FREEPORT-MCMORAN

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July 17, 2019

Certified Mail #70182290000117903587
Return Receipt Requested

Ms. Rebecca Roose, Director
New Mexico Environment Department
Water Protection Division
P.O. Box 5469
Santa Fe, New Mexico 87502

Dear Ms. Roose:

Re: Groundwater Pathway Evaluation Addendum to the Revised Technical Memorandum for the Groundhog No. 5 Stockpile Geochemical Evaluation for the HWCIU – Chino AOC

Freeport-McMoRan Chino Mines Company (Chino) submits under separate cover the *Groundwater Pathway Evaluation Addendum* to the *Revised Groundhog No. 5 Stockpile Geochemical Evaluation Technical Memorandum* (TM) for the Hanover Whitewater Creek Investigative Unit (HWCIU), under the Chino Administrative Order on Consent (AOC). The TM was submitted on March 5, 2018 to the New Mexico Environment (NMED). The Addendum is provided in response to comments received from NMED on the Revised TM. The report was submitted today to Mr. David Mercer.

Please contact Ms. Pam Pinson at (575) 912-5213 with any questions or comments concerning this report.

Sincerely,

Sherry Burt-Kested, Manager
Environmental Services

SBK:pp
20190717-002

c: David Mercer, NMED
Joseph Fox, NMED
Kurt Vollbrecht, NMED
Petra Sanchez, US EPA
Mike Steward, FCX

TECHNICAL MEMORANDUM

DATE July 16, 2019 **Project No.** 1665189

TO Pam Pinson Freeport-McMoRan Chino Mines Company

CC Joanna Moreno

FROM Jen Pepe, Senior Engineer/PM and
Kent Johnejack P.E., Associate

EMAIL jpepe@golder.com

REVISED GROUNDHOG NO. 5 STOCKPILE GEOCHEMICAL EVALUATION ADDENDUM GROUNDWATER PATHWAY EVALUATION

1.0 INTRODUCTION

This technical memorandum has been prepared by Golder Associates Inc. (Golder) for Freeport-McMoRan Chino Mines Company (Chino) as an Addendum to the Revised Groundhog No. 5 Stockpile Geochemical Evaluation (Golder 2018a) to provide additional evaluation of the groundwater pathway from the Groundhog No. 5 Stockpile located in Lucky Bill Canyon. The site is part of the Chino Administrative Order on Consent, Hanover/Whitewater Creek Investigation Unit.

On June 6, 2019, Chino participated in a conference call with New Mexico Environmental Department (NMED) to discuss the previous evaluation and NMED's questions concerning the groundwater pathway. In a letter dated June 13, 2019, NMED provided additional comments stating:

"NMED has determined that while the report adequately addressed the waste rock stockpile's geochemistry and its potential impact to surface water, the report is limited and incomplete in evaluating the potential impacts to groundwater due to there being no monitoring wells immediately downgradient of the waste rock stockpile.

NMED requests that supplemental information be provided with the report to demonstrate protection of groundwater quality be performed and submitted for review within 30 days. This could include additional modeling of groundwater mixing and flow path; a technical discussion of the interaction between groundwater, the stockpile, infiltration, and geologic/hydrologic controls; and the resulting impact of placing a minimum of one foot cover system with vegetation, as required under the Mining and Minerals Division permit. In addition, discussion of possible data gaps such as the absence of downgradient monitoring wells and any other assumptions taken into consideration regarding the potential impact to groundwater should be explained thoroughly."

This addendum presents the supplemental information requested by NMED, and includes:

- A detailed description of the site characteristics affecting seepage to groundwater.
- Results of modeled groundwater quality that may occur downgradient of the stockpile based on mixing of stockpile seepage and groundwater, utilizing a one-foot growth medium cover system requested by New Mexico Mines and Minerals Division (MMD). For comparison groundwater quality was also modeled without the addition of a soil cover cap per discussion between Chino and MMD.

- Groundwater mixing calculations are based on the previous Groundhog No. 5 Stockpile evaluations, the site-wide groundwater modeling effort completed under the Site-Wide Abatement efforts, and other Chino stockpile infiltration studies performed by Golder.
- A discussion of data gaps and recommendations.

2.0 BACKGROUND

The Work Plan was requested by NMED in a letter dated March 12, 2014, when Chino determined that well GH-97-04 located at the toe of the stockpile (Figure 1) was not collecting enough seepage water to consistently evaluate water quality. The Work Plan, approved by NMED in a letter dated June 19, 2014, proposed a new collection system to capture seepage from under the alluvial at its interface with bedrock.

The NMED requested additional characterization, monitoring, and regrading to limit ponding and limit potential impacts to groundwater associated with the stockpile as well. Chino performed additional characterization, monitoring, and remedial action work, including upgrades to surface water diversions and seepage collection systems, as described in the Work Plan. The Work Plan also provides a summary of previous characterization of the stockpile performed in 2004 (Golder 2005) and supplemental characterization performed in 2006 (Golder 2007).

This Addendum summarizes key observations and results of the Work Plan and Geochemical Evaluation relevant to the groundwater pathway, details of groundwater mixing calculations performed in July 2019, and expected water quality at a downstream location in Lucky Bill Canyon. The downstream location was selected as the location of historical Well GH-97-03 (Figure 1). Well GH-97-03 was originally installed at this location because it is directly downstream of the stockpile, but it was damaged shortly after installation by storm flows in the canyon. The well was usually dry but produced enough water for one sample in 1997 before it was damaged. Sulfate and total dissolved solids (TDS) concentrations in GH-97-03 were 238 mg/L and 507 mg/L, respectively, before controls were put in place at the stockpile.

3.0 SITE DESCRIPTION AND PREVIOUS INVESTIGATIONS

The Groundhog No. 5 Stockpile is a small waste rock stockpile with a footprint of less than 2 acres associated with the Groundhog No. 5 Shaft located on the north wall of Lucky Bill Canyon near its confluence with Bayard Canyon (Figure 1). The primary ores extracted from the Groundhog No. 5 Shaft consisted of lead and zinc sulfides occurring in mineralized veins in older rock units below the Sugarlump and Kneeling Nun Tuff Formations, that are exposed along the surface in Lucky Bill Canyon as well as Bayard Canyon at the confluence point. The tuffs overlie Cretaceous-Tertiary sediments (the Colorado Formation), which in turn overlie a series of Paleozoic limestones and shales. Stockpile material types at the site include limestone, granodiorite, diorite, quartz monzonite, and tuff (Golder 2009) that have been deposited on colluvium overlying bedrock tuff. The stockpile was regraded and related head frame infrastructure removed in 2006 under the MMD Closure Closeout Plan. Chino regraded the surface in 2014 to limit stormwater run-on and promote runoff from the top of the stockpile. The current stockpile configuration is shown on Figure 2.

Previous investigations of the stockpile area include:

- A 2004 site investigation including three test pits in the stockpile to estimate the lateral and vertical extend of the stockpile material and to characterize the chemical nature of the material with respect to expected environmental behavior and suitability of the stockpile material for vegetation substrate (Golder 2005). The investigation included inspection of the area surrounding the stockpile for seeps and springs.
- In 2006, a supplemental site investigation was conducted after the stockpile was regraded to characterize the distribution of materials in the upper 3 feet of the stockpile after regrading (Golder 2007). Five test pits were excavated in the stockpile.
- In 2014, the seepage collection trench was excavated to bedrock along the toe of the stockpile and logged the colluvium and bedrock units encountered (Golder 2014).

No saturated zones were observed in test pits during the 2004 and 2006 investigations in either the stockpile material or underlying colluvium, and no seeps were identified during the 2004 investigation. No test pits were excavated to bedrock.

During the excavation of the seepage collection trench, the stockpile materials, colluvium, and bedrock surface were visually inspected to check for any indication of stockpile impacts and seepage or groundwater flow paths. The trench was logged for soil classification, lithology of rock fragments, zones of moisture, and presence of secondary mineralization or precipitates. The colluvium was approximately 7.5 feet to 9 feet deep along the trench alignment. The upper 3 feet was silty to clayey sand with gravel. Below 3 feet, the colluvium was a silty sand with gravel matrix with 25 to 60 percent oversized material (greater than 3 inches in diameter). The lithology of the clasts and boulders was primarily Sugarlump Tuff, but some mineralized jasperoid, fine grained intrusives, and granodiorite were present. Mineralization within the cobbles included limonite, goethite, pyrite, and iron staining. The presence of these sulfide bearing clasts indicates that the colluvium is derived from tuff and intrusive dikes prevalent in the area. The trench was excavated to bedrock. The bedrock was deepest in the middle of the trench, and the top 2 to 3 inches of the Sugarlump Tuff bedrock surface in the deeper portion of the trench was observed to be weathered to soft and stained slightly yellow orange indicating flow had been occurring along this interface. No zones of moisture were encountered except along this weathered interface. Below the weathered surface of the bedrock, the tuff was competent, unstained, and hard.

The greater part of the excavated trench was then included in the construction of the seepage collection trench (Figure 3). Based on observations during excavation of the trench, and as designed, the interceptor ditch is positioned to intercept seepage at the toe of the stockpile.

A shallow seepage collection well (GH-97-04) is located at the toe of the stockpile. This well was installed under the Administrative Order on Consent (AOC) in 1997 to collect samples of shallow groundwater (Daniel B. Stephens and Associates, Inc [DBS&A] 1997). The well was installed using a backhoe to excavate to bedrock and installing horizontal perforated pipe attached to a riser pipe. During the excavation of the seepage collection trench, it was discovered that the collection point (screen) in seepage collection well GH-97-04 was several feet above the bedrock interface, positioned on and above a boulder.

4.0 CONCEPTUAL MODEL

The Groundhog No. 5 Stockpile is a coarse textured waste rock pile. Based on test pits excavated after the stockpile was regraded, the materials on the top of the stockpile are generally finer in texture (oversize fraction less than 10 percent in Test Pits GH5-4 and GH5-5) and predominantly angular limestone gravel. The fraction of oversize material and the amount of quartz monzonite gravel is greater on the regraded slope than on the flat top of the stockpile. Some finer soils have formed or been deposited by wind on the stockpile surface.

Figure 4 shows a conceptual model for water inflows and outflows for the area of the Groundhog No. 5 Stockpile. The stockpile is underlain by colluvium on the hillside, which is underlain by bedrock (Sugarlump Tuff). With respect to groundwater, the stockpile is unsaturated based on the absence of springs and dry conditions in test pits and colluvium, and upwelling of groundwater into the stockpile is not likely. The current working site-wide groundwater model indicates that groundwater is 10 to 20 feet below the base of the colluvium. Because the stockpile is located along a relatedly steep slope and well above the base of the drainage, it would be very unlikely for groundwater levels to rise enough to inundate the stockpile materials.

Upstream surface water has been diverted around the stockpile in diversion ditches constructed during regrading of the stockpile in 2006. While negligible amounts of water may enter the colluvium at the uphill portion of the drainage ditch during rainfall events that generate runoff, the majority of the water inflow to the stockpile is due to incident precipitation. Precipitation onto the stockpile surface will either evaporate (evapotranspiration), infiltrate into the stockpile, or run off the stockpile surface. Infiltration into the stockpile that reaches a depth below the influence of evaporation will migrate downward to the colluvium, and either flow along the top of the colluvium or along the colluvium/bedrock contact toward the stockpile toe, or downward into the regional groundwater. The two test pit investigations were performed during winter months when there had been no recent rainfall, and the colluvium, underlying the stockpile material was dry. No water was present in the well GH-97-04 at the stockpile toe during these investigations.

During trench excavation, the bedrock surface was observed to be weathered and stained in only the upper two to three inches, and hard and unweathered beneath, indicating flow had occurred along the bedrock contact. The hydraulic conductivity of the volcanic bedrock of the North Mine Area is known to be the lowest of any of the major bedrock units in this area (Golder 2007). The geometric mean hydraulic conductivity of the Sugarlump Tuff, which underlies the stockpile is 8.2E-4 feet per day (ft/d) (2.9E-7 centimeters per second) (Golder 2007). In comparison, the hydraulic conductivity of the colluvium which would be in the range of 1 to 100 cm/s (Klute and Dirksen 1986), promoting flow through the colluvium at the contact. Based on this information, it is unlikely that significant seepage is occurring into the regional groundwater.

Groundwater near the stockpile exhibits an upward gradient along the stream channel in Lucky Bill Canyon as illustrated on Figure 3. This upward gradient beneath the drainages in the North Mine Area has been determined from the installation of numerous monitoring wells along Hanover Creek, Whitewater Creek, and in the Lampbright Area (Tributaries 1 and 2) (Golder 2008). This characteristic upward gradient along major drainages is further demonstrated by the site-wide groundwater modeling results that includes the Lucky Bill Canyon area (Golder 2008), and as evidenced by intermittent flow in the stream and a thick riparian zone along the centerline of the valley. A large portion of the shallow groundwater along the riparian zone and surface water in the stream channel is lost to evapotranspiration.

Groundwater impacts throughout the North Mine Area are being addressed specifically as part of the site-wide groundwater abatement investigation. This includes specifically the Lucky Bill Canyon area.

5.0 AVAILABLE INFORMATION

To evaluate potential water quality effects from the stockpile, Golder utilized data from monitoring programs and from earlier reports as follows:

- Groundwater sulfate and TDS concentrations available for area wells and the seepage collection trench (Table 1)
- Downgradient monitoring well sulfate and TDS concentrations from Well GH-97-03 for September 1997
- Sulfate and TDS concentrations in wells completed in the Sugarlump Tuff and unaffected by mining operations north of Lucky Bill Canyon for background for over 10 years (Well 526-96-12; Figure 1)
- Sulfate and TDS concentrations in the seepage collection trench (identified as the Lucky Bill Trench) from 2014 to 2019.
- Seepage estimates developed for the Closure Closeout Plan (Golder 2018b) for Chino Stockpiles (uncovered and covered with a vegetated cover system)
- Aquifer properties from the Site-Wide Abatement groundwater model (depth to groundwater and flow direction at the stockpile)

6.0 GROUNDWATER QUALITY ESTIMATES

The concentrations of TDS and sulfate in groundwater in the bedrock were calculated for steady state conditions using the following three components of flow (Figure 5):

1) Infiltration of precipitation flux through the vadose zone between upgradient surface water divide (ridge) and the stockpile, containing an assumed background concentration based on average and maximum observed concentrations at Wells 526-96-12 (Table 2).
2) Seepage from the stockpile calculated as the flux through the unsaturated zone under conditions of no cover and 1-foot cover, containing an assumed stockpile concentration based on average and maximum observed concentrations at the Lucky Bill trench (Table 2).
3) Recharge flux through the vadose zone between the stockpile and the downgradient Well GH-97-03, containing zero concentration (clean precipitation).

The method described here is similar to that used to calculate dilution factors for the Yucca Mountain nuclear repository (Baca et al. 1997).

The flux due to infiltration of precipitation upgradient of the stockpile was calculated assuming a net infiltration rate the same as that of the uncapped stockpile (2.67 cm/year based on Golder 2018b) and an area equal to the width of the stockpile perpendicular to groundwater flow (300 feet) and the distance from the upgradient surface water divide to the stockpile (about 700 feet) (Figure 6).

The flux through the stockpile was calculated based on cover modeling for the stockpile for different cover scenarios and the stockpile footprint (80,000 square feet).

The flux due to infiltration of precipitation downgradient of the stockpile was calculated assuming a net infiltration rate the same as that of the uncapped stockpile (2.67 cm/year based on Golder 2018b) and an area equal to the width of the stockpile perpendicular to groundwater flow (300 feet) and the distance to the downgradient Well GH-97-03 of about 500 feet (Figure 6).

This approach conservatively estimates loading by ignoring other factors that may further dilute the seepage including:

- Stockpile seepage that does not reach the water table or is intercepted in the trench
- Groundwater flow down valley which would mix with seepage from the stockpile
- Dispersion due to heterogeneities in the bedrock and colluvium, as well as changes in flow rates and directions during storm events
- Reaction of sulfate or components of TDS with the formations it flows through.

The resulting calculations are summarized in Tables 3 and 4. Results shown in these tables indicate that for the average and maximum stockpile concentration cases with no stockpile cover or with one foot of vegetated cover, calculated groundwater concentrations for both TDS and sulfate fall below groundwater quality standards and are similar to the observed concentrations in Well GH-97-03.

7.0 EVALUATION OF UNCERTAINTIES

The groundwater mixing model uses existing data developed from studies conducted at Chino over the past several years. Seepage estimates through the stockpile were developed for the Closure Closeout Plan (Golder 2018b) and groundwater parameters are consistent with the site-wide abatement groundwater model. Water quality is conservatively estimated using the total seepage out the bottom of the stockpile with water quality consistent with 3 years of monitoring data from the trench. Incoming upgradient groundwater quality is from area wells installed in the Sugarlump Tuff. This model using site data indicates that the water quality at the location of damaged Well GH-97-03 would meet water quality standards under the current conditions and with a 1-foot cover.

Installation of additional wells upgradient, through, or downgradient of the stockpile may help define the aquifer properties and seepage rates, but the water quality in the stockpile area in bedrock is likely to be influenced by the natural mineralization in the area. Shallow wells near the stockpile can also be influence by mineralized colluvium and bedrock. Cobbles in the soils above the bedrock in the trench excavation were observed to have minor amounts of sulfides. Due to the potential to introduce additional uncertainties in water quality in wells, from localized mineralization, continued refinement of the site-wide groundwater to address the groundwater pathway in Lucky Bill Canyon is preferred to installation of additional monitoring wells.

Assumptions used in the mixing model are estimates of recharge upgradient and downgradient of the stockpile, and through the stockpile. Evaluation of groundwater flows and predicted water quality in Lucky Bill Canyon are being evaluated under Site-Wide Abatement with the existing site-wide groundwater model. Additional modeling of water quality and recharge rates will continue under Site-Wide Abatement and will improve the resolution of the estimates used in the mixing calculations presented here.

Conclusions

Site investigations completed at the site as well as the low hydraulic conductivity of the Sugerlump Tuff have indicated that there is no significant flows reaching bedrock under the Groundhog No. 5 Stockpile. Previous test pit investigations and trench excavation did not identify any areas of moisture accumulation in the stockpile materials or underlying colluvium. During excavation of the seepage trench, bedrock was observed to be deepest in the middle of the trench, and the top 2 to 3 inches of the Sugarlump Tuff bedrock surface in the deeper portion of the trench were observed to be weathered to soft and stained slightly yellow orange indicating flow had occurred along this interface. No zones of moisture were encountered except along this weathered interface. Below the weathered surface of the bedrock, the tuff and quartz monzonite was competent, unstained, and unfractured.

The mixing model presented in this Addendum used site data and conservative assumptions to evaluate the potential for stockpile seepage to reach groundwater at a location in a nearby downstream location (the former location of GH-97-03). Based on the groundwater evaluation and mixing model, Golder concludes:

- The groundwater mixing model indicates that for the average and maximum stockpile concentration cases with no stockpile cover and with one foot of vegetated soil cover, calculated groundwater concentrations for both TDS and sulfate fall below groundwater quality standards (Tables 3 and 4).
- Additional wells may be influenced by natural mineralization in the bedrock and colluvium, and do not definitively isolate potential impacts from the stockpile. The mixing model indicates that water quality would comply with standards for sulfate and TDS. Continued development of the site-wide groundwater model under Site-Wide Abatement can refine the assumptions of the mixing model.

Golder Associates Inc.

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JP/KJ/sb

https://golderassociates.sharepoint.com/sites/14828g/2019 scope/addendum/1665189-tm-rev0-addendum to the geochem model report-071619.docx

8.0 REFERENCES

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Golder. 2018a. Revised Groundhog No. 5 Stockpile Geochemical Evaluation. Prepared for Freeport McMoRan Chino Mines Company Hurley New Mexico. February 28.

Golder. 2018b. Chino Mine Closure/Closeout Plan Update. Prepared for Freeport McMoRan Chino Mines Company Hurley New Mexico. February 14.

Tables

Table 1: Water Quality Data Utilized in Mixing Model

Site Number	Sample Identifier	Sample Date	Reason for No Sample	SO4, Tot. (mg/L)	TDS Ratio (Ratio)	TDS (mg/L)	TDS, sum (mg/L)
Water Quality Standard				600		1000	
526-96-12	MK1027-2	10/27/1996		22.8	NA	283	NA
526-96-12	MK1027-3	10/27/1996		22.8	NA	288	NA
526-96-12		10/27/1996		NA	NA	NA	NA
526-96-12	6388	04/02/1997		16.3	NA	291	NA
526-96-12	D-018	04/02/1997		16.3	NA	274	NA
526-96-12	6560	09/17/1997		10.9	NA	321	NA
526-96-12		09/17/1997		NA	NA	NA	NA
526-96-12	7037	01/08/1998		13.2	NA	**1,320**	NA
526-96-12	7404	06/08/1998		8.3	NA	308	NA
526-96-12	7574	08/25/1998		NA	NA	316	NA
526-96-12	7821	11/30/1998		9.4	NA	300	NA
526-96-12	7978	02/02/1999		NA	NA	285	NA
526-96-12	8168	05/04/1999		12.6	NA	275	NA
526-96-12	8340	07/06/1999		NA	NA	277	NA
526-96-12	8604	10/20/1999		13.8	NA	327	NA
526-96-12	8780	01/12/2000		NA	NA	276	NA
526-96-12	9037	04/04/2000		15.5	NA	288	NA
526-96-12	9208	07/05/2000		NA	NA	320	NA
526-96-12	9610	10/09/2000		16.9	NA	310	NA
526-96-12	9786	01/22/2001		NA	NA	260	NA
526-96-12	10188	04/11/2001		13.8	NA	226	NA
526-96-12	27752	07/30/2001		NA	NA	324	NA
526-96-12	33430	10/30/2001		13.3	NA	290	NA
526-96-12	112611	01/28/2002		NA	NA	318	NA
526-96-12	119065	04/04/2002		14.2	NA	316	NA
526-96-12	211938	07/17/2002		NA	NA	292	NA
526-96-12	214318	10/01/2002		13.8	NA	312	NA
526-96-12	216127	02/03/2003		NA	NA	308	NA
526-96-12	218781	05/05/2003		13.1	NA	325	NA
526-96-12	221051	07/21/2003		NA	NA	312	NA
526-96-12	222419	10/20/2003		11.7	NA	310	NA
526-96-12	224408	02/09/2004		NA	NA	310	NA
526-96-12	226560	04/19/2004		12.6	NA	303	NA
526-96-12	229861	07/19/2004		NA	NA	286	NA
526-96-12	233101	10/20/2004		11.2	NA	273	NA
526-96-12	239029	01/24/2005		NA	NA	315	NA
526-96-12	250251	04/27/2005		10.8	NA	298	NA
526-96-12	261607	07/25/2005		NA	NA	295	NA
526-96-12	270643	11/22/2005		10.8	NA	289	NA

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Site Number	Sample Identifier	Sample Date	Reason for No Sample	SO4, Tot. (mg/L)	TDS Ratio (Ratio)	TDS (mg/L)	TDS, sum (mg/L)
526-96-12	273431	02/21/2006		NA	NA	299	NA
526-96-12	278843	04/24/2006		11	NA	290	NA
526-96-12	282957	07/18/2006		NA	NA	284	NA
526-96-12	286251	10/11/2006		10.7	NA	288	NA
526-96-12	299171	02/07/2007		10	NA	292	NA
526-96-12	303234	05/15/2007		NA	NA	NA	NA
526-96-12	305959	07/11/2007		11.5	NA	288	NA
526-96-12	312636	10/23/2007		11.1	NA	300	NA
526-96-12	314339	01/24/2008		12.4	NA	280	NA
526-96-12	316930	04/28/2008		13.7	NA	320	NA
526-96-12	318242	07/28/2008		11.3	NA	290	NA
526-96-12	320070	10/07/2008		13.3	NA	280	NA
526-96-12	320761	01/15/2009		13.4	NA	290	NA
526-96-12	321479	04/27/2009		10.4	NA	295	NA
526-96-12	322169	07/09/2009		10.9	NA	318	NA
526-96-12	526-96-12	10/21/2009		10.6	NA	323	NA
526-96-12	526-96-12	03/05/2010		11.7	NA	293	NA
526-96-12	323649	04/07/2010		11.3	NA	312	NA
526-96-12	324367	08/05/2010		9.35	NA	322	NA
526-96-12	325180	10/05/2010		10.6	NA	309	NA
526-96-12	325904	01/13/2011		10.2	NA	275	NA
526-96-12	326673	04/20/2011		10.2	NA	333	NA
526-96-12	327391	07/18/2011		9.75	NA	279	NA
526-96-12	328178	10/11/2011		10.1	NA	314	NA
526-96-12	328884	01/11/2012		9.19	NA	287	NA
526-96-12	329648	04/11/2012		8.81	NA	306	NA
526-96-12	330449	07/06/2012		9.72	NA	320	NA
526-96-12	331266	10/16/2012		8.88	NA	295	NA
526-96-12	332086	02/04/2013		9.58	NA	303	NA
526-96-12	332945	04/10/2013		9.39	NA	292	NA
526-96-12	333774	07/15/2013		10.3	NA	302	NA
526-96-12	334656	11/12/2013		9.25	NA	273	NA
526-96-12	335457	01/10/2014		11.2	NA	294	NA
526-96-12	336292	04/01/2014		10.6	NA	299	NA
526-96-12	337171	07/01/2014		11	NA	295	NA
526-96-12	338056	10/03/2014		10.4	NA	301	NA
526-96-12	338872	01/12/2015		9.79	NA	300	NA
526-96-12	339717	04/01/2015		9.9	NA	294	NA
526-96-12	340624	07/01/2015		9.53	1.14	306	267.7
526-96-12	341561	10/16/2015	Inaccessible	NS	NS	NS	NS
526-96-12	342480	01/25/2016	Inaccessible	NS	NS	NS	NS
526-96-12	343383	04/12/2016		2.26	NA	306	NA
526-96-12	344540	07/13/2016		10.5	1.09	305	280.9

Table 1: Water Quality Data Utilized in Mixing Model

Site Number	Sample Identifier	Sample Date	Reason for No Sample	SO4, Tot. (mg/L)	TDS Ratio (Ratio)	TDS (mg/L)	TDS, sum (mg/L)
526-96-12	345605	10/25/2016		9.84	NA	304	NA
526-96-12	346688	01/13/2017		11.4	NA	301	NA
526-96-12	347687	04/12/2017		11.6	NA	292	NA
526-96-12	348775	07/03/2017		10.3	1.11	306	274.7
526-96-12	349801	12/13/2017		9.72	NA	299	NA
526-96-12	350667	01/16/2018		11.3	NA	312	NA
526-96-12	351579	04/05/2018		10.7	NA	311	NA
526-96-12	352338	07/06/2018		10.4	NA	327	NA
526-96-12	353286	10/09/2018		9.46	NA	286	NA
526-96-12	354309	01/16/2019		8.9	NA	302	NA
526-96-12	355109	04/16/2019		9.18	NA	282	NA
526-99-02	267354	12/21/2005		154	NA	433	NA
526-99-02	273851	03/07/2006		159	NA	435	NA
526-99-02	278627	06/13/2006	could not locate	NS	NS	NS	NS
526-99-02	282757	08/01/2006		164	NA	449	NA
526-99-02	286044	10/16/2006		162	NA	466	NA
526-99-02	299164	02/19/2007		164	NA	451	NA
526-99-02	303230	05/21/2007	broken air line, needs replacing	NS	NS	NS	NS
526-99-02	305893	08/02/2007		165	NA	430	NA
526-99-02	312632	10/30/2007		167	NA	450	NA
526-99-02	314388	02/28/2008		168	NA	410	NA
526-99-02	316955	05/05/2008		166	NA	460	NA
526-99-02	318247	08/18/2008		163	NA	460	NA
526-99-02	320075	10/23/2008		165	NA	450	NA
526-99-02	320773	03/02/2009		156	NA	459	NA
526-99-02	321505	05/14/2009		168	NA	444	NA
526-99-02	322174	08/19/2009		175	NA	463	NA
526-99-02	526-99-02	11/05/2009		161	NA	437	NA
526-99-02	526-99-02	03/03/2010	Not Pumping	NS	NS	NS	NS
526-99-02	323675	05/04/2010		116	NA	388	NA
526-99-02	324372	08/17/2010		153	NA	448	NA
526-99-02	325207	10/06/2010		161	NA	441	NA
526-99-02	325951	01/19/2011		162	NA	472	NA
526-99-02	326699	05/04/2011		168	NA	434	NA
526-99-02	327396	07/18/2011		161	NA	441	NA
526-99-02	328205	10/11/2011		166	NA	425	NA
526-99-02	328931	01/11/2012		170	NA	442	NA
526-99-02	329674	04/11/2012		151	NA	470	NA
526-99-02	330454	07/09/2012		165	NA	454	NA
526-99-02	331292	10/16/2012		158	NA	453	NA
526-99-02	332133	01/25/2013		164	NA	483	NA
526-99-02	332971	04/10/2013		167	NA	433	NA

Table 1: Water Quality Data Utilized in Mixing Model

Site Number	Sample Identifier	Sample Date	Reason for No Sample	SO4, Tot. (mg/L)	TDS Ratio (Ratio)	TDS (mg/L)	TDS, sum (mg/L)
526-99-02	333779	07/18/2013		168	NA	450	NA
526-99-02	334684	10/09/2013		169	NA	447	NA
526-99-02	335504	01/10/2014		175	NA	451	NA
526-99-02	336319	04/03/2014		172	NA	445	NA
526-99-02	337177	07/25/2014	Not Pumping	NS	NS	NS	NS
526-99-02	338084	10/08/2014		168	NA	440	NA
526-99-02	338919	01/12/2015		168	NA	464	NA
526-99-02	339744	04/09/2015		166	NA	439	NA
526-99-02	340630	07/14/2015		173	1.25	462	370.4
526-99-02	341589	10/16/2015		167	1.26	470	374
526-99-02	342527	01/13/2016	Not Pumping	NS	NS	NS	NS
526-99-02	343410	04/05/2016		177	1.23	471	383.4
526-99-02	344546	07/13/2016		169	1.24	455	367.3
526-99-02	345633	10/10/2016		172	1.24	459	371
526-99-02	346735	01/13/2017		173	1.2	454	377.9
526-99-02	347714	04/24/2017		178	1.19	464	388.9
526-99-02	348781	07/26/2017		183	1.22	464	381
526-99-02	349829	10/25/2017	Dry	NS	NS	NS	NS
526-99-02	350714	01/16/2018		179	1.22	462	379.2
526-99-02	351606	04/11/2018		175	NA	473	NA
526-99-02	352344	07/09/2018		190	NA	459	NA
526-99-02	353313	10/10/2018		177	NA	469	NA
526-99-02	354358	01/16/2019		176	NA	459	NA
526-99-02	355136	04/16/2019		185	NA	469	NA
Luckybill Trench	Luckybill Trench	09/30/2014		**2,070**	NA	**3,070**	NA
Luckybill Trench	Luckybill Trench	01/19/2015	Dry	NS	NS	NS	NS
Luckybill Trench	Luckybill Trench	02/10/2015		**1,680**	NA	**2,380**	NA
Luckybill Trench	339359	03/26/2015	Dry	NS	NS	NS	NS
Luckybill Trench	339781	04/29/2015	Dry	NS	NS	NS	NS
Luckybill Trench	340170	06/11/2015	Dry	NS	NS	NS	NS
Luckybill Trench	340697	07/31/2015	Dry	NS	NS	NS	NS
Luckybill Trench	341047	08/31/2015		**1,530**	1.04	**2,290**	2,200.4
Luckybill Trench	341219	09/30/2015	Dry	NS	NS	NS	NS
Luckybill Trench	341626	10/28/2015	Dry	NS	NS	NS	NS
Luckybill Trench	341893	11/30/2015	Dry	NS	NS	NS	NS
Luckybill Trench	342049	12/30/2015	Dry	NS	NS	NS	NS
Luckybill Trench	342576	01/22/2016	Dry	NS	NS	NS	NS
Luckybill Trench	342880	02/26/2016	Dry	NS	NS	NS	NS
Luckybill Trench	343038	03/16/2016		**1,430**	1.01	**2,100**	2,089.4

Table 1: Water Quality Data Utilized in Mixing Model

Site Number	Sample Identifier	Sample Date	Reason for No Sample	SO4, Tot. (mg/L)	TDS Ratio (Ratio)	TDS (mg/L)	TDS, sum (mg/L)
Luckybill Trench	343446	04/26/2016	Dry	NS	NS	NS	NS
Luckybill Trench	343735	05/16/2016	Dry	NS	NS	NS	NS
Luckybill Trench	344014	06/24/2016	Dry	NS	NS	NS	NS
Luckybill Trench	344637	07/29/2016	Dry	NS	NS	NS	NS
Luckybill Trench	345060	08/11/2016	Dry	NS	NS	NS	NS
Luckybill Trench	345144	09/06/2016	Dry	NS	NS	NS	NS
Luckybill Trench	Luckybill Trench	09/29/2016	Dry	NS	NS	NS	NS
Luckybill Trench	346099	11/08/2016		**1,950**	1.08	**3,040**	2,811.1
Luckybill Trench	346300	11/15/2016		**1,910**	1.02	**2,800**	2,758.2
Luckybill Trench	Luckybill Trench	12/30/2016	Dry	NS	NS	NS	NS
Luckybill Trench	346794	02/03/2017		**1,820**	1.06	**2,820**	2,649.3
Luckybill Trench	347152	02/16/2017		**1,860**	1.01	**2,690**	2,658.3
Luckybill Trench	347798	04/28/2017	Dry	NS	NS	NS	NS
Luckybill Trench	348318	06/19/2017	Dry	NS	NS	NS	NS
Luckybill Trench	349865	10/27/2017	Dry	NS	NS	NS	NS
Luckybill Trench	350123	12/01/2017	Dry	NS	NS	NS	NS
Luckybill Trench	350318	12/18/2017	Dry	NS	NS	NS	NS
Luckybill Trench	350763	01/24/2018	Dry	NS	NS	NS	NS
Luckybill Trench	351066	02/09/2018	Dry	NS	NS	NS	NS
Luckybill Trench	351260	03/13/2018	Dry	NS	NS	NS	NS
Luckybill Trench	351642	04/10/2018	Dry	NS	NS	NS	NS
Luckybill Trench	351902	05/11/2018	Dry	NS	NS	NS	NS
Luckybill Trench	351961	06/01/2018	Dry	NS	NS	NS	NS
Luckybill Trench	Luckybill Trench	07/23/2018		NA	NA	NA	NA
Luckybill Trench	352828	08/06/2018		**1,850**	NA	**2,760**	NA
Luckybill Trench	352997	09/13/2018	Not Enough Water to Pump	NS	NS	NS	NS
Luckybill Trench	353325	10/18/2018	Dry	NS	NS	NS	NS
Luckybill Trench	353689	11/07/2018	Not Enough Water to Sample	NS	NS	NS	NS
Luckybill Trench	353860	12/03/2018	Not Enough Water to Sample	NS	NS	NS	NS
Luckybill Trench	354408	01/17/2019	Not Enough Water to sample	NS	NS	NS	NS
Luckybill Trench	354642	02/13/2019	Dry	NS	NS	NS	NS
Luckybill Trench	354809	03/01/2019	Dry	NS	NS	NS	NS
Luckybill Trench	355153	04/01/2019	Dry	NS	NS	NS	NS
Luckybill Trench	355487	05/08/2019	Not Enough Water to Pump	NS	NS	NS	NS
Luckybill Trench	355639	06/03/2019	Dry	NS	NS	NS	NS

Table 2: Summary Statistics for Sulfate and TDS Concentrations

Location ID	Constituent	Total Number of Measurements	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)	Average Concentration (mg/L)
Luckybill Trench	Sulfate	9	1,430	2,070	1,789
526-96-12*	Sulfate	71	2.3	22.8	11
GH-97-03	Sulfate	1	-	-	238***
Luckybill Trench	TDS	9	2,100	3,070	2,661
526-96-12	TDS	87	226	333	299
GH-97-03	TDS	1	-	-	507***

**Measurement taken on 01/08/1988 removed from dataset as considered an outlier (1,320 mg/L)

***only one measurement taken

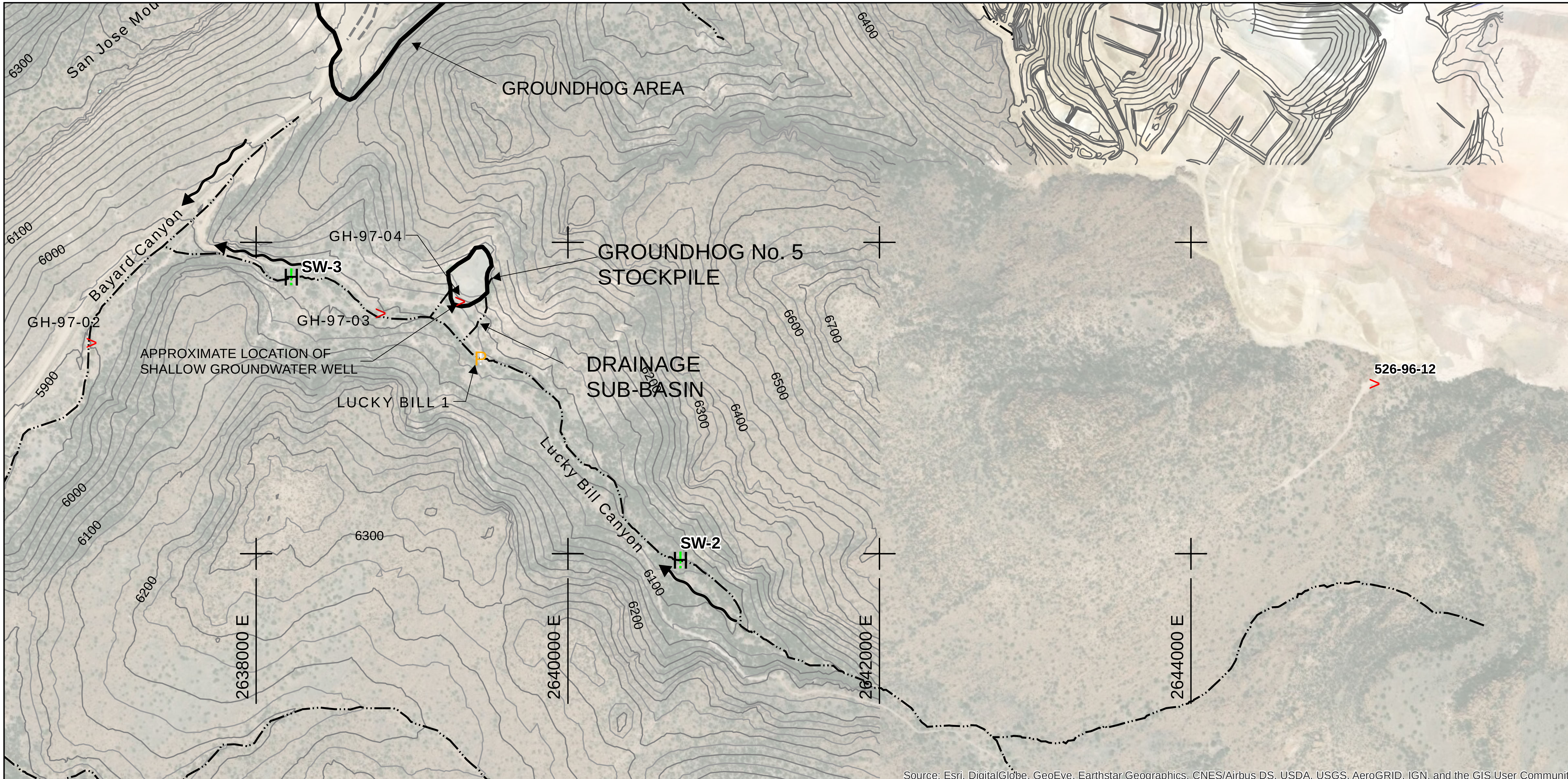
Table 3: Model Results for Sulfate Concentrations

	Parameters	SO4 Summary			
		SO4 average concentration, no cover	SO4 average concentration, 1 ft cover	SO4 max concentration, no cover	SO4 max concentration, 1 ft cover
Source	Infiltration through stockpile (ft^3/year)	7,006	2,362	7,006	2,362
Source	Constituent concentration in stockpile (mg/L)	1,789	1,789	2,070	2,070
Upgradient Flow	Upgradient Recharge to mixing zone (ft^3/year)	18391	18391	18391	18391
Upgradient Flow	Constituent background concentration in recharge (mg/L)	11	11	23	23
Downgradient Flow	Downgradient Recharge to mixing zone (ft^3/year)	13,136	13,136	13,136	13,136
Downgradient Flow	Constituent background concentration in recharge (mg/L)	0	0	0	0
Mixing	Total Flow to mixing zone (ft^3/year)	38,533	33,889	38,533	33,889
Mixing	Total constituent mass in mixing zone (kg/year)	360.8	125.6	422.5	150.3
	Final Concentration at GH-97-03 (mg/L)	331	131	387	157
	Water quality standard (mg/L)	600	600	600	600
	Measured concentration at GH-97-03 (mg/L)	238	238	238	238

Table 4: Model Results for Sulfate Concentrations

	Parameters	TDS Summary: TDS average concentration, no cover	TDS average concentration, 1 ft cover	TDS max concentration, no cover	TDS max concentration, 1 ft cover
Source	Infiltration through stockpile (ft^3/year)	7,006	2,362	7,006	2,362
	Constituent concentration in stockpile (mg/L)	2,661	2,661	3,070	3,070
Upgradient Flow	Upgradient Recharge to mixing zone (ft^3/year)	18391	18391	18391	18391
	Constituent background concentration in recharge (mg/L)	299	299	333	333
Downgradient Flow	Downgradient Recharge to mixing zone (ft^3/year)	13,136	13,136	13,136	13,136
	Constituent background concentration in recharge (mg/L)	0	0	0	0
Mixing	Total Flow to mixing zone (ft^3/year)	38,533	33,889	38,533	33,889
	Total constituent mass in mixing zone (kg/year)	683.4	333.5	782.5	378.7
	Final Concentration at GH-97-03 (mg/L)	626	347	717	395
	Water quality standard (mg/L)	1000	1000	1000	1000
	Measured concentration at GH-97-03 (mg/L)	507	507	507	507

Figures



LEGEND

- SHALLOW GROUNDWATER WELL
- SEEP-INFLUENCED SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION
- WATER COURSE
- DIRECTION OF FLOW

NOTES

1. CONTOUR INTERVAL = 25 FEET

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
FREEPORT-MCMORAN CHINO MINES COMPANY
HURLEY, NEW MEXICO

PROJECT
REVISED GROUNDHOG NO. 5 STOCKPILE GEOCHEMICAL EVALUATION ADDENDUM GROUNDWATER PATHWAY

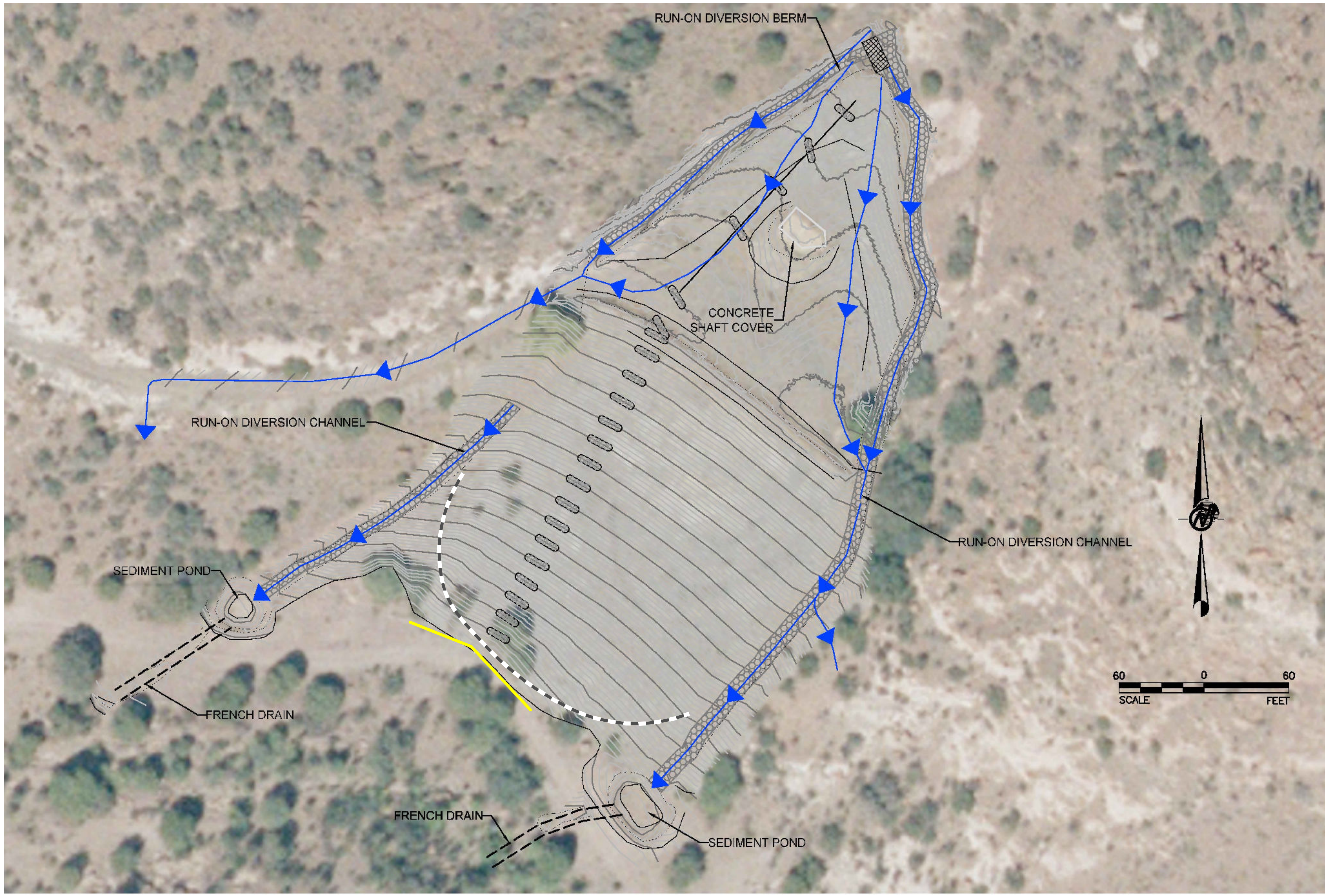
TITLE
GROUNDHOG NO. 5 STOCKPILE LOCAITON AND ADJACENT GROUNDWATER WELLS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-07-16
PREPARED	DZF
DESIGN	DZF
REVIEW	JP
APPROVED	KJ

PROJECT No.	REVIEW	FIGURE
1665189	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:



LEGEND

- FLOW
- DOWNHILL TOE OF STOCKPILE MATERIALS
- GROUNDHOG NO. 5 STOCKPILE SEEPAGE COLLECTION TRENCH

NOTES

REFERENCE

1. DRAWING PROVIDED BY TELESTO SOLUTIONS INCORPORATION AFTER REGRADING IN 2006

CLIENT
FREEPORT-MCMORAN CHINO MINES COMPANY
HURLEY, NEW MEXICO

PROJECT
REVISED GROUNDHOG NO. 5 STOCKPILE GEOCHEMICAL EVALUATION ADDENDUM GROUNDWATER PATHWAY

TITLE
GROUNDHOG NO. 5 STOCKPILE – 2014 IMPROVED DRAINAGE MODIFICATION

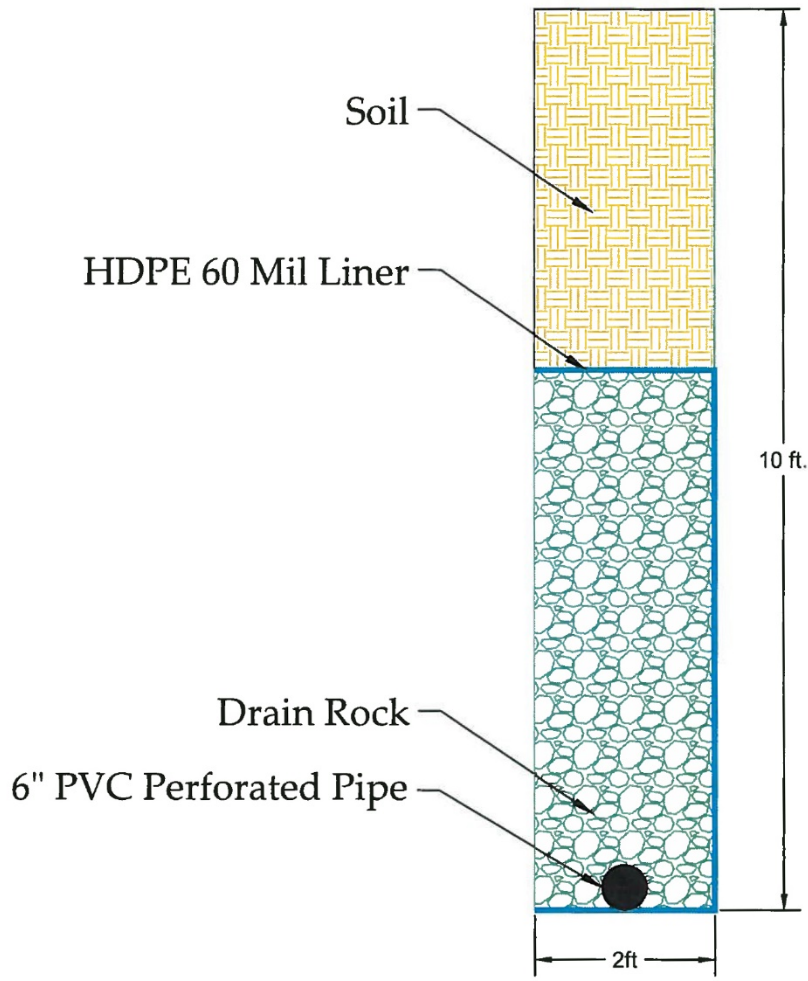
CONSULTANT

GOLDER

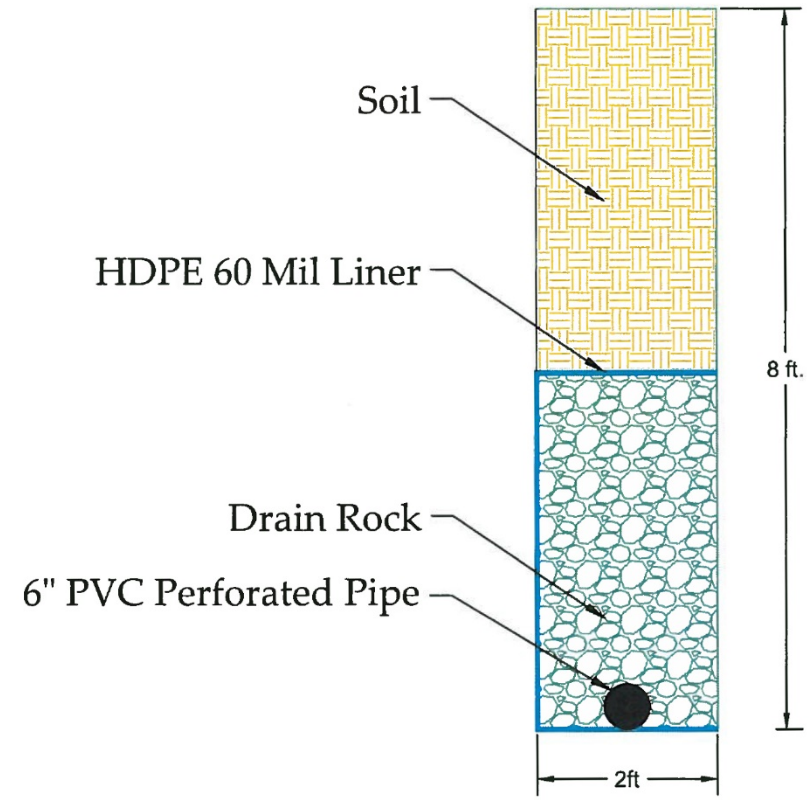
YYYY-MM-DD	2019-07-16
PREPARED	DZF
DESIGN	DZF
REVIEW	JP
APPROVED	MB

PROJECT No. 1665189 | Rev. 1 | FIGURE 2

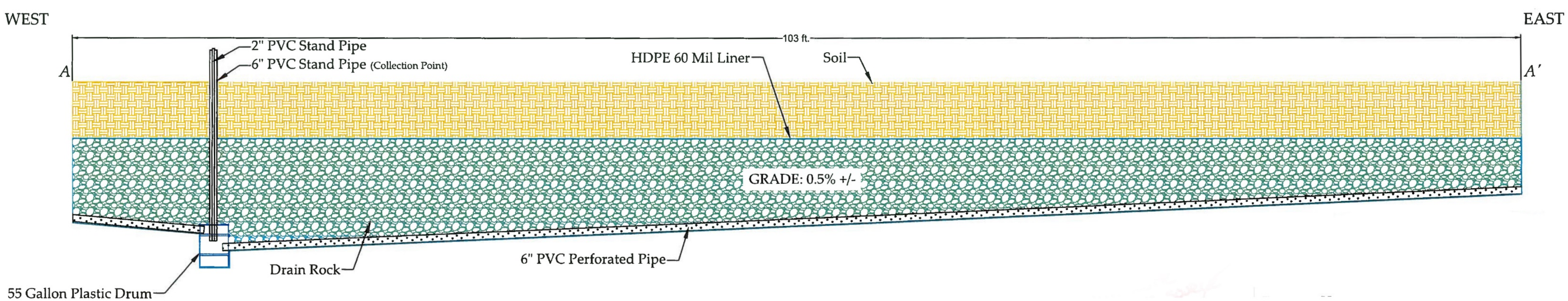
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI B



West End of Trench



East End of Trench



SOURCE: FREEPORT-MCMORAN COPPER & GOLD

CLIENT
FREEPORT-MCMORAN CHINO MINES COMPANY
HURLEY, NEW MEXICO

PROJECT
GROUNDHOG NO. 5 WORK PLAN FOR ADDITIONAL CHARACTERIZATION AND CONTROLS

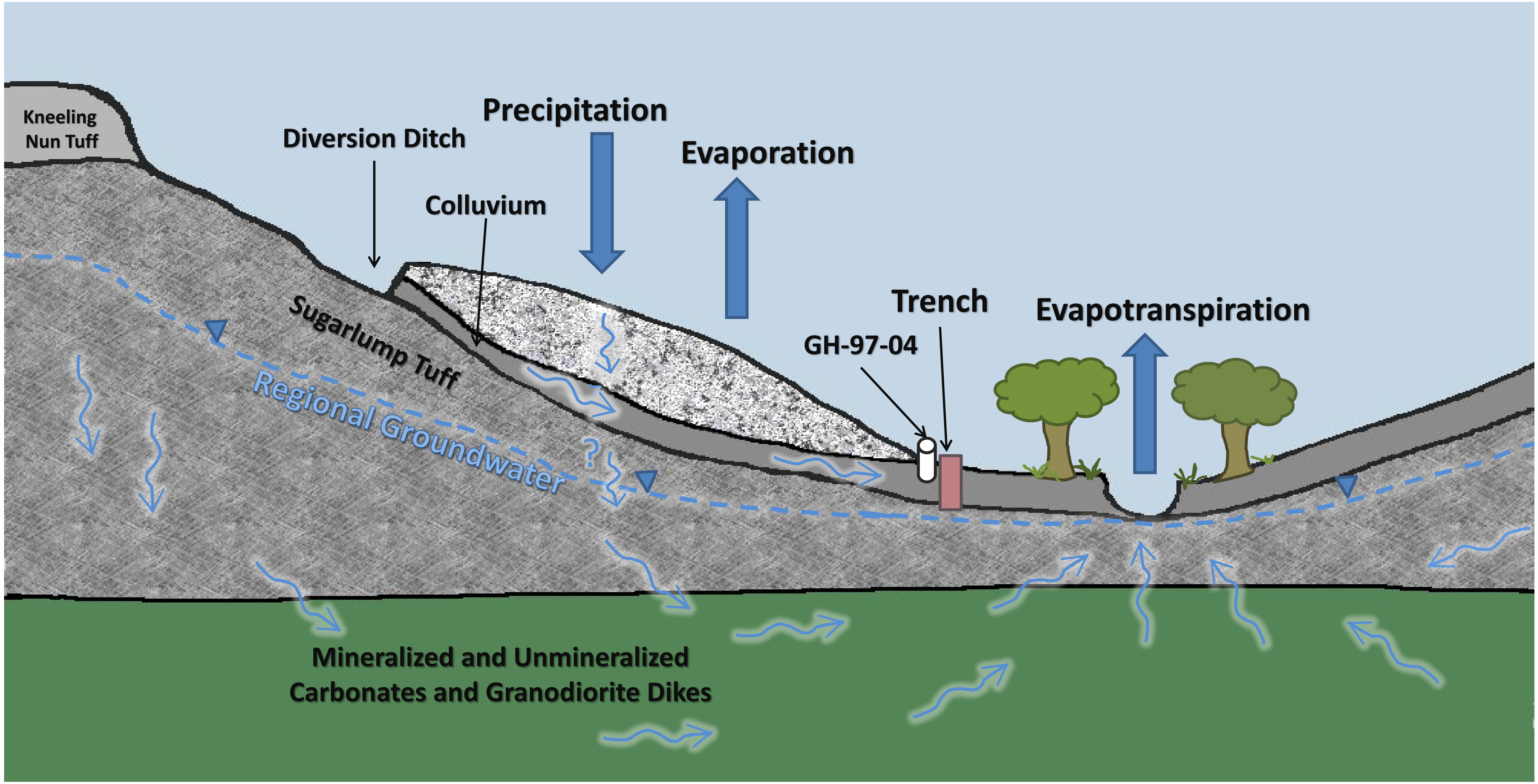
CONSULTANT

GOLDER

YYYY-MM-DD	2019-07-16
PREPARED	DZF
DESIGNED	DZF
REVIEWED	JP
APPROVED	KJ

TITLE
GROUNDHOG NO. 5 COLLECTION TRENCH

PROJECT NO. 1665189
REV.
FIGURE 3



CLIENT
FREEPORT-MCMORAN CHINO MINES COMPANY
HURLEY, NEW MEXICO

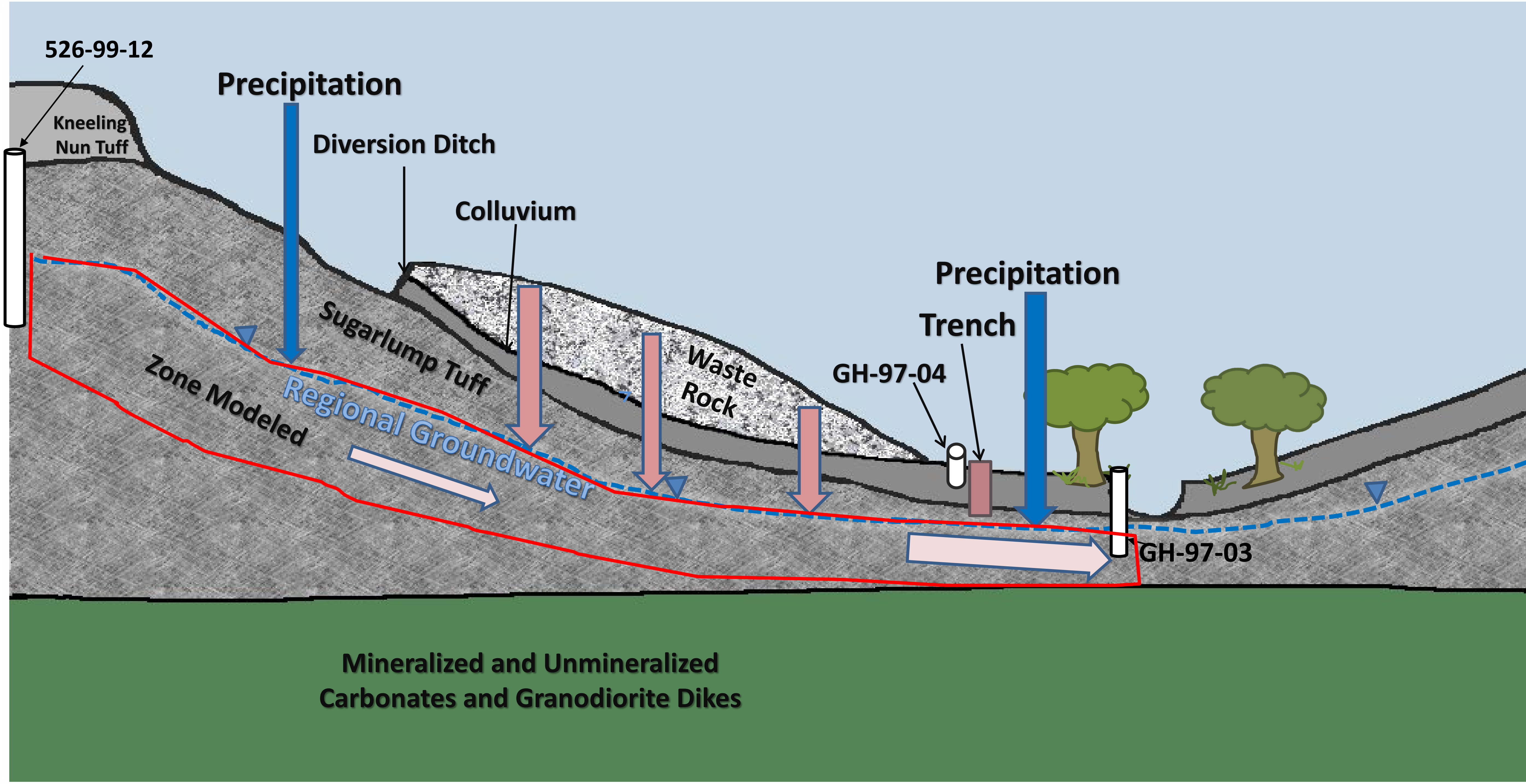
PROJECT
GROUNDHOG NO. 5 WORK PLAN FOR ADDITIONAL CHARACTERIZATION AND CONTROLS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-07-16
PREPARED	DZF
DESIGNED	DZF
REVIEWED	JP
APPROVED	KJ

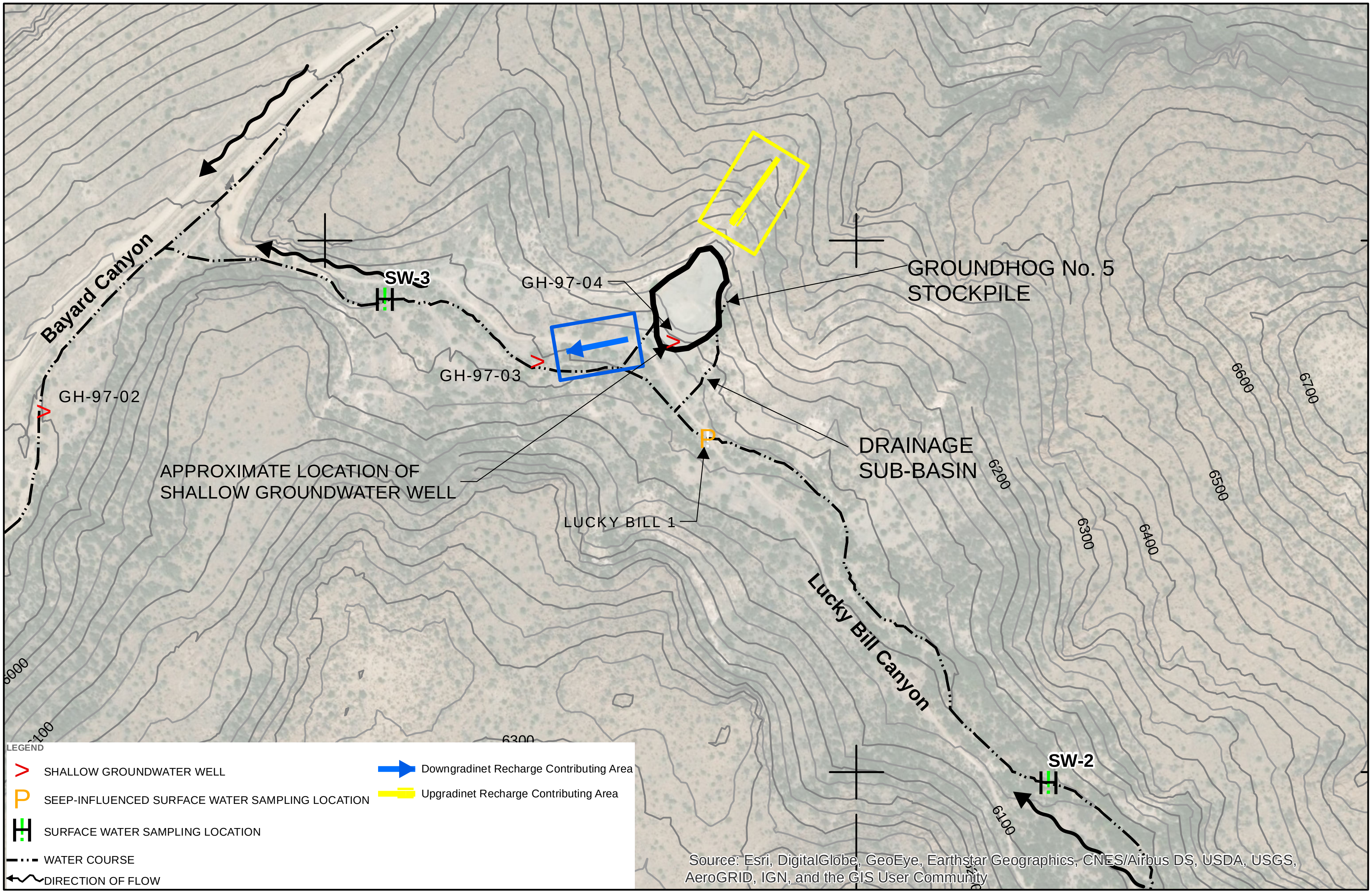
TITLE
HYDROGEOLOGIC CONCEPTUAL MODEL

PROJECT NO.	REV.	FIGURE
1665189		4



CLIENT FREEPORT-MCMORAN CHINO MINES COMPANY HURLEY, NEW MEXICO	PROJECT GROUNDHOG NO. 5 WORK PLAN FOR ADDITIONAL CHARACTERIZATION AND CONTROLS
CONSULTANT GOLDER YYYY-MM-DD 2019-07-16 PREPARED DZF DESIGNED DZF REVIEWED JP APPROVED KJ	TITLE GROUNDWATER MIXING MODEL CONCEPTUAL MODEL PROJECT NO. 1665189 REV. FIGURE 5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



CLIENT
FREEPORT-MCMORAN CHINO MINES COMPANY
HURLEY, NEW MEXICO

PROJECT
REVISED GROUNDHOG NO. 5 STOCKPILE GEOCHEMICAL EVALUATION ADDENDUM GROUNDWATER PATHWAY

TITLE
GROUNDHOG NO. 5 STOCKPILE LOCAITON AND ADJACENT GROUNDWATER WELLS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-07-16
PREPARED	DZF
DESIGN	DZF
REVIEW	JP
APPROVED	KJ

PROJECT No. 1665189 | REVIEW 0 | FIGURE 6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: