**REPORT**

# HYDROGEOLOGY BASELINE

## *Sabajo Gold Project, Suriname*

Submitted to:

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# 1.0 INTRODUCTION

This hydrogeology baseline report summarizes the hydrogeological information collected by Golder Associates Inc. (Golder) as part of the hydrogeological characterization of Newmont Suriname, LLC's (Newmont) Sabajo Project in Suriname, South America (Sabajo Project or Project Area). This report presents the findings of the Phase I and II hydrogeologic investigations, including a conceptual hydrogeologic model. Evaluation of the baseline hydrogeology at Sabajo is required to understand the potential short and long-term impacts that may occur during development and operation of the Sabajo Project.

The Sabajo Project is a proposed expansion of the Merian Project and is located in the Para district of northeastern part of Suriname, 30 kilometers (km) west of Merian and about 20 km northeast of the Afobaka dam (Figure 1-1). Newmont began exploration activities at Sabajo in 2009, and the resource has been defined to a sufficient degree to advance the project from a Right of Exploration to a Right of Exploitation in 2018. As such, Newmont commissioned Golder to prepare an Environmental and Social Impact Assessment (ESIA) and submitted it to the National Institute of Environment and Development (NIMOS) and other interested stakeholders. This baseline hydrogeologic report has been prepared to support the ESIA.

Golder completed two phases of work to evaluate the hydrogeology of the Project Area. The initial phase (Phase I) of hydrogeological characterization activities began in 2016, consisting of the installation of four groundwater monitoring wells within targeted hydrogeologic units to monitor the groundwater at the proposed ore stockpile and waste rock storage areas, and from the Cassador fault/shear zone at the proposed Sabajo pit (Golder 2016).

Phase II hydrogeological characterization activities were conducted in 2017 and included additional geological, geochemical, and hydrogeological investigations as described in the Sabajo Phase II Hydrogeology Investigation Work Plan (Golder 2017).

## 1.1 Site Setting

The Project is located in the northeastern part of Suriname, approximately 100 km south of Paramaribo (Figure 1-1). The Project site is located in the Commewijne watershed in a largely undeveloped part of Suriname. The area immediately surrounding the Project has been modified to a significant degree by timber cutting and small-scale mining.

### 1.1.1 Topography

Elevations within the Project area vary from approximately 80 meters (m) WGS84 at local topographic highs to approximately 30 m WGS84 in low-lying areas. Topography within the project area is irregular with moderate relief, and is dissected by numerous small streams. Hillslopes are moderately steep with typical slopes of approximately 30% to 50%. Valley bottoms are generally wide and flat.

### 1.1.2 Climate

The Project area has a tropical climate influenced by year-round trade winds from the northeast with four distinct seasons:

- Short rainy season: mid-December to mid-February;
- Short dry season: mid-February to mid-April;
- Long wet season: mid-April to mid-August; and

- Long dry season: mid-August to mid-December.

The long-term, annual mean rainfall in Suriname (1901 – 2015) varies between approximately 1,450 millimeters (mm) at low-lying areas to 3,000 mm in the mountainous regions, and overall averages 2,379 mm for the period of record. The monthly rainfall is typically highest in May-June and lowest in September-October.

Average annual precipitation at Sabajo ranges from a minimum of 2,209 mm in 2015 to a maximum of 2,740 mm in 2013. Overall average precipitation at Sabajo is 2,422 mm for the period of record. The average annual precipitation at Sabajo from 2010 to 2016 is very similar (within 2 % difference) to the annual average precipitation at Merian (2,382 mm) and within the range measured at the regional gauges (Golder 2018).

Average monthly temperature at Sabajo ranges from 27.7 °C in October to 24.8 °C in January. Maximum temperatures ranged from 31.3 to 36.1 °C in the dry months from August through October. Low temperatures ranged from 19.6 to 22.3 °C, usually in the dry months (Golder 2018).

Monthly evaporation at the Project site is estimated to range from 64 mm to 162 mm, with an annual average of 1,248 mm (Golder 2018).

### 1.1.3 Surface Water

There are two primary unnamed drainages on the Project site (Figure 1-2). One flows predominantly west and the other flows predominantly east within the Project area. Downstream, both drainages trend north and merge approximately 5 km north of the Project exploitation concession boundary and eventually flow in the Commewijne River near the village of Java, which is approximately 35 km north of Sabajo. There are a series of small tributary streams that flow into the unnamed creeks in the vicinity or downgradient of the Project site.

## 2.0 DATA SOURCES

Several types of data from various sources were collected, compiled, and analyzed to evaluate the hydrogeological conditions at the Project Area. Golder collected the majority of the data during the course of the Phase I and Phase II activities according to the Hydrogeological Investigation Work Plan (Golder 2017), and obtained supplementary data from Newmont, including geologic logs and geologic cross sections from exploration and condemnation holes. The hydrogeologic baseline for the Project Area includes data from the following sources:

- Climate information from the Merian weather station;
- Geological information from the Newmont exploration program;
- Geological information from the drilling and installation of monitoring wells and test wells in the area of the proposed main Sabajo Pit ([SP] also known as Pit 1), the Waste Rock Facility (WRF[1]) area, and the Ore Stockpile (OS) area in 2016 and 2017;
- Slug tests in monitoring wells to estimate the hydraulic properties of the hydrogeological units;
- Pumping tests in the test wells to estimate the hydraulic properties and hydrogeological boundary conditions;

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[1] The WRF area was originally termed the Waste Rock Disposal (WRD) prior to the ESIA. All monitoring wells in the WRF area were installed prior to the name change and have the prefix “WRD”.

- Water quality sampling of the monitoring wells and test wells to characterize baseline groundwater quality; and
- Discrete and continuous groundwater level measurements in the monitoring wells and test wells from December 2016 to September 2017 to assess the change in groundwater levels with time.

## 2.1 Data Collection Program

During the Phase I and Phase II investigations in 2016 and 2017, groundwater monitoring wells were installed within targeted hydrogeologic units to assess the nature and occurrence of groundwater in the vicinity of the proposed SP, OS and WRF areas, and from the Cassador fault/shear zone within the area of the proposed SP. The findings of the Phase I and Phase II investigations were used to prepare this baseline hydrogeological report, including a conceptual hydrogeological model for the Project Area. Details of Phase I and Phase II field and laboratory activities are discussed in detail below, and a map of borehole locations is presented in Figure 2-1.

### 2.1.1 Field Investigation

#### *2.1.1.1 Phase I*

The Phase I hydrogeological investigation was conducted between October and November 2016. Monitoring well installation oversight was provided by Newmont personnel with technical support from Golder, and consisted of the following.

- Installation of four monitoring wells to evaluate baseline hydrogeological conditions of the Project Area including:
  - Installation of two monitoring wells in saprock; one in the WRF area (WRD-MW-01-SR) and one in the OS area (OS-MW-01-SR).
  - Installation of one monitoring well in saprolite quartz veins (WRD-MW-01-SQ) in the WRF area.
  - Installation of one monitoring well in bedrock in the SP area (SP-MW-01-BR).
- Development of monitoring wells and measurement of groundwater levels.
- Collection of baseline groundwater quality samples from Phase I monitoring wells in December 2016.
- Development of a preliminary hydrogeological conceptual model to guide the strategy of the Phase II hydrogeologic investigation.

#### *2.1.1.2 Phase II*

Based on the findings of the Phase I hydrogeologic characterization, Golder prepared a Work Plan for the Phase II investigation (Golder 2017a). The field work portion of the Phase II investigation at the Project Area was conducted from May to July 2017, and consisted of the following:

- Installation of five wells to further evaluate the hydrogeological conditions at the Project Area including:
  - Two monitoring wells in the saprolite quartz veins in the SP area (SP-MW-01-SQ, SP-MW-02-SQ)
  - One monitoring well and one test well in bedrock in the proposed SP area (SP-MW-02-BR and SP-TW-01-BR)
  - One test well in saprock in the proposed SP area (SP-TW-01-SR)

- Following installation and development of the Phase I and II monitoring and test wells, hydraulic testing was conducted including:
    - Slug tests to evaluate the hydraulic conductivity of the near-borehole material in the screened interval.
    - A 4-hour step-rate pumping test followed by 3-day constant-rate pumping tests at test well SP-TW-01-BR, and a 1-day constant-rate pumping test at SP-MW-01-SR to evaluate well performance and hydraulic properties of transmissivity, storativity, and boundary conditions.
- Collection of baseline groundwater quality samples from monitoring wells in April, June, August, and September 2017.

The monitoring wells installed during Phase I and Phase II were drilled and installed with Sandvik 710 and 740 coring rigs using PQ-sized drill casing (122.6-mm outside diameter [OD]). The test wells were first drilled with PQ, followed by over-reaming with 6.25-inch (158.8-mm) OD tri-cone bit. The monitoring wells were completed using 2-inch (50 mm) diameter PVC screen and casing. The test wells were completed using 4-inch (101.6-mm) inside diameter (ID) Schedule 40 PVC 20-slot (0.020-inch or 0.51-mm) well screen and casing. For all wells, the final well completion depths and screened intervals were selected based on the core logs and drilling observations.

Following well construction, Newmont surveyed the well locations and elevations to the WGS84 datum, UTM North Zone 21.

Well construction details are summarized in Table 2-1. Phase II borehole logs are included in Appendix A; well construction diagrams are included in Appendix B; and well development records are included in Appendix C.

### 2.1.2 Hydraulic Testing

Hydraulic testing was conducted in the monitoring wells using slug tests and in the test wells using pumping tests' these test types are described below.

#### *2.1.2.1 Slug Testing*

Slug tests (falling- and rising-head tests) were conducted in each monitoring and test well installed as part of the Phase I and Phase II investigations to estimate the hydraulic properties of the screened intervals in the monitoring wells. The slug tests were conducted by quickly dropping or removing a solid slug rod approximately 2 m long into or out of the well to quickly raise or drop the water level, or by adding 3 liters of drinking water to raise the water level[2]. The return of the water level back to the original static water level was recorded using a pressure transducer with data logger and an electric water level tape.

#### *2.1.2.2 Pump Testing*

Pumping tests were completed in two test wells (SP-TW-01-SR and SP-TW-01-BR) during Phase II. The pumping tests in SP-TW-01-BR included a 4-hour step-rate test followed by a 3-day constant-rate pumping test. A 1-day constant-rate pumping test was conducted in SP-MW-01-SR; a step-rate test was not conducted in this well due to low well yield. The pumping tests were conducted to evaluate:

- Hydraulic properties (transmissivity and storativity)

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[2] 3-liter slugs of drinking water used in SP-MW-01-SQ and SP-MW-02-SR.

- Hydraulic boundaries, such as a recharge from a nearby stream or leakage from overlying hydraulic units or low-permeability boundary effects from a nearby fault or change in lithology
- Drainage or depressurization effects from the overlying saprolite from pumping in the bedrock and saprolite/quartz vein system

The pumping tests were completed using a temporary submersible pump (Grundfos 15 SQE-290). Pumping rates were controlled with a ball valve on the discharge pipe and flow was measured using a bucket and stop watch. Purged groundwater was discharged to nearby surface water bodies and drainages. Groundwater levels were measured using Instrumentation Northwest (INW) LevelScout pressure transducers and Solinst Model 101 electric water level tapes during the pumping tests.

#### 2.1.2.3 Step-Rate Pumping Test

The purpose of the step-rate pumping tests in the test wells was to determine well performance (i.e. turbulent vs. laminar flow losses), specific capacity, and the pumping rate for the constant-rate pumping test. Specific capacity is a normalized measure of well capacity equal to the pumping rate per meter of drawdown in a well for a specific pumping period, and is used to estimate the potential yield of a well. Specific capacity is typically reported in liters per minute per meter of drawdown (L/min/m) for a specified pumping duration.

#### 2.1.2.4 Constant-Rate Tests

The purpose of the constant-rate pumping tests was to determine hydraulic properties and boundary conditions of the bedrock and saprock hydrogeologic units.

**Table 2-1: Well Construction Details**

| Well ID | Northing[1] | Easting[1] | Ground Surface Elevation[2] | Screened Geologic Unit | Construction Date Start | Construction Date End | Drill Depth (m bgs) | Top of Saprock (m bgs) | Top of Bedrock (m bgs) | Saprock Elevation[2] | Bedrock Elevation[2] | Total Well Depth Including Filter Pack (m bgs) | Top of Screen (m bgs) | Bottom of Screen (m bgs) | Top of Sand (m bgs) | Bottom of Sand (m bgs) | Top of Bentonite (m bgs) | Bottom of Bentonite (m bgs) | Final Stickup (m ags) | Final Stickup Elevation[2] | Borehole Radius (mm) | PVC Casing Inside Radius (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-MW-01-SQ | 562,357 | 743,181 | 66.39 | Saprolite Quartz Vein | 5/30/2017 | 5/31/2017 | 74.0 | 68.0 | 70.7 | -1.6 | -4.3 | 65.9 | 54.9 | 64.0 | 47.9 | 65.9 | Unknown | 47.9 | 0.86 | 67.25 | 61 | 25.4 |
| SP-MW-02-SR | 563,183 | 741,536 | 52.95 | Saprock | 5/31/2017 | 6/1/2017 | 29.6 | 1.6 | 4.0 | 51.4 | 49.0 | 30.0 | 13.8 | 29.0 | 11.0 | 30.0 | 8.0 | 11.0 | 0.92 | 53.87 | 61 | 25.4 |
| SP-MW-02-BR | 563,171 | 741,528 | 53.05 | Cassador Fault | 5/27/2017 | 5/30/2017 | 78.1 | 1.2 | 31.5 | 51.9 | 21.6 | 61.0 | 39.7 | 61.0 | 38.0 | 61.0 | 35.0 | 38.0 | 0.88 | 53.93 | 61 | 25.4 |
| SP-TW-01-SR | 562,368 | 743,205 | 65.90 | Saprock | 5/31/2017 | 6/4/2017 | 82.0 | 69.5 | 80.5 | -3.6 | -14.6 | 81.0 | 70.9 | 80.0 | 67.9 | 81.0 | 66.0 | 67.9 | 0.89 | 66.79 | 100 | 50.8 |
| SP-TW-01-BR | 562,348 | 743,191 | 66.49 | Cassador Fault | 6/4/2017 | 6/8/2017 | 127.0 | 58.0 | 69.8 | 8.5 | -3.3 | 124.5 | 99.4 | 123.8 | 95.8 | 124.5 | 88.0 | 95.8 | 0.86 | 67.35 | 79 | 50.8 |
| SP-MW-01-BR | 562,370 | 743,174 | 66.63 | Cassador Fault | 11/10/2016 | 11/12/2016 | 158.0 | 62.9 | 63.0 | 3.7 | 3.6 | 158.0 | 135.8 | 151.0 | 134.0 | 158.0 | 132.0 | 134.0 | 0.92 | 67.55 | 61 | 25.4 |
| WRD-MW-01-SR | 561,651 | 741,865 | 28.06 | Saprock | 11/6/2016 | 11/7/2016 | 41.8 | 27.0 | 34.6 | 1.1 | -6.5 | 41.8 | 27.2 | 33.2 | 25.8 | 35.2 | 24.1 | 25.8 | 0.93 | 28.99 | 61 | 25.4 |
| WRD-MW-01-SQ | 561,654 | 741,866 | 27.92 | Saprolite Quartz Vein | 11/8/2016 | 11/9/2016 | 18.0 | 27.0 | 34.6 | 0.9 | -6.7 | 18.0 | 10.0 | 16.0 | 9.0 | 18.0 | 8.0 | 9.0 | 0.93 | 28.85 | 61 | 25.4 |
| OS-MW-01-SR | 563,464 | 743,280 | 25 | Saprock | 11/14/2016 | 11/16/2016 | 28.0 | 17.5 | 22.3 | 7.5 | 2.7 | 28.0 | 18.0 | 27.0 | 17.0 | 28.0 | 16.0 | 17.0 | 1 | 26.00 | 61 | 25.4 |

Notes:

1 Coordinates are in UTM 21 N projection

2. Elevations are in the WGS84

Shaded cells are estimated values. Coordinates and elevation based on handheld GPS.

### 2.1.3 Sampling and Laboratory Water Quality Analysis

Baseline groundwater quality samples were collected by Mike Meyer Consulting in November and December 2016 (from Phase I monitoring wells) using temporary bladder pumps and peristaltic pumps. Golder collected water quality samples between April 2017 and September 2017 (Phase I and Phase II wells) using dedicated bladder pumps (QED Model P1101M) and peristaltic pumps (Geotech Geopump™ Series II) with dedicated tubing. The bladder pumps were operated with a QED MP50 controller with built-in air compressor. Table 2-2 is a summary of the bladder pumps installed by Golder at Sabajo.

**Table 2-2: Sabajo Dedicated Bladder Pumps**

| Well ID | Well Depth (m bgs) | Top of Screen (m bgs) | Bottom of Screen (m bgs) | Bladder Pump Sample Depth (m bgs) |
|---|---|---|---|---|
| SP-MW-01-SQ | 65.9 | 54.9 | 64.0 | 59 |
| SP-MW-02-SR | 30.0 | 13.8 | 29.0 | 22.9 |
| SP-MW-02-BR | 61.0 | 39.7 | 61.0 | 50 |
| SP-MW-01-BR | 158.0 | 135.8 | 151.0 | 145.4 |
| OS-MW-01-SR | 28.0 | 18.0 | 27.0 | 23.6 |

Samples were collected using a low-flow method, where flow rates were typically between 50 and 300 milliliters per minute (mL/min) and water level drawdown was less than 10 cm. The following field parameters were monitored in a flow-through cell; samples were collected after three consecutive readings on 3 to 5-minute intervals were within the tolerance criteria listed within the parentheses:

- Turbidity (less than 5 NTU);
- Temperature (within 0.5 °C);
- Specific conductance (within 10%);
- pH (within 0.1 standard pH units);
- Oxidation-reduction potential (ORP) (within 10%); and
- Dissolved oxygen (DO) (within 10%).

Samples were packed in coolers with ice and sent to SVL Analytical, in Kellogg, Idaho, United States of America for analysis. The analytical suite for samples included general chemistry parameters, dissolved and total metals[3], nutrients, organics and field parameter measurements. Dissolved metal samples were filtered with a 0.45 micrometer (µm) filter prior to analysis.

Following measurement of elevated arsenic concentrations in some monitoring wells during initial sampling rounds, selected samples were filtered in the field with both a 0.45 µm and 0.10 µm filter prior to analysis. Analysis of groundwater samples following filtration with a 0.10 µm filter was conducted to confirm that arsenic

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[3] Dissolved and total metal parameter suite: Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Tl, V and Zn.

was present in the dissolved fraction and not associated with colloidal or particulate material that passes the 0.45 µm filter.

# 3.0 DATA ANALYSIS AND EVALUATION

This section presents analysis and evaluation of hydraulic testing at the Sabajo Project.

## 3.1 Slug Tests

Slug test data were analyzed using the Hvorslev (1951) solution, which evaluates the hydraulic conductivity of the screened interval in each well based on the following equation:

$$K = \frac{r^2 \ln(\frac{L_e}{R})}{2L_e t_{37}}$$

Where:

K is the hydraulic conductivity (m/day)
Le is the effective length of open interval of the well (m)
r is the radius of the well casing (m)
R is the radius of the well, typically the radius of the borehole (m)
$t_{37}$ is the time at which the change in head during the test as recovered 63% (days)

The estimated hydraulic conductivity values represent the average hydraulic conductivity of the near-borehole material within the screened interval. The results of the slug tests are summarized in Table 3-1. Figures D-1 through D-16 in Appendix D present the slug test hydrographs and analyses.

**Table 3-1: Summary of Slug Test Results**

| Well | Screened Interval Lithology | Test No. | Type | Hydraulic Conductivity, K (cm/s) | Figure No. |
|---|---|---|---|---|---|
| SP-MW-01-SQ | Saprolite Quartz Vein, reddish yellow silty clay (sedimentary protolith) with occasional quartz veins, 0.5 to 1 cm thick | 1 | Falling-head test | 9.7E-05 | D-2 |
| | | 2 | Falling-head test | 9.7E-05 | D-3 |
| SP-MW-02-SR | Saprock, slightly weathered, dark grey, fractured, weak to strong saprock (siltstone/mudstone protolith) | 1 | Falling-head test | 8.3E-05 | D-5 |
| | | 2 | Falling-head test | 6.1E-05 | D-6 |
| SP-MW-02-BR | Cassador Fault Zone, slightly weathered, black, carbonaceous siltstone/mudstone, fractured with some quartz veins, 1 to 2 cm thick | 1 | Falling-head test | 1.4E-05 | D-8 |
| | | 2 | Rising-head test | 1.5E-05 | D-9 |
| | | 3 | Falling-head test | 1.0E-05 | D-10 |

| Well | Screened Interval Lithology | Test No. | Type | Hydraulic Conductivity, K (cm/s) | Figure No. |
|---|---|---|---|---|---|
| WRD-MW-01-SQ | Saprolite quartz veins, fine-grained volcano-sedimentary protolith | 1 | Falling-head test | 1.1E-04 | D-12 |
| | | 2 | Rising-head test | 1.2E-04 | D-13 |
| WRD-MW-01-SR | Saprock, fractured, volcano-sedimentary protolith | 1 | Falling-head test | 4.2E-04 | D-15 |
| | | 2 | Rising-head test | 3.6E-04 | D-16 |

## 3.2 Pumping Tests

### 3.2.1 Step-Rate Pumping Test

Figure E-1 in Appendix E is a hydrograph of the step-rate pumping test conducted in SP-TW-01-SR on June 30, 2017. The static water level in the well prior to testing was 36.35 m bgs. SP-TW-01-SR was pumped at three increasing rates (steps), for a total test duration of about 3 hours and 10 minutes. The duration of the three steps was about 60 minutes; a fourth step was attempted, but the pumping level drew down to the pump intake at 65.5 m bgs after about 8 minutes into the step. The drawdown at the end of the test was about 29.9 m (i.e. depth to water of 65.5 m bgs). Water level recovery after the end of the test was monitored with a pressure transducer and datalogger. The water level recovered to 36.45 m bgs after about 4 hours from the end of the test, resulting in lowering of the pre-test water level by 0.1 m.

Figure E-2 is a plot of the drawdown during the step-rate test in SP-TW-01-SR and the pumping rate. Drawdown at 2 minutes into Step 1 was 6.80 m at a pumping rate of about 2.9 L/min. From 2 to 40 minutes of Step 1, the water level recovered 1.3 m in response to reducing the pumping rate to 1.5 L/min. The drawdown at the end of Step 1 was 5.6 m. Step 2 was conducted at an average pumping rate of 2.9 L/min. The total drawdown at the end of Step 2 was 10.8 m but did not appear to have achieved a quasi-steady-state condition (i.e. little change in drawdown versus time). Step 3 was conducted at an average pumping rate of 5.3 L/min; total drawdown at the end of Step 3 was 21.9 m and was steadily increasing, because the water level had not reach quasi-steady state conditions. A fourth step was attempted at a rate of 10.5 L/min, but the test was shut down after 8 minutes into the last step due to limited available drawdown.

Due to the low capacity of SP-TW-01-SR, quasi-steady-state conditions during the step rate test were not achieved for pumping rates greater than about 3 L/min, thus the test was not analyzed for well efficiency. Based on the results of the test, the estimated specific capacity of SP-TW-01-SR is 0.35 to 0.39 L/min/m after 60 minutes of pumping.

The recovery data were analyzed using HydroBench™, a software program developed by Golder to analyze the observed hydraulic test pressures using a deconvolution method (i.e. reproducing a synthetic type-curve based on model parameters to match the observed pressure response). The recovery analysis in HydroBench™ uses an algorithm to produce type curves to match test pressures and pressure derivatives using a least-squares-regression model based on well construction and aquifer parameters, such as transmissivity, storativity, well skin, static pressure, and wellbore storage. Pressure derivatives are useful for diagnosing different flow regimes based on pressure behavior. For example, flow dominated purely by wellbore casing storage will have a slope = 1 on a derivative plot; whereas flow from an infinite-acting aquifer (i.e. flow to a well not affected by hydraulic boundaries such as faults, streams, or leakage) will have a slope = 0 on a derivative plot; this represents steady flow to a well with no change in the rate of drawdown versus time.

Figures E-3 through E-5 are plots of the step-rate test water level recovery in SP-TW-01-SR using HydroBench™. The derivative plot in Figure E-4 shows that the early time recovery was affected by wellbore casing storage until about 12 minutes, when the recovery begins to transition to a response from the hydrogeologic formation. The downward spike in the pressure derivative at about 330 minutes was due to bad / missing pressure transducer data. The increase in the derivative from 330 minutes until the end of the test is interpreted to be a transition to a lower-permeability zone, such as the Cassador Fault or a lower permeability material. The late-time derivative response could also indicate possible dual-porosity, where flow is primarily through the fractured and porous saprock with secondary flow contributing from the surrounding saprolite, because the end of recovery water level was lower than the pre-test static water level by 0.1 m, suggesting the pumping test may have partially dewatered the saprock at SP-TW-01-SR. Based on the modeled response using a weighted-average pumping rate of 3.8 L/min, the transmissivity of the saprock at SP-TW-01-SR is 3.9 square meters per day ($m^2$/d).

## 3.2.2 Constant-Rate Tests

Figures of the constant-rate pumping test water levels and test analyses are presented in Appendix E.

### *3.2.2.1 SP-TW-01-BR*

A 3-day constant-rate pumping test was conducted in SP-TW-01-BR starting on June 23, 2017 at 9:44 AM and ending on June 26, 2017 at 10:07 AM. Figure E-6 is a hydrograph of the constant-rate pumping test in SP-TW-01-BR. Static water level in SP-TW-01-BR prior to testing was 35.70 m bgs (elevation 30.79 m WGS84). The weighted average pumping rate during the test was 4.4 L/min. Groundwater levels were monitored in SP-MW-01-SQ, SP-MW-01-BR, and SP-TW-01-SR.

Figure E-7 and E-8 are semi-log plots of the drawdown and recovery in the pumping well and the observation wells from the constant-rate pumping test. The pumping rates during the first 40 minutes of the test fluctuated by 3.3 to 6.7 L/min; pumping rates were steadier through the remainder of the test, with fluctuations between 3.9 and 4.5 L/min (with the exception of a brief generator power failure after about 3,200 minutes of pumping). Total drawdown by the end of the test in SP-TW-01-BR was 42.03 m.

SP-MW-01-BR is a bedrock monitoring well located 28 m from SP-TW-01-BR and responded to pumping after about 30 minutes from the start of the test. The total drawdown in SP-MW-01-BR at the end of the test was 3.36 m. SP-MW-01-SQ and SP-TW-01-SR are located 14 m and 25 m from SP-TW-01-BR, respectively. These wells showed an apparent response to pumping after about 8 hours from the start of the test, with a total drawdown of 0.04 m (SP-MW-01-SQ) and 0.13 m (SP-TW-01-SR).

Figures E-9 through E-13 are plots of the drawdown and recovery analyses for SP-TW-01-BR in HydroBench™. The log-log plot of the test pressure and pressure derivative during the drawdown phase of the pumping test are shown in E-10. The derivative of the test pressures during the pumping test are noisy due to the variability in the pumping rates. The log-log plot of recovery in SP-TW-01-BR is shown in figure E-12. Based on the pressure derivative, the first 80 minutes of recovery is affected by wellbore casing storage and then transitions to an aquifer (or hydrogeologic) response from 80 to about 1,700 minutes. The late-recovery after 1,700 minutes is interpreted to be infinite-acting radial flow, representing the response of the fractured bedrock within the Cassador Fault Zone. The estimated transmissivity of the Cassador Fault at SP-TW-01-BR based on the modeled type curve is 3.1 $m^2$/d.

The drawdown and recovery in the observation wells were not analyzed for hydraulic properties, because the drawdown in SP-TW-01-BR were affected by wellbore casing storage and boundary conditions (i.e. did not achieve infinite-acting radial flow) before responses in the observation wells were observed.

#### *3.2.2.2 SP-TW-01-SR*

A 24-hour constant-rate pumping test was conducted in SP-TW-01-SR starting on July 1, 2017 at 8:50 AM and ending on July 2, 2017 at 9:00 AM. Figure E-14 is a hydrograph of the constant-rate pumping test. Static water level prior to testing was 35.48 m bgs (elevation 30.42 m WGS84). The weighted average pumping rate during the test was 4.9 L/min. Groundwater levels were monitored in nearby observation wells SP-TW-01-BR, SP-MW-01-BR, and SP-MW-01-SQ.

Figures E-15 and E-16 are semi-log plots of the drawdown and recovery in the pumping well and observation wells from the constant-rate test. The pumping rates varied between 3.3 and 6.7 L/min during the first 170 minutes of the test, but became steadier for the remainder of the test, fluctuating between 4.3 and 5.3 L/min. Total drawdown by the end of the test was 24.37 m in SP-TW-01-SR. The observation wells completed in the saprolite quartz veins and Cassador Fault Zone, which are located 25 to 31 m from SP-TW-01-SR, responded to pumping after about 15 minutes into the test, with a total drawdown of 0.19 to 0.22 m by the end of the test. The water level in SP-TW-01-SR fully recovered at about t/t’ = 6, indicating the saprock unit at this location received recharge during the test. The water level in SP-MW-01-SQ recovered to within 0.03 m of static conditions by t/t’ = 2. Recovery in SP-MW-01-BR and SP-TW-01-BR was within 0.06 and 0.10 m of static conditions by t/t’ = 3.5.

Figure E-17 is a plot of the modeled and observed test pressures in SP-TW-01-SR from the constant-rate test using HydroBench™. The modeled test pressures for all phases of the test (i.e. pre-test, drawdown, and recovery) are based on a single set of parameters and the using a weighted average pumping rate of 4.9 L/min during the drawdown phase. Overall, the modeled test pressures match reasonably well with all phases of the test; the deviation between modeled and observed pressures during the early part of the drawdown phases is due to the variability in the pumping rate during the early part of the test.

Figures E-18 and E-19 are plots of the observed and modeled recovery test pressures and recovery derivative. The modeled test pressures and derivatives were matched primarily to the recovery phase, because the data from the drawdown phase were noisy due to the variability in the pumping rate. As seen in Figure E-18, the first 10 minutes of recovery were affected by wellbore casing storage. From about 10 to 160 minutes, the water level response transitions from wellbore storage to a hydrogeological response. The derivative response after 160 minutes continues to decrease as a result of a decrease in the rate of drawdown, which is indicative of a recharge boundary, such as the Cassador Fault Zone. The estimated transmissivity of the saprock at SP-TW-01-SR based on the modeled type curve is 5.1 $m^2/d$.

The observation well data were not analyzed for hydraulic parameters, because the drawdown in SP-TW-01-SR were affected by wellbore casing storage and boundary conditions (i.e. did not achieve infinite-acting radial flow) before responses in the observation wells were observed.

### 3.2.3 Summary of Pumping Test Results

The pumping test results are summarized in Table 3-2.

**Table 3-2: Summary of Pumping Test Results**

| Test | Screened Interval Lithology | Well | Transmissivity, T ($m^2$/day) | Figures |
|---|---|---|---|---|
| SP-TW-01-BR Constant-Rate | Cassador Fault Zone, black, carbonaceous, fractured siltstone/mudstone | SP-TW-01-BR | 3.1 | E-8 to E-13 |
| SP-TW-01-SR Step-Rate Recovery | Saprock, moderately weathered and fractured, tan to dark gray, sandstone protolith. | SP-TW-01-SR | 3.9 | E-3 to E-5 |
| SP-TW-01-SR Constant-Rate | | SP-TW-01-SR | 5.1 | E-17 to E-19 |

# 4.0 HYDROGEOLOGICAL CONCEPTUAL MODEL

A conceptual hydrogeological model was developed to assess the groundwater conditions present in the Project Area, based on the data collected during the Phase I and Phase II investigations. This section describes the hydrogeological units identified at the Project Area and the characteristics of each unit including geological characteristics, hydraulic properties, groundwater flow, recharge/discharge, and groundwater quality.

## 4.1 Hydrogeological Units

The geology in the vicinity of the Project Area consists of a surficial saprolitic sequence derived from the chemical weathering of the underlying volcanic and sedimentary bedrock. Bedrock consists of a volcanic sequence (e.g. dacite and andesite) separated from a sedimentary sequence of rocks (e.g. greywacke, sandstones and siltstones) by a steeply dipping northwest-southeast trending shear zone known as the Cassador Fault Zone. The resource is an epithermal deposit of gold and silver found in sheets of cross-cutting quartz veins associated with the shear zone.

The hydrogeological units at the Project Area are as follows:

- Alluvium (In-situ and reworked)
- Saprolite / Saprolite with Quartz Veins (SQ)
- Saprock (SR)
- Bedrock (BR)
- Cassador Fault (CF), a unit with the bedrock.

Geologic cross section alignments are presented in Figure 2-1, and geological cross sections are presented in Figures 4-1 and 4-2.

### 4.1.1 Alluvium

Unconsolidated alluvial materials are primarily found in stream valleys in the Project Area. The unconsolidated materials include native alluvial deposits consisting of sand and silt, and similar materials that have been reworked by small-scale mining activities. The in-situ and reworked alluvial materials are estimated to range in thickness from 1 to 4 m based on visual observations in areas of small-scale mining. The estimated width of the alluvial deposits ranges from less than 40 m to 300 m. Alluvium was not encountered in any of the coreholes drilled as part of this investigation, and therefore is not included in the geologic cross sections.

### 4.1.2 Saprolite with Quartz Veins

Saprolite is formed from deep chemical weathering and oxidation of underlying volcanic and sedimentary bedrock and is primarily composed of fine-grained soil particles (clay, silt and fine sand). Saprolite was observed in each of the coreholes and was typically identified as a reddish-brown to yellow-brown clayey silt with iron and manganese oxide staining or mottling. Weathering has resulted in a saprolite profile that extends on average to 50 to 60 m bgs. The saprolite sequence across the Project Area exhibits local variation in thickness ranging from less than 1 m to over 90 m.

Figures 4-1 and 4-2 show the estimated saprolite thicknesses across the Project Area. The thinnest areas of saprolite are generally found in stream valleys and other low-lying areas where erosion has removed the thick saprolite soils. The thickest sequences of saprolite are generally found in upland areas and the proposed main SP area.

The prominent geologic structures within the saprolite are relict fabric, foliation, or bedding that were present in the original unweathered rock, including remnant quartz veins that are associated with the ore bodies. Quartz veins have also been encountered in other areas, including the waste rock facility. The quartz veins in the saprolite may be relatively intact or broken and rubbly with a gravelly appearance. Higher density occurrences of quartz veins are typically found near the ore body within the main pit and along strike of the Cassador Fault Zone. Higher densities of quartz veins were observed in several coreholes near Pit 1 (SP-MW-02-BR, SP-TW-01-BR, SP-MW-01-SQ) and WRF area (WRD-MW-01-SQ). Within the saprolite, the quartz veins were typically observed to be disseminated and saccharoidal (i.e. granular with a “sugary” texture) with a halo of white clay, and ranged in thicknesses of less than 1 cm to 10 cm. Quartz veins of about 3.5 m thick have been observed in saprolite during exploration drilling by Newmont.

### 4.1.3 Saprock

A transition zone of partially weathered or oxidized rock, commonly referred to as saprock, occurs below the saprolite and overlying bedrock (Figures 4-1 and 4-2). Saprock is characterized as having properties of weak rock and displays the primary textural features found in the underlying bedrock. Quartz veins extend through the saprock between overlying saprolite and underlying fresh bedrock. Based on corehole logs, the quartz veins in the saprock range in thickness from less than 1 cm to 1.5 m. The saprock thickness in the Project Area is estimated to range from less than 1 m to about 35 m, where thicker occurrences of saprock are found in the Pit 1 area. The saprock is generally encountered at an elevation of between +50 m and -40 m.

### 4.1.4 Bedrock

Bedrock underlies the saprock and contains zones of both weathered and fractured and unfractured rock. The bedrock consists of a sequence of volcanic (i.e. dacite and andesite) and sedimentary (i.e. graywacke, sandstone, siltstone and black shales) rocks. Based on available well logs and corelogs, quartz veins in the bedrock range in thickness from less than 1 cm to 5 m. The top of fresh unweathered bedrock was generally encountered at an elevation of +20 to -50 m. Observations during core logging in the Pit 1 area suggests that the bedrock is generally more fractured in the upper 20 to 30 m of the bedrock surface and associated with the Cassador Fault Zone (Figure 4-1).

### 4.1.5 Cassador Fault Zone

The Cassador Fault is a regional shear zone that runs through the bedrock within the proposed Pit 1 and generally trends northwest-southeast and dips steeply to the northeast between about 60 to 75 degrees (Figures 4-1 and 4-2). The Cassador Fault is the principal structural control on the Sabajo deposit and is identified as a zone of carbonaceous fine-grained sedimentary rock (siltstone to mudstone) and typically has a fractured halo and fine-grained gouge zone of 5 to 10 m. The total width of the fault zone in the Project Area is estimated to be about 100 to 150 m, based on geologic cross-sections. The footwall rock is composed predominantly of dacite and the hanging wall rocks are composed mostly of andesite and sedimentary rocks (i.e. sandstone, mudstones, and interbedded black shales).

From observations and discussions with the Project geologist during David Banton’s (Golder Principal Hydrogeologist) site visit in January 2018, the Cassador Fault in the northwestern end of the existing pit appears to be more silica-rich compared to the southeastern area of the pit, based on outcrops of vuggy and saccharoidal quartz veining within the fault. The southeastern exposure of the Cassador Fault in the existing pit appears to be of lower permeability compared to the north end of the fault zone.

## 4.2 Hydraulic Properties

Hydraulic properties for each hydrogeologic unit were estimated from pumping tests and slug tests performed at monitoring and test wells across the Project Area. In total, there were 16 hydraulic tests conducted: 14 slug tests were performed to evaluate the hydraulic conductivity of the near-borehole materials in the screened zone; and two constant-rate pumping tests were conducted to determine transmissivity, storativity, and hydraulic boundary conditions of the screened zones in the test wells. Table 4-1 presents a summary of the hydraulic properties estimated from the slug and pumping tests, and additional details for each hydrogeologic unit are discussed below.

### 4.2.1 Saprolite and Saprolite Quartz Veins

Hydraulic properties for the saprolite and/or saprolite quartz veins hydrogeologic unit were estimated from slug tests performed in saprolite quartz vein monitoring wells SP-MW-01-SQ and WRD-MW-01-SQ. No wells are screened solely in the saprolite, as the saprolite tends to be low permeability and yields very little water based on data collected from Merian.

Figures D-1 through D-3 and D-11 through D-13 present the results of the slug test analyses in the saprolite quartz veins. Based on the results of these slug tests, the estimated hydraulic conductivity of the saprolite quartz veins ranges from $9.7 \times 10^{-5}$ to $1.2 \times 10^{-4}$ centimeters per second (cm/s), with a geometric mean of $1.1 \times 10^{-4}$ cm/s (Table 4-1).

**Table 4-1: Hydrogeologic Units and Hydraulic Properties**

| Hydrogeologic Unit | Geologic Description | Thickness (m) | Hydraulic Properties | | | | Hydraulic Behavior |
|---|---|---|---|---|---|---|---|
| | | | No. of Tests | Hydraulic Conductivity Range (cm/s)[1] | Hydraulic Conductivity Geomean (cm/s)[1] | Transmissivity ($m^2/d$) | |
| **Alluvium (native and reworked)** | In-situ and reworked alluvial materials found in stream valleys, consisting of sand to coarse gravel-sized quartz vein fragments in a silty to fine sand matrix. | < 5 m (estimated) | N/A | 1 x $10^{-7}$ to 1 x $10^{-2}$ | N/A | No data | Unconfined, hydraulic continuity with surface water |
| **Saprolite / Saprolite Quartz Veins** | Saprolite: Formed from the deep chemical weathering and oxidation of the underlying bedrock comprised primarily of fine-grained soil particles (silt and fine sand). | 1 to 90 | 89 | 2 x $10^{-7}$ to 1 x $10^{-4}$ | 9 x $10^{-6}$ | No data | Unconfined |
| | Saprolite Quartz Veins: Relict features from the weathering of the underlying bedrock containing intruded quartz veins. Higher density occurrences of quartz veins are typically found near the epithermal deposits and were observed in several coreholes near the Sabajo pit. | Disseminated throughout Saprolite (typically < 1 to 10 cm thick) | 4 | 9.7 x $10^{-5}$ to 1.2 x $10^{-4}$ | 1.2 x $10^{-4}$ | No data | Unconfined. Hydraulic continuity with surface water where outcrops in/near stream channels |

**Table 4-1: Hydrogeologic Units and Hydraulic Properties (continued)**

| Hydrogeologic Unit | Geologic Description | Thickness (m) | Hydraulic Properties | | | | Hydraulic Behavior |
|---|---|---|---|---|---|---|---|
| | | | No. of Tests | Hydraulic Conductivity Range (cm/s)[1] | Hydraulic Conductivity Geomean (cm/s)[1] | Transmissivity ($m^2/d$) | |
| **Saprock** | Transition zone of partially weathered or oxidized rock. Saprock is characterized as having properties of weak rock and displays the primary textural features found in the bedrock. | 1 to 35 | 7 | $6.1 \times 10^{-5}$ to $4.2 \times 10^{-4}$ | $1.7 \times 10^{-4}$ | 3.9 to 5.1 | Semi-confined to confined with some hydraulic continuity with surface water where subcrops in/near stream channels. |
| **Bedrock / Cassador Fault** | Bedrock: Sequence of volcanic (i.e. dacite and andesite) and sedimentary (i.e, graywacke, sandstone, and siltstone) rocks. | > 80 | 65 | $1 \times 10^{-7}$ to $3 \times 10^{-3}$ | $9 \times 10^{-5}$ | No data | Confined. Low permeability in unfractured bedrock. Moderately permeable in fractured bedrock. Limited hydraulic continuity with surface water. |
| | Cassador Fault: A zone of carbonaceous fine-grained sedimentary rock (silt stone to mudstone) and typically has a fractured halo and fine-grained gouge zone of 5 to 10 meters. The total width of the fault zone at Sabajo is estimated to be about 100 to 150 m, based on geologic cross-sections. The footwall rock is composed predominantly of dacite and the hanging wall rocks are composed mostly of sedimentary rocks and andesite | | 5 | $1 \times 10^{-5}$ to $1.5 \times 10^{-5}$ | $1.3 \times 10^{-5}$ | 3.1 | Confined, moderately permeable in fractured zone with preferential flow/continuity along strike of of fault and with fractured bedrock in hanging wall. |

### 4.2.2 Saprock

Hydraulic properties for the saprock unit were estimated from a pumping test performed at saprock monitoring well SP-TW-01-SR and slug tests performed in saprock monitoring wells SP-MW-02-SR, SP-TW-01-SR, WRD-MW-01-SR, and OS-MW-01-SR.

Figures D-4 through D-6 and D-14 through D-16 present the results of the slug test analysis. Based on the results of these slug tests, the estimated hydraulic conductivity of the saprock ranges from 6.1 x $10^{-5}$ to 4.2 x $10^{-4}$ cm/s, with a geometric mean of 1.7 x $10^{-4}$ cm/s.

The step rate and constant rate pumping tests conducted in saprock monitoring well SP-TW-01-SR indicated a transmissivity of about 3.5 to 10 $m^2$/d (Table 4-2). Storativity was not estimated from the pumping tests, because of the slow response in the observation wells during testing. Based on the results of the tests, the saprock unit behaves as a semi-confined to confined hydrogeologic unit.

### 4.2.3 Bedrock

The bedrock unit was not tested during the field investigation in 2017; therefore, the hydraulic conductivity values in Table 4-1 are from testing similar bedrock at the Merian Gold Operation; these consisted of folded and faulted, interbedded graywackes, mudstones, siltstones, and sandstones. The estimated average hydraulic conductivities for fractured and less fractured sedimentary bedrock is 6 x $10^{-5}$ cm/s and 3 x $10^{-7}$ cm/s, respectively.

### 4.2.4 Cassador Fault Zone

Hydraulic properties for the Cassador Fault Zone where tested southeast of Pit 1 were estimated from a pumping test performed at SP-TW-01-BR and slug tests performed at each well completed in the Cassador Fault Zone (SP-MW-02-BR, SP-TW-01-BR, and SP-MW-01-BR). The results of the slug tests indicate that hydraulic conductivity of the Cassador Fault ranges from 1 x $10^{-5}$ to 1.5 x $10^{-5}$ cm/s, with a geometric mean of 1.3 x $10^{-5}$ cm/s.

The estimated transmissivity of the Cassador Fault from the constant-rate test in SP-TW-01-BR is 3.1 $m^2$/d. Drawdown in SP-TW-01-BR after three days of continuously pumping at about 4.5 L/min was about 43 m. Drawdown in the bedrock monitoring well located about 28 meters from the test well was about 3.4 m after 3 days of pumping, compared to maximum drawdowns of about 0.04 and 0.13 m in the saprolite quartz vein and saprock monitoring wells, which were located 14 to 25 m away from the test well, respectively. The observation well response to pumping the bedrock test well indicates limited hydraulic connection between the fractured bedrock and the overlying hydrogeologic units. The testing suggests preferential groundwater flow within the hanging wall fractured bedrock network associated with the Cassador Fault Zone to the southeast of Pit 1. The hydraulic behavior of the Cassador Fault Zone may act differently toward the north-northwest where higher density occurrence of quartz veins within the fault zone were observed.

Storativity was not estimated from the pumping tests, because of the slow response in the observation wells during testing. Based on the results of the tests, the Cassador Fault in the southeast area behaves as a confined hydrogeologic unit. The hydraulic behavior of this fault may vary along strike depending on the degree of fracturing and presence of quartz veins, especially where fractures or permeable preferential pathways daylight at or near ground surface.

## 4.3 Groundwater Levels and Groundwater Flow

### 4.3.1 Seasonal Groundwater Changes

Groundwater levels have been measured periodically in the monitoring and test wells completed at site to evaluate the groundwater level response to precipitation, stream stage fluctuations, and other external influences (e.g. atmospheric and earth tides). The depth to groundwater observed in wells ranges from less than a meter in lowland areas (OS area) to 36.4 m bgs in upland areas (SP area).

Figures 4-3 to 4-5 show changes in groundwater levels in wells in the SP and WRF areas. Each figure depicts water levels measured in wells completed at different depths and in different hydrogeologic units (i.e. saprolite quartz vein unit, saprock unit, and Cassador Fault unit). These figures also show daily precipitation observed at the Merian weather station.

Groundwater levels in the saprolite quartz vein unit at the SP-MW-01-SQ location show influences from precipitation events, where water level rises of 1 to 3 cm were observed in response to infiltration of precipitation (Figure 4-4). Overall, groundwater levels in the saprolite quartz vein unit in the SP area (SP-MW-01-SQ; Figure 4-4) increased by about 10 cm from late June to late September 2017 in response to cumulative precipitation from July to September 2017.

The saprock monitoring well completed at the SP-MW-02-SR location showed less response to precipitation. Figure 4-3 shows that in August 2017, the rate of groundwater level decline (following a dry period from mid-June to mid-July) reduced following increased precipitation in mid- to late-July. Given that SP-MW-02-SR is a relatively shallow saprock well (i.e. screened from 13.8 to 20 m bgs), and the observed delay in response to precipitation was about 1 to 2 weeks, indicates the overlying materials are of low to moderate permeability.

In the WRF and close to the valley floor (see Figure 4-5), continuous water level monitoring in WRD-MW-01-SR shows that the water levels in the saprock responded within about 4 days to precipitation by about 3 to 15 cm (the monitored interval in the saprock is about 26 to 35 m bgs at this location); this indicates that the near surface geological units at this location are relatively permeable. The saprolite well in this area (WRD-SW-01-SQ) was installed with oversight by Newmont during the Phase I investigation and was logged as having between 10 to 55% quartz veins within the saprolite.

Groundwater levels in the saprolite quartz vein system and saprock in the WRF area increased by about 1.4 m (Figure 4-5) from December 2016 to June 2017. During this period of time, the Project Area received about 1.1 m of precipitation. From June to September 2017, groundwater levels declined by nearly 2 m in the saprock and bedrock at the SP-MW-02 location and by about 1 m in the saprock and saprolite quartz veins at the WRF location. During this period of time, the cumulative precipitation measured at Merian was 545 mm, with most of the precipitation (i.e. 500 mm) occurring before August 10, 2017.

Short-term diurnal fluctuations in continuous water level readings (1 to 10 cm) were observed in the Cassador Fault monitoring well at the SP area (i.e. SP-MW-01-BR; Figure 4-4); these diurnal fluctuations are attributed to earth tides, indicating that the Cassador Fault is a rigid, confined hydraulic unit with low storativity.

### 4.3.2 Groundwater Flow Directions

Groundwater elevations and schematic groundwater flow directions at the end of the long wet season (August 2017) are presented in Figure 4-6. Shallow groundwater flow (i.e. within the upper 150 m of the subsurface) generally mimics surface topography, where higher groundwater elevations are observed in upland areas (i.e.

hills) and lower groundwater elevations are observed in lowland areas (i.e. valley bottoms and streams). A groundwater divide is inferred to exist near the surface water divide toward the western end of the Project Area (shown as a dark blue line). Overall, groundwater flows away from the hills and converges toward major stream drainages.

## 4.4 Hydraulic Gradients

The hydraulic gradient is the change in groundwater elevation over a distance along a groundwater flow line. It represents the slope of the water table (unconfined aquifer) or the piezometric surface (confined aquifer). For a given value of hydraulic conductivity, a steeper hydraulic gradient indicates a greater volume of groundwater flow per unit cross-sectional area of the hydrogeologic unit.

The horizontal component of hydraulic gradient across the Project Area is variable, reflecting the topographic conditions, characteristics and thickness of the hydrogeologic units, and variations in hydraulic conductivity. The horizontal hydraulic gradients within the different hydrogeologic units were not evaluated as part of this baseline study due to the sparsity of data (both number of wells and number of common hydrogeologic units to evaluate); however, the horizontal gradient of the shallow groundwater ranges from about 0.005 to 0.033 m/m. The steeper horizontal gradient occurs where the topographic relief is higher, and the shallower gradients occur where the topographic relief is low.

The vertical component of hydraulic gradient was evaluated at each location where multiple wells were constructed. A downward (negative) component of hydraulic gradient indicates groundwater is flowing downward from a shallower hydrogeologic unit to deeper one, and generally reflects flow from infiltration at the surface. An upward (positive) component of gradient indicates that groundwater is flowing from deeper units under greater pressure head toward shallower units, and generally reflects flow from bedrock toward the saprolite and eventually discharging to surface water.

Table 4-2 presents a summary of vertical components of hydraulic gradients observed during August and September 2017. These data indicate that the vertical components of hydraulic gradient in the Project Area are relatively low but vary in terms of upward and downward flow paths. Groundwater flow is upward in the relatively low-lying area at WRD-MW-01 well pair location from the saprock to the saprolite and both upward and downward flow the upland areas of the proposed SP area (upward at SP-MW-01 and downward at SP-MW-02). The apparent upward component of groundwater flow could be a result of structural control on the deeper groundwater flow paths or could be a result of using data from wells separated by a horizontal distance of between 14 and 25 m at this location and not representative of the actual vertical component of hydraulic gradient. The downward component of flow observed at the SP-MW-02 is near the groundwater divide, where recharge is expected to occur.

**Table 4-2: Vertical Hydraulic Gradients**

| Location | Date | Vertical Component of Hydraulic Gradient (m/m) |
|---|---|---|
| **Bedrock and Saprock** | | |
| SP-TW-01-SR / SP-TW-01-BR | 8/19/2017 | 0.008 |
| SP-MW-02-BR / SP-MW-02-SR | 8/19/2017 | -0.060 |
| **Bedrock and Saprolite** | | |
| SP-MW-01-BR / SP-MW-01-SQ | 8/19/2017 | 0.004 |
| **Saprolite and Saprock** | | |
| WRD-MW-01-SQ / WRD-MW-01-SR | 8/19/2017 | 0.008 |
| SP-MW-01-SQ / SP-TW-01-SR | 8/19/2017 | -0.026 |

Notes:
Positive values represent an upward component of hydraulic gradient
Negative values represent a downward component of hydraulic gradient

## 4.5 Groundwater Recharge/Water Balance

Groundwater recharge at Sabajo will generally occur in upland areas (i.e. hilltops) and discharge in lowland areas (i.e. valley bottoms) to streams. Higher rates of recharge are expected to occur where more permeable pathways are exposed at or near the ground surface, such as a higher density quartz veining within the saprolite or where fractured saprock or bedrock is exposed at the surface.

A simplified water balance for the project area is presented below:

$$R = P - E - S$$

Where:

R is the groundwater recharge (mm)
P is precipitation (mm)
E is evaporation / evapotranspiration (mm)
S is surface water runoff (mm)

The average annual precipitation in the Project area is estimated to be 2,422 mm. Evaporation is estimated to be 1,248 mm annually. Surface water runoff will be dependent on soil type, topographic relief, vegetation/rainforest canopy density, and rainfall storm intensity and will vary across the site. Overall, the annual surface water runoff is estimated to be about 30% of the annual precipitation (730 mm) (Golder 2018). The resulting estimated groundwater recharge is about 450 mm (or about 18% of annual precipitation).

## 4.6 Groundwater Quality

Baseline groundwater quality was characterized to support evaluations of possible short- and long-term impacts to water quality that may occur during development and operation of the Sabajo Project. Groundwater samples were collected from the Sabajo Project monitoring wells between December 2016 and September 2017 to define baseline groundwater quality, which may be affected by small-scale mining activities in the Project Area. This section presents a summary of the baseline groundwater quality results. The complete groundwater quality data set and information on quality assurance / quality control (QA/QC) procedures and results are presented in the baseline water quality data report (Golder 2018).

### 4.6.1 Groundwater Monitoring

Baseline groundwater quality samples were collected from the Phase I and Phase II monitoring wells and test wells between December 2016 and September 2017. Table 4-3 is a summary of the sampling events showing which wells were sampled during each sampling event. SP-MW-01-SQ and SP-MW-02-SR were slug tested with drinking water in early June 2017, but were airlifted 1 week prior to the sampling events on June 27 and 28, 2017 to remove at least 3 times the amount of water used during the slug tests (i.e. 3 liters per test; 6 liters total per well) to ensure a representative sample of the formation water. Groundwater quality field data sheets from each sampling event are included in Appendix F.

**Table 4-3: Summary of Groundwater Quality Sampling Events**

| **Well ID** | **Screened Geologic Unit** | **Sampling Event** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Dec-16 | Apr-17 | Jun-17 | Aug-17 | Sep-17 | Total |
| WRD-MW-01-SQ | Saprolite Quartz Vein | x | x | | x | x | 4 |
| SP-MW-01-SQ | Saprolite Quartz Vein | | | x | x | x | 3 |
| SP-MW-02-SR | Saprock | | | x | x | x | 3 |
| OS-MW-01-SR | Saprock | x | x | | | | 2 |
| WRD-MW-01-SR | Saprock | x | x | | x | x | 4 |
| SP-TW-01-SR | Saprock | | | | | | 0 |
| SP-MW-02-BR | Cassador Fault | | | x | x | x | 3 |
| SP-TW-01-BR | Cassador Fault | | | x | | | 1 |
| SP-MW-01-BR | Cassador Fault | x | x | x | x | x | 5 |

### 4.6.2 Groundwater Quality Results

Groundwater quality statistical summary results are summarized in Table F-1 in Appendix F. In this table, the number of samples (including duplicates) and the maximum and minimum concentrations by hydrogeologic unit (i.e. saprolite quartz vein, saprock and bedrock within the Cassador Fault Zone) are shown. The following presents a summary of the data provided in Table F-1.

- pH: Groundwater field measured pH values ranged from acidic (4.6 s.u.) to circum-neutral (6.9 s.u.). The pH values measured in the saprolite quartz vein wells demonstrated the most variability ranging from 4.6 to 6.6 standard units (s.u.). The saprock well pH values ranged from 5.6 to 6.8 s.u. The Cassador Fault well pH values were the most consistent, ranging from 6.0 to 6.9 s.u.

- Total Dissolved Solids (TDS): Groundwater TDS concentrations ranged from approximately 40 to 380 milligrams per liter (mg/L). The highest TDS concentrations (i.e., >270 mg/L) were measured in two of the Cassador Fault wells (i.e., SP-MW-01-BR and SP-TW-01-BR). TDS concentrations were lower in the third Cassador Fault well (i.e., approximately 100 mg/L at well SP-MW-01-BR). TDS concentrations in the saprock wells ranged from approximately 50 to 270 mg/L and from 40 to 100 mg/L in the saprolite quartz vein wells.

- Alkalinity: Alkalinity concentrations were variable ranging from approximately 10 to 340 mg/L as $CaCO_3$. The highest alkalinity concentrations (i.e., >200 mg/L as $CaCO_3$) were measured in two of the Cassador Fault wells (i.e., SP-MW-01-BR and SP-TW-01-BR). Alkalinity concentrations were lower in the third Cassador Fault well (i.e., approximately 50 to 80 mg/L as $CaCO_3$ at well SP-MW-01-BR). Alkalinity concentrations in the saprock wells ranged from approximately 20 to 130 mg/L and from 10 to 70 mg/L in the saprolite quartz vein wells.
- Sulfate: Groundwater sulfate concentrations ranged from 2 to 44 mg/L. Sulfate concentrations in the saprock wells spanned this entire range. The lowest (2 mg/L) and highest (~40 mg/L) sulfate concentrations were measured in two of the saprock wells (i.e., wells OS-MW-01-SR and SP-MW-02-SR). The range of sulfate concentrations measured in the saprolite quartz vein and Cassador Fault wells were similar (i.e., approximately 3 to 30 mg/L).
- Metals:
    - Aluminum (Al): Dissolved aluminum was typically below detection in groundwater (<0.08 mg/L). Total recoverable aluminum concentrations ranged from below detection to almost a milligram per liter.
    - Arsenic (As): Dissolved and total recoverable arsenic concentrations in the saprolite quartz vein and saprock wells were low ranging from below detection (<0.003 mg/L) to 0.006 mg/L. Arsenic concentrations were elevated in two of the Cassador Fault wells (i.e., SP-MW-01-BR and SP-TW-01-BR) ranging from 1.1 to 1.7 mg/L. As discussed in Golder (2018), following measurement of elevated arsenic concentrations (i.e., > 1 mg/L) in samples from some of the bedrock wells, for selected samples, samples were collected using both the standard 0.45 micron filter (µm) and a 0.10 µm filter. Use of a smaller filter was intended to determine if the arsenic was present in the dissolved or colloidal fraction. For the sampling event that included sample filtration using both filters, dissolved arsenic concentrations were essentially equal indicating that the arsenic is present in the dissolved fraction and not associated with colloids. The maximum arsenic concentration in the third Cassador Fault well was 0.015 mg/L (i.e., well SP-MW-02-BR).
    - Barium (Ba): Barium was present in groundwater samples at concentrations ranging from approximately 0.01 to 0.07 mg/L.
    - Copper (Cu) and Nickel (Ni): Dissolved and total recoverable copper and nickel concentrations were low in groundwater. When detected, copper and nickel were present at low (<0.01 mg/L) levels.
    - Iron (Fe): Dissolved iron concentrations in groundwater ranged from below detection (<0.1 mg/L) to 8 mg/L. Dissolved iron concentrations were highest in the Cassador Fault wells (SP-MW-01-BR and SP-MW-02-BR) ranging from 0.5 to 8 mg/L. Dissolved iron concentrations were lower in the saprolite quartz vein wells (below 0.4 mg/L) compared to the saprock wells.
    - Manganese (Mn): Dissolved manganese concentrations in groundwater ranged from 0.01 to 1 mg/L. Similar to iron, dissolved manganese concentrations were highest in the Cassador Fault wells ranging from 0.5 to 1 mg/L. Dissolved manganese concentrations were less than 0.5 mg/L in the saprolite quartz vein and saprock wells.
    - Zinc (Zn): Dissolved zinc concentrations in groundwater ranged from below detection (<0.01 mg/L) to 0.05 mg/L.

  - The following metals were below detection in both the dissolved and total fractions of all groundwater samples collected over the period of record: antimony (Sb); cadmium (Cd); chromium (Cr); cobalt (Co); lead (Pb); mercury (Hg); selenium (Se); thallium (Tl); and, vanadium (V).
  - Dissolved molybdenum and silver were below detection in all saprolite quartz vein and Cassador Fault well samples. These metals were detected on occasion at low levels (up to approximately 0.01 mg/L) in the saprock well samples.
- Nitrogen: Nitrogen concentrations were low in groundwater samples. Ammonia concentrations ranged from below detection (<0.03 milligrams per liter-nitrogen [mg/L-N]) to 0.9 mg/L-N. Nitrate plus nitrite concentrations ranged from below detection (<0.05 mg/L-N) to 0.3 mg/L-N.
- Cyanide: When analyzed, cyanide was below detection in all samples.
- Organics: When analyzed, organics (i.e., diesel, lube oil and gasoline) were below detection in all samples.

Arsenic, iron and manganese concentrations are generally highest in the Cassador Fault wells. Field personnel noted the smell of hydrogen sulfide during sampling of well SP-MW-01-BR. The presence of these metals is therefore likely associated with high mobility under reducing conditions.

A Piper plot of groundwater samples is shown in Figure 4-7. A charge balance criterion of less than 10% was applied to all data included in plotting. Groundwater in the Cassador Fault wells at the southeast end of Pit 1 (i.e. SP-MW-01-BR and SP-TW-01-BR) is classified as Ca-Mg-$HCO_3$ type. These are the wells where elevated arsenic concentrations have been measured. The major ion signature of the Cassador Fault well located at the northwest end of Pit 1 (SP-MW-02-BR) is typically classified as Na-$HCO_3$. The dominant cations in bedrock groundwater therefore range from calcium and magnesium to sodium. Sodium is the dominant cation in the saprolite quartz vein groundwater samples. The major ion composition of the quartz vein wells is typically classified as Na-$HCO_3$-$SO_4$ type (i.e., wells SP-MW-01-SQ and WRD-MW-01-SQ). The plot shows that the saprock major ion chemistry is somewhat intermediate to bedrock and quartz vein major ion chemistry. Sodium is often the dominant cation; although the cation signature of some samples is dominated by calcium. Bicarbonate is typically the dominant anion with variable amounts of sulfate.

## 4.7 Conceptual Hydrogeological Model

The Sabajo Project is located in the Commewijne watershed in the northeastern part of Suriname. The Project area is largely undeveloped rainforest land, but has had significant modification from timber cutting and small-scale mining. The site topography is irregular with moderate relief and is dissected by numerous small streams that eventually flow north to the Commewijne River. Elevations within the Project area range from about 30 m to 80 m WGS84. The climate is tropical with four distinct seasons: (1) a short rainy season from mid-December to mid-February; (2) a short dry season from mid-February to mid-April; (3) a long wet season from mid-April to mid-August; and (4) a long dry season from mid-August to mid-December.

Groundwater at Sabajo occurs within the alluvium, saprolite/saprolite quartz veins, saprock, fractured bedrock, and Cassador Fault Zone. Below is a summary of the hydrogeologic units and their properties:

**Alluvium** consists of in-situ and reworked alluvial materials found in stream valleys, consisting of sand to coarse-sized quartz vein fragments in a silty to fine sand matrix. The thickness of the alluvium is estimated to be less than 5 m. This unit was not tested, but the hydraulic conductivity is estimated to range from 1 x $10^{-7}$ to 1 x $10^{-2}$ cm/s, based on literature values (Freeze and Cherry, 1979).

**Saprolite** is formed from the deep chemical weathering and oxidation of the underling bedrock. At Sabajo, saprolite has typically formed into a silty clay to clayey silt from volcanic rocks (dacite and andesite) and from sedimentary rocks (graywacke, sandstone, siltstone, and mudstone). Saprolite ranges in thickness from 1 to 90 m at the site (i.e. typically greater in thickness in upland areas). Hydraulic conductivity was not tested in saprolite without quartz veins, but is estimated to range between 2 x $10^{-7}$ to 1 x $10^{-4}$ cm/s based on testing at the Merian Project in similar saprolite material.

**Saprolite quartz veins** are relict features from the weathering of the underlying bedrock containing intruded quartz veins. Higher density quartz veins are typically found near epithermal deposits and were observed in several coreholes near the Sabajo pit. The quartz veins are disseminated throughout the saprolite and are typically less than 1 cm to 20 cm thick. The hydraulic conductivity is estimated to range from 9.7 x $10^{-5}$ to 1.2 x $10^{-4}$ cm/s. This unit acts as an unconfined unit.

**Saprock** is the term used to describe the transition zone of partially weathered or oxidized rock. Saprock is typically characterized as having properties of weak rock and displays the primary textural features found in the bedrock. This unit ranges in thickness from 1 to 35 m with a range in estimated hydraulic conductivity of 6.1 x $10^{-5}$ to 4.2 x $10^{-4}$ cm/s. The saprock unit acts as a semi-confined to confined hydraulic unit with some hydraulic continuity with surface water where it subcrops in or near stream channels.

**Bedrock** is composed of volcanic (dacite and andesite) and sedimentary rocks (graywacke, sandstone, siltstone, and mudstone) rocks. The thickness of the bedrock unit is greater than 80 m in the project area. The upper 20 to 30 m of bedrock was observed to be more fractured. No test were performed in the bedrock at the Project site, but the estimated range in hydraulic conductivity is expected to be 1 x $10^{-7}$ to 3 x $10^{-3}$ cm/s based on hydraulic test results in similar sedimentary rocks at the Merian Project. The bedrock is expected to act as a confined hydraulic unit with low permeability in the less fractured bedrock and have limited hydraulic continuity with surface water.

**Cassador Fault** is a zone of carbonaceous fine-grained sedimentary rocks (siltstone to mudstone) and typically has a fractured halo and fine-grained fault gouge zone of about 5 to 10 m. The total width of the fault zone is estimated to be about 100 to 150 m at Sabajo. The footwall rock is predominantly composed of dacite and the hanging wall rocks are predominantly composed of sedimentary rocks and andesite. The hydraulic conductivity of the Cassador Fault in the area southeast of the Sabajo Pit ranges from 1 x 10-5 to 1.5 x 10-5 cm/s. The northern exposure of the Cassadaor Fault was observed to have a higher density in quartz veins and could therefore be more permeable than the Cassador Fault tested to the south. This unit behaves as a confined hydraulic unit with preferential flow / hydraulic continuity along strike of the fault and with fractured bedrock in the hanging wall.

The dominant groundwater flow paths are expected to be within the quartz vein system, saprock, and (to a lesser degree) the fractured bedrock, which have relatively higher hydraulic conductivities compared with the unfractured bedrock and saprolite. Although hydraulic characteristics of the saprolite was not separately tested during the Sabajo Project hydrogeological investigation, testing at Merian has shown that groundwater flow through saprolite is minor because of its low permeability. Hydraulic characteristics of the saprolite quartz veins unit was evaluated. Groundwater flow in unfractured bedrock is also relatively minor because of the very low permeability (absence of fractures).

Groundwater within the Cassador Fault Zone is interpreted to flow preferentially within the fractured rock network associated with the hanging wall. There appears to be limited vertical hydraulic connection to the overlying saprock and saprolite quartz vein units in the southeastern area of the Sabajo Pit, based on hydraulic testing and groundwater quality sampling.

Shallow groundwater flow in the Project Area generally mimics the surface topography, where groundwater flows away from recharge areas on hilltops and ridges to converge and discharge in the valley bottoms to surface water and as evapotranspiration from phreatic vegetation. Based on measured groundwater levels, groundwater elevations in the Project Area range from about 19 to 36 m amsl, with lower groundwater elevations found in valley bottoms (i.e. OS and WRF areas) and the higher groundwater elevations found in upland areas (SP area). Groundwater levels at individual wells over the period of record (2016-2017) have fluctuated from less than 20 cm to more than 2 m.

Downward components of hydraulic gradient were observed from saprolite quartz veins to saprock and from sapock to bedrock in the upland areas and near the watershed boundary to the west, where recharge is expected to occur. In the lowland areas, and upward component of groundwater flow was observed from saprock to saprolite quartz veins, where groundwater discharge to streams is expected to occur. At the southwest end of the SP, an apparent upward component of hydraulic gradient was observed from bedrock to the overlying saprock and saprolite quartz veins, suggesting a structural control on deeper groundwater flow paths; this is also consistent with observations of reducing conditions in this area (i.e. elevation arsenic, iron, and manganese).

Measurements show an increase in groundwater levels in the saprock and possibly saprolite quartz veins in the WRF area in response to precipitation indicating that the near surface materials are moderately permeable, likely because of the presence of quartz veins within the saprolite. Where the saprolite is thick and quartz veins are absent, interaction between surface water and groundwater is expected to be minor due to the low permeability of the saprolite.

Water balance shows groundwater recharge to be approximately 18% of annual precipitation and occurring primarily in the months of December to June based longer-term water level observations. Annual precipitation is 2,422 mm with an estimated annual evaporation of 1,248 mm. Surface water runoff is estimated to be about 30% of the annual precipitation, but will vary across the site, depending on soil type, topographic relief, vegetation, and storm duration/intensity. Groundwater discharges to surface water year-round in streams and comprises the highest proportion of total streamflow during the long dry season as baseflow.

The groundwater quality of the saprolite quartz veins and saprock generally has relatively lower pH, TDS, and total alkalinity compared to the groundwater quality in the Cassador Fault, which is indicative of recent recharge and shallower / shorter groundwater flow paths. The water quality signature of the Cassador Fault in the area southeast of main Sabajo Pit exhibits a Ca-Mg-$HCO_3$ -type water with elevated arsenic, indicating confined and reducing conditions. In the northwestern area of the Sabajo Pit (i.e. at SP-MW-02), the water quality signature of the Cassador Fault was a Na-$HCO_3$-type water, which is similar to water quality signature of the saprock and saprolite quartz vein wells in the SP and WRF areas. This suggests the Cassador Fault may be less confined and/or in more direct hydraulic communication with the overlying saprolite and saprock hydrogeologic units in the northwestern area of the main Sabajo Pit where higher density of saccharoidal and vuggy quartz veins have been observed in outcrops of the fault zone.

# 5.0 REFERENCES

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# Signature Page

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David Banton
*Principal Hydrogeologist*

DH/DB/sb

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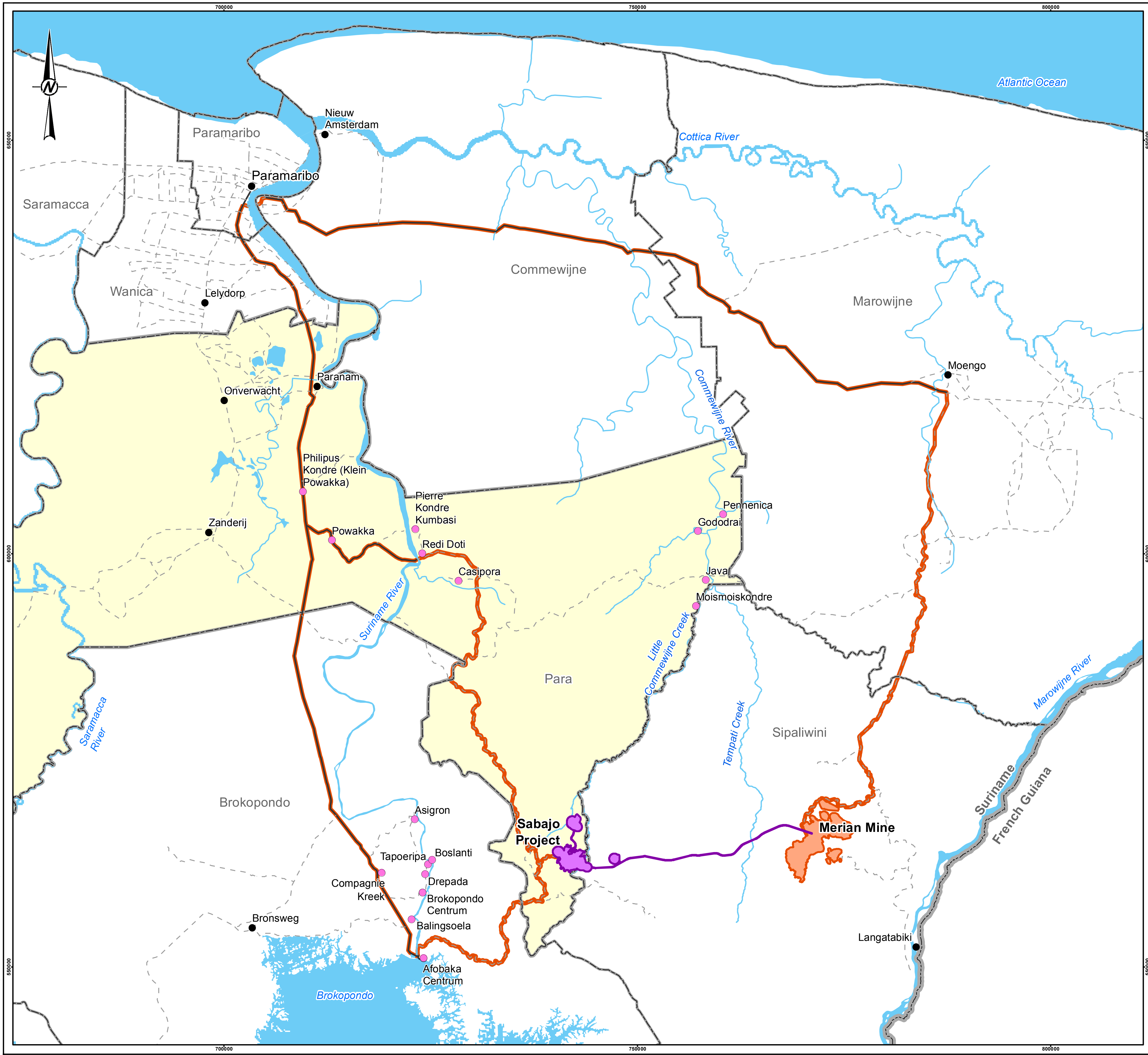
# Figures



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| - - - | INTERNATIONAL BOUNDARY |
| — | PAVED ROAD |
| - - | UNPAVED ROAD |
| — | WATERCOURSE |
| ▬ | WATERBODY |
| — | POTENTIAL PROJECT ACCESS ROUTES |
| ▭ | SABAJO PROJECT PHYSICAL IMPACT AREA |
| ▭ | MERIAN MINE EXISTING AND APPROVED FOOTPRINT |
| ▭ | PARA DISTRICT |

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**NOTE(S)**

**REFERENCE(S)**
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DATUM: WGS84 PROJECTION: UTM ZONE 21

CLIENT
NEWMONT SURINAME

PROJECT
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TITLE
**SABAJO PROJECT LOCATION**

CONSULTANT

GOLDER

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| YYYY-MM-DD | 2018-02-27 |
| DESIGNED | JP |
| PREPARED | AL |
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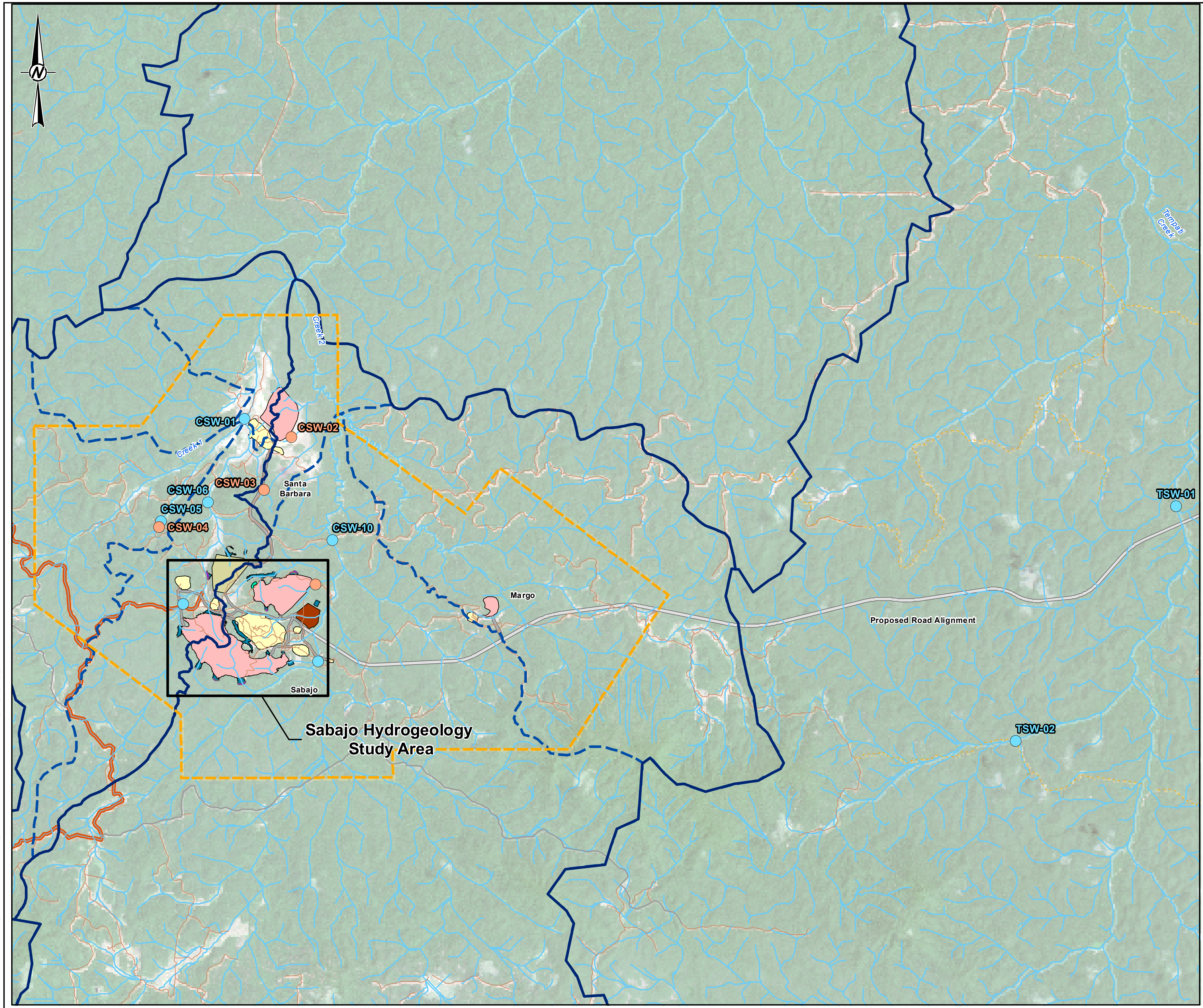

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- ● INACTIVE
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- ▭ SUB-BASIN BOUNDARY
- — ROAD
- — LOCAL ROAD
- ---- ATV TRAIL
- — POTENTIAL PROJECT ACCESS ROAD
- — WATERCOURSE

PROJECT FOOTPRINT
- ▭ PIT
- ■ STOCKPILE
- ▭ WASTE ROCK STORAGE FACILITY
- ▭ SURFACE FACILITIES
- ■ LANDFILL
- ■ ROAD
- ▭ MERIAN TRANSPORT CORRIDOR
- ■ WATER MANAGEMENT BERM
- ■ WATER MANAGEMENT POND

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1. COORDINATE SYSTEM: WGS 1984 UTM ZONE 21N
2. BASE DATA AND TOPOGRAPHY PROVIDED BY NEWMONT

CLIENT
NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
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CONSULTANT
GOLDER

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| DESIGNED | HJ |
| PREPARED | HJ |
| REVIEWED | DH |
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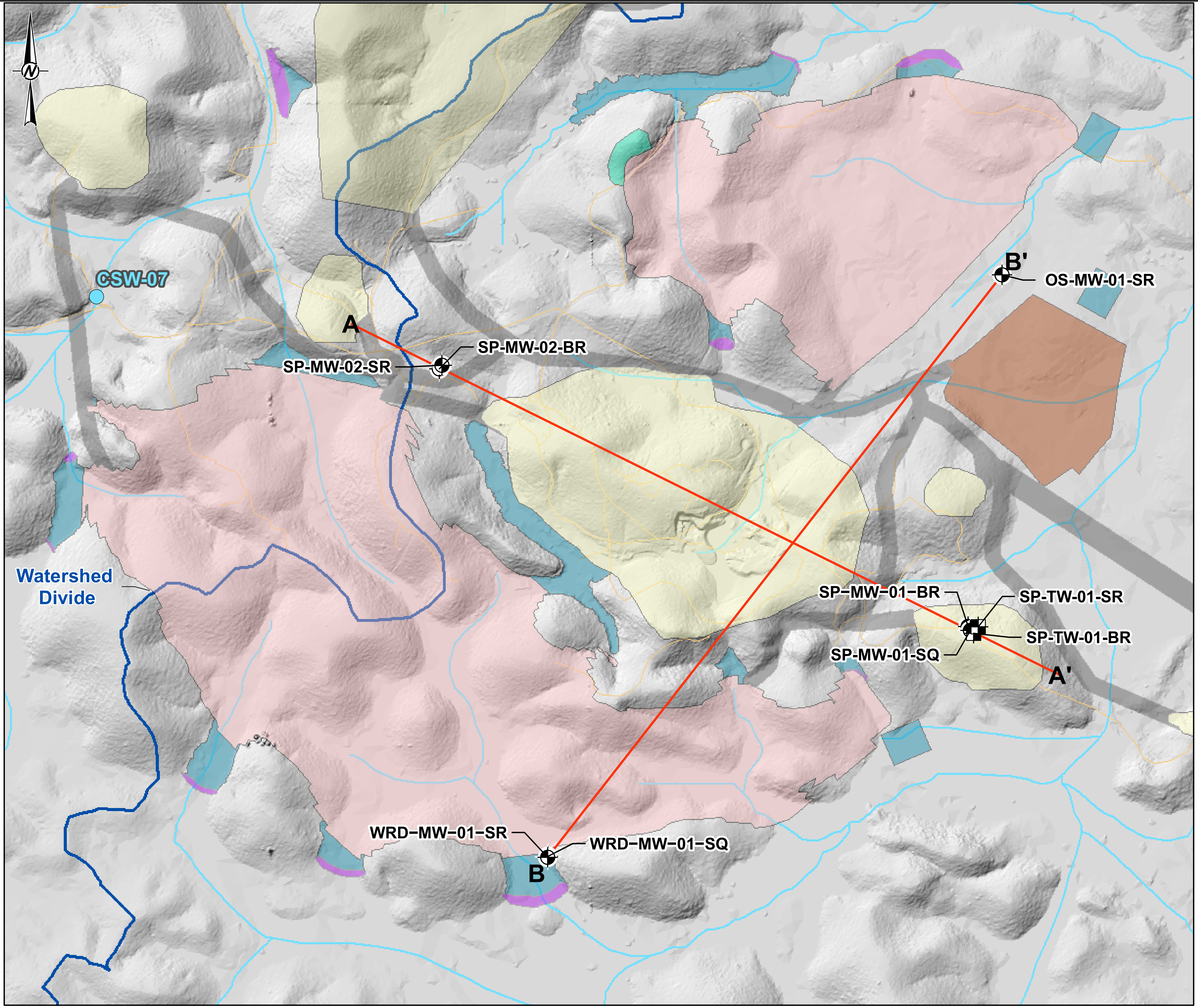

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- GEOLOGIC CROSS-SECTION
- ● SURFACE WATER MONITORING LOCATION

**GROUNDWATER MONITORING LOCATION**

- ⊕ MONITORING WELL
- ▚ TEST WELL

- ☐ LOCAL WATERSHED
- LOCAL ROAD
- WATERCOURSE

**PROPOSED PROJECT FOOTPRINT**

- ▭ PIT
- ▭ STOCKPILE
- ▭ WASTE ROCK STORAGE FACILITY
- ▭ SURFACE FACILITIES
- ▭ LANDFILL
- ▭ ROAD
- ▭ WATER MANAGEMENT BERM
- ▭ WATER MANAGEMENT POND

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**REFERENCE(S)**
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PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
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CONSULTANT

GOLDER

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| PREPARED | HJ |
| REVIEWED | DH |
| APPROVED | DB |

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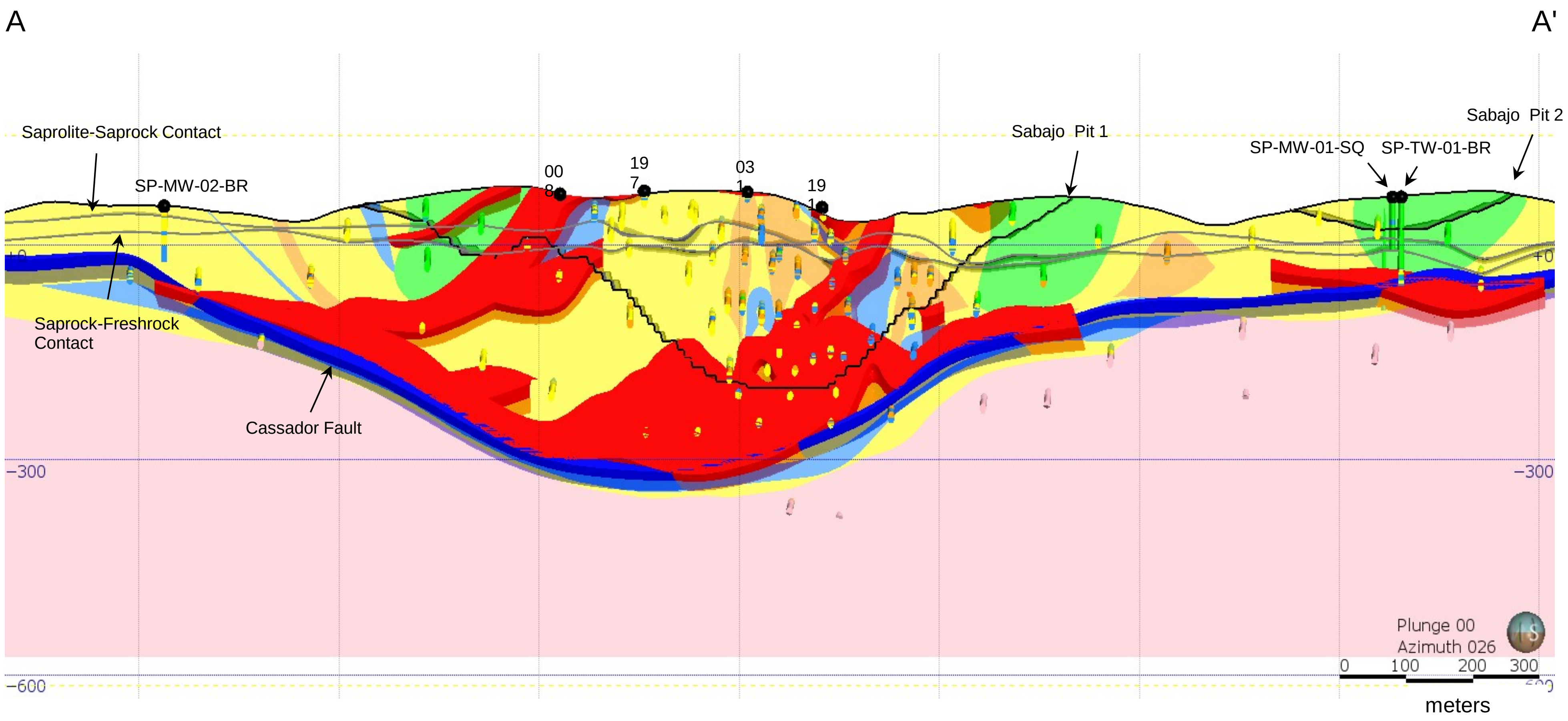

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🟧 Sedimentary Breccia (BxS)
🟩 Andesite (AN)
⬜ Dacite (DA)
🟦 Cassador Fault
🟥 Ore body

● Drill Collar

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PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

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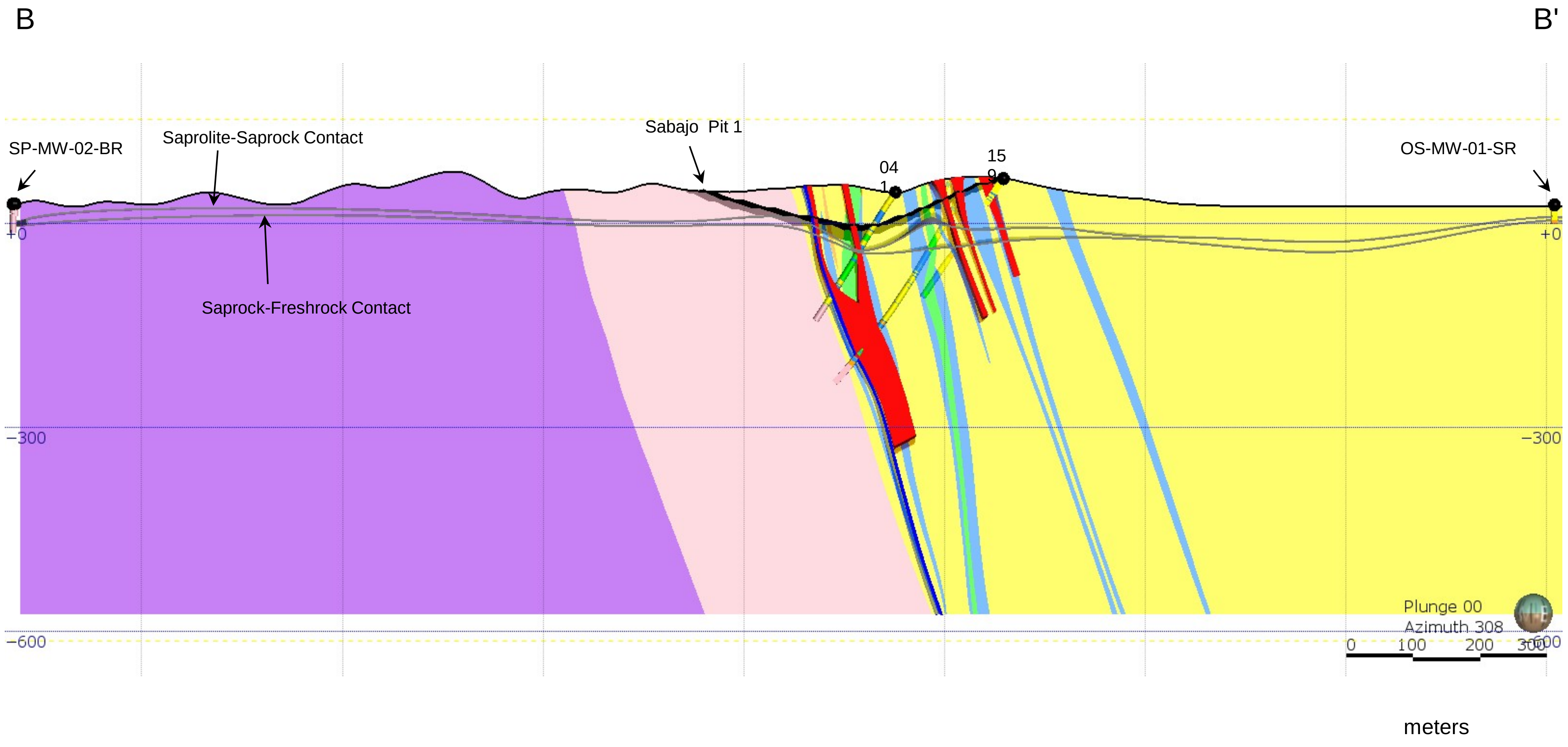

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⬜ Dacite (DA)
🟪 Intermixed Volcanoclastic Sediments
🟦 Cassador Fault
🟥 Ore body
● Drill Collar

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SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
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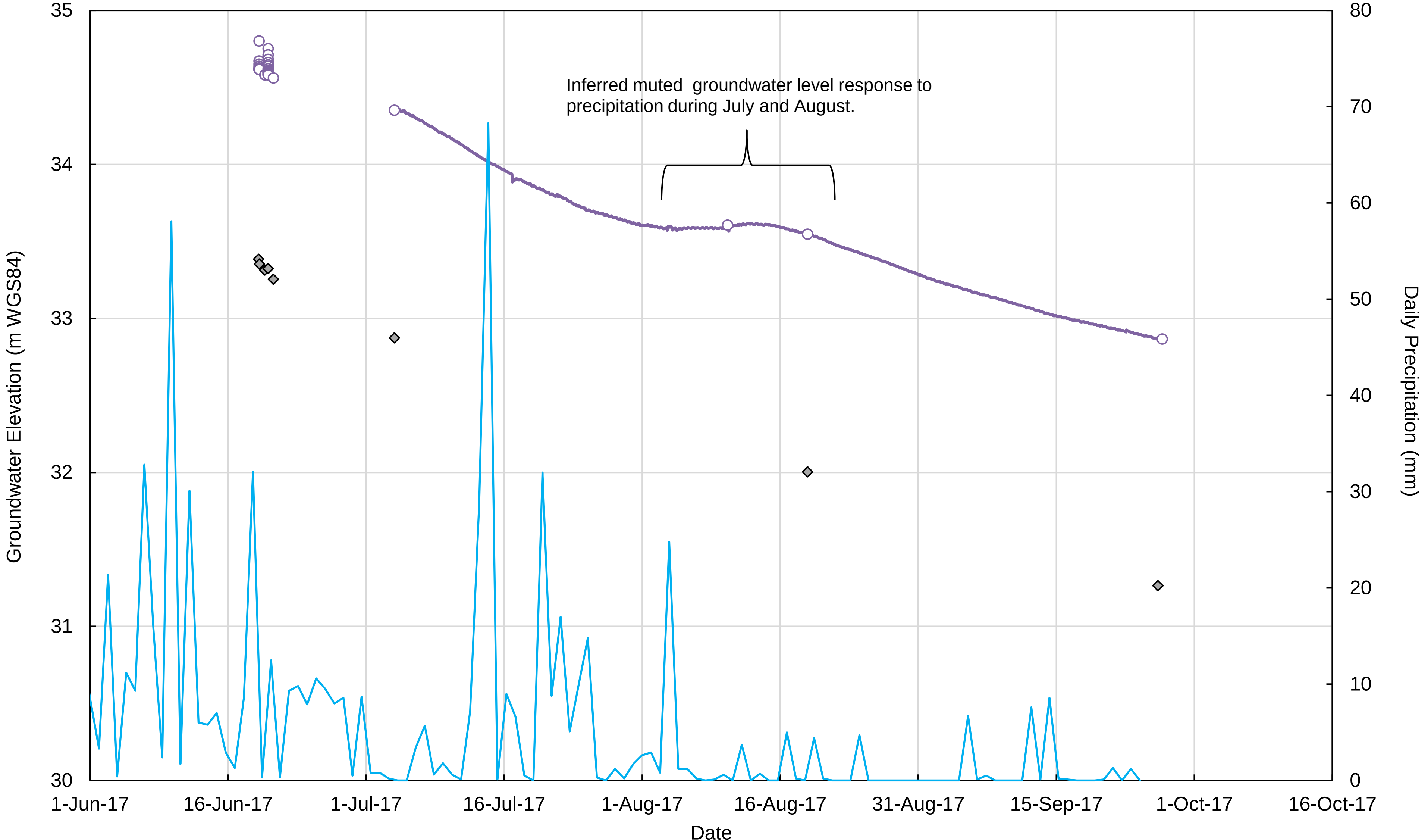

Note: Merian climate station is located approximately 30 km to the east of Sabajo.

LEGEND

○ SP-MW-02-SR Manual

— SP-MW-02-SR Transducer

◆ SP-MW-02-BR Manual

— Merian Precipitation

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PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**GROUNDWATER LEVELS NORTHWEST SABAJO PIT AREA**

| PROJECT NO. | PHASE | REV. | FIGURE |
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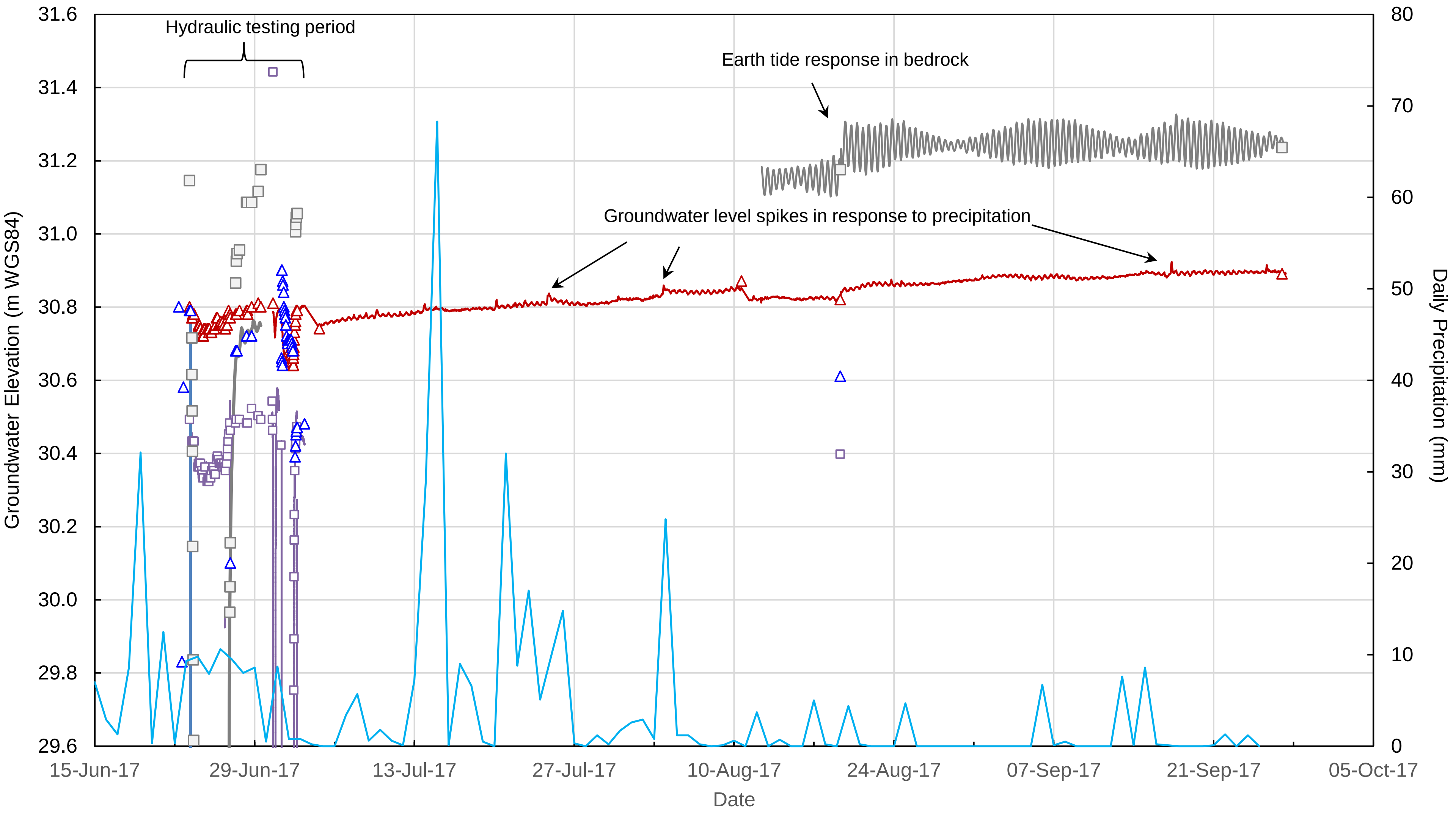

Note: Merian climate station is located approximately 30 km to the east of Sabajo.

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△ SP-MW-01-SQ Manual

□ SP-TW-01-SR Manual

△ SP-TW-01-BR Manual

□ SP-MW-01-BR Manual

— Merian Precipitation

— SP-MW-01-SQ Transducer

— SP-TW-01-SR Transducer

— SP-TW-01-BR Transducer

— SP-MW-01-BR Transducer

CLIENT
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GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**GROUNDWATER LEVELS SOUTHWEST SABAJO PIT AREA**

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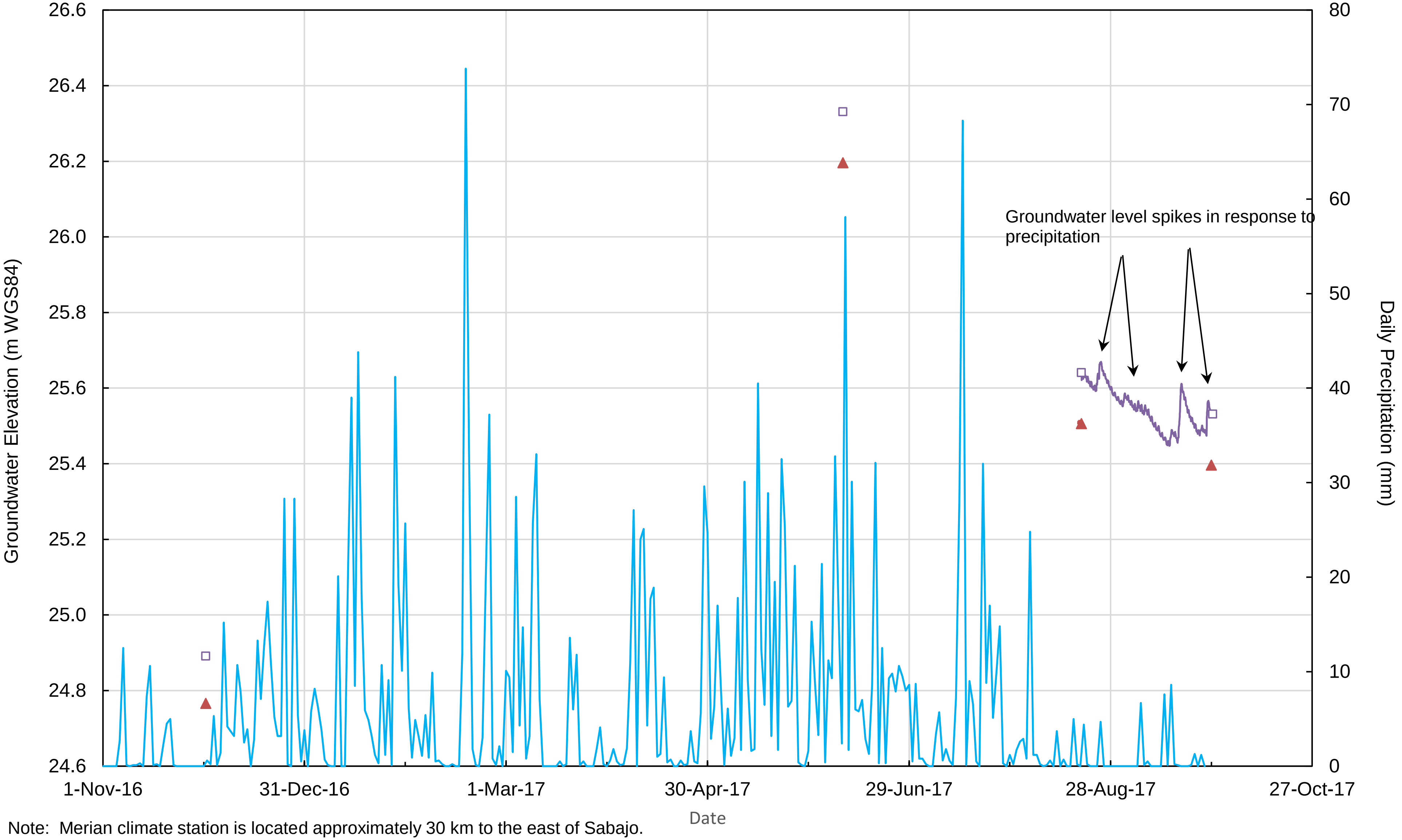

Note: Merian climate station is located approximately 30 km to the east of Sabajo.

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▲ WRD-MW-01-SQ Manual

— WRD-MW-01-SQ Transducer

☐ WRD-MW-01-SR Manual

— WRD-MW-01-SR Transducer

— Merian Precipitation

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PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
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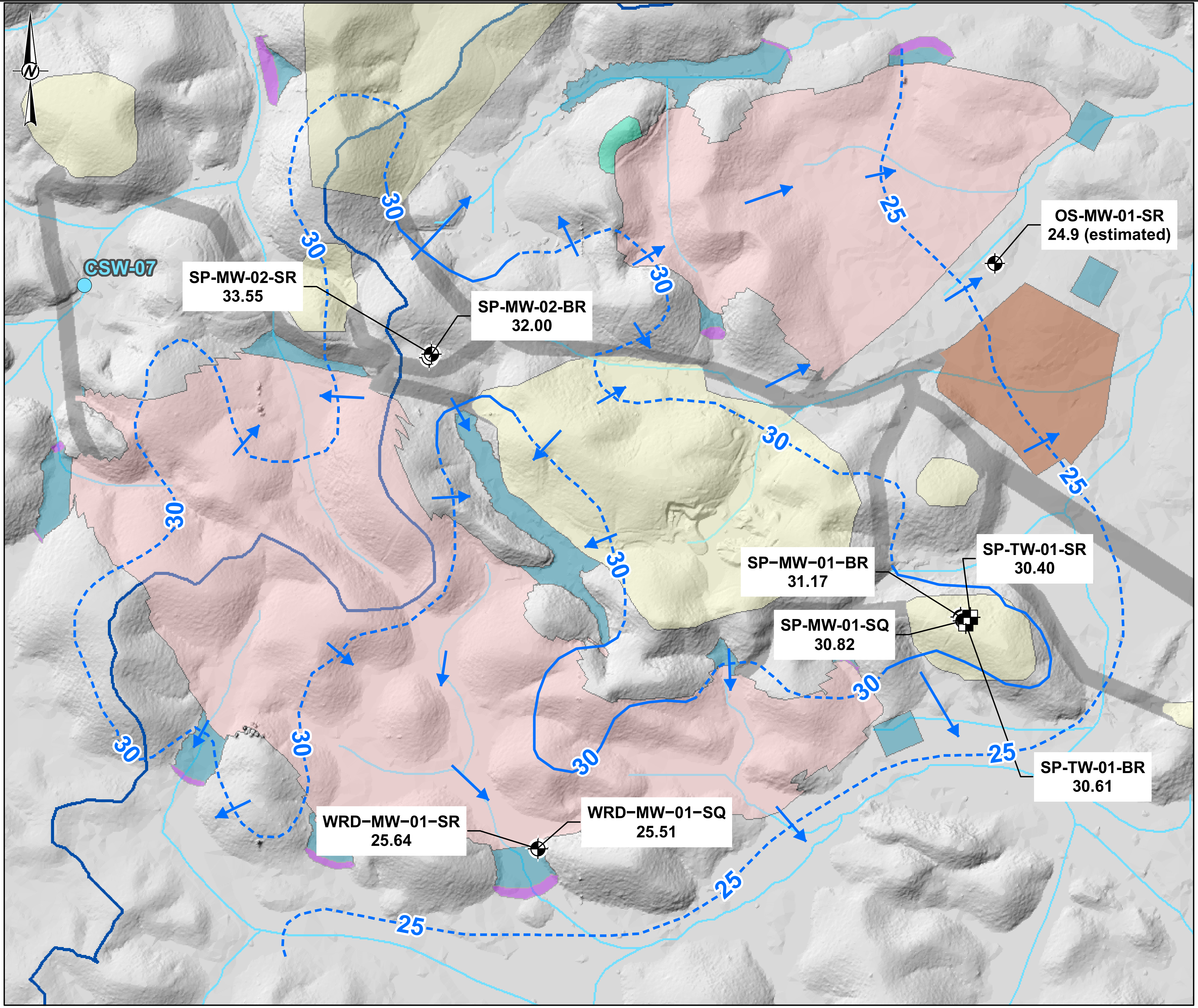

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- - - INFERRED GROUNDWATER CONTOUR ELEVATION (M AMSL)
- → GROUNDWATER DIRECTIONAL ARROW

**GROUNDWATER MONITORING LOCATION**

WATER LEVELS (M AMSL) AUGUST 2017

- ⊕ MONITORING WELL
- ▚ TEST WELL

- ▭ LOCAL WATERSHED
- — WATERCOURSE

**PROPOSED PROJECT FOOTPRINT**

- ▨ PIT
- ▨ STOCKPILE
- ▨ WASTE ROCK STORAGE FACILITY
- ▨ SURFACE FACILITIES
- ▨ LANDFILL
- ▨ ROAD
- ▨ WATER MANAGEMENT BERM
- ▨ WATER MANAGEMENT POND

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**REFERENCE(S)**
1. COORDINATE SYSTEM: WGS 1984 UTM ZONE 21N
2. BASE DATA AND TOPOGRAPHY PROVIDED BY NEWMONT

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NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**PROJECT AREA GROUNDWATER ELEVATIONS – AUGUST 2017**

CONSULTANT

GOLDER

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| DESIGNED | HJ |
| PREPARED | HJ |
| REVIEWED | DH |
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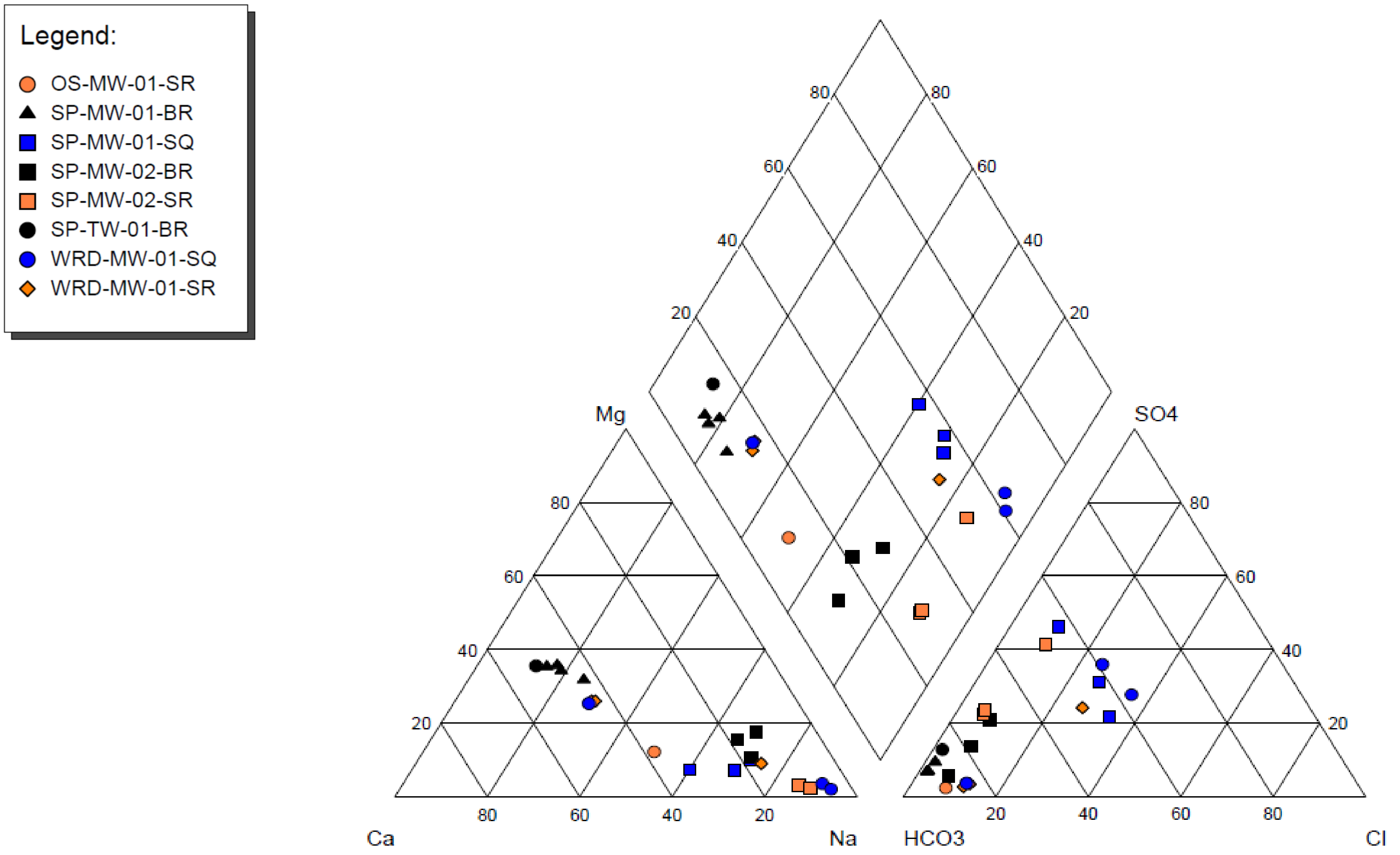


LEGEND

CLIENT
NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

CONSULTANT

GOLDER

TITLE
**GROUNDWATER PIPER PLOT**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | 4-7 |

## APPENDIX A

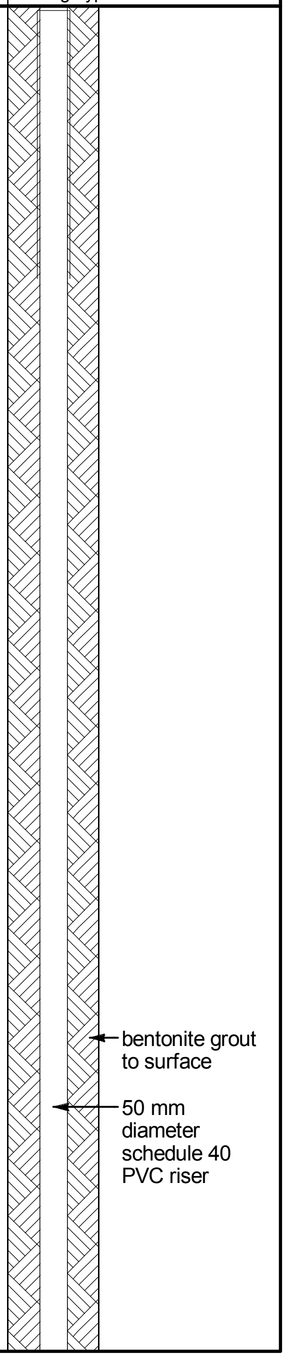
# Borehole Logs

# WELL NUMBER SP-MW-01-SQ

PAGE 1 OF 3

**CLIENT** Newmont Suriname, LLC
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation
**PROJECT NUMBER** 166932601
**PROJECT LOCATION** Suriname
**DATE STARTED** 5/30/17 **COMPLETED** 5/31/17
**GROUND ELEVATION** 66.39 m WGS84 **HOLE SIZE** 4.8-inch (122-mm)
**DRILLING CONTRACTOR** Major Drilling
**GROUND WATER LEVELS:**
**DRILLING METHOD** PQ Core
**AT TIME OF DRILLING** ---
**LOGGED BY** CDL/TG **CHECKED BY** DH
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM<br>Casing Top Elev: 67.25 (m)<br>Casing Type: Schedule 40 PVC |
|---|---|---|---|---|---|---|
| | | . | | | (CH) CLAY, red (10R 4/8) to reddish yellow (7.5 YR 7/8) [SAPROLITE] | |
| 5 | | | | | | |
| | | | | | Crushed quartz ~0.5 cm thick | |
| 10 | | | | | | |
| 15 | | | CH | | | |
| | | | | | Crushed quartz, 0 degree inclination | |
| | | | | | Two crushed quartz veins, ~0.5 cm thick | |
| 20 | | | | | | |
| | | | | | Crushed quartz, 3 mm thick, 45 degree inclination | |
| 25 | | | | | | |
| | | | | | Vein structures, argillic alteration | |
| 30 | | | | | | |



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# WELL NUMBER SP-MW-01-SQ

**CLIENT** Newmont Suriname, LLC

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

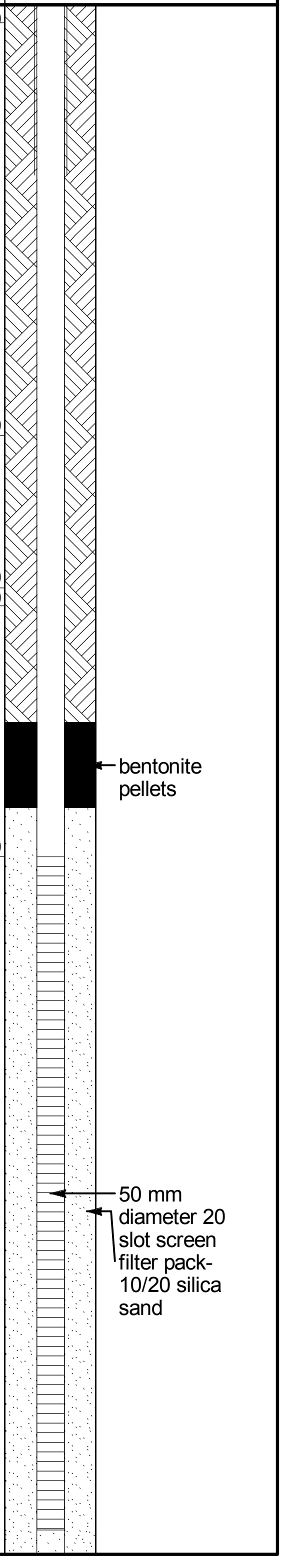
**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | MATERIAL DESCRIPTION |
|---|---|---|---|---|
| 35 | | | CH | 30.40 (CH) CLAY, red (10R 4/8) to brown/gray (10 YR 5/6) [SAPROLITE] 35.99 |
| 40 | | | CH | 39.60 (CH) CLAY, red (10R 4/8) [SAPROLITE] 26.79 |
| | | | | 43.00 Moderately weathered, massive, red (10 R 4/8), R2 [SAPROCK] 23.39 |
| 45 | | | CH | 43.40 (CH) CLAY, red (10R 4/8) [SAPROLITE] 22.99 |
| 50<br>55<br>60 | | | CL | 49.00 (CL) SILTY CLAY, red/yellow (7.5 YR 7/8) [SAPROLITE] 17.39<br>Quartz vein, ~1 cm<br>Crushed quartz , ~0.5 cm<br>Quartz vein, 70 degree inclination<br>Quartz vein, 70 degree inclination |

GRAPHIC LOG

WELL DIAGRAM



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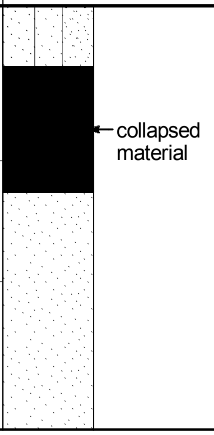
**CLIENT** Newmont Suriname, LLC

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | | MATERIAL DESCRIPTION | | WELL DIAGRAM |
|---|---|---|---|---|---|---|---|---|
| 65 | | | CL | ▨ | 68.00 | Quartz vein, ~1 cm<br>(CL) SILTY CLAY, red/yellow (7.5 YR 7/8) [SAPROLITE] *(continued)*<br>Quartz vein, 30 degree inclination | -1.61 |  |
| 70 | | | | × | 70.70 | Moderately weathered, massive, grey (N8 to N6), R2 [SAPROCK]<br>Crushed quartz, 45 degree, ~0.5 cm | -4.31 | |
| | | | | ▧ | 74.00 | Fresh rock, grey (N8 to N6), R4, METASEDIMENTARY, [BEDROCK]<br>Quartz veins, <1 cm<br>Quartz veins, <1 cm | -7.61 | |

Bottom of hole at 74.00 m.

# WELL NUMBER SP-MW-02-BR

**CLIENT** Newmont Suriname, LLC

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

**DATE STARTED** 5/27/17 **COMPLETED** 5/30/17

**GROUND ELEVATION** 53.05 m WGS84 **HOLE SIZE** 4.8-inch (122-mm)

**DRILLING CONTRACTOR** Major Drilling

**GROUND WATER LEVELS:**

**DRILLING METHOD** PQ Core

**AT TIME OF DRILLING** ---

**LOGGED BY** CDL/TG **CHECKED BY** DH

**AT END OF DRILLING** ---

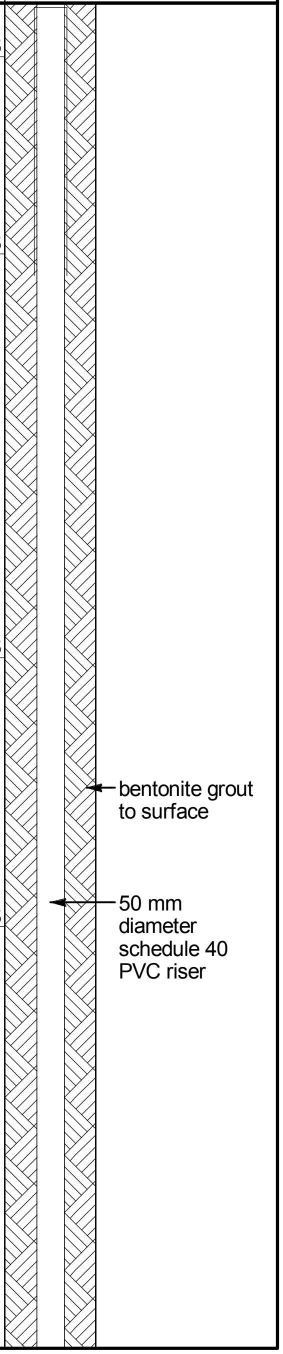
**NOTES**

**AFTER DRILLING** ---

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | | |
|---|---|---|---|---|---|---|---|
| | | | ML | | (ML) CLAYEY SILT, yellow to red/brown (2.5 YR 3/6 to 2.5 YR 8/6), [SAPROLITE] | 1.20 | 51.85 |
| 5 | | | | | Highly weathered, red and yellow oxidation along remnant veins, grey, (N8 to N6), R2 [SAPROCK] | 5.60 | 47.45 |
| | | | | | Slightly weathered, FeOx and MnOx healed non-planar fracture, grey (N8), R3 [SAPROCK] | | |
| 10 | | | | | Slightly weathered, fresh ductile/brittle shear with FeOx staining, vertical | | |
| | | | | | Crushed quartz, ~10 cm thick | 14.60 | 38.45 |
| 15 | | | | | Highly weathered, red and yellow oxidation along remnant veins, grey, (N8 to N6), R2 [SAPROCK] | | |
| | | | | | Quartz vein, 75 degree inclination, ~0.5 cm thick | | |
| 20 | | | | | Crushed quartz vein, near vertical | 20.60 | 32.45 |
| | | | | | Quartz vein, 30 degree inclination, ~ 2 mm thick<br>Disseminated quartz infill, ~1 cm thick | | |
| 25 | | | | | Fracture, ~ 85 degree inclination, FeOx and MnOx staining | | |
| | | | | | Quartz vein crushed, ~ 85 degrees inclination, ~1 cm wide | | |
| 30 | | | | | Heavily weathered to completely weathered | | |

WELL DIAGRAM

Casing Top Elev: 54 (m)
Casing Type: Schedule 40 PVC



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# WELL NUMBER SP-MW-02-BR

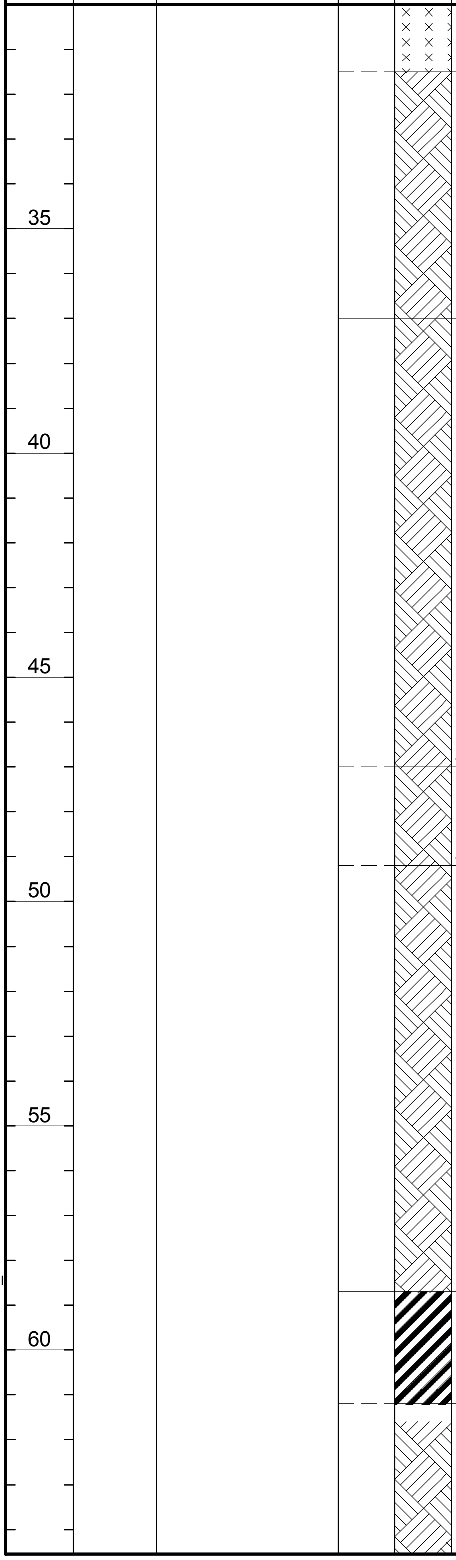
**CLIENT** Newmont Suriname, LLC

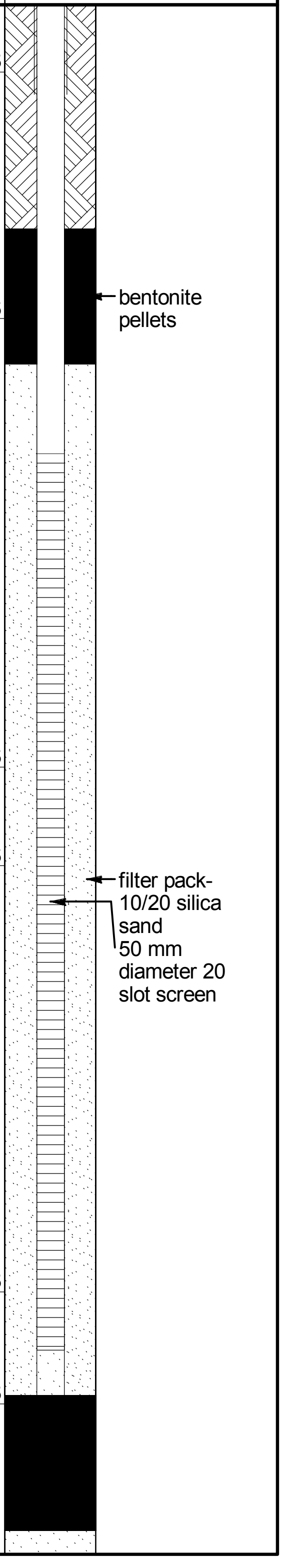
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | | WELL DIAGRAM |
|---|---|---|---|---|---|---|---|
| | | | | | Highly weathered, red and yellow oxidation along remnant veins, grey, (N8 to N6), R2 [SAPROCK] *(continued)* | | |
| | | | | 31.50 | Cross-cutting quartz vein, 25 degree inclination, ~1 cm wide | 21.55 | |
| | | | | | Slightly weathered, silty carbonaceous sedimentary rock interbedded with medium carbonaceous siltstone, grey (N5) with MnOx staining, R3 [BEDROCK]<br>Quartz in-fill, ~1.5 m<br>Silty carbonaceous, sedimentary rock, interbedded, moderately carbonaceous siltstone<br>Increase in carbon content | | |
| | | | | 37.00 | | 16.05 | |
| | | | | | Crushed quartz<br>Quartz vein, discontinuous, ~ 1 mm thick | | |
| | | | | 47.00 | Quartz veins, 75 degree inclination, ~ 1 cm thick | 6.05 | |
| | | | | 49.20 | Quartz veins, 80 degree inclination, ~2 cm thick, discontinuous, wavy | 3.85 | |
| | | | | 58.70 | Fault gouge, completely crushed | -5.65 | |
| | | | | 61.20 | METASEDIMENT, interbedded, 45 degree dip [BEDROCK] | -8.15 | |





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**CLIENT** Newmont Suriname, LLC

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM |
|---|---|---|---|---|---|---|
| 65<br>70<br>75 | | | | | METASEDIMENT, interbedded, 45 degree dip [BEDROCK] *(continued)*<br>78.10 -25.05 | |

Bottom of hole at 78.10 m.

# WELL NUMBER SP-MW-02-SR

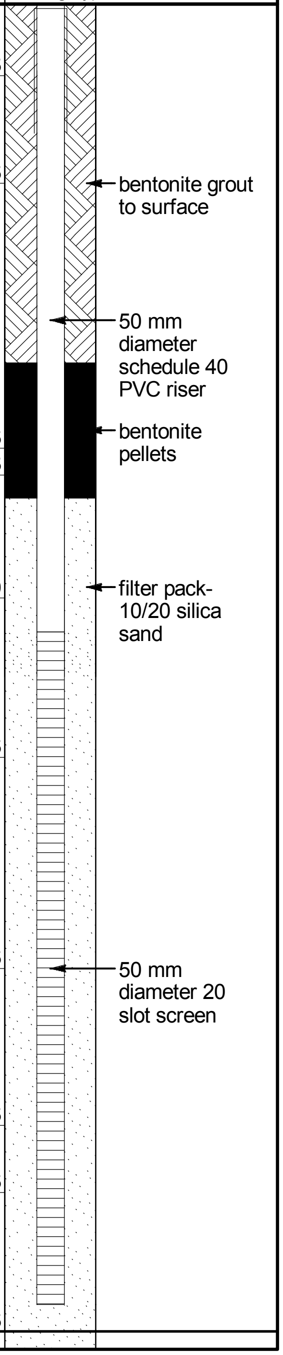
PAGE 1 OF 1

**CLIENT** Newmont Suriname, LLC
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation
**PROJECT NUMBER** 166932601
**PROJECT LOCATION** Suriname
**DATE STARTED** 5/31/17 **COMPLETED** 6/1/17
**GROUND ELEVATION** 52.95 m WGS84 **HOLE SIZE** 4.8-inch (122-mm)
**DRILLING CONTRACTOR** Major Drilling
**GROUND WATER LEVELS:**
**DRILLING METHOD** PQ Core
**AT TIME OF DRILLING** ---
**LOGGED BY** CDL/TG **CHECKED BY** DH
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
|  |  | . | ML |  | (ML) CLAYEY SILT, dark yellowish brown (10 YR 4/8), disturbed [SAPROLITE]<br>1.60 51.35 |
|  |  |  |  |  | Moderately to slightly weathered, massive, grey (N7 to N8), R2 [SAPROCK]<br>4.00 48.95 |
| 5 |  |  |  |  | Slightly weathered to fresh rock, metasediment, grey (N8), fined grained, R3 [SAPROCK]<br>9.90 43.05 |
| 10 |  |  |  |  | Quartz FeMnOx<br>10.50 42.45 |
|  |  |  |  |  | Heavily fractured, mechanically crushed, slightly weathered<br>Siltstone Interbed, very ductile/brittle features<br>13.25 39.70 |
| 15 |  |  |  |  | Slightly weathered, vuggy, dark grey (N4), R4 [SAPROCK]<br>Slightly weathered, vuggy, dark grey (N4), R4 [SAPROCK]<br>16.80 36.15 |
| 20 |  |  |  |  | Fresh rock, dark grey (N4), fine grained, R4 [BEDROCK]<br>21.50 31.45 |
|  |  |  |  |  | Fresh rock, dark grey (N4), fine grained, R4 [BEDROCK]<br>25.00 27.95 |
| 25 |  |  |  |  | Fresh rock, dark grey (N4) with minor FeOx Alteration, fine grained, R4 [BEDROCK]<br>26.50 26.45 |
|  |  |  |  |  | Fresh rock, dark grey (N4), fine grained, R4 [BEDROCK]<br>29.60 23.35 |

WELL DIAGRAM

Casing Top Elev: 53.87 (m)
Casing Type: Schedule 40 PVC



Bottom of hole at 29.60 m.

# WELL NUMBER SP-TW-01-BR

**CLIENT** Newmont Suriname, LLC

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

**DATE STARTED** 6/4/17 **COMPLETED** 6/8/17

**GROUND ELEVATION** 66.49 m WGS84 **HOLE SIZE** 6.25-inch (159-mm)

**DRILLING CONTRACTOR** Major Drilling

**GROUND WATER LEVELS:**

**DRILLING METHOD** PQ Core / Tri-Cone

**AT TIME OF DRILLING** ---

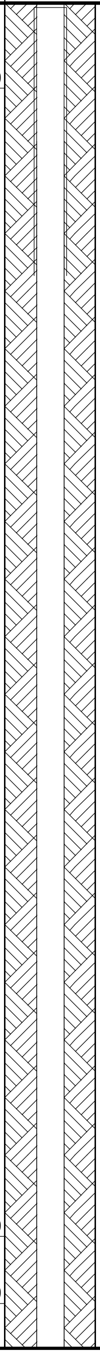
**LOGGED BY** CDL/TG **CHECKED BY** DH

**AT END OF DRILLING** ---

**NOTES**

**AFTER DRILLING** ---

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM<br>Casing Top Elev: 67.35 (m)<br>Casing Type: Schedule 40 PVC |
|---|---|---|---|---|---|---|
| | | | ML | | (ML) FILL, CLAYEY SILT, moist, soft, red/brown, amorphous disturbed [SAPROLITE] | |
| | | | | | 1.90 64.59 | |
| | | | | | (ML) CLAYEY SILT, moist, soft, red/brown (10 YR 4/8 to 10 YR 3/6), amorphous natural ground [SAPROLITE] | |
| 5 | | | | | | |
| | | | | | Quartz vein fractured, ~1 cm wide | |
| | | | | | Quartz vein fractured, ~1.5 cm wide | |
| 10 | | | | | | |
| 15 | | | ML | | Quartz vein fractured, ~2 cm wide | |
| 20 | | | | | | |
| | | | | | Quartz vein crushed, ~2.5 cm wide | |
| | | | | | Quartz vein crushed, ~2.5 cm wide<br>Quartz vein crushed, ~2.5 cm wide | |
| 25 | | | | | | |
| | | | | | 27.50 38.99 | |
| | | | ML | | (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] | |
| | | | | | 29.00 37.49 | |
| 30 | | | ML | | (ML) CLAYEY SILT, moist, soft, red/brown/grey (10 R 4/8, 2.5 YR 5/4) [SAPROLITE] | |



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GOLDER

# WELL NUMBER SP-TW-01-BR

**CLIENT** Newmont Suriname, LLC
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation
**PROJECT NUMBER** 166932601
**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM |
|---|---|---|---|---|---|---|
| | | | ML | | | |
| | | | ML | | 30.75 (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] 35.74 | |
| | | | ML | | 31.50 (ML) CLAYEY SILT, moist, soft, red/brown/grey (10 R 4/8, 2.5 YR 5/4) [SAPROLITE] 34.99 | |
| | | | ML | | 32.00 (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] 34.49 | |
| 35 | | | ML | | 34.00 (ML) CLAYEY SILT, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE]<br>3 Quartz veins, over 0.25 m 32.49 | |
| | | | ML | | 38.50 (ML) CLAYEY SILT, moist, soft, brown/grey (10 YR 5/6) [SAPROLITE]<br>Quartz vein, ~45 degrees, ~1.5 cm wide<br>Quartz vein, horizontal, ~1 cm wide 27.99 | |
| 40 | | | ML | | 40.00 (ML) CLAYEY SILT, moist, soft, dark grey/brown (2.5 YR 5/2) [SAPROLITE]<br>Quartz vein, ~2 cm wide 26.49 | |
| | | | ML | | 41.50 (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] 24.99 | |
| 45 | | | ML | | 42.00 (ML) CLAYEY SILT, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE] 24.49 | bentonite grout to surface |
| | | | ML | | 47.50 (ML) SILT with some clay, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE] 18.99 | |
| | | | ML | | 48.00 (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] 18.49 | |
| | | | ML | | 48.50 (ML) CLAYEY SILT, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE] 17.99 | |
| | | | ML | | 49.00 (ML) CLAYEY SILT, moist, soft, tan (10 YR 6/8) [SAPROLITE] 17.49 | 122 mm diameter schedule 40 PVC riser |
| 50<br>55 | | | ML | | 50.00 (ML) SILT with some clay, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE]<br>Quartz vein, ~1.5 cm wide<br>Quartz vein fractured, ~1 cm wide 16.49 | |
| | | | | | 56.90 Completely weathered to moderately weathered, massive, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE TO SAPROCK ] 9.59 | |
| | | | ML | | 57.80 (ML) SILT with some clay, moist, soft, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROLITE] 8.69 | |
| 60 | | | | | 60.00 Moderately weathered, andesite protolith, red/brown (10 R 4/8 and 10 YR 3/6) [SAPROCK]<br>Fe crushed, ~3 cm wide 6.49 | |
| | | | | | 62.00 Moderately weathered, andesite protolith, grey (N8), R2 [SAPROCK] 4.49 | |

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# WELL NUMBER SP-TW-01-BR

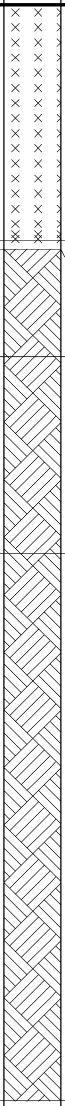
**CLIENT** Newmont Suriname, LLC

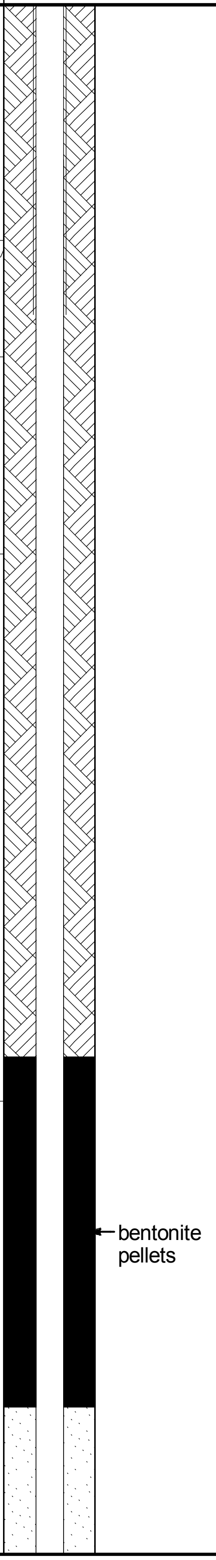
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|
| 65 | | | | Moderately weathered, andesite protolith, grey (N8), R2 [SAPROCK] *(continued)* | |
| 69.80 | | | | Completely crushed [SAPROCK TO BEDROCK] | -3.31 |
| 70.00 | | | | Fresh rock, andesite, grey (N8), fine grained, R3 [BEDROCK] | -3.51 |
| 72.40 | | | | Completely crushed, R1 | -5.91 |
| | | | | Quartz and Fe healed fracture, vertical, ~1 cm wide | |
| 76.80 | | | | | -10.31 |
| | | | | Quartz and Fe healed fracture<br>Quartz and Fe healed fracture | |
| 89.00 | | | | Fresh rock, andesite, grey (N8), fine to medium grained, R3 [BEDROCK] | -22.51 |





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# WELL NUMBER SP-TW-01-BR

**CLIENT** Newmont Suriname, LLC

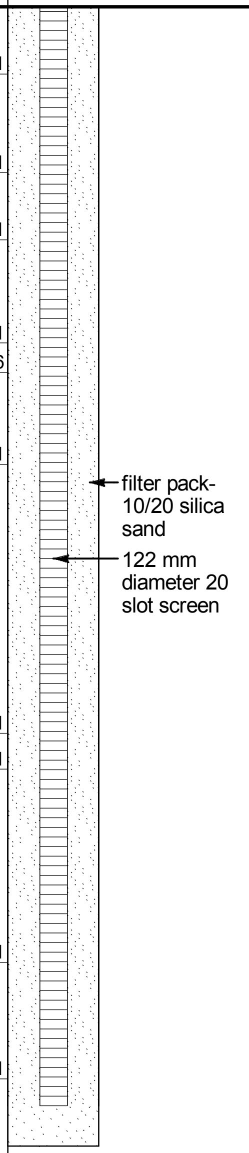
**PROJECT NUMBER** 166932601

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT LOCATION** Suriname

| MATERIAL DESCRIPTION | DEPTH (m) | |
|---|---|---|
| Black carbonaceous rock with Fe alteration. Lots of fractures, difficult to tell which are mechanical. | 100.60 | -34.11 |
| Fresh rock, andesite, grey (N8), fine grained, R4 [BEDROCK]<br>Quartz vein, ~45 degrees<br>FeOx staining | 102.80 | -36.31 |
| FeOx staining | 104.30 | -37.81 |
| FeOx staining | 106.60 | -40.11 |
| Fresh rock, black shale with pyrite, fine grained, R4 [BEDROCK] | 107.25 | -40.76 |
| Fresh rock, andesite, grey (N8), fine grained, R4 [BEDROCK] | 109.30 | -42.81 |
| Moderately weathered, regional shear zone above Cassador Fault, black, R1 [BEDROCK] | 115.30 | -48.81 |
| Moderately weathered, carbonized siltstone brittle fracture, black, R4 to R5 [BEDROCK] | 116.10 | -49.61 |
| Moderately weathered, crushed, black, R1 [BEDROCK] | 120.40 | -53.91 |
| Moderately weathered, crushed Cassador Fault, black, R1 [BEDROCK]<br>Quartz vein, ~2 cm wide | 123.00 | -56.51 |
| Fresh rock, vuggy andesite, grey (N8), fine grained, R5 [BEDROCK]<br>Quartz vein | 126.50 | -60.01 |

WELL DIAGRAM

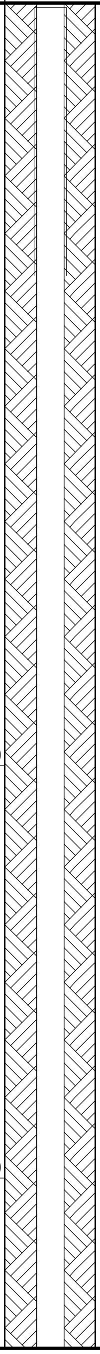


Bottom of hole at 126.50 m.

# WELL NUMBER SP-TW-01-SR

PAGE 1 OF 3

**CLIENT** Newmont Suriname, LLC
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation
**PROJECT NUMBER** 166932601
**PROJECT LOCATION** Suriname
**DATE STARTED** 5/31/17 **COMPLETED** 6/4/17
**GROUND ELEVATION** 65.9 m WGS84 **HOLE SIZE** 7.875-inch (200-mm)
**DRILLING CONTRACTOR** Major Drilling
**GROUND WATER LEVELS:**
**DRILLING METHOD** PQ Core / Tri-Cone
**AT TIME OF DRILLING** ---
**LOGGED BY** CDL/TG **CHECKED BY** DH
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM<br>Casing Top Elev: 66.83 (m)<br>Casing Type: Schedule 40 PVC |
|---|---|---|---|---|---|---|
| 5<br>10<br>15 | | . | ML | | (ML) CLAYEY SILT, red, [SAPROLITE] |  |
| 20<br>25 | | | ML | | 17.00 48.90<br>(ML) CLAYEY SILT, yellow/brown, [SAPROLITE] | |
| 30 | | | ML | | 26.20 39.70<br>(ML) CLAYEY SILT, red, remnant argillite fractures, white [SAPROLITE] | |

*(Continued Next Page)*

**CLIENT** Newmont Suriname, LLC

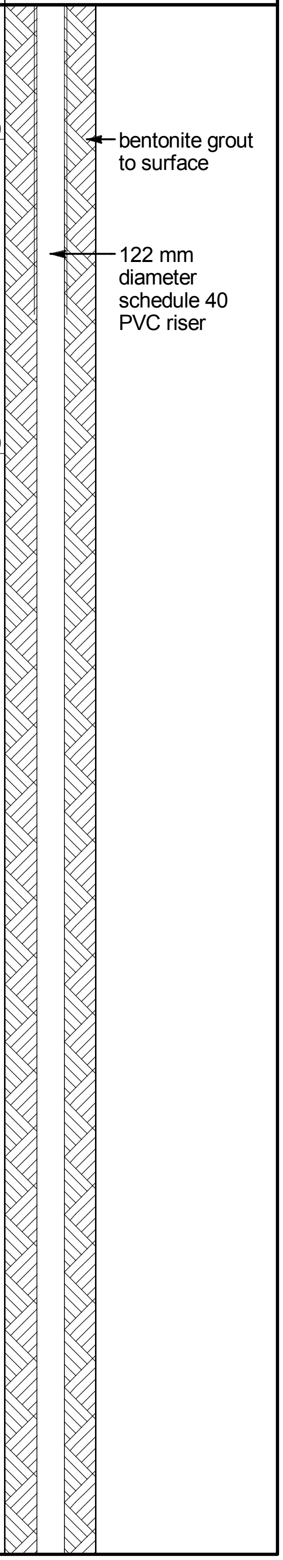
**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT NUMBER** 166932601

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|---|---|
| | | | ML | | | (ML) CLAYEY SILT, red, remnant argillite fractures, white [SAPROLITE] *(continued)* | |
| 35 | | | ML | | 33.00 | (ML) CLAYEY SILT, yellow/red to yellow/brown, [SAPROLITE] | 32.90 |
| 40<br>45<br>50<br>55<br>60 | | | ML | | 40.00 | (ML) CLAYEY SILT, yellow to tan, remnant fractures weathered to clay, [SAPROLITE] | 25.90 |

WELL DIAGRAM



*(Continued Next Page)*

GOLDER

# WELL NUMBER SP-TW-01-SR

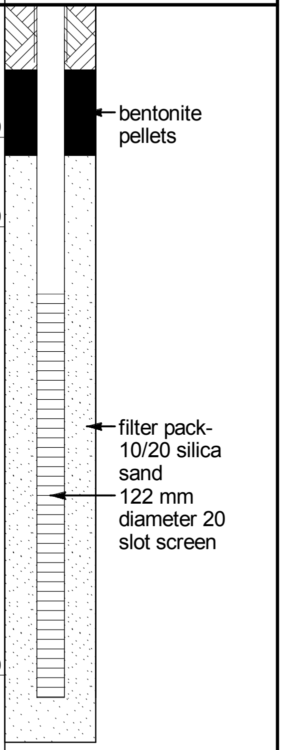
**CLIENT** Newmont Suriname, LLC

**PROJECT NUMBER** 166932601

**PROJECT NAME** Sabajo Phase II Hydrogeologic Investigation

**PROJECT LOCATION** Suriname

| DEPTH (m) | SAMPLE TYPE NUMBER | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | WELL DIAGRAM |
|---|---|---|---|---|---|---|
| 65 | | | ML | | (ML) CLAYEY SILT, yellow to tan, remnant fractures weathered to clay, [SAPROLITE] *(continued)* | |
| | | | | | 67.50 -1.60 | |
| | | | | | Completely weathered to moderately weathered, tan, R1 to R2. Transition [SAPROLITE/SAPROCK] | |
| | | | | | 69.50 -3.60 | |
| 70 | | | | | Moderately weathered, sandstone protolith, dark grey (N4), R2 to R3 [SAPROCK] | |
| 75 | | | | | | |
| | | | | | 79.50 Large altered fracture at base [SAPROCK] -13.60 | |
| 80 | | | | | METASEDIMENT, fine grained [BEDROCK] | |
| | | | | | 82.00 -16.10 | |



Bottom of hole at 82.00 m.

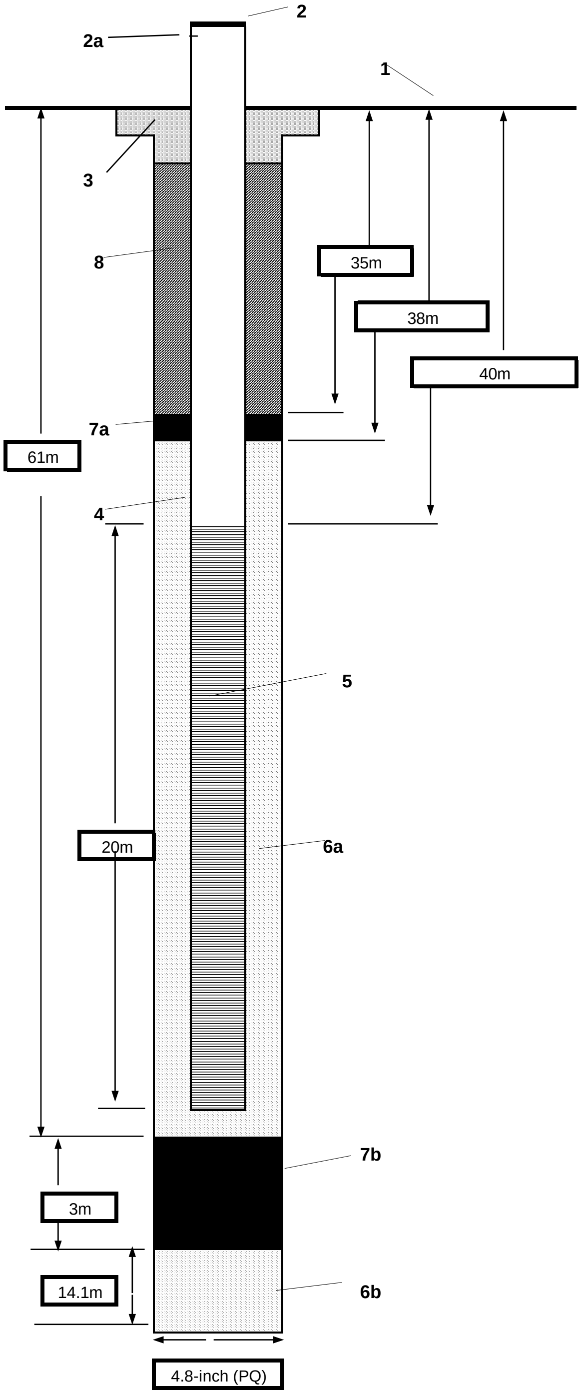
## APPENDIX B

# Well Completion Diagrams

| GOLDER | **PROJECT NUMBER**<br>**166932601** | **WELL NUMBER**<br>**SP-MW-02-BR** SHEET 1 OF 1 |
|---|---|---|

# Well Completion Diagram

PROJECT : Sabajo Phase II Hydrogeologic Investigation
LOCATION : Sabojo Project Suriname
DRILLING CONTRACTOR : Major Drilling, Inc.
DRILLING METHOD AND EQUIPMENT USED : Method: CORE/PQ Drill Rig: Sandvik DE 710/740
WATER LEVELS : 22.67m BTOC (9/27/17) START : May 29, 2017 END : May 29, 2017 LOGGER : CDL



1- Ground elevation at well 53.05m amsl

2- Top of casing elevation 53.9m amsl
a) vent hole? N/A

3- concrete pad dimensions N/A

4- Dia./type of well casing 2-Inch Schedule 40 PVC

5- Type/slot size of screen 2-Inch Schedule 40 PVC (0.020 Slot)

6- Type screen filter 10/20 Sand
a) Quantity used 16 x 50lb Bags
b) Quantity Used 15 x 50lb Bags

7- Type of seal PEL PLUG
a) Quantity used 1.25 x 5-Gallon Buckets
b) Quantity Used 0.75 x 5-Gallon Bucket

8- Grout
a) Grout mix used Bentonite Grout
b) Method of placement Tremie Pipe
c) Vol. of well casing grout -

Development method Air Lift

Development time June 9-10, 2017

Estimated purge volume 620 gallons

Comments 3 bags of 3/8-inch bentonite pellets used at 9.5m bgs
Friction fit bottom cap

| PROJECT NUMBER | WELL NUMBER |
|---|---|
| **166932601** | **SP-MW-02-SR** SHEET 1 OF 1 |

# Well Completion Diagram

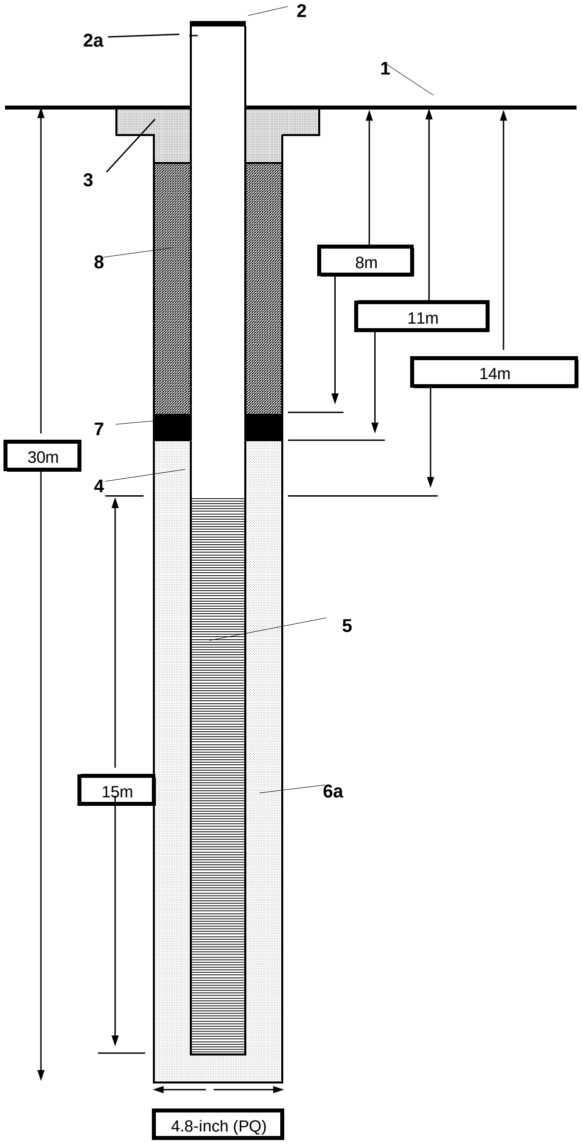
PROJECT : Sabajo Phase II Hydrogeologic Investigation

LOCATION : Sabojo Project Suriname

DRILLING CONTRACTOR : Major Drilling, Inc.

DRILLING METHOD AND EQUIPMENT USED : Method: CORE/PQ Drill Rig: Sandvik DE 710/740

WATER LEVELS : 21.6m BTOC (9/27/17) START : May 31, 2017 END : June 1, 2017 LOGGER : CDL



| | | |
|---|---|---|
| 1- | Ground elevation at well | 52.95m amsl |
| 2- | Top of casing elevation | 53.79m amsl |
| | a) vent hole? | N/A |
| 3- | concrete pad dimensions | N/A |
| 4- | Dia./type of well casing | 2-Inch Schedule 40 PVC |
| 5- | Type/slot size of screen | 2-Inch Schedule 40 PVC (0.020 Slot) |
| 6- | Type screen filter | 10/20 Sand |
| | a) Quantity used | 14 x 50lb Bags |
| 7- | Type of seal | PEL PLUG |
| | a) Quantity used | 1 x 5-Gallon Bucket |
| 8- | Grout | |
| | a) Grout mix used | 4.5 x 50lb Bags 3/8-Inch Bentonite Chips |
| | b) Method of placement | Poured into Annulus |
| | c) Vol. of well casing grout | - |
| | Development method | Air Lift |
| | Development time | June 10-11, 2017 |
| | Estimated purge volume | 71 gallons |
| | Comments | Friction fit bottom cap |

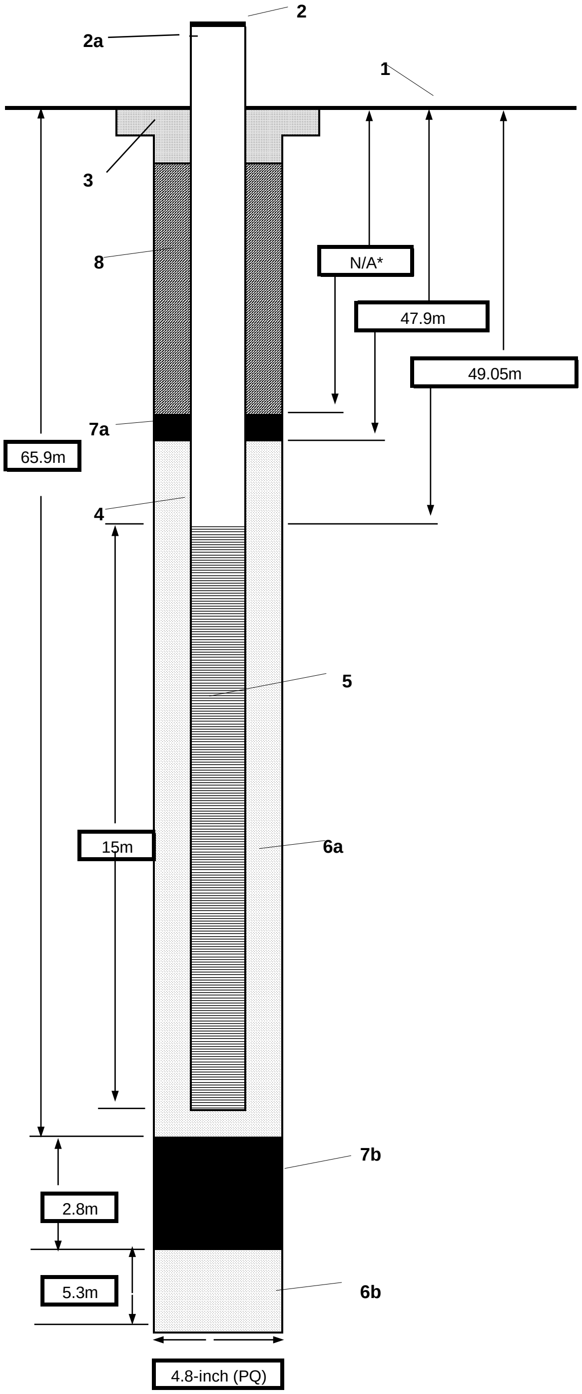
GOLDER

**PROJECT NUMBER**
**166932601**

**WELL NUMBER**
**SP-MW-01-SQ**
SHEET 1 OF 1

# Well Completion Diagram

PROJECT : Sabajo Phase II Hydrogeologic Investigation
LOCATION : Sabojo Project Suriname
DRILLING CONTRACTOR : Major Drilling, Inc.
DRILLING METHOD AND EQUIPMENT USED : Method: CORE/PQ Drill Rig: Sandvik DE 710/740
WATER LEVELS : 36.36m BTOC (9/27/17) START : May 30, 2017 END : May 30, 2017 LOGGER : TG



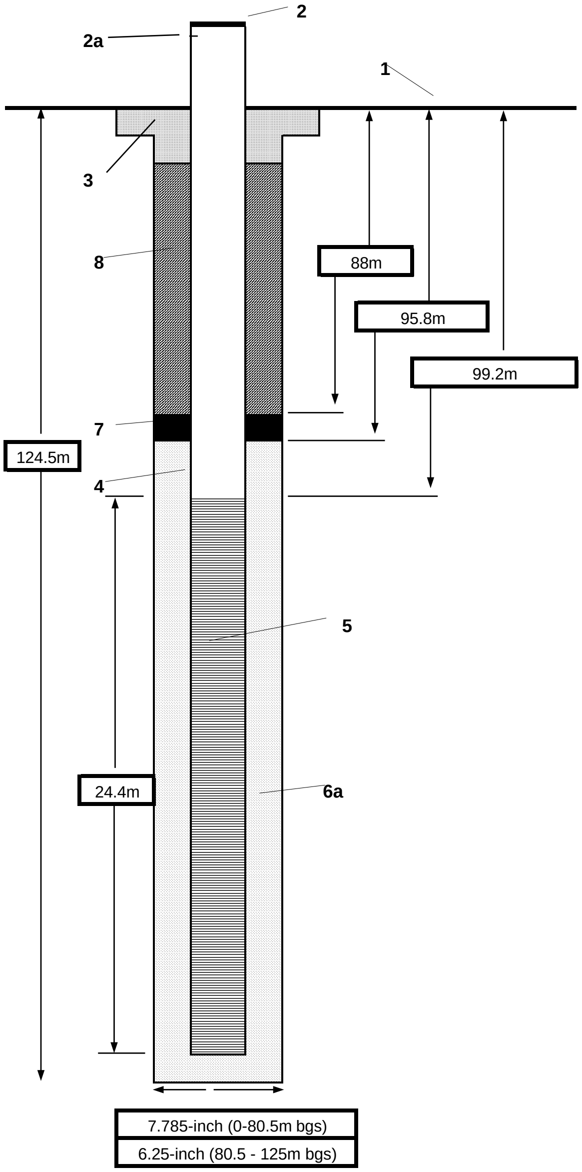
| | |
|---|---|
| 1- Ground elevation at well | 66.39m amsl |
| 2- Top of casing elevation | 67.23m amsl |
| a) vent hole? | N/A |
| 3- concrete pad dimensions | N/A |
| 4- Dia./type of well casing | 2-Inch Schedule 40 PVC |
| 5- Type/slot size of screen | 2-Inch Schedule 40 PVC (0.020 Slot) |
| 6- Type screen filter | 10/20 Sand |
| a) Quantity used | 10 x 50lb Bags |
| b) Quantity Used | 5 x 50lb Bags |
| 7- Type of seal | PEL PLUG |
| a) Quantity used | 2 x 5-Gallon Buckets |
| b) Quantity Used | 1 x 5-Gallon Bucket |
| 8- Grout | |
| a) Grout mix used | Bentonite Grout |
| b) Method of placement | Tremie Pipe |
| c) Vol. of well casing grout | - |
| Development method | Air Lift |
| Development time | June 12-17, 2017 |
| Estimated purge volume | 843 gallons |

Comments Centralizers at ~ 12m, 32m, 49m, and 64m bgs, friction bottom cap
Top of bentonite seal unknown, could not measure past centralizer at 32m bgs.

| | | |
|---|---|---|
| GOLDER | **PROJECT NUMBER**<br>**166932601** | **WELL NUMBER**<br>**SP-TW-01-BR** SHEET 1 OF 1 |

# Well Completion Diagram

PROJECT : Sabajo Phase II Hydrogeologic Investigation
LOCATION : Sabojo Project Suriname
DRILLING CONTRACTOR : Major Drilling, Inc.
DRILLING METHOD AND EQUIPMENT USED : Method: CORE/PQ Drill Rig: Sandvik DE 710/740
WATER LEVELS : 32.56m BTOC (6/12/17) START : June 4, 2017 END : June 6, 2017 LOGGER : CDL



1- Ground elevation at well: 66.49m amsl

2- Top of casing elevation: 67.35m amsl
a) vent hole?: N/A

3- concrete pad dimensions: N/A

4- Dia./type of well casing: 4-Inch Schedule 40 PVC

5- Type/slot size of screen: 4-Inch Schedule 40 PVC (0.020 Slot)

6- Type screen filter: 10/20 Sand
a) Quantity used: 21 x 50lb Bags

7- Type of seal: PEL PLUG
a) Quantity used: 1.75 x 5-Gallon Bucket

8- Grout
a) Grout mix used: Bentonite Grout
b) Method of placement: Tremie Pipe
c) Vol. of well casing grout: -

Development method: Air Lift

Development time: June 12-17, 2017

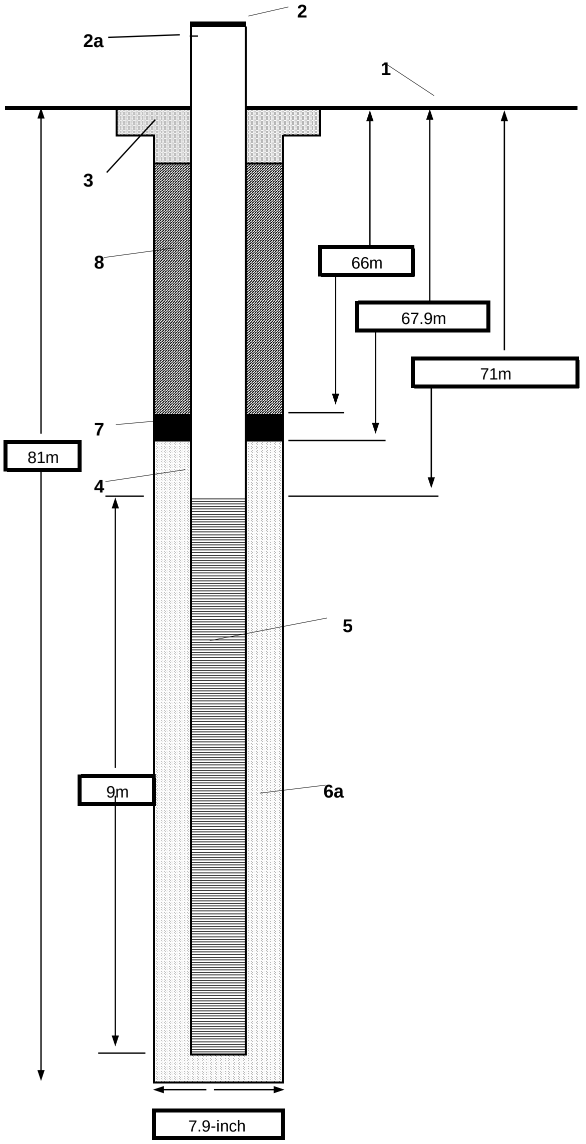
Estimated purge volume: 1,506 gallons

Comments: Threaded bottom cap

|  | PROJECT NUMBER<br>**166932601** | WELL NUMBER<br>**SP-TW-01-SR** | SHEET 1 OF 1 |
|---|---|---|---|

# Well Completion Diagram

PROJECT : Sabajo Phase II Hydrogeologic Investigation
LOCATION : Sabojo Project Suriname
DRILLING CONTRACTOR : Major Drilling, Inc.
DRILLING METHOD AND EQUIPMENT USED : Method: CORE/PQ Drill Rig: Sandvik DE 710/740
WATER LEVELS : 36.23m BTOC (6/12/17) START : June 1, 2017 END : June 1, 2017 LOGGER : TG



|  |  |
|---|---|
| 1- Ground elevation at well | 65.9m amsl |
| 2- Top of casing elevation | 66.83m amsl |
| a) vent hole? | N/A |
| 3- concrete pad dimensions | N/A |
| 4- Dia./type of well casing | 4-Inch Schedule 40 PVC |
| 5- Type/slot size of screen | 4-Inch Schedule 40 PVC (0.020 Slot) |
| 6- Type screen filter | 10/20 Sand |
| a) Quantity used | 14.5 x 50lb Bags |
| 7- Type of seal | PEL PLUG |
| a) Quantity used | 1.5 x 5-Gallon Buckets |
| 8- Grout |  |
| a) Grout mix used | Bentonite Grout |
| b) Method of placement | Tremie Pipe |
| c) Vol. of well casing grout | - |
| Development method | Air Lift |
| Development time | June 12-15, 2017 |
| Estimated purge volume | 1,928 gallons |
| Comments | Threaded bottom cap |

## APPENDIX C

# Well Development Records

Page 1 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-~~M~~TW-01-SR
**Project Number:** 166932601
**Observer:** TG/CDL
**Project Name:** Sabajo
**Flow Measurement:**
**Date:** June 12/17 - June 15/17
**Static Water Level:**
**Weather:** Sunny, high 35°C
**Measuring Point:**

Depth to Water

Total L Purged

| | Time | Pumping Rate (mGL) | Depth to Water (~~m~~ L ) | Conductivity (uS/cm) | Turbidity (NTU) | pH | Temperature (°C) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 12 | 08:30 | 35.30 | | | | | | 08:50 Dev starts at |
| | 09:56 | 35.33 | | | | | | SP-MW-01-SQ |
| | 10:56 | 35.34 | | | | | | |
| | 13:10 | 3535 | | | | | | |
| | 15:08 | 35.35 | | | | | | |
| | 16:08 | 35.34 | | | | | | |
| June 13 | 07:56 | 35.38 | | | | | | |
| | 10:23 | 35.37 | | | | | | 10:34 Dev starts at |
| | 11:37 | 35.38 | | | | | | SP-~~M~~TW-01-BR |
| | 13:45 | 35.40 | | | | | | |
| | 14:55 | | | | | | | Unable to get good |
| | 16:50 | 35.40 | | | | | | WL due to pouring |
| June 14 | 08:14 | 35.42 | | | | | | rain getting in casing |
| | 11:38 | 35.42 | | | | | | |
| | 14:42 | 35.42 | | | | | | |
| | 17:07 | 35.42 | | | | | | Add 1.5 gallon of |
| | | | | | | | | Aqua clear to well |
| | | | | | | | | |
| June 15 | 07:44 | 35.32 | | | | | | Air On |
| | 10:30 | | | | | | | Air off, adjust straps |
| | 10:33 | | | | | | | Air On ~8L/min |
| | 10:34 | | | | | | | Air off |
| | 11:00 | | 500 | | | | | Air On, Very turbid water |
| | 11:25 | | | | | | | Air off |
| | 11:45 | | 650 | | | | | Air On, Very turbid. |
| | 12:30 | | | | | | | Air off |
| | 13:00 | | 800 | | | | | Air On |
| | 13:30 | | | | | | | Air off |
| | 14:00 | | ~~1000~~950 | | | | | Air On |
| | 14:30 | | | | | | | Air off |
| | 15:00 | | 1100 | | | | | Air On |
| | 15:30 | | | | | | | Red-Brown |
| | 15:53 | | | 365.7 | 230.1 | 8.61 | 30.2 | Air off |
| | 16:00 | | 1250 | | | | | |
| | 16:08 | ~57 | | | | | | Air on |
| | 16:30 | | | | | | | |

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Page 2 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-TW-01-SR
**Observer:** TG/CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 15 → June 17/17
**Weather:** Sunny with Rainy peri

| | Time | Total L Purged<br>Pumping ~~Rate~~ ( L ) | Depth to Water ( mGL ) | Conductivity (µS/cm) | Turbidity (NTU) | pH | Temperature (°C) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 15 | 16:49 | | | 348.4 | 1022 | 8.56 | 29.7 | light Brown/Red |
| | 17:00 | 1400 | | ~~348.4~~ | ~~102.2~~ | ~~8.56~~ | ~~29.7~~ | |
| | 17:12 | | | | | | | Air On |
| | 17:43 | 1550 | | 348.4 | 105.3 | 8.54 | 29.7 | Air OFF |
| | 1830 | | | | | | | AIR ON > 30 |
| | 1900 | 1700 | | | | | | " OFF |
| | 1930 | | | | | | | " ON > 30 |
| | 2000 | 1850 | | | | | | " OFF |
| | 2030 | | | | | | | " ON > 45 |
| | 2115 | 2000 | | | | | | " OFF |
| June 16 | 07:51 | | 35.66 | | | | | |
| | 07:55 | | | | | | | |
| | 08:16 | | | 348.4 | 81.3 | 8.47 | 25.2 | Start Air |
| | 08:27 | | | 361.4 | 465.3 | 8.57 | 25.9 | |
| | 08:30 | 2200 | | | | | | |
| | 09:00 | | | | | | | |
| | 09:05 | | | | | | | Air Off |
| | 09:34 | 2350 | | 341.6 | 113.8 | 8.18 | 25.2 | Air On |
| | 10:00 | | | 341.6 | 623.9 | 8.48 | 28.8 | |
| | 10:08 | | | | | | | Air off |
| | 10:30 | 2500 | | 342.2 | 1044.5 | 8.31 | 27.7 | Air On |
| | 11:15 | | | 340.1 | 1205.3 | 8.47 | 28.5 | |
| | 11:45 | 2650 | | 353.2 | 526.8 | 7.85 | 27.2 | Air Off, Red/Brown Water |
| | 12:42 | | | 340 | 752.6 | 8.45 | 27.8 | Air On |
| | 13:00 | | 41.62 | | | | | Air off |
| | 13:30 | 2800 | | 348.2 | 116.2 | | | |
| | 14:00 | | | 346.4 | ~~341.8~~ 400.1 | 8.22 | 27.9 | |
| | 14:36 | 2950 | | 347.9 | 1070.0 | 8.51 | 30.0 | Air On |
| | 15:15 | | | 349 | 586.4 | 8.30 | 28.1 | Air Off |
| | 15:45 | | | 329.8 | 68.2 | 8.44 | 27.7 | Air On |
| | 16:15 | 3100 | | 336.9 | 94.1 | 8.19 | 26.6 | Air OFF |
| une 7 | 07:31 | 4200 | | | | 8.46 | 28.8 | Air On |
| | 07:32 | | 35.68 | | | | | |
| | 07:34 | | | 349.8 | 50.5 | 7.67 | 24.6 | Air OFF → Low Fuel |
| | 08:50 | | | 336.3 | 207.4 | 8.41 | 26.4 | 18:30-21:30 Air On<br>Air On |

Golder Associates Inc.

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Page 3 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-TW-01-SR
**Observer:** TG/CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 17
**Weather:**

Total L Purged

| Time | Pumping Rate ( ) | Depth to Water ( mGL ) | Conductivity ( uS/cm) | Turbidity ( NTU ) | pH | Temperature (°C ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|
| 09:20 | | | | | | | |
| 09:57 | | | 354.0 | 83.7 | 8.49 | 27.6 | |
| 10:29 | | | 339.6 | 60.6 | 8.49 | 28.7 | |
| 10:57 | | | 336.7 | 59.2 | 8.52 | 28.9 | |
| 12:55 | | | 341.4 | 55.4 | 8.52 | 30.4 | |
| 13:57 | | | 338.7 | 49.8 | 8.45 | 30.2 | |
| 15:69 | | | 340.7 | 78.1 | 8.44 | 29.1 | |
| | | | 339.7 | 70.7 | 8.48 | 29.5 | |
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Page 1 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-~~MW~~TW-01-BR
**Observer:** TG/CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**
Total L Purged

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 12/17 + June 13/17
**Weather:** Sunny

| | Time | Pumping Rate ( ) | Depth to Water (mGL ) | Conductivity ( ) | Turbidity ( ) | pH | Temperature ( ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 12 | 08:20 | | 31.70 | | | | | 08:50 Dev starts at |
| | 09:52 | | 31.79 | | | | | SP-MW-01-SQ |
| | 10:52 | | 31.86 | | | | | |
| | 13:08 | | 32.00 | | | | | |
| | 15:08 | | 32.05 | | | | | |
| | 16:04 | | 32.22 | | | | | |
| June 13 | 07:53 | | 32.09 | | | | | |
| | 10:12 | | 32.21 | | | | | Start putting air |
| | | | | | | | | line to 80m* |
| | 10:34 | | | | | | | Air on, ~~continuously~~ turn |
| | | | | | | | | off. and let recover |
| | | | | | | | | For ~1min, run for ~3min |
| | | | | | | | | Producing ~0.5L/min. No |
| | | | | | | | | Aqua Clear used in Well ∴ |
| | | | | | | | | water is slippery b/c drilling gel |
| | 11:10 | 220 | | | | | | Air off b/c hose is |
| | | | | | | | | sliding down. Wait for pipe |
| | | | | | | | | clamp before re-starting |
| | 11:25 | | | | | | | Air on |
| | 11:40 | 229,5 | | | | | | Air off |
| | 13:41 | ⌐ | 51.36 | | | | | |
| | 14:00 | | | | | | | Air on |
| | 14:21 | 280 | | | | | | Air off, not much water |
| | | | | | | | | coming out ∴ let recover. Put |
| | | | | | | | | ~1/4 gallon of Aqua clear in well |
| | 15:59 | | 54.1 | | | | | Air on |
| | 16:06 | 500 | | | | | | Back to just spitting, |
| | | | | | | | | turn air off to let recover |
| | 16:30 | | | | | | | Air on |
| | 16:34 | 750 | | | | | | Air off |
| | 17:00 | | | | | | | Air on |
| | 17:04 | 1000 | | | | | | Air off |
| | 17:15 | 1100 | | | | | | Air on |
| | 17:19 | | | | | | | Air off |
| | 17:40 | | | | | | | Air On |
| | 17:43 | 1350 | | | | | | Air off |

* Air hose keeps getting blown out of the hole, trying to find a method where there is enough weight on it, it will stay down. End up tying to truck. At 80psi (lowest compressor can do). Won't be able to surge, as well due to no bleed off value

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Page 2 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-TW-01-BR
**Observer:** TG / CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 13/17 + June 14/17
**Weather:** Sunny

| | Time | ~~Pumping Rate~~ Total L Purged ( ) | Depth to Water ( mGL ) | Conductivity ( µS/cm ) | Turbidity ( NTU ) | pH | Temperature ( °C ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 13 | 18:25 | 1280 | ~63 | | | | | Blow ~180L |
| | 19:00 | 1460 | | | | | | Blow ~180L |
| | 19:30 | 1640 | | | | | | Blow ~180L |
| | 20:00 | 1820 | | | | | | Blow ~180L |
| | 20:30 | 2000 | | | | | | Blow ~180L |
| | ~~08:30~~ | | | | | | | Pour 1 gallon Aquaclear in well overn |
| June 14 | 08:30 | | | | | | | Compressor on site |
| | 08:40 | | | | | | | Turn Air on |
| | 09:00 | 2500 | | | | | | Air off ~~~1000L~~ 500L |
| | 09:15 | | | | | | | Air on |
| | 09:19 | | | 542 | 32.3 | 8.29 | 26.1 | |
| | 09:21 | 2680 | | | | | | Air off, ~180L |
| | 09:40 | | | | | | | Air On |
| | 09:45 | | | 492.8 | 7.2 | 8.26 | 26.8 | |
| | 09:48 | | | | | | | Air off |
| | 10:14 | | | | | | | Air on |
| | 10:17 | | | 499.1 | 7.4 | 8.33 | 27.2 | Think samples are biased |
| | 10:44 | | | 543 | 8.4 | 8.58 | 28.8 | to low turbidity b/c I |
| | | | | | | | | have been unable to catch |
| | | | | | | | | enough water in the "big |
| | | | | | | | | blasts" instead collecting |
| | | | | | | | | from misting water |
| | 10:45 | 3035 | | | | | | Air off |
| | 11:15 | | | | | | | Air on |
| | 11:18 | | | 494.7 | 4.1 | 8.28 | 27.4 | |
| | 11:45 | 3235 | | 531 | 6.0 | 8.64 | 29.8 | Air off |
| | 12:50 | | | 491.9 | 4.3 | 8.24 | 27.5 | Air on |
| | 01:32 | 3435 | | 600 | 5.9 | 8.63 | 30.9 | Air off |
| | 1403 | 3635 | | 655 | 5.6 | 8.13 | 29.2 | AIR ON |
| | 14:30 | 3835 | | 682 | 5.3 | 8.60 | 31.1 | Air off |
| | 15:00 | | ~64 | | | | | Air on |
| | 15:04 | | | 525 | 4.8 | 8.27 | 29.8 | |
| | 15:31 | 4035 | | 584 | 6.9 | 8.59 | 31.9 | Air off |
| | 16:00 | | | 538 | 6.3 | 8.23 | 27.7 | Air on |
| | 16:30 | 4235 | | 510 | 4.5 | 8.60 | 30.6 | Air off |

Page 3 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-TW-01-BR
**Observer:** TG/CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 14/17 + June 15/17
**Weather:** Sunny

| | Time | Total L Purged Pumping ~~Rate~~ ( L ) | Depth to Water ( mGL ) | Conductivity ( µS/cm ) | Turbidity ( NTU ) | pH | Temperature ( °C ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 14 | 17:00 | | | 488.6 | 3.8 | 8.16 | 26.6 | Air On |
| | 17:18 | 4335 | | 517 | 4.2 | 8.62 | 29.1 | Air off |
| | 19:15 | | | | | | | Air On |
| | 19:45 | 4535 | | | | | | Air off |
| | 20:00 | | | | | | | Air On |
| | 20:30 | 4735 | | | | | | Air off |
| | 20:45 | | | | | | | Air On |
| | 21:15 | 4935 | | | | | | Air off |
| June 15 | 07:52 | | 36.66 | | | | | |
| | 07:55 | | | | | | 2 | |
| | 08:01 | | | | | | | Air On |
| | 08:01 | | | | | | | |
| | 08:29 | | | 1054 | 13.9 | 7.75 | 25.6 | |
| | 08:45 | 5435 | | 543 | 9.0 | 8.50 | 26.9 | |
| | 09:00 | | | 491.7 | 5.8 | 8.61 | 28.1 | |
| | 09:16 | | | 475.6 | 4.8 | 8.55 | 27.1 | Air off |
| | 09:30 | | | 493.4 | 4.1 | 8.64 | 287 | Air On |
| | 09:45 | 5700 | | 503 | 4.9 | 8.65 | 28.6 | |
| | | | | 507 | 8.4 | 8.61 | 28.8 | |
| | | | | | | | | |
| | 11:47 | | | | | | | Air off |
| | 14:14 | | 48.09 | | | | | 10:30 Air On |
| | 16:05 | | 39.81 | | | | | at SP-TW-01-SR |
| | 1835 | | 37.95 | | | | | |
| June 16 | 07:54 | | 36.67 | | | | | |
| | 10:07 | | 36.10 | | | | | |
| | 12:44 | | 36.07 | | | | | |
| | 14:45 | | 36.09 | | | | | |
| | 16:24 | | 36.10 | | | | | |
| | 07:29 | | 36.07 | | | | | |
| | | | 35.93 | | | | | |
| | | | | | | | | ~11:00 begin lowering Pump |
| | 13:50 | | | | | | | Test Pump at ~45m depth |
| | | | | | | | | It's working (14 risers in) |
| | 15:30 | | | | | | | Switch from using Rope to lower pump to using wire |

Golder Associates Inc.

0.15

Page 1 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-MW-01-SQ
**Project Number:** 1669332601
**Observer:** TG/CDL
**Project Name:** Sabajo
**Flow Measurement:**
**Date:** June 12/17 + June 13/17
**Static Water Level:**
**Weather:** Sunny 35°C
**Measuring Point:**

June 12

| Time | Total L purged<br>Pumping ~~Rate~~ ( ) | Depth to Water (mGL) | Conductivity (uS/cm) | Turbidity (NTU) | pH | Temperature (°C) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|
| 08:15 | | 35.64 | | | | | |
| 08:50 | | | | | | | Air on. Alternating |
| | | | | | | | on/off, ~20 sec |
| | | | | | | | on/10 off. Hose |
| | | | | | | | at 48 m, ~4L/min |
| 09:45 | 220 | | | | | | Air off |
| 09:47 | | 36.66 | | | | | |
| 10:03 | | | | | | | Air on. Alternating air on/ |
| 10:45 | 400 | 35.80 | | | | | Air off |
| 11:00 | | | | | | | Air on |
| 11:32 | 520 | ~~36.05~~ | | | | | Air off |
| 11:42 | | 36.05 | | | | | |
| 13:01 | | 35.61 | | | | | |
| 13:20 | | | | | | | ~~Air~~ |
| 13:35 | | | 61.7 | 276 | 8.11 | 28.9 | Air on, Run continously ~6L/min |
| 13:53 | 718 | | 160.1 | 25.9 | 7.85 | 27.9 | Air off |
| 14:15 | | | | | | | Air on continously |
| 14:30 | | | 158.9 | 22.6 | 7.76 | 27.7 | |
| 14:33 | | | 164.7 | 74.0 | 7.59 | 26.2 | |
| 14:47 | | | 133.8 | 13.8 | 7.62 | 26.3 | |
| 15:00 | 988 | | 126.5 | 13.6 | 7.44 | 26.1 | |
| 15:07 | | 35.88 | | | | | Air off |
| 15:15 | | | | | | | |
| 15:30 | | | 135.9 | 21.4 | 7.55 | 25.9 | Air on |
| 15:45 | | | 118.8 | 23.8 | 7.48 | 26.0 | |
| 15:58 | | | | | | | |
| 16:00 | 1258 | | 113.7 | 20.3 | 7.35 | 25.7 | |
| 16:02 | | ~~36.45~~ | | | | | Air off |
| | | 35.97 | | | | | |
| 16:15 | | | | | | | |
| 16:30 | | | 119.5 | 34.2 | 7.47 | 26.5 | Air on |
| 16:45 | | | 144.5 | 44.0 | 7.50 | 26.1 | |
| 17:00 | 1528 | | 116.6 | 31.8 | 7.46 | 26.0 | |
| 07:50 | | 35.60 | | | | | Air off |
| 08:10 | | | | | | | |
| | | | ~~252.7~~ | ~~18.7~~ | ~~6.23~~ | ~~24.9~~ | Air on |

June 13

Page 2 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-MW-01-SQ
**Project Number:** 166932601
**Observer:** TG/CDL
**Project Name:** Sabajo
**Flow Measurement:**
**Date:** June 13/17 + June 14/17
**Static Water Level:**
**Weather:** Sunny
**Measuring Point:**

Total L produced

| Time | Pumping Rate ( L ) | Depth to Water ( mGL ) | Conductivity (µS/cm) | Turbidity (NTU) | pH | Temperature ( °C ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|
| 08:23 | | | 252.7 | 18.7 | 6.23 | 24.9 | |
| 08:37 | | | | | | | Turn air off b/c big |
| 08:41 | | | | | | | compressor on site, needs |
| 08:45 | | | 142.9 | 9.6 | 6.93 | 25.8 | truck moved, Air back on 08:41 |
| 08:57 | | | 127.5 | 12.5 | 7.14 | 25.5 | |
| 09:00 | 1798 | | | | | | Air off |
| 09:15 | | | | | | | Air on |
| 09:30 | | | 116.7 | 10.0 | 7.18 | 26.2 | |
| 09:47 | | | 104.2 | 9.8 | 7.22 | 26.2 | |
| 10:00 | 2068 | | 100.7 | 7.0 | 7.18 | 26.1 | Air off<br>10:34 Dev starts |
| 10:38 | | | | | | | Air on<br>at SP-TW-01-BR |
| 10:58 | | | 111.8 | 8.2 | 7.20 | 26.6 | |
| 11:16 | | | 95.3 | 6.1 | 7.28 | 26.6 | |
| 11:27 | | | 91.7 | 6.70 | 7.20 | 26.2 | |
| 11:30 | 2380 | | | | | | Air off |
| 14:00 | | | | | | | Air on |
| 14:15 | | | 108.7 | 8.4 | 7.24 | 27.6 | |
| 14:30 | | | 98.5 | 7.8 | 7.30 | 27.0 | |
| 14:45 | 2650 | | 93.8 | 12.5 | 7.25 | 26.0 | Air off |
| 15:05 | | | 91.6 | 10.7 | 7.26 | | Air on |
| 15:16 | | | | | | 26.3 | |
| 15:32 | | | 96.9 | 9.6 | 7.24 | 26.6 | |
| 15:48 | | | 83.9 | 7.7 | 7.28 | 27.3 | |
| 15:50 | 2920 | | | | | | Air off |
| 16:00 | | | | | | | Air on |
| 16:17 | | | 82.9 | 8.2 | 7.25 | 26.6 | |
| 16:30 | | | 78.4 | 7.1 | 7.13 | 26.1 | |
| 16:45 | 3190 | | 76.9 | 8.3 | 7.07 | 26.3 | Air off |
| 17:00 | | | | | | | Air on |
| 17:20 | | | 85.8 | 10.8 | 7.19 | 26.1 | |
| 17:22 | | | | | | | Air off, rain |
| 08:10 | | 35.63 | | | | | incoming. |
| 11:33 | | 35.61 | | | | | |
| 14:38 | | 35.64 | | | | | |
| 17:05 | | 35.64 | | | | | |

June 13

June 14

Yesterday we cut the air hose on the side of the well ∴ using a pipe clamp to secure it today ∴ not able to get WL tape past it

**Golder Associates Inc.**

Page 3 of

# WELL DEVELOPMENT FORM

**Well ID:** SP-MW-01-SQ
**Observer:** TG/CDL
**Flow Measurement:**
**Static Water Level:**
**Measuring Point:**

**Project Number:** 166932601
**Project Name:** Sabajo
**Date:** June 15/17
**Weather:**

June 16

| Time | Pumping Rate ( ) | Depth to Water (mGL) | Conductivity ( ) | Turbidity ( ) | pH | Temperature ( ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|
| 07:35 | | 35.63 | | | | | |
| | | | | | | | |
| | | | | | | | 10:30 Air on |
| 11:45 | | 35.67 | | | | | at SP-TW-01-SR |
| 14:12 | | 35.70 | | | | | |
| 16:03 | | 35.71 | | | | | |
| 18:33 | | 35.73 | | | | | |
| 07:56 | | 35.65 | | | | | |
| 10:05 | | 35.71 | | | | | |
| 12:47 | | 35.71 | | | | | |
| 14:43 | | 35.73 | | | | | |
| 16:21 | | 35.74 | | | | | |
| 07:25 | | 35.63 | | | | | |
| 13:05 | | 35.75 | | | | | |
| 14:15 | | 35.75 | | | | | |

# WELL DEVELOPMENT FORM

**Well ID:** SP-MW-01-BR

**Observer:** TG/CDL

**Flow Measurement:**

**Static Water Level:** 36.44 mTOC

**Measuring Point:**

**Project Number:** 166932601

**Project Name:** Sabajo

**Date:** June 12

**Weather:**

| | Time | Pumping Rate ( ) | Depth to Water (mTOC) | Conductivity ( ) | Turbidity ( ) | pH | Temperature ( ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|---|
| June 12 | 13:18 | | 36.44 | | | | | 08:50 Dev starts |
| | 15:11 | | 36.44 | | | | | at SP-MW-01-SQ |
| | 16:08 | | 36.45 | | | | | |
| | 17:18 | | 36.43 | | | | | |
| June 13 | 08:00 | | 36.41 | | | | | |
| | 10:28 | | 36.40 | | | | | 10:34 Dev starts at |
| | 11:32 | | 36.45 | | | | | SP-TW-01-BR |
| | 13:50 | | 37.08 | | | | | |
| | 15:08 | | 37.10 | | | | | |
| | 16:56 | | 37.60 | | | | | |
| June 14 | 08:06 | | 37.11 | | | | | |
| | 11:31 | | 37.47 | | | | | |
| | 14:35 | | 38.18 | | | | | |
| | 17:03 | | 38.58 | | | | | |
| June 15 | 07:32 | | 37.27 | | | | | |
| | | | | | | | | 10:36 Dev Starts at |
| | | | | | | | | SP-TW-01-SR |
| | 11:43 | | 37.91 | | | | | |
| | 14:10 | | 37.72 | | | | | |
| | 16:01 | | 37.71 | | | | | |
| | 18:31 | | 37.72 | | | | | |
| June 16 | 07:48 | | 36.72 | | | | | |
| | 10:04 | | 36.62 | | | | | |
| | 12:50 | | 36.63 | | | | | |
| | 14:41 | | 36.65 | | | | | |
| | 16:19 | | 36.65 | | | | | |
| | 07:23 | | 36.59 | | | | | |
| | 13:01 | | 36.56 | | | | | |
| | 14:12 | | 36.58 | | | | | |
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Water levels

# WELL DEVELOPMENT FORM

**Well ID:**

**Observer:**

**Flow Measurement:**

**Static Water Level:**

**Measuring Point:**

**Project Number:** 166932601

**Project Name:** Sabajo

**Date:** June 17/17

**Weather:**

| Time | Pumping Rate ( ) | Depth to Water ( mGL ) | Conductivity ( ) | Turbidity ( ) | pH | Temperature ( ) | Notes (e.g. pump on/off, color, smell, etc.) |
|---|---|---|---|---|---|---|---|
| 07:47 | | 20.78 | | | | | SP-MW-02-BR |
| 07:49 | | 18.18 | | | | | SP-MW-02-SR |
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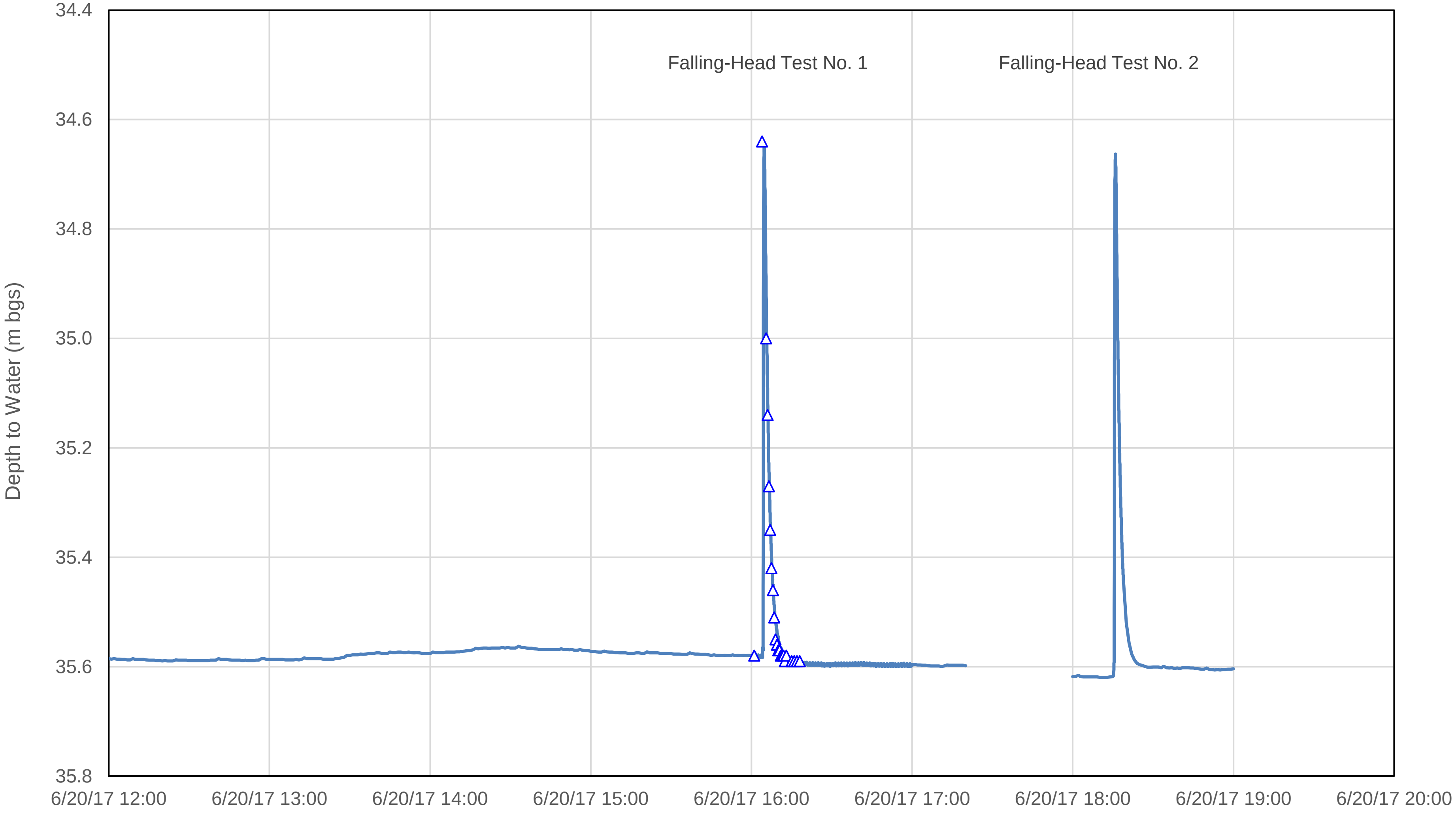
## APPENDIX D

# Slug Tests



LEGEND

— Transducer Data

△ Manual Water Level Reading

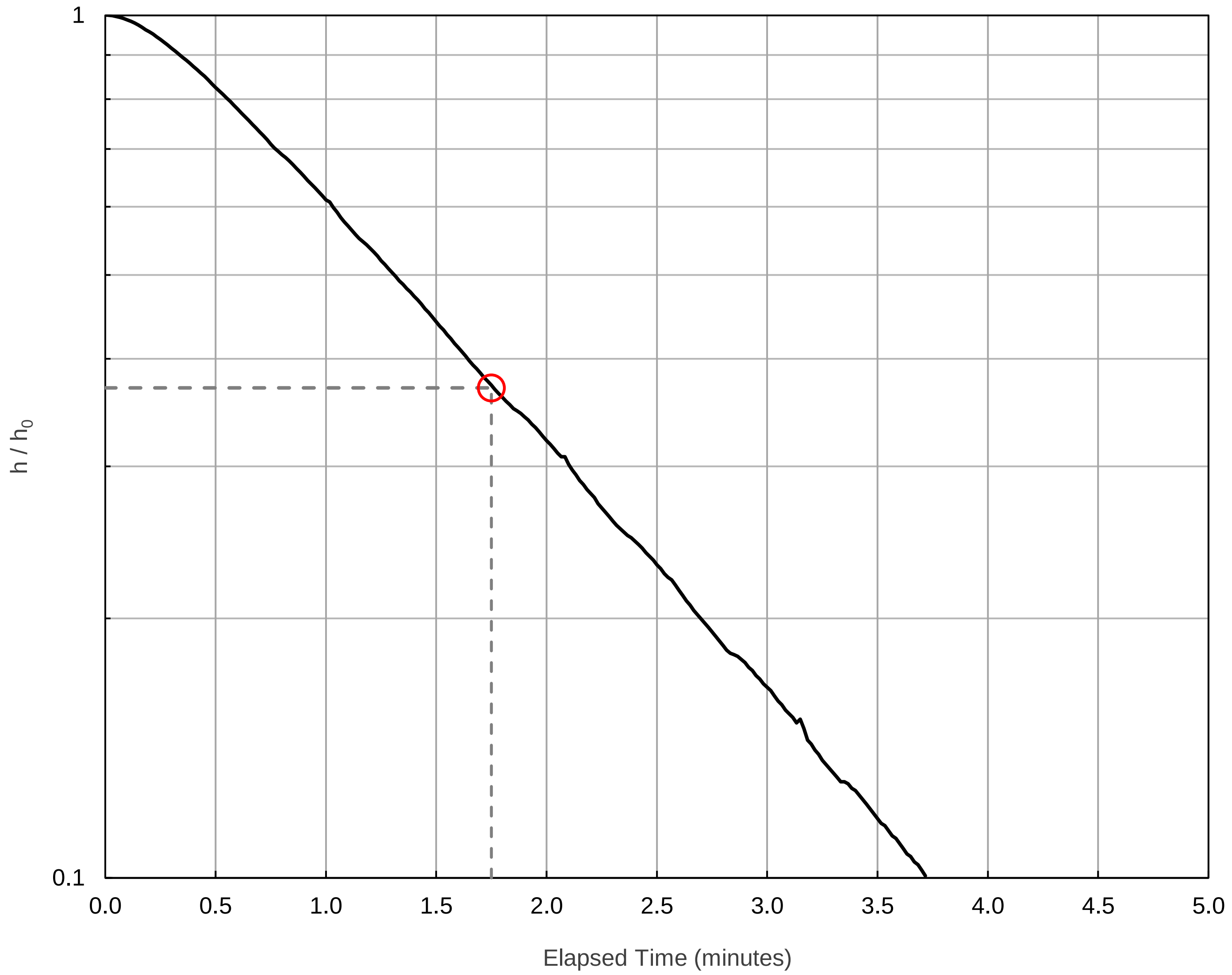
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-01-SQ SLUG TESTS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-1 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

K = 9.7 x $10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 18 meters
$t_{37}$ = 1.75 minutes

LEGEND

— Test Data

CLIENT
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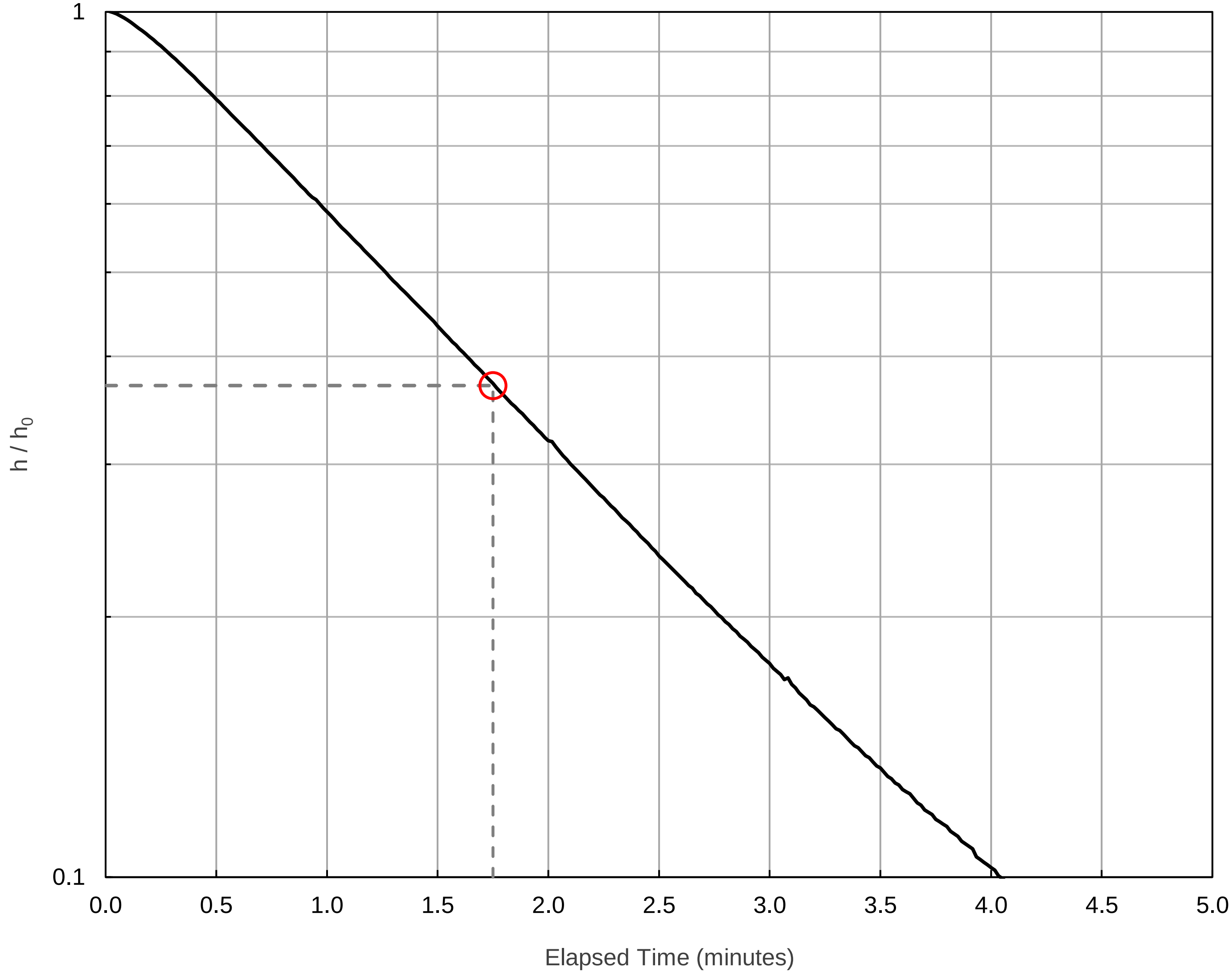
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-01-SQ SLUG TEST NO. 1 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-2 |



**Hvorslev Method**

$K = r^2\ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 9.7 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 18 meters
$t_{37}$ = 1.75 minutes

LEGEND

— Test Data

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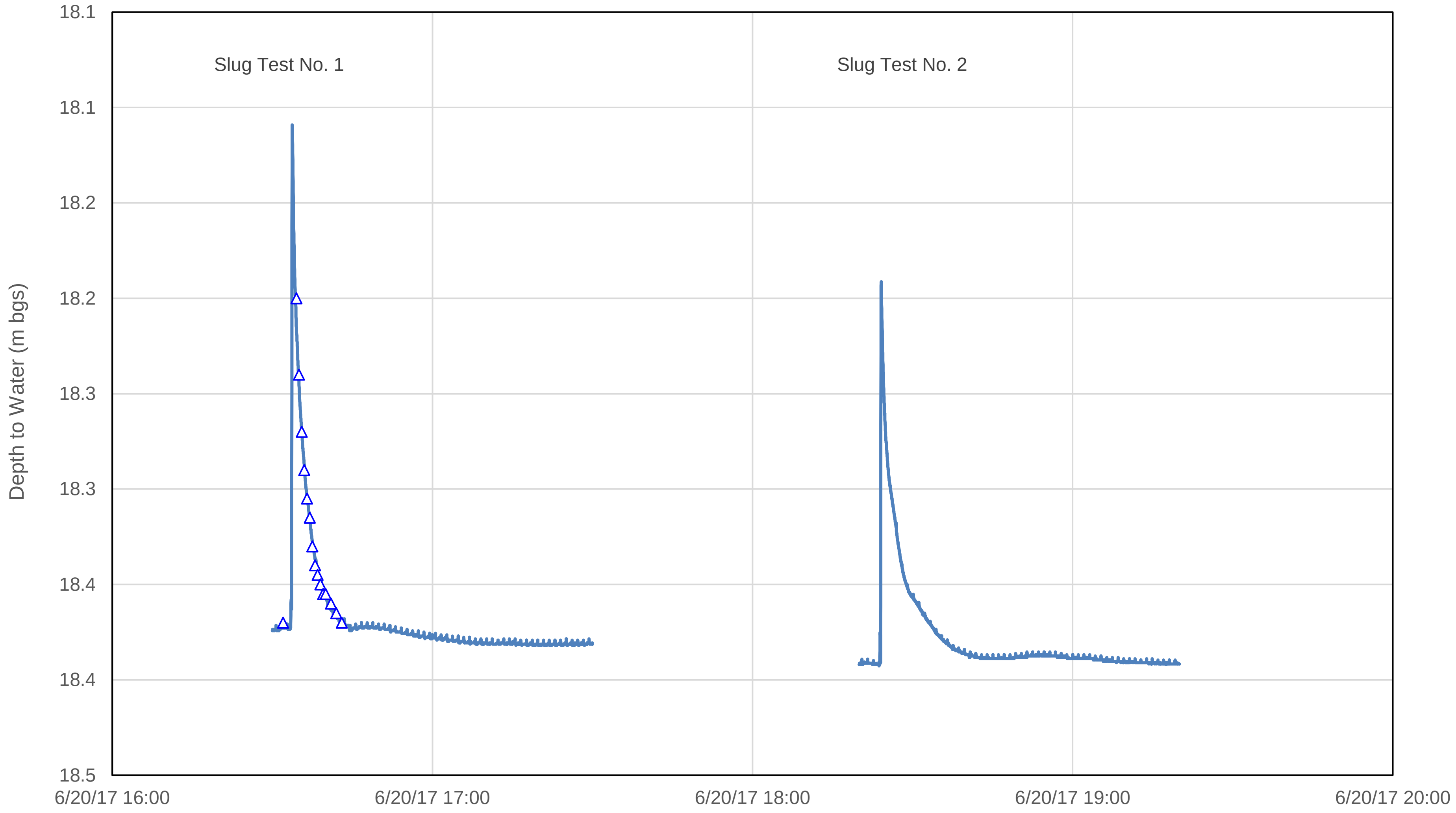
PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

CONSULTANT
GOLDER

TITLE
**SP-MW-01-SQ SLUG TEST NO. 2 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-3 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-MW-02-SR Slug Tests-RevB.xlsx



LEGEND

— Transducer Data

△ Manual Water Level Reading

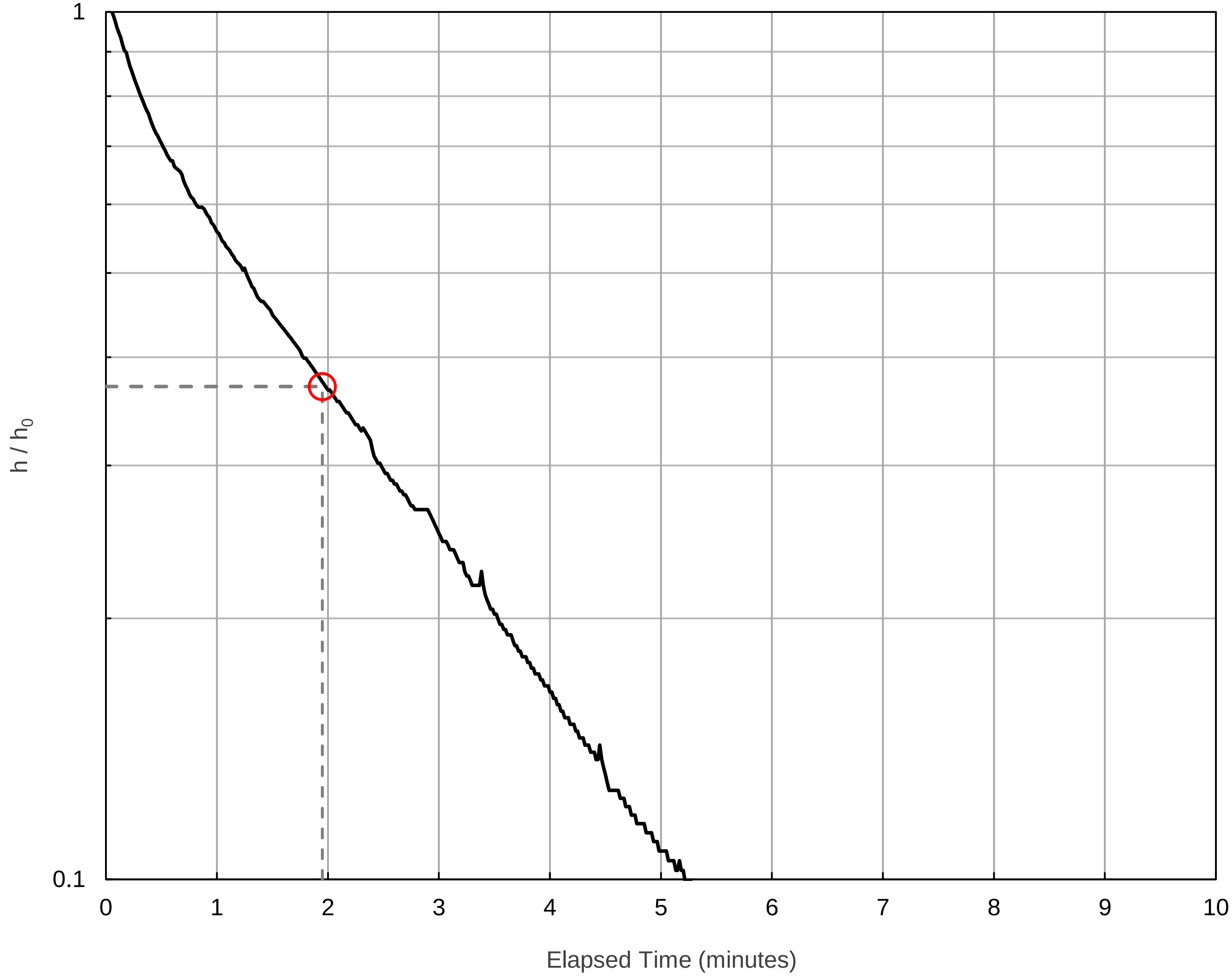
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-SR SLUG TESTS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-4 |



**Hvorslev Method**

$K = r^2\ln(L_e/R)/2L_et_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 8.3 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 19 meters
$t_{37}$ = 1.95 minutes

LEGEND

— Test Data

CLIENT
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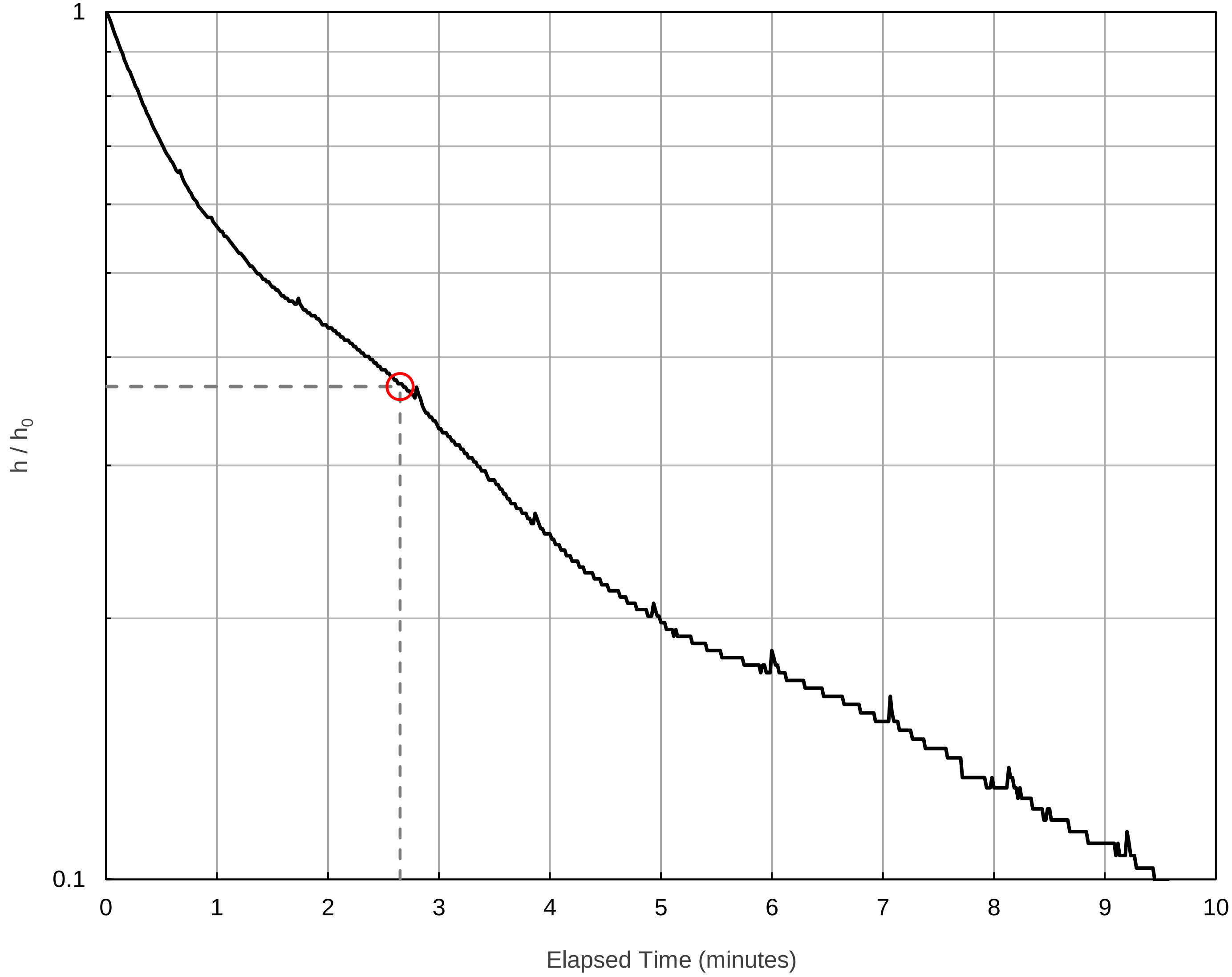
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-SR SLUG TEST NO. 1 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-5 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 6.1 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 19 meters
$t_{37}$ = 2.65 minutes

LEGEND

— Test Data

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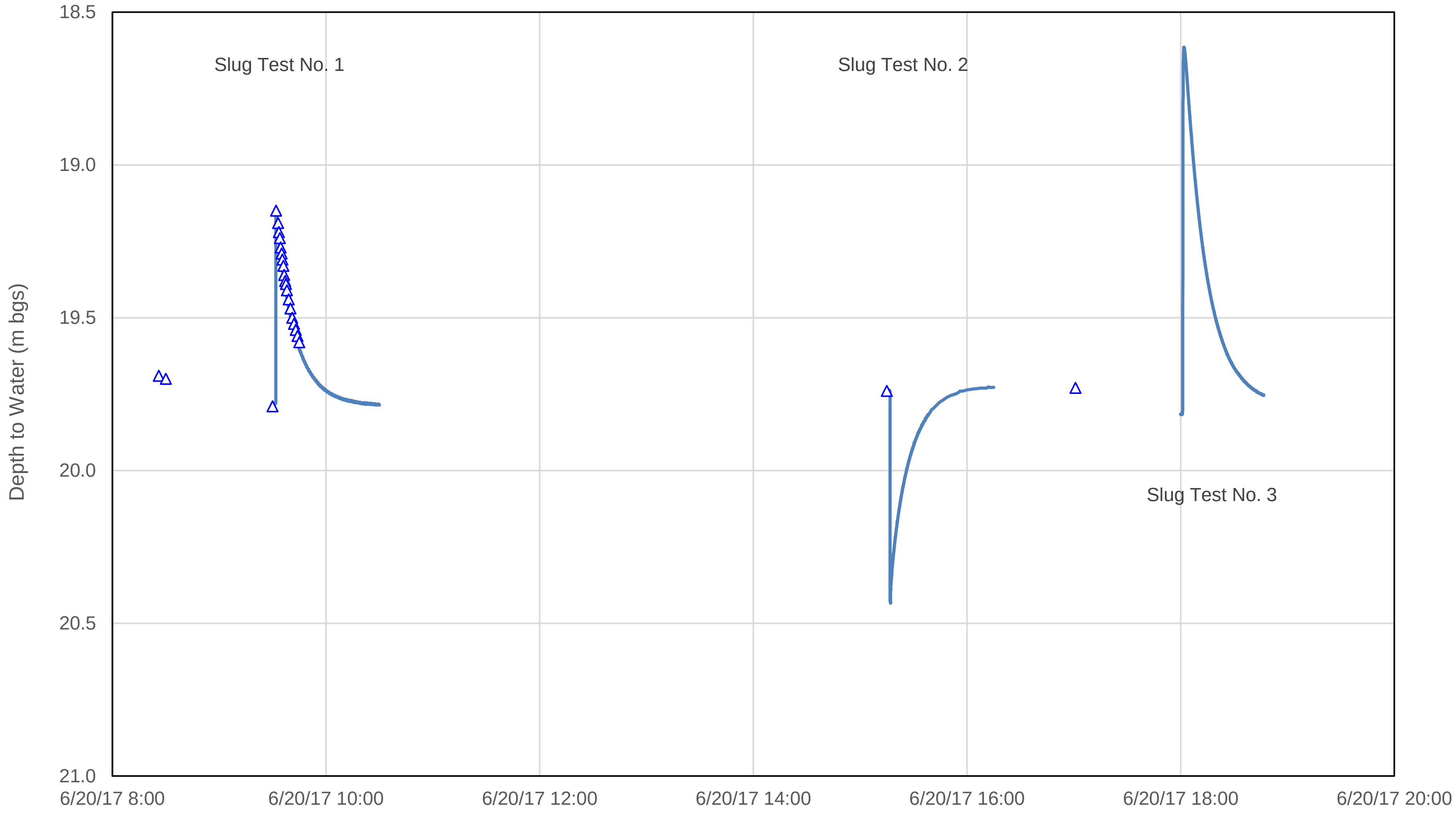
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-SR SLUG TEST NO. 2 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-6 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-MW-02-BR Slug Tests-RevB.xlsx



LEGEND

— Transducer Data

△ Manual Water Level Reading

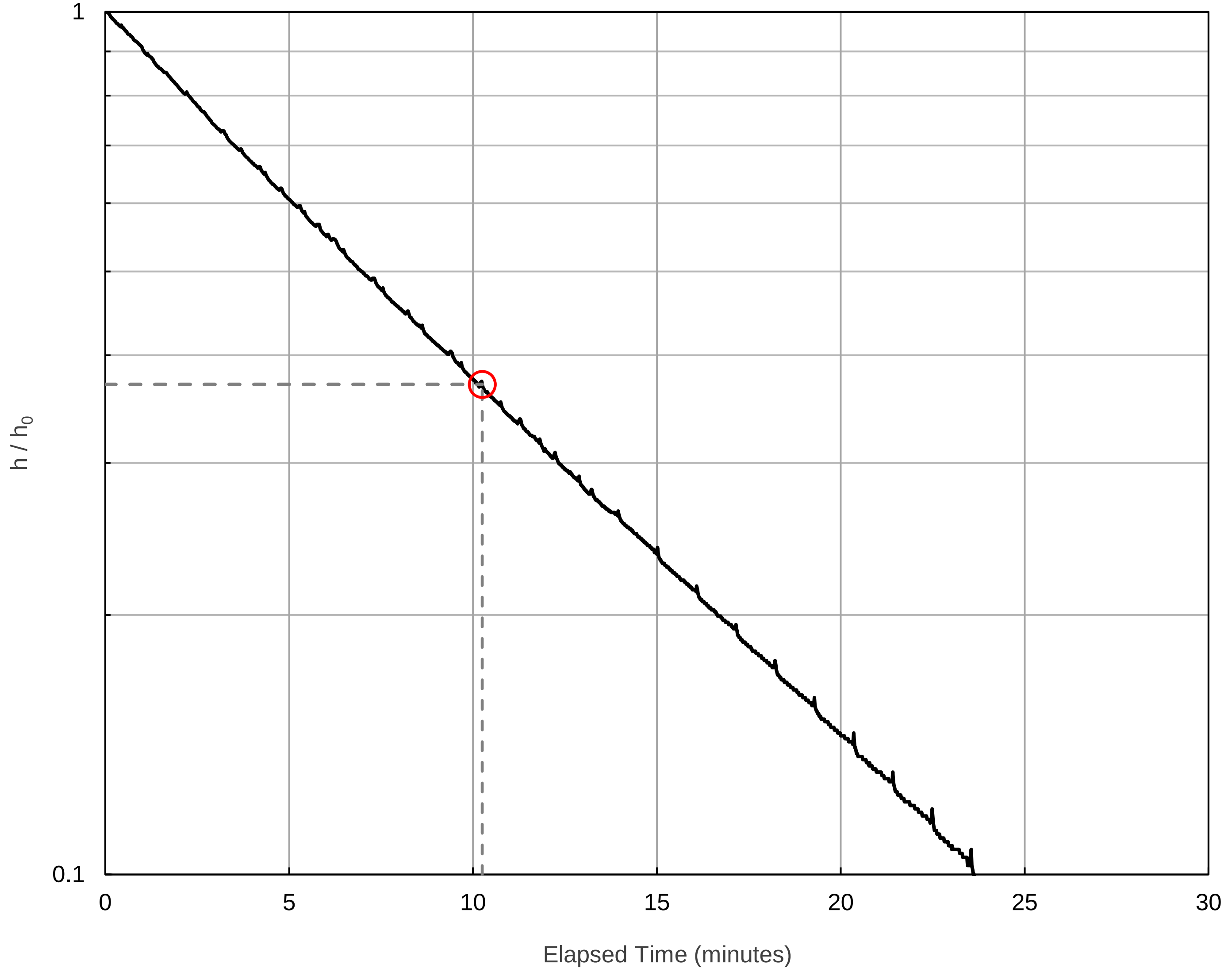
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-BR SLUG TESTS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-7 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 1.4 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 23 meters
$t_{37}$ = 10.25 minutes

LEGEND

— Test Data

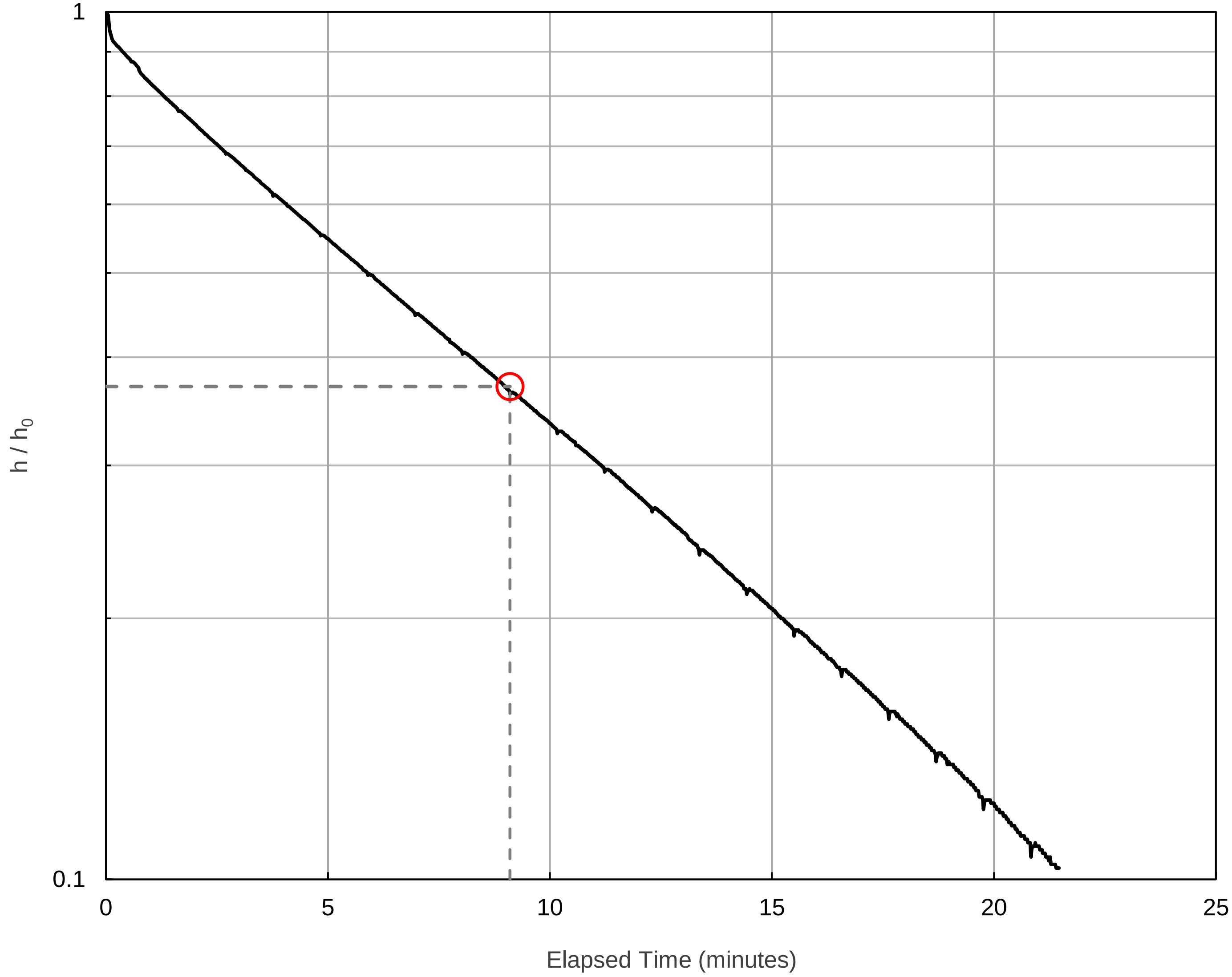
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-BR SLUG TEST NO. 1 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-8 |



**Hvorslev Method**

K = $r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

K = $1.5 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 23 meters
$t_{37}$ = 9.1 minutes

LEGEND

— Test Data

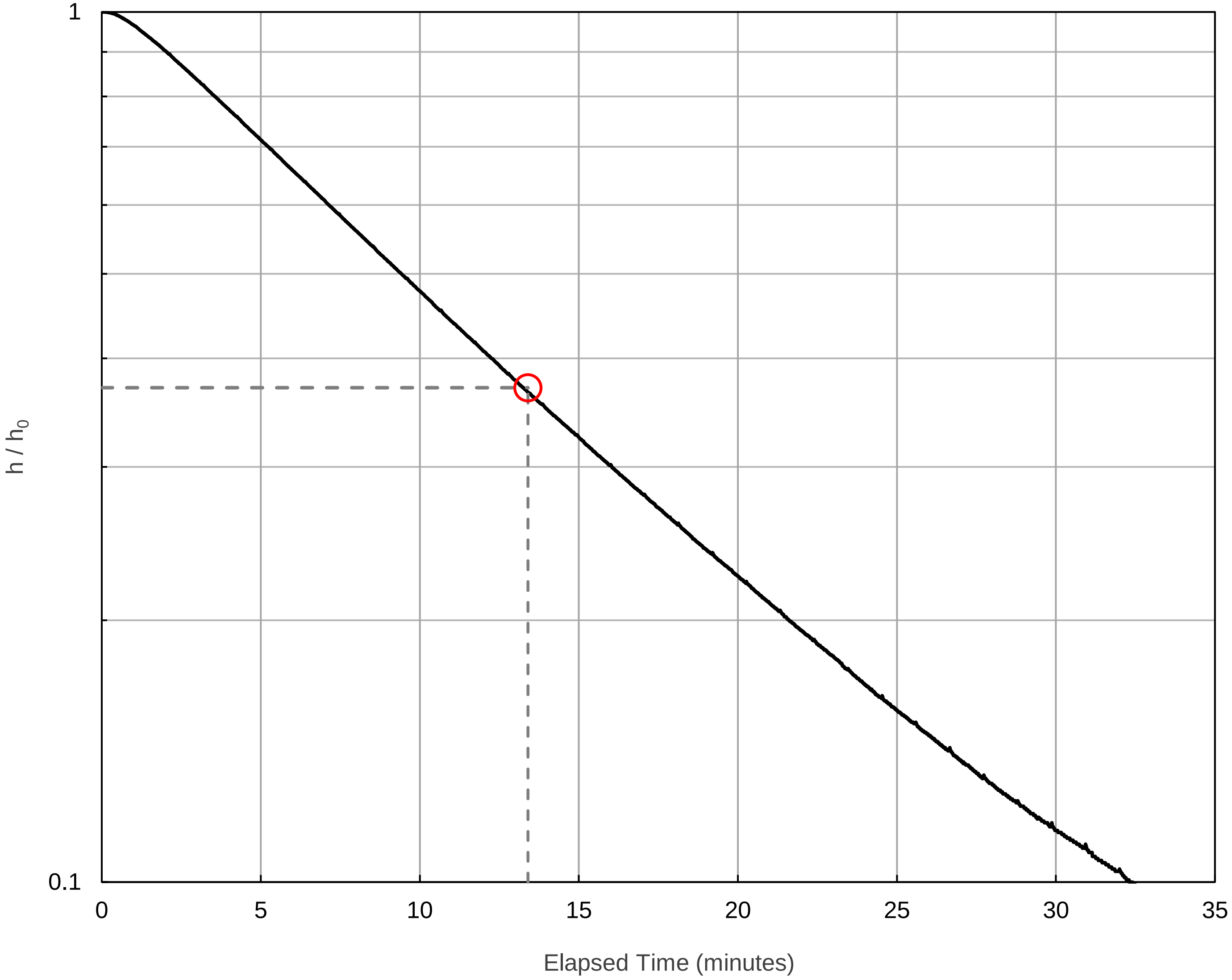
CLIENT
NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

CONSULTANT
GOLDER

TITLE
**SP-MW-02-BR SLUG TEST NO. 2 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-9 |



**Hvorslev Method**

$K = r^2\ln(L_e/R)/2L_et_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 1.0 \times 10^{-5}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 23 meters
$t_{37}$ = 13.4 minutes

LEGEND

— Test Data

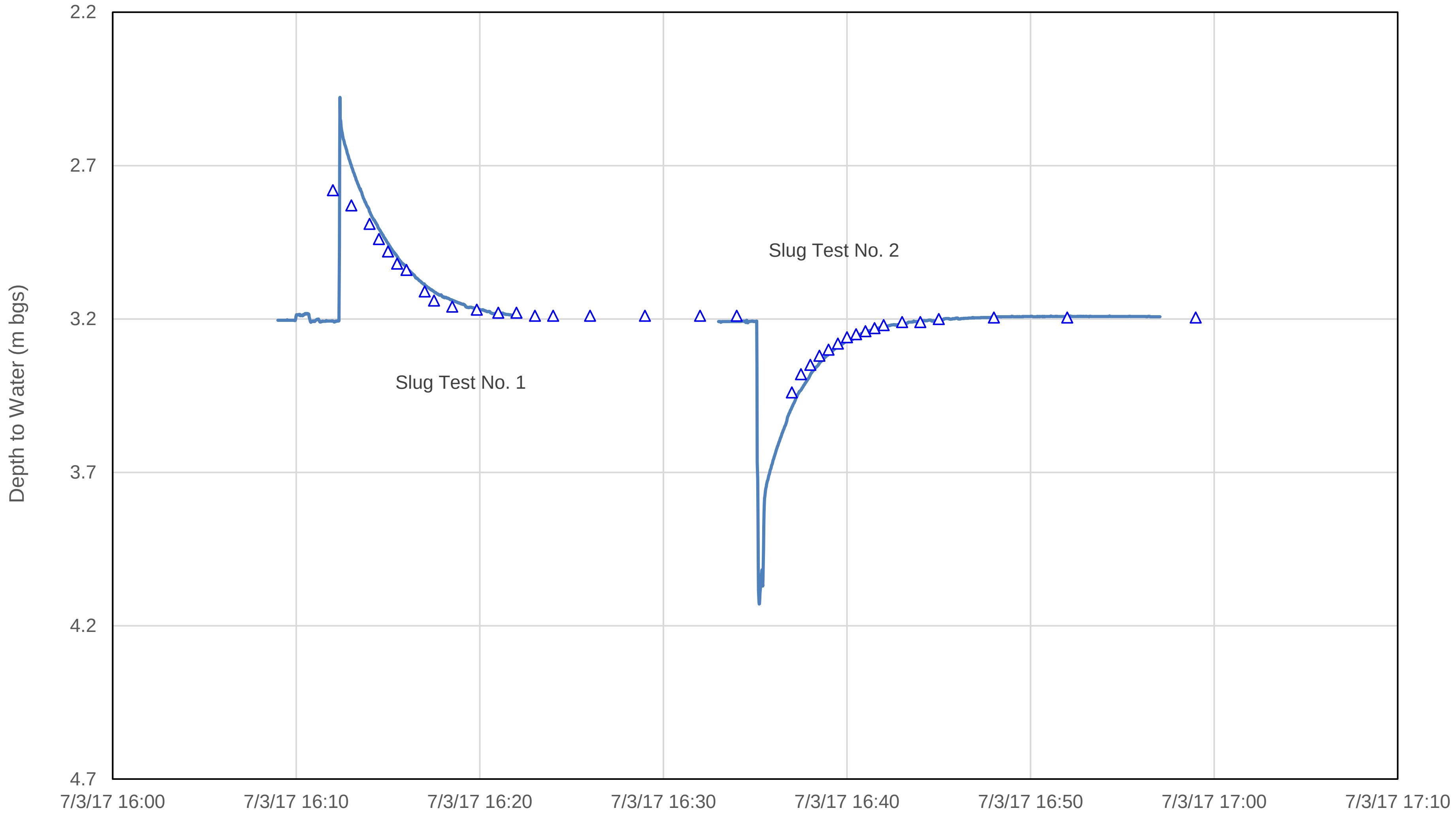
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-MW-02-BR SLUG TEST NO. 3 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-10 |



LEGEND

— Transducer Data

△ Manual Water Level Reading

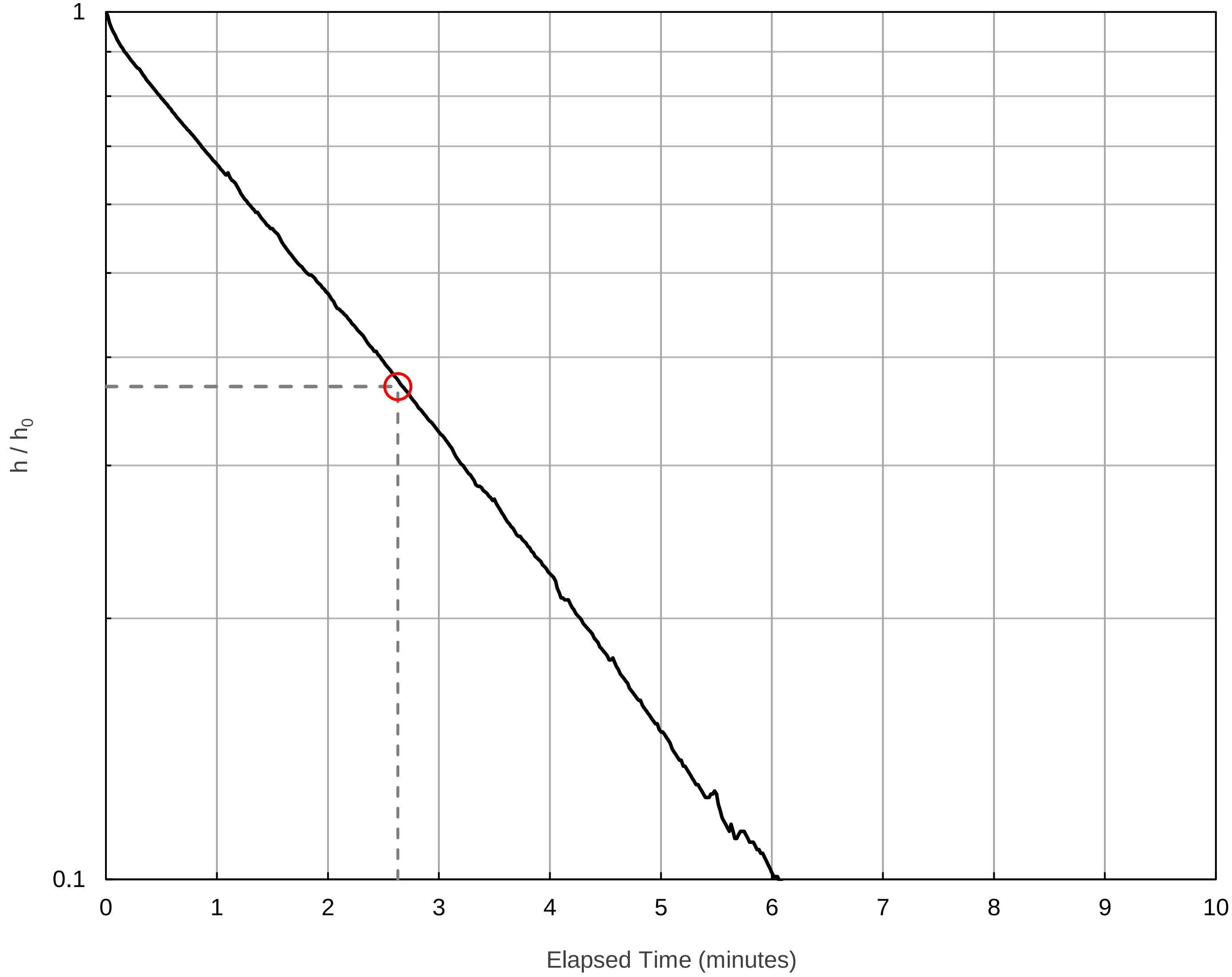
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SQ SLUG TESTS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-11 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 1.1 \times 10^{-4}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 9.0 meters
$t_{37}$ = 2.63 minutes

LEGEND

— Test Data

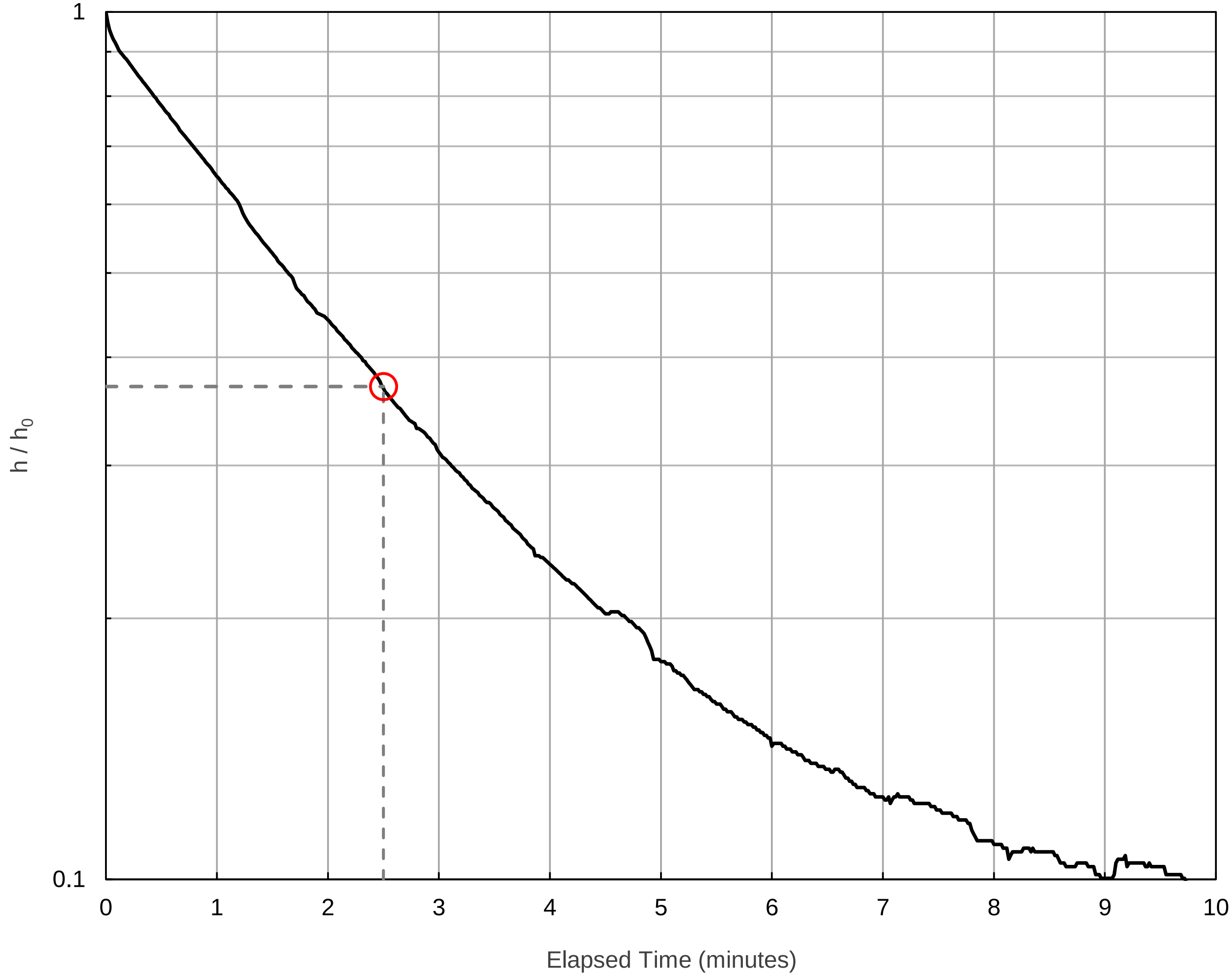
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SQ SLUG TEST NO. 1 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-12 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 1.2 \times 10^{-4}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 9.0 meters
$t_{37}$ = 2.50 minutes

LEGEND

— Test Data

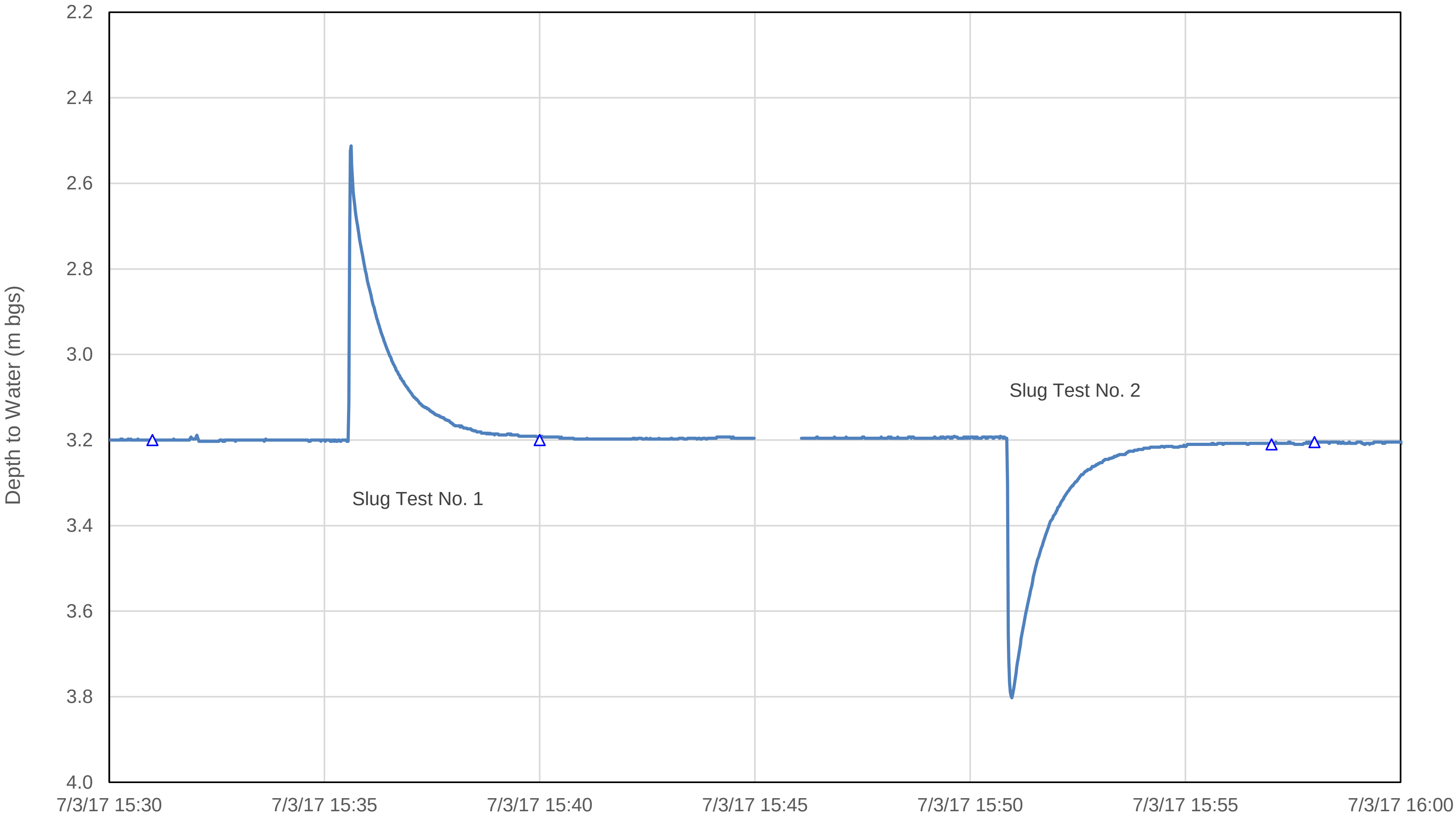
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SQ SLUG TEST NO. 2 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-13 |



LEGEND

— Transducer Data

△ Manual Water Level Reading

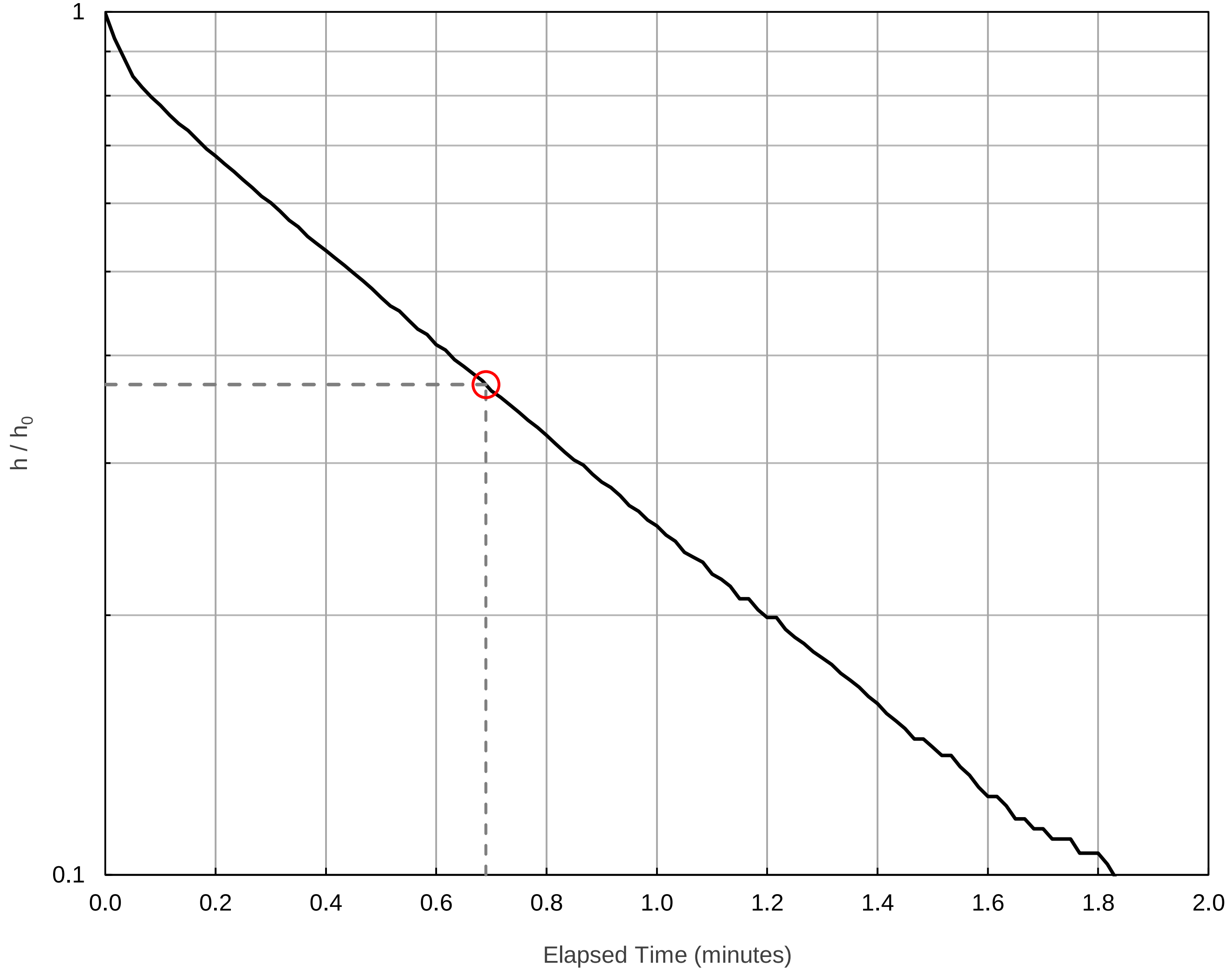
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SR SLUG TESTS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-14 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

$K = 4.2 \times 10^{-4}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 9.4 meters
$t_{37}$ = 0.69 minutes

LEGEND

— Test Data

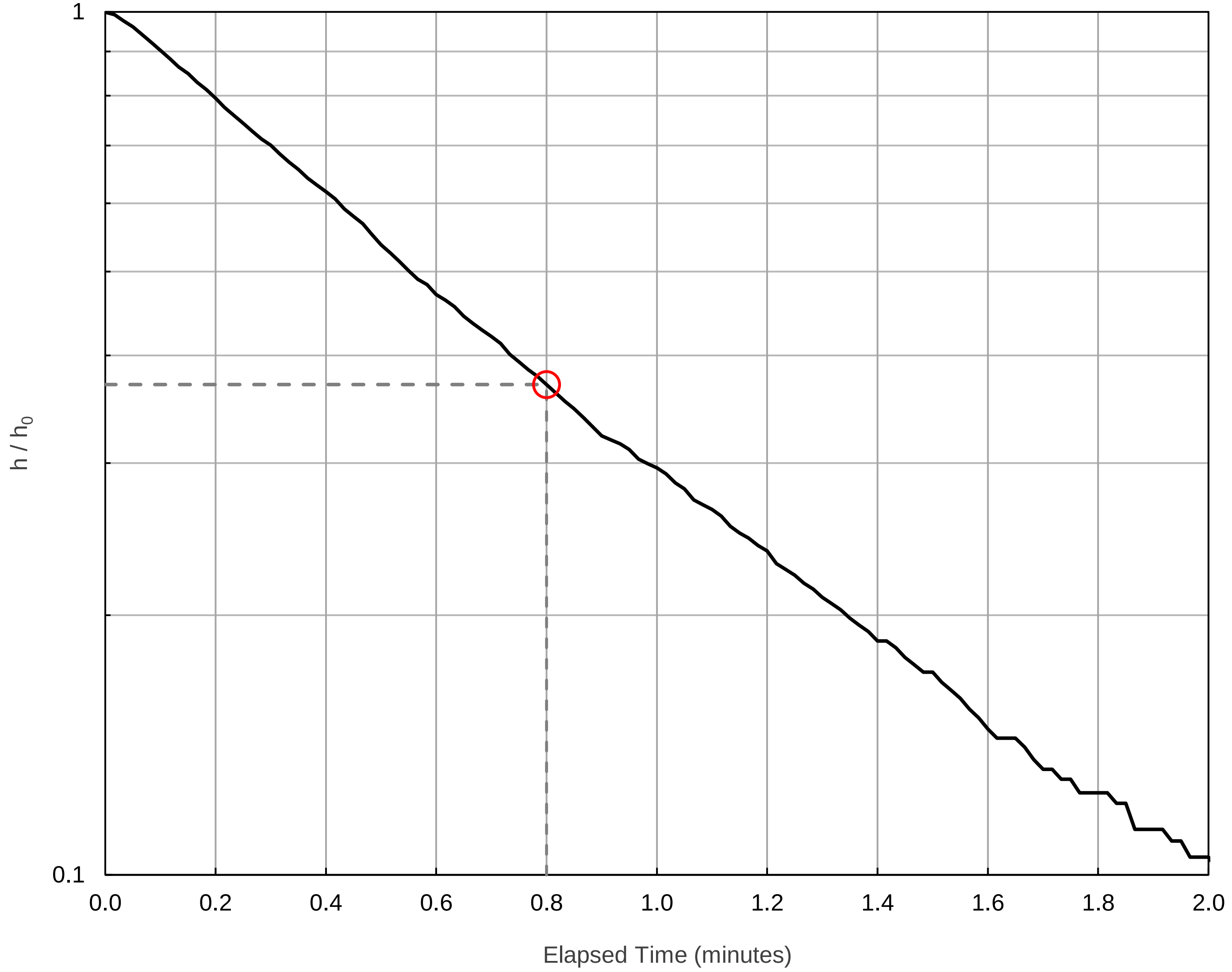
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SR SLUG TEST NO. 1 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-15 |



**Hvorslev Method**

$K = r^2 \ln(L_e/R)/2L_e t_{37}$

K - hydraulic conductivity
r - radius of well casing
R - radius of filter pack
$L_e$ - length of filter pack
$t_{37}$ - time when $h/h_0 = 0.37$
h - displaced head
$h_0$ - initial displaced head

**Slug Test Analysis:**

K = 3.6 x $10^{-4}$ cm/s

r = 0.025 meters
R = 0.061 meters
$L_e$ = 9.4 meters
$t_{37}$ = 0.80 minutes

LEGEND

— Test Data

CLIENT
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GOLDER

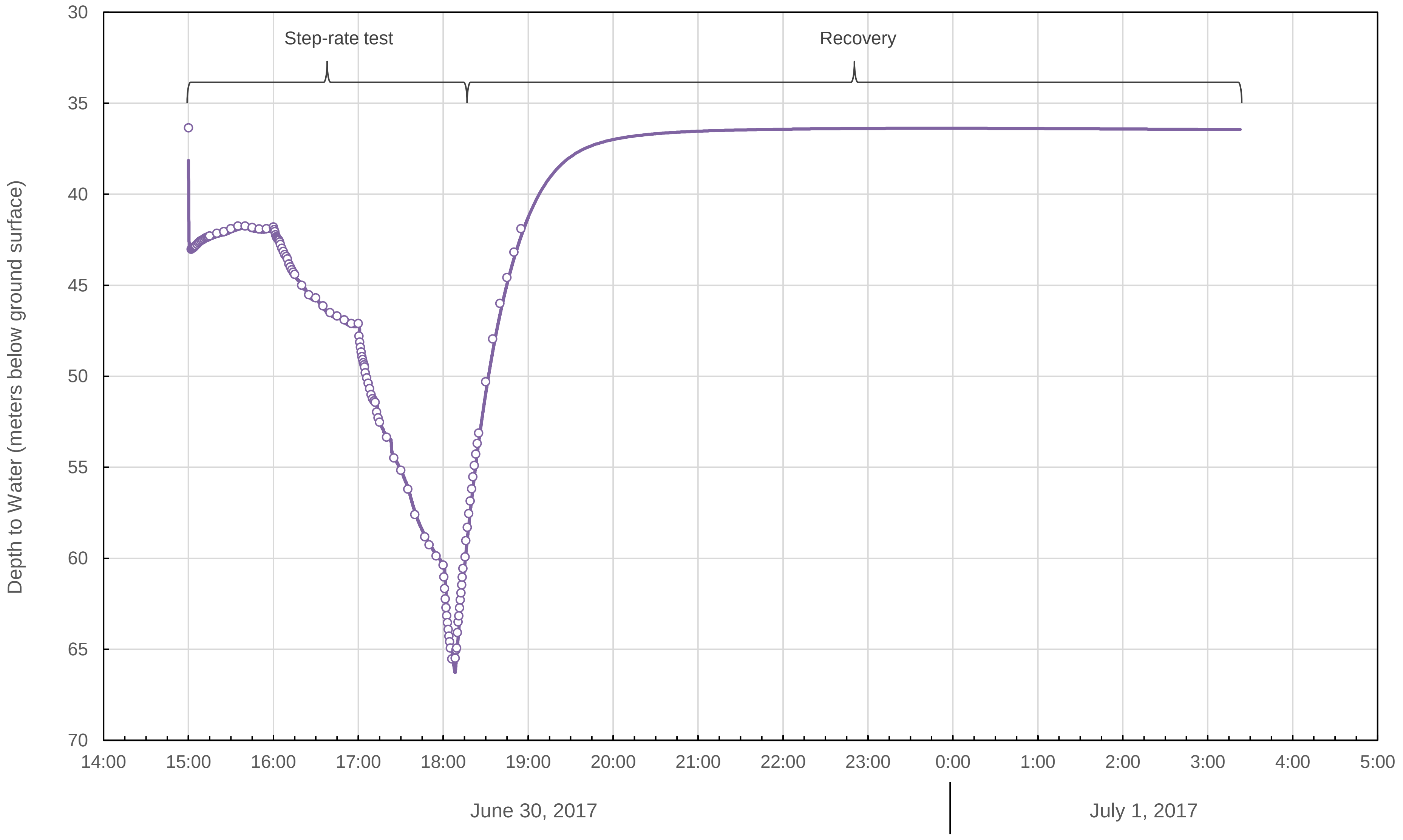
PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**WRD-MW-01-SR SLUG TEST NO. 2 ANALYSIS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | D-16 |

## APPENDIX E

# Pumping Tests



LEGEND

━ Transducer Data

○ Manual Readings

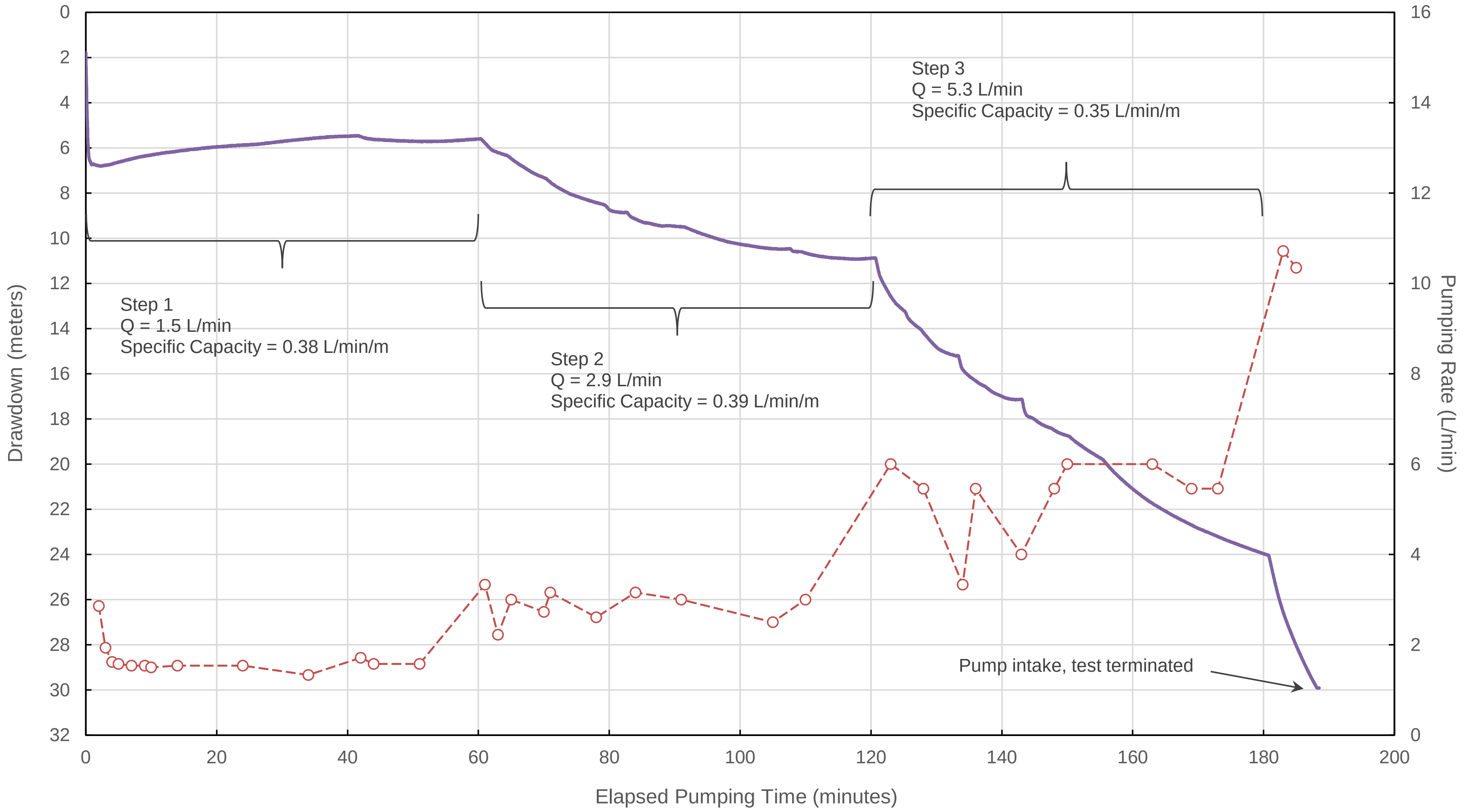
CLIENT
NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

CONSULTANT
GOLDER

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-1 |



LEGEND

CLIENT
NEWMONT SURINAME, LLC

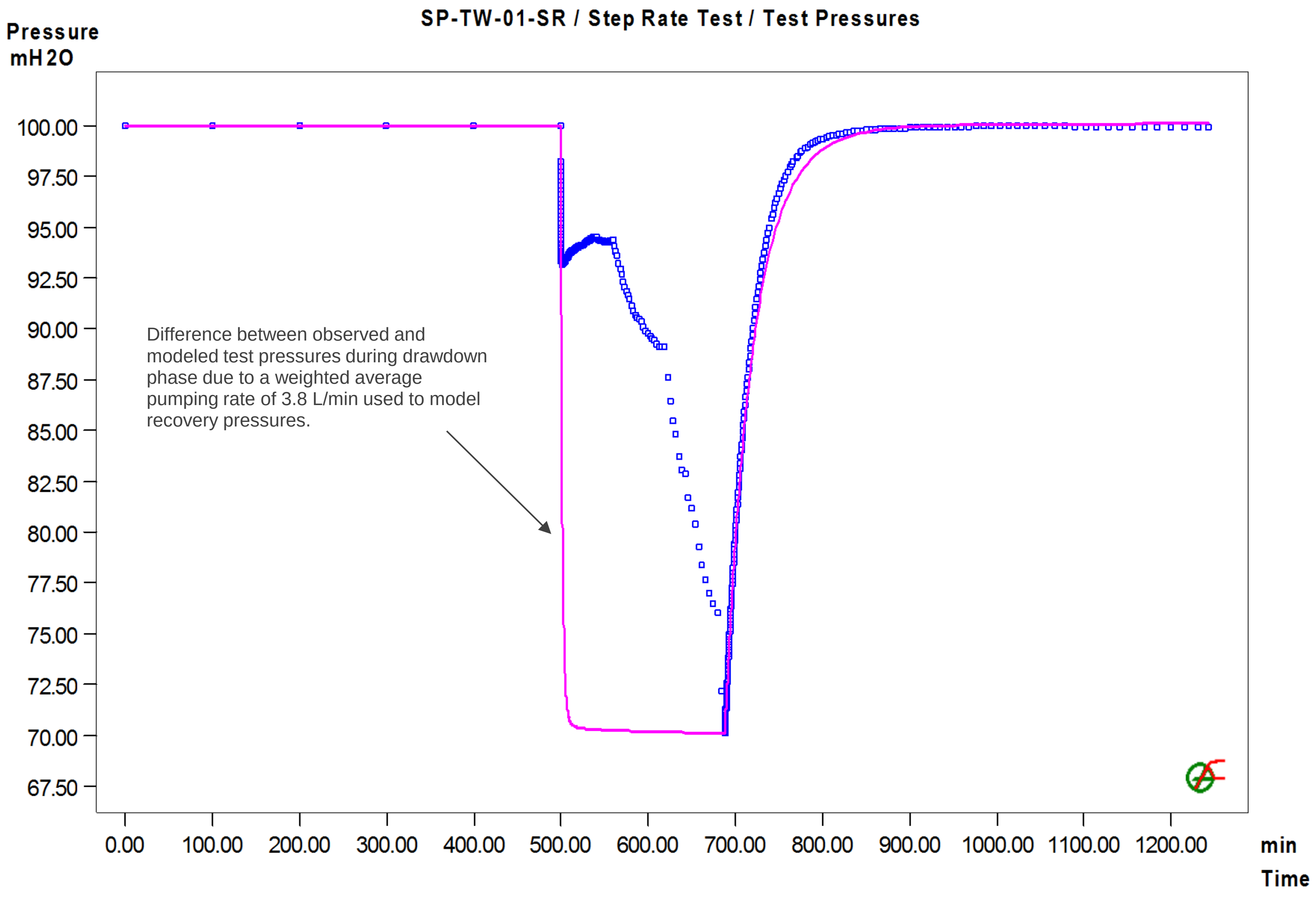
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST**
**DRAWDOWN AND PUMPING RATE VERSUS TIME**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-2 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-SR_SRT_20180314.xlsx



Difference between observed and modeled test pressures during drawdown phase due to a weighted average pumping rate of 3.8 L/min used to model recovery pressures.

LEGEND

□ Test Pressure

— Test Pressure Model

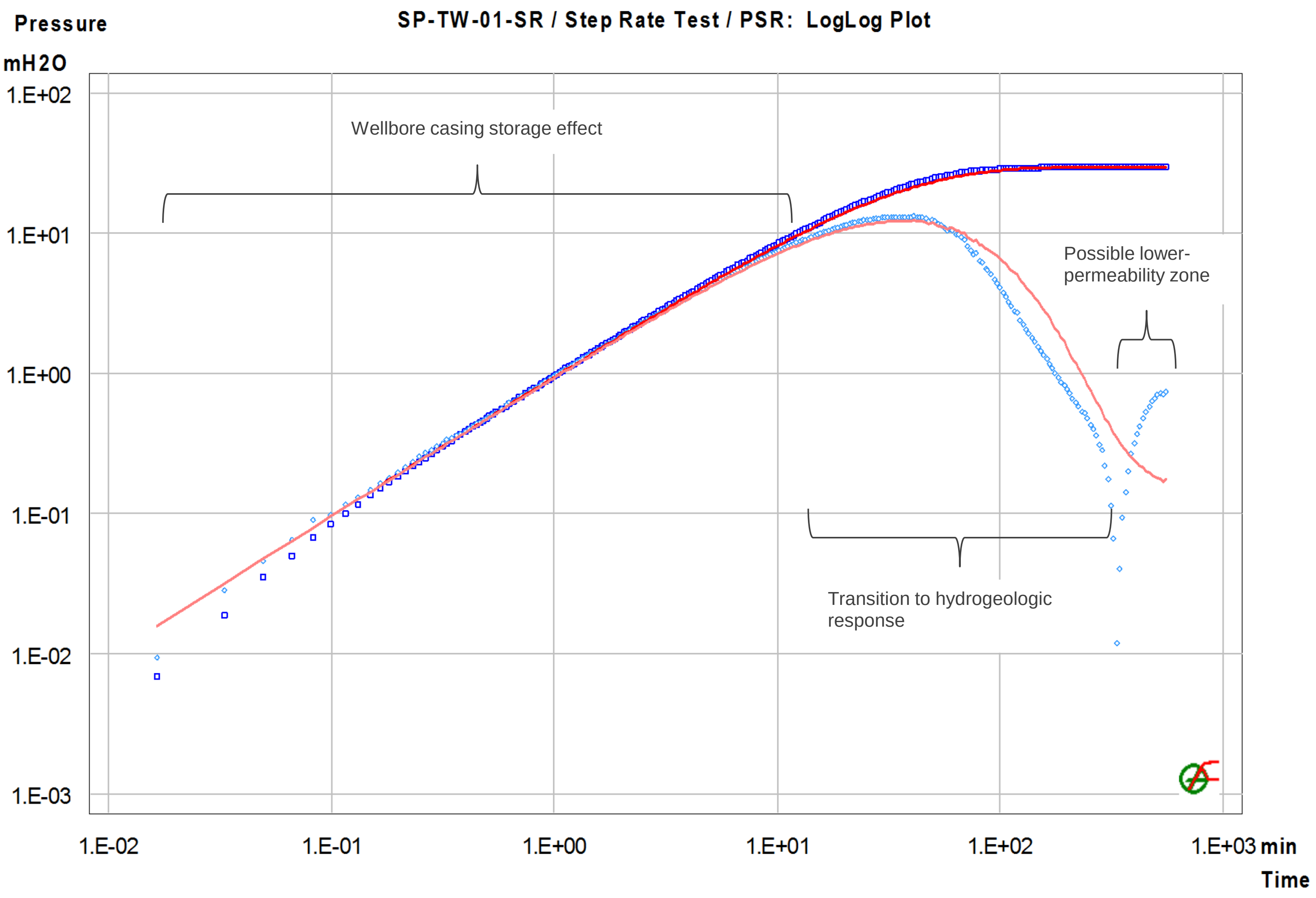
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST**
**OBSERVED VERSUS MODELED TEST PRESSURES**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-3 |



LEGEND

- ◻ Test Pressure
- ◇ Pressure Derivative
- 🟥 Test Pressure Model
- 🟥 Pressure Derivative Model

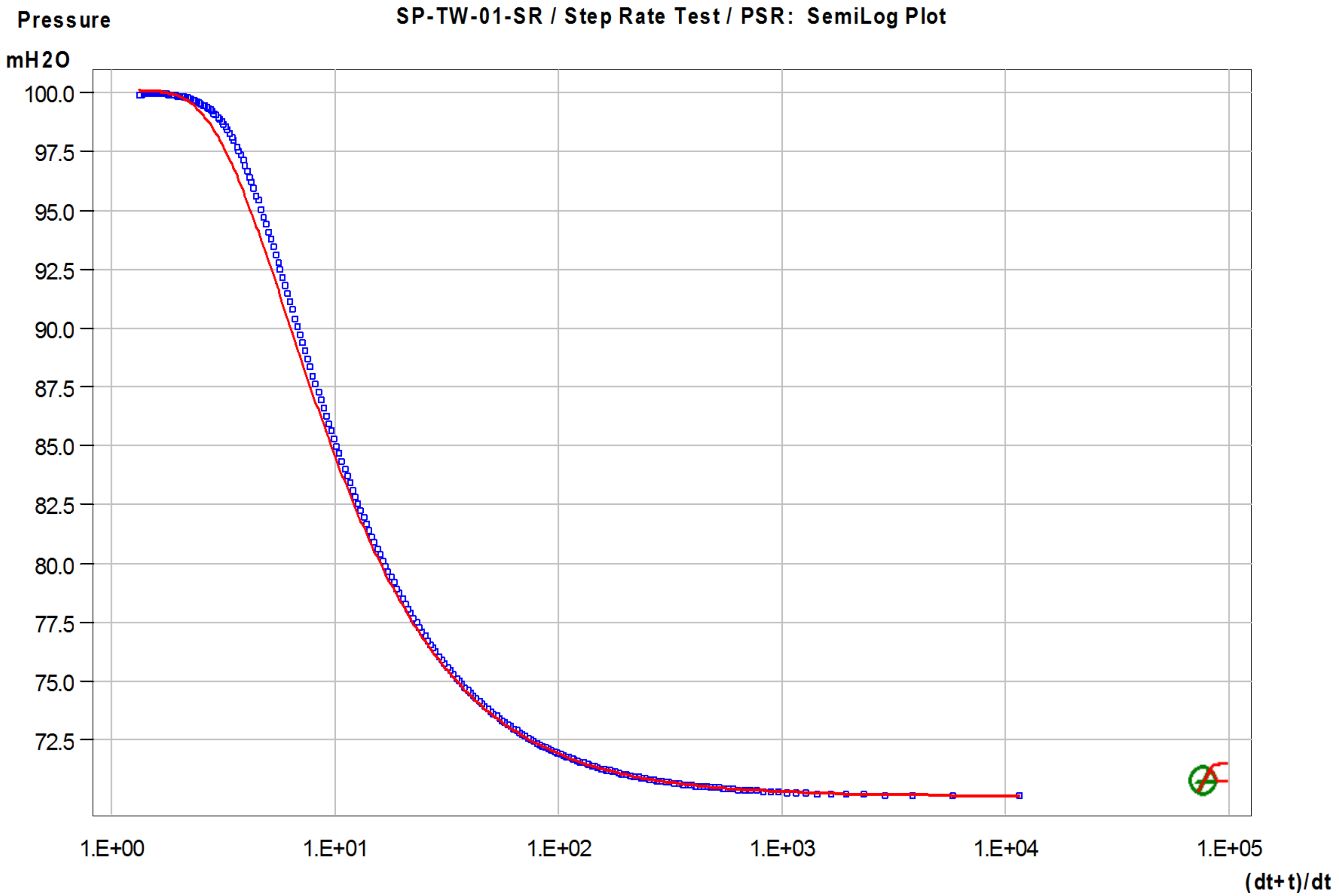
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST**
**OBSERVED VS. MODELED RESIDUAL DRAWDOWN DERIVATIVE**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-4 |



LEGEND

□ Test Pressure

— Test Pressure Model

CLIENT
NEWMONT SURINAME, LLC

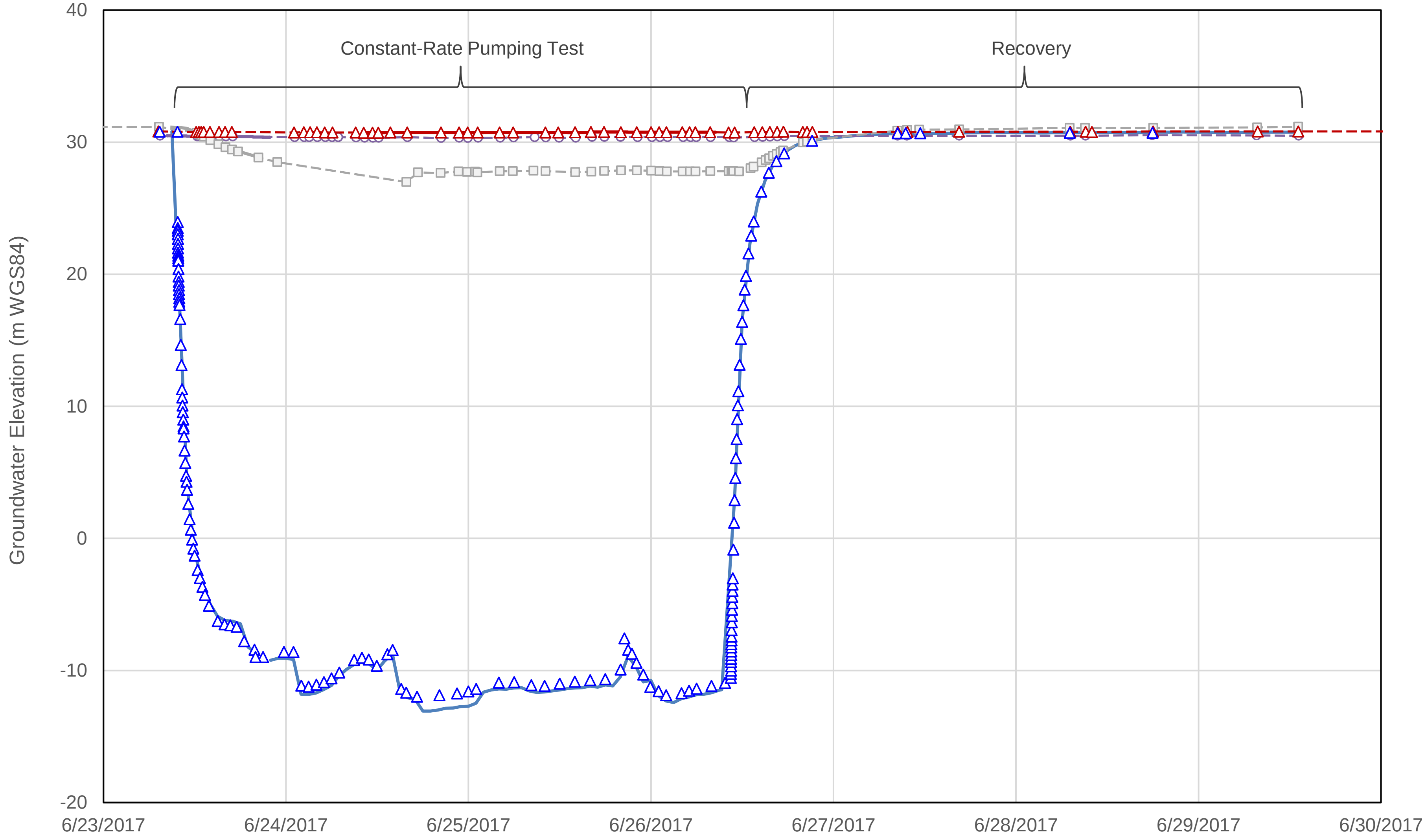
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST**
**OBSERVED VERSUS MODELED RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-5 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: Sabajo Water Levels.xlsx



LEGEND

— SP-TW-01-BR Transducer

△ SP-TW-01-BR Manual

— SP-TW-01-SR Transducer

--○-- SP-TW-01-SR Manual

— SP-MW-01-BR Transducer

--□-- SP-MW-01-BR Manual

— SP-MW-01-SQ Transducer

--△-- SP-MW-01-SQ Manual

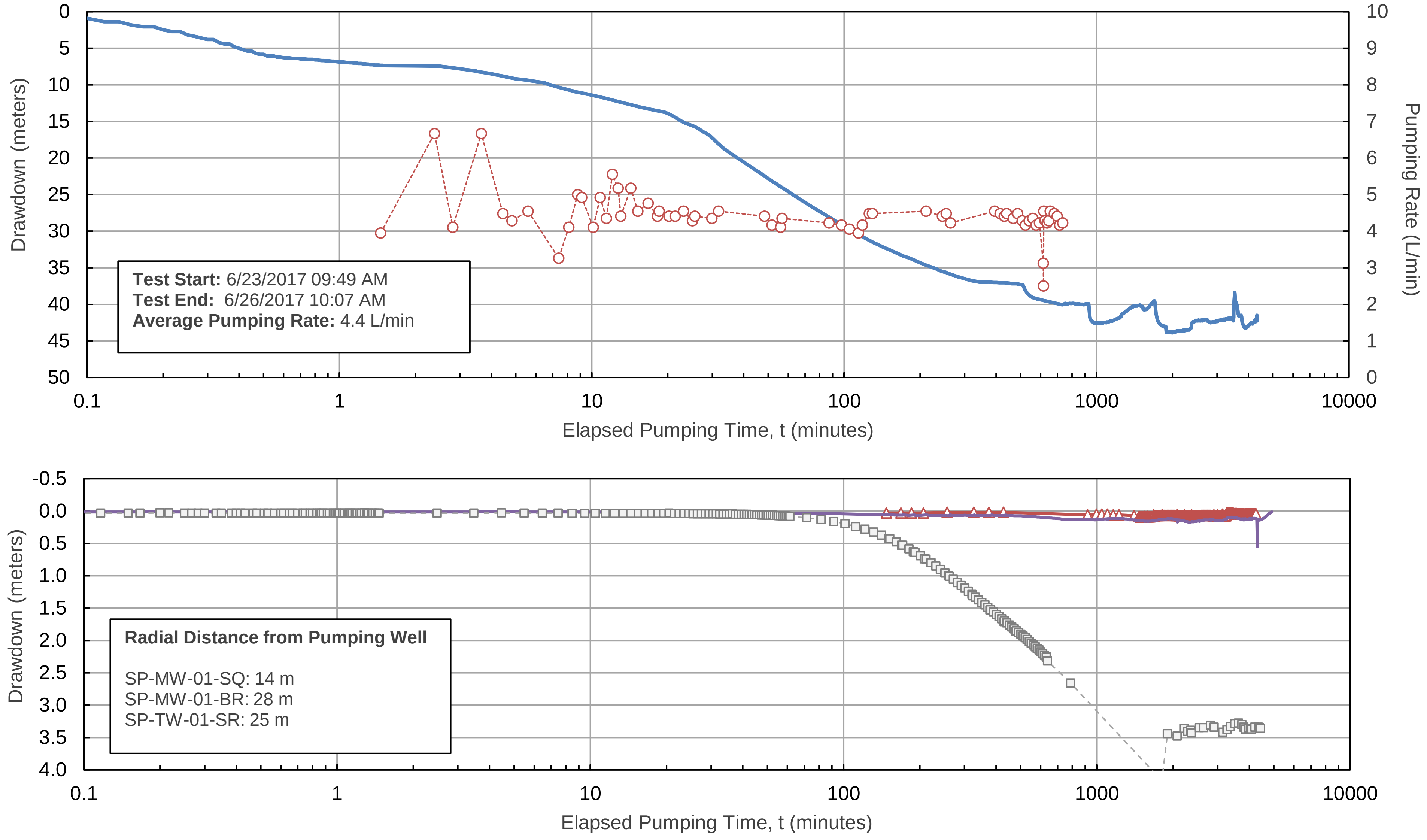
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONSTANT-RATE PUMPING TEST**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-6 |



**Test Start:** 6/23/2017 09:49 AM
**Test End:** 6/26/2017 10:07 AM
**Average Pumping Rate:** 4.4 L/min

**Radial Distance from Pumping Well**

SP-MW-01-SQ: 14 m
SP-MW-01-BR: 28 m
SP-TW-01-SR: 25 m

LEGEND

| | |
|---|---|
| ━━ | SP-TW-01-BR |
| - -○- - | Pumping Rate |
| ━△━ | SP-MW-01-SQ |
| ━━ | SP-TW-01-SR |
| - -□- - | SP-MW-01-BR |

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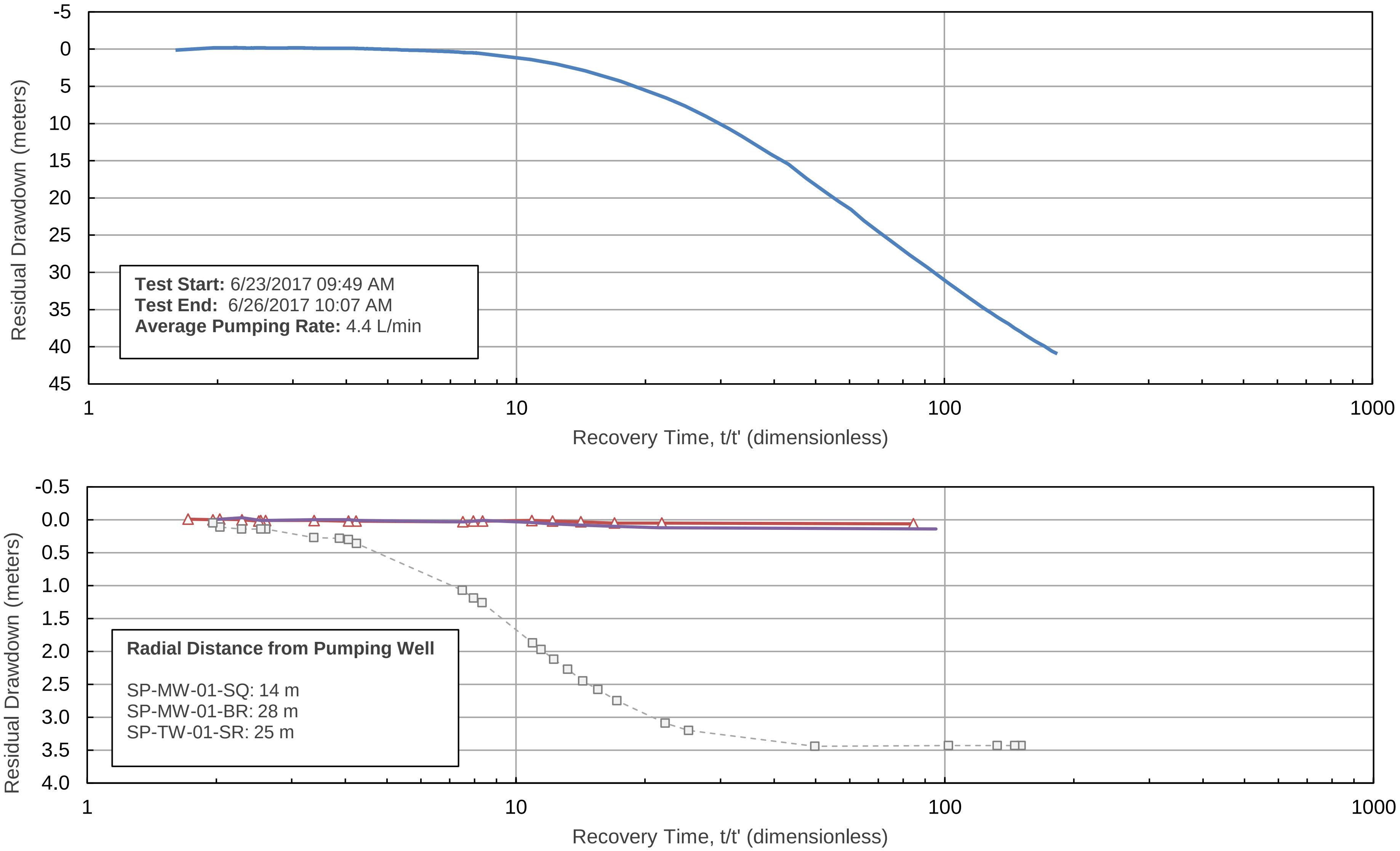
PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONSTANT-RATE TEST DRAWDOWN**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-7 |



**Test Start:** 6/23/2017 09:49 AM
**Test End:** 6/26/2017 10:07 AM
**Average Pumping Rate:** 4.4 L/min

**Radial Distance from Pumping Well**

SP-MW-01-SQ: 14 m
SP-MW-01-BR: 28 m
SP-TW-01-SR: 25 m

LEGEND

- SP-TW-01-BR
- △ SP-MW-01-SQ
- SP-TW-01-SR
- □ SP-MW-01-BR

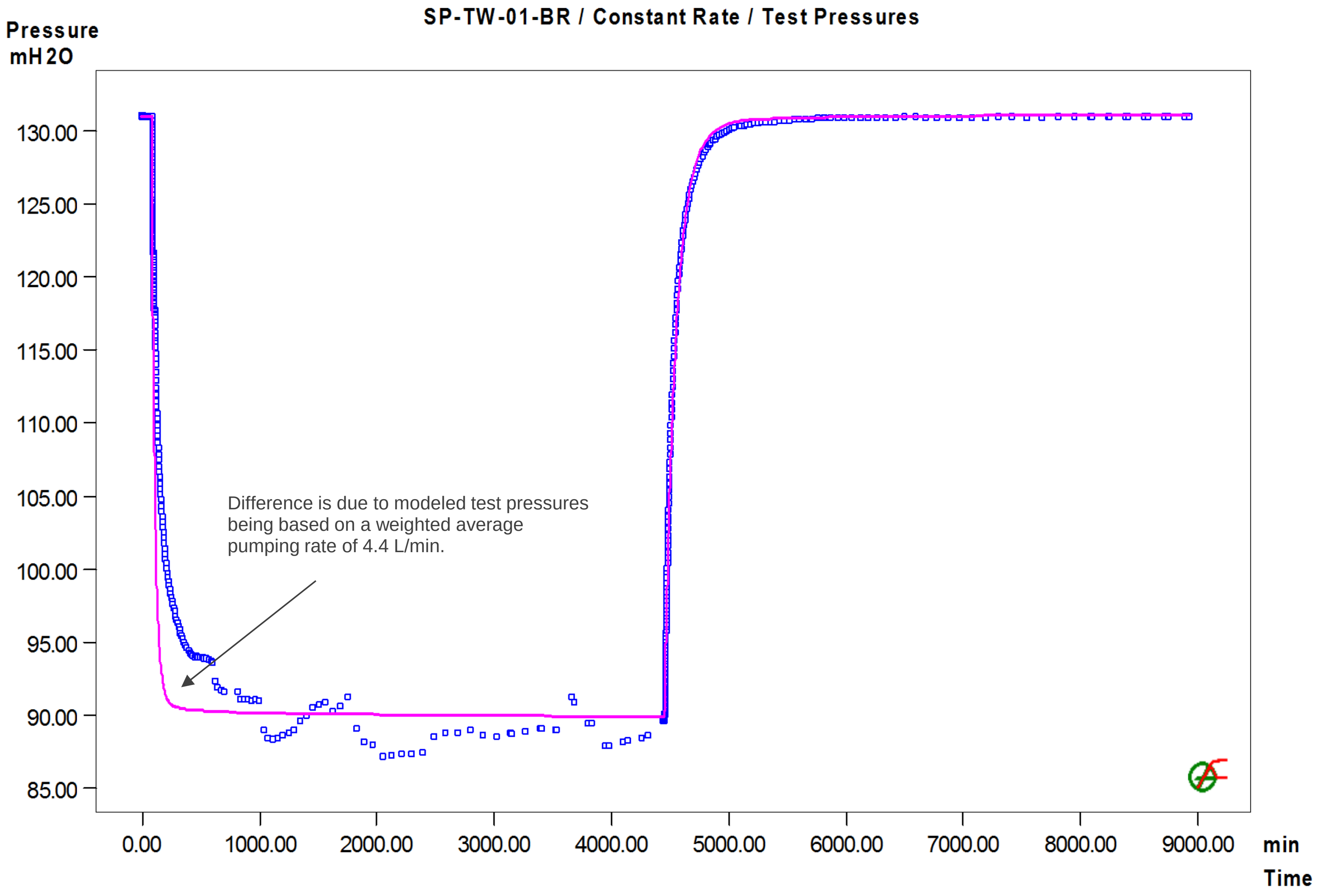
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONSTANT-RATE TEST RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-8 |



Difference is due to modeled test pressures being based on a weighted average pumping rate of 4.4 L/min.

LEGEND

□ Test Pressure

▬ Test Pressure Model

CLIENT
NEWMONT SURINAME, LLC

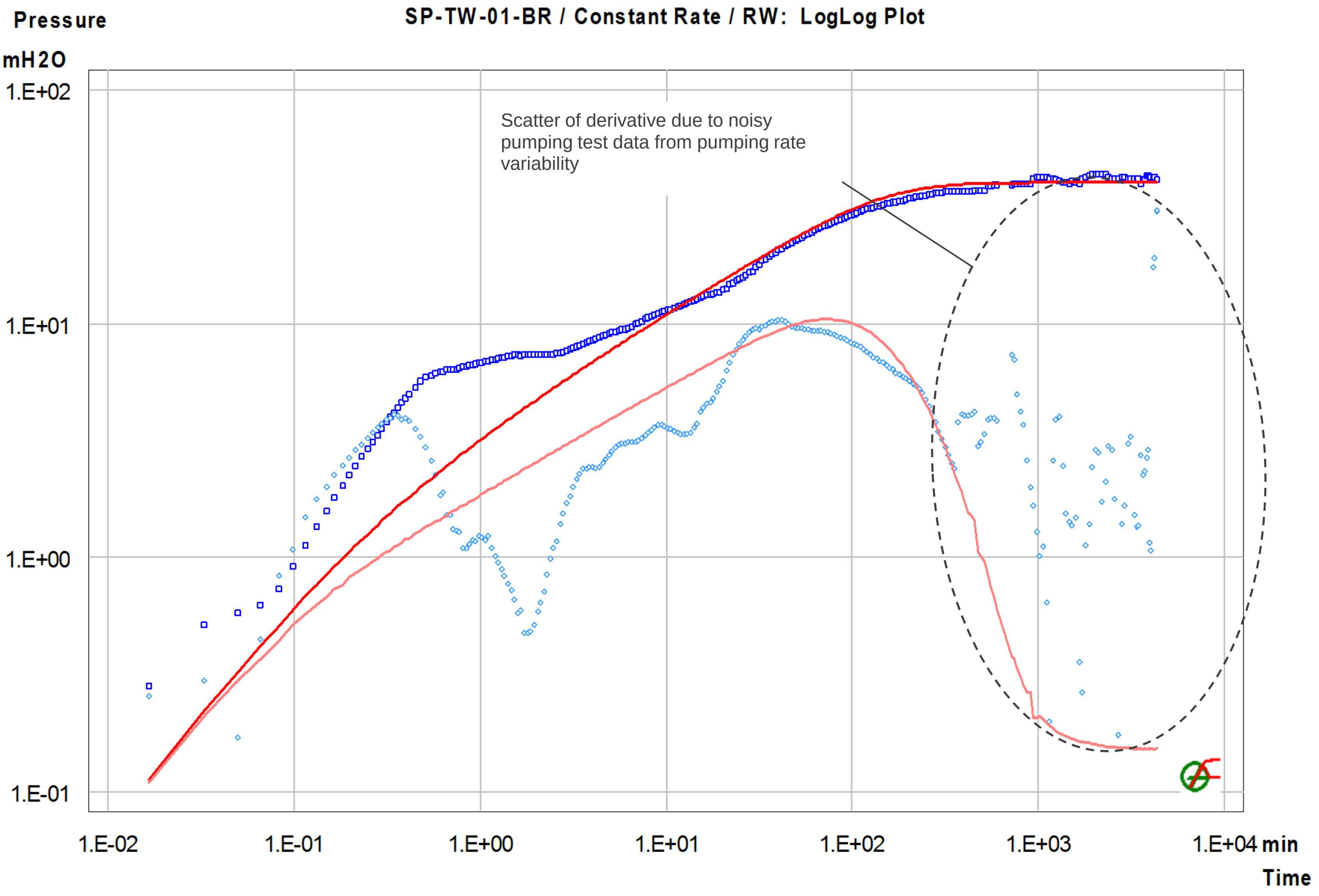
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONSTANT-RATE TEST**
**OBSERVED VERSUS MODELED TEST PRESSURES**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-9 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-BR_CRT_20180318.xlsx



Scatter of derivative due to noisy pumping test data from pumping rate variability

LEGEND

□ Test Pressure

◇ Pressure Derivative

— Test Pressure Model

— Pressure Derivative Model

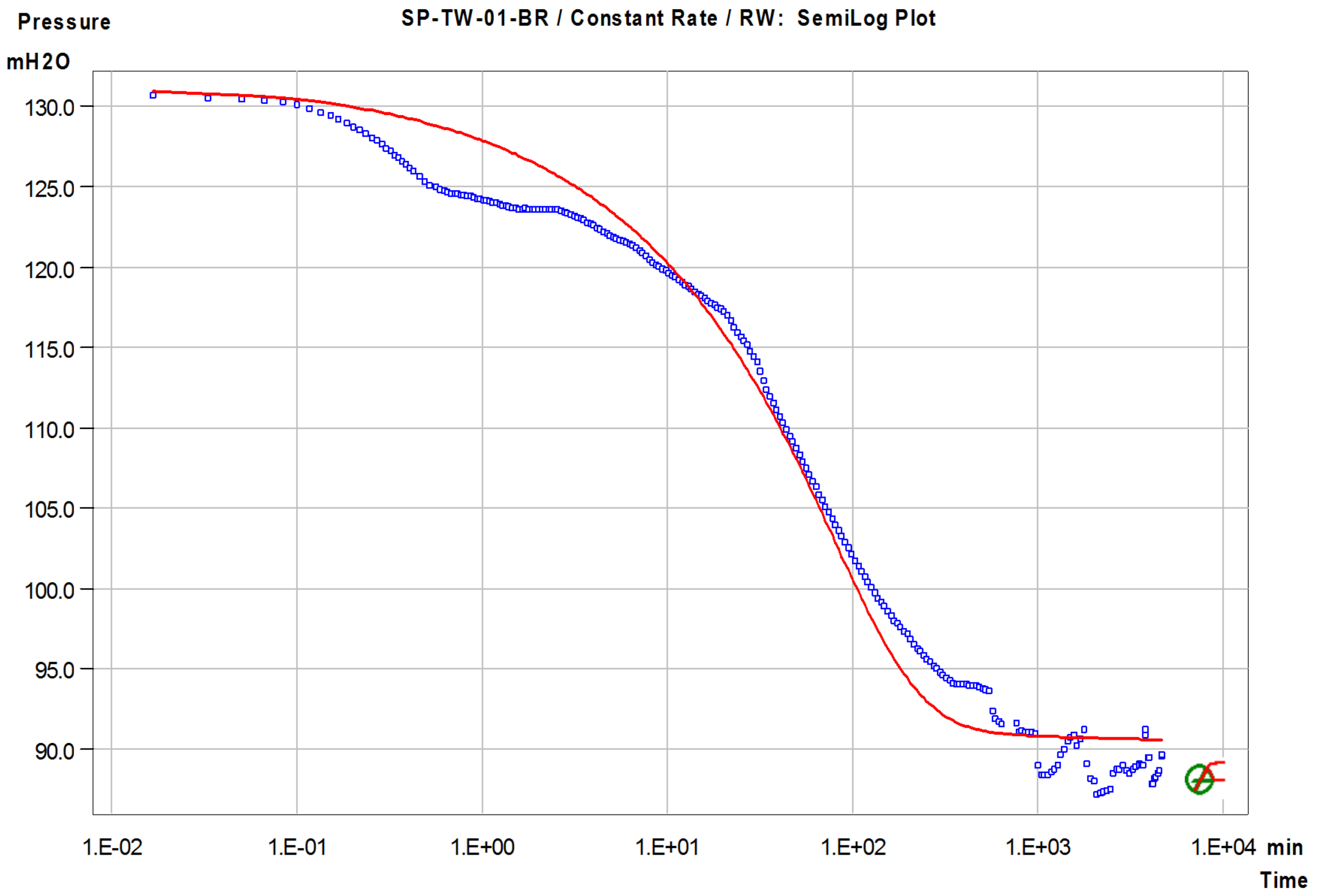
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONTANT-RATE TEST DRAWDOWN ANALYSIS**
**OBSERVED VS. MODELED DRAWDOWN DERIVATIVE**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-10 |



LEGEND

□ Test Pressure

🟥 Test Pressure Model

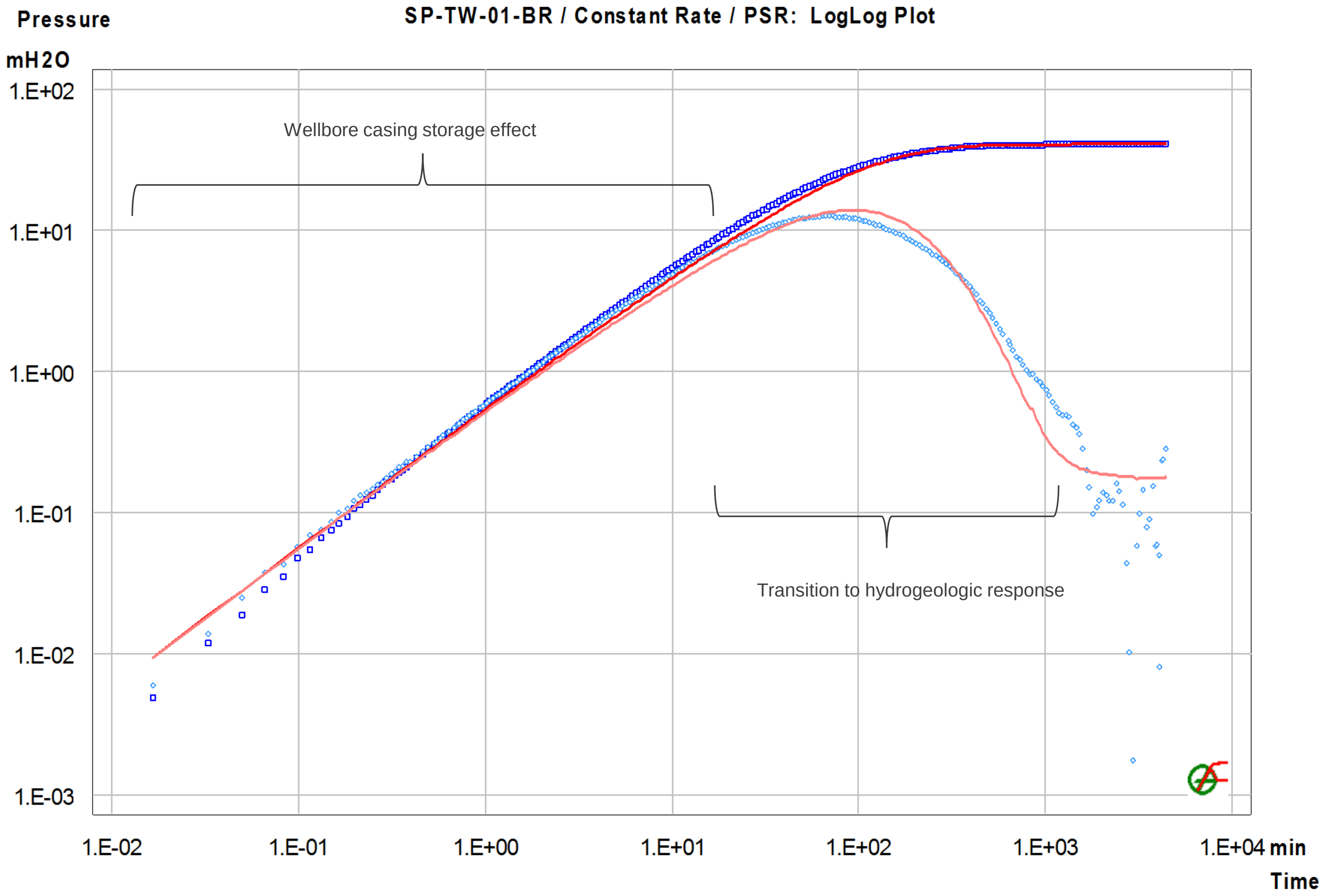
CLIENT
NEWMONT SURINAME, LLC

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

CONSULTANT
GOLDER

TITLE
**SP-TW-01-BR CONSTANT-RATE TEST RECOVERY ANALYSIS OBSERVED VS. MODELED RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-11 |



LEGEND

□ Test Pressure

◇ Pressure Derivative

— Test Pressure Model

— Pressure Derivative Model

CLIENT
NEWMONT SURINAME, LLC

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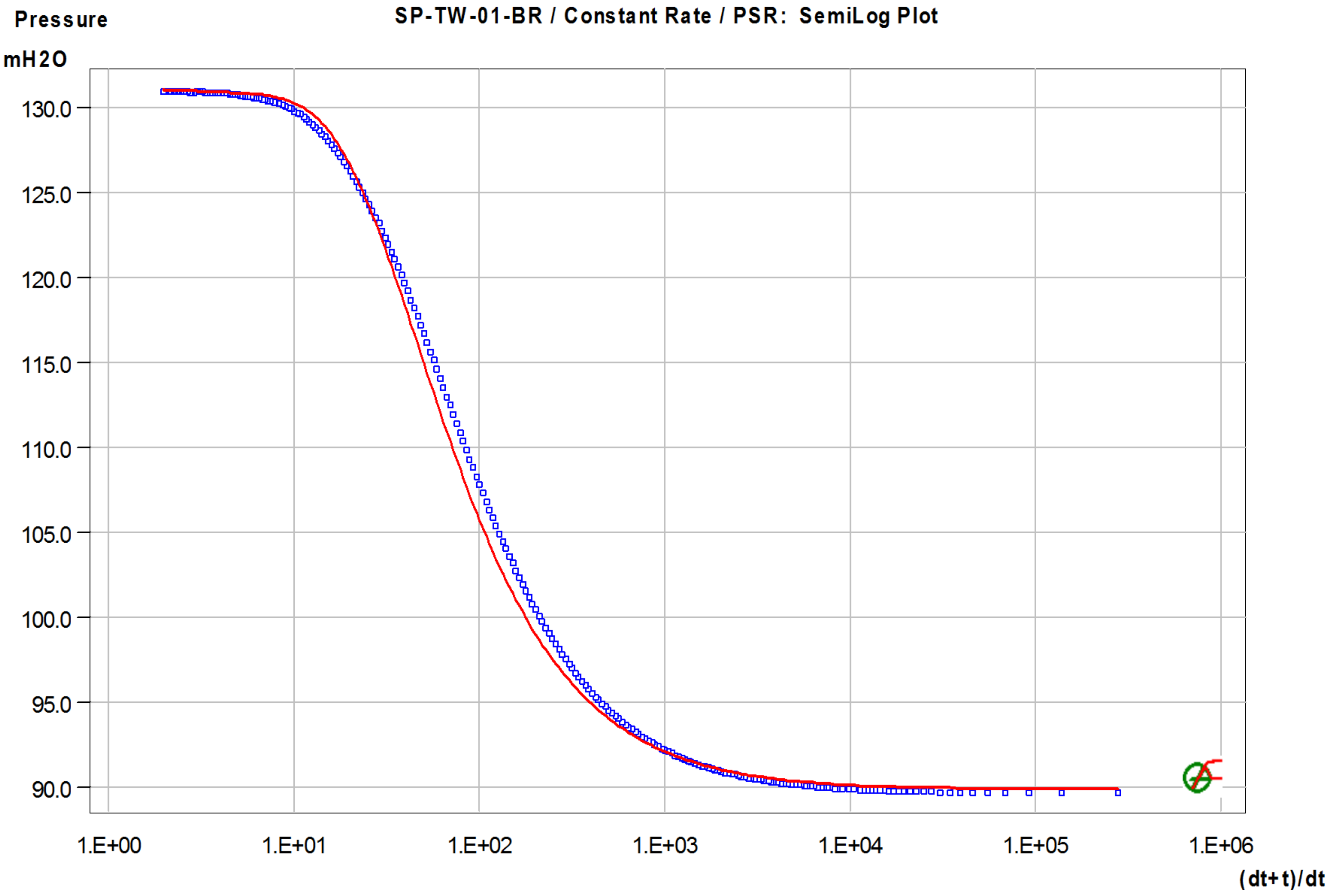
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONTANT-RATE TEST RECOVERY ANALYSIS**
**OBSERVED VS. MODELED RESIDUAL DRAWDOWN DERIVATIVE**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-12 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-BR_CRT_20180318.xlsx



LEGEND

□ Test Pressure

— Test Pressure Model

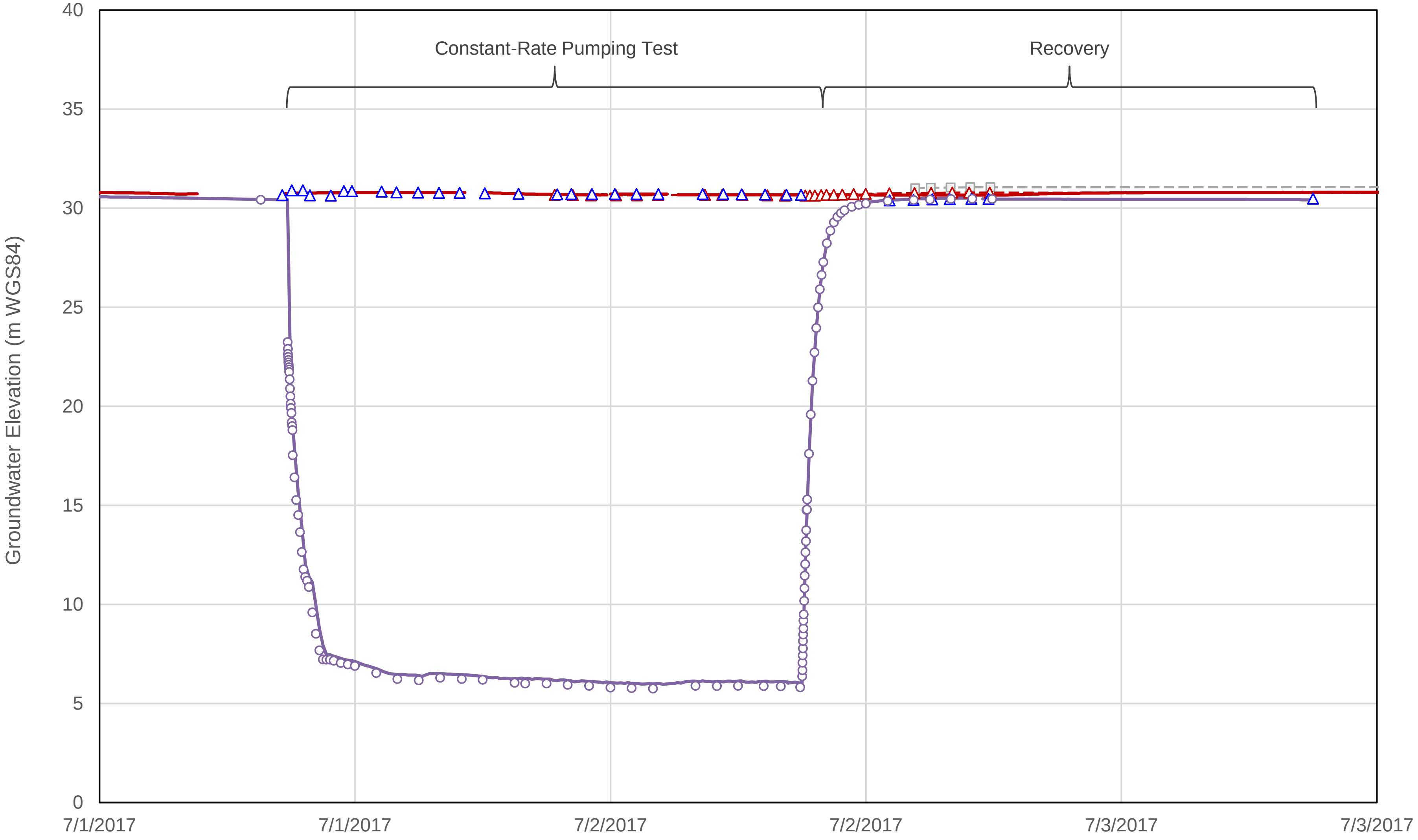
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-BR CONSTANT-RATE TEST RECOVERY ANALYSIS**
**OBSERVED VS. MODELED RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-13 |



LEGEND

△ SP-TW-01-BR Manual
— SP-TW-01-SR Transducer
○ SP-TW-01-SR Manual
--□-- SP-MW-01-BR Manual
— SP-MW-01-SQ Transducer
--△-- SP-MW-01-SQ Manual

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NEWMONT SURINAME, LLC

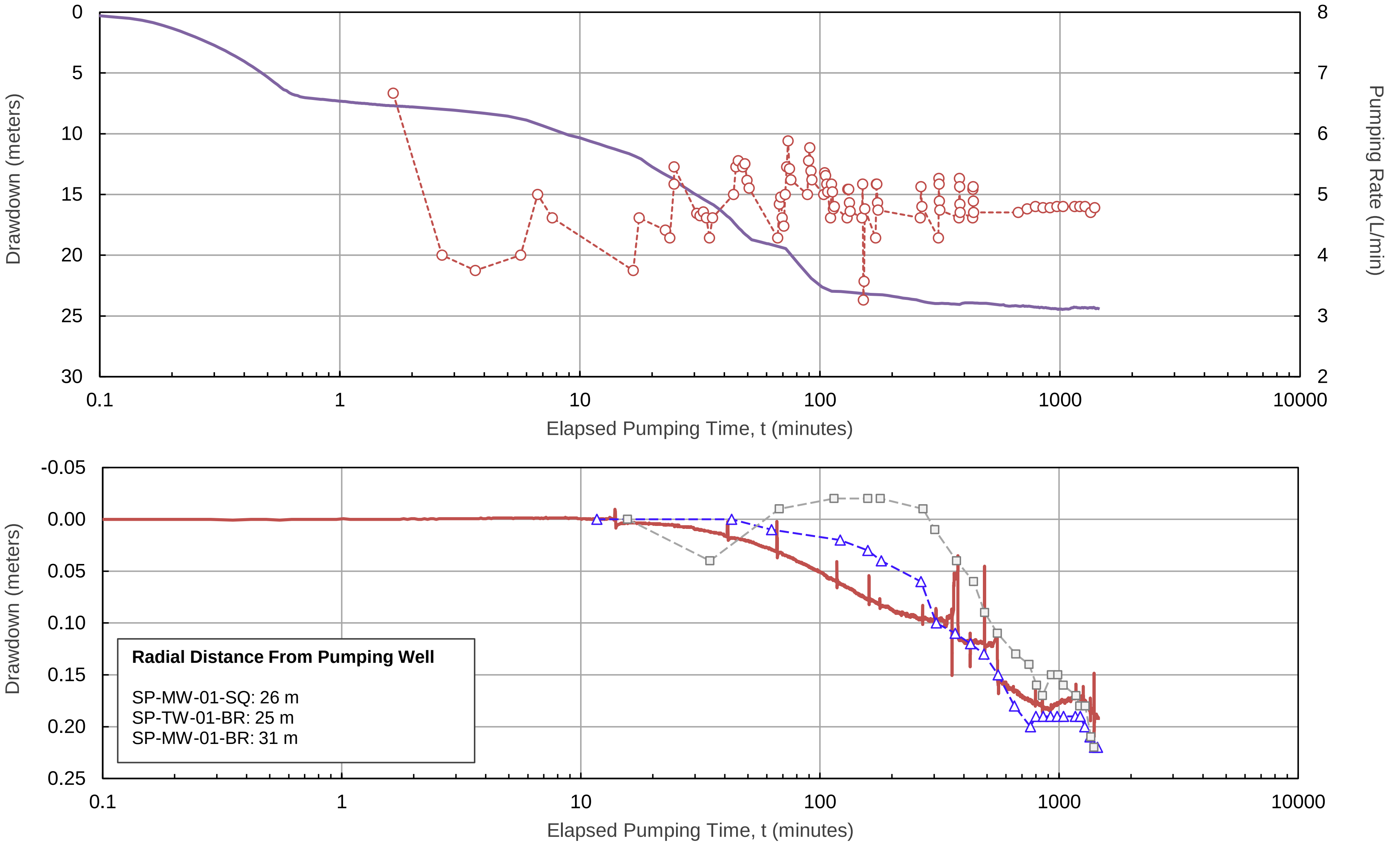
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR CONSTANT-RATE PUMPING TEST**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-14 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-SR_CRT_20180315.xlsx



LEGEND

- ━ SP-TW-01-SR
- --○-- Pumping Rate
- ━ SP-MW-01-SQ
- --△-- SP-TW-01-BR
- --□-- SP-MW-01-BR

CLIENT
NEWMONT SURINAME, LLC

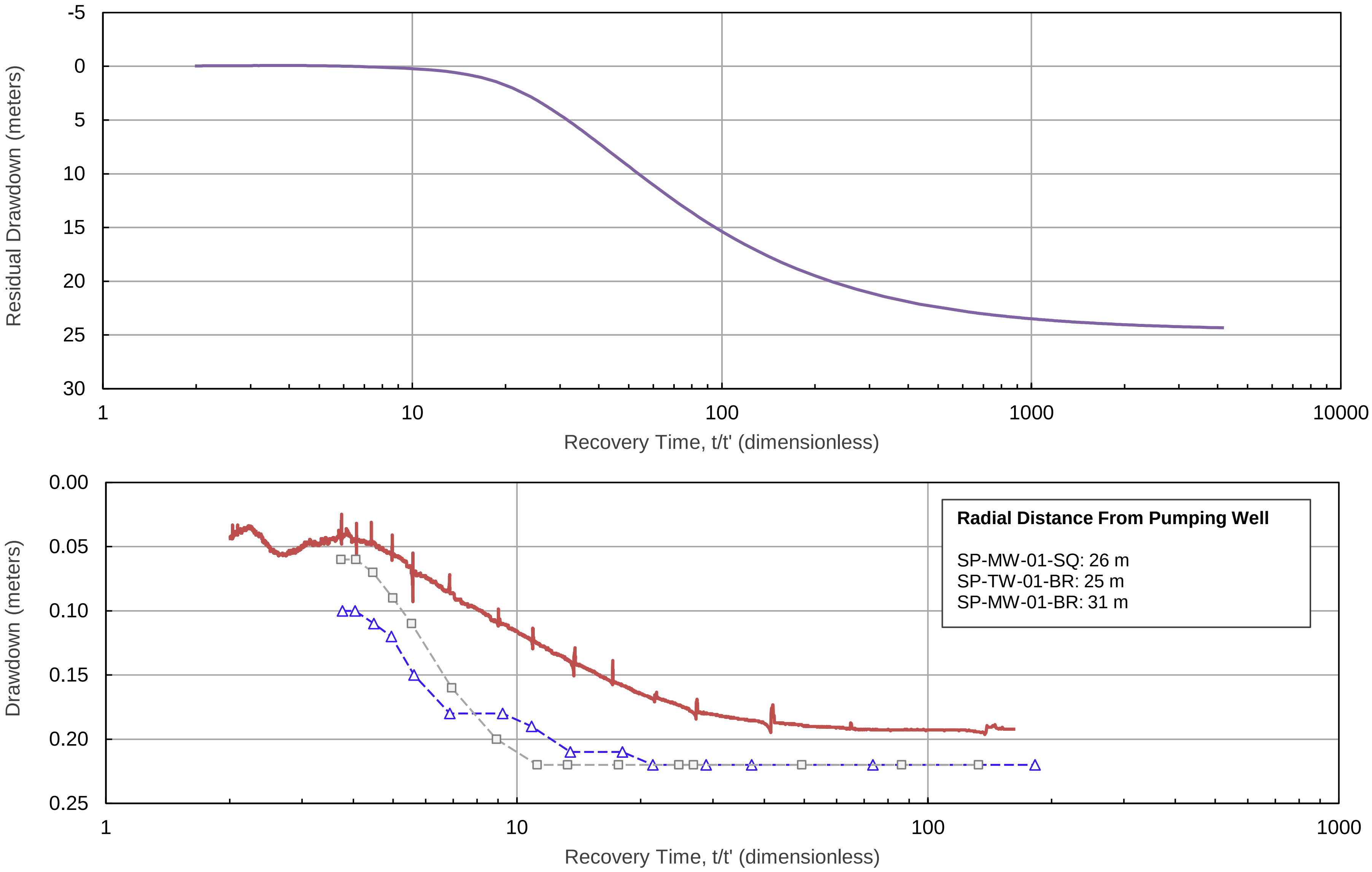
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR STEP-RATE PUMPING TEST DRAWDOWN**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-15 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-SR_CRT_20180315.xlsx



LEGEND

— SP-TW-01-SR
— SP-MW-01-SQ
–△– SP-TW-01-BR
–□– SP-MW-01-BR

CLIENT
NEWMONT SURINAME, LLC

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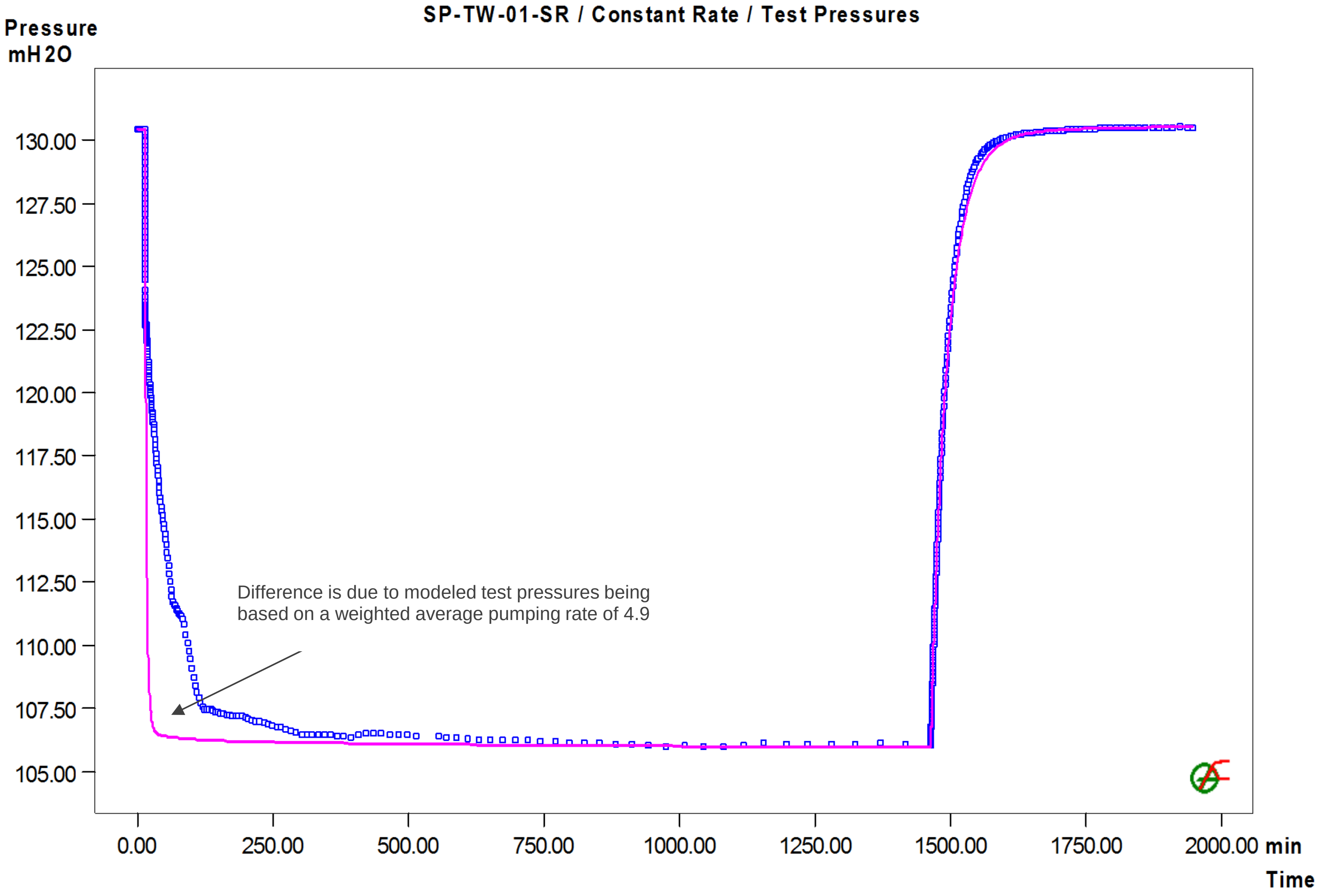
PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR CONSTANT-RATE TEST RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-16 |



Difference is due to modeled test pressures being based on a weighted average pumping rate of 4.9

LEGEND

□ Test Pressure

— Test Pressure Model

CLIENT
NEWMONT SURINAME, LLC

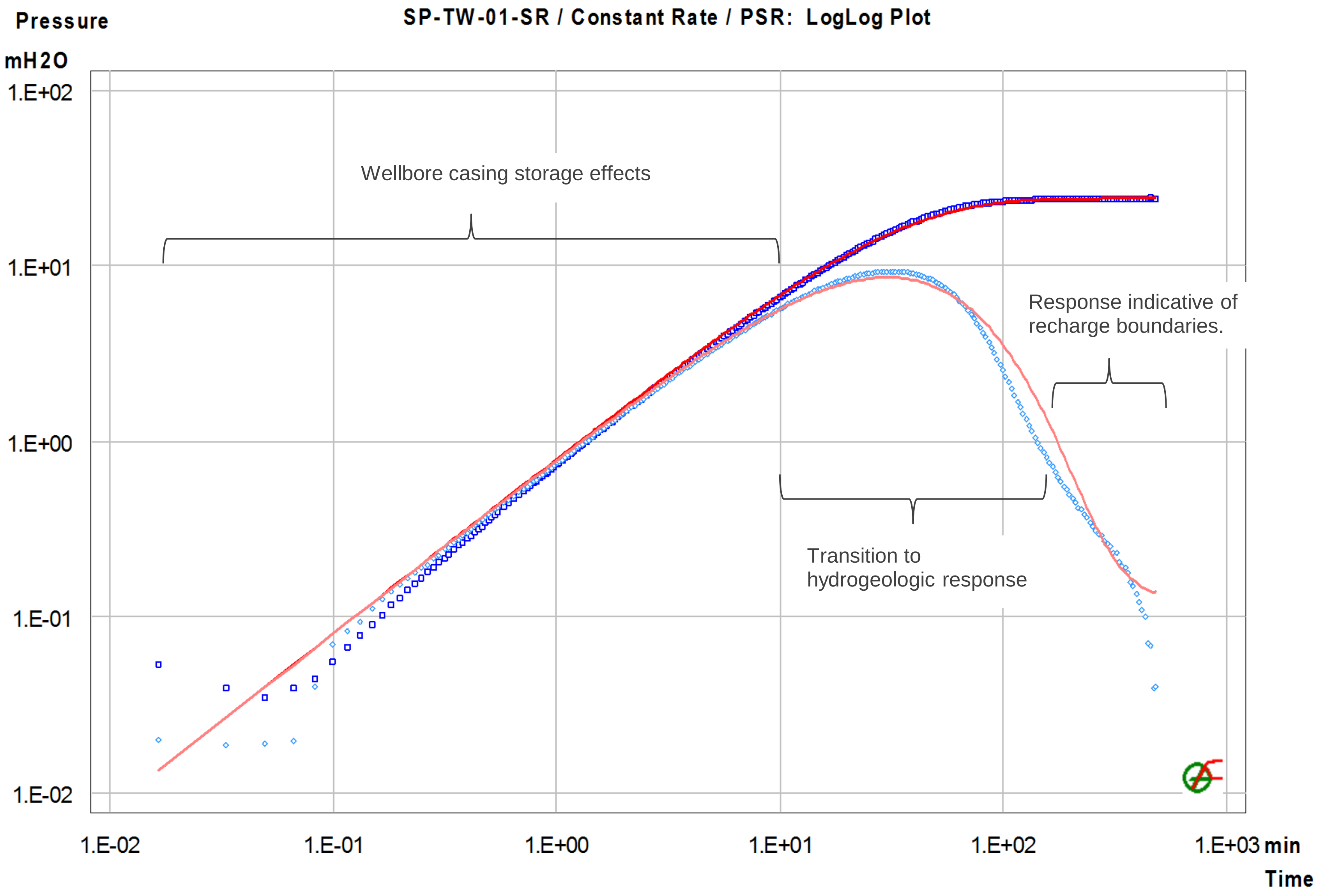
CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR CONSTANT-RATE TEST**
**OBSERVED VERSUS MODELED TEST PRESSURES**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-17 |

PATH: C:\Users\dholom\Documents\Projects\Newmont\Sabajo\Upload to SP | FILE NAME: SP-TW-01-SR_CRT_20180315.xlsx



LEGEND

□ Test Pressure

◇ Pressure Derivative

— Test Pressure Model

— Pressure Derivative Model

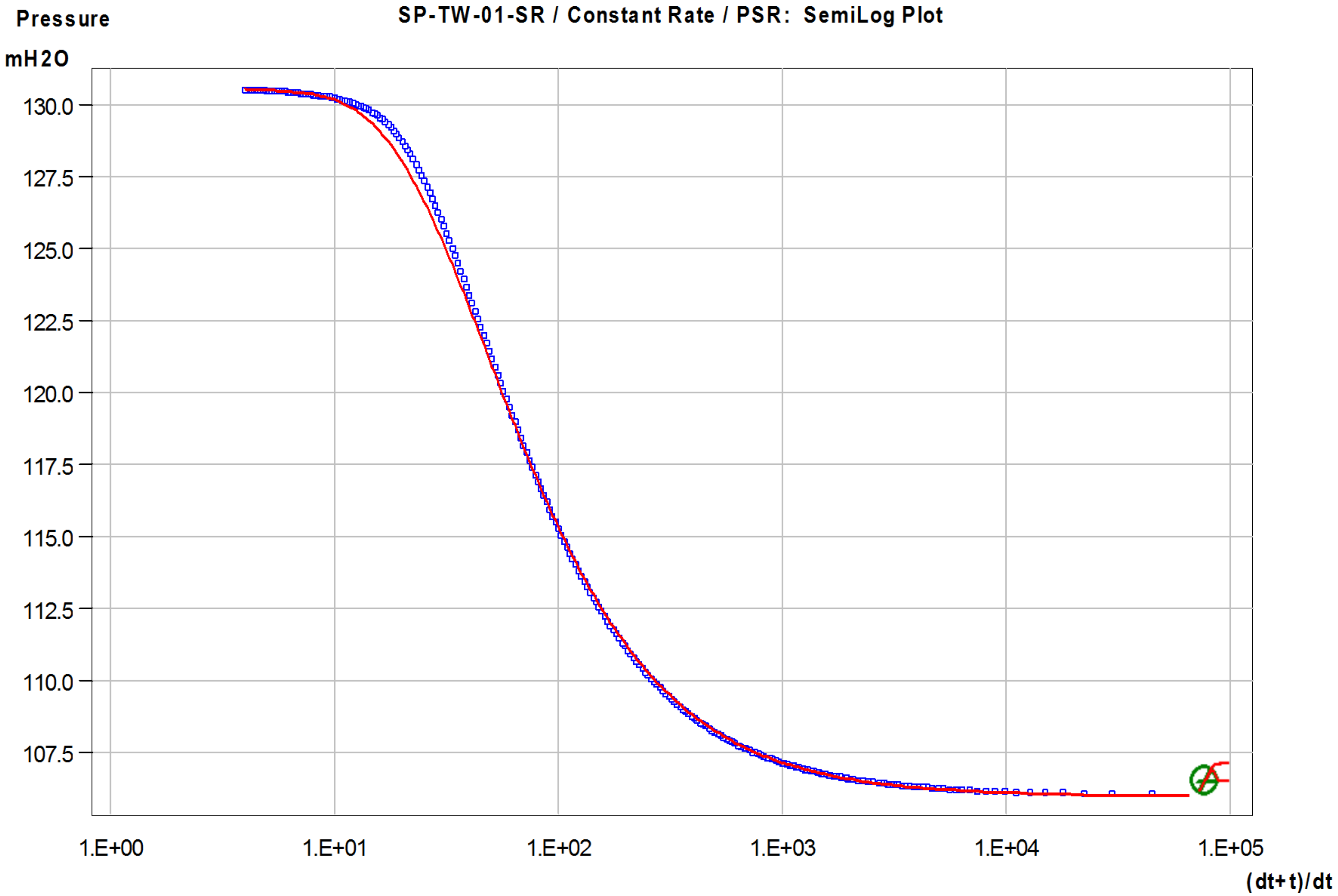
CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR CONSTANT-RATE TEST RECOVERY ANALYSIS**
**OBSERVED VERSUS MODELED RESIDUAL DRAWDOWN DERIVATI**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-18 |



LEGEND

□ Test Pressure

━ Test Pressure Model

CLIENT
NEWMONT SURINAME, LLC

CONSULTANT
GOLDER

PROJECT
SABAJO PHASE II HYDROGEOLOGIC INVESTIGATION

TITLE
**SP-TW-01-SR CONSTANT-RATE TEST RECOVERY ANALYSIS**
**OBSERVED VERSUS MODELED RECOVERY**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 166932601 | 3000 | A | E-19 |

## APPENDIX F

# Water Quality Field Data

**Table F-1: Groundwater Monitoring Summary Results**

| Parameter | Fraction (a) | Unit | All Groundwater Stations | | Quartz Vein (SQ) | | | Saprock (SR) | | | Bedrock (BR) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2016 - 2017 | | 2016 - 2017 | | | 2016 - 2017 | | | 2016 - 2017 | | |
| | | | Min | Max | Count | Min | Max | Count | Min | Max | Count | Min | Max |
| **FIELD PARAMETERS** | | | | | | | | | | | | | |
| pH | | pH | 4.6 | 6.9 | 7 | 4.6 | 6.6 | 7 | 5.6 | 6.8 | 7 | 6.0 | 6.9 |
| Specific Conductance | | µS/cm | 47 | 634 | 7 | 47 | 151 | 7 | 80 | 374 | 6 | 63 | 634 |
| Turbidity | | NTU | 0 | 250 | 7 | 3.4 | 250 | 7 | 2.5 | 152 | 8 | 0 | 35 |
| Temperature | | °C | 25 | 29 | 7 | 26 | 29 | 7 | 25 | 28 | 8 | 26 | 29 |
| Oxygen Reduction Potential (ORP) | | mV | -143 | 192 | 7 | 19 | 192 | 7 | -102 | 131 | 8 | -143 | 98 |
| Dissolved Oxygen (DO) | D | mg/L | 0.17 | 7.5 | 7 | 0.26 | 7.5 | 7 | 0.17 | 1.6 | 8 | 0.31 | 6.0 |
| **GENERAL CHEMISTRY** | | | | | | | | | | | | | |
| pH | | pH | 5.7 | 8.3 | 7 | 5.7 | 7.5 | 7 | 6.5 | 7.6 | 9 | 7.0 | 8.3 |
| Specific Conductance | | µmhos/cm | 47 | 617 | 7 | 47 | 146 | 7 | 77 | 361 | 9 | 141 | 617 |
| Total Dissolved Solids (TDS) | | mg/L | 38 | 382 | 8 | 38 | 104 | 10 | 49 | 267 | 10 | 97 | 382 |
| Total Suspended Solids (TSS) | | mg/L | 5.0 | 65 | 8 | <5 | 26 | 10 | <5 | 65 | 10 | 5.0 | 27 |
| Hardness | | mg/L $CaCO_3$ | 0.89 | 118 | 8 | 0.89 | 19 | 10 | 3.1 | 29 | 10 | 6.9 | 118 |
| **MAJOR IONS** | | | | | | | | | | | | | |
| Total Alkalinity | | mg/L $CaCO_3$ | 8.3 | 337 | 8 | 8.3 | 67 | 10 | 17 | 131 | 9 | 49 | 337 |
| Bicarbonate | | mg/L $CaCO_3$ | 8.3 | 337 | 8 | 8.3 | 67 | 10 | 17 | 131 | 9 | 49 | 337 |
| Carbonate | | mg/L $CaCO_3$ | <DL | 5.7 | 8 | <1 | <1 | 10 | <1 | <1 | 9 | 1.0 | 5.7 |
| Chloride | | mg/L | 3.6 | 7.9 | 8 | 4.4 | 7.6 | 10 | 4.7 | 7.9 | 10 | 3.6 | 5.6 |
| Fluoride | | mg/L | <DL | 0.48 | 8 | <0.1 | 0.15 | 10 | <0.1 | 0.42 | 10 | 0.10 | 0.48 |
| Sulfate | | mg/L | 2.0 | 44 | 8 | 2.8 | 26 | 10 | 2.0 | 44 | 10 | 4.9 | 31 |
| Calcium | D | mg/L | 0.66 | 64 | 7 | 0.66 | 13 | 7 | 2.1 | 13 | 9 | 4.3 | 64 |
| Magnesium | D | mg/L | 0.21 | 28 | 7 | 0.21 | 4.5 | 7 | 0.72 | 4.6 | 9 | 1.6 | 28 |
| Sodium | D | mg/L | 6.6 | 70 | 7 | 6.6 | 18 | 7 | 9.8 | 70 | 9 | 14 | 39 |
| Potassium | D | mg/L | <DL | 3.3 | 7 | <0.5 | <0.5 | 7 | <0.5 | 3.3 | 9 | 0.53 | 1.4 |
| Calcium | TR | mg/L | 2.2 | 60 | 1 | 2.2 | 2.2 | 3 | 8.0 | 22 | 1 | 60 | 60 |
| Magnesium | TR | mg/L | 0.83 | 25 | 1 | 0.83 | 0.83 | 3 | 2.1 | 6.9 | 1 | 25 | 25 |
| Potassium | TR | mg/L | <DL | 0.79 | 1 | <0.5 | <0.5 | 3 | <0.5 | 0.79 | 1 | 0.77 | 0.77 |
| **DISSOLVED METALS** | | | | | | | | | | | | | |
| Aluminum | D | mg/L | <DL | 0.17 | 8 | <0.08 | <0.08 | 10 | <0.08 | 0.17 | 10 | <0.08 | <0.08 |
| Antimony | D | mg/L | <DL | <DL | 8 | <0.003 | <0.003 | 10 | <0.003 | <0.003 | 10 | <0.003 | <0.003 |
| Arsenic | D | mg/L | <DL | 1.7 | 8 | <0.003 | 0.004 | 10 | <0.003 | 0.006 | 10 | <0.003 | 1.7 |
| Barium | D | mg/L | 0.009 | 0.064 | 7 | 0.010 | 0.031 | 7 | 0.009 | 0.047 | 9 | 0.011 | 0.064 |
| Beryllium | D | mg/L | <DL | <DL | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 |
| Boron | D | mg/L | <DL | 0.055 | 8 | <0.04 | <0.04 | 10 | <0.04 | 0.055 | 10 | <0.04 | <0.04 |
| Cadmium | D | mg/L | <DL | <DL | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 |
| Chromium | D | mg/L | <DL | <DL | 8 | <0.006 | <0.006 | 10 | <0.006 | <0.006 | 10 | <0.006 | <0.006 |
| Cobalt | D | mg/L | <DL | <DL | 8 | <0.006 | <0.006 | 10 | <0.006 | <0.006 | 10 | <0.006 | <0.006 |
| Copper | D | mg/L | <DL | 0.003 | 8 | <0.001 | 0.002 | 10 | <0.001 | 0.003 | 10 | <0.001 | 0.002 |
| Iron | D | mg/L | <DL | 8.0 | 8 | <0.1 | 0.36 | 10 | <0.1 | 4.0 | 10 | <0.1 | 8.0 |
| Lead | D | mg/L | <DL | <DL | 8 | <0.003 | <0.0075 | 10 | <0.003 | <0.0075 | 10 | <0.003 | <0.0075 |
| Manganese | D | mg/L | 0.009 | 1.0 | 8 | 0.024 | 0.45 | 10 | 0.009 | 0.50 | 10 | 0.52 | 1.00 |
| Mercury | D | mg/L | <DL | <DL | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 |
| Molybdenum | D | mg/L | <DL | 0.011 | 8 | <0.008 | <0.008 | 10 | <0.008 | 0.011 | 10 | <0.008 | <0.008 |
| Nickel | D | mg/L | <DL | <DL | 8 | <0.001 | <0.01 | 10 | <0.001 | <0.01 | 10 | 0.002 | <0.01 |
| Selenium | D | mg/L | <DL | <DL | 8 | <0.003 | <0.003 | 10 | <0.003 | <0.003 | 10 | <0.003 | <0.003 |
| Silver | D | mg/L | <DL | 0.0001 | 8 | <0.0001 | <0.0001 | 10 | <0.0001 | 0.0001 | 10 | <0.0001 | <0.0001 |
| Thallium | D | mg/L | <DL | <DL | 7 | <0.001 | <0.001 | 7 | <0.001 | <0.001 | 9 | <0.001 | <0.001 |
| Vanadium | D | mg/L | <DL | <DL | 1 | <0.005 | <0.005 | 3 | <0.005 | <0.005 | 1 | <0.005 | <0.005 |
| Zinc | D | mg/L | <DL | 0.045 | 8 | <0.01 | 0.016 | 10 | <0.01 | 0.015 | 10 | <0.01 | 0.045 |
| **TOTAL METALS** | | | | | | | | | | | | | |
| Aluminum | TR | mg/L | <DL | 0.86 | 8 | <0.08 | 0.49 | 10 | <0.08 | 0.86 | 10 | <0.08 | 0.73 |
| Antimony | TR | mg/L | <DL | <DL | 8 | <0.003 | <0.003 | 10 | <0.003 | <0.003 | 10 | <0.003 | <0.003 |
| Arsenic | TR | mg/L | <DL | 1.7 | 8 | <0.003 | <0.003 | 10 | <0.003 | 0.005 | 10 | <0.003 | 1.7 |

**Table F-1: Groundwater Monitoring Summary Results**

| Parameter | Fraction $^{(a)}$ | Unit | All Groundwater Stations | | Quartz Vein (SQ) | | | Saprock (SR) | | | Bedrock (BR) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2016 - 2017 | | 2016 - 2017 | | | 2016 - 2017 | | | 2016 - 2017 | | |
| | | | Min | Max | Count | Min | Max | Count | Min | Max | Count | Min | Max |
| Barium | TR | mg/L | 0.010 | 0.069 | 7 | 0.010 | 0.034 | 7 | 0.012 | 0.048 | 9 | 0.012 | 0.069 |
| Beryllium | TR | mg/L | <DL | 0.0002 | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | 0.0002 |
| Boron | TR | mg/L | <DL | 0.048 | 8 | <0.04 | <0.04 | 10 | <0.04 | 0.048 | 10 | <0.04 | <0.04 |
| Cadmium | TR | mg/L | <DL | <DL | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 |
| Chromium | TR | mg/L | <DL | <DL | 8 | <0.006 | <0.006 | 10 | <0.006 | <0.006 | 10 | <0.006 | <0.006 |
| Cobalt | TR | mg/L | <DL | <DL | 8 | <0.006 | <0.006 | 10 | <0.006 | <0.006 | 10 | <0.006 | <0.006 |
| Copper | TR | mg/L | <DL | 0.009 | 8 | <0.001 | 0.002 | 10 | <0.001 | 0.009 | 10 | <0.001 | 0.008 |
| Iron | TR | mg/L | 0.12 | 8.8 | 8 | <0.1 | 0.50 | 10 | 0.12 | 5.0 | 10 | 0.14 | 8.8 |
| Lead | TR | mg/L | <DL | <DL | 8 | <0.003 | <0.0075 | 10 | <0.003 | <0.0075 | 10 | <0.003 | <0.0075 |
| Manganese | TR | mg/L | 0.027 | 1.0 | 8 | 0.027 | 0.47 | 10 | 0.040 | 0.49 | 10 | 0.54 | 1.01 |
| Mercury | T | mg/L | <DL | <DL | 8 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 | 10 | <0.0002 | <0.0002 |
| Molybdenum | TR | mg/L | <DL | 0.011 | 8 | <0.008 | <0.008 | 10 | <0.008 | 0.011 | 10 | <0.008 | <0.008 |
| Nickel | TR | mg/L | <DL | <DL | 8 | <0.001 | <0.01 | 10 | <0.001 | <0.01 | 10 | 0.001 | <0.01 |
| Phosphorus | TR | mg/L | <DL | 0.60 | 1 | <0.05 | <0.05 | 3 | <0.05 | 0.16 | 1 | 0.60 | 0.60 |
| Selenium | TR | mg/L | <DL | <DL | 8 | <0.003 | <0.003 | 10 | <0.003 | <0.003 | 10 | <0.003 | <0.003 |
| Silver | TR | mg/L | <DL | 0.001 | 8 | <0.0001 | <0.0001 | 10 | <0.0001 | 0.001 | 10 | <0.0001 | <0.0001 |
| Thallium | TR | mg/L | <DL | <DL | 7 | <0.001 | <0.001 | 7 | <0.001 | <0.001 | 9 | <0.001 | <0.001 |
| Vanadium | TR | mg/L | <DL | <DL | 1 | <0.005 | <0.005 | 3 | <0.005 | <0.005 | 1 | <0.005 | <0.005 |
| Zinc | TR | mg/L | <DL | 0.11 | 8 | <0.01 | 0.018 | 10 | <0.01 | 0.014 | 10 | <0.01 | 0.11 |
| **NUTRIENTS** | | | | | | | | | | | | | |
| Ammonia as N | | mg/L | <DL | 0.88 | 7 | <0.03 | 0.18 | 7 | <0.03 | 0.60 | 9 | 0.035 | 0.88 |
| Nitrate/Nitrite as N | | mg/L | <DL | 0.30 | 8 | <0.05 | 0.17 | 10 | <0.05 | 0.30 | 10 | <0.05 | 0.14 |
| Phosphorus | D | mg/L | <DL | 0.34 | 7 | <0.05 | 0.05 | 7 | <0.05 | 0.25 | 9 | <0.05 | 0.34 |
| **CYANIDE AND ORGANICS** | | | | | | | | | | | | | |
| Diesel | | mg/L | <DL | <DL | 2 | <0.1 | <0.1 | 2 | <0.1 | <0.1 | 3 | <0.1 | <0.1 |
| Lube Oil | | mg/L | <DL | <DL | 2 | <0.5 | <0.5 | 2 | <0.5 | <0.5 | 3 | <0.5 | <0.5 |
| Gasoline | | mg/L | <DL | <DL | 2 | <0.1 | <0.1 | 2 | <0.1 | <0.1 | 3 | <0.1 | <0.1 |
| Cyanide (total) | | mg/L | <DL | <DL | 1 | <0.01 | <0.01 | 3 | <0.01 | <0.01 | 1 | <0.01 | <0.01 |
| Total Organic Carbon | | mg/L | - | - | 0 | - | - | 0 | - | - | 0 | - | - |

Notes:

<DL = less than analytical detection limit

$^{(a)}$ Fraction: D = dissolved; TR = total recoverable; T = total

DL = analytical detection limit; °C = degrees Celsius; mV = millivolt; N = nitrogen; µS/cm = microSiemens per centimeter; NTU = nephelometric turbidity units; µmhos/cm = micromhos per centimeter; mg/L = milligrams per liter

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