tyrone Mine Facility is monitored as part of DP-166, DP-396, and DP-455. Groundwater in this area flows east/northeast, essentially in the same direction as Upper Oak Grove Wash.

In 2004, water quality at six regional monitor wells outside or just within the southern limit of the MMD permit boundary exceeded groundwater quality standards. Monitor wells MB-13 and MB-15 are located outside the MMD permit boundary. Sulfate and TDS were measured in these wells at concentrations up to 1,470 and 2,650 mg/L, respectively. Monitor wells 2-12, MB-18D, MB-32 and MB-37 are located within the MMD permit boundary; sulfate and TDS were measured in these wells at concentrations up to 2,740 and 4,190 mg/L, respectively. Several of these wells were located adjacent to the No. 1C waste rock pile prior to its removal from Oak Grove Wash, and were most likely directly impacted by seepage through the waste rock pile materials.

Groundwater quality downgradient of impacted water along the southern MMD permit boundary is currently monitored at wells in the lower reach of Upper Oak Grove Wash (e.g., MB-31 and MB-29) and in Lower Oak Grove Wash (e.g., MB-4, MB-8, and MB-43). While downgradient wells in Upper Oak Grove Wash exhibit mine-related impacts, wells further downgradient in Lower Oak Grove Wash meet groundwater quality standards (Figure 8). A network of monitor wells currently exists to monitor water quality downgradient of water quality impacts on the southern MMD permit boundary. These wells will continue to be monitored under East Side (DP-363, DP-383, and DP-896) monitoring requirements.

4. Affected Area and Data Gap Summary

This section provides a summary of areas outside the Tyrone MMD permit boundary that have been identified as affected by sources originating within the permit boundary. In the event that there is insufficient data to determine whether an area is affected and to what degree, data gaps and the proposed means of addressing the data gaps are also identified.

4.1 Summary of Affected Areas

The following sections discuss affected media, existing abatement measures, ongoing monitoring, and future proposed studies required as part of other environmental permit conditions for each area.

4.1.1 Mangas Valley

Air. All of the tailing impoundments in the Mangas Valley are scheduled for reclamation by 2008. The No. 3X tailing impoundment is currently undergoing reclamation, and a large portion of this impoundment has been covered as set forth in the requirements of the DP-27 Settlement Agreement.

Soil and Sediments. Impacts to soil and sediment could have resulted from wind-blown tailing and the tailing dam failure that occurred in 1980. Potential impacts will be investigated under Condition 84 of DP-1341. Tailing that could be identified in sufficient quantities has been collected, piled and covered at a number of tailing repositories in the Mangas Valley, most of which are outside the permit boundary.

Surface Water. Stormwater runoff is managed within the MMD permit boundary by a series of berms, reservoirs, and other best management practices (BMPs). There are eight designated outfalls in the Mangas Valley near the MMD permit boundary monitored under the Tyrone SWPPP. Surface water monitoring will also be conducted in accordance with an NMED-approved monitoring plan submitted under Condition 34 of the DP-27 Settlement Agreement .

Groundwater. Monitor wells within the Mangas Valley indicate that groundwater has not been impacted outside the MMD permit boundary. Groundwater monitoring will continue in the Mangas Valley under the DP-27 Settlement Agreement in accordance with a groundwater monitoring plan submitted by Tyrone for approval by NMED.

4.1.2 Deadman Canyon

Air. No impacts to air quality are known to have occurred in this area.

Soil and Sediments. Impacts to soil and sediments have occurred in this area due to seepage from mine facilities. A significant portion of existing impacts may be attributable to the former USNR leach stockpile (not part of Tyrone's operations), which Tyrone removed from Deadman Canyon in 2000, and the materials placed on the No. 2 leach stockpile complex (HAI, 2001). Additional sediment samples will be collected in Deadman Canyon during installation of a new perched zone/regional groundwater monitor well pair where the canyon narrows near Seep 5E. The monitor well pair will be installed during the summer of 2005 under DP-1341 Conditions 34 and 82.

Surface Water. Impacts to surface water have occurred in this area due to runoff events from the No. 2 leach stockpile area and the presence of impacted groundwater in seeps that emanate in the canyon or its tributaries. Nine designated outfalls in Deadman Canyon outside or very close to the MMD permit boundary are monitored under the Tyrone SWPPP. Stormwater runoff is managed within the MMD permit boundary by a series of berms, reservoirs, and other BMPs.

Groundwater. Existing monitor wells within Deadman Canyon indicate that perched water is impacted from the reach west of Copper Mountain Pit north to where the MMD permit boundary crosses the canyon, at which point Deadman Canyon is again within the MMD permit boundary. Perched water is impacted by TDS, sulfate, and several metals (DBS&A, 2004). Regional groundwater in Deadman Canyon has been impacted at one monitor well, which exceeds the NMWQCC standard for iron by a marginal amount (DBS&A, 2004). Three additional monitor wells (two shallow and one regional) will be installed in Deadman Canyon during the summer of

2005 under DP-1341 Conditions 34 and 82. The purpose of the wells is to better define the extent of impacts to groundwater quality and the relationship between shallow and regional water.

4.1.3 Oak Grove Wash/Brick Kiln Gulch (East Side Area)

Air. No impacts to air quality are known to have occurred in this area.

Soil and Sediments. Impacts to soil and sediments have occurred in this area due to seepage of fugitive PLS from mine facilities. Impacts occur within the Oak Grove Wash and Brick Kiln Gulch alluvium, and limited portions of Gila conglomerate beneath the alluvium. The Burro Mountain tailing impoundment was covered with a dust cap in 2002, and was totally reclaimed in 2004. Impacts from wind-blown tailing from this facility, if any exist, are not subject to MMD regulations because the facility received tailing from the concentrator from 1916 to 1921, after which it has not been active (i.e., this facility is pre-Mining Act). Additional investigations to define the extent and nature of impacted soils and sediments are in progress under DP-1341 Conditions 34 and 82. Soil and sediment samples will be collected at two locations in Oak Grove Wash to evaluate the effects of PLS seepage in the vadose zone.

Surface Water. Impacts to surface water may have occurred in this area due to infrequent runoff events from the mine stockpile area. Stormwater runoff is managed within the MMD permit boundary by a series of berms, reservoirs and other BMPs. There are eight designated outfalls in Brick Kiln Gulch or Oak Grove Wash near the MMD permit boundary monitored under the Tyrone SWPPP.

Groundwater. Impacts to both perched and regional groundwater have occurred in this area due to seepage from the Nos. 1, 1A, 1B leach stockpiles and the No. 1C waste rock pile. NMWQCC groundwater standards are exceeded for TDS, sulfate, and a variety of metals at some wells. A number of abatement measures have been implemented to address groundwater impacts in this area, including the installation of numerous groundwater capture systems and removal of that portion of the No.1C waste rock pile that was placed within Upper Oak Grove Wash. Additional investigations to define the extent and nature of impacted media are in progress under DP-1341 Conditions 34 and 82. Soil and sediment samples will be collected at two locations in Oak Grove Wash, and four additional regional groundwater monitor wells will be constructed and sampled near or outside the MMD permit boundary to better define the extent of regional groundwater impacts.

4.1.4 Upper Oak Grove Wash (South Side)

Air. No impacts to air quality are known to have occurred in this area.

Soil and Sediments. Limited impacts to shallow alluvial sediments have occurred in this area due to seepage from mine facilities immediately to the north. Several perched seepage zone interceptor trenches have been installed to collect seepage along the toe of the No. 1C waste rock pile.

Surface Water. No known surface water impacts occur in this area. Stormwater runoff is managed within the MMD permit boundary by a series of berms, reservoirs, and other BMPs. Any impacts to stormwater that do occur would be monitored at the outfall points farther down Oak Grove Wash.

Groundwater. Existing regional monitor wells within Upper Oak Grove draw immediately south of the No. 1C waste rock pile area exceed NMWQCC groundwater standards for TDS, sulfate and manganese. The possibility that manganese could occur in groundwater at levels that exceed NMWQCC groundwater standards will be investigated under DP-1341 Condition 34. Regional groundwater in this area generally moves to the northeast toward the mine facilities or beneath Oak Grove Wash, where a network of monitor wells exists to evaluate and monitor impacts.

4.2 Data Gaps and Proposed Additional Studies

There are very few data gaps at the Tyrone Mine relative to affected areas outside the MMD permit boundary. Impacts to air, soils and sediments, surface water, and groundwater have been extensively investigated and/or monitored under the numerous DPs and the Tyrone

SWPPP required by regulatory agencies. Where data gaps have been identified as part of ongoing studies and regulatory requirements (e.g. DP-1341), studies have been completed, are in progress, or have been proposed to address them (Table 2). Given the comprehensive extent of existing and proposed monitoring and existing, ongoing, or proposed environmental studies, only two additional tasks are proposed by Tyrone as part of the AAS. Each task is described below. Task 1 is proposed to address concerns raised by MMD relative to pipeline transmission facilities that serve operations within the MMD permit boundary, while Task 2 is proposed by Tyrone for completeness regarding the AAS requirement of MMD Permit No. GR010RE.

4.2.1 Proposed Task 1 - Evaluation of Environmental Impacts of Transmission Facilities

MMD has raised concerns regarding the potential for environmental impacts of transmission facilities to the Tyrone Mine, specifically the water supply pipeline between Bill Evans Lake and the mine, and the pipeline from the Little Rock Mine to the No. 1X tailing impoundment.

Available records regarding the Little Rock pipeline will be reviewed to determine if any breaks or spills were recorded in the past. If there were, corrective actions taken will be reviewed and a field inspection will be conducted to evaluate the potentially affected area.

The route of the water supply pipeline from Bill Evans Lake will be examined to evaluate potential disturbances to land surface such as areas where vegetation can not be established. The pipeline material, and its potential for any adverse environmental effects, will also be determined and reported on.

4.2.2 Proposed Task 2 - Evaluation of Impacts to Land Surface

Potential effects to land surface outside the MMD permit boundary have not been evaluated in detail. Although affected areas in this category are expected to be minimal, aerial photographs taken by the mine in 2004 and available facility drawings will be used to evaluate the extent of impacted land surface outside the MMD permit boundary attributable to mining operations within the permit boundary. Field checks of any potentially affected areas will be conducted.

In addition, should any affected areas be identified, a timeline of the construction and operation of the identified feature will be determined to the extent possible. The purpose of this task is to evaluate whether or not MMD regulations apply to a specific feature.

5. Schedule

Each of the proposed AAS tasks will be completed within eight months (240 days) of MMD approval of this work plan.

References

Daniel B. Stephens & Associates, Inc. (DBS&A). 1997a. *Preliminary site-wide groundwater study, Tyrone Mine closure/closeout*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. May 31, 1997.

DBS&A. 1997b. *Supplemental groundwater study, Tyrone Mine Closure/closeout*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. November 14, 1997.

DBS&A. 1999. *Revised closure/closeout plan, Tyrone Mine*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. April 30, 1999.

DBS&A. 2003. *DP-1341 Condition 82 supplemental groundwater study work plan*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. November 25, 2003.

DBS&A. 2004. *Stage 1 abatement plan proposal, Tyrone Mine Facility*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. October 15, 2004.

DuHamel, J.E., S.S. Cook, and J. Kolessar. 1995. Geology of the Tyrone porphyry copper deposit, New Mexico. pp.464-472 *in* Pierce, F.W. and J.G. Bolm (eds.), *Porphyry copper deposits of the American Cordillera*, Geological Society Digest 20.

HAI. 2001. *Tyrone Mine No. 2 leach stockpile discharge plan DP-166: Evaluation of potential seepage to Deadman Canyon and supplemental monitoring results, April 1 through September 30, 2001*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. October 31, 2001.

Hedlund, D.C. 1978. *Geologic map of the Tyrone quadrangle, Grant County, New Mexico*. U.S. Geological Survey Miscellaneous Field Studies Map MF-1037, 1:24,000. Denver, Colorado.

Kolessar, J. 1982. The Tyrone copper deposit. pp. 327-333 *in* Titley, S.R. (ed.), *Advances in geology of the porphyry copper deposits southwestern North America*. University of Arizona Press, Tucson, Arizona.

Paige, S. 1922. *Copper deposits of the Tyrone district, New Mexico*. U.S. Geological Survey Professional Paper 122. U.S. Government Printing Office, Washington, D.C. 53p.

Phelps Dodge Tyrone, Inc. (PDTI). 2003. *MSGP - 2000, Storm water pollution prevention plan.* Phelps Dodge Tyrone, Inc. Environment, Land & Water Department. January 2003.

PDTI. 2004a. Letter from Joseph A. Brunner to Clint Marshall, New Mexico Environment Department Mining Environmental Compliance Section, regarding Response to comments, DP-1341, Condition 84, Tyrone work plan for reclaimed tailing repositories. April 30, 2004.

PDTI. 2004b. Letter from Joseph A. Brunner to Clint Marshall, New Mexico Environment Department Mining Environmental Compliance Section, regarding DP-1341, Condition 84, Supplemental assessment of the No. 3 tailing reclaim area, Reclamation reference area. May 24, 2004.

PDTI. 2005. Letter from Joseph A. Brunner to Clint Marshall, New Mexico Environment Department Mining Environmental Compliance Section, regarding DP-1341, Condition 85, Investigation of tailing transport and deposition impacts work plan, Tyrone Mine, Response to NMED comments. February 4, 2005.

Tetra Tech EM Inc. (TTEMI). 2001. *Assessment of No. 3 tailing pond reclaim area, Tyrone Mine*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. June 28, 2001.

TTEMI. 2004a. *Supplemental assessment of the No. 3 tailing pond reclaim area*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. February 26, 2004.

TTEMI. 2004b. *Investigation of tailing transport and deposition impacts work plan, DP-1341 Condition 85*. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. April 2, 2004.

Trauger, F.D., 1972. *Water resources and general geology of Grant County, New Mexico*. New Mexico State Bureau of Mines and Mineral Resources, Socorro, New Mexico. 211p. April 1982 (revised July 1982).

Figures

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TYRONE AFFECTED AREAS STUDY
WORK PLAN
Site Location

Daniel B. Stephens & Associates, Inc.
4-4-05
JN LT05.0045

Figure 1

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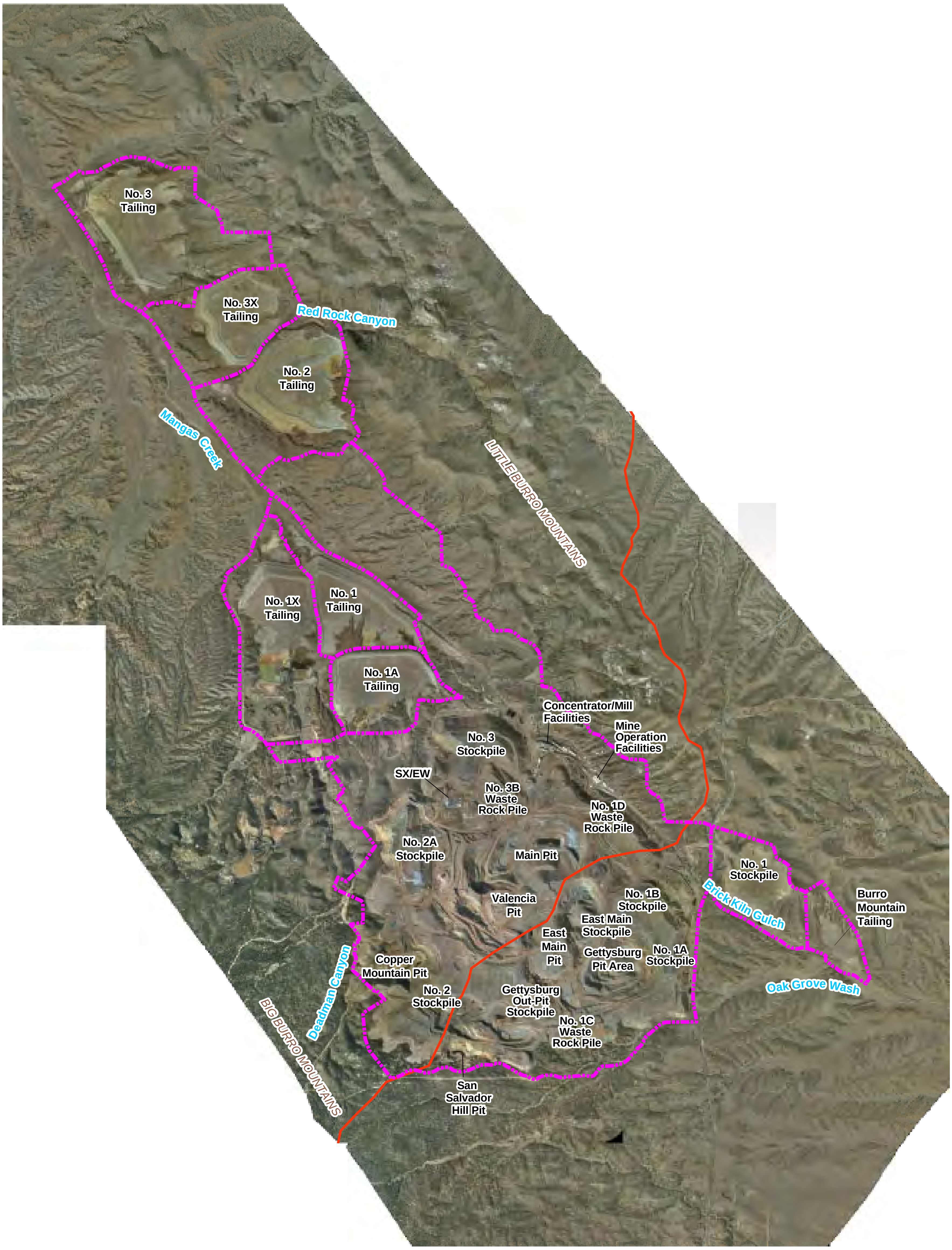

Explanation

Mine permit boundary

Continental divide

TYRONE AFFECTED AREAS STUDY WORK PLAN

Tyrone Mine Site Layout

Figure 2

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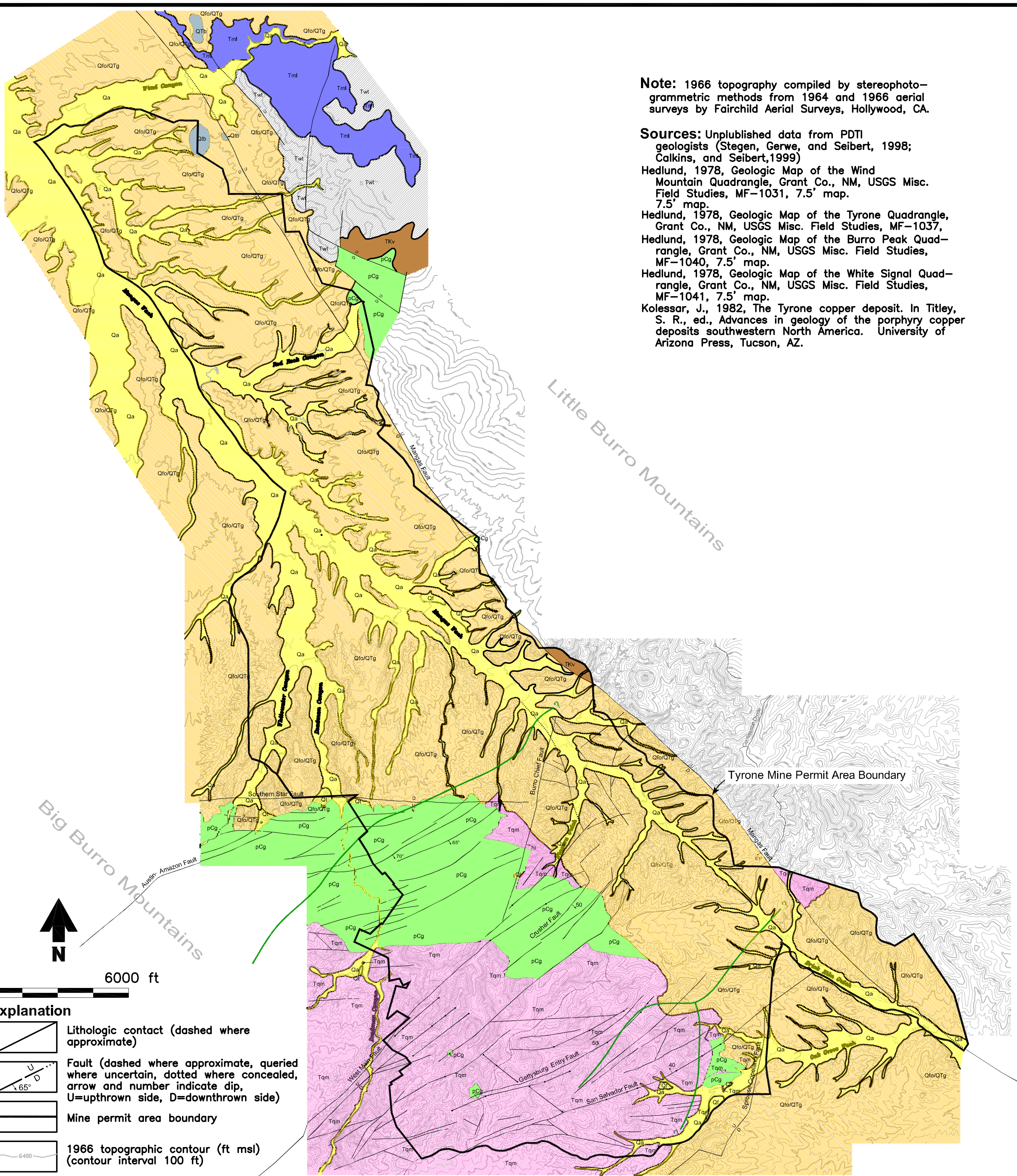
4-12-05

JN 9404



Note: 1966 topography compiled by stereophotogrammetric methods from 1964 and 1966 aerial surveys by Fairchild Aerial Surveys, Hollywood, CA.

Sources: Unplublished data from PDTI geologists (Stegen, Gerwe, and Seibert, 1998; Calkins, and Seibert,1999)

Hedlund, 1978, Geologic Map of the Wind Mountain Quadrangle, Grant Co., NM, USGS Misc. Field Studies, MF–1031, 7.5' map. 7.5' map.

Hedlund, 1978, Geologic Map of the Tyrone Quadrangle, Grant Co., NM, USGS Misc. Field Studies, MF–1037,

Hedlund, 1978, Geologic Map of the Burro Peak Quadrangle, Grant Co., NM, USGS Misc. Field Studies, MF–1040, 7.5' map.

Hedlund, 1978, Geologic Map of the White Signal Quadrangle, Grant Co., NM, USGS Misc. Field Studies, MF–1041, 7.5' map.

Kolessar, J., 1982, The Tyrone copper deposit. In Titley, S. R., ed., Advances in geology of the porphyry copper deposits southwestern North America. University of Arizona Press, Tucson, AZ.

Explanation

- Lithologic contact (dashed where approximate)
- Fault (dashed where approximate, queried where uncertain, dotted where concealed, arrow and number indicate dip, U=upthrown side, D=downthrown side) (U, D, 65°)
- Mine permit area boundary
- 1966 topographic contour (ft msl) (contour interval 100 ft) (6400)
- Continental Divide
- Qa — Alluvium (Holocene): unconsolidated poorly sorted gravel, sand, and silt
- Qf — Fan deposits (Holocene and/or Pleistocene): sheet flood fan deposits
- Qt — Talus (Holocene and/or Pleistocene)
- Qtb — Basalt (Pleistocene and/or Pliocene?)
- Qfo/QTg — Undifferentiated older fan deposits, undifferentiated sheet flood deposits (Pleistocene) and Gila Conglomerate (Pleistocene, Pliocene, and Miocene): upper eroded surface locally cemented by caliche
- Tml — Andesite and basaltic andesite (Oligocene?) flows and pyroclastic rocks exposed in Wind Canyon
- Twt — Ash–flow tuff of Wind Mountain, undifferentiated (Oligocene?)
- TKv — Undifferentiated volcanic rocks (Cretaceous)
- Tqm — Quartz monzonite of Tyrone (Paleocene): undifferentiated quartz monzonite, quartz monzonite porphyry, and related intrusive rocks.
- pCg — Burro Mountain granite (Precambrian): contains dikes of quartz monzonite and other lithologies

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TYRONE AFFECTED AREAS STUDY WORK PLAN

Geologic Map of the Tyrone Mine Area

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Figure 3

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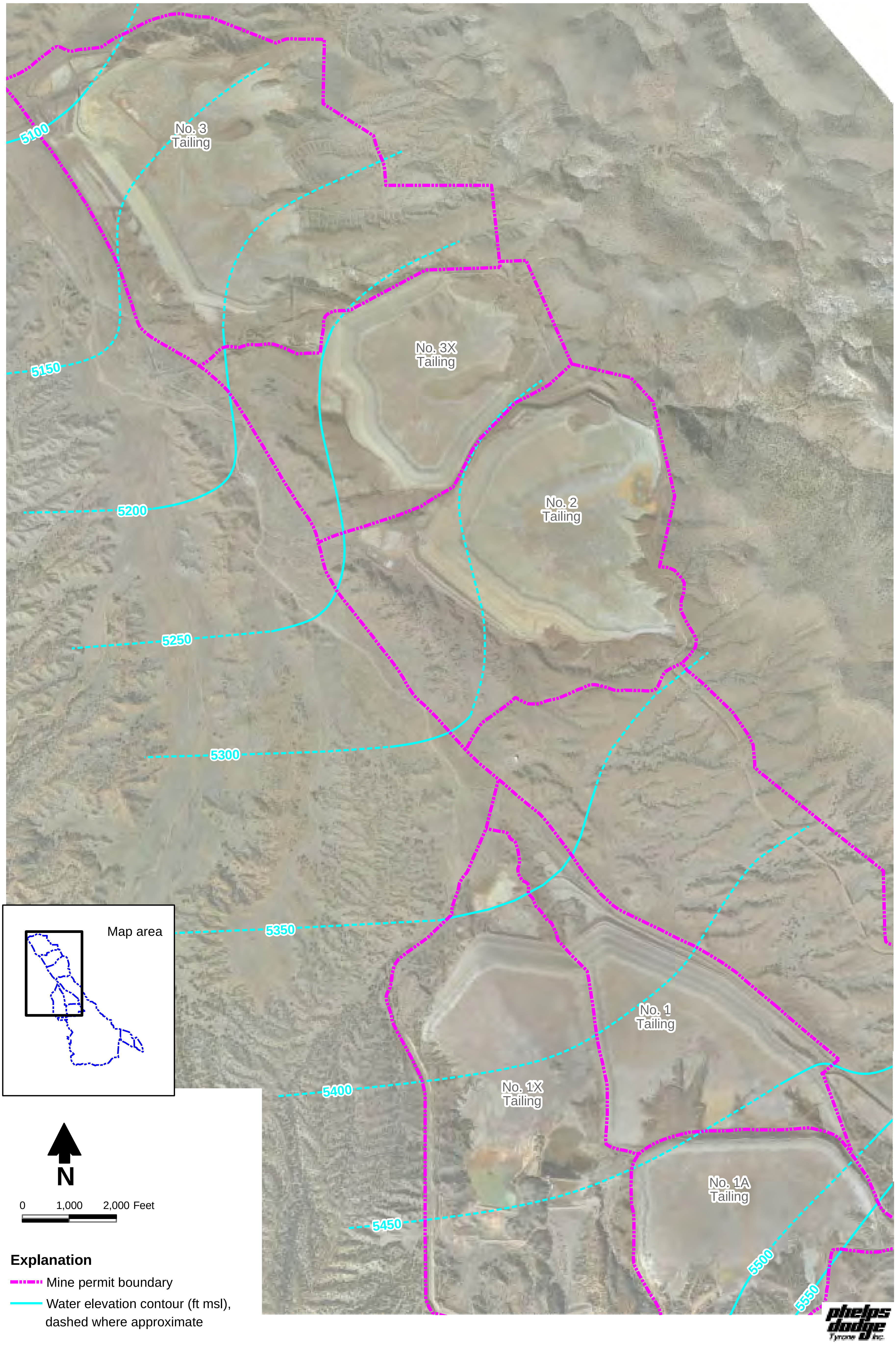

TYRONE AFFECTED AREAS STUDY WORK PLAN

2004 Regional Groundwater Elevations
Northern Portion of Tyrone Mine

Figure 4

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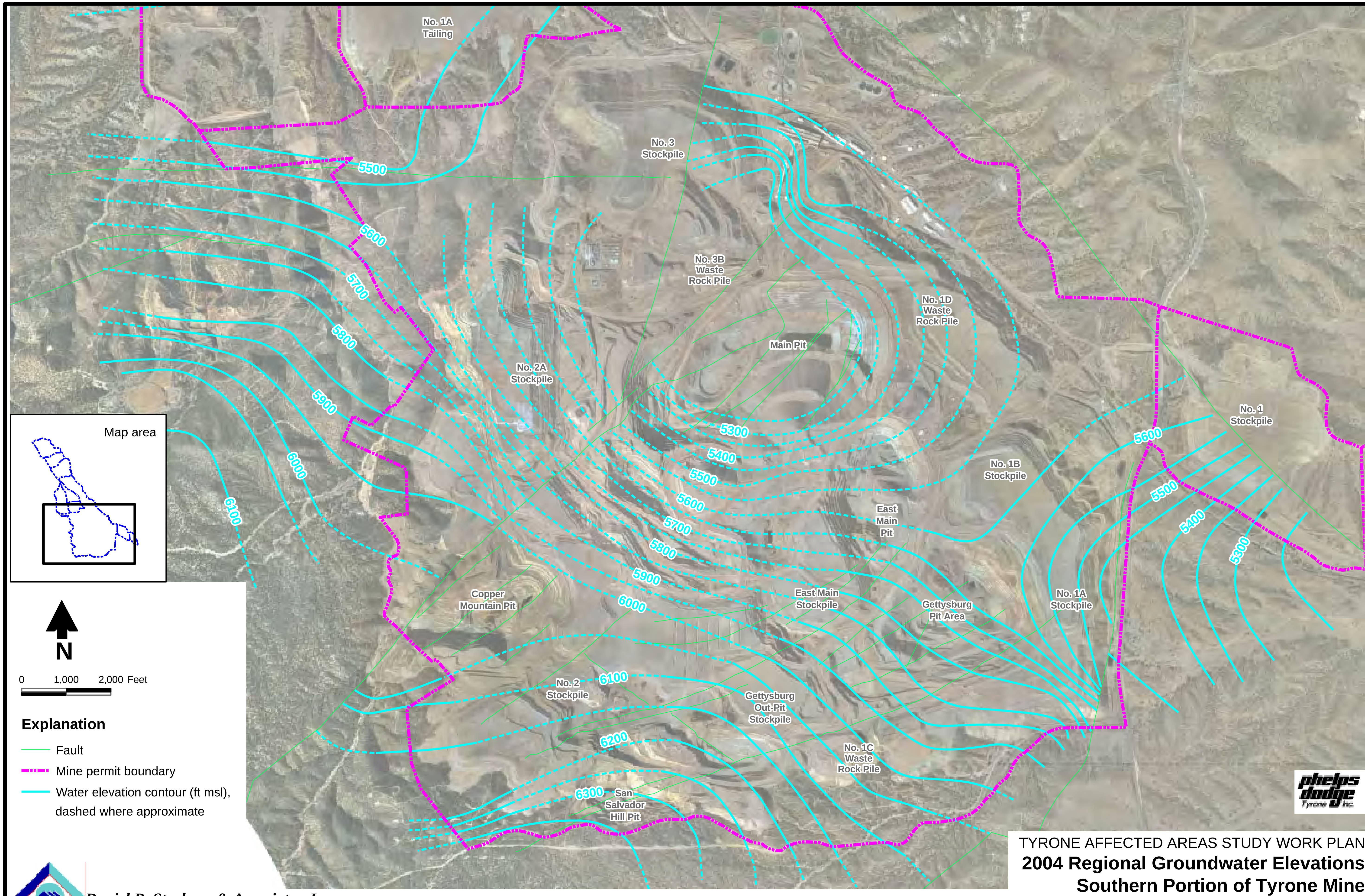
JN 9404



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TYRONE AFFECTED AREAS STUDY WORK PLAN

2004 Regional Groundwater Elevations
Southern Portion of Tyrone Mine

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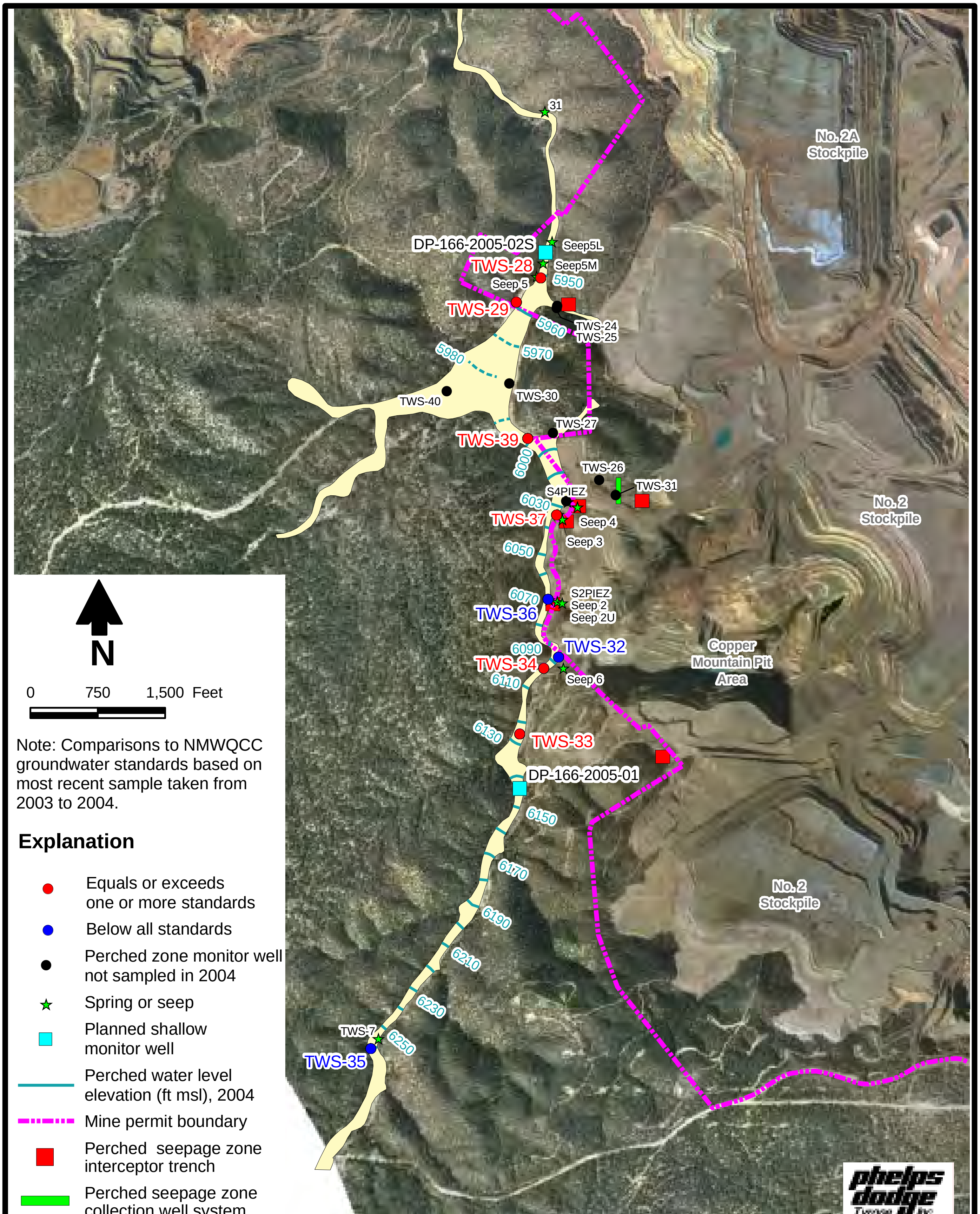
Figure 5



TYRONE AFFECTED AREAS STUDY WORK PLAN

Perched Water in Deadman Canyon and Summary of NMAC 20.6.2 Exceedances

Daniel B. Stephens & Associates, Inc.

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Figure 6

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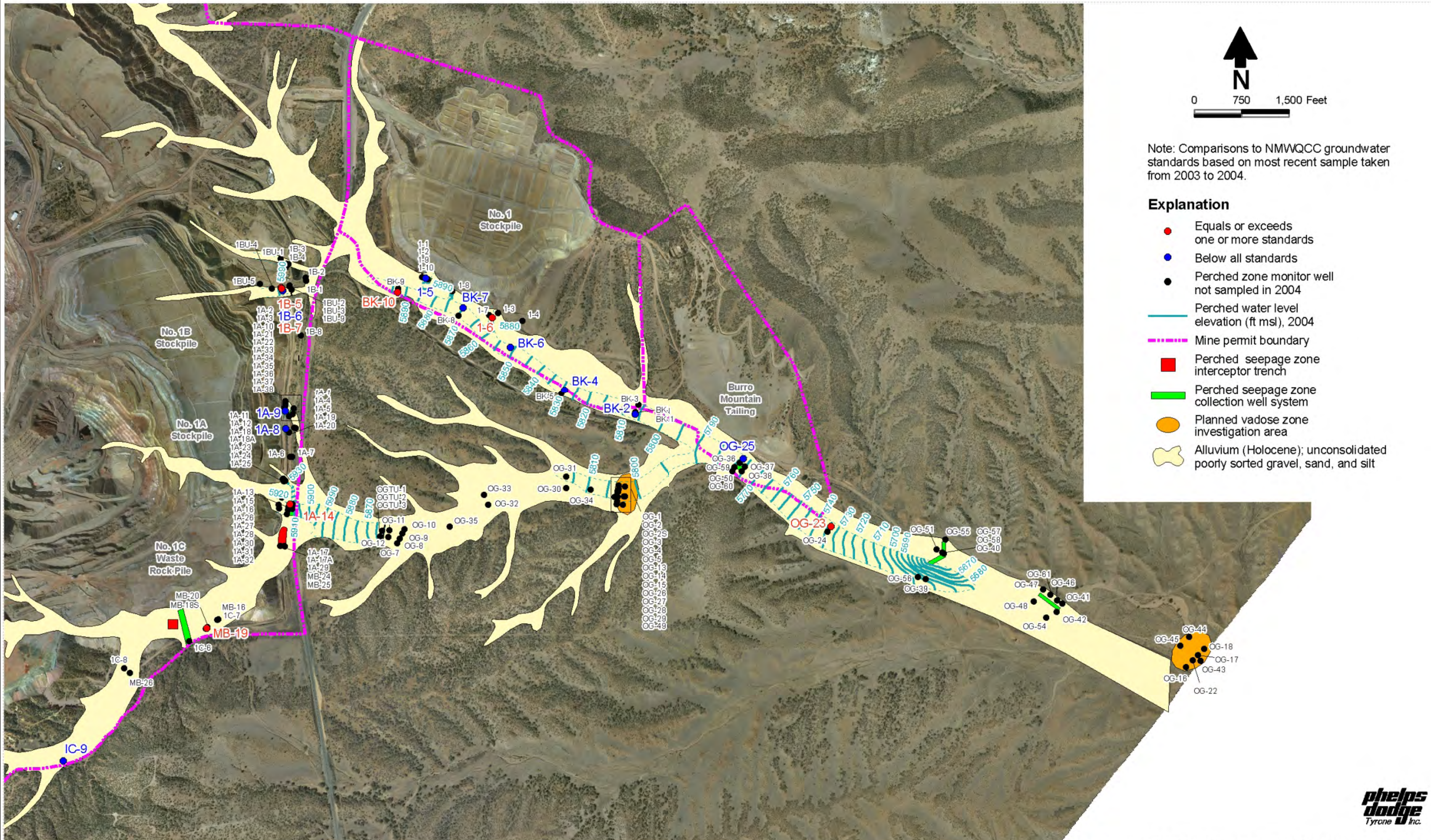

TYRONE AFFECTED AREAS STUDY WORK PLAN

Perched Water in Oak Grove Wash/Brick Kiln Gulch and Summary of NMAC 20.6.2 Exceedances

Figure 7

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4-4-05 JN 9404

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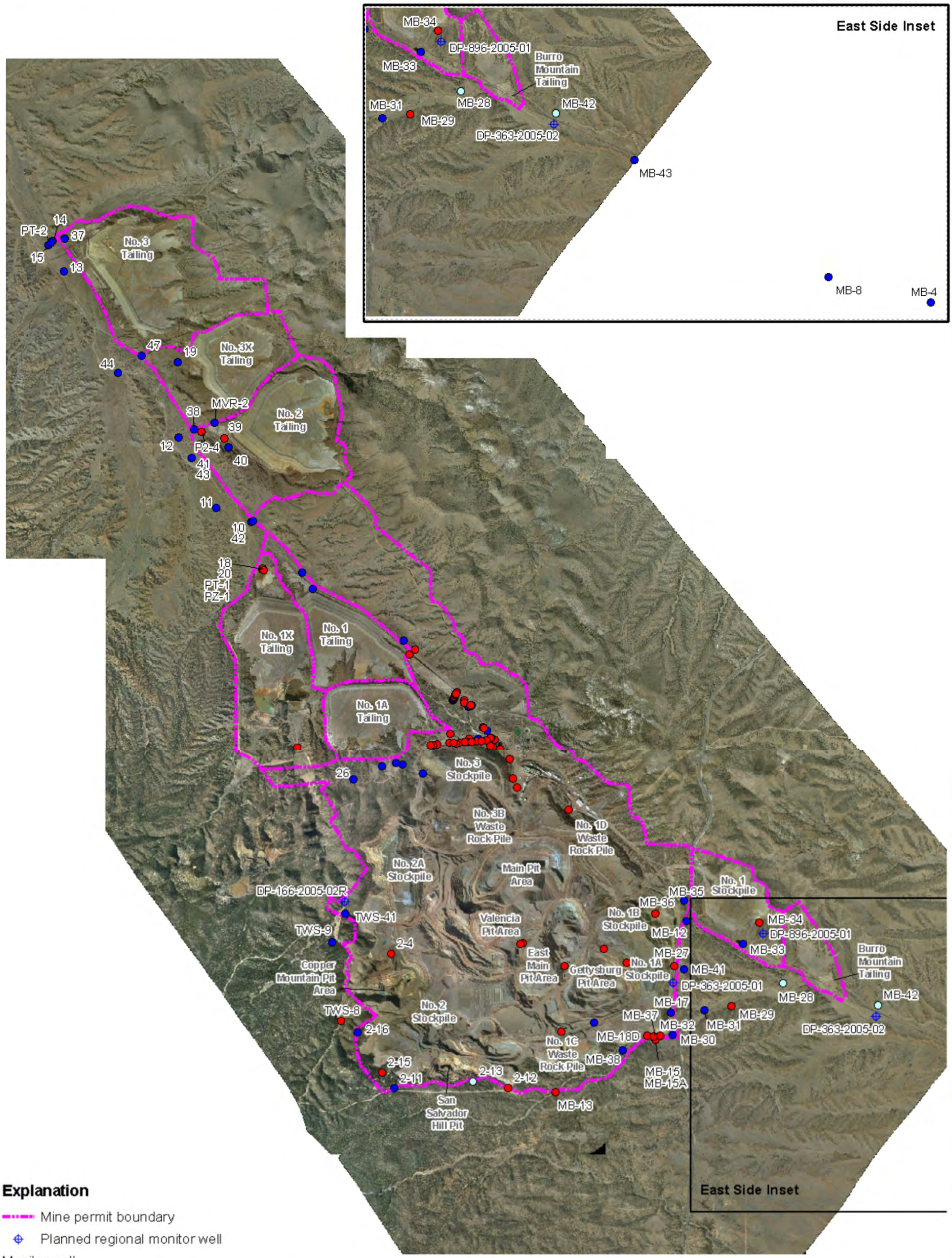

Explanation

- Mine permit boundary
- Planned regional monitor well

Monitor well

- Equals or exceeds one or more standards
- Well exceeds for manganese only
- Below all standards

Note: Only wells near and outside the mine permit boundary are labeled.

Comparisons to NMWQCC groundwater standards based on most recent sample taken from 2003 to 2004.

N

0 2,500 5,000 Feet

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TYRONE AFFECTED AREAS STUDY WORK PLAN

Regional Groundwater Quality Data Summary of NMAC 20.6.2 Exceedances

Figure 8

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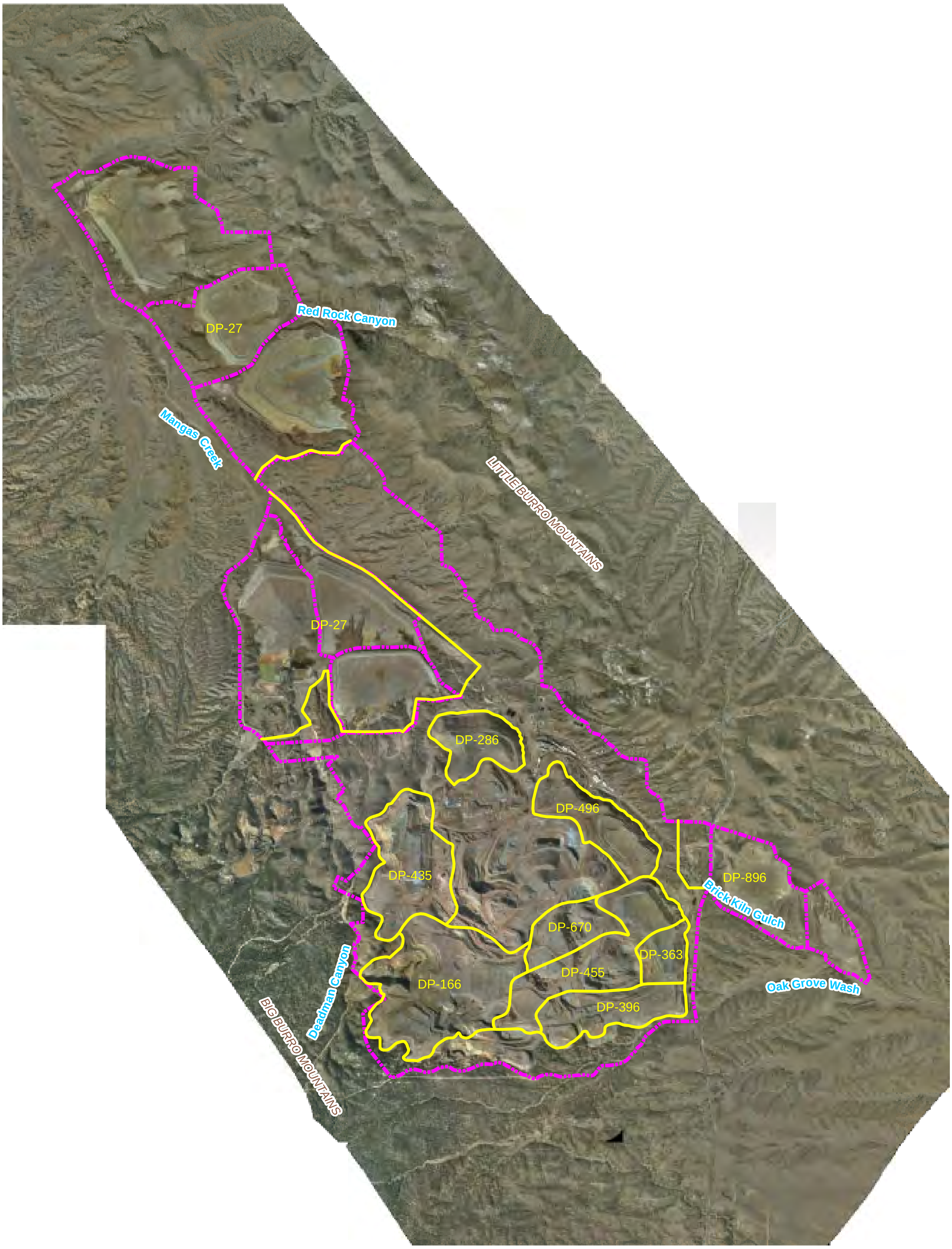
4-12-05 JN 9404



N

0 2,500 5,000 Feet

Explanation

Discharge plan outline

Mine permit boundary

phelps dodge Tyrone Inc.

Figure 9

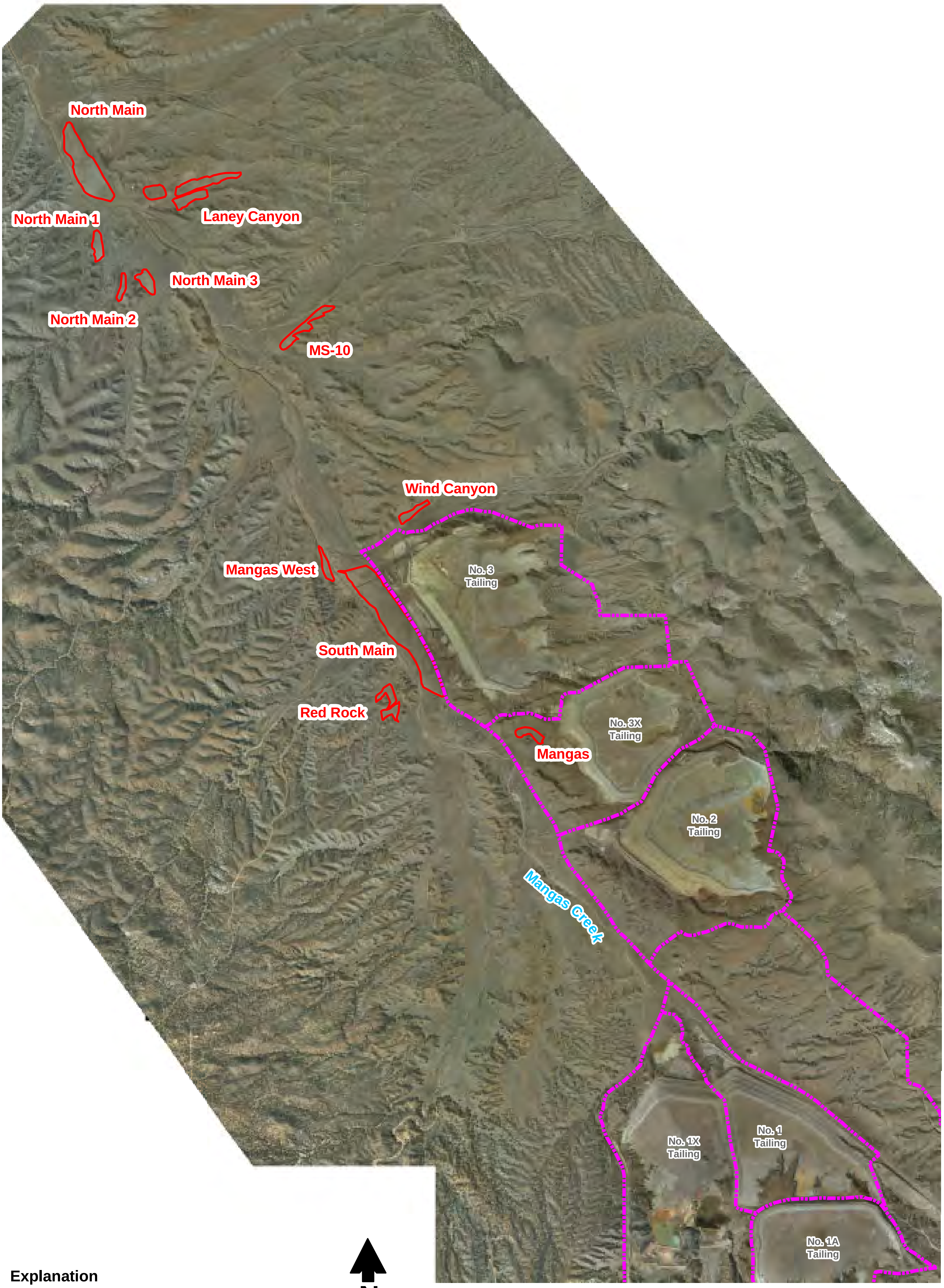
TYRONE AFFECTED AREAS STUDY WORK PLAN

Operational Discharge Plan (DP) Areas

Daniel B. Stephens & Associates, Inc.

4-12-05 JN 9404

S:/PROJECTS/9404/GIS/MXD/A0WEXH~W/TAILING_SPILLS.MXD 504040



N

0 2,000 4,000 Feet

Explanation

Reclaimed area

Mine permit boundary

phelps dodge Tyrone Inc.

TYRONE AFFECTED AREAS STUDY WORKPLAN

Reclaimed Areas Associated with the No. 3 Tailing Spill

Figure 10

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4-4-05

JN 9404

Source: PDTI, 2005

phelps dodge Tyrone Inc.

TYRONE AFFECTED AREAS STUDY
WORK PLAN
Tailing Deposition Study
Sediment Sample Location

Daniel B. Stephens & Associates, Inc.

4-5-05 JN LT05.0045

T:\VDR\00-LITIGATION\LT05_0045\LT05_0045_04W.DWG

Figure 11

Tables

Table 1. Example Perched Zone Water Quality

Constituent	Concentration (mg/L)			
	NMAC Section 20.6.2.3 Groundwater Standard	Oak Grove Wash	Deadman Canyon	
		OG-23 1/22/04	Upgradient Well TWS-35 6/14/04	Downgradient Well TWS-28 6/15/04
Aluminum (Al)	5.0	**118**	<0.02	**6.5**
Arsenic (As)	0.1	0.015	<0.01	<0.01
Cadmium (Cd)	0.01	**0.2**	<0.002	0.0067
Chloride (Cl)	250	4.15	8.64	11.3
Cobalt (Co)	0.05	**0.768**	<0.006	**0.188**
Chromium (Cr)	0.05	0.0151	<0.006	<0.006
Copper (Cu)	1.0	**53.1**	<0.006	**37.8**
Fluoride (F)	1.6	NM	0.55	**2.53**
Iron (Fe)	1.0	**86.5**	<0.02	0.029
Manganese (Mn)	0.2	**58.6**	0.0331	**11.2**
Nickel (Ni)	0.2	**0.345**	<0.01	0.066
Lead (Pb)	0.05	<0.005	<0.005	<0.005
Sulfate (SO_4)	600	**2,250**	60	**722**
Total dissolved solids (TDS)	1,000	**3,150**	261	**1,100**
Zinc (Zn)	10	**42.4**	0.0269	2.19

Bold indicates values that exceed the 20.6.2.3103 NMAC standard.
mg/L = Milligrams per liter
NM = Not measured

Table 2. Schedule for Affected Area Study Tasks

Affected Area Study	DP-1341 Conditions	Objective	Expected Completion Date
Mangas Valley			
No. 3 tailing spill areas	84	• Evaluate reclamation success	April 29, 2005 (report due)
Tailing deposition	85	• Determine extent and magnitude of any tailing deposition in Mangas Valley	February 15, 2006 (report due)
Deadman Canyon			
Perched water impacts	34 and 82	• Better define downgradient extent of perched water impacts • Address water quality fluctuations	November 2005
Oak Grove Wash/Brick Kiln Gulch			
Perched and regional water impacts	34 and 82	• Assess potential leaching and remobilization of contaminants in PLS-impacted sediments • Better characterize regional groundwater and contaminant transport on the East Side	November 2005
All Areas			
Surface water and groundwater impacts	89	• Evaluate closure alternatives to ensure that requirements of the WQA and NMWQCC regulations are met	April 8, 2007