PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP02 Data Report - Borehole Drilling and Coring for IG_BH01

APM-REP-01332-0229 **November 2018**

Golder Associates Ltd.

nwmo
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REPORT

PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP2 Data Report - Borehole Drilling and Coring for IG_BH01

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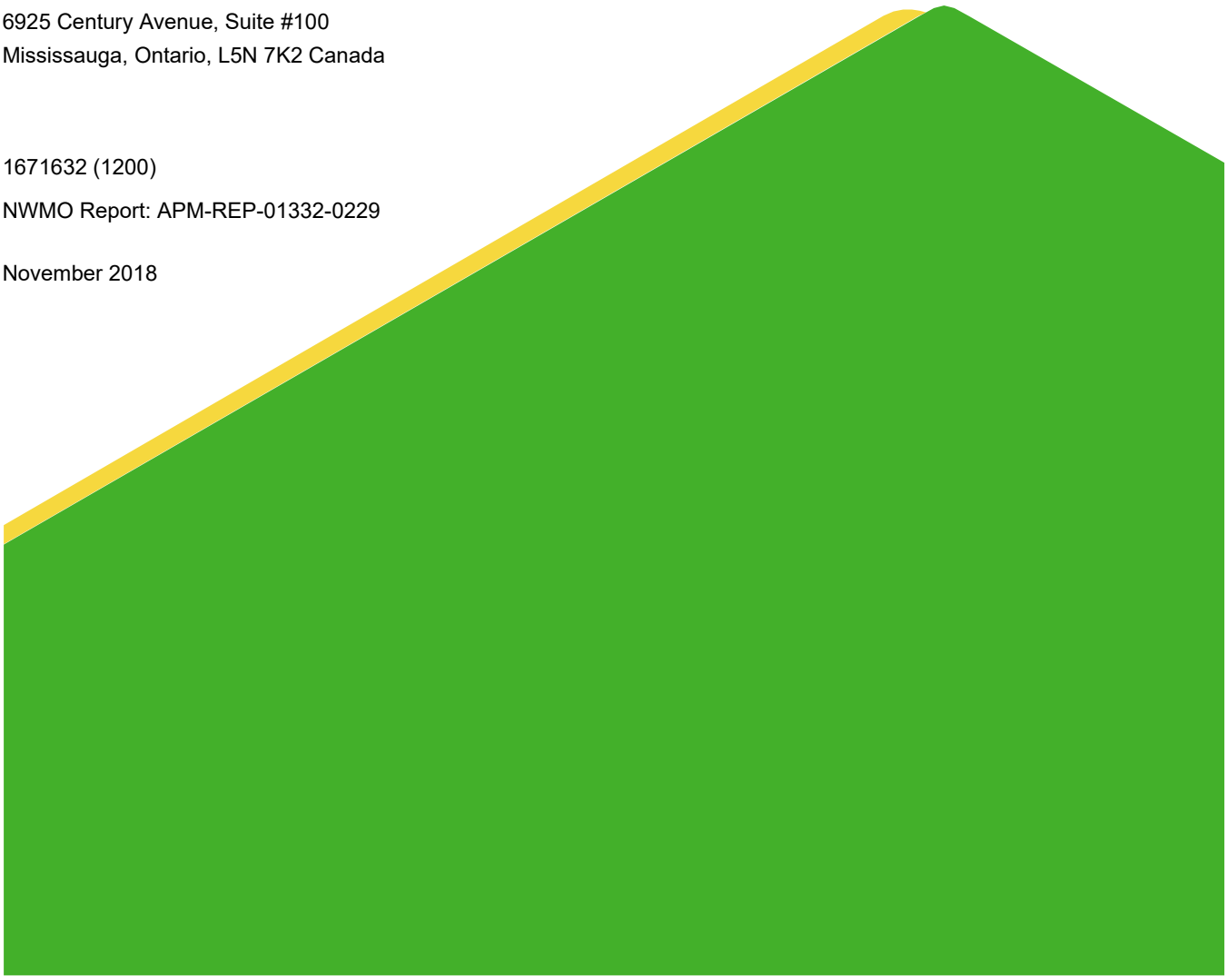
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BOREHOLE DRILLING AND CORING FOR IG_BH01

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Table of Contents

1.0 INTRODUCTION 1

2.0 BACKGROUND INFORMATION 1

2.1 Geological Setting 1

2.2 Technical Objectives 4

3.0 DESCRIPTION OF ACTIVITIES 4

3.1 Health and Safety 5

3.2 Quality Confirmation 6

4.0 SUMMARY OF DRILLING, CORING AND CASING 6

4.1 Drilling Details 11

4.1.1 Drill Rig Setup 11

4.1.2 Rig Maintenance 13

4.1.3 Tracking Borehole Depth 14

4.1.4 Drill Cuttings Management and Disposal 15

4.2 Casing Installation and Cementing Details 16

4.3 Coring Details 19

4.3.1 Ground Conditions 20

4.3.2 Core Quality 20

4.3.3 Drill Bit Changes 21

4.4 Temporary Shutdown 21

4.5 Borehole Location and Orientation Details 23

4.5.1 Borehole Orientation 23

4.6 Monitoring Drilling Parameters 24

4.7 Borehole Flushing 25

5.0 SUMMARY OF DRILL FLUID MANAGEMENT AND USE OF TRACERS 26

5.1 Drill Fluid Closed System 26

5.2 Fresh Water Management and Sampling 27

5.2.1 Water Source Samples and Testing 27

5.2.2 Fluorescein Addition 29
5.3 Drill Fluid Field Parameters 29
5.3.1 Drill Fluid Parameter Data 31
5.4 Drill Fluid Additives 32
5.5 Drill Fluid Return Volume Monitoring Data 32
5.5.1 Pre-Casing Volume Observations 32
5.5.2 Post-Casing Volume Observations 32
5.6 Drill Fluid Archive Samples and Testing 32
6.0 OPPORTUNISTIC GROUNDWATER SAMPLE LOCATIONS 33
7.0 REFERENCES 33

TABLES

Table 1: Details of Casing and Coring Rods used by Rodren for IG_BH01 20
Table 2: Summary of Drill Bits used for Coring of IG_BH01 21
Table 3: IG_BH01 Final Surveyed Collar and Casing Coordinates 23
Table 4: Sample Bottle Requirements for Maxxam Analytics and Isotope Tracer Technologies 28
Table 5: Drill Fluid Monitoring Parameters and WP7 Triggers 30

FIGURES

Figure 1: Location of IG_BH01 in Relation to the Wabigoon / Ignace Area 2
Figure 2: Geological Setting of the Northern Portion of the Revell Batholith 3
Figure 3: Timeline of Drilling, Coring, Casing and Sampling Activities for IG_BH01 8
Figure 4: IG_BH01 Drilling Progress 9
Figure 5: IG_BH01 Daily Shift Progress 10
Figure 6: Solids Removal Unit – centrifuge used to remove cuttings from drill fluid return. 11
Figure 7: Confirming Vertical Alignment of Drill 12
Figure 8: View of IG_BH01 Site Entrance with Dyment Road Visible on the Right Side 12
Figure 9: Select Photographs of the Rodren Drill Rig. Top left: Drill Controls and Gauges; Top right: Controls and Rig Mast in the Down Position; Bottom left: Drill Head during Coring; Bottom right: View of Drill Rig, Support Shack (Rodren sign) and SRU Container (green). 13
Figure 10: Verifying 3.0 m Standard Drill Rod Length (left) and View of Opened Rod Bundle Showing Greased Threads (right). 14

Figure 11: Verifying 4.15 m Length Core Barrel from the Drill Bit (left) to the Top of the Barrel with the Locking Assembly (right). 14

Figure 12: Field Verification of the Rod Count and Hole Depth during Final Bit Change at 944.28 mbgs. 15

Figure 13: Drill Cuttings being Discharged into a Burlap Bag from the Centrifuge in the SRU 16

Figure 14: Installed PWT Conductor Casing 16

Figure 15: Diluted, Unset Cement Mixture Retrieved from above Plug used to Install Surface Casing (top) and Cored through the Van Ruth Plug (bottom). 18

Figure 16: Final IG_BH01 Schematic 19

Figure 17: Packer Pressure and Water Level for IG_BH01 during Temporary Site Shut-down. 22

Figure 18: Borehole Deviation and Bullseye Plot from Final EZ-GYRO™ Survey 24

Figure 19: IG_BH01 Drill Fluid System 26

Figure 20: Rodren Water Truck used for Transporting Fresh Water to Site 27

Figure 21: Fluorescein Traced Source Water (100 ppb) in the Tank used during Drilling of IG_BH01 29

Figure 22: View of Drill Fluid Saturated with Cuttings in the Drill Tank (left) and a Sample of this Drill Fluid after Filtering for the Fluorescein Concentration Reading (right). 30

APPENDICES

APPENDIX A
Original IG_BH01 Site Survey by J. D. Barnes

APPENDIX B
Table B-1: IG_BH01 Final and Interim REFLEX EZ-SHOT™ Borehole Orientation Measurements

Table B-2: IG_BH01 Drilling and Drill Fluid Parameters

Table B-3: Field Parameters of Archived Drill Water Samples

APPENDIX C
IG_BH01 Drilling and Drill Fluid Parameter Figures

APPENDIX D
Final IG_BH01 Flushing Data

1.0 INTRODUCTION

The Initial Borehole Drilling and Testing project in the Wabigoon and Ignace Area, Ontario is part of Phase 2 Geoscientific Preliminary Field Investigations of the NWMO's Adaptive Phased Management (APM) Site Selection Phase.

This project involves the drilling and testing of the first of three deep boreholes within the northern portion of the Revell batholith. The first drilled borehole, IG_BH01, is located a direct distance of approximately 21 km southeast of the Wabigoon Lake Ojibway Nation and a direct distance of 43 km northwest of the Town of Ignace. Access to the IG_BH01 drill site is via Highway 17 and primary logging roads, as shown on Figure 1.

The project was carried out by a team led by Golder Associates Ltd. (Golder) on behalf of the NWMO. This report describes the methodology, activities and results for Work Package 2 (WP2): Borehole Drilling and Coring for IG_BH01, which includes: borehole drilling, coring and casing installation, borehole deviation, and drilling fluid management and use of tracers.

2.0 BACKGROUND INFORMATION

2.1 Geological Setting

The approximately 2.7 billion year old Revell batholith is located in the western part of the Wabigoon Subprovince of the Archean Superior Province. The batholith is roughly elliptical in shape trending northwest, is approximately 40 km in length, 15 km in width, and covers an area of approximately 455 km^2. It is likely that the batholith is approximately 2 km to 3 km thick through the center of the northern portion (SGL, 2015). The Revell batholith is surrounded by the Raleigh Lake (to the north and east) and Bending Lake (to the southwest) greenstone belts (Figure 2).

Borehole IG_BH01 is within an investigation area of approximately 19 km^2 in size situated in the northern portion of the Revell batholith. Bedrock exposure in this area is very good due to minimal overburden, few water bodies, and relatively recent logging activities. Ground elevations generally range from 400 to 450 m above sea level. The ground surface broadly slopes towards the northwest as indicated by the flow direction of the main rivers in the area (Revell and Mennin rivers). Local water courses within the investigation area tend to flow to the southwest towards Mennin Lake.

The northern portion of the Revell batholith is composed mainly of granodiorite and tonalite, which together form a relatively homogeneous intrusive granitoid complex. The granodiorite and tonalite are massive to weakly foliated. Overall, the tonalite transitions gradationally into granodiorite and no distinct contact relationships between these two rock types are typically observed. There is also a younger granite intrusion, which is observed southeast of the investigation area and primarily in the central portion of the Revell batholith. The granite, which is massive to weakly foliated, post-dates and intrudes into the granodiorite-tonalite intrusive complex (Golder and PGW, 2017). In the centre of the investigation area, a west-northwest trending mafic dyke is interpreted from aeromagnetic data and observed during detailed mapping to be approximately 15-20 m wide (Figure 2). This dyke is associated with a similarly-orientated mafic dyke that stretches along the entire northern limit of the investigation area. Both dykes, along with others in the northern portion of the Revell batholith, have a similar character and are interpreted to be part of the Wabigoon dyke swarm. It is assumed based on surface measurements that these mafic dykes are sub-vertical (Golder and PGW, 2017).

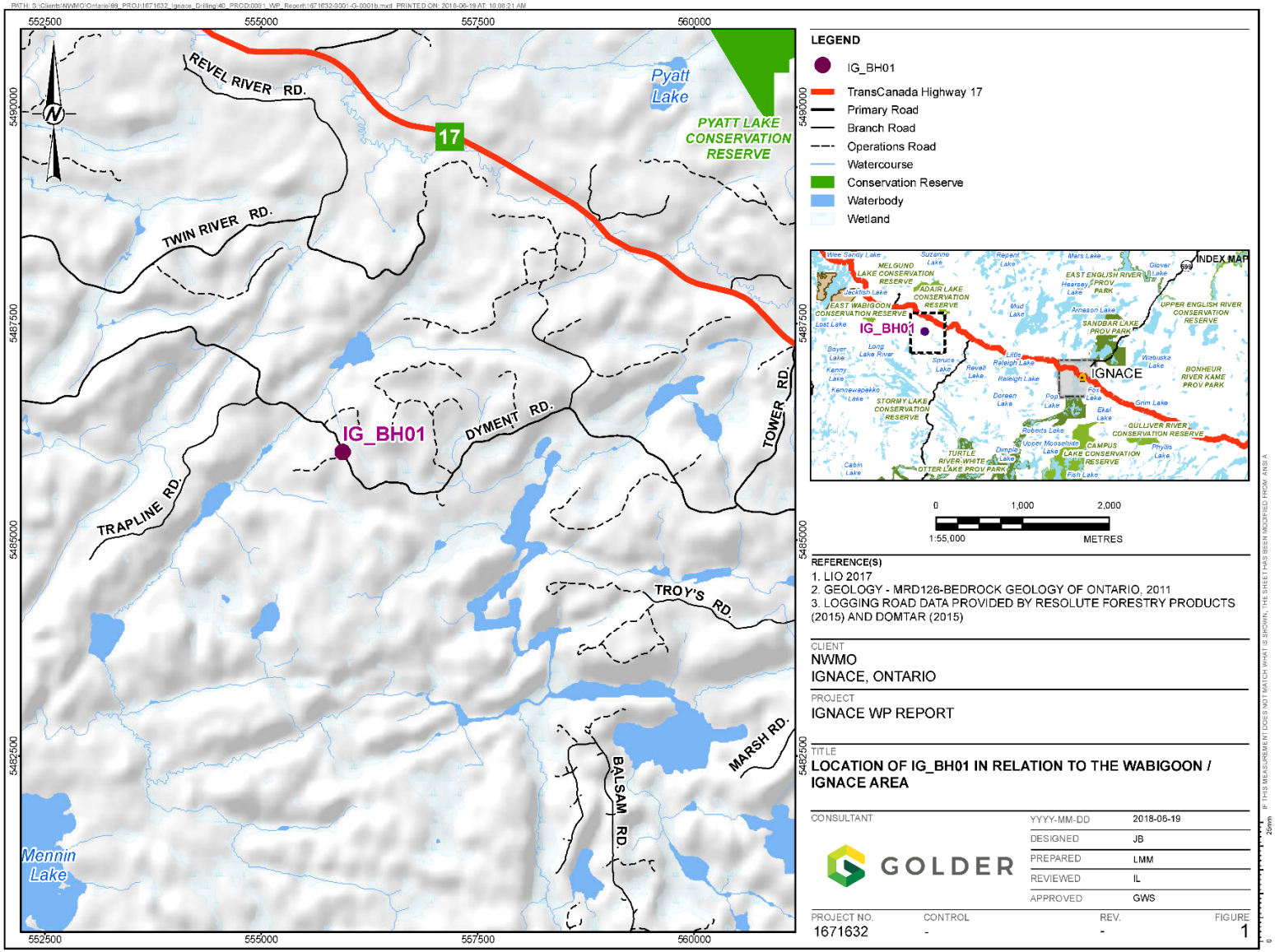


Figure 1: Location of IG_BH01 in Relation to the Wabigoon / Ignace Area

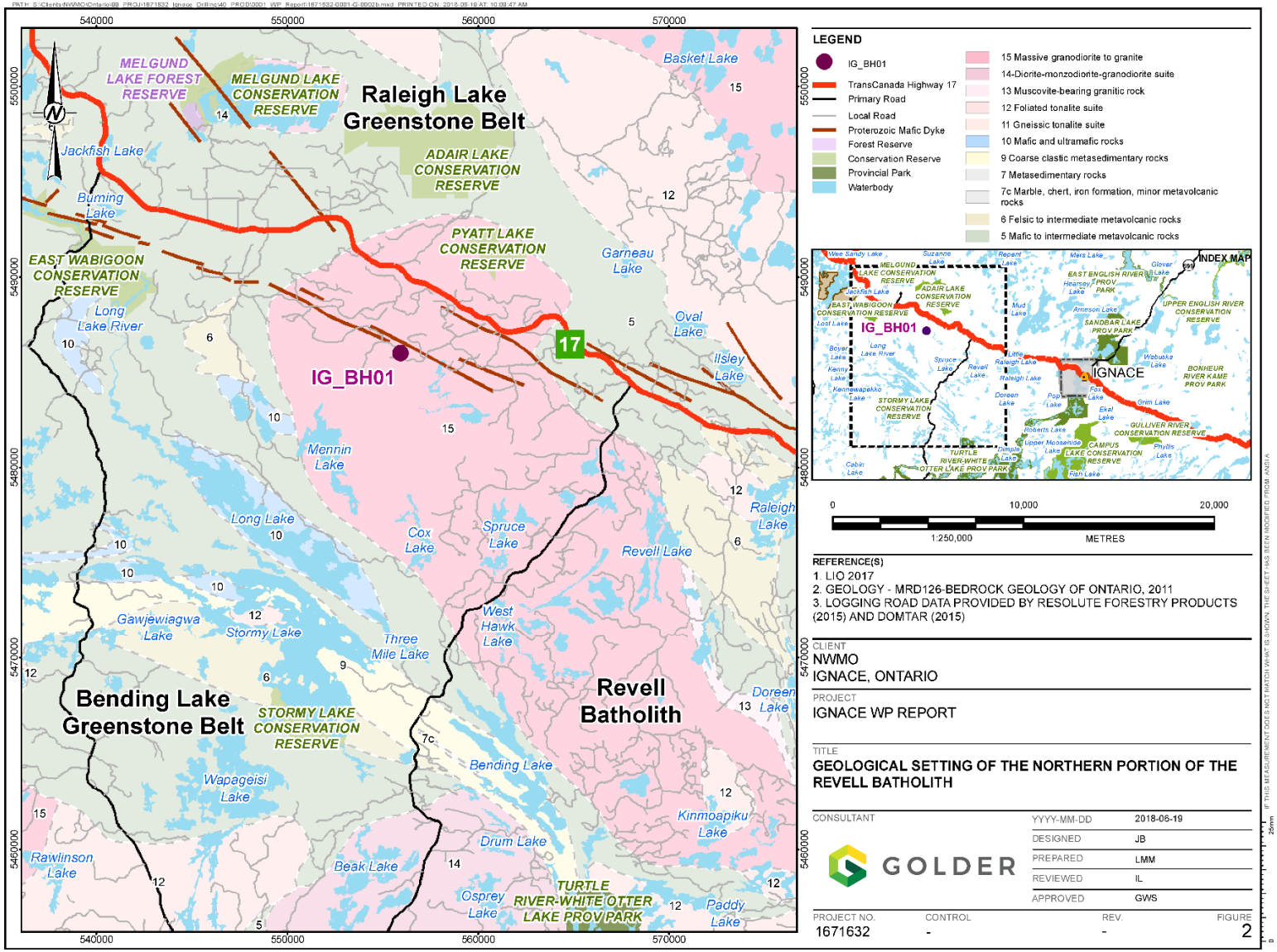


Figure 2: Geological Setting of the Northern Portion of the Revell Batholith

Long, narrow valleys are located along the western and southern limits of the investigation area (Figure 1). These local valleys host creeks and small lakes that drain to the southwest and may represent the surface expression of structural features that extend into the bedrock. A broad valley is located along the eastern limits of the investigation area and hosts a more continuous, un-named water body that flows to the south. The linear and segmented nature of this waterbody's shorelines may also represent the surface expression of structural features that extend into the bedrock.

Details of the lithological units and structures found within the investigation area are provided in the Detailed Geological Mapping Report (Golder and PGW, 2017).

2.2 Technical Objectives

The technical objectives of the borehole drilling, coring and casing installation activities are:

- The collection of high quality bedrock core, which will allow geological and geotechnical core logging and the collection of core samples. Core samples will be used for laboratory testing programs to characterize the bedrock environment;
- To provide opportunity to complete supplementary studies such as borehole geophysical logging, hydraulic testing and opportunistic groundwater sampling while drilling; and
- To provide stable borehole walls to allow for future testing and monitoring.

The main objectives of the Drilling Fluid Management and Use of Tracers activities are:

- Optimize drilling to minimize borehole deterioration;
- Effectively remove any cuttings to maintain efficient drilling; and
- Trace the drilling fluids using a fluorescein tracer and measure fluid parameters (e.g. temperature, density and electric conductance) in order to recognize drilling fluid contamination of groundwater (to be discussed in the WP7 Report – Opportunistic Groundwater Sampling for IG_BH01, Golder 2018a) and porewater extraction samples (to be discussed in the WP4C Report – Porewater Extraction and Analysis for Petrographic Analysis for IG_BH01, Golder 2018b).

3.0 DESCRIPTION OF ACTIVITIES

Activities were overseen by Lead Contractor Golder Associates with Rodren Drilling Ltd. (Rodren), based in Winnipeg, Manitoba, contracted by Golder to carry out the drilling for IG_BH01.

Permission to drill was obtained from the Ministry of Natural Resources and Forestry (MNRF) on October 10th, 2017 with formal notification to prepare to mobilize to site given to Golder via email from the NWMO on October 4th, 2017.

Drilling was carried out on a 24 hour, 7 days per week basis. Day shifts ran from 7 am to 7 pm, with night shifts from 7 pm to 7 am. A driller and helper were on site for each day and night shift, and a drilling foreman was typically present during the day shifts, or as required. A Golder drilling supervisor was present on site for all drilling activities. Both the Golder drilling supervisor and the Golder core logger from WP3 initially followed the same shift schedule as the drillers. Due to fatigue concerns, Golder reduced the number of hours on site, effective November 30th, where the drilling supervisors (WP2) and core loggers (WP3) shifts ended at 6 am (night shift) and started at 8 am (day shift). The Golder site supervisors (WP1) were generally on site during this 2 hour

window, as their shifts were shifted to 6 am to 4 pm; however no drilling was carried out during this period. When the Golder site supervisor was not on site, the drilling supervisor took over this role. This was documented in the supervisor sign-in sheet located in the Golder trailer at the site entrance.

The Golder drilling supervisor's responsibilities were divided between two main activities: (1) Drilling, Coring and Casing (2) Drilling Fluid Management and Use of Tracers. These activities included the following actions:

Drilling, Coring and Casing

- Verifying drill rig setup;
- Tracking and recording borehole deviation;
- Supervising installation and cementing casing(s);
- Tracking depth of the borehole;
- Monitoring drilling parameters during drilling; and
- Managing drill cutting collection and disposal.

Drilling Fluid Management and Use of Tracers

- Testing all fresh source water added to the drill fluid system;
- Monitoring drill fluid parameters and volume changes during drilling;
- Identifying any triggers for an opportunistic ground water sample;
- Collecting and archiving drill fluid samples every 50m;
- Supervising borehole flushing prior to geophysical survey (WP5); and
- Recording observed drilling parameters and measured volume changes, drill fluid parameters and borehole depth for each run.

3.1 Health and Safety

The Ignace drilling and testing program conformed to applicable health and safety standards for the duration of the program. A comprehensive "pre-drill" drill rig inspection was completed by Golder and Rodren prior to the start of coring, on November 6th, 2017 and included the following checks:

- Emergency switches are in working order;
- Equipment and protective guards are in place;
- Cables, chains, pulleys, cable winches, latches / lifting devices are in proper working order;
- Drill string (coring rods) are manufacturer recommended;
- Mast is unmodified from manufacturer and regularly inspected;
- Drill controls are appropriate and free from obstructions;
- Hydraulic lines are secure and not bent or pinched;
- Pump lines (water hoses) are in good condition with whip checks, where required;

- Fire prevention supplies are present;
- Exhaust piping is directed appropriately;
- Fuel is properly stored; and
- Other general items including maintenance logs to confirm inspections were available.

In addition to the pre-dill inspection, Rodren also completed daily rig inspection and a monthly rig inspection, to ensure that rig safety was maintained throughout the drilling program.

Once drilling commenced, a Casella Sound Level Meter was used to establish zones where hearing protection was required, that is, all areas with an equivalent sound exposure level exceeding 83 dBA (O.Reg. 851/139) due to the prolonged exposure of 12-hour shifts. The area inside of the drill rig was established as the only area requiring hearing protection, however, hearing protection was generally used in the areas around the drill rig as well.

An RKI Model GX-2012, 4-Gas Monitor was installed in the drill rig and used to monitor for levels of oxygen, carbon monoxide, hydrogen sulphide and combustible gases during drilling. The gas monitor was bump checked by the Golder site supervisor daily. No exceedances of safe limits of these gases were encountered during drilling of IG_BH01.

Health and safety toolbox meetings were held at the beginning of each shift (day and night), where attendance of all site personnel was mandatory. The meeting reviewed all activities to be completed during that shift, and identified the hazards and mitigation efforts to reduce risk of injury. Any visitors on site, who did not participate in the toolbox meetings, were required to review and acknowledge the toolbox report before allowed to perform work on site.

3.2 Quality Confirmation

Cross-shifts between day and night shift were carried out to transfer knowledge and information about the previous shift activities. These were typically 10-15 minutes, but longer when more specific knowledge needed to be relayed. When the crews did not cross on site, typically during the morning switch, the knowledge transfer was done in Ignace or over the phone. Cross-shifts were also carried out between crews switching rotations and typically involved spending an entire shift together on site to ensure procedures were kept consistent.

Quality Confirmation was completed for each 24-hour period by the drilling supervisors and included tracking of the drilled depth at the start and end of each day and night shift, verification of the drilling parameters recorded, verification and comments for drill fluid parameter triggers and volume loss observations, as well as drill fluid samples collected, and borehole orientation surveys conducted.

Drilling supervisors ensured all tools were properly calibrated before the start of the project and performed daily calibration checks of all instruments to be used at the start of each 24-hour period. If a tool not anticipated to be used became necessary during the shift, it was calibration checked as required prior to use.

4.0 SUMMARY OF DRILLING, CORING AND CASING

Drilling of IG_BH01 commenced on November 2nd, 2017 and was completed on January 16th, 2018, with a temporary site shut down occurring over the holidays (December 22nd, 2017 to January 3rd, 2018). A timeline of the various activities and progress are detailed in Figure 3.

The borehole was advanced to 1001.27 metres below ground surface (mbgs) drilled depth based on the rod count and measured stickup of the drill rods on the final drill run. The final depth of IG_BH01, based on measurement of the length of retrieved core, was 1001.18 mbgs, indicating that final core run broke 9 cm higher than the final position of the drill bit and was therefore not recovered.

Coring progress over the program was variable due to bit changes or other drilling related maintenance, weather delays (equipment freezing in extreme cold typically) and frequent stoppages for WP3 core logging and WP4 core sampling activities. The overall progress is shown graphically on Figure 4, and the daily progress by shift is shown on Figure 5. The maximum meterage attained for a single shift was 23.99 m on November 27th night shift, but the average rate per shift was 10.65 m (excluding WP7 sampling activities, surface casing installation and cementing, and the temporary site shut down over the holidays in December).

Drilling of IG_BH01 was completed on the day shift of January 16th, 2018. This was followed by the final borehole EZ-GYRO™ survey, borehole flushing, rod removal and preparation for geophysical logging. The core logging and sampling supplies were packed into storage containers and remained on site. Equipment related to WP2 was not demobilized from site upon completion of drilling as most of the sampling and monitoring supplies were required for continued monitoring of drilling fluid during WP5 and WP6 activities, as well as during WP7 opportunistic groundwater sample attempts carried out during WP6 – Hydraulic Testing.

Task Name	Duration	Start	Finish
Mobilization & Fluid Monitoring Setup	7 days	31-Oct-17	06-Nov-17
PWT Casing Installation and Cementing	0.5 days	02-Nov-17	02-Nov-17
Drilling & Coring Activities	50 days	06-Nov-17	16-Jan-18
WP7 - Groundwater Collection	4.5 days	11-Nov-17	26-Nov-17
Televiewer Survey	1 day	16-Nov-17	16-Nov-17
HWT Casing Installation and Cementing	4 days	17-Nov-17	21-Nov-17

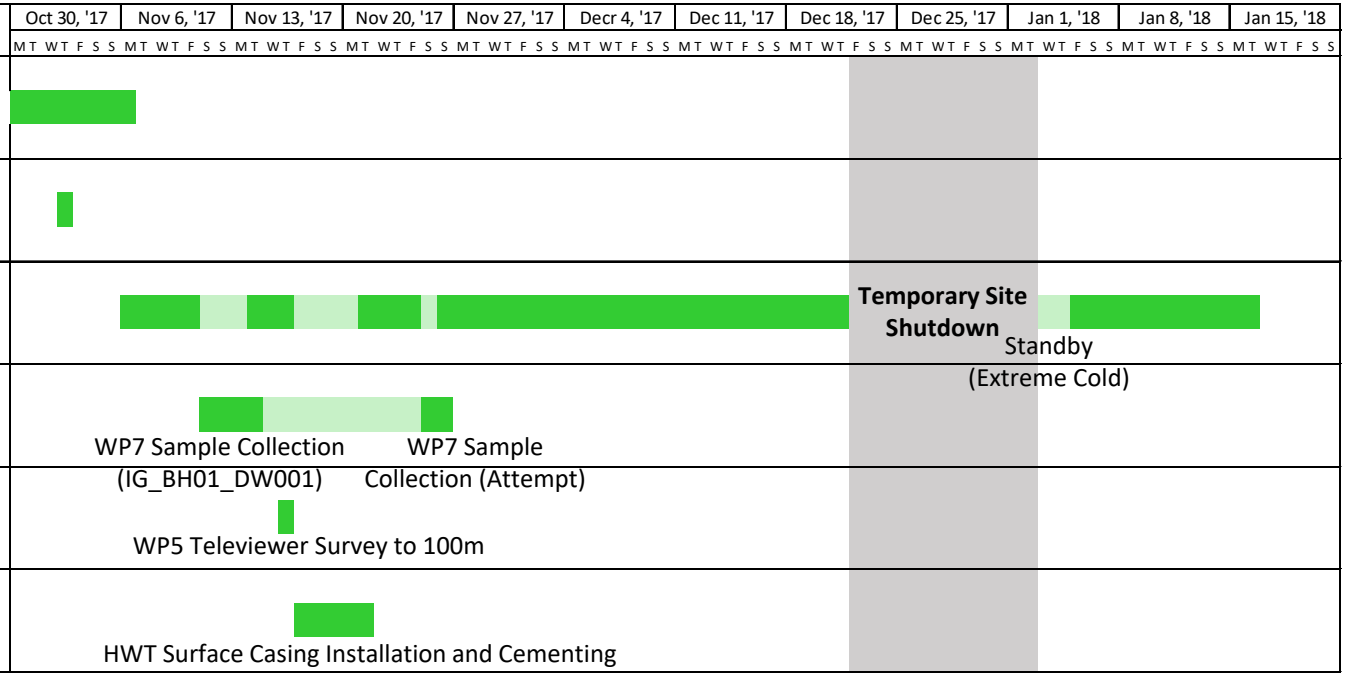


Figure 3: Timeline of Drilling, Coring, Casing and Sampling Activities for IG_BH01

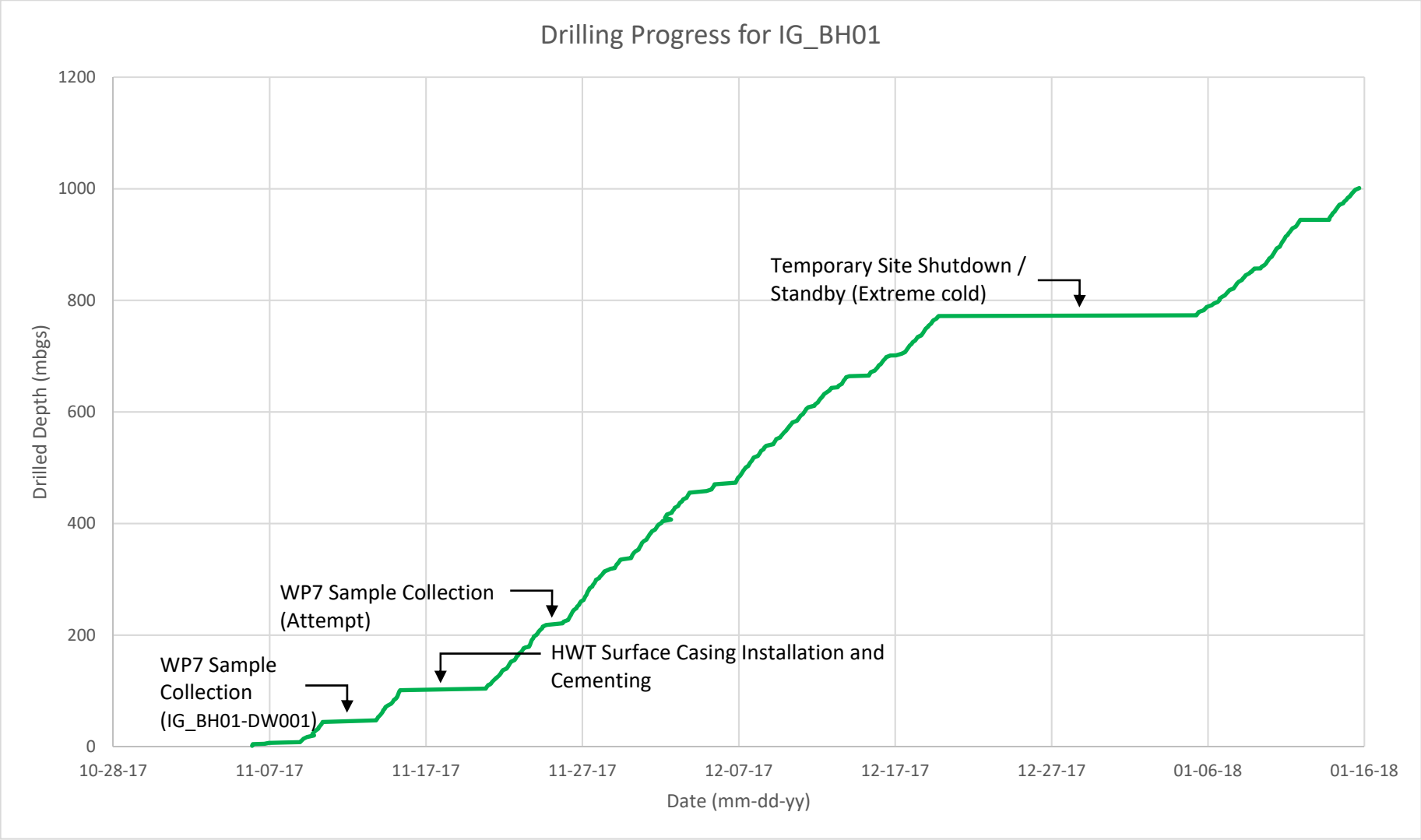


Figure 4: IG_BH01 Drilling Progress

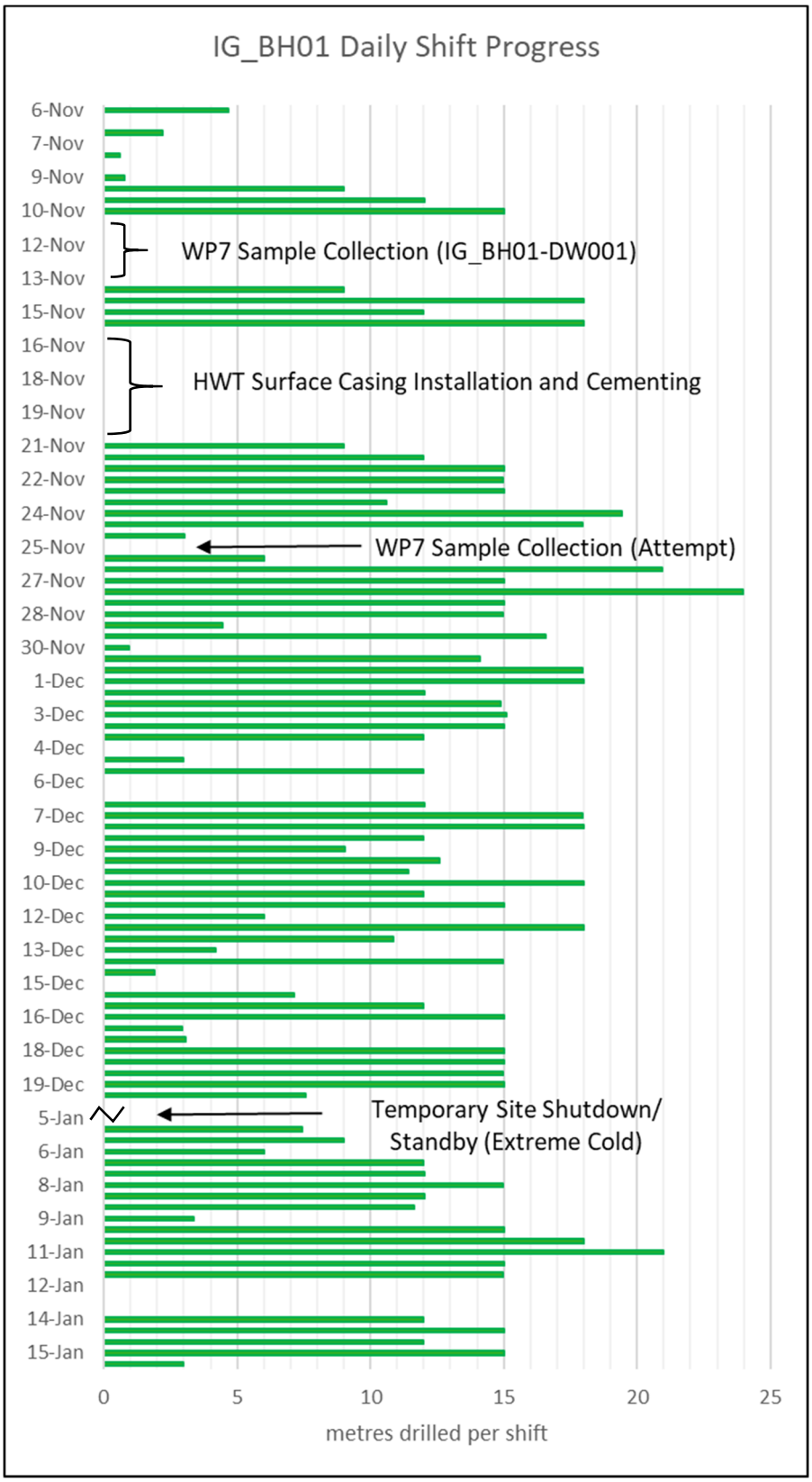


Figure 5: IG_BH01 Daily Shift Progress

4.1 Drilling Details

4.1.1 Drill Rig Setup

A skid mounted Discovery Diamond Drill model EF-75 12 HH was used for the program, set up with containment to minimize drill fluid entering the environment. Drilling was carried out with a constant water flush, with the drill water (drill fluid) recycled using a Solids Removal System™ (SRU) from Australian Mud Company Pty Ltd. (AMC). This system utilized a centrifuge to remove cuttings from the return drill fluid and is shown in Figure 6.



Figure 6: Solids Removal Unit – centrifuge used to remove cuttings from drill fluid return

Set-up of the drill rig commenced once the site was prepared with a level drill pad. Rodren mobilized to site on October 27th, 2017 with flatbed trucks carrying their drilling infrastructure and began to position and level the centrifuge and drill rig. All drilling infrastructure placement was completed the following day (October 28th, 2017), with Rodren then offsite until November 1st, 2017 when Golder WP2 and WP3 personnel also mobilized to site.

During the following days, Golder unpacked and set up the site trailers and carried out equipment calibrations, while Rodren prepared their drilling support shack, connecting hoses and lines and completed the drill deck. The borehole was planned to be drilled at a vertical (-90°) inclination, and prior to drilling, the drill rig was aligned vertical using a level, as depicted below in Figure 7. The borehole was surveyed with a REFLEX EZ-GYRO™ every 50 m during drilling, and every 10 m upon completion of drilling. The overall view of the IG_BH01 site entrance is shown in Figure 8, with images of the drill rig shown in Figure 9.



Figure 7: Confirming Vertical Alignment of Drill



Figure 8: View of IG_BH01 Site Entrance with Dyment Road Visible on the Right Side



Figure 9: Select Photographs of the Rodren Drill Rig. Top left: Drill Controls and Gauges; Top right: Controls and Rig Mast in the Down Position; Bottom left: Drill Head during Coring; Bottom right: View of Drill Rig, Support Shack (Rodren sign) and SRU Container (green)

4.1.2 Rig Maintenance

Maintenance activities of the drill rig and coring supplies during advancement of IG_BH01 were generally typical of a drilling program, but some issues were exacerbated by the extreme cold conditions. The cold temperatures resulted in hose lines between the drilling components (drill and centrifuge) rapidly freezing when circulation was paused, often during shift change. This caused a delay on the order of two hours to either replace hoses or to remove, thaw and replace them. The wireline retrieval line broke three times during the program, resulting in its eventual replacement which eliminated the splices required to repair it.

4.1.3 Tracking Borehole Depth

The depth of the hole was monitored on a per run basis by the drilling supervisors. This was done by measuring the stickup of the drill rods from a fixed reference point at the completion of each run plus the fixed stick up of that reference point from the ground surface, which was subtracted from the length of the drill string (core barrel plus the drill rods). The chosen reference point was the top of the drill head when it was at its lowest possible position, which was 1.87 m above ground surface. Stickups were typically on the order of a few centimetres, but if a run blocked before 3 metres was cored, the stickup was higher.

Figure 10 and Figure 11 below show the verification of the core barrel and drill rod lengths carried out prior to drilling. The core barrel was measured as 4.15 m long and all drill rods on site were confirmed as 3.0 m long (metric) HQ rods. No additional rod grease was added during the coring process, but the rods came from the manufacturer with a small amount of grease around the threads, as shown in Figure 10. As described above, the borehole depth was tracked by the number of rods added to the drill string.



Figure 10: Verifying 3.0 m Standard Drill Rod Length (left) and View of Opened Rod Bundle Showing Greased Threads (right)



Figure 11: Verifying 4.15 m Length Core Barrel from the Drill Bit (left) to the Top of the Barrel with the Locking Assembly (right)

A final manual rod count was performed during the final bit change at 944.28 mbgs while all the rods were pulled from the borehole and on surface. This was verified by both the WP2 and WP3 field staff on site (Figure 12).

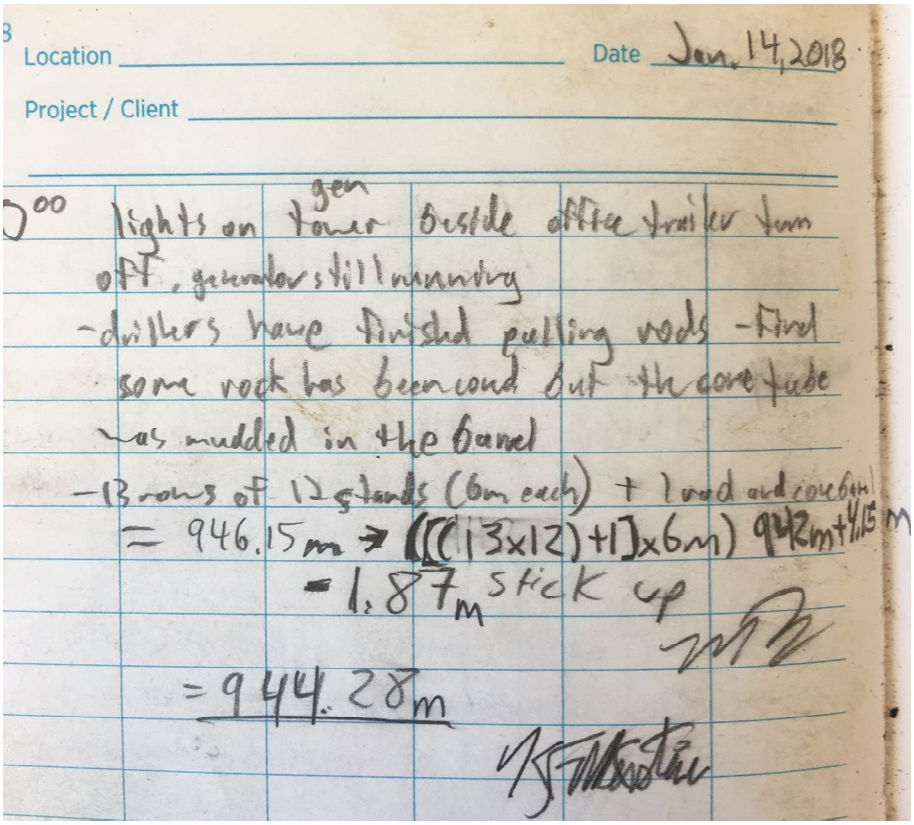


Figure 12: Field Verification of the Rod Count and Hole Depth during Final Bit Change at 944.28 mbgs

4.1.4 Drill Cuttings Management and Disposal

The drill fluid return containing cuttings from the borehole was pumped directly to the SRU™, where the fine solids were separated from the water and directed to burlap bags in steel holding containers (Figure 13).

The efficiency of the centrifuge system appeared to vary somewhat throughout the drilling program, with the centrifuge at times removing less cuttings from the drill fluid than anticipated. This resulted in increased turbidity of the drill fluid, which reduced its ability to effectively clean cuttings from the drill bit as coring progressed. To improve this, an additive was introduced as described in Section 5.4 (at borehole depth 560.31 mbgs), and increased maintenance activities were carried out daily on the centrifuge system.

The drill cuttings were sampled on November 17th, 2017 and sent to Maxxam Analytics in Mississauga to be analyzed according to Ontario Regulation 558. Note that the sample was labelled “CUTTINGS” instead of IG_BH01_TCLP001. The results indicated that the drill cuttings were safe for disposal and were accepted by the Ignace landfill.



Figure 13: Drill Cuttings being Discharged into a Burlap Bag from the Centrifuge in the SRU

4.2 Casing Installation and Cementing Details

Prior to commencing coring activities, PWT conductor casing was installed and cemented approximately 1.35 m into the bedrock, to prevent drill fluid from escaping through the fractured upper bedrock. No overburden was encountered or recovered during the casing installation as bedrock was present at surface. The conductor casing was installed on November 2nd, 2017 after the drill rig mast was aligned to vertical. The freshly installed casing after cementing is shown on Figure 14.



Figure 14: Installed PWT Conductor Casing

The PWT sized conductor casing was cemented with a steel sump box around the collar of the hole to contain return drill fluid. Once coring began, drill fluid volume losses greater than 200 L were observed during coring of the initial drill runs, with fluorescein coloured water observed to have escaped through the constructed drill pad

and upper fractured bedrock. This indicated that open fractures connected to ground surface intersected the borehole below 1.35 mbgs, and was mitigated by implementing two actions: first, the steel box around the borehole collar was removed, the gravel fill material within its footprint carefully cleared, and the box cemented in place to create a better seal to the top of the bedrock; and second, temporary HWT sized surface casing was advanced past the cemented PWT conductor casing depth to prevent drill water outflow through open fractures.

The HWT surface casing was advanced beyond the PWT conductor casing to provide a temporary seal from conductive near surface fractures during the initial drill runs, as well as to provide smaller diameter casing to stabilize the HQ sized drill rods during coring. A bentonite slurry (made with PureGold® Medium Chips by CETCO®) was also injected through the temporary HWT surface casing to prevent water loss through these near surface open fractures. These measures allowed routine coring to continue and the borehole was advanced to 101.27 mbgs.

Coring activities were halted when the borehole was advanced to 101.27 mbgs. At this depth, the borehole was flushed and prepared for the televiewer survey. Once the parameters of the flush water were within acceptable criteria (see Section 4.6), the HQ drill rods were removed from the borehole and an acoustic televiewer survey was completed. Note that high turbidity of the fluid in the borehole caused by the rod removal prevented the acquisition of a good quality optical televiewer survey.

After consultation with the NWMO, HWT surface casing was then installed and cemented. Surface casing installation depth was determined, in coordination with NWMO, once the first 100 m of geophysical survey images were reviewed. This depth was selected so that depths with evidence of open fractures (down to 66.79 mbgs), confirmed by the geophysical televiewer survey, were cased and cemented to seal them from the rest of the hole. The installation and cementing of the surface casing served to prevent mixing of the ground water from these shallow permeable zones with the rest of the borehole. Golder supervised Rodren throughout the installation of the HWT surface casing and cementing activities.

The surface casing installation process involved first reaming the borehole with HWT casing to the desired depth of 69 mbgs. A casing shoe bit was used to ream the borehole as the HWT casing was advanced. A Van Ruth plug was then installed below the casing, leaving a small gap between the casing shoe and the plug. The HWT casing was lifted slightly in order to create space for the cement mixture to flow between the HWT casing and the borehole wall.

The cement mixture was batched on surface and approximately 400 litres pumped down the inside of the HWT casing. Rodren provided Type HS High Sulphate resistant cement by LaFarge, which provides high sulphate resistance. The cement was then pumped down the hole until the cement mixture could be observed returning to surface through the annular space between the outside of the HWT casing and the inside of the PWT conductor casing. A sample of the cement mixture was collected from the mixing tank and from the annular return in order to confirm proper curing of the cement at surface.

The cement was left to cure for 36 hours, at which time a cored sample of the cement material above the plug was retrieved. As the plug had been pumped down using water, the remaining cement above the plug was diluted and therefore did not set, as shown in Figure 15. While this was visually misleading, the plug prevented dilution of the cement below it and in the annular space. This was verified by checking the samples collected and allowed to cure on surface. The Van Ruth plug was then cored through (Figure 15) and regular coring activities resumed for the remainder of the borehole to 1001.18 mbgs. The final IG_BH01 borehole schematic is shown in Figure 16.

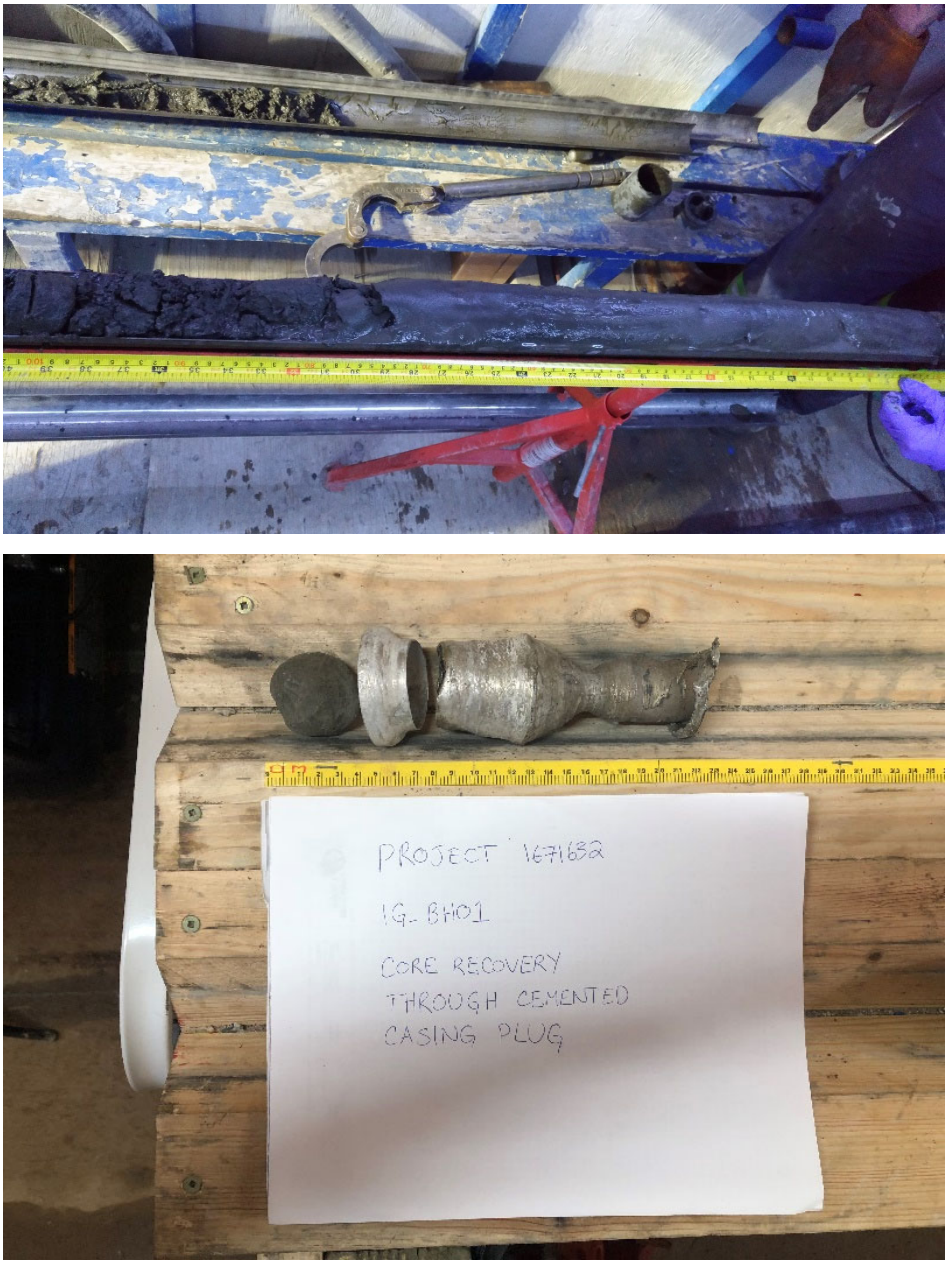


Figure 15: Diluted, Unset Cement Mixture Retrieved from above Plug used to Install Surface Casing (top) and Cored through the Van Ruth Plug (bottom)

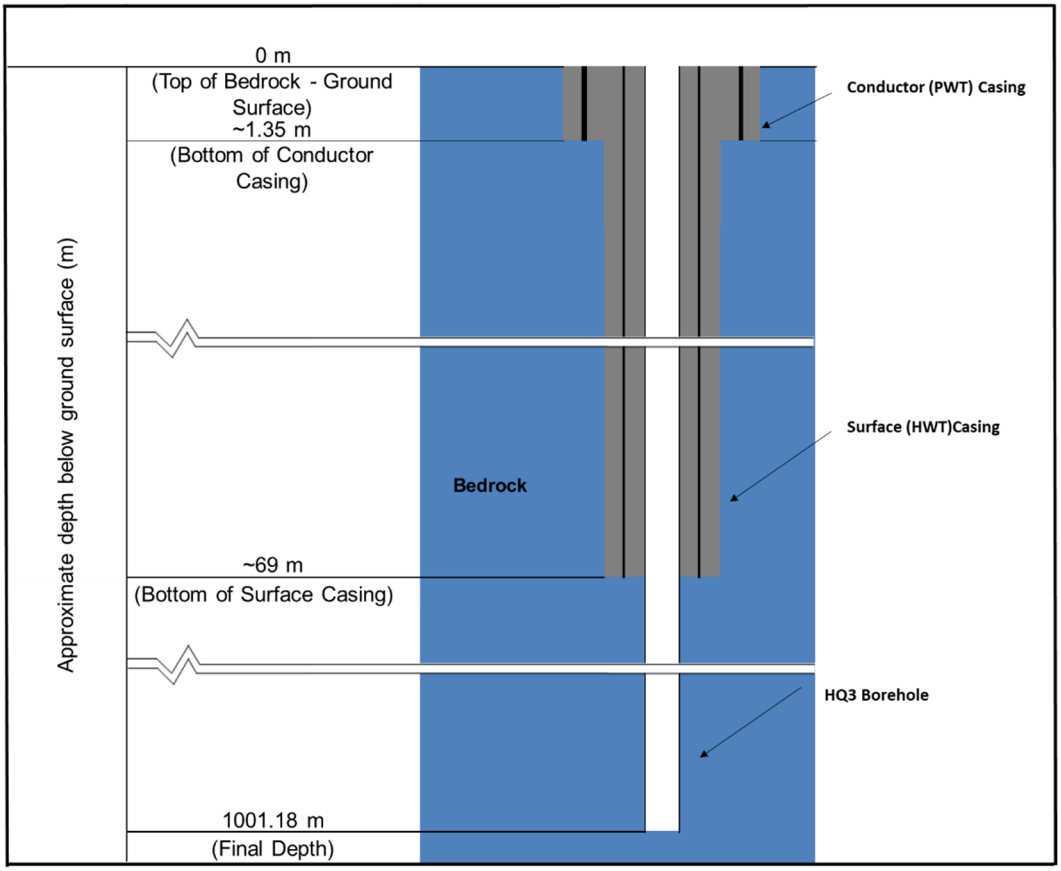


Figure 16: Final IG_BH01 Schematic

4.3 Coring Details

New, three (3) metre long HQ sized Boart Longyear drill rods were added manually to the drill string one rod at a time as drilling progressed. As with standard deep drilling programs, two core tubes were available at all times, so that when one was removed with a drilled run, the second could be lowered and locked in place while the core was extracted from the first tube. Core tubes were lowered and retrieved using a wireline system in which an overshot tool locked on to the top of the core tube. The core tube was pumped down and locked into the core barrel using the downhole pump; the drillers monitored when it was locked into place by observing a spike in the downhole fluid pressure. This time required to pump and lock the core tube into place to continue coring increased with the depth of hole; having a second tube to start this process while the core was extracted from the first was valuable for efficiency.

The first two runs were completed without the use of the core tube due to the length of the core barrel and overshot device needed to retrieve the core tube assembly. After this, the borehole was advanced using a triple tube wireline drilling system for the remainder of the hole to minimize disturbance to the recovered drill core. Triple tube coring involves using steel, split core liners to line the inside of the core recovery tube, which is locked within the core barrel during drilling. The core tube is recovered using the wireline at the completion of each drill run, with the split liners removed from the core tube on surface. The split liners help reduce the volume of drill fluid that can circulate within the core tube, helping to prevent the drilled core from being disturbed and to retain fine grained materials encountered. See Table 1 for details on casing and coring rods.

Table 1: Details of Casing and Coring Rods used by Rodren for IG_BH01

Casing Type	Outer Diameter (mm)	Inner Diameter (mm)	Joint Torque (Nm)	Weight (kg/m)
Conductor (PWT) Casing	139.7	127.0	N/A	21.4
Surface (HWT) Casing	114.3	101.6	N/A	17.4
HQ Drill Rods	88.9	77.8	2000	11.44
HQ3 Drill Bit	96.0[1]	61.1[2]	N/A	N/A

[1]Open borehole diameter. [2]HQ3 core diameter size.

4.3.1 Ground Conditions

In general, ground conditions were good and did not cause problems with the drilling process; there were no occurrences of core tubes blocked by poor quality or fractured rock, which would have caused the core run to be retrieved before completing a full length run of 3 m. No circulation losses were encountered, and after installing the surface casing, the drill fluid losses were minimal.

4.3.2 Core Quality

There were 13 instances of core loss encountered in IG_BH01, all due to mechanical grinding from the drilling process. Twelve of these instances were less than 10 cm, while the first instance was longer, likely due to the increased fracturing at surface and prior to installation of the conductor casing. None of these losses of drill core were observed in the televiewer logs, confirming their mechanical origin. Instances of mechanically broken core were also occasionally encountered. These typically occurred where the presence of sand sized ground core within the split tube resulted in the drill core becoming jammed in the core tube. When this occurred, drillers had to use mechanical force on surface to remove the inner split tube, causing damage to the rock core in the process.

“Candy cane” striping was observed on occasion on the drill core, caused by the core tube moving within the barrel during the drilling process. Normally, the backend assembly at the top of the core tube engages a locking mechanism that prevents the core tube from rotating along with the core barrel. On occasion, this mechanism failed and the “candy cane” pattern was observed on the core; occasional failure of this is not uncommon in deep drilling programs. Inspections of the drill string tooling were carried out to ensure the system was functioning as intended and the striping of the core was not continuous.

Ribbing (uneven or wavy core diameter) of the core tends to occur as the drill bit becomes worn down and increased torque is required to continue coring. Drillers were typically aware when this occurred due to noticeably reduced rates of penetration, and verified suspicions by inspecting the core for these signs. Bit sharpening involved momentarily increasing torque or cutting off the water supply to sharpen the drill bit by exposing fresh diamonds, but results in increased ribbing. Drillers commonly carry out bit sharpening to maintain performance during the life of the bit. Towards the end of the borehole, efforts were made to restrict bit sharpening to the start or end of a drill run so that uneven diameter core was not present within the central part of a core run (mainly for aesthetic purposes).

4.3.3 Drill Bit Changes

Drill bit changes were required as coring advanced and the drill bit became worn down. Bit changes involved removing the core tube from the rods, then using the rod handler on the drill rig to remove all the drill rods from the borehole, typically two at time. These stands of rods were stacked in the drill shack during the bit change so that they were easily accessed by the rod handler to go back down the borehole. When all the rods were removed, the core barrel was inspected for damage and signs of wear, and the bit replaced. Drilling in this relatively hard rock required frequent bit changes (approximately 1 every 100 m of drilling). A summary of the drill bit types used during the drilling program are shown in Table 2.

Table 2: Summary of Drill Bits used for Coring of IG_BH01

Drill Bit Name	Depth used from (mbgs)	Depth used to (mbgs)	Total drilled length used (m)
Safari 9E	0.00	77.28	77.28
Safari 9E	77.28	177.86	100.58
Safari 9E	177.86	318.71	140.85
Longyear 10	318.71	335.27	16.56
Safari 9E	335.27	443.29	108.02
Safari 9E	443.29	539.29	96.00
Safari 8-9 Turbo	539.29	643.09	103.80
Hero 9 Abrasive (Forida)	643.09	701.49	58.40
911 (Forida)	701.49	771.85	70.36
Safari 9E	771.85	856.90	85.05
Hero 7 (Forida)	856.90	944.28	87.38
Hero 7 (Forida)	944.28	1001.27	56.99

4.4 Temporary Shutdown

There was a temporary site shutdown from December 22nd, 2017 to January 3rd, 2018. Drilling was stopped on December 20th, at a depth of 771.85 mbgs, and preparations were made to seal the borehole for the shutdown period.

The open borehole was sealed at a nominal depth of 415 mbgs using a single pneumatic packer assembly. The intent of the packer installation was to prevent circulation of groundwater between the shallow section of the borehole and the deeper repository horizon while drilling was suspended. The packer installation depth was chosen as it was an intact zone to provide a good packer seat and was below the shallow-to-deep groundwater transition zone. Prior to installing the packer, the borehole was flushed to remove cuttings by pumping fresh, fluorescein traced (100 ppb concentration) water through the drill string to the bottom of the borehole. Approximately 7 – 8 m^3 of fresh water was flushed through, which represented over two borehole volumes.

Following the borehole flushing, the drill rods were pulled back to the target depth and the packer assembly was lowered into the borehole through the rods. A packer inflation test was completed inside the rods near the surface and once the assembly was confirmed to be holding pressure it was deflated and lowered into position past the end of the drill rods. The packer was then inflated to the calculated pressure (hydrostatic pressure above the packer + packer stretch to borehole wall + maximum differential pressure + factor of safety = inflation pressure) and checked to make sure it was holding the required pressure. A lift test was also completed, which involved raising the HQ rods 10 cm while holding the wireline and observing the wireline to remain in place. This confirmed that the packer was set in place.

The static water level was measured as 38.38 mbgs on December 22nd, 2017 at 4:30 AM. It remained reasonably steady throughout the break, as shown in Figure 17.

During the temporary site shutdown, the site supervisor made daily checks of the packer pressure and the water level in the upper part of the borehole. On December 27th, 2017, a temporary loss of packer pressure occurred and coincided with a slight decrease in the borehole water level. The packer pressure was brought back up and the water level stabilized for the remainder of the site shut-down period.

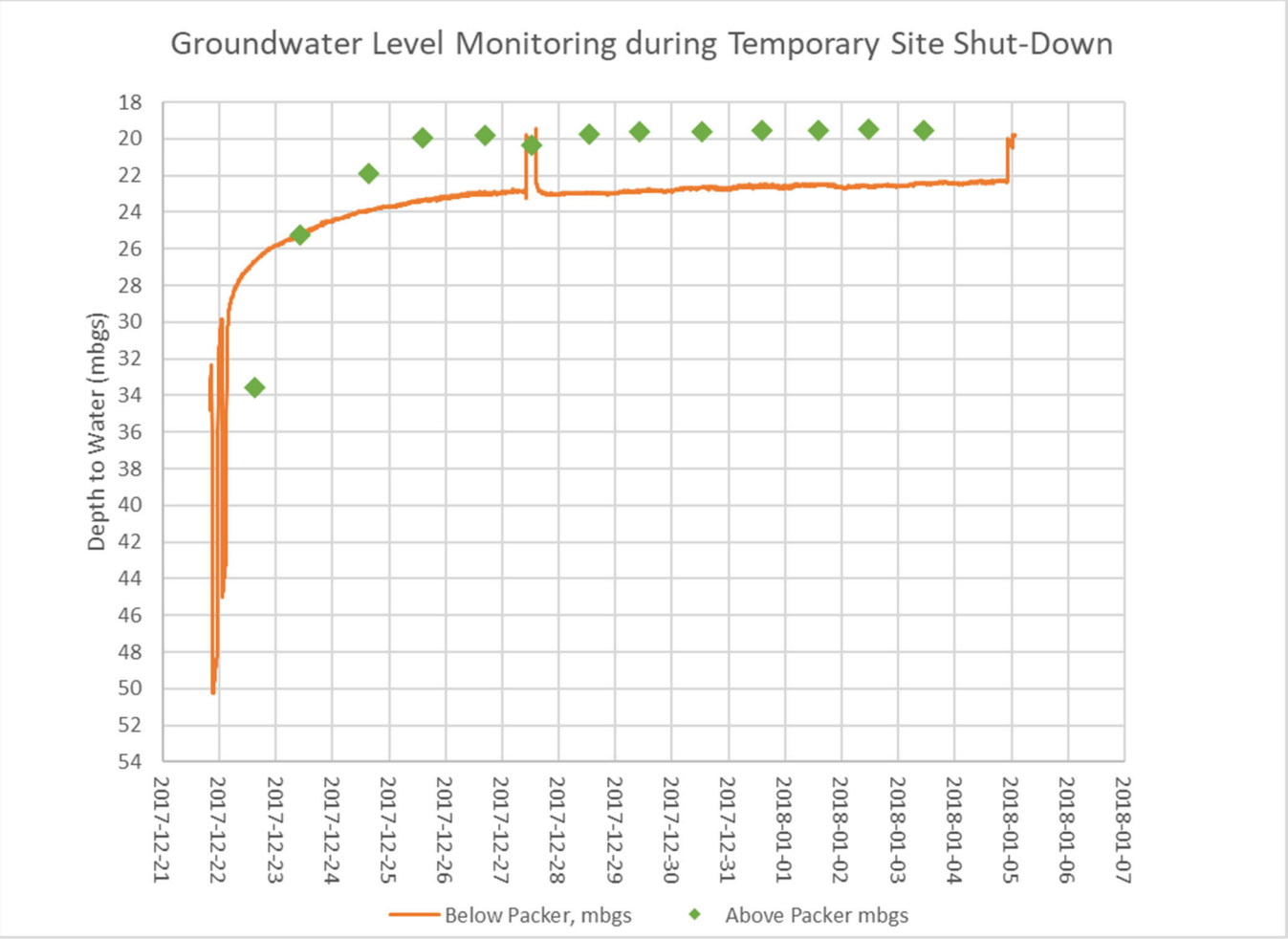


Figure 17: Packer Pressure and Water Level for IG_BH01 during Temporary Site Shut-down

Following the temporary site shutdown, the packer was deflated and removed from the borehole, the drill rods were extended back to the bottom of the borehole and drilling was resumed. Note, Golder was on-site January

3rd; however due to cold winter temperatures, below -30°C, drilling did not resume until January 5th, 2018. In addition, the severe cold continued to impact drilling progress between January 5th and 6th 2018.

4.5 Borehole Location and Orientation Details

The planned drill site for IG_BH01 was surveyed by J. D. Barnes Limited on July 5th, 2017. This original site survey involved the use of a local base station to establish observed reference points that were used to derive various site benchmarks, including a standard iron bar, concrete plinths and iron bars, as well as the planned borehole collar. These are shown in Appendix A.

The as-built borehole collar was surveyed on March 15th, 2018 by J. D. Barnes Limited, and the as-built coordinates of IG_BH01 are presented in Table 3. The coordinates for the borehole collar were measured using the Westbay installation casing coordinates for the Easting and Northing, as these represented the centre of the borehole. Due to gravel covering the surface around the borehole collar, the elevation for the collar was taken from the coordinates of the closest visible outcrop of bedrock (located within 15cm of the casing).

Table 3: IG_BH01 Final Surveyed Collar and Casing Coordinates

Point	Northing (m)	Easting (m)	Elevation (m)
Bedrock (borehole collar)	5486016.45	555943.35	430.72
Top of surface (HWT) casing	5486016.41	555943.35	430.91
Top of conductor (PWT) casing	5486016.54	555943.33	430.87
Top of Westbay casing	5486016.45	555943.35	431.04

Note: Elevations are Geodetic and referred to the Ministry of Transportation of Ontario benchmark No. 00819668142, with a published benchmark of 409.07 meters. Coordinates are referred to UTM Zone 15, NAD 83 (CSRS).
Note: Extensions to the length of casing stickup added after March 15th, 2018 are not included in these coordinates.

4.5.1 Borehole Orientation

The borehole was planned to be drilled at a vertical (-90°) inclination with no correction made for deviation as the drilling progressed.

The borehole was surveyed with a REFLEX EZ-GYRO™ every 50 m during drilling. Generally, the borehole was advanced two runs (about 6 m) past the 50 m mark and the core tube locked into place. This allowed the EZ-GYRO tool to sit at approximately the 50 m mark (50, 150, 200 m etc.) accounting for the length of the core barrel and actual measurement point of the tool. The EZ-GYRO was then calibration checked on surface and the tool lowered into the borehole to perform the survey. Rodren then presented the survey results to Golder and they were entered into the acQuire database. The tool's accuracy from the manufacturer is listed as ±1° for azimuth and ±0.3° for dip.

A final borehole survey with the EZ-GYRO was carried out upon completion of drilling, with a measurement point taken every 10 m. The interim survey data collected during drilling at 50 m increments and the final survey collected every 10 m upon completion of drilling are consistent, and the final survey is presented in Table B-1 (Appendix B). Figure 18 presents the borehole deviation graphically, calculated using the minimum curvature method. Inspection of Figure 18 shows the borehole deviating 27.5 m at a depth of 1001.18 m, from the original collar location, that is 27.4 m to the West and 1.9 m to the South. The final average borehole azimuth and inclination is 266° and -88.4°.

As part of WP5, six additional deviation runs were completed using the OBI40-2G and ABI40-2G probes, as described in WP5 Report Section 2.4.15 (Golder 2018c).

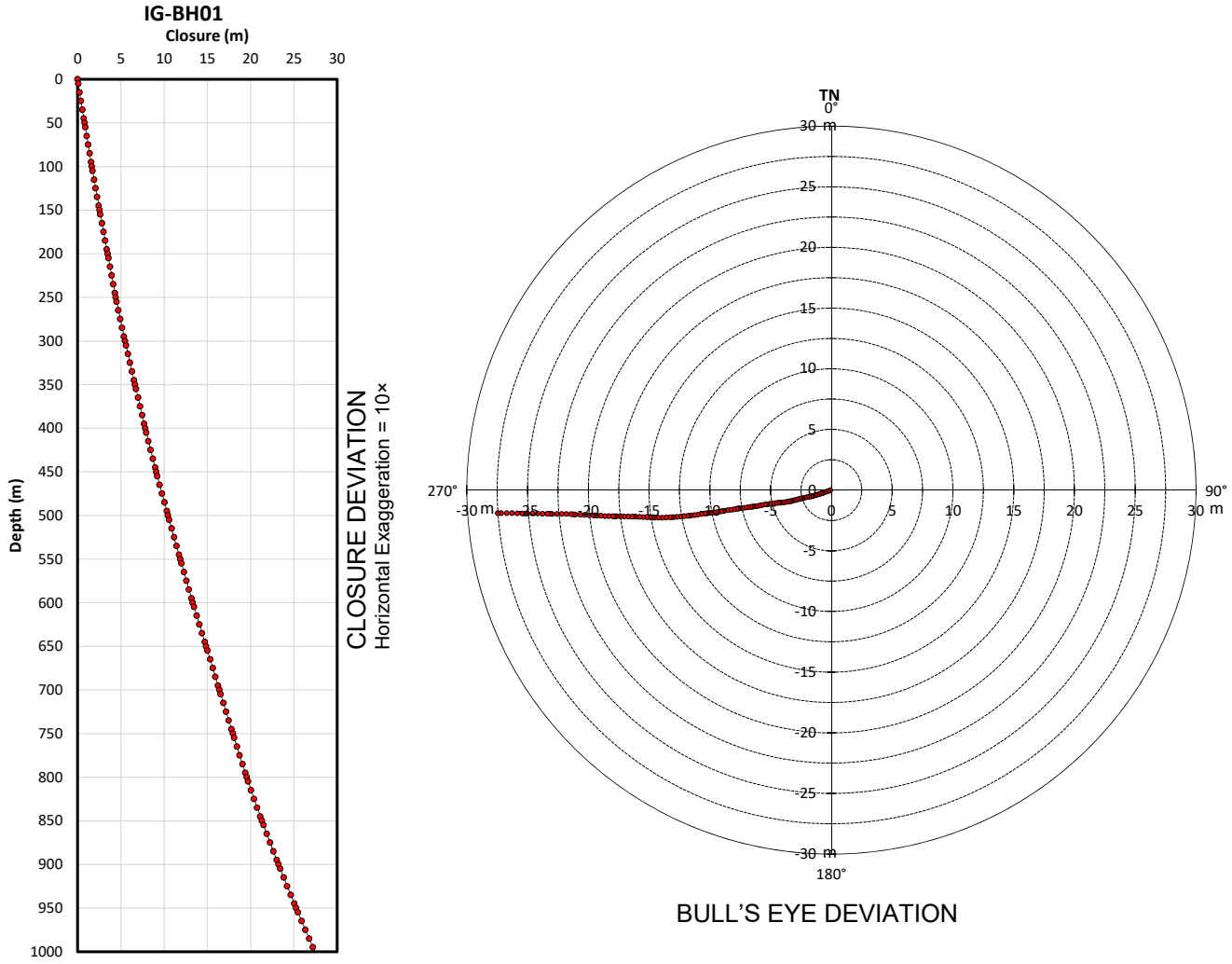


Figure 18: Borehole Deviation and Bullseye Plot from Final EZ-GYRO™ Survey

4.6 Monitoring Drilling Parameters

Drilling supervisors were stationed at the rig during coring, to record the start and end times of each drill run and observe the drilling parameters during coring as well as any occurrences of drill fluid spills or maintenance related activities. The drill parameters included bit rotation speed, torque, thrust / holdback or down pressure, fluid injection pressure and downhole fluid flow. These parameters were observed from the gauges at the drill controls. In general, these parameters were steady over the duration of a 3 m run, with overall patterns observed for IG_BH01.

Results of the drilling parameters collected are shown graphically on Figure C-1 (Appendix C) and presented in Table B-2 (Appendix B). General observations are listed below.

- Rate of Penetration was observed to be consistent at an average of approximately 17.8 minutes per metre, excluding an anomalous value of 71.4 minutes per metre for a 28 cm run drilled before a bit change at 701.21 m.
- Rotation Speed was reduced with depth with the increasing weight of the drill string.
- Torque and down pressure were increased with depth, with the down pressure adjusted from thrust to holdback pressure at approximately 550 m. The down pressure was shown on a single gauge, therefore the adjustment from thrust to holdback had to be communicated by the drillers.
- Pump pressure generally increased with depth as a higher pump rate was required to adequately flush the hole.

It should be noted for all parameters that day shift and night shift drillers had different approaches to their drilling technique and fluctuations in all observed parameters reflect this.

4.7 Borehole Flushing

Borehole flushing was carried out on IG_BH01 with 25 ppb fluorescein traced fresh water prior to geophysical televiewer surveys on two occasions: prior to installation and cementing of the surface casing, and at the completion of drilling.

Fresh water was circulated with a fluorescein tracer (target concentration of 25 ppb) into the borehole through the drill rods until the return fluid was clear and had water quality indicator parameters that were targeted to be within 10% of the source water for turbidity, dissolved oxygen and electrical conductivity, within 20% of the source water fluorescein concentration and within 0.5 of pH, of that of the fresh water used. Once reached, fresh water was to be circulated, targeting an additional 2 borehole volumes of water. After this point, drill rods were withdrawn from the borehole, and the flushed water in the borehole allowed to “settle”, targeting 12 hours before geophysical logging took place.

Prior to surface casing installation flushing was carried out on November 16th, 2017, with the borehole at a depth of 101.27 mbgs and an approximate volume of 730 litres. Approximately 4,500 litres of fresh water (over 7 borehole volumes with HQ rods in place) was flushed through the borehole, with the fluid parameters consistently monitored to determine when they were within specified indicator parameters of the fresh water. The final fluid parameters were within 10% of the source water for turbidity, dissolved oxygen and electrical conductivity, within 20% of the source water fluorescein concentration and within 0.5 of pH. Due to water capacity limitations, only one additional borehole volume was flushed through the system, prior to pulling the rods and initiating the geophysical logging.

In order to facilitate the final post-drilling borehole flushing, a ~75,000 litre (20,000 gallon) capacity tank was brought to site to allow multiple borehole volumes to be flushed before pausing. Flushing was carried out in two rounds over two days, from January 16 to early morning of January 18, 2018. Approximately, a total of 37,000 litres representing over 6 borehole volumes (borehole volume with HQ rods) were flushed through the borehole. Appendix D presents the water quality parameters for the final borehole flushing.

5.0 SUMMARY OF DRILL FLUID MANAGEMENT AND USE OF TRACERS

5.1 Drill Fluid Closed System

The drill fluid system consisted of three components: a centrifuge (SRU™) tank, a plastic mixing tank in the rig and the borehole itself. The centrifuge tank (approximate capacity of 2.60 m^3) pumped water to the tank in the drill rig (approximate capacity of 0.65 m^3) using a submersible pump, from which water was pumped downhole using the rig's pump. The drill water returning to surface was pumped via a submersible pump, located in a steel sump box sealed at the collar of the hole (sump box can be seen in Figure 14), to the centrifuge where the cuttings were removed, and the cleaned water fell back into the centrifuge tank. This provided a closed system where fresh water was only introduced after confirmation from the Golder drilling supervisor. A schematic representing this closed drill fluid system is shown in Figure 19. Note that flowmeters were installed on the rig to show the fluctuating flow rate going down the borehole and returning to surface, but *totalizing* flowmeters were not available, therefore these did not provide a useful means to calculate volume in vs volume out of the borehole.

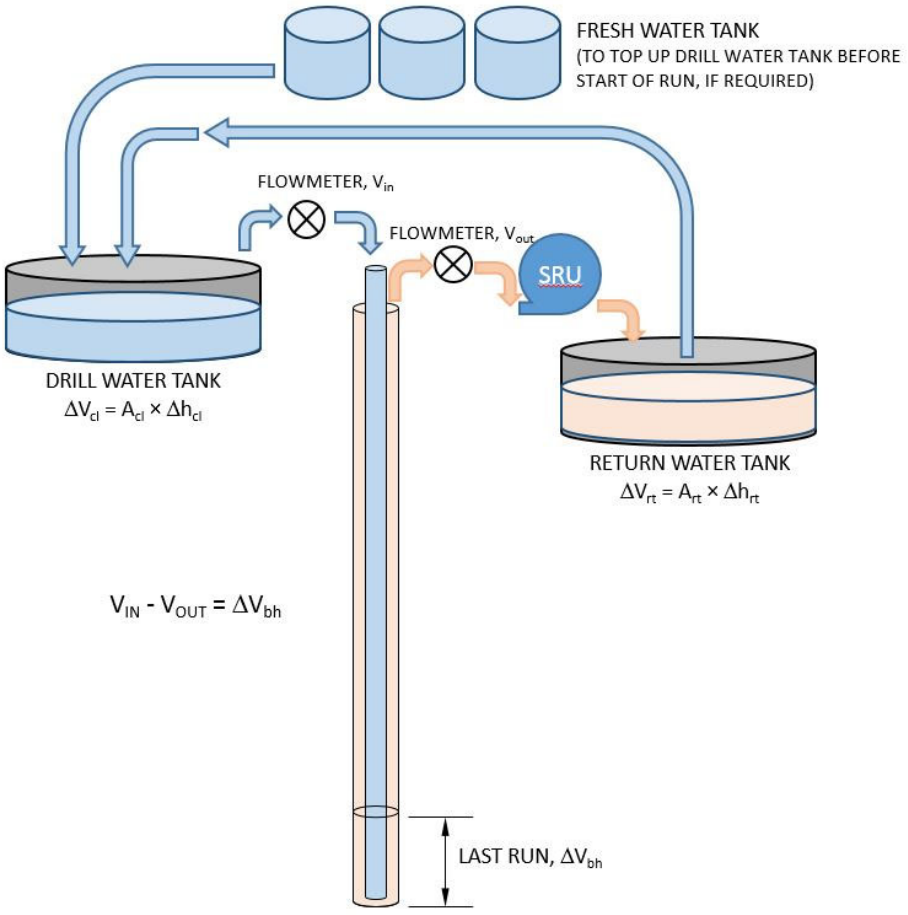


Figure 19: IG_BH01 Drill Fluid System

The volume of the system was monitored by measuring the depth of water in the borehole, the drill tank and the centrifuge tank, once all bypasses and pumps were temporarily off so that all water levels were steady. System volumes were measured at the end of each run, as well as at the start of every run when there was a significant delay in drilling, and when fresh water was added into the system. Fresh water was added to the drill system as

water was lost to the formation and as the volume of the system increased relative to the volume of drill water in the system (that is, as the hole was deepened, the available volume of the system increased). A baseline reading of the new drill fluid volume in the system was recorded when this was done, so that subsequent fluid losses to the rock could be identified as potential groundwater sampling triggers. More details of the volume monitoring can be found in Section 5.5.

5.2 Fresh Water Management and Sampling

Fresh water was stored in water tanks located in a heated storage trailer adjacent to the drill rig. Three tanks were available, with capacities of 3000 litres (800 gallons), 3800 litres (1000 gallons) and 4500 litres (1200 gallons). Fresh water was collected from a municipal source in Ignace by Rodren and transported to site using a 4560 litre (1200 gallon) tank mounted on the bed of a flatbed truck (Figure 20). Ignace has a water treatment plant, and municipal water is treated to adhere to Ontario drinking water standards. The municipal water is sourced from Lake Michel, which is located approximately 1km north of Ignace, and undergoes filtration and chlorination at the water treatment plant. Where possible, two individual tanks of fresh water were circulated together using a submersible pump, in order to mix them into a single batch of fresh water for sampling. Each batch of fresh water was individually sampled before being introduced to the drill water system and entering the borehole. All fresh water batches were termed “water source” and designated for sample collection as IG_BH01_WSXXX.



Figure 20: Rodren Water Truck used for Transporting Fresh Water to Site

5.2.1 Water Source Samples and Testing

Water source samples were collected from all batches of fresh water delivered to site, prior to fluorescein addition and prior to introducing the water to the drill system. Water was collected from the storage tanks into a clean, triple rinsed 19 litre (5 gallon) bucket, and then transferred into labelled bottles using new syringes, or new tubing with a peristaltic pump. Samples were collected for submission to Maxxam Analytics (Maxxam) and Isotope Tracer Technologies (IT2) as per Table 4, and in-field geochemistry analyses were carried out on samples IG_BH01_WS001 to IG_BH01_WS012. For those samples that did not have in-field geochemistry analyses performed on them, 1 litre amber bottles were used to collect archive samples, should further analysis be required.

In-field geochemistry analyses methodologies are described in the WP7 Report – Opportunistic Groundwater Sampling for IG_BH01 (Golder 2018a) and include alkalinity, sulphide, ferrous iron and dissolved oxygen analyses.

Table 4: Sample Bottle Requirements for Maxxam Analytics and Isotope Tracer Technologies

Parameter Group	Parameter List	Bottle Type Requirement	Sample Volume Requirement	Head Space Requirement	Field Filtering Requirement	Preservative Requirement
Major Elements & Metals (Maxxam)	Na, K, Ca, Mg, Sr, Li, Si, S_{Total}, Fe_{Total}	HDPE plastic bottles	120 mL	Fill line	Yes, 0.45 µm filter	Trace grade nitric acid
	SiO_2	HDPE plastic bottles	250 mL	None	Yes, 0.45 µm filter	None
	S^{2-}_{Total}	HDPE plastic bottles	125 mL	Fill line	Yes, 0.45 µm filter	Zinc acetate and sodium hydroxide solution
Anions & Nutrients (Maxxam)	Br, F, Cl, I, SO_4, PO_4, NO_3, NO_2	HDPE plastic bottles	500 mL	None	Yes, 0.45 µm filter	None
	NH_4+NH_3, N_{Total}	HDPE plastic bottles	250 mL	Fill line	Yes, 0.45 µm filter	Trace grade sulphuric acid
	P_{Total}					
Stable Isotopes (IT2)	$\delta^{18}O$, δ2H	HDPE plastic bottles	30 mL	No headspace	Yes, 0.45 µm filter	None
	$^{87}Sr/^{86}Sr$	HDPE plastic bottle	1000 mL	No headspace	Yes, 0.45 µm filter	None
	$\delta^{13}C$ DIC	Amber glass vials, teflon cap	2 x 40 mL glass vials with septa caps	No headspace	Yes, 0.45 µm filter	None
Radio-isotopes (IT2)	^{14}C-DIC	HDPE plastic bottle	500 mL	No headspace	Yes, 0.45 µm filter	None
	^{3}H	HDPE plastic bottle	500 mL	No headspace	Yes, 0.45 µm filter	None

A total of 19 water source samples were collected during the drilling program as follows:

- IG_BH01_WS001 to IG_BH01_WS015 were collected and used during regular coring activities;
- IG_BH01_WS016 and IG_BH01_WS017 were collected from the fresh water used for the final post-drilling borehole flushing; and
- IG_BH01_WS018 and IG_BH01_WS019 were collected and used to top up the borehole during the WP5 geophysics and WP6 packer testing activities (to avoid influencing the static water level).

All water source data (including in-field parameters, in-field analyses and laboratory results) are included in the Opportunistic Groundwater Sampling WP7 report for IG_BH01 (Golder 2018a).

5.2.2 Fluorescein Addition

After a sample was collected from the fresh water tank or tanks, fluorescein was measured using an analytical scale (due to the small mass of powdered fluorescein required for each tank) and added to the tank or tanks. Each tank was circulated to mix in the fluorescein using a submersible pump with an attached hose placed inside the tank. The tanks were generally left to circulate and mix for about 2 hours or until consistent concentration readings were collected. The water was tested for fluorescein concentration using the AquaFluor fluorometer until the desired concentration was achieved. Once the fluorescein concentration was close to the specified target (100 ppb during drilling and 25 ppb for post-drilling flushing), the water was transferred to the drill system as required. Figure 21 below shows the traced source water in one of the fresh water tanks used during the program.

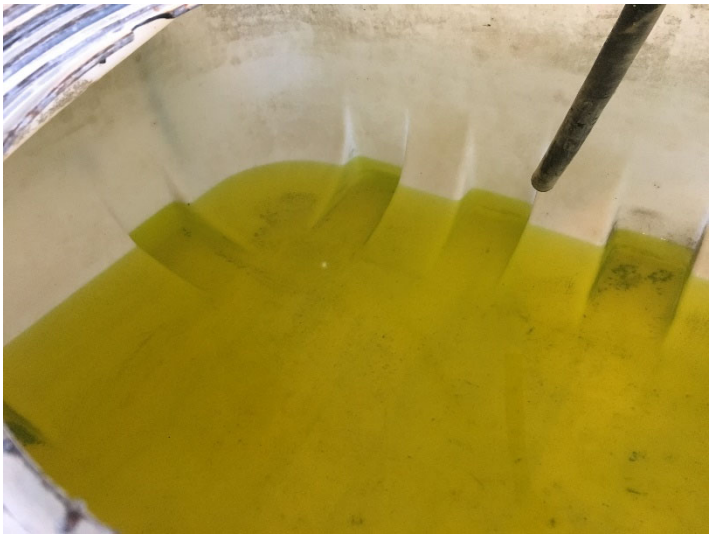


Figure 21: Fluorescein Traced Source Water (100 ppb) in the Tank used during Drilling of IG_BH01

5.3 Drill Fluid Field Parameters

At the end of the core run, drilling supervisors communicated with the drillers to time the collection of drill fluid with the completion of the run, to pause to allow a rod stick-up measurement, followed by the temporary shutting off of pumps to measure the fluid volumes in the tanks. Drillers and drill supervisors developed a workflow to communicate when the drillers could proceed to the next activity, that is, when measurements and sample collection were complete, and the drillers could lower the overshot to retrieve the core barrel.

Drill fluid field parameters were measured using a Horiba U52-2 multiparameter water quality meter. A baseline reading was taken prior to the start of drilling, and all subsequent occasions when fresh water was added to the system. New baseline readings were typically collected from the centrifuge tank. At the end of each drill run, a sample of water for field parameters was collected from the outlet of the centrifuge that drained into the tank. This system allowed a sample of water directly from the borehole (and not diluted into the centrifuge tank) to be collected and tested, providing the most representative parameters possible for that run.

Fluorescein concentration was also measured from this sample, however the system was modified at run CR14 (29.27 mbgs) to collect two fluorescein readings for each run to get a representative concentration change. At the start of the run, the water in the drill tank (to be fed downhole) was tested for fluorescein concentration, and again from the centrifuge outlet sample at the end of the run.

The presence of cuttings in the drill water was observed to mask the fluorescein concentration readings measured with the AquaFluor, and drill fluid samples were therefore filtered using an inline high volume 0.45 µm filter prior to

collecting readings. Figure 22 shows the turbid (saturated with drill cuttings) recycled drill fluid in the drill tank (after being cleaned via the centrifuge and prior to being pumped back down hole) and this fluid after filtering prior to reading fluorescein concentration.

The field parameters of the drill fluid measured each run and the corresponding triggers to initiate a WP7 opportunistic groundwater sample collection attempt are presented in Table 5. These parameters were monitored each run, and if a trigger was considered valid, Golder and the NWMO would coordinate to initiate an opportunistic groundwater sample (WP7).



Figure 22: View of Drill Fluid Saturated with Cuttings in the Drill Tank (left) and a Sample of this Drill Fluid after Filtering for the Fluorescein Concentration Reading (right)

Table 5: Drill Fluid Monitoring Parameters and WP7 Triggers

Field Parameter	Instrument	Trigger to Initiate WP7 / Target ranges for borehole flushing
Fluorescein dye (tracer)	Aquafluor Handheld Fluorometer/Turbidimeter	20% change in concentration from previous drill fluid source Note: Minimum detection limit of the fluorometer (0.4 ppb)
Turbidity	Horiba U52-2 multiparameter water quality meter	10% change from the previous drill fluid source
Dissolved Oxygen		10% change from the previous drill fluid source
Electrical conductivity		10% change from the previous drill fluid source
pH		change of at least 0.5 from previous drill fluid source
Temperature		N/A
Density	Hydrometer	N/A

5.3.1 Drill Fluid Parameter Data

The drill fluid parameter data is shown graphically on Figures C-2 and C-3 (Appendix C) and presented in Table B-2 (Appendix B). General observations and comments are listed below.

- Fluorescein concentration required frequent adjustment in the drill fluid system, with fluorescein added about every 10-15 runs. The presence of cuttings in the drill fluid were observed to mask the light-based fluorescein reading with the fluorometer, and therefore required that samples be filtered prior to collecting measurements. Figure D-2 shows the low readings observed between 0 – 100 m prior to consistently filtering samples. The remainder of the borehole shows spikes to approximately 140 ppb where fluorescein was added to bring the concentration back up to 100 ppb in the drill system. As the borehole depth and drill fluid system volume increased, the time for the fluorescein readings to equalize in the system when extra fluorescein was added increased, and concentration readings frequently varied over 20% between the fluid going downhole and the return.
- The frequent fluorescein adjustments were necessary as the concentration in the drill fluid decreased as the fluid was processed through the centrifuge and cuttings were removed.
- Density of the drill fluid increased as the saturation with cuttings increased. When the density is observed to drop back closer to 1 g/cm^3, this corresponds with the addition of fresh water to the system.
- Turbidity remained above the Horiba's measurement range (1000 NTU) for the majority of the program, as the drill fluid became increasingly saturated with drill cuttings.
- Small variations in electrical conductivity were observed, again trending consistently as the cuttings saturation increased, and then dropping with the addition of fresh water.
- Dissolved oxygen (DO) fluctuated continuously in the sensor's range, and although an increasing trend is observed at the start of drilling, remained relatively consistent from approximately 200 mbgs to the end of the hole.
- There is a marked spike in pH at approximately 100m, after the installation and cementing of the surface casing, and this decreased as drilling progressed. A few marked decreases down to around pH 7 can be observed at 662.28 mbgs, 771.85 mbgs and 944.28 mbgs and correspond to periods of standby outlined below.
- There was a temporary environmental shutdown (<24 hr) on December 14th at shift change, to address an identified drill fluid spill. Fluctuations in density, drill fluid temperature, pH and DO can be observed at 662.28 mbgs and correspond to this standby period.
- After the temporary shutdown of 16 days with no drilling at 771.85 mbgs, the fluids within SRU and drill tank were replaced with fresh water, but the drill fluid in the borehole remained unchanged, and made up a large portion of the system volume, approximately 2.3 m^3 of the 3.6 m^3 total system. Upon resumption of drilling, this addition of fresh water is most apparent in the density measurements, which started again close to that of fresh water, and then increased as the system mixed and drill fluid again became more saturated with cuttings.
- Another very noticeable spike in drill fluid parameters occurred during the bit change at 944.28 mbgs, during which time the borehole was not circulated for about 44 hours. Electrical conductivity spiked from readings close to 1 mS/cm to readings in the range of 7 – 9 mS/cm, while pH dropped from 10 to 7.

5.4 Drill Fluid Additives

On December 10th, 2017, a powdered polymer, AMC CR 650™, was added to the drill fluid to improve the ability of the fluid to lift cuttings from the drill bit and out of the borehole. This occurred with the borehole at a depth of 560.31 mbgs, while the drillers were experiencing the drill bit consistently binding with cuttings and causing spikes in the torque. 122 grams of CR 650™ was added to the drill tank between runs CR197 and CR198, with approximately 500 litres of drill fluid in the tank. A further 110 grams was added to the drill tank during coring of run CR198. A sample was then collected from the drill tank and denoted IG_BH01_DW026. It was sampled for major anions and dissolved metals and a 1 litre amber bottle was collected as an archive sample in the event that further analysis was required. The results are included in the Opportunistic Groundwater Sampling WP7 report for IG_BH01 (Golder 2018a).

5.5 Drill Fluid Return Volume Monitoring Data

Drill fluid volumes were monitored continuously during coring activities by checking the water levels in the centrifuge, drill tank and borehole. When losses greater than 100 litres were observed, the Golder WP7 lead was contacted following the opportunistic groundwater sampling protocol as described in WP7. If a volume loss was observed, the drillers were instructed not to proceed with setting up for the next core run until the core was extracted and could be observed for indications of water bearing features. The system volume gradually increased as the hole was deepened, and water was occasionally lost on surface due to human error (sump box overflowing if pump shut off, pulling core tube too quickly resulting in drill fluid splashing out), as well as bound in the cuttings. Gradual system losses required occasional topping up of the system with fresh, fluorescein water. Table B-2 includes volume changes for each drill run. Comments are included to document specific instances of water losses observed.

5.5.1 Pre-Casing Volume Observations

Drill water was lost through the gravel pad prior to re-sealing the sump box on surface, and through near surface fractures. The surface casing was temporarily lowered, and a bentonite slurry injected to seal near surface bedrock fractures, as described in Section 4.2. This allowed drilling to continue without large volume losses that would have otherwise presented false WP7 triggers. After passing the permeable zone during run CR018 (41.26 – 44.27 mbgs) and collecting the first ground water sample, drill water continued to be lost to this zone and losses were greater than 100 litres until the lowering and cementing of the surface casing to 69 mbgs.

5.5.2 Post-Casing Volume Observations

Following cementing of the surface casing, typically, losses greater than 100 litres could be explained by water losses observed on surface, or attributed to uncertainty in the tank measurements if no signs of water bearing features were found in the core. The most common water drill fluid loss on surface was when the sump box filled with return drill fluid and the submersible pump was temporarily switched off, allowing the fluid to overflow the box. Occasional larger losses were encountered if a transfer hose to a tank became dislodged and spilled on surface.

5.6 Drill Fluid Archive Samples and Testing

Drill fluid samples were collected and archived in 1 litre amber bottles every 50 m during drilling. These samples were generally collected from the centrifuge outlet into a clean, triple rinsed 19 litre (5 gallon) bucket, which was taken to the sampling area and transferred into the labelled bottles using new syringes, or new tubing with a peristaltic pump.

Drill fluid samples were also collected during opportunistic groundwater sample collection. In this instance, since coring was not actively occurring at the time of WP7 initiation, the drill fluid sample was collected from the centrifuge tank.

Drill fluid samples were also collected at three specified depths where microbiology core samples were collected. These samples were collected from the centrifuge outlet during drilling of the core and are covered under research and development activities.

The first drill fluid archive depth coincided with the first opportunistic groundwater sample; therefore, IG_BH01_DW001 was collected from the centrifuge tank with the hole at a depth of 47.07 mbgs and was considered part of WP7.

A complete list of drill water sample field parameters collected under WP2 are provided in Table B-3.

6.0 OPPORTUNISTIC GROUNDWATER SAMPLE LOCATIONS

Only one (1) opportunistic groundwater sample was successfully collected during drilling of IG_BH01 (sample IG_BH01-GW001). During run CR018, from 41.16 mbgs to 44.27 mbgs, a volume loss of 208 L was observed, along with iron stained weathered open joints, indicating water movement through the rock mass.

A second opportunistic groundwater sample was attempted at run 79, from 215.26 mbgs to 218.28 mbgs, where a 264 L volume loss occurred. The interval contained a fracture with possible clay infilling, as well as a shear with some observed aperture and staining. The purge rate assessment revealed that the interval was not permeable enough to produce the required purge volume in 72 hours, and the attempt was abandoned. No further opportunistic groundwater samples were attempted for the remainder of the drilling of IG_BH01.

Further details of the sample collection and results will be presented in the WP7 Opportunistic Groundwater Sampling Report (Golder 2018a).

7.0 REFERENCES

Golder (Golder Associates Ltd.), 2017. Phase 2 Initial Borehole Drilling and Testing, Ignace Area - Initial Borehole Characterization Plan for IG_BH01.

Golder, 2018a. Phase 2 Initial Borehole Drilling and Testing, Ignace Area - WP7 Data Report – Opportunistic Groundwater Sampling for IG_BH01. NWMO Report Number: APM-REP-01332-0236.

Golder, 2018b. Phase 2 Initial Borehole Drilling and Testing, Ignace Area - WP4C Data Report – Porewater Extraction and Analysis and Petrographic Analysis for IG_BH01. NWMO Report Number: APM-REP-01332-0233.

Golder, 2018c. Phase 2 Initial Borehole Drilling and Testing, Ignace Area - WP5 Data Report – Geophysical Borehole Logging and Interpretation for IG_BH01. NWMO Report Number: APM-REP-01332-0234.

Golder and PGW (Paterson Grant and Watson Ltd.), 2017. Phase 2 Geoscientific Preliminary Assessment, Geological Mapping, Township of Ignace and Area, Ontario. NWMO Report Number: APM-REP-01332-0225.

SGL (Sander Geophysics Limited), 2015. Phase 2 Geoscientific Preliminary Assessment, Acquisition, Processing and Interpretation of High-Resolution Airborne Geophysical Data, Township of Ignace, Ontario. Prepared for Nuclear Waste Management Organization (NWMO). NWMO Report Number: APM-REP-06145-0002.

APPENDIX A

Original IG_BH01 Site Survey by J. D. Barnes

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TOPOGRAPHIC PLAN OF

PROPOSED NWMO SITE WEST OF IGNACE, ONTARIO
UNSURVEYED TERRITORY

DISTRICT OF KENORA

SCALE 1 : 500

10 0 10 20 30 metres

METRIC DISTANCES AND/OR COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

J.D. BARNES LIMITED

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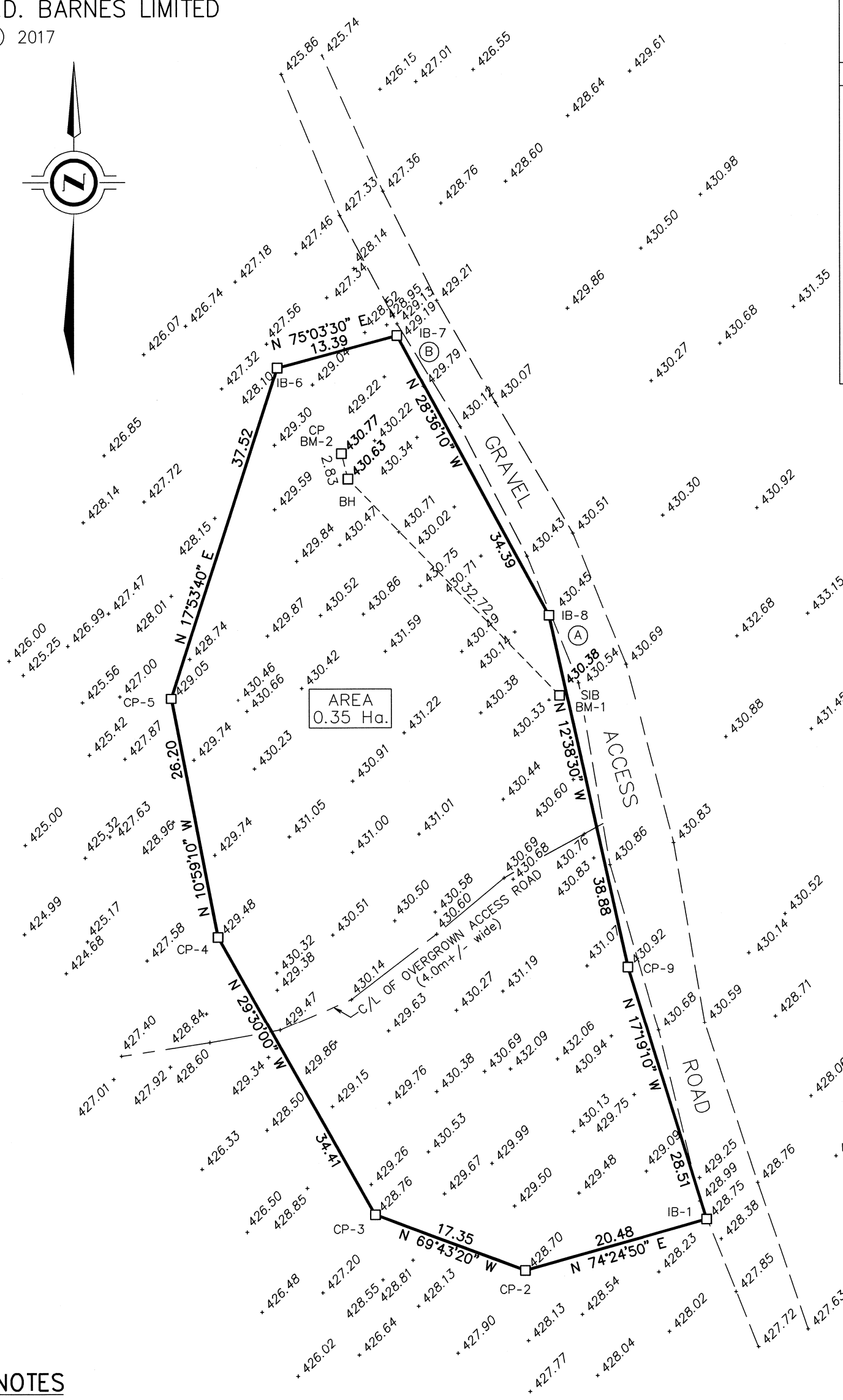


TABLE OF COORDINATES

COORDINATES DERIVED FROM REAL TIME KINEMATIC (RTK) OBSERVATIONS.

MONUMENT	EASTING	NORTHING
BH	555943.77	5486015.75
IB-1	555982.52	5485935.90
CP-2	555962.80	5485930.40
CP-3	555946.54	5485936.41
CP-4	555929.60	5485966.35
CP-5	555924.61	5485992.06
IB-6	555936.13	5486027.75
IB-7	555949.06	5486031.20
IB-8	555965.52	5486001.02
CP-9	555974.03	5485963.10
SIB BM-1	555966.67	5485992.38
CP BM-2	555943.06	5486018.48

NOTES

BEARINGS ARE UTM GRID, DERIVED BY REAL TIME KINEMATIC (RTK) OBSERVATIONS FROM A LOCAL BASE STATION (N 5 485 973.03, E 555 984.11), ESTABLISHED USING THE PRECISE POINT POSITIONING (PPP) SERVICE, TO OBSERVED REFERENCE POINTS (ORP's) A AND B. THE RESULTANT BEARING BETWEEN ORP's A AND B IS N 28°36'10" W, UTM ZONE 15, NAD83 (CSRS) (1997.0).

COORDINATES ARE UTM ZONE 15 NAD83 (CSRS) (1997.0) AND ARE REFERRED TO THE MINISTRY OF TRANSPORTATION OF ONTARIO HORIZONTAL CONTROL MONUMENT No. 00819970048, HAVING PUBLISHED COORDINATES OF N 5 487 156.78, E 561 636.99.

DISTANCES SHOWN ARE GROUND DISTANCES AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999572.

ELEVATION NOTE

ELEVATIONS HEREON ARE GEODETIC AND ARE REFERRED TO THE MINISTRY OF TRANSPORTATION OF ONTARIO BENCHMARK No. 00819668142, HAVING A PUBLISHED ELEVATION OF 409.07 METRES (CGVD-1928:1978).

SITE BENCHMARKS - TOP OF SIB ELEVATION = 430.38 METRES
CENTRE OF CP ELEVATION = 430.77 METRES.

LEGEND

□	DENOTES	SURVEY MONUMENT SET
SIB	DENOTES	STANDARD IRON BAR
IB	DENOTES	IRON BAR
CP	DENOTES	CONCRETE PIN
BM	DENOTES	BENCHMARK
BH	DENOTES	BOREHOLE

THE FIELD WORK REPRESENTED IN THIS PLAN WAS COMPLETED ON JULY 5, 2017.

J.D.BARNES LIMITED
SURVEYING MAPPING GIS
LAND INFORMATION SPECIALISTS
1001 WILLIAM STREET, SUITE 102A, THUNDER BAY, ON P7B 6M1
T: (807) 622-6277 F: (807) 626-8040 www.jdbarnes.com

KJ	DRAWN
RK	CHECKED
07/07/2017	DATED:
17-32-152-00	Ref. No.

PLOTTED 18/08/2017 G:\17-32-152\00\Drawing\152-00-TOPO.dgn

APPENDIX B

Table B-1: IG_BH01 Final and Interim REFLEX EZ-SHOT™ Borehole Orientation Measurements

Table B-2: IG_BH01 Drilling and Drill Fluid Parameters

Table B-3: Field Parameters of Archived Drill Water Samples

Depth	[1]Survey Type	Azimuth (°)	Dip (°)
0	EZ-GyroP	258.82	-88.92
5	EZ-GyroP	245.77	-89.17
15	EZ-GyroP	247.76	-89.12
25	EZ-GyroP	251.56	-89.03
35	EZ-GyroP	249.36	-89.12
45	EZ-GyroP	253.05	-88.97
50	EZ-GyroD	256.65	-88.94
55	EZ-GyroP	251.16	-89.06
65	EZ-GyroP	251.75	-89.05
75	EZ-GyroP	252.46	-89.03
85	EZ-GyroP	253.95	-89.02
95	EZ-GyroP	254.42	-89.05
100	EZ-GyroD	256.37	-88.97
105	EZ-GyroP	256.78	-89.04
115	EZ-GyroP	262.3	-89.05
125	EZ-GyroP	256.07	-89.03
135	EZ-GyroP	256.84	-88.93
145	EZ-GyroP	254.98	-88.88
150	EZ-GyroD	258.93	-88.92
155	EZ-GyroP	262.69	-88.83
165	EZ-GyroP	252	-88.92
175	EZ-GyroP	253.42	-88.93
185	EZ-GyroP	254.78	-88.96
195	EZ-GyroP	257.83	-88.96
200	EZ-GyroD	260.96	-88.82
205	EZ-GyroP	259.82	-88.96
215	EZ-GyroP	260.62	-88.97
225	EZ-GyroP	263.17	-88.94
235	EZ-GyroP	265.5	-88.89
245	EZ-GyroP	263.11	-88.89
250	EZ-GyroD	263.04	-88.75
255	EZ-GyroP	263.2	-88.85
265	EZ-GyroP	263.54	-88.81
275	EZ-GyroP	262	-88.78
285	EZ-GyroP	261.66	-88.75
295	EZ-GyroP	260.28	-88.73
300	EZ-GyroD	266.22	-88.65
305	EZ-GyroP	260.36	-88.67
315	EZ-GyroP	258.16	-88.67
325	EZ-GyroP	259.24	-88.69
335	EZ-GyroP	261.51	-88.69
345	EZ-GyroP	263.96	-88.63
350	EZ-GyroD	259.14	-88.55
355	EZ-GyroP	262.74	-88.66
365	EZ-GyroP	261.75	-88.67
375	EZ-GyroP	263.6	-88.67
385	EZ-GyroP	263.93	-88.63
395	EZ-GyroP	263.56	-88.64

GOLDER

Depth	[1]Survey Type	Azimuth (°)	Dip (°)
400	EZ-GyroD	252.44	-88.61
405	EZ-GyroP	261.03	-88.62
415	EZ-GyroP	261.71	-88.57
425	EZ-GyroP	261.24	-88.49
435	EZ-GyroP	262.09	-88.5
445	EZ-GyroP	261.99	-88.51
450	EZ-GyroD	257.05	-88.52
455	EZ-GyroP	262.13	-88.48
465	EZ-GyroP	261.26	-88.46
475	EZ-GyroP	261.36	-88.39
485	EZ-GyroP	262.74	-88.38
495	EZ-GyroP	264.14	-88.45
500	EZ-GyroD	260.26	-88.49
505	EZ-GyroP	262.38	-88.38
515	EZ-GyroP	259.7	-88.37
525	EZ-GyroP	263.12	-88.39
535	EZ-GyroP	261.19	-88.29
545	EZ-GyroP	265.24	-88.44
550	EZ-GyroD	264.4	-88.35
555	EZ-GyroP	265.42	-88.38
565	EZ-GyroP	264.11	-88.38
575	EZ-GyroP	264.82	-88.33
585	EZ-GyroP	265.82	-88.3
595	EZ-GyroP	265.85	-88.27
600	EZ-GyroD	267.01	-88.34
605	EZ-GyroP	266.63	-88.24
615	EZ-GyroP	267.26	-88.24
625	EZ-GyroP	268.56	-88.2
635	EZ-GyroP	269.34	-88.17
645	EZ-GyroP	273.4	-88.16
650	EZ-GyroD	270.19	-88.19
655	EZ-GyroP	273.21	-88.17
665	EZ-GyroP	272.36	-88.19
675	EZ-GyroP	273.01	-88.25
685	EZ-GyroP	274.86	-88.28
695	EZ-GyroP	271.65	-88.21
700	EZ-GyroD	268.18	-88.15
705	EZ-GyroP	271.74	-88.23
715	EZ-GyroP	270.93	-88.2
725	EZ-GyroP	271.39	-88.2
735	EZ-GyroP	271.72	-88.16
745	EZ-GyroP	269.93	-88.18
750	EZ-GyroD	268.46	-88.26
755	EZ-GyroP	272.78	-88.19
765	EZ-GyroP	272.11	-88.17
775	EZ-GyroP	272.73	-88.1
785	EZ-GyroP	274.05	-88.09
795	EZ-GyroP	274.2	-88.11

GOLDER

Depth	[1]Survey Type	Azimuth (°)	Dip (°)
800	EZ-GyroD	273.01	-88.18
805	EZ-GyroP	271.34	-88.08
815	EZ-GyroP	274.01	-88.02
825	EZ-GyroP	271.2	-87.97
835	EZ-GyroP	272.18	-87.85
845	EZ-GyroP	271.96	-87.84
850	EZ-GyroD	280.44	-87.81
855	EZ-GyroP	272.54	-87.85
865	EZ-GyroP	269.62	-87.8
875	EZ-GyroP	269.89	-87.81
885	EZ-GyroP	270.05	-87.73
895	EZ-GyroP	273.13	-87.75
900	EZ-GyroD	271.29	-87.77
905	EZ-GyroP	268.03	-87.67
915	EZ-GyroP	272.64	-87.7
925	EZ-GyroP	271.44	-87.64
935	EZ-GyroP	270.64	-87.6
945	EZ-GyroP	270.11	-87.61
950	EZ-GyroD	266.4	-87.68
955	EZ-GyroP	272.27	-87.52
965	EZ-GyroP	273.53	-87.55
975	EZ-GyroP	270.48	-87.5
985	EZ-GyroP	269.07	-87.46
995	EZ-GyroP	270.42	-87.44

Notes:

[1]EZ-GyroP measurements are final post drilling survey points, EZ-GyroD measurements were collected during drilling of IG_BH01

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
06-Nov-17 16:20	1	0	1.69	0		116.3		11.36	9.9	1.00	0.442		12.81		9.02		130.3			8	700	1500	1500	0	25	
06-Nov-17 17:30	2	1.69	4.69	0		119.7	3%	10.19	10	1.00	0.439	-1%	12.61	-0.20	8.82	-2%	147.2	13%		10	700	1500	1200	0	25	
07-Nov-17 11:20	3	4.69	5.27	-240		104.1	-13%	7.87	10.1	1.00	0.613	40%	13.09	0.48	8.50	-4%	94.9	-36%		26	700	1000	1900	0	25	Water loss through drill pad and near surface fractures
07-Nov-17 18:09	4	5.27	6.91	-109		105.2	1%	12.53	10.1	1.00	0.573	-7%	12.93	-0.16	6.42	-24%	103.5	9%		15	900	1700	1500	0	25	Water loss through drill pad and near surface fractures
08-Nov-17 16:16	5	6.91	7.51	-153		106	1%	5.74	9.9	1.00	0.137	-76%	11.73	-1.20		-100%		-100%		35	1000	1500	1500	0		Water loss through drill pad and near surface fractures
09-Nov-17 17:56	6	7.51	8.27	-70		48.6	-54%	8.55	9.2	1.01	0.229	67%	11.05	-0.68	7.11		1000			8	1000	1200	1500	0		Sump box re-cemented in place, HWT casing temporarily installed
09-Nov-17 20:30	7	8.27	11.27	-46		82.5	70%	6.72	9.3	1.00	0.323	41%	11.81	0.76	9.53	34%	1000	0%		27	1000	1400	1300	0		
09-Nov-17 23:00	8	11.27	14.26	-46		26.52	-68%	11.18	9	1.01	0.310	-4%	11.72	-0.09	9.73	2%	1000	0%		20	800	1300	1500	0		
10-Nov-17 4:20	9	14.26	17.26	-87		19.7	-26%	13.94	8.8	1.01	0.345	11%	11.73	0.01	9.70	0%	1000	0%		23	800	1300	1400	0		
10-Nov-17 15:15	10	17.26	20.26	-21		6.9	-65%	9.97	8.2	1.01	0.344	0%	11.60	-0.13	9.35	-4%	1000	0%		13	800	1300	1400	0		
10-Nov-17 12:55	11	20.26	23.27	-73		48.5	603%	8.59	9.9	1.00	0.095	-72%	10.62	-0.98	10.65	14%	1000	0%		22	800	1400	1400	0		
10-Nov-17 15:15	12	23.27	26.27	-105		34.96	-28%	12.42	9.6	1.00	0.118	24%	10.84	0.22	8.51	-20%	1000	0%		22	800	1400	1400	0		Water loss due to spill over sump box
10-Nov-17 18:05	13	26.27	29.27	-131		58.86	68%	13.3	9.8	1.00	0.140	19%	11.80	0.96	5.61	-34%	1000	0%		25	800	1500	1000	0	15	Water loss due to spill over sump box
10-Nov-17 21:45	14	29.27	32.26	-165	79.9	73.4	-8%	10.67	9.8	1.00	0.130	-7%	10.89	-0.91	10.39	85%	1000	0%		17	800	1500	1100	25	25	
10-Nov-17 23:00	15	32.26	35.26	-77	60.8	42.3	-30%	12.05	9.7	1.00	0.141	8%	10.78	-0.11	9.85	-5%	1000	0%		17	800	1600	1400	25	25	
11-Nov-17 1:20	16	35.26	38.26	-63	41.6	22.3	-46%	15.13	9.6	1.00	0.159	13%	11.05	0.27	9.11	-8%	1000	0%		20	750	1600	1100	50	30	
11-Nov-17 3:05	17	38.26	41.26	-97	29.9	45.1	51%	15.05	9.4	1.00	0.176	11%	10.76	-0.29	9.06	-1%	1000	0%		17	750	1600	1000	50	30	
11-Nov-17 4:30	18	41.26	44.27	-208	21.6	15.9	-26%	14.31	9	1.01	0.190	8%	10.60	-0.16	9.02	0%	1000	0%		17	750	1500	1000	35	25	WP7 triggered due to water loss and evidence of water bearing fractures in the core
14-Nov-17 14:35	19	44.27	47.22	-182	107.2	74.25	-31%	13.65	9.9	1.00	0.091	-52%	9.40	-1.20	10.14	12%	1000	0%	435	20	700	2000	1000	20	20	Volume loss due to factures in run 18
14-Nov-17 16:15	20	47.22	50.28	-138	103.1	31.88	-69%	13.94	9.7	1.00	0.099	9%	9.57	0.17	11.50	13%	1000	0%	430	15	700	2000	1200	50	25	Volume loss due to factures in run 18
14-Nov-17 17:55	21	50.28	53.28	-190	79.06	28.59	-64%	16.15	9.5	1.00	0.117	18%	9.91	0.34	5.86	-49%	1000	0%	301	12	800	2000	1500	50	30	Volume loss due to factures in run 18
14-Nov-17 20:25	22	53.28	56.27	-185		88.3	209%	17.12	9.6	1.00	0.118	1%	9.72	-0.19	10.00	71%	1000	0%	337	13	800	2000	1200	50	25	Volume loss due to factures in run 18. Filtered flourescien readings began to be recorded for the SRU outlet.
14-Nov-17 22:45	23	56.27	59.27	-143		86.5	-2%	17.84	9.4	1.00	0.154	31%	9.78	0.06	9.68	-3%	1000	0%	212	15	750	2000	1300	60	35	Volume loss due to factures in run 18
15-Nov-17 0:25	24	59.27	62.26	-277		84.3	-3%	19.03	9.2	1.01	0.169	10%	9.96	0.18	9.27	-4%	1000	0%	180	18	750	1900	1300	60	30	Volume loss due to factures in run 18
15-Nov-17 1:40	25	62.26	65.27	-102		76.6	-9%	19.77	8.8	1.01	0.188	11%	9.78	-0.18	8.84	-5%	1000	0%	159	13	750	2000	1500	70	30	Volume loss due to factures in run 18. Fluorescein added to bring drill water up to 100 ppb.
15-Nov-17 3:50	26	65.27	68.27	-152		121.3	58%	17.47	9.7	1.00	0.129	-31%	9.86	0.08	9.98	13%	1000	0%	164	20	750	1900	1300	65	30	Volume loss due to factures in run 18
15-Nov-17 5:05	27	68.27	71.27	-160		119.1	-2%	17.77	9.6	1.00	0.156	21%	9.83	-0.03	9.57	-4%	1000	0%	156	17	750	2000	1100	60	35	Volume loss due to factures in run 18
15-Nov-17 9:05	28	71.27	74.28	-318	39.26	22.95	-42%	15.81	9.6	1.00	0.148	-5%	9.74	-0.09	10.72	12%	1000	0%	169	22	700	2000	1500	50	25	Volume loss due to factures in run 18
15-Nov-17 10:30	29	74.28	75.2	-157	31.92		-19%													22	800	2000	1500	50	25	Volume loss due to factures in run 18. Partial run due to bit change. Not enough return to collect SRU sample before drilling stopped.
15-Nov-17 13:55	30	75.2	77.28	-185	33.18	112.5	4%	14.06	9.2	1.01	0.174		9.85		10.56		1000		148	14	800	1500	1200	50	25	Volume loss due to factures in run 18. End of run after bit change.
15-Nov-17 16:05	31	77.28	80.28	-179	116.8	112	-4%	13.6	8.9	1.01	0.173	-1%	9.82	-0.03	9.90	-6%	1000	0%	140	13	800	1500	1000	40	20	Volume loss due to factures in run 18. All drill water began to be filtered to collect flourescein concentration readings.
15-Nov-17 17:25	32	80.28	83.26	-134	114.3	111.1	-3%	13.54	8.9	1.01	0.195	13%	9.87	0.05	11.48	16%	1000	0%	149	13	800	1700	1000	40	20	Volume loss due to factures in run 18
15-Nov-17 21:00	33	83.26	86.25	-255	107.5	90.2	-16%	12.99	9.5	1.00	0.107	-45%	9.78	-0.09	10.98	-4%	1000	0%	153	18	800	1500	1200	100	30	Volume loss due to factures in run 18. Water loss on surface due to opening of bypass. SRU topped up prior to this run.
15-Nov-17 22:45	34	86.25	89.27	-229	96.2	88.8	-8%	12.04	9.2	1.01	0.121	13%	9.77	-0.01	10.65	-3%	1000	0%	154	13	800	1600	1300	50	30	Volume loss due to factures in run 18
16-Nov-17 0:00	35	89.27	92.27	-132	93.4	94	1%	11.33	9	1.01	0.117	-3%	9.71	-0.06	11.16	5%	1000	0%	164	15	800	1500	1300	50	25	Volume loss due to factures in run 18
16-Nov-17 0:55	36	92.27	95.27	-112	95.1	87.9	-8%	12.01	8.6	1.01	0.125	7%	9.61	-0.10	11.14	0%	1000	0%	174	10	800	2000	1000	60	27	Volume loss due to factures in run 18. Driller changed drilling approach to a high torque and low thrust pressure; results in a faster and smoother run.
16-Nov-17 1:55	37	95.27	98.26	-86	92.9	86.3	-7%	13.41	8.4	1.01	0.136	9%	9.83	0.22	11.73	5%	1000	0%	154	12	800	2000	1100	70	30	Volume loss due to factures in run 18
16-Nov-17 3:35	38	98.26	101.27	-171	90.3	87.8	-3%	9.93	8.8	1.01	0.141	4%	9.34	-0.49	11.04	-6%	1000	0%	165	8	800	1900	1100	60	25	Volume loss due to factures in run 18
21-Nov-17 13:40	BL	101.27	101.27			98.37		6.61	10	1.00	3.080	2084%	12.32	2.98	10.52	-5%	20.6	-98%	-10							New baseline after HWT casing installation
21-Nov-17 15:00	39	101.27	104.26	6	98.37	115.6	18%	6.91	9.9	1.00	1.070	-65%	11.91	-0.41	10.25	-3%	1000	4754%	-23	15	700	2000	800	75	15	
21-Nov-17 16:45	40	104.26	107.28	-59	114.3	104.4	-9%	8.16	9.9	1.00	1.200	12%	12.02	0.11	10.49	2%	1000	0%	-20	17	700	1500	1000	75	20	
21-Nov-17 18:20	41	107.28	110.28	-248	112.1	108.9	-3%	7.73	9.9	1.00	1.260	5%	11.98	-0.04	10.83	3%	389	-61%	-21	15	800	2000	1000	100	20	No evidence of water bearing fractures in run; volume measurement uncertainty
21-Nov-18 21:20	42	110.28	111.81	-68	106.2	108.7	2%	7.39	9.9	1.00	1.020	-19%	12.02	0.04	10.43	-4%	704	81%	-18	13	700	1500	1500	75	25	
21-Nov-17 23:00	43	111.81	113.26	-36	108.4	107.3	-1%	8.2	10	1.00	1.040	2%	12.00	-0.02	12.09	16%	1	-100%	-13	21	700	1750	1200	100	25	

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
22-Nov-17 0:40	44	113.26	116.26	-51	111.6	106	-5%	9.36	10	1.00	1.070	3%	12.00	0.00	8.08	-33%	254	25300%	-16	22	700	1900	1750	100	25	
22-Nov-17 3:15	45	116.26	119.26	-77	111.9	103.4	-8%	9.26	10	1.00	0.864	-19%	11.92	-0.08	8.35	3%	910	258%	-4	20	700	1750	1500	90	25	
22-Nov-17 6:05	46	119.26	122.26	-101	104.1	99.8	-4%	9.56	10	1.00	0.838	-3%	11.50	-0.42	8.40	1%	567	-38%	-3	17	700	1700	1500	100	27	No evidence of water bearing fractures in run
22-Nov-17 9:05	47	122.26	125.26	-51	104.6	103	-2%	10.02	9.9	1.00	0.827	-1%	11.55	0.05	12.96	54%	1000	76%	-11	22	750	1500	1000	50	15	a couple of torque spikes in lower part of the run
22-Nov-17 11:45	48	125.26	128.26	-78	103.5	102.5	-1%	10.52	9.9	1.00	0.790	-4%	11.44	-0.11	12.92	0%	1000	0%	-1	20	700	1500	1000	50	15	
22-Nov-17 13:40	49	128.26	131.28	3	105.8	101	-5%	11.07	9.7	1.00	0.713	-10%	11.39	-0.05	10.82	-16%	1000	0%	3	28	700	1500	1200	75	20	
22-Nov-17 15:20	50	131.28	134.28	-152	105.1	100.5	-4%	11.67	9.9	1.00	0.836	17%	11.45	0.06	11.20	4%	1000	0%	3	23	700	1500	1000	75	25	No fractures in core
22-Nov-17 17:20	51	134.28	137.28	-92	102.2	100.6	-2%	12.08	9.8	1.00	0.813	-3%	11.38	-0.07	12.40	11%	1000	0%	1	20	750	2000	1200	75	20	No evidence of water bearing fractures in run
22-Nov-17 21:40	BL	137.28	137.28	765	100.6	112.8	12%	11.8	10	1.00	0.415	-49%	11.80	0.42	12.67	2%	1000	0%	54		700					SRU tank refilled with fresh water
22-Nov-17 22:50	52	137.28	140.26	-133	112.8	115.5	2%	9.9	9.9	1.00	0.542	31%	11.34	-0.46	11.83	-7%	1000	0%	19	23	700	1600	1500	85	21	No fractures in core
23-Nov-17 0:42	53	140.26	143.25	-115	122.9	110.2	-10%	11.4	9.8	1.00	0.448	-17%	10.91	-0.43	11.88	0%	1000	0%	60	22	700	2000	1500	90	20	No fractures in core
23-Nov-17 2:15	54	143.25	146.27	-52	112.2	109.8	-2%	11.78	9.7	1.00	0.439	-2%	10.94	0.03	11.95	1%	1000	0%	39	20	700	1900	1500	90	25	
23-Nov-17 4:00	55	146.27	149.26	-82	114.7	113.9	-1%	11.44	9.6	1.00	0.425	-3%	10.86	-0.08	11.78	-1%	1000	0%	57	20	700	2000	1500	90	25	
23-Nov-17 5:33	56	149.26	152.27	-66	115	108.5	-6%	12	9.5	1.00	0.429	1%	10.79	-0.07	11.87	1%	1000	0%	61	20	700	1500	1750	90	25	
23-Nov-17 10:10	BL	149.26	152.27	655		122.4		8.75	9.7	1.00	0.332	-23%	10.62	-0.17	12.88	9%	1000	0%	88							SRU tank refilled with fresh water
23-Nov-17 11:10	57	152.27	155.28	-11	122.4	118.8	-3%	10.24	9.5	1.00	0.385	16%	10.76	0.14	12.42	-4%	1000	0%	24	20	700	1500	1500	50	15	
23-Nov-17 12:45	58	155.28	158.28	-99	125.9	112	-11%	11.42	9.4	1.00	0.320	-17%	10.35	-0.41	12.51	1%	1000	0%	84	18	700	1700	1200	75	20	
23-Nov-17 14:00	59	158.28	161.29	-18	118.1	110.7	-6%	12.36	9.4	1.00	0.330	3%	10.35	0.00	12.68	1%	1000	0%	75	15	700	2000	1500	75	25	
23-Nov-17 16:40	60	161.29	164.28	-79	119.4	116.8	-2%	11.33	9.3	1.00	0.343	4%	10.38	0.03	13.01	3%	1000	0%	69	15	700	2500	1200	125	40	
23-Nov-17 18:15	61	164.28	167.28	-66	117.2	115.3	-2%	11.94	9.3	1.00	0.401	17%	10.64	0.26	11.82	-9%	1000	0%	56	15	700	2500	1100	125	35	
23-Nov-17 20:21	BL	167.28	167.28	-31	115.3	115.2	0%	10.49	9.4	1.00	0.375	-6%	10.65	0.01	12.17	3%	1000	0%	71							New set of readings taken due to short delay in starting next run
23-Nov-17 21:35	62	167.28	170.26	-110	115.2	115.1	0%	11.41	9.3	1.00	0.403	7%	10.70	0.05	11.96	-2%	1000	0%	59	22	700	1900	1500	100	35	No fractures in core
23-Nov-17 23:18	63	170.26	173.26	-48	116.1	113.1	-3%	12.14	9.3	1.00	0.392	-3%	10.65	-0.05	12.18	2%	1000	0%	61	20	700	2000	1500	100	35	
24-Nov-17 0:57	64	173.26	176.26	1004	115.3	112.4	-3%	11.79	9.3	1.00	0.340	-13%	10.49	-0.16	12.10	-1%	1000	0%	74	17	700	200	1500	100	30	SRU tank refilled; new BL not taken prior to starting run
24-Nov-17 3:40	65	176.26	177.86	-56	109.9	109.9	0%	11.46	9.5	1.00	0.291	-14%	10.45	-0.04	12.65	5%	1000	0%	75	33	700	2000	1000	200	35	Partial run due to bit change
24-Nov-17 9:05	66	177.86	179.28	-134	109.8	106.6	-3%	12.32	9.5	1.00	0.351	21%	10.42	-0.03	12.15	-4%	1000	0%	75	11	700	1500	1500	50	20	Partial run due to bit change; volume loss due to extended circulation time
24-Nov-17 10:35	67	179.28	182.34	-83	111.4	115.9	4%	11.12	9.1	1.01	0.336	-4%	10.34	-0.08	12.12	0%	1000	0%	87	10	700	1500	1500	75	25	Top of HWT casing cut lower to reduce drill fluid loss from splashing
24-Nov-17 11:35	68	182.34	185.26	-53	121.3	117.5	-3%	11.27	8.5	1.01	0.366	9%	10.46	0.12	12.10	0%	1000	0%	65	10	700	1500	1500	75	25	
24-Nov-17 12:35	69	185.26	188.28	-17	117.7	119.8	2%	11.31	9	1.01	0.359	-2%	10.38	-0.08	12.04	0%	1000	0%	83	12	700	1500	1500	100	20	
24-Nov-17 13:35	70	188.28	191.28	-62	118.7	118.8	0%	10.85	9	1.01	0.361	1%	10.40	0.02	11.81	-2%	1000	0%	77	12	700	1500	1200	175	40	
24-Nov-17 15:35	71	191.28	194.29	-21	119.8	111.2	-7%	11.76	8.9	1.01	0.369	2%	10.36	-0.04	11.98	1%	1000	0%	88	13	700	1800	1100	150	35	
24-Nov-17 16:35	72	194.29	197.29	-69	113.3	107.6	-5%	11.9	8.8	1.01	0.372	1%	10.36	0.00	13.34	11%	1000	0%	77	12	700	2000	1200	175	35	
24-Nov-17 20:24	73	197.29	200.26	-24	107.1	114.5	7%	10.74	9	1.01	0.348	-6%	10.99	0.63	11.97	-10%	1000	0%	154	11	700	1750	1500	100	35	
24-Nov-17 22:25	74	200.26	203.26	-66	116.8	111	-5%	10.39	8.9	1.01	0.361	4%	10.99	0.00	11.82	-1%	1000	0%	149	14	700	1500	1500	100	35	
25-Nov-17 0:05	75	203.26	206.26	-2	102.9	97.01	-6%	13.65	8.9	1.01	0.353	-2%	10.83	-0.16	11.59	-2%	1000	0%	157	14	700	2000	1500	100	35	
25-Nov-17 2:32	76	206.26	209.26	-62	107	103	-4%	12.53	8.6	1.01	0.362	3%	10.95	0.12	12.68	9%	1000	0%	166	15	700	1500	1750	100	35	
25-Nov-17 5:17	77	209.26	212.24	-84	105.5	104.9	-1%	12.54	8.5	1.01	0.356	-2%	10.84	-0.11	12.62	0%	1000	0%	170	14	700	2000	1500	100	25	
25-Nov-17 6:18	78	212.24	215.26	-6	104.3	107	3%	11.77	8.4	1.01	0.370	4%	10.90	0.06	12.03	-5%	1000	0%	148	12	700	1750	1500	100	30	
25-Nov-17 11:50	79	215.26	218.28	-264	108.2	103.1	-5%	11.31	8.5	1.01	0.385	4%	10.57	-0.33	11.75	-2%	1000	0%	169	13	700	1700	1500	100	35	WP7 triggered due to water loss and evidence of water bearing fractures in the core
26-Nov-17 11:45	BL	215.26	218.28	78		93.81		8.01	10	1.00	0.159	-59%	10.87	0.30	14.13	20%	524	-48%	203							SRU tank refilled with fresh water
26-Nov-17 12:30	80	218.28	221.3	-46	93.81	64.85	-31%	10.05	9.5	1.00	0.130	-18%	10.28	-0.59	13.29	-6%	1000	91%	223	13	700	2000	1500	125	30	
26-Nov-17 14:35	81	221.3	224.3	-64	114.7	113.8	-1%	10.45	9.5	1.00	0.133	2%	10.08	-0.20	13.04	-2%	1000	0%	231	12	700	1700	1500	150	35	
26-Nov-17 20:35	BL	221.3	224.3	-110	113.8	92.72	-19%	11.37	9.8	1.00	0.129	-3%	10.30	0.22	14.60	12%	1000	0%	254							New set of readings taken due to drilling delay and cross shift
26-Nov-17 21:15	82	224.3	227.27	-67	92.72	92.73	0%	13.39	9.5	1.00	0.151	17%	10.37	0.07	12.97	-11%	1000	0%	240	15	700	2000	1250	110	30	
26-Nov-17 22:40	83	227.27	230.26	-5	97.38	96.59	-1%	12.01	9.4	1.00	0.170	13%	10.54	0.17	13.06	1%	1000	0%	220	15	700	1800	1700	110	30	
27-Nov-17 0:05	84	230.26	233.26	-2	99.47	95.67	-4%	12.54	9.4	1.00	0.190	12%	10.59	0.05	12.16	-7%	1000	0%	220	17	700	2000	1100	100	30	
27-Nov-17 1:30	85	233.26	236.26	-24	96.58	94.99	-2%	13.26	9.4	1.00	0.203	7%	10.44	-0.15	11.92	-2%	1000	0%	240	18	700	2000	1500	110	35	
27-Nov-17 2:50	86	236.26	239.26	-62	96.86	94.54	-2%	13.19	9.3	1.00	0.223	10%	10.62	0.18	11.37	-5%	1000	0%	209	17	700	2000	1750	110	40	
27-Nov-17 4:10	87	239.26	242.26	-41	94.73	97.75	3%	13.25	9.4	1.00	0.235	5%	10.51	-0.11	11.61	2%	1000	0%	220	15	700	2100	1000	110	35	
27-Nov-17 6:13	88	242.26	245.26	-15	94.37	94.21	0%	12.62	9.2	1.01	0.243	3%	10.61	0.10	11.89	2%	1000	0%	201	13	700	1800	1700	120	40	
27-Nov-17 9:55	89	245.26	248.28	-36	90.32	93.2	3%	11.72	9.2	1.01	0.255	5%	10.32	-0.29	11.83	-1%	1000	0%	235	13	700	2000	1200	175	40	
27-Nov-17 11:00	90	248.28	251.28	-55	96.33	99.82	4%	11.14	9	1.01	0.265	4%	10.30	-0.02	13.44	14%	1000	0%	225	13	700	2000	1500	125	40	
27-Nov-17 13:15	BL	248.28	251.28	1302		109.6		9.46	9.5	1.00	0.170	-36%	10.01	-0.29	13.97	4%	1000	0%	269							SRU tank refilled with fresh water
27-Nov-17 14:00	91	251.28	254.27	-22	109.6	114.7	5%	10.92	9.3	1.00	0.192	13%	10.07	0.06	13.47	-4%	1000	0%	221	12	700	2000	1500	200	40	
27-Nov-17 15:10	92	254.27	257.27	-32	105.8	104.2	-2%	11.3	9.2	1.01	0.200	4%	10.05	-0.02	13.55	1%	1000	0%	238	13	700	1700	1500	200	40	
27-Nov-17 16:45	93	257.27	260.27	-68	106.9	105.6	-1%	11.27	9.2	1.01	0.202	1%	10.08	0.03	12.21	-10%	1000	0%	235	15	700	2000	1500	200	40	
27-Nov-17 20:15	BL	260.27	260.27	-92	105.6	111	5%	9.31	9.3	1.00	0.211	4%	10.27	0.19	12.36	1%	1000	0%	232							New set of readings taken after cross shift
27-Nov-17 21:05	94	260.27	263.25	-19	111	108.9	-2%	9.82	9.2	1.01	0.221	5%	10.31	0.04	13.98	13%	1000	0%	216	19	700	2000	1200	190	40	

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
27-Nov-17 22:25	95	263.25	266.27	-21	108.6	106.8	-2%	9.22	9.2	1.01	0.227	3%	10.29	-0.02	14.12	1%	1000	0%	222	16	700	2000	1200	110	20	
27-Nov-17 23:30	96	266.27	269.28	-22	105.8	105.9	0%	10.23	9	1.01	0.249	10%	10.31	0.02	11.50	-19%	1000	0%	216	12	700	2000	1000	110	30	
28-Nov-17 1:30	97	269.28	272.28	-24	105.2	104.3	-1%	10.71	9	1.01	0.252	1%	10.31	0.00	11.89	3%	1000	0%	218	14	700	2000	1000	110	35	
28-Nov-17 2:17	98	272.28	275.32	-51	102.7	107.7	5%	10.38	9.1	1.01	0.256	2%	10.29	-0.02	11.91	0%	1000	0%	218	14	700	2100	1100	120	40	
28-Nov-17 3:28	99	275.32	278.28	-30	105.8	103.6	-2%	10.29	8.9	1.01	0.261	2%	10.33	0.04	11.34	-5%	1000	0%	189	11	700	2000	1500	110	40	
28-Nov-17 5:15	100	278.28	281.29	-42	104.4	105.3	1%	9.81	8.9	1.01	0.269	3%	10.29	-0.04	11.62	2%	1000	0%	205	12	700	2000	1500	120	40	
28-Nov-17 6:20	101	281.29	284.26	-37	103.5	106.4	3%	10.41	8.7	1.01	0.282	5%	10.31	0.02	12.42	7%	1000	0%	216	12	700	2000	1000	110	40	
28-Nov-17 10:25	102	284.26	287.28	-77	90.48	94.12	4%	10.31	8.6	1.01	0.266	-6%	10.29	-0.02	12.44	0%	1000	0%	211	12	700	2200	1300	200	30	
28-Nov-17 11:20	103	287.28	290.28	29	92.5	90.96	-2%	10.91	8.5	1.01	0.268	1%	10.27	-0.02	12.33	-1%	1000	0%	203	8	700	2500	1100	220	45	
28-Nov-17 13:40	104	290.28	293.28	-219	87.54	81.62	-7%	12.45	8.8	1.01	0.272	1%	10.29	0.02	11.74	-5%	1000	0%	204	12	700	1800	1500	200	45	SRU tank cleaned out between runs
28-Nov-17 14:55	105	293.28	296.28	5	80.9	90.98	12%	11.99	8.5	1.01	0.282	4%	10.31	0.02	11.15	-5%	1000	0%	183	10	700	2000	1500	200	45	
28-Nov-17 16:10	106	296.28	299.28	-150	92.62	91.03	-2%	12	8.8	1.01	0.294	4%	10.25	-0.06	11.20	0%	1000	0%	204	10	700	2300	1300	200	45	Began draining SRU tank during run, assumed previous tank level
28-Nov-17 18:30	BL	299.28	299.28	1481	91.03	71.5	-21%	9.97	9.8	1.00	0.102	-65%	9.81	-0.44	11.10	-1%	1000	0%	274							SRU tank refilled with fresh water
28-Nov-17 20:58	107	299.28	302.33	-100	71.5	78.41	10%	9.71	9.6	1.00	0.133	30%	10.04	0.23	11.50	4%	1000	0%	233	18	700	2100	1600	110	35	
28-Nov-17 22:40	108	302.33	305.26	-37	90.7	89.24	-2%	9.29	9.4	1.00	0.178	34%	10.13	0.09	11.04	-4%	1000	0%	227	20	700	2100	1500	110	40	
29-Nov-17 1:05	109	305.26	308.29	-206	85.11	81.79	-4%	10.41	9.4	1.00	0.185	4%	10.09	-0.04	10.73	-3%	1000	0%	214	26	700	2200	1100	110	35	Water loss due to hoses spilling on surface
29-Nov-17 3:16	110	308.29	311.29	-49	84.84	80.79	-5%	10.96	9.4	1.00	0.195	5%	10.07	-0.02	10.08	-6%	1000	0%	210	32	700	2000	1500	110	35	
29-Nov-17 5:12	111	311.29	314.25	-42	81.83	80.47	-2%	11.2	9.5	1.00	0.199	2%	9.99	-0.08	11.95	19%	1000	0%	253	29	700	2200	1500	120	35	
29-Nov-17 11:13	112	314.25	317.28	-35	74.65	76.4	2%	12.17	9.2	1.01	0.217	9%	9.97	-0.02	7.60	-36%	1000	0%	291	17	700	2400	1500	200	40	
29-Nov-17 14:00	113	317.28	318.71	-17	64.74	71.84	11%	11.78	9.5	1.00	0.216	0%	9.95	-0.02	10.62	40%	1000	0%	253	28	700	2000	2000	210	45	
29-Nov-17 20:20	BL	318.71	318.71	3	71.8	80.18	12%	9.94			0.222	3%	10.00	0.05	8.02	-24%	1000	0%	283							New set of readings taken after cross shift
29-Nov-17 20:50	114	318.71	320.28	-59	80.18	79.95	0%	9.92	9.3	1.00	0.228	3%	10.05	0.05	8.47	6%	1000	0%	233	10	700	1500	2000	150	35	
29-Nov-17 22:10	115	320.28	323.27	-57	79.11	79.11	0%	10.48	8.8	1.01	0.236	4%	10.05	0.00	10.93	29%	1000	0%	210	13	700	2200	2000	110	30	
29-Nov-17 23:35	116	323.27	326.06	-27	93.24	104.8	12%	10.92	9	1.01	0.247	5%	10.10	0.05	8.87	-19%	1000	0%	218	18	700	2000	1750	120	35	
30-Nov-17 1:55	117	326.06	329.25	-40	97.34	96.67	-1%	11.26	9	1.01	0.242	-2%	10.00	-0.10	10.11	14%	1000	0%	203	17	700	1600	1900	200	45	
30-Nov-17 3:55	118	329.25	332.26	-86	94.3	96.98	3%	11.07	9	1.01	0.248	2%	10.01	0.01	9.50	-6%	1000	0%	204	17	700	1700	1600	150	40	
30-Nov-17 5:15	119	332.26	334.8	-42	96.87	94.9	-2%	11.92	9.4	1.00	0.259	4%	9.99	-0.02	10.35	9%	1000	0%	201	17	700	2500	1500	210	45	
30-Nov-18 5:53	120	334.8	335.27	-22	97.4	98.53	1%	10.92	9	1.01	0.253	-2%	10.04	0.05	10.47	1%	1000	0%	204	17	700	2100	1700	250	40	
30-Nov-17 9:20	BL	335.27	336.22	995		94.95		9.6	9.5	1.00	0.166	-34%	9.83	-0.21	11.75	12%	1000	0%	222							SRU tank refilled with fresh water
30-Nov-17 9:45	121	335.27	336.22	-46	78.87	85.05	8%	10.78	9.3	1.00	0.270	63%	10.07	0.24	10.46	-11%	1000	0%	198	16	700	2300	1300	400	40	System circulating / equalizing after fresh water addition
30-Nov-17 21:18	BL	336.22	336.22	-463																						Volume BL taken after bit change
30-Nov-17 21:50	122	336.22	338.27	234	89.59	89.18	0%	10.51	9.2	1.01	0.215	-20%	9.81	-0.26	10.80	3%	1000	0%	219	15	700	1600	2000	180	40	No water added; change due to measurement uncertainty and system circulation
30-Nov-17 22:55	123	338.27	341.26	-32	87.19	86.54	-1%	10.44	9	1.01	0.236	10%	9.75	-0.06	10.46	-3%	1000	0%	223	12	700	2100	1400	150	35	
01-Dec-17 0:12	124	341.26	344.27	-25	91.32	87.07	-5%	10.45	9	1.01	0.246	4%	9.85	0.10	9.73	-7%	1000	0%	206	14	700	2000	1500	150	35	
01-Dec-17 2:00	125	344.27	347.28	-37	87.21	80.84	-7%	11.08	9	1.01	0.250	2%	9.84	-0.01	10.82	11%	1000	0%	216	15	700	2500	1000	120	35	
01-Dec-17 4:37	126	347.28	350.32	-68	86.44	83.9	-3%	10.57	9	1.01	0.255	2%	9.86	0.02	11.00	2%	1000	0%	214	14	700	2250	1100	160	40	
01-Dec-17 9:25	127	350.32	353.28	-67	73.5	78.31	7%	11.76	8.8	1.01	0.251	-2%	9.87	0.01	10.30	-6%	1000	0%	366	10	700	2500	1000	160	40	
01-Dec-17 10:25	128	353.28	356.3	-39	78.53	65.74	-16%	11.61	8.7	1.01	0.253	1%	9.83	-0.04	11.70	14%	1000	0%	228	10	700	2300	1500	200	40	
01-Dec-17 11:55	129	356.3	359.28	-57	72.21	72.65	1%	11.48	8.8	1.01	0.256	1%	9.80	-0.03	11.19	-4%	1000	0%	215	13	700	2300	1500	200	40	
01-Dec-17 13:35	130	359.28	362.26	-31	74.96	78.22	4%	11.44	8.7	1.01	0.259	1%	9.75	-0.05	10.85	-3%	1000	0%	222	13	700	2000	1200	200	40	
01-Dec-17 14:35	131	362.26	365.28	-36	79.99	81.73	2%	11.56	8.9	1.01	0.269	4%	9.77	0.02	9.96	-8%	1000	0%	215	13	700	2000	1500	200	40	
01-Dec-17 14:35	BL	365.28	365.28	154	94.09	96.9	3%	7.85	10	1.00	0.076	-72%	9.12	-0.65	12.03	21%	1000	0%	275							SRU tank refilled with fresh water, system circulating
01-Dec-17 17:15	132	365.28	368.26	-57	94.09	96.9	3%	9.08	9	1.01	0.218	187%	9.78	0.66	12.83	7%	1000	0%	222	18	700	2000	1300	300	40	
01-Dec-17 21:25	133	368.26	371.23	-74	96.9	86.37	-11%	9.24	9.2	1.01	0.207	-5%	9.88	0.10	10.55	-18%	1000	0%	223	18	700	1800	1600	200	40	
01-Dec-17 23:00	134	371.23	374.27	-49	83.74	78.26	-7%	9.88	9.1	1.01	0.203	-2%	9.87	-0.01	10.15	-4%	1000	0%	221	18	700	2200	1250	150	35	
02-Dec-17 0:40	135	374.27	377.28	-30	82.57	79.79	-3%	10.16	9	1.01	0.217	7%	9.91	0.04	11.76	16%	1000	0%	217	22	700	1900	1600	200	35	
02-Dec-17 2:20	136	377.28	380.28	-32	80.92	79.29	-2%	10.41	9	1.01	0.222	2%	9.92	0.01	11.99	2%	1000	0%	214	22	700	1500	2500	200	40	
02-Dec-17 4:18	137	380.28	383.29	-48	81.01	79.36	-2%	10.06	9.1	1.01	0.225	1%	9.92	0.00	11.54	-4%	1000	0%	221	21	700	1700	1600	110	30	
02-Dec-17 6:00	138	383.29	386.27	-52	80.05	68.06	-15%	10.11	8.7	1.01	0.206	-8%	9.81	-0.11	9.06	-21%	1000	0%	289	23	700	2100	1650	200	35	DO not stabilized
02-Dec-17 10:45	139	386.27	389.28	-244	74.66	68.13	-9%	10.48	8.7	1.01	0.248	20%	9.82	0.01	13.43	48%	1000	0%	214	18	700	2000	1500	180	35	Drillers drained some water from SRU tank, no real loss
02-Dec-17 12:30	140	389.28	392.28	-1	74.04	74.53	1%	11.21	8.9	1.01	0.256	3%	9.81	-0.01	12.31	-8%	1000	0%	221	20	700	2000	1500	200	35	
02-Dec-17 14:05	141	392.28	395.27	2	75.11	73.67	-2%	11.53	8.7	1.01	0.266	4%	9.85	0.04	13.10	6%	1000	0%	216	15	700	2000	1500	180	35	
02-Dec-17 16:15	142	395.27	398.29	-26	73.41	72.6	-1%	11.07	8.7	1.01	0.276	4%	9.83	-0.02	13.50	3%	1000	0%	220	13	700	2000	2000	200	50	
02-Dec-17 20:20	BL	398.29	398.29	1223	72.6	85.89	18%	8.22	9.63	1.00	0.139		9.63		11.73		1000		269							Drill fluid replaced with fresh water; high concentration of cuttings present in drill fluid
02-Dec-17 20:42	143	398.29	401.28	-9	85.89	72.3	-16%	9.02	8.5	1.01	0.233	68%	9.83	0.20	10.01	-15%	1000	0%	231	17	700	2100	1500	200	35	
02-Dec-17 22:16	144	401.28	404.15	-37	76.4	76.48	0%	10.14	8.7	1.01	0.218	-6%	9.84	0.01	10.29	3%	1000	0%	238	17	700	2000	2000	190	35	
03-Dec-17 11:10	145	404.15	407.24	-22	77.81	76.54	-2%	10.99	9.1	1.01	0.249	14%	10.03	0.19	10.77	5%	1000	0%	207	19	700	2250	1100	180	40	
03-Dec-17 1:47	146	407.24	410.32	-114	76.34	78.38	3%	10.74	8.9	1.01	0.250	0%	10.15	0.12	10.70	-1%	1000	0%	178	14	700	2250	1750	190	40	Some water removed from drill tank at end of run; measurement uncertainty.

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
03-Dec-17 3:20	147	410.32	413.28	-28	75.06	75.84	1%	11.5	8.9	1.01	0.249	0%	10.01	-0.14	10.66	0%	1000	0%	177	20	700	2150	1250	180	35	
03-Dec-17 4:50	148	413.28	416.28	-55	74.43	74.23	0%	11.46	8.8	1.01	0.258	4%	10.14	0.13	10.82	2%	1000	0%	175	17	700	2000	2000	190	40	
03-Dec-17 11:20	BL	416.28	416.28	139		80.79		6.91	9.9	1.00	0.102	-60%	9.20	-0.94	15.47	43%	1000	0%	258							SRU tank refilled with fresh water, system circulating
03-Dec-17 12:00	149	416.28	419.28	-14	82.3	73.85	-10%	9.12	9.2	1.01	0.258	153%	9.68	0.48	12.35	-20%	1000	0%	193	13	700	2300	1700	300	35	System circulating / equalizing after fresh water addition
03-Dec-17 13:30	150	419.28	422.29	-40	78.61	81.01	3%	9.5	9.5	1.00	0.177	-31%	9.40	-0.28	13.12	6%	1000	0%	195	20	700	2000	1500	210	35	System circulating / equalizing after fresh water addition
03-Dec-17 15:35	151	422.29	425.3	-37	84.09	85.76	2%	9.51	9.3	1.00	0.181	2%	9.58	0.18	11.59	-12%	1000	0%	163	17	700	2300	1200	200	35	
03-Dec-17 17:00	152	425.3	428.28	-37	85.81	75.39	-12%	11.16	9.4	1.00	0.187	3%	9.59	0.01	13.21	14%	1000	0%	181	20	700	2000	1200	280	45	
03-Dec-17 20:35	BL	428.28	428.28	191	75.39	74.55	-1%	11.61	9.4	1.00	0.181		9.65		10.22		1000		204							SRU tank cleaned and refilled with fresh water
03-Dec-17 21:41	153	428.28	431.28	-57	74.55	75.54	1%	10.64	9.2	1.01	0.194	7%	9.76	0.11	11.04	8%	1000	0%	200	19	700	2000	1500	180	30	System circulating / equalizing after fresh water addition
03-Dec-17 23:15	154	431.28	434.27	-39	67.8	62.98	-7%	10.4	9.3	1.00	0.151	-22%	9.65	-0.11	12.54	14%	1000	0%	198	18	700	2250	1500	180	30	System circulating / equalizing after fresh water addition
04-Dec-17 0:58	155	434.27	437.28	-25	160.2	61.1	-62%	11.51	9.5	1.00	0.146	-3%	9.70	0.05	11.09	-12%	1000	0%	198	21	700	2100	1600	400	30	Fluorescein added to SRU tank at start of run; system circulating
04-Dec-17 4:15	156	437.28	440.28	-123	92.66	111.9	21%	12.23	9.3	1.00	0.173	18%	9.67	-0.03	10.53	-5%	1000	0%	198	18	700	2100	1500	150	20	Intact core, no evidence of water bearing features
04-Dec-17 6:03	157	440.28	443.29	-33	94.28	89.16	-5%	13.06	9.4	1.00	0.174	1%	9.70	0.03	11.52	9%	1000	0%	199	23	700	2100	1600	100	20	
04-Dec-17 11:05	158	443.29	446.27	-71	91.66	90.3	-1%	13.77	9.2	1.01	0.187	7%	9.60	-0.10	10.74	-7%	1000	0%	190	30	700	2300	1500	200	30	
04-Dec-17 12:25	159	446.27	449.28	-65	88.42	88.24	0%	14.95	9.4	1.00	0.195	4%	9.61	0.01	10.16	-5%	1000	0%	157	17	700	2500	1500	200	35	
04-Dec-17 13:55	160	449.28	452.3	-62	88.08	87.58	-1%	14.38	9.3	1.00	0.204	5%	9.68	0.07	10.50	3%	1000	0%	189	20	700	2300	1500	200	30	
04-Dec-17 15:45	161	452.3	455.28	-73	87.43	83.64	-4%	14.74	9.3	1.00	0.207	1%	9.68	0.00	10.25	-2%	1000	0%	114	20	700	2500	2000	250	40	
05-Dec-17 17:00	BL	455.28	455.28	40				6.27	9.3	1.00	0.224	8%	9.37	-0.31	9.93	-3%	1000	0%	197							SRU tank refilled with fresh water
05-Dec-17 17:35	162	455.28	458.28	-71	84.64	71.98	-15%	9.47	8.9	1.01	0.234	4%	9.47	0.10	6.75	-32%	1000	0%	126	12	700	2300	1500	200		
06-Dec-17 1:20	163	458.28	461.28	-6	81.2	74.3	-8%	12.61	8.4	1.01	0.247	6%	9.44	-0.03	5.98	-11%	1000	0%	179	18	680	2000	1200	100		
06-Dec-17 3:05	164	461.28	464.28	-103	84.8	75.3	-11%	11.88	8.8	1.01	0.267	8%	9.46	0.02	6.41	7%	1000	0%	187	23	670	2200	1200	110		Intact core, no trigger
06-Dec-17 4:45	165	464.28	467.28	-47	83.5	73.1	-12%	13.37	8.4	1.01	0.262	-2%	9.42	-0.04	6.01	-6%	1000	0%	161	22	650	2400	1100	130		
06-Dec-17 6:00	166	467.28	470.28	-21	81.9	65.02	-21%	17.61	8.9	1.01	0.277	6%	9.51	0.09	5.73	-5%	1000	0%	188	15	680	2400	1400	130		
07-Dec-17 13:35	BL	470.28	470.28	-205	70.86	70.86	0%	6.31	9.1	1.01	0.271	-2%	9.44	-0.07	13.54	136%	1000	0%	221							New set of readings taken due to drilling delay
07-Dec-17 14:15	167	470.28	473.28	-44	70.86	70.09	-1%	9.51	9	1.01	0.283	4%	9.67	0.23	11.98	-12%	1000	0%	163	17	700	2500	1200	200	45	
07-Dec-17 15:35	168	473.28	476.38	-69	69.5	68.34	-2%	10.36	9	1.01	0.283	0%	9.50	-0.17	11.92	-1%	1000	0%	178	17	700	2500	1200	200	45	
07-Dec-17 16:50	169	476.38	479.28	-24	68.34	66.53	-3%	10.96	8.5	1.01	0.299	6%	9.66	0.16	11.48	-4%	1000	0%	183	15	700	2300	1200	200	45	
07-Dec-17 17:20	BL			603				10.96	8.5	1.01	0.299	0%	9.66	0.00	11.48	0%	1000	0%	183							SRU tank refilled with fresh water, system circulating
07-Dec-17 18:05	170	479.28	482.29	-48	66.53	63.81	-4%	11.23	8.7	1.01	0.306	2%	9.64	-0.02	11.23	-2%	1000	0%	165	15	700	2200	1200	200	40	Fluorescein added to drill fluid system
07-Dec-17 20:50	171	482.29	485.06	-48	122.1	63.6	-48%	11.58	9	1.01	0.281	-8%	9.53	-0.11	11.98	7%	1000	0%	367	23	650	2400	1200	90	20	Fluorescein equalizing in drill system
07-Dec-17 22:40	172	485.06	488.17	-24	84.07	135.1	61%	11.82	8.8	1.01	0.309	10%	9.53	0.00	12.38	3%	1000	0%	263	23	660	2400	1400	120	30	Fluorescein equalizing in drill system
08-Dec-17 0:15	173	488.17	491.1	-35	119.2	98.6	-17%	11.7	8.9	1.01	0.281	-9%	9.47	-0.06	11.91	-4%	1000	0%	277	23	680	2300	1200	110	25	Fluorescein equalizing in drill system
08-Dec-17 1:55	174	491.1	494.2	-11	123.4	93.4	-24%	12.28	8.5	1.01	0.291	4%	9.50	0.03	11.95	0%	1000	0%	224	23	680	2400	1200	110	25	Fluorescein equalizing in drill system
08-Dec-17 3:55	175	494.2	497.25	-66	97	111.4	15%	12.35	8.6	1.01	0.303	4%	9.47	-0.03	11.59	-3%	1000	0%	206	27	670	2400	1200	120	30	
08-Dec-17 5:40	176	497.25	500.26	-55	108.7	89.5	-18%	12.77	8.8	1.01	0.301	-1%	9.48	0.01	11.89	3%	1000	0%	205	23	690	2500	1400	140	25	
08-Dec-17 9:30	177	500.26	503.11	-45	90.17	92.77	3%	11.33	9.2	1.01	0.322	7%	9.63	0.15	11.25	-5%	1000	0%	226	17	700	2400	1400	200	40	
08-Dec-17 11:10	178	503.11	506.22	-79	95.8	92.06	-4%	12.55	8.9	1.01	0.328	2%	9.64	0.01	10.32	-8%	1000	0%	217	23	700	2500	1200	200	40	
08-Dec-17 12:35	179	506.22	509.28	-45	96.78	91.77	-5%	12.7	8.5	1.01	0.332	1%	9.62	-0.02	9.23	-11%	1000	0%	198	18	680	2400	1400	200	40	
08-Dec-17 15:00	180	509.28	512.29	-143	89.41	85.06	-5%	13.08	8.7	1.01	0.341	3%	9.64	0.02	9.25	0%	1000	0%	185	20	700	2500	1400	180		
08-Dec-17 15:30	BL	512.29	512.29	1134				13.08	8.7	1.01	0.341	0%	9.64	0.00	9.25	0%	1000	0%	185							SRU tank refilled with fresh water
08-Dec-17 16:30	181	512.29	515.3	-212	84.3	74.6	-12%	11.65	8.8	1.01	0.339	-1%	9.62	-0.02	9.56	3%	1000	0%	186	20	700	2300	1500	180	40	Some water loss noted on surface; no trigger
08-Dec-17 18:10	182	515.3	518.28	-37	76.29	75.5	-1%	12.79	9	1.01	0.298	-12%	9.63	0.01	9.62	1%	1000	0%	178	23	700	2500	1000	200	45	
09-Dec-17 0:25	183	518.28	521.27	-256	79.1	74.5	-6%	12.04	8.9	1.01	0.291	-2%	9.45	-0.18	8.70	-10%	1000	0%	282	27	650	2500	1300	80		Water loss from broken water swivel and overfilling of drill tank
09-Dec-17 2:20	184	521.27	524.29	-18	74.9	75.1	0%	13.19	8.9	1.01	0.310	7%	9.45	0.00	9.10	5%	1000	0%	294	25	650	2500	1200	110		
09-Dec-17 3:55	185	524.29	527.27	-44	74.3	74	0%	13.14	9	1.01	0.310	0%	9.49	0.04	8.90	-2%	1000	0%	270	20	650	2500	1400	150		
09-Dec-17 5:20	186	527.27	530.27	-22	74.2	70.3	-5%	12.83	8.7	1.01	0.325	5%	9.53	0.04	8.78	-1%	1000	0%	229	20	650	2600	1500	100		
09-Dec-17 9:20	187	530.27	533.22	-8	59.64	68.49	15%	11.74	8.8	1.01	0.303	-7%	9.53	0.00	9.50	8%	1000	0%	192	17	700	2700	1200	200	35	
09-Dec-17 10:30	188	533.22	536.28	-20	69.52	67.5	-3%	12.27	8.9	1.01	0.300	-1%	9.52	-0.01	9.46	0%	1000	0%	216	15	680	2500	1300	180	40	
09-Dec-17 13:15	189	536.28	539.29	-22	66.11	64.92	-2%	12.17	8.5	1.01	0.315	5%	9.62	0.10	9.43	0%	1000	0%	196	17	650	3000	1000	200	35	
09-Dec-17 23:20	BL	539.29	539.29	141				10.82	9.4	1.00	0.246	-22%	9.46	-0.16	9.72	3%	1000	0%	255							SRU tank refilled with fresh water
10-Dec-17 0:05	190	539.29	542.27	-2	87.8	60.3	-31%	10.77	8.8	1.01	0.330	34%	9.61	0.15	9.61	-1%	1000	0%	256	15	650	2500	1200	150	30	System circulating / equalizing after fresh water and fluorescein addition
10-Dec-17 1:30	191	542.27	545.28	-53	84.1	67.5	-20%	12.07	8.8	1.01	0.316	-4%	9.40	-0.21	9.52	-1%	1000	0%	214	15	650	2500	1300	140	25	Fluorescein equalizing in drill system
10-Dec-17 3:20	192	545.28	548.29	-82	70.1	82.1	17%	12.11	8.5	1.01	0.305	-3%	9.55	0.15	9.53	0%	1000	0%	185	20	650	2500	1200	150	30	Fluorescein equalizing in drill system
10-Dec-17 4:35	193	548.29	551.28	-48	83	72	-13%	11.79	8.6	1.01	0.354	16%	9.58	0.03	8.79	-8%	1000	0%	185	13	650	2500	1500	150	30	Fluorescein equalizing in drill system
10-Dec-17 5:25	194	551.28	551.89	-1	75.2	72.4	-4%	10.99	8.9	1.01	0.344	-3%	9.40	-0.18	8.79	0%	1000	0%	194	16	650	2500	1200	150	30	Partial run due to core blocked in tube

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
10-Dec-17 10:35	195	551.89	554.3	-160	78.39	72.57	-7%	12.13	8.9	1.01	0.350	2%	9.50	0.10	10.75	22%	1000	0%	207	23	650	2500	1200	250	35	Loss likely due to extended circulation during during cross shift drilling delay
10-Dec-17 12:10	196	554.3	557.27	-12	72.57	72.22	0%	11.93	8.8	1.01	0.359	3%	9.56	0.06	12.59	17%	1000	0%	194	17	650	2500	1000	250	40	
10-Dec-17 14:35	197	557.27	560.31	-88	79.32	71.08	-10%	11.4	8.7	1.01	0.367	2%	9.52	-0.04	13.26	5%	1000	0%	197	21	650	2500	1500	250	40	
10-Dec-17 16:40	198	560.31	563.29	-36	72.85	66.18	-9%	12.68	8.3	1.01	0.389	6%	9.69	0.17	10.24	-23%	1000	0%	170	23	650	2500	2700	300	50	
10-Dec-17 19:35	199	563.29	566.26	31	68.67	62.3	-9%	14.02	8.5	1.01	0.392	1%	9.64	-0.05	10.92	7%	1000	0%	165	28	650	2500	2350	275	40	Fluorescein added to drill fluid system
10-Dec-17 21:30	200	566.26	569.28	-28	67.2	74.9	11%	13.87	8.6	1.01	0.397	1%	9.55	-0.09	10.38	-5%	1000	0%	223	25	650	2500	2300	175	35	Fluorescein equalizing in drill system
10-Dec-17 23:35	201	569.28	572.27	-36	92.1	92.2	0%	14.05	8.5	1.01	0.405	2%	9.61	0.06	10.67	3%	1000	0%	215	30	650	2500	2200	200	30	
11-Dec-18 1:20	202	572.27	575.28	-50	93.9	90.6	-4%	14.02	8.5	1.01	0.411	1%	9.48	-0.13	10.84	2%	1000	0%	192	22	650	2500	2500	240	30	
11-Dec-18 2:35	BL	575.28	575.28	978				8.96	9.4	1.00	0.255	-38%	9.49	0.01	13.44	24%	1000	0%	226							SRU tank refilled with fresh water
11-Dec-18 3:45	203	575.28	578.29	8	100.8	79.7	-21%	12.03	8.5	1.01	0.395	55%	9.60	0.11	10.83	-19%	1000	0%	186	18	650	2600	2500	250	35	System circulating / equalizing after fresh water addition
11-Dec-17 5:35	204	578.29	581.27	-41	81.2	81.2	0%	12.16	8.7	1.01	0.378	-4%	9.57	-0.03	10.50	-3%	1000	0%	196	23	650	2500	2300	250	40	
11-Dec-17 12:25	205	581.27	584.27	-24	88.17	84.58	-4%	11.69	9	1.01	0.352	-7%	9.46	-0.11	10.19	-3%	1000	0%	215	25	600	3500	2200	250	45	
11-Dec-17 14:25	206	584.27	587.25	-57	85.89	79.39	-8%	12.08	8.8	1.01	0.362	3%	9.47	0.01	12.12	19%	1000	0%	221	23	550	3000	1700	250	55	
11-Dec-17 16:10	207	587.25	590.26	-20	81.31	75.28	-7%	11.22	8.7	1.01	0.371	2%	9.53	0.06	10.71	-12%	1000	0%	208	20	500	3000	1000	275	45	
11-Dec-17 18:00	208	590.26	593.27	-13	80.96	76.32	-6%	10.99	8.6	1.01	0.377	2%	9.42	-0.11	12.38	16%	1000	0%	190	23	550	2500	2500	225	45	
11-Dec-17 21:25	209	593.27	596.27	-26	72.5	68.3	-6%	11.95	8.7	1.01	0.386	2%	9.54	0.12	11.27	-9%	1000	0%	168	23	600	2400	2400	200	40	Fluorescein added to drill fluid system
11-Dec-17 23:25	210	596.27	599.29	-81	152.4	81.9	-46%	11.5	8.7	1.01	0.383	-1%	9.38	-0.16	10.27	-9%	1000	0%	181	23	600	2500	2200	150	30	Fluorescein equalizing in drill system
12-Dec-17 1:10	211	599.29	602.29	-9	94.3	117	24%	11.16	8.7	1.01	0.397	4%	9.54	0.16	10.41	1%	1000	0%	145	22	580	2400	2400	225	35	Fluorescein equalizing in drill system
12-Dec-17 2:45	212	602.29	605.29	6	128.9	80.2	-38%	10.56	8.4	1.01	0.400	1%	9.42	-0.12	10.63	2%	1000	0%	172	18	550	2400	2400	200	30	Fluorescein equalizing in drill system
12-Dec-18 5:40	213	605.29	608.27	-12	91.7	102	11%	10.32	8.5	1.01	0.399	0%	9.47	0.05	11.21	5%	1000	0%	173	17	520	2500	2000	180	30	Fluorescein equalizing in drill system
12-Dec-17 15:20	214	608.27	611.27	-178	97.97	98.46	1%	9.37	8.2	1.01	0.431	8%	9.64	0.17	14.23	27%	1000	0%	170	15	500	2500	2000	250	40	Centrifuge cleaned; measurement uncertainty
12-Dec-17 17:05	215	611.27	614.26	-2	104.4	99.36	-5%	10.11	8.4	1.01	0.425	-1%	9.58	-0.06	11.04	-22%	1000	0%	185	18	500	2500	2200	275	45	
12-Dec-17 20:40	216	614.26	617.29	-34	95.2	92.4	-3%	12.11	8.4	1.01	0.446	5%	9.66	0.08	11.65	6%	1000	0%	160	23	550	2400	2500	200	30	
12-Dec-17 22:25	217	617.29	620.29	-20	90.7	89	-2%	12.08	8.5	1.01	0.440	-1%	9.53	-0.13	12.05	3%	1000	0%	166	20	550	2300	2500	200	30	
13-Dec-17 0:10	218	620.29	623.27	-7	91.3	89.5	-2%	12.5	8.5	1.01	0.453	3%	9.56	0.03	10.69	-11%	1000	0%	160	22	550	2400	2400	200	35	
13-Dec-17 2:30	219	623.27	626.3	-33	89.4	85.9	-4%	13.23	8.4	1.01	0.457	1%	9.58	0.02	10.31	-4%	1000	0%	154	25	550	2400	2300	200	35	
13-Dec-17 4:30	220	626.3	629.27	-23	84.9	83.9	-1%	13.61	8.5	1.01	0.461	1%	9.54	-0.04	10.36	0%	1000	0%	157	25	550	2400	2400	175	30	
13-Dec-17 6:15	221	629.27	632.25	-31	83.5	81.06	-3%	12.6	8.5	1.01	0.479	4%	9.57	0.03	12.39	20%	1000	0%	182	18	550	2500	2500	225	35	Run was completed and nightshift left site; dayshift completed drill fluid parameters and volume calculations
13-Dec-17 10:10	222	632.25	635.26	-68	84.08	83.66	0%	12.01	8.2	1.01	0.486	1%	9.39	-0.18	10.24	-17%	1000	0%	235	15	500	2500	2000	275	40	
13-Dec-17 14:05	223	635.26	638.27	-95	79.37	79.58	0%	12.73	8.2	1.01	0.490	1%	9.48	0.09	10.83	6%	1000	0%	234	15	500	2500	2000	275	40	
13-Dec-17 15:55	224	638.27	641.19	-32	92.74	80.97	-13%	10.8	8.1	1.01	0.497	1%	9.56	0.08	11.41	5%	1000	0%	211	17	500	2200	2500	275	40	
13-Dec-17 17:25	225	641.19	643.09	-12	86.84	85.28	-2%	11.9	8.9	1.01	0.330	-34%	9.33	-0.23	13.79	21%	1000	0%	220	24	500	3000	2200	275	45	Partial run due to bit change
14-Dec-17 2:35	226	643.09	644.28	-1034	81.2	65.1	-20%	13.87	8.9	1.01	0.443	34%	9.44	0.11	5.83	-58%	1000	0%	165	17	600	2500	2700	200	35	Completed partial run after bit change. Approx. 1000 L drill fluid spill from SRU tank; representative volume loss from drilling not available. Drill fluid sampled before passing through centrifuge.
14-Dec-17 4:00	BL	644.28	644.28	1007				10.22	9.2	1.01	0.288	-35%	9.34	-0.10	13.99	140%	1000	0%	228							SRU tank refilled with fresh water
14-Dec-17 4:50	227	644.28	647.28	-236	88.6	76	-14%	11.61	8.4	1.01	0.437	52%	9.38	0.04	11.39	-19%	1000	0%	165	17	550	2500	2100	210	35	System circulating / equalizing after fresh water addition
14-Dec-17 9:15	228	647.28	650.27	7	81.9	78.16	-5%	12.17	8.9	1.01	0.373	-15%	9.35	-0.03	10.67	-6%	1000	0%	197	13	550	2500	1900	225	35	
14-Dec-17 10:35	229	650.27	653.27	-12	84.02	81.16	-3%	12.72	8.8	1.01	0.362	-3%	9.40	0.05	12.11	13%	1000	0%	182	13	500	3000	1200	275	45	
14-Dec-17 12:10	230	653.27	656.28	-42	82.45	77.31	-6%	11.58	8.5	1.01	0.394	9%	9.32	-0.08	10.01	-17%	1000	0%	168	10	500	2500	2000	250	45	
14-Dec-17 14:15	231	656.28	659.27	-59	85.74	80.92	-6%	11.49	8.5	1.01	0.372	-6%	9.25	-0.07	11.03	10%	1000	0%	186	8	500	2800	2000	300	40	
14-Dec-17 16:00	232	659.27	662.24	-18	79.82	73.95	-7%	11.7	8.4	1.01	0.373	0%	9.85	0.60	10.30	-7%	1000	0%	174	13	500	3000	2200	250	45	
14-Dec-17 20:50	233	662.24	664.16	-41	77.7	88.5	14%	18.09	8.5	1.01	0.395	6%	9.74	-0.11	10.08	-2%	1000	0%	193	13	550	2500	2400	190	30	Partial run
16-Dec-17 1:30	BL	664.16	664.16	1103				12.06	9.2	1.01	0.265	-33%	7.38	-2.36	10.00	-1%	1000	0%	198							SRU tank refilled with fresh water
16-Dec-17 2:40	234	664.16	665.29	-57	94.5	98.1	4%	7.83	8.6	1.01	0.382	44%	9.36	1.98	8.60	-14%	1000	0%	280	22	550	2600	2000	190	35	System circulating / equalizing after fresh water addition
16-Dec-17 4:15	235	665.29	668.28	-26	96	100.2	4%	10.87	8.1	1.01	0.405	6%	9.64	0.28	10.40	21%	1000	0%	125	18	550	2500	2200	200	27	System circulating / equalizing after fresh water addition
16-Dec-17 5:40	236	668.28	671.28	-78	98.8	91.2	-8%	10.01	8.7	1.01	0.308	-24%	9.51	-0.13	10.83	4%	1000	0%	150	17	520	2600	2200	250	35	System circulating / equalizing after fresh water addition
16-Dec-17 11:45	237	671.28	674.28	-46	95.97	92.52	-4%	10.37	8.5	1.01	0.400	30%	9.60	0.09	11.77	9%	1000	0%	164	15	500	2800	2200	250	40	
16-Dec-17 13:50	238	674.28	676.99	-25	95.84	91.08	-5%	10.82	8.6	1.01	0.383	-4%	9.60	0.00	10.70	-9%	1000	0%	165	18	500	2500	1700	275	50	
16-Dec-17 16:20	239	676.99	680.14	-13	92.65	88.63	-4%	12.05	8.5	1.01	0.394	3%	9.57	-0.03	12.31	15%	1000	0%	169	16	500	2800	1800	300	60	
16-Dec-17 18:10	240	680.14	683.27	-66	90.47	88.36	-2%	12.6	8.6	1.01	0.390	-1%	9.56	-0.01	10.67	-13%	1000	0%	168	21	500	2800	1500	275		
16-Dec-17 21:20	241	683.27	686.25	-23	73.3	80.5	10%	11.55	8.4	1.01	0.413	6%	9.58	0.02	10.49	-2%	1000	0%	139	22	550	2500	2600	200		
16-Dec-17 23:05	242	686.25	689.21	-6	79.6	84.3	6%	12.23	8.2	1.01	0.410	-1%	9.58	0.00	11.41	9%	1000	0%	168	20	500	2500	2300	175		
17-Dec-17 1:00	243	689.21	692.28	-47	84.4	76.7	-9%	13.78	8.1	1.01	0.439	7%	9.62	0.04	10.10	-11%	1000	0%	121	23	500	2000	2800	200		
17-Dec-17 3:25	244	692.28	695.25	-25	81.8	78.6	-4%	11.72	8.5	1.01	0.426	-3%	9.50	-0.12	11.10	10%	1000	0%	158	20	500	2500	2500	175		
17-Dec-17 5:25	245	695.25	698.27	-30	80.6	79.5	-1%	12.17	8.5	1.01	0.436	2%	9.51	0.01	11.22	1%	1000	0%	151	22	500	2400	2500	210		

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
17-Dec-17 11:40	246	698.27	701.21	-47	87.34	82.63	-5%	11.97	8.5	1.01	0.427	-2%	9.52	0.01	9.23	-18%	1000	0%	132	24	500	2500	2500	400		Drilling paused for centrifuge repair during run
17-Dec-17 20:25	247a	701.21	701.49	-12	95.8	103.7	8%	14.11	8.8	1.01	0.440	3%	9.33	-0.19	11.07	20%	1000	0%	156	71	500	2500	2600	300		Partial run due to bit change
18-Dec-18 4:05	BL	701.49	701.49	5				11.98	8.8	1.01	0.445	1%	9.36	0.03	9.20	-17%	1000	0%	173							Baseline after bit change
18-Dec-17 5:10	247b	701.49	704.26	25	99.5	97	-3%	10.82	8.4	1.01	0.460	3%	9.38	0.02	10.71	16%	1000	0%	139	17	500	2300	2500	225		Completed run after bit change; 247a and 247b logged as CR247
18-Dec-17 10:20	248	704.26	707.25	-45	105.9	104.3	-2%	11.71	8.3	1.01	0.466	1%	9.41	0.03	8.95	-16%	1000	0%	165	12	450	2800	2200	275		
18-Dec-17 12:15	249	707.25	710.27	-47	101.5	92.15	-9%	11.9	8.1	1.01	0.479	3%	9.32	-0.09	8.60	-4%	1000	0%	157	13	400	3000	2200	275		
18-Dec-17 13:50	250	710.27	713.28	-24	91.2	91.83	1%	11.91	8.4	1.01	0.479	0%	9.42	0.10	9.70	13%	1000	0%	174	15	450	2800	2200	275		
18-Dec-17 15:50	251	713.28	716.28	-16	89.44	89.93	1%	12.57	8.1	1.01	0.482	1%	9.38	-0.04	9.34	-4%	1000	0%	171	18	450	2700	1800	275		
18-Dec-17 17:35	252	716.28	719.26	-23	89.3	90.6	1%	13.58	8.2	1.01	0.480	0%	9.40	0.02	9.45	1%	1000	0%	165	22	500	2500	1800	300		
18-Dec-17 20:35	253	719.26	722.25	-121	83.7	90.1	8%	13.39	8.3	1.01	0.493	3%	9.43	0.03	8.93	-6%	1000	0%	163	22	480	2200	2400	250		Drill fluid spill into cuttings containment (approx. 75 L)
18-Dec-17 22:15	254	722.25	725.28	13	85.9	86	0%	12.92	8.2	1.01	0.494	0%	9.48	0.05	10.14	14%	1000	0%	160	18	500	2400	2100	200		
19-Dec-17 1:55	255	725.28	728.29	48	81.5	79.4	-3%	12.64	8.2	1.01	0.505	2%	9.34	-0.14	10.60	5%	1000	0%	153	18	500	2400	2300	225		
19-Dec-17 3:50	256	728.29	731.27	-86	82.7	82.5	0%	12.9	8.1	1.01	0.506	0%	9.46	0.12	9.58	-10%	1000	0%	153	20	480	2500	2000	225		
19-Dec-17 5:40	257	731.27	734.27	-80	81.5	79.4	-3%	12.74	8.1	1.01	0.513	1%	9.40	-0.06	10.01	4%	1000	0%	149	18	500	2400	2200	250		
19-Dec-17 11:15	258	734.27	737.27	-40	77.56	77.33	0%	12.98	7.9	1.02	0.540	5%	9.32	-0.08	9.82	-2%	1000	0%	175	15	450	2800	1500	300		
19-Dec-17 13:05	259	737.27	740.25	-27	76.81	76.69	0%	12.63	8	1.01	0.532	-1%	9.31	-0.01	12.35	26%	1000	0%	178	17	450	2500	2000	275		
19-Dec-17 14:45	260	740.25	743.11	-41	80.3	80.32	0%	12.04	7.8	1.02	0.547	3%	9.38	0.07	10.00	-19%	1000	0%	176	16	450	2000	2500	275		
19-Dec-17 16:25	261	743.11	746.26	0	80.93	78.5	-3%	12.03	7.9	1.02	0.553	1%	9.38	0.00	10.07	1%	1000	0%	177	14	450	2500	2500	275		
19-Dec-17 18:05	262	746.26	749.26	-66	79.54	77.94	-2%	11.44	7.6	1.02	0.563	2%	9.36	-0.02	9.31	-8%	1000	0%	158	17	450	2600	2200	275		
19-Dec-17 21:00	263	749.26	752.28	-47	76	70.6	-7%	11.36	7.9	1.02	0.566	1%	9.35	-0.01	11.19	20%	1000	0%	173	20	480	2300	2200	200		
19-Dec-17 22:00	BL	752.28	752.28	308				10.25	8.4	1.01	0.470	-17%	9.36	0.01	13.09	17%	1000	0%	183							SRU tank refilled with fresh water
19-Dec-17 22:55	264	752.28	755.28	-80	77.9	71.2	-9%	10.93	7.7	1.02	0.574	22%	9.31	-0.05	11.98	-8%	1000	0%	155	17	450	2500	2100	250		System circulating / equalizing after fresh water addition. Fluorescein added to drill system.
20-Dec-17 2:10	265	755.28	758.29	-43	124.2	93.8	-24%	10.04	8.3	1.01	0.513	-11%	9.32	0.01	12.20	2%	1000	0%	162	23	450	2500	2100	200		System circulating / equalizing after fresh water and fluorescein addition
20-Dec-17 3:50	266	758.29	761.29	-9	84.1	142.6	70%	9.85	7.9	1.02	0.568	11%	9.44	0.12	11.87	-3%	1000	0%	175	17	450	2300	2300	250		System circulating / equalizing after fresh water and fluorescein addition
20-Dec-17 5:50	267	761.29	764.27	-68	114.1	82.7	-28%	9.32	8	1.01	0.533	-6%	9.32	-0.12	11.71	-1%	1000	0%	161	17	450	2500	2700	275		System circulating / equalizing after fresh water and fluorescein addition
20-Dec-17 10:30	268	764.27	767.25	-40	85.93	104.1	21%	10.4	7.9	1.02	0.537	1%	9.45	0.13	10.24	-13%	1000	0%	169	15	450	2500	2500	300		System circulating / equalizing after fluorescein addition
20-Dec-17 12:25	269	767.25	770.26	-4	108.3	87.29	-19%	10.71	7.9	1.02	0.513	-4%	9.39	-0.06	10.04	-2%	1000	0%	187	22	500	2500	2500	350		System circulating / equalizing after fluorescein addition
20-Dec-17 14:05	270	770.26	771.85	-12	88.43	102	15%	12.74	8.7	1.01	0.545	6%	9.33	-0.06	11.66	16%	1000	0%	190	35	450	3000	2000	400		System circulating / equalizing after fluorescein addition
	BL	771.85	771.85	557	77.21	77.21	0%	6.74	10	1.00	0.178	-67%	7.99	-1.34	13.82	19%	1000	0%	195							Initial parameter readings after temporary shut-down.
06-Jan-18 1:15	271	771.85	773.28	-48	77.21	90.58	17%	6.8	9.9	1.00	0.445	150%	7.48	-0.51	10.70	-23%	1000	0%	180	17	450	1700	3000			System circulating / equalizing with fresh water and water that was down hole
06-Jan-18 3:05	272	773.28	776.28	-62	82.81	114.5	38%	8.43	9.8	1.00	0.115	-74%	9.34	1.86	11.51	8%	1000	0%	135	17	450	1500	3000			System circulating / equalizing
06-Jan-18 5:05	273	776.28	779.28	-45	98.79	69.88	-29%	8.7	9.8	1.00	0.153	33%	9.37	0.03	12.20	6%	1000	0%	146	22	450	1800	2700			System circulating / equalizing
06-Jan-18 11:25	BL	779.28	779.28	-34	98.79	69.88	-29%	8.7	9.8	1.00	0.153	0%	9.37	0.00	12.20	0%	1000	0%	146							System circulating / equalizing
06-Jan-18 12:30	274	779.28	782.27	-186	78.14	77.21	-1%	8.54	9.5	1.00	0.200	31%	9.11	-0.26	12.21	0%	1000	0%	157	13	500	2500	2200	375		System circulating / equalizing. Volume loss from measurement uncertainty; no evidence of water bearing fractures in core.
06-Jan-18 15:00	275	782.27	785.27	-20	76.67	79.45	4%	5.49	9.9	1.00	0.284	42%	8.06	-1.05	13.24	8%	1000	0%	175	17	500	2000	3000	200		System circulating / equalizing
06-Jan-18 17:20	276	785.27	788.26	-206	69.87	66.39	-5%	8.04	9.8	1.00	0.233	-18%	8.98	0.92	13.18	0%	1000	0%	174	17	500	2000	2500	200		Fresh water added to SRU prior to this run, apparent volume loss due to measurement uncertainty; no evidence of water bearing fractures in core.
07-Jan-18 1:00	277	788.26	791.28	-35	73.29	79.6	9%	8	9.7	1.00	0.242	4%	9.29	0.31	12.42	-6%	1000	0%	137	22	500	1700	3000	125		
07-Jan-18 4:05	278	791.28	794.28	-82	74.52	68.68	-8%	8.44	9.5	1.00	0.259	7%	9.39	0.10	12.30	-1%	1000	0%	117	17	500	2000	3200	100		
07-Jan-18 10:10	279	794.28	797.26	681	65.31	65.21	0%	7.92	9.5	1.00	0.268	3%	9.21	-0.18	10.88	-12%	1000	0%	121	20	500	2000	3000	250		SRU tank refilled with fresh water during run
07-Jan-18 12:45	280	797.26	800.25	-68	100.8	72.95	-28%	9.13	9.5	1.00	0.242	-10%	9.52	0.31	11.93	10%	1000	0%	123	13	500	2000	3000	250		System circulating / equalizing
07-Jan-18 13:05	281	800.25	803.25	-76	76.38	95.05	24%	9.41	9.4	1.00	0.267	10%	9.33	-0.19	13.43	13%	1000	0%	127	17	500	2100	3100	275		
07-Jan-18 16:45	282	803.25	806.26	-6	89.06	82.06	-8%	9.86	9.4	1.00	0.271	1%	9.50	0.17	13.75	2%	1000	0%	138	15	500	1900	3000	275		
07-Jan-18 21:10	283	806.26	809.29	-94	76.04	69.9	-8%	10.44	9.5	1.00	0.284	5%	9.43	-0.07	10.61	-23%	1000	0%	113	31		1700	3000	150		
07-Jan-18 23:35	284	809.29	812.29	-50	73.17	70.11	-4%	11.34	9.6	1.00	0.271	-5%	9.55	0.12	10.09	-5%	1000	0%	102	30		1800	2700	175		
08-Jan-18 1:50	285	812.29	815.28	-39	69.02	68.65	-1%	11.7	9.5	1.00	0.290	7%	9.57	0.02	10.04	0%	1000	0%	70	25		1800	2700	175		
08-Jan-18 4:10	286	815.28	818.28	-33	140	61.87	-56%	12.52	9.5	1.00	0.274	-6%	9.81	0.24	12.13	21%	1000	0%	122	27	300	2000	2500	200		
08-Jan-18 10:20	287	818.28	821.26	-136	70.71	89.86	27%	10.75	9.5	1.00	0.294	7%	9.65	-0.16	10.25	-15%	1000	0%	99	23	500	2700	2000	275		Return valve left open, drill fluid loss observed on surface

GOLDER

Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
08-Jan-18 12:10	288	821.26	824.26	-7	99.88	86.03	-14%	11.2	9.5	1.00	0.298	1%	9.63	-0.02	10.20	0%	1000	0%	106	17	500	2000	2200	300		
08-Jan-18 14:00	289	824.26	827.25	-59	83.46	88.04	5%	11.37	9.4	1.00	0.307	3%	9.65	0.02	10.36	2%	1000	0%	118	18	500	2800	1500	275		
08-Jan-18 15:35	290	827.25	830.16	1	91.63	79.46	-13%	11.11	9.3	1.00	0.313	2%	9.93	0.28	10.67	3%	1000	0%	117	13	500	2100	2300	275		
08-Jan-18 18:15	291	830.16	833.25	-70	78.52	79.41	1%	11.91	9.4	1.00	0.323	3%	9.72	-0.21	10.26	-4%	1000	0%	105	18	500	2300	1500	325		
08-Jan-18 22:55	292	833.25	836.28	-74	83.71	77.43	-8%	11.24	9.5	1.00	0.333	3%	9.61	-0.11	9.95	-3%	1000	0%	86	30		2000	2000	150		
09-Jan-18 1:00	293	836.28	839.28	-17	72.92	76.94	6%	11.47	9.4	1.00	0.329	-1%	9.97	0.36	10.25	3%	1000	0%	90	23		2200	1700	150		
09-Jan-18 3:05	294	839.28	842.13	-60	76.96	70.81	-8%	11.15	9.3	1.00	0.342	4%	9.82	-0.15	10.09	-2%	1000	0%	78	23		2300	1700	150		
09-Jan-18 5:10	295	842.13	845.28	23	125.3	75.32	-40%	11.33	9.2	1.01	0.351	3%	9.77	-0.05	9.81	-3%	1000	0%	64	22		2200	2000	125		
09-Jan-18 10:20	296	845.28	848.28	-80	71.01	106.8	50%	11.48	9.3	1.00	0.360	3%	9.56	-0.21	10.55	8%	1000	0%	179	20	500	1500	2000	325		
09-Jan-18 12:55	297	848.28	851.12	-71	112.9	104.6	-7%	11.79	9.2	1.01	0.380	6%	9.36	-0.20	9.20	-13%	1000	0%	162	43	500	3000	500	275		
09-Jan-18 14:10	298	851.12	851.38	26	104.6	98.09	-6%	11.69	9.4	1.00	0.385	1%	9.60	0.24	10.28	12%	1000	0%	170	29						Short run to retreive slipped core
09-Jan-18 16:00	299	851.38	854.27	-23	95.21	87.92	-8%	11.48	9.2	1.01	0.396	3%	9.83	0.23	9.47	-8%	1000	0%	153	17	500	3000	600	300		
09-Jan-18 18:15	300	854.27	856.9	-15	82.35	85.4	4%	11.64	9.3	1.00	0.395	0%	9.66	-0.17	9.61	1%	1000	0%	160	32	500	3000	500	275		Partial run due to bit change
10-Jan-18 3:50	301	856.9	857.26	-57	86.33	78.39	-9%	11.25	9.5	1.00	0.399	1%	9.37	-0.29	9.57	0%	1000	0%	188	28		2400	2500	125		Fresh water added to SRU after bit change.
10-Jan-18 5:35	302	857.26	860.27	-19	80.16	79.54	-1%	11.8	8.8	1.01	0.504	26%	9.56	0.19	8.12	-15%	1000	0%	153	17		2500	1500	150	35	System circulating / equalizing after fresh water addition
10-Jan-18 9:55	303	860.27	863.27	-60	75.21	80.08	6%	11.54	9.1	1.01	0.421	-16%	9.67	0.11	8.21	1%	1000	0%	144	18	500	3000	800	275		System circulating / equalizing after fresh water addition
10-Jan-18 12:15	304	863.27	866.27	-15	78.43	70.54	-10%	11.93	9.5	1.00	0.810	92%	8.53	-1.14	10.56	29%	1000	0%	175	15	500	2700	1100	275	50	Variable drill water turbidity noted and causing variable paramter readings
10-Jan-18 14:05	305	866.27	869.26	-51	69.39	68.52	-1%	11.99	9	1.01	0.466	-42%	9.71	1.18	9.50	-10%	1000	0%	151	17	600	3100	600	250	50	Variable drill water turbidity noted and causing variable paramter readings
10-Jan-18 15:40	306	869.26	872.26	-104	115.8	91.4	-21%	11.96	9.6	1.00	0.766	64%	8.82	-0.89	9.18	-3%	1000	0%	187	15	500	3000	900	300	50	Variable drill water turbidity noted and causing variable paramter readings. One stained fracture observed in core.
10-Jan-18 17:25	307	872.26	875.27	0	72.33	111.1	54%	11.98	9	1.01	0.552	-28%	9.48	0.66	8.30	-10%	1000	0%	162	17	500	3000	800	300	50	Variable drill water turbidity noted and causing variable paramter readings
10-Jan-18 20:55	308	875.27	878.27	-77	117.8	60.39	-49%	12.42	9.8	1.00	0.710	29%	9.25	-0.23	8.96	8%	1000	0%	170	18		2500	2000	125	30	Variable drill water turbidity noted and causing variable paramter readings
10-Jan-18 22:30	309	878.27	881.28	-15	70.26	76.13	8%	12.85	9.3	1.00	0.672	-5%	9.25	0.00	10.15	13%	1000	0%	171	13		2500	2000	125	30	Variable drill water turbidity noted and causing variable paramter readings
11-Jan-18 0:05	310	881.28	884.28	29	73.74	102.7	39%	12.67	9.1	1.01	0.574	-15%	9.63	0.38	8.77	-14%	1000	0%	168	15		2200	1800	125	30	
11-Jan-18 1:40	311	884.28	887.27	-57	101.8	98.19	-4%	11.82	9.3	1.00	0.627	9%	9.32	-0.31	8.07	-8%	1000	0%	177	13		2500	2000	125	30	
11-Jan-18 3:15	312	887.27	890.28	-15	95.73	69.26	-28%	11.24	9.7	1.00	0.684	9%	9.38	0.06	8.41	4%	1000	0%	180	13		2500	2000	100	25	
11-Jan-18 4:40	313	890.28	893.28	-44	72.02	65.63	-9%	11.17	9.5	1.00	0.690	1%	9.36	-0.02	8.83	5%	1000	0%	187	13		2200	2200	125	30	
11-Jan-18 9:20	314	893.28	896.28	-37	52.52	78.74	50%	9.16	8.5	1.01	0.689	0%	9.36	0.00	8.30	-6%	1000	0%	142	10	500	2500	2000	300	50	
11-Jan-18 10:45	315	896.28	899.28	-25	88.55	72.12	-19%	9.06	8.9	1.01	0.715	4%	9.85	0.49	9.93	20%	1000	0%	128	12	500	2800	1600	300	50	
11-Jan-18 11:00	BL	899.28	899.28	1203	83.62	83.62	0%	7.24	9.5	1.00	0.403	-44%	9.54	-0.31	10.95	10%	1000	0%	140							SRU tank refilled with fresh water
11-Jan-18 12:05	316	899.28	902.28	-238	83.62	75.32	-10%	8.52	8.4	1.01	0.750	86%	9.63	0.09	11.16	2%	1000	0%	126	12	500	2700	1300	325	50	Measurement uncertainty accounting for volume loss. System circulating / equalizing after fresh water addition.
11-Jan-18 13:35	317	902.28	905.28	-75	71.82	74.9	4%	8.91	8.2	1.01	0.786	5%	9.57	-0.06	8.62	-23%	1000	0%	129	12	500	2600	1300	325	50	System circulating / equalizing after fresh water addition
11-Jan-18 15:25	318	905.28	908.27	13	75.66	73.16	-3%	9.31	8.9	1.01	0.605	-23%	9.59	0.02	11.00	28%	1000	0%	88	12		2900	1500	400	55	System circulating / equalizing after fresh water addition
11-Jan-18 17:00	319	908.27	911.28	-63	72.16	71.88	0%	9.4	8.4	1.01	0.724	20%	9.74	0.15	8.50	-23%	1000	0%	137	13		3100	1200	350	50	System circulating / equalizing after fresh water addition
11-Jan-18 18:25	320	911.28	914.28	-15	61.63	64.91	5%	9.35	8.5	1.01	0.632	-13%	9.73	-0.01	8.81	4%	1000	0%	151	12		3000	1400	325	50	
11-Jan-18 21:20	321	914.28	917.28	-54	66.09	64.15	-3%	9.67	8.8	1.01	0.647	2%	9.79	0.06	8.40	-5%	1000	0%	137	15		2200	2000	175		
11-Jan-18 22:50	322	917.28	920.28	18	63.88	55.82	-13%	9.81	8.8	1.01	0.684	6%	9.81	0.02	9.42	12%	1000	0%	191	15		2200	2000	175		
12-Jan-18 1:10	323	920.28	923.28	-79	104.9	64.43	-39%	9.5	8.5	1.01	0.719	5%	9.70	-0.11	8.05	-15%	1000	0%	185	15		2500	2500	150		
12-Jan-18 3:00	324	923.28	926.27	-15	121.5	64.63	-47%	9.48	8.5	1.01	0.695	-3%	9.79	0.09	8.56	6%	1000	0%	165	18		2000	2500	175		
12-Jan-18 5:00	325	926.27	929.29	-63	79.08	97.62	23%	9.62	8.7	1.01	0.690	-1%	10.15	0.36	9.38	10%	1000	0%	153	23		1500	2800	175		
12-Jan-18 10:05	326	929.29	932.28	-104	89.92	85.61	-5%	6.4	8.5	1.01	0.745	8%	9.85	-0.30	9.97	6%	1000	0%	115	15		2500	2000	325	50	No breaks in core
12-Jan-18 11:50	327	932.28	935.28	-26	92.53	86	-7%	8.45	8.5	1.01	0.728	-2%	10.06	0.21	10.55	6%	1000	0%	152	18		2500	1800	300	50	
12-Jan-18 13:25	328	935.28	938.27	5	78.74	79.67	1%	8.28	8.5	1.01	0.753	3%	10.10	0.04	10.88	3%	1000	0%	157	15		2100	1600	350	50	
12-Jan-18 15:05	329	938.27	941.23	-55	82.8	74.23	-10%	8.4	8.5	1.01	0.740	-2%	10.19	0.09	11.36	4%	1000	0%	138	15		3500	1500	350	50	
12-Jan-18 16:50	330	941.23	944.28	-33	72.62	75.74	4%	9.06	8.5	1.01	0.753	2%	10.17	-0.02	10.64	-6%	1000	0%	147	16		2500	1500	350	50	
14-Jan-18 13:00	BL	944.28	944.28	649	38.75	38.75	0%	5.18	9.1	1.01	5.75	664%	7.84	-2.33	11.86	11%	1000	0%	179							SRU tank refilled with fresh water after extended bit change
14-Jan-18 13:40	331	944.28	947.27	-15	38.75	58.18	50%	5.71	9.1	1.01	3.40	-41%	8.32	0.48	13.14	11%	1000	0%	120	13	500	2500	1300	325	40	System circulating / equalizing after fresh water addition
14-Jan-18 15:25	332	947.27	950.28	-51	58.51	54.69	-7%	6.94	9	1.01	10.20	200%	7.13	-1.19	9.93	-24%	1000	0%	76	13	500	2000	1300	350	40	System circulating / equalizing after fresh water addition
14-Jan-18 17:10	333	950.28	953.28	-50	54.16	60.95	13%	7.81	9.1	1.01	5.26	-48%	7.39	0.26	9.00	-9%	1000	0%	101	13	500	3000	1100	300	40	System circulating / equalizing after fresh water addition
14-Jan-18 18:45	334	953.28	956.27	-42	59.71	131.2	120%	7.99	9.1	1.01	9.94	89%	7.03	-0.36	11.70	30%	1000	0%	73	13	500	2900	1200	300	45	System circulating / equalizing after fresh water and fluorescein addition

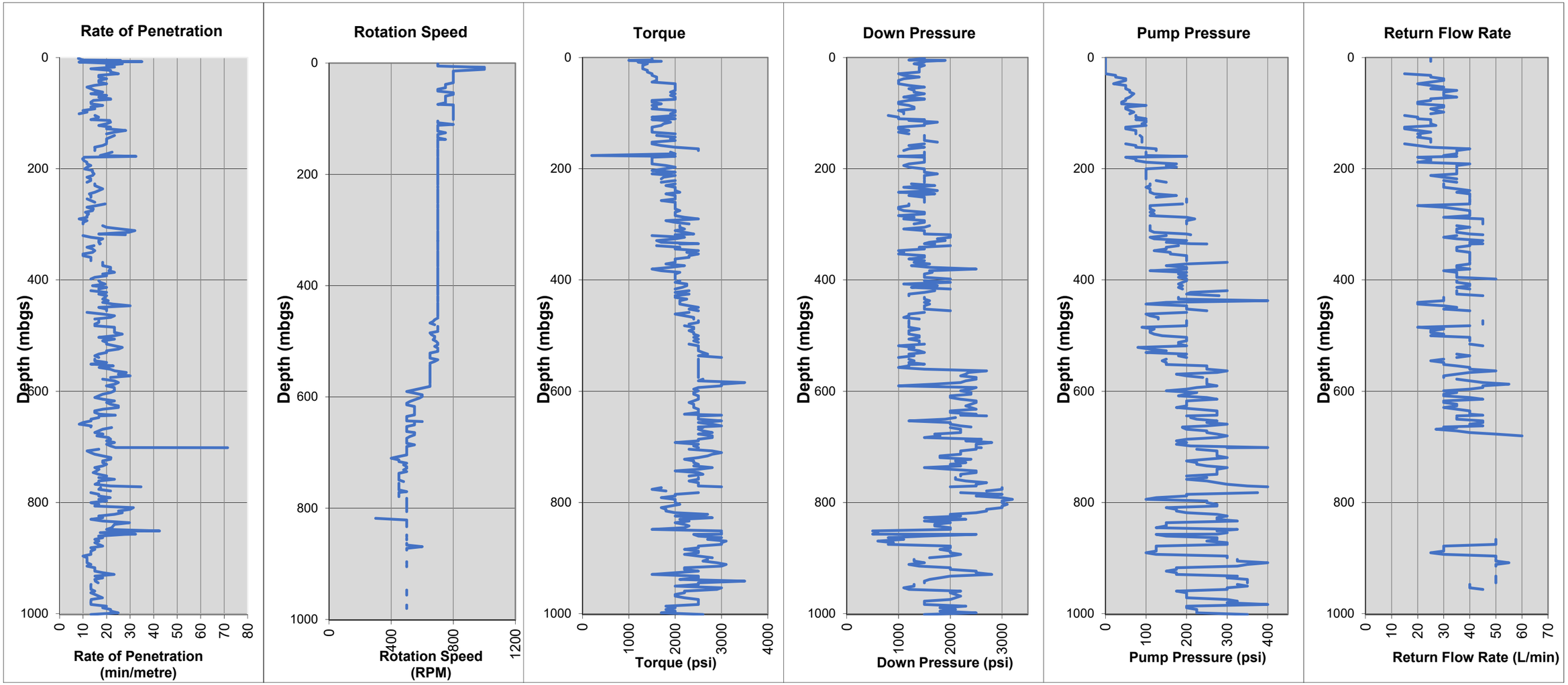
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Date and Time (End of Run)	Run #	Top of Run	Bottom of Run	Drill Fluid Volume Change (L)	Fluorescein Concentration			Temp	Density		Elec. Cond.		pH		Dissolved Oxygen		Turbidity		ORP	ROP	Bit Rotation	Torque	Thrust Pressure (Downpressure)	Fluid Injection (pump) Pressure	Return Flow Rate	Comments
					Inlet (rig)	Outlet (SRU)	Change				Reading	Change	Reading	Change	Reading	Change	Reading	Change								
		(mbgs)	(mbgs)	>100 L	(ppb)	(ppb)	>20% change	(°C)	API Gravity	SG	(mS/cm)	>10% change		>0.5 Change	(mg/L)	>10% Change	(NTU)	>10% Change	(mV)	min/m	RPM	psi	psi	psi	L/min	
14-Jan-18 21:35	335	956.27	959.27	-89	124.9	79.76	-36%	8.46	9.4	1.00	8.94	-10%	6.89	-0.14	8.92	-24%	1000	0%	55	15		2200	2200	175		System circulating / equalizing after fresh water and fluorescein addition
14-Jan-18 23:20	336	959.27	962.28	-22	92.93	60.65	-35%	7.99	9.6	1.00	6.37	-29%	7.27	0.38	9.25	4%	1000	0%	56	13		2200	2000	200		System circulating / equalizing after fresh water and fluorescein addition
15-Jan-18 1:00	337	962.28	965.27	-42	67.04	117	75%	8.89	9.5	1.00	7.48	17%	7.37	0.10	10.86	17%	1000	0%	47	15		2000	2100	200		System circulating / equalizing after fresh water and fluorescein addition
15-Jan-18 2:50	338	965.27	968.28	1	101.4	93.5	-8%	8.49	9.3	1.00	9.39	26%	7.75	0.38	9.38	-14%	1000	0%	40	17		2000	2200	200		
15-Jan-18 4:55	339	968.28	971.3	-66	102.3	61.63	-40%	8.76	9.5	1.00	7.30	-22%	7.38	-0.37	9.70	3%	1000	0%	15	18		2200	2100	200		
15-Jan-18 10:50	340	971.3	974.27	-51	70.71	86.89	23%	7.36	9.4	1.00	8.00	10%	7.28	-0.10	10.35	7%	1000	0%	60	13	500	2500	2000	300		
15-Jan-18 12:35	341	974.27	977.27	-29	85.41	83.7	-2%	7.96	9.3	1.00	8.92	12%	7.25	-0.03	10.75	4%	1000	0%	52	13	500	2500	1500	325		
15-Jan-18 15:30	342	977.27	980.28	-70	83.69	80.83	-3%	6.9	9.4	1.00	7.83	-12%	7.48	0.23	11.03	3%	1000	0%	73	13	500	2500	1500	300	40	
15-Jan-18 17:15	343	980.28	983.27	-13	79.36	76.91	-3%	8.12	9.2	1.01	8.62	10%	7.33	-0.15	10.90	-1%	1000	0%	85	13		2500	1500	400		
15-Jan-18 20:30	344	983.27	986.28	-74	70.9	84.18	19%	7.6	9.4	1.00	8.62	0%	7.40	0.07	10.86	0%	1000	0%	38	20		1800	2300	200		
15-Jan-18 22:35	345	986.28	989.28	12	80.02	73.06	-9%	7.86	9.4	1.00	8.69	1%	7.46	0.06	11.07	2%	1000	0%	47	18		2000	1800	200		
16-Jan-18 0:40	346	989.28	992.28	-77	72.51	65.33	-10%	8.07	9.4	1.00	7.86	-10%	7.69	0.23	12.87	16%	1000	0%	50	22		1800	2100	225		
16-Jan-18 2:50	347	992.28	995.27	-33	64.61	70.82	10%	8.45	9.4	1.00	8.71	11%	7.50	-0.19	10.64	-17%	1000	0%	37	22		2000	1800	225		
16-Jan-18 5:20	348	995.27	998.28	-57	71.16	62.12	-13%	8.5	9.4	1.00	7.97	-8%	7.88	0.38	10.89	2%	1000	0%	66	25		1700	2500	225		
16-Jan-18 11:15	349	998.28	1001.27	30	59.82	60.62	1%	8.22	9.5	1.00	7.13	-11%	8.29	0.41	10.28	-6%	1000	0%	137	13		2600	1500	350	45	

Sample ID	From	To	Date	Fluorescein	Temp	Density	EC	pH	DO	ORP	Turbidity
-	mbgs	mbgs	dd-mmm-yy	ppb	°C	SG	mS/cm	-	mg/L	mV	NTU
IG_BH01_DW003	98.26	101.27	16-Nov-17	87.8	9.93	1.01	0.141	9.34	11.04	165	1000
IG_BH01_DW004	149.26	152.27	23-Nov-17	108.5	12.00	1.00	0.429	10.79	11.87	61	1000
IG_BH01_DW005	200.26	203.26	25-Nov-17	111.0	10.39	1.01	0.361	10.99	11.82	149	1000
IG_BH01_DW007	248.28	251.28	27-Nov-17	99.8	11.14	1.01	0.265	10.3	13.44	225	1000
IG_BH01_DW008	299.28	302.33	28-Nov-17	78.4	9.71	1.00	0.133	10.04	11.50	233	1000
IG_BH01_DW009	347.28	350.32	01-Dec-17	83.9	10.57	1.01	0.255	9.86	11.00	214	1000
IG_BH01_DW010	398.29	401.28	02-Dec-17	72.3	9.02	1.01	0.233	9.83	10.01	231	1000
IG_BH01_DW011	449.28	452.30	04-Dec-17	87.6	14.38	1.00	0.204	9.68	10.50	189	1000
IG_BH01_DW012	497.25	500.26	08-Dec-17	89.5	12.77	1.01	0.301	9.48	11.89	205	1000
IG_BH01_DW014	548.29	551.28	10-Dec-17	72.0	11.79	1.01	0.354	9.58	8.79	185	1000
IG_BH01_DW015	599.29	602.29	12-Dec-17	117.0	11.16	1.01	0.397	9.54	10.41	145	1000
IG_BH01_DW016	647.28	650.27	14-Dec-17	78.2	12.17	1.01	0.373	9.35	10.67	197	1000
IG_BH01_DW017	698.27	701.21	17-Dec-17	82.6	11.97	1.01	0.427	9.52	9.23	132	1000
IG_BH01_DW018	749.26	752.28	19-Dec-17	70.6	11.36	1.02	0.566	9.35	11.19	173	1000
IG_BH01_DW019	797.26	800.25	07-Jan-18	73.0	9.13	1.00	0.242	9.52	11.93	123	1000
IG_BH01_DW020	848.28	851.12	09-Jan-18	104.6	11.79	1.01	0.380	9.36	9.20	162	1000
IG_BH01_DW021	899.28	902.28	11-Jan-18	75.3	8.52	1.01	0.750	9.63	11.16	126	1000
IG_BH01_DW022	947.27	950.28	14-Jan-18	54.7	6.94	1.01	10.20	7.13	9.93	76	1000
IG_BH01_DW023	998.27	1001.27	16-Jan-18	60.6	8.22	1.00	7.13	8.29	10.28	137	1000

APPENDIX C

IG_BH01 Drilling and Drill Fluid Parameter Figures



NOTES

1. Gaps in data appear where readings were not available.

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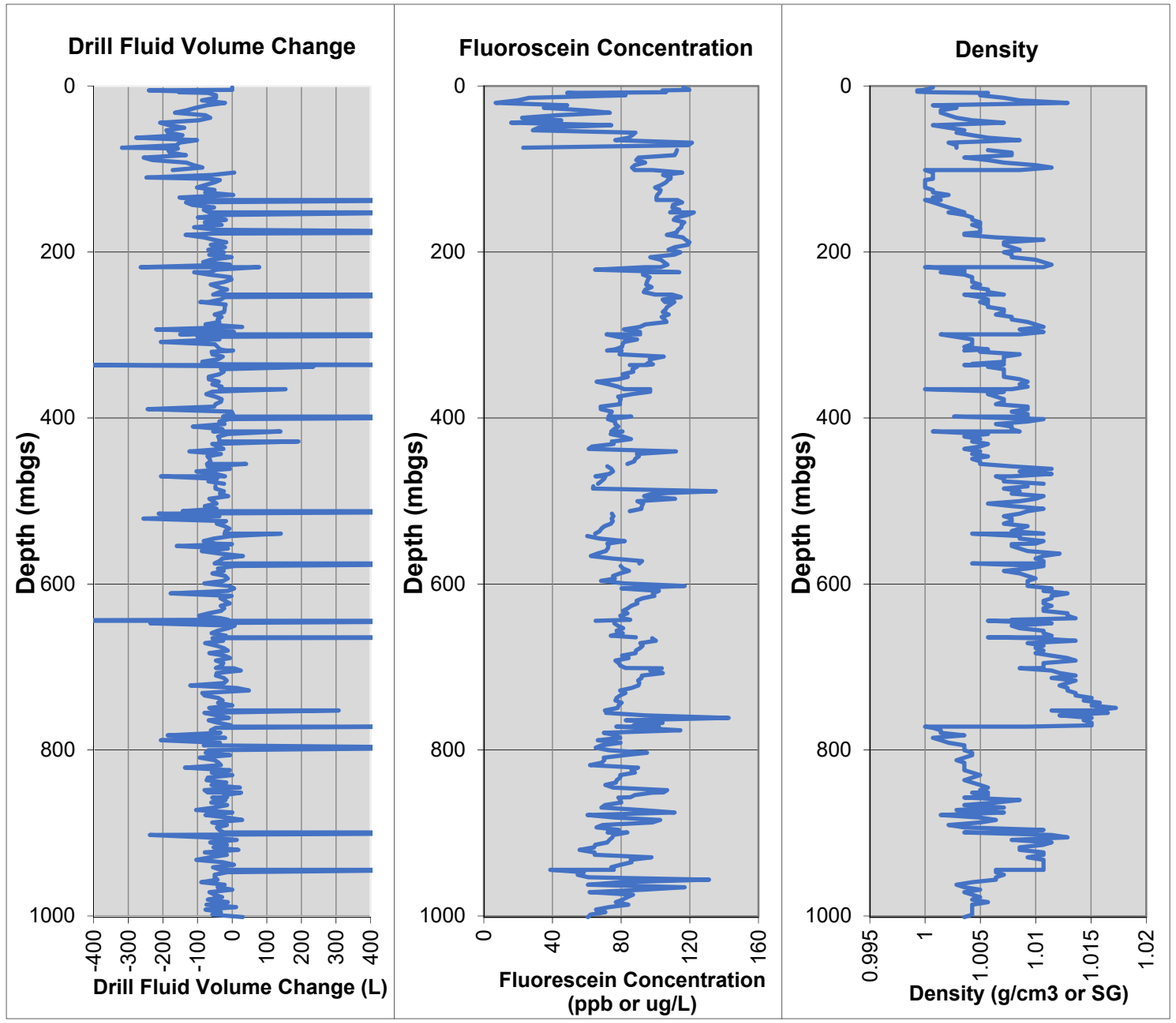
TITLE
Figure C-1: Drilling Parameters

DATE
2018-03-19

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PROJECT NO.
1671632 (1200)

https://golderassociates.sharepoint.com/sites/13226g/Technical Work/WP2 Drilling/Reporting/R4b-Final/Appendix C/Drill Parameters.pptx



NOTES

1. Gaps in data appear where readings were not available.

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NWMO Ignace Drilling

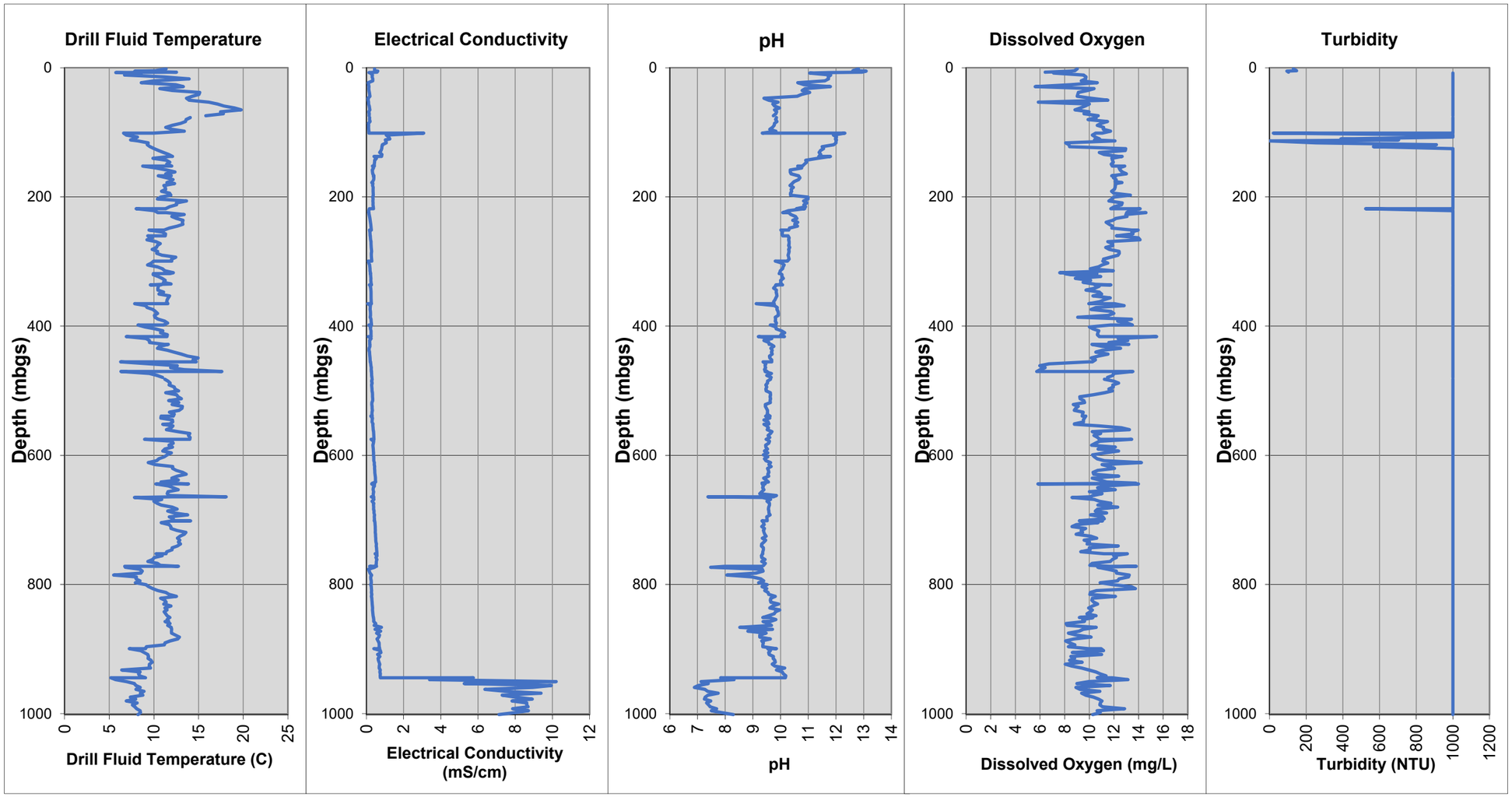
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Figure C-2: Drill Fluid Parameters

DATE
2018-03-19

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1671632 (1200)

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NOTES

1. Gaps in data appear where readings were not available.

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Figure C-3: Drill Fluid Parameters

DATE
2018-03-19

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APPENDIX D

Final IG_BH01 Flushing Data

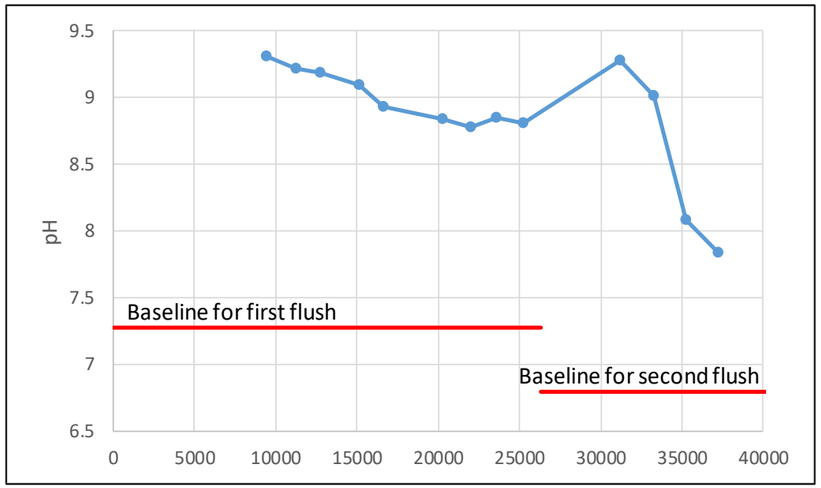
Flush Sequence	Date / Time	Elapsed Time (minutes)	Approx. Volume (L)	Fluorescein (ppb)	Temperature (°C)	pH	ORP (mV)	Conducivity (mS/cm)	Turbidity (NTU)	DO[1] (mg/L)
1	2018-01-17 16:45	180	9450	31	17.22	9.31	132	0.072	284	0
	2018-01-17 17:15	210	11250	-	17.18	9.21	147	0.059	188	-
	2018-01-17 17:40	235	12750	-	17.85	9.18	174	0.060	211	-
	2018-01-17 18:20	275	15150	-	18.11	9.09	181	0.054	156	9.03
	2018-01-17 18:45	300	16650	-	18.83	8.93	178	0.052	128	0
	2018-01-17 19:45	360	20250	27.57	17.98	8.84	148	0.048	133	2.59
	2018-01-17 20:15	390	22050	28.35	18.10	8.77	139	0.055	108	0.22
	2018-01-17 20:40	415	23550	27.39	17.77	8.85	141	0.046	109	4.01
	2018-01-17 21:08	443	25230	27.70	16.45	8.81	131	0.047	148	0
2	2018-01-19 0:20	570	31230	21.01	16.39	9.27	153	0.070	171	0
	2018-01-19 1:20	630	33230	19.63	17.13	9.01	179	0.050	98	0.29
	2018-01-19 2:20	690	35230	19.63	17.27	8.08	214	0.047	54	5.89
	2018-01-19 3:05	735	37230	20.35	17.07	7.84	161	0.047	42	0

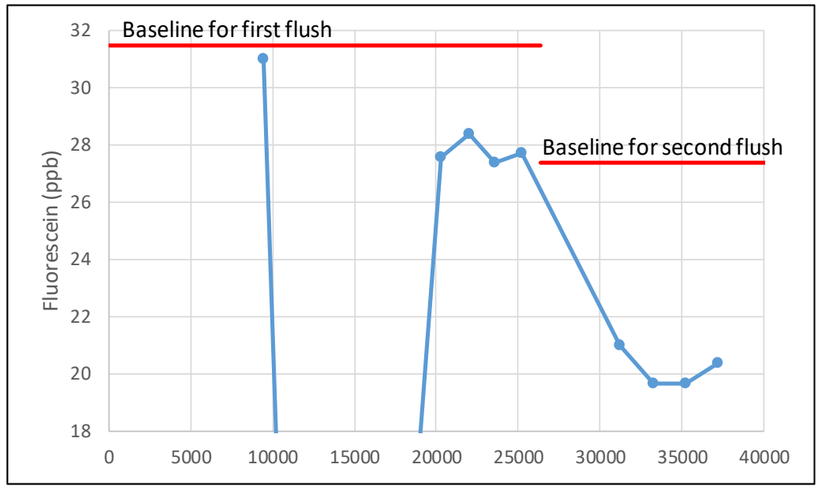
Notes:

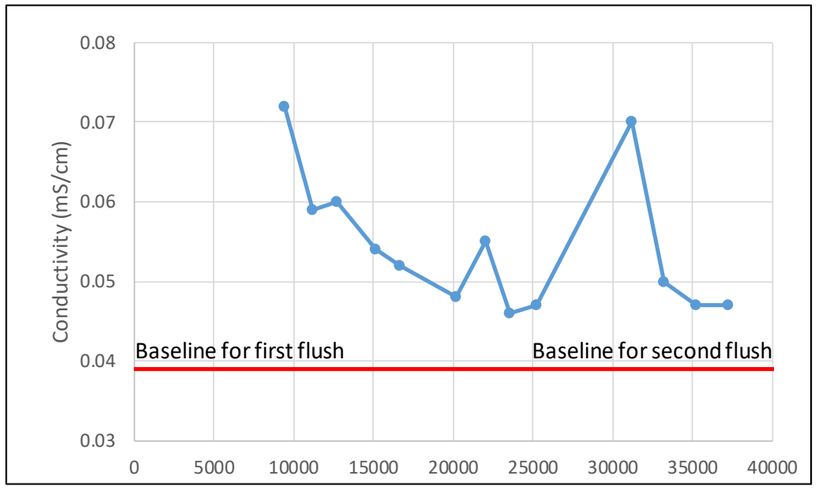
[1]DO sensor gave zero reading intermitently

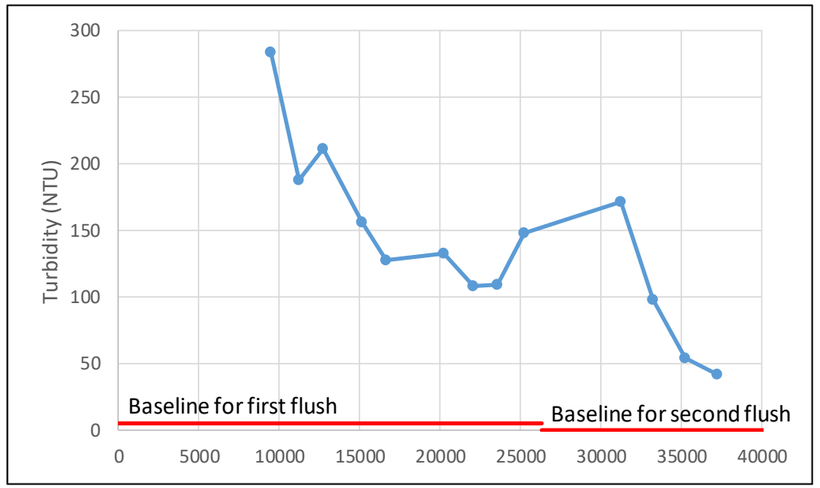
"-" appears where parameter was not collected

GOLDER









NOTES

1. Gaps in data appear where readings were not available.
2. Baseline readings collected from source water at the start of flushing. IG_BH01_WS016 used for first flush, IG_BH01_WS017 used for second flush.

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Figure D-1: Select Water Quality Parameters collected during IG_BH01 final flushing

DATE
2018-05-03

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