FREEPORT-McMoRan

Sierrita Operations
Environment, Land & Water Department
6200 West Duval Mine Road
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Green Valley, Arizona 85622-0527

October 12, 2015

Hand Delivered

Ms. Joey Pace
Project Manager
Voluntary Remediation Program
Arizona Department of Environmental Quality
1110 W. Washington St.
Phoenix, AZ 85007

RE: Revised Data Gaps Work Plan,
Freeport-McMoRan Sierrita Mine, Green Valley, Arizona; Site Code: 100073-03

Dear Ms. Pace:

Please find enclosed the revised Data Gaps Work Plan (Work Plan). This work plan incorporates changes requested by the ADEQ in a letter dated December 24, 2014, to which Sierrita responded on January 23, 2015. The ADEQ conditionally approved the clarifications in a letter dated March 11, 2015. These clarifications included changes to the proposed well construction details, which have been revised in this document, and additional information to document that chemical concentrations in specific wells are representative of background groundwater quality conditions. A review of background groundwater quality conditions was submitted by Sierrita as a separate document on March 24, 2015. This review was subsequently discussed in a conference call with ADEQ on May 13, 2015, and the ADEQ presented specific analytes (principally sulfate) of concern. Sierrita has decided to proceed with this work plan, as agreed, but also to include additional sampling and to review additional information, to verify that the selected background wells represent background groundwater quality conditions. This information will then be presented with the subsequent data gaps report.

Additionally, a Site visit was conducted by ARCADIS on June 22 and 23, 2015 to review the locations or the proposed groundwater monitoring wells. The proposed locations were adjusted and has been included in the enclosed Work Plan.

Should you need additional information please do not hesitate to contact me at (520) 393-2314 or 520-289-0937.

Sincerely,

John D. Stitzer
Resource Analyst
Freeport-McMoRan Sierrita Inc.

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Voluntary Remediation Program

VRP Site Code – 100073-03

Data Gaps Work Plan

Sierrita Mine
Green Valley, Arizona

October 8, 2015

ARCADIS

Voluntary Remediation Program

Data Gaps Work Plan

Sierrita Mine
Green Valley, Arizona

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October 8, 2015

ARCADIS

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
APP	Aquifer Protection Permit
A.R.S.	Arizona Revised Statutes
AWQS	Arizona Aquifer Water Quality Standards
bgs	below ground surface
BHHRA	baseline human health risk assessment
BMP	Best Management Practices
CLEAR	Continuous Liquid Extraction and Regeneration
COI	Constituents of Interest
CSM	Conceptual Site Model
DOT	Department of Transportation
DQO	Data Quality Objective
ETI	Esperanza Tailings Impoundment
FAA	Federal Aviation Administration
FSP	Field Sampling Plan
ft/day	feet per day
GPL	Groundwater Protection Level
MOC	Mitigation Order on Consent
PDF	Portable Document Format
QAPP	Quality Assurance Project Plan
Sierrita	Freeport-McMoRan Sierrita Inc.
Site	The Sierrita VRP study area
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
STI	Sierrita Tailings Impoundment
SWPPP	Stormwater Pollution Protection Plan
SX/EW	Solution Extraction/Electrowinning
URS	URS Corporation
USC	Upper Santa Cruz
USEPA	United States Environmental Protection Agency
VRP	Voluntary Remediation Program

1. Introduction

This document presents a work plan to collect groundwater and soil data for the Sierrita Mine located near Green Valley, Arizona (Figure 1). The data are to be collected under the Arizona Department of Environmental Quality's (ADEQ's) Arizona Voluntary Remediation Program (VRP). Freeport-McMoRan Sierrita Inc. (Sierrita) submitted an application to enter into the VRP on June 19, 2007 to evaluate certain operations and constituents that are not considered by other regulatory programs, such as the Mitigation Order on Consent (MOC), Docket No. P-50-06, and the Sierrita area-wide Aquifer Protection Permit (APP) No. P 101679. The VRP is not applicable to actions taken under the MOC, Arizona Revised Statutes (A.R.S.) § 49-172(B)(3)(c). Most facilities at Sierrita are governed by the area-wide APP. Discharge controls, compliance with Aquifer Water Quality Standards (AWQS), future closure, and other actions for the APP facilities are governed by the APP and are not intended to be addressed under the VRP. On August 15, 2007, ADEQ accepted Sierrita into the VRP, as site code 100073-03.

The Sierrita VRP study area (Site) to be addressed in the VRP includes a portion of the area within the property boundary of Sierrita Mine (Figure 1). Site characterization activities for the VRP were conducted between July 2008 and July 2009 following the 2008 ADEQ-approved VRP Work Plan (URS Corporation [URS] 2008a). The results of those characterization activities were reported to ADEQ (URS 2012; ARCADIS 2013a, 2013b). Following these submittals, additional data collection needs were identified to complete the VRP investigation at Sierrita. The primary objective of this work plan is to describe collection of the remaining data identified by ADEQ (ADEQ 2014a) and Sierrita to complete the site characterization for the VRP.

This work plan incorporates changes requested by the ADEQ in a letter dated December 24, 2014 (ADEQ 2014b), to which Sierrita responded on January 23, 2015 (Freeport-McMoRan 2015a). The ADEQ conditionally approved the clarifications in a letter dated March 11, 2015 (ADEQ 2015). These clarifications included changes to the proposed well construction details, which have been revised in this document, and additional information to document that chemical concentrations in specific wells are representative of background groundwater quality conditions. A review of background groundwater quality conditions was submitted by Sierrita as a separate document on March 24, 2015 (Freeport-McMoRan 2015b). This review was subsequently discussed in a conference call with ADEQ on May 13, 2015, and the ADEQ presented specific analytes (principally sulfate) of concern. Sierrita has decided to proceed with this work plan, as agreed, but also to include additional sampling and to review additional

information, to verify that the selected background wells represent background groundwater quality conditions. This information will then be presented with the subsequent data gaps report.

As this work plan is limited in scope to address data gaps only and will be conducted over a relatively short timeframe, the ADEQ waived the requirements cited in A.R.S. § 49-175 in accordance with A.R.S. § 49-175(C) (ADEQ 2014b), except for the following:

- A.R.S. § 49-175A.4 – Schedule for submission of progress reports
- A.R.S. § 49-175A.5 – A proposal for community involvement as prescribed by A.R.S. § 49-176
- A.R.S. § 49-175A.8 – A list of any permits or legal requirements known to apply to the work
- A.R.S. § 49-175B.

The work plan is structured with an overview of the VRP conceptual site model (CSM) provided in Section 2 to address an ADEQ information request in a letter to Sierrita dated April 11, 2014. Section 3 includes a summary of the data gaps identified to date for the VRP and a description of the additional site characterization activities. The proposed groundwater sampling program is presented in Section 4. A list of permits or legal requirements known to apply to the work is provided in Section 5. A proposal for a community involvement program, as prescribed by A.R.S. § 49-176, is provided in Section 6. A project and reporting schedule, including submission of progress reports, is provided in Section 7.

All work activities described in this work plan will be performed in accordance with the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP)/QAPP addendum (URS 2008b) prepared for groundwater investigation activities at Sierrita and data collection/data management for the VRP, respectively. ARCADIS has prepared FSP and QAPP addenda to address updates to laboratory analytical methods and standard operating procedures (SOPs) for the data collection described in this work plan. The FSP Addendum is included in Appendix A, and the QAPP addendum is included in Appendix B.

2. CSM Overview

A comprehensive description of the VRP CSM was provided in the groundwater investigation report (ARCADIS 2013a). The CSM provides the foundation for identifying further data collection needs for the VRP. An overview of the CSM is presented in this section to provide context for the data gaps that will be filled through the investigation activities described in this work plan. This section also includes the following information, requested by ADEQ (ADEQ 2014a):

ADEQ Comment	**Section number where information is provided:**
ADEQ Comment No. 3: VRP suggests that Sierrita include soil and sediment data into the site's conceptual site model and subsequent groundwater investigation.	Data are provided in Section 2.5. Review of these data indicates no potential for connection between soil/sediment and groundwater.
ADEQ Comment No. 4: VRP requests that Sierrita provide an all-inclusive data set for any and all groundwater wells installed before, during, and after the Work Plan period.	The data set and description of the existing well network are included in Section 2.4.
ADEQ Comment No. 15: Figures 5 and 6: VRP would like to remind Sierrita of the commitment made in their February 22, 2012 letter titled Voluntary Remediation Program - Soil and Sediment Characterization Report in regards to developing "updated geologic cross-sections" based upon new information obtained during any soil and groundwater work. As such, VRP recommends including at least two updated cross-sections (north-south and east-west, or best-fit based on well locations) for each of the investigation areas (background, west, central, and east). Please include applicable wells and respective information such as: total depth, screening interval, groundwater elevation, known faults, and a legend that matches the formations discussed in the report.	Cross sections are described in Section 2.2, located on Figure 3, and presented as Figures 4 through 11.

2.1 Site Location and Description

Sierrita operates an open pit mine and mineral concentration facility located in Pima County, approximately 6 miles northwest of Green Valley, Arizona (Figure 1). Green Valley lies approximately 25 miles south of the City of Tucson, Arizona. Sierrita

operations include conventional crushing and flotation, followed by differential flotation, leaching and roasting of molybdenum disulfide, rhenium recovery, molybdenum disulfide production and packaging, molybdenum trioxide production and packaging, leach stockpiles, and solution extraction/electrowinning (SX/EW).

Currently, there are both active operations and former operations at the Site. For purposes of data presentation and discussion, the Site is divided into four spatial areas, referred to as "investigation areas". These investigation areas reflect different operational areas of the Site. The investigation areas are shown on Figure 2, and are identified as follows:

- Background Areas (North, South, and West)
- West Investigation Area
- Central Investigation Area
- East Investigation Area

2.2 Hydrogeology

Sierrita is located in the Upper Santa Cruz (USC) Basin and Range Lowlands Hydrogeologic Province. The USC Basin is a north-trending alluvial valley drained by the Santa Cruz River (ELMA and Dames and Moore 1994). The principal hydrogeologic units at the Site include the alluvial aquifer, the basin fill aquifer, and the bedrock hydrostratigraphic unit. Alluvial deposits occur as thin, discontinuous deposits throughout the Site, typically within natural drainage channels. The basin fill aquifer primarily occurs east of Demetrie Wash and is not present in the Sierrita pit or plant areas. The bedrock hydrostratigraphic unit underlays the entire Site and exhibits a wide range of permeabilities, indicative of micro- and macro-scale fracturing. Cross sections that illustrate the hydrogeological features of the Site are located on Figure 3 and presented on Figures 4 through 11.

The surface water regime of the Site is divided into four major surface water drainage basins, each associated with one of the four major washes that cross the Site. The washes include Demetrie, Amargosa, Esperanza, and Tinaja Washes. An unnamed drainage (Unnamed Wash) connects with the Tinaja Wash south of the Esperanza Wash. The locations of the washes are shown on Figure 2.

2.3 Geology and Geochemistry

The principal geologic formations at Sierrita include:

1. Alluvial Deposits
2. Basin Fill Deposits
3. Bedrock Complex, consisting of:
    a. Tinaja Peak Formation
    b. Pantano Formation
    c. Tertiary Intrusives
    d. Ruby Star Granodiorite
    e. Demetrie Volcanics
    f. Harris Ranch Quartz Monzonite
    g. Ox Frame Volcanics.

Groundwater geochemistry at Sierrita is in part controlled by the type of underlying geologic formations. As described in the groundwater investigation report CSM (ARCADIS 2013a), the geochemistry of the basin fill aquifer and bedrock hydrostratigraphic unit is conducive to dissolution of major cation, anion, and trace metals that may occur naturally in the mineralized system. The different mineralized bedrock formations and the basin fill deposits contribute directly to the variability in groundwater constituent of interest (COI) concentrations. As stated in the VRP Work Plan, the objective of the VRP is to assess potential impacts to soil, groundwater, and sediment from past releases and historical Sierrita operations for COIs. COIs include uranium, radionuclides, and other mining-related metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, sodium, thallium, and zinc).

The COI list for the VRP investigation was selected based on a review of the list of groundwater constituents currently monitored or regulated at Sierrita under its APP permit, historical groundwater quality data for the Sierrita Mine, and current and historical mining processes and operations. These constituents also occur naturally in soils, rock, and groundwater common to mineralized mining areas. Uranium concentrations and isotopic composition in the bedrock hydrostratigraphic unit reflect naturally occurring mineralization processes. Subsequently, radionuclides present in the bedrock hydrostratigraphic unit within the other investigation areas are detectable but consistent (with few exceptions), with levels of radionuclides measured in the Background Areas. Soil data collected for the VRP will reflect the variety of natural geologies exposed at the surface of the Site.

2.4 Current Well Network and Monitoring Programs

Sierrita maintains a network of monitoring wells within and adjacent to Site boundaries. These wells are monitored for the MOC, Docket No. P-50-06, and/or the Sierrita area-wide APP No. P 101679. Some of these wells were also monitored for the VRP. Maps provided in Appendix C show which wells are monitored for which program.

The network of groundwater wells sampled at the Site for the 2008-2009 VRP is shown on Figure 12. Many of these wells are also part of ongoing groundwater monitoring programs under the MOC and/or APP. These groundwater monitoring programs sample select wells quarterly and biennially for radionuclides, general chemistry, and/or dissolved metals. Table 1 identifies the constituents currently measured under these programs, compared for reference to the constituent list for the 2008-2009 VRP monitoring program. Because wells at the Site are monitored under the MOC or APP, additional data are available for some wells, which are reported to ADEQ regularly per MOC and APP requirements. Appendix D provides groundwater monitoring results reported for wells sampled during and since the 2008-2009 VRP through 2014, including water elevation and water quality data.

The wells sampled for the 2008-2009 VRP represent a subset of all the wells currently on and around the Site. A map provided in Appendix C shows the wells on and immediately surrounding the Site.

2.5 Sources of Constituents

This section summarizes the primary and secondary sources of COIs at the Site and at each of the investigation areas. Further description and details about the sources of COIs are provided in the groundwater investigation report (ARCADIS 2013a).

2.5.1 Primary Sources of Constituents

Primary sources of COIs to groundwater at the Site may include natural background or contributions from operations. Groundwater issues with respect to current operations are addressed primarily under the APP.

Collectively, geochemical data have indicated that impacts from operations are limited in areal extent. The general chemistry of the basin fill aquifer and background bedrock hydrostratigraphic unit is conducive to the dissolution of trace metals that may occur naturally in the mineralized system. Radionuclide COIs in the bedrock hydrostratigraphic unit are consistent with those in the Background Areas.

In the West Investigation Area, Headwall No. 3 and the SX-3 Stormwater Pond have contributed to the presence of limited metal and general chemistry COIs in groundwater, as observed in the bedrock hydrostratigraphic unit at BW-02. Higher chloride levels compared to background were also observed in samples from PZ-16 (a bedrock well downgradient from Headwall No. 5) and MH-27 (a bedrock well downgradient from Headwall No. 2). However, the extent of contribution to groundwater at these locations is limited, as demonstrated by MH-20 (downgradient of the SX-3 Stormwater Pond and BW-02) and MH-19 (downgradient from Headwall No. 5 and PZ-16), which exhibit concentrations of COIs consistent with background and/or lower than numeric AWQS.

In the East Investigation Area, groundwater concentrations of COIs, except sulfate (which is being addressed under the MOC), are representative of the natural background concentrations of the basin fill aquifer. Seepage from the Sierrita Tailings Impoundment (STI) and Esperanza Tailings Impoundment (ETI) has not resulted in increases in metal or radionuclide COI concentrations higher than background and/or numeric AWQS.

In the Central Investigation Area, the concentrations of COIs in the alluvial aquifer are affected in the vicinity of active operations extending from Bailey Lake to downgradient of Amargosa Pond. Engineering controls in this area limit the potential for COI migration in groundwater. Samples from wells installed downgradient from the

engineering controls in this area (MH-22 and MH-23, respectively) show low concentrations of metal and radionuclide COIs. Groundwater concentrations in these wells also exhibit high alkalinity, indicating that acidic leaching solutions have not migrated downgradient in groundwater.

Groundwater in the vicinity of Former Continuous Liquid Extraction and Regeneration (CLEAR) Plant operations and downgradient of the Former Raffinate Pond exhibits concentrations of COIs higher than background and/or numeric AWQS, although sampling locations are within the facility boundary. Concentrations of chloride and other general major anions/cations in groundwater near the Former CLEAR Plant reflect former processes, which used sodium and potassium chloride brines and sodium hydroxide and ferric chloride reagents to produce metallic copper. Groundwater near the Former Raffinate Pond reflects a combination of natural background (the downgradient monitoring well is screened in Ruby Star Granodiorite) or contribution of former operations.

2.5.2 Secondary Sources of COIs

COIs released to sediment and soil would represent a potential secondary source of COI to groundwater. However, the soil investigation reports for the Site have shown, with the exception of a data gap for one constituent, that surface soil and sediment are not sources of COIs to groundwater.

The soil data collected to date included 261 soil samples (plus 12 duplicates), which were analyzed for 18 metal COIs and five radiological COIs. These samples were collected from in and around each of nine facility operations in the Central Investigation Area, as well as the former Rhenium Pond subarea in the East Investigation Area. These areas were identified as locations where potential releases of COIs could occur to surface soil and/or sediment.

ADEQ has established soil groundwater protection levels (GPLs) for metals, which are a screening method to determine if residual contaminant concentrations could cause or threaten to cause contamination of groundwater. Soil GPLs were compared to all soil and sediment data collected from the Site as reported by URS (2012) and ARCADIS (2013b).

These data indicate that, with one exception, none of the metals in soil are a potential source of COIs to groundwater that would elevate groundwater COI concentrations to levels higher than numerical AWQS. Comparison of antimony concentrations to standard GPLs indicated exceedances in the Former CLEAR Plant and in the Central

Investigation Area. However, a site-specific GPL can be calculated, which will more accurately reflect potential for migration of COIs from soil to groundwater. The GPL calculation requires that soil samples be analyzed for synthetic precipitation leaching procedure (SPLP), which was not completed for antimony in soil. Therefore, a site-specific GPL for antimony is identified as a data gap for the VRP.

The VRP investigation did not include the collection and analysis of water samples to determine if surface water is a potential source to groundwater. However, 36 sediment samples were collected from 18 locations during the 2008-2009 VRP to assess whether COIs have been released to sediment in these drainage channels. These samples were collected from alluvial channels that flow from the historical site areas into Demetrie Wash.

The analytical results for all of the sediment samples were lower than GPLs.

Therefore, the results of the investigation show that soil and sediment at the Site do not represent a secondary source of COIs (with the exception of antimony, to be addressed) to groundwater.

2.6 Groundwater Transport

This section summarizes the primary transport mechanisms controlling COI transport for the Site and at each of the investigation areas. Further description and details of groundwater transport are provided in the groundwater investigation report (ARCADIS 2013a).

Groundwater transport of COIs at the Site is principally controlled by the geological formations and their nature. The geological formations include relatively high permeability alluvial and basin fill sediments and low permeability bedrock complexes of volcanic and intrusive origin, with variable fracturing.

The alluvial deposits at the mine site are limited to natural drainage channels, including Demetrie Wash, Amargosa Wash, Esperanza Wash, and Tinaja Wash. During significant rainfall events, which occur mostly during the wet season (mid-June through September), these channels exhibit underflow, with hydraulic conductivities measured up to 150 feet/day (ft/day; ELMA 2001). During the dry season, these sediments are typically dry, with the groundwater level occurring in the underlying bedrock. COI transport within these sediments is therefore limited to the wet season and/or significant precipitation events, when flushing occurs.

The basin fill deposits occur generally east of Demetrie Wash, trending from the northwest and extending east underneath the tailings impoundments, and are not present in the Sierrita pit or plant areas. The thickness of the basin fill deposits increases to the east up to more than 1,000 feet near the southeast corner of the STI. These sediments exhibit hydraulic conductivities in the order of 100 ft/day (ELMA 2001) and are hydraulically connected to the Demetrie Wash east of the STI. However, COI migration along the Demetrie Channel does not continue to the south, as indicated by analytical samples collected from well MH-22, located in the channel directly south of the Central Investigation Area.

Various bedrock formations are present throughout the Site, but are considered one hydrostratigraphic unit. The overall permeability of the bedrock hydrostratigraphic unit is considered low. The units are variably fractured and jointed. These zones of higher permeability can act as preferential flow conduits for the migration of constituents in groundwater. Migration of COIs along fracture zones is limited due to chemical reactions along flow paths such as pH neutralization, mineral precipitation, and sorption reactions. The limited COI migration has been observed (for example) in wells MH-19 and MH-20 (downgradient from impacted wells in the West Investigation Area) or at MH-22 and MH-23 (downgradient from impacted wells in the Central Investigation Area).

The driving mechanism of vertical transport of COIs is precipitation, which occurs during the wet season, when rapid pulses of water move into the alluvium. However, responses may be complex at the Site, given that engineering controls (including sumps and interceptor systems downgradient of former and active facilities) collect alluvial groundwater. Storm water management systems also control infiltration of precipitation to the alluvial aquifer. Limited understanding of surface water-groundwater system interaction, particularly in response to precipitation events, was identified as a data gap to interpret the source-distribution dynamics of groundwater COIs and the hydraulic connection (or lack thereof) with facility operations, alluvial groundwater quality, and bedrock groundwater quality.

General COI migration for each of the individual areas is summarized as follows:

- East Investigation Area - Transport of COIs is primarily controlled by flow in basin fill aquifer. The Demetrie Wash extends through the southwestern portion of the area, which is in hydraulic connection with the basin fill deposits. The STI deposits overlie the basin fill deposits (Figure 4), with downgradient COI migration to the east from these deposits monitored using a well field to the east of the STI.

- CLEAR Plant, Central Investigation, and Western Investigation Areas – Former facilities in these areas were constructed atop bedrock and/or alluvial sediments. COI migration in the alluvium (wash channels) will transport laterally along the alluvium and vertically from the alluvium into bedrock. Lateral migration will likely occur in the alluvial channels during wet periods, with slow and limited lateral migration in the bedrock, as has been indicated from hydraulic testing to date and confirmed by groundwater monitoring.

3. Program Objectives, Data Quality Objectives, and Criteria for Measurement Data

Site characterization activities for the VRP were performed in 2008 and 2009. Table 2 summarizes the activities and the objectives described in the 2008 VRP Work Plan. Following these activities, the data were assessed, and data gaps were identified in the groundwater investigation report (ARCADIS 2013a). Table 2 has been updated to summarize results, preliminary conclusions, and recommendations for each groundwater sampling location. ADEQ provided comments on the groundwater investigation report and identified additional data gaps (ADEQ 2014a). A summary of these data gaps, and the responses or action items identified, is presented in Table 3. These data gaps identify supplemental site characterization activities for focused areas in each investigation area.

The data quality objective (DQO) process is a series of planning steps designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. The U.S. Environmental Protection Agency (USEPA) has issued guidelines to help data users develop project-specific DQOs (USEPA 2006). These guidelines were followed to develop the DQOs for the data gaps identified in Tables 2 and 3.

Step 1: State the Problem

The purpose of this step is to describe the problem to be studied so that the focus of the investigation will be unambiguous.

The problem to be addressed in this phase is that groundwater and soil concentrations of COIs must meet the ADEQ criteria specified in the QAPP in order to fulfill the requirements of the VRP. However, some data gaps exist with respect to characterization of the nature and extent of groundwater COIs at the Site, including potential migration pathways of COIs. The soil data gaps include the potential for antimony to leach from soil to groundwater at concentrations that could exceed the AWQS. Therefore, the purpose of this work plan is to collect additional groundwater and soil data that can be used to complete the characterization of the nature and extent of COIs in groundwater and soil in focused areas of the Site.

Step 2: Identify the Goals of the Study

This step identifies what questions the investigation will attempt to address and what actions may result.

The goal of the study is to fill remaining data gaps related to COI nature and extent at focused areas at the Site. The results of the data gap assessment will provide the data to assess whether any further actions are needed at the Site to fulfill the requirements of the VRP.

Step 3: Identify Information Inputs

The purpose of this step is to identify the environmental data that need to be obtained and measurements that need to be taken to resolve the decision statement.

The data needed to achieve the objective of this effort are outlined in Table 3.

Step 4: Define the Boundaries of the Study

This section specifies the spatial and temporal boundaries of this investigation.

The investigation effort will be performed within the VRP-defined spatial Site boundaries as shown on Figures 1 and 2.

Groundwater COI concentrations, as well as groundwater elevations, are expected to vary seasonally due to rainfall patterns. Therefore, groundwater COI samples will be collected quarterly for 1 year after additional monitoring well installations have been completed to characterize COI concentrations during the wet and dry seasons. Soil metal COIs are not expected to significantly vary in the short term; therefore, no temporal data needs were identified for the soil data collection program.

Step 5: Develop the Analytic Approach

The purpose of this step is to develop an approach to analyze the study results and draw conclusions from the data.

The approach to analyze groundwater and soil COI concentrations, obtained by sample collection and chemical analysis, will be to update the CSM for groundwater and soil at the Site.

Step 6: Specify Performance or Acceptance Criteria

The purpose of the step is to derive the performance or acceptance criteria that the collected data will need to achieve in order to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty estimates within acceptable levels.

Data validation and verification procedures described in the QAPP addendum (Appendix B) are designed so that the data meet acceptance criteria.

Step 7: Optimize the Design for Obtaining Data

The final step of the DQO process is to develop a resource-effective design for collecting and measuring environmental data.

Section 4 of this work plan, along with the FSP Addendum (Appendix A), describes the design and process for obtaining environmental data, respectively.

4. Supplemental Site Characterization Activities

The sections below describe the supplemental site characterization activities for the overall Site and for each investigation area. Table 2 provides a review of the 2008-2009 VRP objectives, findings, and recommendations for further monitoring or sampling on a well-by-well basis. Additional data gaps were identified in the groundwater investigation report and by ADEQ, and these data gaps are summarized in Table 3. Subsequently, the sections below describe the means to collect data for each well and/or area identified in Tables 2 and 3.

4.1 Site-Wide Monitoring

The data gap assessment identified the need for additional groundwater collection to provide a more complete data set of current groundwater conditions. This proposed groundwater monitoring program (the “data gaps program”) is presented in Table 4 and on Figure 13. The data gaps program includes both existing and new wells proposed to be installed for the VRP. The location and installation of new wells are described in further detail in Sections 4.2 through 4.6. The installation depths for the new wells have been determined considering observed wet and dry season groundwater elevations, which are presented on Figures 14 and 15, respectively. The proposed screen intervals extend beyond the extrapolated dry season groundwater elevations.

Many wells within the proposed monitoring network are already sampled for the APP and/or MOC programs for Sierrita. Table 4 distinguishes those wells and the current monitoring program for each. Wells previously sampled as part of the 2008-2009 VRP, which are not proposed to be monitored for the data gaps program, are listed in Table 5.

Groundwater sampling for the VRP is proposed to be conducted quarterly for one year after installation of the new monitoring wells to characterize the current groundwater COI concentrations. Sample collection, preparation, and laboratory analyses will be performed in accordance with the QAPP addendum (Appendix B). The QAPP addendum details the parameters to be analyzed and corresponding analytical methods.

4.2 East Investigation Area

Supplemental characterization activities in the East Investigation Area include assessing background concentrations of basin fill deposits and continuing to monitor groundwater wells in this area. These activities will meet the following objectives:

- Update understanding of groundwater conditions north, east, and south of the STI.
- Determine background conditions for the basin fill deposit.

To assess background analyte concentrations in the basin fill deposits, a new well will be installed (MW-2015-04) as shown on Figure 16. This location will represent background conditions because it is hydrologically cross-gradient of the STI. A review of the available geological maps (Spencer et al. 2003) and previously drilled well logs in this area indicates that sufficient basin fill materials exist at this location to enable a well installation.

The proposed well construction details are presented in Table 6 and Appendix E. The well will be drilled to approximately 45 feet below the groundwater table into the saturated basin fill deposits, with the well screened across the saturated interface. It is anticipated that the well will be approximately 310 feet deep, based on the static water depths for 2013/2014, which indicate that the depth to water will be approximately 265 feet below ground surface (bgs; Figures 14 and 15). The well will be developed and, if sufficiently saturated, sampled as part of the proposed 2015 groundwater sampling plan.

The proposed groundwater well monitoring program for the East Investigation Area, with stated rationale for sampling at each well, is summarized in Table 4 and presented on Figure 13. The data gaps program includes collecting samples from wells previously sampled for the 2008-2009 VRP and new wells, as well as collecting samples from some existing monitoring wells in place south of the STI. Wells MH-9 and MH-10 will be added to the data gaps program to provide water quality information south of the STI in response to ADEQ comment number 10 (ADEQ 2014a). Note that the groundwater flow in the vicinity of the STI is from west to east due to the effect of groundwater pumping related to the MOC extraction wells. Therefore, in reference to ADEQ comments regarding the need for sampling upgradient of the STI, the proposed sampling activity would accomplish this objective.

4.3 Central Investigation Area - Former CLEAR Plant

Supplemental characterization activities in the Former CLEAR Plant area within the Central Investigation Area include hydrogeological assessment, groundwater monitoring, and soil analysis.

4.3.1 Groundwater Assessment Activities

The specific objectives of the supplemental groundwater assessment activities in this area are to:

- Provide downgradient characterization of COIs from the Former CLEAR Plant for both the alluvial and bedrock formations.
- Assess the hydraulic characteristics of both the alluvium and bedrock formations including the vertical hydraulic gradient.
- Assess the hydraulic connection between the alluvium and bedrock formations and response to precipitation events.

The proposed assessment will include installation of two new wells (MW-2015-05 and MW-2015-01) as shown on Figure 17. MW-2015-05 will be screened in the lower portion of the quaternary alluvial sediments, and MW-2015-01 will be screened in the upper portion of the underlying bedrock, anticipated to be the Ruby Star Granodiorite formation.

The proposed well construction details are presented in Table 6 and Appendix E. The alluvial well will be drilled to the base of the alluvial deposits, screened across the saturated interface, and used to assess the saturated thickness and hydraulic characteristics of the alluvium. Based on previous groundwater monitoring in the area, it is anticipated that groundwater will be encountered at approximately 20 feet bgs. The bedrock well will be drilled into and screened in the upper portion of the bedrock. The exact screen interval will depend on the conditions encountered in the field, but screen lengths of 30 feet are anticipated for both the alluvial and bedrock wells. For the bedrock well, to ensure an effective seal from the overlying alluvium, a 5-foot bentonite seal will be placed across the contact of the alluvium and bedrock, above which a Portland cement grout mix will be extended to the surface.

After installation and well development, if sufficient water is available in each of the two new wells, hydraulic testing will be conducted. Hydraulic testing will include 2- to 4-hour pumping test(s) in each of the newly installed wells, followed by recovery testing and/or slug testing, with the exact tests depending on the saturated thickness and well yields.

The hydraulic method(s) to be employed will be determined during development activities, which will inform an approximation of the respective well yield. Step testing will be performed to determine the potential well yield and the pumping rate to be used for a constant rate test.

The constant rate pumping test will include both formations being pumped to enable the assessment of formation hydraulic parameters and the hydraulic interaction. As part of testing activities, pressure transducers will be deployed in both wells. Manual water-level readings will also be collected during testing as a backup and for cross-reference. Hydraulic testing will follow SOPs contained in the FSP Addendum (Appendix A).

Following the hydraulic testing described above, pressure transducers will be deployed in both wells for 1 year to determine long-term water-level changes and potential connection between precipitation events and alluvium-bedrock hydraulic interaction. Proposed groundwater well monitoring in this area is summarized in Table 4 and presented on Figure 13.

4.3.2 Soil Assessment Activities

Two soil samples collected during the 2008-2009 VRP activities yielded exceedances of the antimony GPL in the Former CLEAR Plant area. These samples (CP-1 and CP-2, both collected from a depth of 0.25 foot bgs) are shown on Figure 18. Two confirmation samples will be collected from the vicinity of each area (four samples total) to a depth of 0.25 foot bgs and analyzed for total and SPLP antimony in order to calculate a site-specific GPL.

4.4 Central Investigation Area - Former Raffinate Pond/Amargosa Wash Areas

Supplemental characterization activities in the Former Raffinate Pond and Amargosa Wash areas within the Central Investigation Area include hydrogeological assessment, groundwater monitoring, and soil analysis.

4.4.1 Groundwater Assessment Activities

The specific objectives of the supplemental groundwater assessment activities in this area are to:

- Provide downgradient characterization of COIs in both the alluvium and bedrock formations.
- Assess the hydraulic characteristics of both the alluvium and bedrock formations including the vertical hydraulic gradient.
- Assess the hydraulic connection between the alluvium and bedrock formations and response to precipitation events.

The proposed assessment will include installation of two new bedrock wells (MW-2015-02 and MW-2015-03) as shown on Figure 19. The anticipated well construction details are presented in Table 6 and Appendix E. The wells will be drilled and screened in the upper portion of the bedrock. The exact screen interval will depend on the conditions encountered, but the installation depths are anticipated to be in the region of 50 to 90 feet bgs, with 50 feet of screen installed. To ensure an effective seal from the overlying alluvium, a 5-foot bentonite seal will be placed across the contact of the alluvium and bedrock, above which a Portland cement grout mix will be placed to the surface.

After installation and well development, if sufficient water is available in each of the two new wells, hydraulic testing will be conducted. Hydraulic testing will include recovery testing and/or slug testing, with the exact testing depending on the saturated thickness and well yields. The hydraulic method(s) to be employed will be determined during the development activities, which will inform an approximation of the respective well yield.

As part of hydraulic testing activities, pressure transducers will be deployed in the wells. Manual water level readings will also be collected during testing as a backup and for cross-reference. Hydraulic testing will follow SOPs contained in the FSP Addendum (Appendix A).

Pressure transducers will be deployed to the alluvium/bedrock well pairs MW-22/MW-23 and TW-2008-13/MW-2008-08 for 1 year to determine long-term water-level changes and potential connections between precipitation events and alluvium-bedrock

hydraulic interaction. Proposed groundwater well monitoring in this area is summarized in Table 4 and presented on Figure 13.

4.4.2 Soil Assessment Activities

One soil sample collected during the 2008-2009 VRP activities exceeded the antimony GPL in the Central Investigation Area. This sample (EM-17, at a depth of 0.25 foot bgs) is shown on Figure 20. Two confirmation samples will be collected from this vicinity at a depth of 0.25 foot bgs and analyzed for total and SPLP antimony in order to calculate a site-specific GPL.

4.5 West Investigation Area

The specific objectives of the supplemental groundwater assessment activities in this area are to:

- Provide downgradient characterization of COIs in both the alluvium and bedrock formations.

- Assess the hydraulic connection between the alluvium and bedrock formations and response to precipitation events.

Pressure transducers will be deployed to the alluvium/bedrock well pair TW-2008-05/BW-02 for 1 year to determine long-term groundwater-level changes and potential connections between precipitation events and alluvium-bedrock hydraulic interaction (Figure 21). Proposed groundwater well monitoring in this area is summarized in Table 4 and presented on Figure 13.

4.6 Remediation Levels

At this stage of the investigation, there is no indication that any source to be addressed in the VRP action will cause or contribute to an exceedance of an aquifer water quality standard beyond the boundary of the facility where the source is located. Consequently, Sierrita has not identified any source for which remediation levels or controls may need to be established in order to meet the requirements of A.R.S. § 49-175B.4. During the course of the investigation, Sierrita will continue to evaluate whether any remediation levels or controls need to be established to meet the requirements of A.R.S. § 49-175(B).(4). For a COI in groundwater for which there is no aquifer water quality standard, Sierrita will discuss with ADEQ and propose

remediation levels consistent with A.R.S. § 49-282.06, background levels, and the principles of A.R.S. § 49-175(B).(4). In this regard, there are no drinking water sources within the Sierrita facility boundary.

During the course of the investigation, Sierrita will continue to evaluate whether any remediation levels or controls need to be established to meet the requirements of A.R.S. § 49-175(B).(4) or whether the results of the investigation support a conclusion that no source will cause or contribute to an exceedance of an aquifer water quality standard beyond the boundary of the facility where the source is located, such that A.R.S. § 49-175(B).(4) will be satisfied without any need to establish any remediation levels or controls under the VRP. The same approach will be taken with regard to any constituent for which no aquifer water quality standard has been set.

Following the receipt of all validated data, a report will be submitted to ADEQ within 90 days with the results of the investigation. This report will provide recommended remediation levels, if needed, for groundwater and locations where compliance with those remediation levels is to be measured in groundwater. In addition to aquifer water quality standards, remediation levels may consider applicable permits, mitigation orders, and other provisions of Arizona statute and code that address hazardous substances. This will allow the VRP to review submitted data comprehensively and provide guidance on remedial action and closure under the VRP for the same constituents that would not conflict or contradict what has been established elsewhere for the Site. Soil data collected in accordance with the proposed work plan will be reported as part of the Data Gaps Report; however, soil is being evaluated in a baseline human health risk assessment (BHHRA). Following conclusion of the BHHRA, draft remediation levels or controls for soil will be proposed if needed in a feasibility study.

5. Permits and Legal Requirements

Sierrita will obtain all necessary permits and abide by all legal requirements relevant and applicable. This may include, but is not limited to the following:

- Employment of Arizona-registered land surveyors
- Employment of Arizona-registered drillers
- Employment of Arizona-licensed laboratories (see the Quality Assurance Project Plan for additional guidelines on laboratory requirements)
- Utility clearance in accordance with state laws
- Drilling and well construction in accordance with Arizona Department of Water Resources (ADWR) guidelines and under and ADWR-approved permit
- Investigation-derived waste storage, transport, and disposal in accordance with legal requirements
- Transportation or shipment of samples in accordance with Department of Transportation (DOT) and/or Federal Aviation Administration (FAA) rules
- Sierrita will comply with Best Management Practices (BMPs) as outlined in the Storm Water Pollution Protection Plan (SWPPP).

6. Community Involvement

Per ADEQ's email approval, dated September 11, 2015, Sierrita will continue to maintain a record of materials and to make certain records are available to the public, Sierrita will maintain a document repository at Joyner-Green Valley Branch Library in Green Valley. The repository will contain all documents and information required to be prepared or maintained by the VRP. The document repository at the Joyner-Green Valley Branch Library is accessible during normal business hours. Sierrita will also maintain an internet web site to make available published documents in portable document format (PDF). The URL for the web site is: http://www.fcx.com/sierrita/program.htm.

7. Project Schedule and Reporting

The field activities, starting with pre-mobilization, are estimated to begin 60 days following ADEQ's review and approval of this work plan. Sierrita will provide ADEQ with an interim project update 30 days after validated data are received for the first round of monitoring. A draft report will be submitted to ADEQ 90 days after receipt of all validated data.

8. References

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ARCADIS

Tables

Table 1
Analyte List for Sierrita APP Wells, MOC Wells, and VRP 2008-2009 Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Parameter	Units	APP	MOC	2008-2009 VRP Program
Depth to water level	feet	x		x
Water level elevation	feet amsl	x		x
Temperature - field	ºF	x	x	x
pH - field	SU	x	x	x
pH - lab	SU	x		x
Specific conductance - field	µmhos/cm	x	x	x
Total Dissolved Solids - lab	mg/L	x		x
Total Alkalinity	mg/L	x		x
Bicarbonate	mg/L	x		x
Carbonate	mg/L	x		x
Sulfate	mg/L	x	x	x
Chloride	mg/L	x		x
Fluoride	mg/L	x		x
Nitrate + nitrite	mg/L	x		x
Calcium	mg/L	x		x
Magnesium	mg/L	x		x
Potassium	mg/L	x		x
Sodium	mg/L	x		x
Aluminum	mg/L	x		x
Antimony	mg/L	x		x
Arsenic	mg/L	x		x
Barium	mg/L	x		x
Beryllium	mg/L	x		x
Cadmium	mg/L	x		x
Chromium (total)	mg/L	x		x
Cobalt	mg/L	x		x
Copper	mg/L	x		x
Iron	mg/L	x		x
Lead	mg/L	x		x
Manganese	mg/L	x		x
Mercury	mg/L	x		x
Molybdenum	mg/L	x		x
Nickel	mg/L	x		x
Selenium	mg/L	x		x
Thallium	mg/L	x		x
Uranium	mg/L	x		x
Zinc	mg/L	x		x
Free Cyanide	mg/L	x		
Gross Alpha particle activity	pCi/L	x		x
Gross Beta particle activity	pCi/L			x
Gross Alpha - adjusted	pCi/L	x		x
Radium 226	pCi/L	x		x
Radium 228	pCi/L	x		x
Uranium isotopes (U-234, U-235, U-238)	pCi/L	x		x
Carbon disulfide	mg/L	x		
Benzene	mg/L	x		
Toluene	mg/L	x		
Ethylbenzene	mg/L	x		
Total xylenes	mg/L	x		

Notes:
APP - Aquifer Protection Permit
MOC - Mitigation Order on Consent
VRP - Voluntary Remediation Program
mg/L - milligrams per liter
µmhos/cm - micromhos per centimeter
SU - standard units
amsl - above mean sea level
pCi/L - picoCuries per liter
°F - degrees Fahrenheit

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
Background Areas						
MH-17	Permanent Monitoring Well	Harris Ranch Quartz Monzonite	N/A - Background areas	Represents background groundwater conditions in the Harris Ranch Quartz Monzonite.	Low but variable concentrations of metal and radionuclide COIs were found in background bedrock wells. This variability reflects the different bedrock formations that contribute naturally occurring concentrations of COIs, including radionuclides. Radionuclide activity exceeded AWQS in almost all wells. Some background wells exhibited high TDS, sulfate, and/or other cation/anion concentrations, reflecting the geology of the formation in which the well is screened.	Monitoring events for the VRP should include these background wells as a means to assess contribution of natural background to groundwater concentrations of COIs.
MH-21	Permanent Monitoring Well	Ruby Star Intrusives	N/A - Background areas	Verify background COI concentrations in the Ruby Star Granodiorite and compare results to newly installed background wells.		
MW-2008-12	Permanent Monitoring Well	Ruby Star Granodiorite	N/A - Background areas	Evaluate background concentrations in hornblende rich Ruby Star Granodiorite.		
MW-2008-13	Permanent Monitoring Well	Ruby Star Granodiorite	N/A - Background areas	Evaluate background concentrations in hornblende rich Ruby Star Granodiorite.		
MW-2008-14	Permanent Monitoring Well	Tinaja Peak Formation	N/A - Background areas	Evaluate background concentrations in Tinaja Peak Formation.		
MW-2008-15	Permanent Monitoring Well	Harris Ranch Quartz Monzonite	N/A - Background areas	Evaluate background concentrations in Harris Ranch Quartz Monzonite.		
PZ-01	Permanent Monitoring Well	Tinaja Peak Formation	N/A - Background areas	Represents background conditions in the Tinaja Peak Formation.		
Central Investigation Area						
Amargosa East Sump	Active Facility	N/A - Not a well	Amargosa Wash	Not specified	The general chemical characteristics of the active facilities reflect leaching and flotation operations. Leaching solutions exhibit low pH, high sulfate, and other major cations and anions. The flotation process for copper and molybdenum uses an alkaline process, and the solutions from these operations exhibit comparatively higher pH, alkalinity, and lower TDS. Both flotation and leaching solutions contain relatively higher concentrations of trace metals, especially divalent cations, and concentrated radionuclide activity relative to background as a result of processing operations.	No further investigation of processing solutions is recommended. Data collected to date have adequately characterized these potential sources.
Amargosa Pond	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
Amargosa West Sump	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
B Pond	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
B Seepage Silo	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
Bailey Lake	Active Facility	N/A - Not a well	Amargosa Wash	Characterize COIs in process solution.		
Bailey Sump	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
C Seepage Silo	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
Decant Solution (Molybdenum)	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
Headwall No. 1	Active Facility	N/A - Not a well	Amargosa Wash	Characterize COIs in process solution.		
Raffinate Pond No. 2	Active Facility	N/A - Not a well	Amargosa Wash	Characterize COIs in process solution.		
SX-Sump 1	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
SX-Sump 2	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
SX-Sump 3	Active Facility	N/A - Not a well	Amargosa Wash	Not specified		
BW-03	Permanent Monitoring Well	Ruby Star Granodiorite	Amargosa Wash	Evaluate potential releases from upgradient process areas along the west side of Demetrie Wash and potential influence from Amargosa Wash.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Chloride, calcium, hardness, and TDS higher than in north background wells. Concentrations of radionuclide COIs consistent with background.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.
BW-04	Permanent Monitoring Well	Bedrock Complex	Amargosa Wash	Evaluate potential releases from B Pond and Amargosa Wash area in general. May assist with determining effectiveness of B Sump.	Cadmium and nickel > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Chloride, calcium, hardness, and TDS concentrations are higher than in north background wells. Concentrations of radionuclide COIs consistent with background.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
MH-22	Permanent Monitoring Well	Alluvium	Amargosa Wash	Evaluate alluvial groundwater in Demetrie Wash to identify potential releases from Demetrie and Amargosa Washes.	This well is only periodically saturated. One sample collected, showing Metal COIs < AWQS; Gross alpha and Gross beta > AWQS. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program. Assess alluvial-bedrock groundwater interaction downgradient of Central Investigation Area.

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
MH-23	Permanent Monitoring Well	Demetrie Volcanics	Amargosa Wash	Evaluate potential influence of alluvial water with underlying bedrock groundwater (collocated with MH-22).	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS. Chloride, calcium, hardness, and TDS were higher than in the north background wells. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program. Assess alluvial-bedrock groundwater interaction downgradient of Central Investigation Area.
MW-2008-01	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality upgradient of the Former CLEAR Plant Area.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Radionuclide and general chemistry concentrations are consistent with background.	The Former CLEAR Plant is a source of general chemistry COIs to groundwater. Additional characterization proposed to characterize this source.
MW-2008-02	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality immediately downgradient of the Former CLEAR Plant.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, chloride, hardness, and TDS were higher than upgradient well concentrations. Radionuclide concentrations are consistent with background.	The Former CLEAR Plant is a source of general chemistry COIs to groundwater. Additional characterization proposed to characterize this source.
MW-2008-03	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality immediately downgradient of the Former E Pond.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, chloride, hardness, and TDS werehigher than north background and upgradient groundwater concentrations. Radionuclide concentrations are consistent with background.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
MW-2008-04	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality immediately downgradient of the Former Evaporation Pond.	Only one monitoring quarter indicated nickel > AWQS. Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, chloride, hardness, and TDS werehigher than north background and upgradient groundwater concentrations. Radionuclide concentrations are consistent with background.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
MW-2008-05	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality immediately downgradient of the Old D Pond.	Only one monitoring quarter indicated selenium > AWQS. Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, chloride, hardness, and TDS are consistent with, or lower than, concentrations in the well upgradient of Old D Pond. Radionuclide and general chemistry concentrations are consistent with background. Soil samples in Old D Pond did not indicate that selenium has the potential to migrate to groundwater from this source.	Old D Pond is not a source of COIs to groundwater. Further investigation of this source is not needed.
MW-2008-06	Permanent Monitoring Well	Ruby Star Granodiorite	Demetrie Wash	Evaluate groundwater quality upgradient of the Old D Pond.	Se > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, chloride, hardness, and TDS were higher than north background wells or groundwater upgradient of the former CLEAR Plant. Radionuclide concentrations are consistent with background. Soil samples in Old D Pond did not indicate that selenium has the potential to migrate to groundwater from this source.	Old D Pond is not a source of COIs to groundwater. Further investigation of this source is not needed.
MW-2008-07	Permanent Monitoring Well	Ruby Star Intrusives	Amargosa Wash	Evaluate groundwater quality immediately upgradient of the Former C Pond.	Ni, Be, Cd > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Hardness, calcium, and magnesium are higher than north background wells. Radionuclide concentrations are consistent with background.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, bedrock groundwater is subject to fracture-flow; hence, inclusion of this well is recommended during VRP investigation to characterize nature and extent from Former Raffinate Pond.
MW-2008-08	Permanent Monitoring Well	Ruby Star Granodiorite	Amargosa Wash	Evaluate groundwater quality immediately downgradient of the Former C Pond.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. General chemistry parameters are consistent with the well upgradient of Former C Pond. Radionuclide concentrations are consistent with background.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and provides information as to the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
MW-2008-09	Permanent Monitoring Well	Ruby Star Intrusives	Amargosa Wash	Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.	Be, Cd, Pb, Ni > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Magnesium, hardness, TDS, sulfate, and potassium are higher than the background. Radionuclide concentrations are consistent with background. Although COIs in upgradient sources (measured at MW-2008-11) are higher than background and/or AWQS, concentrations appear to increase downgradient of the Former Raffinate Pond.	Former Raffinate Pond is a source of COIs to groundwater. Additional characterization in this area is proposed.
MW-2008-10	Permanent Monitoring Well	Ruby Star Granodiorite	Amargosa Wash	Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.	Be, Cd, Ni > AWQS, although soil results do not indicate a potential for these COIs to migrate to groundwater. Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Magnesium, hardness, TDS, sulfate, and potassium are higher than the background. Radionuclide concentrations are consistent with background. Although COIs in upgradient sources (measured at MW-2008-11) are higher than background and/or AWQS, concentrations appear to increase downgradient of the Former Raffinate Pond.	Former Raffinate Pond is a source of COIs to groundwater. Additional characterization in this area is proposed.
MW-2008-11	Permanent Monitoring Well	Ruby Star Granodiorite	Amargosa Wash	Evaluate groundwater quality upgradient of the Former Raffinate Pond.	Be, Cd, Ni > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Magnesium, hardness, TDS, sulfate, and potassium are higher than the 95th percentile of the north background wells. Radionuclide concentrations are consistent with background.	VRP investigation of groundwater contributions from the Former Raffinate Pond should include this location to understand COI concentrations upgradient of this facility. Additionally, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.
PZ-02	Permanent Monitoring Well	Demetrie Volcanics	Amargosa Wash	Evaluate quality of bedrock groundwater downgradient of sulfide leach stockpile and in vicinity of Headwall No. 1 and Bailey Lake.	Cd, Ni, Se > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Calcium, magnesium, sodium, nitrate, and TDS are higher than north background wells. Radionuclide concentrations are consistent with background. pH is circumneutral and sulfate concentration matches background.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
PZ-03	Permanent Monitoring Well	Ruby Star Intrusives	Amargosa Wash	Evaluate bedrock groundwater quality in Amargosa Wash and possibly part of the Esperanza Mill area. Provides an additional Ruby Star Granodiorite monitoring point.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Chloride, magnesium, calcium, hardness, sulfate, and TDS are higher than the 95th percentile of north background wells. Radionuclide concentrations are consistent with background.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
PZ-05	Permanent Monitoring Well	Ruby Star Intrusives	Demetrie Wash	Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.	As > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. TDS, sodium, potassium, magnesium, hardness, chloride, and calcium are higher than north background wells. Radionuclide concentrations are consistent with background.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.
PZ-06	Permanent Monitoring Well	Ruby Star Intrusives	Demetrie Wash	Evaluate bedrock groundwater quality upgradient of the general mill area.	As, Be, Cd, Cr, Ni > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Potassium, nitrate, magnesium, chloride, calcium, and hardness are higher than north background wells. Sulfate and TDS are increasing over time. Radionuclide concentrations are consistent with background.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.
PZ-04	Permanent Monitoring Well	Ruby Star Intrusives	Demetrie Wash	Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. TDS, sulfate, sodium, magnesium, hardness, fluoride, chloride, and calcium are higher than north background wells. Radionuclide concentrations are consistent with background.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.
TW-2008-08	Temporary Monitoring Well	Alluvium	Amargosa Wash	Confirm that the pond (Launders Facility) has not released elevated concentrations of COIs from process solutions to groundwater.	This well was dry.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
TW-2008-09	Temporary Monitoring Well	Alluvium	Amargosa Wash	Confirm that the ponds (Headwall No. 1 and Bailey Lake) have not released elevated concentrations of COIs from process solutions to groundwater.	Be, Cd, Cr, Ni, Se > AWQS; Gross alpha and Gross beta > AWQS. Most general chemistry parameters are higher than north background.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.
TW-2008-10	Temporary Monitoring Well	Alluvium	Amargosa Wash	Confirm that the pond (Raffinate Pond No. 2) has not released elevated concentrations of COIs from process solutions to groundwater.	Sb, As, Be, Cd, Cr, Pb, Ni, Se > AWQS; Gross alpha and Gross beta > AWQS. Most general chemistry parameters are higher than north background.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.
TW-2008-11	Temporary Monitoring Well	Alluvium	Amargosa Wash	Confirm that the pond (former A Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	Be, Cd, Cr, Ni, Se > AWQS; Gross alpha and Gross beta > AWQS. Most general chemistry parameters are higher than north background wells.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.
TW-2008-12	Temporary Monitoring Well	Alluvium	Amargosa Wash	Confirm that the pond (B Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	Be, Cd, Ni > AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Most general chemistry parameters are higher than north background wells.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.
TW-2008-13	Temporary Monitoring Well	Alluvium	Amargosa Wash	Not specified.	Metal COIs < AWQS; Gross alpha, Gross beta, and Ra226+Ra228 > AWQS. Radionuclide concentrations are consistent with bedrock background wells. Most general chemistry parameters are consistent with north background wells.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.
TW-2008-14	Temporary Monitoring Well	Alluvium	Amargosa Wash	Not specified.	This well was dry.	No further monitoring recommended.
TW-2008-15	Temporary Monitoring Well	Alluvium	Amargosa Wash	Not specified.	This well was dry.	This is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.
West Investigation Area						
Headwall No. 2	Active Facility	N/A - Not a well	Esperanza Wash	Characterize COIs in process solution.	See note above for active facilities.	No further investigation is needed. See above for active facilities.
Headwall No. 3	Active Facility	N/A - Not a well	Esperanza Wash	Characterize COIs in process solution.		
Headwall No. 5	Active Facility	N/A - Not a well	Esperanza Wash/Unnamed Wash	Characterize COIs in process solution.		
SX-3 Stormwater Pond	Active Facility	N/A - Not a well	Esperanza Wash	Characterize COIs in process solution		
BW-02	Permanent Monitoring Well	Demetrie Volcanics	Esperanza Wash	Confirm no releases have occurred from process solution ponds located in Esperanza Wash.	Be, Cd, Ni > AWQS. Detection limits for Gross alpha and Gross beta are > AWQS. TDS, sulfate, calcium, chloride, hardness, nitrate, and magnesium are higher than west background wells.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
MH-18	Permanent Monitoring Well	Tinaja Peak Formation	Tinaja Wash	Evaluate impacts from waste rock stockpile and possibly represent groundwater conditions generally upgradient of Sierrita.	Metal and radionuclide COIs < AWQS. TDS, sulfate, nitrate, hardness, chloride, and calcium are higher than west background wells. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program.
MH-19	Permanent Monitoring Well	Tinaja Peak Formation	Esperanza Wash	Evaluate shallower aquifer impacts from sulfide leach area and Headwall No. 5.	Metal COIs < AWQS; Gross alpha > AWQS. TDS, sulfate, nitrate, hardness, chloride and calcium are higher than west background wells. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program.

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
MH-20	Permanent Monitoring Well	Demetrie Volcanics	Esperanza Wash	This well is screened at a deeper elevation than well BW-02. Evaluate deeper aquifer impacts.	Metal and Radionuclide COIs < AWQS. TDS and sulfate are higher than west background wells. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program.
MH-27	Permanent Monitoring Well	Demetrie Volcanics	Esperanza Wash	Evaluate quality of bedrock groundwater in vicinity of Headwall No. 2.	Metal COIs < AWQS; detection limits for Gross alpha and Gross beta are > AWQS. TDS, sulfate, sodium, magnesium, hardness, chloride, and calcium are higher than west background wells. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue to monitor per APP program.
PZ-16	Permanent Monitoring Well	Demetrie Volcanics	Esperanza Wash	Evaluate quality of bedrock groundwater in vicinity of Headwall No. 5.	Metal COIs < AWQS; Gross alpha > AWQS and detection limits for Gross beta are > AWQS. TDS, sulfate, sodium, magnesium, hardness, chloride, and calcium are higher than west background wells.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.
TW-2008-02	Temporary Monitoring Well - Destroyed	Alluvium	Esperanza Wash	Confirm that the plant (SX Plant No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	This well was dry.	This well has been destroyed and cannot be monitored.
TW-2008-03	Temporary Monitoring Well	Alluvium	Esperanza Wash	Confirm that the pond (Headwall No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	This well was dry.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.
TW-2008-04	Temporary Monitoring Well	Alluvium	Esperanza Wash	Confirm that the pond (Raffinate Pond No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	This well had water during only one quarter of monitoring due to dry conditions, and only radionuclides were measured. Radionuclide concentrations were > AWQS but consistent with background.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.
TW-2008-05	Temporary Monitoring Well	Alluvium	Esperanza Wash	Confirm that the pond (SX-3 Stormwater Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	This well was dry.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.
TW-2008-07	Temporary Monitoring Well	Alluvium	Esperanza Wash	Confirm that the pond (Headwall No. 2) has not released elevated concentrations of COIs from process solutions to groundwater.	This well had water during only one quarter of monitoring due to dry conditions, and only radionuclides were measured. Radionuclide concentrations were > AWQS but consistent with background.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.
East Investigation Area						
Reclaim Pond Settling Basin	Active Facility	N/A - Not a well	N/A - East of washes	Gather data to characterize COI concentrations in reclaim water.	See note above for active facilities.	No further sampling is recommended. See above for active facilities.
MH-14	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS. Radionuclide concentrations are consistent with background. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue monitoring per APP program.
MH-15W	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality in central portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS. Radionuclide concentrations are consistent with background. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue monitoring per APP program.
MH-16W	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality in southern portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS. Radionuclide concentrations are consistent with background. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue monitoring per APP program.
MH-28	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS. Radionuclide concentrations are consistent with background. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue monitoring per APP program.
MH-29	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality in southern portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS. Radionuclide concentrations are consistent with background. Note that this well is a POC well; the APP establishes specific Action Levels for constituents in groundwater for these wells.	Continue monitoring per APP program.

Table 2
2008-2009 VRP Program Objectives, Findings, and Conclusions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Feature ID	Type of Feature	Screened Interval Lithology	Associated Wash	2008 VRP Work Plan Objective	Summary of Findings	Conclusions/Recommendations
MH-30	Permanent Monitoring Well	Basin Fill Deposits (20 ft), Mesozoic Sedimentary Rocks (80 ft)	N/A - East of washes	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Metal COIs < AWQS; Gross alpha > AWQS.	Continue monitoring per APP program.
PZ-07	Permanent Monitoring Well	Basin Fill Deposits (8 feet), Ruby Star Intrusives (42 feet)	Demetrie Wash	Evaluate groundwater quality at northern edge of basin fill deposits and northern Sierrita property boundary.	Metal COIs < AWQS; Gross alpha and Ra226+Ra228 > AWQS.	Further characterization is proposed to confirm upgradient concentrations of COIs in basin fill.
PZ-09	Permanent Monitoring Well	Basin Fill Deposits (82 feet), Ruby Star Intrusives (18 feet)	N/A - East of washes	Not specified	This well was dry.	No further monitoring recommended.
PZ-08	Permanent Monitoring Well	Demetrie Volcanics	Demetrie Wash	Evaluate southern portion Sierrita property boundary and groundwater quality before it flows beneath Sierrita Tailing Impoundment.	Metal and Radionuclide COIs < AWQS. General chemistry COIs are consistent with background.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.
PZ-2007-05	Permanent Monitoring Well	Basin Fill Deposits	N/A - East of washes	Evaluate basin fill deposits groundwater quality immediately downgradient of the Esperanza Tailing Impoundment and near the Sierrita Tailing Impoundment reclaim pond.	Metal COIs < AWQS; Gross alpha > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.
PZ-2008-19	Permanent Monitoring Well (well buried)	Tailings	N/A - East of washes	Not specified.	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.
PZ-2008-20	Permanent Monitoring Well (well buried)	Tailings	N/A - East of washes	Not specified.	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.
PZ-2008-16	Permanent Monitoring Well (well buried)	Tailings	N/A - East of washes	Not specified.	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.

Notes:
Wells are generally ordered in this table upgradient to downgradient per area or feature.
N/A = not applicable
* - denotes that well construction diagrams unavailable; assumed lithology
APP - Aquifer Protection Permit
AWQS - Arizona Aquifer Water Quality Standards
CLEAR - Continuous Liquid Extraction and Regeneration
COIs - constituents of interest
MOC - Mitigation Order on Consent
POC - point of compliance
Ra226 - radium 226
Ra228 - radium 228
STI - Sierrita Tailings Impoundment
TDS - total dissolved solids
VRP - Voluntary Remediation Program

Table 3
Summary of Data Gaps and Actions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Objective	Source	Comment or Data Gap Identified	Response Summary	Action or Proposed Sampling
Site Wide				
Incorporate soil and sediment data into the CSM.	ADEQ 4/14	ADEQ Comment No. 3: VRP suggests that Sierrita include soil and sediment data into the Site's conceptual site model and subsequent groundwater investigation.	Sierrita responded that the findings of the soil investigation, which showed a lack of connection between soil and groundwater (demonstrated by comparison to GPLs), would be included in the Work Plan to support Sierrita' s rationale for proposed data collection.	Text description of soil/sediment connection to groundwater is provided in the Work Plan (see Section 2). Site-specific GPLs for antimony in the CLEAR Plant and Esperanza Mill subarea need to be determined. Four samples in the CLEAR Plant subarea and two samples in the Esperanza Mill subarea will be collected for total and SPLP antimony analysis.
Provide an all-inclusive data set for groundwater.	ADEQ 4/14	ADEQ Comment No. 4: VRP requests that Sierrita provide an all-inclusive data set for any and all groundwater wells installed before, during, and after the Work Plan period.	Sierrita responded that monitoring data at the Site collected since 2009 will be considered to assist in further development of the VRP CSM and data gaps Work Plan.	A comprehensive well map is provided in the Work Plan, as well as the data collected for the APP and MOC during the period 2009-2014.
Conduct groundwater monitoring events, coinciding with the Site's wet and dry seasons. Use the new monitoring data to provide groundwater contours of alluvial and basin fill aquifers in addition to the bedrock aquifer.	ADEQ 4/14	ADEQ Comment No. 6: VRP requests that additional site-wide groundwater monitoring be conducted to provide a more complete data set of current groundwater conditions. VRP suggests that the monitoring events be conducted semi-annually in January and July, coinciding with the Site's wet season. a. With the additional monitoring data, VRP suggests contouring the groundwater elevations for the alluvial and basin fill aquifers in addition to the bedrock aquifer. b. VRP also suggests that Sierrita use the additional data collected to re-assess aquifer characteristics calculated by URS such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	Sierrita responded that a groundwater collection program will be proposed in the Work Plan for wells within VRP-defined site boundaries. The program will incorporate the VRP requests made in comment #6.	Additional sampling is proposed in the Work Plan (see Section 4.1). Groundwater contours of each aquifer/unit will be made following the monitoring events.
Revise Table 17 in the Groundwater investigation report.	ADEQ 4/14	ADEQ Comment No. 12: Table 17: VRP suggests that this table include a preliminary outcome/conclusion and recommendations column.	Sierrita responded that the Work Plan will contain a table of wells proposed for further monitoring and the rationale as to why each well was included as a monitoring point for the VRP.	A table summarizing the preliminary outcome/conclusion and recommendations column following the groundwater investigation is provided in the Work Plan (see Table 2).
Provide additional geologic cross sections.	ADEQ 4/14	ADEQ Comment No. 15: Figures 5 and 6: VRP would like to remind Sierrita of the commitment made in their February 22, 2012 letter titled Voluntary Remediation Program - Soil and Sediment Characterization Report in regards to developing "updated geologic cross sections" based on new information obtained during any soil and groundwater work. As such, VRP recommends including at least two updated cross sections (north-south and east-west, or best-fit based on well locations) for each of the investigation areas (background, west, central, and east). Please include applicable wells and respective information such as: total depth, screening interval, groundwater elevation, known faults, and a legend that matches the formations discussed in the report.	Sierrita responded that additional cross sections will be forthcoming in the Work Plan.	Additional cross sections are provided in the Work Plan (see Section 2 and Figures 3 through 11).
Central Investigation Area - Active Facility Area in Amargosa Wash				
Perform additional characterization of the extent of impacts in the alluvial and bedrock aquifer is needed in the active facility area in Amargosa Wash.	ADEQ 4/14	ADEQ Comment No. 9: Page 58, Section 4.3.4 "Active Facilities in the Central Investigation Area", 1st paragraph: VRP suggests installing groundwater monitoring wells alongside Amargosa Wash.	Migration potential in alluvium and bedrock in proximity to the active facilities warrants further investigation in the Amargosa Wash.	Additional wells are proposed in this area in the bedrock aquifer (Figure 19).
	ADEQ 4/14	ADEQ Comment No 10: Page 67, Section 6.5 "Data Gaps and Recommendations for Further Data Collection": VRP concurs with the recommendations and data gaps presented here. However, VRP requests that Sierrita also include the following: • Monitoring wells south of the STI. • Monitoring wells within, or adjacent to, the major washes. • Install well pairs in alluvium and bedrock in areas where alluvium is present at the surface. • Continue the investigation/analysis of background water quality. VRP notes that Sierrita' s background water quality analysis is the basis for most of the data analysis, preliminary conclusions, and proposed data gaps. With the data set currently presented in the Report, VRP does not concur with the proposed background water quality. VRP requests that Sierrita collect additional alluvial (if applicable), basin fill, bedrock, and groundwater samples from several areas that are not down-gradient or cross-gradient of current or historical mining operations and/or disturbed land areas.	Sierrita responded that it will incorporate data collection requests in the Work Plan. Data collection and well installation will coincide with specific areas identified for further investigation.	
	GIR	Section 5, pg. 60: Groundwater COI concentrations higher than background and/or AWQS were observed in samples from wells screened in the alluvial aquifer in Amargosa Wash, near SX-Sump-2, Raffinate Pond No. 2, and Amargosa Pond. There are no wells installed in the bedrock hydrostratigraphic unit in this immediate area, so the extent of impacts to the bedrock hydrostratigraphic unit cannot be ascertained. Additionally, limited alluvial wells are installed in this area, such that characterization of the nature and extent in the alluvial aquifer is also limited.	Sierrita will investigate the extent of COI presence in the alluvial and bedrock units in the Amargosa Wash area, extending from Bailey Lake to Former A pond.	

Table 3
Summary of Data Gaps and Actions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Objective	Source	Comment or Data Gap Identified	Response Summary	Action or Proposed Sampling
Understand precipitation-driven surface water-groundwater system interactions.	ADEQ 4/14	ADEQ Comment No. 6: VRP requests that additional site-wide groundwater monitoring be conducted to provide a more complete data set of current groundwater conditions. VRP suggests that the monitoring events be conducted semi-annually in January and July, coinciding with the Site's wet season. a. With the additional monitoring data, VRP suggests contouring the groundwater elevations for the alluvial and basin fill aquifers in addition to the bedrock aquifer. b. VRP also suggests that Sierrita use the additional data collected to re-assess aquifer characteristics calculated by URS such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	Sierrita responded that a hydraulic testing program will be proposed in the Work Plan for wells within VRP-defined site boundaries.	Pressure transducers are proposed to be installed in MH-22 and MH-23 (Figure 19).
	GIR	Section 5, pg. 61: During groundwater quality sampling events, it was noted that rainfall patterns varied substantially between quarters, as did, at times, groundwater quality concentrations of COIs. Additionally, wells installed in the alluvial aquifer were often dry, suggesting that movement of COIs within the alluvial aquifer and from the alluvial aquifer into the bedrock hydrostratigraphic unit may occur only over short durations, driven by high precipitation events. Therefore, a hydrological investigation of surface water-groundwater system interaction, particularly with respect to response to precipitation events, would aid in further interpretation of source-distribution dynamics of groundwater COIs and connectivity (or lack thereof) between facility operations, alluvial groundwater quality, and bedrock groundwater quality. Concurrent measurements of precipitation, groundwater elevation, and solution pond pump/seepage rates are recommended to facilitate further interpretation.	Sierrita will investigate the migration potential from alluvium to bedrock in the Amargosa Wash area, extending from Bailey Lake to Former A pond.	
Re-assess aquifer characteristics such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	ADEQ 4/14	ADEQ Comment No. 6: VRP requests that additional site-wide groundwater monitoring be conducted to provide a more complete data set of current groundwater conditions. VRP suggests that the monitoring events be conducted semi-annually in January and July, coinciding with the Site's wet season. a. With the additional monitoring data, VRP suggests contouring the groundwater elevations for the alluvial and basin fill aquifers in addition to the bedrock aquifer. b. VRP also suggests that Sierrita use the additional data collected to re-assess aquifer characteristics calculated by URS such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	Sierrita responded that a groundwater collection program will be proposed in the Work Plan for wells within VRP-defined site boundaries. The program will incorporate the VRP requests made in comment #6.	Pumping tests (if sufficient water is available), or else aquifer yield tests, are proposed in MW-2015-05 and MH-2015-01, which are alluvium-bedrock wells in the former CLEAR Plant Area. Slug tests will be performed on MH-2015-02 and MH-2015-03 wells, which are bedrock wells in the Central Investigation Area. Field mapping of exposed formation outcrops will also be completed, which can also be useful to identify areas of fracture.
	GIR	Section 5, pg. 61: Additionally, the potential influence of fracturing in the bedrock on COI distribution is not well understood throughout the Central Investigation Area. Geophysics analysis and/or aquifer testing in this area is suggested as a means to measure fracturing influence on groundwater COI distribution in areas of interest. Deployment of this type of instrumentation, will aid in the analysis of other transient hydraulic conditions, such as storm events, and also support interpretation of subsequent aquifer tests (i.e., pumping tests) in this area; [...]	Sierrita will conduct aquifer testing in the Amargosa Wash area, extending from Bailey Lake to Former A pond.	
Determine extent of downgradient effects.	GIR	Section 5, pg. 60: MH-22 and MH-23 were identified in the Work Plan as downgradient monitoring wells, in the alluvial aquifer and bedrock hydrostratigraphic unit, respectively, for Amargosa Wash and Demetrie Wash. Further characterization of the extent of potential downgradient effects is recommended.	Sierrita will investigate the migration potential from alluvium to bedrock in the Amargosa Wash and Demetrie Wash areas.	Additional sampling is proposed at MH-22 and MH-23 (Figure 19 and Table 4).
Central Investigation Area - Former Raffinate Pond				
Additional characterization of the extent of COI impacts related to the former Raffinate Pond is needed.	GIR	Section 5, pg. 61: The nature and extent of groundwater COI impacts of former operations needs additional characterization.	Sierrita will develop a monitoring program for downgradient wells and determine the COI migration potential from alluvial to bedrock aquifer by review of soil data and alluvial aquifer data collection.	Additional sampling at MW-2008-09, MW-2008-10, and PZ-03 is proposed. There is no alluvial aquifer in this area; therefore, additional well installation is not proposed.
Central Investigation Area - Former CLEAR Plant				
Additional characterization of the extent of COI impacts related downgradient from the CLEAR Plant area is needed.	GIR	Section 5 pg. 61: Understanding the hydrologic regime in the bedrock hydrostratigraphic unit in the vicinity of former CLEAR Plant area, and in the interface between the bedrock hydrostratigraphic unit and the basin fill aquifer, is recommended to help interpret COI impacts to groundwater in this area.	Sierrita will investigate the downgradient COI migration from the former CLEAR Plant area.	An alluvium and bedrock well pair is proposed in the former CLEAR Plant area (Figure 17). Additional sampling is proposed for downgradient wells.
Re-assess aquifer characteristics such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	ADEQ 4/14	ADEQ Comment No. 6: VRP requests that additional site-wide groundwater monitoring be conducted to provide a more complete data set of current groundwater conditions. VRP suggests that the monitoring events be conducted semi-annually in January and July, coinciding with the Site's wet season. a. With the additional monitoring data, VRP suggests contouring the groundwater elevations for the alluvial and basin fill aquifers in addition to the bedrock aquifer. b. VRP also suggests that Sierrita use the additional data collected to re-assess aquifer characteristics calculated by URS such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	Sierrita responded that a groundwater collection program will be proposed in the Work Plan for wells within VRP-defined site boundaries. The program will incorporate the VRP requests made in comment #6.	Pumping tests (if sufficient water is available), or else aquifer yield tests, are proposed in MW-2015-05 and MH-2015-01, which are alluvium-bedrock wells in the former CLEAR Plant Area. Slug tests will be performed on MH-2015-02 and MH-2015-03 wells, which are bedrock wells in the Central Investigation Area. Field mapping of exposed formation outcrops will also be completed, which can also be useful to identify areas of fracture.
	GIR	Section 5, pg. 61: The current hydraulic conductivity estimates for the bedrock hydrostratigraphic unit are subject to uncertainties, due to potential micro and macro structural controls on groundwater flow, and limitations of the current slug test data set. Therefore, hydraulic conductivity estimates should be viewed at this time as preliminary estimates, and further refinements in these areas of interest would be warranted to assist with further interpretation of controls on COI distribution in the alluvial aquifer and bedrock hydrostratigraphic unit. Longer term aquifer performance tests would assist in understanding the transmissivity of the bedrock and connectedness of the fractures, and provide more than a “near well” estimate of hydraulic conductivity.	Sierrita will refine hydraulic conductivity estimates in the former CLEAR Plant area.	

Table 3
Summary of Data Gaps and Actions
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

Objective	Source	Comment or Data Gap Identified	Response Summary	Action or Proposed Sampling
West Investigation Area				
Further monitoring of wells in this investigation area is recommended.	ADEQ 4/14	ADEQ Comment No 10: Page 67, Section 6.5 "Data Gaps and Recommendations for Further Data Collection": VRP concurs with the recommendations and data gaps presented here. However, VRP requests that Sierrita also include the following: • Monitoring wells south of the STI. • Monitoring wells within, or adjacent to, the major washes. • Install well pairs in alluvium and bedrock in areas where alluvium is present at the surface. • Continue the investigation/analysis of background water quality.	Sierrita responded that it will incorporate data collection requests in the Work Plan. Data collection and well installation will correlate with specific areas identified for further investigation.	Additional sampling of bedrock wells in this area is proposed in the Work Plan (see Section 4 and Table 4).
	GIR	Section 5, pg. 62: Data collection recommendations include additional monitoring of the bedrock hydrostratigraphic unit in the vicinity of each of the active facilities in this area to assess potential impacts of the active facilities to groundwater COI concentrations.	Sierrita will develop a monitoring program for existing bedrock wells.	
Understand precipitation driven surface water-groundwater system interactions.	ADEQ 4/14	ADEQ Comment No. 6: VRP requests that additional site-wide groundwater monitoring be conducted to provide a more complete data set of current groundwater conditions. VRP suggests that the monitoring events be conducted semi-annually in January and July, coinciding with the Site's wet season. a. With the additional monitoring data, VRP suggests contouring the groundwater elevations for the alluvial and basin fill aquifers in addition to the bedrock aquifer. b. VRP also suggests that Sierrita use the additional data collected to re-assess aquifer characteristics calculated by URS such as: hydraulic conductivity and horizontal and vertical hydraulic gradients.	Sierrita responded that a hydraulic testing program will be proposed in the Work Plan for wells within VRP-defined site boundaries.	Pressure transducers are proposed to be installed in alluvial-bedrock wells in TW-2008-05 and BW-02, respectively (Figure 21).
East Investigation Area				
Install wells south of STI.	ADEQ 4/14	ADEQ Comment No 10: Page 67, Section 6.5 "Data Gaps and Recommendations for Further Data Collection": VRP concurs with the recommendations and data gaps presented here. However, VRP requests that Sierrita also include the following: • Monitoring wells south of the STI. • Monitoring wells within, or adjacent to, the major washes. • Install well pairs in alluvium and bedrock in areas where alluvium is present at the surface. • Continue the investigation/analysis of background water quality. VRP notes that Sierrita' s background water quality analysis is the basis for most of the data analysis, preliminary conclusions, and proposed data gaps. With the data set currently presented in the Report, VRP does not concur with the proposed background water quality. VRP requests that Sierrita collect additional alluvial (if applicable), basin fill, bedrock, and groundwater samples from several areas that are not downgradient or cross-gradient of current or historical mining operations and/or disturbed land areas.	Sierrita responded that it will incorporate data collection requests in the Work Plan. Data collection and well installation will correlate with specific areas identified for further investigation.	Currently existing wells in the south and west of the STI are proposed for sampling in the Work Plan (see Section 4).
Background Areas				
Continue to investigate background water quality.	ADEQ 4/14	ADEQ Comment No 10: Page 67, Section 6.5 "Data Gaps and Recommendations for Further Data Collection": VRP concurs with the recommendations and data gaps presented here. However, VRP requests that Sierrita also include the following: • Monitoring wells south of the STI. • Monitoring wells within, or adjacent to, the major washes. • Install well pairs in alluvium and bedrock in areas where alluvium is present at the surface. • Continue the investigation/analysis of background water quality. VRP notes that Sierrita' s background water quality analysis is the basis for most of the data analysis, preliminary conclusions, and proposed data gaps. With the data set currently presented in the Report, VRP does not concur with the proposed background water quality. VRP requests that Sierrita collect additional alluvial (if applicable), basin fill, bedrock, and groundwater samples from several areas that are not downgradient or cross-gradient of current or historical mining operations and/or disturbed land areas.	Sierrita responded that it will incorporate data collection requests in the Work Plan. Data collection and well installation will correlate with specific areas identified for further investigation.	A basin fill background well has been identified to supplement bedrock background wells in north and west areas; these wells are proposed for sampling in the Work Plan (see Section 4).

Notes:
ADEQ - Arizona Department of Environmental Quality
APP - Aquifer Protection Permit
AQWS - Aquifer Water Quality Standard
CLEAR - Continuous Liquid Extraction and Regeneration
COIs - Constituents of interest
CSM - Conceptual Site Model
GPL - Groundwater Protection Level
MOC - Mitigation Order on Consent
SPLP - Synthetic Precipitate Leaching Procedure
VRP - Voluntary Remediation Program
URS - URS Corporation
GIR - Voluntary Remediation Program Groundwater Investigation Report (dated December 2013)
ADEQ 4/14 - Comments on Groundwater Investigation Report, Dated April 11, 2014
STI - Sierrita Tailings Impoundment

Table 4
Proposed VRP Data Gaps Groundwater Sampling Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Well Status	2008-2009 VRP	APP Well	MOC Well	2008 VRP Work Plan Objective	Conclusion/Recommendation from 2008-2009 VRP Program	2015 VRP Data Gaps Objective
Background Areas							
MH-17	Active	x			Represents background groundwater conditions in the Harris Ranch Quartz Monzonite.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with Harris Ranch Quartz Monzonite.
MH-21	Active	x	x		Verify background COI concentrations in the Ruby Star Granodiorite and compare results to newly installed background wells.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with Ruby Star Granodiorite.
MW-2008-12	Active	x			Evaluate background concentrations in hornblende rich Ruby Star Granodiorite.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with hornblende rich Ruby Star Granodiorite.
MW-2008-13	Active	x			Evaluate background concentrations in hornblende rich Ruby Star Granodiorite.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with hornblende rich Ruby Star Granodiorite.
MW-2008-14	Active	x			Evaluate background concentrations in Tinaja Peak Formation.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with Tinaja Peak Formation.
MW-2008-15	Active	x			Evaluate background concentrations in Harris Ranch Quartz Monzonite.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with Harris Ranch Quartz Monzonite.
MW-2015-04	New - TBD				N/A - new well proposed for Basin Fill Aquifer	N/A	Evaluate background COI concentrations in basin fill deposits.
PZ-01	Active	x			Represents background conditions in the Tinaja Peak Formation.	Monitoring events for the VRP should include these background wells to assess contribution of natural background to groundwater concentrations of COIs.	Provide current concentrations of background COIs for groundwater associated with Tinaja Peak Formation.
Central Investigation Area							
BW-03	Active	x			Evaluate potential releases from upgradient process areas along the west side of Demetrie Wash and potential influence from Amargosa Wash.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide current concentrations of COIs in alluvium/bedrock groundwater downgradient of the Central Investigation Area.
BW-04	Active	x			Evaluate potential releases from B Pond and Amargosa Wash area in general. May assist with determining effectiveness of B Sump.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of COIs in alluvium/bedrock groundwater downgradient of B Pond and the Central Investigation Area.
MH-22	Active	x	x		Evaluate alluvial groundwater in Demetrie Wash to identify potential releases from Demetrie and Amargosa Washes.	Continue to monitor per APP program. Assess alluvial-bedrock groundwater interaction downgradient of Central Investigation Area.	Evaluate transport mechanism of COIs from alluvium to bedrock for the Site. Provide current concentrations of COIs in bedrock groundwater downgradient of the Central Investigation Area.
MH-23	Active	x	x		Evaluate potential influence of alluvial water with underlying bedrock groundwater (collocated with MH-22).	Continue to monitor per APP program. Assess alluvial-bedrock groundwater interaction downgradient of Central Investigation Area.	Evaluate transport mechanism of COIs from alluvium to bedrock for the Site. Provide current concentrations of COIs in alluvial groundwater downgradient of the Central Investigation Area.
MW-2008-01	Active	x			Evaluate groundwater quality upgradient of the Former CLEAR Plant Area.	The Former CLEAR Plant is a source of general chemistry COIs to groundwater. Additional characterization proposed to characterize this source.	Provide current concentrations of bedrock COIs in groundwater upgradient of the Former CLEAR Plant area.
MW-2008-02	Active	x			Evaluate groundwater quality immediately downgradient of the Former CLEAR Plant.	The Former CLEAR Plant is a source of general chemistry COIs to groundwater. Additional characterization proposed to characterize this source.	Provide current concentrations of bedrock COIs in groundwater downgradient of the Former CLEAR Plant area.
MW-2008-03	Active	x			Evaluate groundwater quality immediately downgradient of the Former E Pond.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of bedrock COIs in groundwater downgradient of the Former CLEAR Plant area.
MW-2008-04	Active	x			Evaluate groundwater quality immediately downgradient of the Former Evaporation Pond.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of bedrock COIs in groundwater downgradient of the Former CLEAR Plant area.
MW-2008-07	Active	x			Evaluate groundwater quality immediately upgradient of the Former C Pond.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, bedrock groundwater is subject to fracture-flow; hence, inclusion of this well is recommended during VRP investigation to characterize nature and extent from Former Raffinate Pond.	Provide current concentrations of COIs in bedrock groundwater downgradient of Former Raffinate Pond.

Table 4
Proposed VRP Data Gaps Groundwater Sampling Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Well Status	2008-2009 VRP	APP Well	MOC Well	2008 VRP Work Plan Objective	Conclusion/Recommendation from 2008-2009 VRP Program	2015 VRP Data Gaps Objective
MW-2008-08	Active	x			Evaluate groundwater quality immediately downgradient of the Former C Pond.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and provides information as to the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.	Evaluate transport mechanism of COIs from alluvium to bedrock for the Site. Provide current concentrations of COIs in bedrock groundwater in the Central Investigation Area.
MW-2008-09	Active	x			Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.	Former Raffinate Pond is a source of COIs to groundwater. Additional characterization in this area is proposed.	Provide current concentrations of COIs in bedrock groundwater downgradient of Former Raffinate Pond.
MW-2008-10	Active	x			Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.	Former Raffinate Pond is a source of COIs to groundwater. Additional characterization in this area is proposed.	Provide current concentrations of COIs in bedrock groundwater downgradient of Former Raffinate Pond.
MW-2008-11	Active	x			Evaluate groundwater quality upgradient of the Former Raffinate Pond.	VRP investigation of groundwater contributions from the Former Raffinate Pond should include this location to understand COI concentrations upgradient of this facility. Additionally, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.	Provide current concentrations of bedrock COIs in bedrock groundwater upgradient of Former Raffinate Pond, and characterize alluvial-bedrock groundwater COI relationship.
MW-2015-01	New - TBD				N/A - new well proposed for bedrock aquifer	N/A - new well	Evaluate transport mechanisms of COIs from alluvial to bedrock groundwater for the Site. Provide update on extent of COIs downgradient of Former CLEAR Plant. Provide current concentrations of COIs in bedrock groundwater downgradient of the Former CLEAR Plant area.
MW-2015-02	New - TBD				N/A - new well proposed for bedrock aquifer	N/A - new well	Assess extent of COIs in bedrock downgradient of the Central Investigation Area.
MW-2015-03	New - TBD				N/A - new well proposed for bedrock aquifer	N/A - new well	Assess extent of COIs in bedrock downgradient of the Central Investigation Area.
PZ-02	Active	x			Evaluate quality of bedrock groundwater downgradient of sulfide leach stockpile and in vicinity of Headwall No. 1 and Bailey Lake.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of COIs in bedrock groundwater in this area.
PZ-03	Active	x			Evaluate bedrock groundwater quality in Amargosa Wash and possibly part of the Esperanza Mill area. Provides an additional Ruby Star Granodiorite monitoring point.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of COIs in bedrock groundwater in the Central Investigation Area.
PZ-04	Active	x			Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.	Provide current concentrations of COIs in bedrock groundwater entering the Central Investigation Area.
PZ-05	Active	x			Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.	Provide current concentrations of COIs in bedrock groundwater entering the Central Investigation Area.

Table 4
Proposed VRP Data Gaps Groundwater Sampling Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Well Status	2008-2009 VRP	APP Well	MOC Well	2008 VRP Work Plan Objective	Conclusion/Recommendation from 2008-2009 VRP Program	2015 VRP Data Gaps Objective
PZ-06	Active	x			Evaluate bedrock groundwater quality upgradient of the general mill area.	Water quality upgradient of Central Investigation Area shows that concentrations are higher than AWQS and/or background. Monitoring events for the VRP should include this well as a means to assess contribution of upgradient groundwater to COIs in the Central Investigation Area.	Provide current concentrations of COIs in bedrock groundwater entering the Central Investigation Area.
TW-2008-08	Active	x			Confirm that the pond (Launders Facility) has not released elevated concentrations of COIs from process solutions to groundwater.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide confirmation/current concentrations of COIs in alluvial groundwater in this area.
TW-2008-09	Active	x			Confirm that the ponds (Headwall No. 1 and Bailey Lake) have not released elevated concentrations of COIs from process solutions to groundwater.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide confirmation/current concentrations of COIs in alluvial groundwater in this area.
TW-2008-10	Active	x			Confirm that the pond (Raffinate Pond No. 2) has not released elevated concentrations of COIs from process solutions to groundwater.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide confirmation/current concentrations of COIs in alluvial groundwater in this area.
TW-2008-11	Active	x			Confirm that the pond (former A Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide confirmation/current concentrations of COIs in alluvial groundwater in this area.
TW-2008-12	Active	x			Confirm that the pond (B Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	Further investigation proposed to assess source and transport potential of COIs in the alluvial aquifer in this area.	Provide current concentrations of COIs in alluvial groundwater downgradient of B Pond and the Central Investigation Area.
TW-2008-13	Active	x			Not specified.	Former C Pond is not a source of COIs to groundwater. Further investigation of this source is not needed. However, this is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.	Evaluate transport mechanism of COIs from alluvium to bedrock for the Site. Provide current concentrations of COIs in alluvial groundwater in the Central Investigation Area.
TW-2008-15	Active	x			Not specified.	This is one of the four alluvial-bedrock well pairs in the Central Investigation Area, and informs an understanding of the dynamic of water and COI transport from alluvial to bedrock groundwater. Recommended for additional sampling to address VRP data gap with respect to this transport mechanism.	Provide confirmation/current concentrations of COIs in alluvial groundwater upgradient of the Central Investigation Area.
MW-2015-05	New - TBD				N/A - new well proposed for alluvial aquifer	N/A - new well	Evaluate transport mechanisms of COIs from alluvium to bedrock for the Site. Provide update on extent of COIs downgradient of Former CLEAR Plant. Provide current concentrations of COIs in alluvial groundwater downgradient of the Former CLEAR Plant.
East Investigation Area							
MH-9	Active	x	x	x	N/A - APP-MOC well proposed for VRP monitoring for basin fill deposits	N/A - new well	Provide COI concentration data in the basin fill deposits to the south of the STI.
MH-10	Active	x	x	x	N/A - APP-MOC well proposed for VRP monitoring for basin fill deposits	N/A - new well	Provide COI concentration data in the basin fill deposits to the south of the STI.
MH-14	Active	x	x	x	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the east of the STI.
MH-15W	Active	x		x	Evaluate basin fill deposits groundwater quality in central portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the east of the STI.

Table 4
Proposed VRP Data Gaps Groundwater Sampling Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Well Status	2008-2009 VRP	APP Well	MOC Well	2008 VRP Work Plan Objective	Conclusion/Recommendation from 2008-2009 VRP Program	2015 VRP Data Gaps Objective
MH-16W	Active	x	x	x	Evaluate basin fill deposits groundwater quality in southern portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the east of the STI.
MH-28	Active	x	x	x	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the east of the STI.
MH-29	Active	x	x	x	Evaluate basin fill deposits groundwater quality in southern portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the east of the STI.
MH-30	Active	x		x	Evaluate basin fill deposits groundwater quality in northern portion of well field.	Continue monitoring per APP program.	Provide COI concentration data in the basin fill deposits to the northeast of the STI.
PZ-07	Active	x			Evaluate groundwater quality at northern edge of basin fill deposits and northern Sierrita property boundary.	Further characterization is proposed to confirm upgradient concentrations of COIs in basin fill.	Provide current COI concentrations for the East Investigation Area to confirm upgradient concentrations of COIs in basin fill.
West Investigation Area							
BW-02	Active	x			Confirm no releases have occurred from process solution ponds located in Esperanza Wash.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of COIs in bedrock downgradient of solution ponds in the Esperanza Wash for the West Investigation Area.
MH-18	Active	x	x		Evaluate impacts from waste rock stockpile and possibly represent groundwater conditions generally upgradient of Sierrita.	Continue to monitor per APP program.	Provide current concentrations of COIs in bedrock in the West Investigation Area.
MH-19	Active	x	x		Evaluate shallower aquifer impacts from sulfide leach area and Headwall No. 5.	Continue to monitor per APP program.	Provide current concentrations of COIs in bedrock downgradient of the sulfide leach area and Headwall No. 5 for the West Investigation Area.
MH-20	Active	x	x		This well is screened at a deeper elevation than well BW-02. Evaluate deeper aquifer impacts.	Continue to monitor per APP program.	Provide current concentrations of COIs in bedrock downgradient of the West Investigation Area.
MH-27	Active	x	x		Evaluate quality of bedrock groundwater in vicinity of Headwall No. 2.	Continue to monitor per APP program.	Provide current concentrations of COIs in bedrock downgradient of Headwall No. 2 for the West Investigation Area.
PZ-16	Active	x			Evaluate quality of bedrock groundwater in vicinity of Headwall No. 5.	Further investigation proposed to assess source and transport potential of COIs in the bedrock aquifer in this area.	Provide current concentrations of COIs in bedrock downgradient of process solution ponds and Headwall No. 5 for the West Investigation Area.
TW-2008-03	Active	x			Confirm that the pond (Headwall No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.	Provide current concentrations of COIs in alluvium downgradient of Headwall No. 3 for the West Investigation Area.
TW-2008-04	Active	x			Confirm that the pond (Raffinate Pond No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.	Provide current concentrations of COIs in alluvium downgradient of Raffinate Pond No. 3 and Headwall No. 3 for the West Investigation Area.
TW-2008-05	Active	x			Confirm that the pond (SX-3 Stormwater Pond) has not released elevated concentrations of COIs from process solutions to groundwater.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.	Provide current concentrations of COIs in alluvium downgradient of SX-3 Stormwater Pond for the West Investigation Area.
TW-2008-07	Active	x			Confirm that the pond (Headwall No. 2) has not released elevated concentrations of COIs from process solutions to groundwater.	Include in data gaps investigation of this investigation area to confirm/provide updated data for alluvial aquifer saturation and COI concentrations.	Provide current concentrations of COIs in alluvium downgradient of Headwall No. 2 for the West Investigation Area.

Notes:
Wells are generally ordered in this table upgradient to downgradient per area or feature.
N/A = not applicable
APP - Aquifer Protection Permit
AWQS - Arizona Aquifer Water Quality Standards
CLEAR - Copper Leach Electrowinning and Regeneration
COIs - constituents of interest
MOC - Mitigation Order on Consent
STI - Sierrita Tailings Impoundment
TBD - To Be Determined
VRP - Voluntary Remediation Program

Table 5
2008-2009 Wells Omitted from the VRP Data Gaps Groundwater Sampling Program
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Well Status	2008-2009 VRP	APP Well	MOC Well	Associated Wash	Screened Lithology	2008 objective	Conclusion/Recommendation from 2008-2009 VRP Program	VRP Data Gaps Groundwater Monitoring Plan
MW-2008-05	Active	X			Demetrie Wash	Ruby Star Granodiorite/Intrusives	Evaluate groundwater quality immediately downgradient of the Old D Pond.	Old D Pond is not a source of COIs to groundwater. Further investigation of this source is not needed.	Remove from VRP groundwater monitoring program.
MW-2008-06	Active	X			Demetrie Wash	Ruby Star Granodiorite/Intrusives	Evaluate groundwater quality upgradient of the Old D Pond.	Old D Pond is not a source of COIs to groundwater. Further investigation of this source is not needed.	Remove from VRP groundwater monitoring program.
PZ-08	Active	X			Demetrie Wash	Demetrie Volcanics	Evaluate southern portion Sierrita property boundary and groundwater quality before it flows beneath Sierrita Tailing Impoundment.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.	Remove from VRP groundwater monitoring program.
PZ-09	Active	X			N/A - East Investigation Area	Other	Not specified	No further monitoring recommended.	Remove from VRP groundwater monitoring program.
PZ-2007-05	Abandoned	X			N/A - East Investigation Area	Basin Fill Deposits	Evaluate basin fill deposits groundwater quality immediately downgradient of the Esperanza Tailing Impoundment and near the Sierrita Tailing Impoundment reclaim pond.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.	Well previously abandoned and has been removed from the program.
PZ-2008-16	Permanent Monitoring Well (well buried)	X			N/A - East of washes	Tailings	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.	Remove from VRP groundwater monitoring program.
PZ-2008-19	Permanent Monitoring Well (well buried)	X			N/A - East of washes	Tailings	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.	Remove from VRP groundwater monitoring program.
PZ-2008-20	Permanent Monitoring Well (well buried)	X			N/A - East of washes	Tailings	Metal COIs < AWQS; Gross alpha and Gross beta > AWQS.	STI is not a source of COIs to groundwater (sulfate addressed through MOC). Further investigation of this source is not needed for the VRP.	Remove from VRP groundwater monitoring program.
TW-2008-02	Temporary Monitoring Well - Destroyed	X			Esperanza Wash	Alluvium	Confirm that the plant (SX Plant No. 3) has not released elevated concentrations of COIs from process solutions to groundwater.	This well was dry.	This well has been destroyed and cannot be monitored.
TW-2008-14	Active	x			Amargosa Wash	Alluvium	Not specified.	No further monitoring recommended.	Remove from VRP groundwater monitoring program.

Notes:
N/A = not applicable
APP - Aquifer Protection Permit
AWQS - Arizona Aquifer Water Quality Standards
COIs - constituents of interest
MOC - Mitigation Order on Consent
STI - Sierrita Tailings Impoundment
VRP - Voluntary Remediation Program

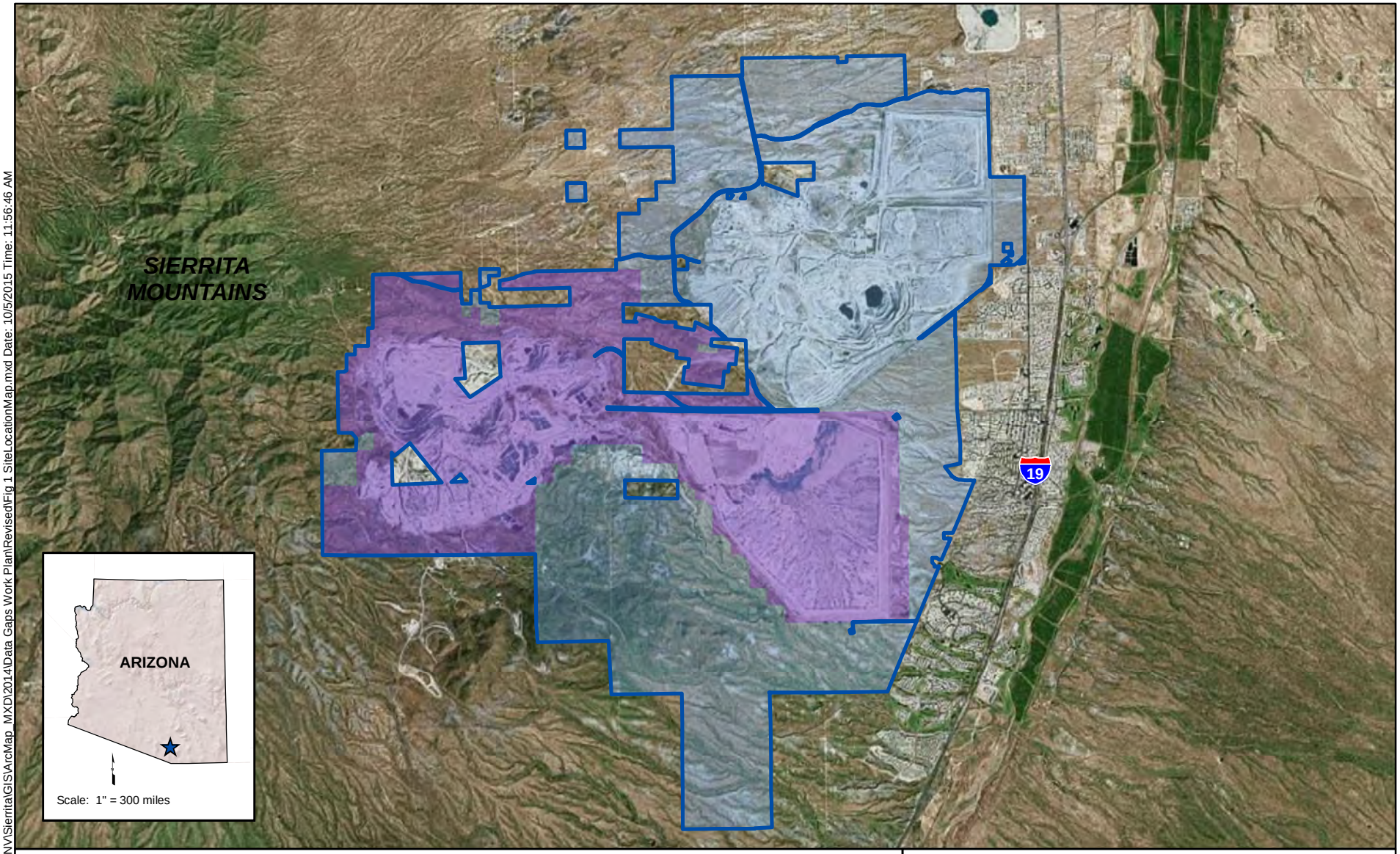
Table 6
Proposed Well Construction Details
Freeport-McMoRan Sierrita Inc.
Green Valley, Arizona

VRP Well ID	Investigation Area	Site Feature	Anticipated Screened Lithology[1]	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Anticipated Groundwater Elevation (feet)	Anticipated Depth to Water (feet)	Approximate Borehole Depth (ft bgs)	Borehole Diameter (inches)	Casing Diameter (inches)	Approximate Screen Top (ft bgs)	Approximate Screen Bottom (ft bgs)	Screen Length (feet)	Type of Well/Borehole	Surface Completion
MW-2015-01	Central Investigation Area (North)	Demetrie Wash	Bedrock	31.876122	-111.095525	3631	3575	20	90	8	4	60	90	30	4-inch PVC Schedule 40 well 0.010 slotted 4-inch PVC Schedule 40 screen 8/12 or 10/20 washed silica sand to 5 feet above screen 5 feet of 3/8-inch Chip Bentonite seal (time release coated) 3-5% bentonite/95-97% Portland cement grout to surface	3-foot steel stick-up with royer lid or locking cap, 4'x4' concrete well apron, 4-in J-plug
MW-2015-02	Central Investigation Area (South)	Bedrock South of CIA	Bedrock	31.862564	-111.105111	3740	3690	50	95	8	4	45	95	50	4-inch PVC Schedule 40 well 0.010 slotted 4-inch PVC Schedule 40 screen 8/12 or 10/20 washed silica sand to 5 feet above screen 5 feet of 3/8-inch Chip Bentonite seal (time release coated) 3-5% bentonite/95-97% Portland cement grout to surface	3-foot steel stick-up with royer lid or locking cap, 4'x4' concrete well apron, 4-in J-plug
MW-2015-03	Central Investigation Area (South)	Bedrock South of CIA	Bedrock	31.860403	-111.096292	3655	3565	90	135	8	4	85	135	50	4-inch PVC Schedule 40 well 0.010 slotted 4-inch PVC Schedule 40 screen 8/12 or 10/20 washed silica sand to 5 feet above screen 5 feet of 3/8-inch Chip Bentonite seal (time release coated) 5% bentonite/95% Portland cement grout to surface	3-foot steel stick-up with royer lid or locking cap, 4'x4' concrete well apron, 4-in J-plug
MW-2015-04	Background Area (South)	Background South of STI	Basin Fill Deposits	31.813239	-111.035961	3091	2830	265	310	8	4	260	310	50	4-inch PVC Schedule 80 well 0.010 slotted 4-inch PVC Schedule 80 screen 8/12 or 10/20 washed silica sand to 5 feet above screen 5 feet of 3/8-inch Chip Bentonite seal (time release coated) 3-5% bentonite/95-97% Portland cement grout to surface	3-foot steel stick-up with royer lid or locking cap, 4'x4' concrete well apron, 4-in J-plug
MW-2015-05	Central Investigation Area (North)	Demetrie Wash	Alluvium	31.876094	-111.095575	3630	3575	20	50	8	4	20	50	30	4-inch PVC Schedule 40 well 0.010 slotted 4-inch PVC Schedule 40 screen 8/12 or 10/20 washed silica sand to 5 feet above screen 5 feet of 3/8-inch Chip Bentonite seal (time release coated) 3-5% bentonite/95-97% Portland cement grout to surface	3-foot steel stick-up with royer lid or locking cap, 4'x4' concrete well apron, 4-in J-plug

Notes:
All depths are approximated and will be determined in the field based on conditions encountered
1 - Lithology is predicted from the present geological interpretation, but differing field conditions may result in a different screened lithology for bedrock wells.
CIA - Central Investigation Area
ft bgs - feet below ground surface
STI - Sierrita Tailings Impoundment
VRP - Voluntary Remediation Program
deg - degrees
ID - Identification
PVC - Polyvinyl chloride

ARCADIS

Figures



LEGEND

- Approximate property boundary
- Approximate VRP site definition

NOTES

· Topographic map source: ESRI USA Topo Maps.

VRP - Voluntary Remediation Program

N

0 1 2 Miles

Scale: 1" = 2 mi

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

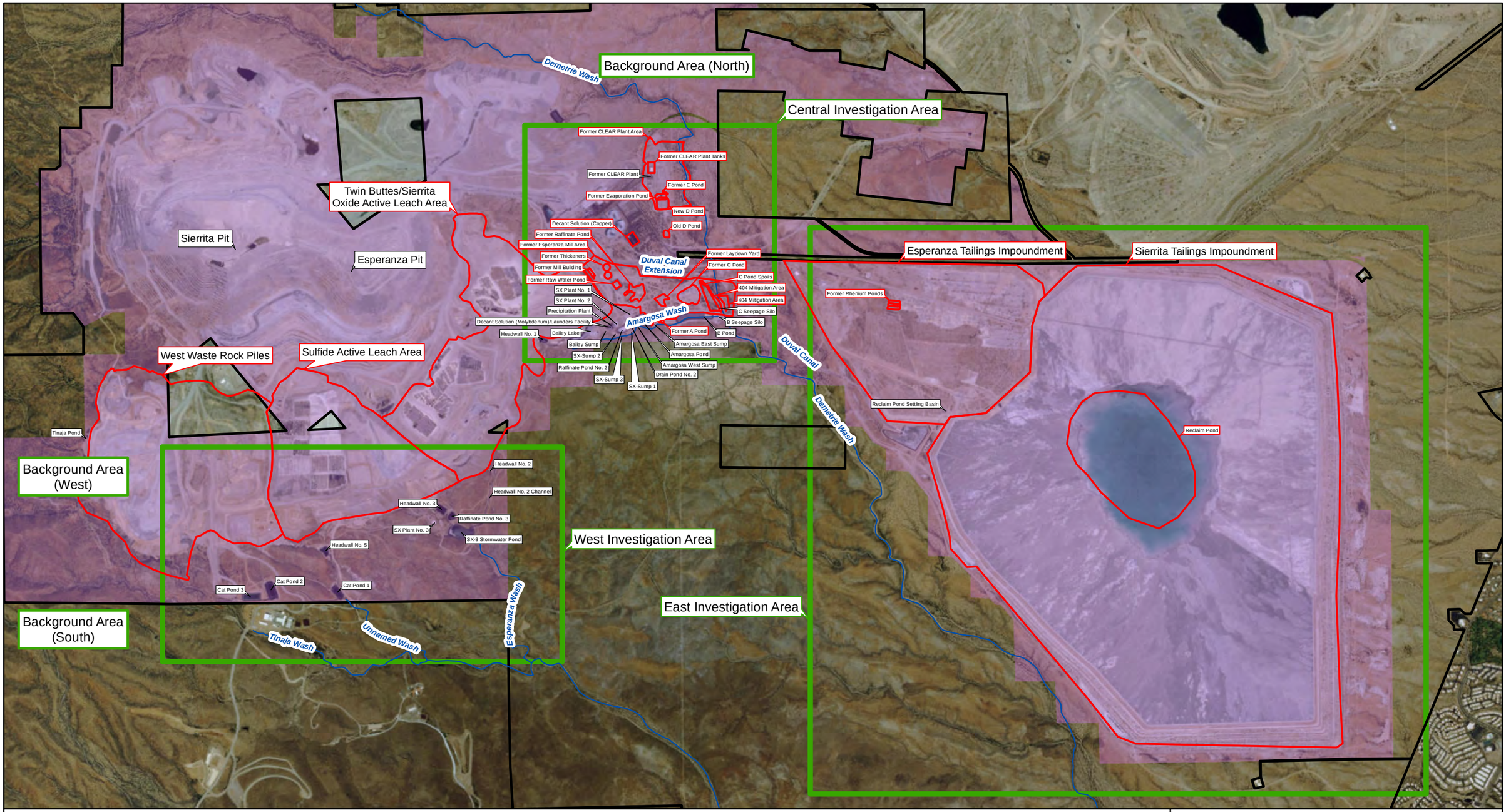
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: W:\GISPROJECTS_ENV\SierritaGIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 1 SiteLocationMap.mxd Date: 10/5/2015 Time: 11:56:46 AM



LEGEND

- Property boundary
- VRP site definition
- VRP investigation area
- Site feature
- Wash

Note:
VRP - Voluntary Remediation Program

N

0 1,500 3,000 6,000 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

SITE FEATURES MAP

ARCADIS

FIGURE **2**

Document Path: W:\GISPROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 2 SiteFeatures.mxd Date: 10/5/2015 Time: 11:57:06 AM

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 Other
- PZ-2008-16 Tailings
- MH-17 Quaternary Alluvium
- BW-02 Basin Fill Deposits
- MH-28 Tinaja Peak Formation
- BW-03 Ruby Star Granodiorite/ Intrusives
- MH-22 Demetrie Volcanics
- MH-17 Harris Ranch Quartz Monzonite

LEGEND

- Site Feature
- 2008 - 2009 VRP Groundwater Monitoring Location
- Cross Section Location
- Inferred Fault (Source: Titley, et al [1986], adapted from Cooper [1973])

NOTES

VRP - Voluntary Remediation Program

[1] = BW-04 is screened in the bedrock complex.

[2] = MH-30 is screened across both basin fill and Mesozoic sedimentary rocks.

[3] = PZ-07 and PZ-09 are screened across both basin fill and Ruby Star Intrusives.

0 1,500 3,000 6,000 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

CROSS SECTION LOCATION MAP

ARCADIS

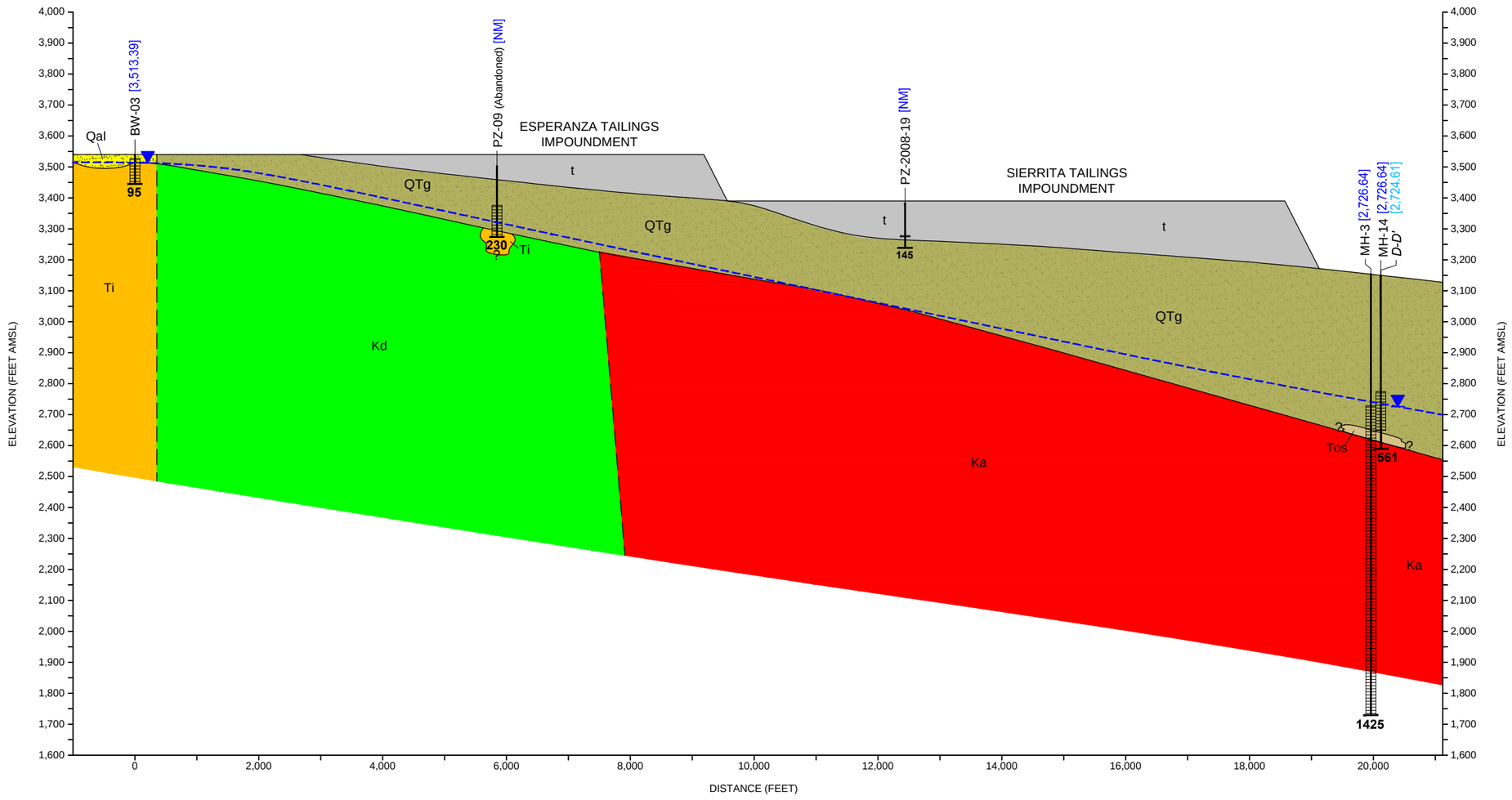
FIGURE 3

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB:BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\RevisedFig 3 CrossSectionMap.mxd

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

A
Northwest

A'
East



LEGEND:

WATER LEVEL (FEET AMSL) [2009], [2013]

WELL/BORING ID (MH-14 [2,726.64] [2,724.61])

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

TOTAL DEPTH (561)

t	FILL / TAILINGS
Qal	QUATERNARY ALLUVIUM
QTg	BASIN-FILL DEPOSITS
Tos	PANTANO FORMATION
Ti	RUBY STAR GRANODIORITE / INTRUSIVES
Ka	ANGELICA ARKOSE
Kd	DEMETRIE VOLCANICS

AMSL	ABOVE MEAN SEA LEVEL
NM	NOT MEASURED

0 2,000 4,000
HORIZONTAL SCALE IN FEET

0 400 800
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION A-A' THROUGH EAST INVESTIGATION AREA

ARCADIS

FIGURE
4

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCADVAZ001233\001400001\DWG\VAZ1233V01.dwg LAYOUT: 9 SAVED: 11/13/2014 11:31 AM ACADVER: 18.1S (LMS TECH)
XREFS: PROJECTNAME: SIERRITA MINE
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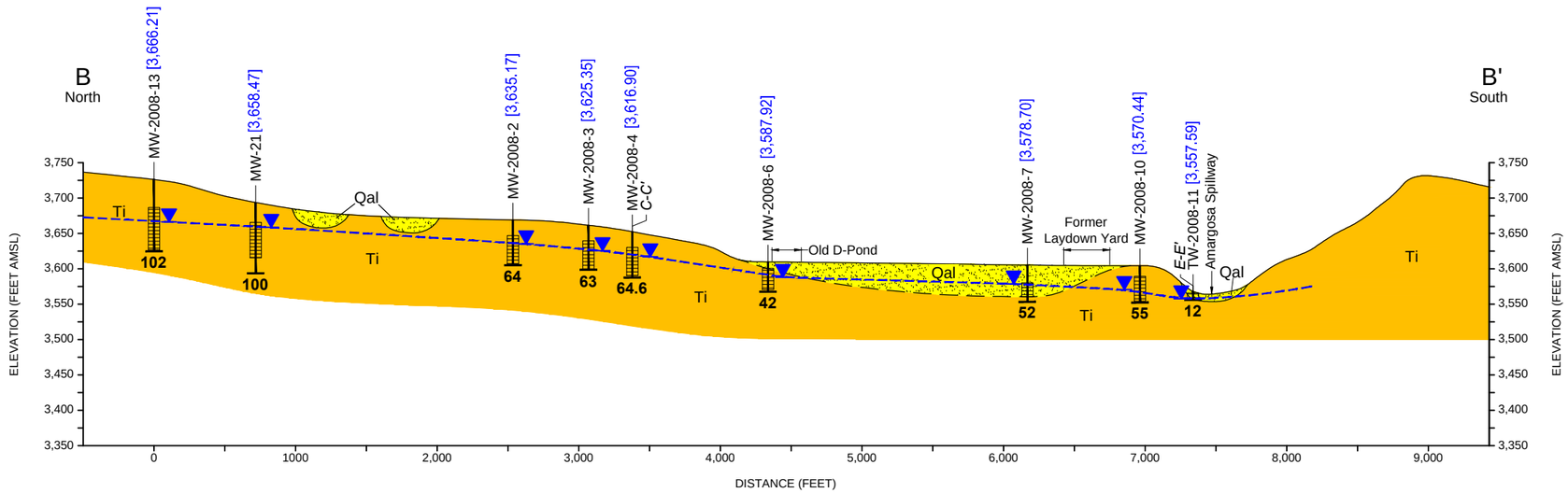

LEGEND:

MW-21 [3,658.47] — WATER LEVEL (FEET AMSL) [2009]

WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

100 — TOTAL DEPTH

Qal — QUATERNARY ALLUVIUM

Ti — RUBY STAR GRANODIORITE / INTRUSIVES

AMSL — ABOVE MEAN SEA LEVEL

0 1,000 2,000
HORIZONTAL SCALE IN FEET

0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION B-B' THROUGH CENTRAL INVESTIGATION AREA AND NORTH BACKGROUND AREA

ARCADIS

FIGURE
5

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCAD\A2001233\00140000\1DWG\A21233V01.dwg LAYOUT: 10 SAVED: 11/13/2014 9:41 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 11/13/2014 9:42 AM BY: HARRIS, JESSICA
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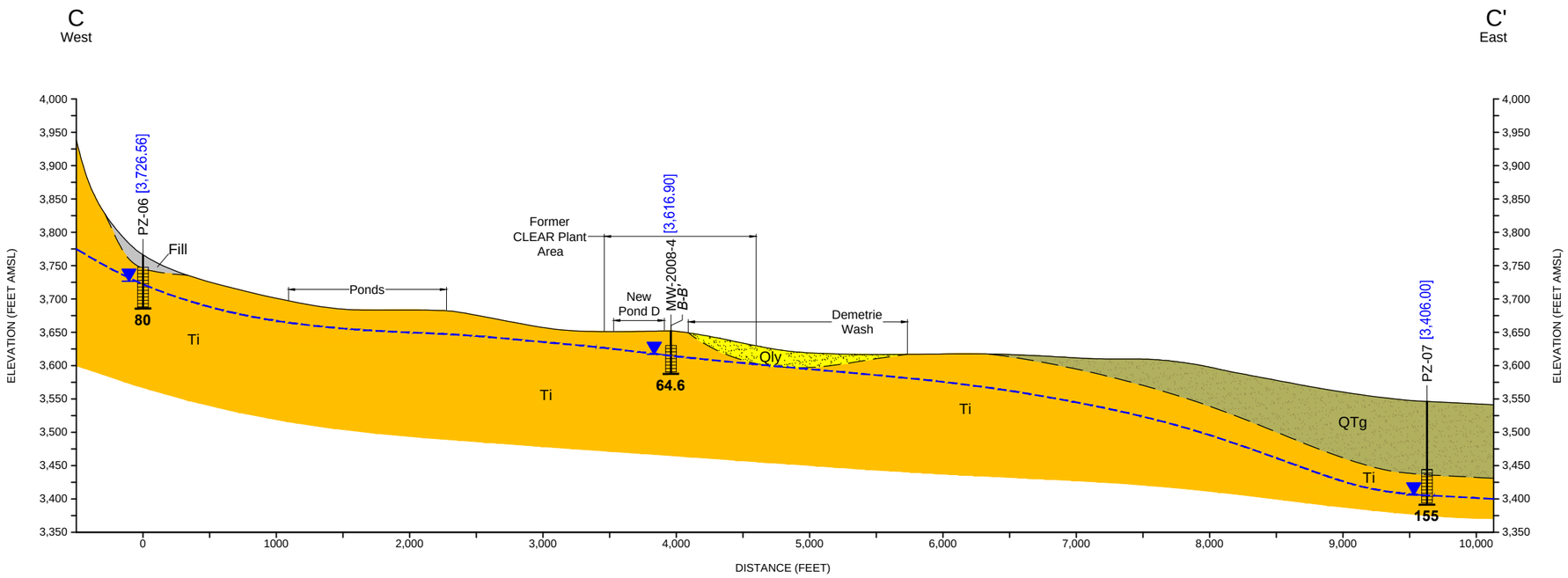


LEGEND:

PZ-06 [3,726.56] — WATER LEVEL (FEET AMSL) [2009]

WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

80 — TOTAL DEPTH

Fill	FILL
Qly	QUATERNARY ALLUVIUM
QTg	BASIN-FILL DEPOSITS
Ti	RUBY STAR GRANODIORITE / INTRUSIVES

AMSL ABOVE MEAN SEA LEVEL
CLEAR CONTINUOUS LIQUID EXTRACTION AND REGENERATION

0 1,000 2,000
HORIZONTAL SCALE IN FEET

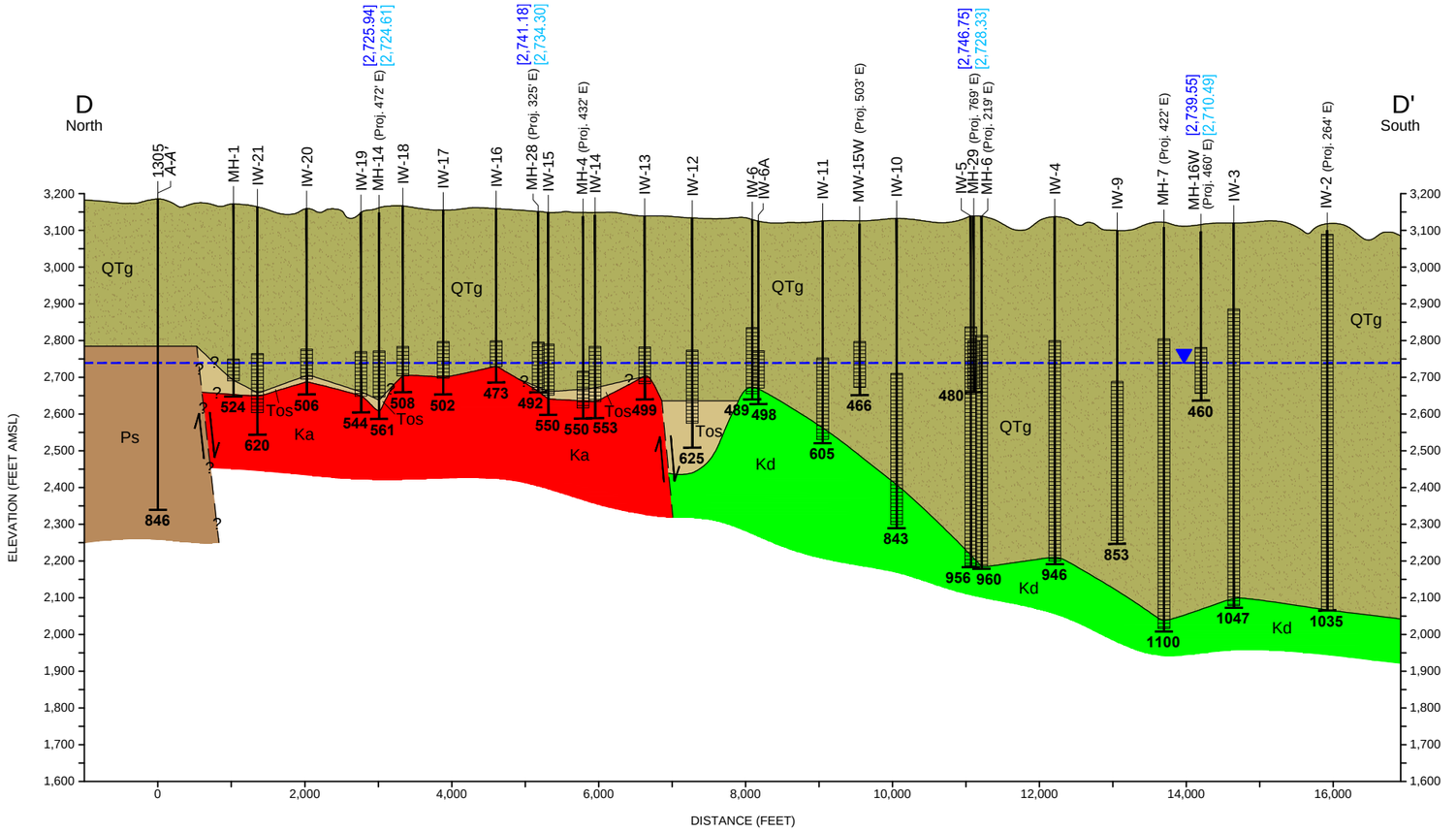
0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

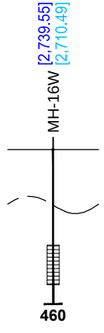
CROSS SECTION C-C' THROUGH CENTRAL INVESTIGATION AREA (NORTH)

ARCADIS

FIGURE
6



LEGEND:



WATER LEVEL (FEET AMSL) [2009], [2013]

WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

TOTAL DEPTH

QTg	BASIN-FILL DEPOSITS
Tos	PANTANO FORMATION
Ka	ANGELICA ARKOSE
Kd	DEMETRIE VOLCANICS
Ps	PALEOZOIC SEDIMENTARY ROCKS

FAULT; ARROWS SHOW RELATIVE DIRECTION OF MOVEMENT; DASHED WHERE UNCERTAIN

AMSL ABOVE MEAN SEA LEVEL

SOURCE: ERROL L. MONTGOMERY AND ASSOCIATES (ELMA). 2001. ADDITIONAL CHARACTERIZATION OF HYDROGEOLOGIC CONDITIONS AQUIFER PROTECTION PERMIT APPLICATION NO. 101679, SIERRITA MINE, PHELPS DODGE SIERRITA, INC. PIMA COUNTY, ARIZONA. JANUARY.

0 2,000 4,000
HORIZONTAL SCALE IN FEET

0 400 800
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION D-D' THROUGH EAST INVESTIGATION AREA

ARCADIS

FIGURE
7

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCADVAZ0012330014\00001\DWG\AZ1233V01.dwg LAYOUT: 12 SAVED: 11/13/2014 8:54 AM ACADVER: 18.1S (LMS TECH)
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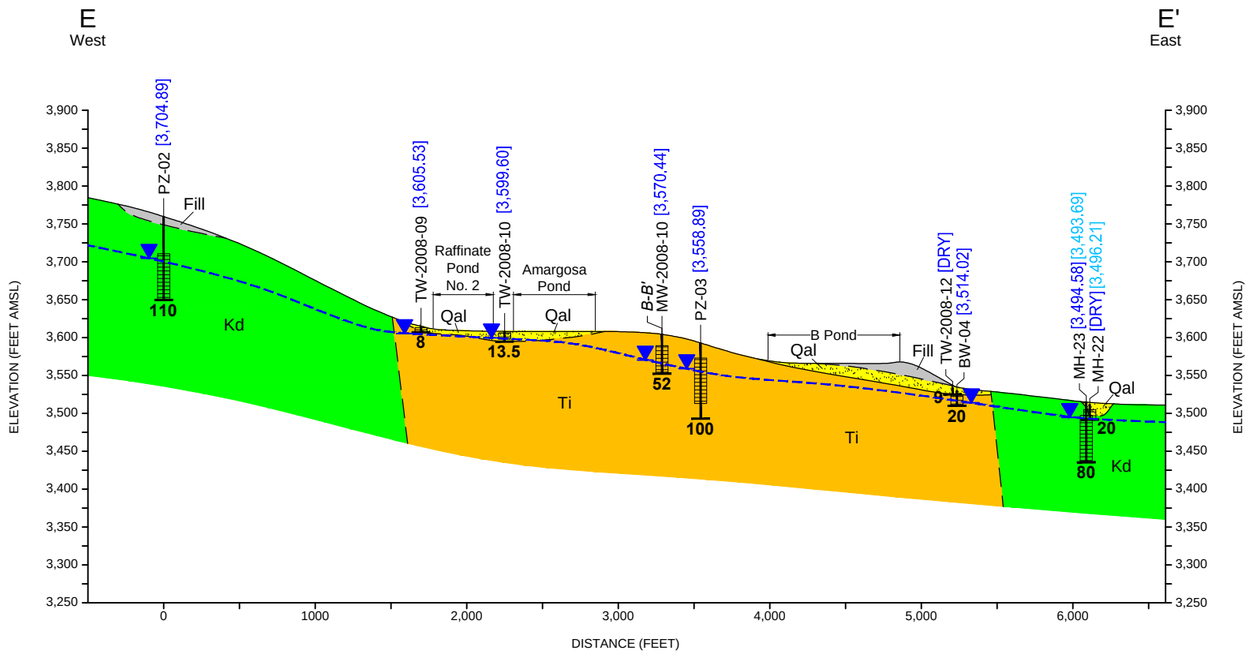


LEGEND:

MH-23 [3,494.58] [3,493.69]

WATER LEVEL (FEET AMSL) [2009], [2013]

WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

80 TOTAL DEPTH

Fill	FILL	AMSL	ABOVE MEAN SEA LEVEL
Qal	QUATERNARY ALLUVIUM	DRY	WELL REPORTED DRY FROM THE FIELD
Ti	RUBY STAR GRANODIORITE / INTRUSIVES		
Kd	DEMETRIE VOLCANICS		

0 1,000 2,000
HORIZONTAL SCALE IN FEET

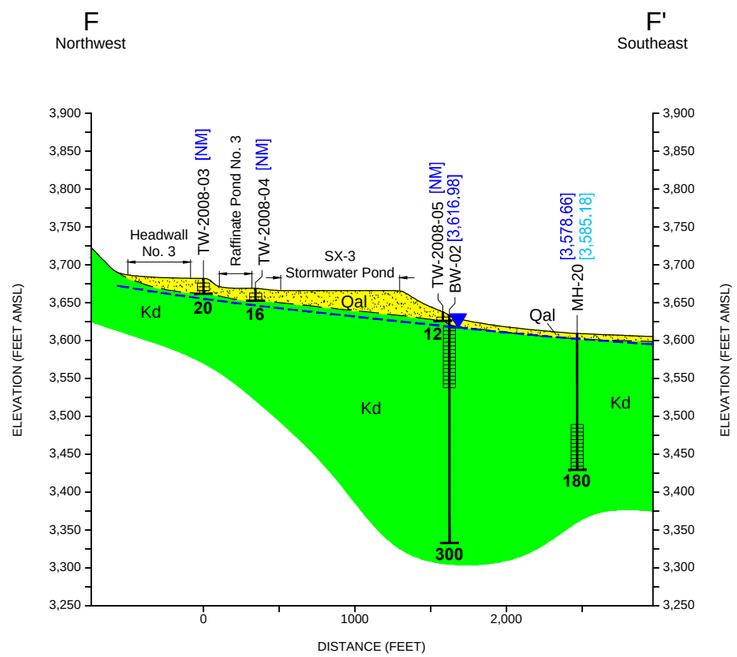
0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION E-E' THROUGH CENTRAL INVESTIGATION AREA (SOUTH)

ARCADIS

FIGURE
8



LEGEND:

[3,578.66] [3,585.18] MH-20 — WATER LEVEL (FEET AMSL) [2009], [2013]

WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

180 — TOTAL DEPTH

Qal — QUATERNARY ALLUVIUM

Kd — DEMETRIE VOLCANICS

AMSL — ABOVE MEAN SEA LEVEL

NM — NOT MEASURED

0 1,000 2,000
HORIZONTAL SCALE IN FEET

0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION F-F' THROUGH WEST INVESTIGATION AREA

ARCADIS

FIGURE
9

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCADVAZ0012330\01400001\DWG\AZ1233V01.dwg LAYOUT: 14 SAVED: 8/20/2014 9:57 AM ACADVER: 18.1S (LMS TECH)
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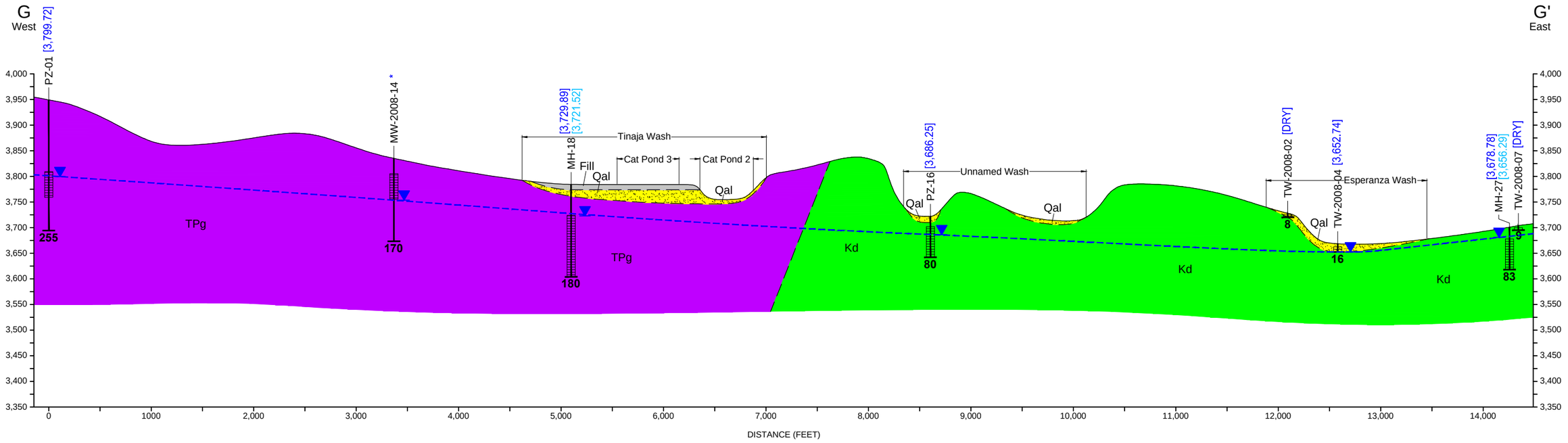

LEGEND:

[3,729.89] MH-18 [3,721.52] — WATER LEVEL (FEET AMSL) [2009], [2013]

MH-18 — WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

180 — TOTAL DEPTH

Fill	FILL
Qal	QUATERNARY ALLUVIUM
TPg	TINAJA PEAK FORMATION
Kd	DEMETRIE VOLCANICS

AMSL	ABOVE MEAN SEA LEVEL
DRY	WELL DRY
*	ESTIMATED DEPTH TO WATER

0 1,000 2,000
HORIZONTAL SCALE IN FEET

0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION G-G' THROUGH WEST INVESTIGATION AREA

ARCADIS

FIGURE
10

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCADVAZ001233\00140000\1DWG\AZ1233V01.dwg LAYOUT: 15 SAVED: 11/13/2014 11:32 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 11/13/2014 11:34 AM BY: HARRIS, JESSICA
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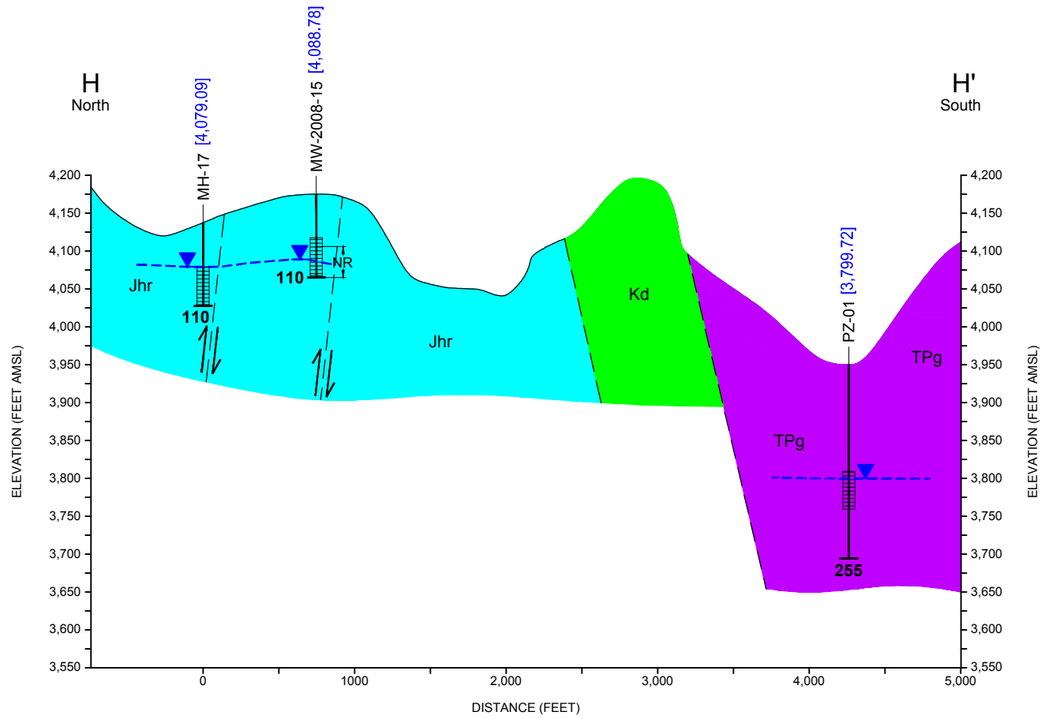
PROJECTNAME: SIERRITA MINE



LEGEND:

MH-17 [4,079.09] — WATER LEVEL (FEET AMSL) [2009]

MH-17 — WELL/BORING ID

GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

WELL SCREEN INTERVAL

110 — TOTAL DEPTH

TPg	TINAJA PEAK FORMATION
Kd	DEMETRIE VOLCANICS
Jhr	HARRIS RANCH QUARTZ MANZONITE

FAULT; ARROWS SHOW RELATIVE DIRECTION OF MOVEMENT; DASHED WHERE UNCERTAIN

AMSL	ABOVE MEAN SEA LEVEL
NR	NO RECOVERY

0 1,000 2,000
HORIZONTAL SCALE IN FEET

0 200 400
VERTICAL SCALE IN FEET

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA
VOLUNTARY REMEDIATION PROGRAM
DATA GAPS WORKPLAN

CROSS SECTION H-H' THROUGH WEST BACKGROUND AREA

ARCADIS

FIGURE
11

CITY: SAN RAFAEL, CA (PETALUMA) DIV/GROUP: ENVCAD DB: J. HARRIS
C:\Users\jharris\Desktop\ENVCADAZ00123300140000001\DWG\AZ1233V01.dwg LAYOUT: 16 SAVED: 11/13/2014 11:32 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 11/13/2014 11:36 AM BY: HARRIS, JESSICA
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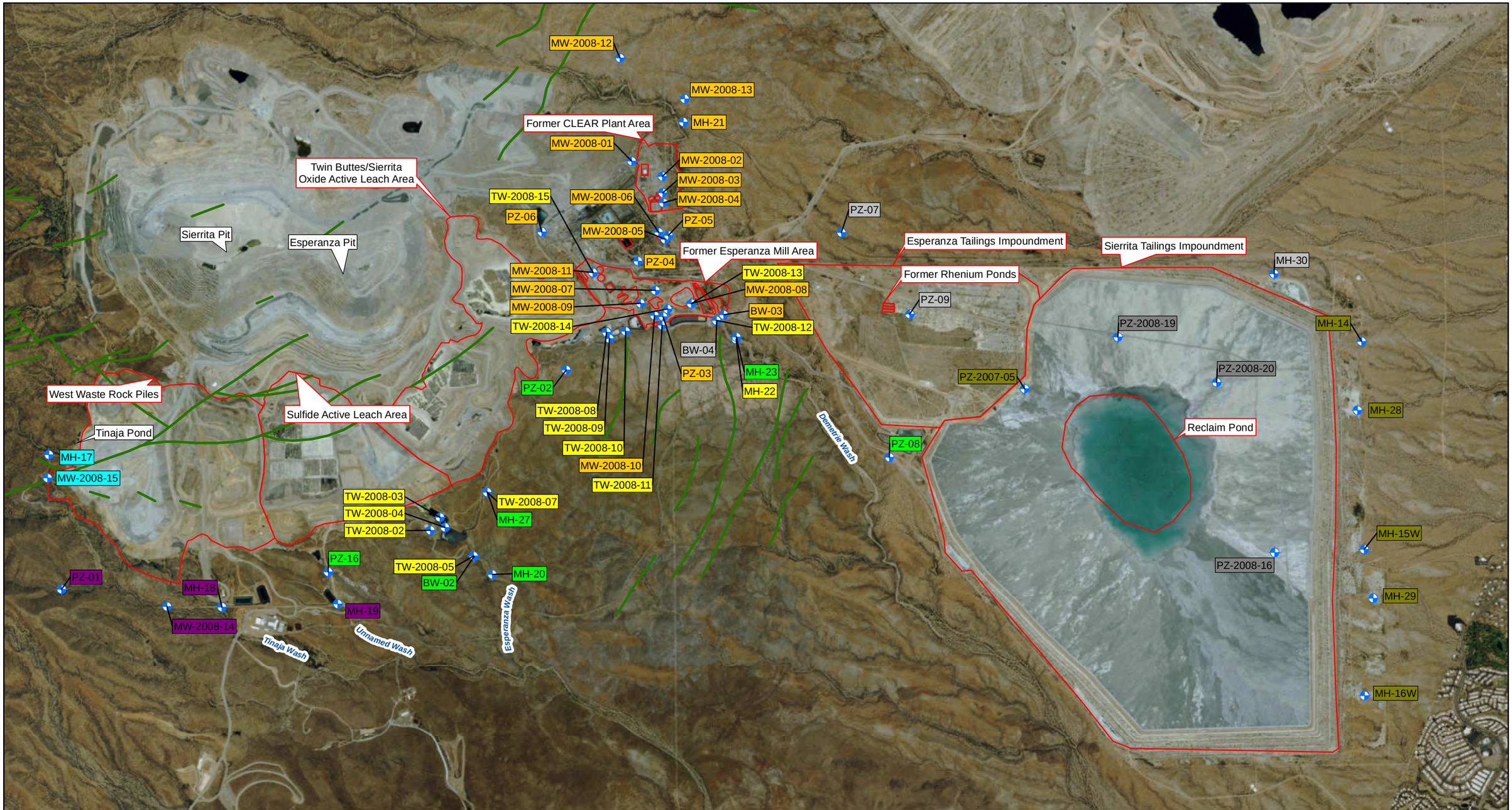
PROJECTNAME: SIERRITA MINE



GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 Other
- PZ-2008-16 Tailings
- MH-17 Quaternary Alluvium
- BW-02 Basin Fill Deposits
- MH-28 Tinaja Peak Formation
- BW-03 Ruby Star Granodiorite/ Intrusives
- MH-22 Demetrie Volcanics
- MH-17 Harris Ranch Quartz Monzonite

LEGEND

- Site Feature
- 2008 - 2009 VRP Groundwater Monitoring Location
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])

NOTES:
VRP - Voluntary Remediation Program
CLEAR - Continuous Liquid Extraction and Regeneration
[1] = BW-04 is screened in the bedrock complex.
[2] = MH-30 is screened across both basin fill and Mesozoic sedimentary rocks.
[3] = PZ-07 and PZ-09 are screened across both basin fill and Ruby Star Intrusives.

0 1,500 3,000 6,000 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

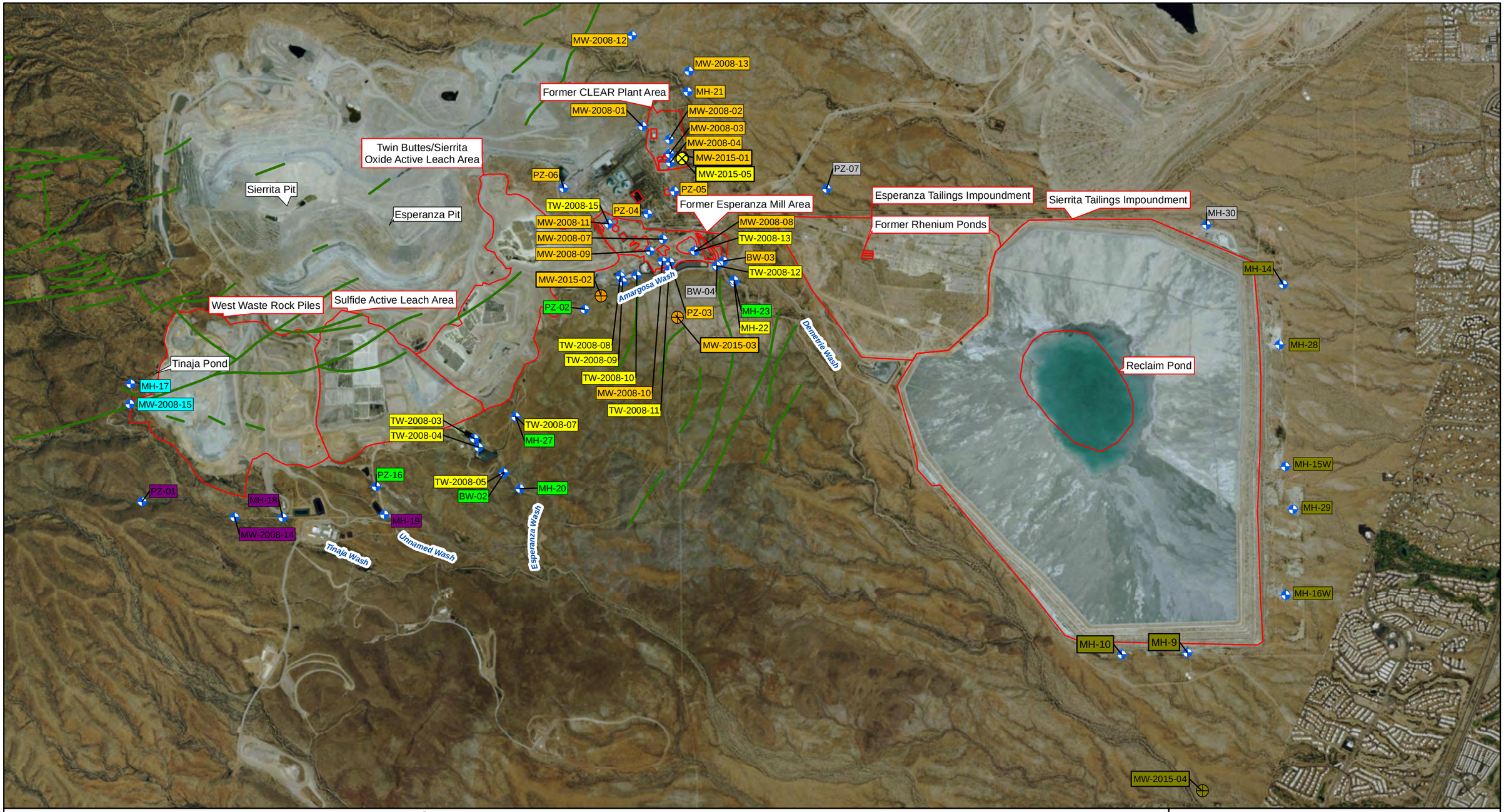
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

2008 - 2009 VRP SITE GOUNDWATER MONITORING WELL NETWORK

ARCADIS

FIGURE **12**

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB:BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GISPROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\RevisedFig 12 VRP_GW_NetworkV2.mxd



GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 — Other
- PZ-2008-16 — Tailings
- MH-17 — Quaternary Alluvium
- BW-02 — Basin Fill Deposits
- MH-24 — Tinaja Peak Formation
- BW-03 — Ruby Star Granodiorite/ Intrusives
- MH-22 — Demetrie Volcanics
- MH-17 — Harris Ranch Quartz Monzonite

LEGEND

- Site Feature
- Data Gaps VRP Groundwater Monitoring Locations
- Proposed Alluvium Well
- Proposed Bedrock Well
- Proposed Basin Fill Well
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])

NOTES:
VRP - Voluntary Remediation Program
CLEAR - Continuous Liquid Extraction and Regeneration
[1] = BW-04 is screened in the bedrock complex.
[2] = MH-30 is screened across both basin fill and Mesozoic sedimentary rocks.
[3] = PZ-07 and PZ-09 are screened across both basin fill and Ruby Star Intrusives.

0 1,700 3,400 6,800 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

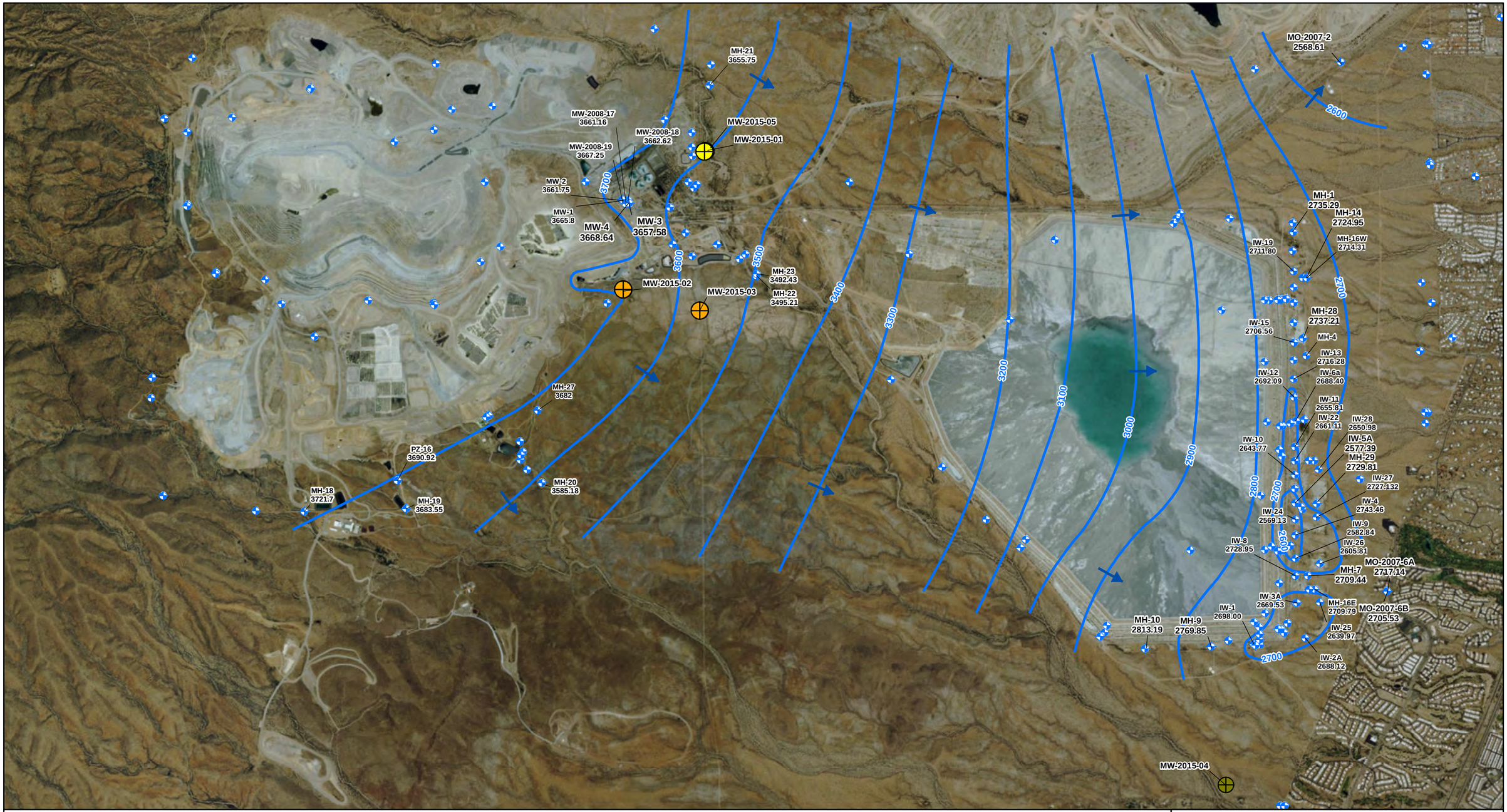
VRP DATA GAPS GROUNDWATER MONITORING PROGRAM

ARCADIS

FIGURE **13**

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\SierritaGIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 13 VRP_GW_Monitoring2015_v3.mxd

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



LEGEND

- Groundwater Monitoring Locations
- Proposed Alluvium Well
- Proposed Ruby Star Bedrock Well
- Proposed Basin Fill Well
- Groundwater Flow Direction
- Water Level Contour

N

0 1,700 3,400 6,800 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

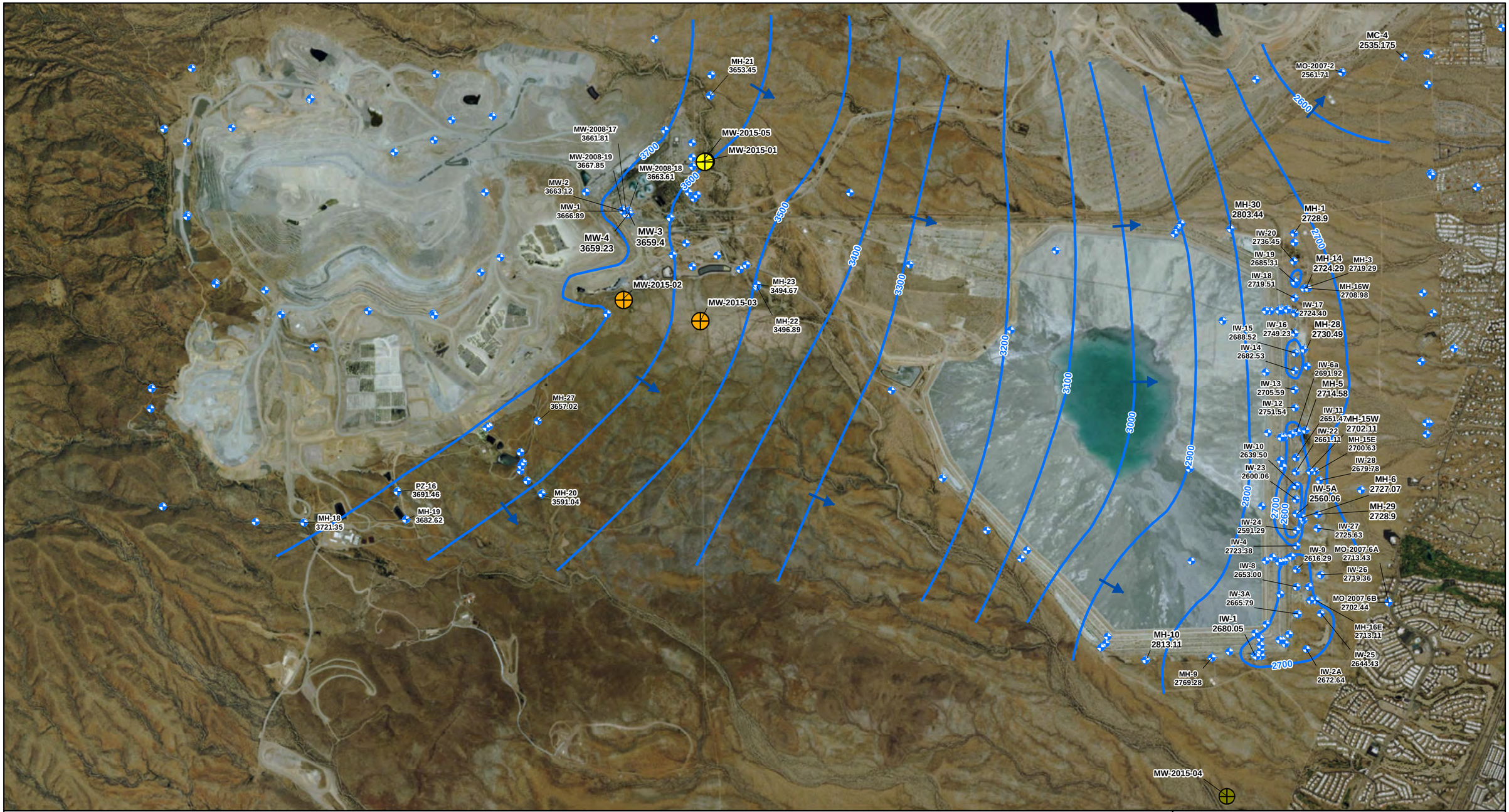
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

PROPOSED WELL LOCATIONS AND THIRD AND FOURTH QUARTER 2013 POTENTIOMETRIC SURFACE MAP

ARCADIS

FIGURE 14

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GISPROJECTS_ENVSierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\RevisedFig 14 Q3Q42013PotSurfMap_ProposedWellLocations.mxd



LEGEND

- Groundwater Monitoring Locations
- Proposed Alluvium Well
- Proposed Ruby Star Bedrock Well
- Proposed Basin Fill Well
- Groundwater Flow Direction
- Water Level Contour

N

0 1,700 3,400 6,800 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

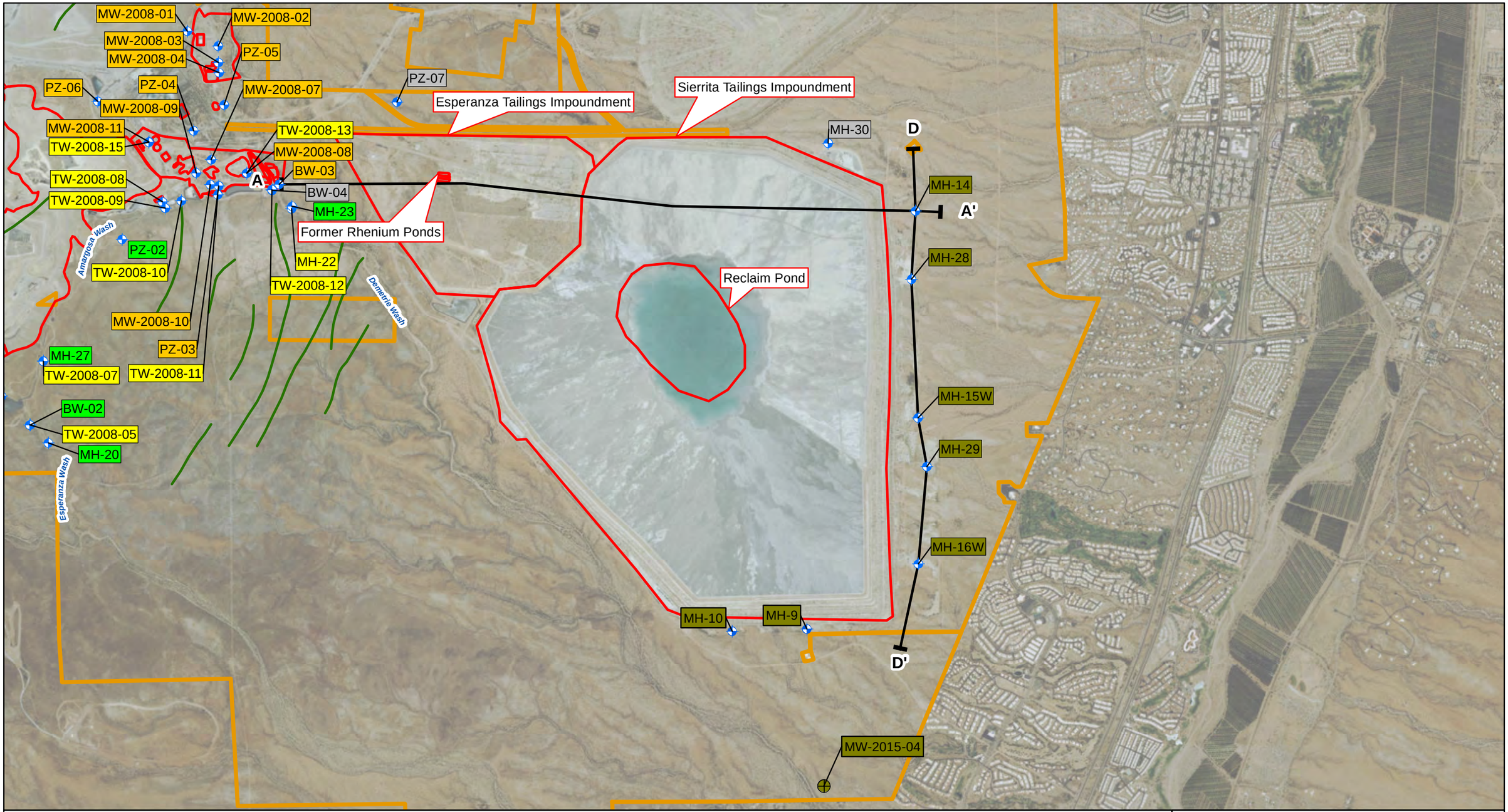
PROPOSED WELL LOCATIONS AND FIRST AND SECOND QUARTER 2014 POTENTIOMETRIC SURFACE MAP

ARCADIS

FIGURE
15

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 15 Q1Q22014PotSurMap_ProposedWellLocations.mxd

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 Other
- PZ-2008-16 Tailings
- MH-17 Quaternary Alluvium
- BW-02 Basin Fill Deposits
- BW-03 Ruby Star Granodiorite/ Intrusives
- MH-22 Demetrie Volcanics

LEGEND

- Site Feature
- Property Boundary
- Proposed Basin Fill Well
- VRP Data Gaps Groundwater Monitoring Location
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])
- Cross Section Location

NOTES:
VRP - Voluntary Remediation Program

N

3,000 1,500 0 3,000 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

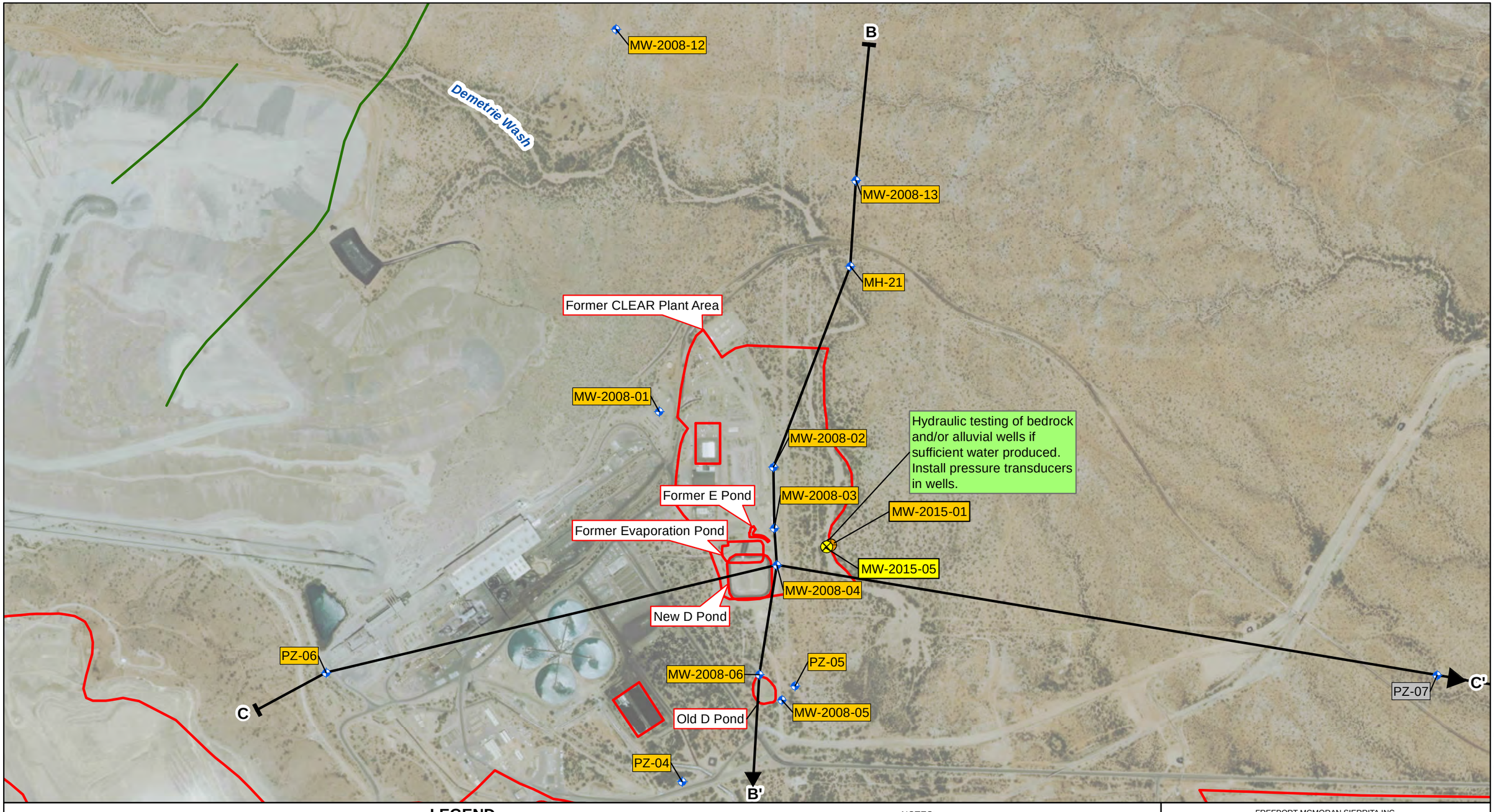
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

EAST INVESTIGATION AREA

ARCADIS

FIGURE
16

Document Path: W:\GIS\PROJECTS_ENV\SierritaGIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 16 EastInvestigation_v3.mxd



GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 Other
- MH-17 Quaternary Alluvium
- BW-03 Ruby Star Granodiorite/ Intrusives

LEGEND

- Site Feature
- VRP Data Gaps Groundwater Monitoring Location
- Proposed Alluvium Well
- Proposed Bedrock Well
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])
- Cross Section Location
- Cross Section Location That Extends Beyond Map Extent

NOTES:
VRP - Voluntary Remediation Program
CLEAR - Continuous Liquid Extraction and Regeneration
[1] = PZ-07 is screened across both basin fill and Ruby Star Intrusives.

0 400 800 1,600 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

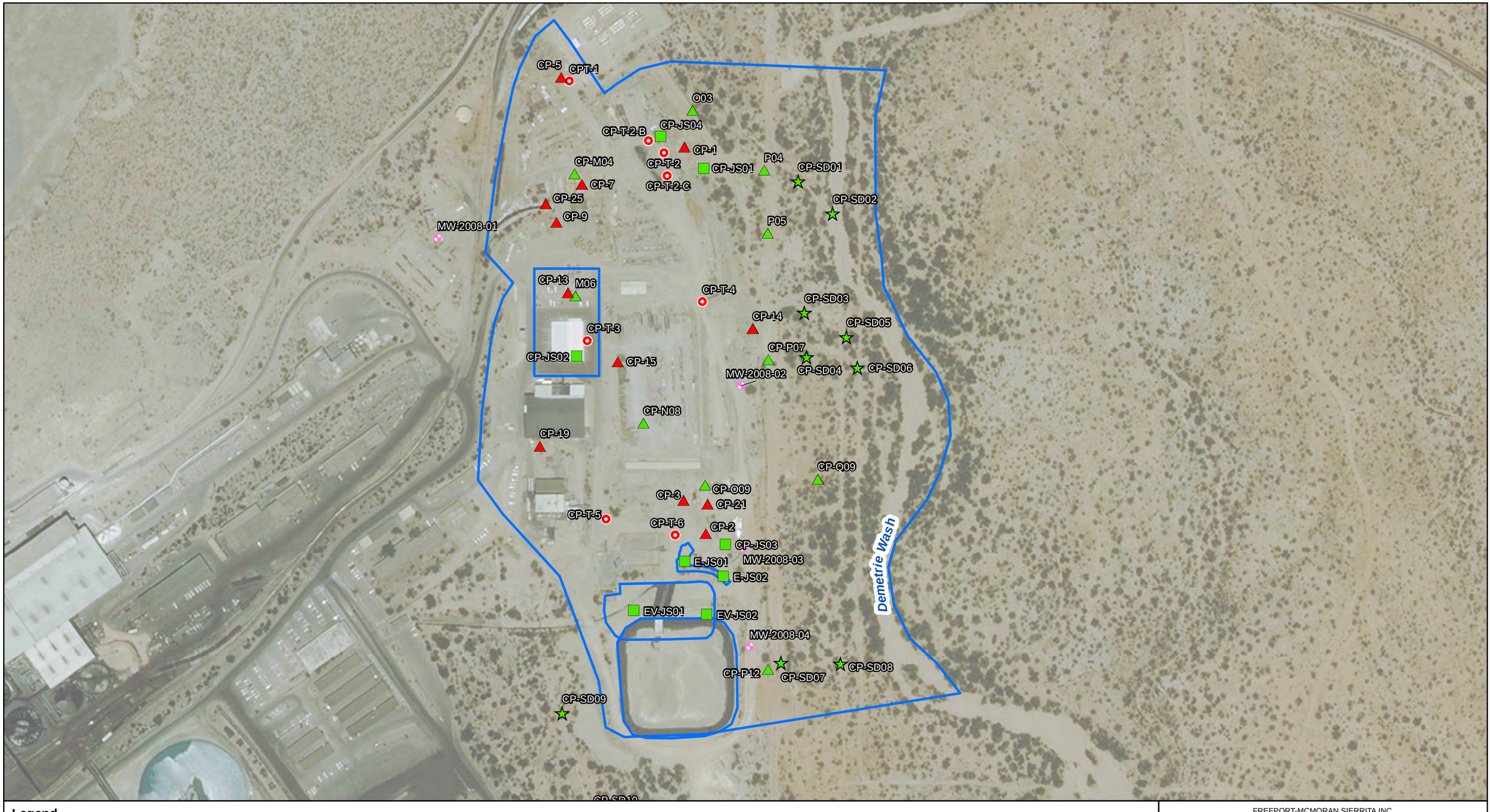
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

CENTRAL INVESTIGATION AREA (NORTH)

ARCADIS

FIGURE **17**

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\RevisedFig 17 CentralInvestigationArea\V2.mxd



Legend

Soil Sample Locations

- Judgment Soil Boring
- Random Soil Boring
- Sediment Sample
- Surface Soil Sample
- Trench Location
- VRP Monitoring Well
- Former CLEAR Plant Subarea

NOTE:
VRP - Voluntary Remediation Program
CLEAR - Continuous Liquid Extraction and Regeneration

0 150 300 600 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

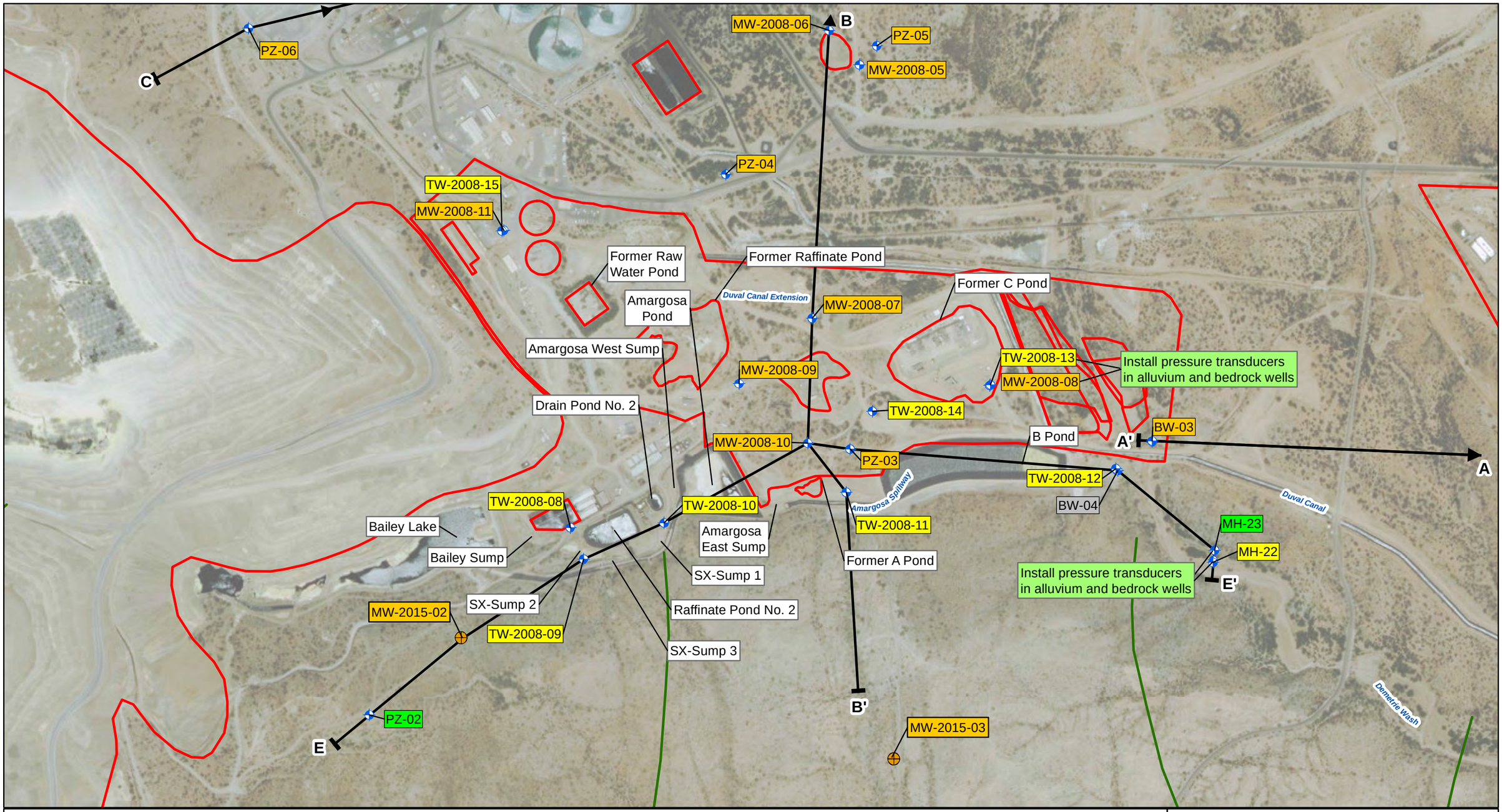
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

FORMER CLEAR PLANT SUBAREA
2008/2009 SOIL SAMPLE LOCATIONS

ARCADIS

FIGURE
18

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 18 FormerCLEARPlant_SoilLocations.mxd



GROUNDWATER WELL LITHOLOGIC UNITS

- BW-04 — Other
- MH-17 — Quaternary Alluvium
- BW-03 — Ruby Star Granodiorite/ Intrusives
- MH-22 — Demetrie Volcanics

LEGEND

- Site Feature
- VRP Data Gaps Groundwater Monitoring Location
- Proposed Bedrock Well
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])
- Cross Section Location
- Cross Section Location That Extends Beyond Map Extent

NOTE:
VRP - Voluntary Remediation Program
[1] = BW-04 is screened in the bedrock complex.

0 300 600 1,200 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

CENTRAL INVESTIGATION AREA (SOUTH)

ARCADIS

FIGURE **19**

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\RevisedFig 19 CentralInvestigationAreaSouth.mxd

Legend

Soil Sample Locations

- Judgment Soil Boring
- Random Soil Boring
- Sediment Sample
- Surface Soil Sample
- Trench Location
- Process Solution
- Boring Location
- VRP Monitoring Well
- VRP/APP-POC
- Mine
- Former Esperanza Mill Subareas

NOTE:
VRP - Voluntary Remediation Program
APP - Aquifer Protection Permit
MOC - Mitigation Order on Consent

0 175 350 700 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

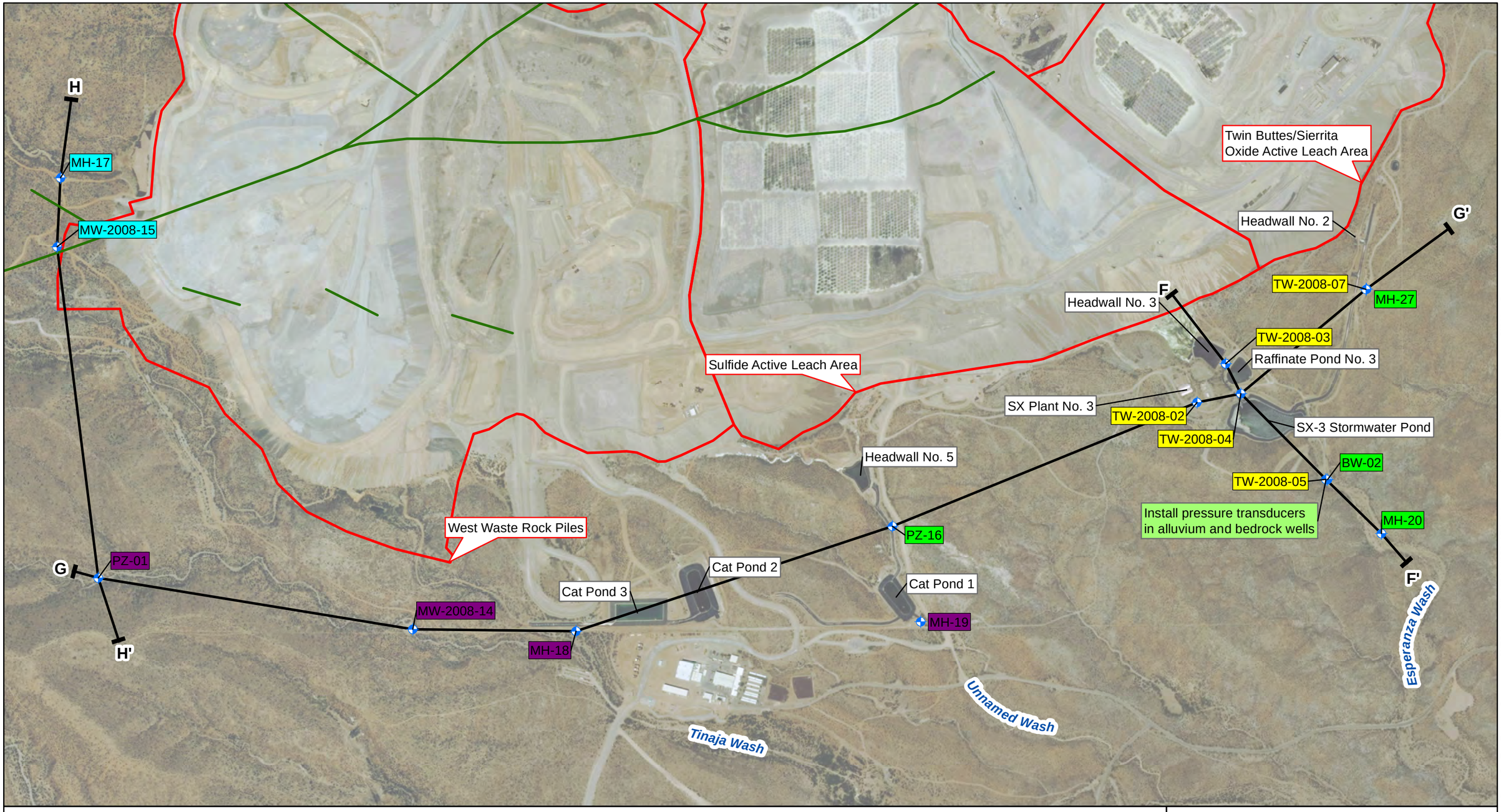
VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

FORMER ESPERANZA MILL SUBAREA
2008/2009 SOIL SAMPLE LOCATIONS

ARCADIS

FIGURE **20**

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 20 FormerEsperanza_SoilLocation.mxd



GROUNDWATER WELL LITHOLOGIC UNITS

- MH-17 Quaternary Alluvium
- MH-28 Tinaja Peak Formation
- MH-22 Demetrie Volcanics
- MH-17 Harris Ranch Quartz Monzonite

LEGEND

- Site Feature
- Cross Section Location
- Inferred Fault (source: Titley, et al [1986], adapted from Cooper [1973])
- VRP Data Gaps Groundwater Monitoring Location

NOTE:
VRP - Voluntary Remediation Program

0 500 1,000 2,000 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

VOLUNTARY REMEDIATION PROGRAM DATA GAPS WORK PLAN

WEST INVESTIGATION AREA

ARCADIS

FIGURE
21

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: BGRIFFITH LD: PIC: PM: TM:
PROJECT: PATH: W:\GIS\PROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2014\Data Gaps Work Plan\Revised\Fig 21 WestInvestigationAreaProposedAssessment_V3.mxd