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Subject:
Voluntary Remediation Program – VRP Site Code: 100073-03
Freeport-McMoRan Sierrita Inc., Green Valley, AZ
Background Soil Assessment Work Plan

ENVIRONMENT

Date:
October 30, 2017

Dear Ms. Pace:

Contact:
Katy Brantingham

On behalf of Sierrita, Arcadis U.S., Inc. is submitting the enclosed three copies of the Background Soil Assessment Work Plan (the Work Plan) for the Freeport-McMoRan Sierrita Inc. (Sierrita) Site that is part of the Arizona Department of Environmental Quality's (ADEQ's) Voluntary Remediation Program (VRP), Site Code 100073-03. This Work Plan outlines field sampling and data evaluation activities to address the ADEQ's request for a soil background study and to finalize the Baseline Human Health Risk Assessment (BHHRA) as discussed during the meeting on April 24, 2017. A proposed schedule for the activities described in the Work Plan is provided below.

Phone:
602.797.4523

Email:
Katy.Brantingham@
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Our ref:
AZ001233.0022

Sierrita Action	Schedule
Submit final background sampling locations to ADEQ following pre-drilling Site visit	Within 30 days of ADEQ's approval of the Work Plan
Begin field sampling activities	Within 30 days of ADEQ's approval of final background sampling locations
Submit background data evaluation report	Within 60 days of receipt of all validated analytical results
Submit revised BHHRA	Within 60 days of receipt of all validated analytical results

Ms. Joey Pace
October 30, 2017

Based on the conclusions of the Background Soil Assessment Report and upon approval of the BHHRA, Sierrita intends to submit a request for Administrative Closure of the Former Continuous Liquid Extraction and Regeneration (CLEAR) Plant and Former Esperanza Mill historical areas of concern.

Please do not hesitate to contact me or Debi Chismar at 520-393-2347 if you have any questions regarding this submittal. Thank you for your assistance and cooperation with our efforts to address environmental issues at this Site.

Sincerely,

Arcadis U.S., Inc.



Kathryn Brantingham

Associate Vice President / CPM2

Copies:

Deborah Chismar, Freeport McMoRan Inc. (2 hard copies, email)

Dave Gosen, Freeport McMoRan Inc. (email)

Stuart Brown, Freeport McMoRan Inc. (email)

Enclosures:

Background Soil Assessment Work Plan, Freeport-McMoRan Sierrita Inc., Green Valley, AZ, Voluntary Remediation Program – VRP Site Code: 100073-03

Ms. Deborah Chismar
Freeport-McMoRan Inc. – Sierrita Operations
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Green Valley, AZ 85622

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Background Soil Assessment Work Plan
Freeport-McMoRan Sierrita Inc., Green Valley, AZ
Voluntary Remediation Program – VRP Site Code: 100073-03

ENVIRONMENT

Date:
October 30, 2017

Dear Ms. Chismar:

Contact:
Kathryn Brantingham

Arcadis has prepared this work plan to collect background soil data and perform a background data evaluation at the Freeport-McMoRan Inc. Sierrita Mine located in Green Valley, Arizona (the Site). The purpose of this work is to address the Arizona Department of Environmental Quality's (ADEQ's) request for a soil background study and to finalize the Baseline Human Health Risk Assessment (BHHRA). This work is associated with ADEQ Voluntary Remediation Program (VRP) project 100073-03. The ultimate objective of the background study and BHHRA is to support Sierrita's request for Administrative Closure of the historical Former Continuous Liquid Extraction and Regeneration (CLEAR) Plant and Former Esperanza Mill Areas of Concern (historical AOCs) under the VRP program.

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The existing approved Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) will be updated as necessary for the work activities described in this work plan¹.

All work activities described in this work plan including utility clearance, surveying, borehole drilling and abandonment, sample transportation, laboratory analysis, and investigative derived waste (IDW) management will be performed in accordance with all necessary permits and all relevant and applicable legal requirements.

¹ Arcadis. 2015. Data Gaps Work Plan, VRP Site Code – 100073-03, Freeport McMoRan Sierrita Inc., Sierrita Mine, Green Valley, Arizona. October 8.

Proposed Background Sampling Locations

The Sierrita Mine and the proposed background sampling area are shown on Figure 1. The proposed background sampling area was selected to be outside and north of the Sierrita Mine's current and historical operational areas of influence (Figure 1). The proposed background sampling locations are shown on Figure 2 along with approximate latitude and longitude. The proposed background sampling locations are positioned on Sierrita-owned property to expedite property access, as shown on Figure 3.

The proposed background sampling area was also selected to be in an area with similar geological conditions as the on-Site locations where elevated concentrations of chemicals of potential concern (COPCs) were observed during the 2008/2009 VRP investigation. The historical AOCs on Site are defined as "disturbed" on available geological maps, as indicated on Figure 4. However, prior to re-grading, these areas appear to have been granodiorite overlain by alluvial deposits of variable age, outside of active river channels. The proposed background sampling locations have been selected to recreate these geological conditions and the relative depth to bedrock recorded during the 2008/2009 VRP investigation, which varied from approximately 5 to 20 feet on Site in the historical AOCs.

Soil Sample Collection and Analysis

This sampling program has been designed to target material from the surface down to the bedrock interface to assess the variation in concentrations of COPCs with depth and lithology. The technical scope of work developed for the background assessment consists of drilling by hollow stem auger (HSA) with drive sample split-barrel soil collection at 12 locations, with up to 7 back-up locations to be used if sampling is not possible at the primary locations. The scope of work is summarized below.

Soil Sample Collection

Up to 12 HSA borings will be completed, with the 12 proposed and 7 additional backup drilling locations presented on Figure 2. At each drilling location up to 6 soil samples will be collected at various depths down to bedrock and analyzed for selected geochemical parameters.

Borings will be advanced to bedrock or 20 feet below ground surface (bgs), whichever is deeper. Drive samples will be retrieved by split spoon-barrel, with blow counts recorded for each drive and the augers advanced after drives. The lithology encountered will be logged by a qualified field geologist. Arcadis will conduct standard geologic logging of the borehole collected from drive samples, including primary sediment or rock type, mineralogy, degree of alteration, color, grain size, rounding, sorting, cementation and other additional observations.

Soil samples will be collected from the 0-0.5, 0.5-2, 5-7, 10-12, 15-17, and 18-20 feet bgs intervals in each boring, unless bedrock is encountered above 20 feet bgs. If bedrock is reached, a soil sample will be collected from the interval from 2 feet above bedrock to bedrock. The actual sample intervals will be based on the total depth reached in each boring. The final boring depth and depth intervals sampled may change at the discretion of the field geologist based on observed lithology and soil conditions, i.e. if a specific geological interval of interest is observed an additional soil sample may be collected.

Soil Sample Analysis

Soil collected from each interval will be analyzed for total metals (antimony, arsenic, copper, lead, molybdenum, and uranium) and isotopic radium (Ra-226, Ra-228). Samples collected from the 0-0.5 and 0.5-2 feet bgs intervals will also be analyzed for isotopic uranium (U-234, U-235, U-238). Samples for total metals will be shipped under chain of custody to SVL Laboratories. Samples for isotopic uranium and radium will be shipped under chain of custody to ALS Laboratories.

Quality Control Samples

To monitor sampling, decontamination, and laboratory performance, field Quality Assurance/Quality Control (QA/QC) samples will be collected and analyzed for the same parameters as the investigative samples. These field QA/QC samples include blind duplicates, equipment blanks, field blanks, and matrix spike/matrix spike duplicates (MS/MSD).

Per FSP and QAPP guidelines, duplicate soil samples will be collected at a frequency of 20% (1 per 20 soil samples). A minimum of two equipment blanks will be collected of cleaning water routed over cleaned sampling equipment to verify the effectiveness of the equipment cleaning process, and one field blank will be collected of the cleaning water itself to verify the quality of the cleaning water source. MS/MSD analyses will be performed for the soil samples at a frequency of 20% (1 per 20 soil samples) as appropriate for the analytical methods utilized.

Boring Abandonment

HSA borings advanced at the Site will be abandoned in accordance with the State of Arizona Department of Water Resources (ADWR) guidance R12-15-803 and R12-15-816. The boreholes will be abandoned by a state licensed contractor and plugged with granular bentonite hydrated with water.

Equipment Cleaning

All HSA and down-hole equipment will be cleaned prior to first use, between each sampling location, and prior to leaving the Site. Potable water for equipment cleaning will be obtained from an approved local source. The following procedures will be used for equipment cleaning:

1. Thoroughly pressure-wash all downhole equipment. This will include, but is not limited to the augers and soil sampler rods.
2. Wash soil sampler with a phosphate-free, laboratory grade detergent and potable water mixture.
3. Rinse soil sampler with distilled water.
4. All cleaned equipment will be isolated from contact with the ground by placing on sheets of polyethylene plastic or comparable material.

Additional monitoring and sampling equipment (e.g. water-level meter if required) will be cleaned using steps 2 through 4.

Waste Management

Impacted materials are not anticipated to be generated during this investigation as drilling and sampling will be performed in background areas. IDW will include limited soil cuttings, cleaning fluids, and personal

protective equipment (PPE). All solid and liquid materials generated during drilling will be temporarily containerized pending disposal. These materials will be disposed of at the Sierrita Mine. Disposable field supplies and PPE, such as gloves, will be placed in trash bags and disposed of in mine trash receptacles as refuse.

Data Evaluation

A Level II data validation will be performed for 100% of the background analytical data, and a Level IV data validation will be performed for 10% of the background analytical data. The validated data will be used in the calculations described in the following sections.

Background Upper Tolerance Limit Calculations

Background upper tolerance limits (UTLs) for metals and radium isotopes will be calculated using the latest version of the United States Environmental Protection Agency's (USEPA's) ProUCL software updated in 2016². Concentration data for each constituent will be assessed using ProUCL to first generate summary statistics, evaluate potential outliers, and to determine the characteristics of the data to determine if each data set follows a parametric (normal) or non-parametric distribution. Normal, lognormal, gamma, or nonparametric UTLs will be calculated for each data set. The UTL 95-95 generated using this method will be exceeded by all (current and future) values coming from the background population less than 5% of the time with a confidence coefficient of 0.95. The ProUCL approach to calculating the UTL's for the constituents under review as part of this evaluation will be statistically robust and defensible as part of standard, accepted practices developed by USEPA for site assessment purposes.

The intent is to calculate background UTLs for each depth interval and each lithology encountered. The lithologies expected to be encountered include alluvium and weathered bedrock. A minimum of ten samples are required to calculate a background UTL. Therefore, if fewer than 10 samples are collected from a certain depth, samples collected from the same lithology at different depths may be combined to achieve the required ten samples for that lithology. At least one background UTL will be calculated for each metal and radium isotope for the alluvial lithology. If sufficient weathered bedrock samples are collected, background UTLs will be calculated for each metal and radium isotope for this lithology as well.

Concentrations of metals and radium isotopes measured in soil from on-Site samples collected during the 2008/2009 VRP investigation will be compared to the background UTLs to determine if on-Site concentrations are less than, equal to, or greater than background for the metals and radium isotopes.

Background Risk Calculations

The results of the background soil assessment will also be used to calculate background risk for use in the BHHRA. The background soil data developed in this work plan will be used in the revised BHHRA to estimate incremental risks. In the BHHRA, excess lifetime cancer risks (ELCRs), noncancer hazard indices (HIs), and hazard quotients (HQs) were calculated based on the 95 percent upper confidence limit

² USEPA. 2016. Statistical Software ProUCL 5.1.00 for Environmental Applications for Data Sets with and without Nondetect Observations. Available at: <https://www.epa.gov/land-research/proucl-software>

of the mean (95% UCL) for the site COPC data for each exposure area (i.e., Former CLEAR Plant and Former Esperanza Mill). The Former Rhenium Ponds were removed from the VRP on January 6, 2017, and therefore, will be removed from the BHHRA. Background-related ELCRs and HIs will be based on COPC exposure point concentrations (EPCs) represented by the 95% UCL of the background datasets, which is the same statistic used to estimate total ELCRs, HIs, and HQs for the two historical AOCs in the BHHRA. The calculation of background ELCRs and HIs will be used to measure the incremental impacts posed by each exposure area at the Site.

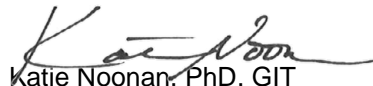
Because COPCs are also present in background soil, receptors at the Site exposure areas may also access other areas where the same COPCs are present. In accordance with USEPA guidance³, both total and background ELCRs and HIs will be estimated to measure the incremental impacts posed by each exposure area at the Site. This will be done to provide a comparison of the Site exposure area soil to background soil and to assist with risk management decisions. Total risks are those associated with the exposure area data. Background risks are those associated with exposures of the same receptors to COPC concentrations at locations other than the Site exposure areas. The only difference between the total risks and the background risks are the concentrations of the COPCs. Incremental risks are total risks minus background risks. USEPA's ProUCL software² will be used to derive the 95% UCL of the arithmetic mean concentration for COPCs in the background soil datasets.

Reporting

Following completion of the background data evaluation, a report will be prepared to summarize the drilling, soil sampling, and background data evaluation results. The report will include boring logs for the background borings and figures of the final background boring locations and metal and isotope results. Additionally, the revised BHHRA that incorporates the background risks will be submitted.

Sincerely,

Arcadis U.S., Inc.



Katie Noonan, PhD, GIT
Project Scientist



Shawn Roberts, PhD
Senior Geologist



Kathryn Brantingham, RG
Associate Vice President/CPM2

³ USEPA. 2002. Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites. EPA 540-R-01-003, OSWER 9285.7-41. September. Available online at: <https://www.epa.gov/sites/production/files/2015-11/documents/background.pdf>.

Ms. Chismar
October 30, 2017

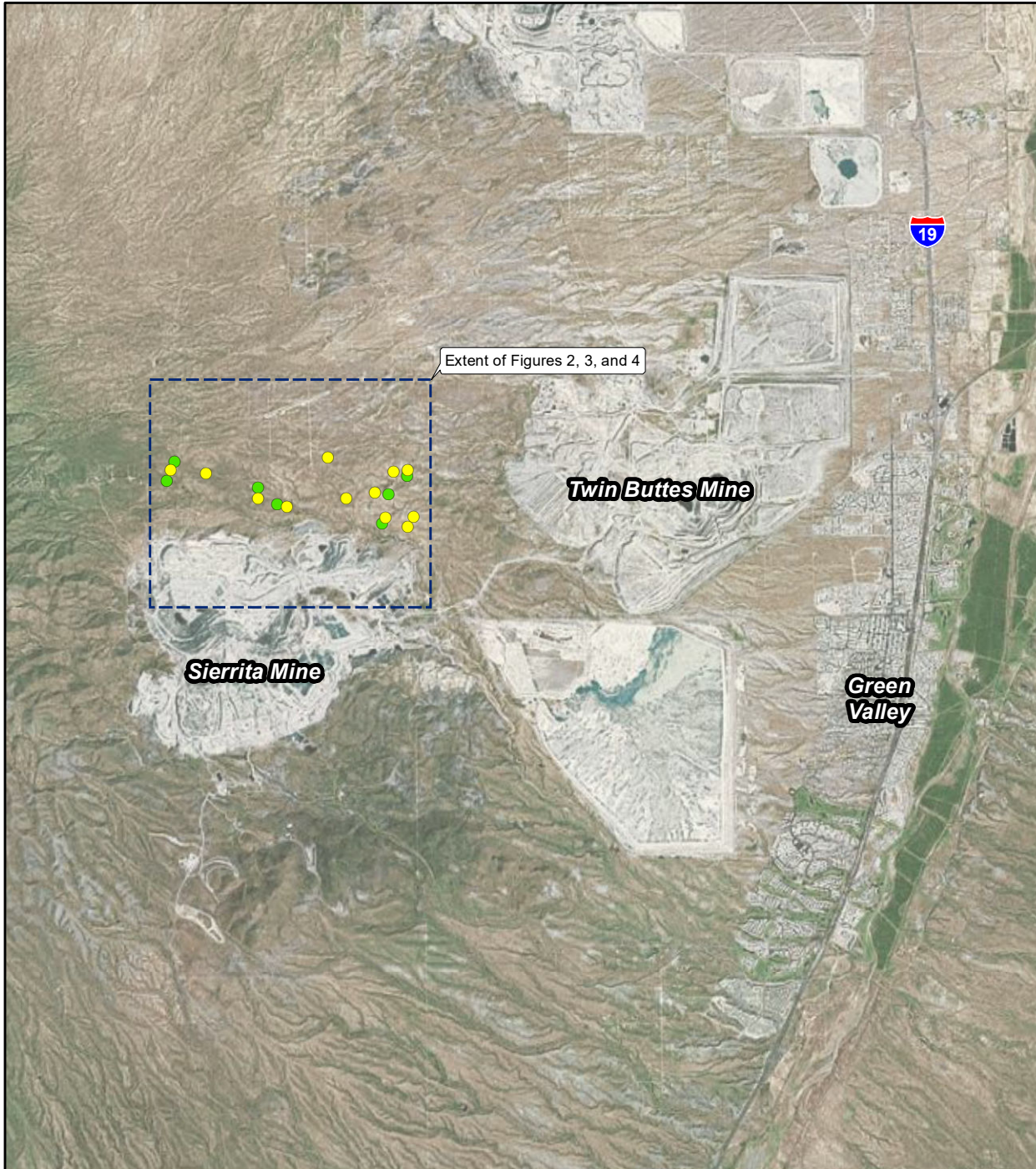
Enclosures:

Figures

1. Site Location and Background Soil Assessment Area
2. Proposed Background Soil Sampling Locations
3. Proposed Background Soil Sampling Locations with Property Boundaries
4. Proposed Background Soil Sampling Locations with Geology

FIGURES





SITE LOCATION

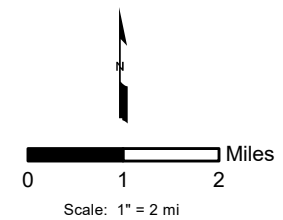


LEGEND

- ★ Site location
- Proposed background soil sampling location
- Proposed backup background soil sampling location

NOTES

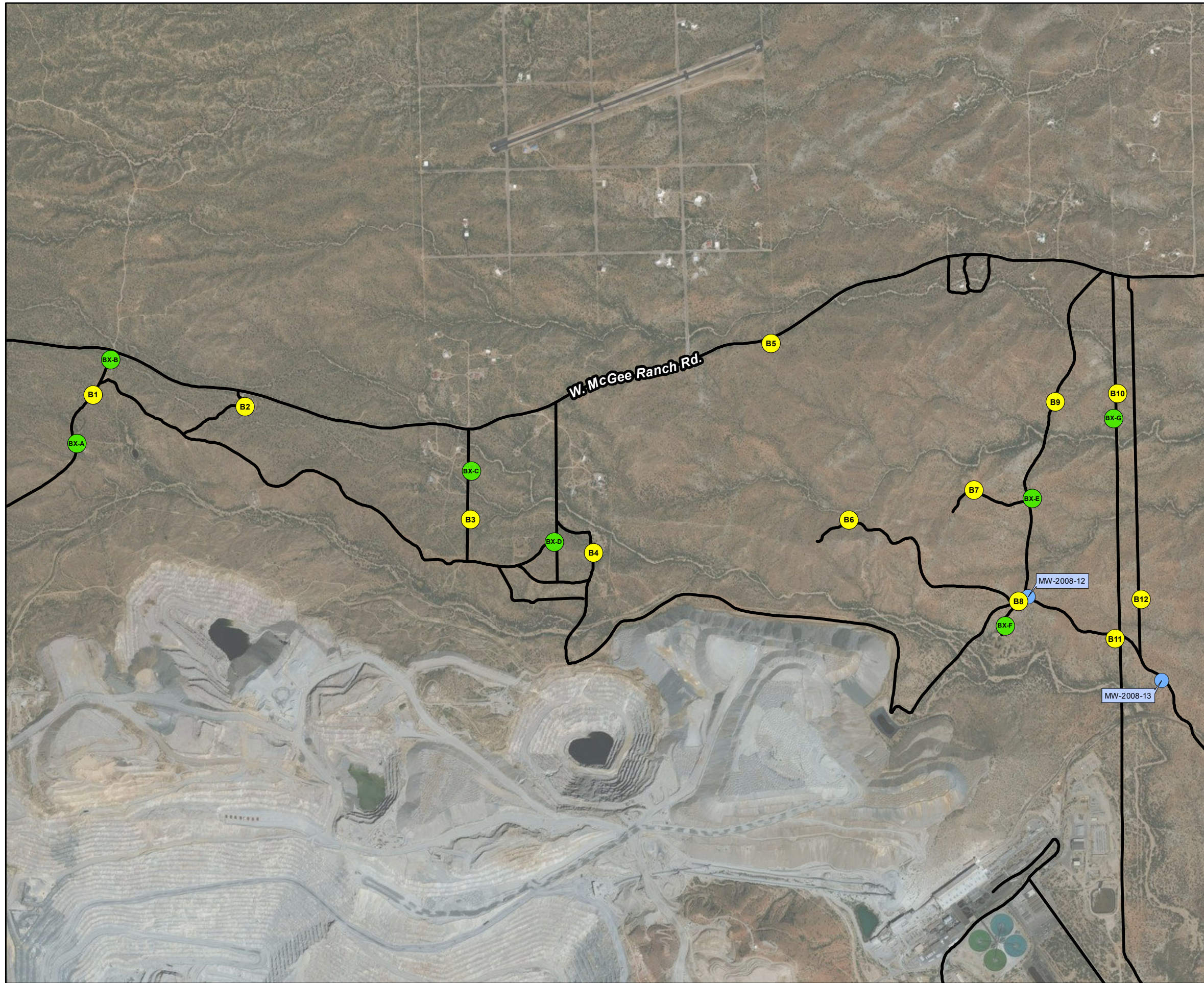
· Aerial photo source: ESRI World Imagery.



FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

**SITE LOCATION AND BACKGROUND
SOIL ASSESSMENT AREA**





LEGEND

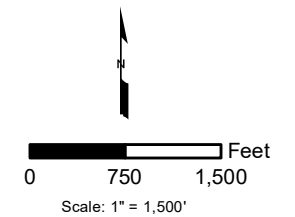
- Proposed background soil sampling location
- Proposed backup background soil sampling location
- Existing groundwater monitoring well
- Existing road

BACKGROUND SAMPLING LOCATIONS

Location ID	Type	Latitude (°N)	Longitude (°W)
B1	Primary	31.896992	111.147335
B2	Primary	31.896439	111.139843
B3	Primary	31.891626	111.128768
B4	Primary	31.890193	111.122721
B5	Primary	31.898949	111.113897
B6	Primary	31.891492	111.110128
B7	Primary	31.892723	111.103948
B8	Primary	31.888026	111.101796
B9	Primary	31.896393	111.099892
B10	Primary	31.896734	111.096838
B11	Primary	31.886412	111.097029
B12	Primary	31.888065	111.095750
BX-A	Backup	31.894940	111.148148
BX-B	Backup	31.898466	111.146446
BX-C	Backup	31.893672	111.128695
BX-D	Backup	31.890665	111.124646
BX-E	Backup	31.892343	111.101080
BX-F	Backup	31.887000	111.102443
BX-G	Backup	31.895686	111.097034

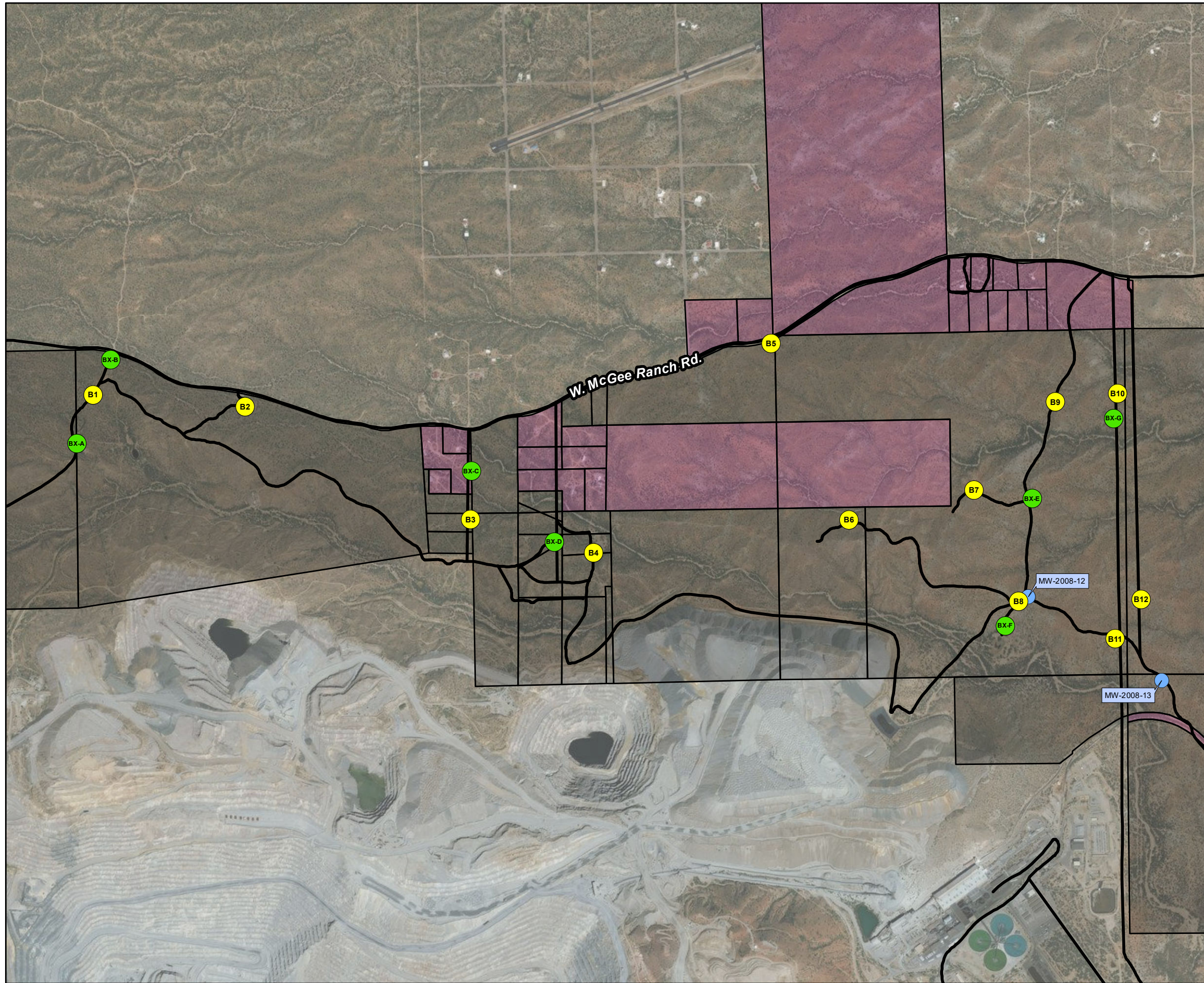
NOTES

- Aerial photo source: ESRI World Imagery.
- If it is determined that any background soil sampling locations cannot be used based on observations made in the field, a backup soil sampling location will be used in its place.



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GREEN VALLEY, ARIZONA

**PROPOSED BACKGROUND
SOIL SAMPLING LOCATIONS**

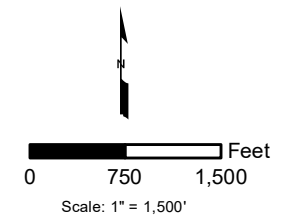


LEGEND

- Proposed background soil sampling location
- Proposed backup background soil sampling location
- Existing groundwater monitoring well
- Existing road
- Parcel owned by Freeport-McMoRan Inc.
- Parcel not owned by Freeport-McMoRan Inc.

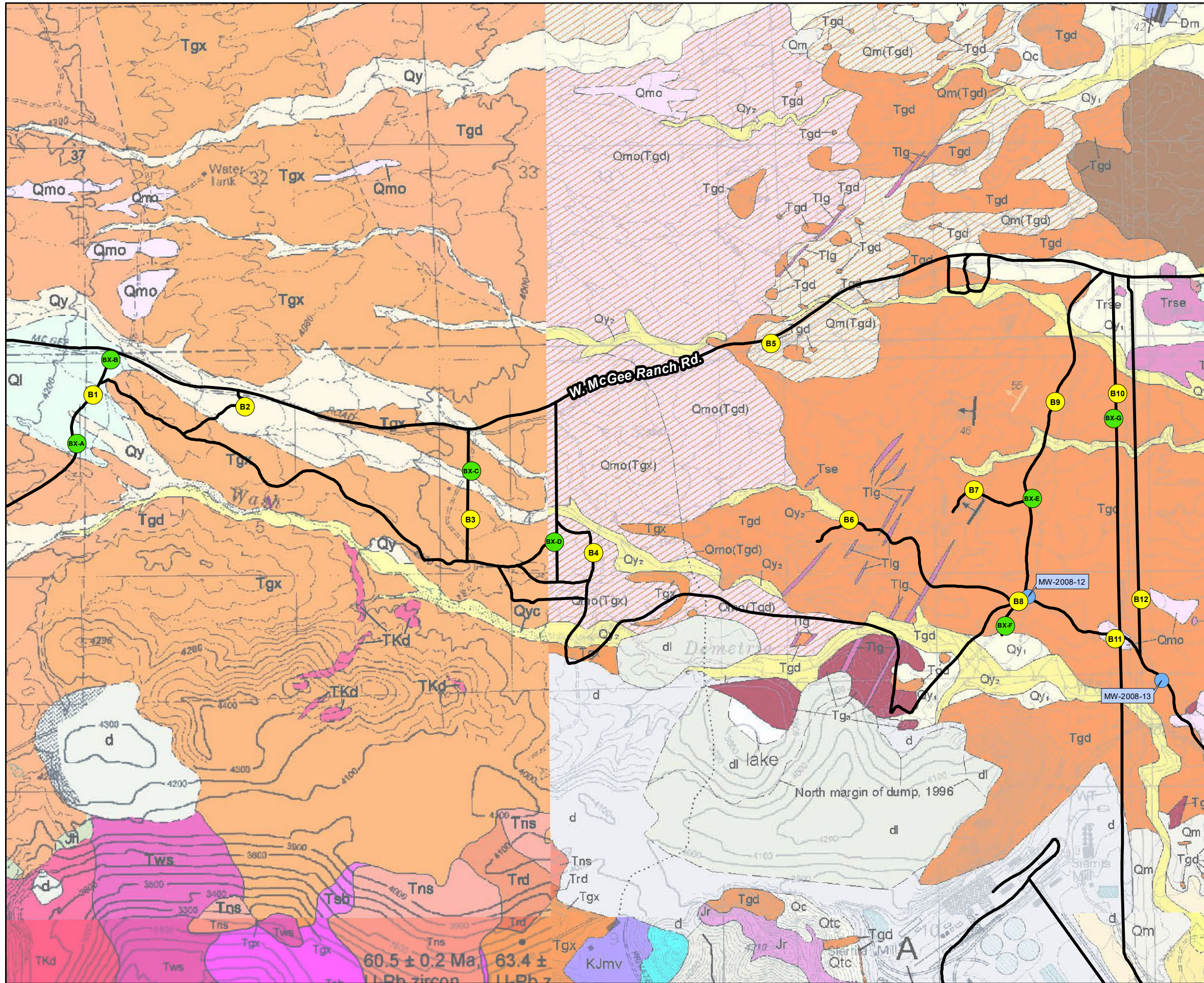
NOTES

- Aerial photo source: ESRI World Imagery.
- Parcel data source: PimaMaps.
- If it is determined that any background soil sampling locations cannot be used based on observations made in the field, a backup soil sampling location will be used in its place.



FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

**PROPOSED BACKGROUND SOIL SAMPLING
LOCATIONS WITH PROPERTY BOUNDARIES**



LEGEND

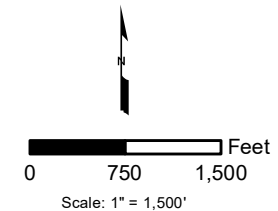
- Proposed background soil sampling location
- Proposed backup background soil sampling location
- Existing groundwater monitoring well
- Existing road

KEY GEOLOGIC UNIT DESCRIPTIONS

- d : Disturbed ground (less than 100 years)
- Ql : Late Pleistocene alluvium (~130 to 750 ka)
- Qmo : Middle to Early Pleistocene alluvium (~500 ka to 1 Ma)
- Qmo(Tgd) : Middle to Early Pleistocene alluvium over Ruby Star granodiorite
- Qmo(Tgx) : Middle to Early Pleistocene alluvium over porphyritic phase, Ruby Star granite
- Qy : Undifferentiated Holocene alluvium (less than 10 ka)
- Qy₁ : Holocene alluvium (~2 to 10 ka)
- Qy₂ : Late Holocene alluvium (less than ~2 ka)
- Tgd : Ruby Star granodiorite (Paleocene); granodiorite phase
- Tgx : Ruby Star granodiorite (Paleocene); porphyritic phase
- Tlg : Biotite leucogranite (Paleocene)

NOTES

- Geologic map is a composite of:
 - Johnson, B.J., et al., 2003, Geologic Map of the Samaniego Peak 7 1/2 Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 30 (DGM-30), 21 p., 1 sheet, scale 1:24,000.
 - Richard, S.M., et al., 2003, Geologic Map of the Twin Buttes 7 1/2 Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 31 (DGM-31), version 1.1, 1 sheet, scale 1:24,000.
 - Ferguson, C.A., et al., 2003, Geologic Map of the Batamote Hills 7 1/2 Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 32 (DGM-32), 31 p., 1 sheet, scale 1:24,000.
 - Spencer, J.E., et al., 2003, Geologic Map of the Esperanza Mill 7 1/2 Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map 33 (DGM-33), 10 p., 1 sheet, scale 1:24,000.
- If it is determined that any background soil sampling locations cannot be used based on observations made in the field, a backup soil sampling location will be used in its place.



FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

PROPOSED BACKGROUND SOIL SAMPLING LOCATIONS WITH GEOLOGY

