Level 1 and Level 2 Hydrogeological and Hydrological Assessment
Proposed Brechin Quarry

Township of Ramara, County of Simcoe

Prepared for:
LCP Quarry Limited

Prepared by:
Azimuth Environmental
Consulting, Inc.

December 2023

AEC 18-288

AZIMUTH ENVIRONMENTAL
CONSULTING, INC.

Environmental Assessments & Approvals

AEC 18-288

December 19, 2023

LCP Quarry Limited

Attention: Mr. Scott Kirby

Re: **Level 1 and Level 2 Hydrogeological and Hydrological Assessment**
Proposed Brechin Quarry – Township of Ramara

Dear Mr. Kirby:

Azimuth Environmental Consulting, Inc. (Azimuth) is pleased to provide the following Level 1 and 2 Hydrogeological and Hydrological Assessment report for the Proposed Brechin Quarry located in the Township of Ramara, County of Simcoe. LCP Quarry Limited (the Applicant) is filing an application with the Ministry of Natural Resources and Forestry (MNRF) for an Aggregate Resources Act (ARA) Class A Quarry Below Water license for a new quarry operation.

This reporting relied on the results of a comprehensive field monitoring and physical testing program completed by Azimuth and WSP Canada Inc. (WSP), and a ground water modelling report prepared by WSP. The results and findings from these programs have contributed to the conceptual understanding of the regional and local setting with respect to surface and ground water conditions and their integrated connection.

If you have any questions or comments, please do not hesitate to contact the undersigned.

Yours truly,
AZIMUTH ENVIRONMENTAL CONSULTING, INC.

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1.0 INTRODUCTION

Azimuth Environmental Consulting, Inc. (Azimuth) was retained by LCP Quarry Limited (the Applicant) to undertake a hydrogeological and hydrological assessment for a potential mineral aggregate quarry on part of Lots 11, 12, and 13, Concession 1 (southwest of the settlement of Brechin) in the Township of Ramara (the "Township"), County of Simcoe (the "County"). A map illustrating the proposed quarry and adjacent lands which constitute the Study Area is shown on Figure 1 (Appendix A).

The Applicant is applying for a new aggregate resource application with the Ministry of Natural Resources and Forestry (MNRF) for an Aggregate Resources Act (ARA) *Class A Licence for an Aggregate Quarry Below the Ground Water Table*. As such, Azimuth has prepared a combined *Level 1 and 2 Hydrogeological and Hydrological Assessment (Water Resources Report)* for the proposed aggregate expansion and operation. WSP Canada Inc. (WSP) (formerly Golder Associates Ltd. [Golder]) also provided support to Azimuth with respect to completing a *Geologic Report* for the project, which included detailed core logging and geophysical testing at the existing boreholes which was used to define the proposed quarry hydrostratigraphy (Golder, 2021). WSP also completed numerical modelling for this application to define potential drawdown effects and impacts to neighbouring ground water users (WSP, 2023).

Both Azimuth and WSP have considerable experience completing aggregate license applications for quarry operations across Southern Ontario, including those on the Carden Plain. The following report has been prepared for the MNRF aggregate resource application, in addition to addressing the various land use planning requirements pertaining to hydrogeology and hydrology.

1.1 Site Description and Proposed Layout

The entire LCP Quarry Limited property holdings include several large parcels that have a land area totaling about 161 hectares (ha). The Municipal Addresses for the four (4) parcels are listed below:

- 1646 Highway 12, Township of Ramara – Part of Lot 11, Concession 1
- 1506 Highway 12, Township of Ramara – Part of Lot 11, Concession 1
- 2440 Concession Road 1, Township of Ramara – Part of Lot 12, Concession 1
- 2530 Concession Road 1, Township of Ramara – Part of Lot 13 Concession 1

The lands are separated by an abandoned raised bed rail alignment that is oriented in a north-south direction located between Part of Lots 12 and 13, Concession 1 (Mara). The eastern two-thirds of the holdings (~120 ha) is comprised of fallow pasture lands that had been primarily used for cattle grazing up to 2022. It is accessed through four (4) existing farm entrances located along Highway 12 (2-total) and Concession Road 1 (2-total). These parcels have been historically farmed since the turn of the century, which is evidenced through historical aerial photographs and the presence of on-site derelict structures (*i.e.,* barns, silos, foundations, *etc.*).

The western parcel of the holdings (~41 ha) was also historically farmed; however, it was more recently developed for use as a small recreational air strip with hanger (known as the Rama Flying Club). It is understood that the air strip was used by both light aircraft and remote-control aircraft. One (1) gated entrance exists along Concession Road 1 which permits access to the western lands. There are also several constructed internal roads/ trails. Based on historical aerial photographs, the air strip was first developed sometime between 1954 and 1978; however, anecdotal information suggests that the air strip has not been in regular use for nearly 20 years.

The area proposed to be licensed under the ARA is 151.4 ha with a proposed extraction area of 91.5 ha. The total property has an area of approximately 161.2 ha. In terms of the proposed quarry operation, the operations and extraction are to occur on the eastern lands while the western lands will used for monitoring and ecological enhancements. The primary entrance/ exit for the quarry is proposed to be from a new entrance constructed at the northern property boundary along Concession Road 2 which has preferred access to Highway 12. Current site features for the site and *Licence Boundary* and *Extraction Limit* are shown on Figure 2. The figures in this report refer to the site plans prepared by MHBC for licencing, which are submitted under separate cover. Please refer to Appendix B for a simplified Site Operations Schematic.

1.2 Aggregate Resources

As per MNRF and the County information sources, there are two (2) ARA licenced sites within 5 km of the proposed quarry (Lafarge Brechin Quarry – Licence 3582 and James Dick Gamebridge Quarry – Licence 3717). Both of these operations are licenced by the MNRF as Class A Licences. There are two (2) additional ARA licenced quarries situated within 10 km from the proposed quarry boundary, however, outside of the Study Area. According to County of Simcoe and Township of Ramara Official Plan mapping, the proposed quarry is situated within a *high potential mineral aggregate resource area* (HPMARA), which includes lands north, south and west of the proposed quarry. The location the HPMARA and nearby aggregate operations are shown on Figure A (overleaf).

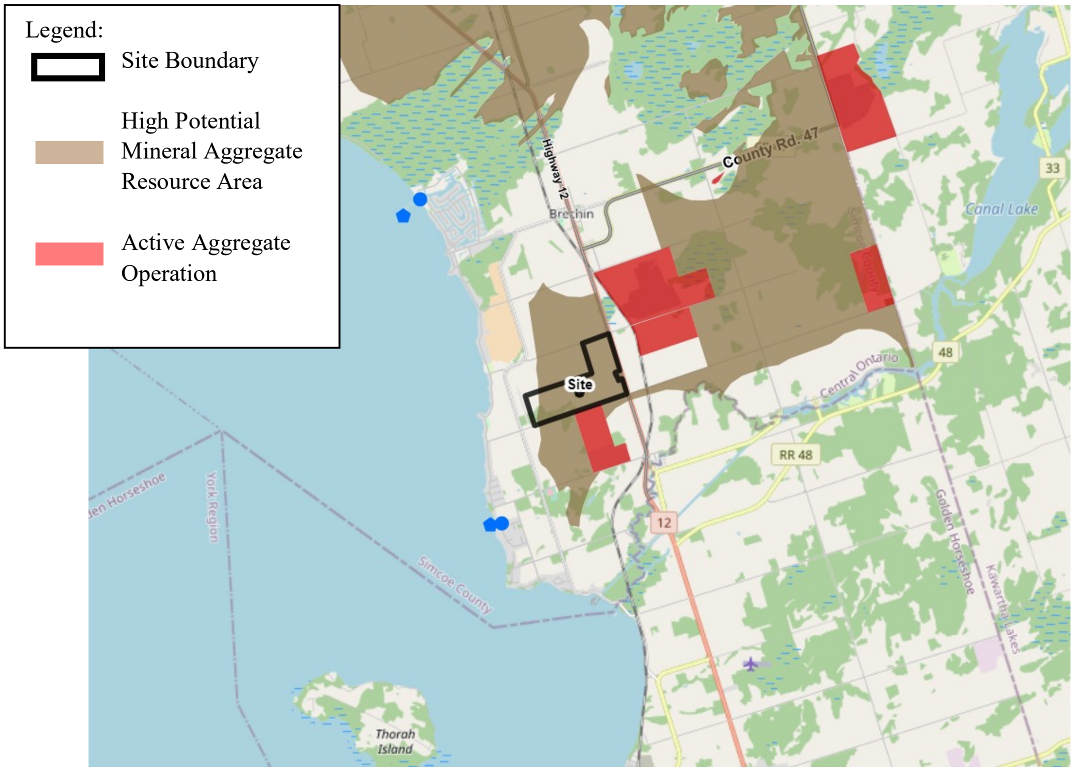


Figure A – County of Simcoe Aggregate Resource Mapping (Simcoe County GIS, 2021)

1.3 Policy

1.3.1 Aggregate Resource Act

The MNRF regulate aggregate resources in Ontario through the *Aggregate Resources Act* (ARA). The application process is regulated under O.Reg. 244/97 (as amended) which was recently updated through the adoption of four (4) new standards:

1. Aggregate Resources of Ontario: Site Plan Standards, August 2020;
2. Aggregate Resources of Ontario: Technical Reports and Information Standards, August 2020;
3. Aggregate Resources of Ontario: Amendment Standards, August 2020; and
4. Aggregate Resources of Ontario: Circulation Standards, August 2020.

The standards detailed in the abovementioned documents have been applied to a new aggregate application for *Class A Licence for an Aggregate Quarry Below the Ground Water Table*.

In addition, the information detailed in this *Level 1 and 2 Hydrogeological and Hydrological Assessment* (Water Report) have been prepared in accordance with the Technical Reports and Information Standards (August, 2020). This report outlines the methodology, data and any mitigation measures/ contingency plans required as a result of the proposed quarry. Details and/or conclusions from this report have also been incorporated into other supporting documents (*i.e.,* Site Plans, monitoring programs, other technical reporting, *etc.*) as required.

1.3.2 County of Simcoe - Official Plan

The County of Simcoe (County) has regard for aggregate resources within their Official Plan (OP) framework, which includes specific policies and schedules (mapping). This includes the protection of these resources for potential extraction in certain geographic areas within their boundary. While proposed new and/or expansions of aggregate operations require approval from the Province and the Township of Ramara, the County has an interest in these aggregate applications, as they relate to the protection of these resources and potential impacts to natural heritage features, ground water resources and the public. Section 4.4 (Aggregate Developments) and Section 4.5 (Resource Conservation) of the County's OP details the specific requirements for proposed aggregate applications and protection of resources, respectively.

The County's Land Use Designation (Schedule 5.1) shows that the proposed quarry is mainly split into two (2) designations "agricultural" (north) and "rural" (south), although a small, internal patch is included in the County's "greenlands" designation. Schedule 5.4.1 illustrates the land areas that are identified as *high potential mineral aggregate resource*, which includes the majority of the lands (Figure A). Lands with this designation are afforded protection by the County for potential long-term use, subject to a number of policies.

The policy is clear that supporting studies (including impact assessments, monitoring and mitigation) for ground- and surface water resources are required for a new proposed quarry. In the County's Official Plan, the site is not situated within a *Wellhead Protection Area and Surface Water Intake Protection Zone* (Schedule 5.2.4), nor the Oak Ridges Moraine, Niagara Escarpment and Greenbelt Plan Area's, and as such, those plans or policies do not apply. The proposed quarry is within a *highly vulnerable aquifer* (HVA) area (Schedule 5.2.5) and is adjacent to a *significant ground water recharge* area (SGRA) (Schedule 5.2.6). Therefore, this Level 1 and 2 Hydrogeological and Hydrological Evaluation has regard for the County's OP and policies with respect to ground- and surface water resources, which includes an impact assessment on natural features (*i.e.,* wetlands, watercourses, *etc.*) and potable water users within the Study Area.

1.3.3 Township of Ramara - Official Plan

The Township of Ramara (Township) is the lower-tier municipality responsible for overseeing planning (and zoning) applications related to the proposed quarry. Current land use designations presented on Schedule A of the OP indicate that the north portion of the proposed quarry is designated as "agricultural", while the southern portion is designated as "rural". The OP indicates that the goal of the Township is to identify aggregate resource areas for the economic development of the Township. The Township's Mineral Aggregate Resource policies are described in Section 5.3.4 of the OP which promote the protection of *Mineral Aggregate Resource Areas* and *High Potential Mineral Aggregate Resource Areas* (HPMARA), as shown in Schedule D of the OP.

As per the OPs schedule, the LCP Quarry Limited lands are identified as a HPMARA. The lands identified as a HPMARA do not entitle those lands to be developed as a pit or quarry; however, it protects these lands for mineral aggregate purposes subject to the policies of the Official Plan. The policies of the Official Plan require consideration for ground water resources and surface water features. As such, a hydrogeologic and hydrologic study is required for an Official Plan amendment and Zoning By-Law amendment with the Township to permit the land use as a *Mineral Aggregate Extraction Area*. This Level 1 and 2 Hydrogeological and Hydrological Evaluation has regard for the Township's OP policies with respect to ground- and surface water resources, which includes an impact assessment on natural features (*i.e.,* wetlands, watercourses, *etc.*) and potable water users within the Study Area.

2.0 REGIONAL SETTING

2.1 Topography, Drainage and Hydrology

The proposed quarry is situated within the Lake Simcoe watershed, which is regulated by the Lake Simcoe Region Conservation Authority (LSRCA). From a regional perspective, the proposed quarry and adjacent area are primarily positioned within the Ramara Creeks Subwatershed area (LSRCA, 2015). This subwatershed encompasses a broad area of about 137 km^2 to the northeast of Lake Simcoe, including ~33% of the entire Township. It includes two (2) creeks, eight (8) small tributaries and ten (10) municipal drains that flow directly to Lake Simcoe. Of the ten (10) municipal drains, the McNabb Drain is located on the north side of the proposed quarry. The subwatershed has a drainage density about 1.6km/km^2, which is relatively low and reflects the subtle topographic relief. A small portion of the proposed quarry (southeast segment) occurs within the Talbot River Subwatershed, which drains to the southeast toward the Talbot River. Ultimately, all discharge from this watercourse also enters Lake Simcoe southwest of the proposed quarry near Gamebridge.

Locally, the proposed quarry's topography follows a similar pattern to the regional description above, as there is a drainage divide that crosses the extraction footprint in a northeast to southwest orientation. This divide directs surface water runoff overland to either the north or southeast. The proposed quarry has a maximum elevation of about 240 meters above sea level (masl) near the proposed quarry's centre and falls to an elevation of about 231 masl at the southeast and north corners of the proposed quarry. Several surface water features and drainage swales occur at the proposed quarry (and along its perimeter outside of the proposed *Licenced Boundary*), which intercept and transport surface water runoff off-site in the flow paths noted above. There are no *Provincially Significant Wetlands* (PSW) on-site or within the 1 km Study Area boundary used in this assessment. The closest PSWs are the *Lagoon City (RM5)* and *Talbot Rivermouth Wetland Complex* which are situated about 5 km north and 3km south of the proposed quarry, respectively.

A number of wetlands and pond features are evident within the proposed quarry. In particular, three (3) distinct pond features are present on-site (all on the eastern portion). These include dug-out ponds located in the northeast and southeast corners of the proposed quarry (which are referenced as Pond 1 and Pond 3, respectively), and a third dug-out pond (Pond 2) located centrally along the western limit of the proposed extraction area adjacent to the former rail corridor. The location of each pond and the drainage features are shown on Figures 2 and 9. All are man-made dugout ponds constructed in the overburden and serve as watering sources for cattle. Pond 1 was constructed within a natural low-lying area (or area of poor drainage) that collects surface water runoff (snow melt and precipitation) from an ephemeral drainage feature (Tributary A). Pond 2 is an irregular shaped dug-out feature that is also positioned within an area of poor drainage and is surrounded by naturalized wetland along its eastern extent and abuts the former rail corridor to the west. Pond 3 is isolated from any direct drainage features (*i.e.,* swales, tributaries, drains, *etc.*) and receives surface water runoff from overland sheet flow and does not have an outlet (*i.e.,* contained on-site).

The regional topography is presented on Figure 3.

2.2 Physiography

The proposed quarry is situated within the physiographic region referred to as the "Simcoe Lowlands" (Chapman & Putnam, 1984). The Simcoe Lowlands represent areas that were flooded by glacial Lake Algonquin and are bordered by shorecliffs, beaches, and boulder terraces. This area covers approximately 2,850 square kilometres and is separated into two areas: the Lake Simcoe basin and the Nottawasaga River basin. The proposed quarry is located within the eastern extent of the Lake Simcoe Basin, which borders the region known as the Carden Plain. The Simcoe Basin is generally associated with sandy beach type deposits; however, the study area is situated within a distinct "clay" and "limestone" plain which occurs along the northeast shoreline of Lake Simcoe. This terrain is more indicative of the limestone plains of the Carden Plain, which suggests the proposed quarry is situated in a transition area between these two (2) distinct physiographic regions.

The regional physiography is presented on Figure 4.

2.3 Surficial Geology

According to Ontario Geological Survey (OGS) (2021), the published surficial geology in the Study Area is fairly complex. At the proposed quarry, surface soils consist of bedrock drift complex overlain onto Paleozoic limestone. This drift is shallow (< 1.5 meters [m]) and is comprised of more fine-textured soils, including sandy silt to clayey silt. The drift is associated with the consolidated Paleozoic bedrock which outcrops locally. Stone poor, glacial till (sandy silt to silt till) deposits are also mapped locally. Fine- and coarse textured glaciolacustrine and organic deposits are also mapped in the Study Area.

Kassenaar and Wexlar (2014) provide additional context with respect to the surficial geology in the Study Area. They note that surficial soils are relatively thin (or absent entirely) throughout much of the Study Area; soils become appreciably thicker towards Lake Simcoe and south of the proposed quarry. Regional OGS data indicate glacial movement occurred through the northeast based on the orientation of a number of drumlins that are evident north of the proposed quarry. Most of the Study Area deposits would have originated directly from glacial meltwater runoff (tills and fluvial deposits) or through glacial lakes (sands, silts and clays). Soils across the Study Area (and Ramara Creeks Subwatershed) are mainly comprised of sandy silt to a stony silt till.

The overburden soils at the proposed quarry generally consist of a weathered sandy silt to silt till with an area of lacustrine clay to the northwest. While there is a limited stone content noted at the time of drilling (~ < 10%), evidence of some boulders (or glacial float) is apparent in some areas of the property (in particular, the southeast portion). Kassenaar and Wexlar (2014), suggest that these soils have a relatively low hydraulic conductivity (K) on the order of ~10^{-7} to 10^{-8} m/s.

The regional surficial geology is presented on Figure 5.

2.4 Bedrock Geology

The regional bedrock geology in the Study Area is well understood and the Paleozoic bedrock stratigraphy is well documented through numerous regional studies completed on Ramara Creeks watershed. This watershed covers a large area that drains to Lake Simcoe between the Talbot River and Atherley Narrows. In general, Paleozoic limestone bedrock occurs beneath the shallow surficial soils (or at surface) and is Ordovician in age. The reader is referred to more detailed geological descriptions prepared for the proposed quarry (Golder (2021), which states "*The bedrock sequence consists of four Paeleozoic Ordovician age formations, including in descending order the Verulam Formation, Bobcaygeon Formation, Gull River Formation and the basal Shadow Lake Formation which lies in unconformity upon the underlying crystalline Precambrian basement.".* The following section provides a summary from that report.

According to OGS (2022), the Verulam Formation forms the uppermost Formation found within the Ramara Creeks watershed and is found at or near surface at the proposed quarry (and surrounding area). This formation is comprised of two (2) subunits (lower unit 1 and upper unit 2) that range in thickness from 45 to 60 m regionally and is 6 to 19m thick on-site (Golder, 2021). Unit 2 is a fragmented unit that can be up to 10 m in thickness (where present) and consists of dark grey shaley nodular micritic to calcarenitic limestone and shale. Unit 1 is softer as it comprised of brownish grey shaley nodular micritic to calcarenitic limestone with interbeds of shale. The shale content of Unit 1 is 10-20% and the shale content of Unit 2 is about 10% higher than Unit 1. The Verulam Formation forms a subcrop belt in the study area, however, outcroppings are not often observed due to the high shale content in the lower, which is easily weathered.

Below the Verulam Formation is the Bobcaygeon Formation which is described to consist of four (4) units, with Unit 4 being the uppermost and Unit 1 being the lowermost. In general, the Formation is approximately 26-27m in thickness, and is comprised of fossiliferous limestone with varying shale content. Unit 4 is comprised of medium brownish grey nodular to argillaceous nodular cacarenitic limestone with a limited shale content that are usually observed in the form of thin partings in the bedding. Unit 3 is a medium brownish grey argillaceous nodular micritic limestone with thin dark grey shale partings. Unit 2 is comprised of thin to medium beds of argillaceous micritic limestone with green shale interbeds and partings. The limestone in these units is thin to medium bedded with flat bases with undulant tops, which is described as "storm beds" (Armstrong & Carter, 2010). Golder (2021) indicates the Unit 1 consists of laminar textured argillaceous micritic limestone characterized by dark grey shaley partings, some that are bioclastic.

Below the Bobcaygeon Formation is the Gull River Formation, which is comprised of primarily thin to thick bedded limestone with dolostone, and consists of four (4) informal units, descending from Unit 4 to Unit 1. According to Golder (2021), Unit 4 is made up of medium to thickly bedded lithographic limestone with fine argillaceous to stylolitic bedding partings. Unit 3 is a medium grey to greenish grey medium bedded dolostone overlying thickly bedded dolostone. This unit is known as the "*Green Marker Bed*" and has a sharp basal contact. Unit 3 is often regarded as an aquifer and is targeted for potable water supplies in the general area. Unit 2 is a medium to thickly bedded lithographic limestone with fine bedding partings, and interbeds of medium brown modular lithographic limestone, according to Golder (2021). Unit 1 is medium bedded dolostone with interbeds of calcareous dolostone, according to Golder (2021).

Below the Gull River Formation is the Shadow Lake Formation. This Formation is middle Ordovician in age and is easily weathered. Its composition varies and is divided into three (3) units, descending from Unit3 to Unit 1; Unit 3 is a medium grey quartz sandstone and is about 2.5m in thickness. Unit 2 consists of 2.5-3m of green and red shales with thin interbeds of quartz sandstone. Unit 1 is 2-3m thick and is primarily arkosic sandstone and may have a pebble conglomerate at its base. The Shadow Lake Formation is the basal unit and unconformably overlays the Precambrian basement rocks. In the study area, the Precambrian basement is situated within the *Grenville Structural Province* and more specifically within the *Central Gneissic Belt*. The rocks composition is generally regarded as a quartz feldspar gneiss.

The regional bedrock topography for the Study Area is presented on Figure 6.

2.5 Karst

Karst features generally form in carbonate-based limestone, dolostone and marble, and are caused by the dissolution of the rock by rainwater and ground water. The slight acidity associated with these solutions creates enhanced dissolution of the bedrock. This occurs where the infiltrating waters enter the rock along fissures and fracture planes. As dissolution occurs, the fissures and fractures are widened, and can become “karstic features” that enhance the permeability of the rock unit and become the primary pathway for water movement (and recharge). This process is also more prevalent in shallow bedrock with limited drift cover (< 1 m).

According to published OGS (2021) mapping, *potential* and *inferred* karst features are mapped north of the proposed quarry and within the Study Area (Figure 7); however, the closest *known* karst feature occurs about 3.5 km north of the proposed quarry towards the Village of Brechin on the east side of Highway 12. Kassenaar and Wexler (2014) discuss karst features in the Ramara Creeks Subwatershed. They indicate that the Gull River and Bobcaygeon Formations are most susceptible to this process because of their high carbonate content and limited (or thin) shale beds. Formations, such as the Verulam and Lindsay, contain much more shale and are therefore less vulnerable to karstification. The proposed quarry is located along the inferred extent between the Verulam and Bobcaygeon Formations. The contact line between these formations forms the inferred limit of *potential* karst as shown on the OGS mapping. Based on the proposed quarry’s detailed geology (discussed in Section 8.0), the bedrock surface across the proposed quarry is that of the Verulam Formation. As such, there is a low potential for karst features to occur here.

2.6 MECP Water Well Records

A review of the MECP Water Well Record database was undertaken as part of this evaluation and a summary of all available wells within 3km of the proposed quarry is provided in Appendix C (MECP, 2022) and the locations are shown on Figure 8. The database also includes OGS drilled boreholes within the Study Area. These records are particularly useful in gaining a sound understanding of the local hydrogeological and geological setting. They also provide insight into the potential potable ground water supply in the area (*i.e.,* water quality and yield). In total, 194 records were present in the database and the table below details the various uses (and percentage use in the area) as indicated on the well logs (if available).

Table 1: MECP Well Record Use

Well Record Indicated Use	n-wells	Percent Use
Domestic	128	66%
School	2	1%
Communal	1	1%
Monitoring / Observation Well	12	6%
Other - Water Supply	1	1%
Other - Institutional	4	2%
Other - Construction	1	1%
Other - Industrial	1	1%
Geotechnical Testhole	8	4%
Municipal Exploration	4	2%
No data/ Unknown	32	16%
Total	**194**	**100%**

All wells are finished in the bedrock (where reported) and most of the wells were constructed between 1948 and 2020, though the majority were constructed between 1970 and 1980. The total depth of wells varies between ~2.5 to 122 m below ground surface (m bgs) with an average depth of ~22 m bgs; although, the majority of domestic use wells are constructed between 15 and 60 m bgs. The shallower wells are generally related to monitoring wells or abandonment records. The well depths in the dataset also correspond with where useable quantities of ground water were encountered. In terms of reported water quality, the majority of wells are being used for domestic drinking water.

Within 500 m of the proposed quarry, five (5) wells were reported to be “fresh”, three (3) were reported as “salty” and/or “sulphur”, and one (1) was listed as “untested”. Recommended well yields range between 1.9 to 94.5 L/min (with a mean of 21.8 L/min). While the mean suggests a rate that exceeds the minimum yield requirement for a residential house (*i.e.,* 13.7 L/min), this value is slightly high-biased due to the presence of one (1) high yield well record (WWR. No.: 5727526). As such, the median value of 7.6 L/min is more representative of potable water supply yields in the area, which is consistent with the terrain and shallow bedrock environment. As previously discussed, overburden conditions on the driller’s logs described a relatively thin layer of brown to grey clay and/or sand (sometimes containing gravel) at surface and overlying the limestone bedrock. This geological description is consistent with published mapping sources.

The well record database was further examined and vetted to ensure accuracy of the database (to the best extent possible). This included adjusting well locations by replotting records or removing records that were not within the Study Area. The finished borehole depth was then used to determine which hydrostratigraphic unit they were targetting. The results indicated that 65% of the wells were completed within the Bobcaygeon Formation and 19% were completed in the Gull River Formation, which represents the majority of the suitable water supply. Additionally, the remaining wells are finished within the Verulam Formation (8%) or Shadow Lake Formation at the Precambrian contact (8%).

Anecdotal evidence indicates that some domestic potable water supplies in the study area may have historically targeted shallow overburden and/or shallow weathered bedrock zones through the construction of "dug wells". Where appreciable depth of overburden is present, a shallow unconfined aquifer may be encountered seasonally, although this is not encountered close to the site. There are no examples of this well construction type in the well record database included in Appendix C. Further review of the dataset (including private well surveys) did not verify any dug wells within the Study Area, consistent with the thin overburden layer at the site.

2.7 Hydrogeology

The hydrogeological conditions in the Study Area are well documented. As noted by Kassenaar & Wexler (2014), the geologic conditions generally dictate the regional hydrogeologic setting, which depends on the geologic formations ability to permit and/or restrict ground water flow. Therefore, the Paleozoic formations are generally defined as aquifers or aquitards depending on their hydraulic properties. Much of the underlying formations display similar hydraulic characteristics, and as such, some are often combined together in regional models (Kassenaar & Wexlar, 2014; Golder, 2011).

Golder (2021) confirmed a slight southwestern dip in the bedrock surface, and as such, ground water flow is expected to occur in a similar flow path within the laterally bedded limestone formations toward Lake Simcoe. Ground water recharge is expected to occur regionally in areas of greater permeability or hydraulic conductivity (K). According to LSRCA (2015), significant ground water recharge areas are situated north, northeast and east of the Study Area within karstic terrain associated with alvars on the Carden Plain (Figure B). Karstic terrain is not generally observed in the immediate Study Area (or at the proposed quarry) due to the low permeability surficial soils (sandy silt till and clay) and limited recharge potential as shown on Figure B. In addition, these karstic features are more associated with the carbonate-rich limestone of the Bobcaygeon Formation which is noted to occur at surface within the Carden Plain, as opposed to the more shaley Verulam Formation which makes up the uppermost bedrock surface within the Study Area. While, the upgradient karst features (alvars) clearly play an important role in conveying and replenishing ground water regionally, they are not expected to occur locally.

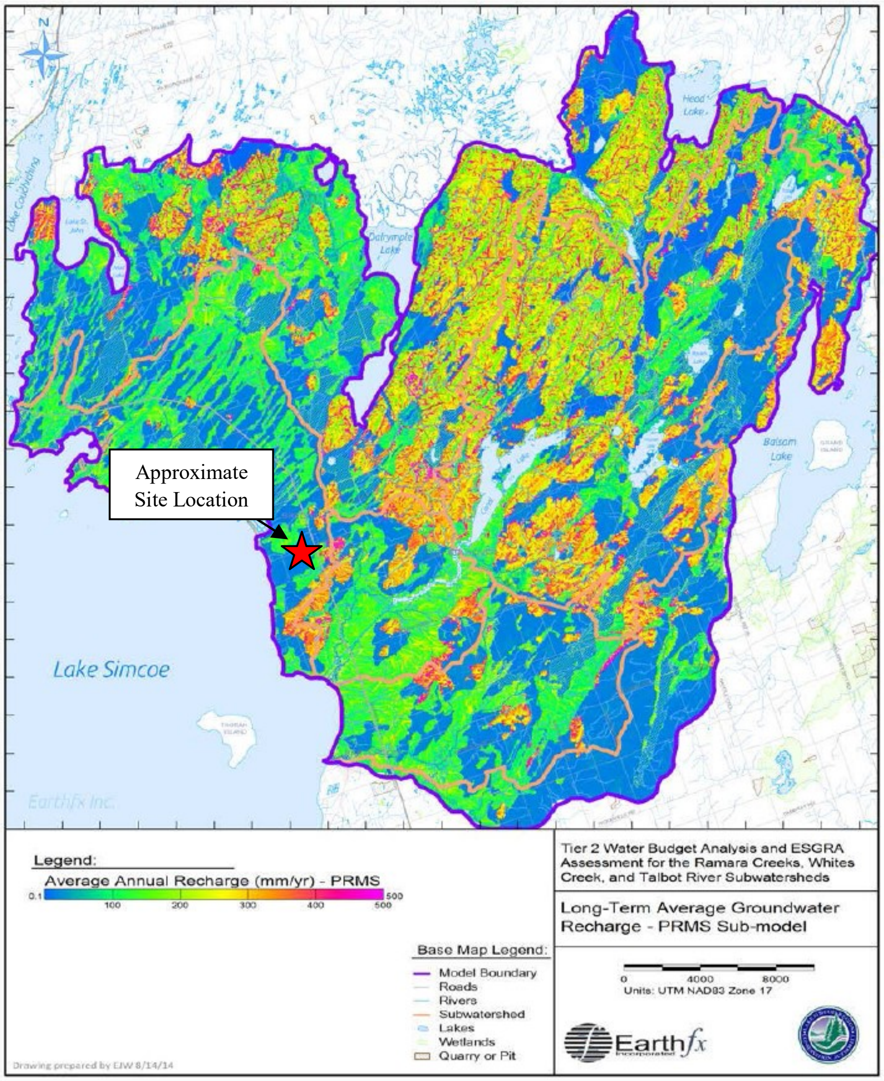


Figure B: **Long-term Average Ground Water Recharge (Kassenaar & Wexler, 2014).**

It is also recognized that the vertical downward movement of water is anticipated in areas where coarse-textured sands and gravels are present as a result of the presence of interstadial tunnel valleys at surface (Kassenaar & Wexler, 2014). Within the bedrock, much of the intact formations are expected to have a fairly low permeability which would limit the vertical movement of ground water in the Study Area. Head elevation data collected as part of this hydrogeological assessment indicate that vertical gradients are downwards on-site.

Higher hydraulic heads generally correlate to horizons with greater K-values, which are often higher in the stratigraphic profile. These areas are most often observed within the

Verulam Formation where ground water persists at between 237 to 231 masl (with published K-values of ~10^{-8} to 10^{-4} m/sec). Similar water levels are noted in the less permeable Bobcaygeon and Upper Gull River Formations. Water levels within the Bobcaygeon Formation occur at ~237 to 229 masl, while heads are typically lower in the Upper Gull River (~229 to 217 masl). The water levels between the Upper Green Marker Beds (GMB) and the Precambrian Basement are quite similar occurring at ranges between 227 to 220 masl, suggesting some interconnectivity between these geologic units. Notwithstanding, some variance is noted between the lower formations which is likely a result of spatial variability.

Again, a review of the MECP Water Well Records was completed to compile supporting hydrogeological data for the proposed quarry and adjacent lands within 3 km. From the review, a total of 190 records with information were identified from a search the Oak Ridges Moraine Groundwater Program databases (ORMGP, 2021). Of these wells, excluding the abandonment well records, the majority of potable water supplies are finished in bedrock aquifers associated with the Bobcaygeon Formation and Gull River Formations (including the GMB), although a few records appear to correlate with weathered bedrock zone and/or Verulam Formation and deeper Shadow Lake Formation/ Precambrian Contact. The depth of potable water wells range between 15 mbgs to 60 mbgs, which also correlates with depths where water was found. Reported well yields within the database range between 1.9 to 94 L/min with an average flow rate of 22 L/min. Golder (2012), also reports that the City of Kawartha Lakes (CKL) target a deeper aquifer formation at the *Shadow Lake*/ *Precambrian* contact zone for a municipal supply source.

Based on the available information, it is understood that three (3) reasonably permeable zones (referred to herein as ‘aquifers’) are present within the Paleozoic limestone in Study Area. These laterally bedded aquifers are separated by thick horizontally layered beds of low permeable Paleozoic formations (aquitards). The detailed hydrostratigraphy is presented in Section 5.3 and provides details about the monitoring intervals targeted for this study. Notwithstanding, a simplified summary of the regional hydrostratigraphy is presented below (and expanded on in a later section of the report):

- Overburden (clay and silty sand till) - Aquitard 1
- Weathered Bedrock Zone - Aquifer 1
- Verulam / Bobcaygeon / Upper Gull River Formations – Aquitard 2
- Upper Green Marker Bed (GMB) (Gull River Formation) - Aquifer 2
- Lower Gull River Formation – Aquitard 3
- Shadow Lake Formation/ Precambrian Contact Zone - Aquifer 3
- Precambrian – Aquitard 4

3.0 METHODOLOGY

3.1 Study Overview

The work plan for the proposed quarry was undertaken by both Azimuth and WSP, with Azimuth serving as the primary physical hydrogeological consultant responsible for undertaking and managing the field programs and data analysis at the proposed quarry. This included developing an extensive long-term water resource monitoring program that was used to generate the *conceptual site model* (CSM) which serves as the basis for the hydrogeological evaluation and provided input to the numerical ground water model completed by WSP. WSP's expertise includes completing several components that are appended to this report, including: a detailed *Geologic Report* (Appendix D) and a *Groundwater Modelling and Private Well Impact Assessment Report* (Appendix E).

All of the information collected through the literature review, monitoring program, and supporting reports has been synthesized into this consolidated *Level 1 and 2 Hydrogeological and Hydrological Assessment* (Water Resources Report). The work plan was intended to be dynamic in nature that allows for it to be altered as needed. It has been divided into five (5) primary phases:

1. Borehole Drilling Program;
2. Physical Testing;
3. Borehole Instrumentation
4. Environmental Monitoring; and
5. Data Analysis and Reporting.

3.2 Borehole Drilling Program

The *Borehole Drilling Program* formed the initial phases of the field work plan that established the on-site network of boreholes (and monitoring wells) that were used in the hydraulic and geophysical testing and long-term monitoring programs. The program was completed over two (2) phases referred to as Phase 1 Boreholes (BH-1 to BH-5) and Phase 2 Boreholes (BH-6 to BH-9). The work aided in testing and evaluating the bedrock environment using a variety of in-situ techniques, which were used to develop the proposed quarry's *Conceptual Site Model* (CSM). This first phase began in early 2019 as a desktop exercise that reviewed publicly available database information (*i.e.,* Ontario Geological Survey [OGS] data, MECP well record summary, *etc.*), in addition to reviewing existing/ shared hydrogeological reports from nearby quarry operations.

The information gathered during the initial background review was used to guide the *Phase 1 Drilling Program* which consisted of HQ coring five (5) boreholes (BH-1 toBH-5). This process recovers complete rock core sequences through the strata in order to log the underlying rock formations. The drilling program was completed between August and September of 2019 by Orbit-Garant and supervised by Azimuth. Four (4) of the cored boreholes fully penetrated the Paleozoic limestone through to the Precambrian basement (all except BH-5). The recovered rock core was labeled, placed in core boxes, and transported to the existing hanger building located on the western portion of the site for safe storage. These boreholes were later subjected to various physical testing programs (*i.e.,* core logging, geophysical testing, packer testing, *etc.*) before being instrumented to facilitate further hydraulic testing and long-term monitoring (ground water elevation and geochemistry). The testing results from these programs were used to determine the monitoring well instrumentation depths based on established hydrostratigraphic intervals.

The *Phase 2 Drilling Program* was completed by Vinson Well Drilling (Vinson) using water well drill rig, using air percussion drilling techniques. Due to this drilling procedure, no core was recovered from these boreholes. The program was completed in August 2020 and included the construction of four (4) 152.4 mm (6-inch) diameter boreholes (BH-6 to BH-9). These boreholes were constructed shallower in the upper limestone formations to an approximate depth of about 43 m below ground surface (bgs). The driller listed that each of the boreholes as "dry" after completion, as no usable ground water aquifer was encountered (*i.e.,* potable water use). WSP logged each of the Phase 2 Boreholes using geophysical testing methods and the results of this testing was used to correlate the formational geology with the previous dataset. The Phase 2 boreholes were again instrumented to facilitate further hydraulic testing and monitoring (ground water level and geochemistry).

The location of the on-site boreholes is shown on Figure 9.

3.3 Physical Testing

3.3.1 Detailed Core Logging and Geophysical Evaluation

As discussed, Golder was tasked with undertaking the detailed core logging of the recovered rock core from the Phase 1 Boreholes and geophysical testing on all of the established boreholes (BH-1 to BH-9).

The above-noted tasks were completed following the completion of the drilling phases. In the late summer/ fall of 2019, the rock core lithology was logged in detail by R. Blair Geoscience Consulting, Inc. (RBGC). In addition to identifying the stratigraphy, physical parameters such as fracture type and frequency were also recorded to aid in identifying any potential/ preferential flow zones. The presence of mineralization on fracture surfaces was also noted, as an indication of secondary mineralization (*i.e.,* calcite) and/or weathering (or dissolution zones). One (1) entire core sequence (BH-2) was analytically tested for its physical performance compared to aggregate specifications (as arranged by Golder).

The geophysical evaluation included physically scanning the borehole for natural gamma and apparent conductivity to aid in the geologic interpretation. An optical and acoustic televiewer was used to identify any open fractures or partings that may represent areas of increased permeability. The results was initially presented a technical memorandum (December 2019), which included a preliminary hydrostratigraphic interpretation that was later refined following the geophysical testing on the Phase 2 Boreholes. The results of these programs are discussed in more detail in Section 5.1 of this report.

3.3.2 Packer Testing

Azimuth completed a downhole packer testing program during the late summer/ fall of 2019 on the Phase 1 Boreholes. The hydraulic properties were evaluated using a downhole inflatable dual-packer system that isolates and assesses the underlying bedrock at discrete intervals inside the borehole. To summarize, the dual packer system is separated at a fixed width (*i.e.,* 1 m, 3 m, *etc.*) and lowered into the borehole. The packers are inflated with nitrogen gas and effectively seal and isolate the packed off space between the packers. Dataloggers are used to monitor real-time water level pressures inside the packed off space (between the packers) and annulus (upper zone). The bottom zone is outfitted with a continuous recording datalogger; however, this is not monitored in real time due to the apparatus set-up.

The annulus and bottom zones are used to monitor for leakage and pressure spikes (bottom only) within the fractured material. A rising head test (or slug test) is then performed on the packed off space to assess permeability and the static hydraulic head (if possible). This is done by introducing a known volume of water into the space and measuring the response near or entirely back to equilibrium (or little to no change). The returned test curve was then analyzed using hydrogeology software (AQTESOLV) to estimate the hydraulic conductivity (K-value) of the test interval within about a half to full order of magnitude. Hvorslev (1951) was the chosen analysis method and was consistently used based on the environment. The interval transmissivity was then simply calculated for each test sequence.

Over the first two (2) boreholes tested (BH-4 and BH-5), the spacing between the packers was 1.1 m (or isolated interval space). This detailed approach was undertaken at the first two (2) boreholes tested in order to provide detailed assessment of the potential fracture permeability within the underlying Paleozoic formations. While this approach produced a large number of testing sequences, a larger packer spacing at the onset may not have captured the variability of discrete fractures present in the formations. In order to ensure that the entire profile was covered, the packer system was only raised at 0.9 m increments, which created about 0.2 m in overlap between test intervals. In order to assess the potential permeability of the bottom 1.0 to 1.5 m of the borehole, a single packer was lowered and a hydraulic test was performed below the packer. Ultimately, the packer spacing interval was increased to 3.1 m for the remainder of the tests (MW-1, MW-2 and MW-3) due to the low permeable bedrock encountered during the first two (2) boreholes. The same procedure described above was followed for these testing sequences, including overlapping. This was completed in order to eliminate the large number of tests where low to no permeability intervals were encountered as this trend consistently dominated the borehole profile in all locations.

The results of the packer testing is discussed in Section 5.2 and the results are provided in Appendix F.

3.3.3 Pumping Test

A preliminary pumping test program was included as part of the hydraulic testing after completing the Phase 2 Boreholes. As discussed above, Vinson indicated that each of the constructed boreholes were "dry" at the time of construction; however, ground water was present in BH-6 and BH-8 (static level of 3.8 m and 2.7 m, respectively) when site visits were completed the following week. Ultimately, there was no expectation that any of the wells would be suitable for testing based on the driller’s recommendations; however, pumping tests were still attempted at the boreholes noted above using a temporary submersible pump supplied by Azimuth. This preliminary testing program was attempted on November 6, 2020.

The intention of the program was to undertake the testing in the spirit of the *Procedure D-5-5 – Technical Guideline for Private Wells: Water Supply Assessment* (1996). This procedure provides calculations for minimum well test rates and yields and is intended to assess water supply for development on individual private water wells. For example, the minimum well yield stipulated in the MECP procedure for residential development is 13.7 L/min (3 IGPM) to satisfy peak demand, which is suitable for a 3-bedroom residential development. Guideline D-5-5 stipulates that a peak demand rate of 3.75 L/person be used for larger residences. In the specified calculation, the peak demand rate is multiplied by the number of bedrooms (plus one extra person). While this procedure is not intended for use in quarry applications, the procedure is a rational process in assessing potential potable water supplies and is the standard frequently relied on by approval agencies. As such, the procedure can be adapted to ensure that meaningful dataset is produced and with reproducible results. In addition, the expectation was that water takings were going to be less than 50,000 L, and as such, a temporary Permit To

Take Water (PTTW) and/or Environmental Activity and Sector Registry (EASR) registration would not be required for this testing program.

A step test was scheduled prior to completing the formal pumping test in order to confirm a target test rate. The intention was to start at a lower test rate (*i.e.,* 13.7 L/min) and gradually increase it as required. Notwithstanding, due to the low yielding nature of the boreholes, only one (1) testing sequence could be achieved at each location before the wellbore was completely dewatered. The flow rate was regulated using a ball-valve and measured using a stopwatch and graduated bucket. All efforts were made to ensure that a constant flow rate was maintained throughout the testing sequence, and as such, minor rate adjustments were made as needed. The water levels in each borehole were monitored using an automatic pressure transducer datalogger that was set to record measurements at 30-second intervals. All datalogger measurements were verified by periodic manual measurements using an electronic water level tape. Also, an analytical water quality sample was to be collected and assessed for a suite of general water quality parameters, including major and minor ions.

The pumping test results are presented in Appendix G and discussed in detail in Section 5.4.

3.4 Borehole Instrumentation

The Phase 1 Boreholes were instrumented in December 2019 by Orbit-Garant and supervised by Azimuth. Each borehole was instrumented with two (2), 25.4 mm (or 1-inch) nominal PVC monitoring wells at two (2) deep intervals. Each monitoring well was constructed at the base of the targeted hydrostratigraphic interval and the associated sand pack was extended to the top of the target hydrostratigraphic interval to cover the full sectional profile. A bentonite seal was then constructed above the interval to separate the lower and upper intervals. As previously indicated, the Phase 1 Boreholes targeted documented (or inferred) permeable zones within the lower formations. This included the following hydrostratigraphic units:

Table 2: Phase 1 Boreholes Hydrostratigraphic Intervals

Hydrostratigraphic Unit	Hydrostratigraphic Unit Identifier	Boreholes
Bobcaygeon Formation, Verulam Formation and Upper Weathered Zone (Bedrock)	Z	BH-1, BH-2, BH-3, BH-4 & BH-5
Weathered Shale/ Clay Zone at Bobcaygeon - Gull River Contact Zone	H	BH-5
Upper Green Marker Bed and Upper Gull River Formation	F	BH-1, BH-2, BH-3, BH-4 & BH-5
Lower Green Marker Bed / Gull River Formation	D	BH-3
Shadow Lake Formation	C	BH-2
Shadow Lake / Precambrian Contact Zone	B	BH-1 & BH4

Notes:
Complete list of Hydrostratigraphic Intervals and rationale presented in Geological Study Report prepared by Golder (June 2021).

The Phase 2 Drilling Program was completed in August of 2020 and included the construction of four (4) 152.4 mm (6-inch) diameter boreholes (BH-6, BH-7, BH-8 and BH-9). Again, these boreholes targeted the shallower limestone formations (*i.e.,* Bobcaygeon Formation, Verulam Formation and upper weathered bedrock zone). The geophysical testing completed on these boreholes was used to correlate the formational geology with the established stratigraphic sequencing determined by WSP. These boreholes were instrumented at three (3) depth intervals (Table 2 below) using 50.8 mm (or 2-inch) nominal PVC riser and screens in the upper limestone formations. Construction of the monitoring wells followed the same underlying principles discussed above.

Table 3: Phase 2 Boreholes Hydrostratigraphic Intervals

Hydrostratigraphic Unit	Hydrostratigraphic Unit Identifier	Boreholes
Verulam Formation	L	BH-6, BH-7, BH-8, & BH-9
Upper Bobcaygeon Formation	K	BH-6, BH-7, BH-8, & BH-9
Lower Bobcaygeon Formation	I	BH-6 & BH-7
Upper Gull River Formation	G	BH-8 & BH-9

Notes:
Complete list of Hydrostratigraphic Intervals and rationale presented in Geological Study Report prepared by Golder (June 2021).

Each well nest was surveyed using a differential GPS (dGPS) to a horizontal and vertical accuracy level of +/- 0.05 m. This included obtaining horizontal positions (UTM coordinates), and ground surface and top of well collar elevations. The location of each borehole (and associated monitoring well nest) is illustrated on Figure 9 and the bedrock surface profile is shown on Figure 10. Moreover, the borehole and instrumentation details are summarized in Appendix H.

3.5 Water Resource Monitoring

3.5.1 Ground Water Monitoring

Ground water elevations at each of the monitoring wells are actively monitored by Azimuth. Each of the monitoring well locations (including two [2] annular space locations at BH-1 and BH-5) are outfitted with a dedicated pressure transducer datalogger (TD-Diver by Schlumberger Water Services). The datalogger is equipped to record head pressure (m of water) and temperature (°C) every 60 minutes and the devices internal time clock is set to match Azimuth's project schedule to ensure consistency between each loggers measurement interval. A barometric datalogger has been placed inside the protective well casing at MW-5 to allow barometric corrections to the water level database. Prior to establishing each long-term monitoring well location, hydraulic testing (or slug testing) was performed in order to confirm the interval's hydraulic conductivity.

The dataloggers are downloaded quarterly. Manual ground water measurements are also collected quarterly from all ground water monitoring wells and annular spaces. The manual measurements are used in part to correlate the head pressure readings collected from the datalogger to a water elevation (meters above mean sea level). Water levels and elevations for each monitoring well are plotted on hydrographs and are discussed in more detail in Section 6.2. In addition, ground water sampling is completed quarterly at all monitoring wells and annular space locations and the results are discussed in Section 6.4. Due to the small diameter (one-inch) wells used at the Phase 1 Borehole locations, new HDPE waterra tubing and foot valves are used to collected the water quality sample during each monitoring round. Dedicated waterra tubing and foot valves are used at the Phase 2 Boreholes as these wells are larger diameter that permit the installation of both dedicated tubing and a pressure transducer datalogger simultaneously.

All samples are collected using contemporary sampling protocols, and where possible, at least three (3) borehole volumes are removed prior to sampling. In most instances the wells "dry out", and therefore, samples are collected following adequate recovery to permit the collection of a representative water sample. Samples are field-filtered using a 0.45µm disposable filter for metals and dissolved organic carbon (DOC) and are collected using a laboratory prepared bottles. The samples are stored on ice in coolers for transportation to Caduceon Environmental Laboratory (Caduceon) in Barrie, ON. Samples are typically submitted no later than 24 hours after collection.

3.5.2 Surface Water Monitoring

Monitoring of surface water features is completed at the proposed quarry through a combination of staff gauges, continuous water level transducers, on-site climate station and water quality sampling (completed by others). Surface water monitoring data is collected on a continuous basis using water level transducers at three (3) dedicated monitoring stations (SW1, SW2 and SW3) and at two (2) on-site pond stations (Pond 1 and Pond 2). These locations are monitored throughout the hydroperiod/ ice-free conditions (May to November) using dedicated pressure transducer dataloggers (Figure 9). All stations are supplemented with manual depth readings and flow measurements (surface water stations only) in order to define rating curves. Runoff measurements are supplemented with manual measurements at four (4) staff gauge stations (SG1 to SG4). Dataloggers are not deployed at these stations as they are ephemeral and predominantly dry, with the exception for immediate responses to large precipitation events. An informal elevation survey was also completed around Pond 1 to better assess flood events and determine overflow elevations.

On-site climate monitoring is also conducted using an ambient air temperature and barometric pressure transducer year-round, and tipping bucket rain gauge from May to December. The data are used in conjunction with climate data from Environment Canada's (EC) Orillia Brain station (Station ID 6115811), which shows a good correlation.

The surface water monitoring data are discussed in more detail in Section 6.1.

4.0 SOURCE WATER PROTECTION

The Clean Water Act (CA S.O. 2006, Chapter 22) primarily focuses on sources of water that have been designated by a municipality as being a current or future source of residential municipal drinking water for the community. The general goal of Source Water Protection is protecting source water from overuse and contamination to ensure safe municipal drinking water supplies.

When assessing the proposed quarry from a Source Water Protection perspective, potential impacts to local municipal and private water supplies from the extraction of aggregate are considered. The closest municipal water supplies are the South Ramara Water Treatment Plant (WTP) and the Brechin & Lagoon City WTP situated about 2.2 km southwest and 4.7 km northwest of the proposed quarry, respectively. Both of these WTPs rely on surface water with lake intakes located along the eastern shoreline of Lake Simcoe. Based on the County's mapping, the proposed quarry does not fall within WHPA boundary (Q1/Q2). The nearest Municipal ground water supply services the Bayshore Village Subdivision and is located about 10 km north of the proposed quarry. The location of these systems is provided in Figure C (overleaf).

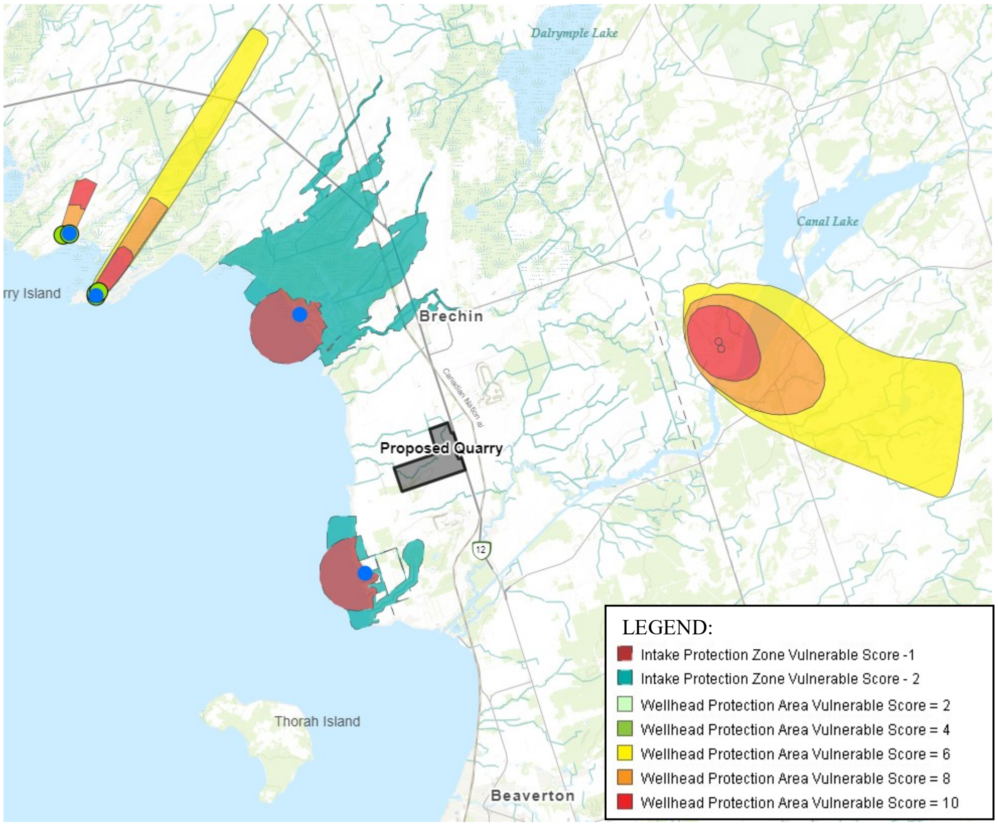


Figure C: Water Systems and Protection Zones Mapping (County of Simcoe, 2023)

Although the proposed quarry is located well outside of municipal WHPA and intake protection zones, this assessment has included a review of the aquifer vulnerability in the local area. This review has also been applied to domestic water wells, which are the primary source of potable water for local residents. Specifically, an assessment of the *Significant Ground Water Recharge Areas* (SGRAs) and *Highly Vulnerable Aquifers* (HVAs) has been completed.

4.1 Significant Ground Water Recharge Areas / Highly Vulnerable Aquifers

In the Ramara Creeks subwatershed, SGRAs are defined as an area that has an average annual recharge rate than is 15% greater than the average annual recharge rate for the watershed; and an area that has a hydrological connection to a surface water body or aquifer that is a source of drinking water for a drinking water system. The vulnerability of SGRAs is categorized as high, medium or low based on their mapped intrinsic susceptibility. The susceptibility of the overburden soil layers is classified based on how readily each layer transmits water, and its thickness. Based on the local surficial geology and physiography, the soils are considered to be shallow and comprised of a fine-textured glacial till, which would not be considered hydraulically conductive. As shown in Figure

D (below), a small SGRA, as delineated in the Lake Simcoe Source Water Protection Plan (2021), is located at the eastern boundary of the site.

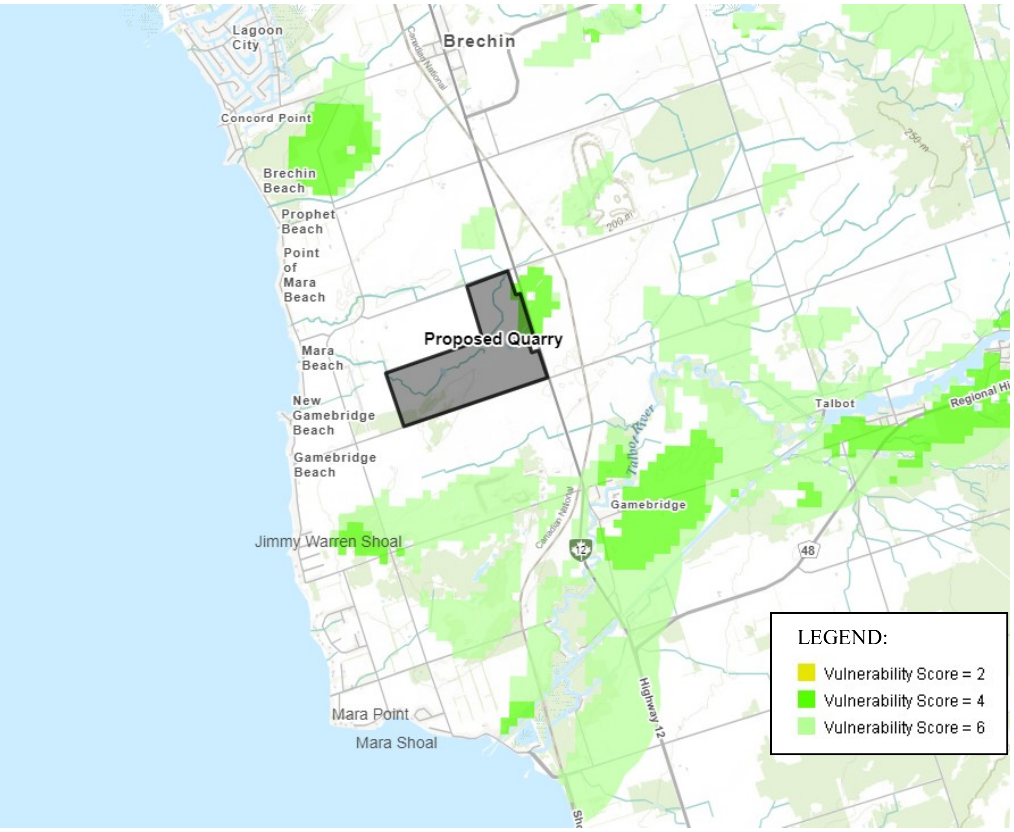


Figure D: Significant Ground Water Recharge Areas (County of Simcoe, 2023)

As shown in Figure E (below), ground water vulnerability is considered “high” at the proposed quarry, as delineated in the Lake Simcoe Source Water Protection Plan (2021). The proposed change in land-use from agriculture to aggregate extraction has been assessed relative to the ground water vulnerability rating (see Section 4.2).

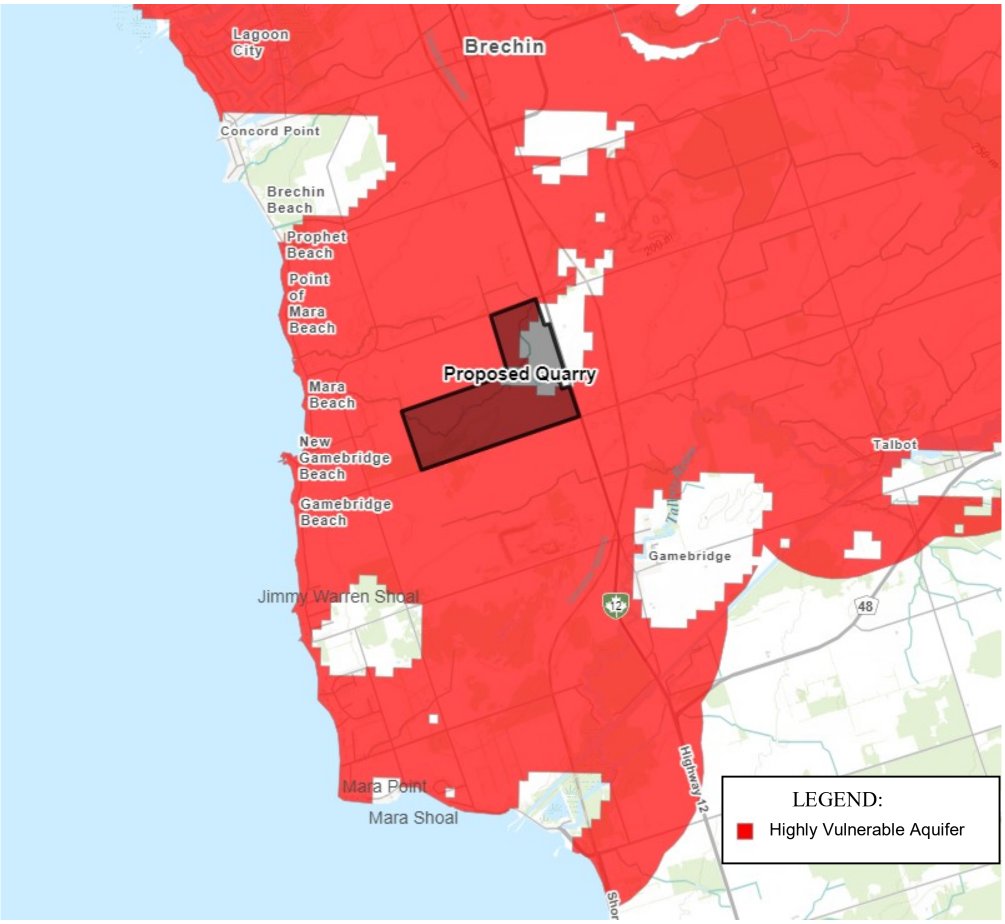


Figure E: Highly Vulnerable Aquifer Mapping (County of Simcoe, 2023)

4.2 Source Water Protection and the Aggregate Industry

MNRF to assessed the role of the aggregate industry and associated lands in the context of source water programs. The MNRF study (Applied Research on Source Water Protection Issues in the Aggregate Industry; Blackport and Golder, 2006) did not link the extraction and processing of stone, sand and gravel as a threat to drinking water sources.

The province of Ontario has identified 21 prescribed drinking water threats under the CWA. Nineteen (19) of these relate to water quality and two (2) to water quantity. The current land use at the proposed quarry is primarily agriculture, which may result in at least five (5) potential prescribed drinking water threats, including:

- Agricultural source material – application to land
- Agricultural source material – storage
- Agricultural source material – management
- Commercial fertilizer – application

- Pesticide – application

As previously discussed, the proposed quarry is located well outside of the protection zones for any communal water supply wells and lake intakes. The proposed change in land use (from agriculture to aggregate extraction) will reduce the number of prescribed drinking water threats.

5.0 PHYSICAL TESTING RESULTS

5.1 Detailed Site Geology

In June 2021, Golder issued a final *Geologic Report* summarizing the results and analysis of the detailed core logging and geophysical evaluation programs for the Phase 1 Boreholes and Phase 2 Boreholes (geophysical evaluation only). Their evaluation also included a review of the results from the in-situ packer testing program (Azimuth). Ultimately, the outcome of the reporting established the stratigraphic and hydrostratigraphic profiles within the Paleozoic bedrock environment beneath the proposed quarry and provided a defined hydrostratigraphic nomenclature for use in the project. The report also discusses the rationale for selecting the particular monitoring well and sand pack zones. The full *Geologic Report* is provided in Appendix D.

5.1.1 Stratigraphy

Based on the results of the drilling programs, the overburden depth is shallow across the proposed quarry and ranges in thickness between 0.5 to 3.7 m bgs. The observed soils consist of fine textured glacial sediments (*i.e.,* till or lacustrine clays). The Paleozoic limestone bedrock was fully explored during the Phase 1 drilling program. The laterally bedded limestone has an observed southwest trending dip and the surface elevation varies due to weathering/ erosion at the bedrock contact. The thickness of the Paleozoic sequences explored at the proposed quarry ranges between about 59 m to 69 m. As previously discussed in Section 2.4, the stratigraphy can be generalized into the following regional formations and numerically labeled sub-units (in brackets) which are presented in descending order below:

- Overburden (Unit 6)
- Verulam Formation (Units 5-2 & 5-1)
- Bobcaygeon Formation (Units 4-4, 4-3, 4-2 & 4-1)
- Gull River Formation (Units 3-4, 3-3, 3-2, & 3-1)
- Shadow Lake Formation (Unit 2)
- Precambrian Basement (Unit 1)

The full *Geologic Report* in Appendix D presents the detailed geological descriptions, cross sections and profiles for each of the formations and their associated sub-units. Notwithstanding, a brief summary of the stratigraphic interaction of these formations and rationale for each sub-unit is provided herein. One clear observation during the detailed core logging is the consistent thickness and continuity of the identified formations across the proposed quarry.

The Verulam Formation is generally described as a shaley limestone that varies in thickness across the proposed quarry from 6 to 19 m. This formation occurs at the top of the bedrock surface and is noticeably weathered within 0.5 to 1.5 m from the surface contact (referred to as the upper weathered bedrock zone). The weathering is related to shale content which ranges from about 20% to 40% in the five (5) boreholes and differentiates the upper and lower units. The upper sub-unit (5-2) has a markedly higher shale content (~30% amongst all boreholes) and was reported to be entirely absent in BH-1, BH-5 and BH-8, which all occur in topographically lower portions of the Site. The lower unit has notably lower shale content (10% to 20%) and a relatively constant thickness of about 9 to 10 m in most boreholes. However, at BH-1 and BH-8, the thickness was lessened to about 6 m due to surface weathering/ erosion. A transitional contact between the two (2) sub-units is noted, while a transitional to sharp contact is evident between the lower unit (5-1) and the Bobcaygeon Formation.

The Bobcaygeon Formation has a uniform thickness across the proposed quarry which ranges between 26 to 27 m. This formation has been subdivided into four (4) distinct lithological units. Golder indicates that the upper unit (4-4) is about 12.5 to 15 m thick and consists of brown/ grey, thinly to thickly bedded nodular to argillaceous nodular calcarenitic limestone. The shale component ranged by about 3% to 9% in this sub-unit and the contact between the lower unit is observed to be gradational. Unit 4-3 is about 3.5 to 5.5 m and is comprised of medium to thickly bedded argillaceous nodular micritic limestone. Also, a unique fossil sequence is found around the midpoint of this unit. Argillaceous and shale content ranges between 5% to 10% throughout this unit and a sharp basal contact is noted at its base. Unit 2 (4-2) is a markedly thinner sequence found to be about 2 m in thickness across the Site. This thinly to medium bedded sequence of argillaceous micritic limestone has a argillaceous and shale content of between 9.5% to 13%. This sequence is characterized by its numerous dark grey shale partings and a sharp basal contact. Lastly, Unit 4-1 consists of thickly bedded nodular micritic limestone that has a uniform thickness of about 6 m. The argillaceous/ shale content is quite low (< 1%) in this sequence and the basal contact is noted by an abrupt colour change from brown/grey to a light brown limestone of the Gull River Formation.

Similarly, the Gull River Formation consists of four (4) stratigraphic units of interbedded limestone (Units 2 & 4) and dolostone (Units 1 & 3) that are about 18.5 m to 19 m in thickness. The upper unit (3-4) is comprised of brown, medium to thickly bedded lithographic limestone that is about 5 m thick. The sequence includes a completely weathered clayey shale parting (~10 cm) that was consistently found about 0.75 m below the upper contact. A sharp basal contact occurs at the top of Unit 3-3, which is partly made up of greenish grey medium bedded dolostone overlying a more brownish grey medium to thickly bedded dolostone. This sequence is consistently about 3.4 m to 3.9 m in thickness across the Site and is regional known as the "Green Marker Bed". A sharp contact separates the dolostones from the underlying limestone that make up Unit 3-2. This stratigraphic unit is slightly thicker (4.7 m to 4.9 m) and is made up of brown to white medium to thickly bedded lithographic limestone. A shale lamination marks a sharp contact with Unit 3-1. Unit 3-1 is about 4.8 m to 5.2 m in thickness and is comprised of greenish grey to brown medium bedded dolostone. Interbedded sequences of thickly bedded calcareous dolostone are also found throughout this sequence. A greenish-grey weathered shale sequence is found about 2 m below the contact. A transitional basal contact is noted between the Gull River Formation and Shadow Lake Formation.

The Shadow Lake Formation is the basal sequence noted in the Paleozoic profile and is uncomfortably overlain onto the Precambrian Basement. This formation is about 7.5 m to 8.5 m in thickness and has not been separated despite its fairly complex geological composition. The upper portion of this stratigraphic sequence is marked by a 2.5 m thick sequence of light grey to greenish-grey quartz sandstone. The mid-portion of the sequence transitions to a dark green and reddish-brown green and red shales that contain thin interbeds of sandstone. The lower portion of this stratum is marked by a 2 m to 3 m thick sequence of greenish grey to dark reddish-brown arkosic sandstone. The basal contact was found to be mostly weathered at the Precambrian Basement which was penetrated in four (4) of the boreholes (BH-1, BH-2, BH-3 and BH-4). These rocks were found to consist of quartz feldspar gneiss.

The detailed borehole logs, cross sections and description are provided in Appendix D.

5.1.2 Structural Contacts

Golder provided structural contact elevations for each of the stratigraphic contacts as interpreted from the results of the detailed core logging and geophysical evaluation. According to their report, the structural contact at the Verulam - Bobcaygeon and the Bobcaygeon - Gull River Formational contacts occurs between 224 to 216 masl and 198 to 190 masl, respectively. The surface contacts at both intervals' slopes to the southwest at about 0.4%. Cross sectional profiles and elevation contour plans were prepared and are included in their report (Appendix D). These profiles and plans demonstrate the depositional consistency and gentle dip in the Paleozoic bedrock.

5.2 Packer Testing

The hydraulic testing data collected from the downhole packer testing program was assessed and interpreted by plotting the interval transmissivity (T) with the elevation depth in order to show the hydraulic testing results across the entire borehole. The interpreted geologic stratigraphy is also plotted on each profile for conceptual purposes. The plots produced from this assessment are provided in Appendix F and the most transmissive zones based on the percent response are summarized in Table 4 (overleaf). A brief discussion regarding each of the tested boreholes (BH-1 to BH-5) is provided below. In addition, the relevant hydraulic conductivity estimates from this testing are also plotted on the borehole profiles provided by Golder (2021), which is included in Appendix D.

Downhole packer testing was used to aid in the instrumentation of the Phase 1 Boreholes, in conjunction with the downhole geophysics and detailed core logging results. As such, the most permeable zones encountered during this assessment were not necessarily instrumented in the Phase 1 Boreholes, as efforts were made to target the lower zones and/or formations. The upper zones and formations were subsequently targeted in the Phase 2 Boreholes.

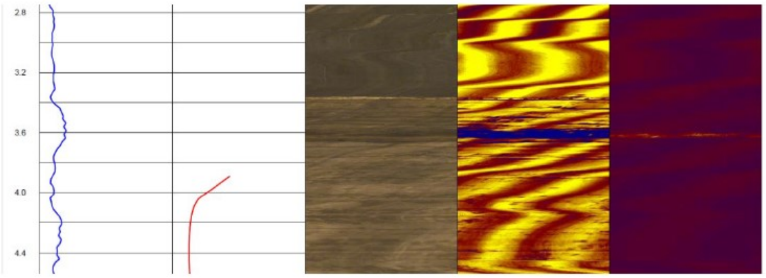
Table 4: Packer Test Results Summary

Borehole ID	Top of Interval (masl)	Bottom of Interval (masl)	Interval Transmissivity (m^2/sec)	Percent Response	Formation Name	Stratigraphic Unit	Hydrostratigraphic Identifier
BH-1	228.9	227.4	1.8E-04	76%	Verulam	5-1	L
BH-1	210.9	208.2	4.2E-05	18%	Bobcaygeon	4-4	K
BH-1	216.4	213.4	3.1E-06	1%	Bobcaygeon	4-4	K
BH-2	195	192.2	3.1E-04	97%	Upper Gull River / GMB	3-4, 3-3	G / F
BH-2	178.5	175.8	9.2E-06	3%	Shadow Lake	2	C
BH-3	212.4	209.7	2.6E-04	97%	Bobcaygeon	4-4	K
BH-4	227.6	226.7	1.6E-04	78%	Verulam	5-1	L
BH-4	178	170	4.7E-06	15%	Lower Gull River / Shadow Lake	3-2, 3-1 / 2	E / D
BH-4	191	190	1.7E-06	1%	Upper Gull River / GMB	3-4, 3-3	G / F
BH-4	215	213	7.0E-07	1%	Bobcaygeon	4-4	K
BH-5	227.1	226.2	3.3E-04	76%	Verulam	5-2	L
BH-5	182	179	1.9E-05	4%	Lower Gull River	3-1, 3-2	E / D
BH-5	196.9	196	1.7E-05	4%	Bobcaygeon	4-1, 4-2	K
BH-5	209.7	208.8	1.0E-05	2%	Bobcaygeon	4-4	K

Notes: masl – meters above sea level

5.2.1 BH-1 Results

According to the testing data the most transmissive fracture plain was found at an elevation of between 228.9 to 227.4 masl and had an interval transmissivity of about 1.8x10^{-4} m^2/sec. The fracture occurs in the upper portion of the borehole and within the Verulam Formation (subunit 5-2). Given that this interval accounts for about 76% of the boreholes response this appears to be controlling fracture at this location. The televiewer image below shows the 2 to 3 cm width shale parting associated with this fracture.

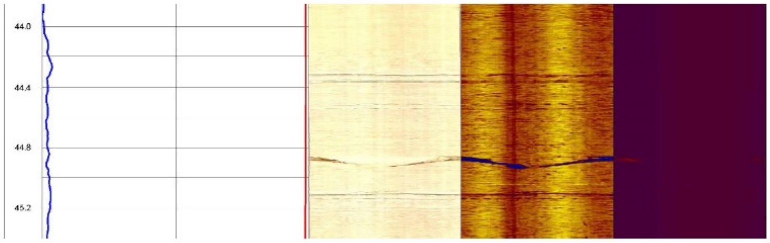


BH-1: 3.59 - 3.62 m

A moderately transmissive zone (4.2x10^{-5} m^2/sec) was also encountered deeper in the profile within the Bobcaygeon Formation between 210.9 to 208.2 masl. This interval theoretically accounts for about 18% of the borehole response and appears to correlate with weathered shale partings in stratigraphic subunit 4-4 (Golder, 2021). It is also worth noting that a second minor fracture/ parting was also noted slightly higher in subunit 4-4 with an interval transmissivity of 3.1x10^{-6} m^2/sec; however, it only accounted for about 1% of the borehole response.

5.2.2 BH-2 Results

Upon reviewing the results for BH-2 the most transmissive fracture was encountered between 195 to 192.2 masl which overwhelmingly accounted for about 97% of the borehole response and an interval transmissivity of 3.1x10^{-4} m^2/sec. This fracture appears to straddle the upper portion of the Gull River Formation (subunit 3-4) and the GMB (subunit 3-3) and is one of the most transmissive units found throughout the testing program. The fracture most certainly straddles the contact between the two (2) distinct subunits noted above. Golder (2021) indicates that this contact zone is comprised of a “weathered shale cap” which suggests ground water movement. Televiewer images provided in Golder (2021) are shown below at the GMB.

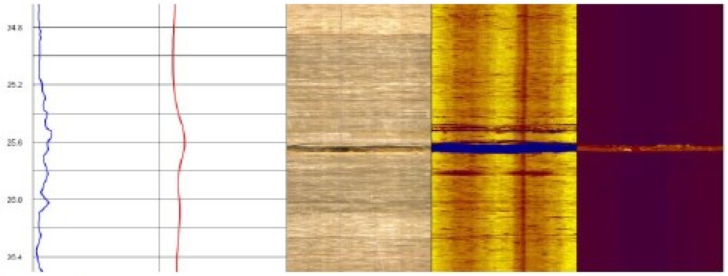


BH-2: 44.86 - 44.88 m

A more modest zone (9.22x10^{-6} m^2/sec) was also noted within the Shadow Lake Formation between 178.5 to 175.7 masl and accounting for about 2% of the borehole response.

5.2.3 BH-3 Results

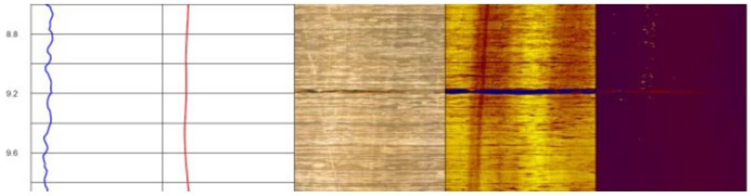
Essentially only one (1) transmissive fracture plain was encountered at BH-3. This fracture occurred between 212.4 to 209.7 masl and had an interval transmissivity of 2.6x10^{-4} m^2/sec. This fracture accounted for about 97% of the entire borehole response. The remainder of the rock profile tested consistently within about a half order of magnitude of 10^{-7} m^2/sec. Similar to the secondary fracture noted in BH-1, this fracture also correlates with the weathered shale zone within the Bobcaygeon Formation (Golder, 2021). The televiewer image below illustrates the open parting noted above and elsewhere on the Site.



BH-3: 25.57 - 25.62 m

5.2.4 BH-4 Results

BH-4 was one of the initial boreholes subjected to the downhole packer testing program, and as such, a more detailed assessment was subsequently undertaken due to the shortened packer spacing (*i.e.,* one-meter interval). The most prominent fracture was encountered between 227.6 to 226.7 masl at an interval transmissivity of about 1.5x10^{-4} m^2/sec, which accounted for about 78% of the borehole response. This fracture was found within subunit 5-2 of the Verulam Formation and is shown below on the televiewer image (Golder, 2021).



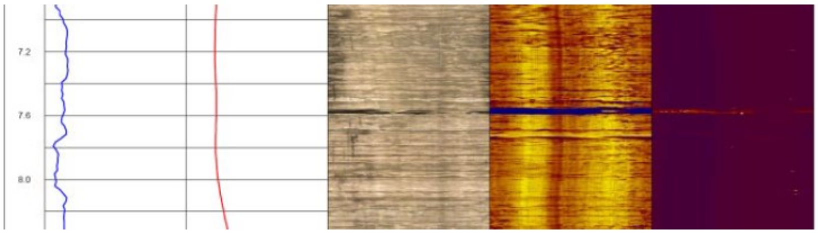
BH-4: 9.18 - 9.20 m

A fairly large zone of permeable rock (~3x10^{-6} m^2/sec) was found toward the base of the borehole between 178 to 170 masl. This zone accounted for about 15% of the borehole response and straddles portions of the lower units of the Gull River Formation (subunits 3-1, 3-2) and the Shadow Lake Formation (subunit 2). Golder (2021) notes that the contact between these horizons is gradational (though marked by a distinct gamma signature). As such, this rather large zone of permeability is likely associated with increase in shale partings and ground water interaction. These zones were regularly encountered in the subsurface; however, most were not found to be overly permeable with the exception of BH-4.

In addition, two (2) minor zones of increased permeability were also found between 191 to 190 masl and 215 to 213 masl; although each only contributing to less than 1% of the borehole response. Notwithstanding, these zones stand out given the low permeability of much of the borehole profile. The first zone was found between 191 to 190 masl and had an interval transmissivity of 1.7x10^{-6} m^2/sec. This zone aligns with the structural contact zones between the upper units of the Gull River Formation and the GMB. The second zone occurs within the weathered shale zone within the Bobcaygeon Formation between 215 to 213 masl (interval transmissivity at 7x10^{-7} m^2/sec).

5.2.5 BH-5 Results

The results for BH-5 provided the most variable results, although the most permeable fracture zone was again encountered in the Verulam Formation (subunit 5-2) which was found between 227.1 and 226.2 masl and an interval transmissivity of 3.3x10^{-4} m^2/sec. This fracture contributed to about 76% of the boreholes response. The televiewer image of this zone is provided below.



BH-5: 7.57 - 7.59 m

Several other moderately permeable zones were also found throughout the profile, including two (2) zones within the Bobcaygeon Formation and one (1) in the lower section of the Gull River Formation. The first occurs at the base of the borehole and within the lower unit of the Gull River Formation (subunit 3-1, 3-2) between 182 to 179 masl and has an interval transimissivity of about 1.9×10^{-5} m^2/sec. This interval accounts for about 4% of the response within borehole. Based on the geological interpretation provided by Golder this appears to be controlled by the lower green beds (subunit 3-1).

There are two (2) notable zones of increased permeability found within the Bobcaygeon Formation. The more permeable occurs within subunits 4-1 and 4-2 at an elevation of 196.9 to 196.0 masl and an estimated interval transmissivity of 1.7×10^{-5} m^2/sec, which accounts for about 4% of the borehole response. A second less permeable zone (1.0×10^{-5} m^2/sec) is also noted within the upper portion of this formation at depth consistent with the weathered shale zone noted in previous boreholes. The fracture occurs at a depth of 209.7 to 208.8 masl and this interval accounts for about 2% of the borehole response.

5.3 Hydrostratigraphy

A preliminary hydrostratigraphy model was developed by Golder in consultation with Azimuth at the completion of Phase 1 Drilling and Physical Testing Programs. This model was later refined by Golder in 2020, following the physical testing of the Phase 2 Boreholes. This included splitting the Gull River Formation into four (4) subunits rather than three (3). This is related to the identification of a lower “Green Marker Bed” (referred to as subunit 3-1) found below the lower unit of this formation (3-2). In addition, not all of the hydrostratigraphic units are instrumented at the proposed quarry given the low permeability of the zones, as determined through the physical testing programs. As such, only select formations or intervals have been instrumented which is summarized in Table 5 (overleaf). Additional information pertaining to the determination of the hydrostratigraphy and monitoring well instrumentation is provided in Golder (2021) (Appendix D).

Table 5: Hydrostratigraphy and Monitoring Well Nomenclature Summary[2]

Hydrostratigraphic Unit	Stratigraphic Unit	Hydrostratigraphic Unit identifier	Monitoring Well	Monitoring Well Identifier
Bobcaygeon[A], Verulam[B] and Upper Weathered Zone	-	Z	5	BH-1Z[B], BH-2Z[A], BH-3Z[A], BH-4Z[B], BH-5Z[B]
Overburden	6	O	0	NA
Upper Weathered Zone (bedrock)	5-1, 5-2	M	0	NA
Verulam Formation	5-2	N	0	NA
Verulam Formation	5-1	L	4	BH-6L, BH-7L, BH-8L, BH-9L
Bobcaygeon Formation	4-4	K	4	BH-6K, BH-7K, BH-8K, BH-9K
Bobcaygeon Formation	4-3	J	0	NA
Bobcaygeon Formation	4-1, 4-2	I	2	BH-6I, BH-7I
Bobcaygeon / Gull River Formational Contact	3-4/4-1	H	1	BH-5H
Upper Gull River Formation	3-4	G	2	BH-8G, BH-9G
Green Marker Bed (upper)	3-3	F	5	BH-1F, BH-2F, BH-3F, BH-4F, BH-5F
Lower Gull River Formation	3-2	E	0	NA
Green Marker Bed (lower)	3-1	D	1	BH-3D
Shadow Lake Formation	2	C	1	BH-2C
Shadow Lake Formation / Precambrian Basement Contact	1/2	B	2	BH-1B, BH-4B
Precambrian Basement	1	A	0	NA

Notes: [1] "NA" – Not applicable as monitoring well not installed at specified interval

[2] Adapted from Section 6.2 of the Geology Study report prepared by Golder (2021).

5.4 Pumping Test

As noted in an earlier section, a pumping test program was attempted in November of 2020 by Azimuth following the completing of the Phase 2 Boreholes. BH-6 and BH-8 were subjected to a relatively short duration pumping test with the idea of determining a long-term test rate. The following discussion describes each testing sequence and hydraulic analysis.

5.4.1 Pumping Test Sequences

Each borehole was tested using the same procedure and test rates, which was intended to start out as a step test in order to assess various test rates. Hydrographs showing the recorded water levels in BH-6 and BH-8 (blue line) and their respective total depths (black, dashed line) are presented in Appendix G. The instantaneous pumping rate was maintained throughout the pumping period at ~17 L/min (4 IGPM) through the use of an adjustable ball valve installed on the primary discharge line. It is recognized that only one (1) testing sequence could be performed as the water levels at both locations rapidly declined to the pump intake at BH-6 and BH-8 after 35- and 45-minutes of pumping, respectively. As such, further yield testing could not be completed and the wells were allowed to fully recover.

Overall, the recovery period was prolonged. Recovery to about 90% at BH-6 and BH-8 was achieved after about 3 and 2 days, respectively. Ultimately, the information obtained through this testing suggests that the water bearing fractures intersected at these two (2) locations are not capable of supporting a water supply.

Water chemistry samples were collected prior to shutting off the pump, and show elevated concentrations of most major ions, including: chloride, sodium, iron, and calcium, indicating a mineralized ground water source. Notwithstanding, the results are markedly more dilute than samples collected later during the monitoring program. As such, it is expected that the initial results may been skewed from drilling fluid remaining in the well bore during testing. This is plausible given its use during the borehole construction and that parameter concentrations increased by about threefold after instrumentation. While the results are not incorporated into the long-term database, the laboratory report is appended (Appendix G).

5.4.2 Hydraulic Analysis

The recovery periods were assessed using hydrogeological software to estimate a transmissivity for each well location. The results of the analysis are presented in Appendix G. The estimated transmissivity (T) for both BH-6 and BH-8 is about $3.0\text{x}10^{-6}$ m^2/sec using the late time recovery data, which represents the majority of the well's recovery. Since the analysis takes into account the length of the bore (or well depth) the estimated T is relatively low, but comparable to the packer testing results detailed earlier. This is particularly relevant since most of the host limestone was found to be relatively impermeable during this testing. The more permeable zones at this location occur within the upper Formations (*i.e.,* Verulam and Bobcaygeon), which were ultimately targeted during the Phase 2 Borehole Instrumentation Program.

5.5 Borehole Hydraulic Testing

Following the instrumentation of each borehole a rising and/or falling head test was performed to assess the hydraulic characteristics of each of the isolated intervals. In general, rising head tests were performed by removing a known volume of ground water and documenting the water level recovery back to its static head elevation to estimate the formations hydraulic conductivity (K). A summary of the hydraulic testing results is provided in Appendix I and a brief discussion is provided below.

Kassenaar & Wexler (2014) also completed a literature review of published hydraulic conductivity values from nine (9) reports and regional studies[1]. The K-values included in their Tier 2 Water Balance Report were obtained from either direct aquifer testing or model calibration values used in previous regional modelling studies. The published values are presented below in Table 6 (overleaf) and are used to compare with values obtained during this study.

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[1] The source material used in the literature noted above is presented in Kassanaar & Wexler (2014).

Table 6: Published Hydraulic Conductivity (K) Estimates[1]

Formation	Geometric Mean (m/sec)	K-range Low (m/sec)	K-range High (m/sec)
Overburden (clay + silty sand till)	1.0E-07	2.0E-08	6.0E-07
Weather Bedrock Zone (Verulam/Lindsay)	5.0E-06	4.0E-07	5.0E-05
Verulam	4.0E-07	1.0E-10	6.0E-04
Upper Bobcaygeon	1.0E-07	5.0E-10	6.0E-03
Lower Bobcaygeon	1.0E-08	1.0E-11	1.0E-05
Upper Gull River	6.0E-07	5.0E-11	2.0E-03
Green Marker Bed	7.0E-06	4.0E-09	2.0E-03
Lower Gull River	6.0E-07	2.0E-11	1.0E-04
Shadow Lake / Precambrian Contact	5.0E-08	1.0E-11	6.0E-04
Precambrian	1.0E-09	1.0E-10	6.0E-08

Notes: [1.] Hydraulic conductivity estimates from Kassenaar & Wexler (2014)

5.5.1 Hydraulic Properties – Phase 1 Boreholes

As previously noted, the hydraulic tests of the Phase 1 Boreholes include BH-1 to BH-5, showed relatively similar results to that of the packer testing (within about one order of magnitude).

Starting from the basement and moving upward, the Shadow Lake Formation/ Precambrian Basement Contact is monitored at two (2) locations (BH-1B and BH-4B). The tested intervals had an estimated K-value of $5.9\text{x}10^{-9}$ m/sec and $2.3\text{x}10^{-8}$ m/sec, respectively. The values are slightly less conductive than what was encountered during the packer testing, which is likely due to the increased surface area relative to the "fracture zone" resulting from the larger "sand pack" length. Overall, the packer testing profile found that the contact zone was not overly conductive throughout that section of the rock (*i.e.,* < 1% of the borehole response). This finding was consistent among all boreholes as minimal weathering was noted. Therefore, the range of values are considered representative of this formation and they are consistent with other published values above.

The Shadow Lake Formation is currently monitored at one (1) location at BH-2C. The estimated K-value was found to be $1.3\text{x}10^{-7}$ m/sec, which is consistent with the packer testing of this interval at this location (and at other boreholes). While this formation is considered to be moderately porous, most of the packer testing of this formation indicated that the conductivity was at the lower part of range between 10^{-7} to 10^{-6} m/sec. Therefore, the estimate determined for this interval is considered representative and is within the range of published values.

The lower Green Marker Bed within the lower unit of the Gull River Formation is monitored at BH-3D only. The hydraulic testing indicates that the K-value at this location is $5.9x10^{-9}$ m/sec. This is about an order of magnitude lower than what was shown by packer testing at this location and on-site. This unit was found to have low permeability, except at BH-5. Overall, the estimated value is representative and consistent with published values.

The upper Green Marker Bed interval is monitored at all of the Phase 1 Boreholes and is denoted by the identifier “F”. The estimated K-value within this formation is 10^{-9} to 10^{-6} m/sec; with BH-2F being the most permeable location. With the exception of BH-2, this zone has low permeability, which was somewhat unexpected given that it is often regarded as a regional aquifer and used for domestic water supplies. While this was somewhat unexpected, these results do fall within the lower end of the range of published values (10^{-9} to 10^{-3} m/sec) (Kassenaar & Wexler, 2014). As such, this formation likely functions as an aquitard rather than an aquifer locally.

Lastly, a relatively small interval marking the weathered clay shale contact between the Bobcaygeon Formation and Gull River Formation is monitored at BH-5H. This zone had an estimated K-value of $2.7x10^{-9}$ m/sec, which is about a half order of magnitude lower than what was derived during the packer testing of BH-5. Therefore, the similarity in transmissivity indicates that it is representative of this formation, and is consistent with published values.

5.5.2 Hydraulic Properties – Phase 2 Boreholes

The upper portion of the Gull River Formation (above the Green Marker Bed) is monitored at BH-8G and BH-9G. Hydraulic testing indicates that this part of the formation has low permeability with a K-value of about $1.0x10^{-8}$ m/sec. While packer testing was not completed on these boreholes, corresponding data collected during the Phase 1 Boreholes testing indicates that the hydraulic properties occur within a similar range (as do the published values). As such, the hydraulic data are representative.

The lower units of the Bobcaygeon Formation are monitored at BH-6I and BH-7I. K-value estimates of this interval were found to be $2.7x10^{-8}$ m/sec. This value is consistent with published K-values that are noted to range between 10^{-11} to 10^{-5} m/sec and closely match the geometric mean values shown in Table 5 ($1.0x10^{-8}$ m/sec). The value is also similar to packer testing results completed on-site. Therefore, the results are representative.

The uppermost subunit (4-4) of the Bobcaygeon Formation is monitored at all four (4) Phase 2 Boreholes and denoted with the identifier (K). This subunit contains a moderately permeable weathered shale lateral fracture that was identified during the detailed core logging, geophysical testing and downhole packer testing, and subsequently correlated in the Phase 2 Boreholes during geophysical testing. Despite being found to be moderately permeable (~10^{-6} to 10^{-5} m/sec) during previous testing, the K-values estimates were found to be about an order of magnitude lower (or about 10^{-8} to 10^{-7} m/sec). It is possible that there may be some spatial variance within this subunit. Notwithstanding, the range of values align well with the published range of value (and geometric mean) for the upper section of the Bobcaygeon Formation. As such, these values are considered representative of this formation.

Finally, the lower subunit of the Verulam Formation (5-1) is also monitored at all four (4) Phase 2 Boreholes and denoted with the identifier (L). Hydraulic testing was completed at all locations with the exception of the BH-9L which continues to be dry. K-value estimates ranged from 5.4×10^{-8} to 3.5×10^{-7} m/sec. These values suggest less permeable conditions compared to the geophysical and downhole packer testing result on the Phase 1 Boreholes, which showed K-values on the order range of 10^{-6} to 10^{-4} m/sec. The permeability of this unit appears to be spatially variable on-site. This suggests that the thin (2 to 3 cm), laterally bedded fracture encountered in BH-1, BH-4 and BH-5 may become less conductive and/or water bearing to the south and east. In addition, this same fracture was not found to be overly permeable (or weathered) at BH-2 and BH-3. As such, the K-value estimates obtained at the above noted boreholes are representative and fall with the range of published values.

6.0 GROUND WATER RESULTS

6.1 Private Well Surveys

On July 30, 2019, an initial local water well survey within 750 m of the proposed quarry was conducted by Azimuth. A letter containing details of the study and a voluntary questionnaire requesting details about their well and property were distributed to neighbouring properties. Details on well construction and location, septic bed location, water treatment system, overburden/outcropping at the property, and water quality information were requested. Attempts to contact neighbouring properties were also completed on February 24, 2022 and June 18, 2022 leaving letter requests for information each time.

A desktop review of the MECP Water Well Record database and local parcel mapping was completed that identified approximately thirty-six (36) parcels within the Study Area. This included the parcels along the following roadways:

- Concession Road 3 – 1 parcel
- Concession Road 2 – 2 parcels
- Concession Road 1 – 12 parcels
- Concession Road A – 1 parcel
- Ramara Road 47 – 9 parcels
- Highway 12 – 11 parcels

Azimuth attempted to directly contact property owners by knocking on the door prior to leaving the letter and questionnaire. Well survey packages were left at each residence by either dropping it in their respective mailbox or at the door and in total thirty-six (36) surveys were distributed.

By August 2023, two (2) of the property owners on Highway 12 and Concession Road 2 close to the site had responded to our requests for information regarding their wells. Both residences obtain their water supply from deep, drilled water wells; however, an MECP well record could not be found for the subject wells. Azimuth was permitted to visit PW4 in June 2022, which has a total measured depth of 41m and static water level of 12.1 m btoc. Follow up efforts to gather additional well information about PW2 have been made via email; however, at this time permission to access the property has not been granted. Well use information provided from the respondents is included in Table 7 below.

Table 7: Private Well Response Information

Well ID	Street	Municipal Water Available	Well Uses	# Of Residents	Treatment Details	Well Type	Depth (m)	Well Construction Date	Historical Issues	Wellhead Accessible	Interest in Monitoring
PW4	Highway 12	no	washing, cooking, garden	2	UV	Drilled	41	NA	none	yes	yes
PW2	Concession Road 2	no	drinking, washing, cooking	4	NA	Drilled	NA	> 35 Years	none	yes	yes

6.2 Ground Water Monitoring

A long-term ground water monitoring program has been established at the proposed quarry in order to track the trends of the ground water levels associated with the various stratigraphic units. Overall, the water levels continue to demonstrate the spatial and temporal differences between the specific formations and across the proposed quarry property. Table 8 below presents the ranges of equilibrium water levels within the geologic formations beneath the proposed quarry. Transient water levels are also shown on the hydrographs below and are due to induced changes due to water sampling or borehole testing.

Table 8: Equilibrium Water Levels from on-site Monitoring Wells

Hydrostratigraphic Unit	Stratigraphic Unit	Hydrostratigraphic Unit identifier	Monitoring Points	Range of Water levels (masl)
Verulam Formation	(5-1), 5-2	(M), L	4	229 - 238
Upper Bobcaygeon Formation	4-4	K	4	227 - 238
Lower Bobcaygeon Formation	(4-3), 4-1, 4-2	(J), I	2	232 - 236
Bobcaygeon/ Gull River Contact	3-4/4-1	H	1	227.5 - 228
Upper Gull River Formation	3-4	G	2	220 - 226
Upper Green Marker Bed (GMB)	3-3	F	5	220 - 232
Lower Gull River Formation and Lower GMB	(3-2), 3-1	(E), D	1	222.5 – 223.5
Shadow Lake Formation	2	C	1	220 - 222.5
Shadow Lake / Precambrian Contact	2/1	B (A)	2	218 - 235

Notes:

1. Identifier in parenthesis indicates interval assumed to be in relation to monitored hydrostratigraphic unit.

The water level data are plotted on hydrographs in order to visualize the trends (Appendix J). The location of each borehole is shown on Figure 9. The tabulated data and hydrographs are provided in Appendix J. A brief discussion of the water level trends is provided below. This includes a comparison to regional precipitation data from the Environment Canada (EC) Orillia Brain Climate Station (detailed further below). It is noted that some of the water levels are also affected by transient conditions due to well testing and water quality sampling.

6.2.1 Water Elevation –Verulam Formation

The water levels in the Verulam Formation are monitored directly at four (4) monitoring well locations (BH-6L, BH-7L, BH-8L and BH-9L). Based on the downhole packer test results, BH-1Z, BH-4Z and BH-5Z also monitor this interval. The range of equilibrium water levels occurs between 229 masl to 238 masl, although the highest elevation also occurs at BH-7L which is about 4 m higher than the expected maximum range of the other monitoring wells. The observed water levels at the remaining monitoring intervals and relevant precipitation data have been plotted on Figure F below.

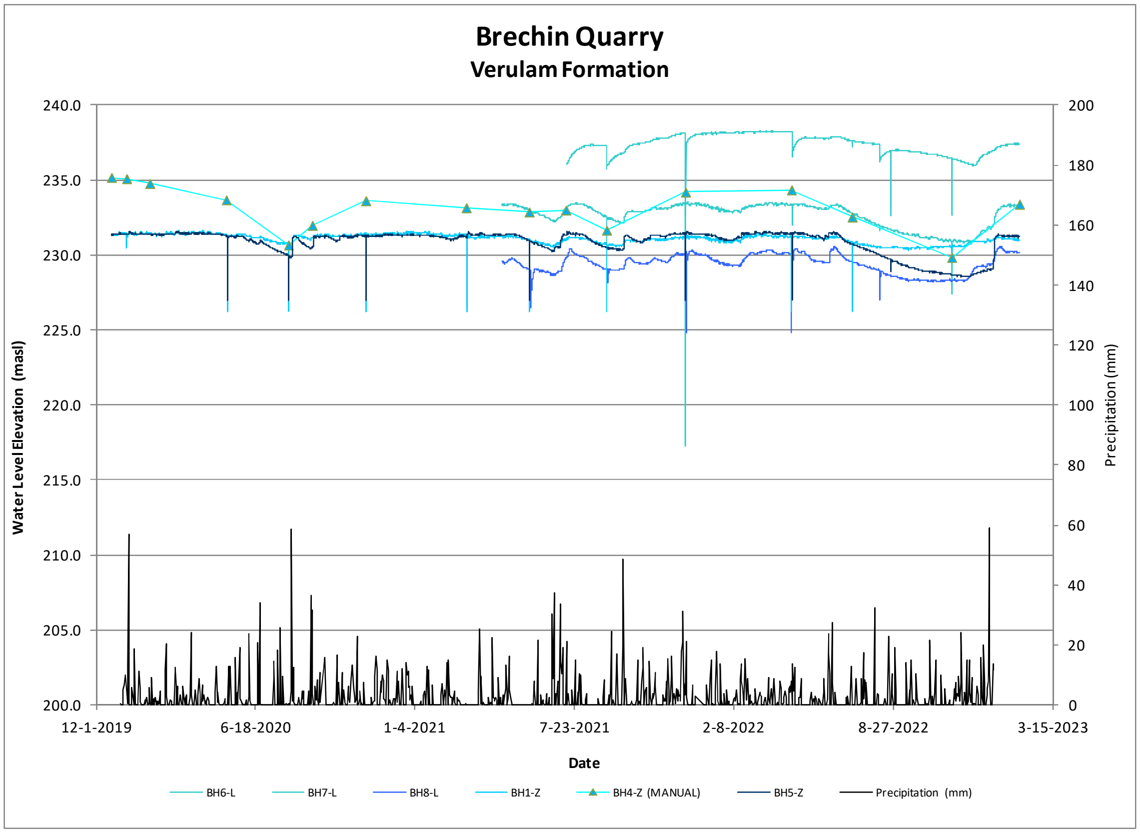

Figure F: **Water levels - Verulam Formation**

Water levels show temporal (or seasonal) trends when compared with corresponding precipitation data. Declining water levels are observed during the warmer months of the year, while higher levels are noted following larger rain events. This formation was consistently the most permeable across the proposed quarry due to its weathered nature and greater shale content. The spatial range and distribution in water levels indicates heterogeneity within the bedrock environment.

6.2.2 Water Elevation – Upper Bobcaygeon Formation

The water levels in the upper units of the Bobcaygeon Formation are directly monitored at four (4) monitoring locations on-site, including BH-6K, BH-7K, BH-8K and BH-9K. Based on the downhole packer test results, BH-2Z and BH-3Z also monitor this interval. The range of water levels occur between 237 masl to 224.2 masl (Δ 14.7 m) and shows considerable spatial variation. The highest water levels occur at BH-7K which is about 4 m higher than the remaining monitoring wells. The water levels from the three intervals of BH-7 suggest some interconnection between the monitoring wells, so that these water elevations may not be representative of the formation. The observed water levels and relevant precipitation data have been plotted on Figure G below.

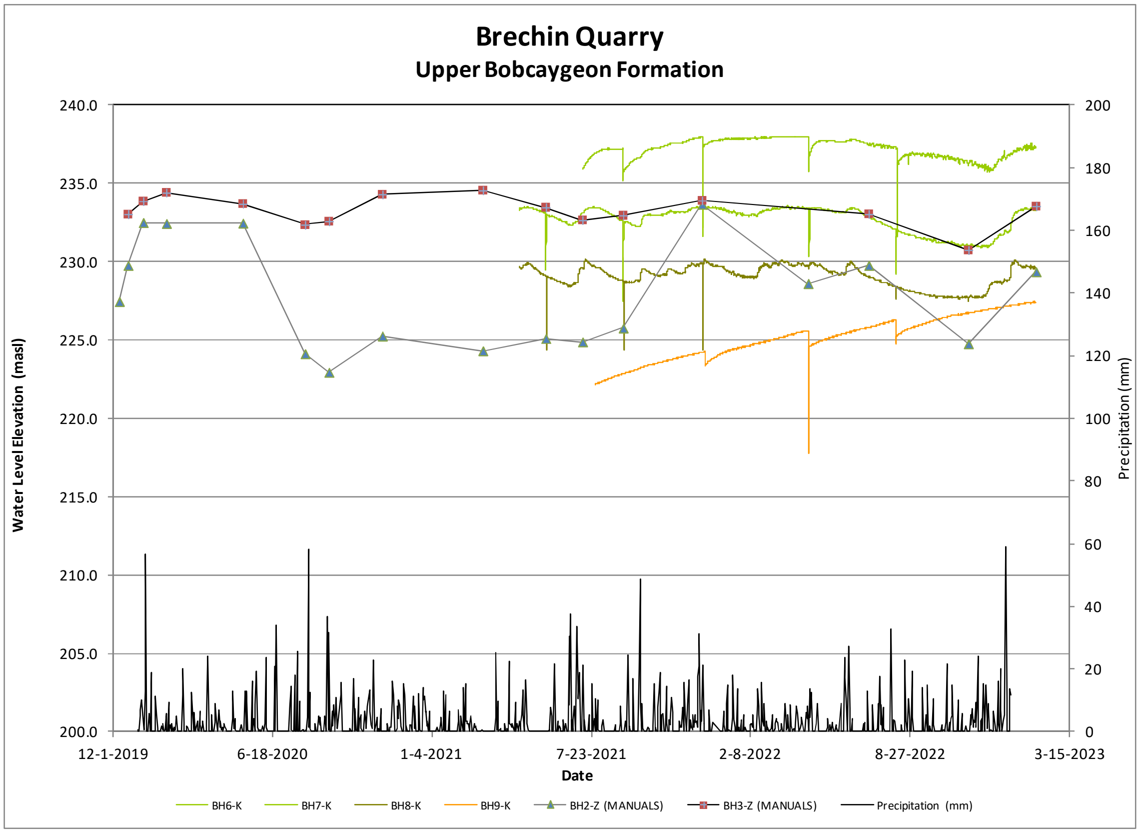

Figure G: Water levels – Upper Bobcaygeon Formation

Similar to the upper GMB observations, the water levels are higher in the western to central portions of the proposed quarry and are lower towards the east. This trend is contrary to the expected regional flow model, which is expected to be oriented westward towards Lake Simcoe. The spatial range and distribution in water levels indicates heterogenity within the bedrock environment, which is consistent with the hydraulic testing results. It is possible that this eastward oriented gradient may be due to dewatering activities at adjacent quarries.

6.2.3 Water Elevation – Lower Bobcaygeon Formation and Contact Zone with Gull River Formation

The lower Bobcaygeon Formation is currently monitored at BH-6 and BH-7 and annotated with the unit identifier "I", while the contact zone between the lower Bobcaygeon Formation and upper Gull River Formation is monitored at BH-5H. The water levels at BH-5H are quite stable over the period of record within a range of about 227.5 masl to 228 masl (Δ 0.5 m). The initial water level was also artificially elevated following instrumentation by about 3 m and only stabilized following the initial sampling event and well development. Drawdown and recovery sequences following sampling are also observed periodically throughout the dataset and full recovery generally occurs over 25 to 30 days, which is expected given the low K-value.

The water levels in the lower Bobcaygeon Formation are fairly stable and a seasonal trend is observed at BH-6I. Water levels are in the range of about 232 masl to 236 masl, with abrupt drawdown and recovery sequences following ground water sampling. A similar, but much slower response curves were noted at BH-7I.

BH-7 was dry after drilling, although, the intervals were instrumented and transducer dataloggers were installed upon observing ground water in the well in July 2021. The recovery sequences take about 30 to 35 days to return to static conditions. Unlike other borehole locations, the water level trends at BH-7 (units “I”, “K” and “L”) all follow a similar pattern, suggesting some degree of interconnectivity. The observed water levels and relevant precipitation data have been plotted on Figure H below.

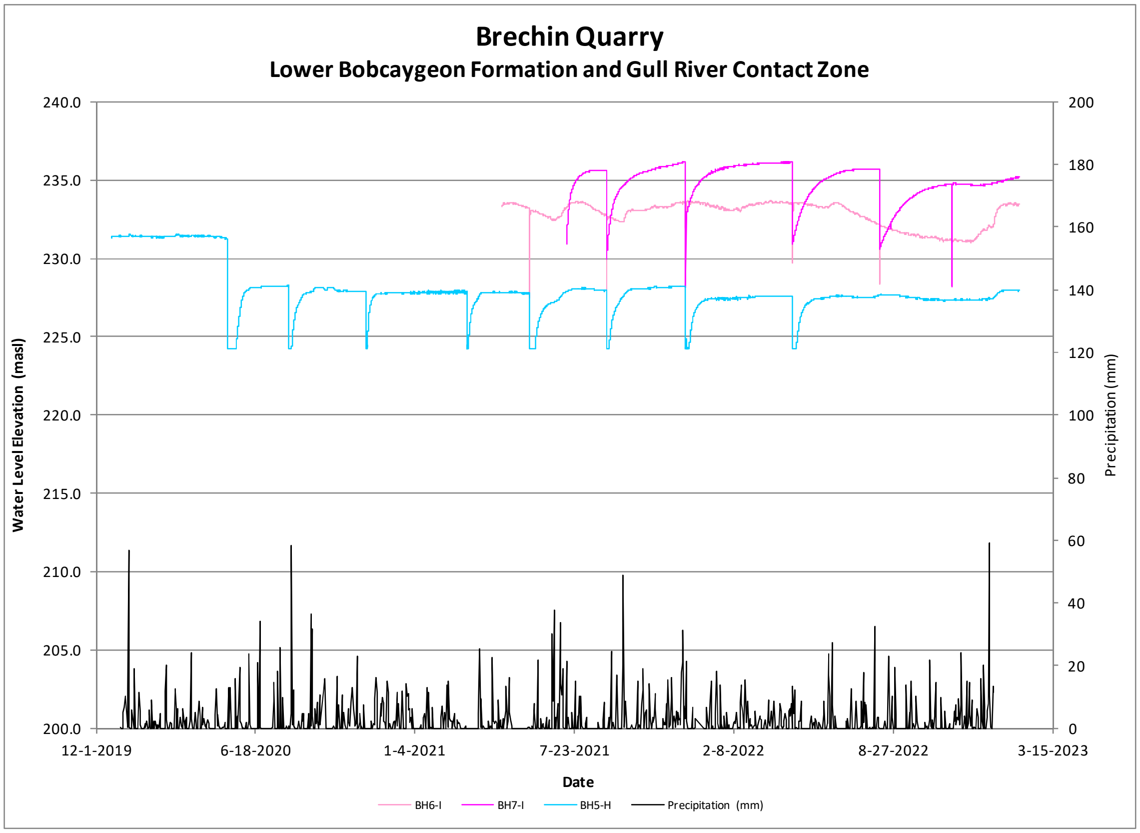

Figure H: Water levels – Lower Bobcaygeon Formation and Gull River Contact Zone

6.2.4 Water Elevation – Upper Gull River Formation

The upper portion of the Gull River Formation is currently monitored at two (2) locations BH-8G and BH-9G. Datasets are available for this formation from April to January 2023). Overall, the water levels are quite stable with only minor temporal changes noted at BH-8G. Both of these wells are located on the eastern limits of the proposed quarry.

The wellbore at BH-9 was initially found to be dry after drilling; however, specific intervals were still instrumented in order to isolate any potential ground water seepage. Transducer dataloggers were not deployed until water was observed in the wellbore in July 2021. The water levels display a prolonged recovery that only reaches static conditions after about six months. The observed water levels and relevant precipitation data have been plotted on Figure I below.

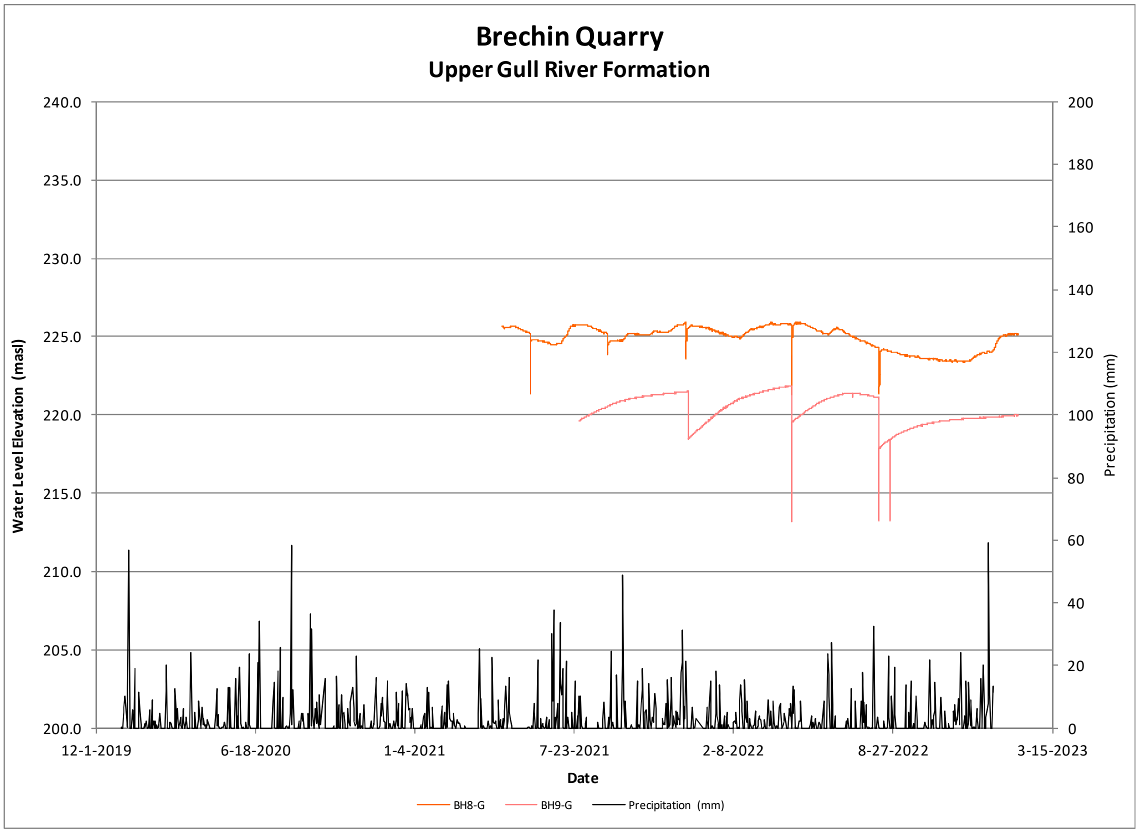

Figure I: Water levels – Upper Gull River Formation

6.2.5 Water Elevation – Upper GMB

The Upper GMB is monitored at all five (5) of the Phase 1 Boreholes and annotated with the unit identifier "F". Water elevations within this formation are spatially variable across the Site. Temporal (or seasonal) changes are not commonly observed as most of the stabilized water levels do not vary by more than about one meter over the period of record; with the exception of BH-5F. Water levels within this formation range from between 220 masl to 232 masl and are higher within the western portion of the proposed quarry and progressively becoming deeper towards the east. The observed water levels at these monitoring intervals and relevant precipitation data have been plotted onto Figure J below.

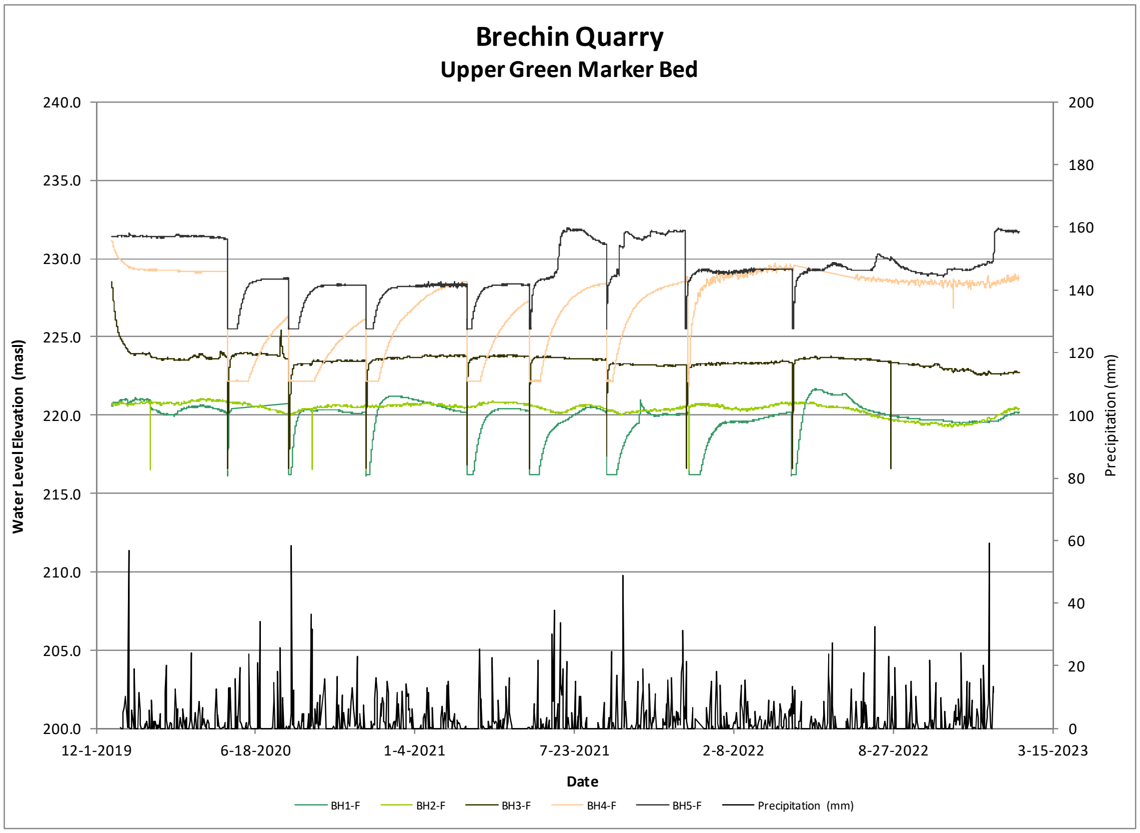

Figure J: Water levels – Upper GMB

This eastward trending gradient is contrary to the expected regional flow model which is expected to be oriented more westward towards Lake Simcoe. Notwithstanding, the spatial variance in water levels suggests heterogeneity within the bedrock, which is consistent with the hydraulic testing results. It is also possible that the eastward trending water levels may reflect that well locations are on opposite side of the on-site ground water divide or may also result from the active Lafarge Brechin Quarry situated northeast of the proposed quarry. Golder (2012) and WSP (2023) have suggested that drawdown of about one meter may occur up to several kilometers from the extraction limit of the quarry operations in the general area.

Distinct drawdown sequences followed by recovery periods are noted as a result of ground water sampling events. Extended recovery periods are noted at several locations due to the low permeability of this unit, taking from several days to more than two months. This trend is most prominent at BH-1F, BH-4F and BH-5F, which all had estimated K-values of about 10^{-9} m/sec.

Water levels at BH-5F increased to about 231 masl in June 2021, which was not observed elsewhere in the formation. From about late June through to early September several frequent and/or large precipitation events were recorded at the EC Orillia Brain Station (308.2 mm) and at the Site (~428 mm) over that time period. This is about 1 to 1.5 times (respectively) greater than the expected climate normals for Orillia[2] over that same period. As such, it is possible that these recent water levels may have resulted from more localized recharge at this location.

6.2.6 Water Levels – Lower GMB and Lower Gull River Formation

The equilibrium water levels in the Lower GMB are monitored solely at BH-3D. These elevations range between 222.5masl to 223.5 masl. The water level was artificially elevated following instrumentation and only began to equilibrate following the initial sampling events and well development. Abrupt drawdown sequences followed by a recovery period of about several days are noted following sampling events. In general, water levels are quite stable at this monitoring point compared to other zones and formations found elsewhere on-site. For simplicity, the Lower GMB and the lower portion of the Gull River Formation are presented together due to their inferred hydraulic connection. The observed water levels at these monitoring intervals and relevant precipitation data have been plotted onto Figure K below.

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[2] Environment Canada's 30-year Canadian Climate Normals Orillia Station Data is estimated to be about 288.1 mm between June 25th to September 31st.

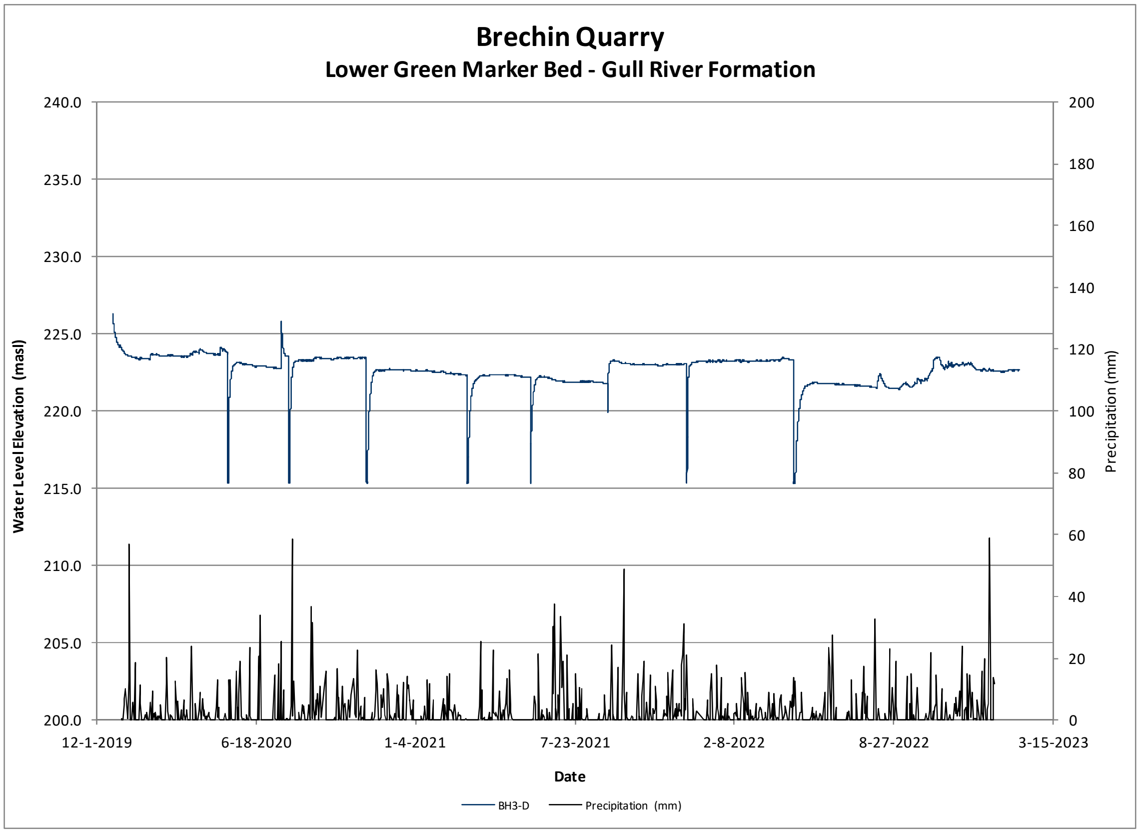

Figure K: **Water levels – Lower Gull River and Lower GMB**

6.2.7 Water Elevation – Shadow Lake Formation and Precambrian Basement

The deepest interval at BH-1 monitors the Shadow Lake Formation and Precambrian Basement contact zone identified as unit "B". Over the period of record, water levels at this location ranged between 218 to 221 masl and occurs on average at about 219.5 masl. A moderate temporal (or seasonal) trend is evident despite the water bearing zone being found quite deep (below 173.2 masl). While precipitation events are not directly observed at this location, the seasonal trends suggest an atmospheric connection from a regional recharge perspective.

This zone is also monitored at BH-4B where the water elevation range is much more variable as water elevations ranged between 227 to 235 masl. The temporal (or seasonal) trend is more pronounced at this location, which also includes more frequent changes in water levels (or storm-type response curves). These water level spikes (followed by a recession) appear to correlate with large precipitation events. These events appear to cause an increase in head pressure within the formation. When plotted with precipitation, the elevation increases appear to lag the initial precipitation events by about 3 to 10 days. The water elevations at these monitoring intervals and relevant precipitation data have been plotted onto Figure L to show these trends.

BH-2C monitors water levels in the Shadow Lake Formation and is identified as unit "C". At this location, water levels range from 220 to 222.5 masl and have a muted seasonal or climatic response. Water levels are transient following sampling and well development and are followed by a slow recovery period (~10 to 14 days).

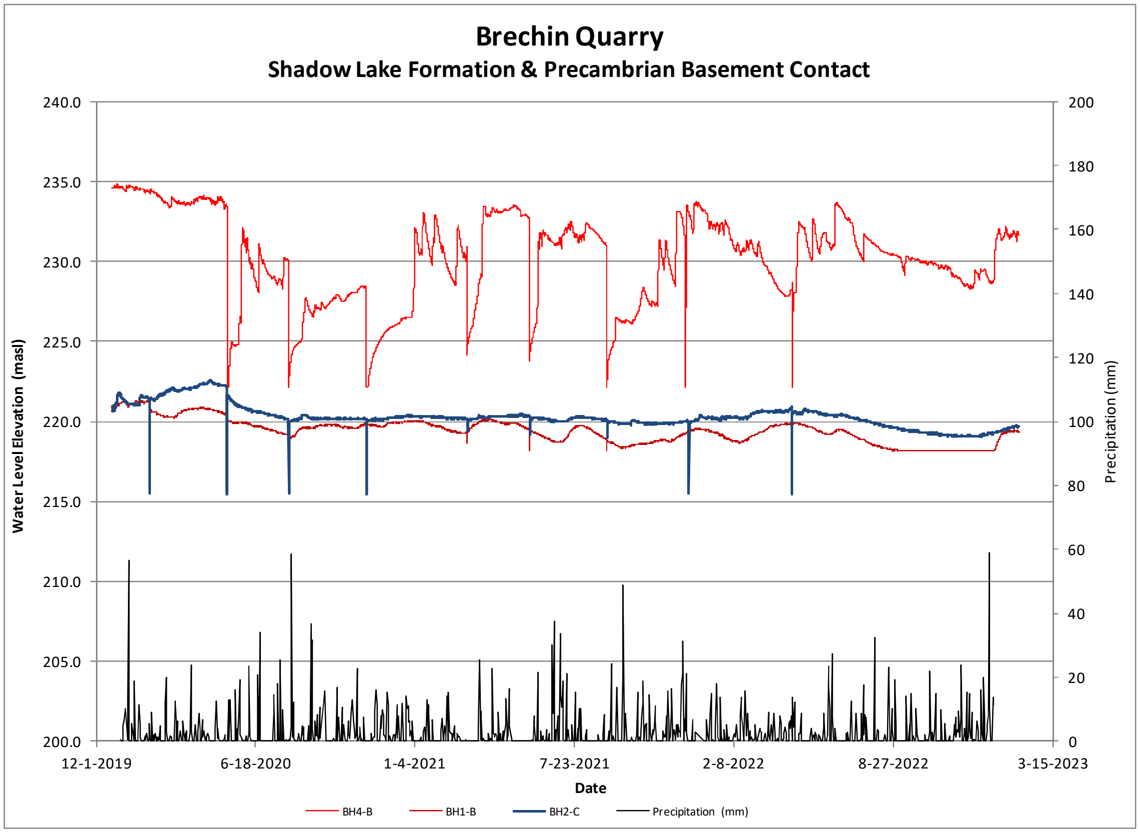

Figure L: Water Levels – Shadow Lake Formation and Precambrian

6.3 Ground Water Flow

The ground water flow pattern beneath the Site was evaluated using a combination of the MECP well record files from the ORMGP (2022) and monitoring data collected from the on-site monitoring wells. While the location of the on-site monitoring wells is well documented, there are inherent limitations with the MECP dataset. This includes inaccuracies with the geospatial referencing and general measurement errors on bore depth, static water levels, and lithology. Seasonality can also create variability between the reported water level measurements depending on the aquifer or formation, and some of the data are decades old. When properly vetted, estimates of the potentiometric surface patterns are generally reasonable.

For each MECP well log, the finished depth was used to estimate which geologic/ aquifer formation the well draws water from. Average static water level measurements were combined with the existing on-site monitoring database and partitioned into three (3) subsets (shallow, intermediate and deep):

- Shallow Aquifer – Verulam and Bobcaygeon Formations;
- Intermediate Aquifer – Gull River Formation; and
- Deeper Aquifer – Shadow Lake Formation and Precambrian Basement

These subsets were contoured in order to obtain representative surfaces for each "aquifer" beneath the proposed quarry. As previously discussed, a simple statistical analysis was also used to remove any data outliers that were found to be outside of two (2) standard deviations from the mean. Other locations were removed due to no data or incorrect spatial data. In total fifteen (15) data points were removed as part of this analysis. The final ground water plots are presented on Figures 11 to 13. A brief description is provided in the following sections. The estimated ground water flow direction in the listed aquifers is considered to be the best representations given the dataset available.

6.3.1 Shallow Bedrock Aquifer

The contoured shallow ground water surface is presented on Figure 11, based on water levels from the MECP well log database. Similar to the topography of the proposed quarry, the apex of the aquifer surface occurs at a maximum elevation of about 234 masl just south of the proposed quarry. A ground water divide occurs in a northeast to southwest orientation separating flow within the shallow bedrock to either the east or west. The eastern flow converges to the south towards the Talbot River. To the west of the divide, flow is towards Lake Simcoe.

6.3.2 Intermediate Bedrock Aquifer

The potentiometric surface in the Intermediate Aquifer is presented on Figure 12. The contour mapping includes water levels from within the Gull River Formation and/or associated Green Marker Bed, based on data from on-site monitoring wells and water levels from the MECP well log database. The flow across the proposed quarry is predominantly westwards towards Lake Simcoe along a similar trending pathway that correlates with the structural contact observed by Golder (2021).

Measured water level data from the on-site wells (BH-1 to BH-5) indicate that water levels are lower along the eastern limits of the proposed quarry. The data indicate the presence of the northeast to southwest trending ground water divide that is evident in the shallow system. The dominant flow pathway in the intermediate zone is still to the west with ground water beneath the northeastern part of the proposed quarry flowing easterly and then towards the south. This finding is representative of hydrogeological conditions within the intermediate formations beneath the Site and is consistent with published resources.

6.3.3 Deep Bedrock Aquifer

The potentiometric surface in the Deep Aquifer is presented on Figure 13. The mapping includes water levels from the Shadow Lake Formation and/or the Precambrian basement. The general flow pattern is somewhat indistinct and appears to be more radial from the proposed quarry. While this pattern is shown, the data used to produce this surface is spatially limited, as there are few data points found toward the outer extent of the Study Area. Regional trends are westward towards Lake Simcoe.

6.3.4 Maximum Predicted Water Table

As per the *Aggregate Resources of Ontario: Technical Report Standards* (2020), the maximum predicted water table surface must be determined from an established long-term dataset at the Site. This may be established through an existing monitoring program or historical data provided in hydrogeological reports for the proposed quarry, and is also documented in a stand-alone report. Water level monitoring has been on-going at the proposed quarry since the end of 2019. The program has evolved in scope from five (5) nested well locations (15 monitoring wells) at its inception to 27 monitoring wells at nine (9) borehole locations. The highest water levels generally occur in the stratigraphic units closer to ground surface (Verulam and Bobcaygeon Formation).

Ground water levels in these units occur within a range of between 227 to 238 masl, which is quite variable. The western part of the lands east of the rail alignment has the highest topographic conditions (236-241 masl), and also the highest ground water levels. In this area in the Verulam Formation, ground water levels occur between 233.4 masl to 230.1 masl, while those in the Bobcaygeon Formation are between 234.6 to 232.4 masl. These ranges represent ambient (or natural) conditions, including natural seasonal variation. These highest predicted water levels are shown on Figure 14.

Under rehabilitated conditions, it is predicted that the quarry lake will rise to an elevation of approximately 232 masl. This reflects the existing topographic elevations in the north and south parts of the proposed quarry, and provides an appropriate elevation to control the quarry lake outlet.

6.4 Ground Water Quality

6.4.1 Hydrogeochemical Characterization

Ground water samples have been collected quarterly from the instrumented monitoring wells since construction. The purpose of this long-term sampling program was to provide a baseline characterization of the ground water quality from the various formations and identify any trends (*i.e.,* seasonal, formational, spatial, *etc.*). Piper diagrams have been used to assess the hydrogeochemical signature of the ground water. Piper diagrams are useful to show ion distribution and ratios as this method downplays the effect of dilution. The general ion chemistry remain consistent unless it has been influenced by some external source, which may include aquifer mixing. The hydrogeochemical database (Appendix K), Piper Diagrams (Appendix L) and the laboratory reports (Appendix M) are appended.

The Piper Diagram presented in Figure M (below) is a compilation of all samples included in the geochemical database. The hydrogeochemical signature is halide-dominated across the study area and within the several hydrostratigraphic intervals. The signature consists of elevated chloride (Cl^-) and sodium (Na^+) that are about an order of magnitude (or more) above the applicable Ontario Drinking Water Standards (ODWS). Modest contributions of calcium (Ca^{2+}), bicarbonate (HCO_3^-) and sulphate (SO_4^-) are also present, derived from the carbonate composition of the bedrock.

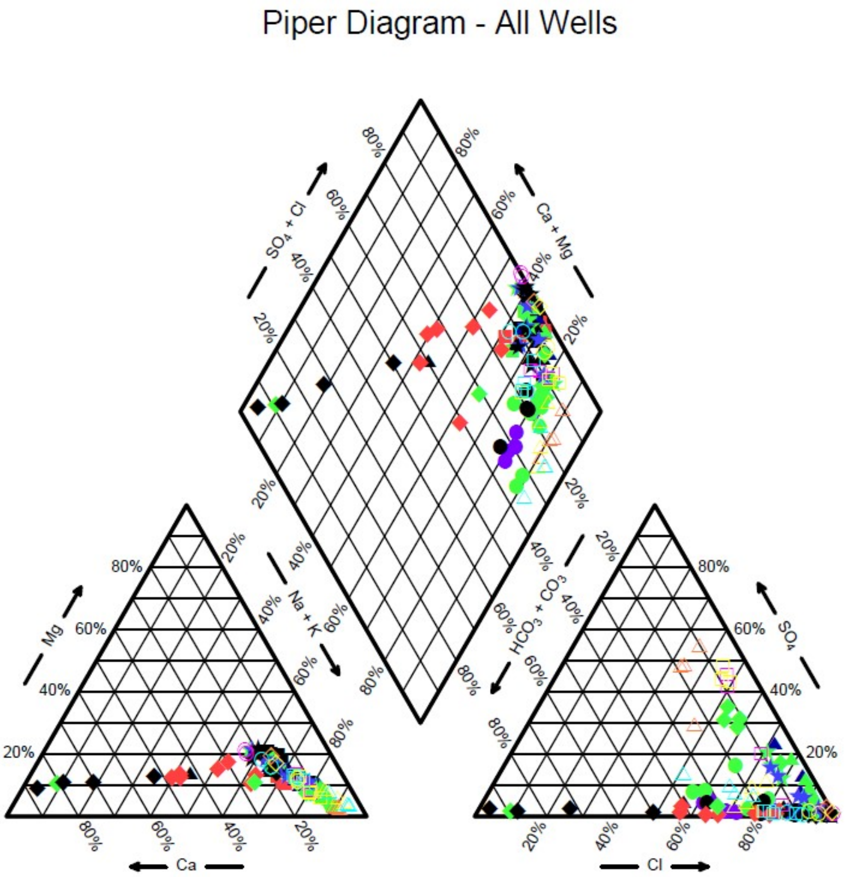

Figure M: Piper Plot – All Brechin Quarry Monitoring Wells

Typically, ground waters sampled in a Paleozoic limestone bedrock environment are often found to be carbonate-rich due to the calcium, magnesium, and carbonate rich minerals occurring within the bedrock. While a halide signature is more atypical, it is frequently associated with shale units. Colgrove and Hamilton (2018) provide a succinct evaluation of natural water quality in southern Ontario bedrock, and show significant areas of the province where various parameters, including chloride, are elevated due to rock-water interaction. An excerpt from their report (Figure N below) shows elevated chloride associated with, and derived from, specific bedrock formations that cover about 25% of southern Ontario. This includes areas along the eastern and southern limits of Lake Simcoe (which include the study area for this report). These elevated concentrations are attributed to connate seawater and/or formational brines.

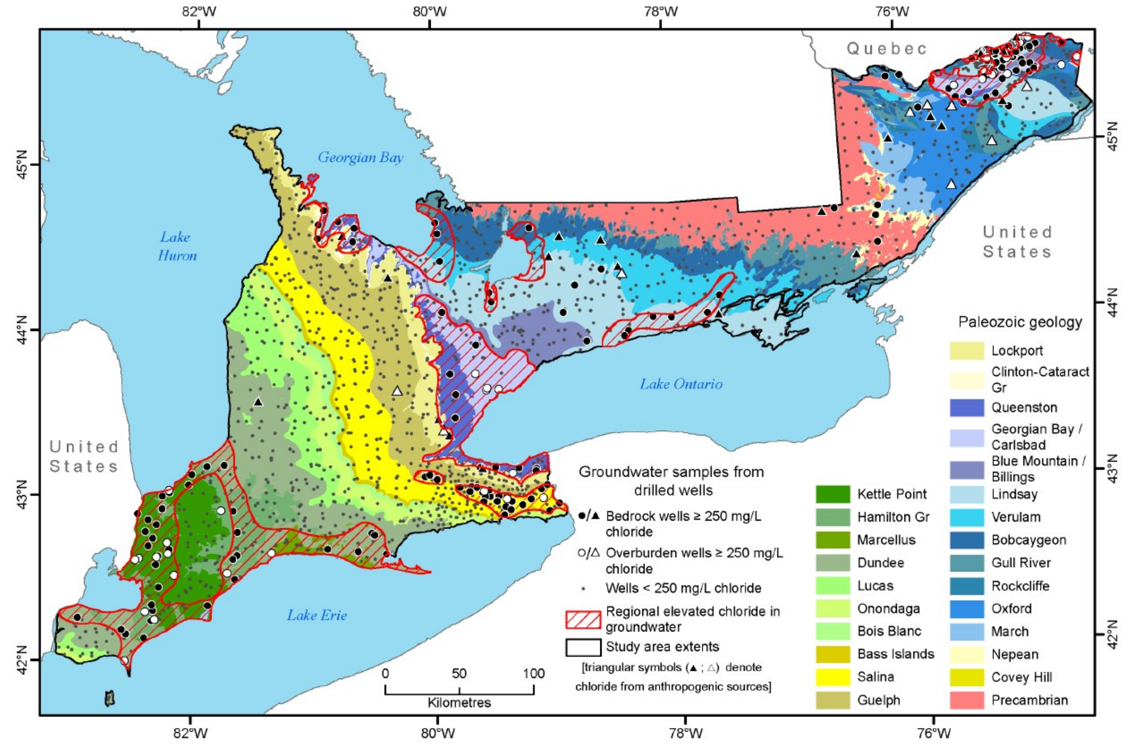

Figure N: Regions of Naturally Elevated Chloride in Southern Ontario (OGS, 2018).

6.4.2 Geochemical Trends and Drinking Water Standards

Other parameters of interest include hardness, total dissolved solids (TDS), electrical conductivity (EC), iron, manganese, and other trace metals. All of the parameters have been compared to the Ontario Drinking Water Quality Standards (ODWQS) and all exceedances are shown on the analytical data summary provided in Appendix K. Many parameters routinely exceed the applicable ODWQS standards including: alkalinity, chloride, sodium, sulphate, dissolved organic carbon (DOC), aluminum, barium, iron, manganese, selenium, TDS and hardness. Turbidity and colour have also found to exceed the ODWQS routinely, however, this more of a by-product of sampling and precipitation of certain parameters like iron.

The most common exceedances noted in the dataset relate to chloride, sodium, TDS and hardness concentrations which are routinely elevated by an order of magnitude or more above the ODWQS. Based on the concentrations encountered, the halide signature appears to be from a naturally occurring source within the Paleozoic limestone and shale environment, rather than anthropogenic sources (*i.e.,* road salt application). Active road salting along Highway 12 may contribute in part to chloride and sodium concentrations, however, the overall effect is expected to be minimal given the reported concentrations. If the sodium and chloride levels were related to road salt, then the molar ratio of the parameters would be close to unity. However, ratios are highly variant, with a range of 0.5 to 3.5.

While a number of major and minor ion parameters contribute to the concentrations of TDS (and EC), sodium and chloride are the primary constituents causing TDS to be elevated. A simple regression analysis was generated to demonstrate this trend and the results are presented on Figure O. The trend analysis combined the reported concentration for sodium and chloride and plotted them against TDS. The analysis shows a strong correlation between the two (2) parameters (R^2=99%). Again, sodium and chloride dominate the analytical signature and between the various formations, so this correlation is expected.

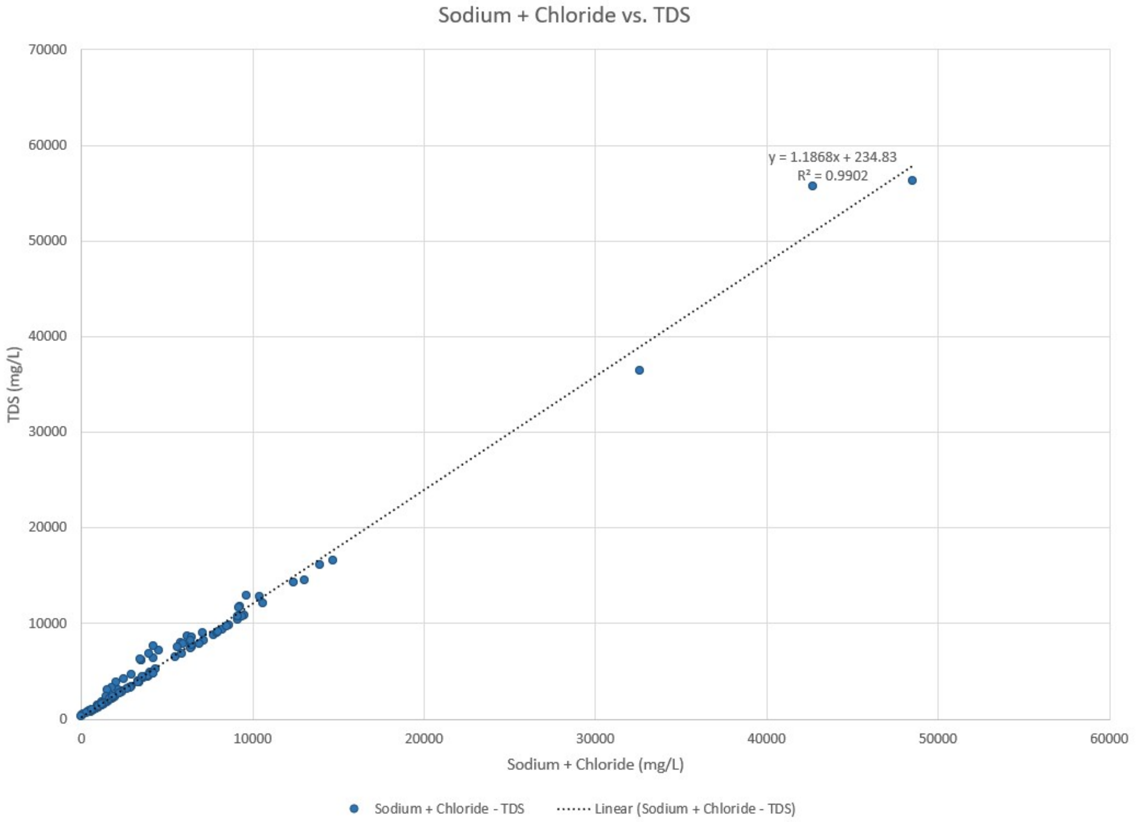

Figure O: Regression Analysis: TDS vs. Chloride + Sodium

Hardness was also found to be elevated across the proposed quarry and commonly exceeds the applicable ODWQS throughout Southern Ontario. Hardness is an aggregation of polyvalent ions, though it is mainly caused from excess calcium and magnesium (and to a lesser extent iron and manganese). These common earth elements are present at the proposed quarry due to the abundance of various carbonate-based minerals (*i.e.,* calcite, dolomite, *etc.*) found within the host bedrock. A regression analysis was also prepared comparing the sum of calcium and magnesium to hardness to assess the strength of the trend. The results of the analysis are presented overleaf in Figure P. As would be expected the results show a near perfect trend (R^2=99%), concluding that nearly all of the hardness is due to the excess calcium and magnesium found within the ground waters sampled.

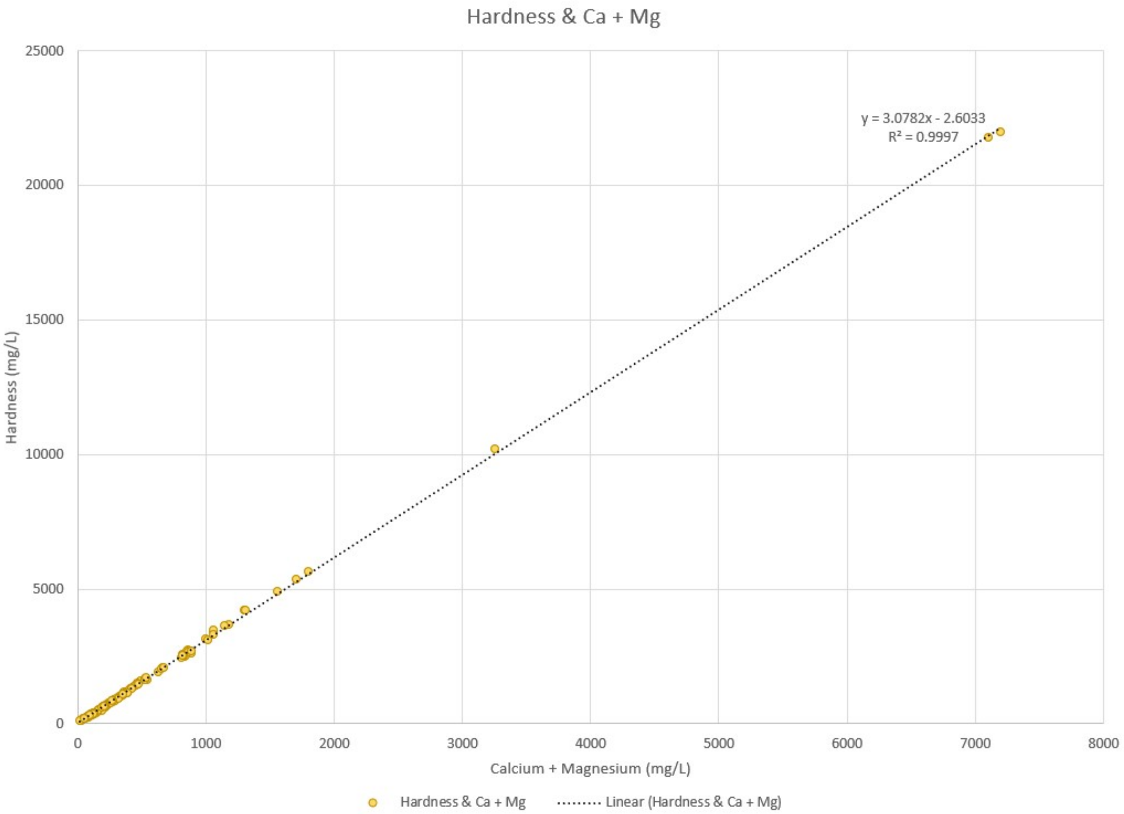

Figure P: Regression Analysis: Hardness vs. Calcium + Magnesium

Other trace elements, such as sulphate, aluminum, iron, manganese and selenium, are common earth elements that are found in most ground waters throughout Southern Ontario. These parameters are found within Paleozoic limestone formations and occur as a result of the host bedrock and formation brines present at the proposed quarry. Various trace metals (*i.e.,* aluminum, iron, manganese, *etc.*) are common impurities in limestone/ dolostone. Therefore, many of these parameters are expected to occur even at slightly elevated concentrations (depending on prevalence within the host bedrock). Again, the cause of these parameter elevations is likely from dissolution of the host bedrock and concentrating these parameters into formational brines due to the low permeable nature of the underlying bedrock.

Overall, the hydrogeochemical signature within the Paleozoic bedrock beneath the proposed quarry does not appear to be suitable for domestic use given the dominant halide signature. If it were not for the halide signature, the ground water quality would still be quite poor due to the elevated concentrations of hardness, iron, manganese, and other trace metals.

7.0 SURFACE WATER RESULTS

7.1 Climate Monitoring

Climate monitoring has been undertaken at the quarry since the start of the monitoring period. This includes collecting hourly temperature (°C) and barometric data (kPa) via a dedicated pressure transducer datalogger installed inside the protective casing at BH-5. A rain gauge was added to the program in May of 2020 which monitors rainfall events at the proposed quarry during the hydroperiod (May and November). The rain gauge was installed in an open area on the western part of the Site near BH-6. While rainfall data are collected, they are primarily used to confirm that data from the ECs Orillia Brain Station are representative for the proposed quarry. The Orillia Brain station monitors regional meteorological conditions, like precipitation, throughout the entire year (including periods of snow cover). While some isolated rain events are noted, they are generally noted to be marginal and are often < 10 mm/day and appear to be localized. Regional rain events correlate quite well with the on-site data and generally fall within the same magnitude range. The meteorological monitoring data are appended, which include data from ECs Orillia Brain Station to supplement the dataset (Appendix N).

7.2 Surface Water Flow

Surface water at the proposed quarry is divided by the north-south oriented railroad alignment. The rail alignment is comprised of a raised railbed of aggregate material and forms a hydraulic boundary for surface water flow between the two lots. Inspections along the alignment have been completed by Azimuth (and other associated consultants) and no culverts crossing the alignment have been observed. In the southern part of the property, the railbed is elevated by approximately 2 to 2.5 m above the surrounding grade, while only being raised by about 0.2 to 0.5 m at the north end of the property.

On the eastern portion of the proposed quarry, there are three (3) main sub-watersheds and one (1) smaller sub-watershed. Locally, the topography forms a broad, low ridge formed within the surface overburden and oriented in a northeast to southwest orientation. This ridge creates a drainage divide that directs surface water runoff overland to either the north, northwest or southeast. Several surface water features and drainage swales occur on-site and along its perimeter outside of the proposed licenced boundary. These features intercept and transport surface water runoff off-site in the flow paths noted above. Flows are primarily regulated by precipitation inputs rather than baseflow contributions from ground water as the water table is within the bedrock. There is one dugout pond (Ponds 1, 2 and 3) within each of the main sub-watersheds, which are located in areas of poor drainage and intercept much of the on-site runoff. Generally, these ponds only discharge when their respective water levels reach an overflow elevation that is based on the features natural topography.

The majority of the property drains northward to the McNabb Drain which is in the regional Ramara Creeks subwatershed. Two (2) on-site catchments drain northward, while the third drains southeast toward the Talbot River subwatershed. This catchment drains by overland flow to the roadside ditching along Concession 1 and Highway 12. The western part of the site (located west of the railbed) drains towards the north and west. The proposed quarry's subwatershed areas (and associated drainage features and watershed divides) are shown on Figure 15, and a more detailed discussion about surface water flow at is provided below.

7.2.1 Tributary A/ Pond 1 Catchment - Northeast Area of Proposed Quarry

The Tributary A / Pond 1 sub-watershed is located in the northeast corner of the proposed quarry and has a catchment area of approximately 63 hectares (ha), of which 43.7 ha is on-site. The sub-watershed drains via an ephemeral drainage feature (Tributary A). At the north property boundary, a dugout pond (Pond 1) was historically built for livestock, between 1954 and 1978 according to historical air photos. The pond has a wetted area of about 1,500m^2 and water levels fluctuate seasonally being more wet during the spring freshet (> 1 m) and drier during summer drought period, when precipitation inputs are limited.

Pond 1 is controlled by a “fill and spill” mechanism. Following a precipitation event or snowmelt, the pond fills up and spills into the surrounding wetland fringe (combined area of approximately 5,000m^2). There is a broad saddle on the northeast side of the pond / wetland that has an invert elevation of approximately 231.1 masl. When the water levels in Pond 1 are higher than this elevation, water overflows and migrates to the Concession 2 roadside ditch. The Concession 2 roadside ditch (at this location) is the McNabb Drain. Monitoring station SW1 is situated downstream of the confluence of Tributary A and the McNabb Drain. In 2020, Pond 1 discharged to the McNabb Drain on 34 days out of a 175-day monitoring period. In 2021, Pond 1 discharged to the McNabb Drain on 71 days out of a 203-day monitoring period. In this area, the surface topography is generally flat, and water pools and remains within the hummocks and rills. This pooled water can remain in place, instead of running off, which has the effect of increasing evaporation and reducing the net surplus / runoff, although a standard water balance model would not account for this effect. There is reasonable correlation between water level and rain events, showing that runoff from precipitation is the primary control on pond water levels.

7.2.2 Tributary C Catchment – North-central Area of Proposed Quarry

This sub-catchment includes the northwestern part of the proposed quarry area, east of the rail alignment. It includes Tributary C, which is an intermittent tributary that is aligned along the west side of the property boundary. The property boundary in this area follows rock piles of cobble and stone picked from the agricultural fields. This tributary rarely flows but discharges to the south roadside ditch of Concession 2, which then crosses to the north side via a culvert to the McNabb Drain (which is the north roadside ditch).

7.2.3 Tributaries B+G/ Pond 2 Catchment - Northwest Area of Proposed Quarry

This sub-catchment includes the northwest part of the proposed quarry from the central ridge to the property boundary. It includes Tributary B, which drains the north flank of the ridge to Pond 2, and Tributary G which flows from Pond 2 north to the McNabb Drain at Concession 2. Tributary G is oriented along the east side of the railbed. The catchment for Pond 2 has an area of 26.5 ha which is entirely on-site.

Along Tributary B and Pond 2, the topographic slope is low, and Tributary B drains through a swale and wetland along the flank of the ridge. In this area, water pools and remains within the hummocks and rills. This pooled water can remain in place, instead of running off, which has the effect of increasing evaporation, although the water balance model does not account for this effect. From Pond 2 to the property boundary, Tributary G also has low grade. In periods of greater runoff, flow is northward in Tributary G to the McNabb Drain. In periods of minimal runoff, water pools within the wetland areas on-site near Pond 2, and the upper section of Tributary G near the outlet of Pond 2. Sections of Tributary G near the north property boundary have been observed dry at times during the monitoring program (SG-4). This is often during the drier summer months when precipitation inputs are limited. In addition, when there is a transition from a wet period to a dry period, pooled water has been noted flowing in a reverse direction back towards Pond 2. This was observed by Azimuth in the spring of 2020.

Tributary G drains into the McNabb Drain, entering the Drain approximately 250m west of the Tributary A outlet. At this point, the McNabb Drain is ditched to the north, leaving the Concession 2 roadside ditch. Surface water levels and flows from this point are measured at SW-2. Discharge at SW-2 is noticeably greater than the upstream monitoring location at SW-1. Presumably, this is largely a result of the inputs from Tributary G to the drainage feature. The catchment for this sub-watershed has a total area of 76.0 ha, of which 26.5 ha is the catchment for Pond 2 as described above. The remaining area is 49.5 ha, and includes off-site farm fields downstream of the property boundary but upstream of the McNabb Drain.

7.2.4 Southeast Area Catchment

The southeast corner of the proposed quarry (east of the rail alignment) is bounded by Highway 12, Concession 1 and the central ridge. This catchment has an area of 62.4 ha, and an on-site area of 59.3 ha. There is no tributary in this catchment. Instead, drainage is overland and is intersected by the Highway 12 and Concession 1 roadside ditches. In some locations, drainage continues past the roadside ditches overland onto the adjacent farm fields to the south, or the roadside ditches divert flow to Highway 12, and then to a small tributary about 300m south of Concession 1. This small tributary flows southeasterly to the Talbot River. Pond 3 is located in this subwatershed. Pond 3 is a small dugout pond, and has no channel coming in nor leaving the pond. Pond 3 is isolated from any direct drainage features (*i.e.,* swales, tributaries, drains, *etc.*) as it receives surface water runoff from overland sheet flow and does not outlet (i.e., contained on-site). As such, water levels are regulated by precipitation events and evaporation (and to lesser degree infiltration). Water levels may possibly breach the edge of the pond seasonally during flood conditions; however, due to the area's poor drainage, any flooding is contained locally.

7.2.5 McNabb Drain Catchment Upstream from Proposed Quarry

Upstream of the proposed quarry, the McNabb Drain has a catchment that extends easterly past Highway 12, and has a sub-catchment an area of approximately 125 ha upstream from where Pond 1 discharges. These lands include the Brechin Industrial Park stormwater controls, the western portion of the Lafarge Brechin Quarry, a larger wetland on the east side of Highway 12 and some agricultural fields. This subwatershed is the contributing section upstream of the discharge points from the subject lands.

7.2.6 McNabb Drain Catchment Downstream from Proposed Quarry

This subwatershed extends from the location where Tributary G enters the McNabb Drain and extends downstream to Lake Simcoe, and also includes a small section in the northwest corner of the property that drains to the roadside ditch of Concession 2. Water level monitoring locations are located about 20m downstream of Concession 2 (SW2), and at Ramara Road 47 (SW3). The water balance focuses on SW2, since lands downstream cannot be potentially affected by the proposed quarry. The McNabb Drain flows approximately 150 m northward from Concession 2 and then turns in a westerly direction into a more naturalized channel feature. The banks of the McNabb Drain become less incised after crossing Ramara Road 47. Based on the Ontario Flow Assessment Tool (OFAT), this sub-watershed has an area of 400 ha. This sub watershed is the receiving body downstream of the discharge points from the subject lands.

7.3 Surface Water Monitoring

As previously indicated, a surface water monitoring program was implemented in the spring of 2020 to monitor on-site features such as ephemeral drainage features and dugout ponds. Staff gauges and stilling wells are used to monitor the presence and physical depth of water, in addition to qualitative details from visual inspections and photographs. The McNabb Drain, being off-site to the north, is also monitored using stilling wells and dataloggers at three (3) strategic locations. Where possible, stream discharge measurements have been collected from these stations during 2020, 2021 and 2022 to establish rating curves and estimate discharge volumes throughout the hydroperiod. This engineered feature conveys the majority of overland run-off from the proposed quarry (and adjacent fields) to Lake Simcoe. This feature also collects discharged water from the stormwater controls at the nearby Lafarge Brechin Quarry.

Surface water stations are monitored on a continuous basis throughout the hydroperiod at three (3) monitoring stations (SW1, SW2 and SW3) and at two (2) pond stations (Pond 1 and Pond 2). Runoff measurements are supplemented with manual measurements at four (4) stations (SG1 to SG4). Dataloggers are not installed at these stations as they are ephemeral in nature and predominantly dry, except for immediate response to precipitation events. The various sampling stations are shown on Figure 9. Representative photographs were captured over the monitoring period and selected photos showing site conditions are provided in Appendix O. A summary of the collected manual data and qualitative information are also included in Appendix O, along with water level and discharge hydrographs for SW1, SW2 and SW3.

7.3.1 Monitoring Results – On-site Ponds

Hourly water level measurements are being collected at Pond 1 and Pond 2 given their inferred connection to the McNabb Drain. Pond 3 is isolated with no inlet or outlet and collects runoff via local overland flows from precipitation and snowmelt. As such, the hydrologic trends of this feature are expected to follow a similar trend as Pond 1. Pond details are provided below in Table 9.

Table 9: Pond Monitoring Data

Monitoring Station	Surface Area (m^2)[1]	Depth (m)[2]	Water Level (m)[3]		
			Minimum	Maximum	Average
Pond 1	1,570	2.1	<0.01	0.72	0.17
Pond 2	920	1.7	0.11	0.70	0.29
Pond 3	630	3.0	NA	NA	NA

Notes:

1. Surface area estimates obtained from aerial imagery (FBS, 2018)
2. Pond depth estimates assumed from overburden depth determine from borehole drilling programs.
3. Based on datalogger measurements collected between 2020 and 2021.
4. Pond 3 not monitored due to no observable hydraulic connection to surface water features (isolated).

Pond 1

Pond 1 is ephemeral as it relies mainly on precipitation and snow melt to maintain water levels rather than inputs from ground water. The hydrograph at Pond 1 (used as a surrogate for Pond 3) displays a typical storm response curve during large precipitation events, while a continuous decline in water levels is noted throughout the summer months primarily due to increased evaporation. These defined temporal trends also suggest that ground water inputs are essentially negligible. Water levels at the pond's monitoring point ranges from nil to 0.72 m above the monitoring point; though average levels occurring at about 0.17 m. While the datalogger has been out of the water for short periods during the early summer months (mainly in 2020), the pond has not been observed to be dry at anytime during the monitoring program.

There is no distinct outlet or overflow at Pond 1, as it releases water overland to the east during flood conditions. Surface water is collected and contained within the pond due to constructed berms along its perimeter. During flooding conditions, water levels rise in the pond and appear to breach the eastern berm area at an elevation of about 231.1 masl[3]. Discharge from the pond occurs as laminar overland flow, while the local topography collects pooled water and directs any runoff towards a roadside ditch located on the south side of Concession Road 2. A culvert at SG1 conveys flows to the McNabb Drain upgradient of SW1. The hydrograph presented in Figure Q (overleaf) shows the relationship between the pond elevation and the expected frequency of discharge events from the pond. In 2020 and 2021, overflow conditions were reported over 34 out of 174 days and 71 out 203 days during the hydroperiod, respectively.

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[3] An elevation survey (referenced to BH1) was completed by Azimuth to establish the overflow elevation of Pond 1, which was found occur at about 231.1 masl.

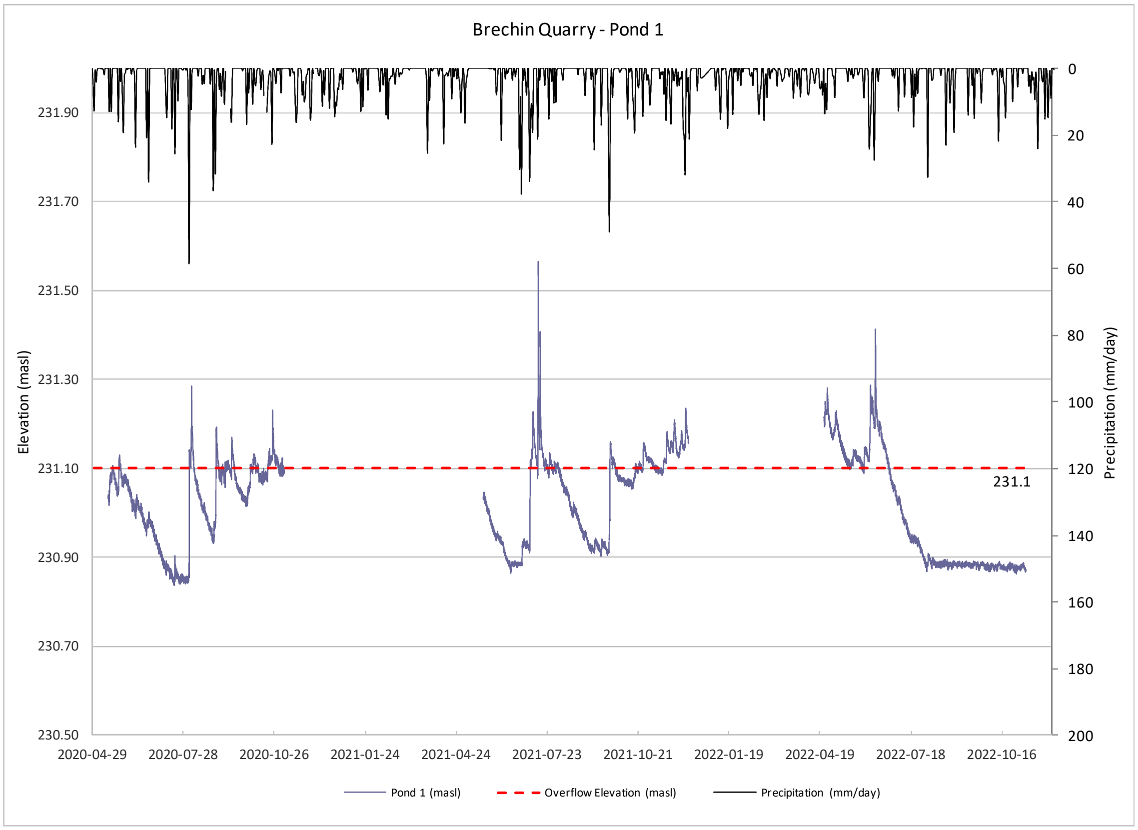


Figure Q: **Pond 1 Hydrograph and Overflow Frequency**

Pond 2

Pond 2 is an irregular shaped dug-out feature that is also positioned within an area of poor drainage at the proposed quarry. In its catchment, some surface water runoff enters the pond via overland sheet flow; however, most of its water contribution enters from an ephemeral drainage feature (Tributary B) situated east which captures runoff and conveys flows westward to the pond. Hydrograph data for Pond 2 (Appendix O), suggest that this feature may be partially supported by shallow perched ground water aquifer, likely associated with the adjacent wetland. Water levels are observed to equilibrate during the summer period, despite increased evaporation and limited precipitation. This trend may suggest that the pond may be buffered from perched ground water stored within the saturated overburden soils associated with the wetlands. The greater vegetation density may also provide protection from excess evaporation, allowing the perched conditions to persist for a longer period of time than seen at the other ponds. Water levels at the ponds monitoring point ranges from 0.11 to 0.70 m above the monitoring point; though average levels occurring at about 0.29 m (see Figure R).

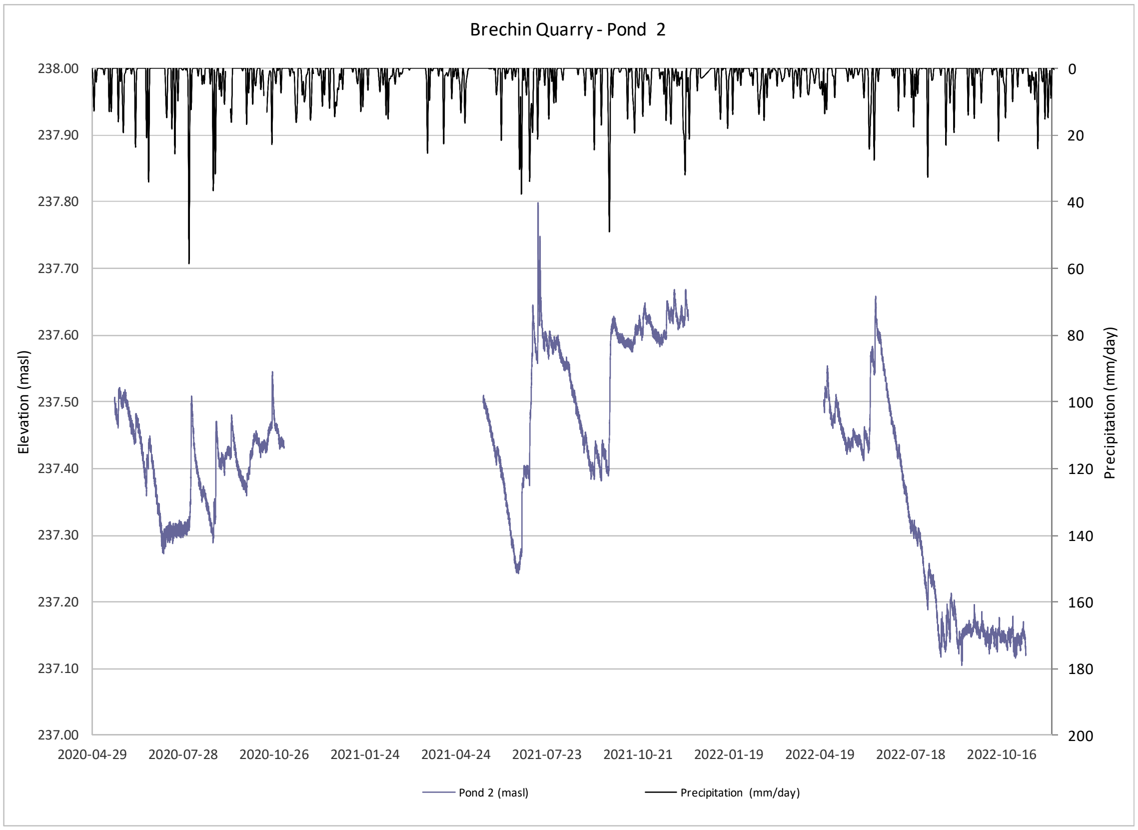


Figure R: Pond 2 Hydrograph

Ultimately, Pond 2 outlets during flood conditions through an ephemeral dugout ditch (Tributary G) situated to its north. This ditch runs parallel with eastern edge of the former rail alignment and surface water flows northward off-site which continues along the rail alignment and discharges through a culvert crossing (south-north orientation) at Concession Road 2 to the McNabb Drain. When surface water contributions become limited in this feature (*i.e.,* at the end of the freshet period), water levels in the pond appear to equilibrate and subside due to increased evaporation. At this point, water levels in Tributary G appear to stagnate and have also been observed to reverse flow back to the pond (during the summer of 2020). This feature was also noted to be dry (or water levels < 0.01 m) during much of 2020. Moreover, a drainage ditch also occurs on the west side of the rail alignment which flows in a similar pathway. Inspections along the rail alignment did not note any culverts or areas where water from the drainage ditches cross over the alignment. However, the east and west ditches appear to coalesce off-site where the former rail alignment has been washed or mechanically dug out. The western ditch along the rail alignment is often noted to be dry and likely conveys overland surface flows off-site.

7.3.2 Monitoring Results – McNabb Drain

Currently there are three (3) surface water stations monitoring water levels and flows along the McNabb Drain (SW1, SW2 and SW3). Hourly water level measurements are collected at these stations and periodic flow measurements are collected throughout the hydroperiod to refine rating curves. SW1 and SW2 are situated along Concession Road 2 and represent a dugout portion of the ditch with steeply incised embankments that are regularly greater than 2 m in height. Substrate conditions at these closely match the overburden conditions (silt and sandy silt), with some overlying “muck” formed from decaying vegetation. The channel is permanently wet, however, channel flow is often not recorded during the summer months. SW3 is situated downgradient of the drains crossing at Highway 47 and is downgradient of a 2 m diameter steel culvert. Downstream of Highway 47, the channel exists in a more natural condition with a cobbly substrate that is substantially wider and has a defined riparian edge that likely reflects the original channel configuration. The hydrologic trends of the McNabb Drain have been observed over the hydroperiod in 2020 and 2021. The drains details are provided below in Table 10.

Table 10: McNabb Drain Surface Water Monitoring Data

Station	Wetted Width (m)[1]	Water Level (m)[2]			Discharge (L/sec)[3]		
		Minimum	Maximum	Average	Minimum	Maximum	Average
SW1	1.7	0.06	1.11	0.28	0.00	234	35
SW2	1.7	0.06	1.15	0.24	0.00	245	50
SW3	2.7	0.02	0.49	0.18	0.00	295	55

Notes:

[1] Average wetted width between 2020 and 2022.

[2] Water level statistics based on datalogger measurements collected between 2020 and 2022.

[3] Discharge estimated using station rating curve (exponential fit) determined from stream flow measurements and water levels collected between 2020 and 2022.

While water levels in upgradient stations (SW1 and SW2) can be greater than 1 m, on average they occur on the order of about 0.27 m and 0.26 m, respectively. This correlates to average flows of about 35 to 50 L/s at each location, respectively. Peak flows are estimated to be about 234 and 245 L/s; however, data in these higher ranges are infrequent due to the features quick hydraulic response to precipitation events (*i.e.,* storm response). Water levels at SW3 are generally less variable which is likely due to its more naturalized condition. Peak water levels at this location occur on the order of about 0.49 m with estimated flows of about 295 L/s. On average, water levels and flows at this location are more on the order of about 0.19 m and 55 L/s, respectively. The majority of flows at all locations occur around the average range of flows (which also represents the 50th percentile). A consistent response pattern is noted across all stations which indicates that flows are largely regulated by large precipitation events (*i.e.,* storm response curves), rather than inputs from ground water. The monitoring results do suggest a "gaining" function to this drainage feature, however, this is more likely a result of water inputs from the extensive tile drain network in the adjacent agricultural fields rather than ground water due to low permeable overburden soils.

The calculated average flows appear robust when compared to the MNRF's Ontario Watershed Information Tool (OWIT), which align quite well to the modeled mean annual flow values for SW1, SW2 and SW3 (30 L/sec, 45 L/sec and 50 L/sec, respectively). Given that the majority of estimated flow data occur around the 50th percentile, the estimated peak flows may be less accurate due to the limited number of measured flow data during these storm response periods. OWIT modelled peak flow estimates (Q_{20}) for these same surface stations are an order of magnitude higher than the calculated peak flows between 2020 and 2021 (or about 1,800 to 2,500 L/s compared to 234 to 295 L/s). This is not unexpected given that the OFAT values represent 20-year flood events, and data collected during this climate period are more on the average to lower range based on observed weather during 2020 and 2021 seasons. It is expected that the rating curves established at each location will continue to be refined; however, the results appear to robustly predict mid- to average conditions, which occur most frequently.

7.3.3 Monitoring Results - Staff Gauge Locations

Runoff measurements are supplemented with manual measurements at four stations (SG1 to SG4). Transducers are not used at these ephemeral stations as they are predominantly dry, except for immediate response to rain events. Spot measurements, notes and photographic media are collected. Most manual measurements record water levels under flowing conditions during the spring and late summer/ fall periods. This is not unexpected due to the shallow nature of these features. Baseflow contribution is expected to be not apparent, such that flowing conditions are solely derived from either snowmelt during the spring freshet and/or large precipitation events. Manual data from these monitoring locations and select photographs are provided in Appendix O.

7.4 Surface Water and Ground Water Interaction

The swales and ephemeral tributaries on-site are very shallow, and do not extend deep enough to intersect the permanent water table. Infiltration is low, being less than 25 mm/year in the regional ground water model (Earthfx, 2014), and falls within the range of 50 to 75 mm/year in the site-specific ground water model undertaken for the quarry application (Golder, 2023). Golder utilized a range of infiltration values (65-75mm/year) in the Carden Plain Cumulative Impact Assessment (Golder, 2012). Thus, the major portion of the water surplus occurs as overland runoff.

A small amount of infiltration may occur within the overburden through to the weathered bedrock zone given the transitional basal contact between the two (2) geologic units; however, this is expected to be minimal. Perched water table conditions are likely limited to areas of poor drainage, such as those noted around the observed ponds. In addition, the lateral and vertical movement of surface water through the subsurface would be hindered by the low conductive nature of the soils (*i.e.,* glacial till). As such, the perched aquifer conditions often become desiccated during the drier months (as noted during the borehole drilling programs). Therefore, evaporation and run-off are the main hydrologic mechanism for conveying surface water at the proposed quarry, and there is limited or poor connection to shallow ground water.

The McNabb Drain is a maintained agricultural drain. Where the Drain is also the Concession 2 roadside ditch, it is incised by about 1 to 2 m, and in some stretches may be deep enough to reach the seasonally perched water table. Ground water contribution (*i.e.,* springs) is not noted along Concession 2, however, due to the low hydraulic conductivity of the overburden they may occur seasonally.

8.0 KARST INSPECTIONS

The proposed quarry is situated in proximity to *potential* and *inferred* karst features mapped north of the proposed quarry and within the Study Area (Figure 7). While the closest *known* karst feature occurs about 3.5 km north of the proposed quarry towards the village of Brechin, it is still warranted to confirm the presence of karst features at the proposed quarry. During field inspections completed during 2019 and 2020, no karst or epikarst features were observed to occur on-site. These features typically include: springs, sinkholes, solution-enhanced crevasses, areas of subsidence or caves. While bedrock is noted to be shallow at the proposed quarry, outcropping is not generally observed in this area; with the exception of some locations near Highway 12 where areas have been disturbed.

While many boulders are found to outcrop at surface across the proposed quarry, they do not appear to be associated with relevant karst features. Based on the field observations, they appear to be residual fragments related to the weathering of the shallow soil exposing the stone content within the glacial till unit. Their inclusion in the glacial till is inferred based on the subangular to subrounded shape of the observed stone material. The blanketing of the proposed quarry with a low permeable glacial till unit would provide protection against karst development. Ford (2010) indicates that karst formation beneath carbonate overburden is limited when the overburden is greater than 1 m in thickness. This indicates that the potential for significant karst processes is limited. Similarly, the carbonate-based soils would be quite alkaline which would neutralize the acidic precipitation that is able to infiltrate, again limiting the potential for dissolution of the upper bedrock unit at the proposed quarry.

Again, the Gull River and Bobcaygeon Formations are most susceptible to karstification due to their high carbonate content and limited (or thin) shale beds. The uppermost bedrock surface is made up of the Verulam Formation (Golder, 2021), which has much greater shale content which makes it less susceptible to these processes. As per OGS mapping, the Verulam and Bobcaygeon Formations contact line appears to demarcate the *potential* karst limit (Figure 7). As such, there is a low potential for karst features to occur at the proposed quarry and a more detailed assessment is not necessary.

9.0 CONCEPTUAL SITE MODEL

9.1 Hydrology

The proposed quarry is situated within the Lake Simcoe watershed, and more specifically, within the Ramara Creeks Sub-watershed and a small portion of the Talbot River Subwatershed. Locally, the topography of the proposed extraction area has a main drainage divide within the overburden in a northeast to southwest orientation. This divide directs surface water runoff overland to either the northwest or southeast. The north subwatershed flows to the McNabb Drain along Concession 2, and has three subcatchments (Tributaries A, C and G) that direct runoff from sections of the proposed quarry northward to Concession 2. The locations of these features are shown on Figure 9.

Within the proposed limit of extraction, there are a number of small wetlands and pond features that reflect topographic depression. These include dug-out ponds located in the northeast and southeast corners of the proposed quarry (which are referenced as Pond 1 and Pond 3, respectively), and a third dug-out pond (Pond 2) located centrally along the western limit of the proposed limit of extraction adjacent to the former rail corridor.

Because of the low permeability of the surficial overburden, and the shallow depth of the upper bedrock surface, the surface water regime controls the majority of flow, and the ground water regime reflects the low infiltration quantity that can migrate downwards via the fractured upper bedrock surface.

These surface water drainage features are isolated from the underlying aquifer networks located within the parent bedrock surface. A small amount of infiltration may occur within the overburden through to the weathered bedrock zone given the transitional basal contact between the two (2) geologic units; however, this is minimal. Perched water table conditions are likely limited to areas of poor drainage, such as those noted around the observed ponds. In addition, the lateral and vertical movement of surface water through the subsurface would be hindered by the low conductive nature of the soils (*i.e.,* glacial till). As such, the perched aquifer within overburden often becomes desiccated during the drier months (as noted during the borehole drilling programs). Therefore, evaporation and run-off are the main hydrologic mechanism for conveying surface water at the proposed quarry, and there is limited or poor connection to shallow ground water.

9.2 Hydrogeology

The hydrogeological conditions in the Study Area are well documented. In general, ground water flow in the Study Area is expected to be primarily northeast to southwest in orientation. Golder (2021) confirmed a slight southwestern dip in the bedrock surface, and as such, ground water flow is expected to occur in a similar flow path within the laterally bedded limestone formations toward Lake Simcoe. Ground water recharge is expected to occur regionally in areas of greater permeability or hydraulic conductivity (K). According to Kassenaar & Wexler (2014), significant ground water recharge areas are situated north, northeast and east of the Study Area within karstic terrain associated with alvars on the Carden Plain. Significant areas of ground water recharge are not noted on-site.

Based on the available information, it is understood that three (3) moderately permeable zones or aquifers occur regionally within the Paleozoic limestone in Study Area. These laterally bedded aquifers are separated by thick horizontally layered beds of low permeable Paleozoic formations (aquitards). However, the proposed quarry does not entirely fit within this regional model. Based on the data collected (hydraulic testing and heads), there appears to be very little hydraulic differences between the Verulam to the Shadow Lake/ Precambrian Basement, indicating that the formations are rather impermeable. Based on this finding, the following simplified hydrostratigraphic model is presented below and discussed in more detail below, given the relative similarities in hydraulic properties (*i.e.,* K-values):

- Overburden (silty sand to silt till, clay) – Aquitard 1
- Weathered Bedrock Zone - Aquifer 1
- Verulam / Bobcaygeon / Gull River Formations – Aquitard 2
- Green Marker Bed – Aquifer 2
- Lower Gull River Formation – Aquitard 3
- Shadow Lake Formation/ Precambrian Contact Zone – Aquifer 3
- Precambrian – Aquitard 4

9.2.1 Aquitard 1 - Overburden

A stone-poor sandy silt/ silt glacial till dominates the landscape at the proposed quarry and in the Study Area. However, some variability is noted in the Study Area as discontinuous interstadial sediments (often associated with glaciolacustrine and glaciofluvial deposits) are found as well. Where present, these interstadial sediments represent the most recent deposition event(s) in the study area.

While monitoring wells on-site do not target this sequence, published K-values are noted to range between 10^{-8} to 10^{-7} m/sec (Kassenaar & Wexler, 2014). The higher range of K-values would represent the discontinuous sands and gravels discussed above, while the lower range is more representative of the till. Based on the findings geological conditions encountered at the proposed quarry, K-values for this horizon are more on the order of 10^{-7} to 10^{-6} m/s. At the time of drilling, the overburden was found to be dry; however, it is worth noting that both drilling programs were completed during the late summer season. Localized perched aquifer conditions may be present in areas of poor drainage on-site (or where overburden is of appreciable thickness) following the spring snow melt/ freshet; however, these conditions do not persist throughout the year. This is supported by water level monitoring at Pond 1 (which is constructed in the overburden) and shows a declining trend in water levels throughout the summer period with little to no baseflow contribution (Figure Q). Water migration in the weathered zone also occurs along dessication fracture networks at a more rapid pace than through the matrix porosity.

9.2.2 Aquifer 1 - Weathered Bedrock Zone

In the study area, the weathered bedrock zone generally occurs within the transitional contact between the overburden and the Verulam Formation (stratigraphic units 5-1 & 5-2). Regionally, this aquifer is most evident where coarse textured soils (*i.e.,* sand and gravel) occur above the weathered bedrock surface (Kassenaar & Wexler, 2014). These coarse textured deposits are associated with buried tunnel valleys that formed during subglacial drainage events. In the study area, this forms a regional shallow aquifer that is often capable of supporting domestic water supplies. At the proposed quarry, the coarse textured basal sediments described above were not encountered during the borehole drilling programs. Notwithstanding, a highly weathered bedrock contact was encountered between 0.5 to 1.5 m bgs in the rock core at BH-2, BH-3 and BH-4. The surface was described by Golder (2021) as consisting of "*broken core, brownish coloured oxide staining on bedded partings and fractures and the breakdown of shaley material to clayey conditions*".

Where present on-site, this sequence is expected to be moderately permeable, with the ability to transmit ground water laterally through the subsurface. While on-site monitoring wells target the lower sections of the Verulam Formation (*i.e.,* stratigraphic unit 5-1), published K-values for the *weathered bedrock zone* range from ~10^{-7} to 10^{-5} m/sec (Kassenaar & Wexler, 2014). Despite the two-order magnitude range in published

K-values, the geological conditions encountered at the proposed quarry for this horizon have a representative average of 10^{-6} m/sec.

9.2.3 Aquitard 2 - Verulam / Bobcaygeon / Gull River Formations

Regionally, the upper bedrock aquitard generally consists of the rather impervious shales and interbedded limestone of the lower Verulam Formation (~6 to 19 m thick), and the more competent limestone of the Bobcaygeon Formation (~26 to 27 m thick) and Upper Gull River Formation (Unit 3-4). Though these formations are easily distinguishable from one another based on geology, these formations are often consolidated given the apparent low permeable conditions that yield relatively similar K-values. Table 6 provides a list of published and in-situ derived K-values for the above noted formations in the Study Area and on-site.

9.2.4 Aquifer 2: Green Marker Bed

On a regional scale, the Green Marker Bed (GMB) are noted as having zones of higher conductivity and have hydraulic responses to events such as pumping tests. However, at the proposed quarry, the hydraulic conductivity of the GMB is generally lower than is observed regionally. While the GMB has the highest range of permeability within Aquitard 2, the observed permeability is much lower than the high permeability observed regionally. Therefore, the GMB on-site can provide a zone of enhanced lateral flow, but not to the extent observed regionally.

9.2.5 Aquitard 3 - Lower Gull River Formation

The Lower Gull River Formation includes thickly bedded limestone and dolostone. Published K-values for this basal contact range between 10^{-11} to 10^{-4} m/sec (Kassenaar & Wexler, 2014). The Lower Green Marker Bed forms the upper contact for this unit and it was also found on-site to have low permeability (5.9x10^{-9} m/sec).

9.2.6 Aquifer 3 - Shadow Lake Formation/ Precambrian Contact Zone

The Shadow Lake Formation represents the bottom of the Paleozoic limestone bedrock (~7.5 to 8.5 m thick), as it overlies the Precambrian basement. The composition of Shadow Lake Formation is quite variable in the Study Area, although it is regionally described as consisting of moderately weathered quartz sandstone, a confining zone of red-green shale beds, and coarse-textured sandstone and conglomerates (Golder, 2021). The basal contact at the weathered crystalline Precambrian basement is generally associated with a regional aquifer in the Study Area. Published K-values for this basal contact range between 10^{-11} to 10^{-4} m/sec (Kassenaar & Wexler, 2014). The Shadow Lake Formation is monitored on-site at BH-2C, while the basal contact interval is monitored at BH-1B and BH-4B. Packer testing at BH-2C indicate that the upper unit of formation (i.e., quartz sandstone) is moderately permeable (~10^{-6} m/sec); although follow-up hydraulic testing of the formation interval is on the order of 10^{-7} m/sec. Packer testing at the contact interval did not demonstrate permeable conditions as K-values were on the order of $\sim10^{-8}$ m/sec, while hydraulic testing of the instrumented intervals ranged between $5x10^{-9}$ to $2x10^{-8}$ m/sec. This is consistent with the core logging and geophysical assessment. As expected, the water levels within the Shadow Lake Formation and the contact interval are not markedly different (~220 masl) and the lowest in the profile; with the exception of BH-4B, which is over 10 m higher in elevation (~231 masl).

10.0 GROUND WATER IMPACT ASSESSMENT

10.1 General

During quarry operations, water that collects within the proposed limit of extraction is to be pumped from the quarry excavation to maintain suitable working conditions. Inherently, this water will be a combination of precipitation and ground water that seeps through the quarry walls and floor. This seepage creates a drawdown zone around the quarry. The scale of drawdown is limited by the hydraulic properties of the bedrock units, climate conditions, and the depth and areal extent of the quarry excavation, and length of time. Ground water models are used to evaluate potential impacts to the surface and ground water regimes. These models use environmental data to calibrate existing conditions and apply various scenarios to predict impacts (if any).

The proposed quarry is located between two (2) other licenced active quarries. The extraction footprint for the proposed quarry is within 700 m of the extraction area of the Lafarge Brechin Quarry and 200m of the extraction area of the James Dick Gamebridge Quarry. As the drawdown effects from a quarry in this geologic setting can extend more than 500m, there is the potential for drawdown and cumulative impacts if specific conditions occur. The greatest potential ground water impacts would occur if the three (3) quarries are at their maximum areal extent and maximum depth at the same time. However, the drawdown from each quarry is a transient condition that will develop and then dissipate after any of the quarries has ceased operations and is permitted to fill as a lake. The quarry operations each are separate entities, and as such, extraction depths and extraction areas are a function of operational and economic conditions. Each quarry will have a different extraction timeline, and therefore are unlikely to reach the end of their operational life at the same time, so the greatest potential impact scenario is unlikely to occur (i.e. all quarries at their maximum areal extents and maximum depths at the same time). It is recognized that quarry extraction occurs over an extended time period, and that any predicted impacts to the ground water regime will occur gradually over many years so that monitoring can observe actual effects as they develop. Although models predict impacts, these are based on certain assumptions. Actual impacts would develop based on transient circumstances depending on the state of each quarry's extraction at any specific point in time. Actual impacts will be identified through a monitoring program that would be continued through the quarry operating lifespan and initial closure/rehabilitation period.

10.2 Ground Water Modelling

A ground water modelling report was prepared by WSP, for the proposed quarry to evaluate and quantify potential impacts related to ground water conditions and private wells within the general area (WSP, 2023). The report is summarized in the sections below; however, the full report has been included in Appendix E.

The ground water model was created on the basis of detailed site information provided by Azimuth and has incorporated conservative assumptions to predict the significance of impacts to the ground water regime. The model was calibrated to observed conditions, and was then utilized to evaluate the following scenarios:

(1) Full development of the Lafarge and James Dick quarries only (the areas currently approved for quarry extraction);
(2) Full development of the proposed quarry with Lafarge and James Dick quarries remaining at existing conditions; and
(3) Full development of the proposed quarry with full development of the Lafarge and James Dick quarries.

The model is a steady-state model that assumes that conditions continue indefinitely. The model assumes that each quarry is pumped to maintain dry working conditions under average climate conditions and that geological conditions are laterally extensive. The use of a transient model may replicate the propagation of impacts more realistically but was considered to not be appropriate as the timeline for each quarry's development cannot be defined. Also, the steady-state model is more conservative and therefore makes worse case predictions for each scenario.

The model allows for determination of the contribution to total drawdown that can be attributed to the proposed quarry under the various scenarios considered. The closest ground water receptors are identified as sixteen (16) private drinking water wells located within approximately one (1) kilometer of the proposed quarry boundary. For the various scenarios, the model was utilized to determine potential drawdown at those receptors. It is expected that actual impacts will be less than those predicted by the model, as the model is based on conservative assumptions.

For instance, Scenario 1 predicts that cumulative impacts from the existing quarries only (not including the proposed quarry) could develop in the future, if they were to reach their approved depth and extraction area simultaneously. This scenario is shown on Figure 10 in the WSP Report. Upon reviewing this outcome, the proposed quarry was designed so that the base of the proposed quarry will remain 10 m above the contact between the Bobcaygeon and Gull River Formations.

Scenario 2 examines the resulting drawdown created by full development of the proposed quarry compared to the predicted drawdown from the two (2) adjacent quarries, if they were to remain in their existing state. The predicted drawdown associated with Scenario 2 is shown on Figure 11 of the WSP Report.

Scenario 3 looks at the full development of all three (3) quarries to their proposed and currently approved limits of extraction. The results of this scenario suggests that the additional drawdown resulting from the proposed quarry is minimal (refer to Figure 14 in the WSP Report). The modelling results for Scenario 3 are shown on Figure 12 of the WSP report.

10.3 Private Well Impact Assessment

The WSP Report (Appendix E) provides an impact assessment for the proposed quarry on private wells under Scenario 2 and provides detailed tables and mapping of the predicted drawdown as a result of the development of the proposed quarry with the adjacent quarries remaining at their existing conditions. Their analysis includes evaluating the predicted drawdown and reduction in available water column in each nearby well (receptor). Table 7 in the WSP Report highlights the results of the impact assessment, which estimates that the available water will still be 20 m or more in the private wells (including PW-1 to PW-7) which are the closest in proximity to the proposed quarry. Four (4) private wells (MECP WWR No.: 4600685, 4600686, 4600687 and 5714004) reportedly have a predicted available water column of less than 20 m, which is mostly due to their shallower well construction. WSP provided additional analysis and commentary on the above-mentioned wells and determined that the wells should not experience any negative well interference resulting from the proposed quarry.

Overall, WSP (2023) concludes that the proposed quarry development should not have a negative impact on nearby private wells. The proposed quarry is predicted to have minimal incremental drawdown should full development of the proposed quarry and the two (2) existing quarries occur on the same timeline. The predicted drawdown will be lessened if the full development of the proposed quarry and the two (2) existing quarries occurred on different timelines. This conclusion was based on the predicted drawdown from Scenario 2 (*i.e.,* maximum contribution to total drawdown from the development of the proposed quarry).

Under Scenario 3 (*i.e.,* full development of all three (3) quarries to their proposed and currently approved limits of extraction), the proposed quarry is predicted to have minimal incremental drawdown for most private wells and is limited to 3.2 m or less for the closest wells along Highway 12.

The model predictions are based on steady-state conditions, which means that the assumed conditions are continued in perpetuity. This is a conservative assumption and estimated worst case for each scenario.

11.0 SURFACE WATER IMPACT ASSESSMENT

11.1 Thornthwaite and Mather Water Budget

In order to determine the potential changes to the natural ground water recharge conditions, a pre- and post-development water balance assessment has been completed using the Thornthwaite and Mather method (1957). This method evaluates evapotranspiration based on precipitation and temperature. Residual soil saturation is a function of topography and soil type. Monthly data are tabulated from daily average temperature and precipitation, and the water budget is a continuous calculation over the period of record.

Values were determined on a monthly basis, compiled from daily Environment Canada meteorological data station located in Orillia, Ontario between 1992 and 2019. The calculations are based on the average conditions during this period; the average precipitation was 1,079 mm, rainfall was 740 mm, and evapotranspiration was 542 mm. The surplus is seasonally divided, with higher surplus in the spring and fall, and very little surplus in the summer season, as shown on Figure S. The total surplus was 537 mm with 200mm being related to rainfall and 337mm related to snow. The average snowmelt is 324mm, primarily occurring in February, March and April.

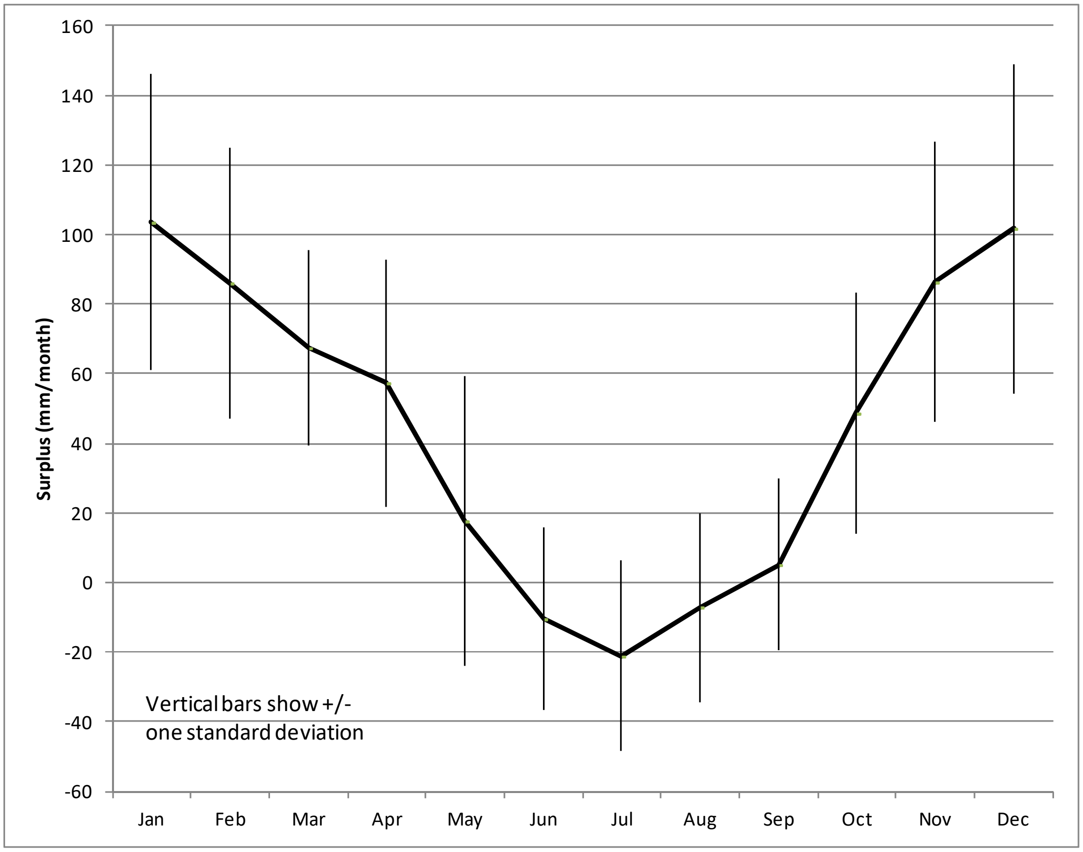


Figure S: Average Monthly Water Surplus, Orillia Brain Station (1992-2019)

Figure T shows the normalized runoff based on the Orillia climate data. The majority of the annual runoff (approximately 80%) occurs as snowmelt and spring rainfall primarily in March and April. The standard deviation in these months is high, because the snowmelt depends on whether it occurs late or early. During the remainder of the year, runoff is low, with almost no runoff from June to September. Fall rains contribute 10 to 15% of the annual runoff mainly in October and November.

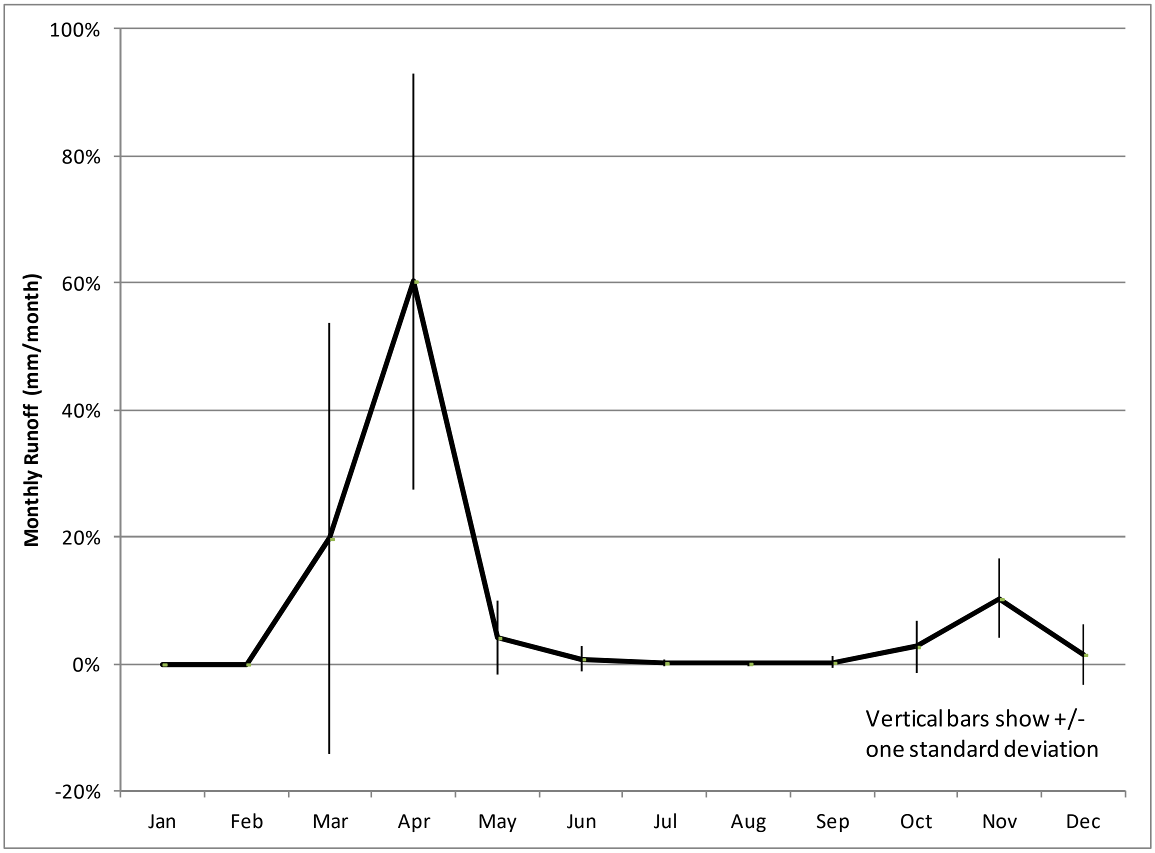


Figure T: Normalized Monthly Runoff

Both Figures S and T demonstrate the high variability in surplus and runoff values, reflecting the significant variation in temperature and precipitation that occur from year to year.

11.2 Pre-Extraction Water Balance

A pre-extraction water balance has been completed for lands to the east of the rail alignment of the proposed quarry. These lands have an area of approximately 120 ha. This area includes sections of four (4) sub-watersheds (Tributaries A, C and G that drain to the Concession 2 roadside ditch and then to the McNabb Drain, and SE Corner which drains towards the Concession 1 roadside ditch and then to a tributary of the Talbot River). An infiltration factor of 75mm/year was utilized, as this factor was determined during the calibration of the ground water model. As discussed above, the tributaries are all intermittent and only flow in relation to significant precipitation or springmelt conditions. The water balance for the lands west of the rail alignment is not expected to change because of the proposed use of these lands for ecological enhancement.

Water enters the proposed quarry by direct precipitation and water leaves by evapotranspiration, infiltration to the ground water regime and runoff to the surface water regime. A full breakdown is provided in Section 11.4, and the pre-extraction water balance is shown in Table 13.

The average precipitation amount is 1,315,000m^3/year, which remains constant for all of the scenarios presented below. Under pre-extraction conditions, evapotranspiration removes 660,500 m^3/year and 91,600 m^3/year infiltrates. Runoff in Tributary A is 201,700 m^3/year, is 117,300 m^3/year in Tributary G at the Pond 2, is 16,200 m^3/year to Tributary C and is 227,700 m^3/year to the SE Corner. Snowmelt accounts for 58% of the total runoff.

11.3 Water Balance During Operations

Water balances have been calculated for each subwatershed separately to determine the changes in those areas before being summed for the licensed area. A full breakdown is provided in Section 11.4. Note that the water balance calculations are a mass balance model, and are based on long term average climate data.

Figure 16 shows the conceptual water management strategy. Water management will include establishment of a quarry floor sump and pumping to a constructed outlet structure (COS) located at or near the property boundary at the south limit of Tributary C. The COS will be a man-made discharge pond that releases water towards the Tributary A-Pond 1 subwatershed by a passive weir. Within the property setback on the west side of Phase 1, a flow channel and wetland will be constructed to offset a wetland area that will be removed during Phase 2. These features are conceptually shown on Figure 16. The constructed channel will direct water from the COS along the west side of Phase 1 and then east along the Concession 2 berm to discharge to Pond 1 and Tributary A, reaching the McNabb Drain. During Phase 1, the quarry footprint only includes areas within the Tributary A catchment. As such, changes to existing conditions are considered to be minimal, as the discharge point from the proposed quarry will remain from Pond 1 to the McNabb Drain. During Phase 2, water from the quarry footprint that was originally in the areas of Tributary G, the Tributary C roadside ditch and the southeast corner catchments will also be discharged via the COS. Runoff from these areas reach the McNabb Drain under pre-extraction conditions. During extraction, discharge from the COS simply moves the discharge point for these waters a short distance upstream within the McNabb Drain.

11.3.1 Water Balance During Extraction - Phase 1 Completed

During Phase 1, quarrying will be underway in the north section of the extraction area, and water will pumped from a floor sump. During this phase, the quarry footprint is fully within the Tributary A sub-watershed. A small section of the Tributary C watershed outlet that currently discharges to the Concession 2 roadside ditch will be re-directed and flow is combined eastward towards Pond 1 (outlet of Tributary A). Tributary G (Pond 2) and the SE Corner sub-watersheds will not be altered, so there is no change within these areas.

The water balance calculations described in this section are based on the areas at the completion of Phase 1. At the completion of Phase 1, the extraction footprint is expected to be approximately 310,000 m^2. Within this area, the net surplus increases because evaporation is less than the evapotranspiration that would have occurred under existing conditions. This surplus will be discharged to the COS and released to the McNabb Drain. The Phase 1 Water Balance is shown in Table B of Section 11.4.

Net surplus increases by 84,000 m^3/year and evaporation / evapotranspiration decreases by the same amount because evaporation is less than evapotranspiration. Infiltration decreases to 68,300 m^3/year because the quarry floor is below the water table. The net runoff to Pond 1 (Tributary A) increases by 123,000 m^3/year, of which 16,000 m^3/year will be re-directed from the on-site portion of the Tributary C catchment to Pond 1.

The water pumped from the quarry will be about 250,000 m^3/year. Of this amount, snowmelt will account for 104,500 m^3/year, while 146,000 m^3/year will be pumped over the spring, summer and fall. It is expected that the water volume pumped from the proposed quarry will be monitored as a result of monitoring conditions associated with an MECP Permit To Take Water.

11.3.2 Water Balance During Extraction - Phase 2 Fully Active

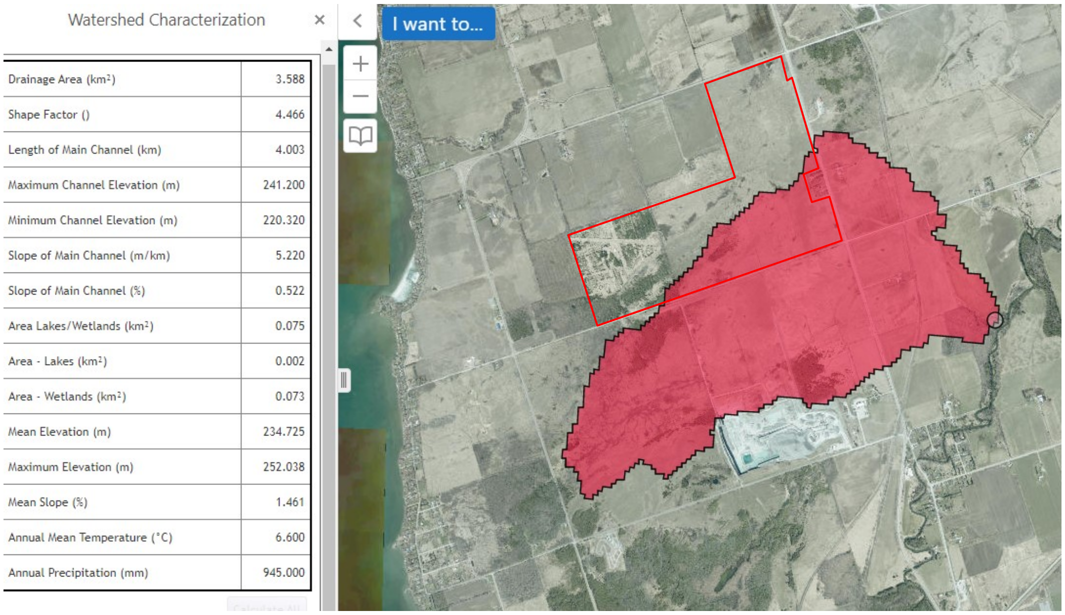
During Phase 2, quarrying is underway in the south section of the extraction area, and water from the quarry floor is pumped to the COS. The overall extent of the quarry excavation has been extended to the full footprint. The Phase 2 area includes more of the Tributary A sub-watershed, part of the Tributary G sub-watershed and the SE Corner sub-watershed. Water is pumped from a constructed sump on the quarry floor and flows to Tributary A. The Phase 2 quarry footprint at completion is approximately 605,000 m^2 plus the Phase 1 quarry footprint of 310,000m^2.

The water balance calculations are based on the areas at the completion of Phase 2. Within this area, the net surplus increases because evaporation is less than the evapotranspiration that would have occurred. This surplus is discharged at the COS and reaches the McNabb Drain. The Phase 2 Water Balance is shown in Table C of Section 11.4.

Compared to the pre-extraction scenario, net surplus increases by 249,000 m^3/year and evaporation / evapotranspiration decreases by the same amount because again evaporation is lower than evapotranspiration. Infiltration decreases to 23,000 m^3/year because the quarry floor is below the water table. The net runoff to the McNabb Drain will be 816,000 m^3/year, of which 300,200 m^3/year is snowmelt.

Monitoring of flows in the McNabb Drain at the outlet of Tributary A (SW1) reached a peak of 0.9 m^3/sec in 2020 and 1.15 m^3/sec in 2021. The highest rate of discharge from the proposed quarry will occur when snowmelt is pumped each spring. It is expected that snowmelt from within the quarry will be pumped out over several weeks. Assuming a four (4) week pumping period, this would require a flow rate of 102 L/sec (0.1m^3/sec) and is about 10% of the peak flows recorded. The effect of the pumping would be to extend the wetted period of the McNabb Drain by about two (2) to four (4) weeks.

During Phase 2, drainage from the quarry area that was originally a portion of the SE corner sub-watershed will be re-directed towards the floor sump and will be discharged via the COS. Pre-extraction drainage in this area is limited to overland flow that currently goes to the roadside ditch on Highway 12, and then to the south for approximately 700 m before entering a small intermittent channel (see Figure U). The diverted area is approximately 35.3 ha in area and consists primarily of agricultural fields. Based on the OWIT, the SE Corner subwatershed has an area of about 359 ha upgradient of its outlet to the Talbot River. The proposed diversion affects about 10% of the contributing watershed, which is not expected to significantly change the sub-watershed.



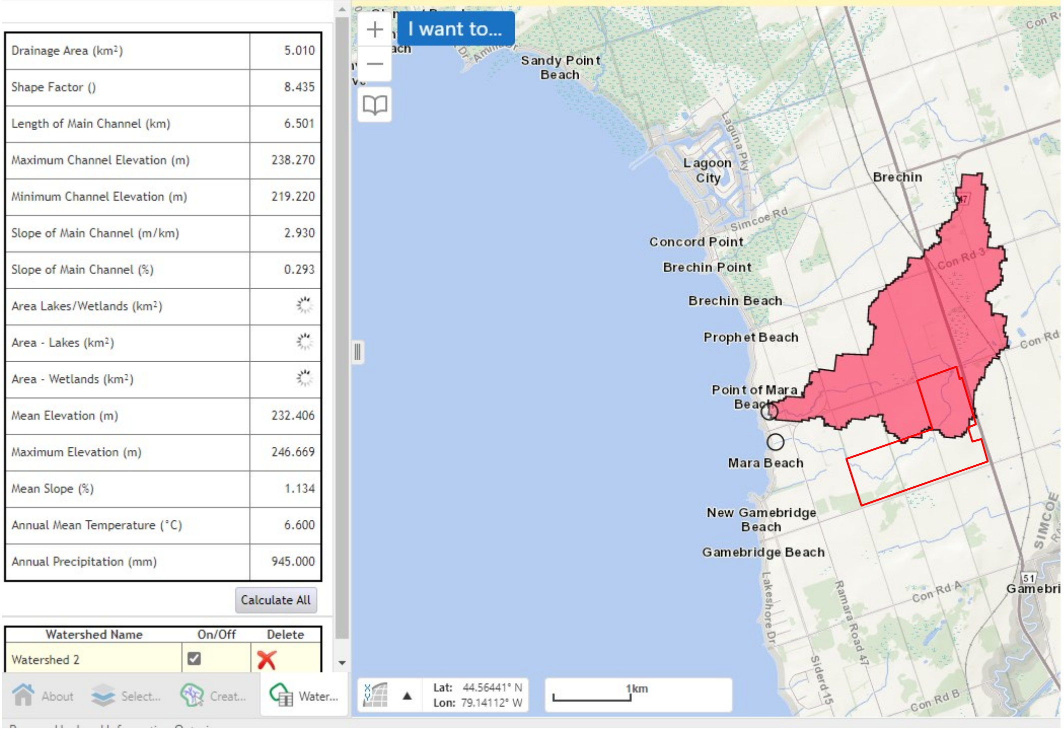
Drainage Area (km²)	3.588
Shape Factor ()	4.466
Length of Main Channel (km)	4.003
Maximum Channel Elevation (m)	241.200
Minimum Channel Elevation (m)	220.320
Slope of Main Channel (m/km)	5.220
Slope of Main Channel (%)	0.522
Area Lakes/Wetlands (km²)	0.075
Area - Lakes (km²)	0.002
Area - Wetlands (km²)	0.073
Mean Elevation (m)	234.725
Maximum Elevation (m)	252.038
Mean Slope (%)	1.461
Annual Mean Temperature (°C)	6.600
Annual Precipitation (mm)	945.000

Figure U: SE Corner Sub-watershed OWIT information

11.3.3 Water Balance During Initial Rehabilitation

Following closure, the pumping of the quarry sump will be turned off, allowing the quarry to fill with water to create a lake. The elevation of the quarry lake will controlled at an elevation of approximately 232 masl. Assuming all surplus rainfall, snowfall and ground water influx within the quarry footprint is allowed to gradually fill the lake, it will take approximately 40 to 50 years to reach its final level, based on average precipitation conditions.

During this period, additional water would not be released through the COS. Tributary A would see a reduction in flow by 140,000 m^3/year compared to the pre-existing conditions, which includes re-direction of 16,200 m^3/year from Tributary C. Tributary G would see a reduction of 102,500 m^3/year such that the McNabb Drain will have a reduction by approximately 259,500 m^3/year. Flows from the quarry excavation footprint (Tributaries, A, C and G = 335,000 m^3/year) represent 13.9% of the McNabb Drain catchment (defined using OWIT)(see Figure W), and as such, the reduction represents a change of ~10%, and should not adversely affect flows within the sub-watershed.



Drainage Area (km²)	5.010
Shape Factor ()	8.435
Length of Main Channel (km)	6.501
Maximum Channel Elevation (m)	238.270
Minimum Channel Elevation (m)	219.220
Slope of Main Channel (m/km)	2.930
Slope of Main Channel (%)	0.293
Area Lakes/Wetlands (km²)	
Area - Lakes (km²)	
Area - Wetlands (km²)	
Mean Elevation (m)	232.406
Maximum Elevation (m)	246.669
Mean Slope (%)	1.134
Annual Mean Temperature (°C)	6.600
Annual Precipitation (mm)	945.000

Watershed Name	On/Off	Delete
Watershed 2	☑	✗

Lat: 44.56441° N
Lon: 79.14112° W

Figure W: McNabb Drain Sub-watershed OWIT Information

When the COS is no longer in use, a small section of the perimeter berm on the west side of Phase 1 will be removed to create a lake outlet for the quarry lake at an elevation of approximately 232 masl. The lake will passively overtop at this location and water will flow north and then east within the setback area, and pass through Pond 1 to the McNabb Drain. Once the quarry lake is filled, runoff to the McNabb Drain will continue, and will be about 407,600m^3/year, which is 26% higher than the pre-extraction contribution of 335,000m^3/year.

11.3.4 Monthly Runoff from the Proposed Quarry

Tables 11 and 12 show the monthly flow as both a quantity (units of m^3/month) and as a percentage of the Pre-Extraction Flow (for the same month). Table 11 shows the total amount of runoff discharged to the McNabb Drain during Phase 1 with Tributary A as the point of discharge point from the quarry, and the Tributary C catchment that discharges to the Concession 2 roadside ditch is re-directed to the Tributary A outlet. Tributary A, Tributary C and Tributary G discharge to the roadside ditch on the south side of Concession 2 in a section that is about 450m long, and it drains through two culverts to reach the northside roadside ditch, which is the McNabb Drain.

During Phase 1, the Tributary G outlet will not be modified, and in Phase 2 the Tributary A outlet will receive water that is being pumped from the quarry. Tables 13 to 15 show the water balance calculations based on the quarry extraction at the end of Phase 1, the end of Phase 2 and following rehabilitation when the quarry has filled to become a small lake.

At the end of Phase 1, the total volume released to the McNabb Drain increases by 32%, and at the end of Phase 2, the volume is increased by 143%. The monthly flow volumes show that 84% of the total runoff is due to snowmelt and spring rain, <1% occurs between June 1 and September 30, and 15% is due to fall rain.

Of note, these volumes are assumed to be pumped from the quarry during the same month that precipitation or snowmelt occurs. However, during operations, the majority of pumping will occur over a period of several weeks which will buffer the peak flows. This infers that the actual water pumping rate is likely to be less than predicted by this water balance exercise. The water balance estimate is based on long term annual climate averages. In reality, water takings from the proposed quarry will closely resemble seasonal trends, meaning increased periods of pumping during the spring and fall, with very little pumping occurring during the drier summer months (and aside from larger precipitation events).

The effect on flows in McNabb Drain will be small. The McNabb Drain watershed has an area of 5.01km^2 so the water management from the quarry effectively increases the watershed by approximately 7%. Figure X shows the estimated monthly average flow in the McNabb Drain, which was estimated by determining a monthly water budget for the watershed outside of the proposed quarry, and then adding the runoff from the proposed quarry for the Phase 1 and 2 extraction areas. Scenarios were also evaluated for the initial rehabilitation (lake filling period) and the final rehabilitation (quarry lake) period. The McNabb Drain exhibits spring periods of high flow, little or no flow in the summer and moderate flow in the fall. The increased flow from the proposed quarry is highest during the snowmelt period, at up to 0.1m^3/s once the Phase 2 extraction is fully active. For comparison, the April average snowmelt is 0.61 m^3/s, the $7Q_{20}$ for the McNabb Drain is 0.22m^3/s and the Q2 is 0.77m^3/s. Thus, the discharge from the proposed quarry licensed area is moderate, and reflects the existing flow regime.

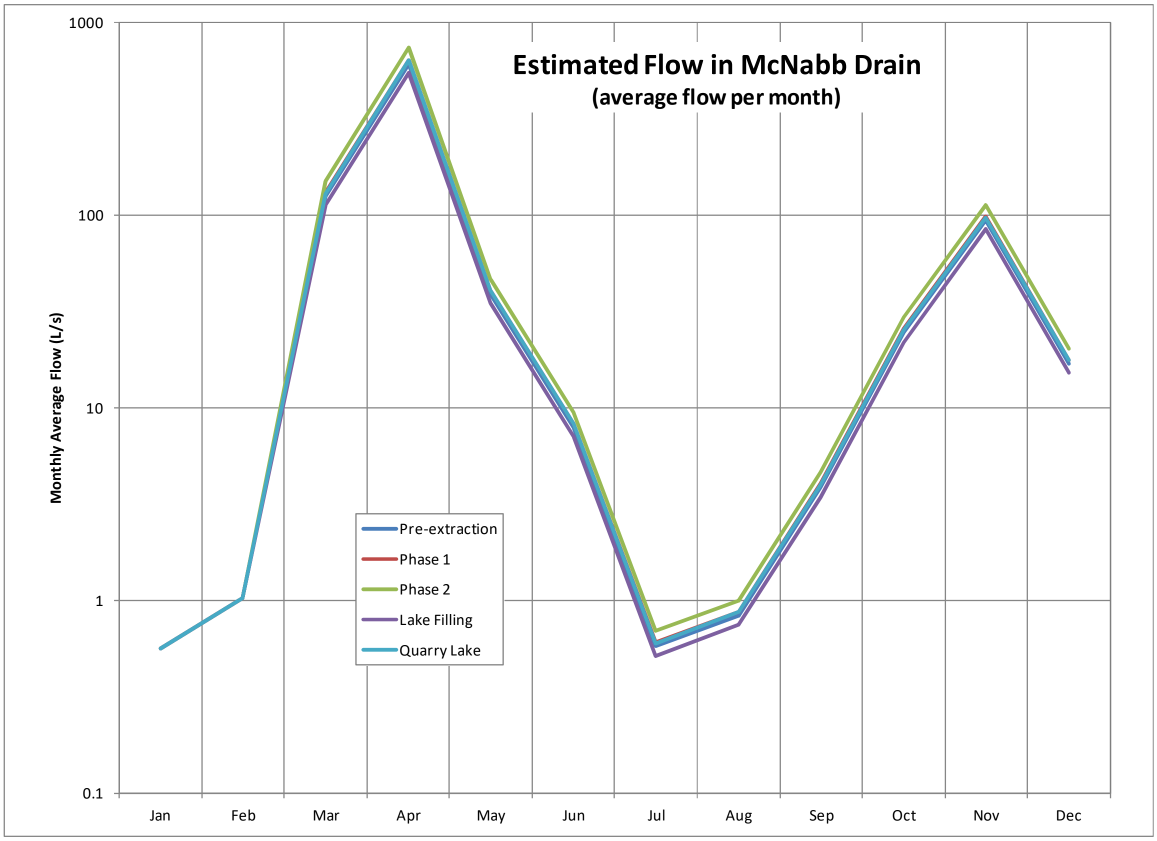


Figure X: Estimated Monthly Flow in the McNabb Drain

Table 11: Monthly Flow from Sub-watershed Discharging from the Proposed Quarry

		Monthly Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
Pre-Extraction	1 Trib A	201677	0	0	28015	132493	8682	1700	129	187	833	5475	20370	3792	201677
	2 Trib G / Pond 2	117302	0	0	16294	77063	5050	989	75	108	484	3185	11848	2206	117302
	3 Trib C	16164	0	0	2245	10619	696	136	10	15	67	439	1633	304	16164
	Total McNabb Drain	335143	0	0	46555	220175	14428	2826	214	310	1384	9099	33850	6302	335143
	4 SE Corner	227677	0	0	31627	149575	9802	1920	146	211	940	6181	22996	4281	227677
	Total	562820	0	0	78181	369749	24230	4745	360	521	2324	15280	56846	10584	562820
Phase 1	1 Trib A	58,513	0	0	8128	38440	2519	493	37	54	242	1589	5910	1100	58513
	2 Trib G / Pond 2	117,302	0	0	16294	77063	5050	989	75	108	484	3185	11848	2206	117302
	3 Trib C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	pumped to Trib A	267,031	0	0	37093	175428	11496	2251	171	247	1103	7250	26971	5021	267031
	Total McNabb Drain	442,846	0	0	61516	290931	19065	3734	283	410	1829	12023	44728	8328	442846
	4 SE Corner	227,677	0	0	31627	149575	9802	1920	146	211	940	6181	22996	4281	227677
	Total	670,523	0	0	93142	440506	28867	5654	429	620	2769	18204	67724	12609	670523
Phase 2	1 Trib A	44,658	0	0	6203	29338	1923	377	29	41	184	1212	4511	840	44658
	2 Trib G / Pond 2	14,778	0	0	2053	9709	636	125	9	14	61	401	1493	278	14778
	3 Trib C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	pumped to Trib A	756,627	0	0	105103	497073	32574	6380	484	700	3124	20542	76420	14228	756627
	Total McNabb Drain	816,064	0	0	113359	536120	35132	6881	522	755	3370	22155	82424	15346	816064
	4 SE Corner	64,655	0	0	8981	42476	2783	545	41	60	267	1755	6530	1216	64655
	Total	880,718	0	0	122340	578596	37916	7426	564	815	3637	23911	88954	16562	880718
Initial Closure	1 Trib A	44,658	0	0	6203	29338	1923	377	29	41	184	1212	4511	840	44658
	2 Trib G / Pond 2	14,778	0	0	2053	9709	636	125	9	14	61	401	1493	278	14778
	3 Trib C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	directed to Trib A	16,164	0	0	2245	10619	696	136	10	15	67	439	1633	304	16164
	Total McNabb Drain	75,600	0	0	10502	49666	3255	637	48	70	312	2052	7636	1422	75600
	4 SE Corner	64,655	0	0	8981	42476	2783	545	41	60	267	1755	6530	1216	64655
	Total	215,855	0	0	29984	141808	9293	1820	138	200	891	5860	21802	4059	215855
After Lake Filled	1 Trib A	44,658	0	0	6203	29338	1923	377	29	41	184	1212	4511	840	44658
	2 Trib G / Pond 2	14,778	0	0	2053	9709	636	125	9	14	61	401	1493	278	14778
	3 Trib C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	directed to Trib A	362,949	0	0	50417	238442	15625	3060	232	336	1499	9854	36658	6825	362949
	Total McNabb Drain	422,385	0	0	58673	277489	18184	3561	270	391	1744	11467	42662	7943	422385
	4 SE Corner	64,655	0	0	8981	42476	2783	545	41	60	267	1755	6530	1216	64655
	Total	909,425	0	0	126328	597454	39152	7668	582	841	3755	24690	91853	17101	909425

Table 12: Percent Change in Monthly Flows by Sub-watershed

		Monthly Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
Phase 1	**1 Trib A**	58513	0%	0%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%
	2 Trib G / Pond 2	117302	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	3 Trib C	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	pumped to Trib A	267031													
	Total McNabb Drain	442846	0%	0%	132%	132%	132%	132%	132%	132%	132%	132%	132%	132%	132%
	4 SE Corner	227677	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Total	670523	0%	0%	119%	119%	119%	119%	119%	119%	119%	119%	119%	119%	119%
			0%												
Phase 2	**1 Trib A**	44658	0%	0%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
	2 Trib G / Pond 2	14778	0%	0%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
	3 Trib C	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	pumped to Trib A	756627													
	Total McNabb Drain	816064	0%	0%	243%	243%	243%	243%	243%	243%	243%	243%	243%	243%	243%
	4 SE Corner	64655	0%	0%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%
	Total	880718	0%	0%	156%	156%	156%	156%	156%	156%	156%	156%	156%	156%	156%
Initial Closure	**1 Trib A**	44658	0%	0%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
	2 Trib G / Pond 2	14778	0%	0%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
	3 Trib C	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	directed to Trib A	16164													
	Total McNabb Drain	75600	0%	0%	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%
	4 SE Corner	64655	0%	0%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%
	Total	215855	0%	0%	38%	38%	38%	38%	38%	38%	38%	38%	38%	38%	38%
After Lake Filled	**1 Trib A**	44658	0%	0%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
	2 Trib G / Pond 2	14778	0%	0%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
	3 Trib C	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	directed to Trib A	362949													
	Total McNabb Drain	422385	0%	0%	126%	126%	126%	126%	126%	126%	126%	126%	126%	126%	126%
	4 SE Corner	64655	0%	0%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%
	Total	909425	0%	0%	162%	162%	162%	162%	162%	162%	162%	162%	162%	162%	162%

11.4 Detailed Water Balances

Table 13: Pre-Extraction Water Balance

	Site				
Catchment Designation	**1 Trib A**	**2 Trib G /Pond 2**	**3 Trib C (to Con2 roadside ditch)**	**4 SE Corner**	**Total**
On-site Area (m^2)	436,700	254,000	35,000	493,000	1,218,700
Pervious Area (m^2)	436,700	254,000	35,000	493,000	1,218,700
Impervious Area (m^2)	0	0	0	0	0
Infiltration Factors					
Topography Infiltration Factor	0.05	0.05	0.05	0.05	
Soil Infiltration Factor	0.05	0.05	0.05	0.05	
Land Cover Infiltration Factor	0.04	0.04	0.04	0.04	
Infiltration Factor	0.14	0.14	0.14	0.14	
Run-Off Coefficient	0.86	0.86	0.86	0.86	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)					
Precipitation (mm/yr)	1,079	1,079	1,079	1,079	1,079
Rainfall (mm/yr)	740	740	740	740	740
Other Inputs (mm/yr)	0	0	0	0	0
Total Inputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	1,079
Outputs (Per Unit Area)					
Precipitation Surplus (mm/yr)	537	537	537	537	537
Net Surplus (mm/yr)	537	537	537	537	537
Evapotranspiration (mm/yr)	542	542	542	542	542
Infiltration (mm/yr)	75	75	75	75	75
Surplus Infiltration (mm/yr)	0	0	0	0	0
Total Infiltration (mm/yr)	75	75	75	75	75
Rainfall Run-Off Pervious Areas (mm/yr)	192	192	192	192	192
Rainfall Run-Off Impervious Areas (mm/yr)	0	0	0	0	0
Total Rainfall Run-Off (mm/yr)	192	192	192	192	192
Snow Runoff from pervious areas (mm/yr)	270	270	270	270	
Total Outputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**
Difference Check (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)					
Precipitation (m^3/yr)	471,199	274,066	37,765	531,947	1,314,977
Run-On (m^3/yr)	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0
Total Inputs (m^3/yr)	**471,199**	**274,066**	**37,765**	**531,947**	**1,314,977**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	234,508	136,398	18,795	264,741	654,442
Net Surplus (m^3/yr)	234,508	136,398	18,795	264,741	654,442
Evapotranspiration (m^3/yr)	236,691	137,668	18,970	267,206	660,535
Infiltration (m^3/yr)	32,831	19,096	2,631	37,064	91,622
Surplus Infiltration (m^3/yr)	0	0	0	0	0
Total Infiltration (m^3/yr)	32,831	19,096	2,631	37,064	91,622
Re-Directed Runoff (m3/yr)					
Run-Off Pervious Areas (m^3/yr)	83,942	48,824	6,728	94,764	234,259
Run-Off Impervious Areas (m^3/yr)	0	0	0	0	0
Snow Runoff (m3/yr)	117,734	68,478	9,436	132,913	328,562
Total Run-Off (m^3/yr)	201,677	117,302	16,164	227,677	562,820
Total Outputs (m^3/yr)	471,199	274,066	37,765	531,947	1,314,977
Difference Check (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**

Table 14: During Extraction – First Phase Completed

	Non Extracted Areas of the Site by catchment				Quarry Footprint	
Catchment Designation	**1 Trib A Buffer**	**2 Trib G / Pond 2 Buffer**	**Con2 roadside ditch)**	**4 SE Corner**	**1 Trib A Quarry**	**Total**
Area (m^2)	126,700	254,000	35,000	493,000	310,000	1,218,700
Pervious Area (m^2)	126,700	254,000	35,000	493,000	0	908,700
Impervious Area (m^2)	0	0	0	0	310,000	310,000
Infiltration Factors						
Topography Infiltration Factor	0.05	0.05	0.05	0.05	0	
Soil Infiltration Factor	0.05	0.05	0.05	0.05	0	
Land Cover Infiltration Factor	0.04	0.04	0.04	0.04	0	
Infiltration Factor	0.14	0.14	0.14	0.14	0	
Run-Off Coefficient	0.86	0.86	0.86	0.86	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	1	
Inputs (Per Unit Area)						
Precipitation (mm/yr)	1,079	1,079	1,079	1,079	1,079	1,079
Rainfall (mm/yr)	740	740	740	740	740	740
Run-On (mm/yr)	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0
Total Inputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	1,079
Outputs (Per Unit Area)						
Precipitation Surplus (mm/yr)	537	537	537	537	809	606
Net Surplus (mm/yr)	537	537	537	537	809	606
Evapotranspiration or evaporation (mm/yr)	542	542	542	542	270	473
Infiltration (mm/yr)	75	75	75	75	0	56
Surplus Infiltration (mm/yr)	0	0	0	0	0	0
Total Infiltration (mm/yr)	75	75	75	75	0	56
Rainfall Run-Off Pervious Areas (mm/yr)	192	192	192	192	0	143
Rainfall Run-Off Impervious Areas (mm/yr)	0	0	0	0	472	120
Total Rainfall Run-Off (mm/yr)	192	192	192	192	472	263
Snowfall runoff	270	270	270	270	337	
Total Outputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)						
Precipitation (m^3/yr)	136,709	274,066	37,765	531,947	334,490	1,314,977
Run-On (m^3/yr)	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0
Total Inputs (m^3/yr)	**136,709**	**274,066**	**37,765**	**531,947**	**334,490**	**1,314,977**
Outputs (Volumes)						
Precipitation Surplus (m^3/yr)	68,038	136,398	18,795	264,741	250,868	738,839
Net Surplus (m^3/yr)	68,038	136,398	18,795	264,741	250,868	738,839
ET or EV (m^3/yr)	68,671	137,668	18,970	267,206	83,623	576,138
Infiltration (m^3/yr)	9,525	19,096	2,631	37,064	0	68,316
Surplus Infiltration (m^3/yr)	0	0	0	0	0	0
Total Infiltration (m^3/yr)	9,525	19,096	2,631	37,064	0	68,316
Rain Run-Off Pervious Areas (m^3/yr)	24,354	48,824	6,728	94,764		174,670
Rain Run-Off Impervious Areas (m^3/yr)	0	0	0	0	146,398	146,398
Snowfall Runoff (m^3/yr)	34,158	68,478	9,436	132,913	104,470	349,456
Total Run-Off (m^3/yr)	58,513	117,302	16,164	227,677	250,868	670,523
Total Outputs (m^3/yr)	136,709	274,066	37,765	531,947	334,490	1,314,977
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**
Water Released to Trib A			16,164		250,868	267,031

Table 15: During Extraction – Second Phase Fully Active

	Non Extracted Areas of the Site by catchment				Quarry Footprint			
Catchment Designation	**1 Trib A Buffer**	**2 Trib G / Pond 2 Buffer**	**3 Trib C (to Con2 roadside ditch)**	**4 SE Corner Buffer**	**1 Trib A Quarry**	**2 Trib G / Pond 2 Quarry**	**4 SE Corner Quarry**	**Total**
Area (m^2)	96,700	32,000	35,000	140,000	340,000	222,000	353,000	1,218,700
Pervious Area (m^2)	96,700	32,000	35,000	140,000	0	0	0	303,700
Impervious Area (Quarry Floor)(m^2)	0	0	0	0	340,000	222,000	353,000	915,000
Infiltration Factors								
Topography Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Soil Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Land Cover Infiltration Factor	0.04	0.04	0.04	0.04	0	0	0	
Infiltration Factor	0.14	0.14	0.14	0.14	0	0	0	
Run-Off Coefficient	0.86	0.86	0.86	0.86	1	1	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)								
Precipitation (mm/yr)	1,079	1,079	1,079	1,079	1,079	1,079	1,079	1,079
Rainfall (mm/yr)	740	740	740	740	740	740	740	740
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	1,079
Outputs (Per Unit Area)								
Precipitation Surplus (mm/yr)	537	537	537	537	809	809	809	741
Net Surplus (mm/yr)	537	537	537	537	809	809	809	741
Evapotranspiration (mm/yr)	542	542	542	542	270	270	270	338
Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Surplus Infiltration (mm/yr)	0	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Rainfall Run-Off Pervious Areas (mm/yr)	192	192	192	192	0	0	0	48
Rainfall Run-Off Impervious Areas (mm/yr)	0	0	0	0	540	540	540	405
Total Rainfall Run-Off (mm/yr)	192	192	192	192	540	540	540	453
Snowfall Runoff	270	270	270	270	270	270	270	
Total Outputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)								
Precipitation (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Run-On (m^3/yr)	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	**104,339**	**34,528**	**37,765**	**151,060**	**366,860**	**239,538**	**380,887**	**1,314,977**
Outputs (Volumes)								
Precipitation Surplus (m^3/yr)	51,928	17,184	18,795	75,180	275,145	179,654	285,665	903,551
Net Surplus (m^3/yr)	51,928	17,184	18,795	75,180	275,145	179,654	285,665	903,551
ET or EV (m^3/yr)	52,411	17,344	18,970	75,880	91,715	59,885	95,222	411,427
Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Surplus Infiltration (m^3/yr)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Rain Run-Off Pervious Areas (m^3/yr)	18,588	6,151	6,728	26,911	0	0	0	58,377
Rain Run-Off Impervious Areas (m^3/yr)	0	0	0	0	183,481	119,802	190,496	493,780
Snowmelt runoff	26,070	8,627	9,436	37,744	91,664	59,851	95,169	328,562
Total Run-Off (m^3/yr)	44,658	14,778	16,164	64,655	275,145	179,654	285,665	880,718
Total Outputs (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Water Released to Trib A			16,164		275,145	179,654	285,665	756,627

Table 16: Initial Rehabilitation (Lake Filling)

Catchment Designation	**Non Excavated Areas of the Site by catchment**				**Quarry Footprint**			**Total**
	1 Trib A Buffer	**2 Trib G / Pond 2 Buffer**	**3 Trib C**	**4 SE Corner**	**1 Trib A Quarry**	**2 Trib G / Pond 2 Quarry**	**4 SE Corner Quarry**	
Area (m^2)	96,700	32,000	35,000	140,000	340,000	222,000	353,000	1,218,700
Pervious Area (m^2)	96,700	32,000	35,000	140,000	0	0	0	303,700
Impervious Area (Quarry Floor)(m^2)	0	0	0	0	340,000	222,000	353,000	915,000
Infiltration Factors								
Topography Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Soil Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Land Cover Infiltration Factor	0.04	0.04	0.04	0.04	0	0	0	
Infiltration Factor	0.14	0.14	0.14	0.14	0	0	0	
Run-Off Coefficient	0.86	0.86	0.86	0.86	1	1	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)								
Precipitation (mm/yr)	1,079	1,079	1,079	1,079	1,079	1,079	1,079	1,079
Rainfall (mm/yr)	740	740	740	740	740	740	740	740
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	1,079
Outputs (Per Unit Area)								
Precipitation Surplus (mm/yr)	537	537	537	537	379	379	379	418
Net Surplus (mm/yr)	537	537	537	537	379	379	379	418
Evapotranspiration or Evaporation (mm	542	542	542	542	700	700	700	661
Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Surplus Infiltration (mm/yr)	0	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Rainfall Run-Off Pervious Areas (mm/y	192	192	192	192	0	0	0	48
Rainfall Run-Off Impervious Areas (mm	0	0	0	0	109	109	109	82
Total Rainfall Run-Off (mm/yr)	192	192	192	192	109	109	109	130
Snowfall runoff	270	270	270	270	270	270	270	270
Total Outputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)								
Precipitation (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Run-On (m^3/yr)	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	**104,339**	**34,528**	**37,765**	**151,060**	**366,860**	**239,538**	**380,887**	**1,314,977**
Outputs (Volumes)								
Precipitation Surplus (m^3/yr)	51,928	17,184	18,795	75,180	128,860	84,138	133,787	856,657
Net Surplus (m^3/yr)	51,928	17,184	18,795	75,180	128,860	84,138	133,787	509,872
ET or EV (m^3/yr)	52,411	17,344	18,970	75,880	238,000	155,400	247,100	805,105
Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Surplus Infiltration (m^3/yr)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Rainfall Run-Off Pervious Areas (m^3/y	18,588	6,151	6,728	26,911	0	0	0	58,377
Rainfall Run-Off Impervious Areas (m^3	0	0	0	0	37,196	24,287	38,618	100,101
Snowmelt runoff (m3/year)	26,070	8,627	9,436	37,744	91,664	59,851	95,169	328,562
Total Run-Off (m^3/yr)	44,658	14,778	16,164	64,655	128,860	84,138	133,787	487,040
Total Outputs (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Water Directed to Trib A			16,164					16,164

Table 17: Full Rehabilitation Scenario (Quarry Lake)

	Non Excavated Areas of the Site by catchment				Quarry Footprint			
Catchment Designation	**1 Trib A Buffer**	**2 Trib G / Pond 2 Buffer**	**3 Trib C**	**4 SE Corner**	**1 Trib A Quarry**	**2 Trib G / Pond 2 Quarry**	**4 SE Corner Quarry**	**Total**
Area (m^2)	96,700	32,000	35,000	140,000	340,000	222,000	353,000	1,218,700
Pervious Area (m^2)	96,700	32,000	35,000	140,000	0	0	0	303,700
Impervious Area (Quarry Floor)(m^2)	0	0	0	0	340,000	222,000	353,000	915,000
Infiltration Factors								
Topography Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Soil Infiltration Factor	0.05	0.05	0.05	0.05	0	0	0	
Land Cover Infiltration Factor	0.04	0.04	0.04	0.04	0	0	0	
Infiltration Factor	0.14	0.14	0.14	0.14	0	0	0	
Run-Off Coefficient	0.86	0.86	0.86	0.86	1	1	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)								
Precipitation (mm/yr)	1,079	1,079	1,079	1,079	1,079	1,079	1,079	1,079
Rainfall (mm/yr)	740	740	740	740	740	740	740	740
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	1,079
Outputs (Per Unit Area)								
Precipitation Surplus (mm/yr)	537	537	537	537	379	379	379	418
Net Surplus (mm/yr)	537	537	537	537	379	379	379	418
Evapotranspiration or Evaporation (mm	542	542	542	542	700	700	700	661
Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Surplus Infiltration (mm/yr)	0	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	75	75	75	75	0	0	0	19
Rainfall Run-Off Pervious Areas (mm/y	192	192	192	192	0	0	0	48
Rainfall Run-Off Impervious Areas (mm	0	0	0	0	109	109	109	82
Total Rainfall Run-Off (mm/yr)	192	192	192	192	109	109	109	130
Snowfall runoff	270	270	270	270	270	270	270	270
Total Outputs (mm/yr)	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**	**1,079**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)								
Precipitation (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Run-On (m^3/yr)	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	**104,339**	**34,528**	**37,765**	**151,060**	**366,860**	**239,538**	**380,887**	**1,314,977**
Outputs (Volumes)								
Precipitation Surplus (m^3/yr)	51,928	17,184	18,795	75,180	128,860	84,138	133,787	856,657
Net Surplus (m^3/yr)	51,928	17,184	18,795	75,180	128,860	84,138	133,787	509,872
ET or EV (m^3/yr)	52,411	17,344	18,970	75,880	238,000	155,400	247,100	805,105
Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Surplus Infiltration (m^3/yr)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	7,270	2,406	2,631	10,525	0	0	0	22,832
Rainfall Run-Off Pervious Areas (m^3/y	18,588	6,151	6,728	26,911	0	0	0	58,377
Rainfall Run-Off Impervious Areas (m^3	0	0	0	0	37,196	24,287	38,618	100,101
Snowmelt runoff (m3/year)	26,070	8,627	9,436	37,744	91,664	59,851	95,169	328,562
Total Run-Off (m^3/yr)	44,658	14,778	16,164	64,655	128,860	84,138	133,787	487,040
Total Outputs (m^3/yr)	104,339	34,528	37,765	151,060	366,860	239,538	380,887	1,314,977
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Water Directed to Trib A			16,164		128,860	84,138	133,787	362,949

11.5 Water Balance Summary

Water balances have been calculated for existing conditions, two (2) stages of quarry extraction and during / after rehabilitation. The licensed area includes four (4) small sub-watersheds; one (1) which is drained solely by overland flow, and three (3) that have small intermittent channels. Differences in the water balance are due to small physical changes that control water migration, such as evapotranspiration from vegetated areas. Evapotranspiration will be greater than direct evaporation from the exposed quarry floor during operation, however, it will be less than the pan evaporation from the final quarry lake after rehabilitation is completed.

The three sub-watersheds that have small intermittent channels cover about 85% of the proposed extraction area, and all discharge to the McNabb Drain within an overall distance of approximately 1000 m. To maintain the hydraulic regime of the McNabb Drain, the discharge location for water from the extraction area will utilize the most upstream of the three locations (i.e. Tributary A). Water pumped from the quarry floor will discharge through a central outlet, and then pass through an area of natural and constructed wetland habitat that covers approximately 8 ha. This discharge process will provide retention so that the flows received in the McNabb Drain do not cause erosion or sedimentation issues.

Under current conditions, ~725,700m^2 of the land east of the rail line drains to the McNabb Drain and 493,000m^2 drains southeasterly to the Talbot River subwatershed. Once Phase 2 quarrying is underway, 353,000m^2 of the SE corner subwatershed will be re-directed to the McNabb Drain since runoff in this area will be controlled within the quarry excavation. This has the effect of increasing the catchment for the McNabb Drain by approximately 7%, and decrease the catchment of the Talbot River by approximately 0.1%.

During the extraction period, the volume of water discharged to the McNabb Drain will increase compared to the pre-extraction volume. The increases are highest during the snowmelt period, at up to 0.1m^3/s during the Phase 2 extraction. For comparison, the $7Q_{20}$ for the McNabb Drain is 0.22m^3/s and the Q2 is 0.77m^3/s. Thus, the discharge from the proposed quarry is moderate, and reflects the existing flow regime.

The proposed quarry's water management strategy is to control and release drainage within established perimeter buffers. Throughout the life of the operation, lands within the extraction footprint will drain across the quarry floor to a sump, which will discharge actively to a COS, which outlets through a weir to Tributary A and the McNabb Drain. A small on-site catchment (Tributary C) occurs adjacent to Tributary A and currently discharges to the Concession 2 roadside ditch. This would be combined with the Tributary A outlet; however, flows from this catchment will still enter the McNabb Drain through the new outlet location. Lands around the south and southeast perimeter of the quarry extraction area will continue to drain to the roadside ditches in the SE Corner sub-watershed. Following closure of the proposed quarry, and once the quarry lake has filled to 232 masl, water will passively controlled and released through the COS, which will continue to outlet through a weir to Tributary A and the McNabb Drain.

Table 18 provides an overall summary of the water balance for various operational periods, reflecting the values discussed in the text above.

Table 18: Water Balance Summary Table

	Site								
Characteristic	**Pre-Extraction**	**Operational Period - Phase 1**	**Change (Pre to Phase 1)**	**Operational Period - Phases 1+2**	**Change (Pre to Phases 1+2)**	**Initial Rehabilitation (Lake filling)**	**Change (Pre- to Closure)**	**Full Rehabilitation - Quarry Lake**	**Change (Pre- to Full Rehabilitation)**
Inputs (Volume)									
Precipitation (m^3/yr)	1,314,977	1,314,977	0	1,314,977	0	1,314,977	0	1,314,977	**0**
Total Inputs (m^3/yr)	1,314,977	1,314,977	0	1,314,977	0	1,314,977	0	1,314,977	**0**
Outputs (Volume)									
Precipitation Surplus (m^3/yr)	654,442	738,839	84,398	903,551	249,109	856,657	202,215	856,657	**202,215**
Evapotranspiration or Evaporation (m^3/yr)	660,535	576,138	-84,398	411,427	-249,109	805,105	144,570	805,105	**144,570**
Total Infiltration (m^3/yr)	**91,622**	**68,316**	**-23,306**	**22,832**	**-68,790**	22,832	-68,790	22,832	**-68,790**
Total Run-Off (m^3/yr)(natural+pumped)	562,820	670,523	107,703	880,718	317,898	487,040	-75,780	487,040	**-75,780**
Water Released to Tributary A	0	267,031	**267,031**	756,627	**756,627**	16,164	16164	467288	**467,288**
Total Outputs (m^3/yr)	**1,314,977**	**1,314,977**	**0**	**1,314,977**	**0**	1,314,977	**0**	**1,314,977**	**0**
Runoff (Volume)									
Trib A Runoff (natural + Released)	201,677	325,544	**123,867**	801285	**599,609**	60,822	**-140,855**	**407,607**	**205,930**
Trib G / Pond 2 Runoff	117,302	117,302	**0**	14,778	**-102,524**	14,778	**-102,524**	**14,778**	**-102,524**
Trib C Runoff	16,164	0	**-16,164**	0	**-16,164**	0	**-16,164**	**0**	**-16,164**
SE Runoff	227,677	227,677	**0**	64,655	**-163,022**	64,655	**-163,022**	**64,655**	**-163,022**
			0						
Total Runoff	562,820	670,523	107,703	880,718	317,898	140,255	-422,565	487,040	**-75,780**

12.0 COMPLAINTS RESPONSE PROGRAM

Based on the results of the physical conditions of the bedrock at the proposed quarry, the design of proposed quarry, the outcome of the ground water modelling (Section 10 and WSP (2022)(Appendix E) and the review of local water supply wells, it is concluded that water well interference complaints attributable to the proposed quarry are unlikely. If water well interference complaints are received in the future, they will be responded to in light of the collected monitoring data and under the Complaints Response Program described below. This program follows a similar scope to response programs in use at other facilities.

A comprehensive complaints response program is available for the purpose of responding to well interference complaints from local water supply well users and to evaluate the potential causes of issues with a well water supply. Each complaint will be dealt with on a case-by-case basis. When a complaint is received by the licensee, the Complaints Response Program detailed below shall be initiated. The objective of the program is to determine a causal relationship and to remedy the water supply issue if it is determined to be related to quarry activities:

1. Immediately upon receiving a complaint, a temporary water supply shall be arranged and provided to the property for as long as required to complete the Complaints Response Program.

2. As soon as can be arranged, a representative of the licensee or their agent will visit the well to make an initial assessment of the complaint. This will include a well/system inspection (where accessible) by a licensed pump maintenance contractor to determine the ground water level, pressure tank configuration, pump depth setting and condition of the well system. The available ground water level data from existing monitoring wells will be reviewed by a licensed professional geoscientist/engineer to estimate the potential ground water level drawdown at the potentially affected well that is the subject of the complaint response. The data will also be evaluated to determine changes in ground water levels that may have occurred due to natural climate conditions. The compiled information regarding the well system and the ground water conditions will be used by the professional hydrogeologist/engineer to prepare an opinion on the likelihood that the well interference is attributable to quarry activities.

3. If it is concluded that the well interference is most likely attributable to quarry dewatering activities from the proposed quarry and the water supply is at risk, the delivery of the temporary water supply shall continue, and a water supply restoration program will be implemented. The decision as to whether to proceed with the water supply restoration program will be based on a review of ground water level information by the professional geoscientist/engineer and well construction and performance information from the licensed pump maintenance contractor as noted above.

The water supply restoration program consists of the following measures which are considered applicable for local water supply wells where the operation of the water supply wells may have been compromised by quarry excavation or based on the analysis of all monitoring data, are assessed to likely be compromised in the near future:

- Well System Rehabilitation – The well system may be rehabilitated by replacement or lowering of pumps, pump lines flushing, well deepening, etc. to improve performance. Where water is unavailable in the shallow bedrock and a well in deeper bedrock is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses prior to deepening the well to provide a basis of comparison. If the ground water in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it would be developed as the domestic supply. Any modifications to a well would be conducted in accordance with Ontario Regulation 903 (or as amended), and by licensed contractors as required;

- Well Rehabilitation, Replacement or Additional Well(s) – The well could be hydro-fractured, replaced or augmented with a new well(s). The feasibility of well replacement would be based on a test drilling program or from monitoring data. Where water is unavailable in the shallow bedrock and a well in deeper bedrock (compared to the original water supply well) is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses to provide a basis of comparison. If the ground water in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it will be developed as the domestic supply. Construction of a new well(s) would be conducted in accordance with Ontario Regulation 903(or as amended), and by licensed contractors as required; and
- Water Treatment Considerations – Appropriate water treatment systems could be incorporated into any restored water supply as discussed above, reflecting MECP treatability guidelines.

Where the quarry activities are determined to have negatively affected a water well supply, the licensee would be responsible for the costs associated with the water supply restoration program. It is important to note that water supply restoration activities undertaken to address an adverse effect shall be done so in consultation with the affected property owner in order to implement a mutually agreeable solution.

13.0 PROPOSED MONITORING PROGRAM

A monitoring program has been developed for the proposed quarry which is currently on-going. The program focuses on monitoring and continuing the characterization of the local ground water regime, mainly from a water level perspective. The monitoring program to date has provided a comprehensive program to describe existing ground water and surface water conditions, and also has established a database of existing water quality conditions. The monitoring program should re-commence 4 months prior to the beginning of quarry excavation to confirm the baseline conditions. When the program re-commences, residents within 500m of the proposed quarry should be contacted to request permission to monitor water levels within the private wells and as part of a one-time program to collect water quality samples to establish baseline conditions.

The following ground and surface water monitoring programs are recommended for the proposed quarry.

13.1 Ground Water Monitoring Program

The recommended ground water monitoring program is expected to be similar to the existing program with some key differences, including the addition of private well monitoring if participation can be granted by neighbouring residents. Existing on-site monitoring wells BH-1 to BH-9, as shown on Figure 9 shall be included in the ground water monitoring program.

- The wells shall be monitored on a quarterly basis and would consist of manual water level measurements and datalogger downloads, in addition to other tasks as needed (*i.e.,* falling/ rising head tests, water quality sampling, *etc.*). Dataloggers in wells would be configured to record water levels at least once per day.

- Manual water level measurements from all monitoring wells shall be collected on a quarterly basis.

- If private properties within 500 m of the proposed quarry provide authorization to monitor their wells, these wells shall include semi-annual manual ground water level measurements collected in the spring and summer to reflect seasonal highs and lows.

- Based on the locations of BH-4 and BH-7, these wells may be removed as part of the quarry extraction as they are both located within the Phase 2 limit of extraction. The remaining existing monitoring well locations are not located within the limit of extraction and will remain for the life of the operation. If any wells become damaged, they shall be replaced as soon as feasible to do so.

13.2 Surface Water Monitoring Program

A surface water and climate monitoring program shall be established. This should be similar to the current program, which has established baseline conditions. This program shall cover the hydroperiod (May to November) and include the following:

- Surface water stations SW-1, SW-2, SW-3, Pond 1 and Pond 2 shall continue to be monitored during the operations of the quarry. Pond 2 will be removed during Phase 2 extraction.
- The surface water monitoring program shall include manual flow/ discharge measurements until a suitable rating curve has been established (e.g. 10 to 12 readings), manual water level measurements, datalogger downloads, and photographic media. Dataloggers at surface water stations shall be configured to

record water levels four times per day during non-freezing times of the year (March to November).

- The existing rain gauge located near BH-6 shall be maintained to monitor isolated rain events. All databases should be updated regularly in order to monitor any seasonal trends.

13.3 Annual Reporting

Annual performance monitoring reports shall be prepared for the quarry and compliance purposes for the dewatering permits issued by the MECP (ECA and PTTW). The reports shall be prepared by a Qualified Person. At least every five years, the report shall include an assessment of the suitability of monitoring locations and frequencies, and include recommendations for revisions to the monitoring program.

14.0 CONCLUSIONS

The proposed quarry is located in the Township of Ramara and consists of Concession 1, part Lots 11, 12 and 13. The property is bounded by Highway 12 to the east, Concession 1 in the south and Concession 2 in the north.

Azimuth was retained to undertake field and interpretative work to describe the hydrogeological conditions at the proposed quarry, as part of a technical team with WSP Canada Inc. (WSP). Azimuth completed borehole drilling, field work, monitoring, data compilation and reporting. WSP undertook core logging, geophysical studies, stratigraphy, hydrostratigraphy and ground water modelling. The proposed quarry provides an opportunity to establish a quarry that will have minimal or negligible impacts to the surrounding natural environment, including ground and surface water regimes and therefore represents a suitable location for the proposed activities.

The proposed quarry is located in an environment with thin overburden deposits consisting primarily of sandy silt till overlying approximately 50 m of Paleozoic limestone and shales at the site. These units consist of (a) the Verulam Formation, (b) the Bobcaygeon Formation, (c) the Gull River Formation, (d) the Shadow Lake Formation and (e) the underlying Precambrian basement. The upper three units are various types of limestone, and the Shadow Lake is sandstone and shales. The base of the proposed quarry will be set to 10 m above the contact between the Bobcaygeon Formation and the Gull River Formation.

The proposed quarry is located between two (2) existing, ARA licenced quarries so there is concern regarding the potential cumulative impacts to the ground water regime. A regional numerical model of the ground water regime demonstrates that the proposed quarry is within the potential drawdown of the two (2) existing quarries, and that the proposed quarry will have minimal incremental impact on the cumulative drawdown. Private residential wells near the quarries are the primary receptors of concern – it is demonstrated that full extraction of the proposed quarry with the two (2) other quarries in their current state would not interfere with these ground water supplies. In the unlikely scenario that all three (3) quarries were at their full extraction at the same time, the incremental effect from the proposed quarry would be negligible for most wells and limited to a maximum of 3.2 m for the closest wells on Highway 12.

Within the proposed extraction footprint, surface water is restricted to intermittent drainage channels and swales. There are four (4) small subcatchments on-site, three of which flow north to join the McNabb Drain at Concession 2. The extraction of the proposed quarry will result in the collection of excess runoff and precipitation, and will direct it to the Tributary A sub-watershed that drains northward to the McNabb Drain. The proposed quarry will have minimal effect on the flow regime of McNabb Drain, and it will continue to have similar flow characteristics to pre-extraction conditions. Once the full extraction footprint is active, the runoff from the proposed quarry increases flow in the McNabb Drain by approximately 20%. The greatest reduction (to 89%) occurs during the initial rehabilitation period, while the quarry is filling with water to become a lake. Percent change during the Phase 1 extraction (+4%) and after final rehabilitation (-2%) are not significant. While the larger percentages are significant as percentages, the flow rates are low, so that the change is a relatively small amount. For example, for all scenarios, summer flow is between 0.6 and 9 L/s, and springmelt flows are between 600 and 732 L/s.

Based on the detailed field investigations, monitoring and interpretation of the data from the property, and the results from the regional ground water model, it is concluded that the proposed quarry will have a minimal and acceptable impact to the ground water and surface water regimes.

15.0 RECOMMENDATIONS

Based the results of the hydrogeological and hydrological assessments for the proposed quarry, the following recommendations are provided for inclusion on the on-site plans:

1. Prior to the start of water taking and/or water discharge, a PTTW and ECA shall be obtained and the licensee shall operate in compliance with these approval

instruments, including the associated monitoring and reporting. The proposed ground and surface water monitoring program outlined in Section 13.0 of this report shall be considered for inclusion in these instruments.

2. The licensee shall implement the Complaints Response Program as outlined in Section 12.0 of this report in the event of a water well interference complaint.

16.0 REFERENCES

Barnett, P.J. Cowan, W.R. and Henry, A.P. 1991. Quaternary Geology of Ontario, Southern sheet; Ontario Geological Survey, Map 2556, Scale 1:1,000,000.

Chapman, L.J. and D.F. Putnam, 1984. The Physiography of Southern Ontario. 3rd Edition, OGS Special Volume 2, MNR, ISBN 0-7743-9422-6.

Earthfx Inc., 2014. Tier 2 Water Budget, Climate Change, and Ecologically Significant Groundwater Recharge Area Assessment for the Ramara Creeks, Whites Creek and Talbot River Subwatersheds.

Golder Associates Ltd., 2021. Geologic Study – Talisker Corporation Proposed Brechin Quarry, Township of Ramara, Ontario. June 2021.

Golder Associates Ltd., 2012. Cumulative Impacts Assessment for Ground Water Takings in the Carden Plain Area. September 2012.

Lake Simcoe Region Conservation Authority (LSRCA), 2015. Ramara Creeks Subwatershed Plan.

Lapcevic, P.A., K.S. Novakowski and E.A. Sudicky, 1998
Groundwater Flow and Solute Transport in Fractured Media
Chapter 17 in The Handbook of Groundwater Engineering
Editor: J.W. Delleur, CRC Press, p. 17-1 to 17-39

MECP, 2020
Map: Well Records. https://www.ontario.ca/environment-and-energy/map-well-records, Township of Ramara

MOE. 2006 (revision). Technical Support Document for Ontario Drinking Water Standards, Objectives, and Guidelines

Oak Ridges Moraine Groundwater Program (ORMGP), 2021.

https://oakridgeswater.ca/

Ontario Geological Survey, 1991. Bedrock Geology of Ontario, South Sheet. Ontario Geological Survey, Map 2544.

WSP, 2023. Groundwater Modelling Report and Private Well Impact Assessment Report

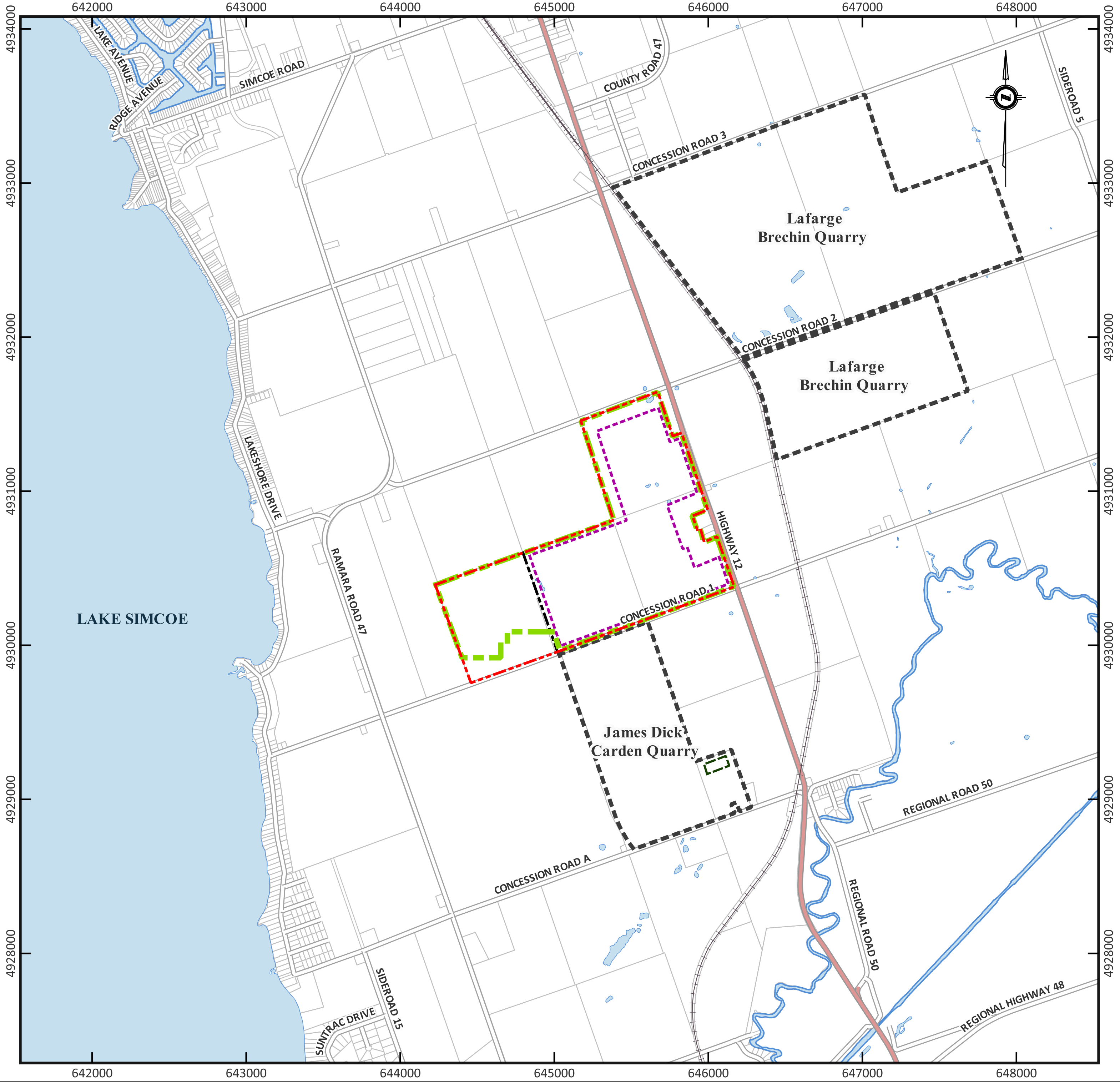
APPENDICES

APPENDIX A

Figures

APPENDIX A

Figures



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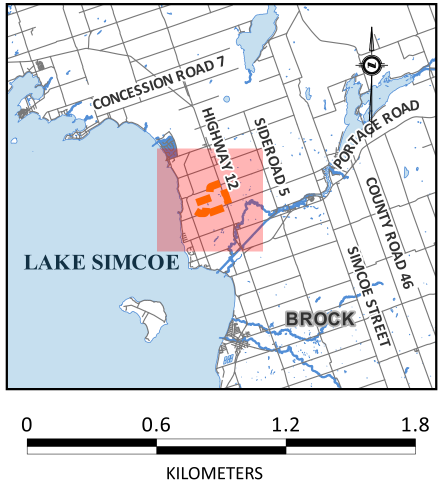
LEGEND

- Approx. Property Boundary
- License Boundary
- MHBC Limit of Extraction
- Former Rail Line
- Waterbody
- Rail
- Road
- Highway
- Authorized Active Aggregate Site

REGIONAL MAP SCALE 1:500000

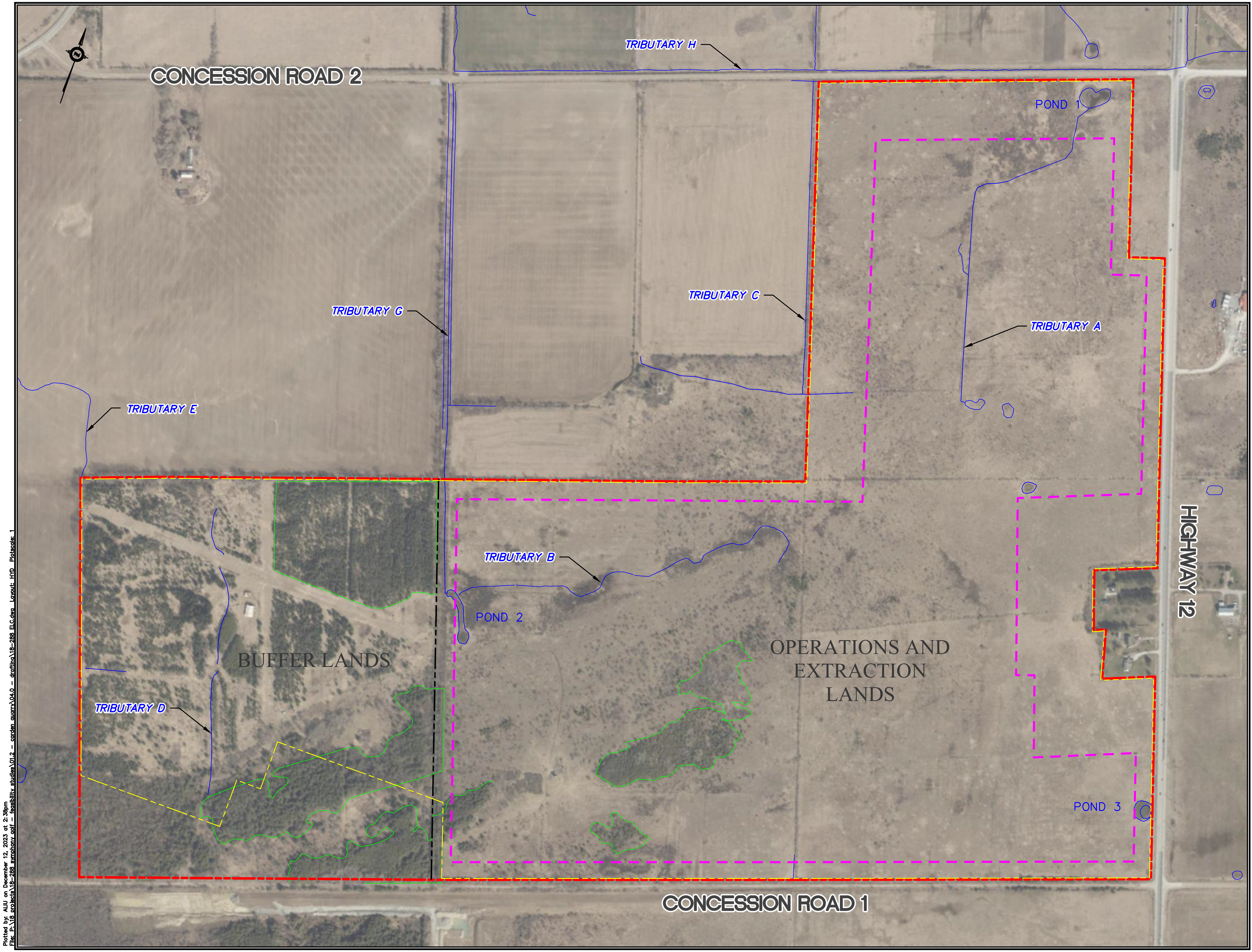


AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

SITE LOCATION

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
CREATED BY:	A.L.	1
PROJECT NO.:	18-288	
BASE MAP:	MNRF	



LEGEND:

- 🟥 APPROX. PROPERTY BOUNDARY
- 🟨 LICENSE BOUNDARY
- ▬ FORMER RAIL LINE
- 🟦 WATERCOURSE (LIO)
- 🟩 WOODLAND BOUNDARY (AZIMUTH, 2023)
- 🟪 EXTRACTION FOOTPRINT

LOCATION PLAN

0 150.00 300.0

HORIZONTAL SCALE 1:6000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

EXISTING FEATURES AND SITE LAYOUT

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	*DECEMBER 2023*	Figure No. 2
CREATED BY:	*A.L.*	
PROJECT NO.:	*18-288*	
REFERENCE:	*SIMCOE COUNTY*	

Plotted by: ALIU on December 12, 2023 at 2:38pm
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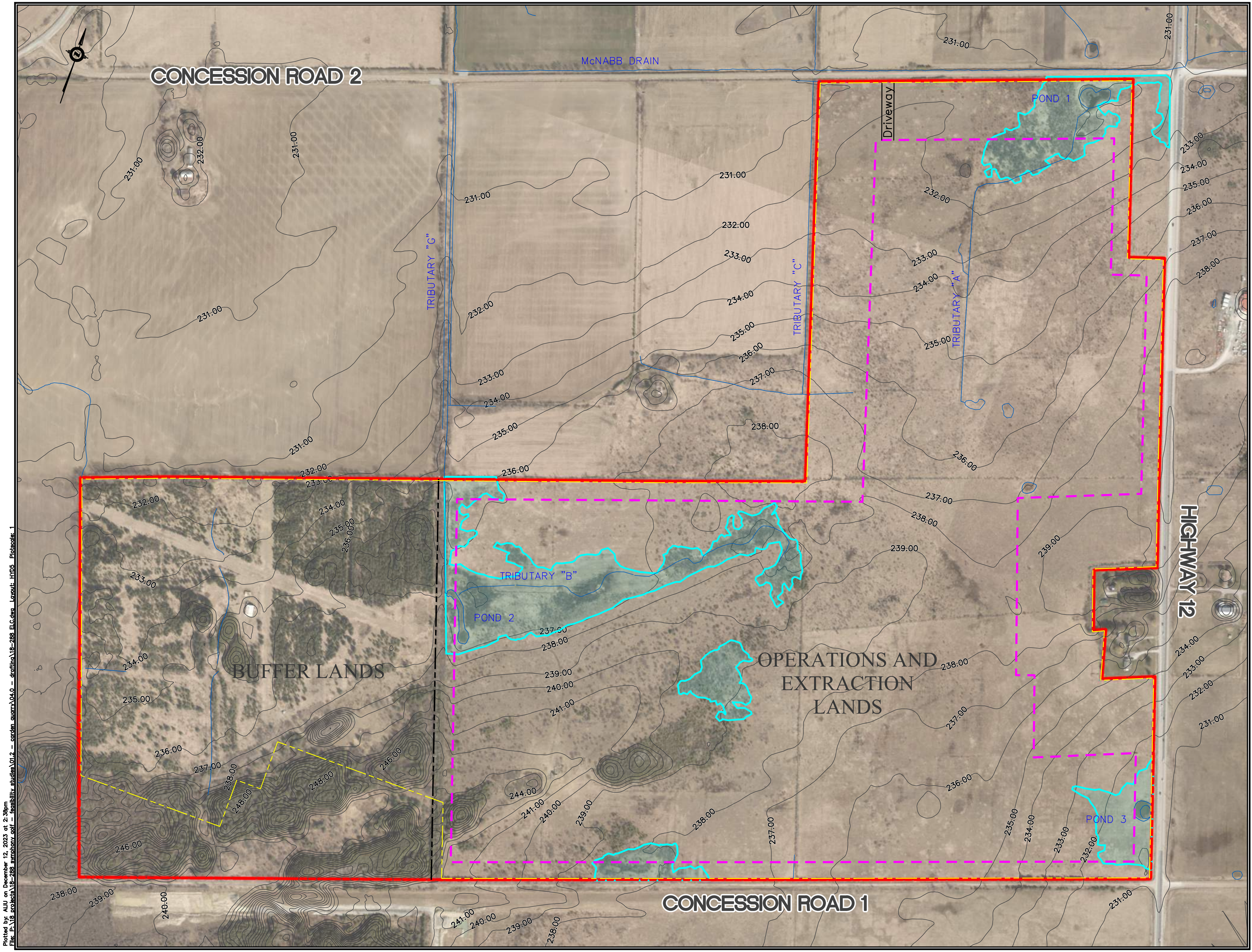

LEGEND:

- APPROX. PROPERTY BOUNDARY
- LICENSE BOUNDARY
- FORMER RAIL LINE
- WATERCOURSE (LIO)
- ▭ WETLAND UNIT (AEC DELINEATED, OCT. 5 2021)
- EXTRACTION FOOTPRINT

LOCATION PLAN

0 150.00 300.0

HORIZONTAL SCALE 1:6000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

TOPOGRAPHY, DRAINAGE AND HYDROLOGY

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No. 3
CREATED BY:	A.L.	
PROJECT NO.:	18-288	
REFERENCE:	SIMCOE COUNTY	

Plotted by: ALIU on December 12, 2023 at 2:38pm
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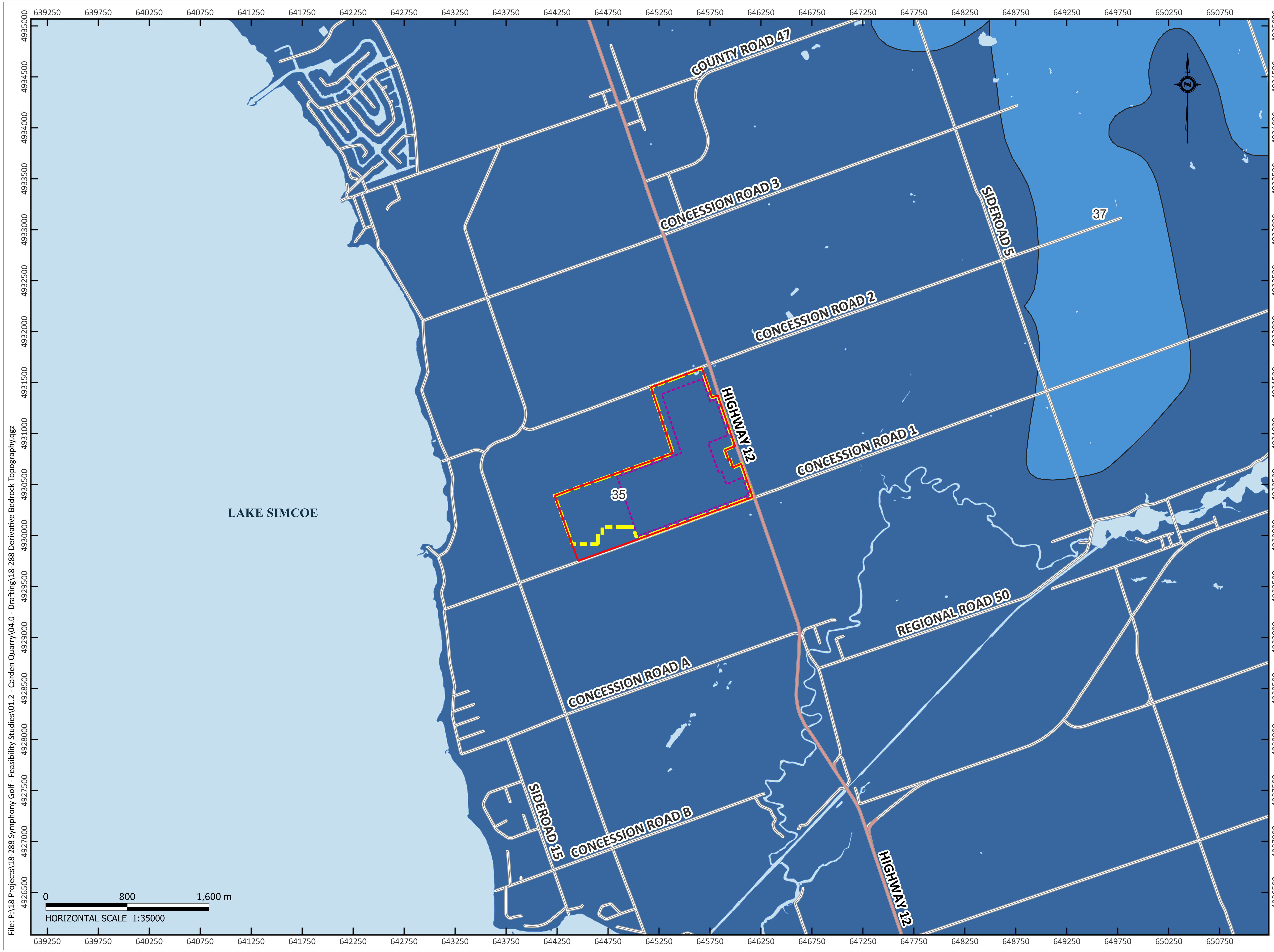


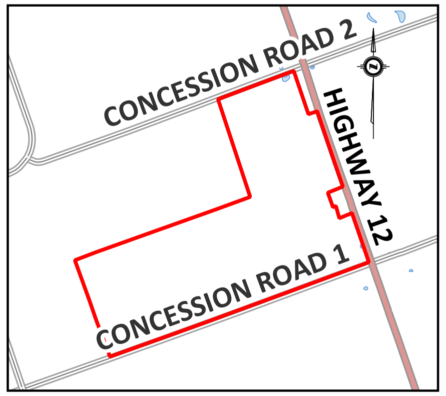
LEGEND

🟥 Subject Property
🟨 License Boundary
🟪 MHBC Limit of Extraction
🟦 Waterbody

Physiographic Regions

35 Simcoe Lowlands
37 Carden Plain

LOCATION MAP SCALE 1:50000



AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

REGIONAL PHYSIOGRAPHY

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
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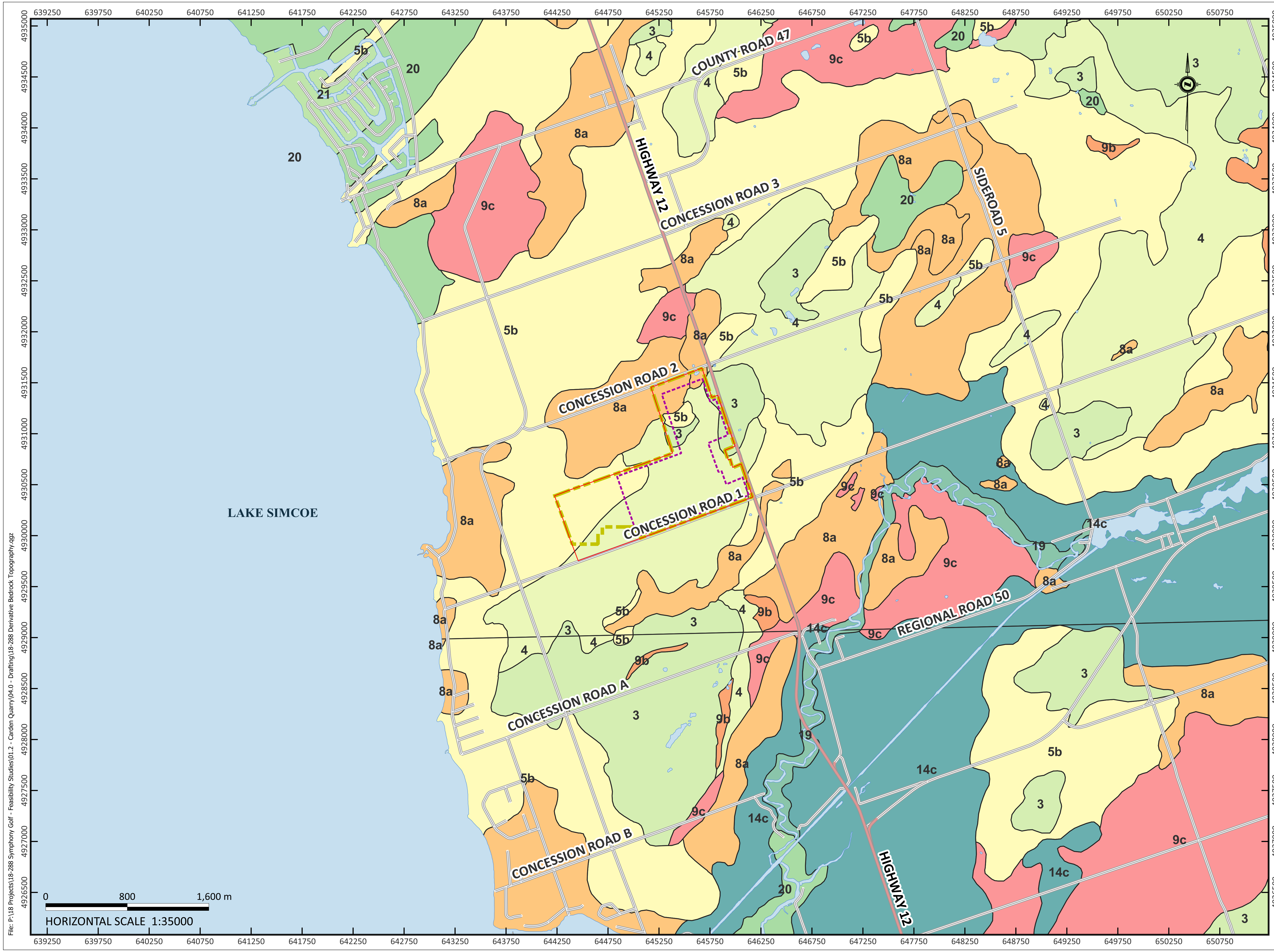
PROJECT NO.:	18-288	
BASE MAP:	MNRF	



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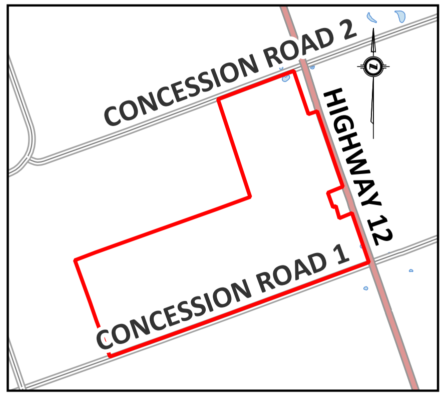
LEGEND

- 🟥 Subject Property
- ▨ License Boundary
- ▨ MHBC Limit of Extraction
- 🟦 Waterbody

Surficial Geology

3	Paleozoic Bedrock
4	Bedrock-drift complex in Paleozoic terrain
5b	Stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain
8a	Massive to well laminated fine-textured galciolacustrine deposits: silt and clay, minor sand and gravel
9b	Littoral deposits, coarse-textured glaciolacustrine deposits: sand, gravel, minor silt and clay
9c	Foreshore and basical deposits, coarse-textured glaciolacustrine deposits: sand, gravel, minor silt and clay
14c	Foreshore and basinal deposits, coarse-textured lacustrine deposits: sand, gravel, minor silt and clay
19	Modern alluvial deposits: clay, silt, sand, gravel, may contain organic remains
20	Organic Deposits: peat, muck, marl
21	Man-made deposits: fill, sewage lagoon, landfill, urban development

LOCATION MAP SCALE 1:50000



AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

REGIONAL SURFICIAL GEOLOGY

BRECHIN QUARRY
BRECHIN, ON

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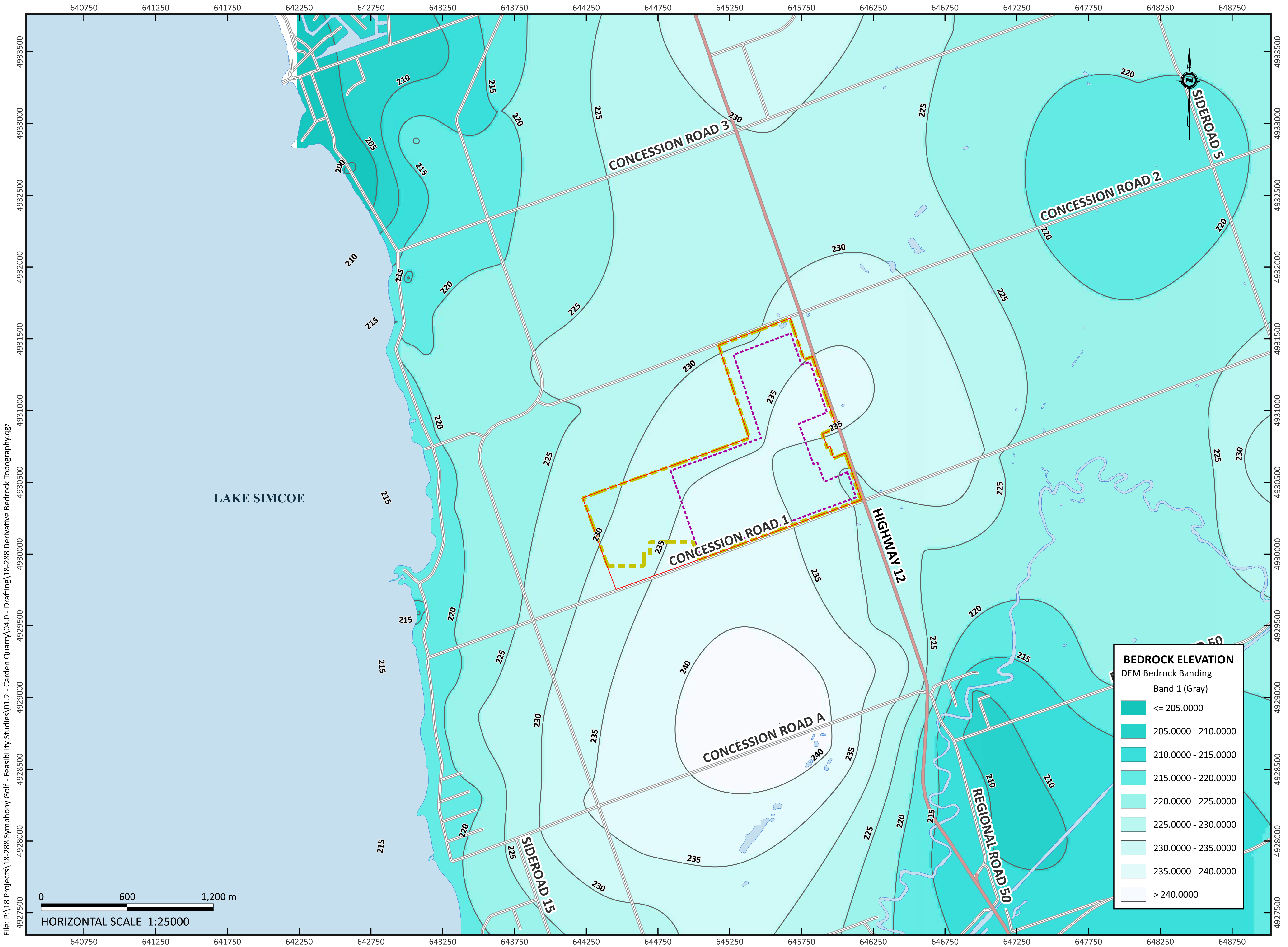
PROJECT NO.:	18-288	
BASE MAP:	MNRF	



BEDROCK ELEVATION

DEM Bedrock Banding

Band 1 (Gray)

🟦	<= 205.0000
🟦	205.0000 - 210.0000
🟦	210.0000 - 215.0000
🟦	215.0000 - 220.0000
🟦	220.0000 - 225.0000
🟦	225.0000 - 230.0000
🟦	230.0000 - 235.0000
🟦	235.0000 - 240.0000
☐	> 240.0000

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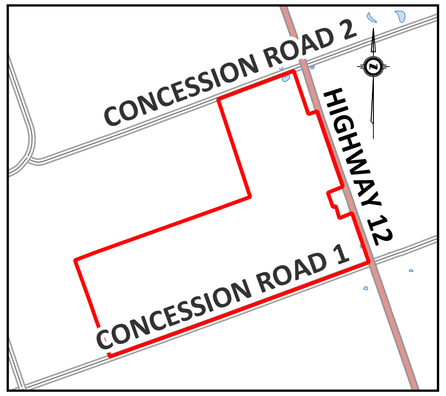
LEGEND

🟥	Subject Property
▭	License Boundary
▭	MHBC Limit of Extraction
—100.00—	Bedrock Contours
🟦	Waterbody

LOCATION MAP SCALE 1:50000



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BEDROCK TOPOGRAPHY

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
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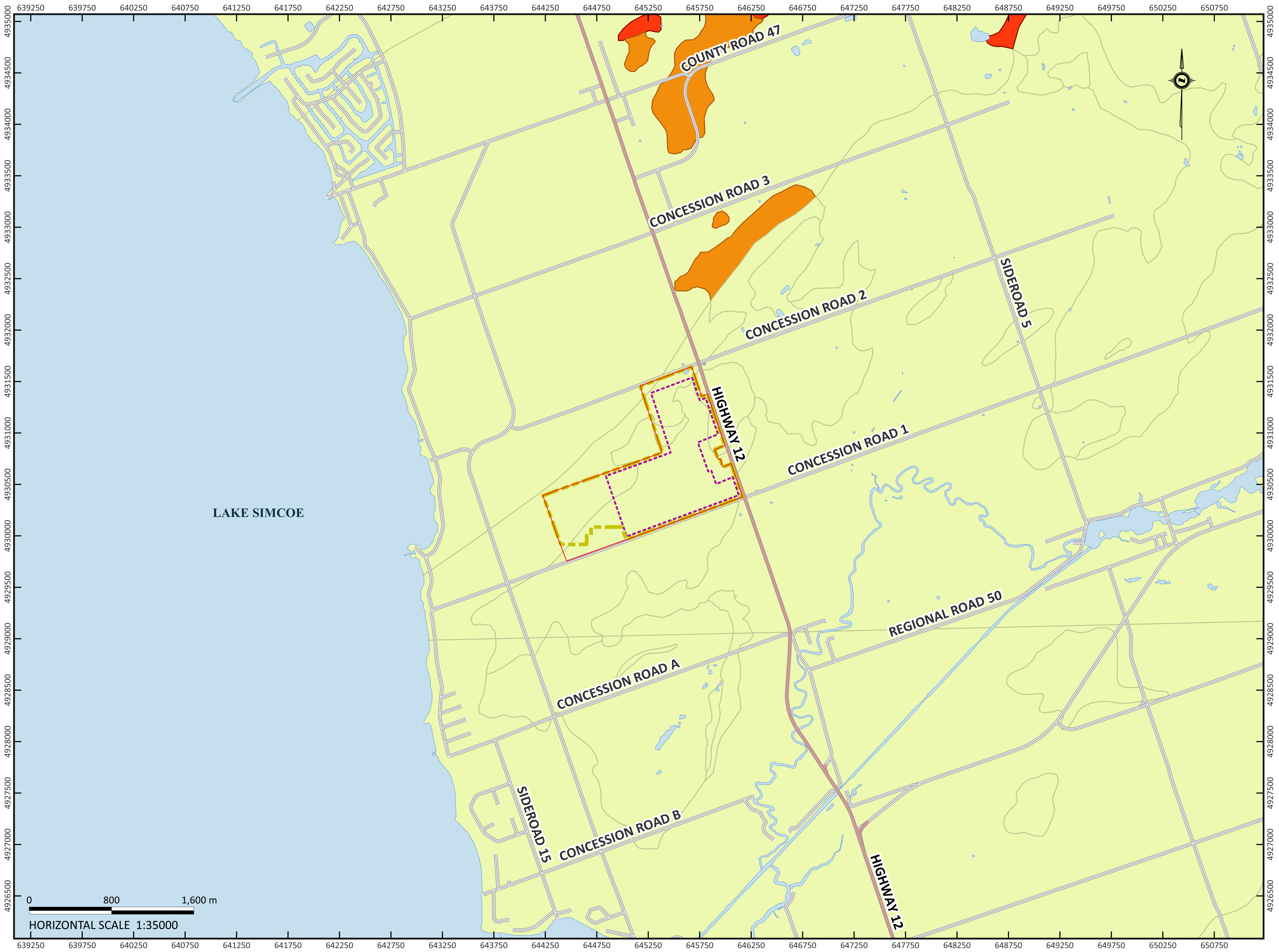

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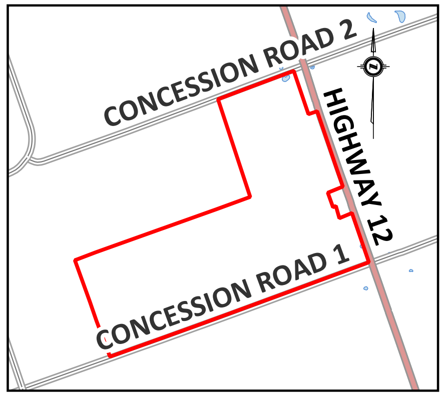
LEGEND

- ☐ Subject Property
- ▭ License Boundary
- ▭ MHBC Limit of Extraction
- 🟦 Waterbody

Karst Topography

- 🟥 Known Karst
- 🟧 Inferred Karst
- 🟨 Unknown

LOCATION MAP SCALE 1:50000



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REGIONAL KARST FEATURES

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
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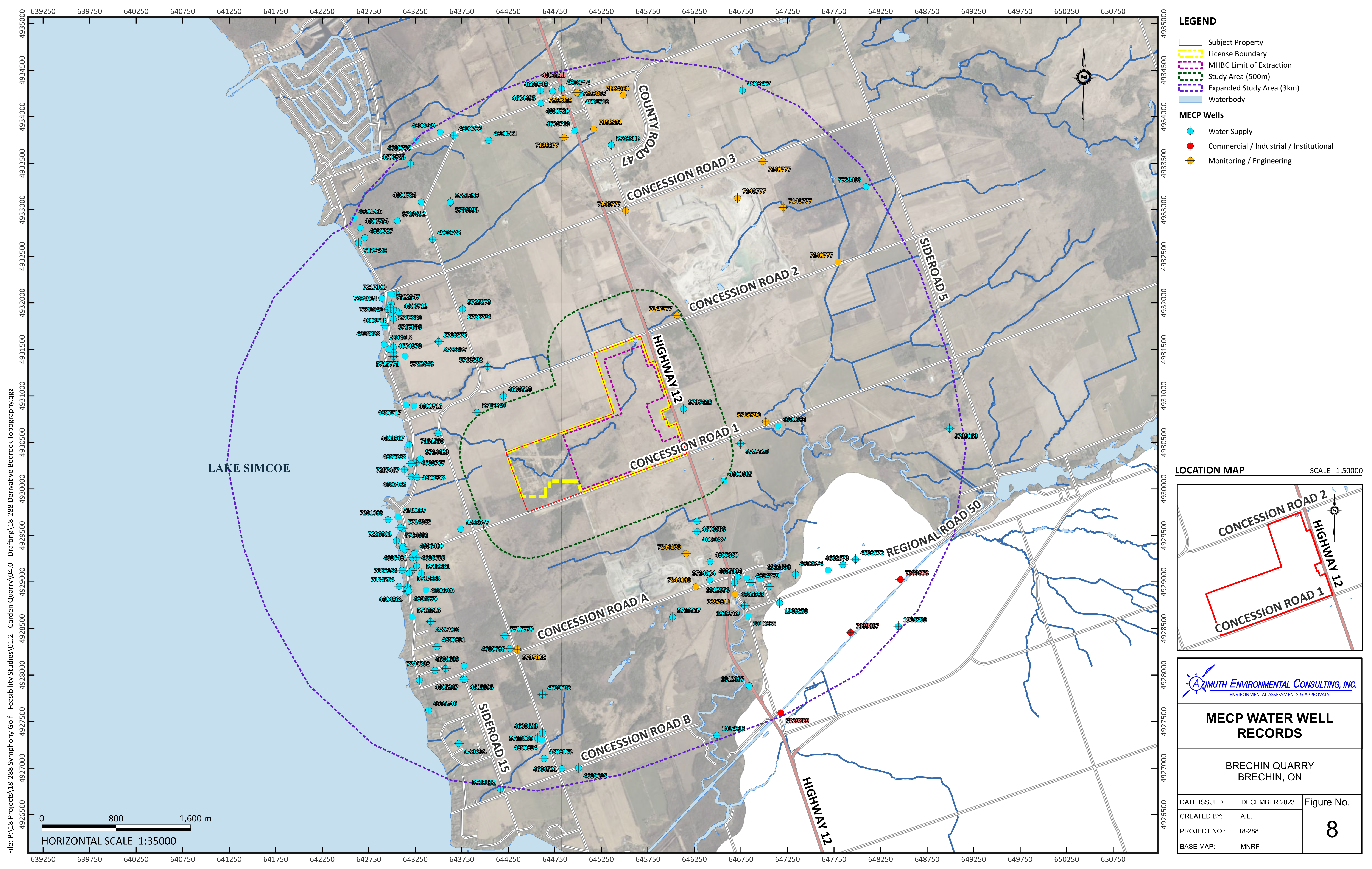

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ENVIRONMENTAL ASSESSMENTS & APPROVALS

MECP WATER WELL RECORDS

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
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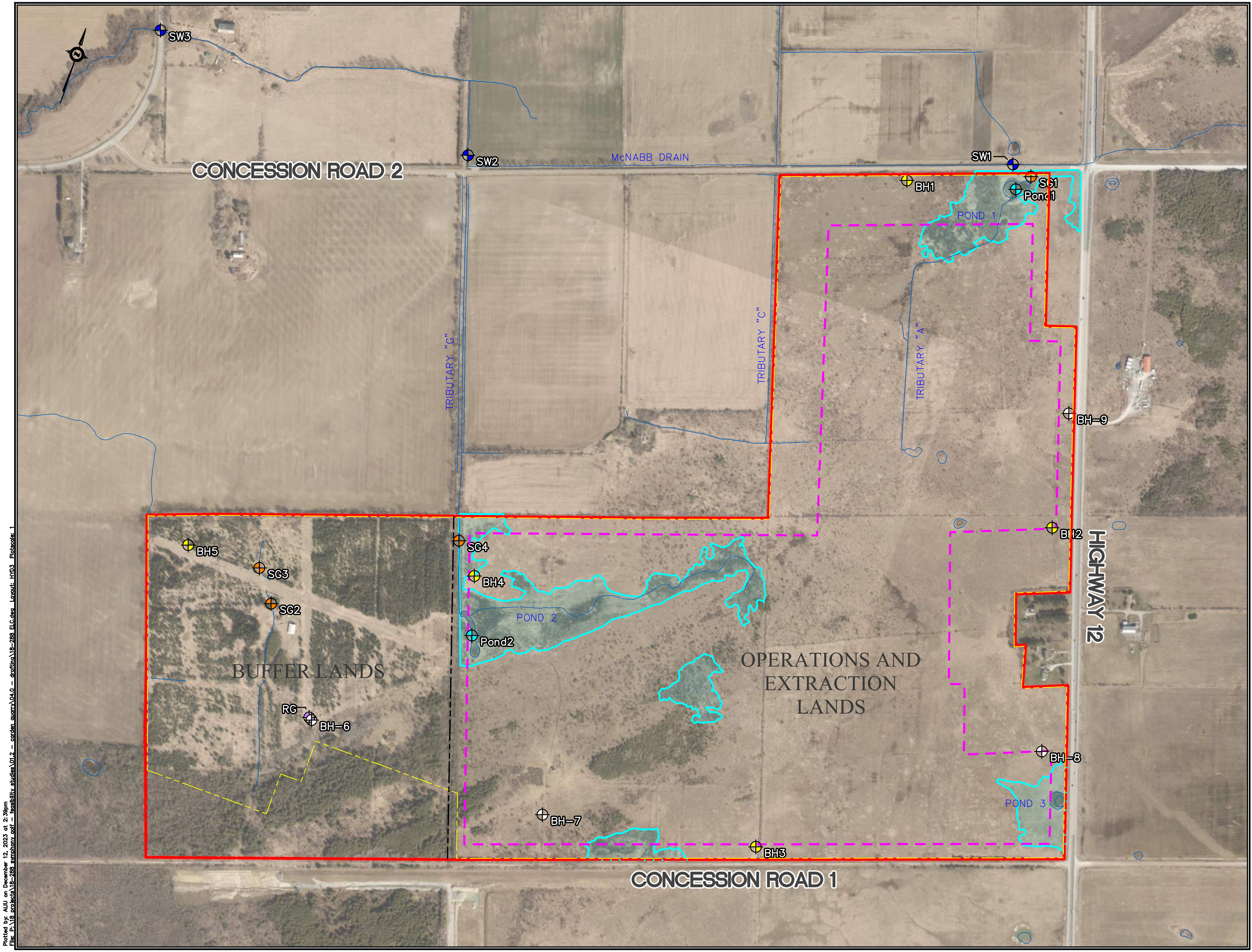
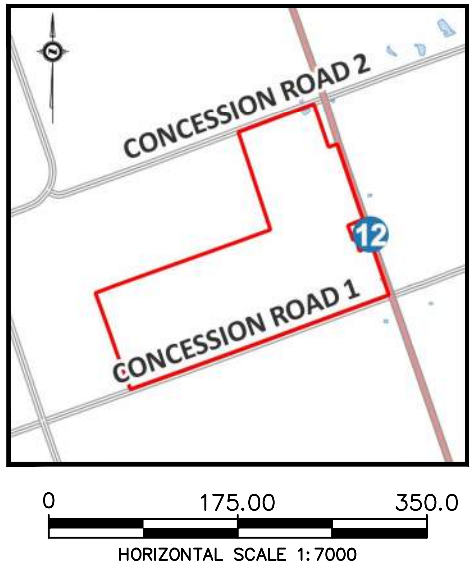
PROJECT NO.:	18-288	
BASE MAP:	MNRF	



LEGEND:

- APPROX. PROPERTY BOUNDARY
- LICENSE BOUNDARY
- FORMER RAIL LINE
- WATERCOURSE (LIO)
- WETLAND UNIT (AEC DELINEATED, OCT. 5 2021)
- EXTRACTION FOOTPRINT
- ⊕ MONITORING WELL LOCATIONS (2019)
- ⊕ STAFF GAUGE LOCATIONS
- ⊕ SURFACE WATER MONITORING LOCATIONS
- ⊕ POND MONITORING LOCATIONS
- ⊕ MONITORING WELL LOCATIONS (2020)
- ⊕ RAIN GAUGE

LOCATION PLAN



AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

EXISTING MONITORING NETWORK

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
CREATED BY:	A.L.	9
PROJECT NO.:	18-288	
REFERENCE:	SIMCOE COUNTY	

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BEDROCK ELEVATION

Bedrock Topology - Site - Clipped

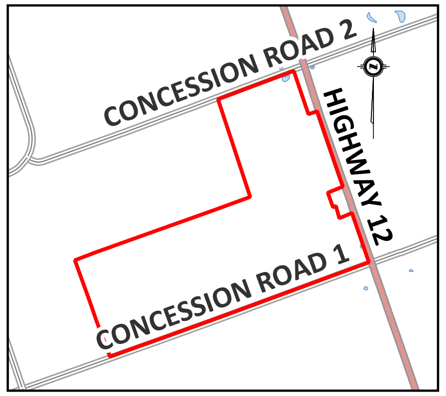
Band 1 (Gray)

- <= 230.0000
- 230.0000 - 231.0000
- 231.0000 - 232.0000
- 232.0000 - 233.0000
- 233.0000 - 234.0000
- 234.0000 - 235.0000
- > 235.0000

LEGEND

- Subject Property
- MHBC Limit of Extraction
- License Boundary
- Waterbody
- Boreholes
- Bedrock Contours
- Highway
- Road

LOCATION MAP SCALE 1:50000



AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

BEDROCK SURFACE PROFILE

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023
CREATED BY:	A.L.
PROJECT NO.:	18-288
BASE MAP:	MNRF

Figure No.
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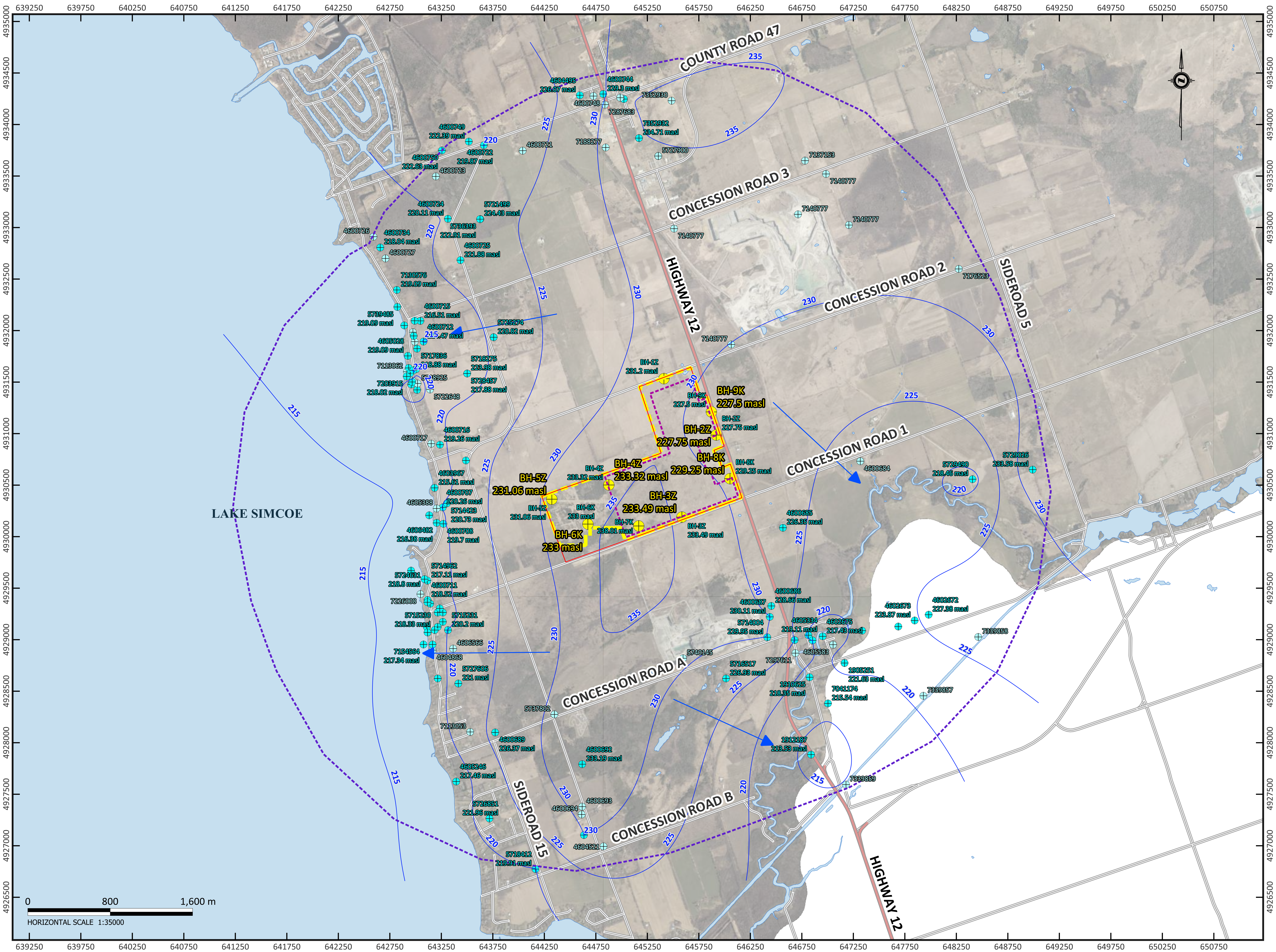

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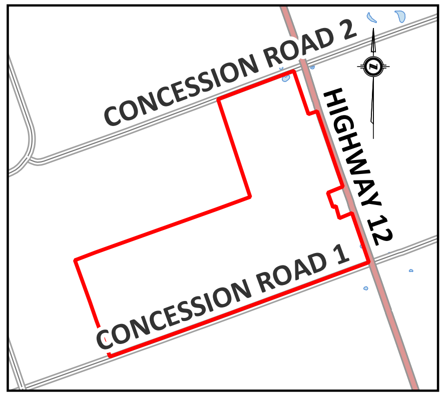
LEGEND

- 🟥 Subject Property
- License Boundary
- MHBC Limit of Extraction
- Expanded Study Area (3km)
- Waterbody
- ⊕ Boreholes - Ground Water Elev. (masl)
- ⊕ MECP Wells - Ground Water Elev. (masl)
- ⊕ MECP Wells - No Ground Water Readings
- 5m Ground Water Contours (masl)
- ➡ Inferred Direction of Ground Water Flow

LOCATION MAP SCALE 1:50000



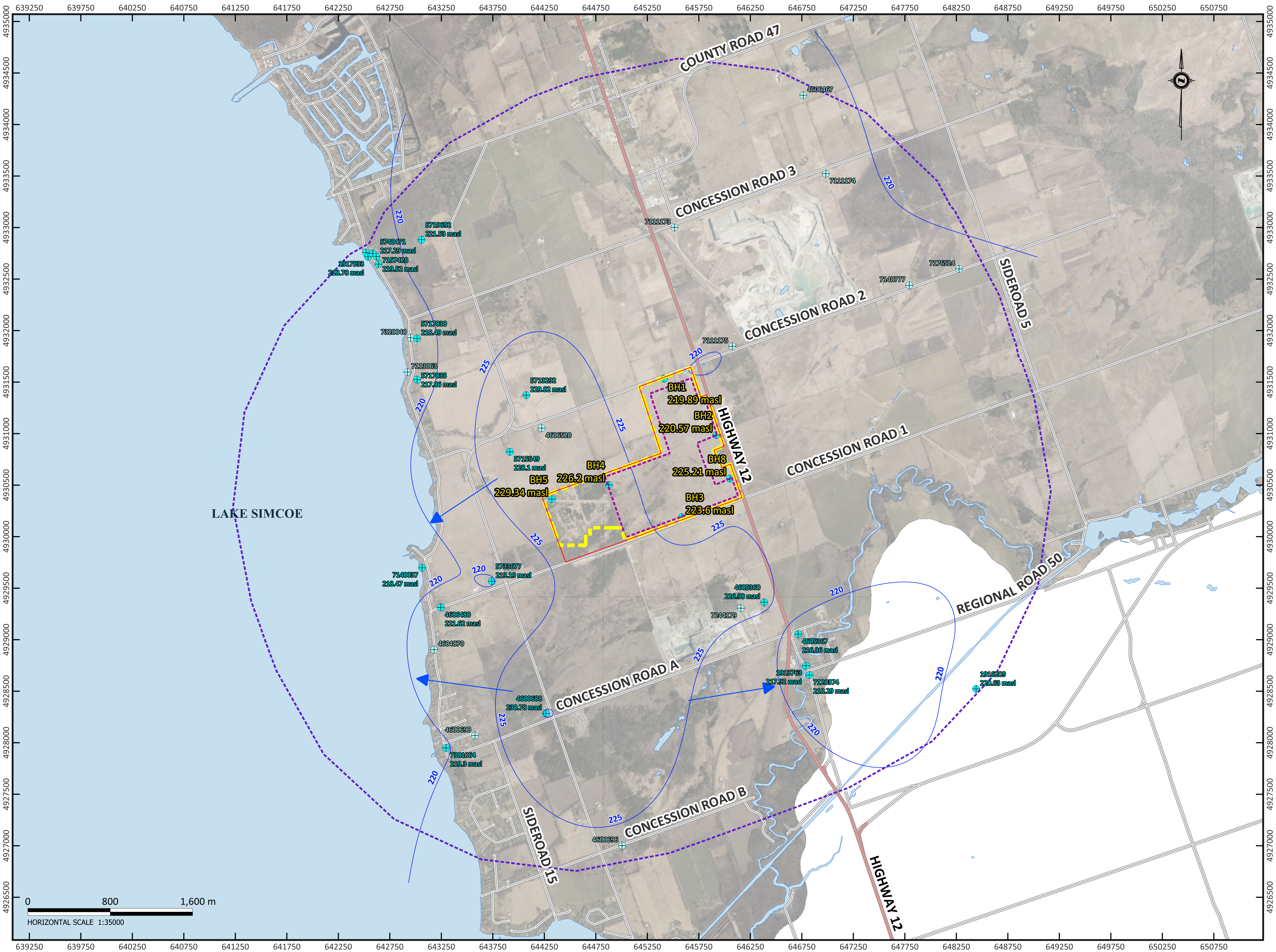
AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

REGIONAL POTENTIOMETRIC SURFACE SHALLOW AQUIFER

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023
CREATED BY:	A.L.
PROJECT NO.:	18-288
BASE MAP:	Simcoe County

Figure No.
11



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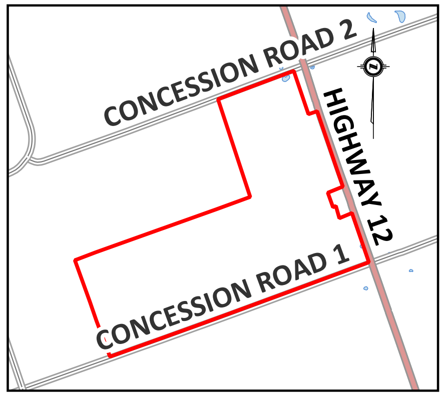
LEGEND

- 🟥 Subject Property
- ▬ License Boundary
- ▭ MHBC Limit of Extraction
- ▭ Expanded Study Area (3km)
- ▭ Waterbody
- ⊕ MECP Wells - Ground Water Elev. (masl)
- ⊕ MECP Wells - No Ground Water Readings
- 100.00 5m Ground Water Contours (masl)
- → Inferred Direction of Ground Water Flow

LOCATION MAP SCALE 1:50000

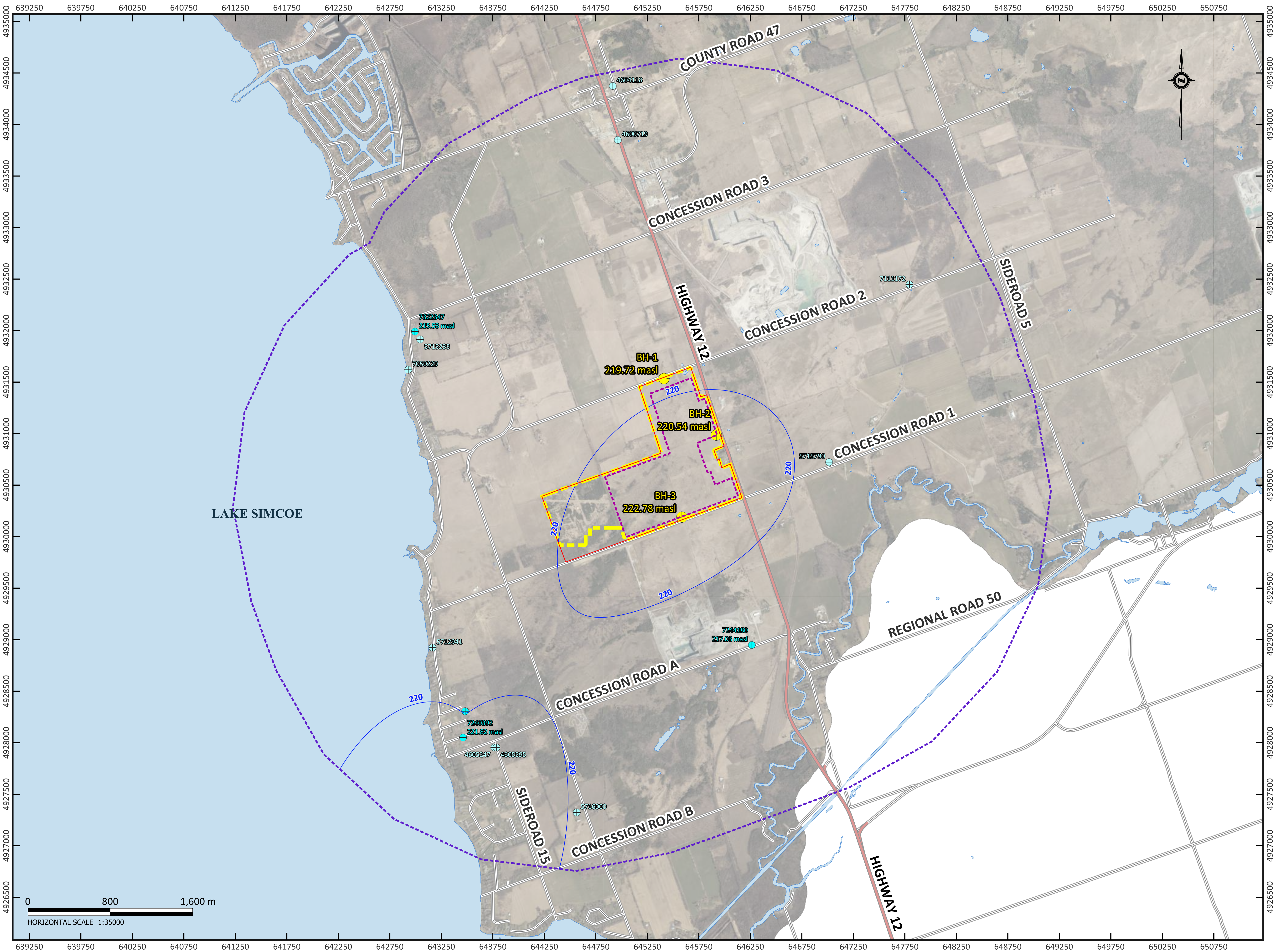


AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

REGIONAL POTENTIOMETRIC SURFACE
INTERMEDIATE AQUIFER

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
CREATED BY:	A.L.	12
PROJECT NO.:	18-288	
BASE MAP:	Simcoe County	

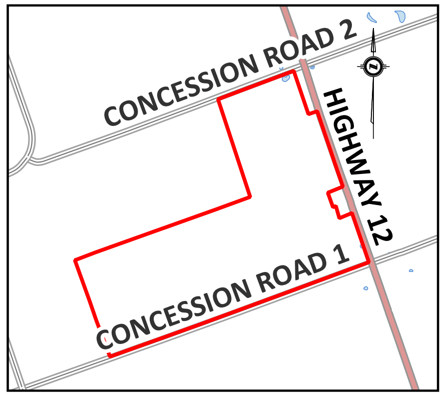


File: P:\18 Projects\18-288 Symphony Golf - Feasibility Studies\01.2 - Carden Quarry\04.0 - Drafting\18-288 Derivative Bedrock Topography.qgz

LEGEND

🟥 Subject Property
▭ License Boundary
▭ MHBC Limit of Extraction
▭ Expanded Study Area (3km)
▭ Waterbody
⊕ Boreholes
⊕ MECP Wells - Ground Water Elev. (masl)
⊕ MECP Wells - No Ground Water Readings
— 5m Ground Water Contours (masl)

LOCATION MAP SCALE 1:50000



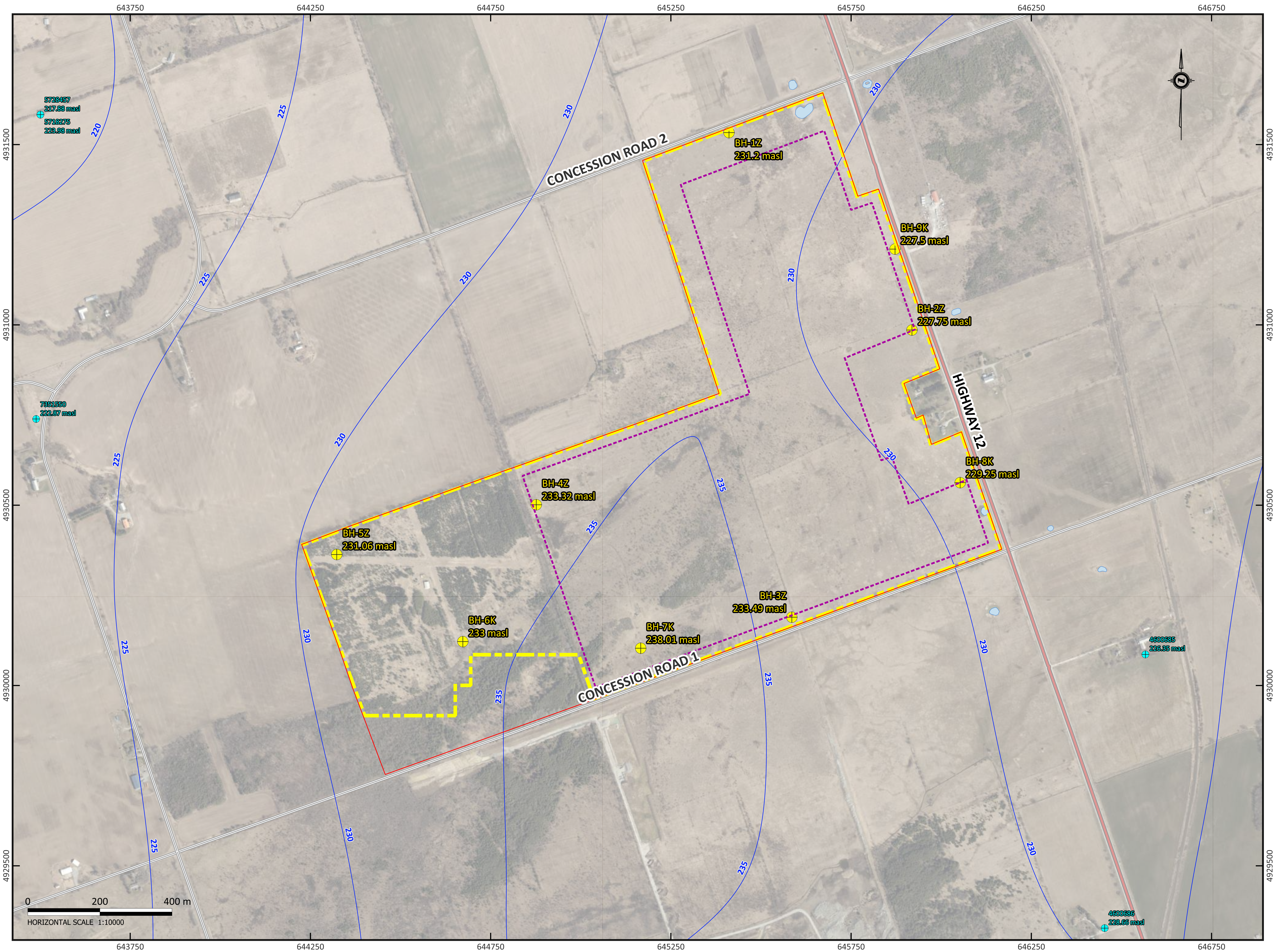
AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

REGIONAL POTENTIOMETRIC SURFACE
DEEP AQUIFER

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023
CREATED BY:	A.L.
PROJECT NO.:	18-288
BASE MAP:	Simcoe County

Figure No.
13



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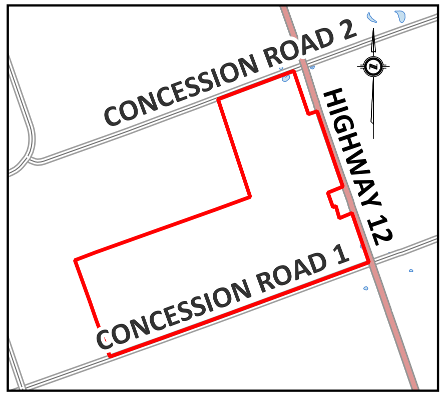
LEGEND

- 🟥 Subject Property
- ▭ MHBC Limit of Extraction
- ▬ License Boundary
- 🟦 Waterbody
- ▬ Highway
- ═ Road
- ⊕ Borehole - Ground Water Elev. (masl)
- —100.00— 5m Ground Water Contours (masl)

LOCATION MAP SCALE 1:50000

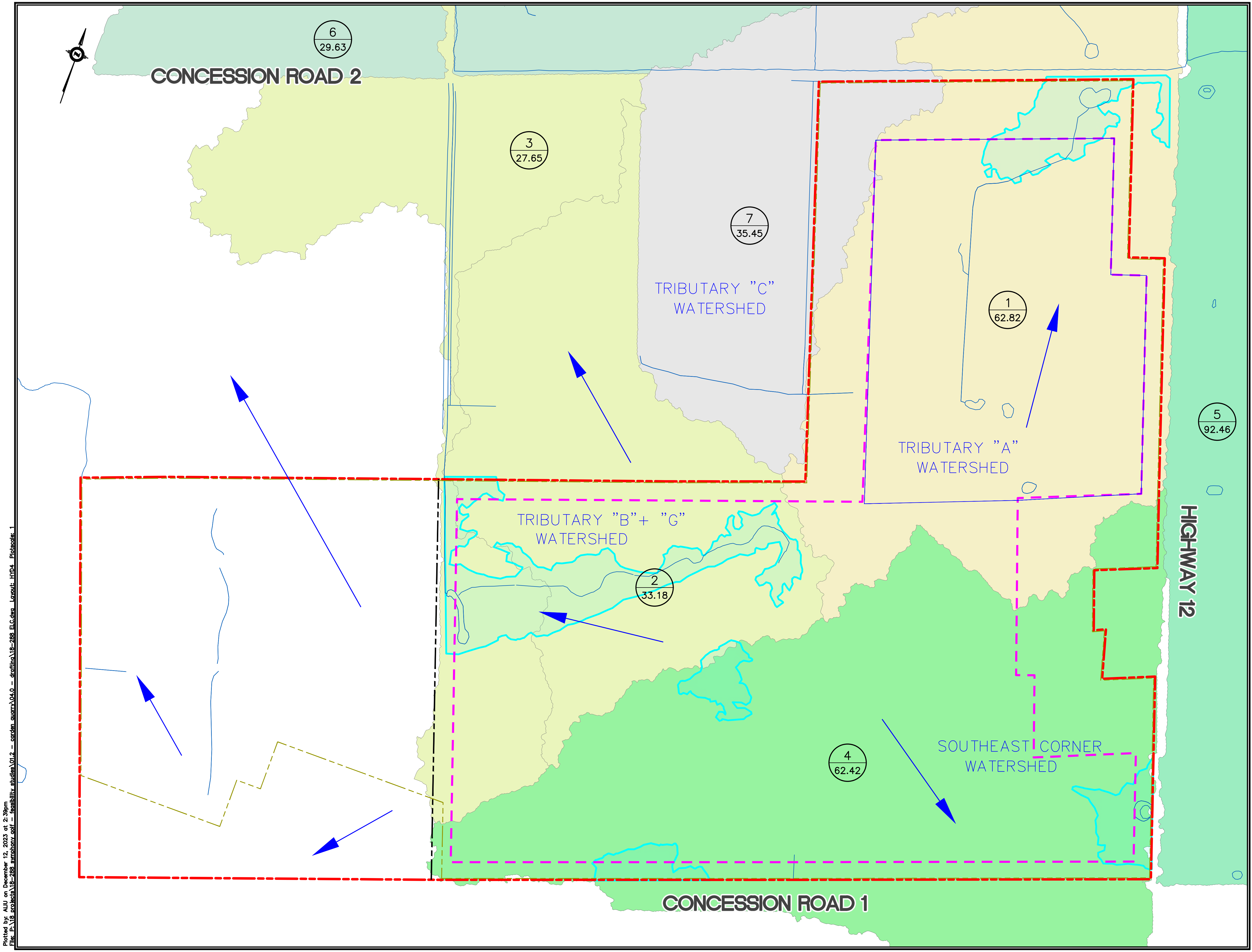


AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

MAXIMUM PREDICTED WATER TABLE CONDITION - SITE

BRECHIN QUARRY
BRECHIN, ON

DATE ISSUED:	DECEMBER 2023	Figure No.
CREATED BY:	A.L.	14
PROJECT NO.:	18-288	
BASE MAP:	MNRF	



LEGEND:

— - —	APPROX. PROPERTY BOUNDARY
— - —	LICENSE BOUNDARY
— - —	FORMER RAIL LINE
——	WATERCOURSE (LIO)
☐	WETLAND UNIT (AEC DELINEATED, OCT. 5 2021)
- - -	DEVELOPMENT FOOTPRINT

SUB BASINS

🟨	SUB–BASIN 1
🟩	SUB–BASIN 2
🟩	SUB–BASIN 3
🟩	SUB–BASIN 4
🟩	SUB–BASIN 5
⬜	SUB–BASIN 6
	SUB–BASIN 7

1 — SUB–BASIN NUMBER
62.82 — SUB–BASIN AREA (ha.)
→ DIRECTION OF OVERLAND DRAINAGE

LOCATION PLAN

0 150.00 300.0
HORIZONTAL SCALE 1:6000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
ENVIRONMENTAL ASSESSMENTS & APPROVALS

SURFACE WATER FLOW REGIME

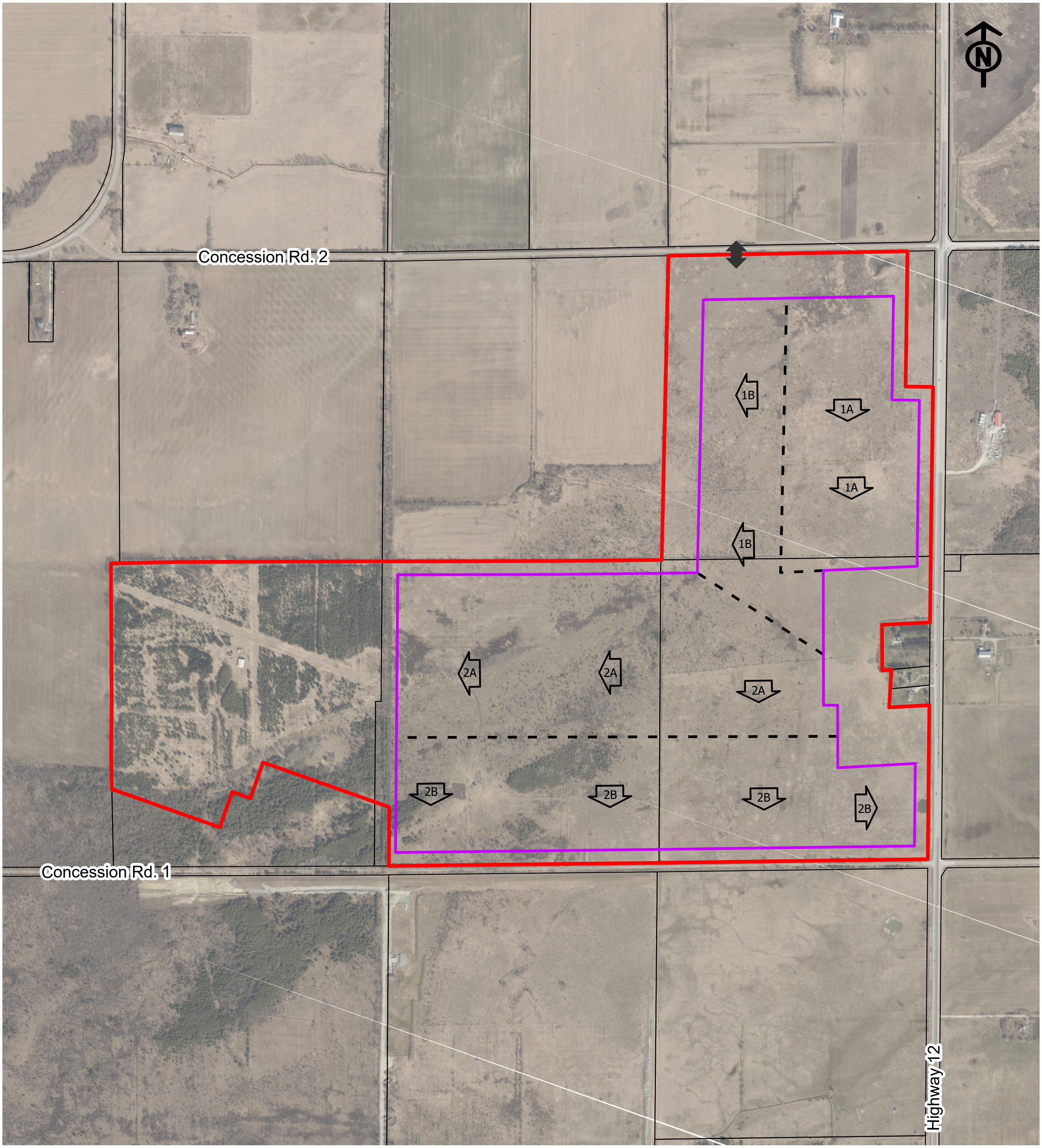
BRECHIN QUARRY
BRECHIN, ON

		Figure No.
DATE ISSUED:	*DECEMBER 2023*	15
CREATED BY:	*A.L.*	
PROJECT NO.:	*18-288*	
REFERENCE:	*SIMCOE COUNTY*	

Plotted by: ALIU on December 12, 2023 at 2:39pm
File: P:\18 projects\18-288 symphony golf – feasibility studies\01.2 – carden quarry\04.0 – drafting\18-288 ELC.dwg Layout: HYD4 Plotscale: 1

APPENDIX B

Site Operations Schematic (MHBC, 2023)



BRECHIN QUARRY SIMPLIFIED OPERATION SCHEMATIC

Proposed Brechin Quarry

Part of Lots 11&12, Concession 1
Township of Ramara
County of Simcoe

LEGEND

🟥 Subject Lands and Proposed Licence Boundary

🟪 Proposed Limit of Extraction

- - - Phasing Area

↕ Proposed Entrance / Exit

☐ Parcel Fabric

DATE December 2023

SOURCES

2022 Ortho Photography County of Simcoe GIS

0 75 150 300
Meters

12135B - Planning Report Figures

MHBC
PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE

APPENDIX C

MECP Domestic Water Well Records

NAME - MECP WWIS ID	EASTING	NORTHING	STATUS	BH - PURPOSE PRIMARY	BH - PURPOSE SECONDARY	BH - DRILL METHOD	BH - DEPTH (M)	BH - STATIC WATER LEVEL (M)	BH - DIAMETER (CM)	ELEVATION - GROUND (mASL)	ELEVATION - BH BOTTOM (mASL)	ELEVATION - BEDROCK (mASL)	AVG STATIC WATER LEVEL (mASL)	PROJECTED FORMATION	NAME - ORIGINAL DRILLER	DATE - ORIGINAL DRILL DATE
4600709	643142.0	4929349.0	Active	Water Supply	Domestic	Cable Tool	13.11	0.92	12.70	219.43	206.32	216.38	218.51	Bobcaygeon	Roger Boadway Ent. Ltd.	1951-07-18
4600686	646279.3	4929652.0	Active	Water Supply	Domestic	Cable Tool	16.15	3.66	17.78	232.32	216.16	228.96	228.66	Bobcaygeon	MOE Driller No. 1344	1958-12-18
7352930	645486.0	4934231.0	Active	Engineering	Monitoring / Observation Well	Diamond	4.88	2.44		238.37	233.49	238.22	235.93	Verulam	G.E.T. DRILLING LTD.	2019-12-10
5719692	643057.0	4932881.0	Active	Water Supply	Domestic	Cable Tool	28.35	3.05	15.24	224.58	196.24	220.92	221.53	Gull River	WEAVER WELL DRILLING	1984-10-15
5738923	642519.0	4932758.0	Active	Active	-	Cable Tool	21.00	0.30	-	219.33	198.33	200.83	219.03	Gull River	WEAVER WELL DRILLING	2004-06-17
5725274	643758.0	4931935.0	Active	Water Supply	Domestic	Cable Tool	28.04	7.62	-	228.44	200.40	220.21	220.82	Bobcaygeon	MOE Driller No. 2515	1989-08-02
4600715	643047.0	4932094.0	Active	Water Supply	Domestic	Cable Tool	7.62	4.57	12.70	221.08	213.46	218.03	216.51	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1948-07-20
5722648	643141.0	4931428.0	Active	Water Supply	Domestic	Not known	15.24	-	-	223.19	207.95	219.53	-	Bobcaygeon	WEAVER WELL DRILLING	1987-09-02
5727606	643415.0	4928574.0	Active	Water Supply	Domestic	Rotary (air)	18.29	4.26	15.24	225.26	206.98	222.83	221	Bobcaygeon	Roger Boadway Ent. Ltd.	1990-11-02
4604868	643165.0	4928898.0	Abandoned	Water Supply	Domestic	Cable Tool	8.84	-	-	221.21	212.37	217.55	-	Bobcaygeon	MOE Driller No. 2518	1971-08-23
1905250	647165.0	4928773.0	Active	Water Supply	Domestic	Cable Tool	13.72	3.05	15.24	224.68	210.96	-	221.63	Bobcaygeon	WEAVER WELL DRILLING	1978-12-20
4605028	642925.0	4931754.0	Active	Water Supply	Domestic	Cable Tool	15.24	2.14	15.24	221.23	205.99	217.57	219.09	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1971-01-07
5739670	643006.0	4931626.0	Active	-	-	Cable Tool	16.00	3.90	-	223.16	207.16	219.06	219.26	Bobcaygeon	WEAVER WELL DRILLING	2005-03-19
7287683	644838.0	4934193.0	Active	Engineering	Geotech Testhole	-	5.79	-	-	231.96	226.17	230.13	-	Verulam	PROFILE DRILLING INC.	2017-05-01
7137153	646781.0	4933649.0	Active	-	-	-	15.85	-	-	230.80	214.95	225.31	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	2009-11-06
5713292	644026.3	4931315.0	Active	Water Supply	Domestic	Cable Tool	32.00	0.00	15.24	229.82	197.81	226.16	229.82	Gull River	MOE Driller No. 4407	1976-05-07
7113062	642916.0	4931600.0	MOE Abandonment Record	-	-	Cable Tool	20.00	-	-	219.06	199.06	215.06	-	Bobcaygeon	WEAVER WELL DRILLING	2008-07-21
4600689	643773.0	4928099.0	Active	Water Supply	Domestic	Cable Tool	12.19	2.74	15.24	229.11	216.92	227.89	226.37	Bobcaygeon	G. Hart & Sons	1956-11-26
7239808	644995.0	4934255.0	Monitoring and Test Hole	Engineering	Monitoring / Observation Well	Driving (direct push)	2.44	-	-	235.42	-	-	-	-	STRATA SOIL SAMPLING INC.	2015-02-25
5716516	643215.0	4928623.0	Active	Water Supply	Domestic	Cable Tool	17.37	2.44	15.24	221.62	204.24	217.65	219.18	Bobcaygeon	WEAVER WELL DRILLING	1979-08-10
4600712	643077.0	4931893.0	Active	Water Supply	Domestic	Cable Tool	13.72	7.62	7.62	222.09	208.37	216.29	214.47	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1948-07-04
7111174	646983.0	4933523.0	Active	-	-	Rotary (air)	45.72	-	-	229.60	183.88	222.59	-	Gull River	Wilson Water Wells Ltd.	2008-08-01
5727900	645357.0	4933694.0	Active	Engineering	Monitoring / Observation Well	Rotary (air)	9.14	-	5.08	235.67	226.52	232.62	-	Verulam	Roger Boadway Ent. Ltd.	1991-02-04
1916209	648443.0	4928522.0	Active	Water Supply	Other - Water Supply	Rotary (conventional)	30.78	7.01	-	227.64	196.86	213.62	220.63	Gull River	CARL BALDWIN WATER WELL DRILLING LTD.	2002-07-30
4604118	644915.0	4934374.0	Abandoned	Institutional	Other - Institutional	Rotary (conventional)	55.17	-	12.70	233.71	178.54	231.88	-	Shadow Lake	Roger Boadway Ent. Ltd.	1969-07-09
5714962	643115.0	4929573.0	Active	Water Supply	Domestic	Cable Tool	15.24	2.74	15.24	219.85	204.61	217.72	217.11	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1977-06-09
4600718	645023.0	4934247.0	Active	Water Supply	Domestic	Cable Tool	9.75	1.22	12.70	235.93	226.18	234.71	234.71	Verulam	Roger Boadway Ent. Ltd.	1949-06-07
1914613	646491.0	4927351.0	Abandoned	Water Supply	Domestic	Not known	-	-	-	221.31	-	-	-	-	DOUGLAS TOWERS & SON WELL DRILLING	2000-06-24
4600721	644040.0	4933746.0	Unknown	Water Supply	Municipal Exploration	Cable Tool	6.40	-	15.24	228.01	221.61	221.91	-	Bobcaygeon	C.E. Snider	1958-07-21
7176524	648277.0	4932598.0	Unknown	Unknown	-	-	42.67	-	-	230.27	187.60	216.55	-	Gull River	Wilson Water Wells Ltd.	2011-11-21
7297611	646688.0	4928869.0	Active	Engineering	Geotech Testhole	Rotary (conventional)	7.62	-	-	222.82	215.20	217.63	-	Bobcaygeon	STRONG SOIL SEARCH INC	2017-04-18
1917533	642538.0	4932716.0	Active	-	-	Cable Tool	20.70	0.40	-	219.18	198.48	-	218.78	Gull River	WEAVER WELL DRILLING	2005-02-07
7140777	646985.0	4933520.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	24.00	-	-	229.60	205.60	-	-	Bobcaygeon	Lantech Drilling Services Inc.	2009-10-14
4600692	644618.0	4927791.0	Active	Water Supply	Domestic	Cable Tool	9.14	4.27	15.24	237.46	228.31	233.80	233.19	Verulam	CARL BALDWIN WATER WELL DRILLING LTD.	1953-11-20
4600749	643517.0	4933834.0	Active	Water Supply	Domestic	Cable Tool	5.49	2.44	12.70	224.83	219.34	-	222.39	Bobcaygeon	MOE Driller No. 1344	1952-10-24
5716000	644565.0	4927323.0	Abandoned	Water Supply	Domestic	Rotary (air)	68.58	-	-	229.30	160.72	229.30	-	Precambrian	CARL BALDWIN WATER WELL DRILLING LTD.	1976-09-12
5717835	643015.0	4931524.0	Active	Water Supply	Domestic	Cable Tool	27.43	6.10	15.24	223.96	196.53	217.86	217.86	Gull River	WEAVER WELL DRILLING	1981-10-20
7140777	645510.0	4932989.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	6.50	-	-	232.81	226.31	-	-	Verulam	Lantech Drilling Services Inc.	2009-10-14
7240392	643461.0	4928049.0	Active	Water Supply	Domestic	Cable Tool	50.29	3.96	-	225.78	175.49	-	221.82	Shadow Lake	CARL BALDWIN WATER WELL DRILLING LTD.	2015-03-27
5716517	646015.0	4928623.0	Active	Water Supply	Domestic	Cable Tool	22.86	12.19	15.24	239.12	216.26	239.12	226.93	Bobcaygeon	WEAVER WELL DRILLING	1979-08-20
7244180	646265.0	4928948.0	Active	Engineering	Monitoring / Observation Well	Rotary (conventional)	55.78	17.46	-	234.49	178.71	232.66	217.03	Shadow Lake	HARDEN ENVIRONMENTAL SERVICES LTD.	2015-05-29
7111175	646075.0	4931847.0	Active	-	-	Rotary (air)	42.67	-	-	234.35	191.68	233.44	-	Gull River	Wilson Water Wells Ltd.	2008-08-01
4600684	647147.3	4930677.0	Abandoned	Water Supply	Domestic	Cable Tool	19.81	-	15.24	226.68	206.86	224.24	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1960-12-03
7113053	643530.0	4928104.0	MOE Abandonment Record	-	-	Cable Tool	20.42	-	-	225.68	205.26	221.42	-	Bobcaygeon	WEAVER WELL DRILLING	2008-08-16
4600707	643264.0	4930284.0	Active	Water Supply	Domestic	Cable Tool	9.14	1.22	10.16	221.48	212.34	219.04	220.26	Bobcaygeon	Roger Boadway Ent. Ltd.	1949-06-02
4606566	643365.0	4928913.0	Abandoned	Water Supply	Domestic	Rotary (air)	16.46	-	15.24	227.19	210.73	224.14	-	Bobcaygeon	Roger Boadway Ent. Ltd.	1976-07-06
5715770	644215.0	4928423.0	Active	Water Supply	Domestic	Rotary (conventional)	24.99	0.61	12.70	235.49	210.50	233.66	234.88	Bobcaygeon	Lang Well Drilling Ltd.	1978-04-23
4600713	642992.0	4931892.0	Abandoned	Water Supply	Domestic	Cable Tool	15.24	-	7.62	221.66	206.42	215.86	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1948-07-11
4600724	643314.0	4933085.0	Active	Water Supply	Domestic	Cable Tool	22.86	7.62	15.24	227.73	204.87	212.49	220.11	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1959-10-31
7352932	645169.0	4933868.0	Active	Engineering	Monitoring / Observation Well	Diamond	4.88	0.61	-	235.32	230.44	232.88	234.71	Verulam	G.E.T. DRILLING LTD.	2019-12-10
5715232	643165.0	4928953.0	Active	Water Supply	Domestic	Cable Tool	14.33	2.44	15.24	220.86	206.53	217.51	218.42	Bobcaygeon	WEAVER WELL DRILLING	1976-06-15
4604521	644825.0	4926993.0	Abandoned	Water Supply	Domestic	Cable Tool	14.02	-	-	232.79	218.77	227.61	-	Bobcaygeon	MOE Driller No. 2518	1970-06-20
7130576	642818.0	4932394.0	Active	-	-	Cable Tool	16.76	0.61	-	219.70	202.94	205.99	219.09	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	2009-05-27
7157428	642640.0	4932645.0	Active	Water Supply	Domestic	Cable Tool	24.99	0.61	-	220.13	195.14	200.32	219.52	Gull River	WEAVER WELL DRILLING	2010-09-12
4602672	647982.0	4929242.0	Active	Water Supply	Domestic	Cable Tool	11.58	1.53	15.24	228.91	217.33	222.51	227.38	Bobcaygeon	MOE Driller No. 1344	1959-01-10
7156164	643108.0	4929124.0	Active	Water Supply	Domestic	Cable Tool	15.24	2.35	-	219.18	203.94	217.35	216.83	Bobcaygeon	G. Hart & Sons Well Drilling Ltd.	2010-09-22
7111172	647795.0	4932447.0	Active	-	-	Rotary (air)	45.72	-	-	224.31	178.59	215.47	-	Shadow Lake	Wilson Water Wells Ltd.	2008-08-01
4600750	643256.0	4933748.0	Active	Water Supply	Domestic	Cable Tool	12.19	4.57	15.24	227.20	215.01	-	222.63	Bobcaygeon	MOE Driller No. 1344	1959-06-05
5737802	644348.0	4928274.0	Active	Engineering	Monitoring / Observation Well	Boring	19.81	-	-	239.31	219.50	-	-	Bobcaygeon	INSITU CONTRACTORS INC.	2003-04-23
5717836	643015.0	4931824.0	Active	Water Supply	Domestic	Cable Tool	18.29	3.05	15.24	221.93	203.64	219.18	218.88	Bobcaygeon	WEAVER WELL DRILLING	1981-10-10
5726851	643717.0	4927264.0	Active	Water Supply	Domestic	Cable Tool	24.38	2.74	15.24	224.70	200.32	220.43	221.96	Bobcaygeon	G. Hart & Sons Well Drilling Ltd.	1990-06-20
5715790	647015.0	4930723.0	Assumed Abandoned	Engineering	Other - Construction	Air Percussion	84.73	-	15.24	230.48	145.75	230.48	-	Precambrian	CARL BALDWIN WATER WELL DRILLING LTD.	1975-11-03
4600693	644618.0	4927379.0	Abandoned	Water Supply	Domestic	Cable Tool	13.72	-	15.24	230.87	217.15	226.30	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1966-12-01
4600744	644822.0	4934296.0	Active	Water Supply	Domestic	Cable Tool	13.72	1.83	12.70	231.13	217.42	229.30	229.3	Bobcaygeon	Roger Boadway Ent. Ltd.	1949-11-12
5712941	643165.0	4928923.0	Abandoned	Water Supply	Domestic	Cable Tool	56.69	-	15.24	220.72	164.03	217.67	-	Precambrian	G. Hart & Sons (2)	1975-06-12
5733677	643739.0	4929567.0	Assumed Abandoned	Water Supply	Domestic	Cable Tool	30.48	7.62	15.24	226.81	196.33	224.37	219.19	Gull River	EADES WELL DRILLING	1998-08-12
4600710	643117.0	4929384.0	Active	Water Supply	Domestic	Cable Tool	16.76	1.83	15.24	220.35	203.59	218.52	218.52	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1962-04-30
7339858	648463.0	4929026.0	MOE Abandonment Record	Industrial	Other - Institutional	-	4.57	-	-	230.51	225.94	-	-	Verulam	WEAVER WELL DRILLING	2019-05-07
7176523	648274.0	4932598.0	Unknown	Unknown	-	-	14.02	-	-	230.27	216.25	-	-	Bobcaygeon	Wilson Water Wells Ltd.	2011-11-19
4600687	646280.3	4929541.0	Active	Water Supply	Domestic	Cable Tool	17.37	2.44	17.78	232.55	215.17	228.28	230.11	Bobcaygeon	MOE Driller No. 1344	1958-12-22
5727898	645357.0	4933694.0	Active	Engineering	Monitoring / Observation Well	Rotary (air)	9.14	-	5.08	235.67	226.52	232.62	-	Verulam	Roger Boadway Ent. Ltd.	1991-02-04
5739485	642823.0	4932229.0	Active	-	-	Cable Tool	15.20	0.10	-	219.19	203.99	210.39	219.09	Bobcaygeon	WEAVER WELL DRILLING	2004-10-18
5715773	643015.0	4931424.0	Active	Water Supply	Domestic	Cable Tool	18.29	3.04	15.24	223.38	205.10	220.95	220.34	Bobcaygeon	WEAVER WELL DRILLING	1978-11-15
5737418	646132.3	4930859.0	Active	Water Supply	Domestic	Air Percussion	35.97	1.83	-	234.67	198.70	234.06	232.84	Gull River	Roger Boadway Ent. Ltd.	2002-10-15
5728254	645357.0	4933694.0	Active	Water Supply	Domestic	Rotary (air)	12.80	-	-	235.67	222.87	234.75	-	Bobcaygeon	Roger Boadway Ent. Ltd.	1991-07-30
1912187	646840.0	4927884.0	Active	Water Supply	Domestic	Rotary (air)	17.68	7.02	15.24	220.55	202.87	211.10	213.53	Bobcaygeon	Roger Boadway Ent. Ltd.	1994-10-21
4606481	643215.0	4929263.0	Active	Water Supply	Domestic	Cable Tool	18.90	3.05	15.24	220.84	201.94	217.79	217.79	Bobcaygeon	WEAVER WELL DRILLING	1976-03-10
4600727	642708.0	4932700.0	Unknown	Water Supply	Municipal Exploration	Cable Tool	18.29	-	15.24	219.45	201.16	201.46	-	Bobcaygeon	C.E. Snider	1959-09-18
4600716	643237.0	4930892.0	Active	Water Supply	Domestic	Cable Tool	17.68	2.74	12.70	222.00	204.32	220.78	219.26	Bobcaygeon	MOE Driller No. 2545	1955-06-16
7050229	642929.0	4931620.0	Active	-	-	Rotary (air)	54.86	-	-	219.46	164.60	214.59	-	Precambrian	LONE STAR WELL DIGGING LTD.	2007-09-20
7140777	646065.0	4931865.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	5.00	-	-	234.02	229.02	-	-	Verulam	Lantech Drilling Services Inc.	2009-10-13
5738924	642971.0	4931513.0	MOE Abandonment Record	-	-	Cable Tool	18.30	-	-	223.43	205.13	218.43	-	Bobcaygeon	WEAVER WELL DRILLING	2004-05-25
4606467	646765.0	4934284.0	Abandoned	Water Supply	Domestic	Cable Tool	45.72	-	15.24	238.69	192.97	224.97	-	Gull River	G. Hart & Sons (2)	1975-02-25
1905251	647165.0	4928773.0	Active	Water Supply	Domestic	Cable Tool	13.72	3.05	15.24	224.68	210.96	-	221.63	Bobcaygeon	WEAVER WELL DRILLING	1978-12-15
5729493	648095.0	4933248.0	Active	Water Supply	Domestic	Cable Tool	24.38	22.86	15.24	226.02	201.64	219.93	203.16	Bobcaygeon	MOE Driller No. 2653	1992-06-24
4605360	646416.3	4929218.0	Active	Water Supply	Domestic	Air Percussion	37.19	7.62	15.24	234.60	197.41	233.38	226.98	Gull River	CARL BALDWIN WATER WELL DRILLING LTD.	1972-08-18
4606484	643265.0	4929173.0	Active	Water Supply	Domestic	Cable Tool	16.15	3.04	15.24	221.20	205.05	218.16	218.16	Bobcaygeon	WEAVER WELL DRILLING	1976-03-16
4605246	643395.0	4927623.0	Active	Water Supply	Domestic	Cable Tool	9.14	3.05	15.24	220.51	211.36	-	217.46	Bobcaygeon	G. Hart & Sons (2)	1972-08-24
7101964	642933.0	4931637.0	Active	-	-	Cable Tool	12.19	2.74	-	220.05	207.86	216.09	217.31	Bobcaygeon	1430867 ONTARIO LTD. O/A DRURY WELL DRILLING	2007-07-01
5717833	643215.0	4929123.0	Active	Water Supply	Domestic	Cable Tool	17.68	3.05	15.24	220.72	203.04	218.28	217.67	Bobcaygeon	WEAVER WELL DRILLING	1981-06-10
7226008	643047.0	4929442.0	Active	Water Supply	Domestic	Rotary (conventional)	17.30	-	-	219.05	201.75	217.55	-	Bobcaygeon	E.S. WELL DRILLING	2014-07-11
4600690	643577.0	4928069.0	Abandoned	Water Supply	Domestic	Cable Tool	45.72	-	15.24	226.27	180.55	221.70	-	Gull River	CARL BALDWIN WATER WELL DRILLING LTD.	1966-11-14
7049417	643116.0	4929070.0	Active	-	-	Cable Tool	14.02	2.22	-	219.37	205.35	217.24	217.15	Bobcaygeon	G. Hart & Sons Well Drilling Ltd.	2007-05-08
7113063	642921.0	4931597.0	MOE Abandonment Record	-	-	Cable Tool	26.60	-	-	219.63	193.03	215.63	-	Gull River	WEAVER WELL DRILLING	2008-07-21
5740145	645597.0	4928819.0	Active	-	-	Rotary (air)	44.50	-	-	245.04	200.54	245.04	-	Bobcaygeon	HARDEN ENVIRONMENTAL SERVICES LTD.	2005-09-14
4605334	646815.0	4929043.0	Active	Water Supply	Domestic	Boring	6.10	4.57	1.94	223.68	217.59	-	219.11	Bobcaygeon	MOE Driller No. 1555	1972-10-17
4600696	645005.0	4927001.0	Abandoned	Water Supply	Domestic	Cable Tool	36.58	-	15.24	233.74	197.17	231.92	-	Gull River	CARL BALDWIN WATER WELL DRILLING LTD.	1960-12-05
4602675	646953.0	4929032.0	Active	Water Supply	Domestic	Cable Tool	11.89	3.05	15.24	220.48	208.59	209.50	217.43	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1964-06-01
4606153	644635.0	4927103.0	Active	Water Supply	Domestic	Cable Tool	14.94	0.00	15.24	230.03	215.09	-	230.03	Bobcaygeon	G. Hart & Sons (2)	1974-05-21

NAME - MECP WWIS ID	EASTING	NORTHING	STATUS	BH - PURPOSE PRIMARY	BH - PURPOSE SECONDARY	BH - DRILL METHOD	BH - DEPTH (M)	BH - STATIC WATER LEVEL (M)	BH - DIAMETER (CM)	ELEVATION - GROUND (mASL)	ELEVATION - BH BOTTOM (mASL)	ELEVATION - BEDROCK (mASL)	AVG STATIC WATER LEVEL (mASL)	PROJECTED FORMATION	NAME - ORIGINAL DRILLER	DATE - ORIGINAL DRILL DATE
7287467	643132.0	4930207.0	Active	Water Supply	Domestic	-	15.24	1.78	-	218.78	203.54	215.88	217	Bobcaygeon	Roger Boadway Ent. Ltd.	2017-04-20
4600711	643117.0	4929384.0	Active	Water Supply	Domestic	Cable Tool	12.19	1.83	15.24	220.35	208.16	217.91	218.52	Bobcaygeon	MOE Driller No. 2518	1966-12-15
4600688	644266.0	4928284.0	Active	Water Supply	School	Cable Tool	38.71	6.10	17.78	236.88	198.17	235.66	230.78	Gull River	G. Hart & Sons	1957-10-29
4604870	643180.0	4928903.0	Abandoned	Water Supply	Domestic	Cable Tool	31.39	-	-	221.39	189.99	217.12	-	Gull River	MOE Driller No. 2518	1971-08-24
4603967	643185.0	4930473.0	Active	Water Supply	Domestic	Cable Tool	14.63	4.57	15.24	220.18	205.55	218.05	215.61	Bobcaygeon	MOE Driller No. 2518	1968-07-05
7351550	643493.3	4930597.0	Active	Water Supply	Domestic	Air Percussion	18.29	3.42	-	226.29	208.00	221.11	222.87	Bobcaygeon	VINSON''S WELL DRILLING	2019-11-22
7322292	642974.0	4931984.0	MOE Abandonment Record	Unknown	-	-	3.96	-	-	221.42	217.46	-	-	Bobcaygeon	G. Hart & Sons Well Drilling Ltd.	2017-09-27
4606482	643205.0	4930133.0	Active	Water Supply	Domestic	Cable Tool	18.59	3.05	15.24	219.43	200.84	216.38	216.38	Bobcaygeon	WEAVER WELL DRILLING	1976-03-15
7120374	646823.0	4928656.0	Active	-	-	-	24.38	2.44	-	220.73	196.34	-	218.29	Gull River	WEAVER WELL DRILLING	2009-03-09
4600719	644964.0	4933850.0	Abandoned	Water Supply	Domestic	Cable Tool	56.39	-	15.24	235.00	178.61	233.48	-	Shadow Lake	CARL BALDWIN WATER WELL DRILLING LTD.	1960-05-31
4605583	647054.0	4928951.0	Abandoned	Water Supply	Domestic	Cable Tool	21.64	-	-	223.09	201.45	209.68	-	Bobcaygeon	G. Hart & Sons (2)	1973-07-05
4600722	643663.0	4933799.0	Active	Water Supply	Domestic	Cable Tool	12.19	5.49	15.24	225.36	213.17	218.35	219.87	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1961-11-12
5727526	646745.3	4930488.0	Active	Water Supply	Domestic	Cable Tool	33.53	1.83	20.32	234.60	201.07	233.69	232.77	Bobcaygeon	DOUGLAS TOWERS & SON WELL DRILLING	-
5715230	643185.0	4929093.0	Active	Water Supply	Domestic	Cable Tool	14.33	2.44	15.24	220.77	206.44	217.41	218.33	Bobcaygeon	WEAVER WELL DRILLING	1976-06-10
4605367	646715.0	4929053.0	Active	Water Supply	Domestic	Air Percussion	32.61	9.15	15.24	226.01	193.39	219.91	216.86	Gull River	CARL BALDWIN WATER WELL DRILLING LTD.	1972-08-15
4605247	643765.0	4927953.0	Abandoned	Water Supply	Domestic	Cable Tool	64.01	-	-	229.09	165.08	226.96	-	Precambrian	G. Hart & Sons (2)	1972-08-21
7301064	643295.0	4927948.0	Unknown	Water Supply	Other - Industrial	Rotary (conventional)	25.30	3.02	-	222.32	197.02	218.97	219.3	Gull River	Roger Boadway Ent. Ltd.	2017-09-21
7339859	647179.0	4927593.0	MOE Abandonment Record	Industrial	Other - Institutional	-	4.57	-	-	220.00	215.43	-	-	Bobcaygeon	WEAVER WELL DRILLING	2019-05-07
4604379	646855.0	4928993.0	Active	Water Supply	Domestic	Boring	6.71	1.53	1.94	221.58	214.87	-	220.05	Bobcaygeon	MOE Driller No. 1556	1970-04-30
5728457	643501.0	4931583.0	Active	Water Supply	Domestic	Cable Tool	27.43	9.15	15.24	227.03	199.60	223.37	217.88	Bobcaygeon	MOE Driller No. 2653	1991-09-16
7239809	644987.0	4934260.0	Monitoring and Test Hole	Engineering	Monitoring / Observation Well	Driving (direct push)	2.29	-	-	235.24	232.96	-	-	Verulam	STRATA SOIL SAMPLING INC.	2015-02-25
4600748	644727.0	4934276.0	Abandoned	Water Supply	Domestic	Cable Tool	28.35	-	25.40	229.62	201.27	228.40	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1966-07-05
1910625	646826.0	4928635.0	Active	Water Supply	Domestic	Boring	11.58	2.44	1.94	220.79	209.21	-	218.35	Bobcaygeon	Freelance Boring & Drilling/The Well Guy	1990-06-05
5735053	648991.0	4930650.0	Active	Water Supply	Domestic	Air Percussion	36.58	3.35	15.24	235.72	199.14	233.58	232.37	Bobcaygeon	MUSKOKA WELLS DRILLING AND PUMP SERVICE LTD.	1999-12-10
4600685	646567.0	4930086.0	Active	Water Supply	Domestic	Cable Tool	17.37	4.27	15.24	230.62	213.24	225.13	226.35	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1961-03-31
7352931	645169.0	4933868.0	Active	Engineering	Monitoring / Observation Well	Boring	4.88	3.05	-	235.32	230.44	233.19	232.27	Verulam	G.E.T. DRILLING LTD.	2017-12-10
4600708	643270.0	4930124.0	Active	Water Supply	Domestic	Cable Tool	9.14	1.22	10.16	220.92	211.78	218.48	219.7	Bobcaygeon	Roger Boadway Ent. Ltd.	1949-06-10
5721499	643629.0	4933082.0	Active	Water Supply	Domestic	Cable Tool	14.33	3.05	15.24	227.48	213.15	224.43	224.43	Bobcaygeon	WEAVER WELL DRILLING	1986-09-01
4600725	643436.0	4932683.0	Active	Water Supply	Domestic	Cable Tool	27.43	6.10	15.24	227.98	200.55	216.39	221.88	Bobcaygeon	MOE Driller No. 1344	1959-11-11
4606520	644198.3	4931000.0	Abandoned	Water Supply	Domestic	Cable Tool	36.58	-	15.24	230.32	193.74	224.83	-	Gull River	MOE Driller No. 4407	1976-06-02
7320040	642952.0	4931930.0	Abandoned	Water Supply	Domestic	Cable Tool	30.48	-	-	221.86	191.38	218.51	-	Gull River	WEAVER WELL DRILLING	2018-10-02
7244179	646158.0	4929305.0	Active	Engineering	Monitoring / Observation Well	Rotary (conventional)	52.46	-	-	237.51	185.05	235.99	-	Gull River	HARDEN ENVIRONMENTAL SERVICES LTD.	2015-05-29
5715233	643045.0	4931914.0	Abandoned	Water Supply	Domestic	Cable Tool	45.72	-	15.24	221.84	176.12	220.31	-	Shadow Lake	G. Hart & Sons (2)	1975-05-29
7217300	642991.0	4932095.0	Active	Water Supply	Domestic	Rotary (conventional)	12.80	0.62	-	220.16	207.36	215.66	219.54	Bobcaygeon	E.S. WELL DRILLING	2014-02-05
7176525	647771.0	4932598.0	Unknown	Unknown	-	-	-	-	-	224.75	-	-	-	-	Wilson Water Wells Ltd.	2011-11-21
7129651	642949.0	4931586.0	Active	-	-	Cable Tool	9.75	2.29	-	221.28	211.53	216.71	218.99	Bobcaygeon	WEAVER WELL DRILLING	2009-08-06
7140777	647793.0	4932439.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	29.00	-	-	224.30	195.30	-	-	Gull River	Lantech Drilling Services Inc.	2009-10-13
7140037	643063.0	4929697.0	Active	Water Supply	Domestic	Rotary (conventional)	24.38	0.91	-	219.38	195.00	216.33	218.47	Gull River	Roger Boadway Ent. Ltd.	2009-12-11
5740471	642618.0	4932719.0	Active	-	-	Cable Tool	28.10	1.80	-	219.09	190.99	199.29	217.29	Gull River	WEAVER WELL DRILLING	2005-12-23
4602673	647846.0	4929186.0	Active	Water Supply	Domestic	Cable Tool	22.25	4.88	15.24	228.75	206.49	221.13	223.87	Bobcaygeon	MOE Driller No. 1344	1959-01-16
7111173	645514.0	4933001.0	Active	-	-	Rotary (air)	42.67	-	-	232.64	189.97	230.50	-	Gull River	Wilson Water Wells Ltd.	2008-08-01
5714423	643305.0	4930323.0	Active	Water Supply	Domestic	Cable Tool	15.85	1.22	15.24	221.95	206.10	219.82	220.73	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1976-11-15
5717830	643015.0	4931924.0	Active	Water Supply	Domestic	Cable Tool	24.38	3.05	15.24	221.54	197.16	206.30	218.49	Gull River	WEAVER WELL DRILLING	1981-11-15
4604970	643015.0	4931464.0	Active	Water Supply	Domestic	Cable Tool	36.27	15.24	15.24	223.76	187.49	220.10	208.52	Gull River	G. Hart & Sons (2)	1971-12-03
4600734	642657.0	4932806.0	Active	Water Supply	Domestic	Cable Tool	19.20	1.52	15.24	219.56	200.36	-	218.04	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1966-05-10
5739768	642958.0	4931477.0	Active	-	-	Cable Tool	17.53	1.18	20.32	223.73	206.20	220.38	222.55	Bobcaygeon	H2O CALVIN MERKLINGER WELL DRILLING	2005-04-15
5727899	645357.0	4933694.0	Active	Engineering	Monitoring / Observation Well	Rotary (air)	15.24	-	5.08	235.67	220.43	232.62	-	Bobcaygeon	Roger Boadway Ent. Ltd.	1991-02-04
7154564	643077.0	4928953.0	Active	Water Supply	Domestic	Rotary (conventional)	9.45	1.37	-	218.71	209.26	216.88	217.34	Bobcaygeon	Roger Boadway Ent. Ltd.	2010-09-22
7322347	642993.0	4931990.0	Active	Water Supply	Domestic	Cable Tool	83.82	5.58	-	221.11	137.29	216.53	215.53	Precambrian	G. Hart & Sons Well Drilling Ltd.	2017-12-01
5712997	643115.0	4929363.0	Active	Water Supply	Domestic	Cable Tool	15.24	3.04	15.24	220.22	204.98	218.70	217.18	Bobcaygeon	MOE Driller No. 2518	1976-04-12
4606480	643245.0	4929313.0	Active	Water Supply	Domestic	Cable Tool	23.77	0.91	15.24	222.53	198.76	219.48	221.62	Gull River	WEAVER WELL DRILLING	1976-03-05
5738925	643019.0	4931486.0	MOE Abandonment Record	-	-	Cable Tool	9.10	-	-	223.87	214.77	218.87	-	Bobcaygeon	WEAVER WELL DRILLING	2004-05-25
4600726	642591.0	4932911.0	Unknown	Water Supply	Municipal Exploration	Cable Tool	15.85	-	15.24	219.37	203.52	203.83	-	Bobcaygeon	C.E. Snider	1959-09-15
5714004	646415.0	4929023.0	Active	Water Supply	Domestic	Cable Tool	10.97	0.91	15.24	230.86	219.89	230.86	229.95	Bobcaygeon	WEAVER WELL DRILLING	1976-11-02
7188277	644846.0	4933777.0	Active	Engineering	Monitoring / Observation Well	Rotary (conventional)	2.44	-	-	232.05	229.61	-	-	Verulam	STRONG SOIL SEARCH INC	2012-07-04
4600717	643152.0	4930902.0	Abandoned	Water Supply	Domestic	Cable Tool	19.51	-	12.70	221.01	201.50	219.48	-	Bobcaygeon	MOE Driller No. 2545	1957-06-19
1916672	647062.0	4928994.0	Abandoned	-	-	Cable Tool	-	-	-	222.66	-	-	-	-	EADES WELL DRILLING	2003-07-25
5718275	643501.0	4931583.0	Active	Water Supply	Domestic	Cable Tool	15.24	3.05	15.24	227.03	211.79	225.81	223.98	Bobcaygeon	WEAVER WELL DRILLING	1982-09-09
4606655	643265.0	4929263.0	Active	Water Supply	Domestic	Cable Tool	12.80	3.05	15.24	220.57	207.77	217.21	217.52	Bobcaygeon	WEAVER WELL DRILLING	1976-07-05
1912556	646680.0	4928996.0	Active	Water Supply	Domestic	Rotary (conventional)	17.68	1.53	20.32	226.59	208.91	220.49	225.06	Bobcaygeon	DOUGLAS TOWERS & SON WELL DRILLING	1995-07-18
5724631	643087.0	4929587.0	Active	Water Supply	Domestic	Cable Tool	12.80	0.61	15.24	219.41	206.60	207.52	218.8	Bobcaygeon	MOE Driller No. 4512	1988-11-20
4606483	643235.0	4929303.0	Active	Water Supply	Domestic	Cable Tool	12.19	3.05	15.24	222.31	210.12	219.26	219.26	Bobcaygeon	WEAVER WELL DRILLING	1976-03-21
5718412	644165.0	4926773.0	Abandoned	Water Supply	Domestic	Rotary (air)	16.15	3.66	-	223.57	207.42	219.30	219.91	Bobcaygeon	Roger Boadway Ent. Ltd.	1980-11-22
4600691	643482.0	4928305.0	Active	Water Supply	Domestic	Cable Tool	48.46	4.57	15.24	223.84	175.38	218.66	219.27	Shadow Lake	CARL BALDWIN WATER WELL DRILLING LTD.	1967-10-04
7140777	646713.0	4933128.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	11.50	-	-	231.05	219.55	-	-	Bobcaygeon	Lantech Drilling Services Inc.	2009-10-14
4602674	647687.0	4929127.0	Active	Water Supply	Domestic	Cable Tool	26.21	7.62	15.24	228.36	202.15	-	220.74	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1962-01-16
4605595	643785.0	4927953.0	Abandoned	Water Supply	Domestic	Rotary (air)	121.92	-	-	230.15	108.23	166.14	-	Precambrian	G. Hart & Sons (2)	1973-08-20
7339857	647930.0	4928455.0	MOE Abandonment Record	Industrial	Other - Institutional	-	4.88	-	-	224.97	220.09	-	-	Bobcaygeon	WEAVER WELL DRILLING	2019-05-07
5729026	648991.0	4930650.0	Active	Water Supply	Domestic	Rotary (conventional)	10.67	2.14	15.24	235.72	225.05	234.19	233.58	Verulam	MOE Driller No. 1456	1991-09-20
7041174	647004.0	4928381.0	Active	-	-	Cable Tool	15.85	6.90	8.00	222.44	206.59	-	215.54	Bobcaygeon	G. Hart & Sons Well Drilling Ltd.	2006-11-28
5725273	643758.0	4931935.0	Active	Water Supply	Domestic	Cable Tool	8.23	0.30	15.24	228.44	220.21	226.31	228.14	Bobcaygeon	MOE Driller No. 2515	1989-05-15
7113052	642978.0	4931614.0	Active	-	-	Cable Tool	9.75	2.13	-	222.61	212.86	220.17	220.48	Bobcaygeon	WEAVER WELL DRILLING	2008-08-01
5736393	643625.0	4933081.0	Active	Water Supply	Domestic	Air Percussion	23.47	4.57	-	227.48	204.01	208.88	222.91	Bobcaygeon	Roger Boadway Ent. Ltd.	2001-08-29
4600714	642982.0	4931948.0	Active	Water Supply	Domestic	Cable Tool	12.19	3.05	12.70	221.44	209.24	216.86	218.39	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1948-07-18
7331905	642948.0	4931432.0	Unknown	Unknown	-	-	-	-	-	223.45	-	-	-	-	WEAVER WELL DRILLING	2018-10-17
7203915	642914.0	4931555.0	Active	Water Supply	Domestic	Rotary (conventional)	15.24	2.59	-	220.61	205.37	216.65	218.02	Bobcaygeon	Roger Boadway Ent. Ltd.	2013-05-09
4600720	644601.0	4934145.0	Active	Water Supply	Communal	Cable Tool	4.57	1.53	15.24	228.73	224.16	-	227.2	Verulam	C.E. Snider	1958-07-17
7264614	642890.0	4932050.0	Active	Water Supply	Domestic	-	18.20	0.63	-	219.00	200.80	213.00	218.37	Bobcaygeon	E.S. WELL DRILLING	2016-04-30
5715231	643315.0	4929093.0	Active	Water Supply	Domestic	Cable Tool	14.02	2.44	15.24	222.64	208.62	219.29	220.2	Bobcaygeon	WEAVER WELL DRILLING	1976-06-04
4600723	643197.0	4933496.0	Unknown	Water Supply	Municipal Exploration	Cable Tool	12.50	-	15.24	220.20	207.70	208.01	-	Bobcaygeon	C.E. Snider	1959-09-04
1913763	646790.0	4928747.0	Assumed Abandoned	Water Supply	Domestic	Cable Tool	30.48	2.13	15.24	220.05	189.57	210.91	217.92	Gull River	EADES WELL DRILLING	1998-08-20
5739668	642586.0	4932749.0	Active	-	-	Cable Tool	23.80	2.00	-	220.51	196.71	201.31	218.51	Gull River	WEAVER WELL DRILLING	2005-02-16
7212593	642967.0	4931501.0	Active	Water Supply	Domestic	Rotary (conventional)	15.24	3.05	-	223.60	208.36	220.55	220.55	Bobcaygeon	Roger Boadway Ent. Ltd.	2013-09-18
7201083	642956.0	4929670.0	Active	Water Supply	Domestic	Rotary (conventional)	15.54	1.04	-	218.64	203.09	216.50	217.6	Bobcaygeon	Roger Boadway Ent. Ltd.	2013-03-07
5715549	643915.0	4930823.0	Active	Water Supply	Domestic	Cable Tool	46.94	3.66	15.24	231.76	184.82	224.14	228.1	Gull River	MOE Driller No. 4241	1978-08-29
4604495	644595.0	4934284.0	Active	Water Supply	School	Boring	5.49	2.44	1.55	228.51	223.02	223.33	226.07	Bobcaygeon	Freelance Boring & Drilling/The Well Guy	1970-07-31
5726803	645357.0	4933694.0	Abandoned	Water Supply	Domestic	Cable Tool	15.24	-	-	235.67	220.43	234.45	-	Bobcaygeon	WEAVER WELL DRILLING	1990-04-02
5728253	645357.0	4933694.0	Active	Water Supply	Domestic	Rotary (air)	12.80	-	-	235.67	222.87	234.45	-	Bobcaygeon	Roger Boadway Ent. Ltd.	1991-07-30
1911638	647336.0	4929087.0	Active	Water Supply	Domestic	Cable Tool	18.29	5.49	15.24	226.30	208.01	-	220.81	Bobcaygeon	Gary Eades Well Drilling	1992-11-11
7140777	647207.0	4933024.0	Active	Engineering	Geotech Testhole	Solid Stem Auger	18.00	-	-	226.24	208.24	-	-	Bobcaygeon	Lantech Drilling Services Inc.	2009-10-14
4605388	643205.0	4930273.0	Abandoned	Water Supply	Domestic	Cable Tool	15.24	-	15.24	220.15	204.91	217.71	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1972-07-27
4600694	644613.0	4927303.0	Abandoned	Water Supply	Domestic	Cable Tool	12.19	-	15.24	230.46	218.27	227.11	-	Bobcaygeon	CARL BALDWIN WATER WELL DRILLING LTD.	1966-12-06
Minimum							**2.29**	**15.48**	**1.55**	**218.64**	**108.23**	**166.14**	**203.16**			
Maximum							**121.92**	**9.11**	**25.40**	**245.04**	**233.49**	**245.04**	**235.93**			
Average							**21.79**	**4.70**	**14.23**	**226.11**	**204.22**	**220.90**	**221.41**			

APPENDIX D

Geologic Report (Golder, 2021)

REPORT

Geological Study

Talisker Corporation Proposed Brechin Quarry
Township of Ramara, Ontario

Submitted to:

Lagoon City Limited Partnership
c/o Talisker Corporation

Submitted by:

Golder Associates Ltd.
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June 2021

Distribution List

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1 e-copy	Azimuth Environmental Consulting Inc.
1 e-copy	MHBC
1 e-copy	Golder Associates Ltd.

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APPENDICES

1.0 INTRODUCTION

The Talisker Corporation (Talisker) proposed Brechin Quarry (hereafter referred to as the “Talisker site”) is located approximately 1 to 1.5 kilometres east of Lake Simcoe bordering the west side of Highway 12 as shown on Figure 1. The subsurface geological conditions beneath the Talisker site were assessed through the coring of five HQ-sized boreholes (BH-1 to BH-5) up to depths of 71 metres (m) extending from the ground surface, through the Paleozoic limestone sequence and into the top of the underlying Precambrian crystalline basement. Boreholes BH-1 to BH-5 are referred to herein as the “Phase 1 boreholes”. In addition, four shallower air percussion boreholes (BH-6 to BH-9) were drilled up to depths 43 m and terminated in the Paleozoic limestone sequence. Boreholes BH-6 to BH-9 are referred to herein as the “Phase 2 boreholes”. The locations of the nine (9) boreholes within the site are shown on Figure 2.

The scope of work undertaken by Golder Associates Ltd. (Golder) is based on our letter dated August 27, 2019, which was authorized by Talisker on September 6, 2019 as well as our letter of September 4, 2020, which was authorized by Talisker on September 10, 2020. For limitations related to this report, please refer to Appendix A.

As noted above, the work was carried out in two phases. Phase 1 included core logging, stratigraphic and hydrostratigraphic interpretation of five HQ core holes while Phase 2 included the geophysical interpretation of the stratigraphy encountered in an additional four air rotary boreholes. The results of the stratigraphic correlation of the five cored boreholes are shown on Figure 3 while that of the four air rotary boreholes are shown on Figure 4. The combined results of the nine boreholes have been used in the overall Talisker site geological interpretation.

The rock core from the five Phase 1 boreholes (i.e., BH-1 to BH-5) was logged in detail to determine the lithology of the various beds and the stratigraphy. In addition, the nine Phase 1 and Phase 2 boreholes were geophysically logged for natural gamma and apparent conductivity to assist with the stratigraphic interpretation as well as optical and acoustic televiewer logs to assist in defining open fractures and bedding partings within the rock sequence. The detailed borehole records including the natural gamma and apparent conductivity geophysical logs are provided on the Record of Boreholes in Appendix B while the results of the optical and acoustic televiewer logs (along with other geophysical data) are provided in Appendix C. The optical and acoustic televiewer logs in Appendix C are presented at two vertical scales; 1:20 to provide close in detailed images and 1:200 for an overview. The televiewer images presented in Section 4.0 of this report were derived from the 1:20 scale images.

Based on the results of the geophysical logging and the core logging of boreholes BH-1 to BH-5, Golder prepared an initial draft technical memorandum dated December 2, 2019, which was submitted to Azimuth Environmental Consulting Inc. (Azimuth). This draft technical memorandum presented Golder’s preliminary interpretation of the data, including proposed stratigraphic and hydrostratigraphic nomenclature for use on this project and suggested monitoring well sand pack zones for the Phase 1 boreholes BH-1 through BH-5. The proposed positioning of the monitoring well sand pack zones were selected based on the following factors:

- Results of Azimuth packer testing received by Golder on November 28, 2019
- Acoustic and optical televiewer data
- Observations during the detailed rock core logging
- Previous experience at other sites on the Carden Plain and other sites underlain by the same Paleozoic stratigraphic sequence

On December 3, 2019, discussion between personnel from Golder, Azimuth and R. Blair Geosciences Inc. lead to a refinement of the proposed monitoring well intake zones. Between December 4 and 10, 2019, Azimuth supervised the installation of two monitoring wells in each of boreholes BH-1 through BH-5. The monitoring wells were installed by Orbit-Garant Drilling. The monitoring well installation details for the Phase 1 boreholes shown on the Record of Boreholes in Appendix B were provided by Azimuth (see Appendix D).

Based on the results of the geophysical logging of boreholes BH-6 to BH-9, coupled with the previously completed geophysical work and core logging at boreholes BH-1 to BH-5 along with the results of the packer testing done by Azimuth on the Phase 1 boreholes, Golder provided Azimuth with the proposed monitoring well sand pack zones for each of boreholes BH-6 to BH-9 on January 8, 2021. On March 4, 2021, Golder provided Azimuth with the hydrostratigraphic reference for each of the monitoring wells installed in the Phase 2 boreholes. The monitoring well installation details for the Phase 2 boreholes shown on the Record of Boreholes in Appendix B were provided by Azimuth (see Appendix D).

In this submission, components of the Golder draft technical memorandum dated December 2, 2019, have been incorporated into this report, as required, such that the proposed stratigraphic and hydrostratigraphic nomenclature for use on this project established from the Phase 1 and 2 drilling programs is clear and the thought process behind the final selection of the monitoring well sand pack zones is evident.

2.0 STRATIGRAPHY

The ground surface of the Talisker site is relatively flat varying in elevation from approximately 230 metres above sea level (m ASL) to 240 m ASL sloping gently westward towards Lake Simcoe (elevation approximately 219 m ASL). The results of the drilling indicated that the site is underlain by approximately 0.5 m to 3.7 m of lacustrine clay and glacial till soil deposits overlying bedrock. This overburden thickness is based on the overburden thickness reported at the nine borehole locations. As such, areas of thinner and thicker overburden may exist on the uninvestigated parts of the Talisker site.

The bedrock sequence consists of four Paleozoic Ordovician age formations including in descending order the Verulam Formation, Bobcaygeon Formation, Gull River Formation and the basal Shadow Lake Formation which lies in unconformity upon the underlying crystalline Precambrian basement. The drilling has indicated that the combined thickness of the Paleozoic Ordovician sequence is approximately 59 m to 69 m subject to the gentle southwestern dip of the strata and elevation variation within the eroded bedrock surface. The stratigraphic relationships of these formations underlying the site are discussed in detail in the following sub-sections.

The stratigraphic relationships shown on Figures 3 and 4 compare the various strata intersections of the nine boreholes to a horizontal base line taken at the Bobcaygeon Formation/Gull River Formations contact. As indicated, the various formations and sub-units are of quite consistent thickness and continuity across the site.

2.1 Verulam Formation

The Verulam Formation is a shaley limestone sequence that forms the bedrock surface and varies in thickness from approximately 6.0 m to 19.0 m as shown on Figures 3 and 4. The Verulam Formation is weathered within 0.5 m to 1.5 m of the bedrock surface. The shaley content on a per core run basis encountered in the five cored boreholes ranged from approximately 20 to 40 percent averaging 28 percent overall. The shaley component of the formation tends to slake and break down to clayey material on wetting and drying when exposed. The very thin to thin limestone interbeds tend to be crystalline calcarenite. The formation has been subdivided into a lower Unit 1 and an upper Unit 2 based on the shale content. Units 1 and 2 are labelled 5-1 and 5-2, respectively, on the report figures, the 5 referring to the Verulam Formation. The underlying formations have similar designations on the report figures (e.g., 4-4 referring to the Bobcaygeon Formation Unit 4 and so on).

Unit 2 forms the bedrock surface and has undergone erosion such that the unit varies in thickness from approximately 3 m to 8.4 m and was absent in boreholes BH-1, BH-5 and BH-8. The unit is comprised of dark grey, very fine to fine grained, very thinly to thinly interbedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and **SHALE.** The argillaceous to shaley component of this sequence averages approximately 30 percent which is reflected by the more positive natural gamma geophysical response shown on Figures 3 and 4. The unit has a transitional basal contact.

Unit 1 has a relatively constant thickness of approximately 9 m to 10 m. The thickness was reduced to approximately 6 m in boreholes BH-1and BH-8 by surface erosion. It is comprised of medium brownish grey, very thinly to thinly interbedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE**. The argillaceous to shaley component averages approximately 10 - 20 percent of the sequence reflected by the relative decrease in gamma counts shown on Figures 3 and 4. The basal contact varies from transitional to sharp with the underlying Bobcaygeon Formation also reflected by a drop in the natural gamma counts across this contact.

2.2 Bobcaygeon Formation

The Bobcaygeon Formation has a consistent thickness of approximately 26 m to 27 m and has been further subdivided into four lithological units based on the core logging. The Bobcaygeon Formation is subdivided in descending order into lithological **Units 4** to **1.** The thickness of the individual units vary slightly inversely proportional to one another while maintaining the overall consistent thickness of the formation as shown on Figures 3 and 4. Each unit is discussed in the following paragraphs in descending order from **Unit 4** at the top to **Unit 1** at the bottom.

Unit 4 varies in thickness from approximately 12.5 m to 15.0 m. It is a fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR** to **ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained, crystalline calcarenitic limestone and subordinate micritic limestone and minor dark grey 2 millimetre (mm) to 10 mm thick shaley partings. Widely spaced thin interbeds of **SHALEY NODULAR CALCARENITIC LIMESTONE** and occasional thin **SHALE** beds and shale partings occur (Figure 3). The argillaceous to shaley component of Unit 4 varied between approximately 3 and 9 percent, averaging approximately 6 percent. The basal contact of the unit is gradational.

Unit 3 varies in thickness from approximately 3.5 m to 5.5 m between the boreholes. The unit is comprised of fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Unit 3 differs from Unit 4 in having a much finer grained limestone matrix unlike the somewhat coarser grained crystalline texture of Unit 4. A distinctive thin, medium grey gastropod fossil limestone bed occurs in the middle of Unit 3 and scattered pelecypod fossil shells occur throughout. The argillaceous to shaley component of Unit 3 varied between approximately 5 and 10 percent, averaging approximately 7 percent. The somewhat higher argillaceous component imparts a more pronounced apparent conductivity geophysical signature to Unit 3 as compared to the overlying Unit 4. The unit has a sharp basal contact.

Unit 2 is a comparatively thin sequence (approximately 2 m) comprised of fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** characterized by numerous dark grey shaley partings less than 10 mm to 100 mm in thickness, some of these beds with burrow casts and gastropod fossils. The argillaceous to shaley component of Unit 2 varies between 9.5 and 13 percent, averaging approximately 12 percent which like Unit 3 imparts a more positive apparent conductivity geophysical signature to Unit 2 compared to Units 4 and 1. Unit 2 has a sharp basal contact.

Unit 1 is approximately 6 m thick and comprised of fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE** with thin, medium grained crystalline calcarenitic limestone interbeds. The argillaceous content is quite low, typically less than 1 percent. There is a sharp basal contact noted by a colour change from medium brownish grey micritic limestone to light creamy brown very fine grained lithographic limestone of the underlying Gull River Formation.

2.3 Gull River Formation

The Gull River Formation is comprised of four units of interbedded limestone (Units 2 and 4) and dolostone (Units 1 and 3) with a combined thickness of approximately 18.5 m to 19.0 m (see Figures 3 and 4). The formation was fully intersected in boreholes BH-1 to BH-4 and partially intersected in boreholes BH-5 and BH-8 while the top few metres were encountered in BH-9. The 4 lithological units are described below in descending order from Unit 4 to Unit 1.

Unit 4 is comprised of a 5 m thick sequence of fresh, creamy white to light to medium creamy brown, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. A distinctive 10 cm thick layer of highly to completely weathered, medium grey, non-calcareous **CLAYEY SHALE** was consistently encountered approximately 0.75 m below the top contact of Unit 4 forming a distinctive marker bed as indicated on Figure 3. The layer has developed from weathered shale and exhibits shiny listric surfaces on weathered shale chips. It is also associated with a sharp natural gamma and apparent conductivity geophysical signature spike (Figure 3). Additional intact to moderately weathered grey shale partings occur deeper within the section as indicated in the Records of Boreholes in Appendix B. There is a sharp basal contact with the underlying laminated shale cap of Unit 3.

Unit 3 is a 3.4 m to 3.9 m thick sequence of fresh, medium grey to greenish grey, fine to medium grained crystalline, faintly to moderately porous, saccharoidal textured, stylolitic, medium bedded **DOLOSTONE** overlying light brownish grey, fine grained saccharoidal, faintly to moderately porous, stylolitic, massive textured, medium to thickly bedded **DOLOSTONE**. The top 0.1 m to 0.3 m of the sequence is marked by interlaminated dark grey shale and lithographic limestone in 1 mm to 10 mm layers overlying black shale and weathered shale. Unit 3 has a sharp basal contact locally marked by a lamination of grey shale separating dolostone from the underlying limestone. The Unit 3 sequence is locally referred to as "**The Green Bed"** due to the greenish grey colouration of the dolostone.

Unit 2 is comprised of approximately 4.7 m to 4.9 m of fresh, creamy light to medium brown to creamy white, very fine grained, porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings and interbeds of thickly bedded, medium brown **NODULAR LITHOGRAPHIC LIMESTONE.** This sequence also includes a grey shale parting and thin, medium grey, argillaceous calcareous dolostone beds in the lower half of the sequence (see Figure 3). This limestone is quite similar to the overlying Gull River Formation Unit 4 limestone. The basal contact of the Unit limestone with the underlying Unit 1 dolostone is sharp and marked by a shale lamination.

Unit 1 is approximately 4.8 m to 5.2 m thick and comprised of fresh, light to medium greenish grey to brown, fine to medium grained crystalline with 0.1 mm to 0.5 mm disseminated quartz grains, faintly to moderately porous, saccharoidal textured with weakly developed stylolites, medium bedded **DOLOSTONE.** The sequence includes secondary interbeds of light brownish grey**,** saccharoidal**,** thickly bedded **CALCAREOUS DOLOSTONE** with porous 1 mm to 10 mm pits. In BH-2, a dark grey, interlaminated **SHALE** and **LIMESTONE** forms a cap at 54.87 to 54.93 m. A faintly to completely weathered shale parting comprised of medium greenish grey, faintly calcareous clayey silt soil with fine dolostone fragments (depth interval 56.57 m to 56.60 m) occurs approximately 2 m below the upper contact of Unit 1 (see Record of Boreholes in Appendix B and Figure 3). Additional shaley partings occur below this layer. The contact with the underlying Shadow Lake Formation sandstone is transitional noted by quartz sand grains within the basal dolostone.

2.4 Shadow Lake Formation

The Shadow Lake Formation is the basal clastic sequence beneath the flat-lying Paleozoic Ordovician limestone/dolostone and lies in unconformity on the Precambrian crystalline basement. The formation varies in thickness between approximately 7.5 m and 8.5 m beneath the Talisker site. The local stratigraphy of the Shadow Lake Formation is subdivided into three main beds as shown on Figure 3.

The top 2.5 m thick layer beneath the Gull River Formation dolostone is comprised of fresh to moderately weathered, light grey to light to medium greenish grey, fine grained (0.1 mm to 2.0 mm), moderately porous, friable (chips crumble with finger pressure), thickly bedded **QUARTZ SANDSTONE** comprised of quartz grains in a sericitic matrix.

The middle layer consists of approximately 2.5 m to 3.0 m of fresh to faintly weathered, medium greenish grey to dark green and reddish brown, fine grained, moderately porous, slake susceptible **GREEN SHALE** and **RED SHALE** with laminations and thin interbeds of sericitic quartz **SANDSTONE.**

The basal bed 2 m to 3 m of the Shadow Lake Formation is comprised of faintly to moderately weathered, friable, greenish grey to dark reddish brown, fine to coarse grained, moderately porous, medium to thickly bedded **ARKOSIC SANDSTONE** with scattered pebbles comprised of angular 5 mm to 15 mm feldspar crystals. Locally, the Precambrian contact is overlain by dark green, medium to coarse grained, porous, friable, thin bed of sandstone or thin pebble conglomerate comprised of angular feldspar crystals (1 mm to 25 mm) in a matrix supported arkosic quartz and feldspar grains. The basal contact varies from moderately to highly weathered, dark reddish brown, disaggregating gneiss with gneissic grains of quartz and feldspar separating along the gneissosity. The angle of the contact encountered in the core varied from sub-horizontal to a dip of 35 degrees.

2.5 Precambrian Basement

The Precambrian basement was penetrated between approximately 0.5 m and 3.0 m in boreholes BH-1 to BH-4 to define the base of the overlying sedimentary sequence. The rock was found to be faintly to moderately weathered, reddish brown to pinkish grey, medium grained crystalline **QUARTZ FELDSPAR GNEISS** with minor biotite and a gneissosity at approximately 20 to 45 degrees to the core axis (dip of approximately 45 to 70 degrees from horizontal). The gneissic surface was moderately weathered to depths of 0.5 m to 1.5 m in boreholes BH-1 and BH-2, respectively, overlying fresh rock while little to no weathering was encountered in boreholes BH-3 and BH-4.

3.0 STRUCTURE

Structural elevation contour surfaces were constructed for the contacts between the Verulam Formation and Bobcaygeon Formation and for the Bobcaygeon Formation and Gull River Formation using the contact intersections encountered in the nine boreholes. These contoured surfaces are shown on Figures 5 and 6, respectively. The contours indicate the Verulam Formation/Bobcaygeon Formation contact occurs between elevations of approximately 224.0 m ASL to 216.0 m ASL within the definable area and the surface slopes consistently southwestward at approximately 0.4 percent (Figure 5).

The Bobcaygeon Formation/Gull River Formation contact occurs approximately 26 m to 27 m lower at elevations of 198.0 m ASL declining consistently southwestward to elevations of 190.0 m ASL at approximately 0.4 percent, essentially the same as that for the overlying Verulam Formation/Bobcaygeon Formation contact. The elevations encountered in BH-1 at the north end of the property (223.79 m ASL and 197.27 m ASL, respectively) appear anomalous suggesting that the slope of the rock strata flattens beneath the north half of the site as indicated on Figures 5 and 6.

A geological cross-section was drawn from northeast to southwest longitudinally though boreholes BH-2, BH-4 and BH-5 as shown on Cross-Section A-A' on Figure 7 (the location of the section line A-A’ is shown on Figure 2). A similar section was drawn approximately northwest to southeast between boreholes BH-1, BH-9, BH-2 and BH-8 as shown on Cross-Section B-B' on Figure 8 (the location of the section line B-B’ is shown on Figure 2). The sections demonstrate the consistent thickness and disposition of the strata overlying the Precambrian basement and the very gentle dip. The May 27, 2021, groundwater elevation data shown on Figures 7 and 8 were provided by Azimuth (see Appendix E).

4.0 HYDROSTRATIGRAPHY

Based on the site investigations involving detailed core logging, optical and acoustic televiewer borehole geophysical logging carried out by Golder and the packer testing carried out by Azimuth, the preliminary hydrogeological features beneath the Talisker site have been identified and are generally similar to that of the other quarry sites on the Carden Plain. Core logging provides an indication of potentially open, transmissive features based on weathering conditions such as solution smoothed surfaces, iron oxide staining or residual clay materials but does not typically give a good indication of the width of the opening. The optical televiewer provides a direct image of the feature where it intersects the borehole wall such that its in-situ conditions including width can be observed, bearing in mind that the intersection can be eroded by the drilling process. The acoustic televiewer transmits an acoustic signal into the borehole and measures the relative signal return time to produce an artificial image. The signal bounces back directly from the intact borehole wall but where there is a feature such as an open bedding parting, the return of the signal is attenuated to produce an indication as to whether the feature is tight or open and penetrative into the rock. The locations of the various weathered bedding partings noted in the borehole cores and the optical/acoustic televiewer images along with the more permeable packer test intervals (approximately 4 x 10-7 m/s to 1 x 10-4 m/s) are summarized on Figure 9.

The shaley limestone bedrock surface beneath the site is weathered to depths of 0.5 m to 1.5 m below the bedrock surface, noted by broken core, brownish coloured oxide staining on bedding partings and fractures and the breakdown of shaley material to clayey conditions. Beneath this shallow weathered zone, limestone and shale is largely intact and the groundwater bearing permeable zones tend to be associated with specific widely separated, stratigraphically controlled, open bedding parting horizons of significant lateral continuity separated by thick sequences of non-porous, intact, low permeability limestone. The open bedding horizons are typically solution weathered features largely associated with thin, laterally continuous weathered shale or clay laminations within the limestone that provide the planes of weakness along which varying degrees of solution weathering of the limestone contact horizon has occurred from groundwater movement over long periods of time. These shaley features are typically less than 1 centimetre (cm) to 10 cm in width including grey clay or shaley fragments with clay developed from decomposed shale beds. These open features can be horizons of moderate to high hydraulic conductivity but very thin in nature (hence the high transmissivity but low storativity) and confined between solid, non-porous, low permeability limestone layers.

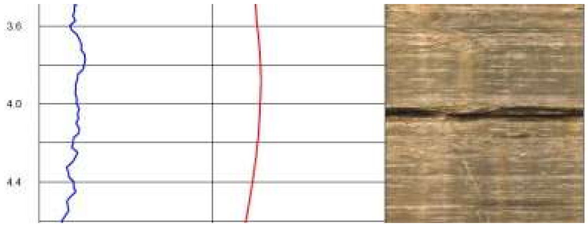
The optical and acoustic televiewer logging was also carried out in the four Phase 2 boreholes. Boreholes BH-7 and BH-9 were essentially dry at the time of logging such that acoustic logs were not available. However, the dry conditions of these boreholes also demonstrates that they did not encounter permeable conditions.

An overview of the various permeable horizons identified within the Talisker site stratigraphy is discussed in the following sub-sections.

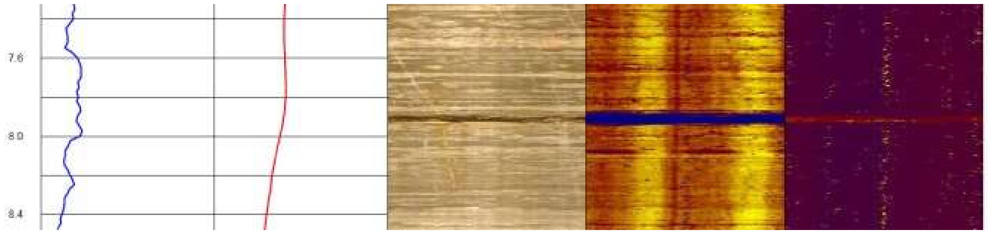
4.1 Verulam Formation

The shaley limestone of Verulam Formation forms the bedrock surface throughout the site and is approximately 6 m to 19 m thick where encountered in the 9 on-site boreholes. The contact with the underlying Bobcaygeon Formation is transitional, noted by the decrease in shale partings in the core and by the negative gamma signature shift (see Figure 9).

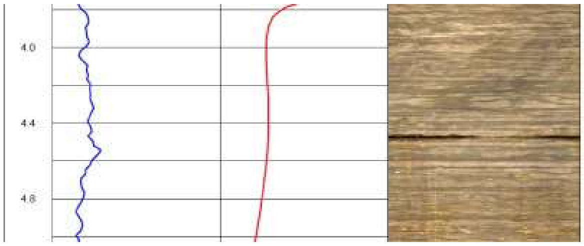
Core logging at the Talisker site indicated weathering occurs to depth of 0.5 m to 1.5 m below the bedrock surface. Two laterally continuous weathered shaley partings forming potentially open permeable horizons were encountered below the weathered bedrock zone. The first parting occurs at depths of 4 m to 8 m below ground surface in boreholes BH-2, BH-3 and BH-4 extending laterally over a distance of approximately 1,000 m at the same stratigraphic horizon. This horizon was situated above the packer testing intervals as indicated on Figure 9. As such, this horizon was not directly tested for hydraulic conductivity but in the televiewer images openings of approximately 3 cm to 5 cm width were indicated as shown in the three images below. This horizon was above the groundwater level in boreholes BH-2 and BH-4, therefore acoustic images are not available, but an acoustic image was available in BH-3 where the image (second image) indicates open conditions.



BH-2: 4.02 - 4.07 m

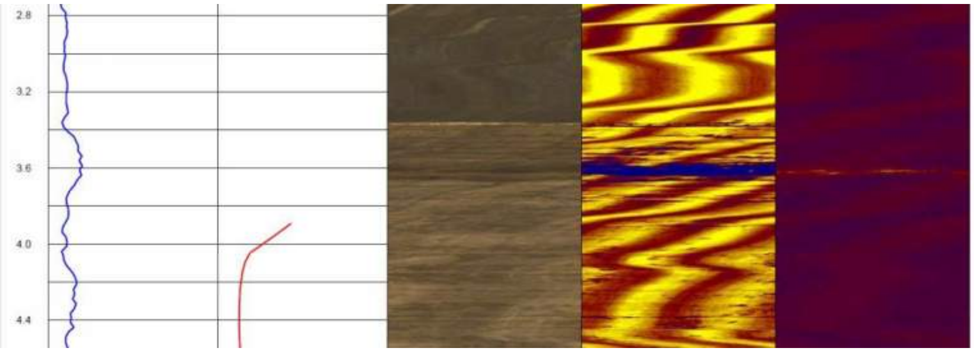


BH-3: 7.90 - 7.93 m

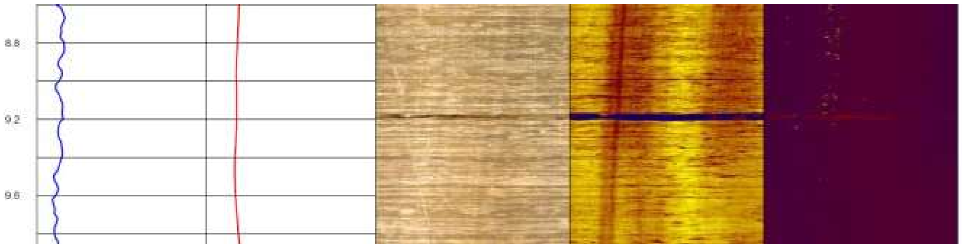


BH-4: 4.47 - 4.50 m

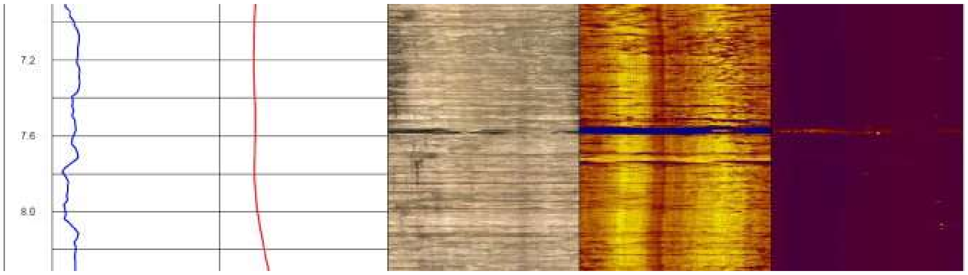
The lower horizon was encountered in boreholes BH-1, BH-4 and BH-5 as indicated in Figure 9 (very permeable in BH-4 at 2 x 10-4 m/s). As indicated on the televiewer images below, this feature appeared to have an open width of 2 cm to 3 cm. The same shale lamination was encountered in boreholes BH-2 and BH-3 but it wasn't noticeably weathered or permeable.



BH-1: 3.59 - 3.62 m



BH-4: 9.18 - 9.20 m



BH-5: 7.57 - 7.59 m

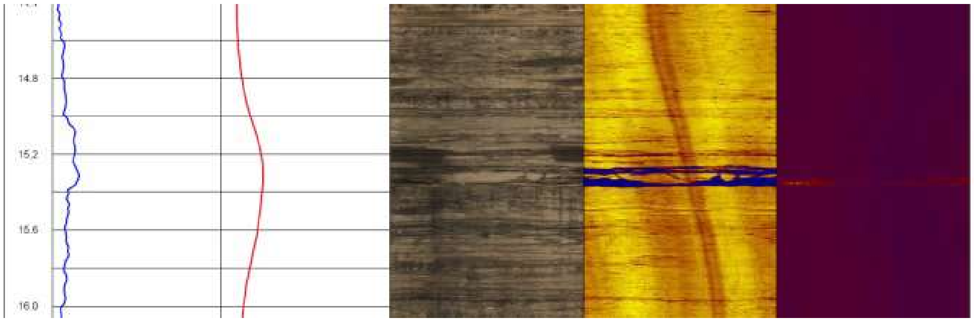
Other less prominent open bedding features were also apparent in the televiewer logs within the Verulam Formation section.

Examination of the televiewer images for the water filled air rotary boreholes BH-6 and BH-8 where acoustic logging was available, noted a potentially permeable shaley horizon at a depth of 7.3 m in BH-6 that would correlate with the upper Verulam Formation bedding horizon.

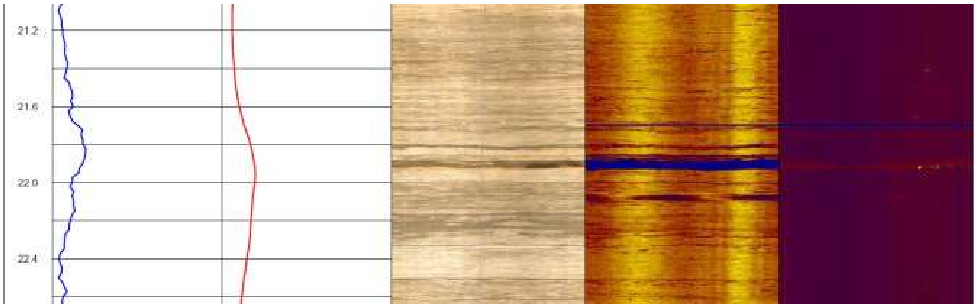
4.2 Bobcaygeon Formation

The Bobcaygeon Formation is largely comprised of fresh, intact limestone with subordinated shaley partings. The sequence is approximately 26 m to 27 m thick and has been stratigraphically subdivided into 4 units based on variations in lithology (see Figure 9).

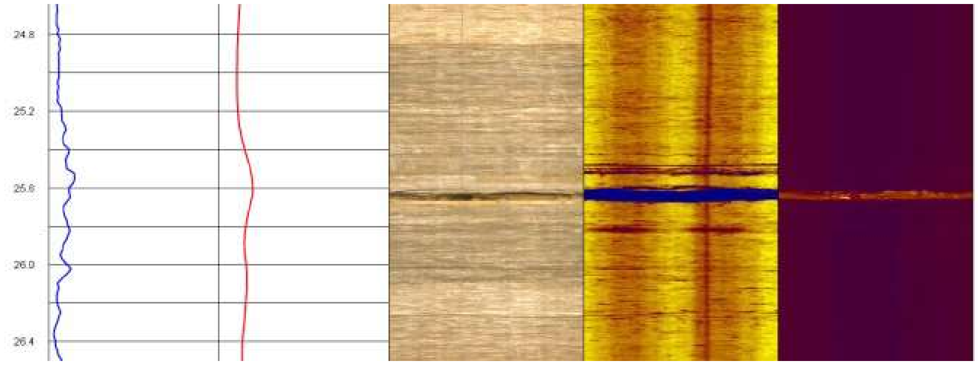
There is a laterally consistent weathered shaley horizon encountered in each of the five Phase 1 boreholes approximately 7 m below the Verulam Formation/Bobcaygeon Formation contact within the middle of Unit 4 (see Figure 9). Packer testing fairly consistently encountered permeable conditions within this horizon (approximately 10-6 m/s to 10-4 m/s) (Figure 9). Televiewer images of the middle Unit 4 weathered shaley horizon are shown below. The same shaley horizon encountered in the Phase 2 boreholes BH-6 to BH-9 did not indicate similar open conditions.



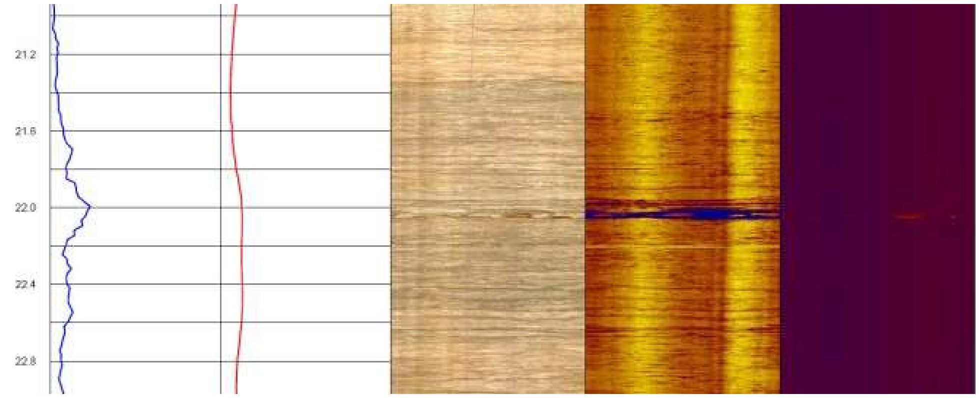
BH-1: 15.00 - 15.05 m



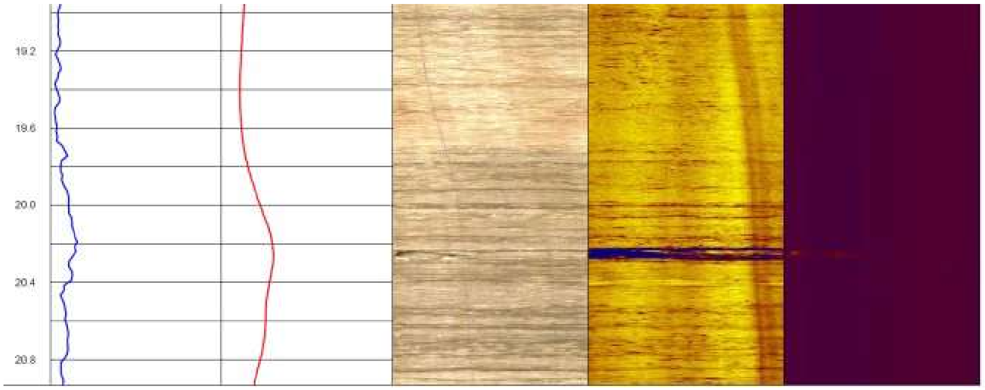
BH-2: 21.88 - 21.92 m



BH-3: 25.57 - 25.62 m



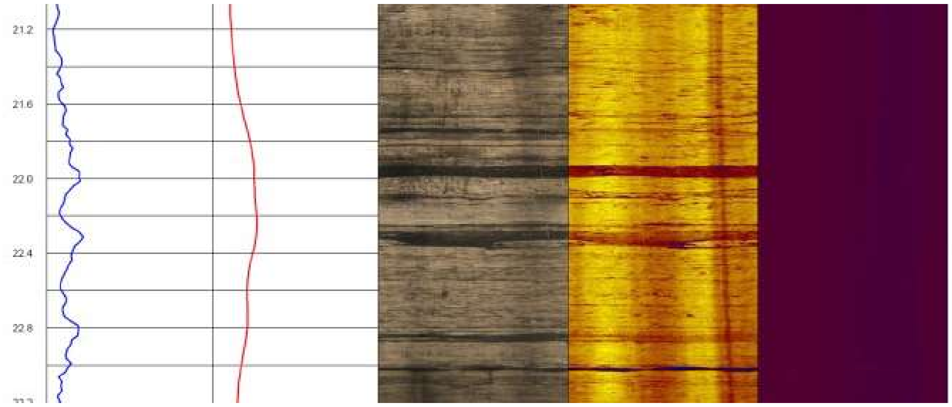
BH-4: 22.05 - 22.10 m



BH-5: 20.29 - 20.31 m

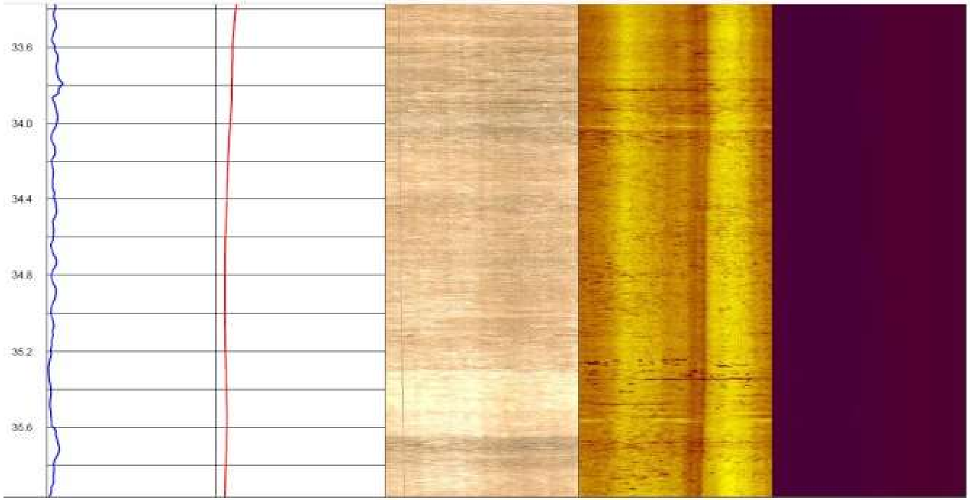
Much of the intervening limestone of Unit 4 was not permeable although packer testing in BH-5 encountered permeable conditions throughout much of Unit 4.

A second weathered shaley parting occurred at the Unit 4/Unit 3 contact in borehole BH-1 within a permeable zone packer tested at 4 x 10-5 m/s (see televiewer image below). Although not apparently encountered in the other boreholes, this would be a horizon where permeable conditions could be anticipated.



BH-1: 22.09 - 22.14 m

Another packer test zone in BH-5 in Unit 1 between 34 m and 35 m depth encountered permeable conditions (2 x 10-5 m/s) but the televiewer image of this interval did not identify any specific open feature as indicated below. Overall, the Bobcaygeon Formation Units 3, 2 and 1 were not found to be permeable.



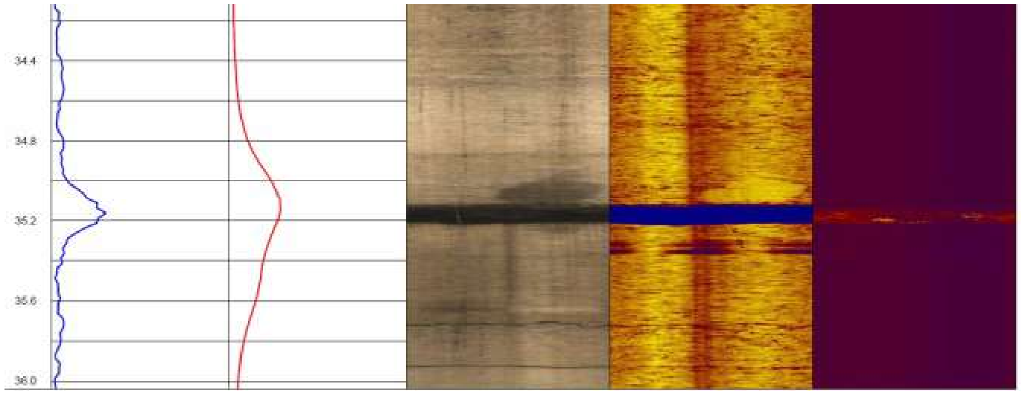
BH-5: 33.4 - 36.0 m

4.3 Gull River Formation

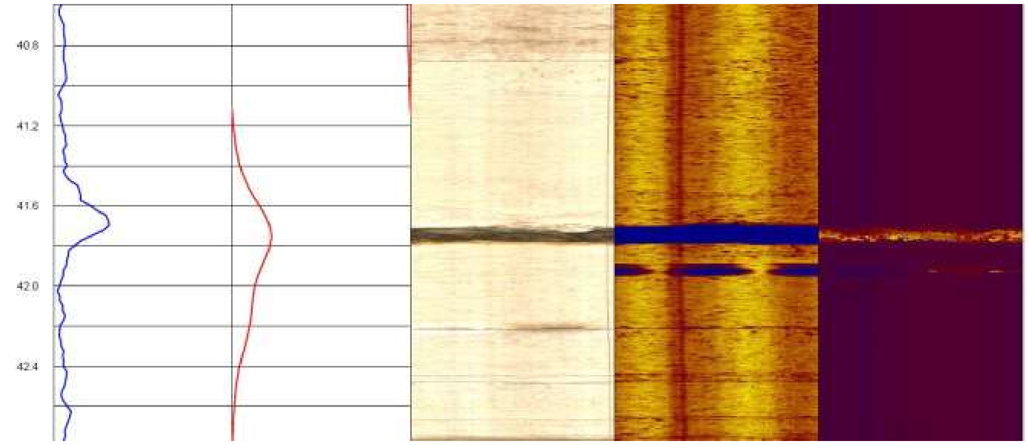
The Gull River Formation is stratigraphically subdivided into 4 units with a total formational thickness of approximately 18.5 m to 19 m (see Figure 9). Throughout the Carden Plain, this formation is typically associated with widely spaced, weathered, permeable bedding horizons either within the limestone or the dolostone that comprises the sequence.

Gull River Formation Unit 4 is comprised of very fine grained lithographic limestone. There is a distinct laterally persistent 10 cm thick weathered shale/clay soil horizon approximately 0.6 to 0.7 m below the Bobcaygeon Formation/Gull River Formation contact that is associated with a distinct natural gamma spike (see Figure 9). The persistent weathering along this horizon is profound requiring some degree of circulating groundwater along the weak limestone/shale contact horizon over time although packer testing did not indicate permeable conditions. A monitoring well sand pack zone in borehole BH-5 was placed across this horizon for additional development and testing.

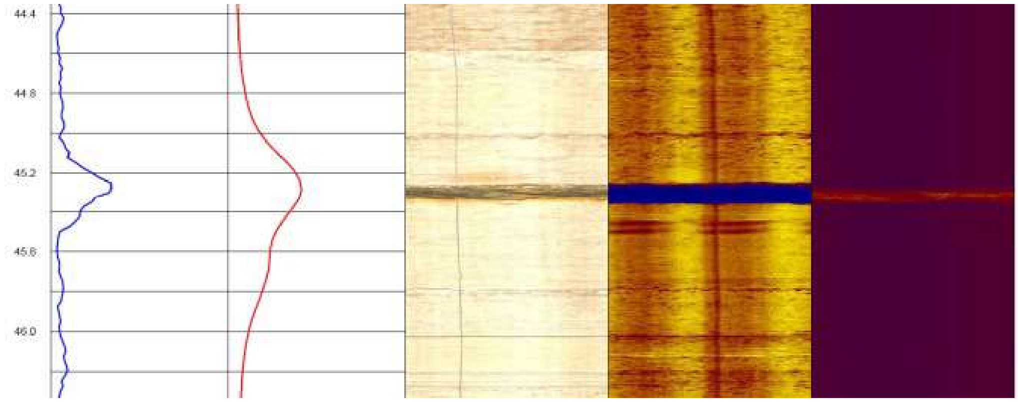
Televiewer images of the clay layer from the five boreholes are shown below.



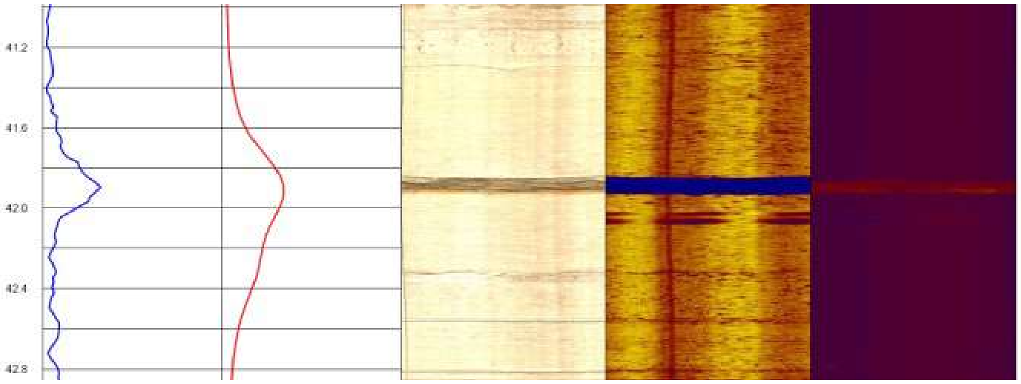
BH-1: 34.94 - 35.05 m



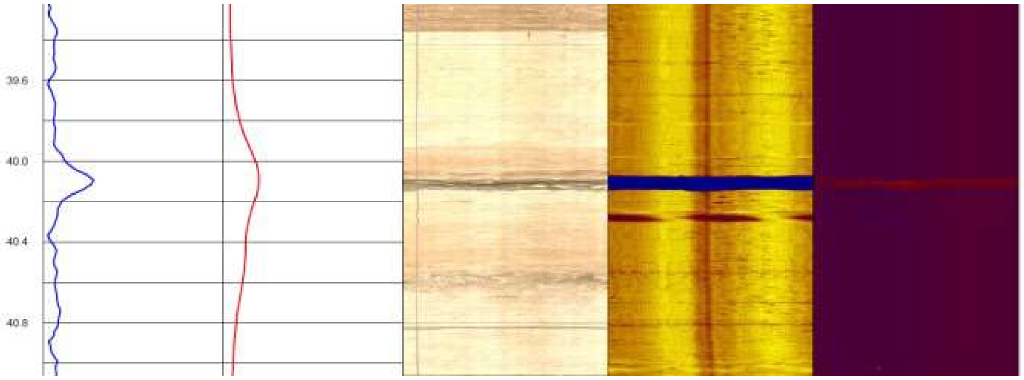
BH-2: 41.68 - 41.80 m



BH-3: 45.30 - 45.40 m

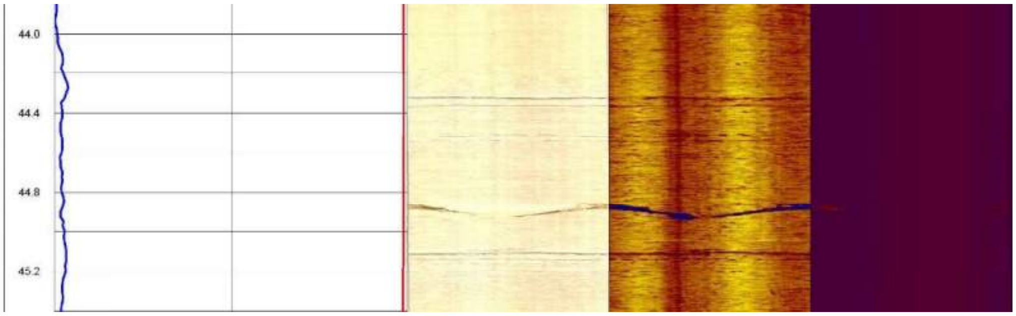


BH-4: 41.91 - 42.02 m



BH-5: 40.11 - 40.20 m

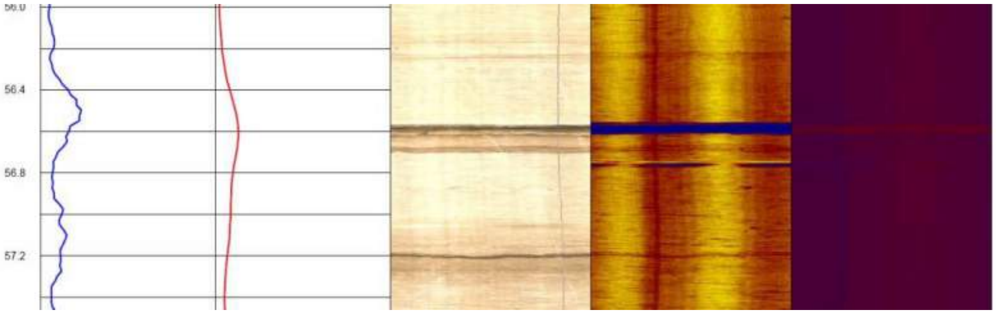
Gull River Formation Unit 3 is comprised of a greenish grey dolostone (hence its reference as "The Green Bed") layer approximately 3 to 4 m thick with a persistent shaley cap and interbedded shale laminations. The shaley cap horizon tends to weather and was found to be quite permeable in BH-2 at 5 x 10-4 m/s (Figure 9). This same permeable horizon has been found at other sites on the Carden Plain indicating its potential significance as a hydrostratigraphic horizon.



BH-2: 44.86 - 44.88 m

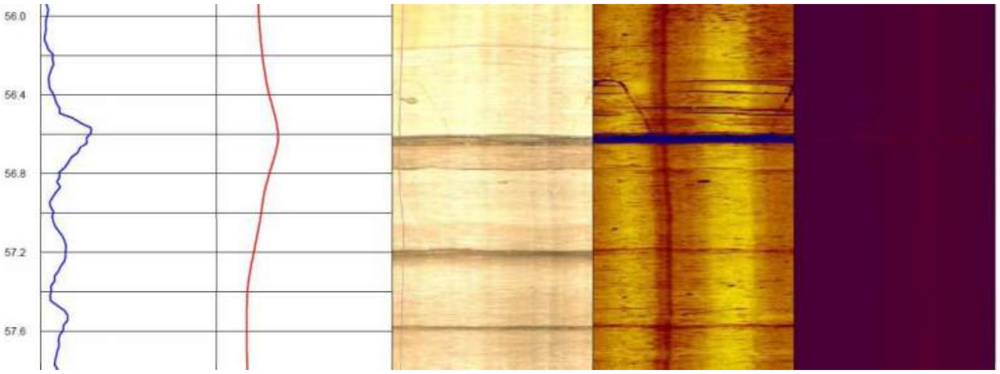
Gull River Formation Unit 2 is a lithographic limestone sequence approximately 5 m thick.

Gull River Formation Unit 1 is comprised of dolostone approximately 5 m thick with shaley partings some of which are weathered including a thin, persistent, completely weathered shale/clay layer associated with a gamma spike approximately 2 m below the Unit 2/Unit 1 contact (see Figure 9).



BH-2: 56.58 - 56.61 m

These particular weathered fractures were not found to be permeable although similar weathered partings in BH-4 were (2 x 10-6 m/s) (see below).

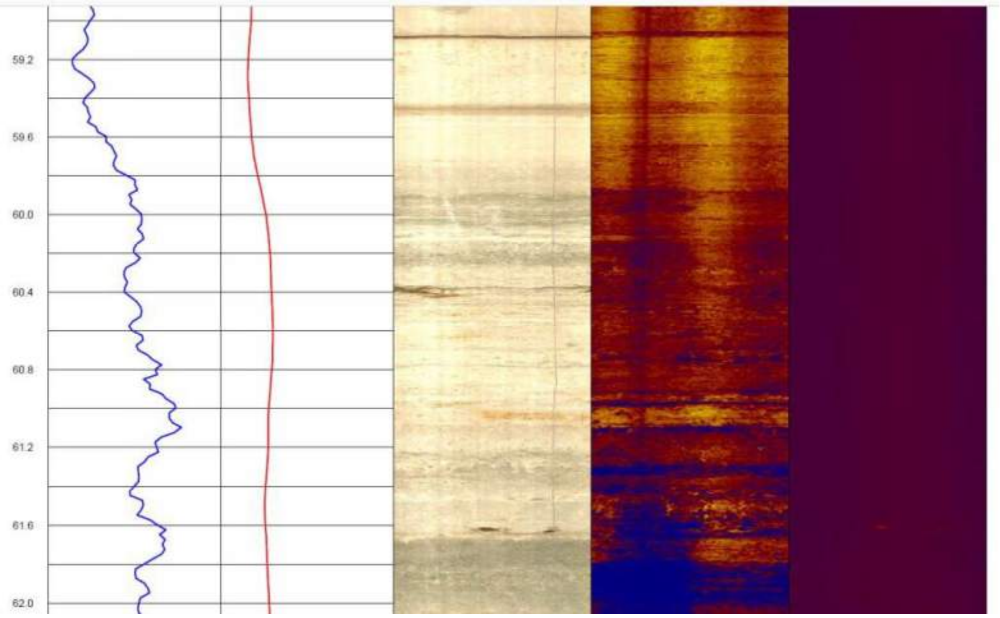


BH-4: 56.64 - 56.69 m

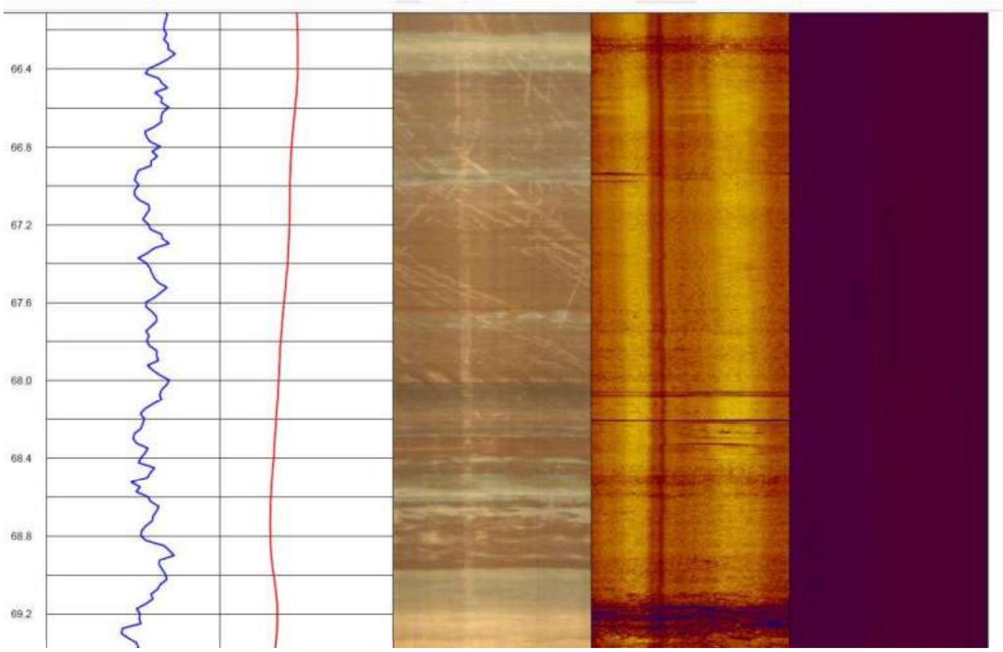
The shaley partings form the weak horizons within the rock sequence where solution openings occur along the shale/limestone interface characteristic of the water bearing features of "The Green Beds" while the intervening limestone beds are solid rock. During coring, flush water and cuttings can be lost to the formation along these horizons resulting in packer test results of lower than anticipated permeability. It is common during air rotary well drilling to encounter water in these horizons perhaps from the pumping development activity associated with the air lifting of water. However, during the air rotary drilling of boreholes BH-6 to BH-9, no specific zones of water production were noted. The Gull River Formation contact with the underlying Shadow Lake Formation is gradational and noted by a sharp increase in natural gamma. No specific open features were associated with this contact.

4.4 Shadow Lake Formation and Precambrian Basement

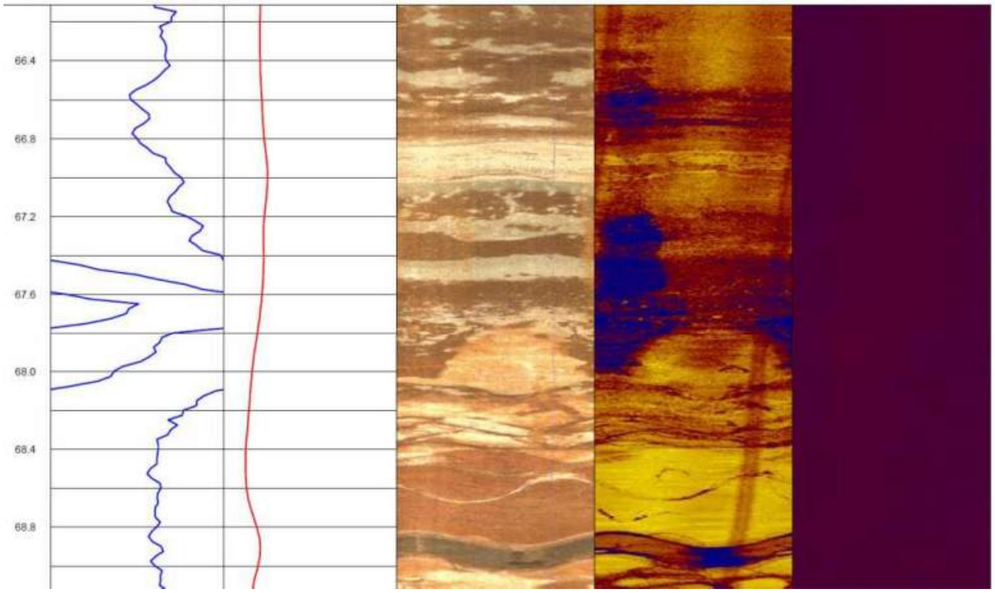
The Shadow Lake Formation is approximately 7.5 m to 8.5 m thick (see Figure 9). The formation consists of 3 stratigraphic layers; an upper faintly to moderately porous quartz sandstone in a serecitic matrix 2.0 m to 2.5 m thick; a middle red to green slake-susceptible shale bed approximately 2.5 m thick that is anticipated to form a significant vertical confining bed; and, a faintly to moderately porous lower arkosic sandstone and pebble conglomerate that directly lies on the weathered crystalline Precambrian surface. Packer testing has indicated moderately permeable conditions which is consistent with the weathered appearance of the rock. Permeability may vary with the amount of sericite forming the matrix. The sericite itself is a weathered product from feldspar grains within the sequence. The 2.5 m thick middle red/green shale layer may form a low permeability aquitard horizon capping the basal Shadow Lake Formation sandstone and Precambrian basement. The three stratigraphic layers within the Shadow Lake Formation unit are shown on the following televiewer images.



BH-2: 59.76 m - 62.60 m, upper Shadow Lake Formation porous, weathered sandstone (3 x 10-6 m/s)

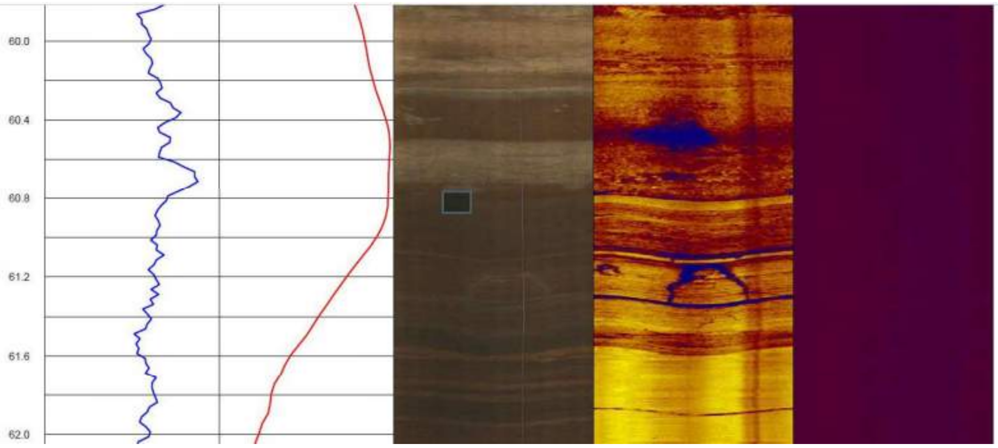


BH-3: 65.66 m – 68.71 m, middle Shadow Lake Formation red and green shale



BH-2: Lower Shadow Lake Formation porous arkosic sandstone (65.71 m - 67.87 m) overlying crystalline Precambrian basement (67.87 m - 70.31 m)

The contact between the Shadow Lake Formation and the underlying Precambrian gneiss was found to be quite abrupt with minimal weathering and packer testing in boreholes BH-1 and BH-4 indicated that it was not a permeable horizon. The contact was imaged in BH-1 as shown below.



BH-1: Basal pebble conglomerate over weathered Precambrian gneiss at 60.95 m and fresh gneiss at 61.52 m

5.0 MONITORING WELL SAND PACK ZONES FOR PHASE 1 AND PHASE 2 BOREHOLES

Based on the review of the Azimuth packer testing results, in association with the results of the Golder core logging and the geophysical optical and acoustic televiewer data (which identifies openings in the rock) and discussion with personnel from Azimuth, the preferred monitoring well sand pack zones (i.e., screened intervals and associated sand pack) were selected. Golder has also considered our existing knowledge of the key hydrostratigraphic units based on our previous work on the Carden Plain and the data requirements for constructing the numerical groundwater flow model for the Talisker site. Golder staff have also had a number of recent discussions with the Ministry of Environment, Conservation and Parks (MECP) hydrogeologists who are responsible for the Carden Plain area (Note: these conversations were not related to the Talisker site) so it would be prudent to consider the MECP expectations at this time where they are considered appropriate for this project.

The first set of monitoring wells (two 1-inch diameter monitors in each Phase 1 borehole to minimize the potential for bridging when installing the bentonite seals) were installed in the five cored boreholes focused on installing wells in the lower parts of these boreholes. This first set of monitors focus primarily on the Gull River Formation, Shadow Lake Formation and the Precambrian basement as site-specific groundwater level and hydraulic conductivity data for these hydrostratigraphic units will be required for the purpose of developing the site conceptual model and the numerical groundwater flow model during subsequent phases of this project. The monitoring well sand pack zones are shown on Figure 9.

During the Phase 2 drilling program, Azimuth/Golder developed a monitoring well (three 2-inch diameter monitors in each borehole) network for the Verulam Formation and the Bobcaygeon Formation as well as the Upper Gull River Formation based on knowledge gained from the core logging, borehole geophysics work and packer testing as well as our experience at other sites on the Carden Plain. The monitoring well sand pack zones are shown on Figure 10.

5.1 Phase 1 Borehole Monitoring Well Installations

For the five cored boreholes BH-1 through BH-5, the more permeable packer test intervals from the cored boreholes are shown by the black vertical T-bar lines on Figure 9 (labelled as “permeable packer test intervals” in the legend) with hydraulic conductivity (K) values in metres per second (m/s). The depth intervals for these more permeable packer test intervals have been corrected on Figure 9 for casing stick up.

The total packer test survey interval within each borehole is shown in pink vertical bar adjacent to the depth scale for each borehole on Figure 9 (labelled as “borehole interval packer tested” in the legend).

On Figure 9, the “casing shoe” is shown based on the televiewer log and the “groundwater” level shown is also from the televiewer log (labelled as “static water level from geophysics” in the legend).

The approximate monitoring well sand pack zones (i.e., screened interval and associated sand pack) are shown in orange on Figure 9 (labelled as “approximate monitoring well sand pack zone” in the legend).

Borehole BH-2 packer testing starts at 20 m depth in the borehole whereas the water level was 19.41 m below ground surface from the televiewer log (i.e., testing below groundwater level). The groundwater levels at the remaining boreholes are within 1 m to 6 m of ground surface.

Below are the monitoring well sand pack zones for the Phase 1 drilling program boreholes BH-1 through BH-5.

Borehole BH-1

- Lower monitoring well sand pack zone 58 to 64 m depth; monitors lower Shadow Lake Formation (below red shale) and Precambrian basement.
- Upper monitoring well sand pack zone 37 to 45 m depth; monitors Gull River Formation upper green beds (Unit 3).

Borehole BH-2

- Lower monitoring well sand pack zone 60 to 64 m depth; monitors upper Shadow Lake Formation (above red shale) including permeable packer test zone.
- Upper monitoring well sand pack zone 43 to 51 m depth; monitors Gull River Formation upper green beds (Unit 3) in permeable packer test zone.

Borehole BH-3

- Lower monitoring well sand pack zone 58 to 63 m depth; monitors Gull River Formation lower green beds (Unit 1).
- Upper monitoring well sand pack zone 48 to 53.5 m depth; monitors Gull River Formation upper green beds (Unit 3).

Borehole BH-4

- Lower monitoring well sand pack zone 65 to 70 m depth; monitors lower Shadow Lake Formation and Precambrian basement beneath red shale.
- Upper monitoring well sand pack zone 44 to 50 m depth; monitors Gull River Formation upper green beds (Unit 3) including the permeable packer test zone.

Borehole BH-5

- Lower monitoring well sand pack zone 44 to 52 m depth; monitors Gull River Formation upper green beds (Unit 3) in permeable packer test zones.
- Upper monitoring well sand pack zone 38 to 41 m depth; monitors 10 cm weathered shale/clay zone just below the Bobcaygeon Formation/Gull River Formation contact. This weathered shale/clay zone was logged in all boreholes, but packer testing did not indicate elevated horizontal hydraulic conductivity over this stratigraphic interval. This monitoring well intake zone will provide an additional assessment of hydraulic conductivity for this stratigraphic interval through completion of rising/falling head testing.

5.2 Phase 2 Borehole Monitoring Well Installations

The monitoring well installations in the Phase 2 boreholes are comparatively shallow (42 m to 43 m deep). The approximate monitoring well sand pack zones (i.e., screened interval and associated sand pack) are shown in orange on Figure 10 (labelled as “approximate monitoring well sand pack zone” in the legend).

Below are the monitoring well sand pack zones for the Phase 2 drilling program boreholes BH-6 through BH-9.

Borehole BH-6

- Lower monitoring well sand pack zone 35 to 42.5 m depth; monitors Bobcaygeon Formation Units 1 and 2.
- Middle monitoring well sand pack zone 20 to 30 m depth; monitors Bobcaygeon Formation Unit 4.
- Upper monitoring well sand pack zone 8 to 15 m depth; monitors groundwater table zone in the Verulam Formation (Unit 1).

Borehole BH-7

- Lower monitoring well sand pack zone 37 to 42.9 m depth; monitors Bobcaygeon Formation Units 1 and 2.
- Middle monitoring well sand pack zone 23 to 32 m depth; monitors Bobcaygeon Formation Unit 4.
- Upper monitoring well sand pack zone 11 to 18 m depth; monitors groundwater table zone in the Verulam Formation (Unit 1).

Borehole BH-8

- Lower monitoring well sand pack zone 35 to 42.8 m depth; monitors Upper Gull River Formation. Borehole BH-8 was terminated in the upper portion of the Gull River Formation Unit 3 Green Bed and the monitoring well sand pack zone includes both Gull River Formation Unit 3 and Unit 4 and straddles the contact with the Bobcaygeon Formation.
- Middle monitoring well sand pack zone 12 to 22 m depth; monitors Bobcaygeon Formation Unit 4.
- Upper monitoring well sand pack zone 6 to 8 m depth; monitors groundwater table zone in the Verulam Formation (Unit 1).

Borehole BH-9

- Lower monitoring well sand pack zone 40 to 43.5 m depth; monitors Upper Gull River Formation Unit 4. This monitor straddles the weathered clayey shale bed marker horizon just below the Bobcaygeon/Gull River Formations contact to further assess the significance of this thin weathered zone.
- Middle monitoring well sand pack zone 18 to 23 m depth; monitors Bobcaygeon Formation Unit 4.
- Upper monitoring well sand pack zone 6.5 to 12 m depth; monitors groundwater table zone in the Verulam Formation (Unit 1).

6.0 PROPOSED STRATIGRAPHIC, HYDROSTRATIGRAPHIC AND MONITORING WELL IDENTIFIER NOMENCLATURE

6.1 Stratigraphy

Based on the detailed core logging, optical and acoustic borehole geophysical logging and the packer testing, the hydrogeological regime beneath the Talisker site is similar to that of the other quarry sites on the Carden Plain. The water bearing permeable horizons are specific stratigraphically controlled horizons associated with thin, solution weathered bedding partings of moderate to high hydraulic conductivity (high transmissivity, low storativity) separated by thick sequences of non-porous, intact, lower permeability limestone. Many of these bedding horizons are associated with thin shales which have formed zones of weakness within the rock sequence that has allowed varying degrees of surface weathering along the shale/limestone contacts.

The subsurface conditions beneath the Talisker site were defined based on the detailed logging of five cored Phase 1 boreholes and geophysical interpretation of the four air rotary Phase 2 boreholes. The locations of the various weathered bedding partings noted in the borehole rock cores and the optical/acoustic televiewer images along with the more permeable packer test intervals (approximately 4 x 10-7 m/s to 1 x 10-4 m/s) are summarized on Figure 9.

6.2 Hydrostratigraphy and Proposed Monitoring Well Nomenclature

Based on site stratigraphy defined from the core logging/geophysics, the results of the packer testing data and the preferred monitoring well intake zones discussed above, the following hydrostratigraphic units and monitoring well nomenclature are proposed for the Talisker site:

Hydrostratigraphic Unit	Stratigraphic Unit (see Figures 9 and 10)	Hydrostratigraphic Unit Identifier	Number of Wells Targeting Unit in Monitoring Well Installation Program	Monitoring Well Identifier
Overburden	6	O	0	N/A
Upper Weathered Zone (bedrock)	5-1, 5-2	N	0	N/A
Verulam Formation	5-2	M	0	N/A
Verulam Formation	5-1	L	4 BH-6, BH-7, BH-8, BH-9	BH-6L BH-7L BH-8L BH-9L
Bobcaygeon Formation	4-4	K	4 BH-6, BH-7, BH-8, BH-9	BH-6K BH-7K BH-8K BH-9K
Bobcaygeon Formation	4-3	J	0	
Bobcaygeon Formation	4-1, 4-2	I	2 BH-6, BH-7	BH-6I BH-7I
Weathered shale/clay zone at Bobcaygeon/ Gull River formational contact	3-4/4-1	H	1 BH-5	BH-5H
Upper Gull River Formation Limestone	3-4	G	2 BH-8, BH-9	BH-8G BH-9G
Upper Green Beds of Gull River Formation	3-3	F	5 BH-1, BH-2, BH-3, BH-4, BH-5	BH-1F BH-2F BH-3F BH-4F BH-5F
Lower Gull River Formation Limestone	3-2	E	0	N/A
Lower Green Beds of Gull River Formation	3-1	D	1 BH-3	BH-3D
Shadow Lake Formation	2	C	1 BH-2	BH-2C
Shadow Lake Formation/Precambrian basement contact zone	1/2	B	2 BH-1, BH-4	BH-1B BH-4B
Precambrian Basement	1	A	0	N/A

Notes: N/A – Not applicable as monitoring well not installed in hydrostratigraphic unit

The remaining non-instrumented upper portion of each Phase 1 borehole was left open to facilitate the collection of groundwater levels from the upper water bearing zones and formations (i.e., Upper Weathered Zone (bedrock), Verulam Formation and Bobcaygeon Formation). A hydrostratigraphic unit identifier of “Z” was added by Azimuth to represent the open part of each Phase 1 borehole as shown in Appendix D.

7.0 CLOSURE

We trust that this assessment satisfies your current requirements. Please contact the undersigned with any questions or concerns.

Golder Associates Ltd.

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RB/KAM/JPAO/sg
https://golderassociates.sharepoint.com/sites/108830/project files/6 deliverables/2021 geological report/19122839-r-rev0-talisker brechin quarry geological report 18june 2021.docx

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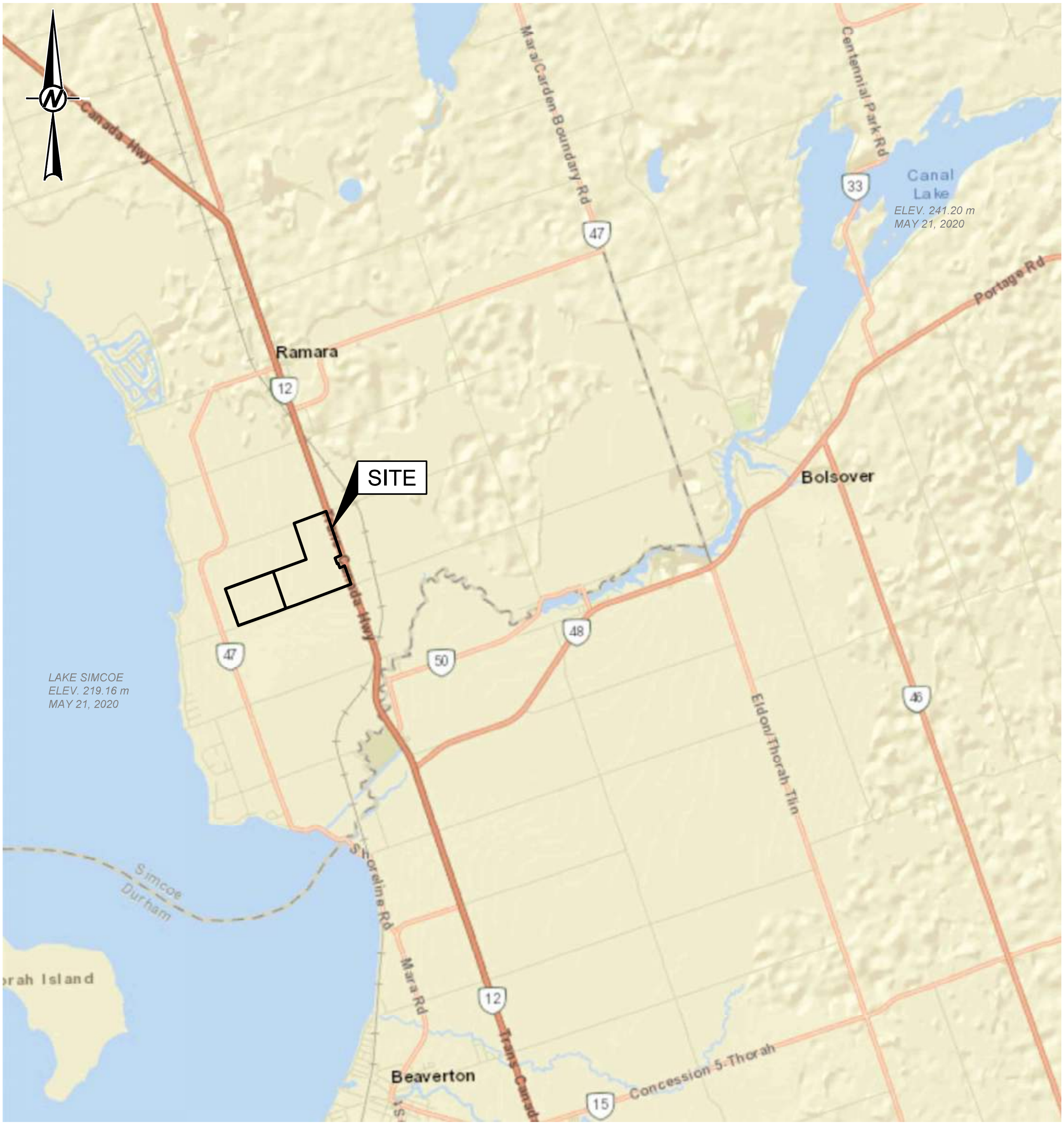

REFERENCE(S)

1. SERVICE LAYER CREDITS: © OPENSTREETMAP (AND) CONTRIBUTORS, CC-BY-SA SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C)
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

0 2,500 5,000

1:100,000 METRES

CLIENT

TALISKER CORPORATION

PROJECT

GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

TITLE

KEY PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0001	0	1

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

KEY MAP

SCALE 1:100,000

LEGEND

⊕	APPROXIMATE BOREHOLE LOCATION
▲	PRIVATE WELL (AS PER MINISTRY OF ENVIRONMENT, CONSERVATION AND PARKS WATER WELL INFORMATION SYSTEM)
— · · —	POTENTIAL LICENSED BOUNDARY
— · —	PRELIMINARY EXTRACTION LIMIT SUBJECT TO TECHNICAL STUDIES
232	TOPOGRAPHIC CONTOUR, mASL
A / 7	CROSS-SECTION LOCATION (REFER TO FIGURE 6 AND FOR CROSS-SECTION DETAILS)

REFERENCE(S)

1. BASE PLAN PROVIDED BY AZIMUTH ENVIRONMENTAL CONSULTING INC. ON MARCH 11, 2020, FILE NO. 18-288.dwg
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

0 250 500
1:10,000 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

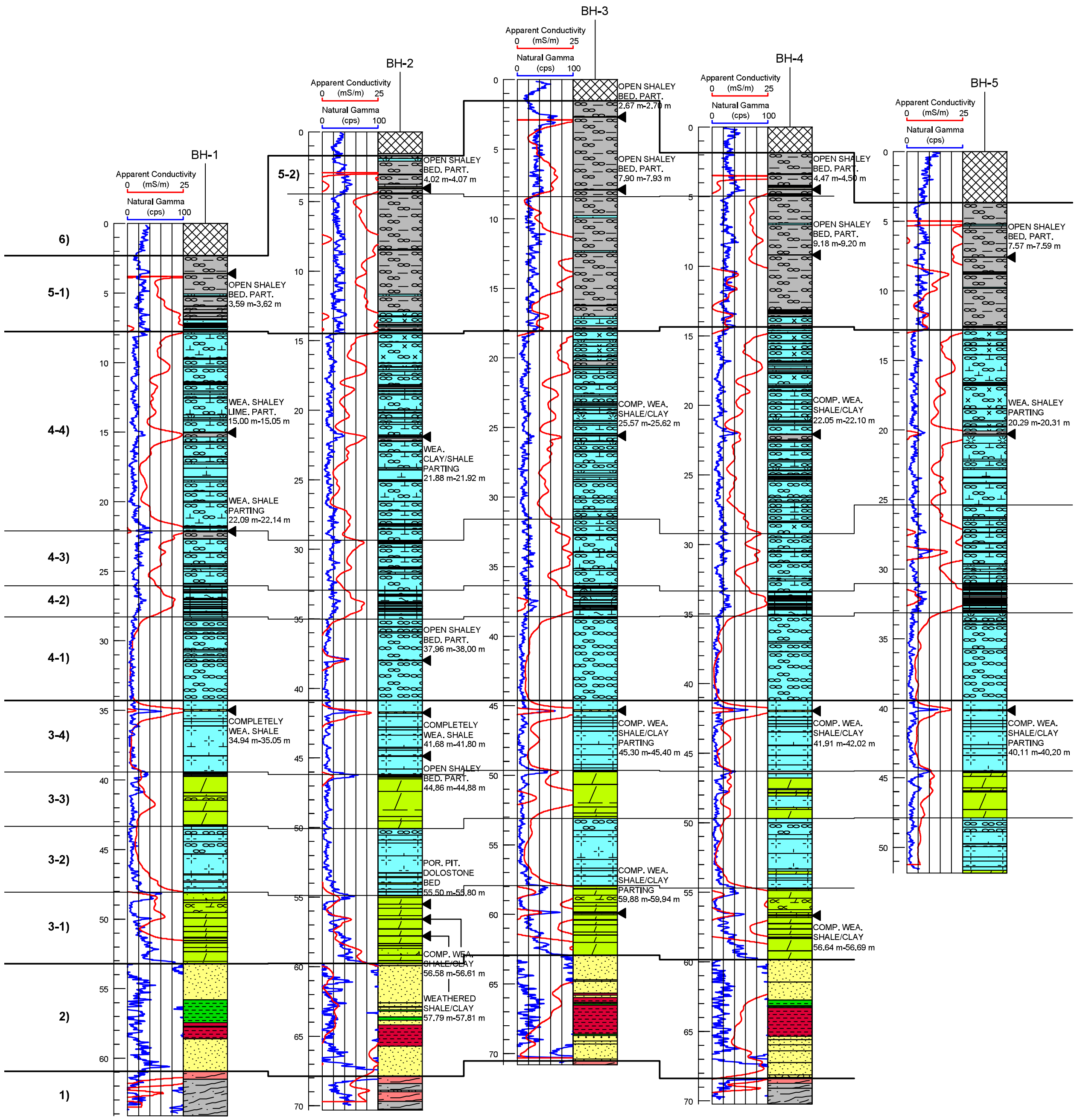
TITLE
BOREHOLE LOCATION PLAN

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	2



STRATIGRAPHIC LEGEND

6) OVERBURDEN

5) VERULAM FORMATION

5-2) UNIT 2, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) UNIT 1, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) BOBCAYGEON FORMATION

4-4) UNIT 4, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) UNIT 3, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-2) UNIT 2, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) UNIT 1, THICKLY BEDDED **NODULAR LIMESTONE**, APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) GULL RIVER FORMATION

3-4) UNIT 4, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) UNIT 3, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS".**

3-2) UNIT 2, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE.**

3-1) UNIT 1, MEDIUM BEDDED **DOLOSTONE.** TRANSITIONAL BASAL CONTACT.

2) SHADOW LAKE FORMATION

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE.**

1) PRECAMBRIAN BASEMENT
PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS.**

BOREHOLE GEOPHYSICAL RECORDS

〰	NATURAL GAMMA (LOGGED BY GOLDER)
〰	APPARENT CONDUCTIVITY (LOGGED BY GOLDER)
━	GEOPHYSICAL FORMATION CONTACT
─	GEOPHYSICAL UNIT CONTACT
◀	OPEN, WEATHERED BEDDING PARTINGS

GENERALIZED LITHOLOGICAL LEGEND

▨	OVERBURDEN	🟩	GREEN SHALE
🟦	LIMESTONE	🟥	RED SHALE
🟩	DOLOSTONE	▨	QUARTZ-HORNBLENDE GNEISS
🟨	SANDSTONE	▨	QUARTZ FELDSPAR GNEISS
▨	GREY SHALE		

NOTE(S)

1. BOREHOLES ARE VERTICALLY SCALED IN DEPTH BELOW GROUND SURFACE IN METRES
2. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS

0 5 10
1:300 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
PHASE 1 STRATIGRAPHIC CORRELATION BOREHOLES BH-1 TO BH-5

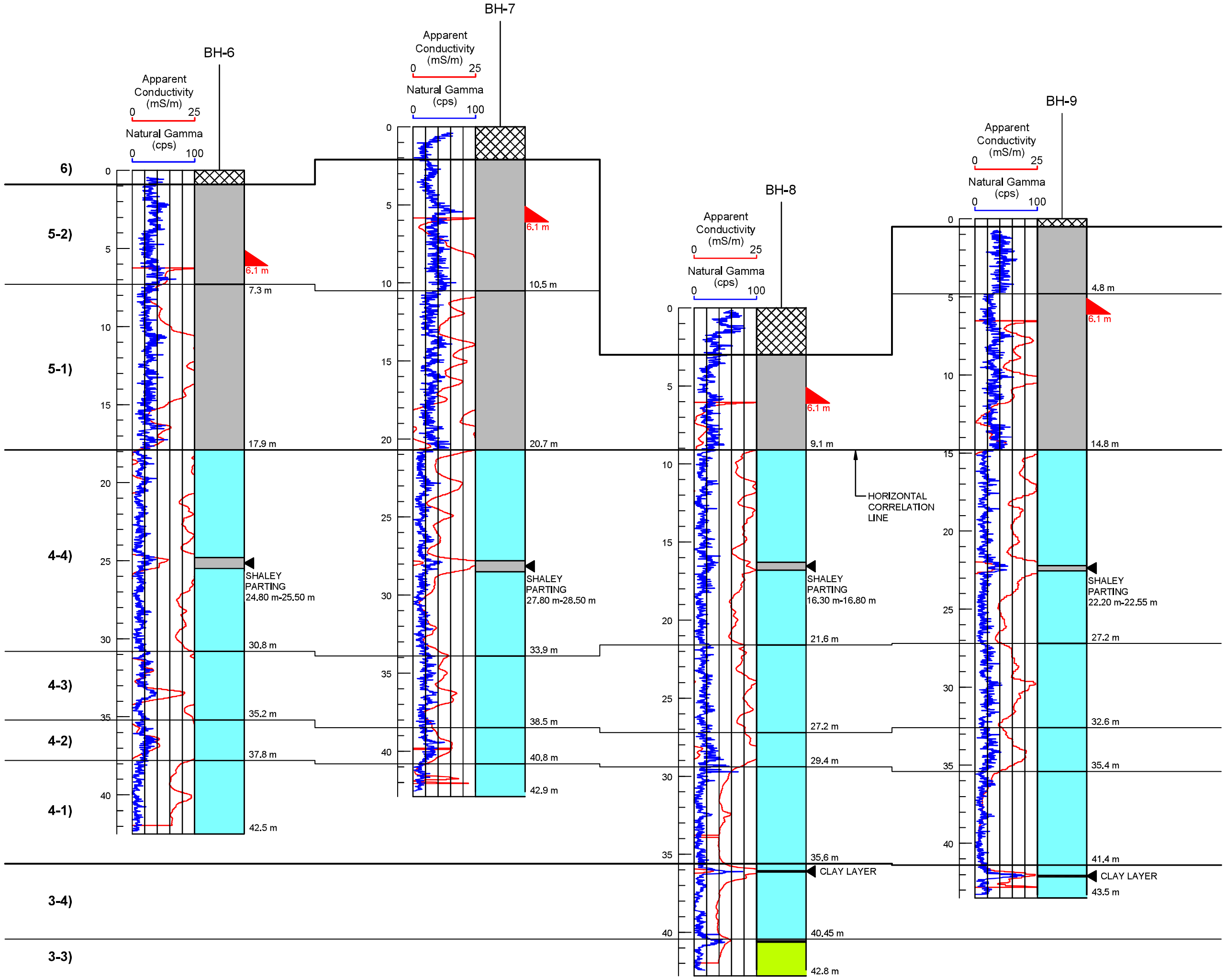
CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	RDB
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm
0



BOREHOLE GEOPHYSICAL RECORDS

NATURAL GAMMA (LOGGED BY GOLDER)

APPARENT CONDUCTIVITY (LOGGED BY GOLDER)

GEOPHYSICAL FORMATION CONTACT

GEOPHYSICAL UNIT CONTACT

GENERALIZED LITHOLOGICAL LEGEND

▨ OVERBURDEN

🟩 DOLOSTONE

🟦 LIMESTONE

⬜ SHALE

LEGEND

6.1 m CASING SHOE

STRATIGRAPHIC LEGEND

6) OVERBURDEN

5) VERULAM FORMATION

5-2) UNIT 2, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) UNIT 1, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) BOBCAYGEON FORMATION

4-4) UNIT 4, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) UNIT 3, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-2) UNIT 2, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) UNIT 1, THICKLY BEDDED **NODULAR LIMESTONE**, APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) GULL RIVER FORMATION

3-4) UNIT 4, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) UNIT 3, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS".**

3-2) UNIT 2, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE.**

3-1) UNIT 1, MEDIUM BEDDED **DOLOSTONE.** TRANSITIONAL BASAL CONTACT.

2) SHADOW LAKE FORMATION

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE.**

1) PRECAMBRIAN BASEMENT
PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS.**

NOTE(S)

1. BOREHOLES ARE VERTICALLY SCALED IN DEPTH BELOW GROUND SURFACE IN METRES
2. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS

0 5 10
1:300 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
PHASE 2 STRATIGRAPHIC CORRELATION BOREHOLES BH-6 TO BH-9

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	RDB
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	4

KEY MAP

SCALE 1:100,000

LEGEND

⊕	APPROXIMATE BOREHOLE LOCATION
▲	PRIVATE WELL (AS PER MINISTRY OF ENVIRONMENT, CONSERVATION AND PARKS WATER WELL INFORMATION SYSTEM)
GS 231.56	GROUND SURFACE ELEVATION, mASL
223.79	ELEVATION OF VERULAM FORMATION / BOBCAYGEON FORMATION CONTACT AT BOREHOLE LOCATION, mASL
— 224 —	STRUCTURE CONTOUR - VERULAM FORMATION / BOBCAYGEON FORMATION CONTACT, mASL
— · · —	POTENTIAL LICENSED BOUNDARY
— · —	PRELIMINARY EXTRACTION LIMIT SUBJECT TO TECHNICAL STUDIES
232	TOPOGRAPHIC CONTOUR, mASL

REFERENCE(S)

1. BASE PLAN PROVIDED BY AZIMUTH ENVIRONMENTAL CONSULTING INC. ON MARCH 11, 2020, FILE NO. 18-288.dwg
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

0 250 500
1:10,000 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
ELEVATION CONTOUR PLAN
VERULAM FORMATION / BOBCAYGEON FORMATION CONTACT

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	5

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

0 25 mm

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KEY MAP

SCALE 1:100,000

LEGEND

⌖	APPROXIMATE BOREHOLE LOCATION
▲	PRIVATE WELL (AS PER MINISTRY OF ENVIRONMENT, CONSERVATION AND PARKS WATER WELL INFORMATION SYSTEM)
GS 231.56	GROUND SURFACE ELEVATION, mASL
197.27	ELEVATION OF BOBCAYGEON FORMATION / GULL RIVER FORMATION CONTACT AT BOREHOLE LOCATION, mASL
— 196 —	STRUCTURE CONTOUR - BOBCAYGEON FORMATION / GULL RIVER FORMATION CONTACT, mASL
– · –	POTENTIAL LICENSED BOUNDARY
— – —	PRELIMINARY EXTRACTION LIMIT SUBJECT TO TECHNICAL STUDIES
232	TOPOGRAPHIC CONTOUR, mASL

REFERENCE(S)

1. BASE PLAN PROVIDED BY AZIMUTH ENVIRONMENTAL CONSULTING INC. ON MARCH 11, 2020, FILE NO. 18-288.dwg
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

0 250 500
1:10,000 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

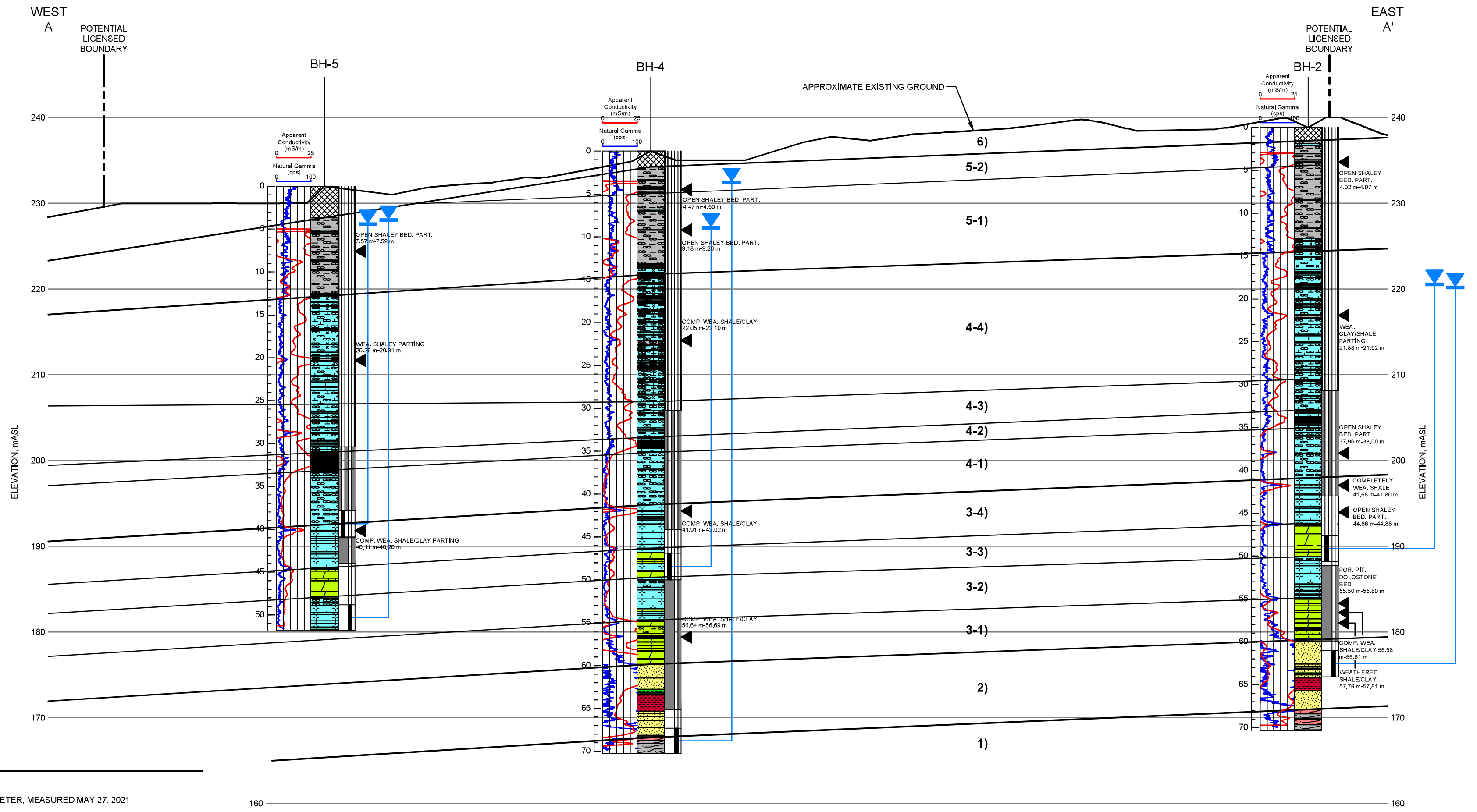
TITLE
ELEVATION CONTOUR PLAN
BOBCAYGEON FORMATION / GULL RIVER FORMATION CONTACT

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	6



LEGEND

▼ WATER LEVEL IN PIEZOMETER, MEASURED MAY 27, 2021

BOREHOLE GEOPHYSICAL RECORDS

NATURAL GAMMA (LOGGED BY GOLDER)

APPARENT CONDUCTIVITY (LOGGED BY GOLDER)

GEOPHYSICAL FORMATION CONTACT

GEOPHYSICAL UNIT CONTACT

GENERALIZED LITHOLOGICAL LEGEND

▨	OVERBURDEN	🟩	GREEN SHALE
🟦	LIMESTONE	🟥	RED SHALE
🟩	DOLOSTONE	▨	QUARTZ-HORNBLENDE GNEISS
🟨	SANDSTONE	▨	QUARTZ FELDSPAR GNEISS
▨	GREY SHALE		

NOTE(S)

1. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS
2. FOR LOCATION OF CROSS-SECTION IN PLAN, SEE FIGURE 2

STRATIGRAPHIC LEGEND

6) **OVERBURDEN**

5) **VERULAM FORMATION**

5-2) **UNIT 2**, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) **UNIT 1**, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) **BOBCAYGEON FORMATION**

4-4) **UNIT 4**, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) **UNIT 3**, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-2) **UNIT 2**, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) **UNIT 1**, THICKLY BEDDED **NODULAR LIMESTONE**, APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) **GULL RIVER FORMATION**

3-4) **UNIT 4**, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) **UNIT 3**, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS"**.

3-2) **UNIT 2**, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE**.

3-1) **UNIT 1**, MEDIUM BEDDED **DOLOSTONE**. TRANSITIONAL BASAL CONTACT.

2) **SHADOW LAKE FORMATION**

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE**.

1) **PRECAMBRIAN BASEMENT**

PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS**.

HORIZONTAL
0 125 250
1:7,500 METRES

VERTICAL
0 10 20
1:500 METRES

CLIENT
TALISKER CORPORATION

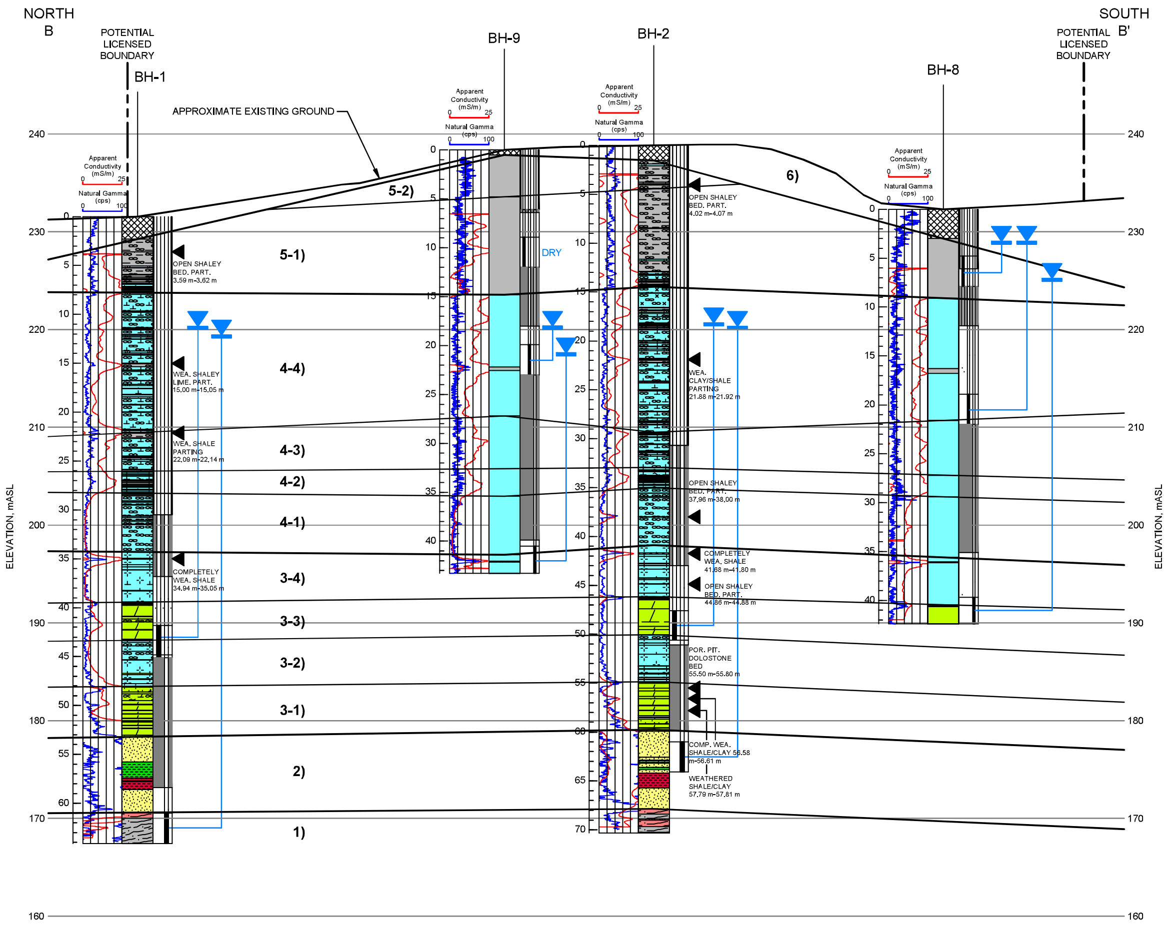
PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
STRATIGRAPHIC CORRELATION CROSS-SECTION A-A'

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	7



LEGEND

WATER LEVEL IN PIEZOMETER, MEASURED MAY 27, 2021

BOREHOLE GEOPHYSICAL RECORDS

NATURAL GAMMA (LOGGED BY GOLDER)

APPARENT CONDUCTIVITY (LOGGED BY GOLDER)

GEOPHYSICAL FORMATION CONTACT

GEOPHYSICAL UNIT CONTACT

GENERALIZED LITHOLOGICAL LEGEND

▨	OVERBURDEN	🟩	GREEN SHALE
🟦	LIMESTONE	🟥	RED SHALE
🟩	DOLOSTONE	▨	QUARTZ-HORNBLENDE GNEISS
🟨	SANDSTONE	▨	QUARTZ FELDSPAR GNEISS
▨	GREY SHALE		

NOTE(S)

1. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS
2. FOR LOCATION OF CROSS-SECTION IN PLAN, SEE FIGURE 2

STRATIGRAPHIC LEGEND

6) **OVERBURDEN**

5) **VERULAM FORMATION**

5-2) **UNIT 2**, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) **UNIT 1**, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) **BOBCAYGEON FORMATION**

4-4) **UNIT 4**, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) **UNIT 3**, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-2) **UNIT 2**, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) **UNIT 1**, THICKLY BEDDED **NODULAR LIMESTONE**, APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) **GULL RIVER FORMATION**

3-4) **UNIT 4**, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) **UNIT 3**, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS"**.

3-2) **UNIT 2**, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE**.

3-1) **UNIT 1**, MEDIUM BEDDED **DOLOSTONE**. TRANSITIONAL BASAL CONTACT.

2) **SHADOW LAKE FORMATION**

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE**.

1) **PRECAMBRIAN BASEMENT**

PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS**.

HORIZONTAL
0 125 250
1:7,500 METRES

VERTICAL
0 10 20
1:500 METRES

CLIENT
TALISKER CORPORATION

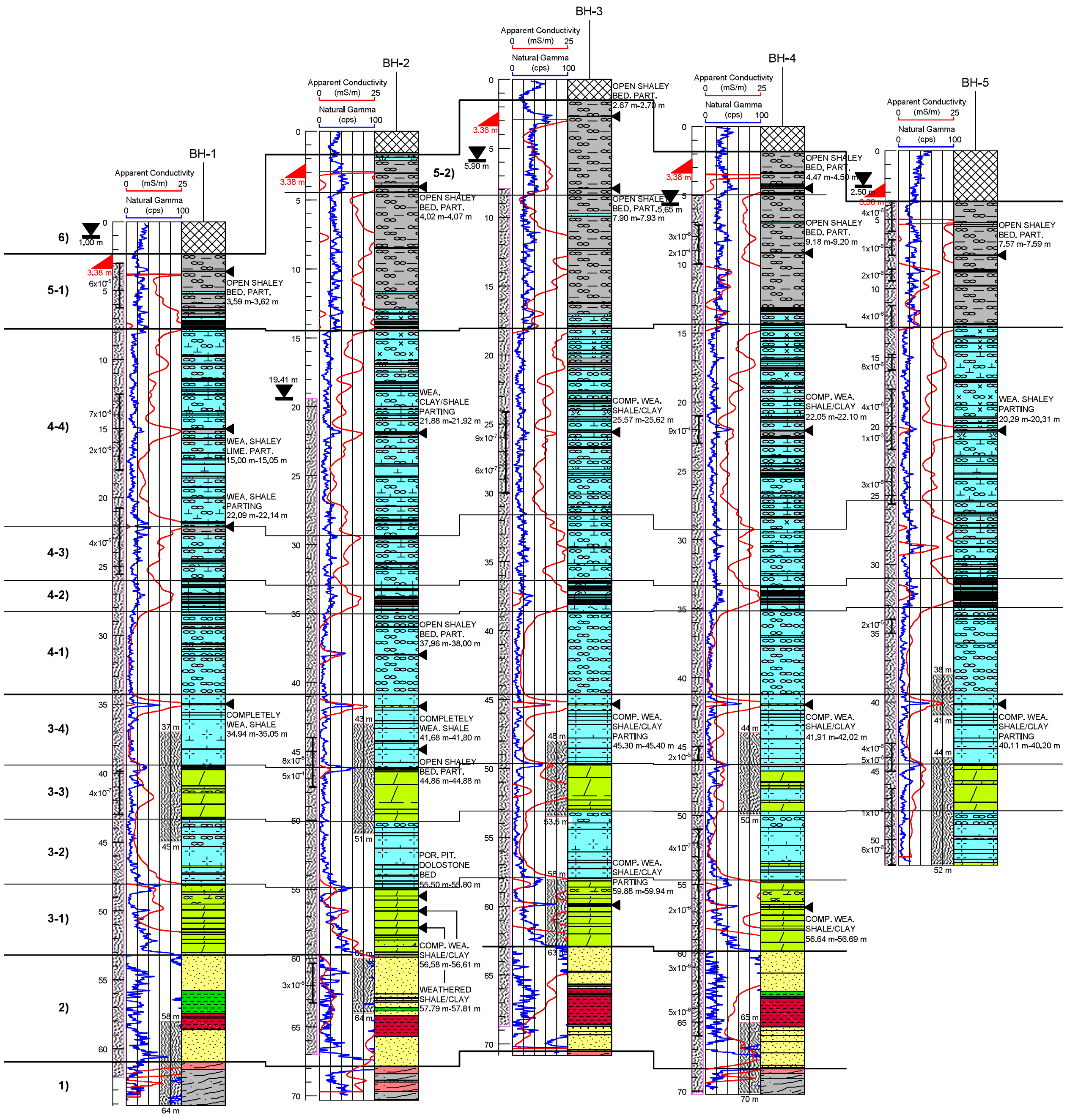
PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
STRATIGRAPHIC CORRELATION CROSS-SECTION B-B'

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-14
DESIGNED	----
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	8



STRATIGRAPHIC LEGEND

6) OVERBURDEN

5) VERULAM FORMATION

5-2) UNIT 2, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) UNIT 1, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) BOBCAYGEON FORMATION

4-4) UNIT 4, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) UNIT 3, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS**.** SHARP BASAL CONTACT.

4-2) UNIT 2, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) UNIT 1, THICKLY BEDDED **NODULAR LIMESTONE,** APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) GULL RIVER FORMATION

3-4) UNIT 4, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) UNIT 3, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS".**

3-2) UNIT 2, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE.**

3-1) UNIT 1, MEDIUM BEDDED **DOLOSTONE.** TRANSITIONAL BASAL CONTACT.

2) SHADOW LAKE FORMATION

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE.**

1) PRECAMBRIAN BASEMENT
PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS.**

BOREHOLE GEOPHYSICAL RECORDS

∿	NATURAL GAMMA (LOGGED BY GOLDER)
∿	APPARENT CONDUCTIVITY (LOGGED BY GOLDER)
━	GEOPHYSICAL FORMATION CONTACT
─	GEOPHYSICAL UNIT CONTACT
◀	OPEN, WEATHERED BEDDING PARTINGS

LEGEND

58 m ▨ 64 m	APPROXIMATE MONITORING WELL SAND PACK ZONE
4x10⁻⁷ I	PERMEABLE PACKER TEST INTERVALS
▨	BOREHOLE INTERVAL PACKER TESTED
◢ 3.38 m	CASING SHOE
▼ 1.00 m	STATIC WATER LEVEL FROM GEOPHYSICS

GENERALIZED LITHOLOGICAL LEGEND

▨	OVERBURDEN	🟩	GREEN SHALE
🟦	LIMESTONE	🟥	RED SHALE
🟩	DOLOSTONE	▨	QUARTZ-HORNBLENDE GNEISS
🟨	SANDSTONE	▨	QUARTZ FELDSPAR GNEISS
▨	GREY SHALE		

NOTE(S)

1. BOREHOLES ARE VERTICALLY SCALED IN DEPTH BELOW GROUND SURFACE IN METRES
2. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS

0 5 10
1:300 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPOSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

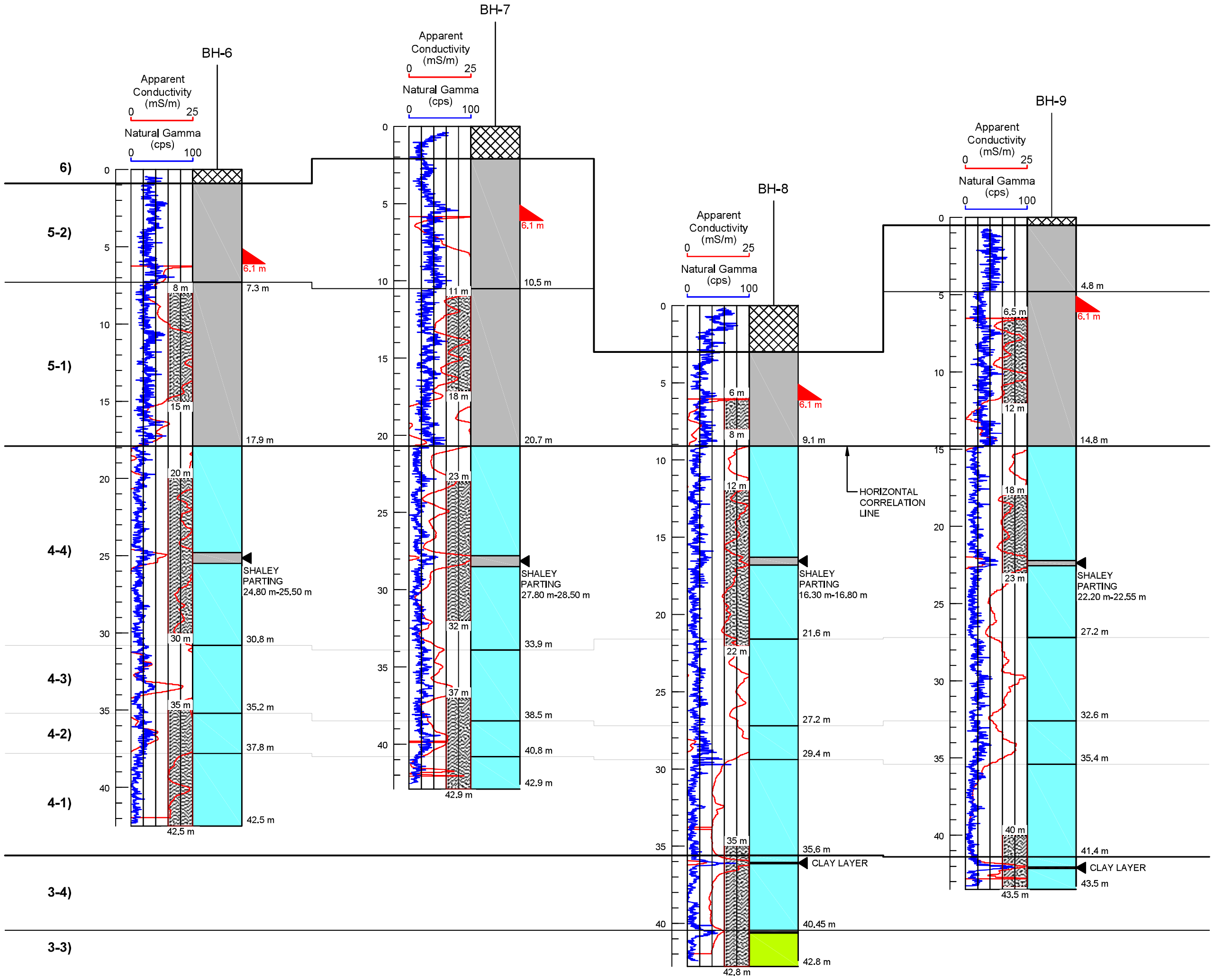
TITLE
STRATIGRAPHY, PACKER TEST RESULTS AND INSTALLED PHASE 1 MONITORING WELL SAND PACK ZONES

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-11
DESIGNED	RDB
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	9



BOREHOLE GEOPHYSICAL RECORDS

NATURAL GAMMA (LOGGED BY GOLDER)	APPARENT CONDUCTIVITY (LOGGED BY GOLDER)

GEOPHYSICAL FORMATION CONTACT

GEOPHYSICAL UNIT CONTACT

GENERALIZED LITHOLOGICAL LEGEND

▨	OVERBURDEN	🟩	DOLOSTONE
🟦	LIMESTONE	⬜	SHALE

LEGEND

6.1 m CASING SHOE

12 m ▨ 22 m APPROXIMATE MONITORING WELL SAND PACK ZONE

STRATIGRAPHIC LEGEND

6) OVERBURDEN

5) VERULAM FORMATION

5-2) UNIT 2, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE AND SHALE**, APPR. 30% SHALE. TRANSITIONAL BASAL CONTACT.

5-1) UNIT 1, VERY THINLY TO THINLY INTERBEDDED **SHALEY NODULAR LIMESTONE**, APPR. 10-20% SHALE. TRANSITIONAL TO SHARP BASAL CONTACT.

4) BOBCAYGEON FORMATION

4-4) UNIT 4, THINLY TO THICKLY BEDDED **NODULAR TO ARGILLACEOUS NODULAR LIMESTONE** WITH 6% SHALEY PARTINGS. GRADATIONAL BASAL CONTACT.

4-3) UNIT 3, MEDIUM TO THICKLY BEDDED **ARGILLACEOUS NODULAR LIMESTONE**, APPR. 7% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-2) UNIT 2, THINLY TO MEDIUM BEDDED **ARGILLACEOUS LIMESTONE**, APPR. 12% SHALEY PARTINGS. SHARP BASAL CONTACT.

4-1) UNIT 1, THICKLY BEDDED **NODULAR LIMESTONE**, APPR. 1% SHALEY PARTINGS. SHARP BASAL CONTACT.

3) GULL RIVER FORMATION

3-4) UNIT 4, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE** WITH 10 CM **CLAY MARKER BED** AT 0.7M BELOW UPPER CONTACT. SHARP BASAL CONTACT.

3-3) UNIT 3, MEDIUM TO THICKLY BEDDED **DOLOSTONE "THE GREEN BEDS".**

3-2) UNIT 2, MEDIUM TO THICKLY BEDDED **LITHOGRAPHIC LIMESTONE.**

3-1) UNIT 1, MEDIUM BEDDED **DOLOSTONE.** TRANSITIONAL BASAL CONTACT.

2) SHADOW LAKE FORMATION

THICKLY BEDDED **QUARTZ SANDSTONE** AND **RED SHALE**, OVERLYING **ARKOSIC SANDSTONE** AND **PEBBLE CONGLOMERATE.**

1) PRECAMBRIAN BASEMENT
PINKISH GREY, MEDIUM GRAINED **QUARTZ FELDSPAR GNEISS.**

NOTE(S)

1. BOREHOLES ARE VERTICALLY SCALED IN DEPTH BELOW GROUND SURFACE IN METRES
2. FOR DETAILED GEOLOGY FOUND AT BOREHOLE LOCATIONS SEE RECORD OF GEOPHYSICAL LOGS

0 5 10
1:300 METRES

CLIENT
TALISKER CORPORATION

PROJECT
GEOLOGICAL STUDY
PROPSED BRECHIN QUARRY
TOWNSHIP OF RAMARA, ONTARIO

TITLE
STRATIGRAPHY AND INSTALLED PHASE 2 MONITORING WELL SAND PACK ZONES

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-06-15
DESIGNED	RDB
PREPARED	JM
REVIEWED	RDB/KAM
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0002	0	10

APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS
OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, **Lagoon City Limited Partnership c/o Talisker Corporation.** The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Record of Boreholes

GEOPHYSICAL LOG OF: BH-1

PROJECT: 19122839

SHEET 1 OF 7

LOCATION: N 4931533.1 ;E 645411.3

DRILLING DATE: August 8-12, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES | DRILLING RECORD: Rotary Drill, HQ Core | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

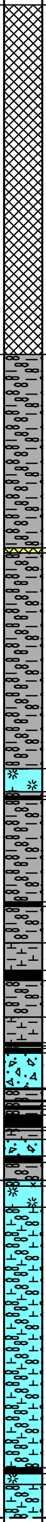
GROUND SURFACE — 231.56

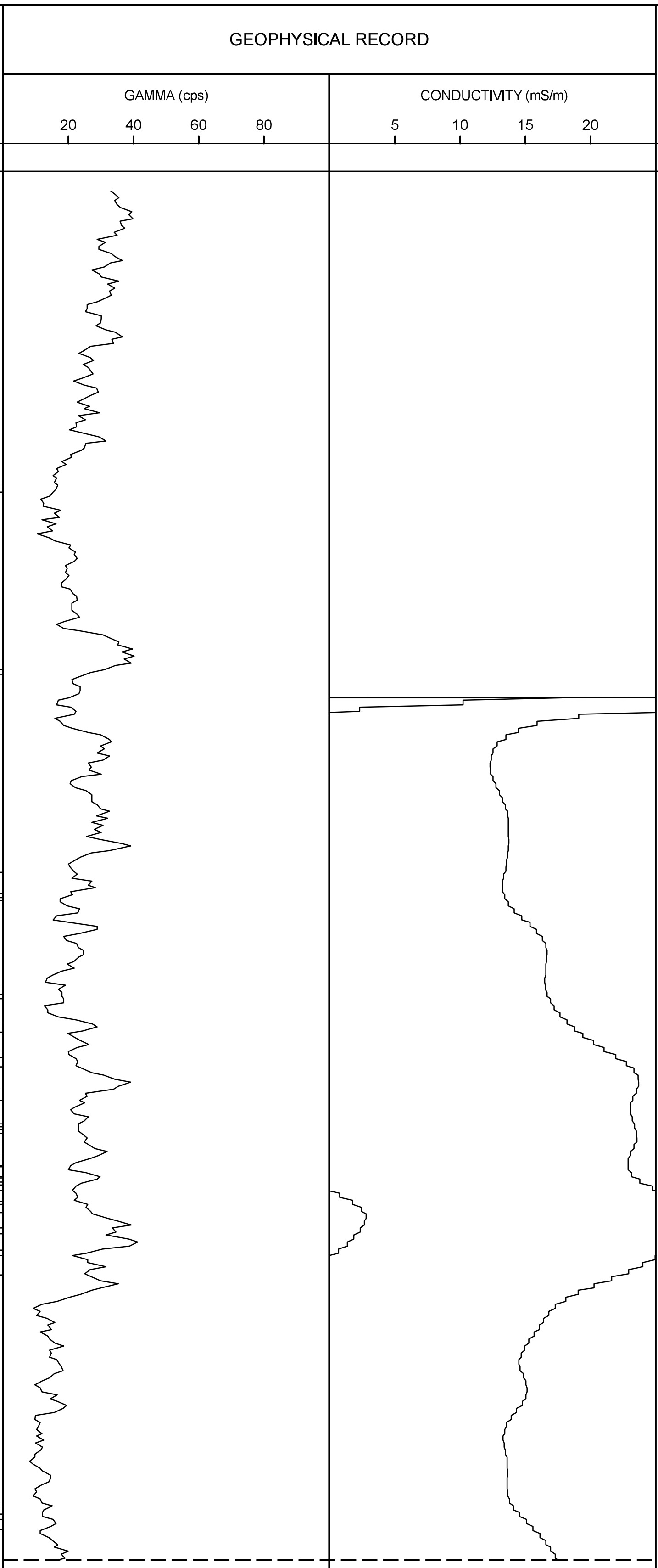
OVERBURDEN, 0.0 m to 2.31 m

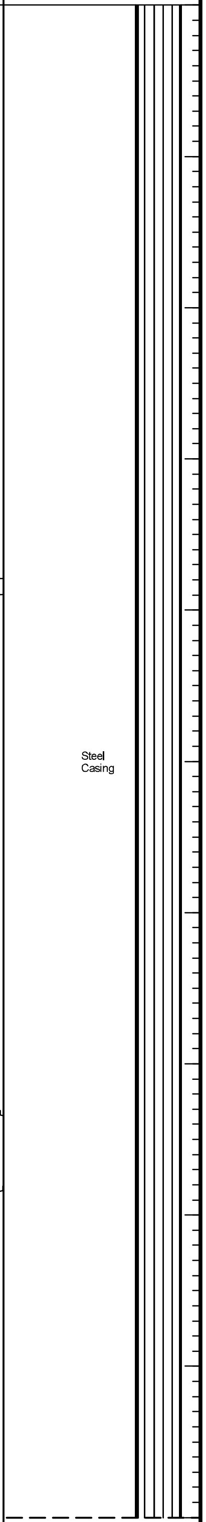
VERULAM FORMATION, 2.31 m to 7.77 m
UNIT 1, 2.31 m to 7.77 m, Moderately weathered on shaley bedding partings from 2.31 m to 3.00 m, fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly interbedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Shaley component tends to slake. Medium grained crystalline calcarenite bed at 5.05-.20m. Lithoclastic calcarenite with shaley clasts at 6.93-7.16m and 7.50-.61m. Measured shale content on per core run basis comprises approximately 17 to 22 percent averaging 19 percent. Open weathered shaley bedding parting at 3.59-.62m. Transitional basal contact noted by decrease in shaley content between 7.36m and 7.77m.

BOBCAYGEON FORMATION, 7.77 m to 34.29 m
UNIT 4, 7.77 m to 22.09 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin calcarenitic lithoclastic limestone beds occur at 15.75-.85m and 21.81-.90m. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 15.00-.34m with open weathered clayey

ELEV.	DEPTH (m)
231.56	0.00
229.25	2.31
227.97	3.62
226.51	5.05
	5.25
225.63	5.96
225.36	6.20
225.18	6.45
224.87	6.69
	6.93
224.40	7.34
	7.50
223.79	7.65
	7.77
	7.81
	7.95
221.89	9.78







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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 2 OF 7

LOCATION: N 4931533.1 ;E 645411.3

INCLINATION: -90° AZIMUTH: ---

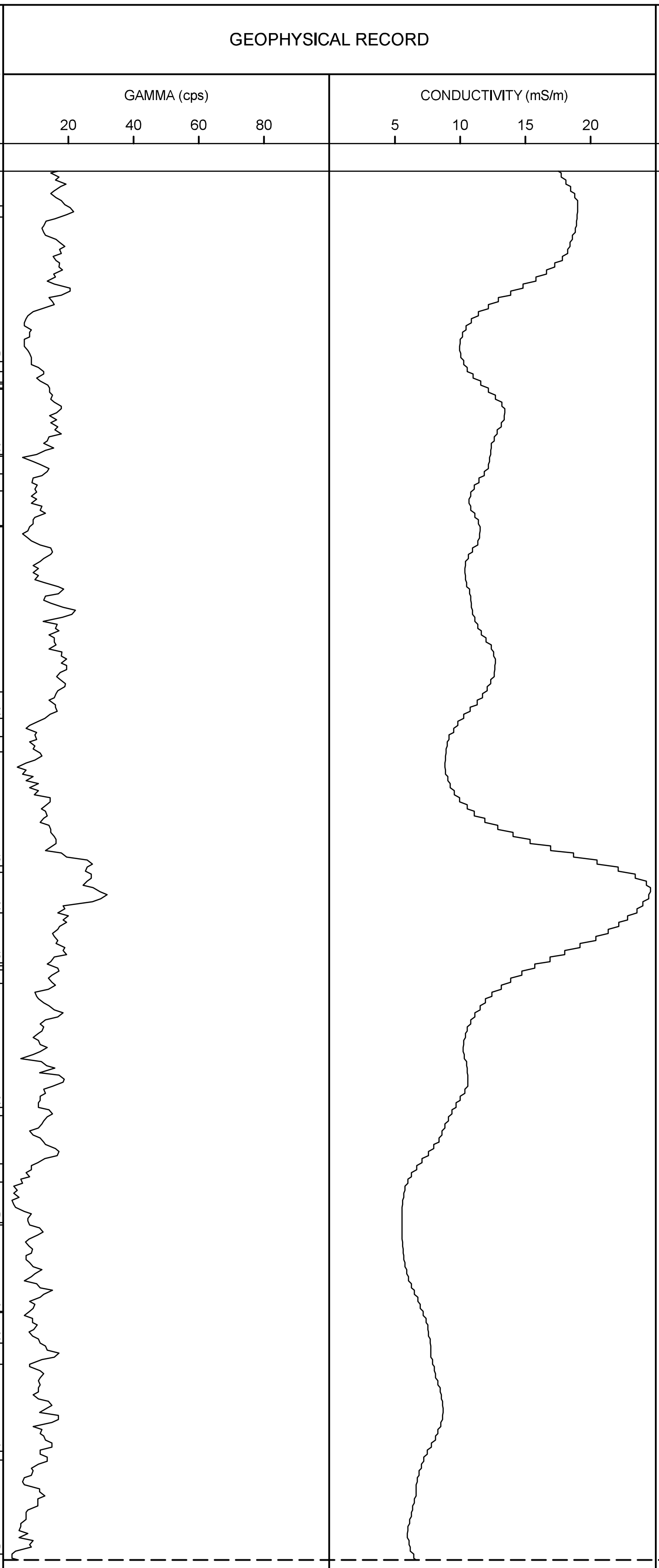
DRILLING DATE: August 8-12, 2019

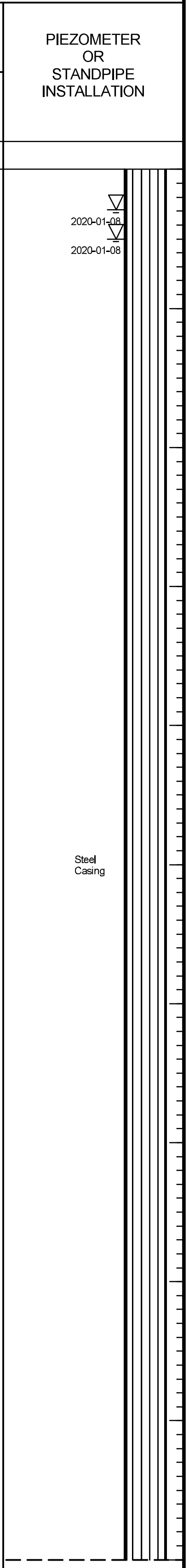
DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
10	Rotary Drill HQ Core	shale bedding parting at 15.00-.05m. Additional prominent dark grey shale partings at 9.67-.71m, 11.52-.53m, 11.56-.57m, 15.70-.72m, 17.57-.59m and 21.76-.81m (burrow casts). Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 17.28-18.45m. Argillaceous to shaley component per core run 1 to 14 percent averaging 6 percent. Gradational basal contact.		221.31 10.25 10.33
11				220.19 11.44 11.57
12				219.52 12.05 12.18 12.30 219.01 12.56
13				217.81 13.75 217.62 13.94
14				14.07 14.18
15				216.56 15.05 216.22 15.34 215.86 15.75 15.85
16				214.82 16.80
17				214.41 17.15 17.28 213.99 17.59
18				213.35 18.22 213.12 18.44 18.59
19				212.34 19.28 211.60
20		*CONTINUED NEXT PAGE*		





DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 3 OF 7

LOCATION: N 4931533.1 ;E 645411.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 8-12, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION

DEPTH SCALE METRES: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

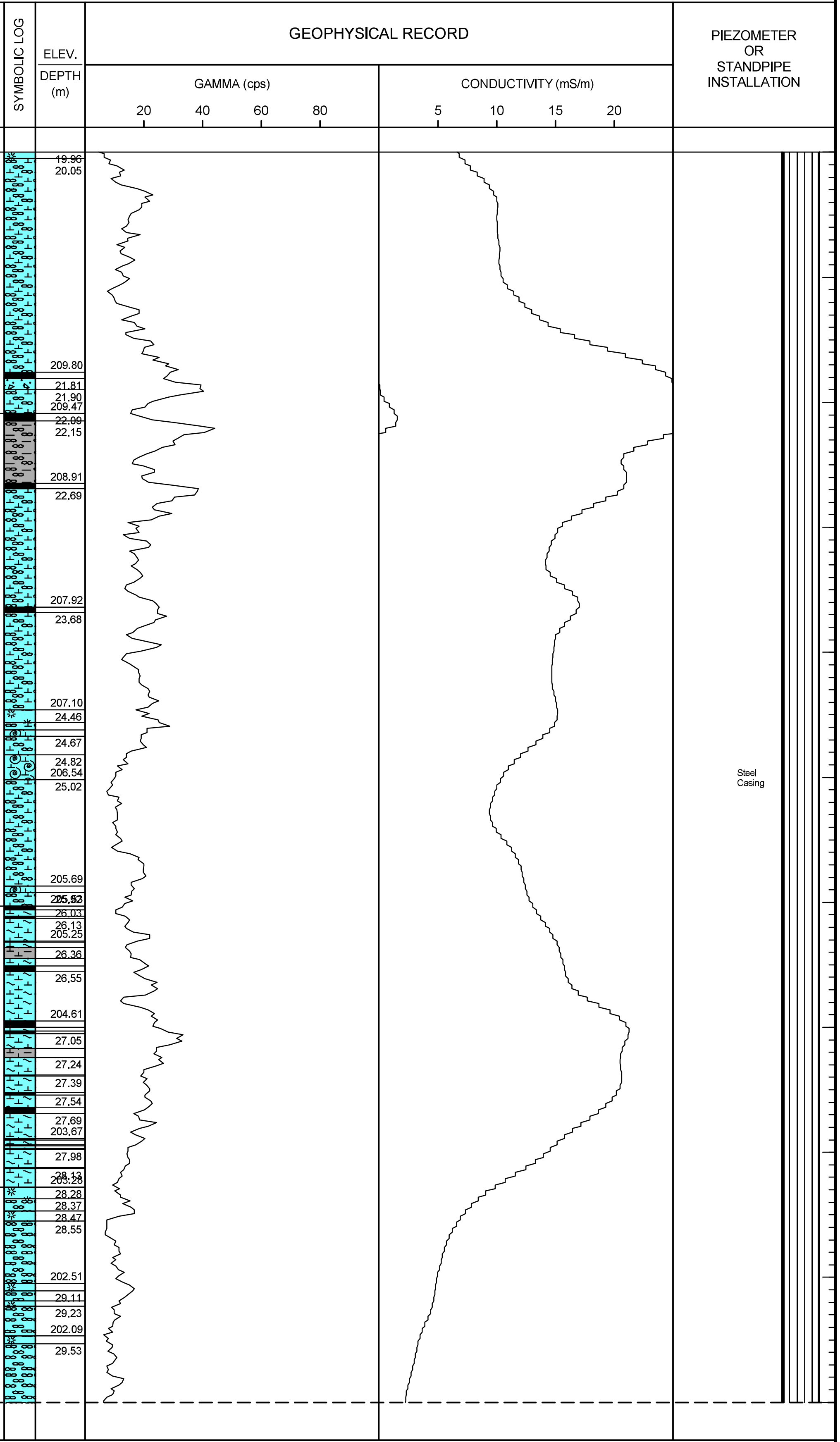
DRILLING RECORD: Rotary Drill, HQ Core

--- *CONTINUED FROM PREVIOUS PAGE* ---

UNIT 3, 22.09 m to 26.03 m Fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings at 22.09-.15m, 22.65-.69m and 23.64-.68m. Thin, medium grey gastropod fossil limestone beds at 24.62-.67m, 24.82-25.02m and 25.87-.92m and scattered pelecypod fossil shells throughout. Argillaceous to shaley component per core run 6 to 18 percent averaging 10 percent. Sharp basal contact.

UNIT 2, 26.03 m to 28.28 m Fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings, some with burrow casts and gastropod fossils. More prominent shale beds at 26.03-.06m, 26.51-.55m, 26.95-27.00m and 27.64-.69m. Argillaceous to shaley component per core run 5 to 14 percent averaging 9.5 percent (2 measurement). Sharp basal contact.

UNIT 1, 28.28 m to 34.29 m Fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Argillaceous nodular limestone at 30.63-.67m. Thin, medium grained crystalline calcarenitic limestone beds occur at 28.28-.37m, 28.47-.55m, 29.05-.11m, 29.19-.23m, 29.47-.53m, 30.67-.80m, 31.05-.19m (stylolitic) and 31.46-.51m. Argillaceous content per core run 0 to 2 percent,



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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 4 OF 7

LOCATION: N 4931533.1 ;E 645411.3

DRILLING DATE: August 8-12, 2019

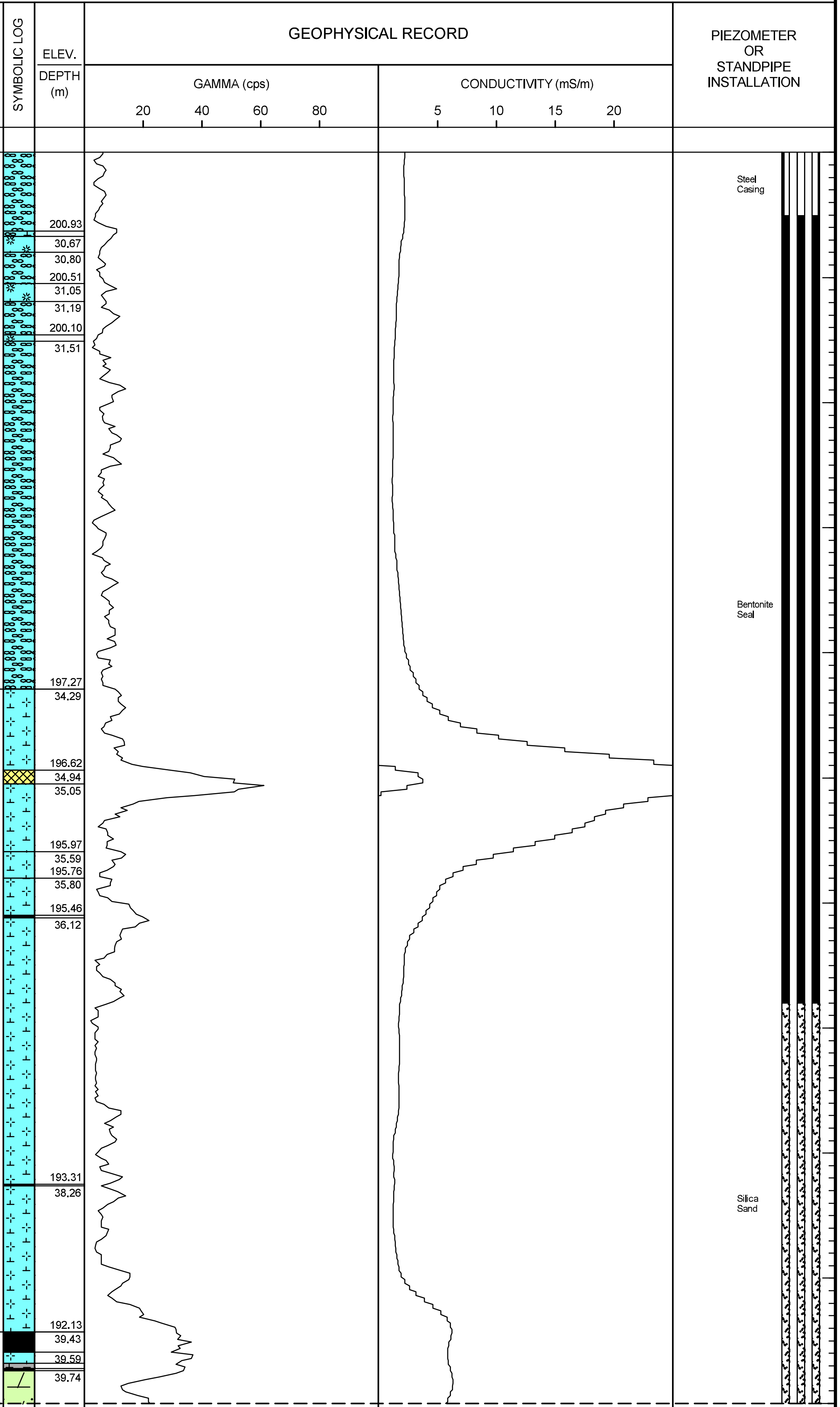
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION
		--- *CONTINUED FROM PREVIOUS PAGE* ---
30	Rotary Drill HQ Core	average 1 percent. Sharp basal contact noted by colour change from medium brownish grey micritic limestone to light creamy brown lithographic limestone across bedding parting.
34.29		**GULL RIVER FORMATION, 34.29 m to 53.20 m** **UNIT 4, 34.29 m to 39.43 m** Fresh, creamy light to medium brown, creamy white at 36.37-37.68m, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly to completely weathered, medium greenish grey, non-calcareous **CLAYEY SHALE MARKER BED** developed from shale at 34.94-35.05m. Additional intact grey shale partings at 35.59m (3-5mm), 35.80m (5mm), 36.10-.12m and 38.25-.26m. Sharp basal contact with underlying laminated shale.
39.43		**UNIT 3, 39.43 m to 43.34 m** Fresh, light greenish grey, fine to medium grained crystalline, faintly to moderately porous, saccharoidal textured, stylolitic,
40		*CONTINUED NEXT PAGE*



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 5 OF 7

LOCATION: N 4931533.1 ;E 645411.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 8-12, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Drilling record: Rotary Drill, HQ Core

medium bedded **DOLOSTONE** at 39.74-40.91m overlying light brownish grey, fine grained crystalline, saccharoidal, faintly porous, stylolitic, massive textured **DOLOSTONE** with light brown mottled dolostone bed at 41.15-.45m. Top of sequence at 39.43-.59m marked by interlaminated dark grey shale and lithographic limestone in 1-10mm layers overlying thin lithographic limestone at 39.59-.68m, limestone with fine shaley laminations at 39.68-.72m and black shale at 39.72-.74m. Sharp basal contact marked by grey shale at 43.33-.34m separating dolostone from underlying limestone. Dolostone sequence forms **The Green Bed.**

UNIT 2, 43.34 m to 48.05 m, Fresh, creamy light to medium brown, creamy white at 43.91-44.44m, very fine grained, porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Medium to thick beds of medium brown **NODULAR LITHOGRAPHIC LIMESTONE** at 43.56-.91m and 44.44-45.32m. Dark grey shale parting at 45.32-.33m. Thin, medium brown, argillaceous dolostone bed at 46.74-.84m. Very thin bed of light to medium grey, fine grained laminated shale and argillaceous limestone at 47.25-.35m. Thin basal bed of fine to medium grained lithoclastic limestone at 47.77-48.05m. Sharp basal contact on dark grey shale.

UNIT 1, 48.05 m to 53.20 m Fresh, light to medium greenish grey to brown, fine to medium grained crystalline with 0.1-0.5 mm disseminated quartz grains, faintly to moderately porous, saccharoidal textured, weakly developed stylolites, medium bedded **DOLOSTONE.** Medium brown and grey **MOTTLED DOLOSTONE** bed at 48.80-49.51m. Dark grey, interlaminated **SHALE and LIMESTONE** cap at 48.05-.13m (shale at 48.09-.13m) and additional dark grey shaley partings occur at 49.91-.93m (partially weathered shale), 50.52-.53m, 50.88-.89m, 51.55-.56m, 51.70-.71m,

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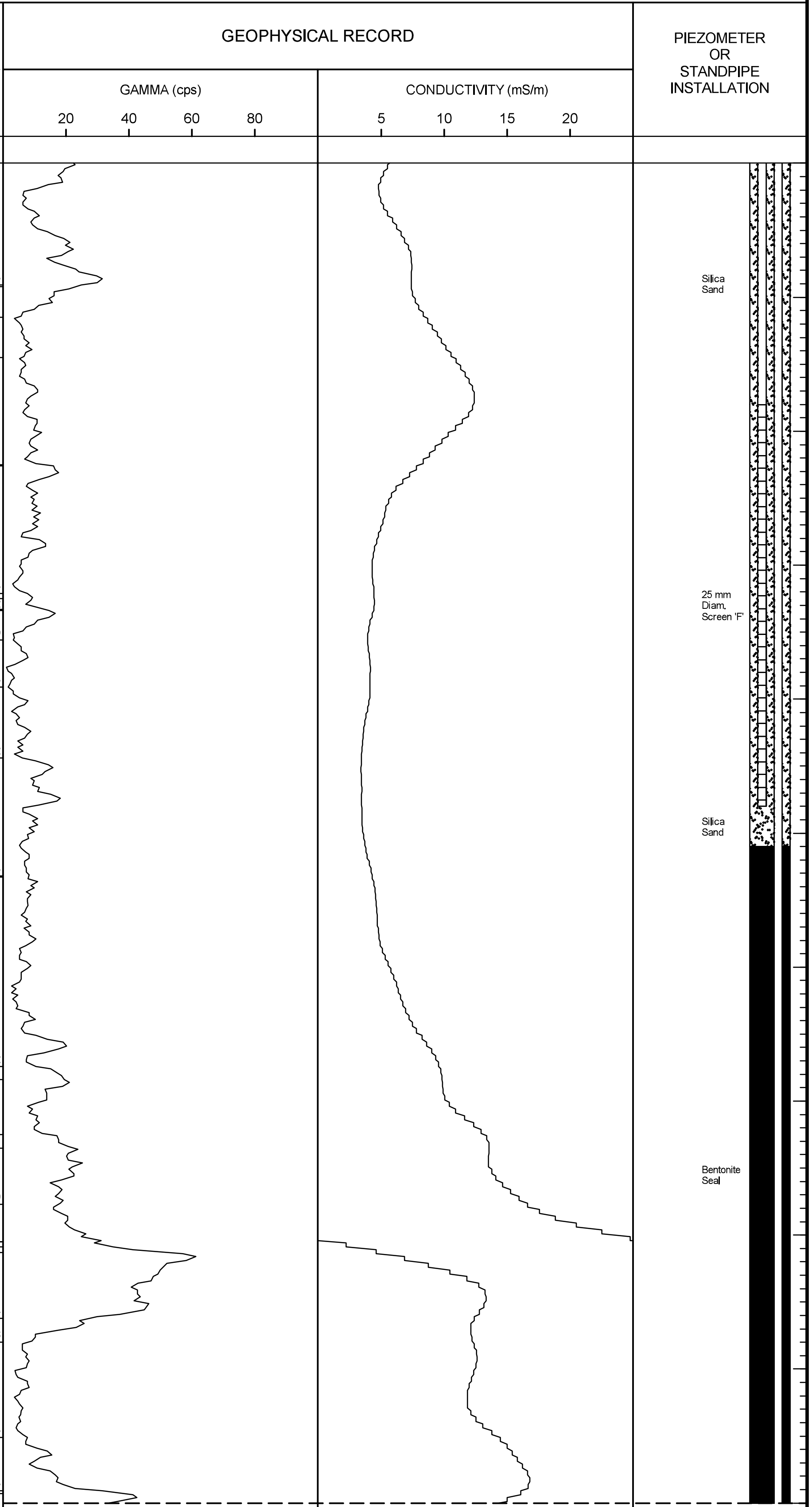
ELEV.	DEPTH (m)
190.65	40.92
190.41	41.15
190.11	41.45
189.31	42.26
188.35	43.22
188.22	43.34
188.00	43.56
187.65	43.91
187.12	44.44
186.24	45.33
184.82	46.74
	46.84
184.31	47.25
	47.35
183.79	47.77
183.51	48.05
	48.13
182.94	48.62
182.76	48.80
182.05	49.51
181.65	



DEPTH SCALE

1 : 50

GOLDER

MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 6 OF 7

LOCATION: N 4931533.1 ;E 645411.3

INCLINATION: -90°   AZIMUTH: ---

DRILLING DATE: August 8-12, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

Rotary Drill
HQ Core

52.05-.06m and 52.34-.35m. Transitional contact with underlying sandstone.

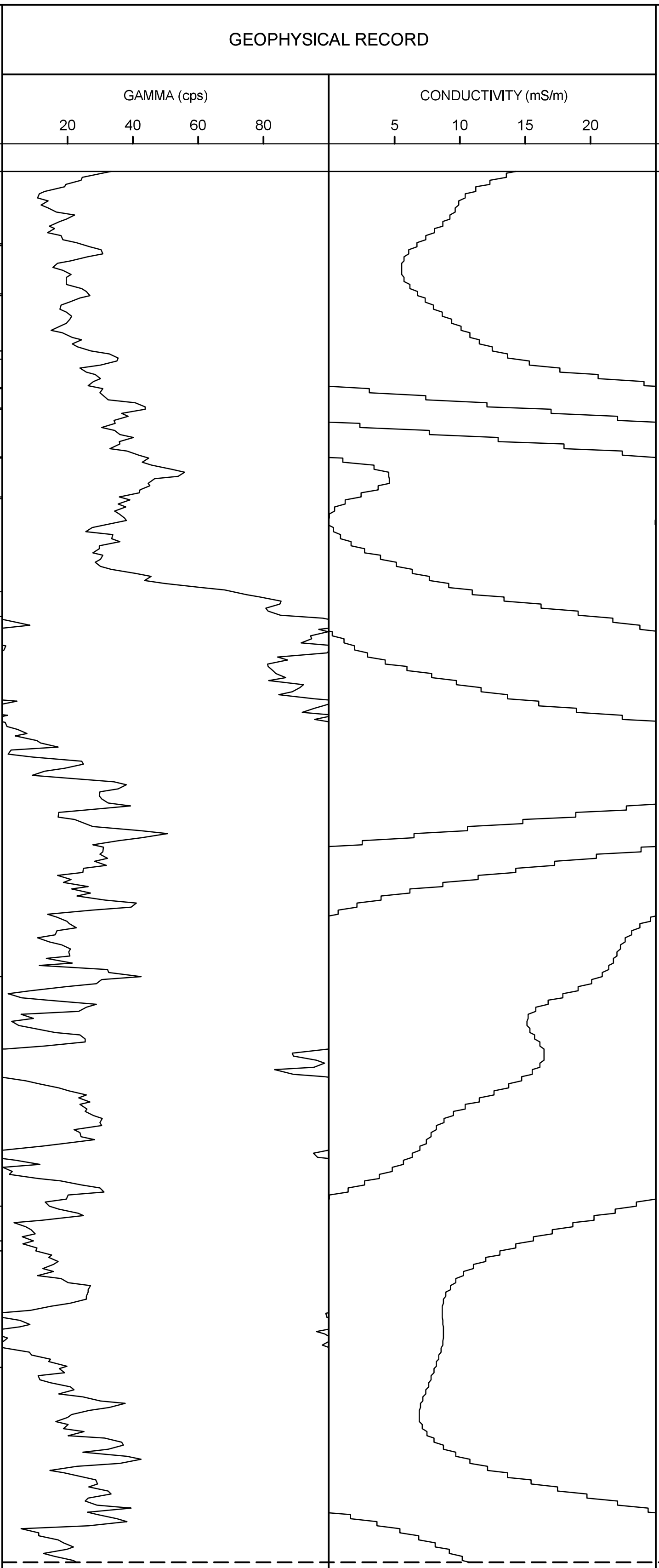
SHADOW LAKE FORMATION, 53.20 m to 60.95 m

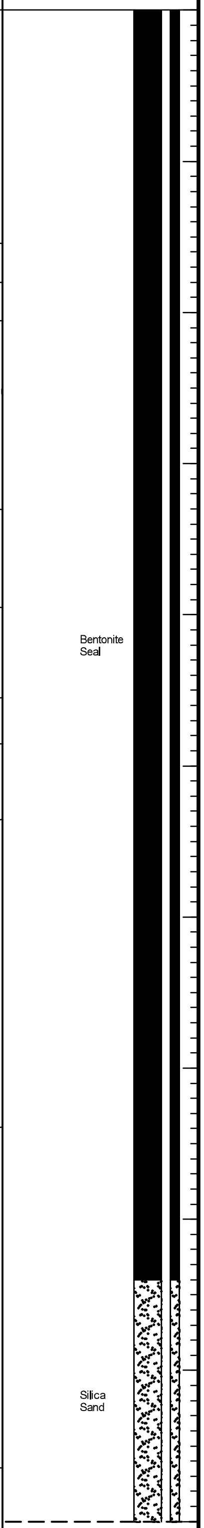
From 53.20 m to 55.79 m, Fresh to moderately weathered, light grey to light to medium greenish grey, fine to coarse grained (0.1-5mm), moderately porous, pitted, friable (chips crumble with finger pressure), thickly bedded **SANDSTONE** comprised of quartz grains in sericitic matrix.

From 55.79 m to 58.60 m, Fresh to faintly weathered, medium greenish grey to dark green, fine grained, moderately porous, slake susceptible **GREEN SHALE** with interbeds of green sandy shale laminations transitional to dark reddish brown, fine grained, slake susceptible **RED SHALE** with dark green sandy shale at 57.69-.76m. Transitional basal contact.

From 58.60 m to 60.95 m, Faintly to moderately weathered, friable, greenish grey to dark reddish brown, fine to coarse grained, moderately porous, medium to thickly bedded **ARKOSIC SANDSTONE** with scattered pebbles comprised of angular 5-15mm feldspar crystals. Basal contact with highly weathered reddish brown disaggregating gneiss at 60.92-.95m angled 35 degrees TCA.

ELEV.	DEPTH (m)
	49.93
181.04	50.53
180.68	50.89
180.27	51.35
180.01	51.56
	51.71
179.51	52.06
179.22	52.35
178.54	53.02
178.36	53.20
175.77	55.79
174.12	57.44
173.87	57.76
172.96	58.60





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DEPTH SCALE
1 : 50

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-1

SHEET 7 OF 7

LOCATION: N 4931533.1 ;E 645411.3

INCLINATION: -90° AZIMUTH: ---

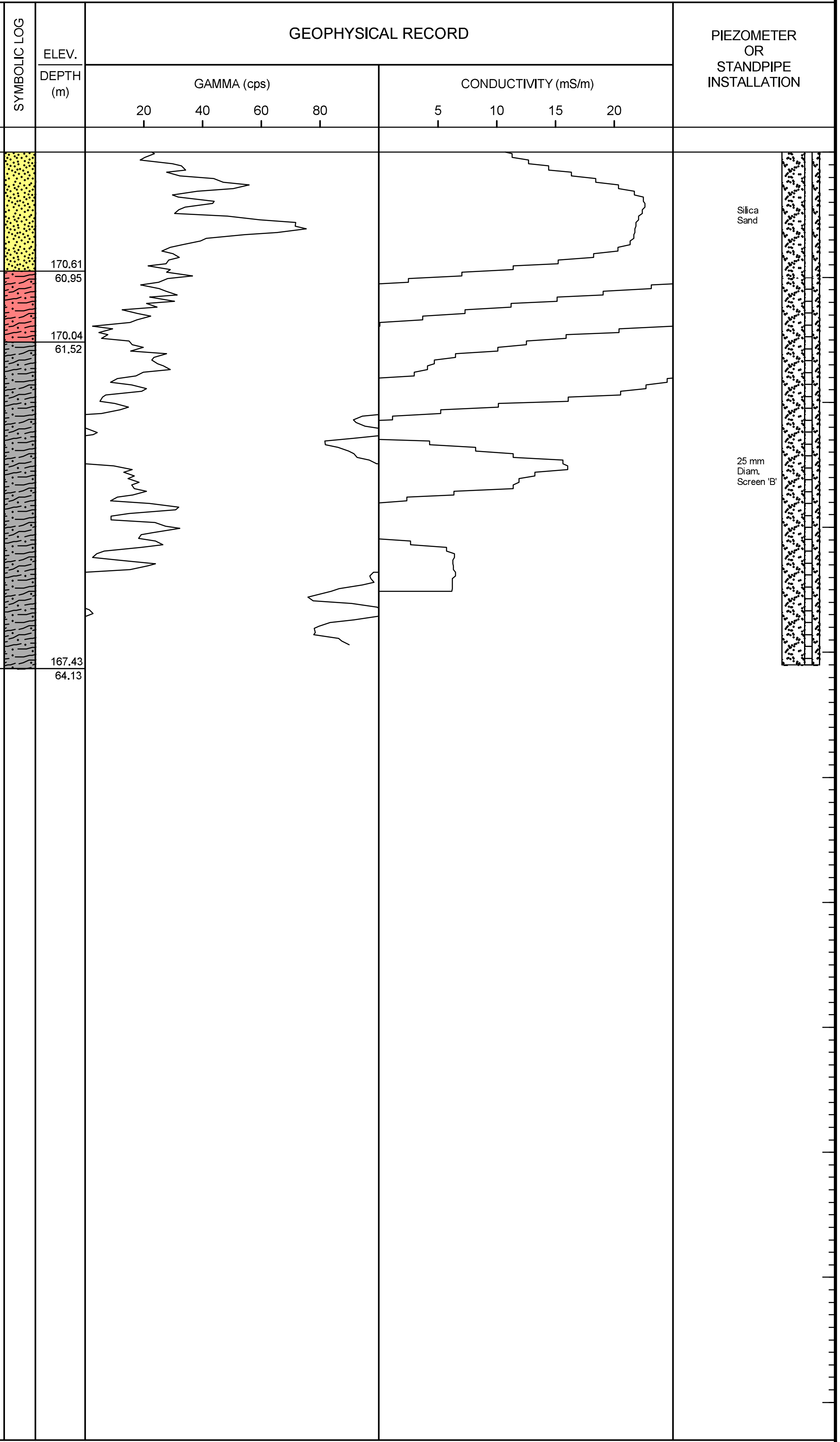
DRILLING DATE: August 8-12, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION
		--- CONTINUED FROM PREVIOUS PAGE ---
60	Rotary Drill HQ Core	
61		**PRECAMBRIAN BASEMENT, 60.95 m to 64.13 m** Moderately weathered reddish brown (60.95-61.52m) overlying faintly weathered to fresh, pinkish grey to grey, medium grained **QUARTZ FELDSPAR GNEISS** with minor micaceous bands, coarse grained pink feldspar porphyroblasts and gneissosity at 35 degrees TCA.
62		
63		
64		**End of Borehole, 64.13 m**
65		
66		
67		
68		
69		
70		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 1 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD: Rotary Drill, HQ Core | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m)

GROUND SURFACE

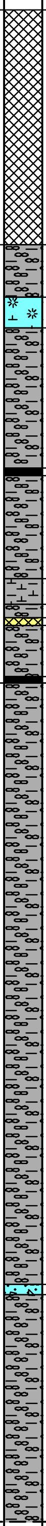
OVERBURDEN, 0.0 m to 1.55 m

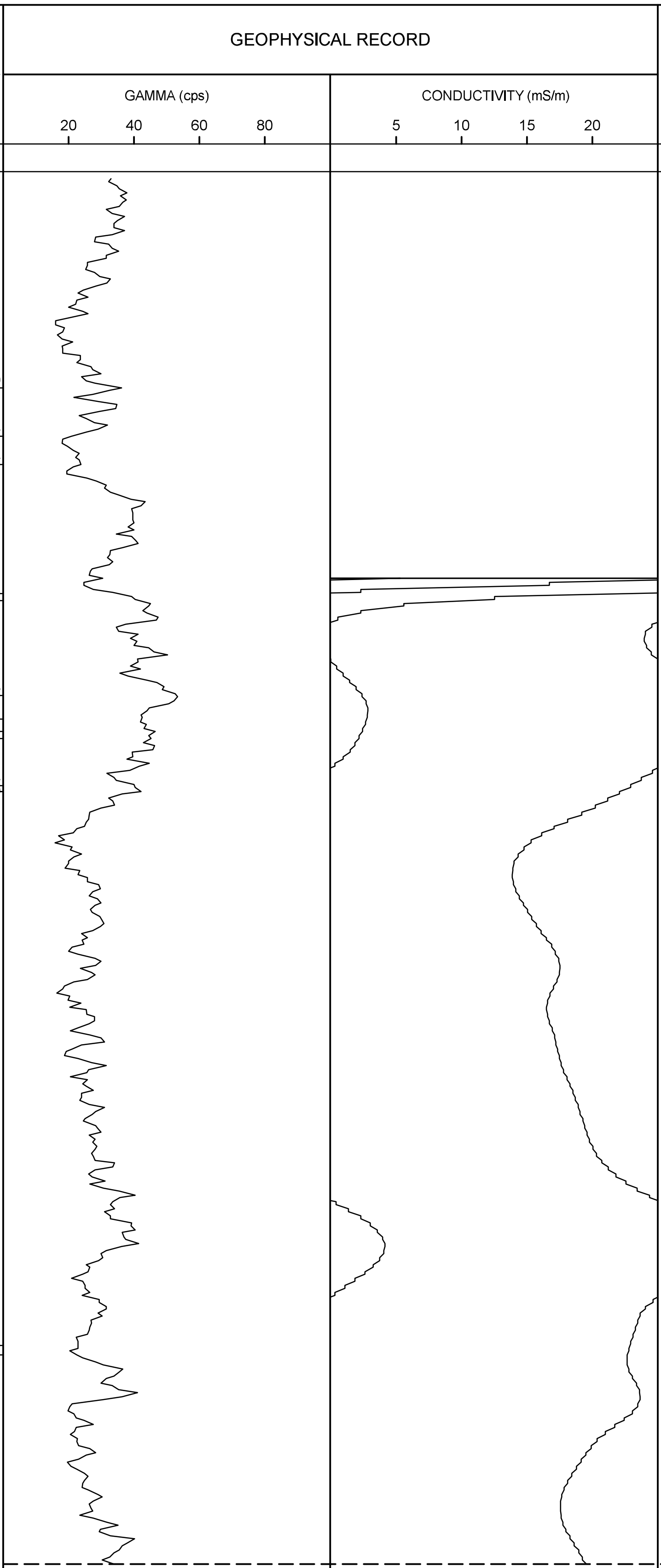
VERULAM FORMATION, 1.55 m to 14.47 m

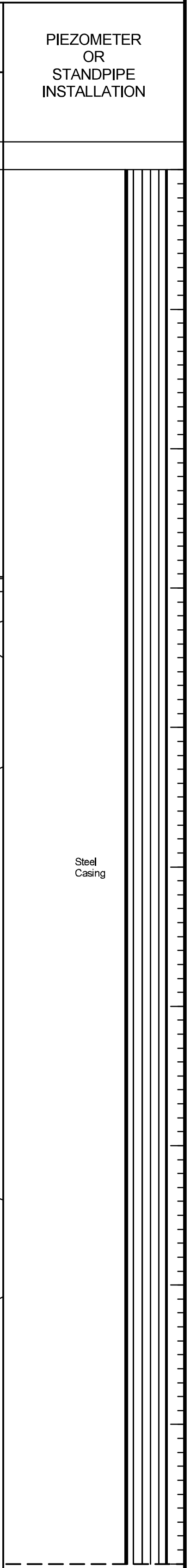
UNIT 2, 1.55 m to 4.45 m, Moderately weathered on shaley bedding partings from 1.55 m to 1.90 m, fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and medium grey **SHALE.** More prominent shale beds occur at 3.03-.08m, 3.76-.97m (shale and shaley limestone) and 4.41-.45m.Shaley component tends to slake. Measured shale content on per core run basis comprises approximately 30-35 percent. Medium grained crystalline calcarenite bed at 1.90-2.10m. Transitional basal contact.

UNIT 1, 4.45 m to 14.47 m, Fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Medium grained crystalline calcarenite beds at 11.65-.80m and 13.84-14.02m. Lithoclastic calcarenite with shaley clasts at 8.43-.50m. Measured shale content on per core run basis comprises approximately 9 to 15 percent. Transitional basal contact noted by decrease in shaley content between 14.20m and 14.47m.

238.84	0.00
237.29	1.55
236.94	1.90
236.74	2.10
235.81	3.08
235.08	3.76
	3.93
	4.07
234.43	
234.39	4.45
230.41	8.50







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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 2 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

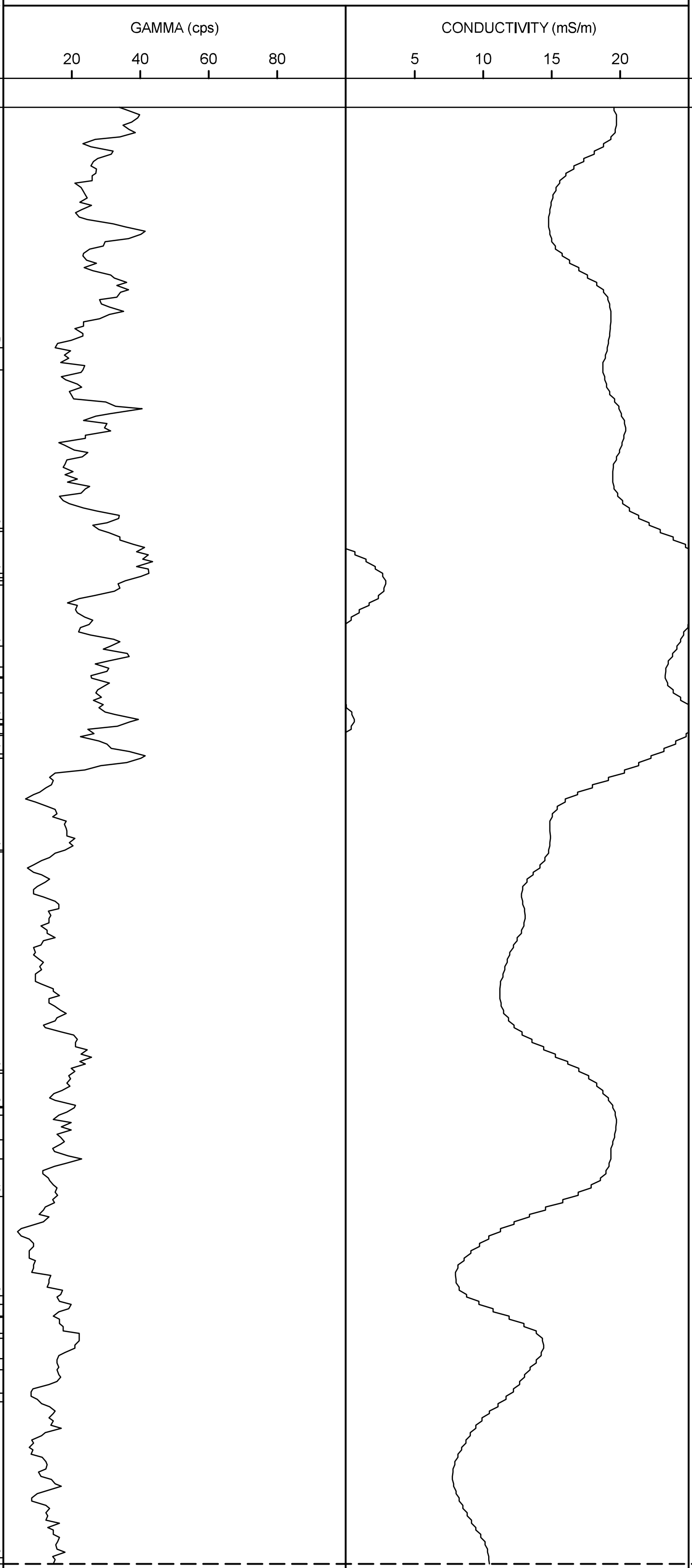
Drilling record: Rotary Drill, HQ Core

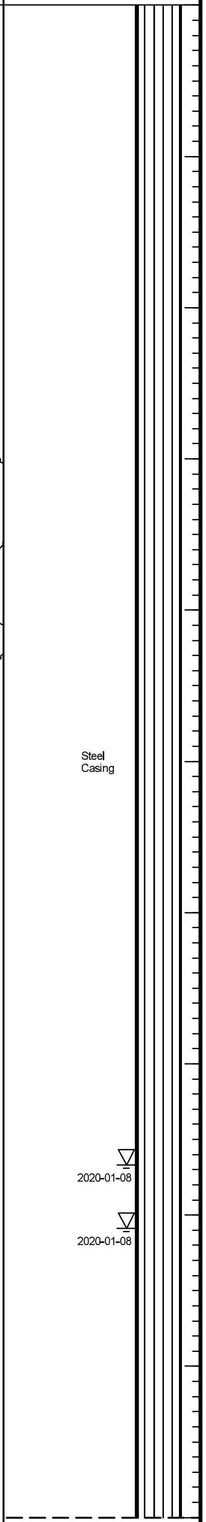
UNIT 1, 4.45 m to 14.47 m, Fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Medium grained crystalline calcarenite beds at 11.65-.80m and 13.84-14.02m. Lithoclastic calcarenite with shaley clasts at 8.43-.50m. Measured shale content on per core run basis comprises approximately 9 to 15 percent. Transitional basal contact noted by decrease in shaley content between 14.20m and 14.47m.

BOBCAYGEON FORMATION, 14.47 m to 40.87 m

UNIT 4, 14.47 m to 29.34 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin calcarenitic lithoclastic limestone bed occurs at 18.83-.89m. Interbeds of **SHALEY NODULAR CALCARENITIC LIMESTONE** occur at 18.30-.45m and 21.88-22.20m with open weathered clayey shale bedding parting at 21.88-.92m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 24.30-25.07m. Additional prominent shale partings at 22.20-.25m and 27.21-.24m. Argillaceous to shaley component per core run 2 to 11 percent averaging 4.3 percent. Gradational basal contact.

Elev. / Depth (m):
227.19
11.65
11.80
225.95
12.91
225.64
13.28
225.14
13.70
13.92
14.02
224.64
14.31
224.37
14.47
223.74
15.11
222.23
16.63
221.98
16.92
17.09
17.22
221.36
17.48
220.68
18.22
18.31
18.45
18.59
18.67
18.89
218.88





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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 3 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

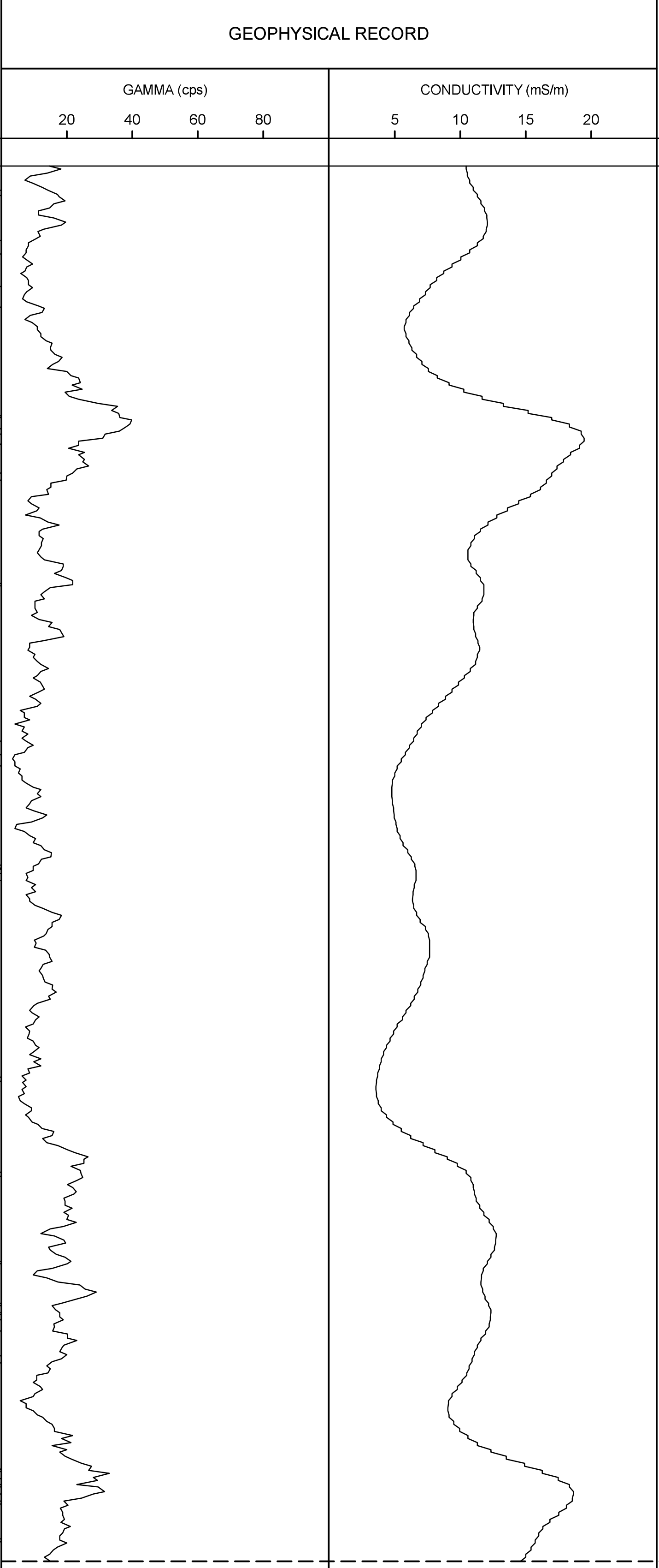
Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Drilling record: Rotary Drill — HQ Core

BOBCAYGEON FORMATION, 14.47 m to 40.87 m
UNIT 4, 14.47 m to 29.34 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin calcarenitic lithoclastic limestone bed occurs at 18.83-.89m. Interbeds of **SHALEY NODULAR CALCARENITIC LIMESTONE** occur at 18.30-.45m and 21.88-22.20m with open weathered clayey shale bedding parting at 21.88-.92m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 24.30-25.07m. Additional prominent shale partings at 22.20-.25m and 27.21-.24m. Argillaceous to shaley component per core run 2 to 11 percent averaging 4.3 percent. Gradational basal contact.

UNIT 3, 29.34 m to 32.94 m Fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with

ELEV. / DEPTH (m):
20.00
20.21
218.31
20.53
20.63
217.98
20.86
21.01
217.05
21.80
21.99
216.64
22.25
215.85
23.01
214.72
24.12
24.22
24.30
213.83
25.12
212.31
26.56
211.63
27.24
210.99
27.87
210.69
28.27
28.35
210.31
28.58
209.50
29.34
29.59
209.00
29.86



Steel Casing

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

GEOPHYSICAL LOG OF: BH-2

PROJECT: 19122839

SHEET 4 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD	PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

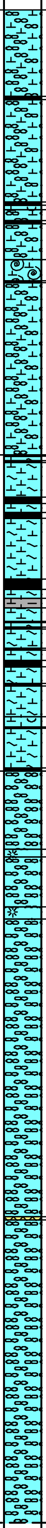
Depth scale (metres): 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

Drilling record: Rotary Drill, HQ Core

thin dark grey **SHALE** partings at 29.34-.36m, 29.41-.45m, 29.57-.59m,29.84-.86m, 30.57-.59m, 31.32-.33m and 31.39-.41m. Thin, medium grey gastropod fossil limestone bed at 31.65-.79m and scattered pelecypod fossil shells throughout. Argillaceous to shaley component per core run 3 to 8 percent averaging 5.7 percent. Sharp basal contact.

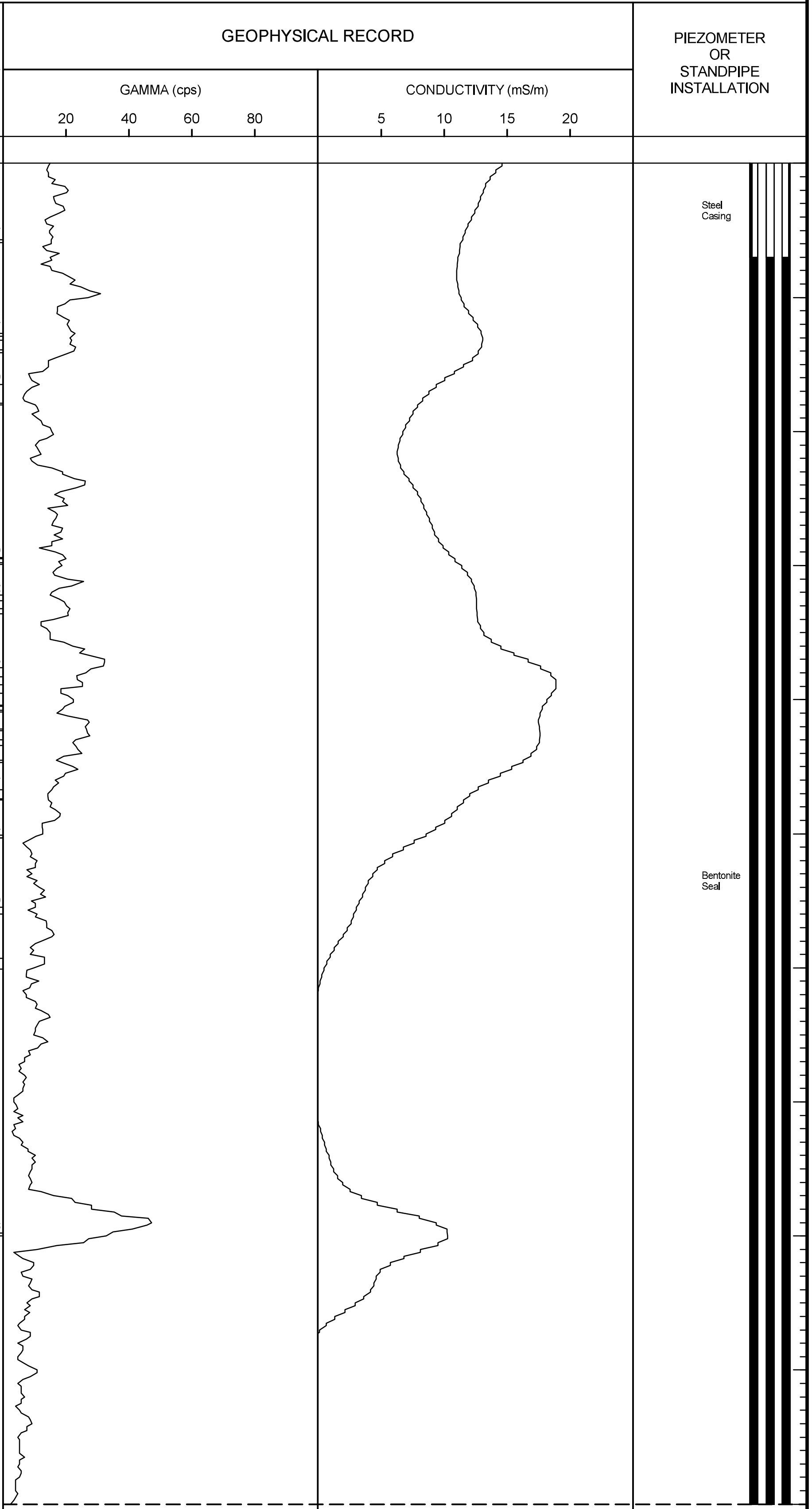
UNIT 2, 32.94 m to 35.03 m Fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings, some with burrow casts and gastropod fossils. Bioclastic limestone bed with pelecypod shells at 34.67-.74m. More prominent shale bed at 33.76-.87m. Argillaceous to shaley component 13 percent (1 measurement). Sharp basal contact.

UNIT 1, 35.03 m to 40.87 m Fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Thin, medium grained crystalline calcarenitic limestone beds occur at 35.55-.60m and 35.93-36.01m. Argillaceous content per core run 0 to 1 percent, average 0.8 percent. Open, weathered shaley parting at 37.98-38.00m. Sharp basal contact noted by colour change from medium brownish grey micritic limestone to light creamy brown lithographic limestone across bedding parting.



ELEV. / DEPTH (m):

208.27
30.59
207.57
31.41
207.19
31.65
31.80
205.90
32.94
32.99
205.62
33.36
205.08
33.95
34.09
34.34
34.47
204.17
34.75
203.83
203.81
35.03
203.29
35.60
202.91
35.93
36.01
200.86
38.00



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OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 5 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
40–50	Rotary Drill HQ Core	*--- CONTINUED FROM PREVIOUS PAGE ---*		

GULL RIVER FORMATION, 40.87 m to 59.76 m

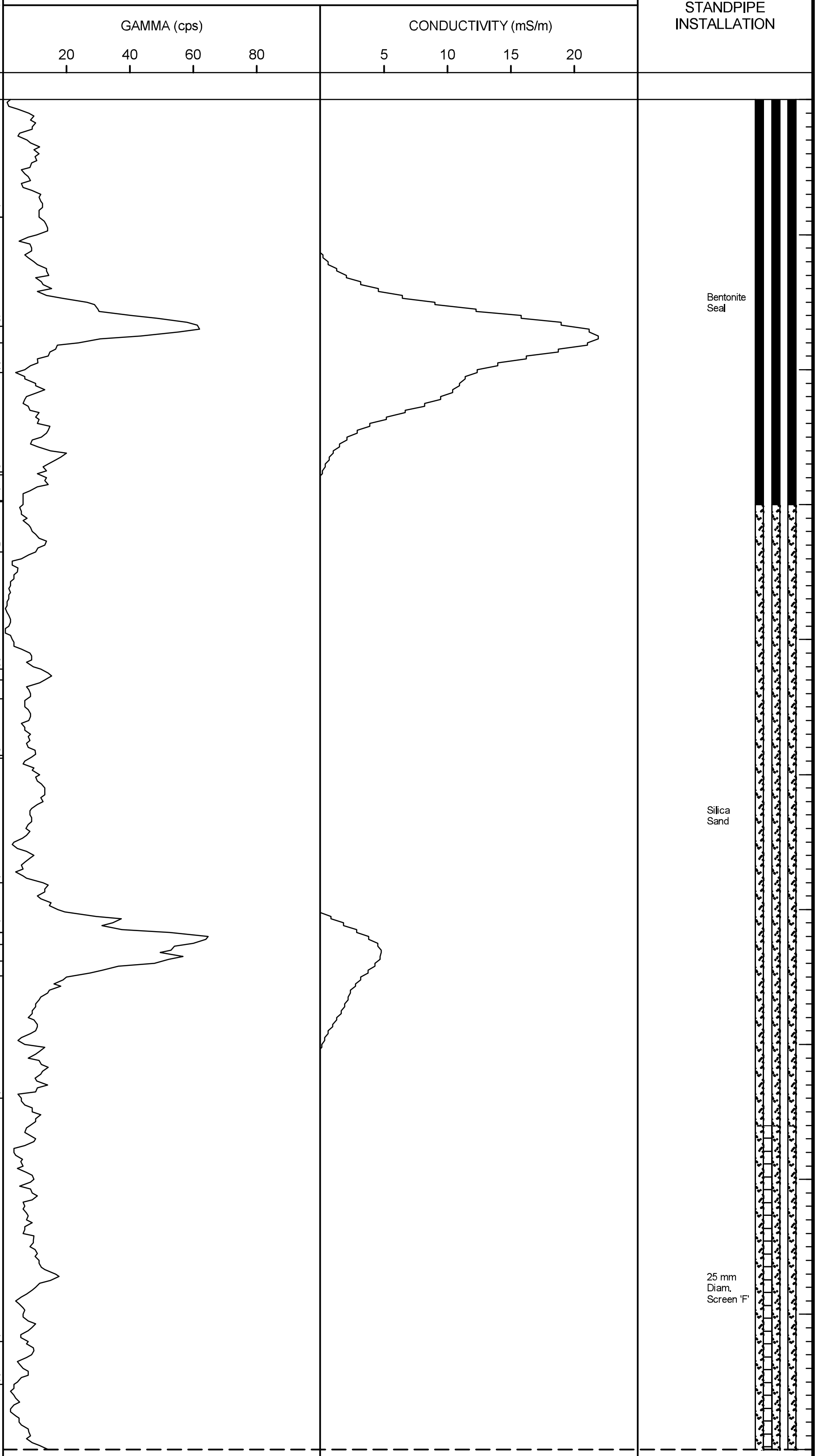
UNIT 4, 40.87 m to 46.17 m Fresh, creamy light to medium brown, creamy white at 42.98-44.22m, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly to completely weathered, medium grey, non-calcareous **CLAYEY SHALE MARKER BED** developed from shale at 41.68-.80m with shinny listric surfaces on weathered shale chips. Additional intact grey shale partings at 42.22m 93-5mm), 42.76-.78m, 42.97-.98m and 44.30-.31m. Open weathered argillaceous parting at 44.87-.88m. Top contact marked by vertical burrow casts 3-5mm dia penetrating 0.10 into lithographic limestone. Sharp basal contact with underlying laminated shale.

UNIT 3, 46.17 m to 50.07 m Fresh, medium grey to greenish grey, fine to medium grained crystalline, faintly to moderately porous, saccharoidal textured, stylolitic, medium bedded **DOLOSTONE** at 46.38-47.40m overlying light brownish grey, fine grained saccharoidal, faintly to moderately porous, stylolitic, massive textured, medium to thickly bedded **DOLOSTONE**. Top of sequence at 46.17-.26m marked by interlaminated dark grey shale and lithographic limestone in 1-10mm layers overlying black shale at 46.26-.38m with weathered shale at 46.37-.38m. Well developed stylolites at 49.20m and 49.52m. Sharp basal contact marked by grey shale at 50.07-.09m separating dolostone from limestone. Dolostone sequence forms **The Green Bed.**

ELEV.	DEPTH (m)
197.97	40.87
197.16	41.68
	41.80
196.82	42.02
196.08	42.78
195.87	42.98
195.49	43.35
194.62	44.22
	44.30
	44.44
193.98	44.88
193.04	45.80
192.67	46.17
	46.26
	46.38
	46.49
191.44	47.40
189.64	49.20
189.32	

GEOPHYSICAL RECORD

PIEZOMETER OR STANDPIPE INSTALLATION



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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 6 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

Rotary Drill

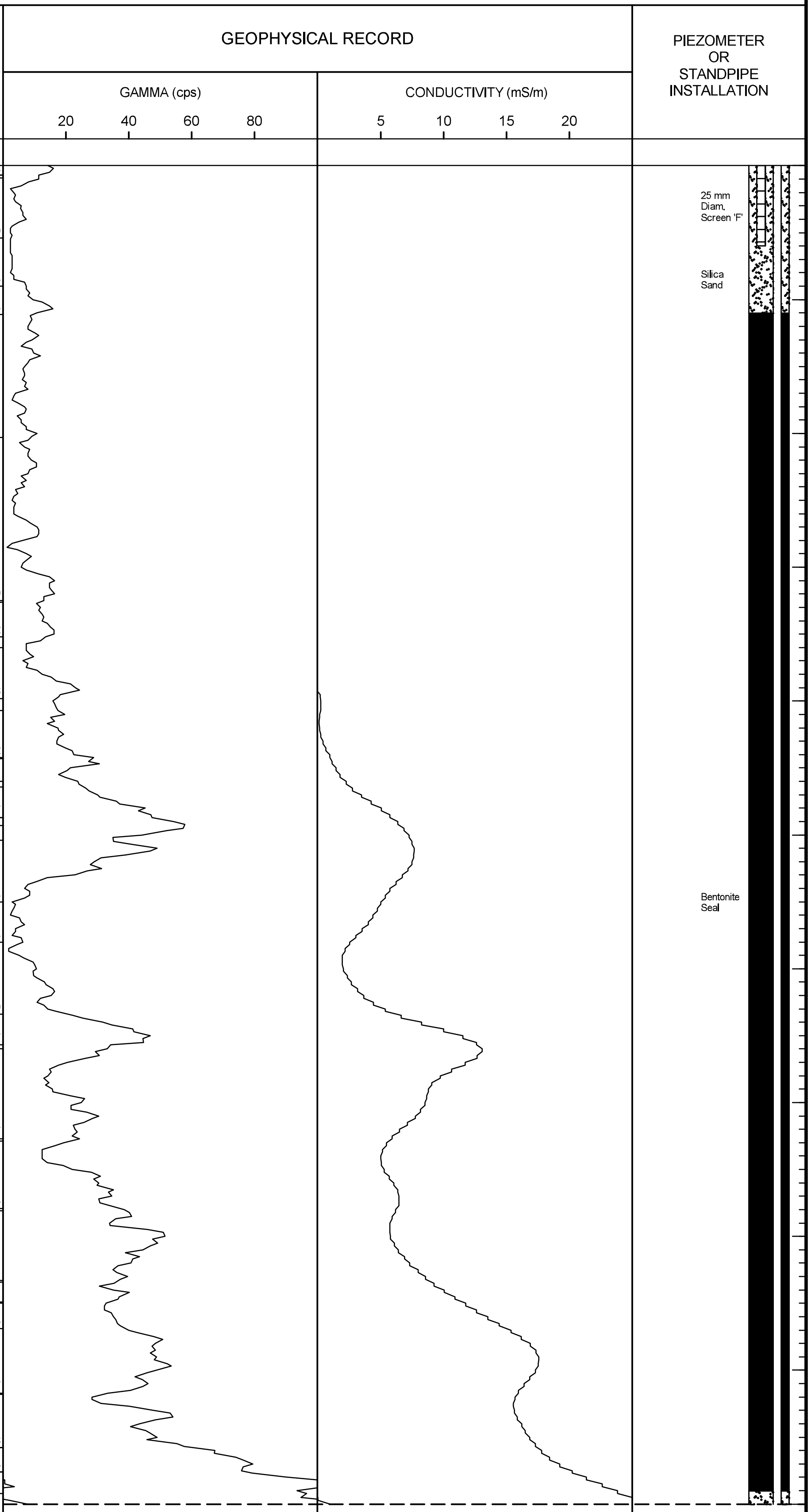
HQ Core

UNIT 2, 50.07 m to 54.87 m, Fresh, creamy light to medium brown, creamy white at 50.54-.90m, very fine grained, porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Thick bed of medium brown **NODULAR LITHOGRAPHIC LIMESTONE** at 50.09-.54m and grey shale parting at 50.07-.09m. Thin, medium grey, argillaceous calcareous dolostone beds at 53.52-.60m and 53.98-54.07m overlying lithographic limestone with very thin beds of light to medium grey, fine grained argillaceous limestone at 54.42-.43m and 54.60-.64m. Sharp basal contact on dark grey shale.

UNIT 1, 54.87 m to 59.76 m Fresh, light to medium greenish grey to brown, fine to medium grained crystalline with 0.1-0.5 mm disseminated quartz grains, faintly to moderately porous, saccharoidal textured, weakly developed stylolites, medium bedded **DOLOSTONE.** Light brownish grey, saccharoidal, thickly bedded **CALCAREOUS DOLOSTONE** interbed at 55.50-56.34m with porous 1-10mm pits at 55.50-.80m. Dark grey, interlaminated **SHALE and LIMESTONE** cap at 54.87-.93m and completely weathered shale comprised of medium greenish grey, faintly calcareous clayey silt soil with fine dolostone fragments at 56.57-.60m overlying medium brown dolostone at 56.60-.77m with sharp stylolite lower contact. Additional shaley partings occur at 57.27-.29m, 57.79-.81m (weathered shale), 58.33-.34m, 58.49-.50m, 59.17-.18m and 59.56-.58m. Transitional contact with underlying sandstone.

SHADOW LAKE FORMATION, 59.76 m to 67.87 m

ELEV.	DEPTH (m)
188.77	50.07
	50.09
188.30	50.54
187.94	50.90
187.73	51.11
186.81	52.03
185.59	53.26
185.32	53.52
	53.60
184.86	53.98
	54.07
184.42	54.43
	54.64
183.97	54.87
	54.93
	55.04
183.34	55.50
183.04	55.80
182.50	56.34
182.27	56.60
181.57	57.29
181.05	57.81
180.51	58.34
	58.50
180.15	58.69
179.67	59.18
179.26	59.58
179.08	59.76



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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 7 OF 8

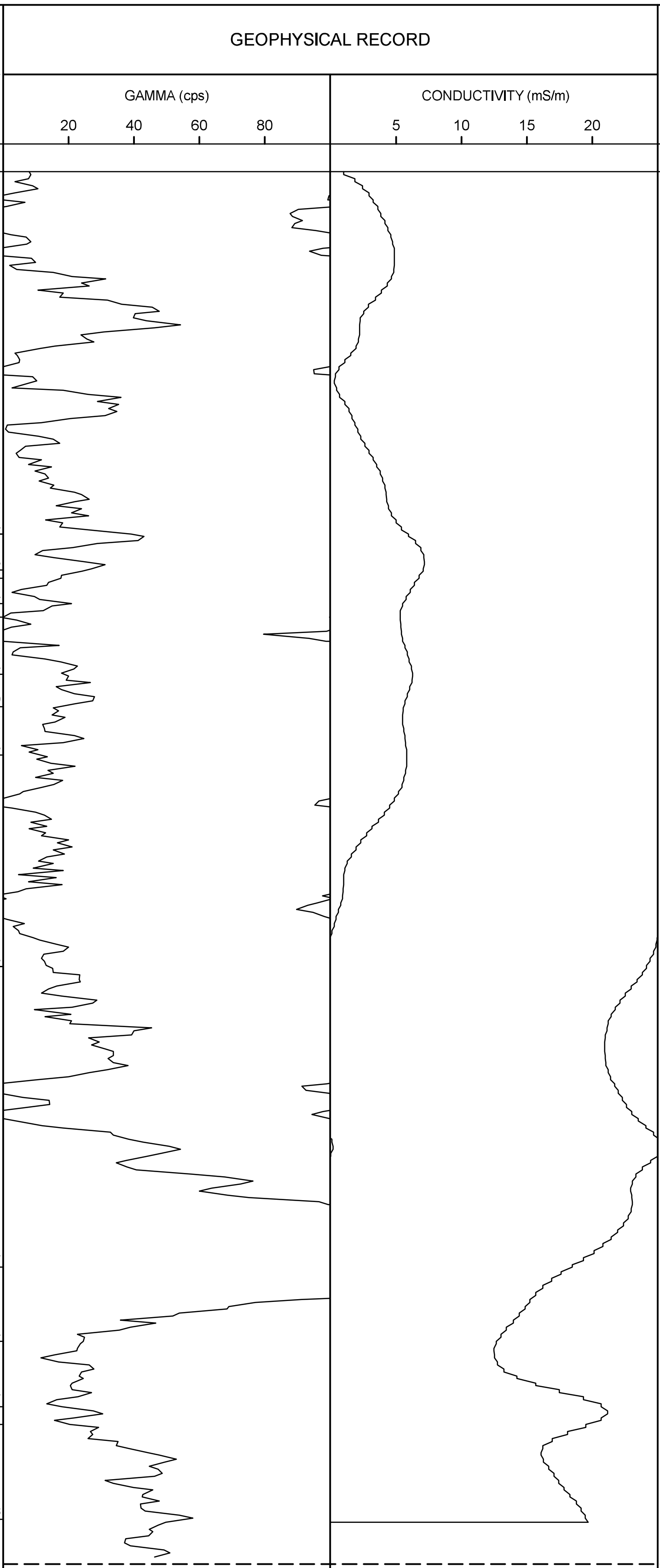
LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

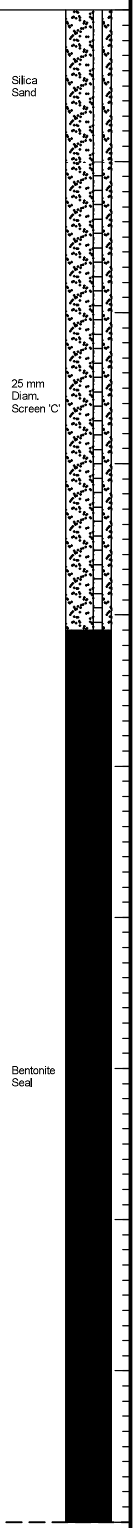
DRILLING DATE: August 13-21, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---	
60	Rotary Drill HQ Core	**From 59.76 m to 62.60 m,** Fresh to moderately weathered, light grey to light to medium greenish grey, fine grained (0.1-2.0mm), moderately porous, friable (chips crumble with finger pressure), thickly bedded **SANDSTONE** comprised of quartz grains in sericitic matrix.	59.92
61			
62			
		From 62.60 m to 65.71 m, Fresh to faintly weathered, medium greenish grey to dark green, fine grained, moderately porous, thinly to medium bedded **SANDSTONE** comprised of quartz grains in a sericitic matrix with thin interbeds of slake susceptible **GREEN SHALE** transitional to dark reddish brown, fine grained, slake susceptible **RED SHALE** with dispersed sand grains and sandstone laminations. Transitional basal contact.	176.24 62.60 175.98 62.92 175.74 63.10 63.20 175.23 63.61 175.00 63.84 174.65 64.19
63			
64			
65			
		From 65.71 m to 67.87 m, Faintly to moderately weathered, friable, greenish grey to dark reddish brown, fine to coarse grained, moderately porous, medium to thickly bedded **ARKOSIC SANDSTONE** with scattered pebbles comprised of angular 5-15mm feldspar crystals. Basal contact with moderately weathered reddish brown gneiss at angle of 25 degrees TCA.	173.13 65.71
66			
67			
		PRECAMBRIAN BASEMENT, 67.87 m to 70.31 m Moderately weathered reddish brown (67.87-68.40m, 69.00-.68m and 70.25-.30m), faintly weathered pinkish grey (68.40-.87m and 69.68-70.25m) with dark green, highly weathered friable gneiss at 68.87-69.00m, medium grained **QUARTZ FELDSPAR GNEISS** with minor biotite and gneissosity at 45 degrees TCA.	170.97 67.87 170.44 68.40 169.97 68.87 69.00 169.16 69.68
68			
69			
70			
		CONTINUED NEXT PAGE	



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-2

SHEET 8 OF 8

LOCATION: N 4930985.7 ;E 645918.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 13-21, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD CONDUCTIVITY (mS/m) 5 10 15 20	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---					
70			▨	168.59 168.53 70.31			Bentonite Seal ■
		End of Borehole, 70.31 m					
71							
72							
73							
74							
75							
76							
77							
78							
79							
80							

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 1 OF 8

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 22-26, 2019

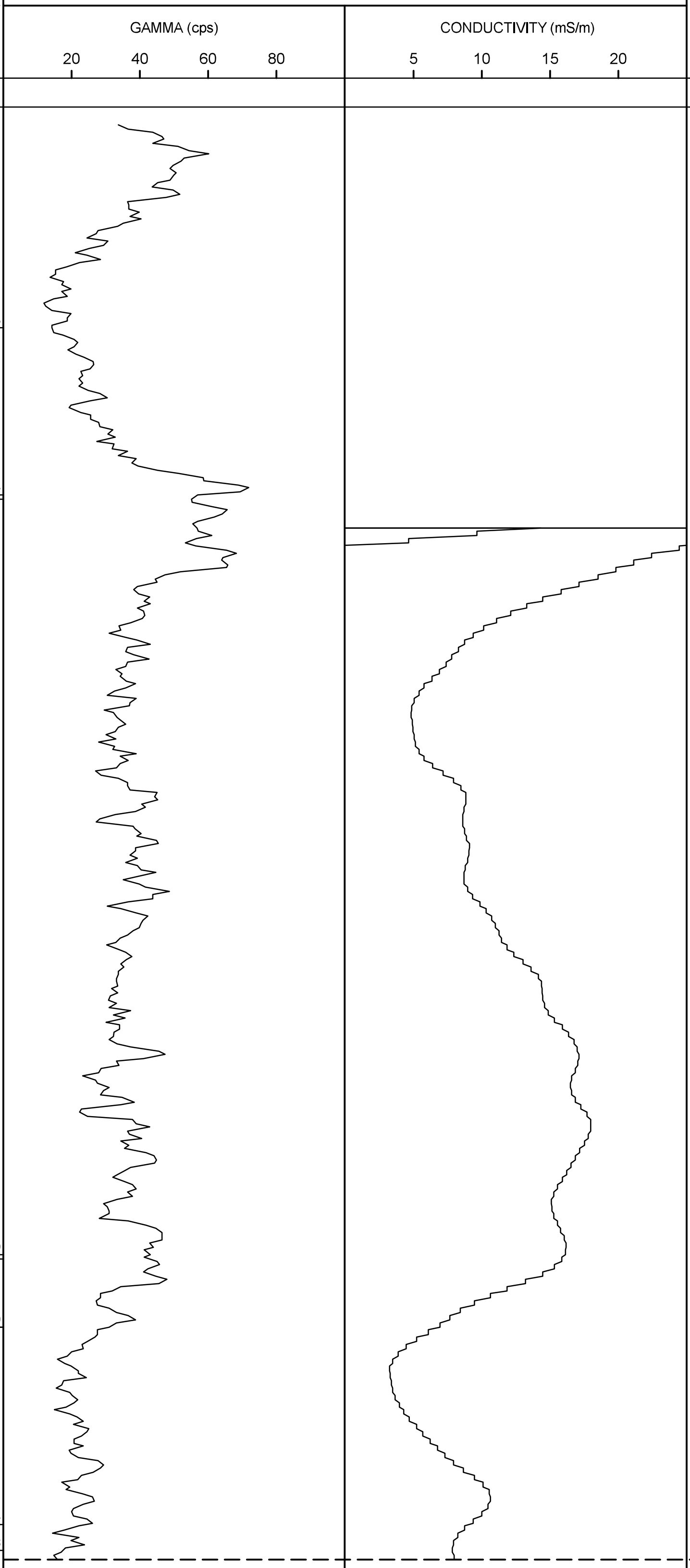
DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		236.70
0	Rotary Drill HQ Core	**OVERBURDEN, 0.0 m to 1.52 m**		0.00
1.52		**VERULAM FORMATION, 1.52 m to 18.07 m** **UNIT 2, 1.52 m to 8.40 m,** Highly weathered on shaley bedding partings from 1.52 m to 2.00 m, fresh, moderately weathered to 3.20 m, faintly to moderately weathered to 4.00 m, becoming fresh at 4.00 m, medium brownish grey, fine grained crystalline, non-porous very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and medium grey **SHALE.** Shaley component tends to slake. Measured shale content on per core run basis comprises approximately 24 to 39 percent averaging 30 percent. Open weathered shaley bedding partings at 2.67-.70m and 7.90-.93m. Transitional basal contact.		235.18 1.52
				234.03 2.70
				228.80 7.93
8.40				228.30 8.40
				226.94 9.76 226.76
10		*CONTINUED NEXT PAGE*		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION

Steel Casing

DEPTH SCALE

1 : 50

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 2 OF 8

LOCATION: N 4930189.3 ;E 645585.6

DRILLING DATE: August 22-26, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION

--- CONTINUED FROM PREVIOUS PAGE ---

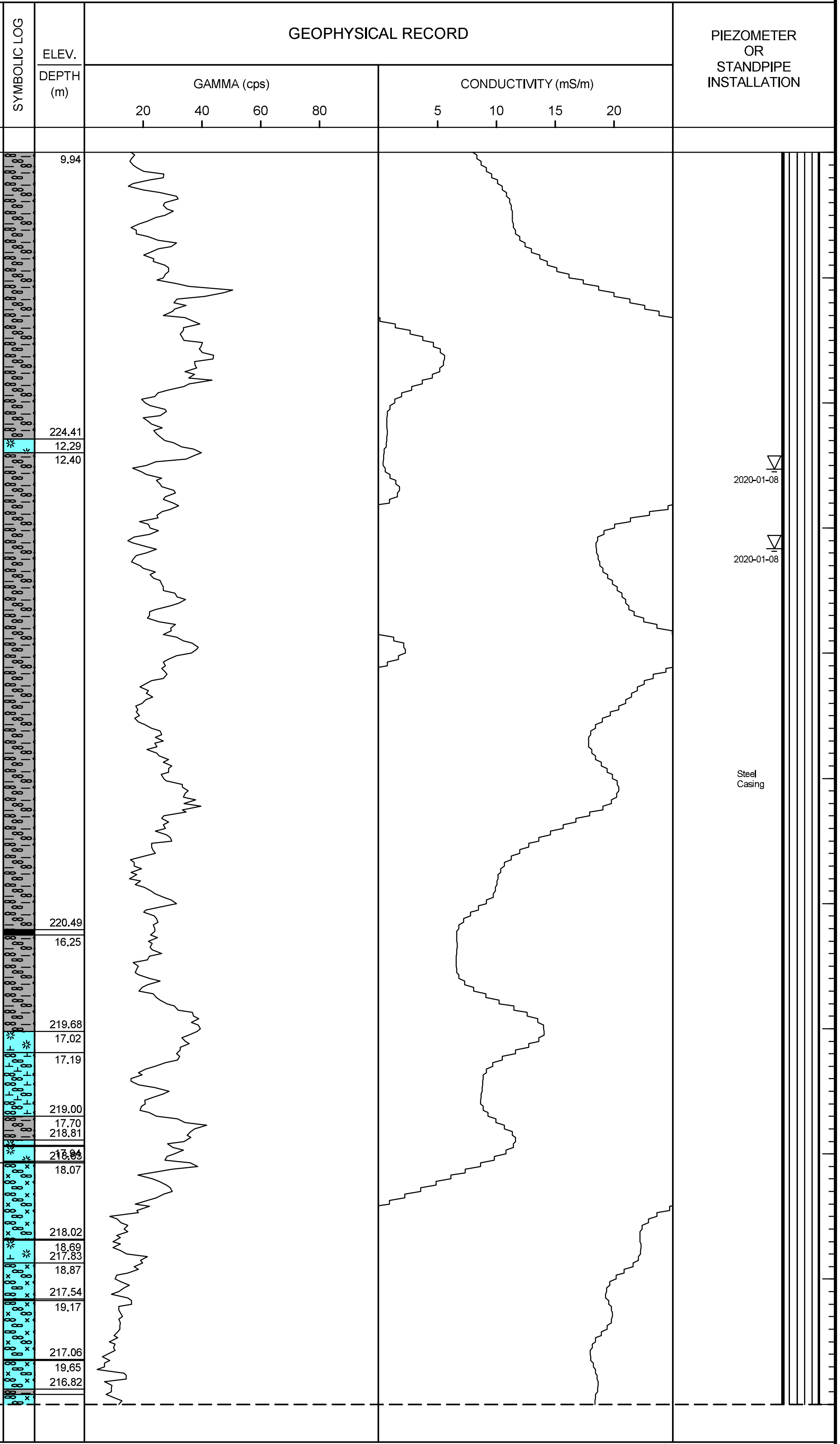
DEPTH SCALE: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

DRILLING RECORD: Rotary Drill, HQ Core

UNIT 1, 8.40 m to 18.07 m, Fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Lithoclastic calcarenite bed at 9.76-.94m and medium grained crystalline calcarenite bed at 12.29-.40m. Measured shale content on per core run basis comprises approximately 11 to 15 percent averaging 13 percent. Transitional basal contact noted by decrease in shaley content between 16.96m and 18.07m.

BOBCAYGEON FORMATION, 18.07 m to 44.63 m

UNIT 4, 18.07 m to 31.60 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin lithoclastic limestone beds occur at 24.71-.84m and 25.46-.57m. Interbeds of **SHALEY NODULAR**



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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 3 OF 8

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

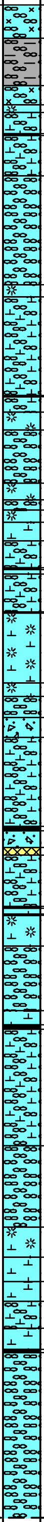
DRILLING DATE: August 22-26, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

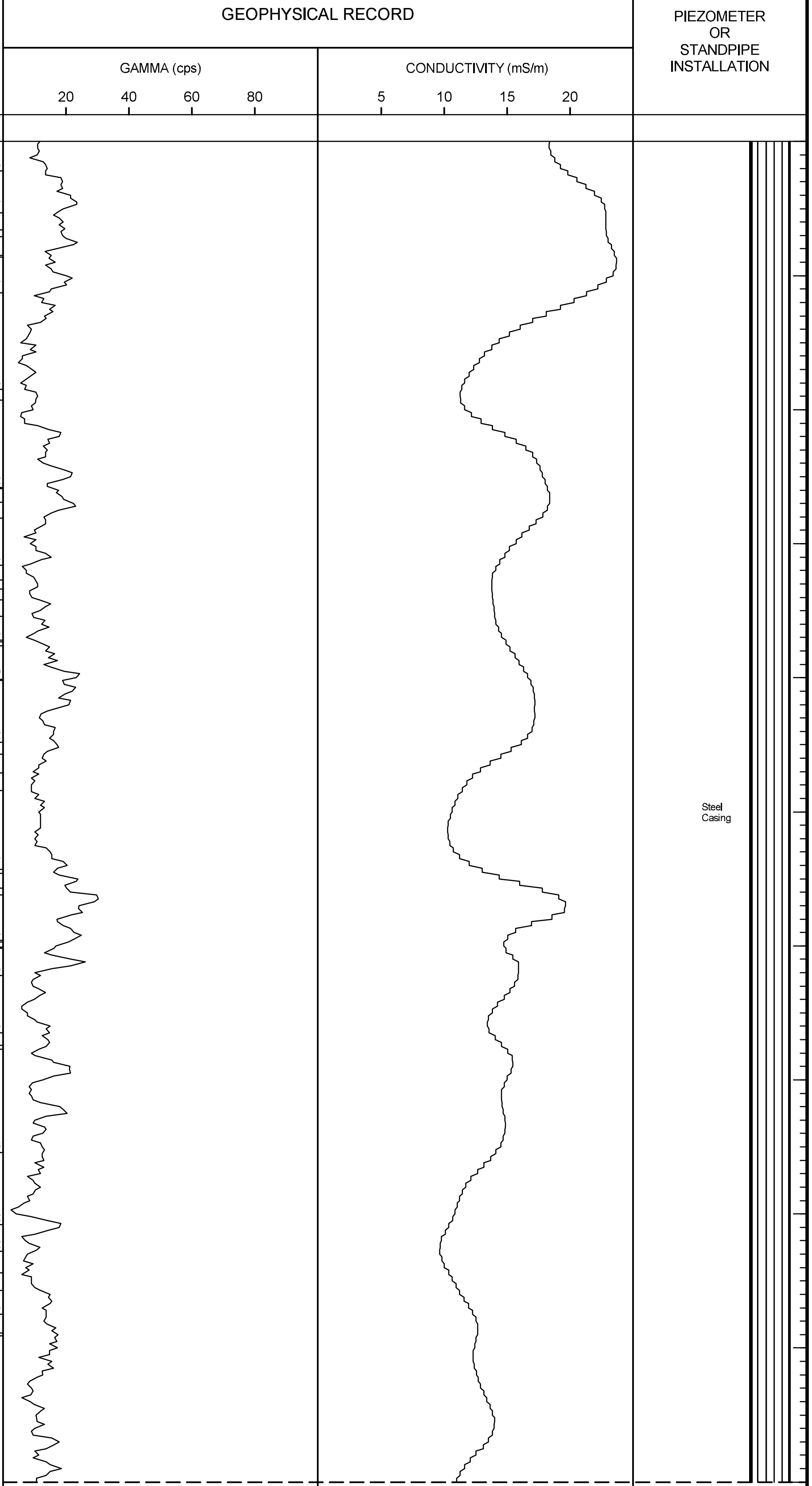
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---				

CALCARENITIC LIMESTONE at 17.70-18.07m, 20.22-.53m and 25.57-26.02m with open weathered clayey shale bedding parting at 25.57-.62m. Additional prominent shale partings at 25.43-.46m (burrow casts), 26.74-.77m and 28.89-.91m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 28.28-.91m. Argillaceous to shaley component per core run 1 to 7 percent averaging 3.2 percent. Gradational basal contact.

Rotary Drill
HQ Core



19.92
216.48
20.22
216.17
20.53
20.71
20.86
215.57
21.13
214.85
21.85
21.93
214.12
22.59
22.69
22.81
213.54
23.16
23.34
23.42
23.54
212.98
23.76
212.69
24.02
212.22
24.48
24.57
24.71
24.84
211.27
25.46
25.62
210.74
26.02
210.48
26.22
210.05
26.65
26.77
209.16
27.54
208.62
28.08
208.42
28.28
28.44
28.57
207.95
28.75
28.91



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DEPTH SCALE
1 : 50

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 4 OF 8

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 22-26, 2019

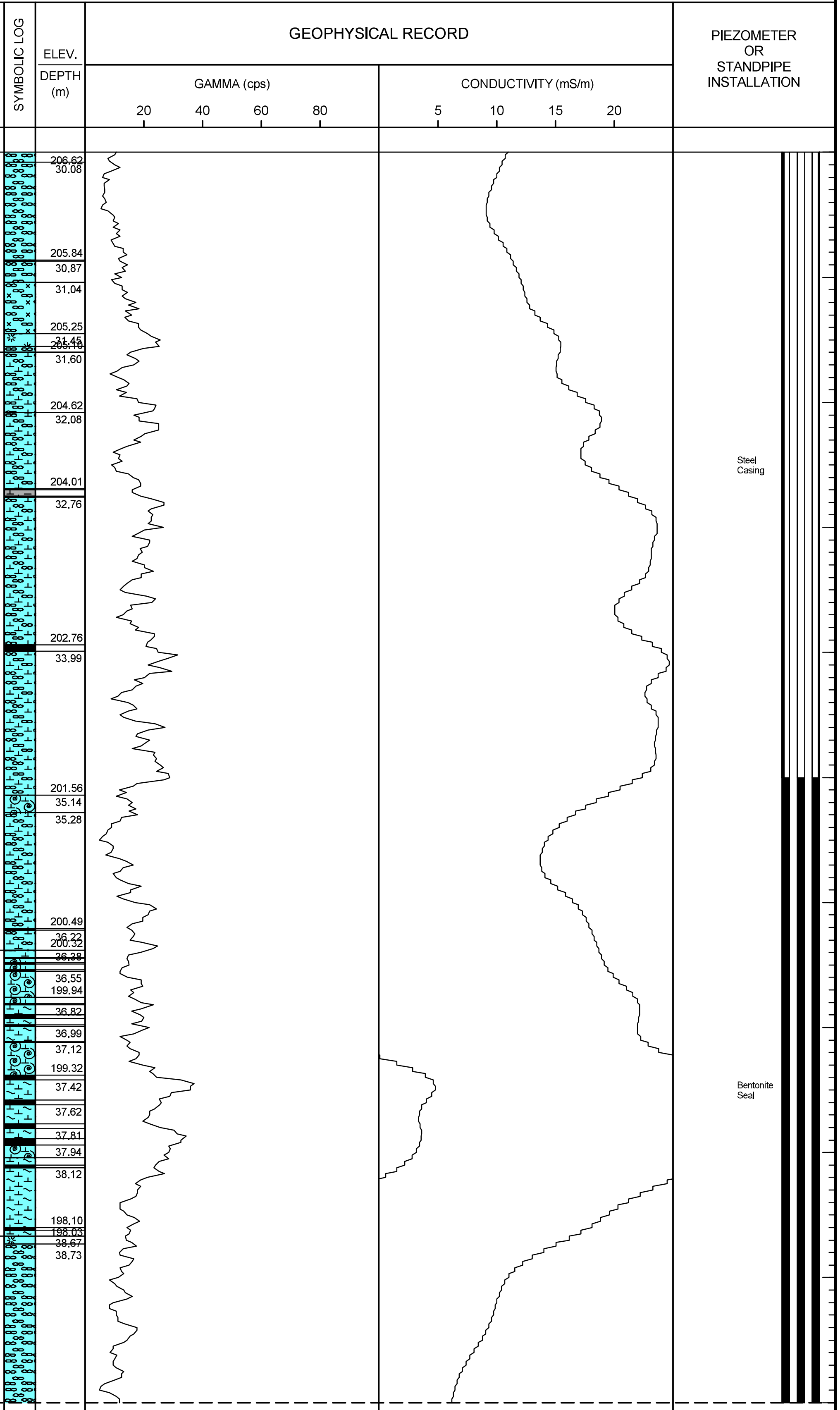
DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION

--- CONTINUED FROM PREVIOUS PAGE ---



30
31
32
33
34
35
36
37
38
39
40

Rotary Drill
HQ Core

UNIT 3, 31.60 m to 36.38 m Fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey burrowed **SHALE** at 33.94-.99m and thin medium grey gastropod fossil limestone bed at 35.14-.28m and scattered pelecypod fossil shells throughout. Argillaceous to shaley component per core run 1 to 9 percent averaging 4.7 percent. Sharp basal contact.

UNIT 2, 36.38 m to 38.67 m Fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings and gastropod fossils. Argillaceous to shaley component 13 percent (1 measurement). Sharp basal contact.

UNIT 1, 38.67 m to 44.63 m Fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Thin, medium grained crystalline calcarenitic limestone bed at 38.67-.73m. Argillaceous content per core run 0 to 6 percent, average 1.8 percent. Sharp basal contact noted by

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 22-26, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)

--- CONTINUED FROM PREVIOUS PAGE ---

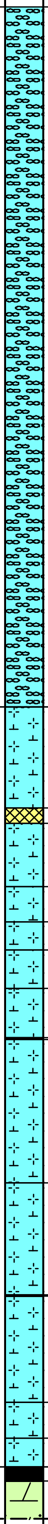
colour change from medium brownish grey micritic limestone to light creamy brown lithographic limestone across bedding parting.

GULL RIVER FORMATION, 44.63 m to 62.93 m

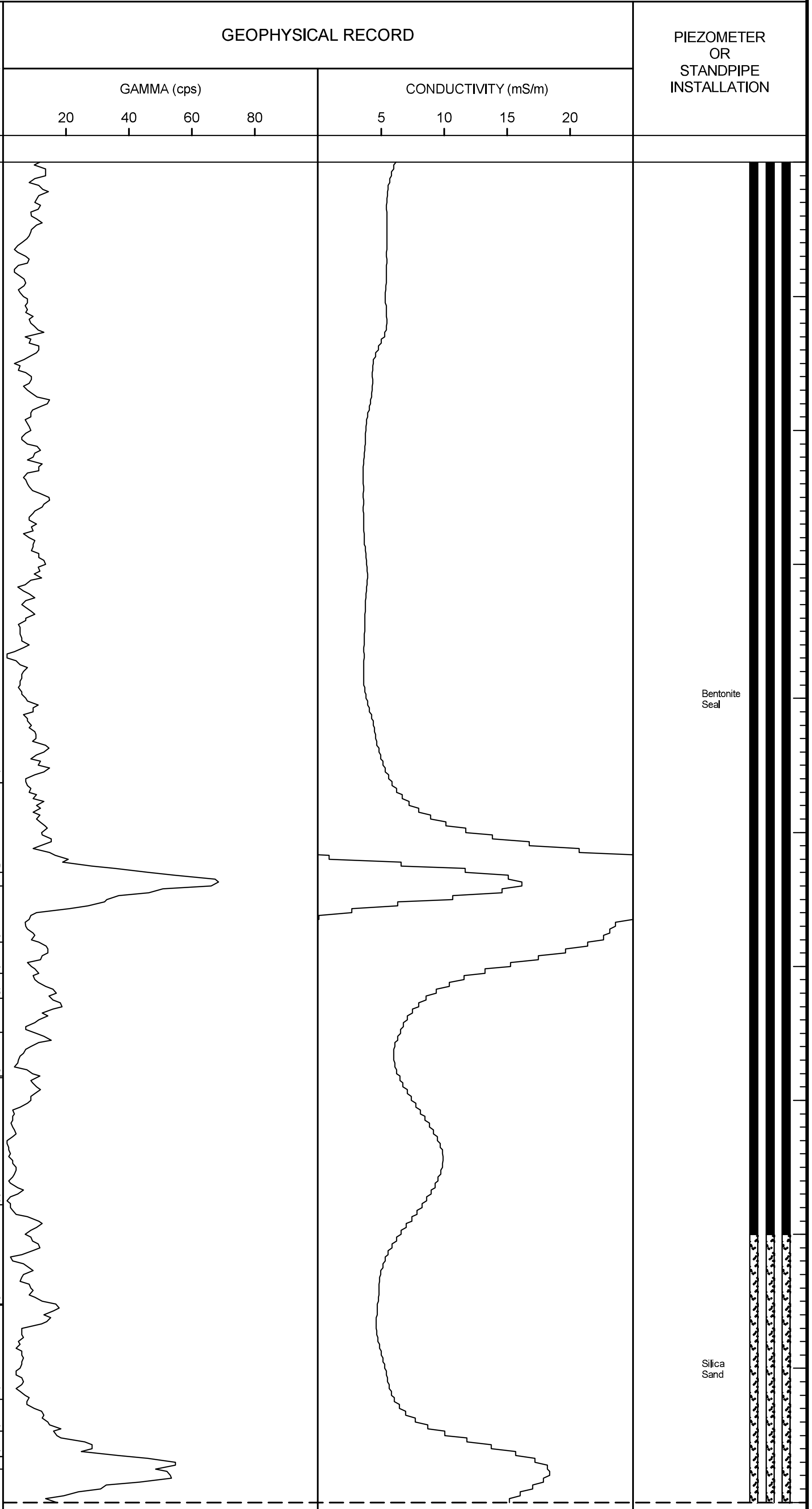
UNIT 4, 44.63 m to 49.66 m Fresh, creamy light to medium brown, creamy white at 46.49-47.77m, very fine grained porcelaneous, non-orous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly weathered, medium greenish grey, faintly calcareous **CLAY MARKER BED** developed from shale at 45.30-.40m. Additional intact grey shale partings at 46.82-.83m and 48.52-.53m. Sharp basal contact marked by dark grey shale.

Rotary Drill

HQ Core



192.07
44.63
191.40
45.30
45.40
190.88
45.82
190.65
46.05
190.46
46.24
190.21
46.49
189.88
46.83
188.92
47.78
188.18
48.53
187.47
49.23
187.23
49.47
187.04
49.66
49.75



Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 22-26, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth scale: 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

Drilling record: Rotary Drill, HQ Core

UNIT 3, 49.66 m to 53.10 m Fresh, medium greenish brown (49.74-50.00m) to light brownish grey (50.00-53.10m), fine to medium grained crystalline, faintly porous, saccharoidal textured, stylolitic, thickly bedded **DOLOSTONE** with dark grey, fissile **SHALE** at 49.99-.75m (weathered at 49.73-.74m) and 50.65-.66m and well developed stylolites at 52.28m, 52.70m and 52.96m; **The Green Bed.** Sharp basal contact.

UNIT 2, 53.10 m to 57.93 m, Fresh, creamy light to medium brown, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Thick bed of medium brown **NODULAR LITHOGRAPHIC LIMESTONE** at 53.10-.96m and grey shale parting at 57.26-.27m. Sharp basal contact.

UNIT 1, 57.93 m to 62.93 m Fresh, light to medium greenish grey to brown, fine to medium grained crystalline with 0.1-0.5 mm disseminated quartz grains, faintly to moderately porous, saccharoidal textured, weakly developed stylolites, medium bedded **DOLOSTONE** with mottled dolostone bed at 58.62-59.16m with transitional upper and lower contacts. Dark grey, fissile **SHALE** cap at 57.93-.98m and completely weathered shale comprised of medium greenish grey clayey silt soil with fine dolostone fragments at 59.88-.94m. Additional shaley partings occur at 58.15-.16m, 59.82-.83m, 59.87-.88m, 60.38-.39m, 60.41-.42m,

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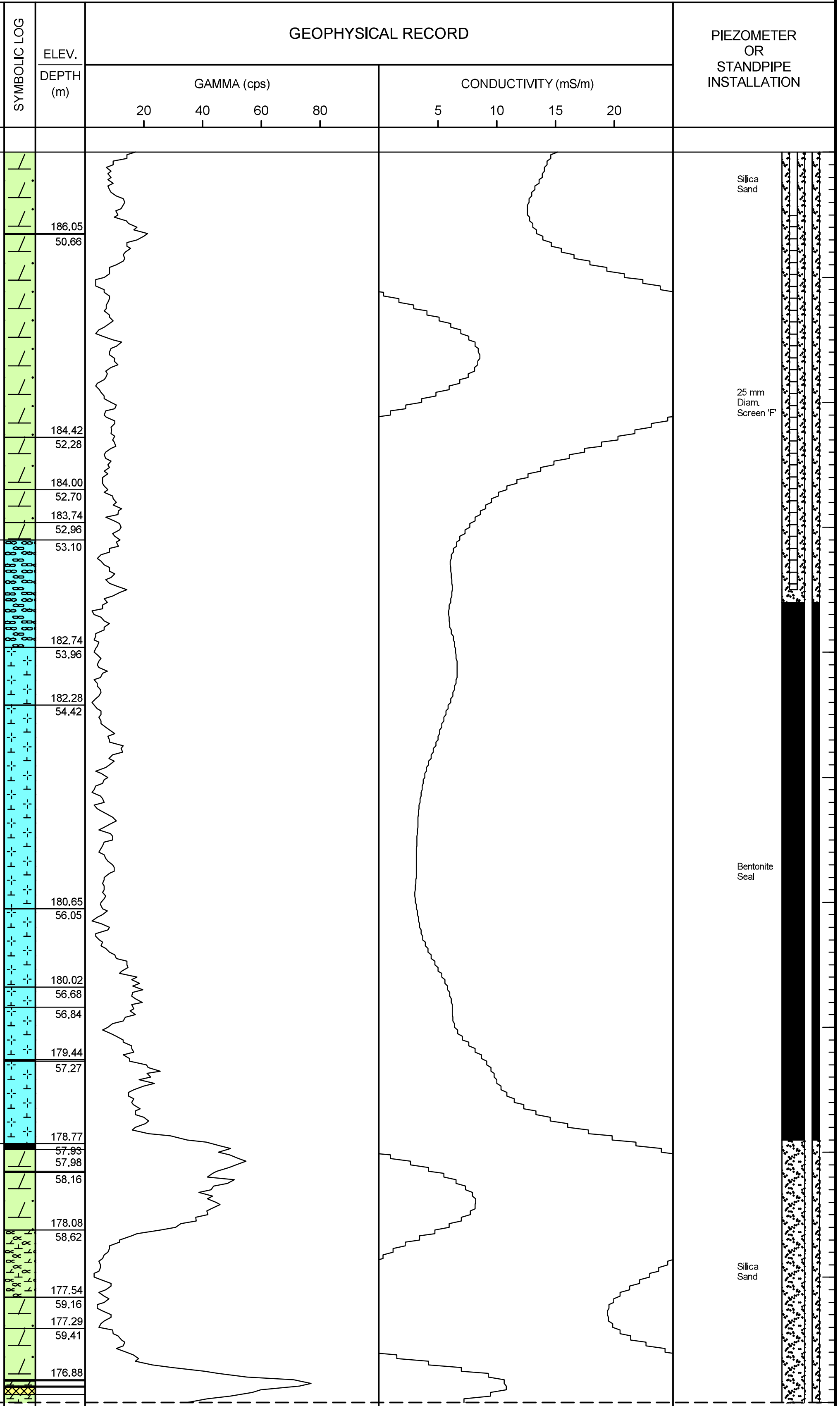


DEPTH SCALE
1 : 50

GOLDER MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 7 OF 8

LOCATION: N 4930189.3 ;E 645585.6

DRILLING DATE: August 22-26, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

DRILLING RECORD: Rotary Drill, HQ Core

--- CONTINUED FROM PREVIOUS PAGE ---

60.74-.75m, 59.48-.49m and 62.30-.31m. Transitional contact with underlying sandstone.

SHADOW LAKE FORMATION, 62.93 m to 70.53 m

From 62.93 m to 65.66 m, Fresh to moderately weathered, light grey to light to medium greenish grey, fine grained (0.1-2.0mm), moderately porous, friable (chips crumble with finger pressure), thickly bedded **SANDSTONE** comprised of quartz grains in sericitic matrix. Thin, dark green sandstone at 64.71-.79m. Transitional basal contact.

From 65.66 m to 68.71 m, Fresh, dark reddish brown, fine grained, slake susceptible **RED SHALE** with dispersed sand grains and sandstone, slake susceptible **GREEN SHALE** at 66.33-.36m and 66.43-.52m and medium greenish grey to dark green, fine grained, moderately porous, thinly bedded **SANDSTONE** comprised of quartz grains in a sericitic matrix at 65.81-.97m and 66.36-.43m. Green sandy shale at 68.60-.71m. Transitional basal contact.

From 68.71 m to 70.53 m, Faintly to moderately weathered, friable, dark reddish brown and green mottled (68.60-69.32m) grading to greenish grey to, fine to coarse grained, moderately porous, medium to thickly bedded **ARKOSIC SANDSTONE** with scattered pebbles comprised of angular 5-15mm feldspar crystals. Dark green, medium to coarse grained, porous,

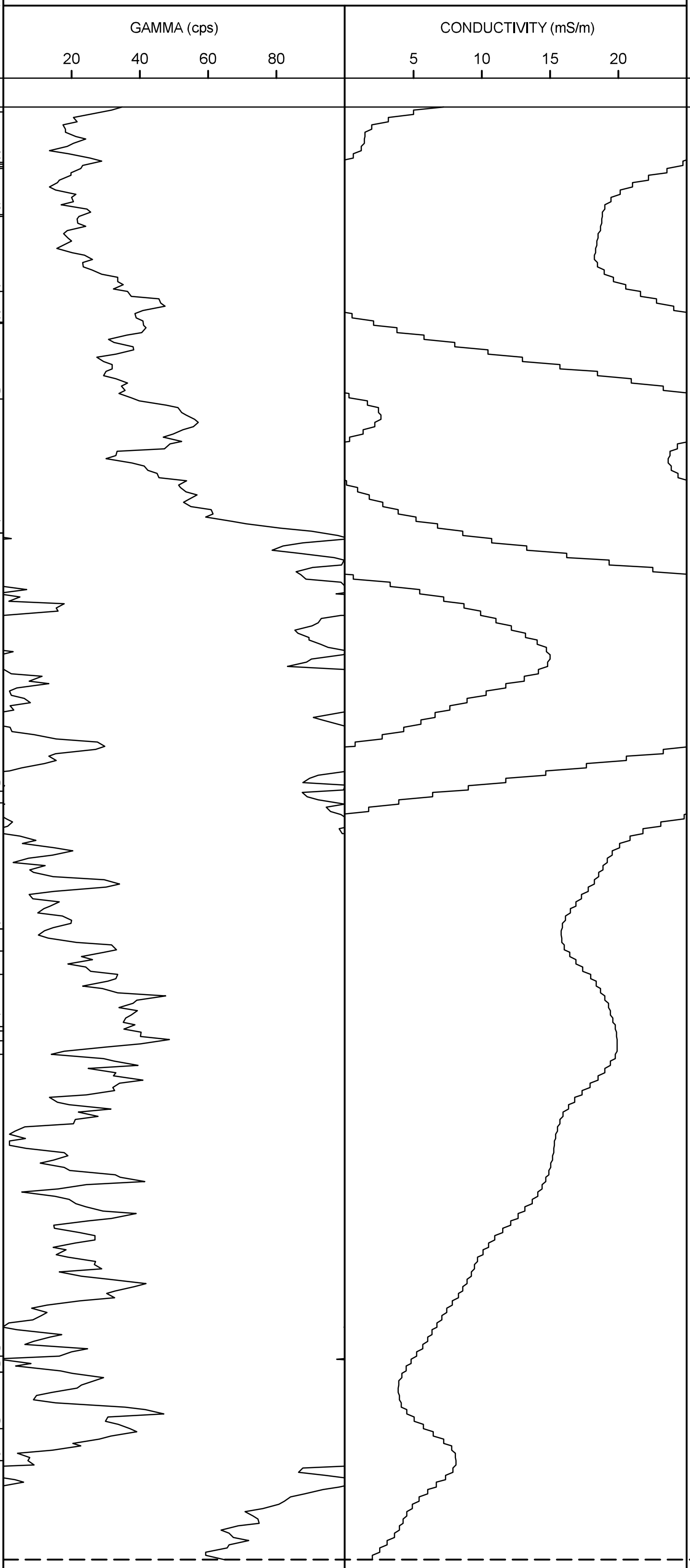
CONTINUED NEXT PAGE

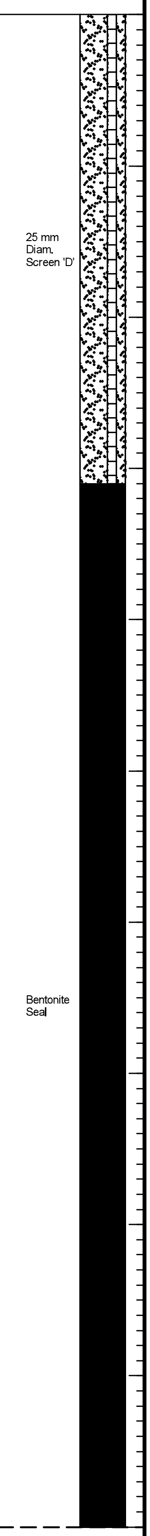
ELEV. / DEPTH (m):

59.94
60.03
176.32
60.42
175.96
60.75
175.43
61.27
175.22
61.49
174.69
62.01
173.77
62.93
171.99
64.71
64.79
171.04
65.66
65.81
65.97
170.37
66.43
66.52
168.10
167.99
68.60
68.71
167.60
69.10
167.38
69.32

DEPTH SCALE METRES: 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70

GEOPHYSICAL RECORD





DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-3

SHEET 8 OF 8

LOCATION: N 4930189.3 ;E 645585.6

INCLINATION: -90° AZIMUTH: ---

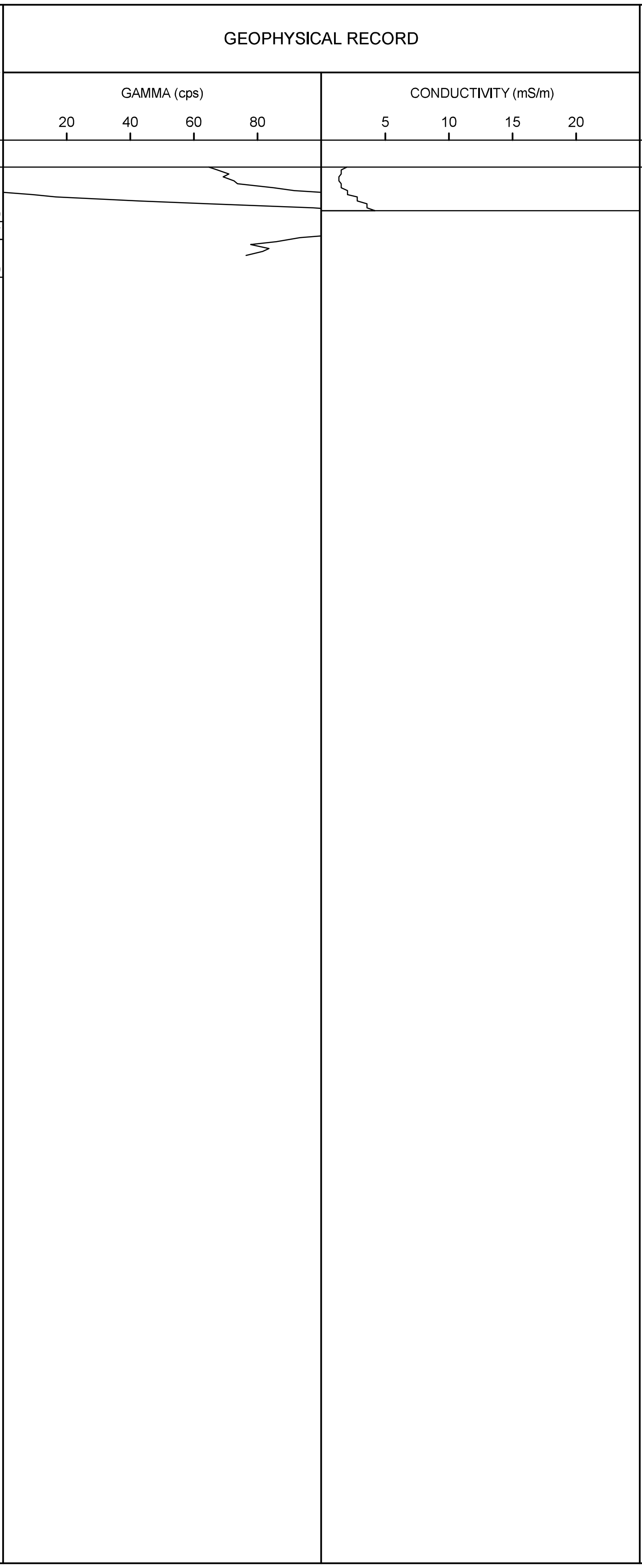
DRILLING DATE: August 22-26, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---			
70	Rotary Drill HQ Core	friable, thin bed of sandstone at the basal contact.		166.30 70.40 166.17	Bentonite Seal
		PRECAMBRIAN BASEMENT, 70.53 m to 70.81 m Faintly weathered, pinkish grey, medium grained **QUARTZ FELDSPAR GNEISS** with gneissosity at 20 degrees TCA and highly weathered dark brown lamination at 70.65-.66m.		70.53 165.89 70.81	
		End of Borehole, 70.81 m			
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					



DEPTH SCALE

1 : 50

GOLDER MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 1 OF 8

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

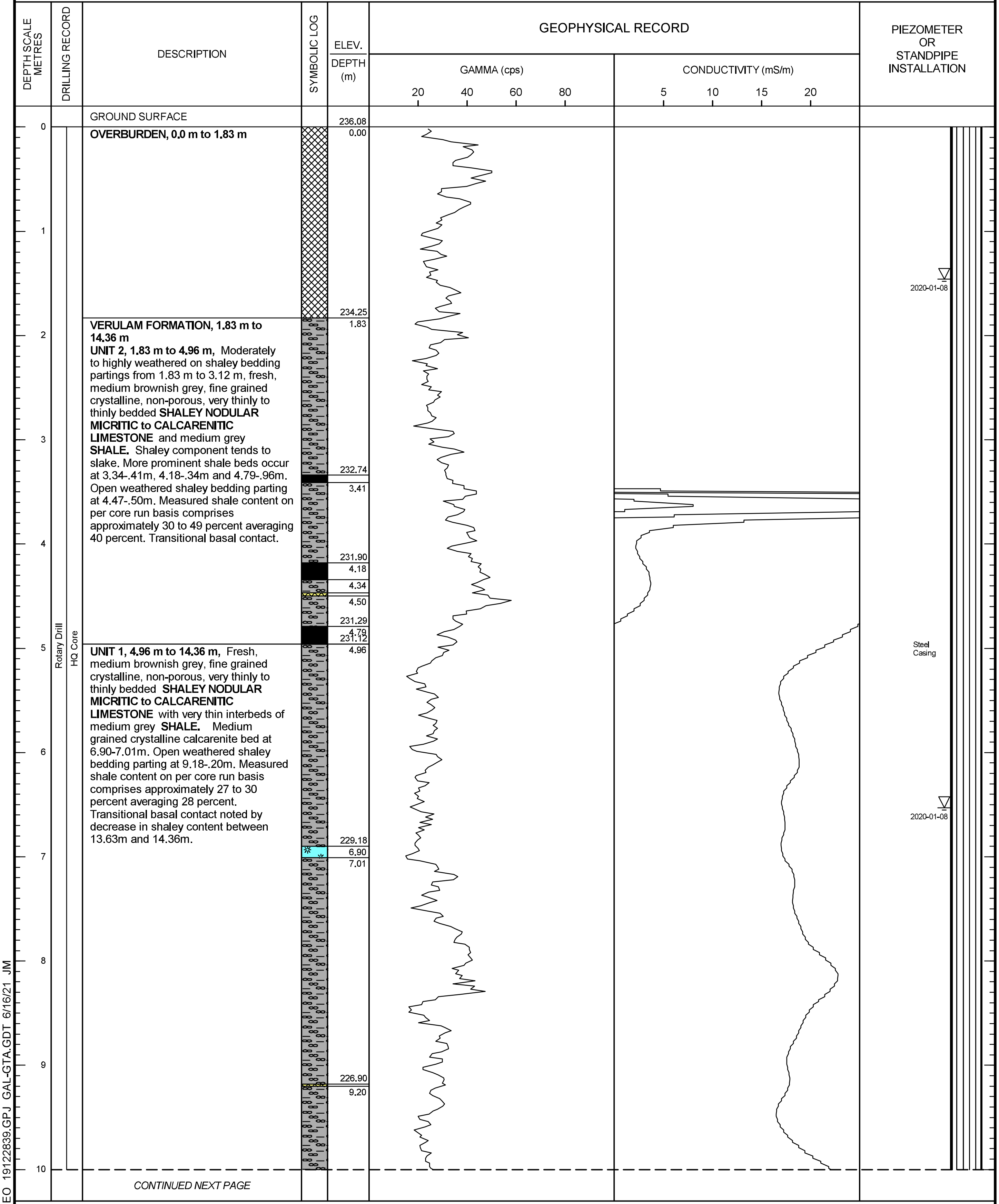
GROUND SURFACE

OVERBURDEN, 0.0 m to 1.83 m

VERULAM FORMATION, 1.83 m to 14.36 m

UNIT 2, 1.83 m to 4.96 m, Moderately to highly weathered on shaley bedding partings from 1.83 m to 3.12 m, fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and medium grey **SHALE.** Shaley component tends to slake. More prominent shale beds occur at 3.34-.41m, 4.18-.34m and 4.79-.96m. Open weathered shaley bedding parting at 4.47-.50m. Measured shale content on per core run basis comprises approximately 30 to 49 percent averaging 40 percent. Transitional basal contact.

UNIT 1, 4.96 m to 14.36 m, Fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Medium grained crystalline calcarenite bed at 6.90-7.01m. Open weathered shaley bedding parting at 9.18-.20m. Measured shale content on per core run basis comprises approximately 27 to 30 percent averaging 28 percent. Transitional basal contact noted by decrease in shaley content between 13.63m and 14.36m.



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DEPTH SCALE

1 : 50

GOLDER MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 2 OF 8

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

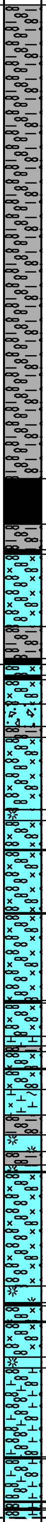
Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Drilling record: Rotary Drill, HQ Core

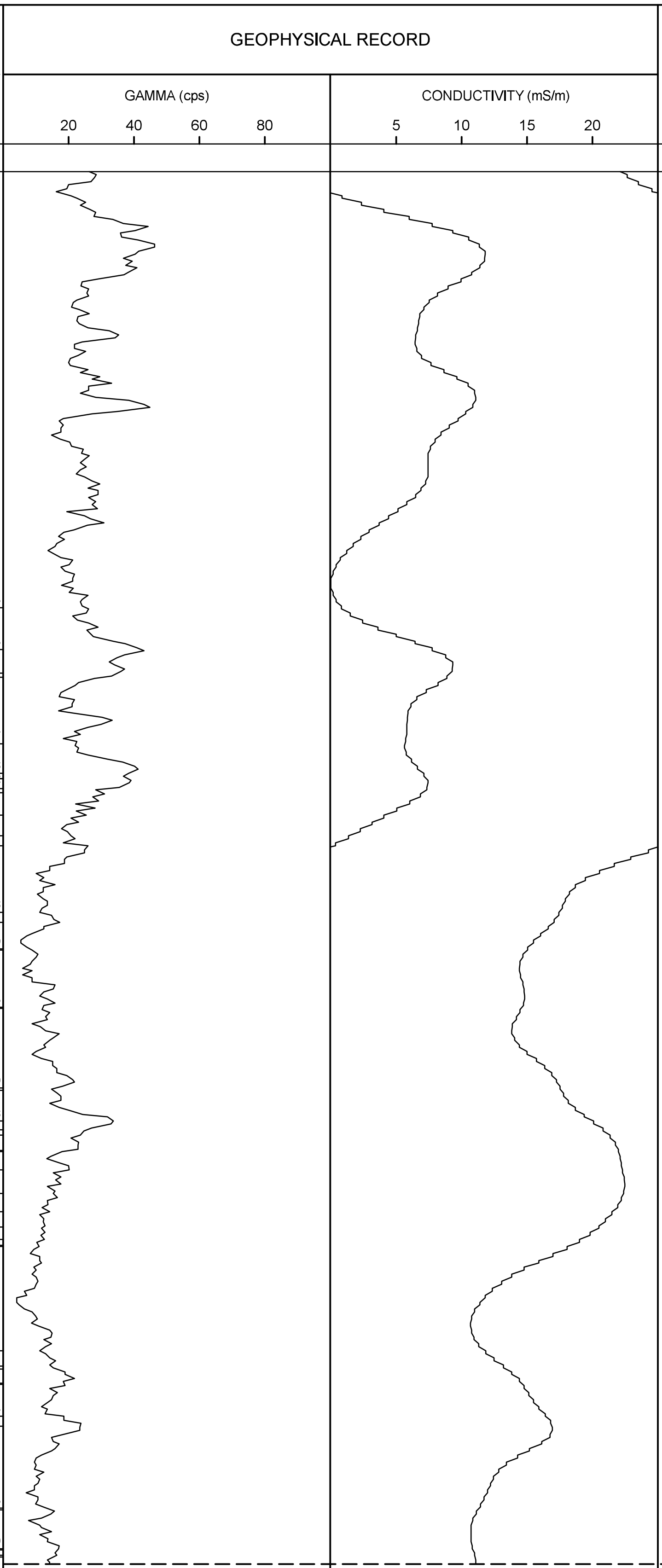
UNIT 1, 4.96 m to 14.36 m, Fresh, medium brownish grey, fine grained crystalline, non-porous, very thinly to thinly bedded **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with very thin interbeds of medium grey **SHALE.** Medium grained crystalline calcarenite bed at 6.90-7.01m. Open weathered shaley bedding parting at 9.18-.20m. Measured shale content on per core run basis comprises approximately 27 to 30 percent averaging 28 percent. Transitional basal contact noted by decrease in shaley content between 13.63m and 14.36m.

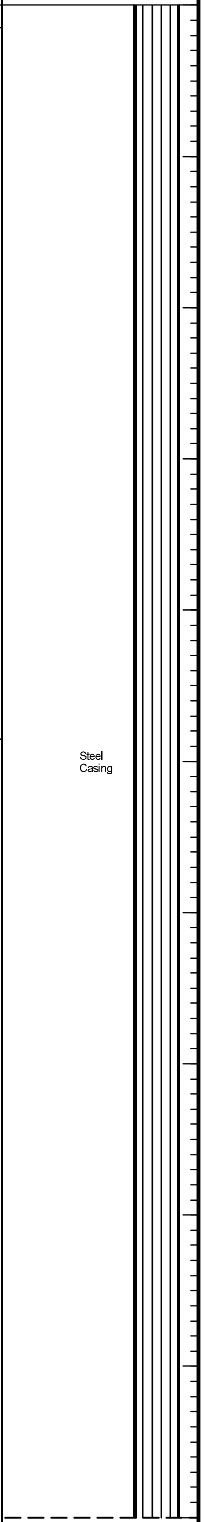
BOBCAYGEON FORMATION, 14.36 m to 41.22 m

UNIT 4, 14.36 m to 29.23 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin calcarenitic lithoclastic limestone bed occurs at 21.36-.46m. Interbeds of **SHALEY NODULAR CALCARENITIC LIMESTONE** occur at 22.05-.65m with open weathered clayey shale bedding parting at 22.05-.10m. Additional prominent shale partings at 14.43-.46m, 16.88-.92m, 25.10-.16m, 25.27-.33m, 26.59-.61m and 27.84-.87m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 24.64-25.46m. Argillaceous to shaley component per core run 5 to 16 percent averaging 7 percent. Gradational basal contact.



Elev. / depth values:
222.95
13.13
222.65
13.43
13.63
221.97
14.11
221.76
221.72
14.36
14.46
14.62
14.84
220.76
15.39
220.50
15.59
220.08
16.01
219.50
16.60
219.26
16.92
17.04
17.17
17.34
17.47
17.58
17.72
217.61
18.47
18.60
18.71
217.14
19.01
216.48
19.61
216.19





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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 3 OF 8

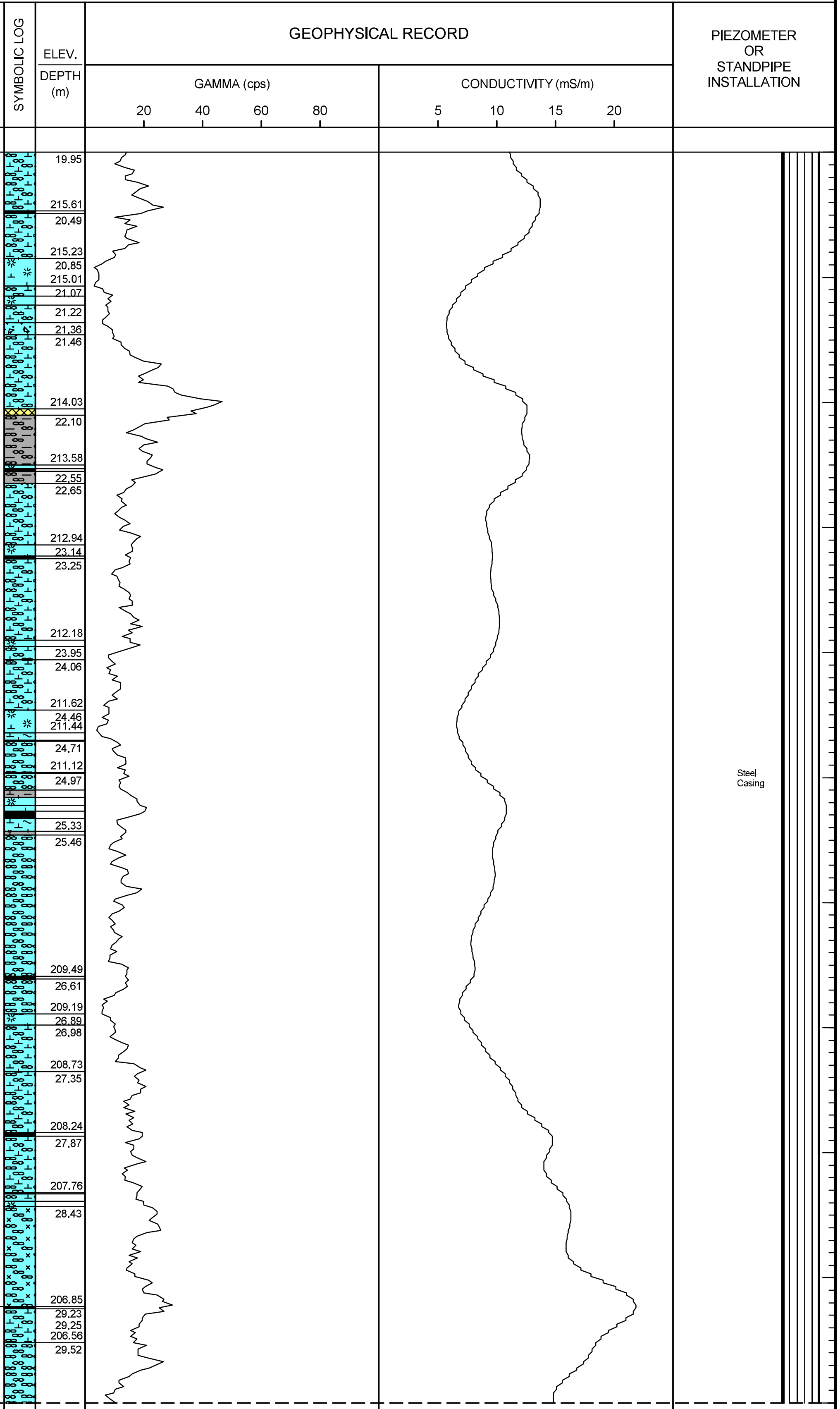
LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION
		--- CONTINUED FROM PREVIOUS PAGE ---
20	Rotary Drill HQ Core	**BOBCAYGEON FORMATION, 14.36 m to 41.22 m** **UNIT 4, 14.36 m to 29.23 m** Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Thin calcarenitic lithoclastic limestone bed occurs at 21.36-.46m. Interbeds of **SHALEY NODULAR CALCARENITIC LIMESTONE** occur at 22.05-.65m with open weathered clayey shale bedding parting at 22.05-.10m. Additional prominent shale partings at 14.43-.46m, 16.88-.92m, 25.10-.16m, 25.27-.33m, 26.59-.61m and 27.84-.87m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 24.64-25.46m. Argillaceous to shaley component per core run 5 to 16 percent averaging 7 percent. Gradational basal contact.
21		
22		
23		
24		
25		
26		
27		
28		
29		**UNIT 3, 29.23 m to 33.34 m** Fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** at 29.23-.28m,
30		*CONTINUED NEXT PAGE*



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

GEOPHYSICAL LOG OF: BH-4

PROJECT: 19122839

SHEET 4 OF 8

LOCATION: N 4930501.1 ;E 644876.6

DRILLING DATE: August 27-30, 2019

DATUM: Geodetic

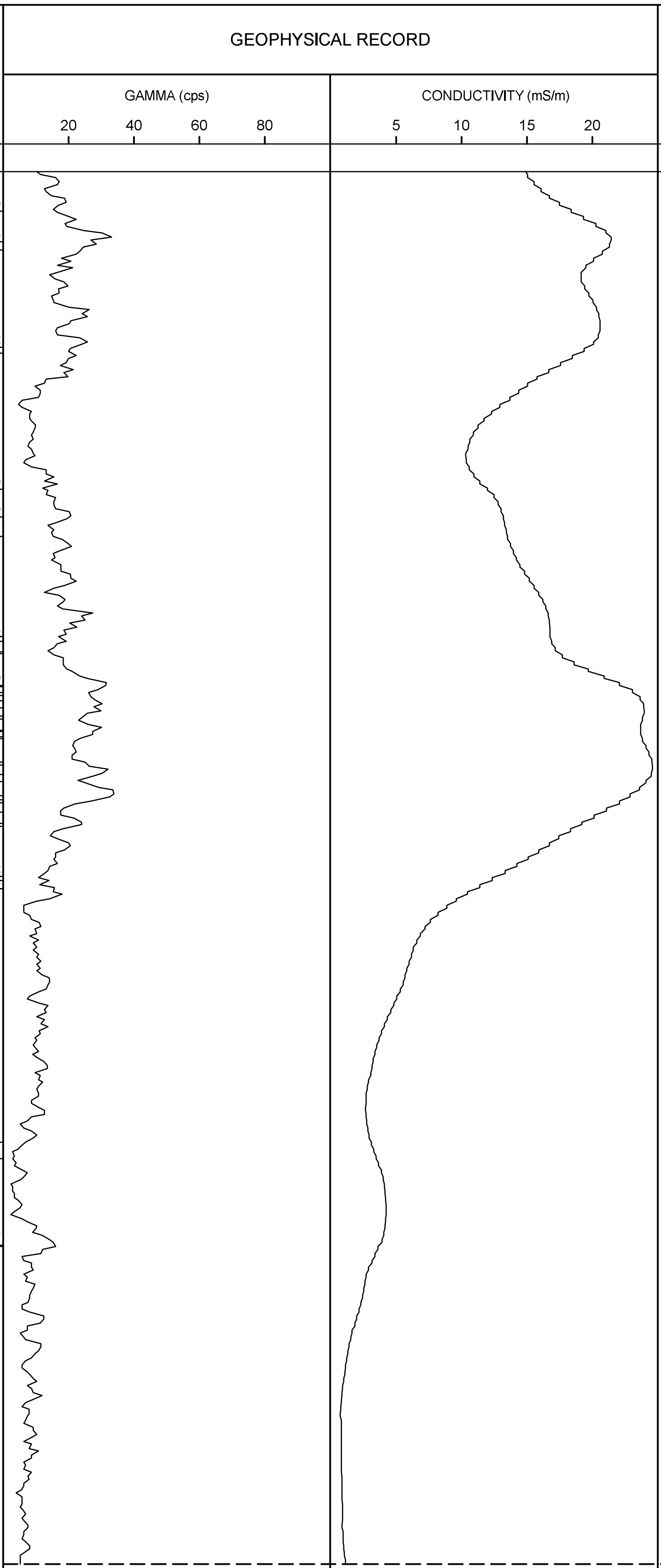
INCLINATION: -90° AZIMUTH: ---

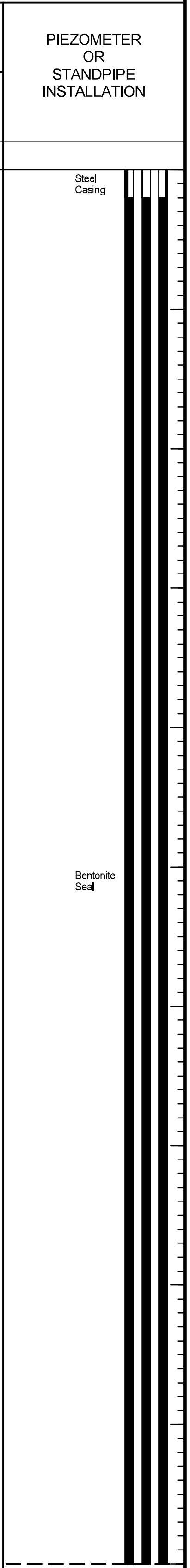
DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---	
30	Rotary Drill HQ Core	30.50-.56m (burrow casts) and 31.26-.30m (shale with limestone nodules) with burrow casts at 33.94-.99m and thin, medium grey gastropod fossil limestone bed at 32.48-.62m and scattered pelecypod fossil shells throughout. Argillaceous to shaley component per core run 6 to 7 percent averaging 7 percent. Sharp basal contact.	205.80 30.28 205.58 30.56 204.82 31.30 203.80 32.28 203.60 32.48 32.62 202.74
33		**UNIT 2, 33.34 m to 35.15 m** Fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings, some with burrow casts and gastropod fossils. Argillaceous to shaley component 13 percent (1 measurement). Sharp basal contact.	33.34 33.37 33.46 202.39 33.93 34.07 34.38 34.60 34.70 201.02 200.93
35		**UNIT 1, 35.15 m to 41.22 m** Fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline interlaminations and beds, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Argillaceous content 0 to 8 percent, average 2.0 percent. Thin, medium grained crystalline calcarenitic limestone bed at 36.97-37.09m. Sharp basal contact noted by colour change from medium brownish grey micritic limestone to light creamy brown lithographic limestone.	35.15 199.11 36.97 37.09 198.37 37.72
40		*CONTINUED NEXT PAGE*	

SYMBOLIC LOG





DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 5 OF 8

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD	PIEZOMETER OR STANDPIPE INSTALLATION

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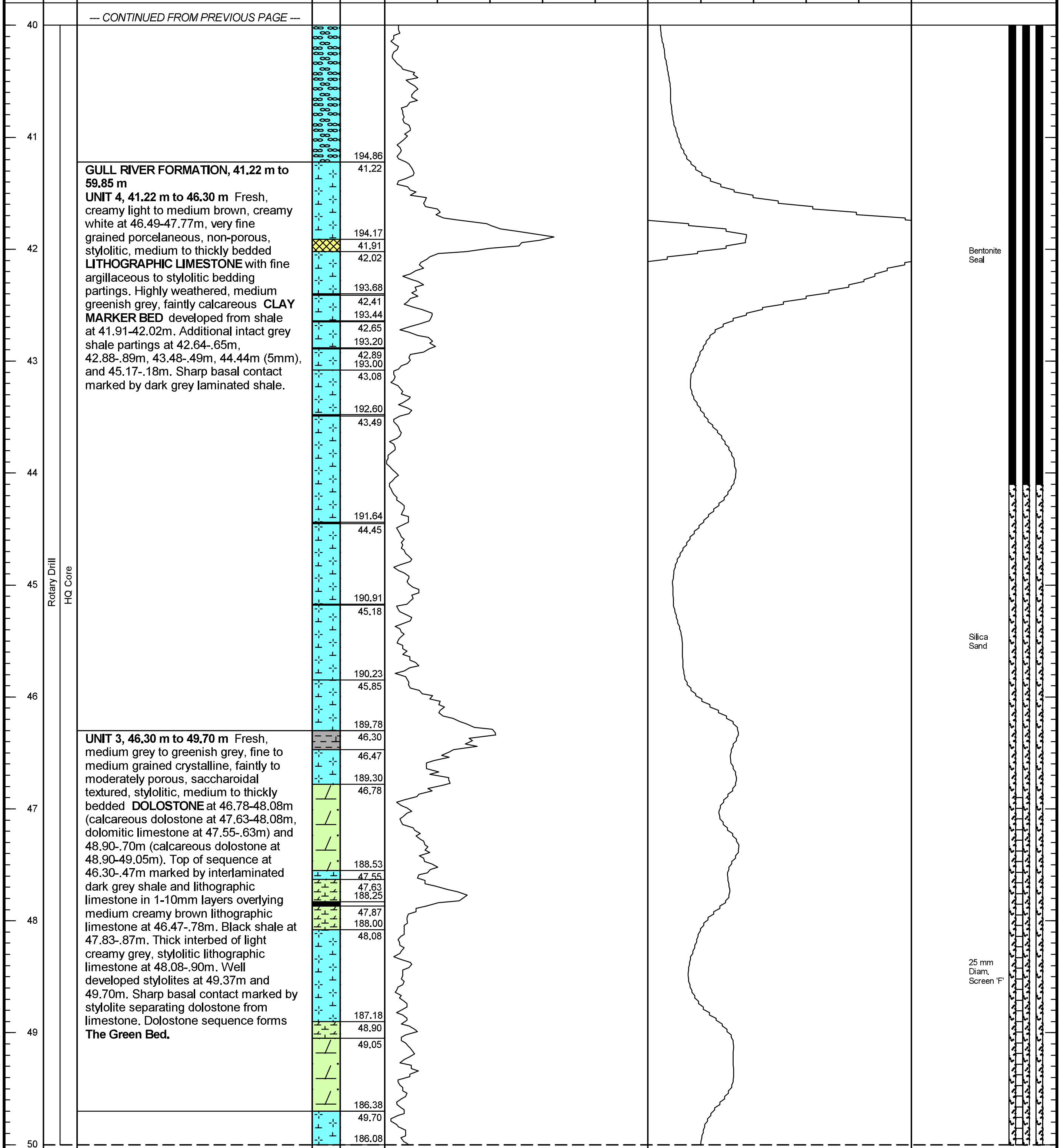

GULL RIVER FORMATION, 41.22 m to 59.85 m

UNIT 4, 41.22 m to 46.30 m Fresh, creamy light to medium brown, creamy white at 46.49-47.77m, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly weathered, medium greenish grey, faintly calcareous **CLAY MARKER BED** developed from shale at 41.91-42.02m. Additional intact grey shale partings at 42.64-.65m, 42.88-.89m, 43.48-.49m, 44.44m (5mm), and 45.17-.18m. Sharp basal contact marked by dark grey laminated shale.

UNIT 3, 46.30 m to 49.70 m Fresh, medium grey to greenish grey, fine to medium grained crystalline, faintly to moderately porous, saccharoidal textured, stylolitic, medium to thickly bedded **DOLOSTONE** at 46.78-48.08m (calcareous dolostone at 47.63-48.08m, dolomitic limestone at 47.55-.63m) and 48.90-.70m (calcareous dolostone at 48.90-49.05m). Top of sequence at 46.30-.47m marked by interlaminated dark grey shale and lithographic limestone in 1-10mm layers overlying medium creamy brown lithographic limestone at 46.47-.78m. Black shale at 47.83-.87m. Thick interbed of light creamy grey, stylolitic lithographic limestone at 48.08-.90m. Well developed stylolites at 49.37m and 49.70m. Sharp basal contact marked by stylolite separating dolostone from limestone. Dolostone sequence forms **The Green Bed.**

ELEV. / DEPTH (m):

194.86
41.22
194.17
41.91
42.02
193.68
42.41
193.44
42.65
193.20
42.89
193.00
43.08
192.60
43.49
191.64
44.45
190.91
45.18
190.23
45.85
189.78
46.30
46.47
189.30
46.78
188.53
47.55
47.63
188.25
47.87
188.00
48.08
187.18
48.90
49.05
186.38
49.70
186.08

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION

--- CONTINUED FROM PREVIOUS PAGE ---

UNIT 2, 49.70 m to 54.69 m, Fresh, creamy light to medium brown, very fine grained, porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Thick bed of medium brown **NODULAR LITHOGRAPHIC LIMESTONE** at 50.01-.85m and grey shale parting at 50.00-.01m. Calcareous dolostone bed at 53.49-.69m. Sharp basal contact.

UNIT 1, 54.69 m to 59.85 m Fresh, light to medium greenish grey to brown, fine to medium grained crystalline with 0.1-0.5 mm disseminated quartz grains, faintly to moderately porous, saccharoidal textured, weakly developed stylolites, medium bedded **DOLOSTONE** with thick mottled dolostone bed at 55.41-56.26m with sharp upper and transitional lower contacts. **CALCAREOUS DOLOSTONE** interbeds at 54.78-.88m, 56.46-.62m, 56.70-.82m and 58.25-.33m. Dark grey, interlaminated **SHALE and LIMESTONE** cap at 57.93-.98m and completely weathered shale comprised of medium greenish grey, faintly calcareous clayey silt soil with fine dolostone fragments at 56.64-.70m. Additional shaley partings occur at 56.62-.64m, 56.82-.83m, 57.23-.27m, 57.63-.64m, 58.24-.25m and 59.20-.21m. Transitional contact with underlying sandstone.

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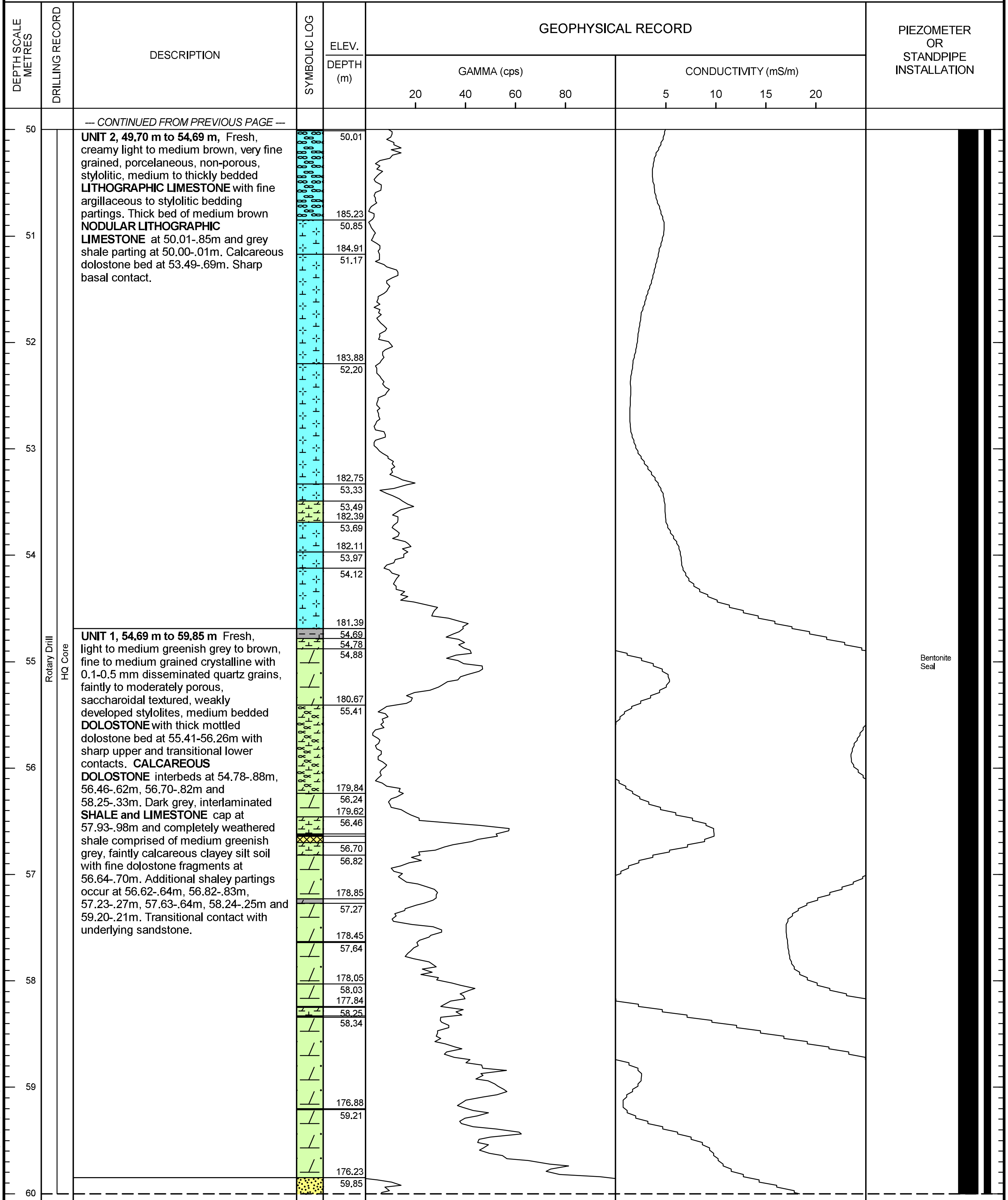


DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 7 OF 8

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

DRILLING RECORD: Rotary Drill, HQ Core

--- CONTINUED FROM PREVIOUS PAGE ---

SHADOW LAKE FORMATION, 59.85 m to 68.32 m

From 59.85 m to 62.75 m, Fresh to moderately weathered, light grey (59.85-61.45m) to light to medium greenish grey (61.45-62.75m), fine grained (0.1-2.0mm), moderately porous, friable (chips crumble with finger pressure), thickly bedded **SANDSTONE** comprised of quartz grains in sericitic matrix.

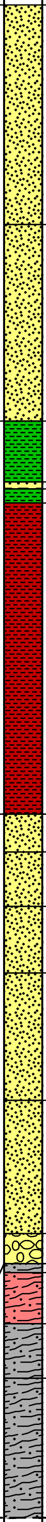
From 62.75 m to 65.35 m, Fresh to faintly weathered, dark green slake susceptible **GREEN SHALE** at 62.75-63.29m with sandy shale at 63.15-.20m overlying dark reddish brown, slake susceptible **RED SHALE** at 63.29m to 65.35m with disseminated quartz grains.

From 65.35 m to 67.24 m, Transitional contact to dark greenish brown (65.35-.60m), light greenish grey (65.60-.96m), reddish brown with green reduction spots (65.96-66.40m), fine to medium grained, moderately porous, medium bedded **ARKOSIC SANDSTONE** comprised of quartz and feldspar grains gradational to porous friable light grey to greenish grey arkosic sandstone at 66.40-67.24m.

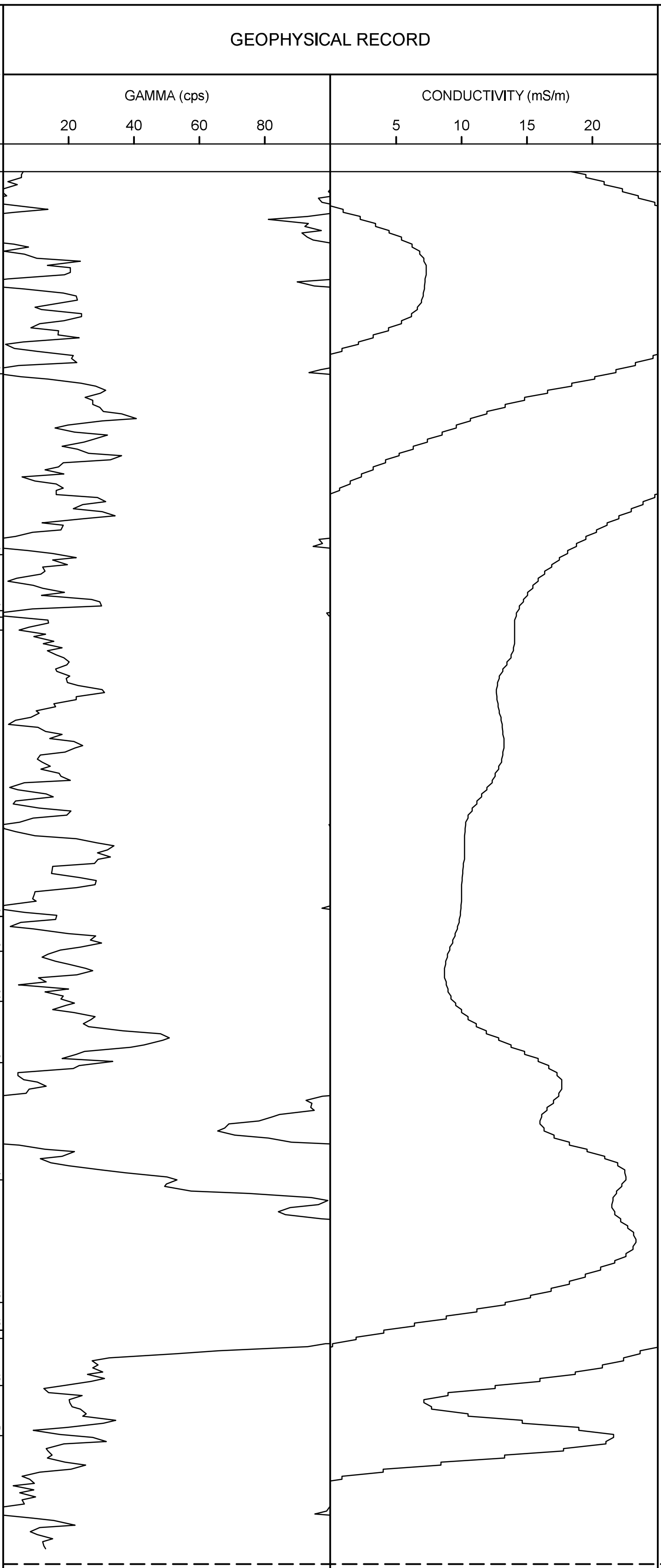
From 67.24 m to 68.32 m, Faintly to moderately weathered, greenish grey to reddish brown, fine to coarse grained, medium bedded **ARKOSIC SANDSTONE** with scattered pebbles comprised of angular 5-15mm feldspar crystals overlying **PEBBLE CONGLOMERATE** at 68.12-.32m comprised of angular feldspar crystals (1-25mm) in matrix supported arkosic quartz and feldspar grains. Basal moderately to highly weathered, dark reddish brown regolith comprised of gneissic grains of quartz and feldspar separating along the gneissosity.

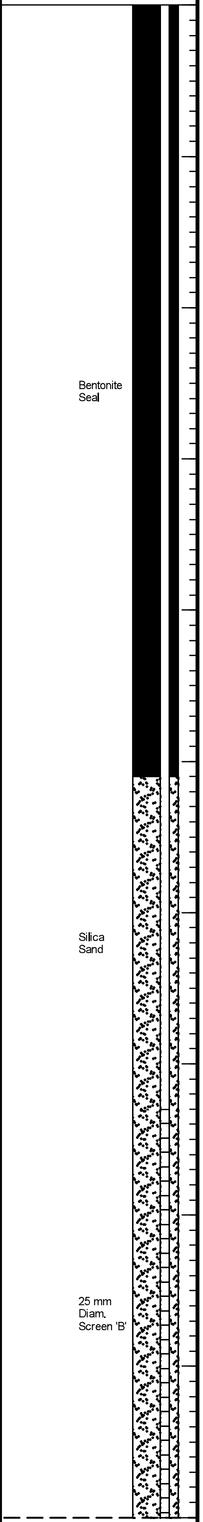
PRECAMBRIAN BASEMENT, 68.32 m to 70.23 m

Faintly weathered becoming fresh at 68.72m, pinkish grey, medium grained **QUARTZ FELDSPAR GNEISS** with minor biotite and gneissosity at 45 degrees TCA and highly weathered dark reddish brown lamination at 69.08m transitional to medium grey gneiss at 69.08m.



ELEV.	DEPTH (m)
174.63	61.45
173.33	62.75
172.93	63.20
	63.29
170.73	65.35
170.48	65.60
170.12	65.96
169.68	66.40
168.84	67.24
167.96	68.12
167.76	68.32
167.36	68.72
167.00	69.08





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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-4

SHEET 8 OF 8

LOCATION: N 4930501.1 ;E 644876.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 27-30, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD CONDUCTIVITY (mS/m) 5 10 15 20	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---					
70			▨	165.85 70.23			▨
		End of Borehole, 70.23 m					
71							
72							
73							
74							
75							
76							
77							
78							
79							
80							

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 1 OF 6

LOCATION: N 4930363.1 ;E 644323.0

DRILLING DATE: September 3-5, 2019

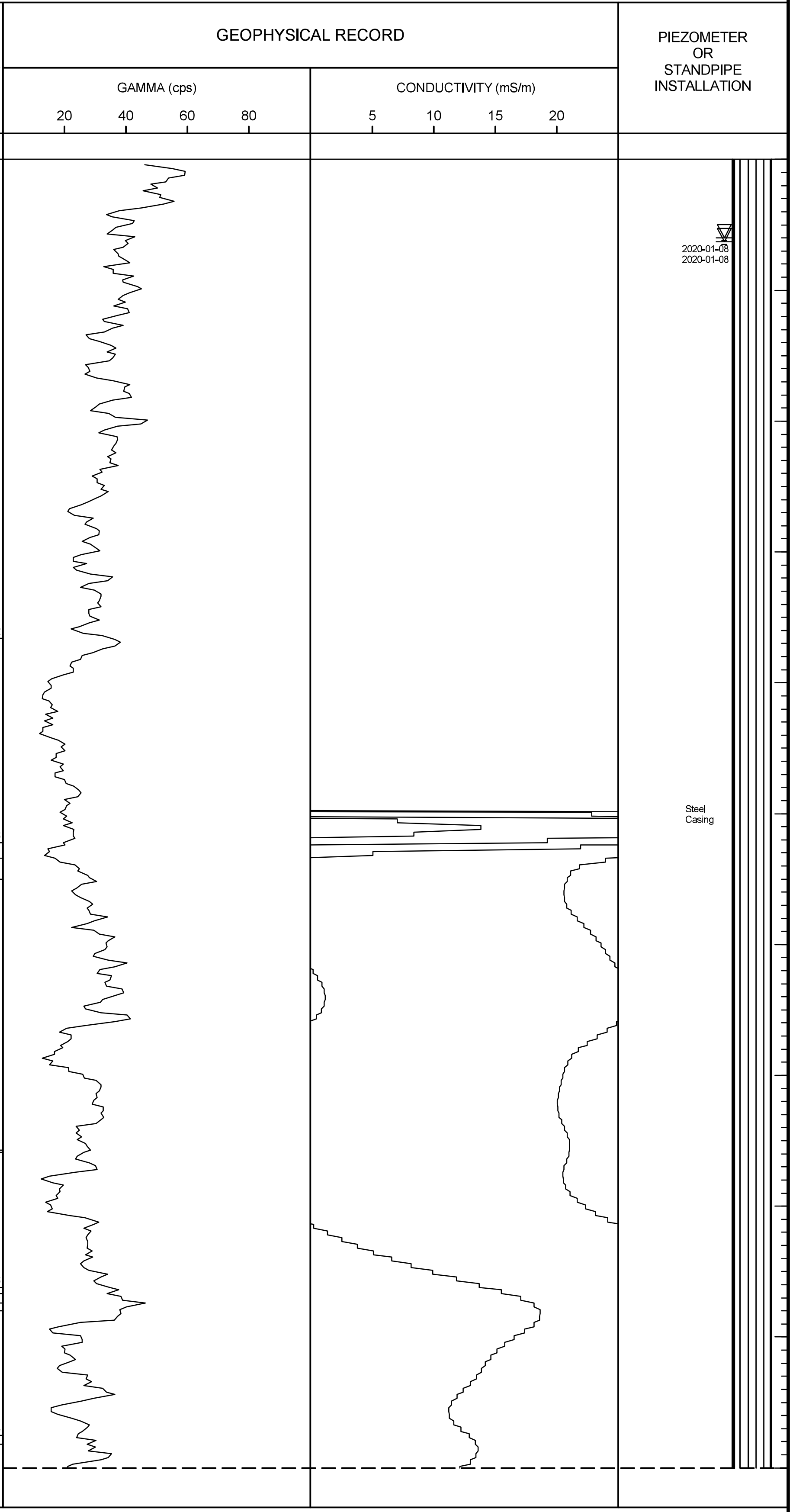
DATUM: Geodetic

DRILL RIG: CME 75 - Track Mounted

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		231.98
0		**OVERBURDEN, 0.0 m to 3.66 m**		0.00
1				
2				
3				
		VERULAM FORMATION, 3.66 m to 12.81 m **UNIT 1, 3.66 m to 12.81 m,** Moderately weathered on shaley bedding partings from 3.66 m to 4.62 m, fresh, very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and very thin interbeds of medium grey **SHALE.** Shaley component tends to slake. Medium grained crystalline calcarenite bed at 5.22-.34m. Lithoclastic calcarenite with shaley clasts at 9.75-.82m. More prominent shale beds at 8.62-.67m and 8.74-.80m. Open weathered shaley bedding parting at 7.57-.59m. Measured shale content on per core run basis comprises approximately 25 to 39 percent averaging 30 percent. Sharp basal contact noted by decrease in shaley content at 12.81m.		228.32 3.66
4				
5	Rotary Drill HQ Core			226.76 5.22 5.34 5.50
6				
7				
				224.41 7.59
8				
				223.36 8.80
9				
				222.23 9.82
10		*CONTINUED NEXT PAGE*		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 2 OF 6

LOCATION: N 4930363.1 ;E 644323.0

DRILLING DATE: September 3-5, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

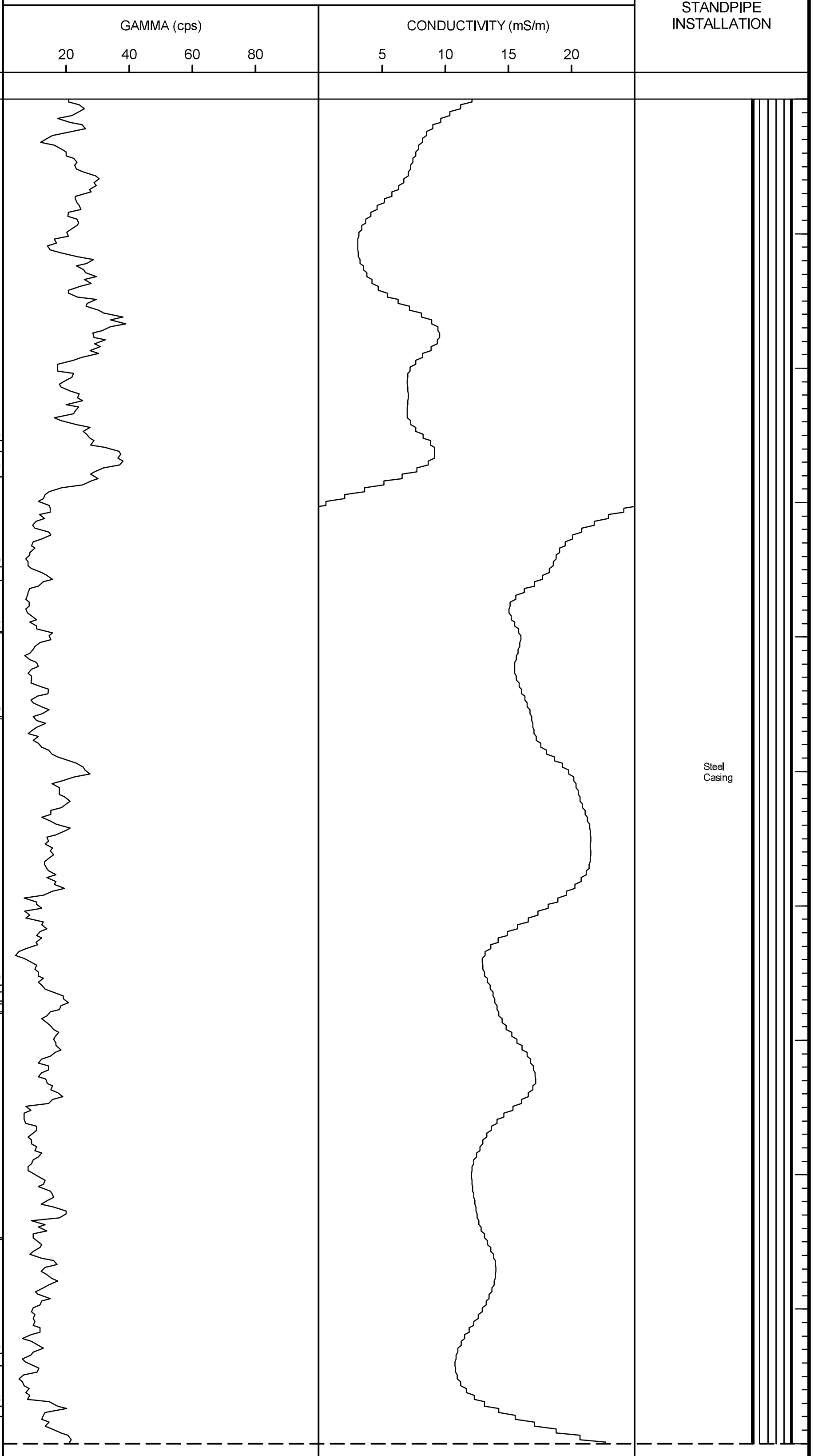
Drilling record: Rotary Drill, HQ Core

VERULAM FORMATION, 3.66 m to 12.81 m
UNIT 1, 3.66 m to 12.81 m, Moderately weathered on shaley bedding partings from 3.66 m to 4.62 m, fresh, very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** and very thin interbeds of medium grey **SHALE.** Shaley component tends to slake. Medium grained crystalline calcarenite bed at 5.22-.34m. Lithoclastic calcarenite with shaley clasts at 9.75-.82m. More prominent shale beds at 8.62-.67m and 8.74-.80m. Open weathered shaley bedding parting at 7.57-.59m. Measured shale content on per core run basis comprises approximately 25 to 39 percent averaging 30 percent. Sharp basal contact noted by decrease in shaley content at 12.81m.

BOBCAYGEON FORMATION, 12.81 m to 39.45 m
UNIT 4, 12.81 m to 25.40 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 20.07-.42m with open weathered clayey shale bedding parting at 20.29-.31m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 22.83-23.77m. Additional prominent shale partings at 14.59-.61m, 16.59-.64m and 16.71-.82m. Argillaceous to shaley component per core run 1 to 12 percent averaging 9 percent. Gradational basal contact.

ELEV.	DEPTH (m)
219.44	12.54
	12.62
219.17	12.81
218.50	13.48
	13.58
218.02	13.97
217.39	14.61
215.39	16.80
213.51	18.48
212.65	19.33
	19.42
212.26	19.72
	19.80

GEOPHYSICAL RECORD



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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 3 OF 6

LOCATION: N 4930363.1 ;E 644323.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 3-5, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

--- CONTINUED FROM PREVIOUS PAGE ---

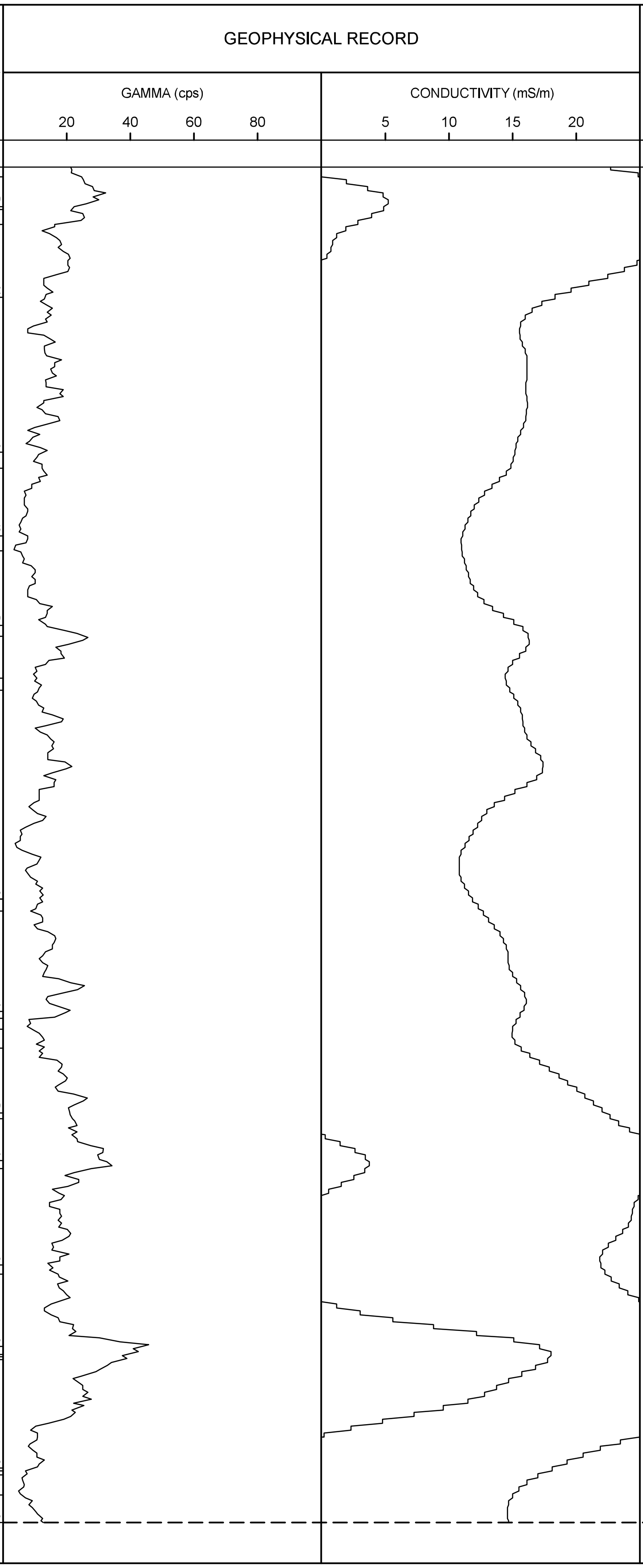
Drilling record: Rotary Drill, HQ Core

BOBCAYGEON FORMATION, 12.81 m to 39.45 m

UNIT 4, 12.81 m to 25.40 m Fresh, medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 20.07-.42m with open weathered clayey shale bedding parting at 20.29-.31m. Thinly bedded **ARGILLACEOUS MICRITIC LIMESTONE and SHALE** at 22.83-23.77m. Additional prominent shale partings at 14.59-.61m, 16.59-.64m and 16.71-.82m. Argillaceous to shaley component per core run 1 to 12 percent averaging 9 percent. Gradational basal contact.

UNIT 3, 25.40 m to 31.04 m Fresh, medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings at 26.98-27.02m (burrow casts), 27.35-.36m, 27.37-.39m, 28.70-.76m, 28.78-.80m and 30.64-.66m. Thin, medium grey gastropod fossil limestone bed at 30.00-.16m and scattered pelecypod fossil shells throughout. Argillaceous to shaley component per core run 5 to 10 percent averaging 6.7 percent. Sharp basal contact.

ELEV.	DEPTH (m)
211.91	20.07
211.69	20.31
	20.42
211.02	20.96
209.88	22.10
	22.22
209.26	22.72
	22.83
208.60	23.38
	23.46
208.21	23.77
	23.86
206.58	25.40
	25.49
205.75	26.28
	26.36
	26.50
205.00	27.02
204.65	27.39
203.88	28.17
203.28	28.80
202.38	29.65
	29.80
201.98	



Steel Casing

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

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DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 4 OF 6

LOCATION: N 4930363.1 ;E 644323.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 3-5, 2019
DRILL RIG: CME 75 - Track Mounted
DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

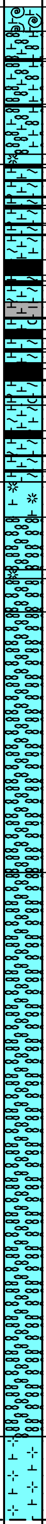
--- CONTINUED FROM PREVIOUS PAGE ---

Depth scale (metres): 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

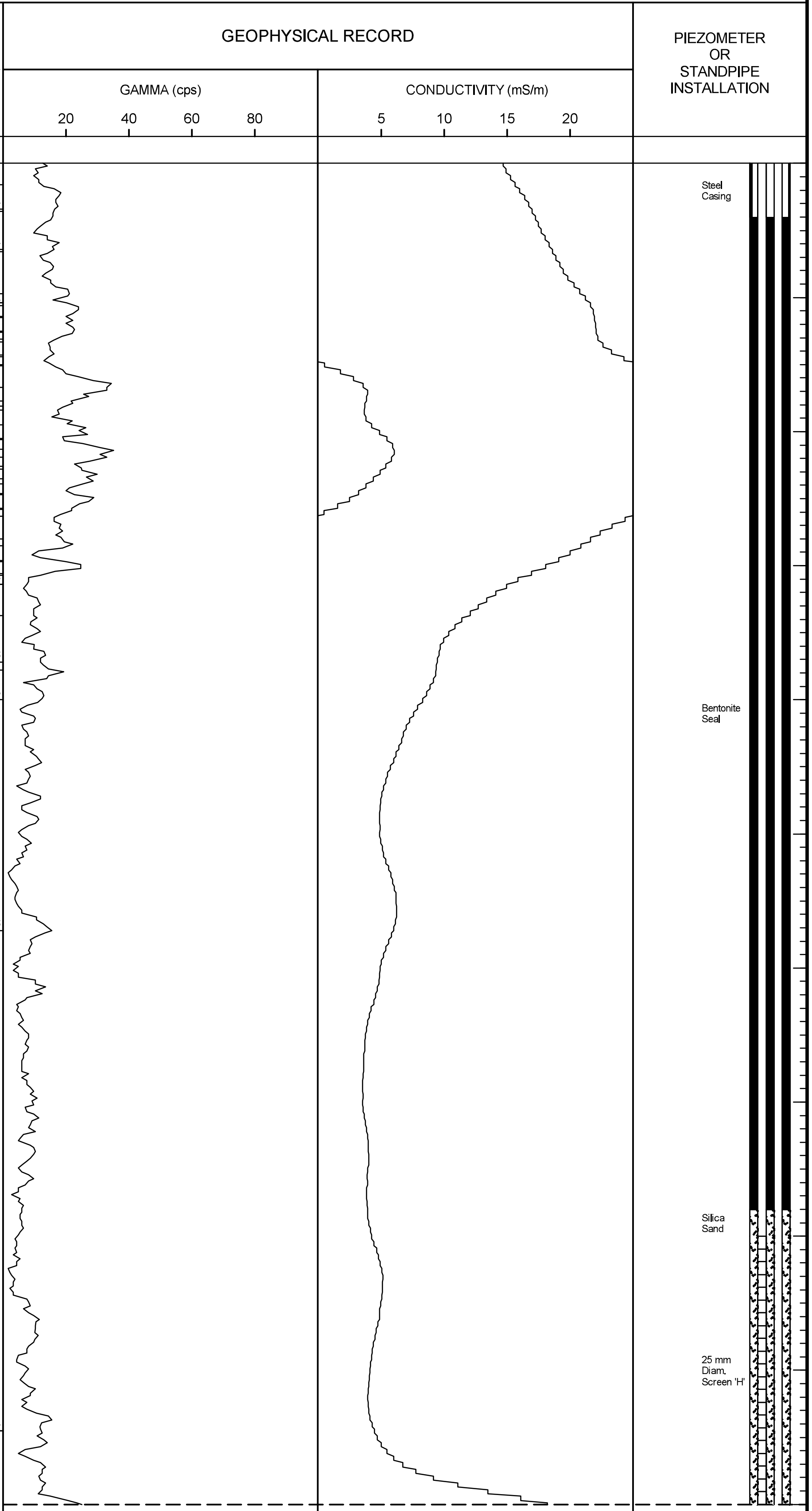
Drilling record: Rotary Drill, HQ Core

UNIT 2, 31.04 m to 33.14 m Fresh, medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings, some with burrow casts and gastropod fossils. Bioclastic limestone beds with pelecypod shells at 32.06-.13m and 32.58-.63m. More prominent shale beds at 31.67-.77m, 31.81-.84m, 32.13-.19m, 32.26-.28m and 32.35-.39m. Argillaceous to shaley component per core run 8 to 17 percent averaging 12.5 percent (2 measurement). Sharp basal contact.

UNIT 1, 33.14 m to 39.45 m Fresh, medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Thin, medium grained crystalline calcarenitic limestone bed at 33.14-.23m (fine-medium grained), 33.23-.37m (medium-coarse grained), 33.72-.78m and 34.00-.10m. Argillaceous content per core run 1 to 4 percent, average 1.8 percent. Basal limestone with burrow casts at 39.79-.85m. Sharp basal contact noted by colour change from medium brownish grey micritic limestone to light creamy brown lithographic limestone across bedding parting.



ELEV. / DEPTH (m):
30.00
30.16
201.64
30.36
201.34
30.66
201.01
200.94
31.04
31.06
31.15
31.33
31.51
31.67
31.84
31.95
32.47
32.63
32.85
32.97
198.64
33.14
198.61
33.37
198.26
33.78
197.98
34.00
196.26
35.72
192.53
39.45



CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 5 OF 6

LOCATION: N 4930363.1 ;E 644323.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 3-5, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | GEOPHYSICAL RECORD | PIEZOMETER OR STANDPIPE INSTALLATION

DRILLING RECORD: Rotary Drill, HQ Core

DEPTH SCALE METRES: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

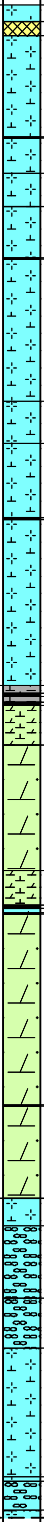
--- CONTINUED FROM PREVIOUS PAGE ---

GULL RIVER FORMATION, 39.45 m to 51.84 m

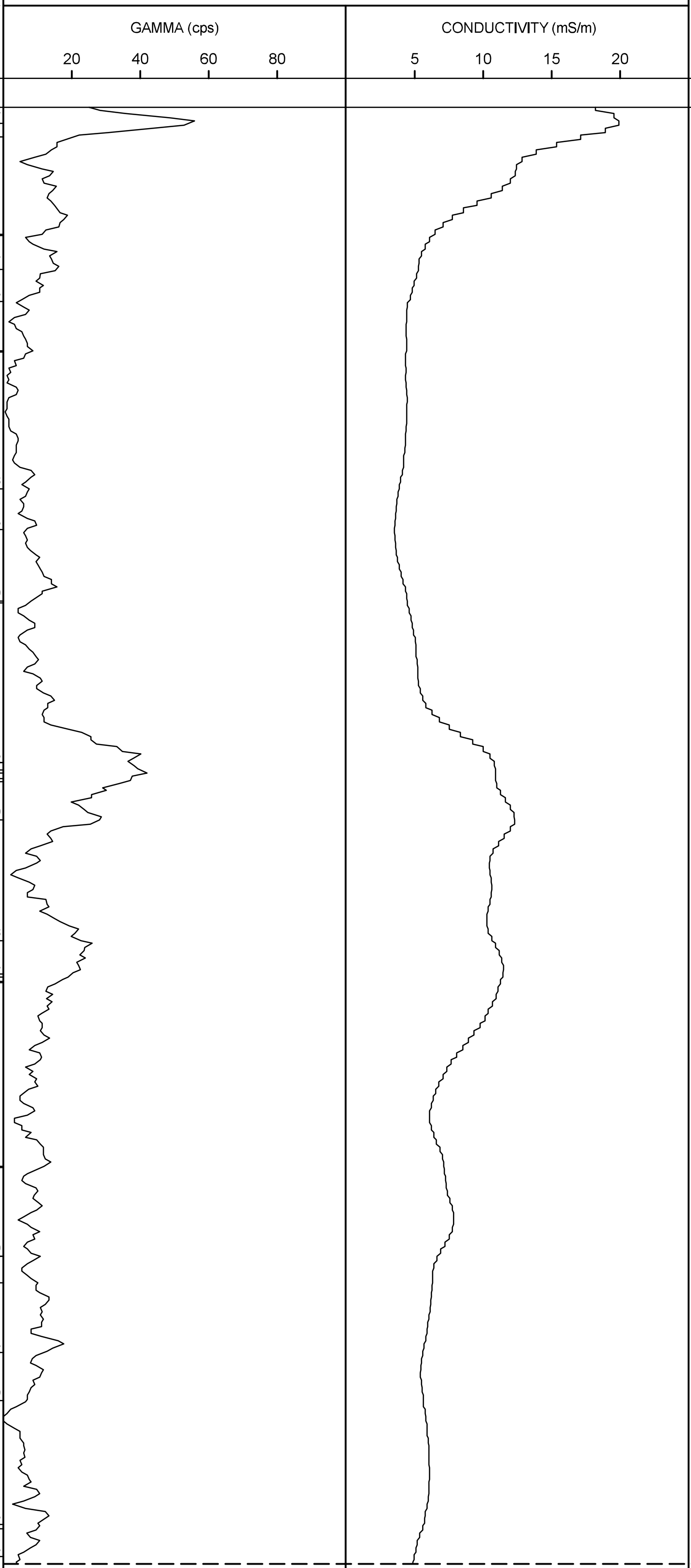
UNIT 4, 39.45 m to 44.50 m Fresh, creamy light to medium brown, creamy white at 41.33-42.90m, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly to completely weathered, medium grey, non-calcareous **CLAYEY SHALE MARKER BED** developed from shale at 40.11-.20m. Additional intact grey shale partings at 40.87m (5mm), 41.11m (5mm), 41.33m (2mm), 41.67-.68m and 43.39-.40m. Sharp basal contact with underlying laminated shale.

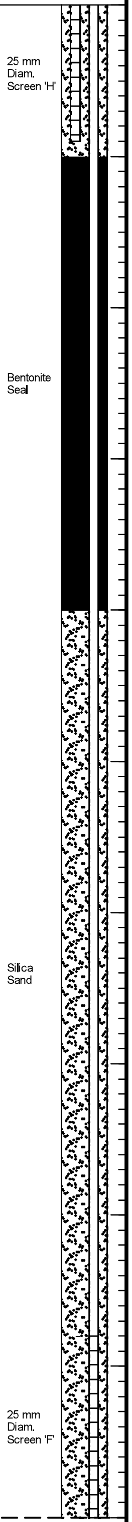
UNIT 3, 44.50 m to 47.89 m Fresh, medium grey, fine grained, non-porous laminated (1-10mm layers) **SHALE and LIMESTONE** cap at 44.50-.63m overlying medium grey to greenish grey, fine to medium grained crystalline, faintly to moderately porous, saccharoidal textured, stylolitic, medium to thickly bedded **DOLOSTONE** at 44.63-45.93m with calcareous dolostone interbeds at 44.63-.89m and 45.72-.95m. Very thin limestone bed at 45.97-46.00m. Dark grey shale partings at 44.55-.57m, 44.61-.63m, 45.95-.97m and 46.00-.01m. Section overlies light brownish grey, fine grained saccharoidal, faintly porous, stylolitic, massive textured, thickly bedded **DOLOSTONE** with shaley parting at 47.27-.28m. Sharp basal contact marked by well developed stylolite at 50.07-.09m separating dolostone from limestone. Dolostone sequence forms **The Green Bed.**

UNIT 2, 47.89 m to 51.84 m, Fresh, creamy light to medium brown, creamy white at 50.54-.90m, very fine grained, porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Thick bed of light brown **NODULAR LITHOGRAPHIC LIMESTONE** at 48.07-.87m and second thin bed at 49.76-.95m with medium brown limestone cap at 49.73-.76m. Brown laminated limestone at 50.97-51.15m. Prominent well developed stylolites at 48.88m and 50.72m. Argillaceous partings at 51.39-40m and medium brownish grey



191.87
40.11
40.20
191.11
40.88
190.87
41.11
190.65
41.33
190.31
41.68
189.36
42.62
189.08
42.90
188.59
43.40
187.48
44.50
44.63
187.09
44.89
186.26
45.72
186.03
46.01
184.71
47.28
184.09
47.89
183.91
48.07
183.43
48.55
183.10
48.88
182.25
49.76
182.03





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OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-5

SHEET 6 OF 6

LOCATION: N 4930363.1 ;E 644323.0

INCLINATION: -90° AZIMUTH: ---

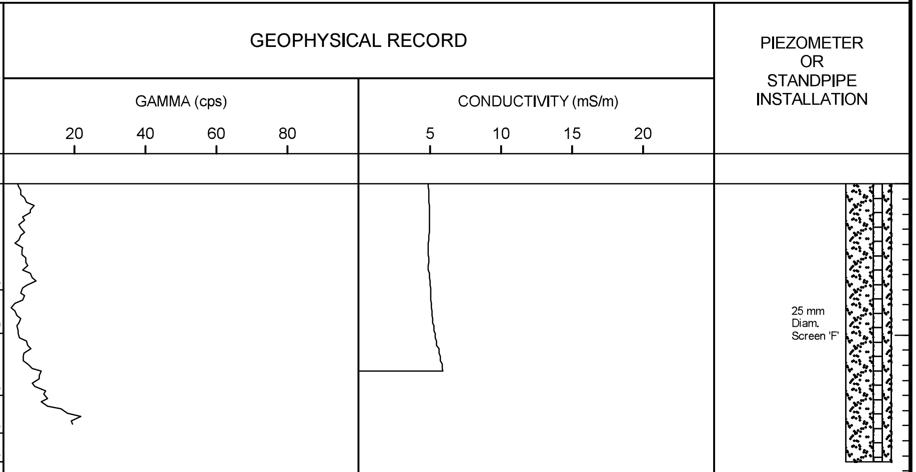
DRILLING DATE: September 3-5, 2019

DRILL RIG: CME 75 - Track Mounted

DRILLING CONTRACTOR: Orbit-Garant Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
50	Rotary Drill HQ Core	**CALCAREOUS DOLOSTONE** bed at 51.65-.84m.		49.95
				181.28 50.70
51				180.99 50.99
				180.58 51.40
				180.33 51.65
				180.14 51.84
52		**End of Borehole, 51.84 m**		
53				
54				
55				
56				
57				
58				
59				
60				



DEPTH SCALE

1 : 50

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-6

SHEET 1 OF 5

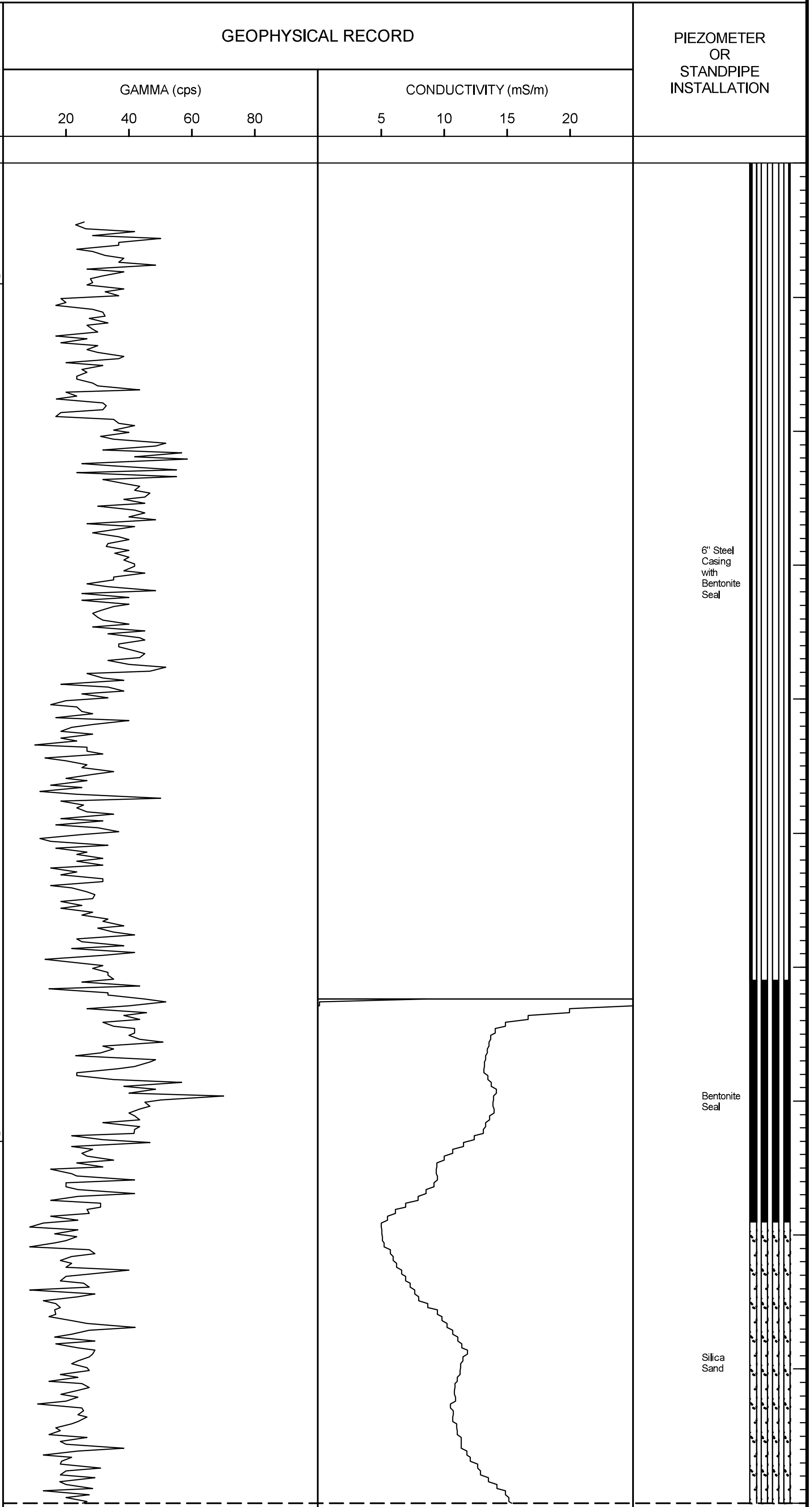
LOCATION: N 4930121.7 ;E 644672.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 2, 2020
DRILL RIG: Schramm T450WS
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		234.19
0	Dual Rotary - Air Percussion 152 mm Casing	**Overburden, 0.0 m to 0.9 m**	▨	0.00
		Bedrock Surface, 0.9 m		233.29
1		**VERULAM FORMATION, 0.9 m to 17.9 m** **UNIT 2, 0.9 m to 7.3 m,** Very thinly to thinly interbedded medium brownish grey to medium grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE and SHALE.** Transitional basal contact.		0.90
2				
3				
4				
5				
6				
7				226.89
		UNIT 1, 7.3 m to 17.9 m, Very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE.** Sharp basal contact.		7.30
8				
9				
10				



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DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-6

SHEET 2 OF 5

LOCATION: N 4930121.7 ;E 644672.8

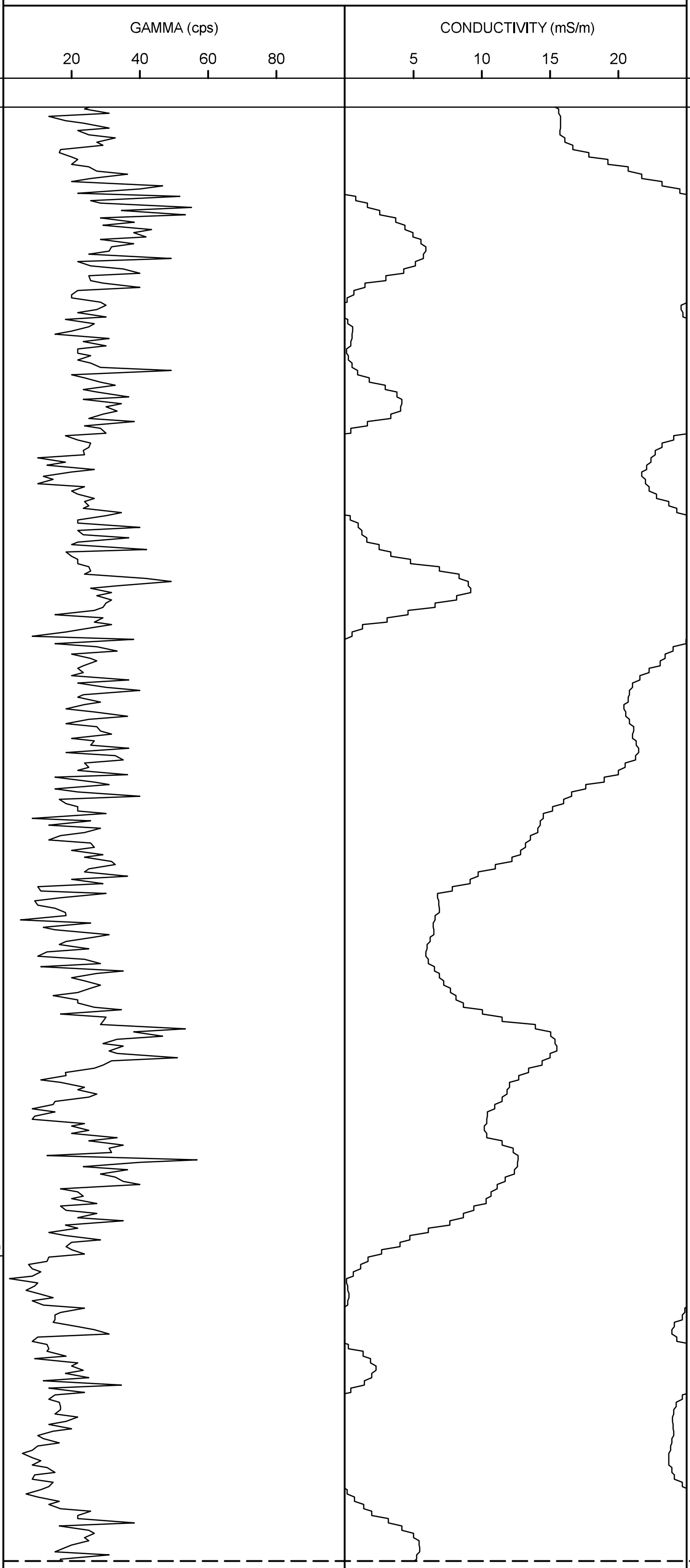
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 2, 2020
DRILL RIG: Schramm T450WS
DRILLING CONTRACTOR: Vinson Well Drilling

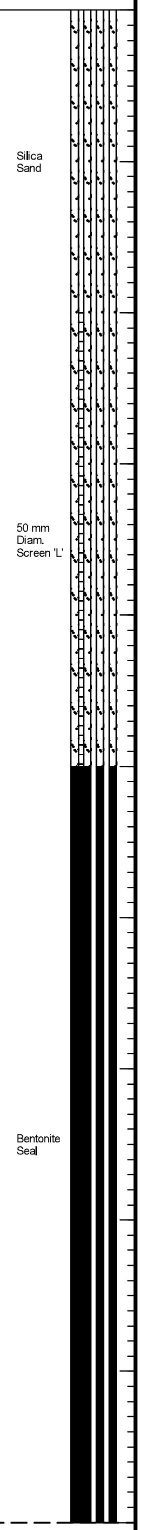
DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
10 – 17.9	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 1, 7.3 m to 17.9 m,** Very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE.** Sharp basal contact.	▨	
17.9 – 20		**BOBCAYGEON FORMATION, 17.9 m to 42.5 m** **UNIT 4, 17.7 m to 30.8 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 24.8-25.5m. Gradational basal contact.	🟦	216.29 17.90
		CONTINUED NEXT PAGE		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-6

SHEET 3 OF 5

LOCATION: N 4930121.7 ;E 644672.8

DRILLING DATE: September 2, 2020

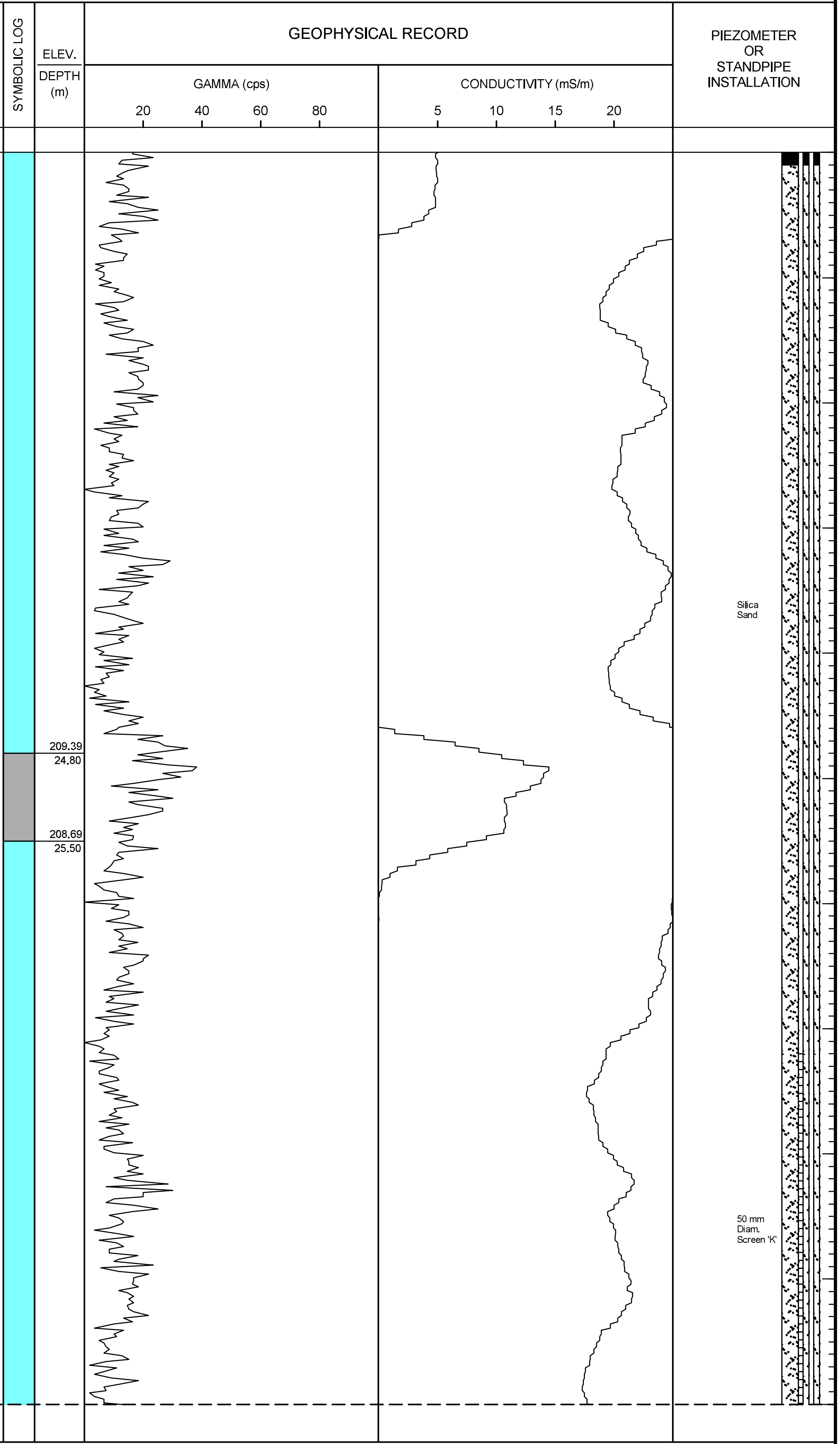
DATUM: Geodetic

DRILL RIG: Schramm T450WS

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Vinson Well Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION
		--- CONTINUED FROM PREVIOUS PAGE ---
20–30	Dual Rotary - Air Percussion 152 mm Casing	**BOBCAYGEON FORMATION, 17.9 m to 42.5 m** **UNIT 4, 17.7 m to 30.8 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 24.8-25.5m. Gradational basal contact.
		CONTINUED NEXT PAGE



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-6

SHEET 4 OF 5

LOCATION: N 4930121.7 ;E 644672.8

INCLINATION: -90° AZIMUTH: ---

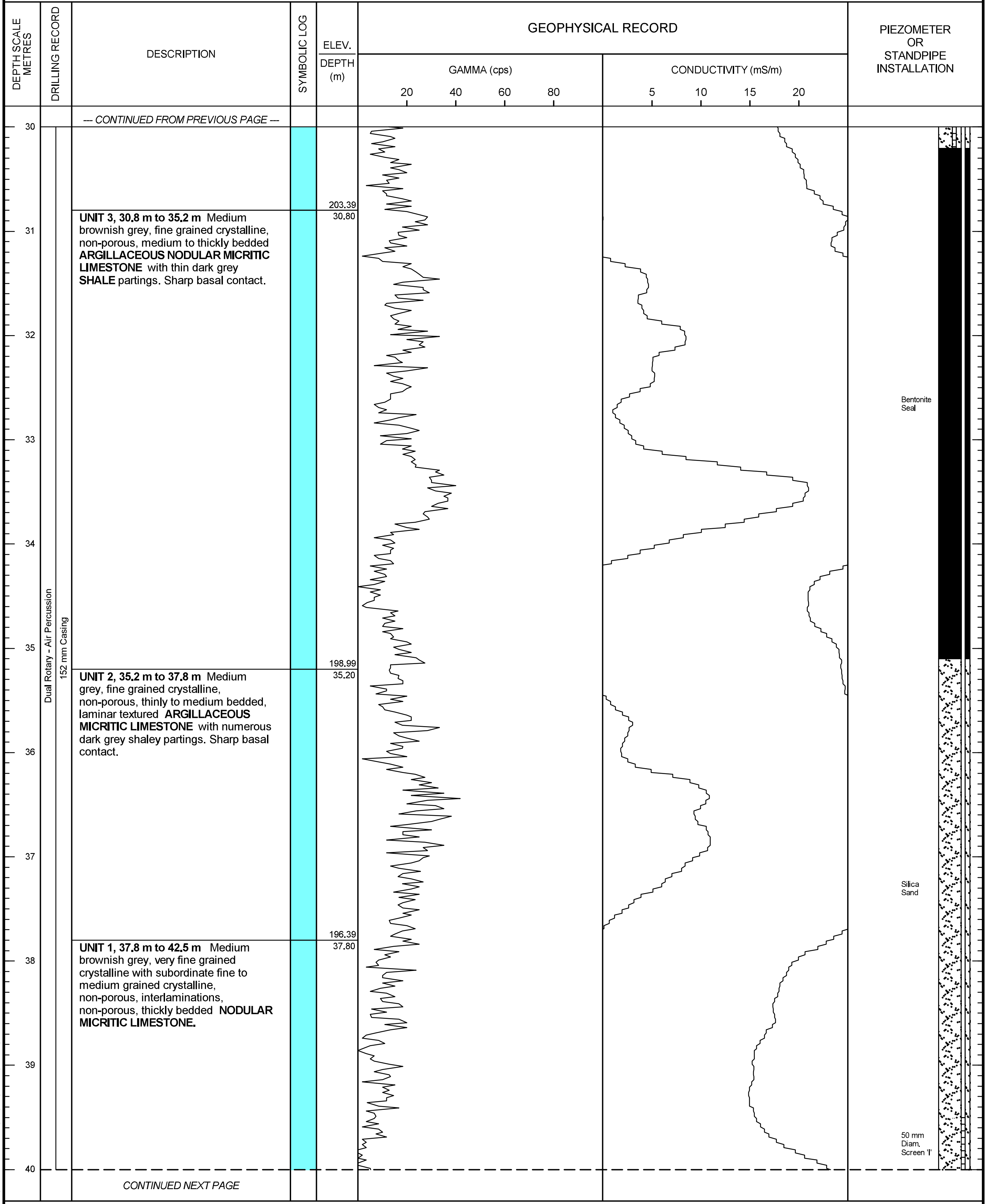
DRILLING DATE: September 2, 2020

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- *CONTINUED FROM PREVIOUS PAGE* ---		
30	Dual Rotary - Air Percussion 152 mm Casing			203.39 30.80
31		**UNIT 3, 30.8 m to 35.2 m** Medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Sharp basal contact.		198.99 35.20
35		**UNIT 2, 35.2 m to 37.8 m** Medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings. Sharp basal contact.		196.39 37.80
38		**UNIT 1, 37.8 m to 42.5 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.**		
40		*CONTINUED NEXT PAGE*		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-6

SHEET 5 OF 5

LOCATION: N 4930121.7 ;E 644672.8

DRILLING DATE: September 2, 2020

DATUM: Geodetic

DRILL RIG: Schramm T450WS

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Vinson Well Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
40	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 1, 37.8 m to 42.5 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.**	🟦	191.69 42.50
41				
42				
		End of Borehole, 42.5 m		
43				
44				
45				
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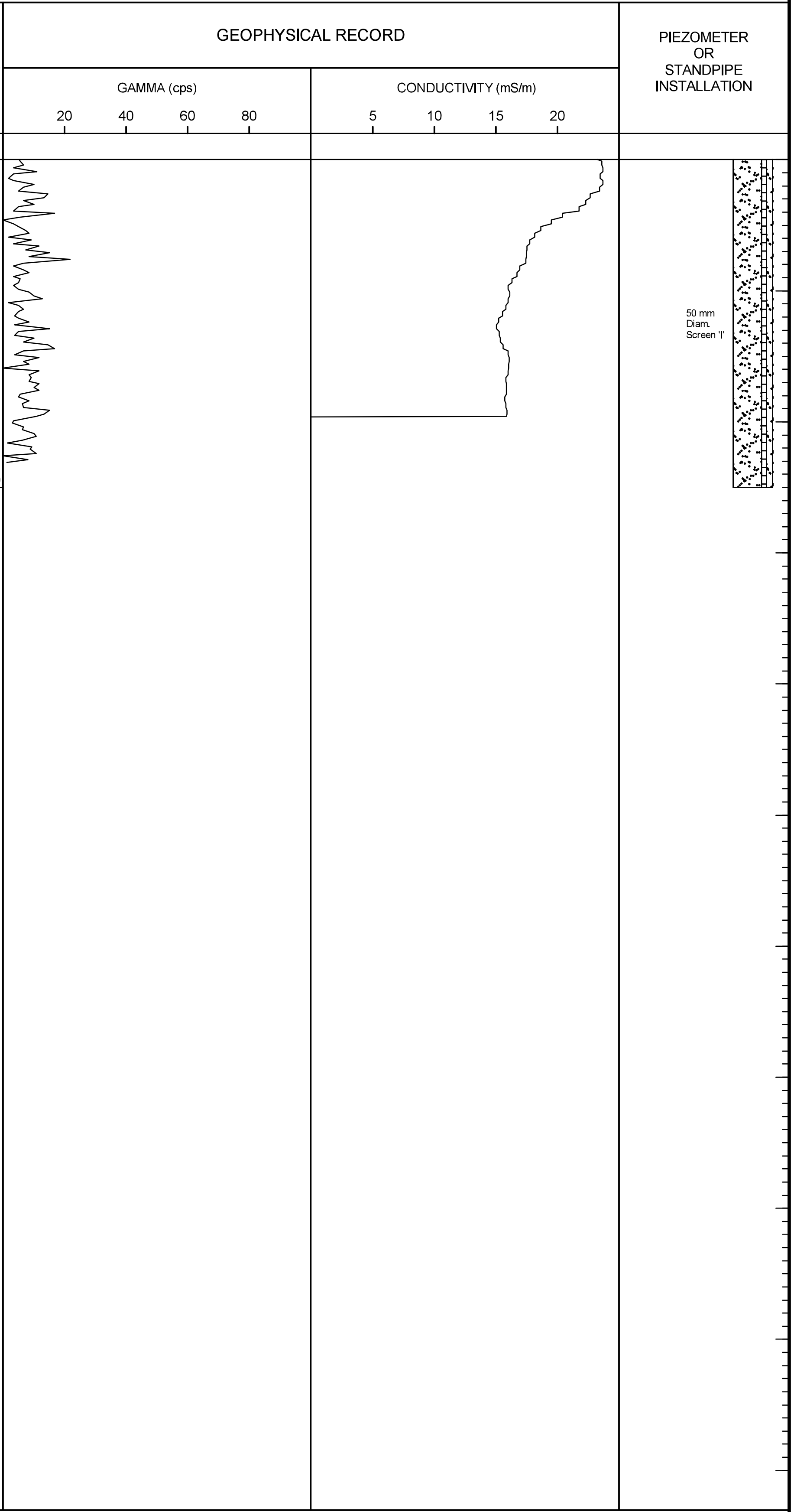
47				
48				
49				
50				



OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-7

SHEET 1 OF 5

LOCATION: N 4930103.3 ;E 645166.4

INCLINATION: -90° AZIMUTH: ---

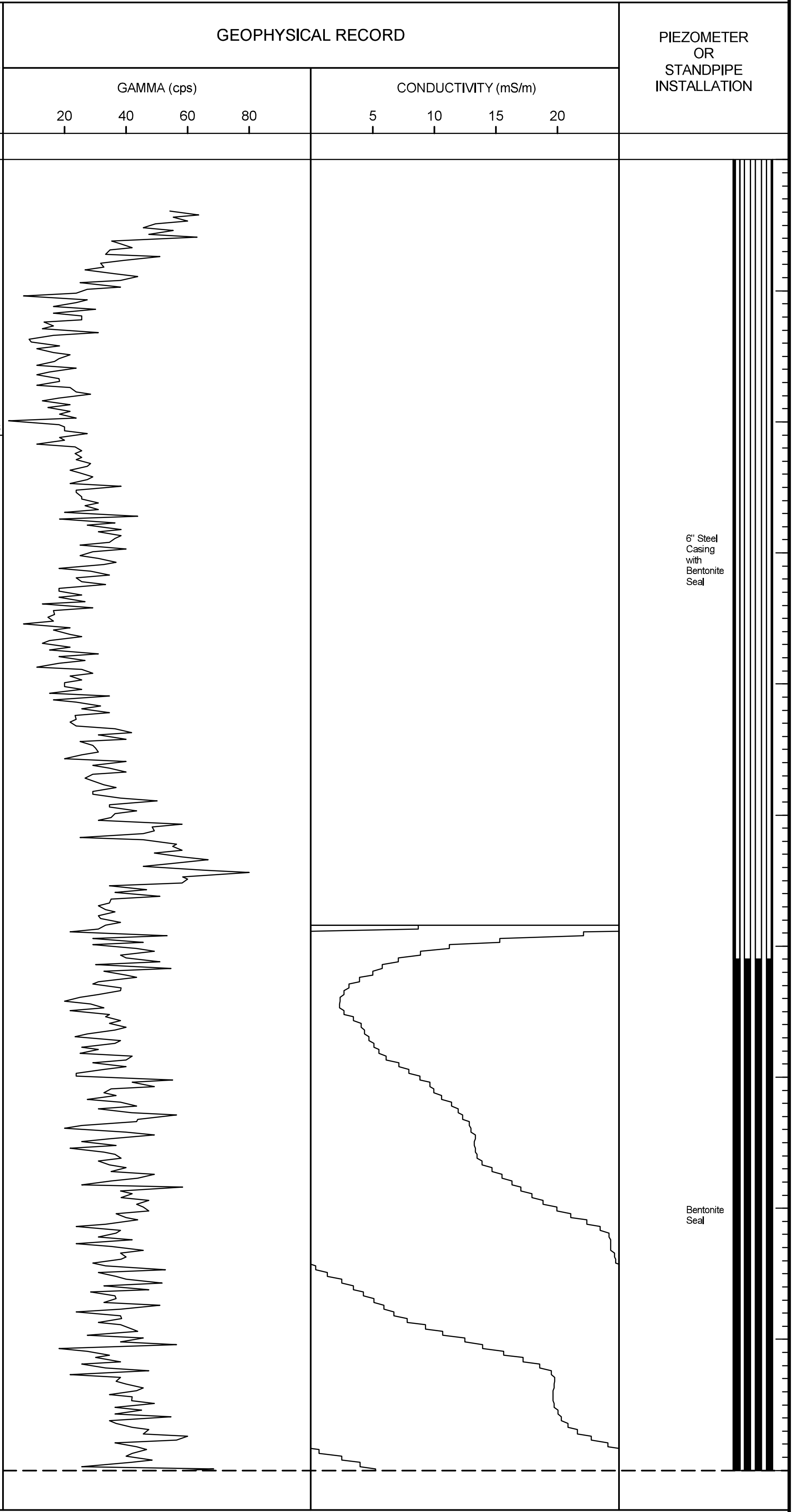
DRILLING DATE: September 3, 2020

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		239.66
0	Dual Rotary - Air Percussion 152 mm Casing	**Overburden, 0.0 m to 2.1 m**	▩	0.00
2		**Bedrock Surface, 2.1 m**		237.56 2.10
		VERULAM FORMATION, 2.1 m to 20.7 m **UNIT 2, 2.1 m to 10.5 m,** Very thinly to thinly interbedded medium brownish grey to medium grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE and SHALE.** Transitional basal contact.	▒	
10		*CONTINUED NEXT PAGE*		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-7

SHEET 2 OF 5

LOCATION: N 4930103.3 ;E 645166.4

INCLINATION: -90° AZIMUTH: ---

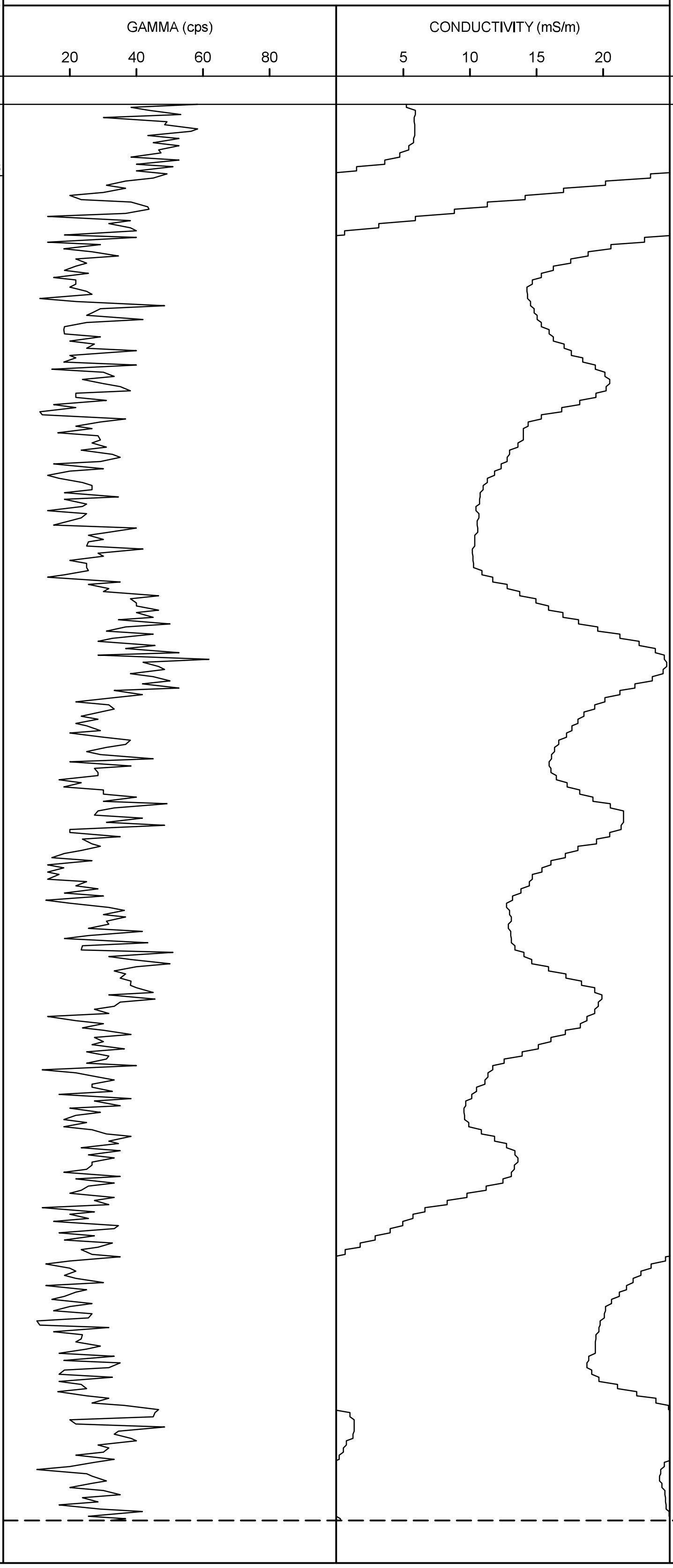
DRILLING DATE: September 3, 2020

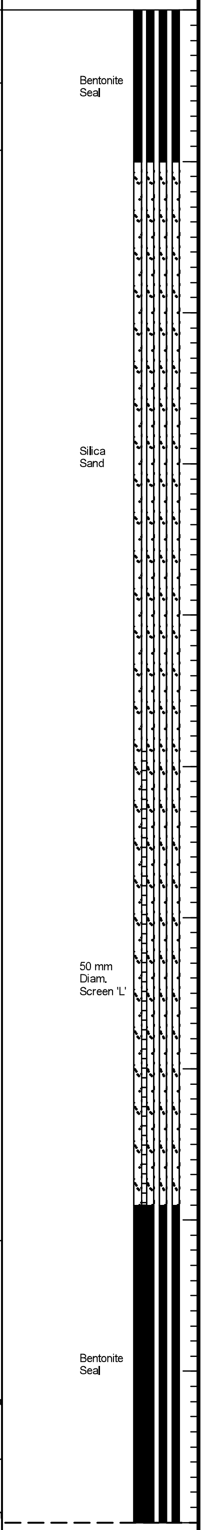
DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	GEOPHYSICAL RECORD	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---				
10	Dual Rotary - Air Percussion 152 mm Casing					
		UNIT 1, 10.5 m to 20.7 m, Very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE.** Sharp basal contact.		229.16 10.50		
11						
12						
13						
14						
15						
16						
17						
18						
19						
20		CONTINUED NEXT PAGE				





DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-7

SHEET 3 OF 5

LOCATION: N 4930103.3 ;E 645166.4

INCLINATION: -90° AZIMUTH: ---

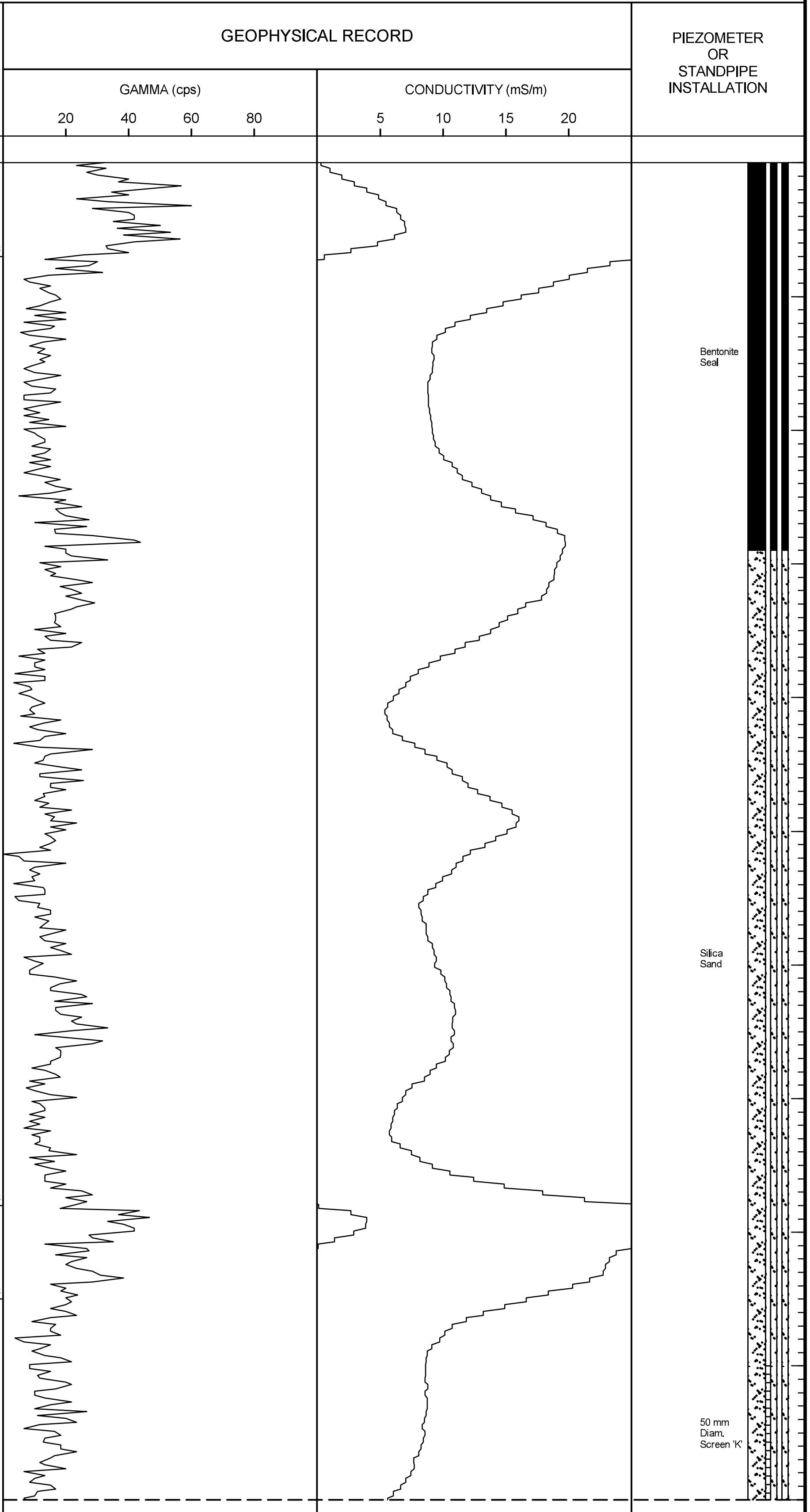
DRILLING DATE: September 3, 2020

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
20				218.96 20.70
21		**BOBCAYGEON FORMATION, 20.7 m to 42.6 m** **UNIT 4, 20.7 m to 33.9 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 27.8-28.5m. Gradational basal contact.		
22				
23				
24				
25	Dual Rotary - Air Percussion 152 mm Casing			
26				
27				211.86 27.80
28				211.16 28.50
29				
30		CONTINUED NEXT PAGE		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-7

SHEET 4 OF 5

LOCATION: N 4930103.3 ;E 645166.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 3, 2020

DRILL RIG: Schramm T450WS

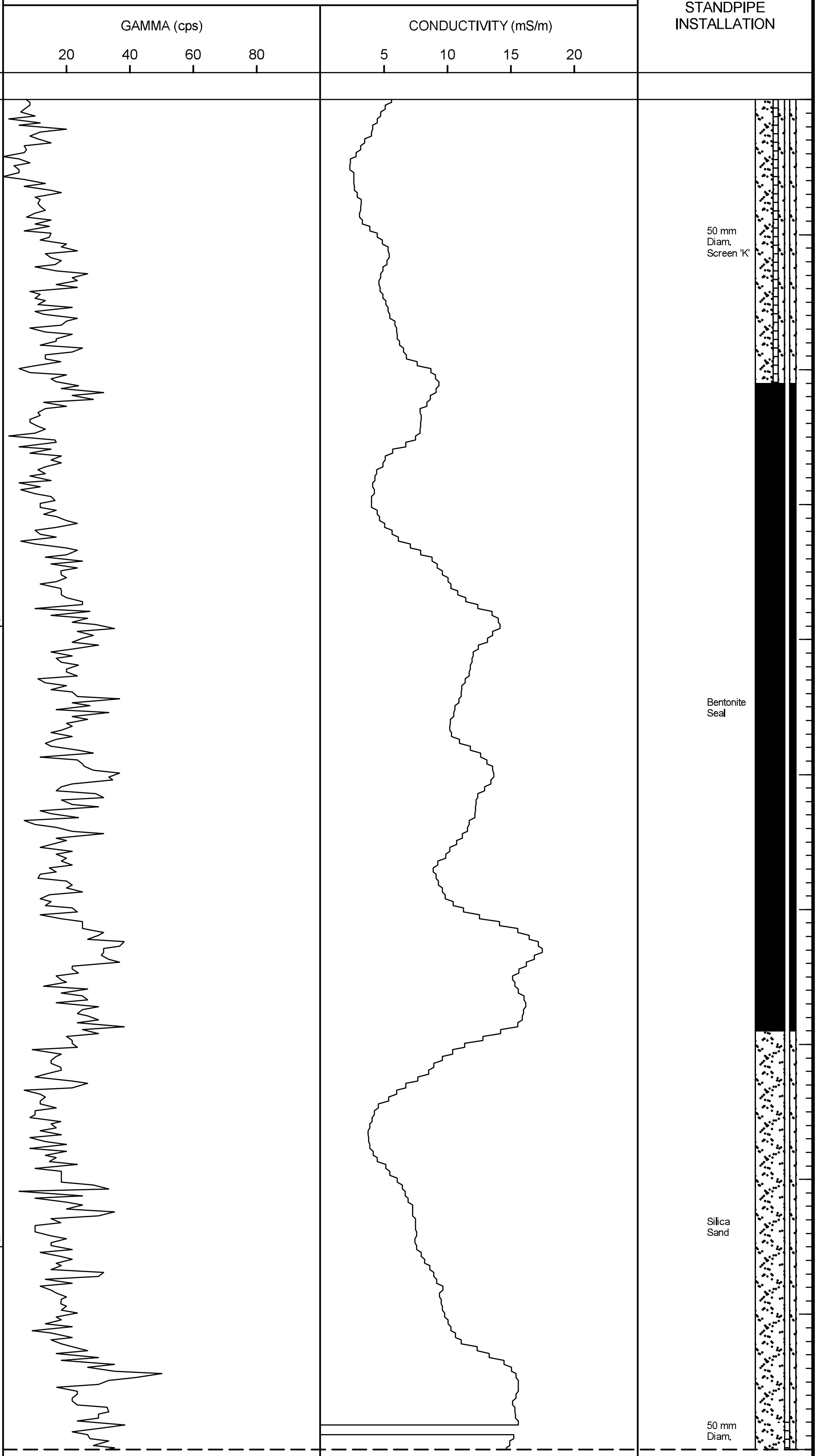
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
30	Dual Rotary - Air Percussion 152 mm Casing	**BOBCAYGEON FORMATION, 20.7 m to 42.6 m** **UNIT 4, 20.7 m to 33.9 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 27.8-28.5m. Gradational basal contact.		
34		**UNIT 3, 33.9 m to 38.5 m** Medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Gradational basal contact.		205.76 33.90
38.5		**UNIT 2, 38.5 m to 40.8 m** Medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings. Sharp basal contact.		201.16 38.50
40		*CONTINUED NEXT PAGE*		

GEOPHYSICAL RECORD

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-7

SHEET 5 OF 5

LOCATION: N 4930103.3 ;E 645166.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 3, 2020

DRILL RIG: Schramm T450WS

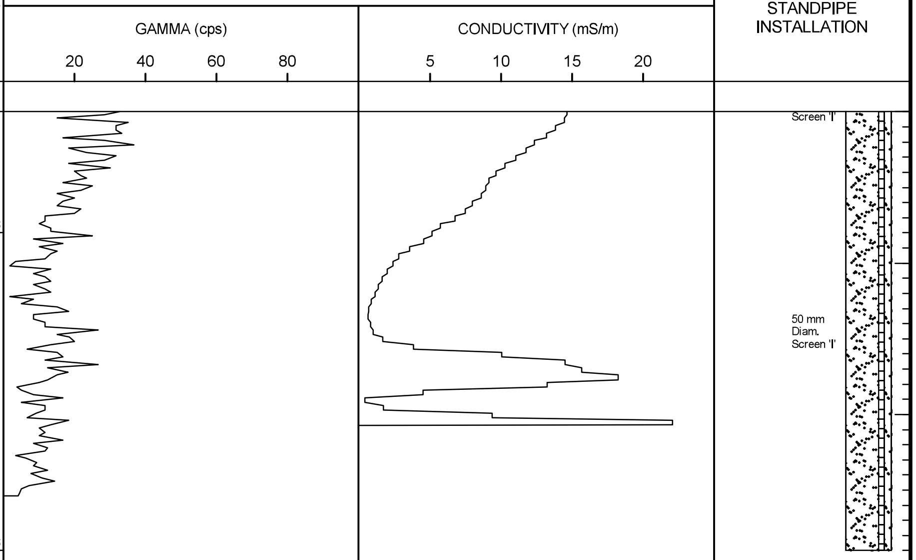
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)
40	Dual Rotary - Air Percussion 152 mm Casing		
40.8		**UNIT 1, 40.8 m to 42.9 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.**	198.86 40.80
41			
42			
42.9		**End of Borehole, 42.9 m**	196.76 42.90
43			
44			
45			
46			
47			
48			
49			
50			

GEOPHYSICAL RECORD



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-8

SHEET 1 OF 5

LOCATION: N 4930562.4 ;E 646052.6

DRILLING DATE: September 1, 2020

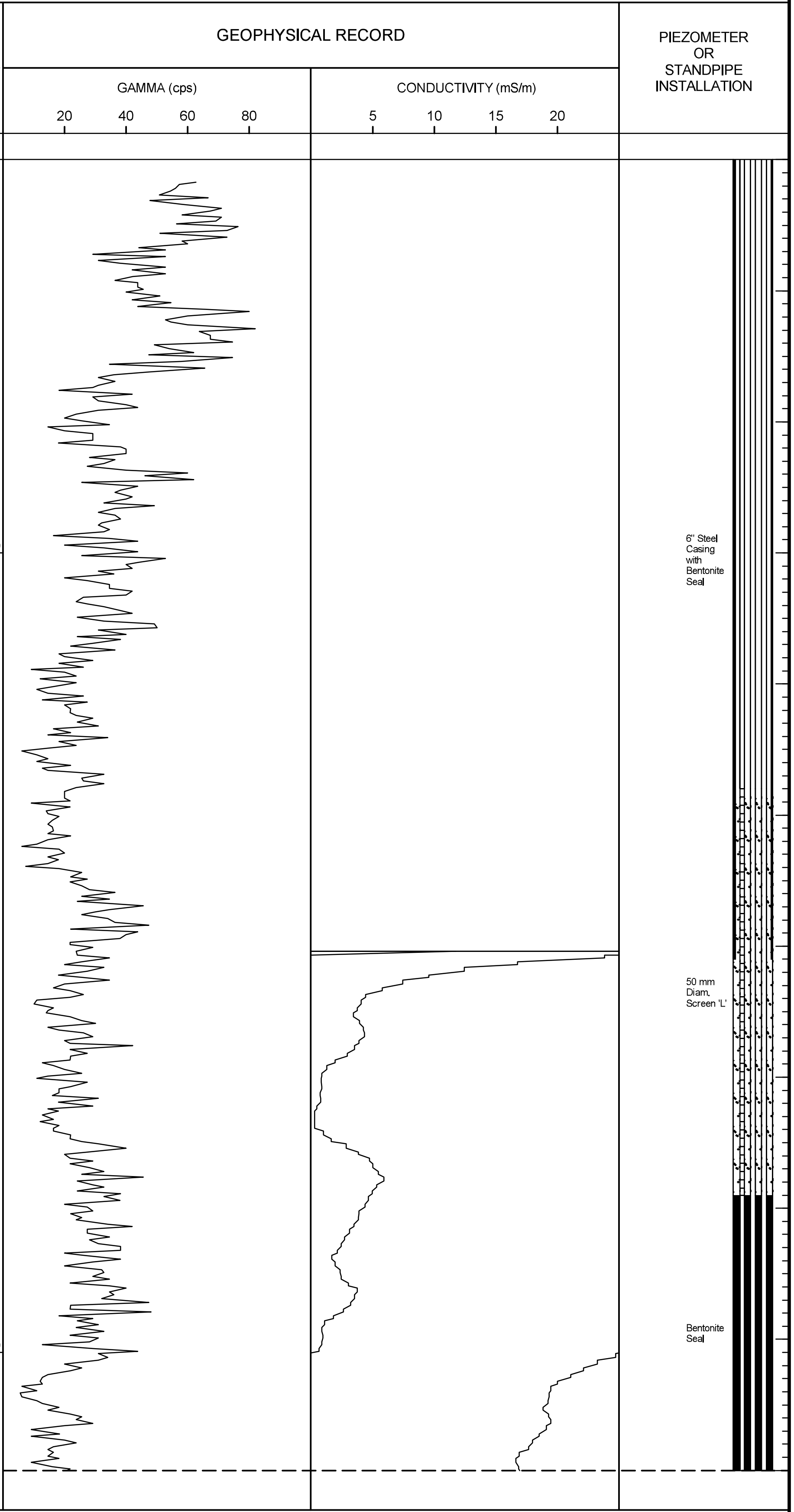
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		232.30
0	Dual Rotary - Air Percussion 152 mm Casing	**Overburden, 0.0 m to 3.0 m** **Bedrock Surface, 3.0 m**	▨	0.00
3		**VERULAM FORMATION, 3.0 m to 9.1 m,** **UNIT 1, 3.0 m to 9.1 m** Very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE.** Sharp basal contact.	■	229.30 3.00
9		**BOBCAYGEON FORMATION, 9.1 m to 35.6 m** **UNIT 4, 9.1 m to 21.6 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR**	🟦	223.20 9.10
10				



CONTINUED NEXT PAGE

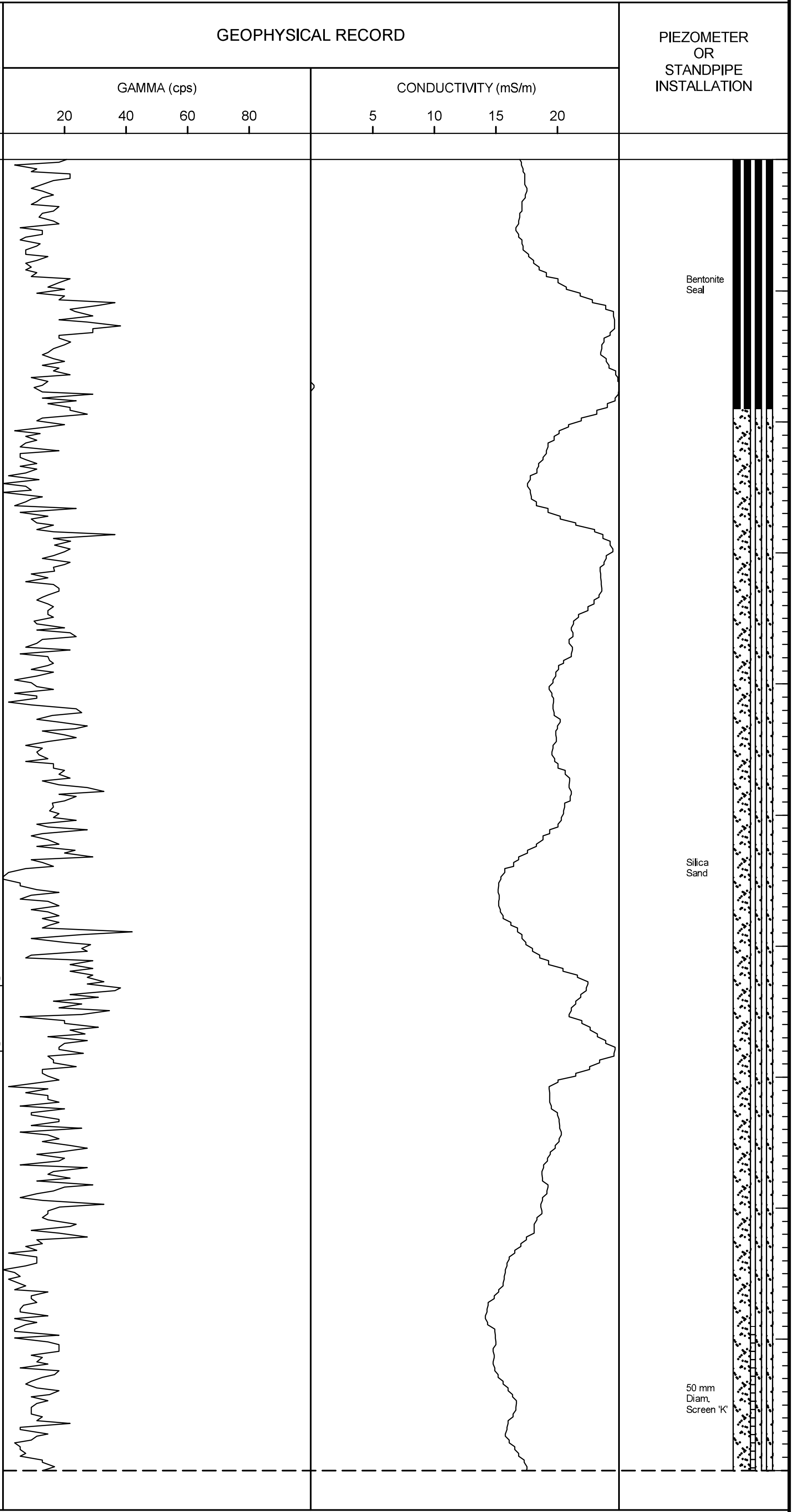
PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-8

SHEET 2 OF 5

LOCATION: N 4930562.4 ;E 646052.6
DRILLING DATE: September 1, 2020
DATUM: Geodetic
DRILL RIG: Schramm T450WS
INCLINATION: -90° AZIMUTH: ---
DRILLING CONTRACTOR: Vinson Well Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
10	Dual Rotary - Air Percussion 152 mm Casing	**CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 16.3-.8m. Gradational basal contact.		
11				
12				
13				
14				
15				
16				216.00 16.30
				215.50 16.80
17				
18				
19				
20		*CONTINUED NEXT PAGE*		



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-8

SHEET 3 OF 5

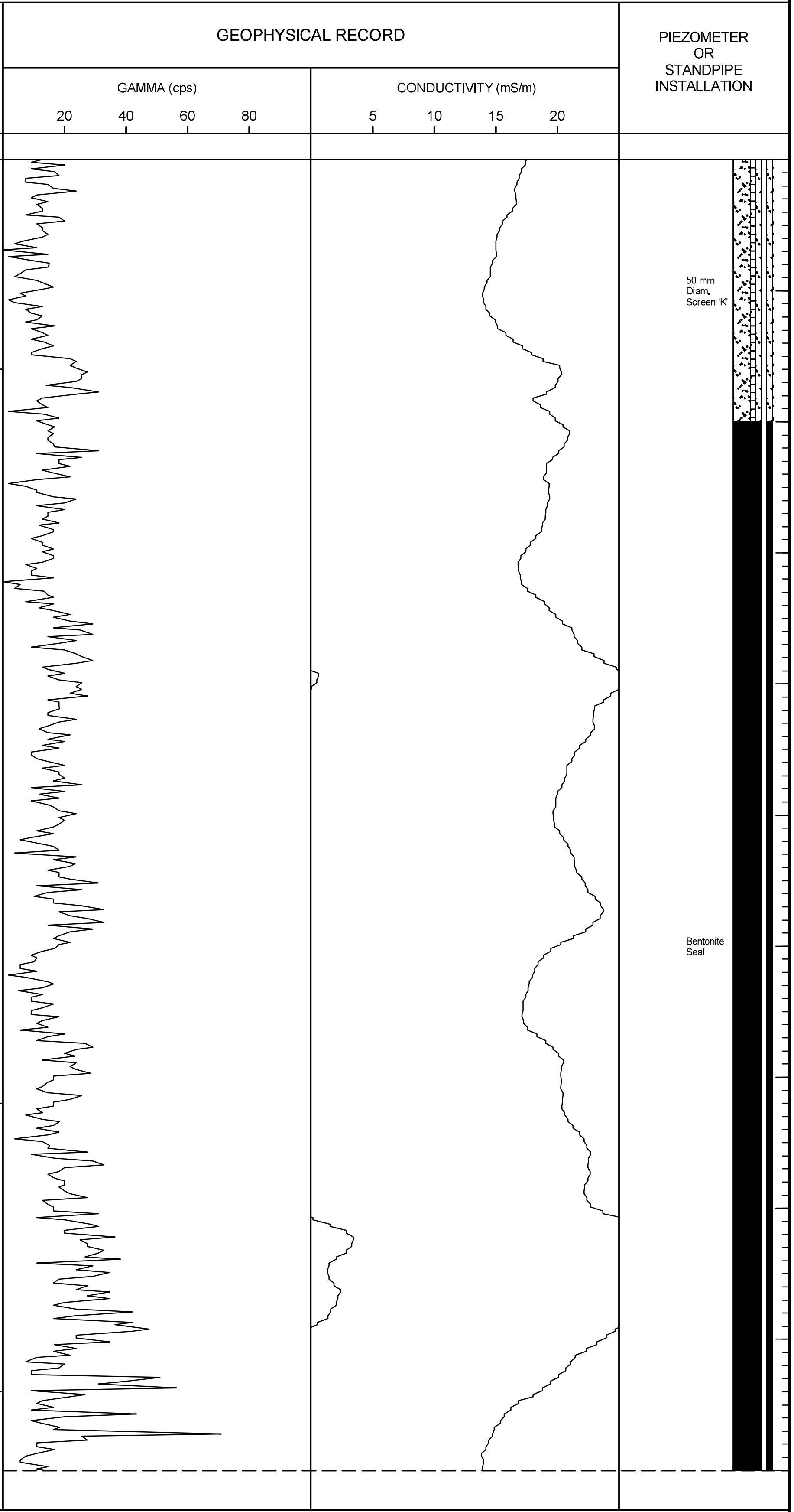
LOCATION: N 4930562.4 ;E 646052.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 1, 2020
DRILL RIG: Schramm T450WS
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
20	Dual Rotary - Air Percussion 152 mm Casing	--- CONTINUED FROM PREVIOUS PAGE ---		
21.6		**UNIT 3, 21.6 m to 27.2 m** Medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Gradational basal contact.		210.70 21.60
27.2		**UNIT 2, 27.2 m to 29.4 m** Medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings. Sharp basal contact.		205.10 27.20
29.4				202.90 29.40
30		CONTINUED NEXT PAGE		



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-8

LOCATION: N 4930562.4 ;E 646052.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 1, 2020

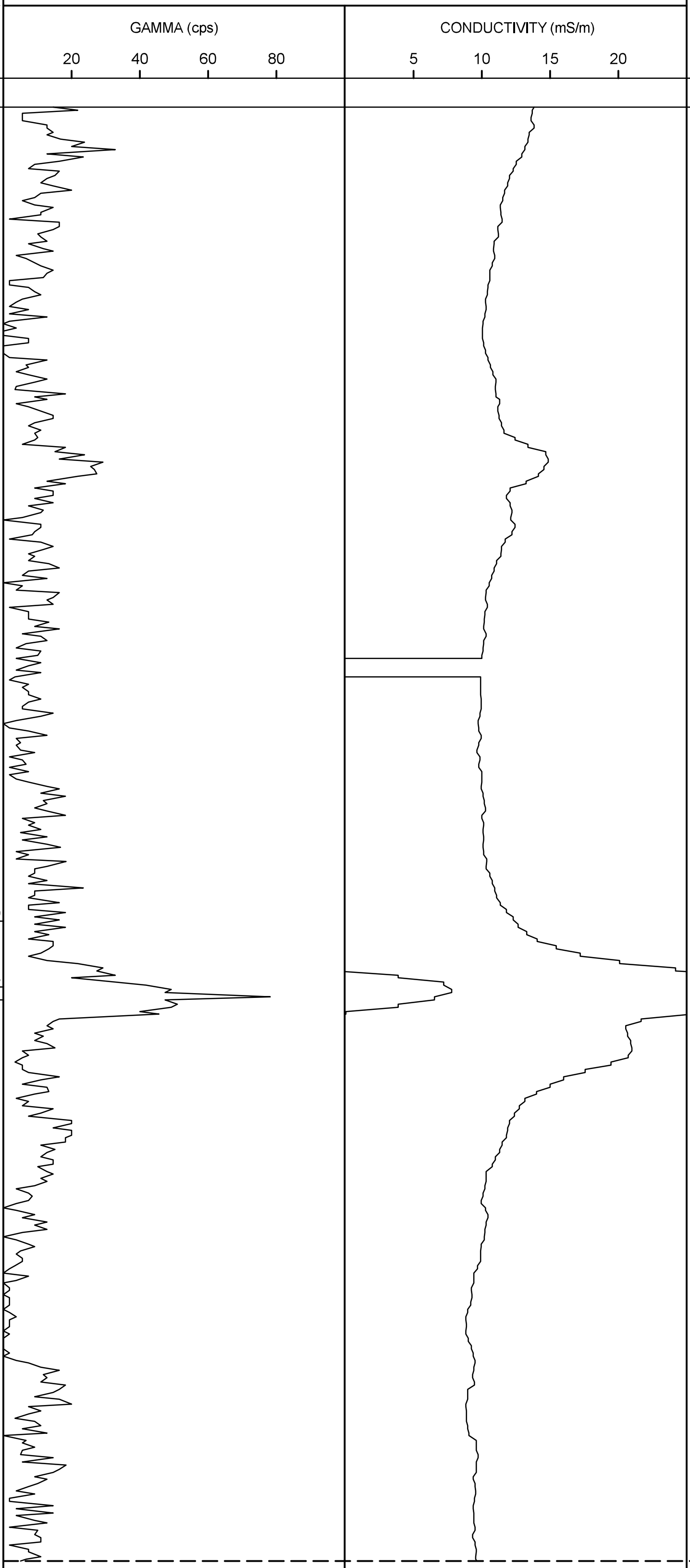
DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

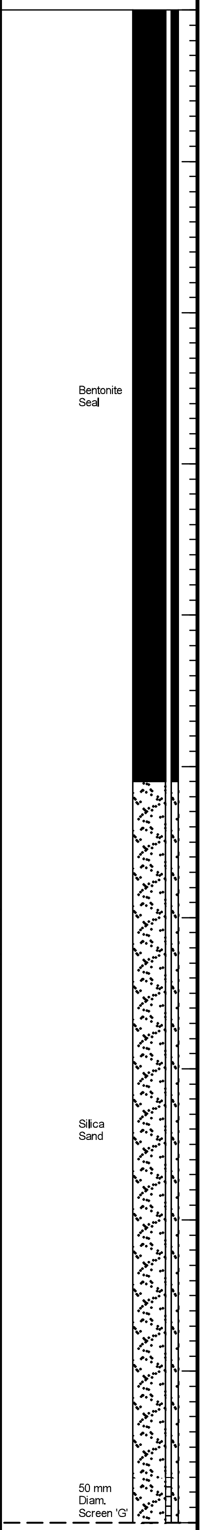
DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
30	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 1, 29.4 m to 35.6 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Sharp basal contact.		
35.6		**GULL RIVER FORMATION, 35.6 m to 42.4 m** **UNIT 4, 35.6 m to 40.45 m** Creamy light to medium brown, very fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly to completely weathered, medium greenish grey, non-calcareous **CLAYEY SHALE MARKER BED** developed from shale at 36.05-.14m. Sharp basal contact with underlying laminated shale.		196.70 35.60
36.05				196.25 36.05 36.14
40		CONTINUED NEXT PAGE		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 50

GOLDER MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-8

SHEET 5 OF 5

LOCATION: N 4930562.4 ;E 646052.6

INCLINATION: -90° AZIMUTH: ---

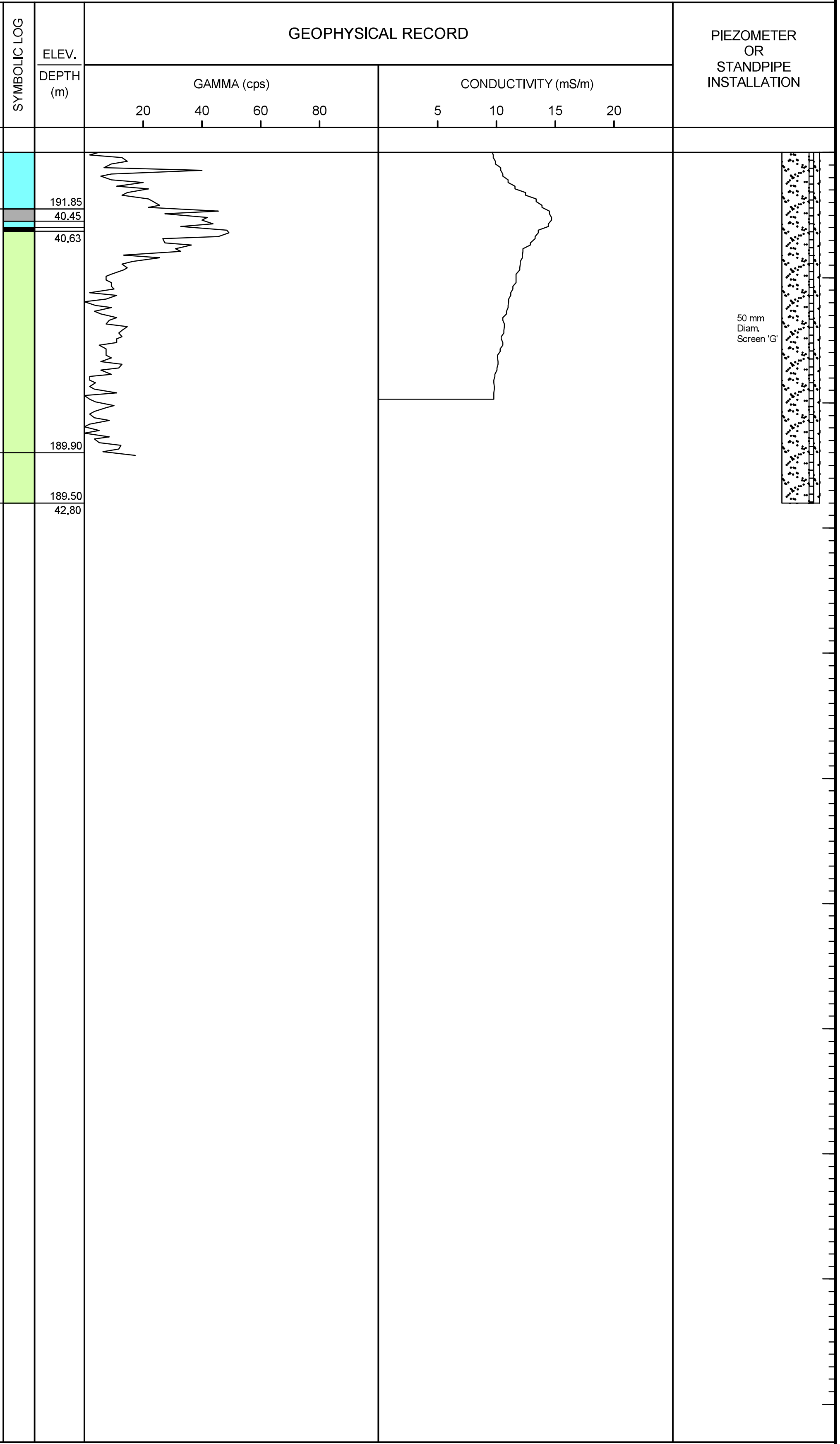
DRILLING DATE: September 1, 2020

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---	
40			191.85 40.45
	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 3, 40.45 m to 42.8 m** Light greenish grey **DOLOSTONE** sequence forming **The Green Bed.** Top of sequence at 40.45-.55m marked by interlaminated dark grey shale and lithographic limestone in 1-10mm layers overlying thin lithographic limestone at 40.55-.60m and black shale at 40.60-.63m.	40.63
41			
42			189.90
			189.50
		End of Borehole, 42.8 m	42.80
43			
44			
45			
46			
47			
48			
49			
50			



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-9

SHEET 1 OF 5

LOCATION: N 4931210.1 ;E 645872.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 16, 2020

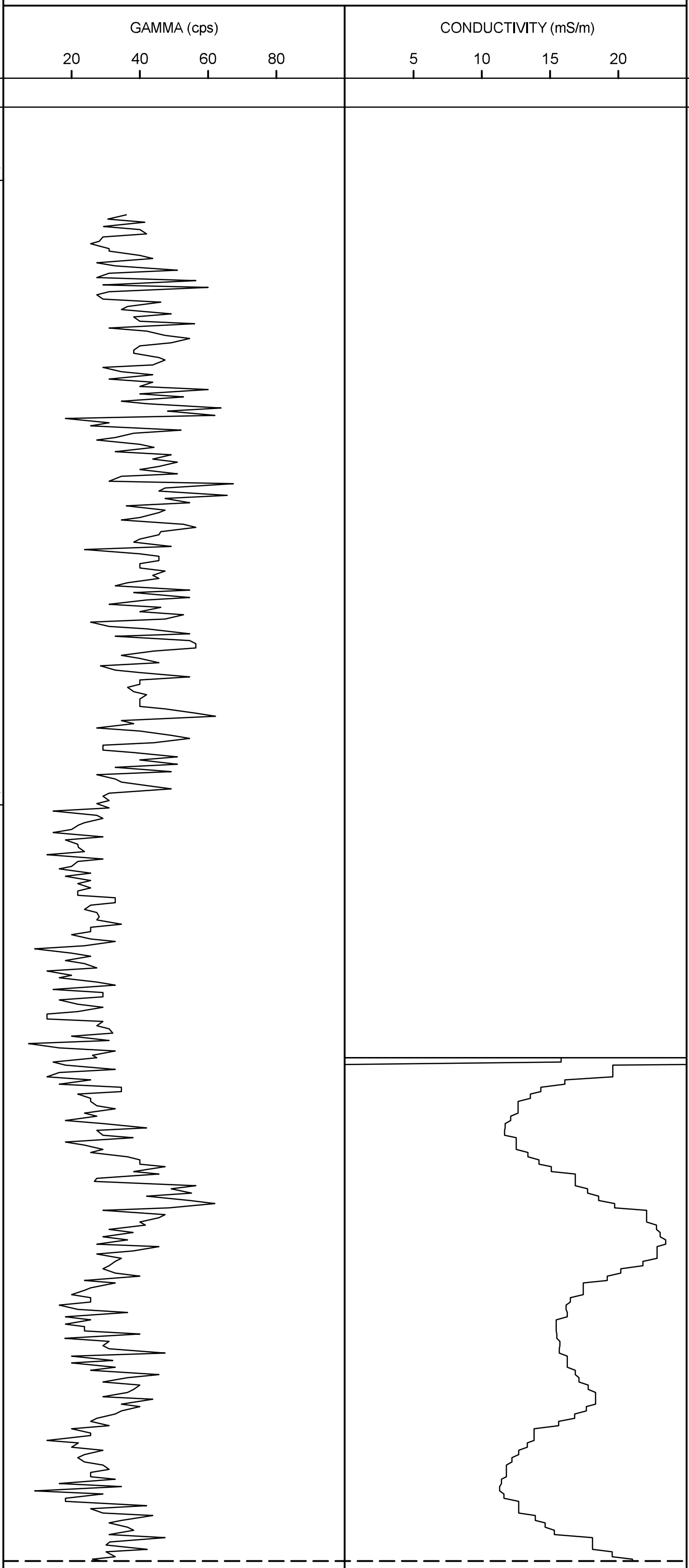
DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

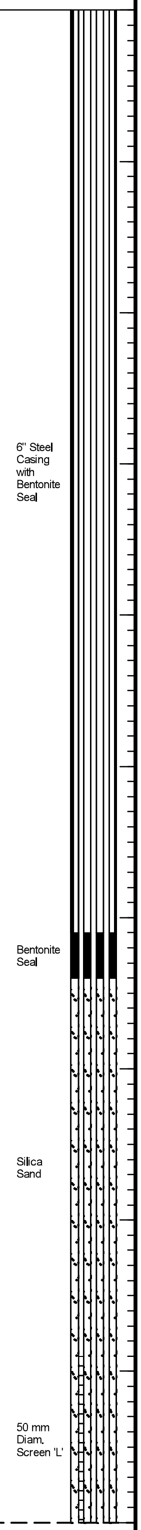
DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		GROUND SURFACE		238.37
0	Dual Rotary - Air Percussion 152 mm Casing	**Overburden, 0.0 m to 0.5 m**	▨	0.00
		Bedrock Surface, 0.5 m		237.87 0.50
1		**VERULAM FORMATION, 0.5 m to 14.8 m** **UNIT 2, 0.5 m to 4.8 m,** Very thinly to thinly interbedded medium brownish grey to medium grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE and SHALE.** Transitional basal contact.		
5		**UNIT 1, 4.8 m to 14.8 m,** Very thinly to thinly interbedded medium brownish grey, fine grained crystalline, non-porous **SHALEY NODULAR MICRITIC to CALCARENITIC LIMESTONE** with interbeds of medium grey **SHALE.** Sharp basal contact.		233.57 4.80
10		*CONTINUED NEXT PAGE*		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



OTTAWA-GEO 19122839.GPJ GAL-GTA.GDT 6/16/21 JM

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-9

SHEET 2 OF 5

LOCATION: N 4931210.1 ;E 645872.0

INCLINATION: -90° AZIMUTH: ---

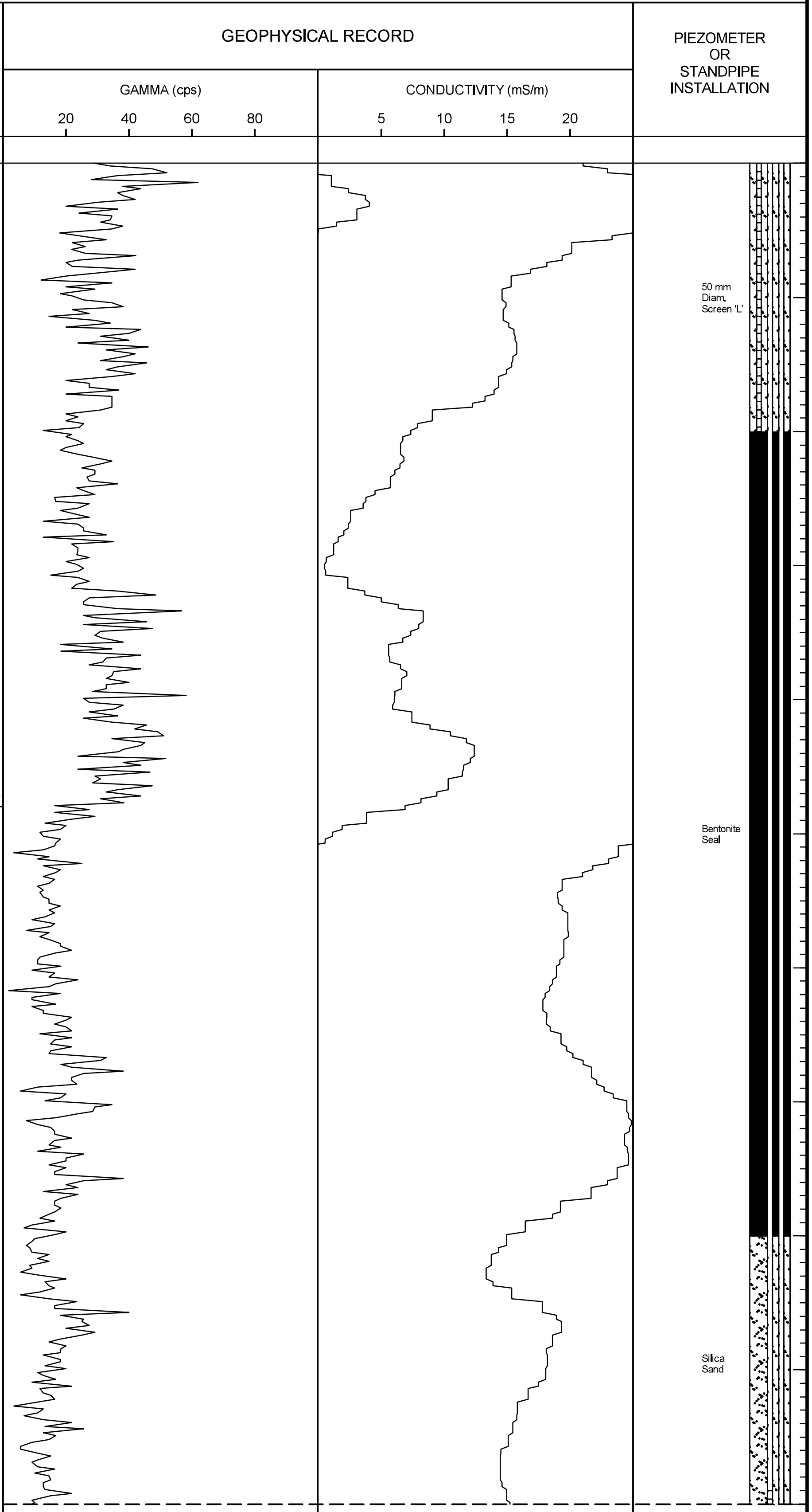
DRILLING DATE: September 16, 2020

DRILL RIG: Schramm T450WS

DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
10 11 12 13 14	Dual Rotary - Air Percussion 152 mm Casing			
15 16 17 18 19 20		**BOBCAYGEON FORMATION, 14.8 m to 41.4 m** **UNIT 4, 14.8 m to 27.2 m** Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 22.20-.55m. Gradational basal contact.		223.57 14.80
		CONTINUED NEXT PAGE		



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-9

SHEET 3 OF 5

LOCATION: N 4931210.1 ;E 645872.0

DRILLING DATE: September 16, 2020

DATUM: Geodetic

DRILL RIG: Schramm T450WS

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Vinson Well Drilling

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m)

--- CONTINUED FROM PREVIOUS PAGE ---

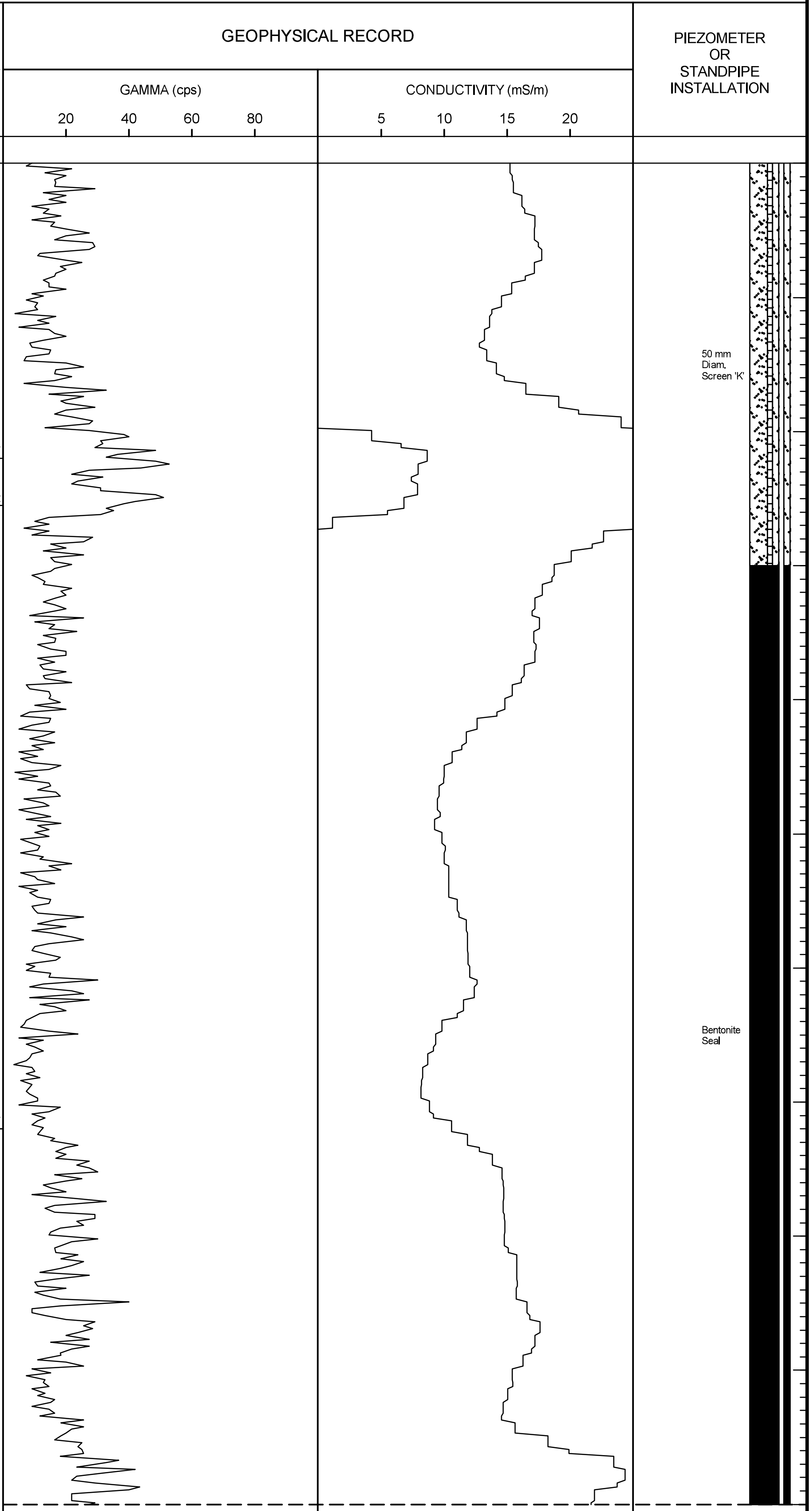
Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Drilling record: Dual Rotary - Air Percussion; 152 mm Casing

BOBCAYGEON FORMATION, 14.8 m to 41.4 m
UNIT 4, 14.8 m to 27.2 m Medium brownish grey, fine to medium grained crystalline, non-porous, thinly to thickly bedded **NODULAR to ARGILLACEOUS NODULAR CALCARENITIC LIMESTONE** with individual thin interbeds of medium grained crystalline calcarenitic limestone and subordinate micrite limestone and minor dark grey, 2-10mm thick shaley partings. Interbed of **SHALEY NODULAR CALCARENITIC LIMESTONE** occurs at 22.20-.55m. Gradational basal contact.

ELEV.	DEPTH (m)
216.17	22.20
215.82	22.55
211.17	27.20

UNIT 3, 27.2 m to 32.6 m Medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Gradational basal contact.



CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-9

SHEET 4 OF 5

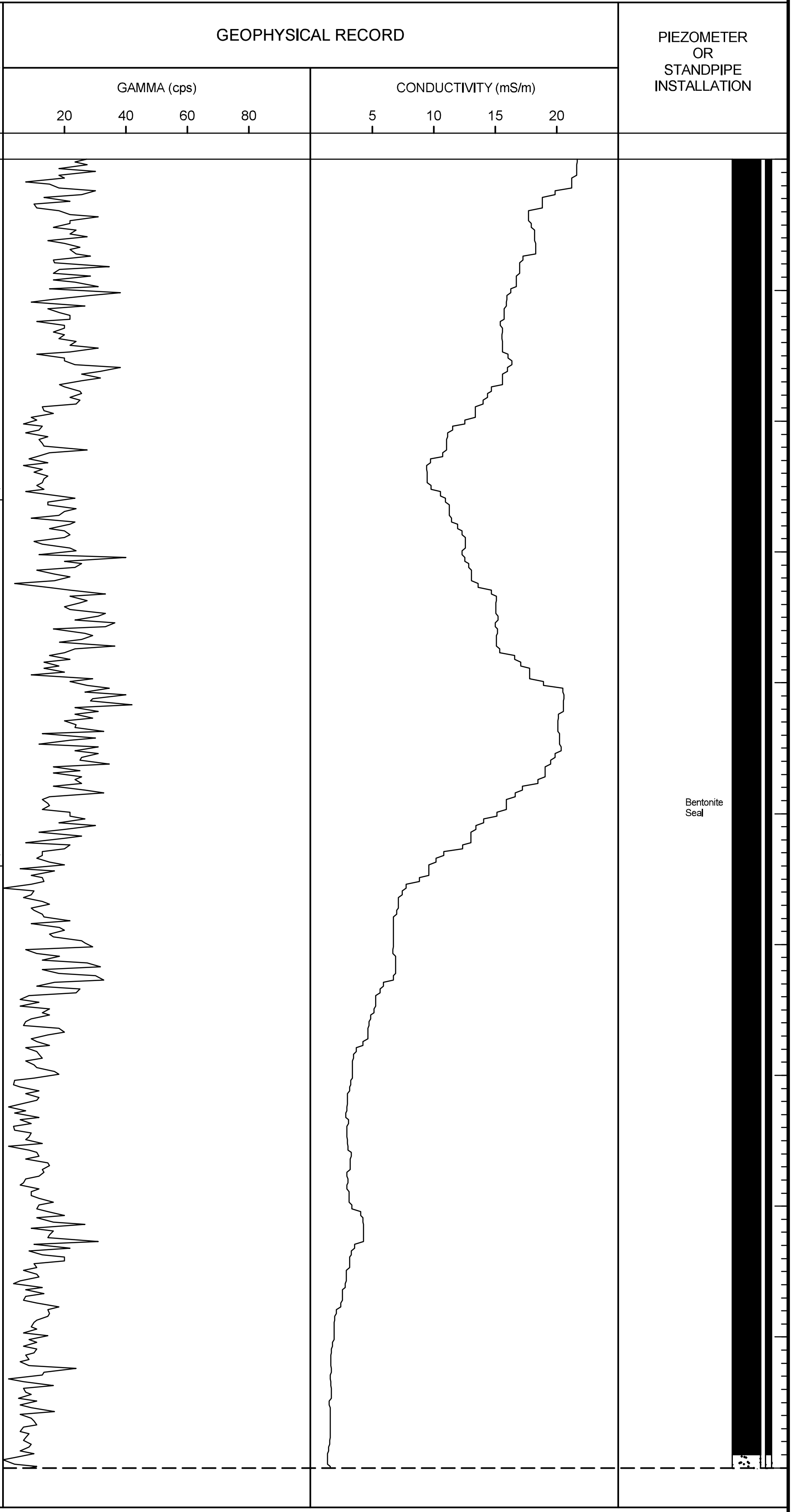
LOCATION: N 4931210.1 ;E 645872.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 16, 2020
DRILL RIG: Schramm T450WS
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- *CONTINUED FROM PREVIOUS PAGE* ---		
30	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 3, 27.2 m to 32.6 m** Medium brownish grey, fine grained crystalline, non-porous, medium to thickly bedded **ARGILLACEOUS NODULAR MICRITIC LIMESTONE** with thin dark grey **SHALE** partings. Gradational basal contact.		
32.6		**UNIT 2, 32.6 m to 35.4 m** Medium grey, fine grained crystalline, non-porous, thinly to medium bedded, laminar textured **ARGILLACEOUS MICRITIC LIMESTONE** with numerous dark grey shaley partings. Sharp basal contact.		205.77 32.60
35.4		**UNIT 1, 35.4 m to 41.4 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Sharp basal contact.		202.97 35.40
40		*CONTINUED NEXT PAGE*		



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB
CHECKED: KAM

PROJECT: 19122839

GEOPHYSICAL LOG OF: BH-9

SHEET 5 OF 5

LOCATION: N 4931210.1 ;E 645872.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 16, 2020

DRILL RIG: Schramm T450WS

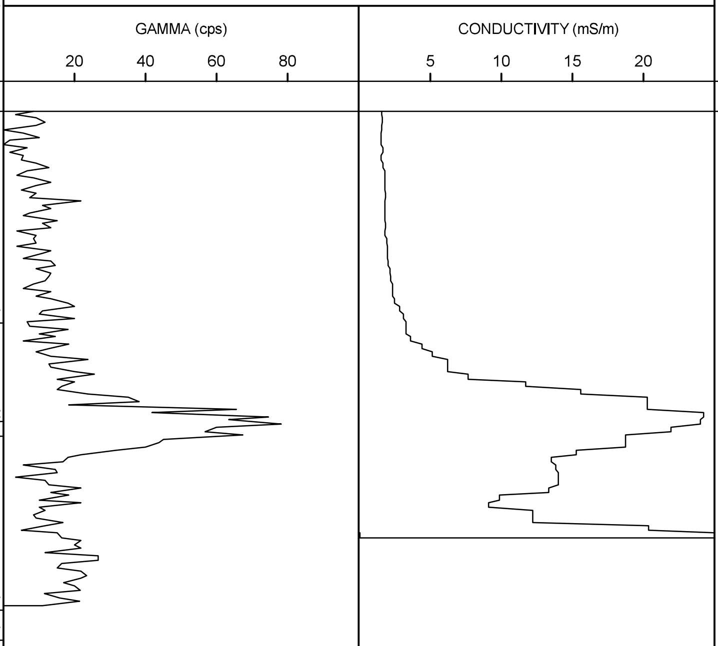
DRILLING CONTRACTOR: Vinson Well Drilling

DATUM: Geodetic

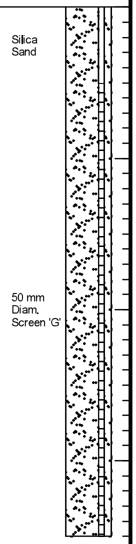
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)
		--- CONTINUED FROM PREVIOUS PAGE ---		
40	Dual Rotary - Air Percussion 152 mm Casing	**UNIT 1, 35.4 m to 41.4 m** Medium brownish grey, very fine grained crystalline with subordinate fine to medium grained crystalline, non-porous, interlaminations, non-porous, thickly bedded **NODULAR MICRITIC LIMESTONE.** Sharp basal contact.		196.97 41.40
41		**GULL RIVER FORMATION, 41.4 m to 43.3 m** **UNIT 4, 41.4 m to 43.5 m** Creamy light to medium brownvery fine grained porcelaneous, non-porous, stylolitic, medium to thickly bedded **LITHOGRAPHIC LIMESTONE** with fine argillaceous to stylolitic bedding partings. Highly to completely weathered, medium greenish grey, non-calcareous **CLAYEY SHALE MARKER BED** developed from shale at 42.05-.15.		196.32 42.05 42.15
42				
43				195.07
				194.87 43.50
		End of Borehole, 43.5 m		

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: KAM/RDB

CHECKED: KAM

APPENDIX C

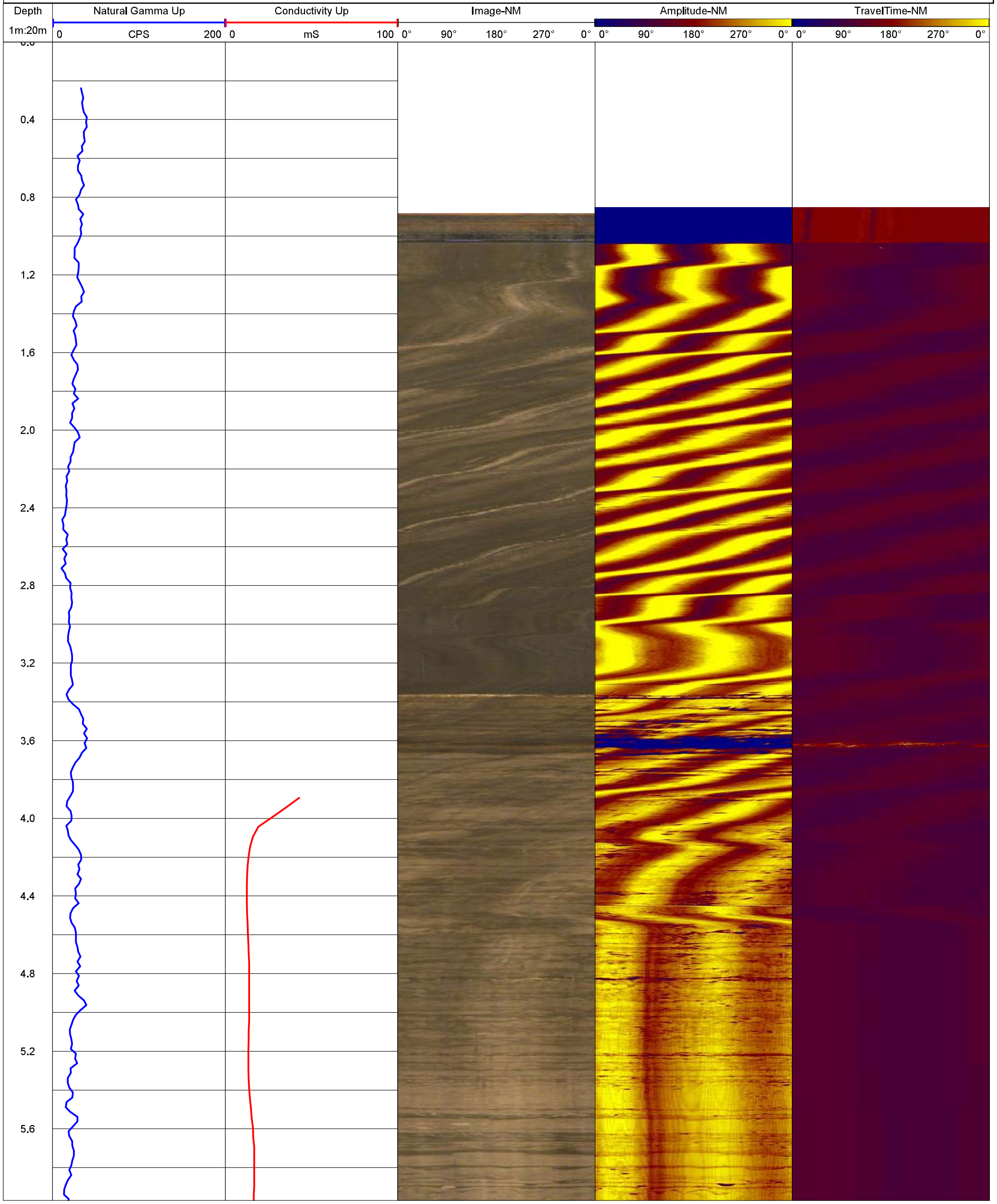
Optical and Acoustic Televiewer Logs (Scales 1:20 and 1:200)

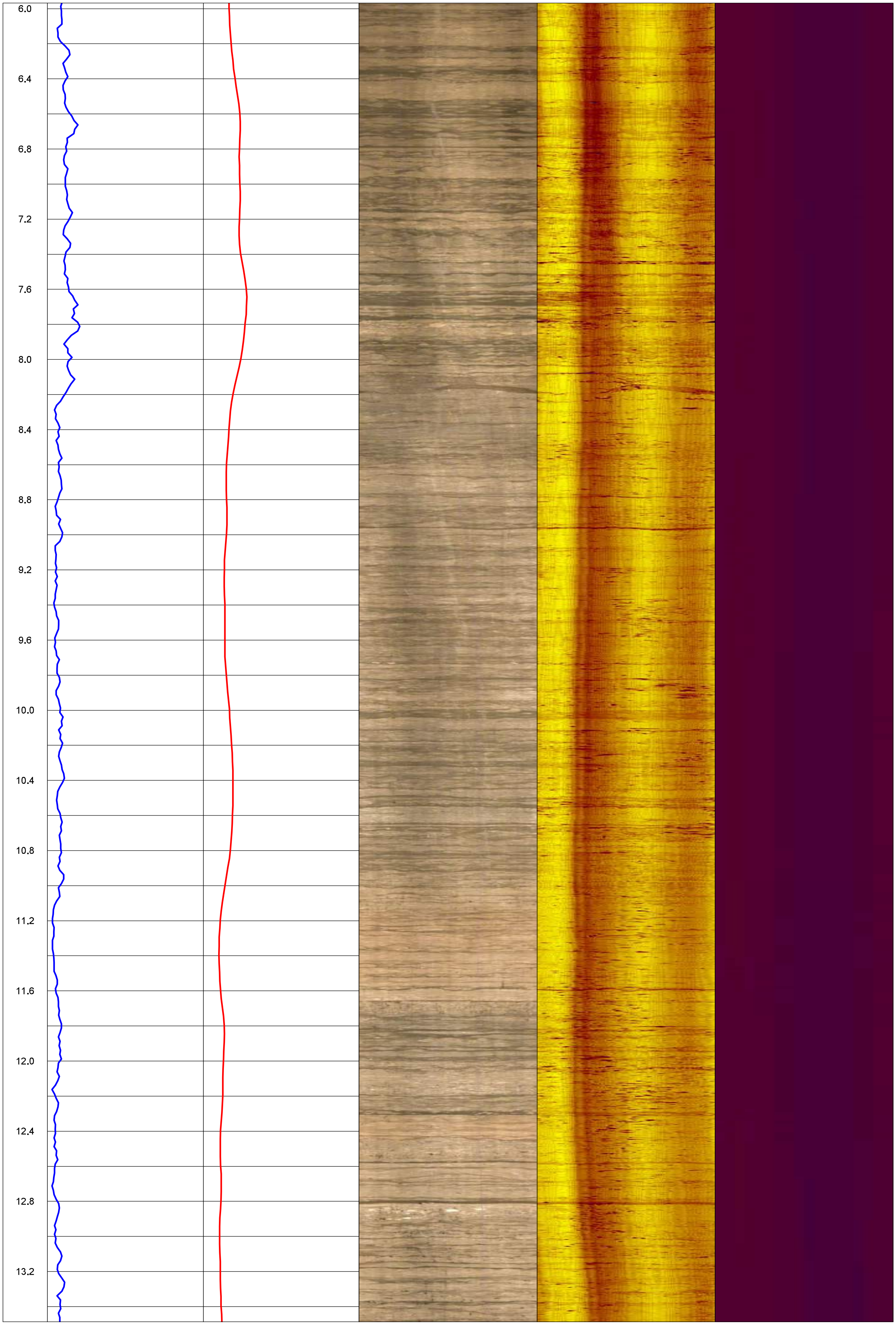
GOLDER

Geophysical Record of Borehole: BH-1

Log Title: BH-1
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	Sept 19, 2019
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PL

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6.4
6.8
7.2
7.6
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8.4
8.8
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9.6
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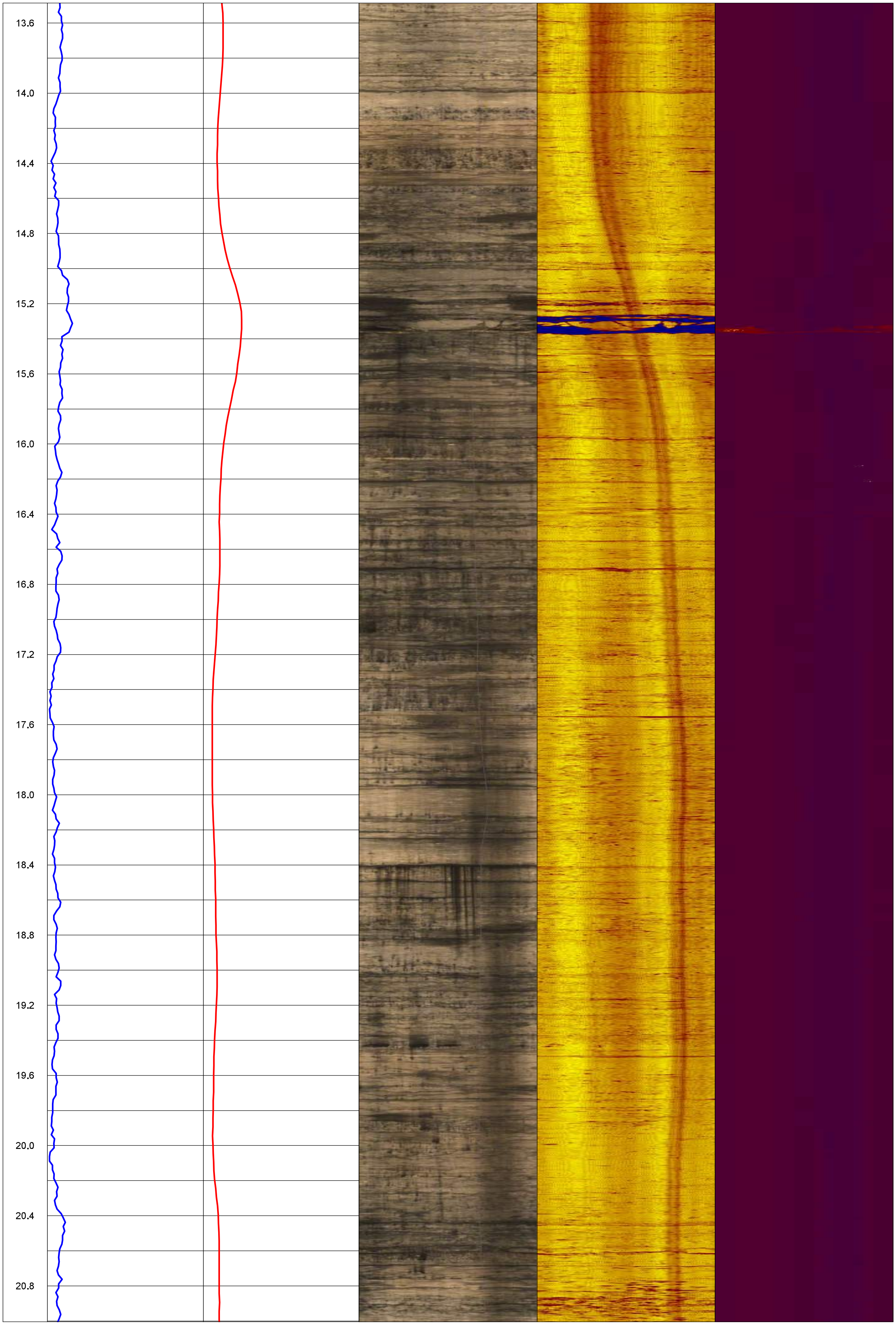
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2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16.0
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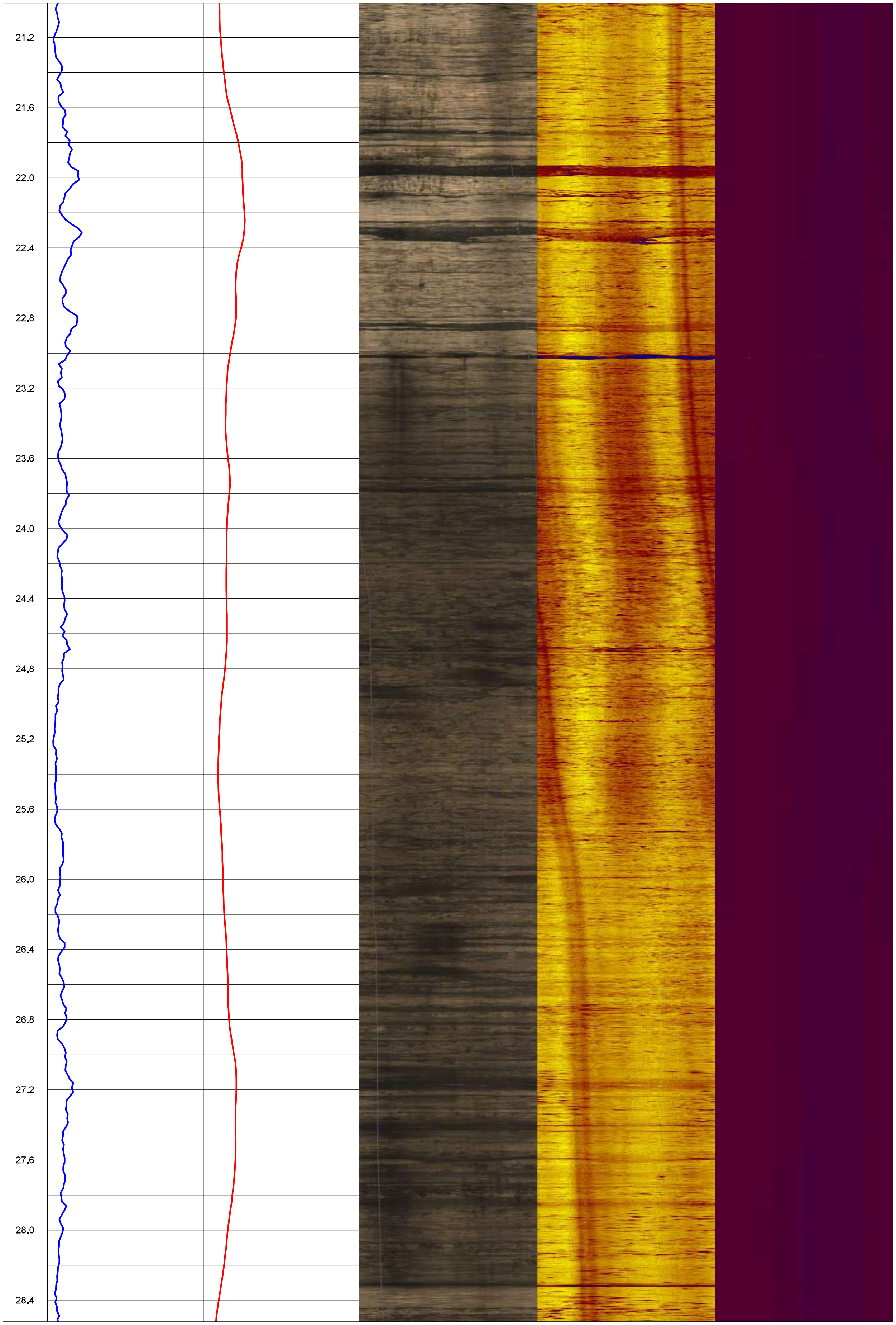
18.0
18.4
18.8
19.2
19.6
20.0
20.4
20.8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26.8
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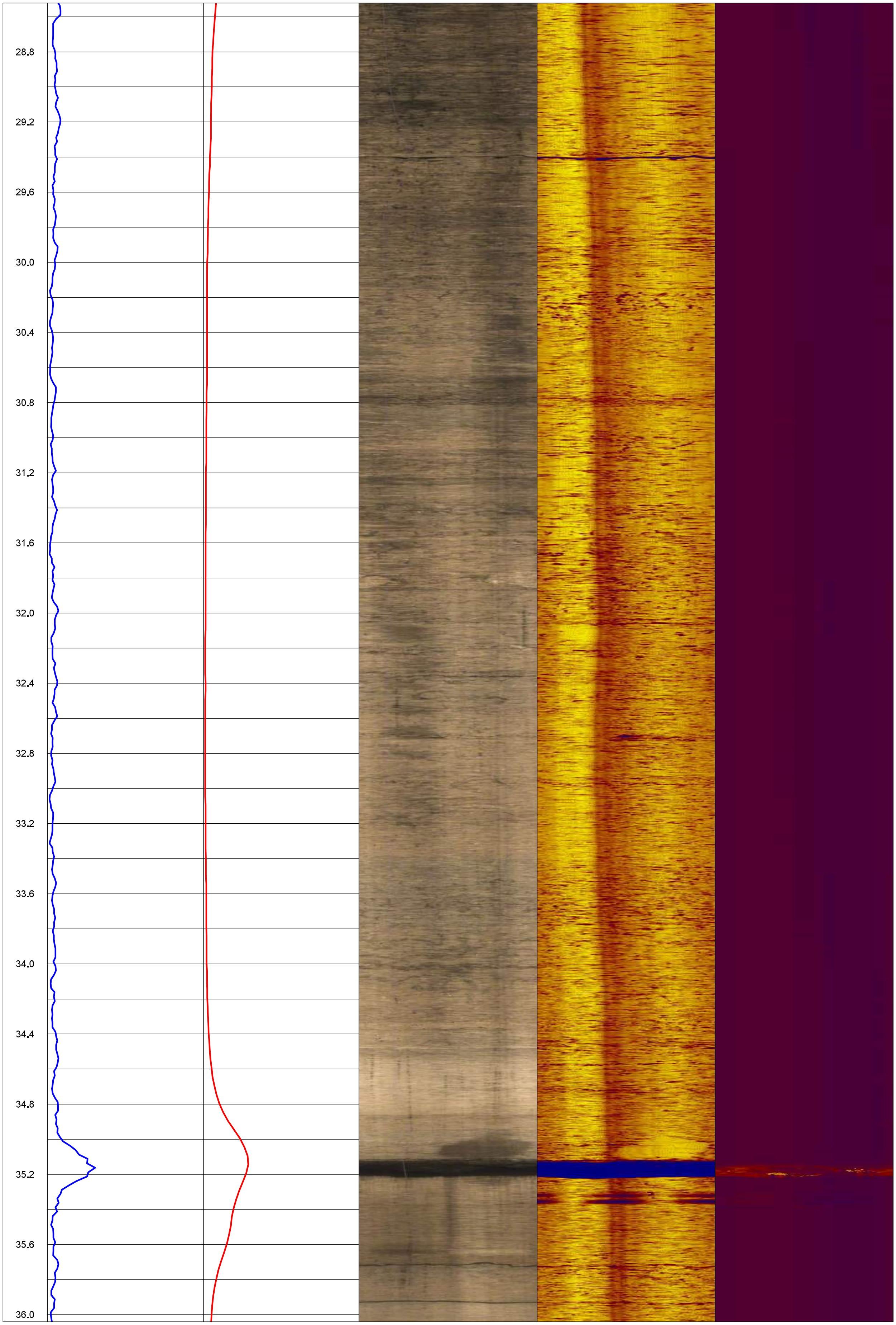
27.6
28.0
28.4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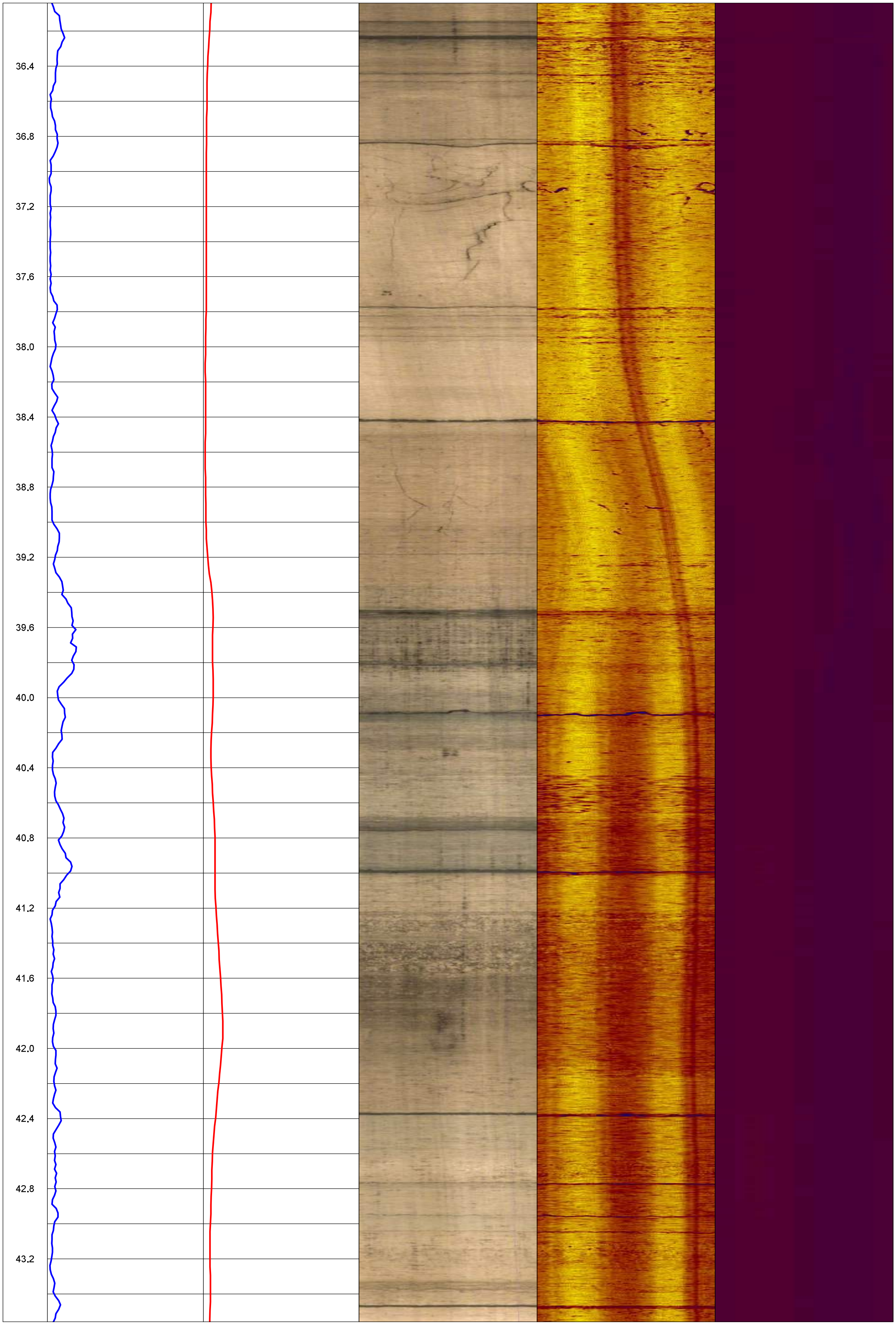
35,2
35,6
36,0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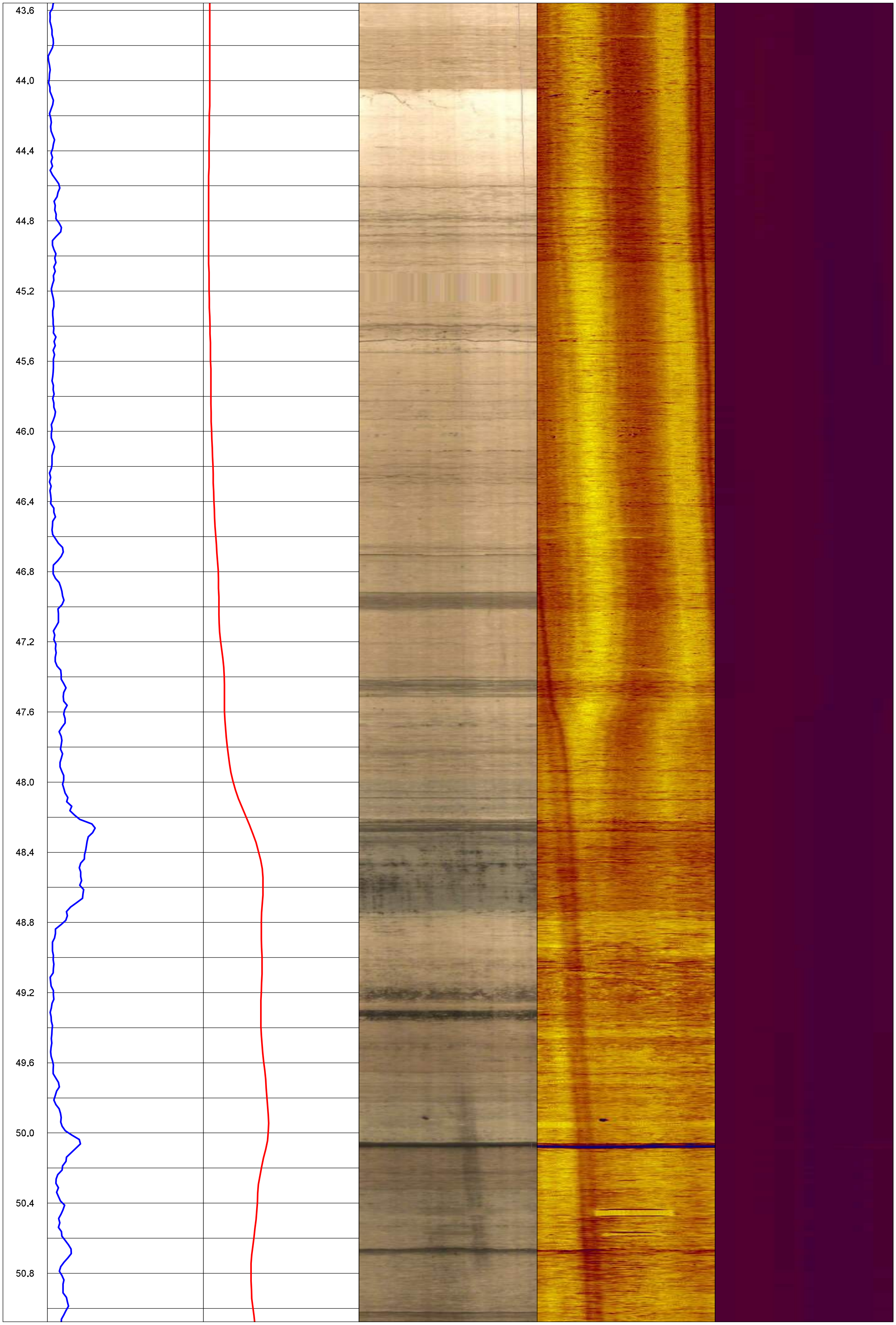
41.6
42.0
42.4
42.8
43.2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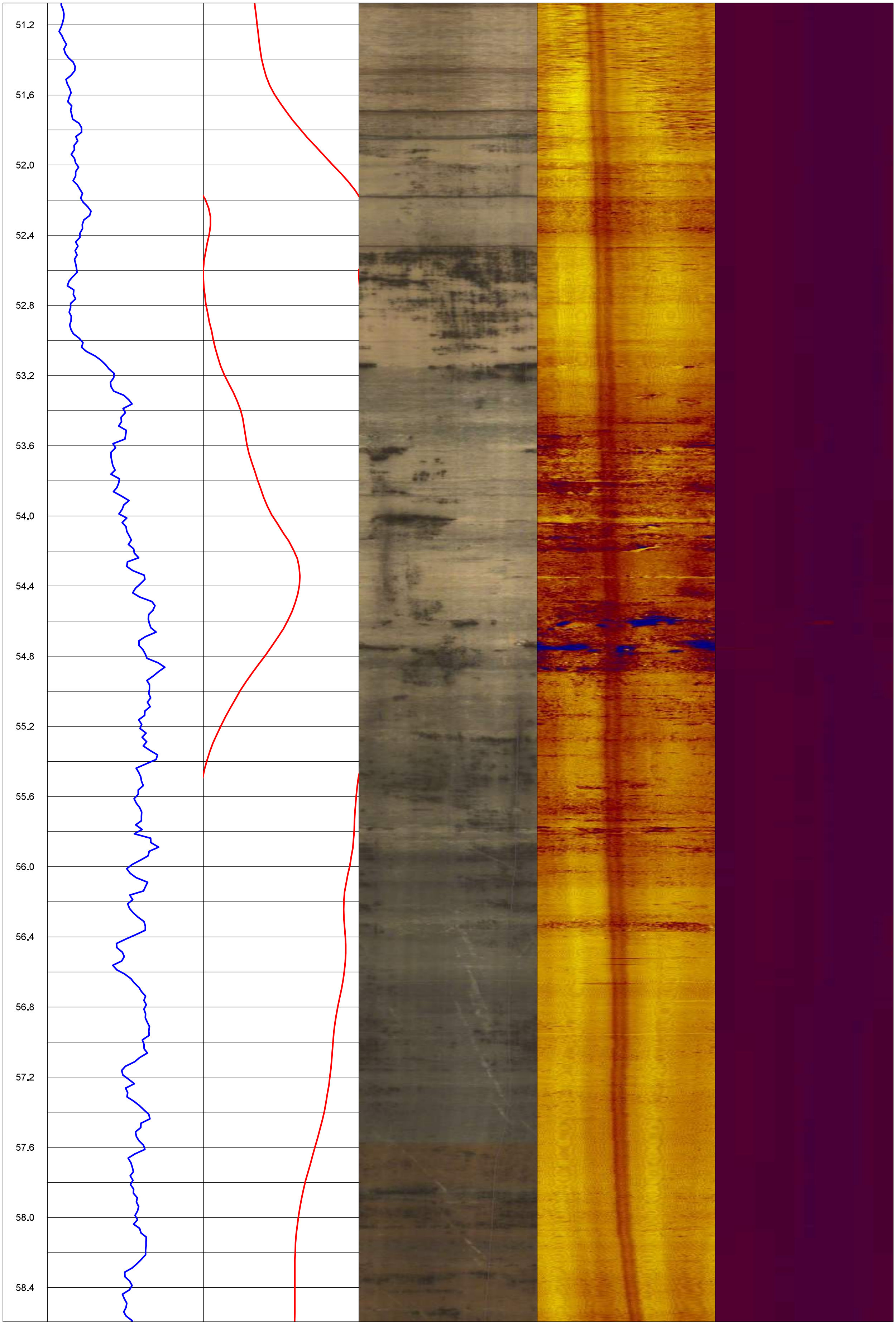
49.6
50.0
50.4
50.8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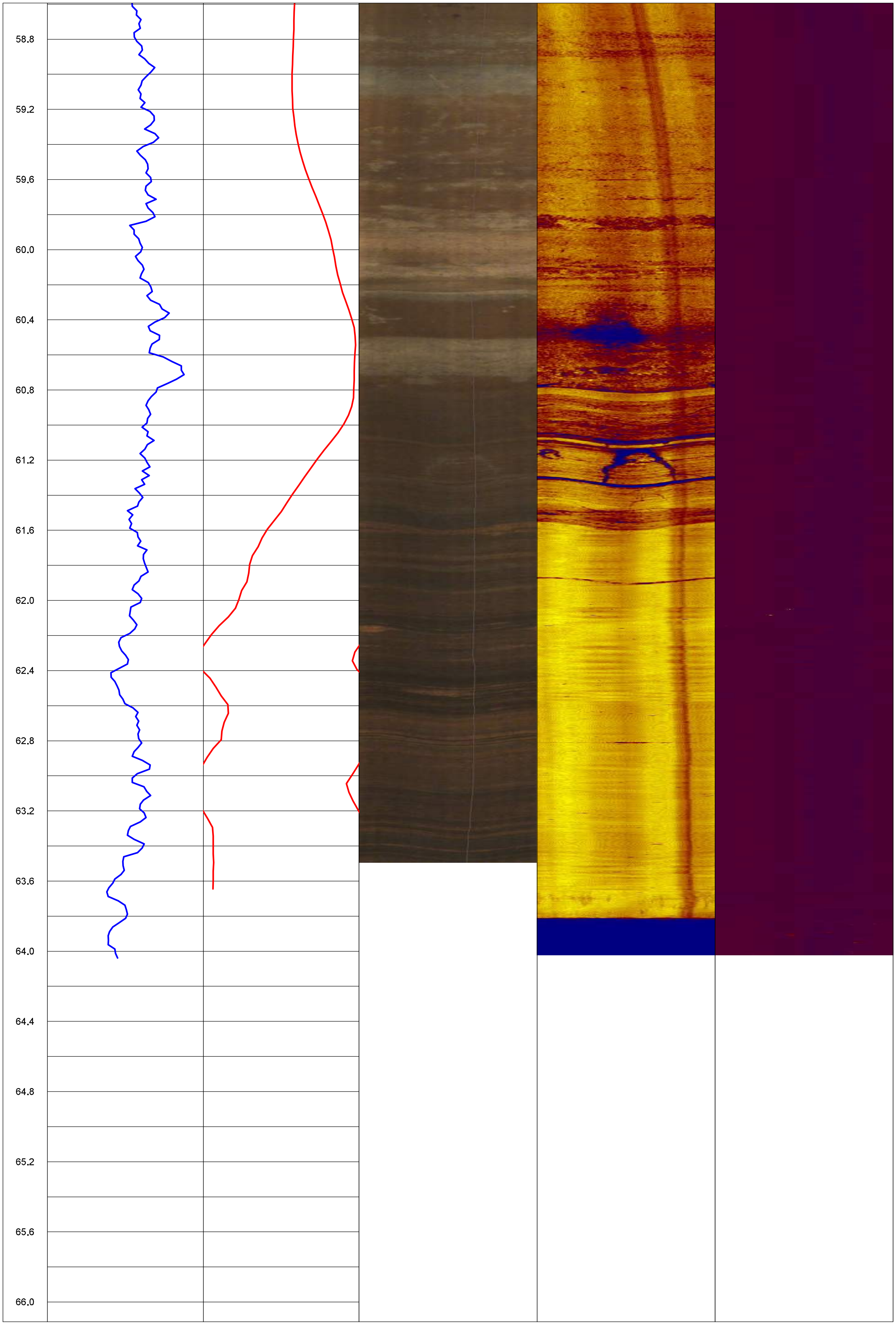
57.2
57.6
58.0
58.4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61,6
62,0
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63,2
63,6
64,0
64,4
64,8
65,2
65,6
66,0

66.4					
66.8					
67.2					
67.6					
68.0					
68.4					
68.8					
69.2					
69.6					
70.0					
70.4					
70.8					

Geophysical Record of Borehole: BH-1

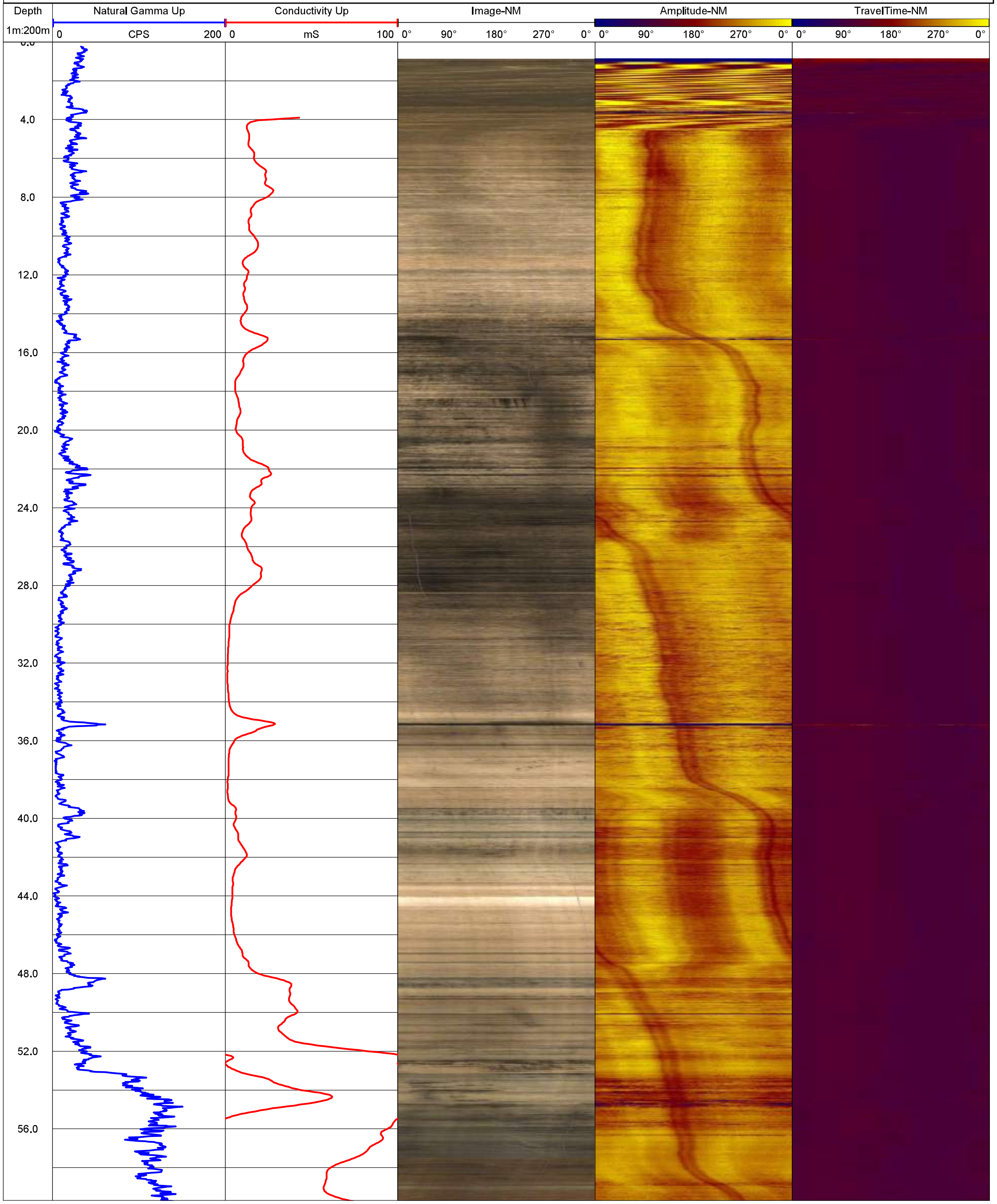
Log Title: BH-1
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

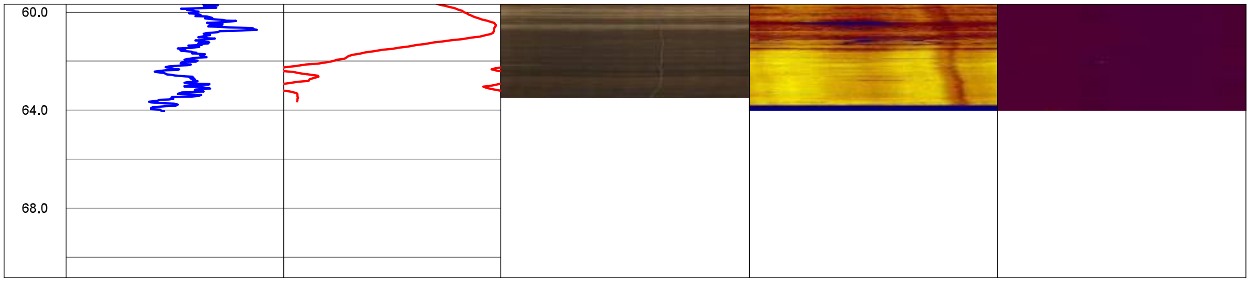
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL




60.0
64.0
68.0

Geophysical Record of Borehole: BH-2

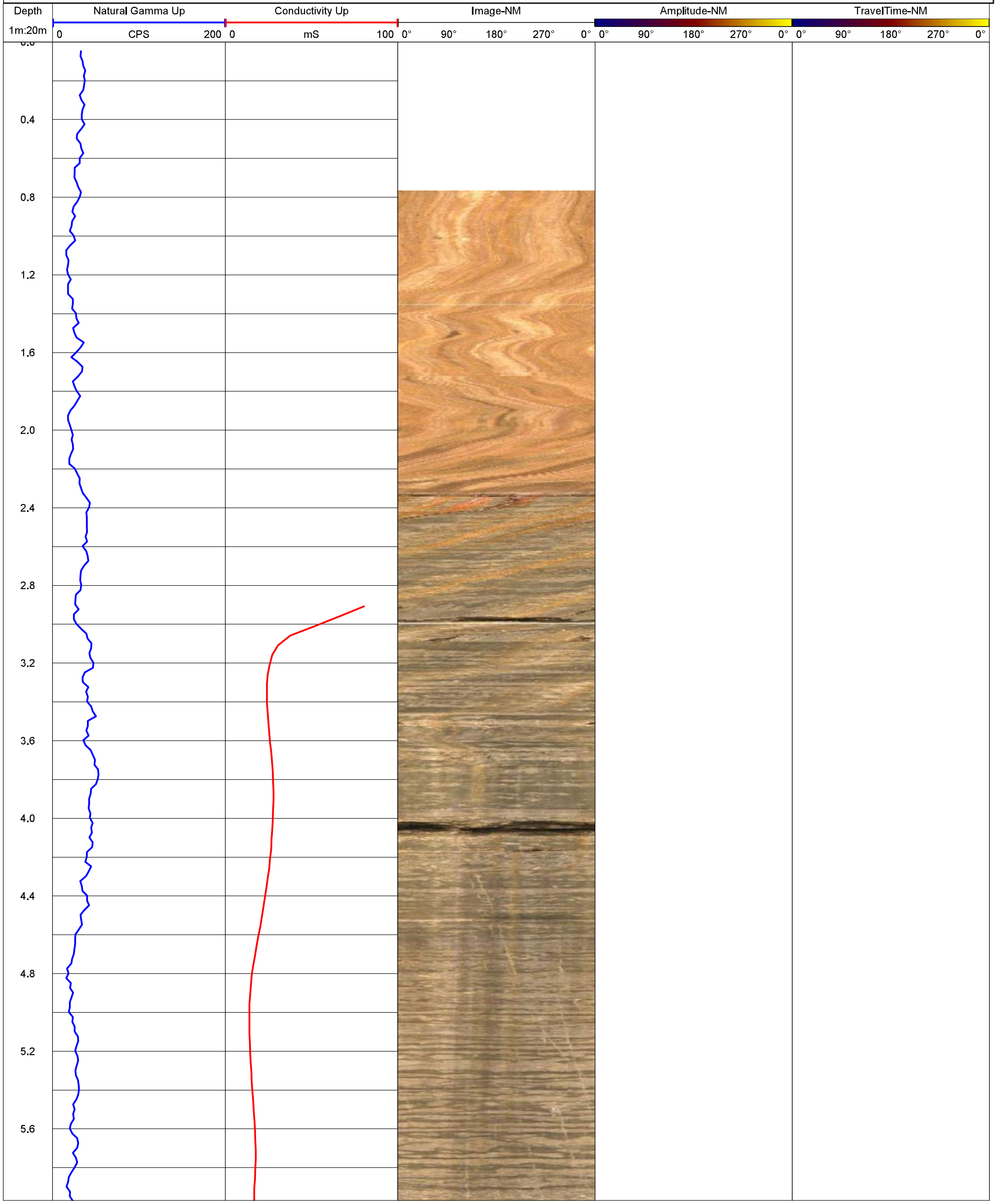
Log Title: BH-2
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

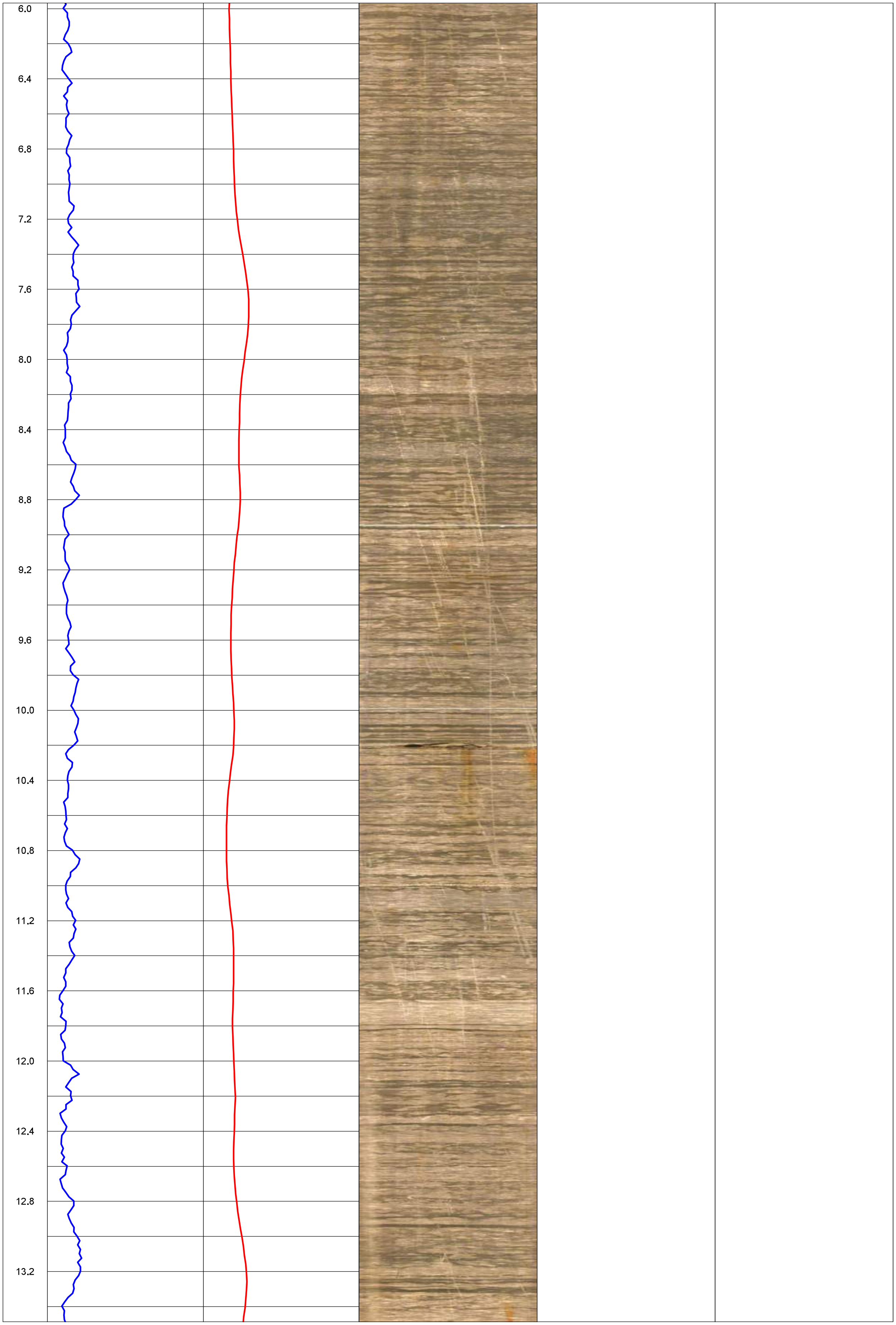
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL

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7.6
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10.8
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11.6
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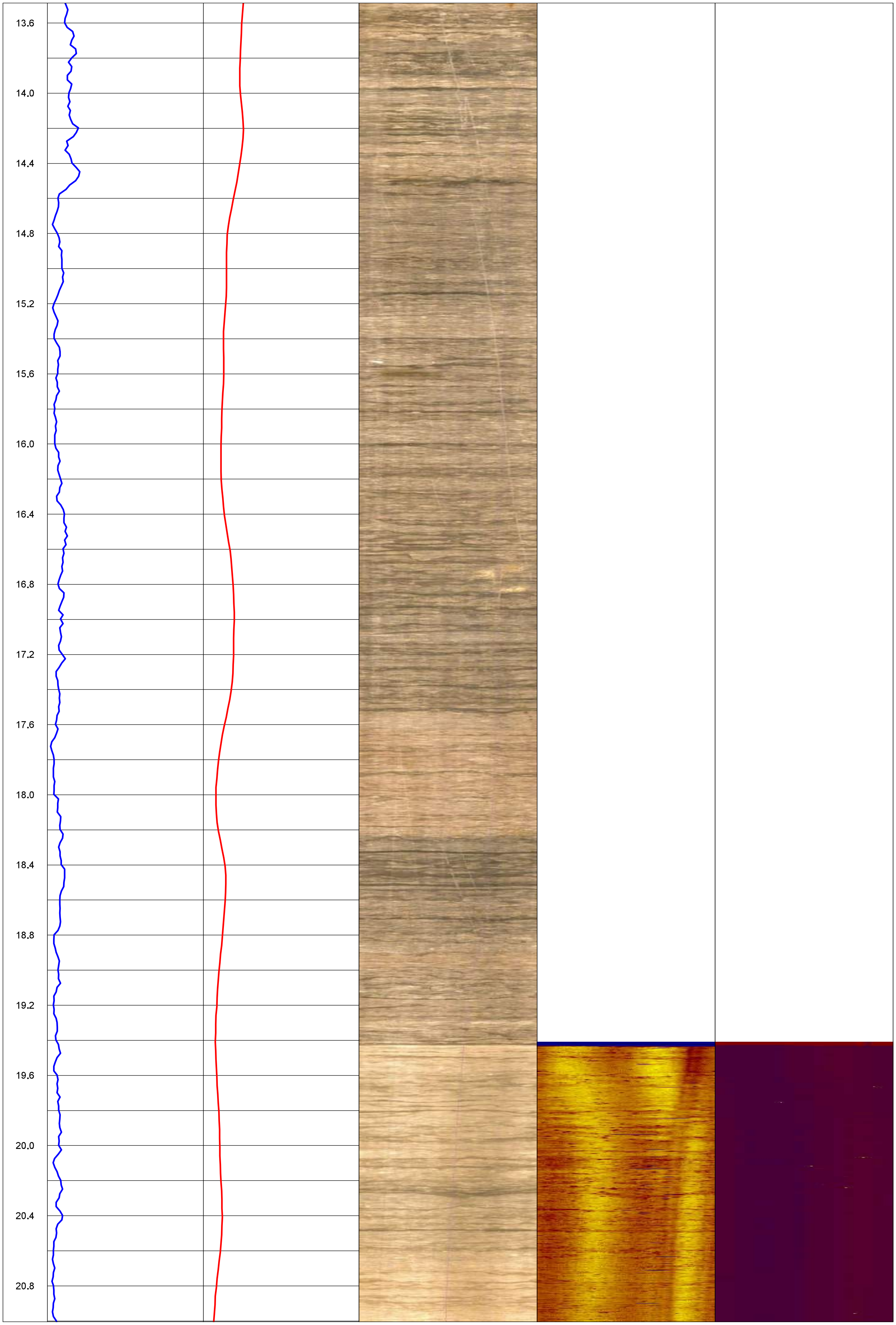
12.4
12.8
13.2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18.8
19.2
19.6
20.0
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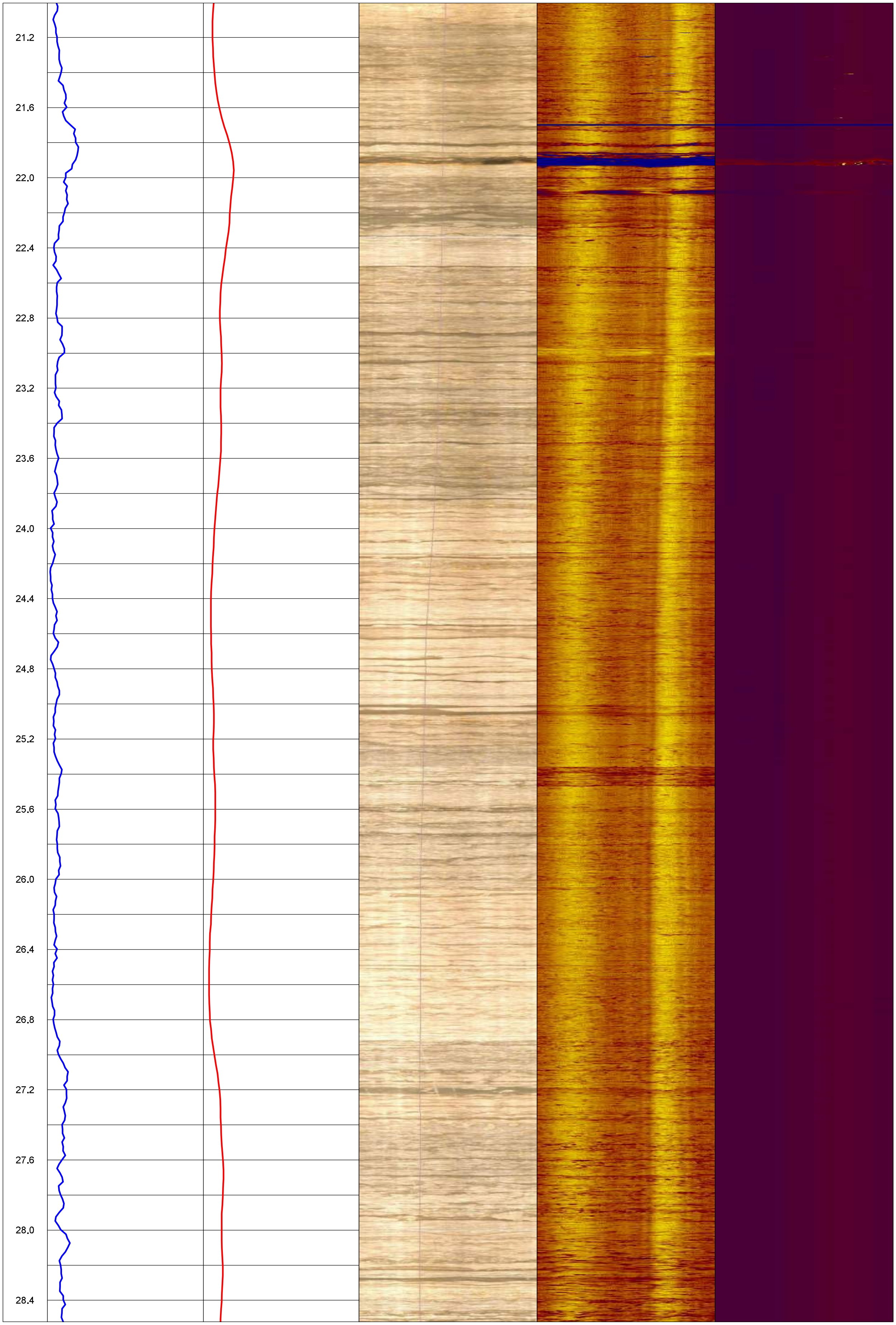
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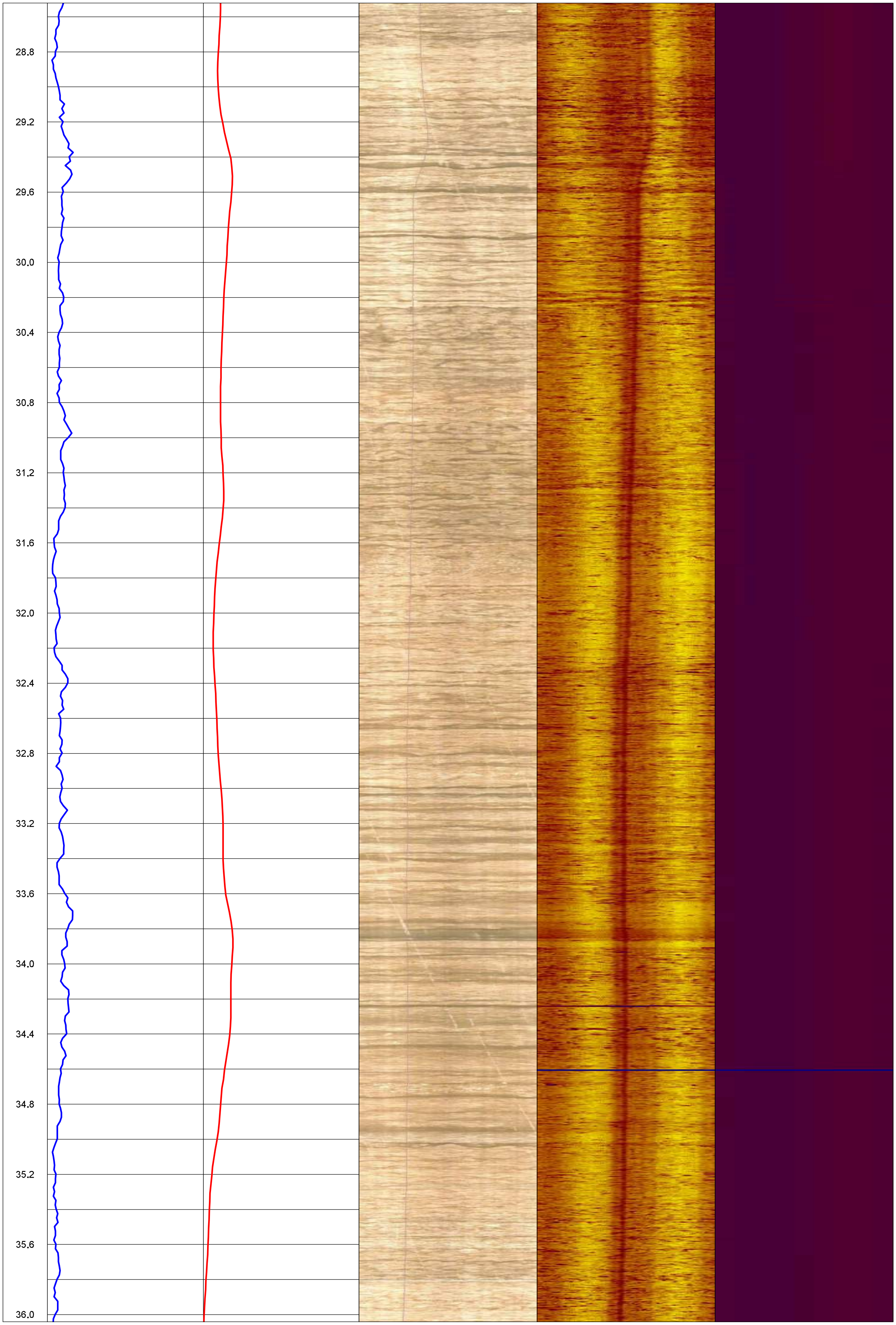
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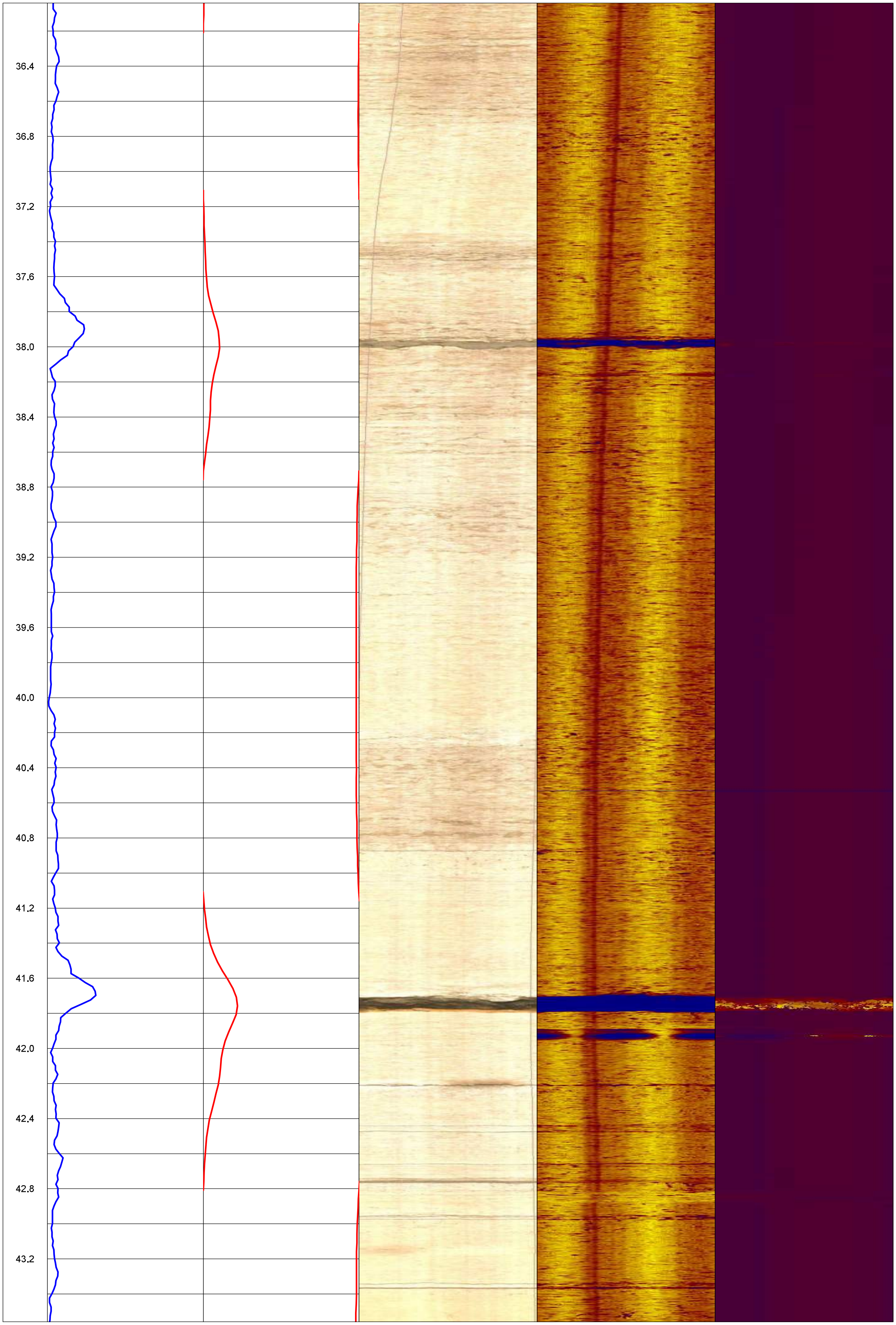
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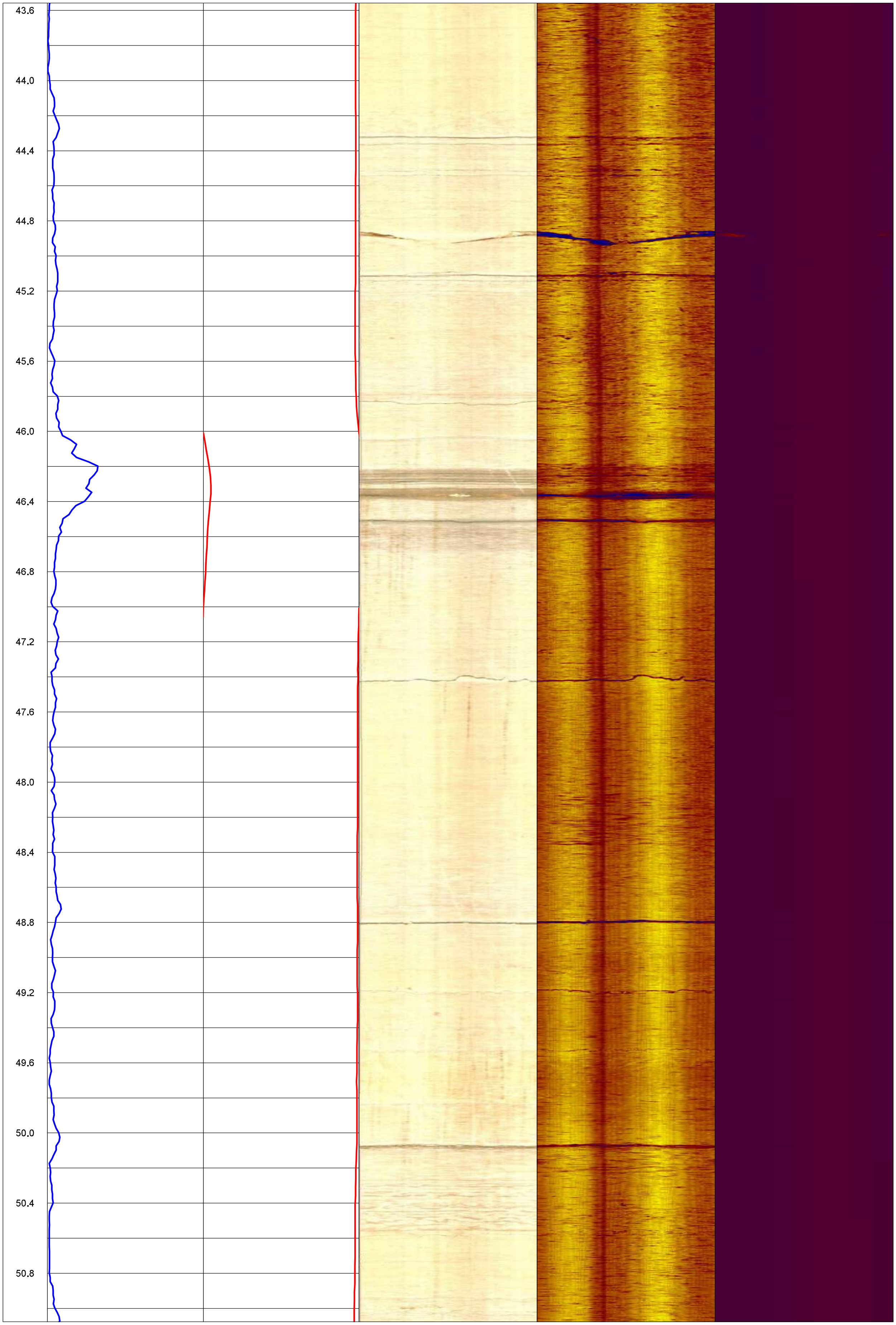
42.8
43.2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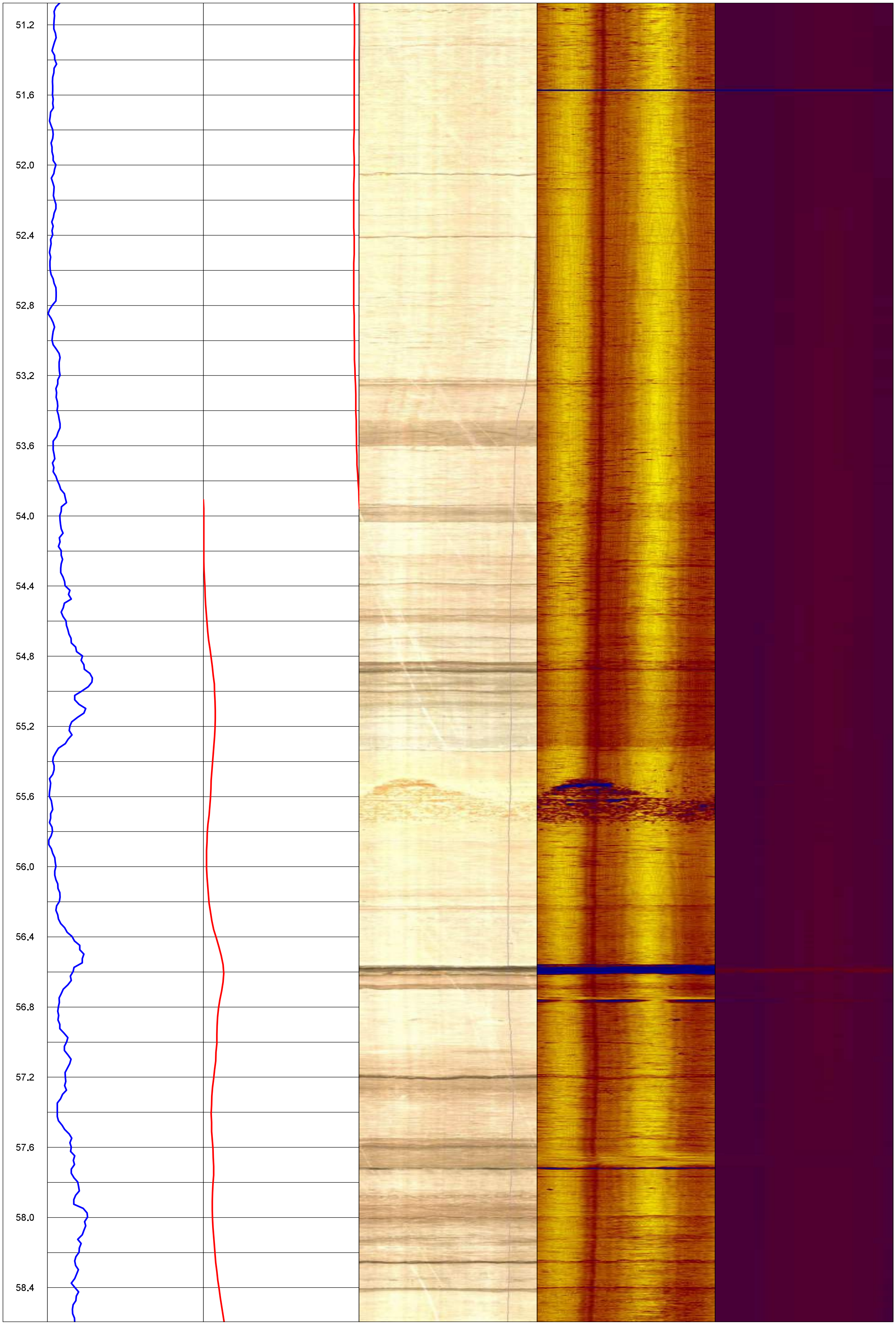
50.4
50.8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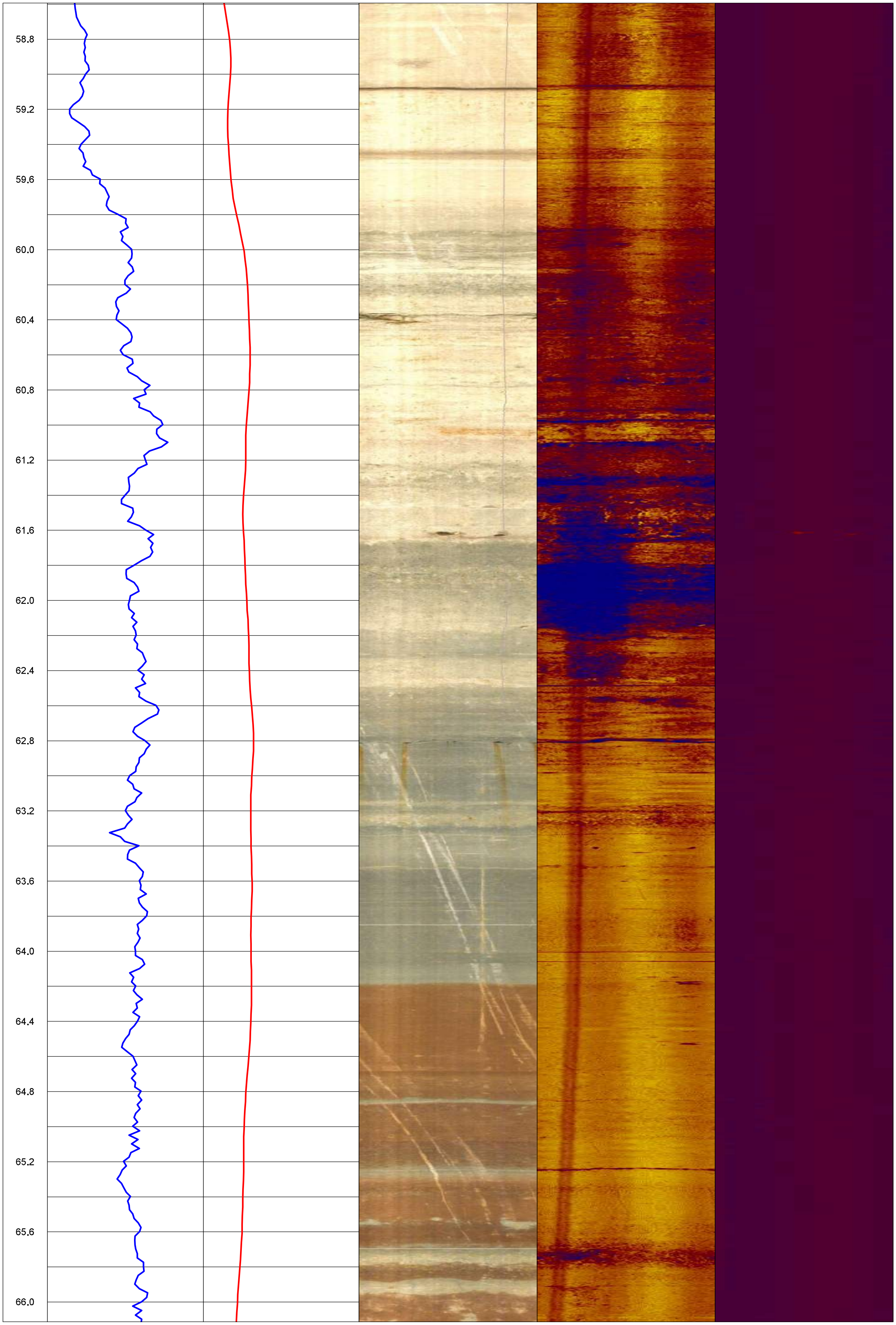
58.4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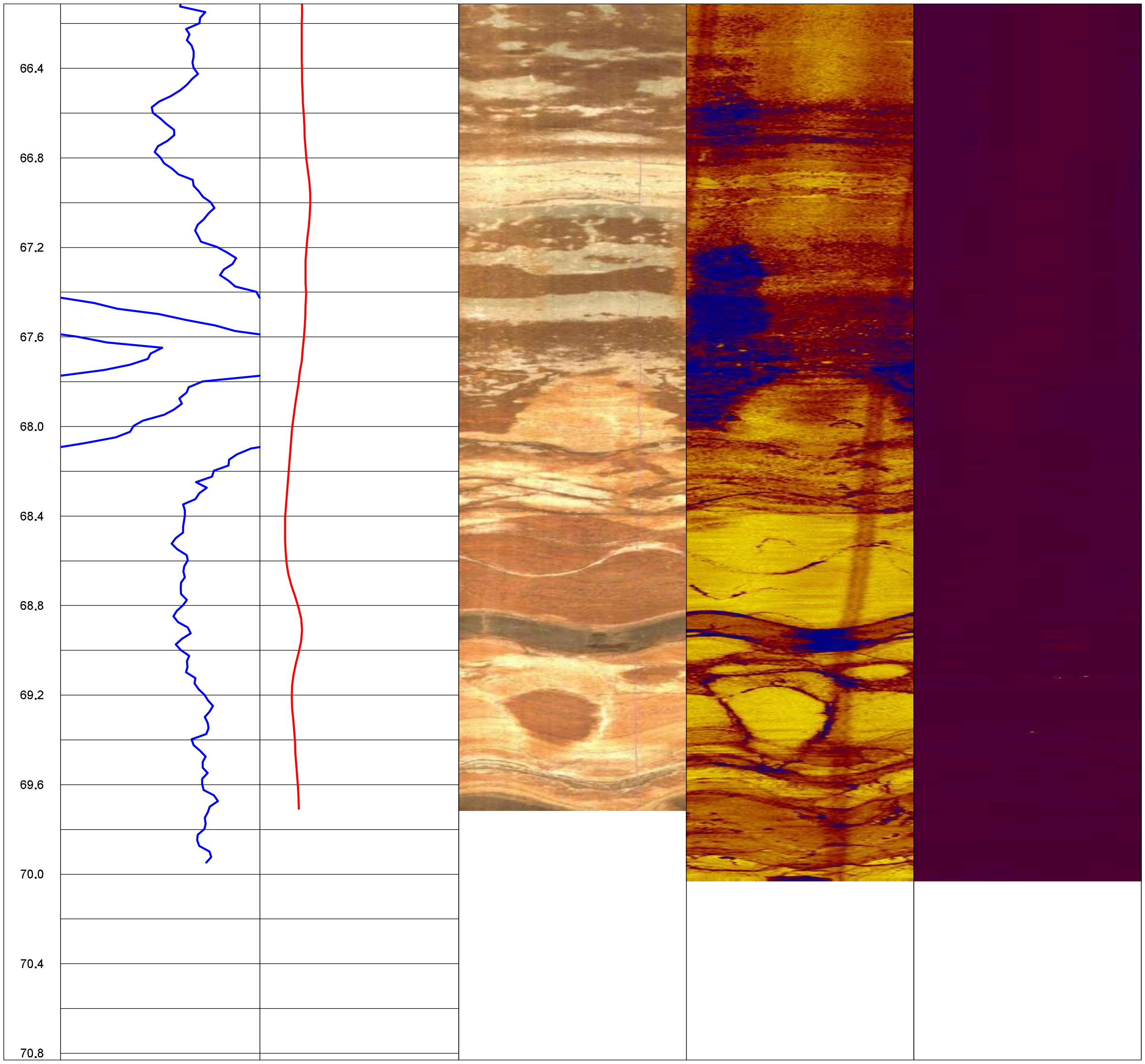
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67.6
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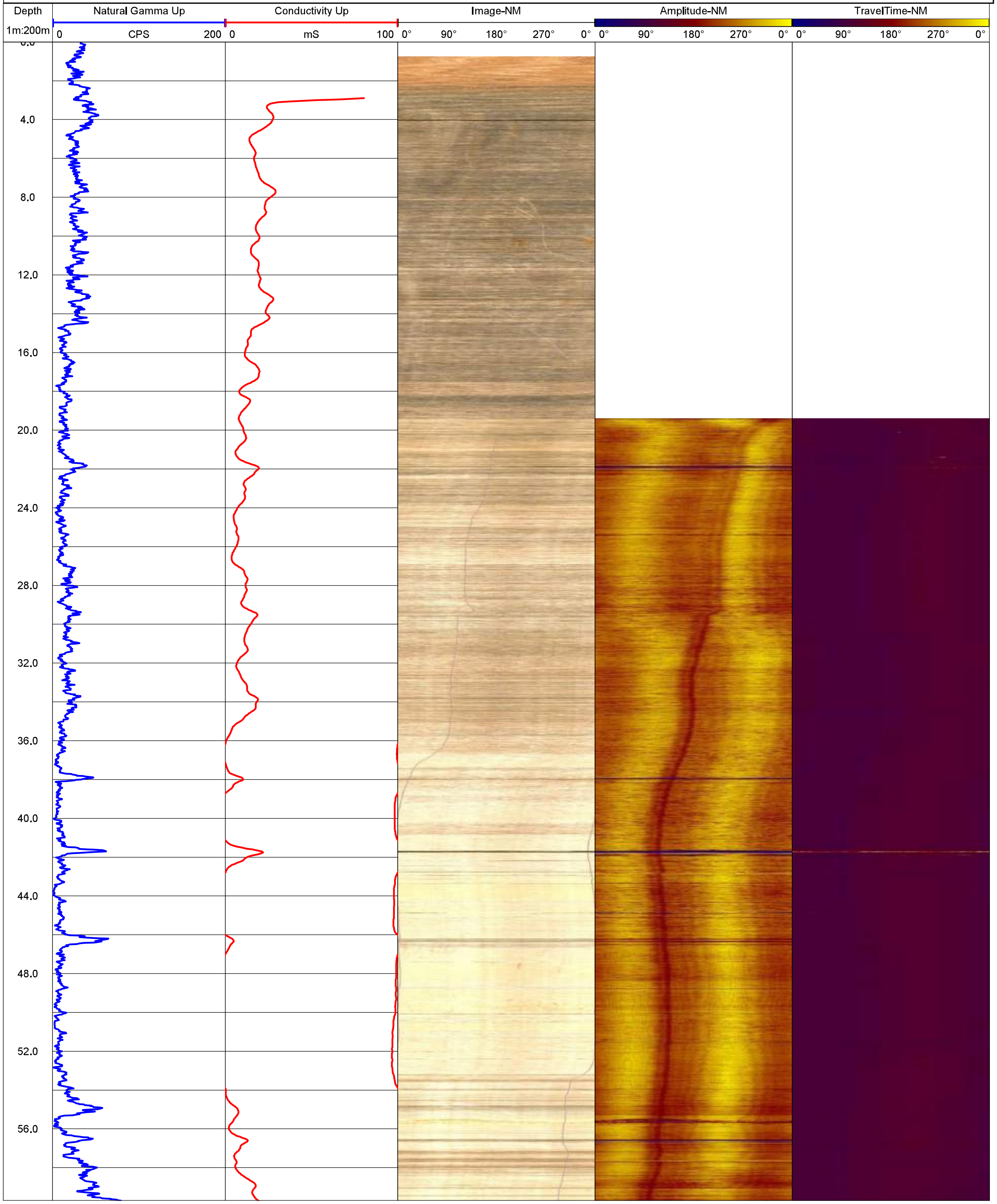
68.4
68.8
69.2
69.6
70.0
70.4
70.8

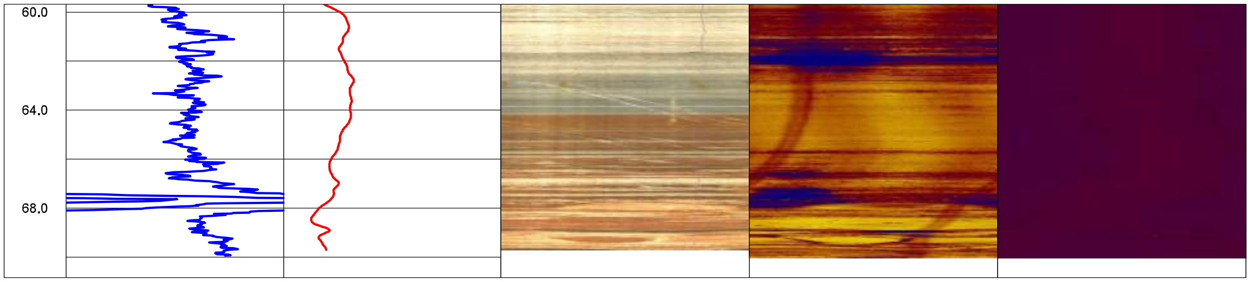
GOLDER

Geophysical Record of Borehole: BH-2

Log Title: BH-2
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	Sept 19, 2019
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PL




60.0
64.0
68.0

GOLDER

Geophysical Record of Borehole: BH-3

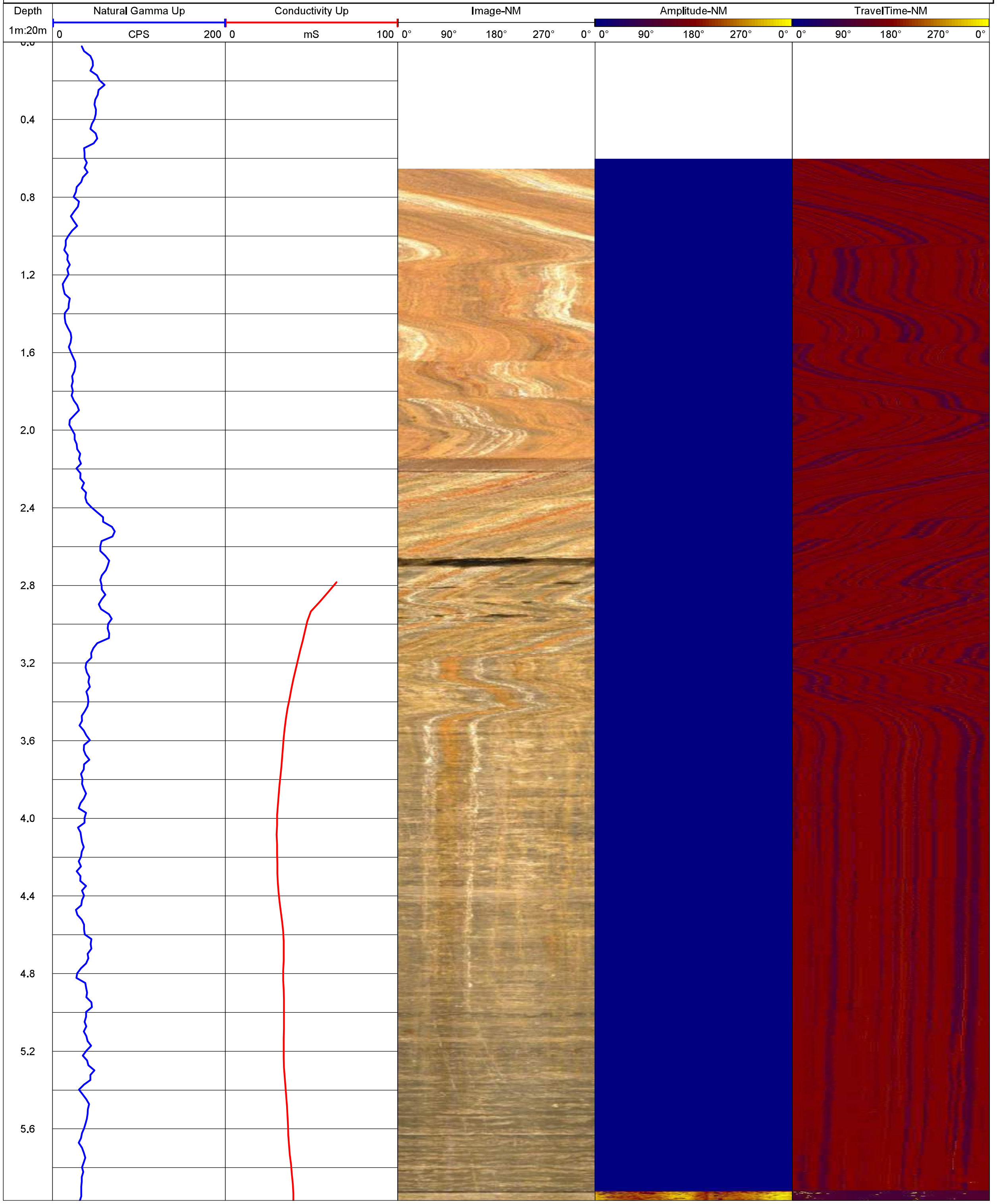
Log Title: BH-3
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

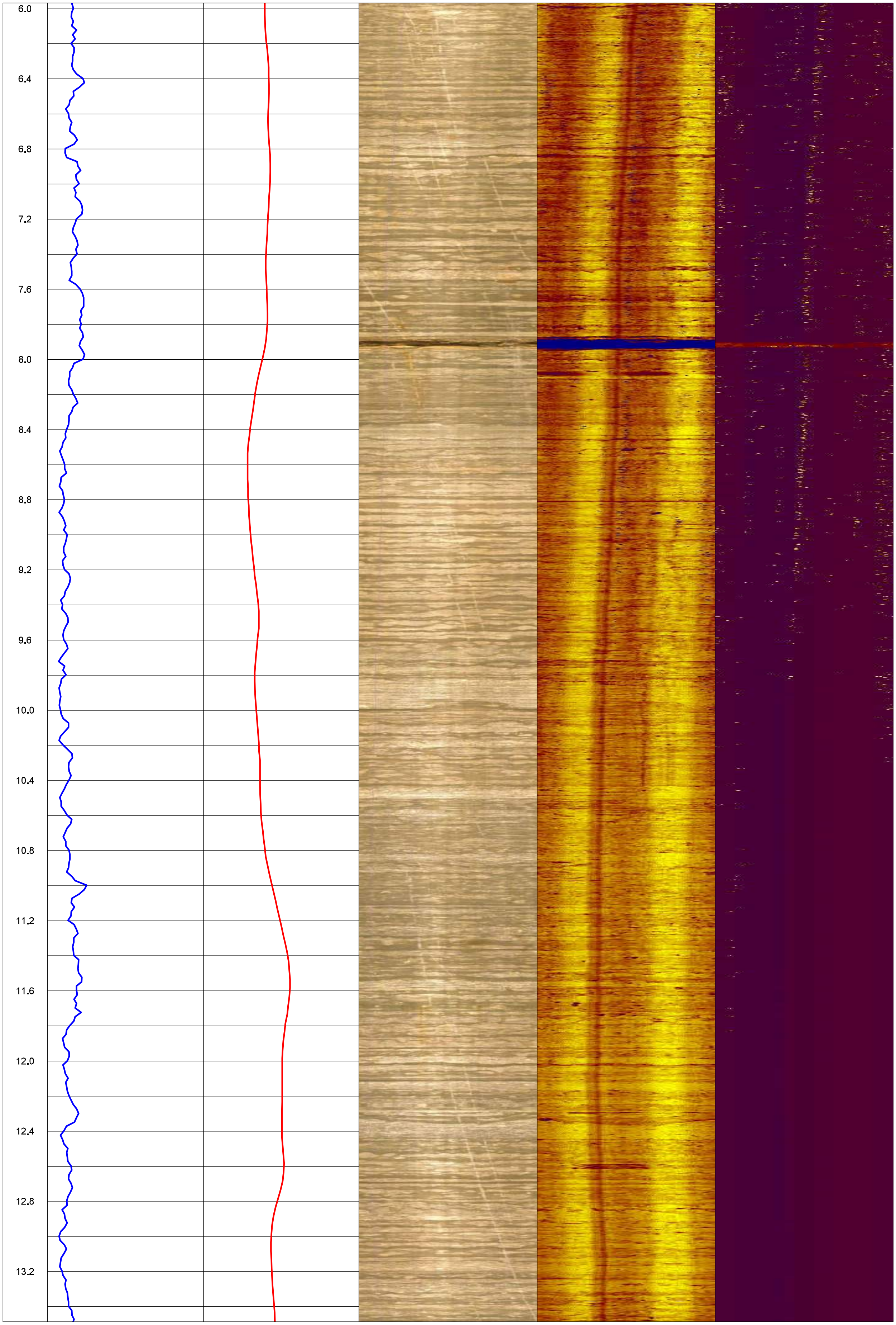
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL

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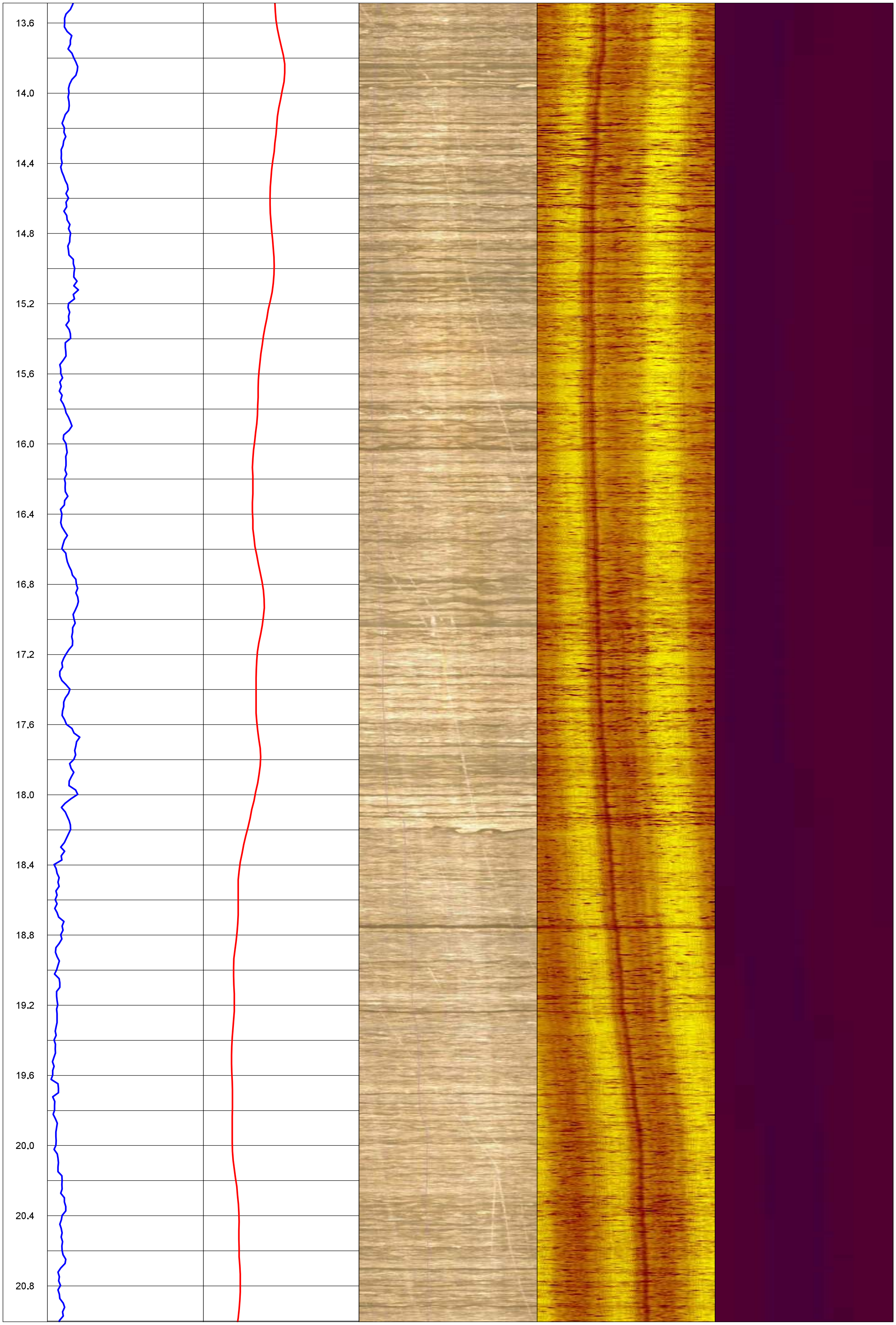
12.8
13.2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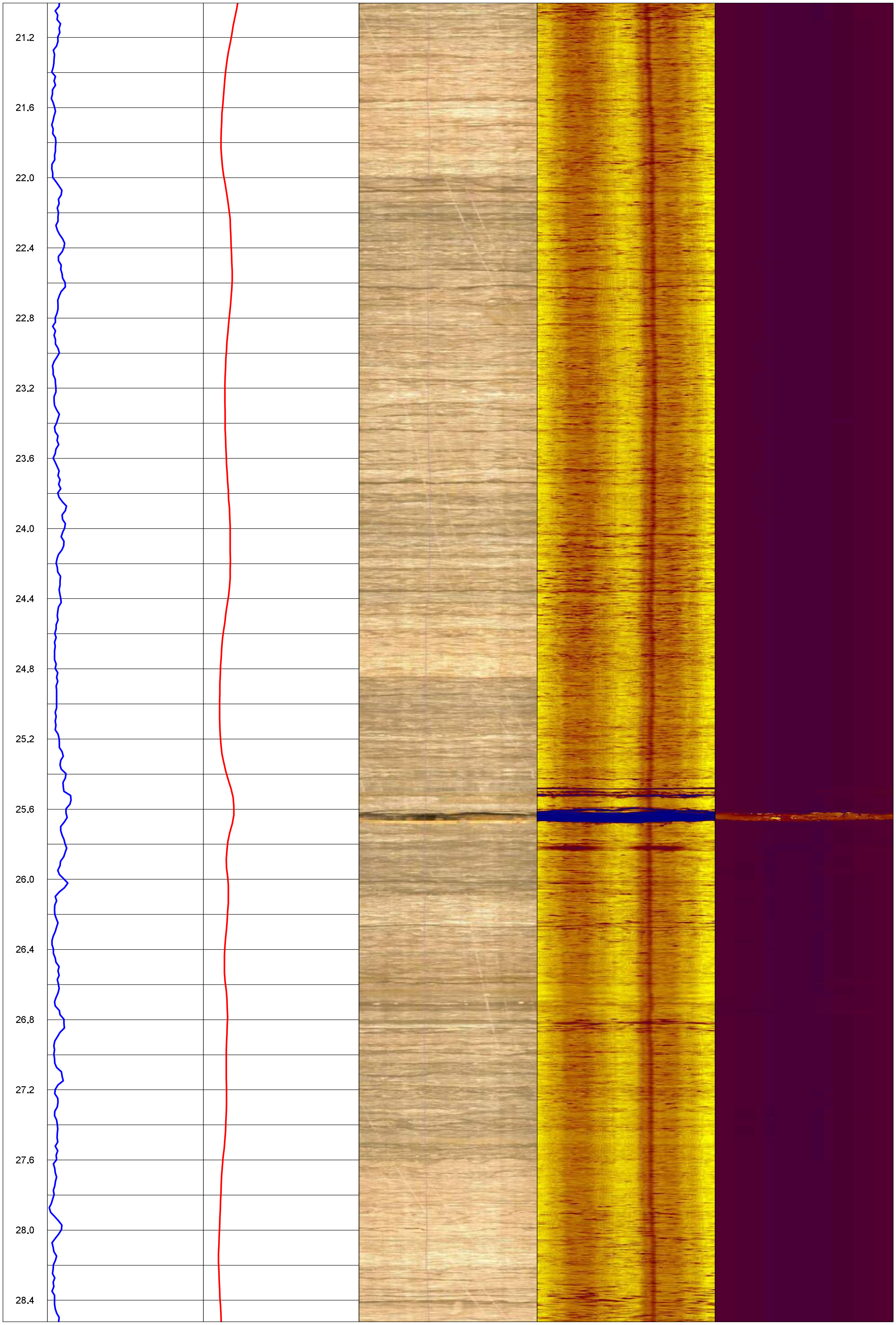
20.8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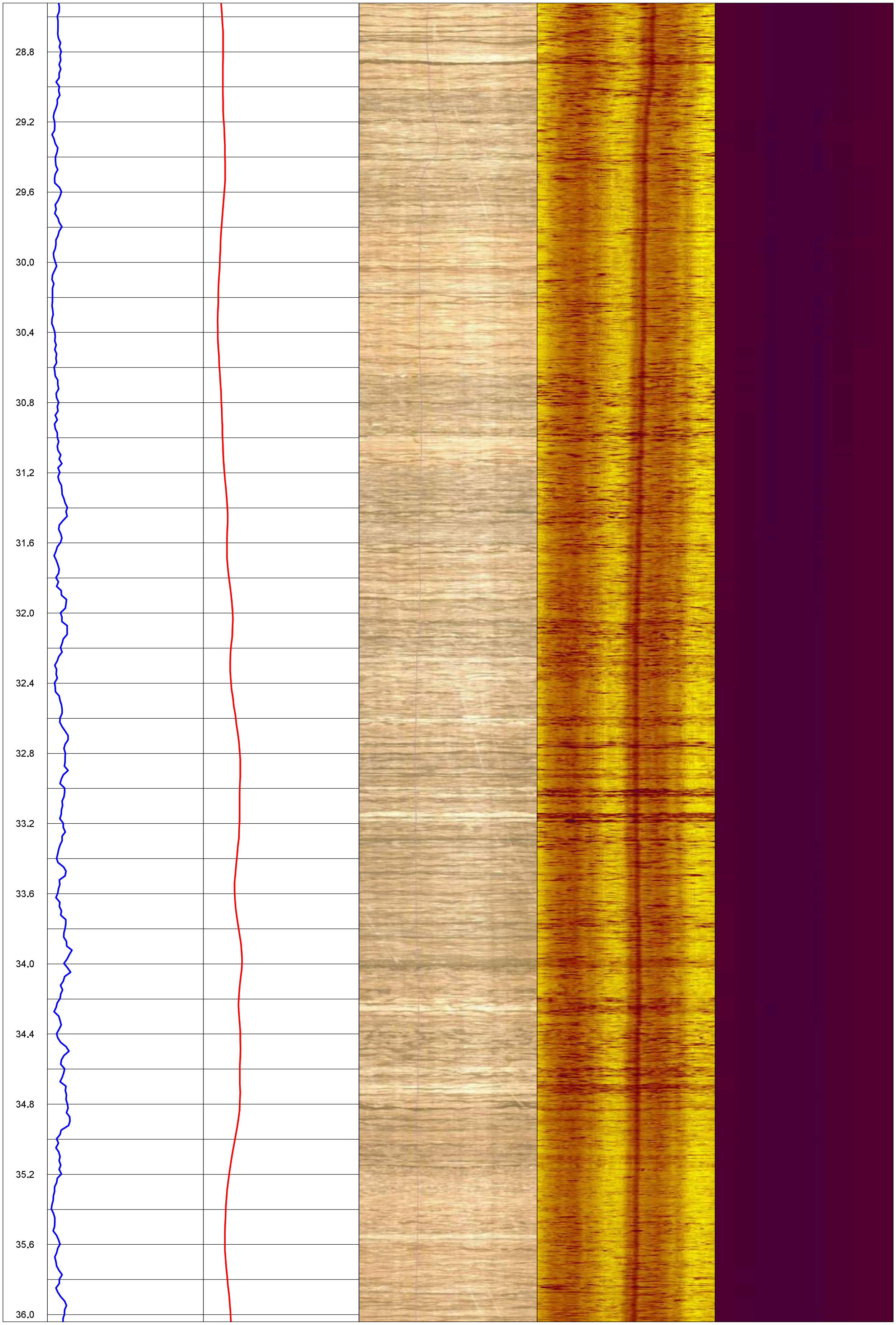
28.0
28.4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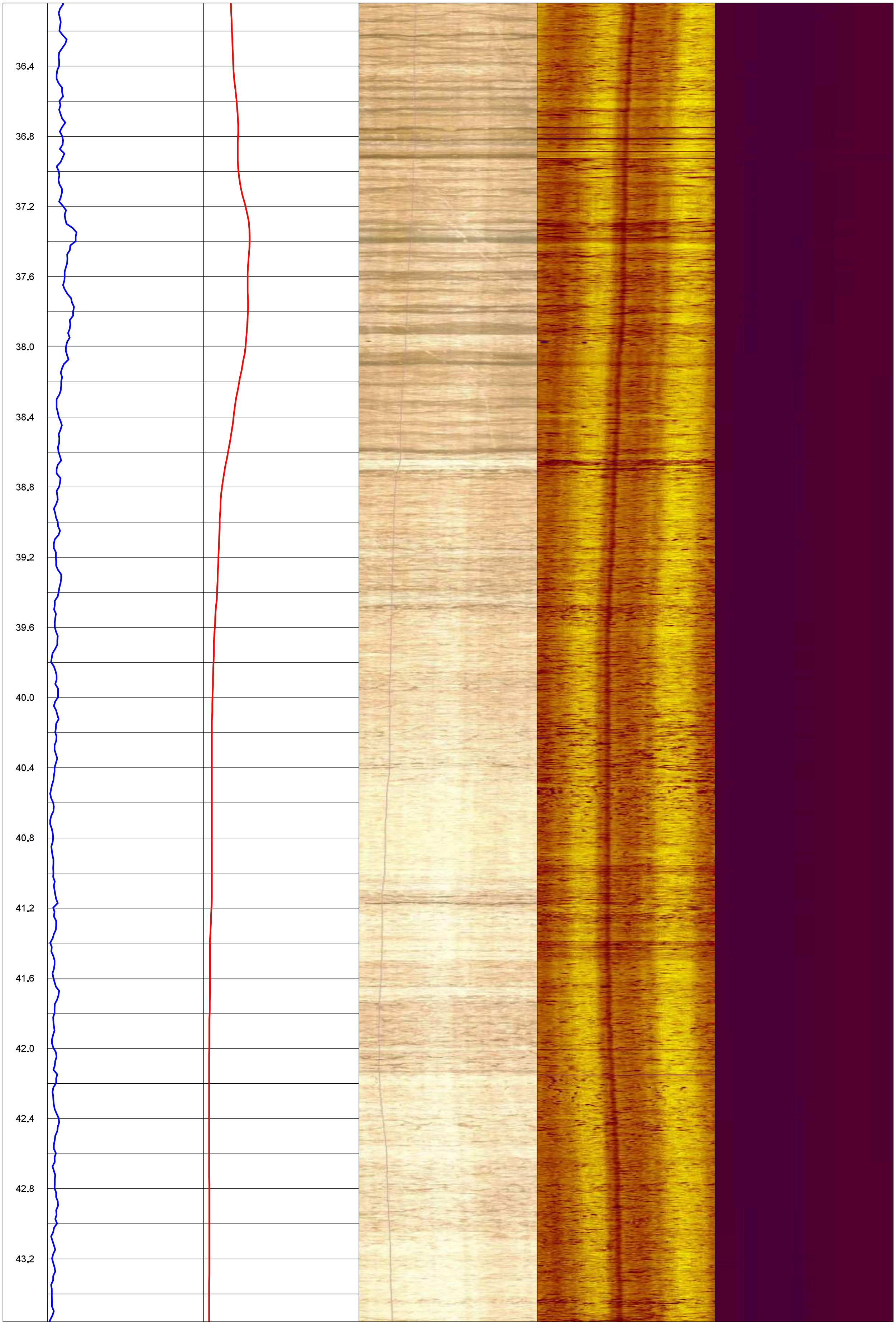
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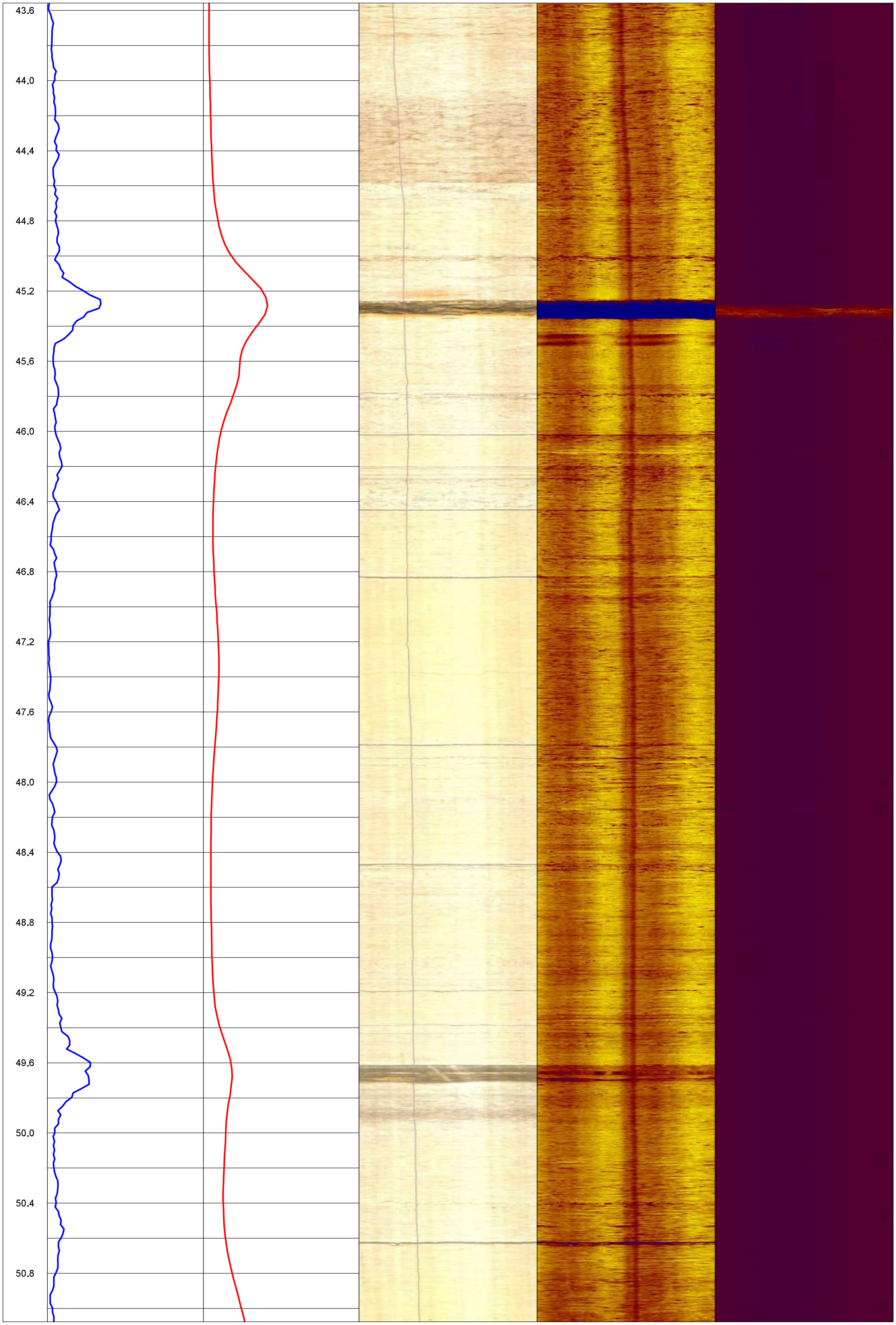
42.8
43.2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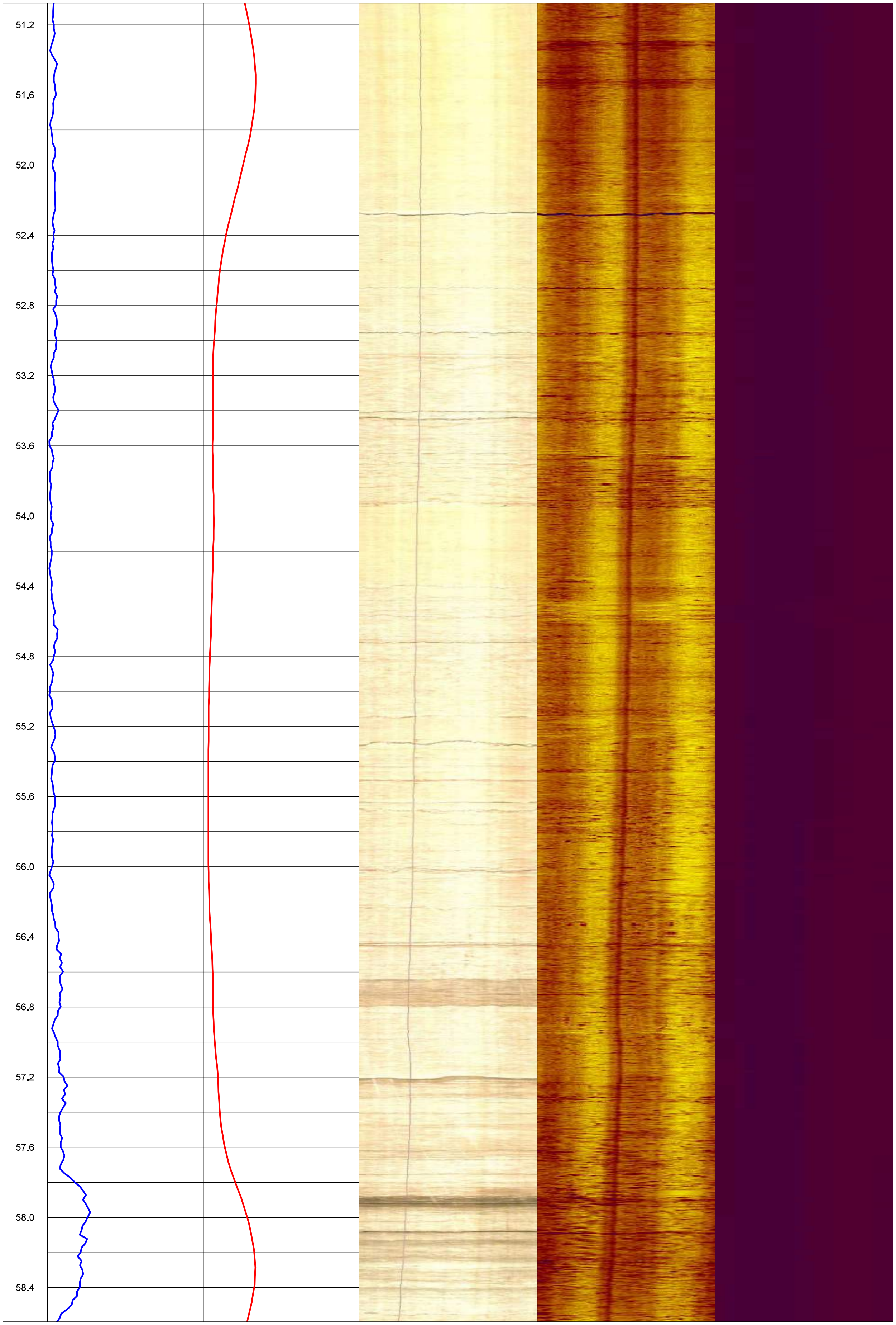
50.8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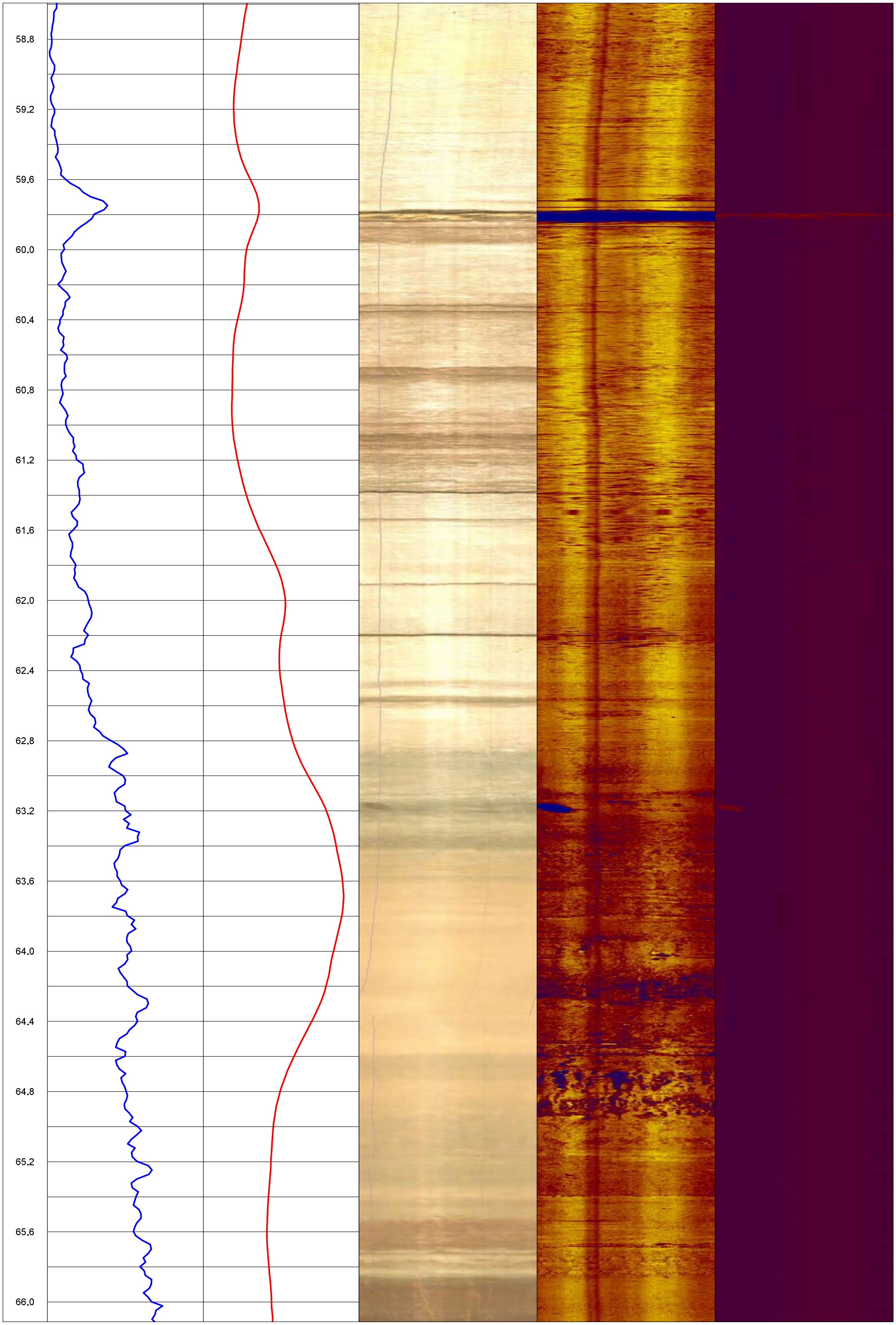
58.0
58.4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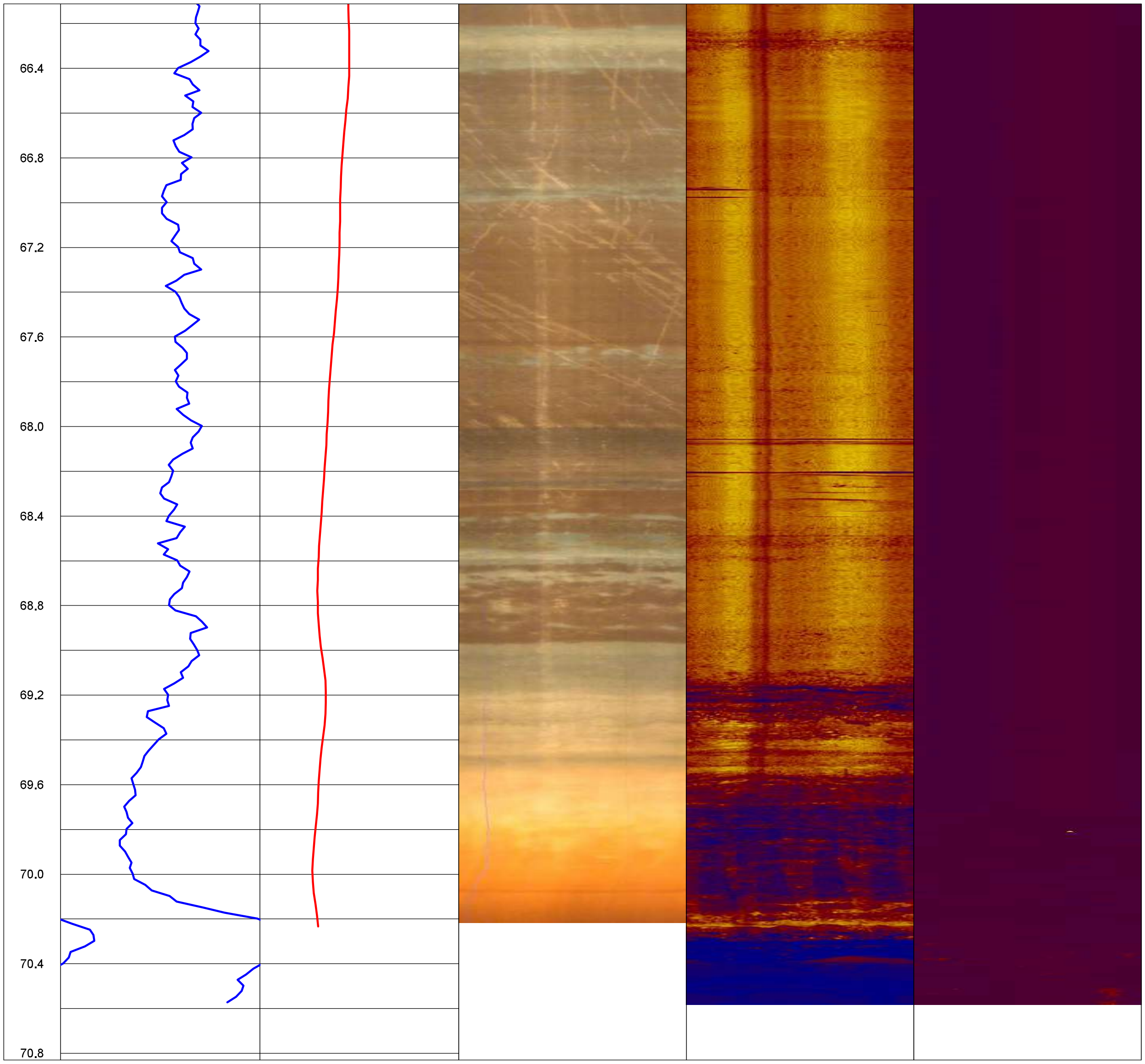
65.6
66.0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67,6
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68,8
69,2
69,6
70,0
70,4
70,8

GOLDER

Geophysical Record of Borehole: BH-3

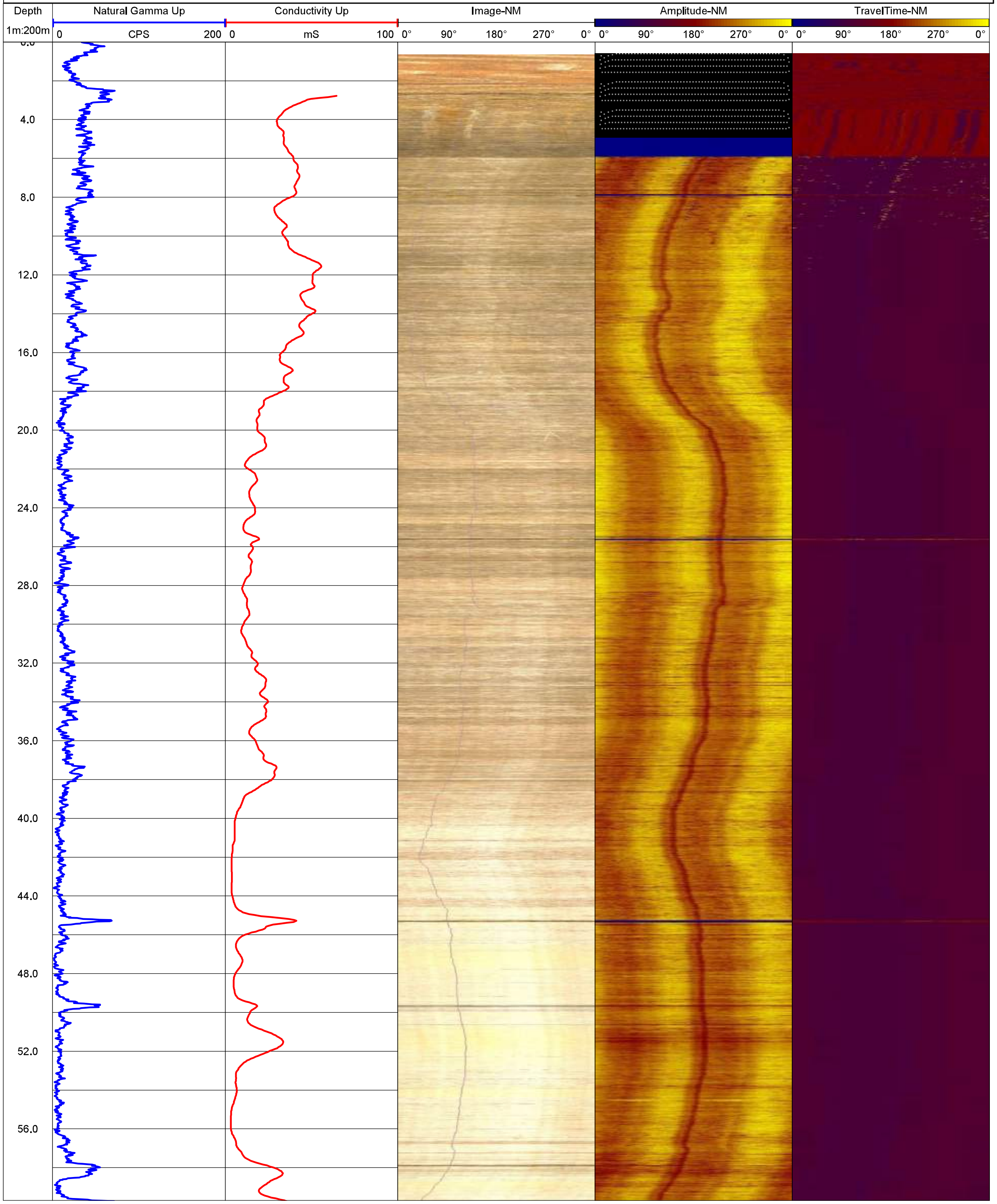
Log Title: BH-3
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

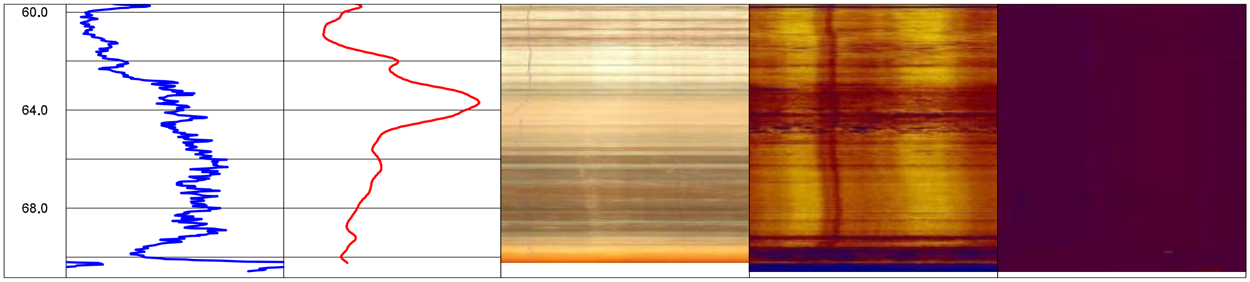
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL




60.0
64.0
68.0

GOLDER

Geophysical Record of Borehole: BH-4

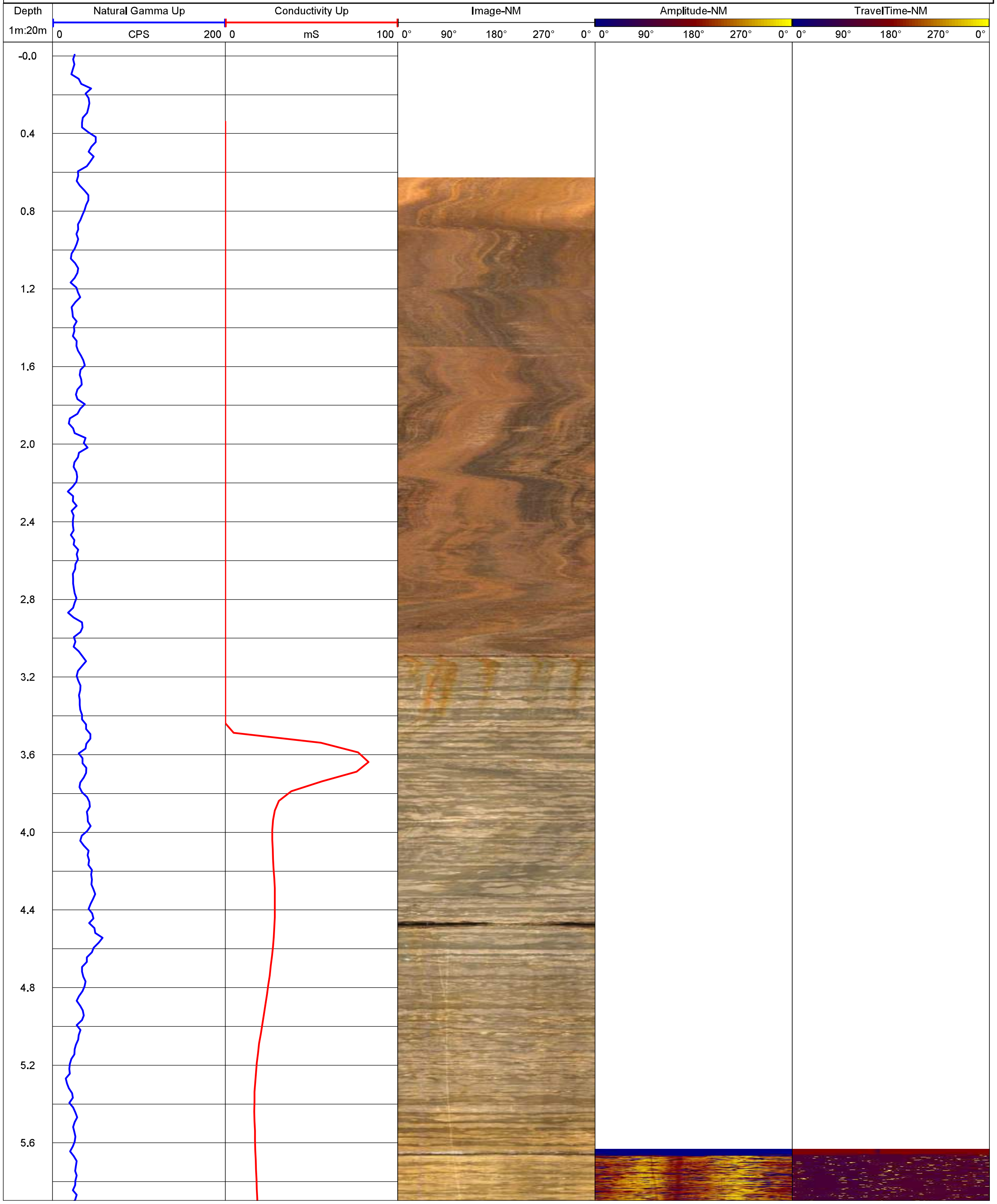
Log Title: BH-4
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

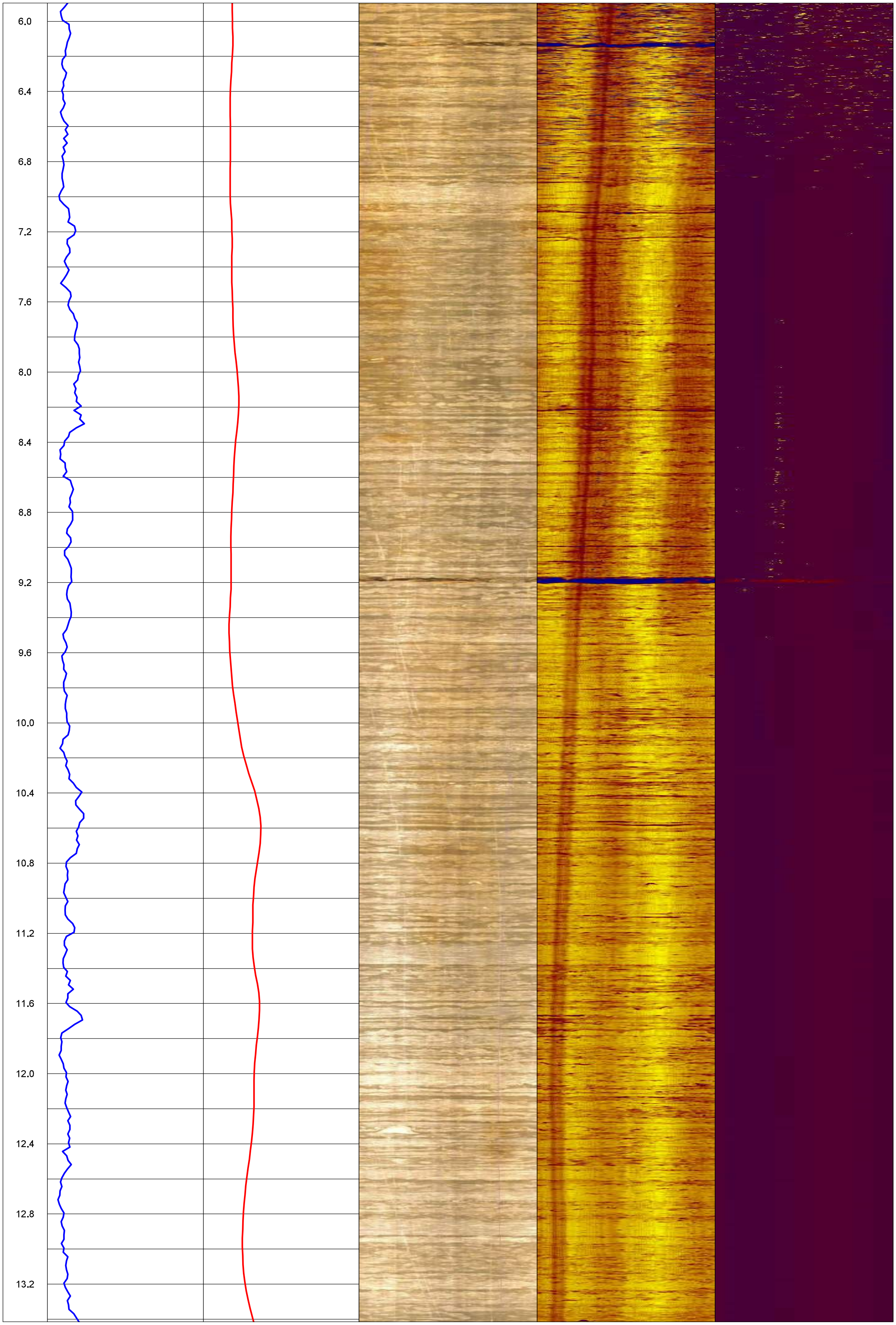
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL

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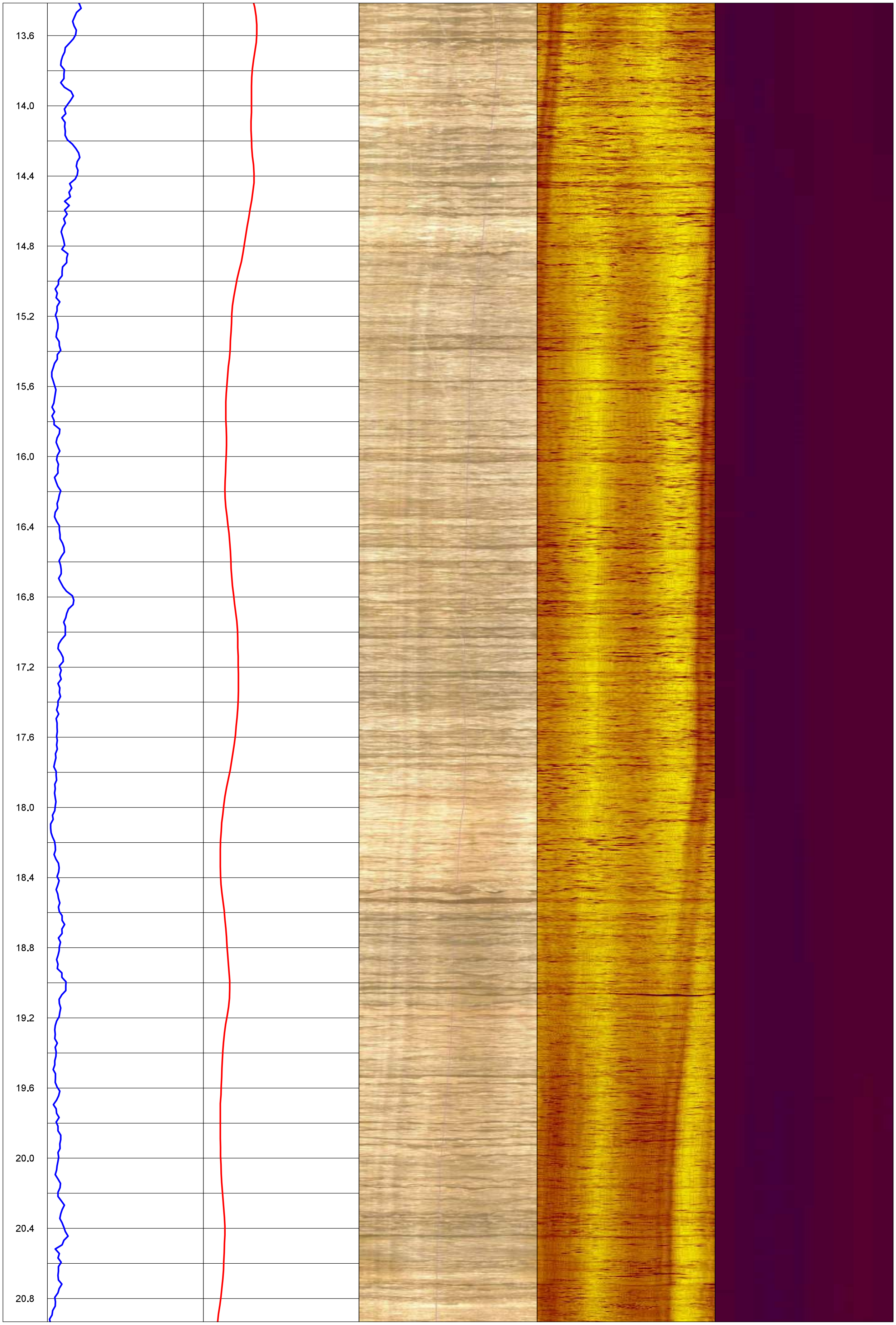
12,8
13,2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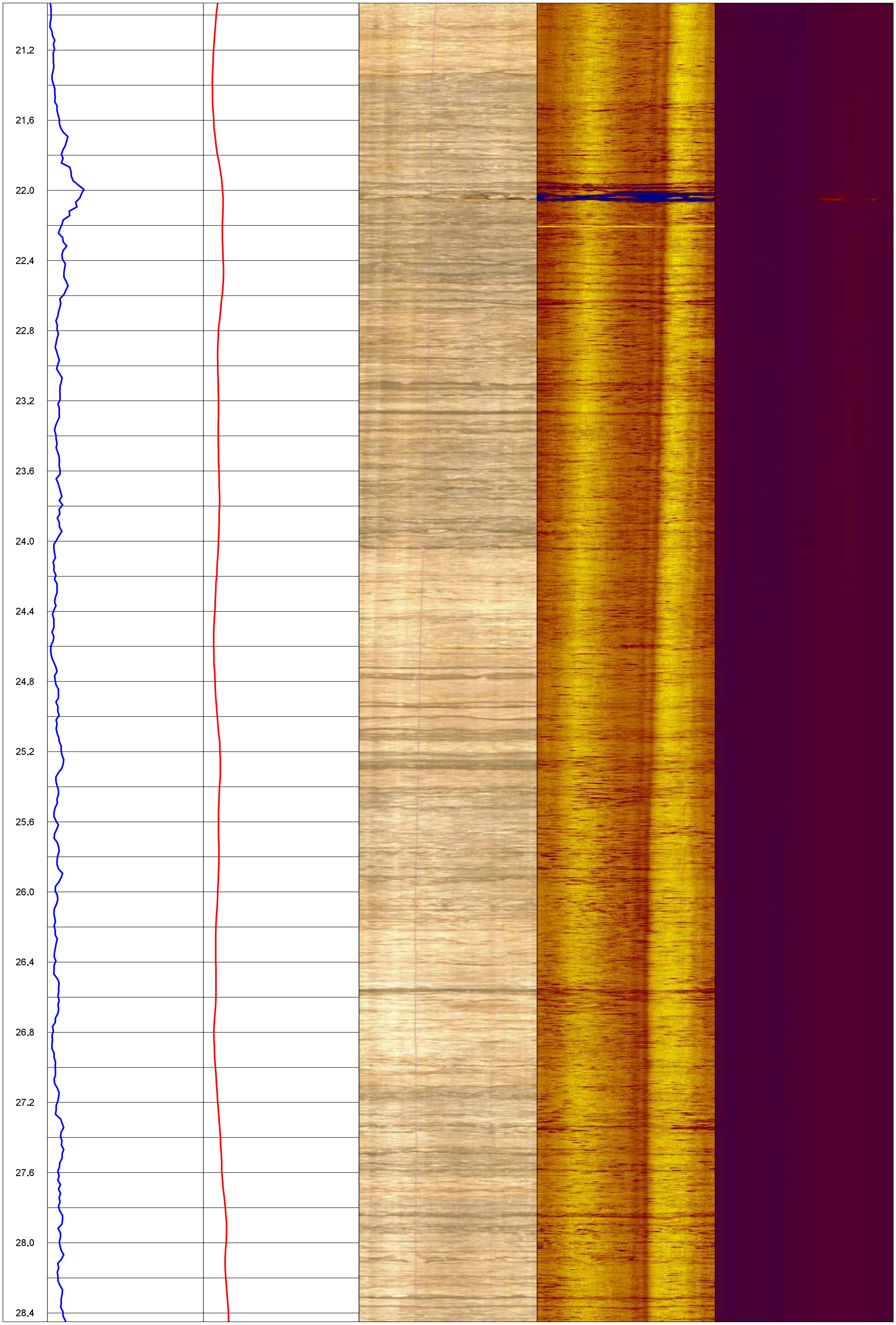
20.8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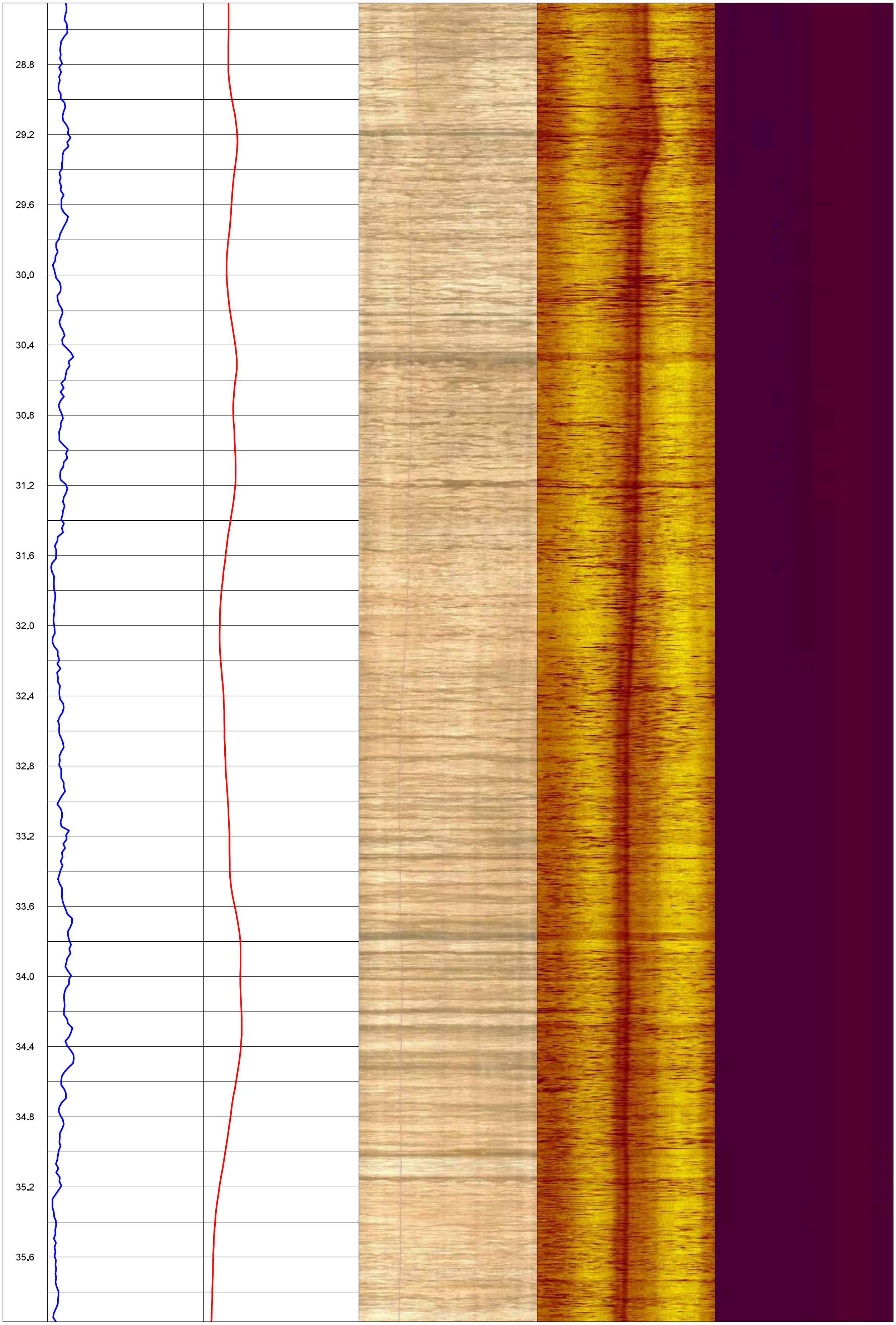
28.4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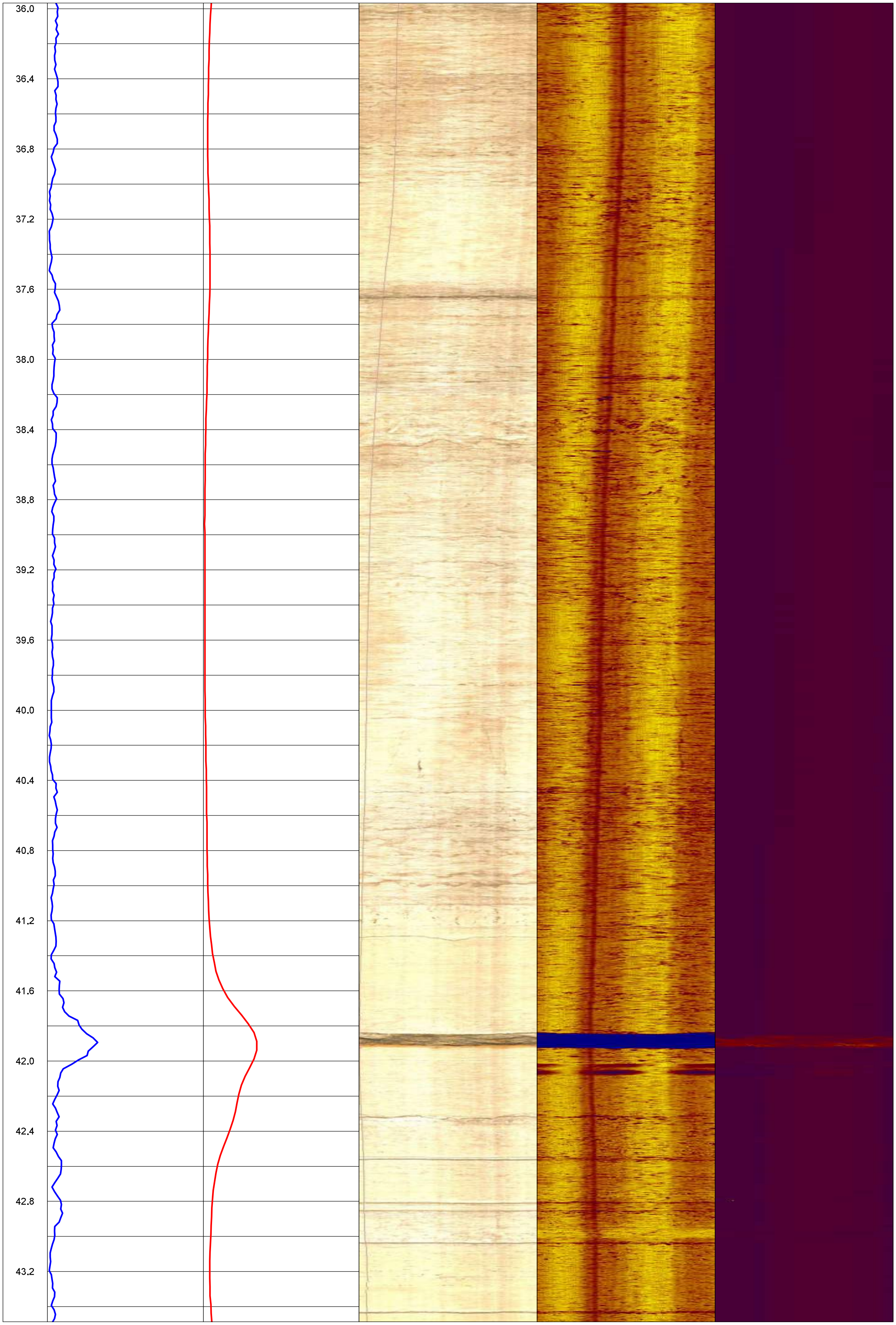
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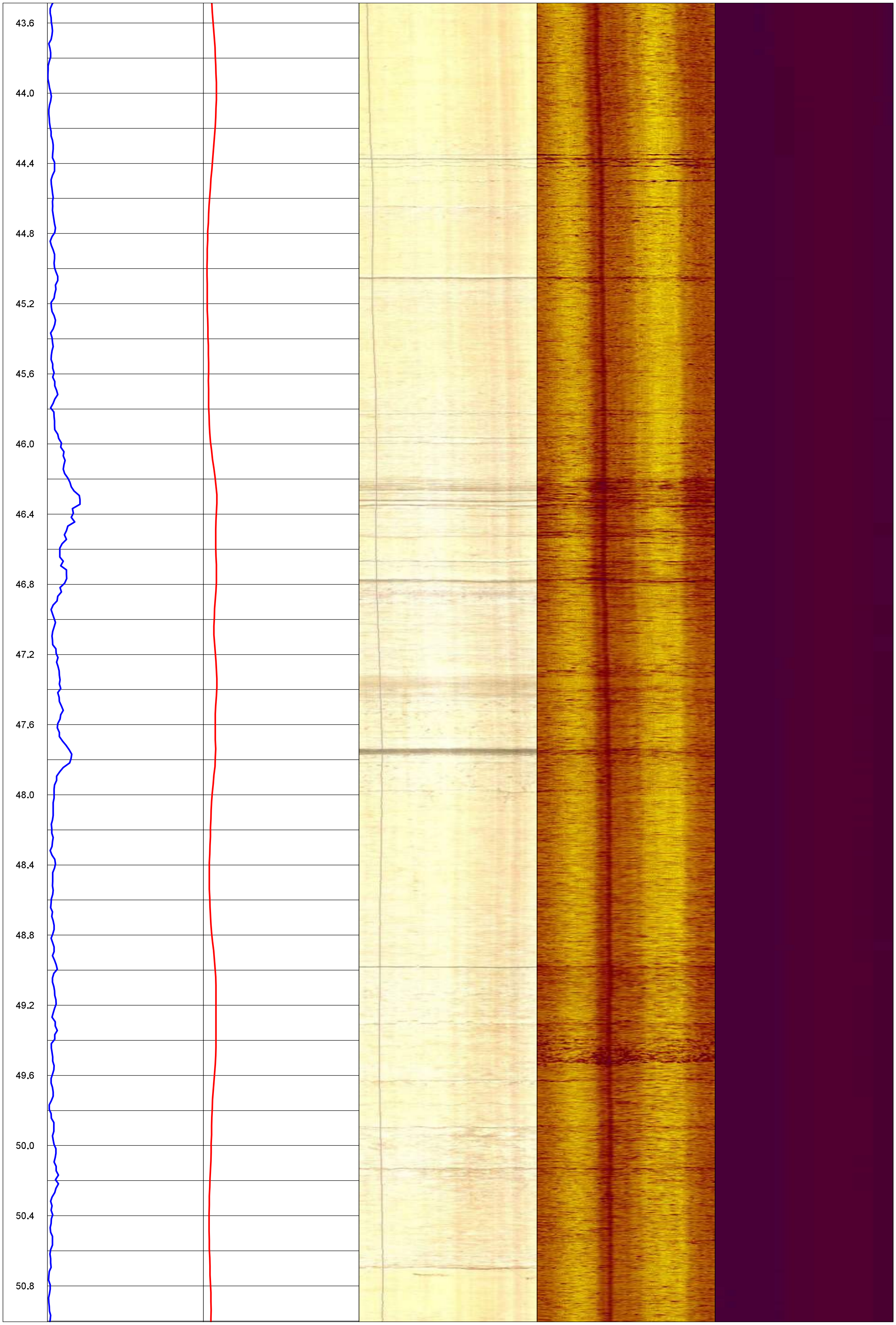
43.2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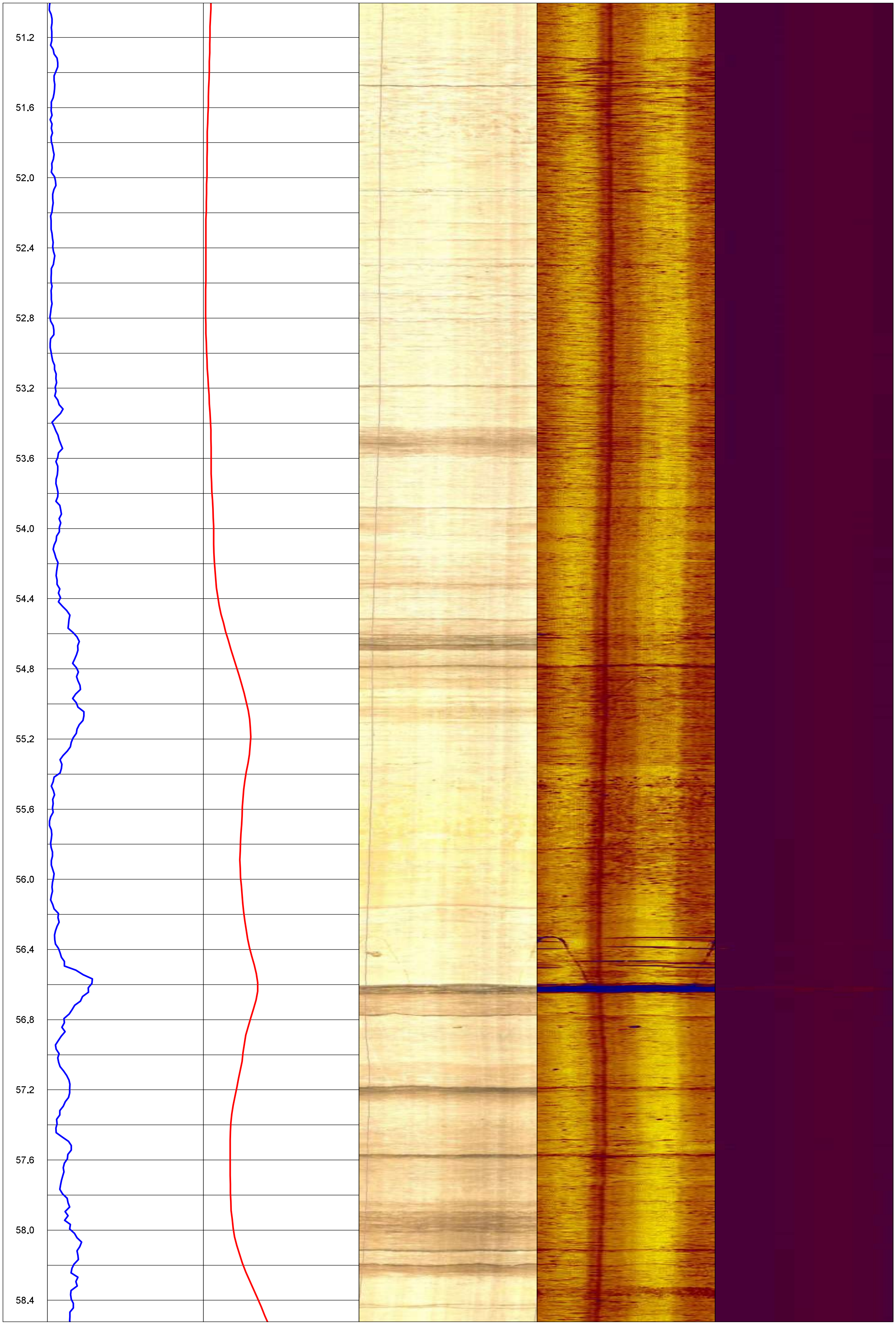
50.8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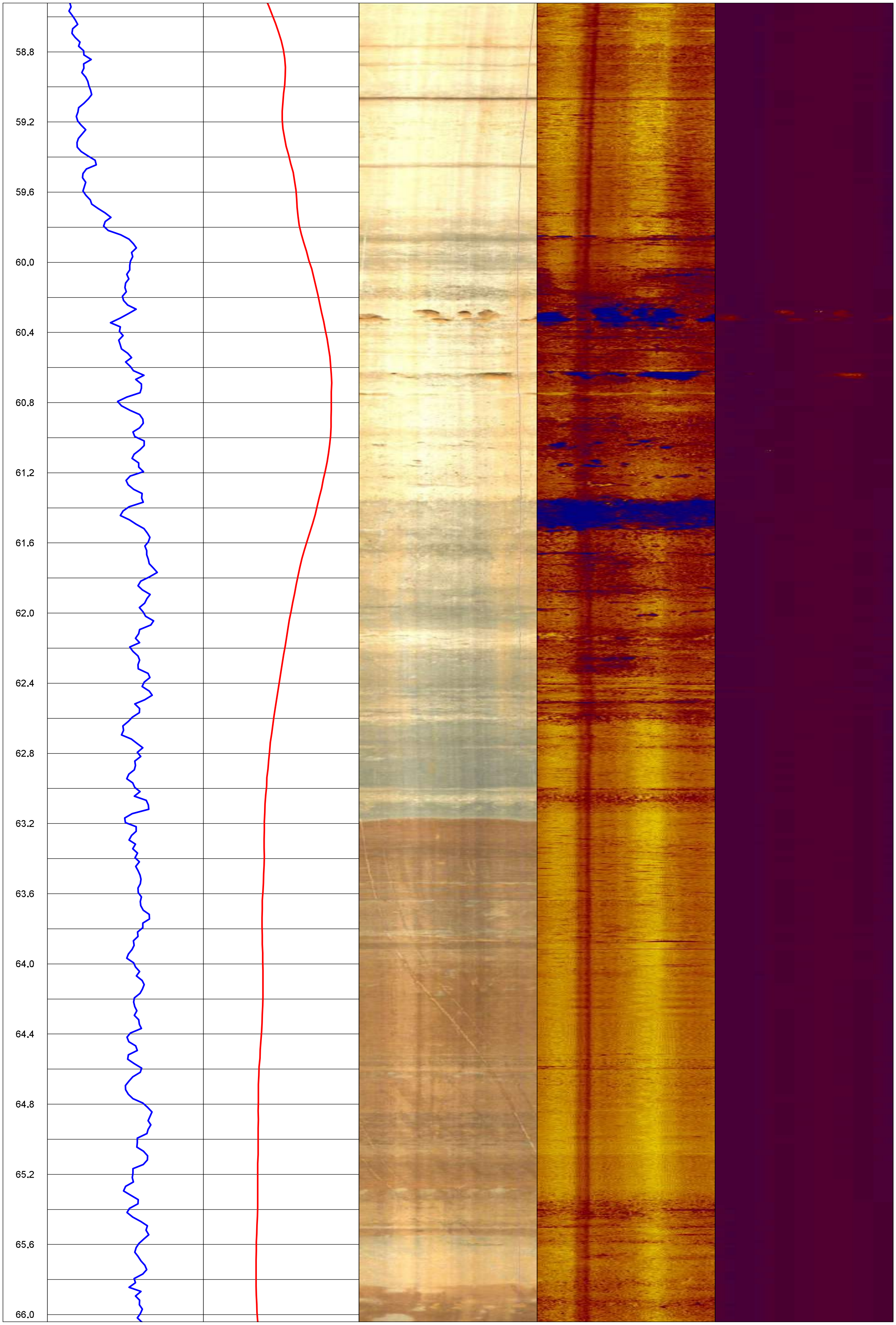
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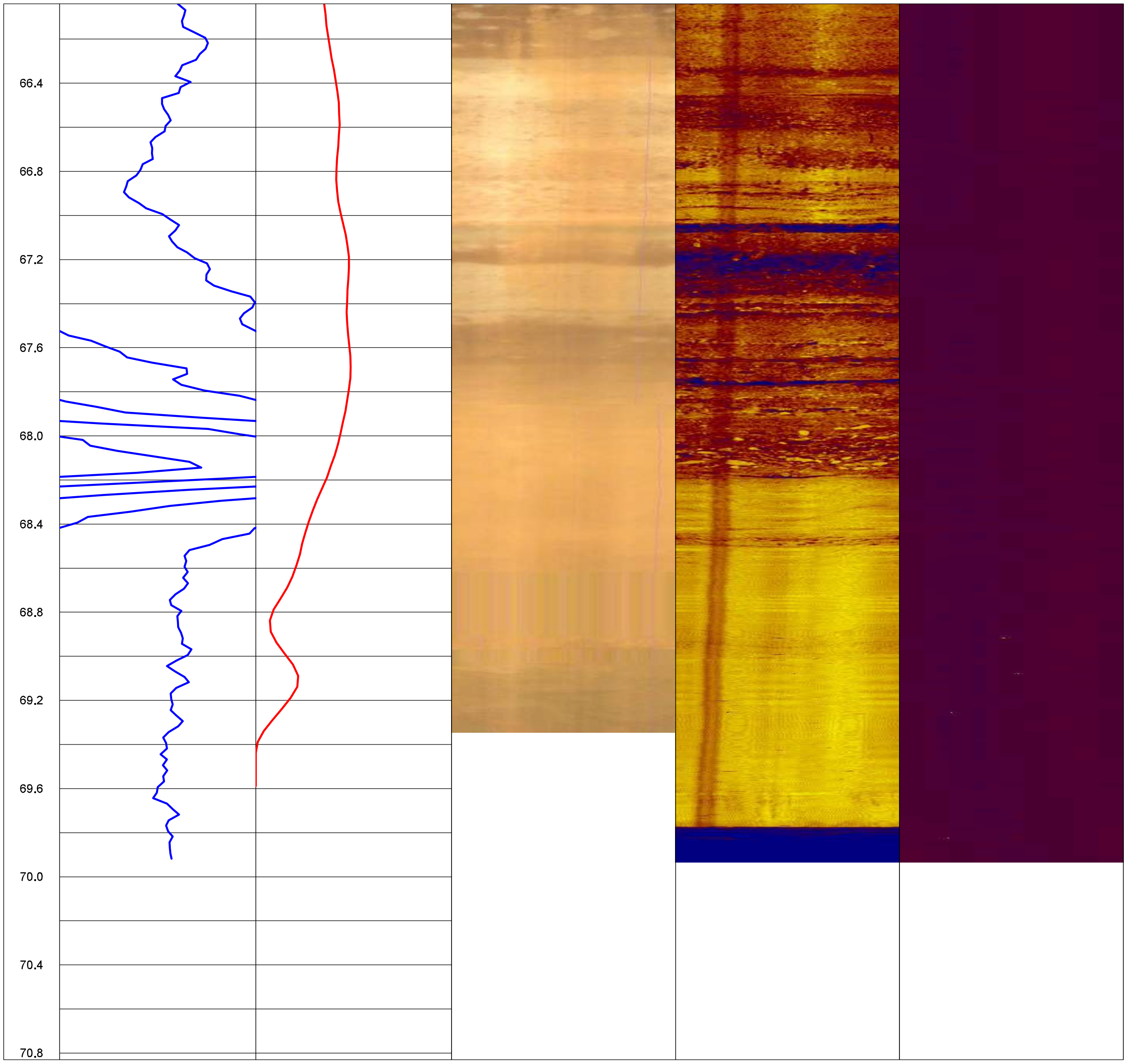
66.4
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68.8
69.2
69.6
70.0
70.4
70.8

GOLDER

Geophysical Record of Borehole: BH-4

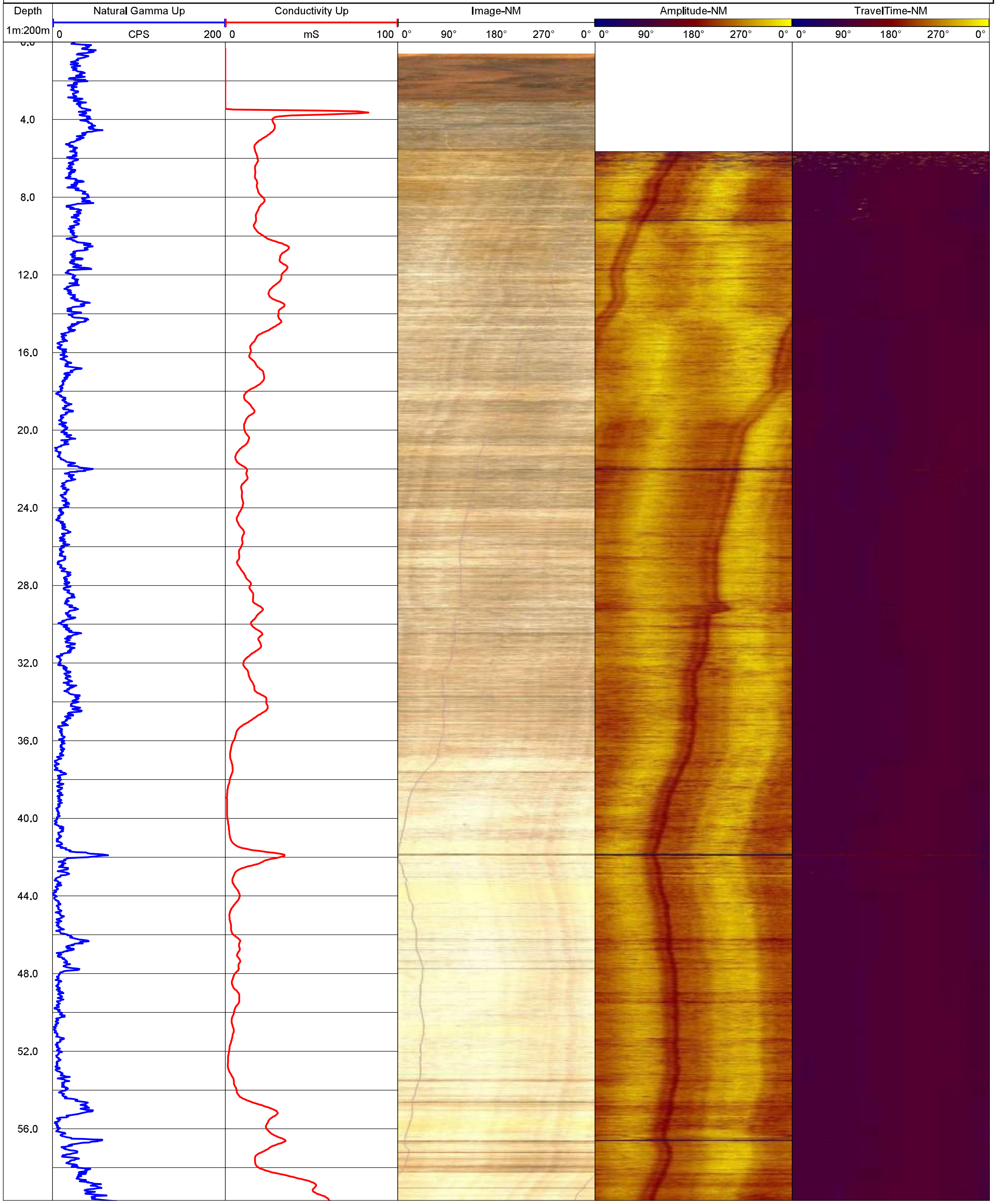
Log Title: BH-4
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

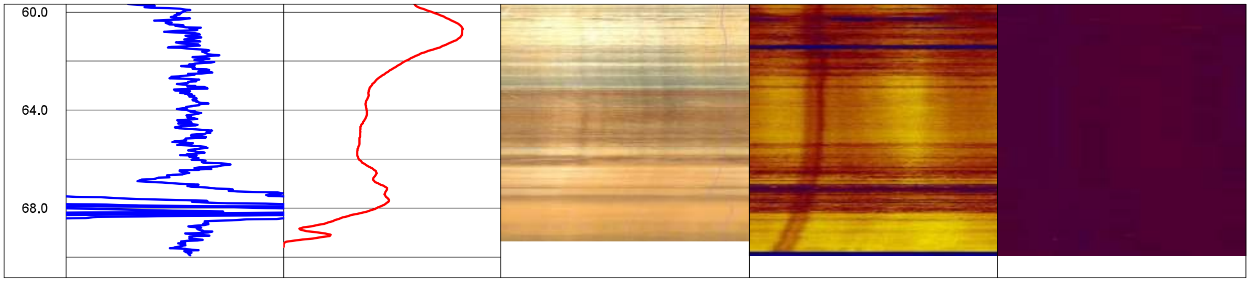
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: Sept 19, 2019
Logged By: PL

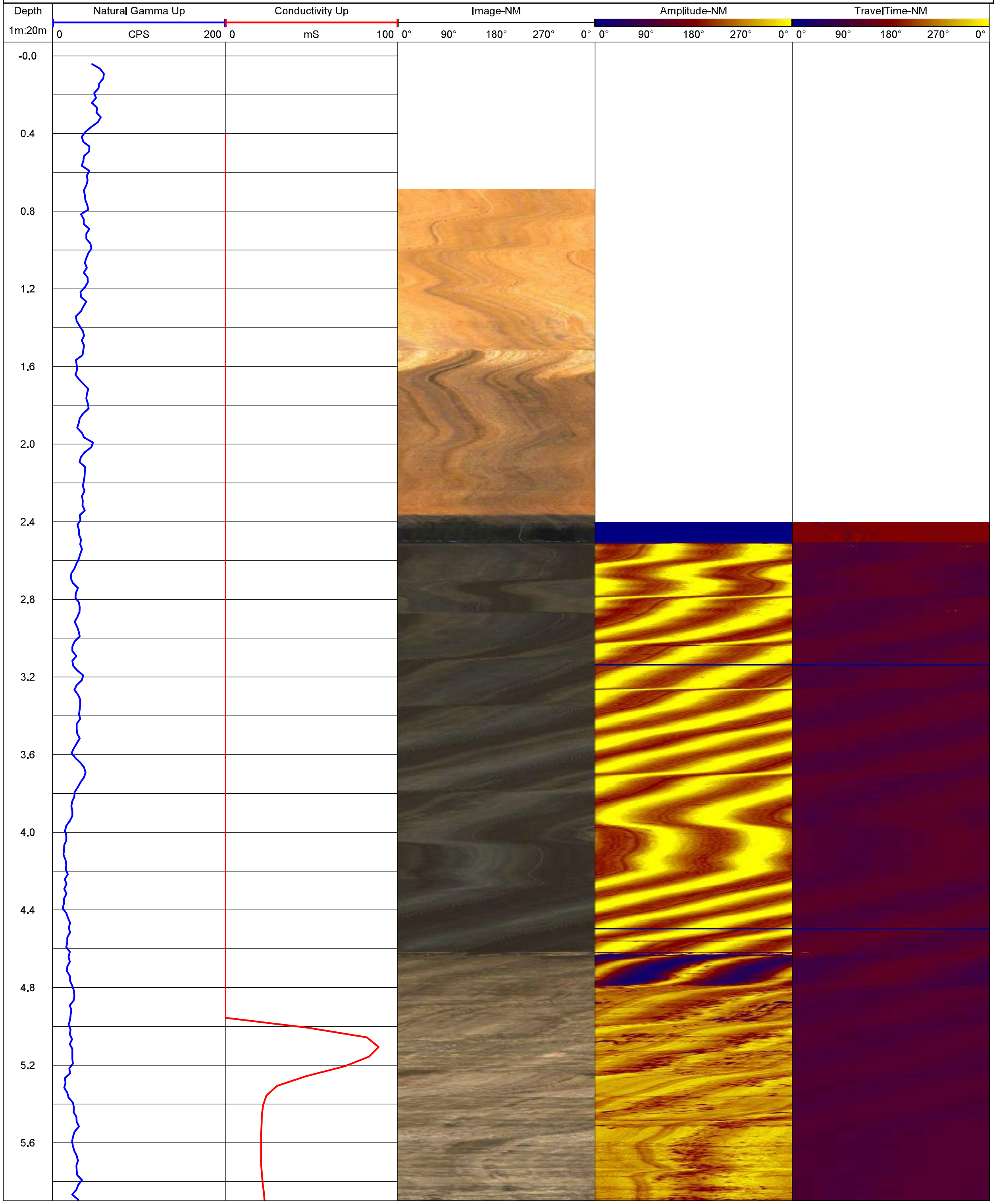


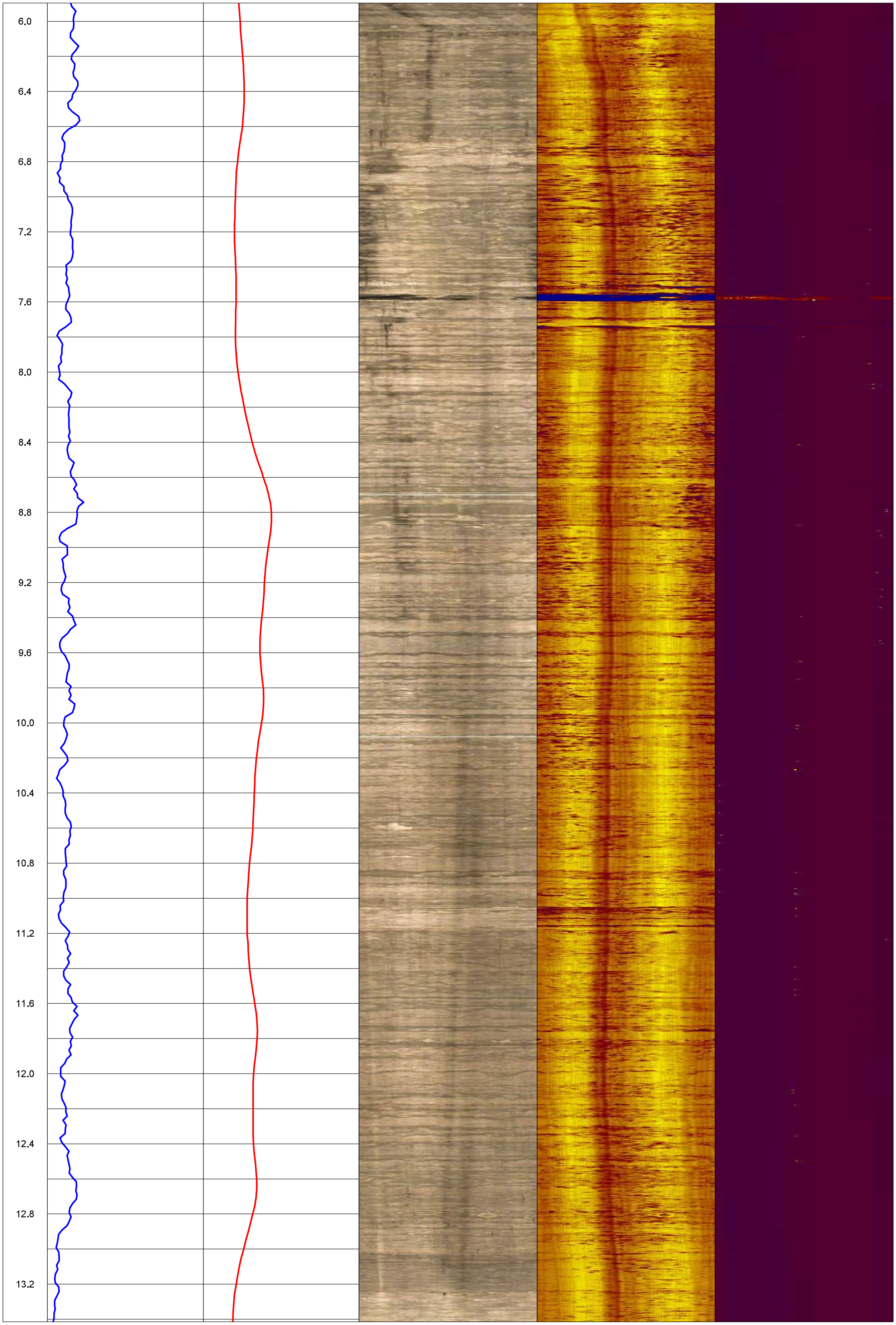

60.0
64.0
68.0

Geophysical Record of Borehole: BH-5

Log Title: BH-5
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	Sept 21, 2019
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PL

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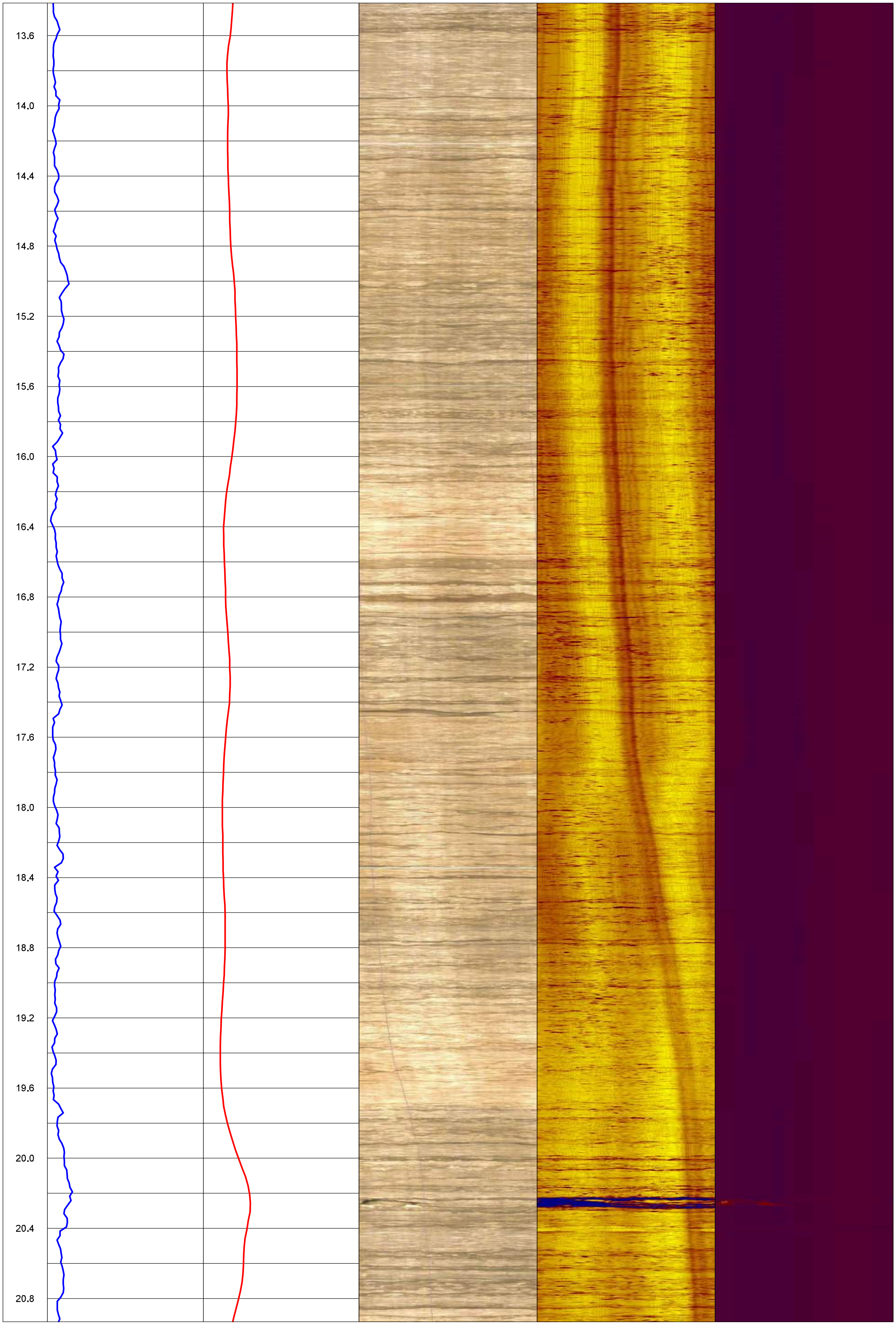
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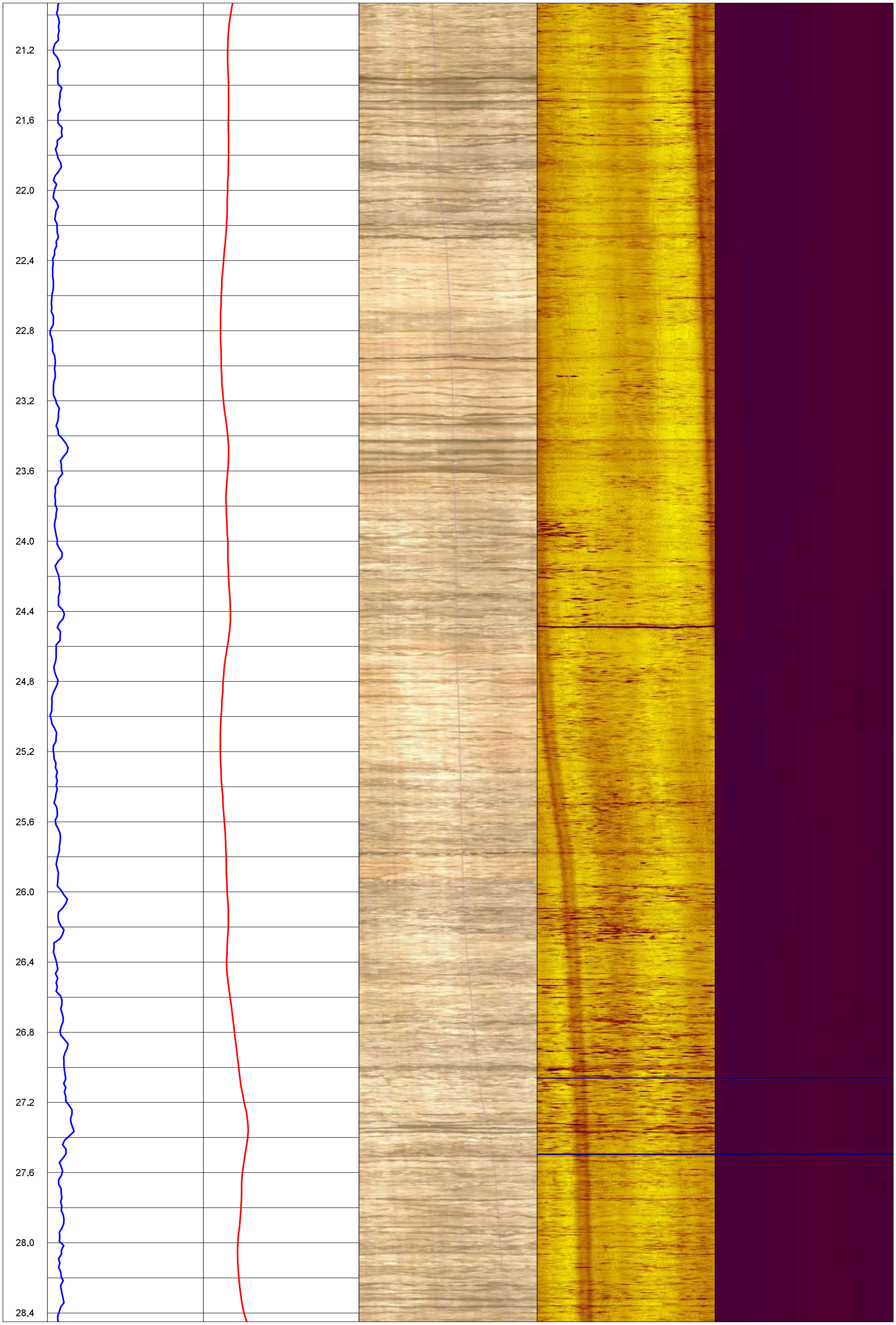
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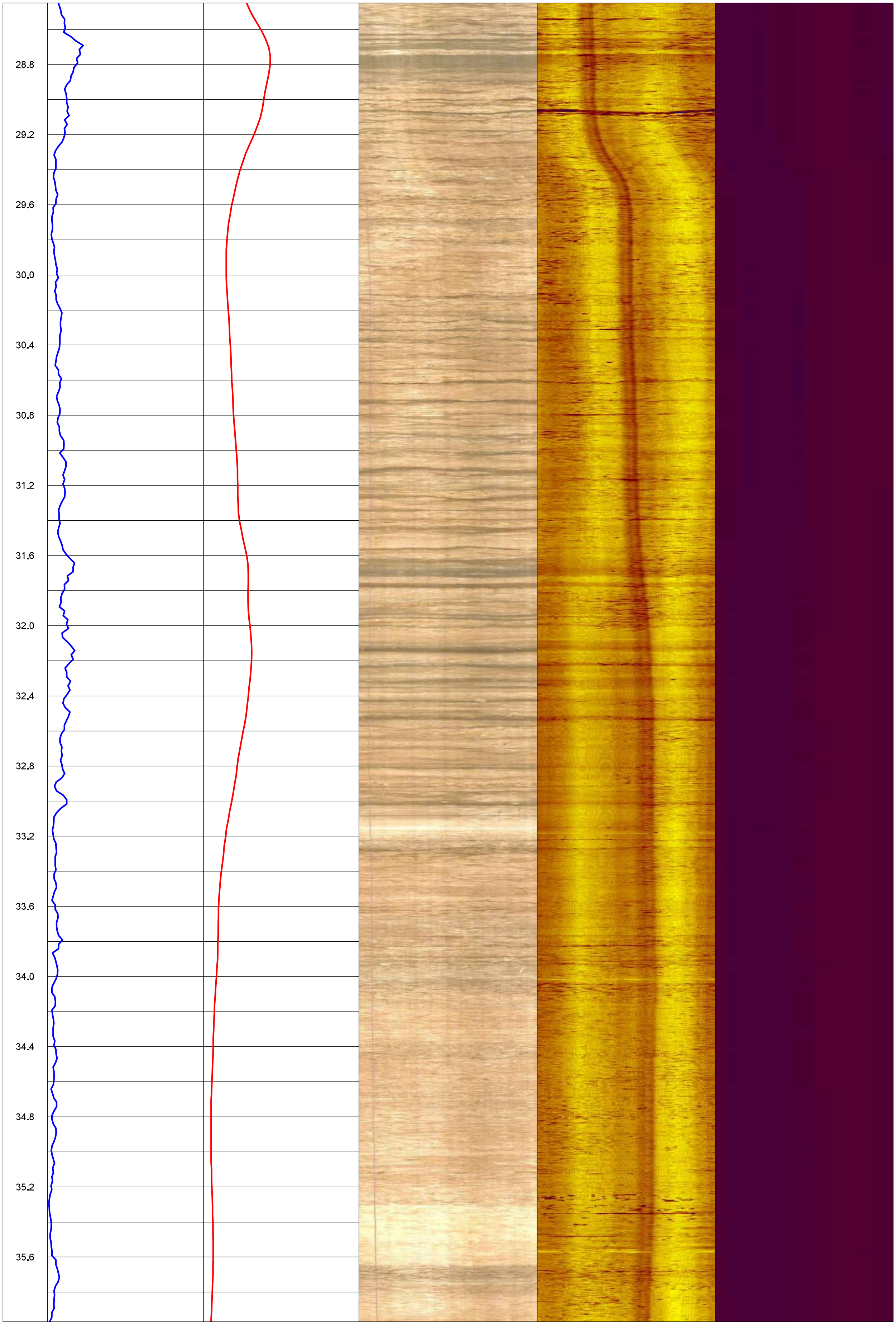
28.4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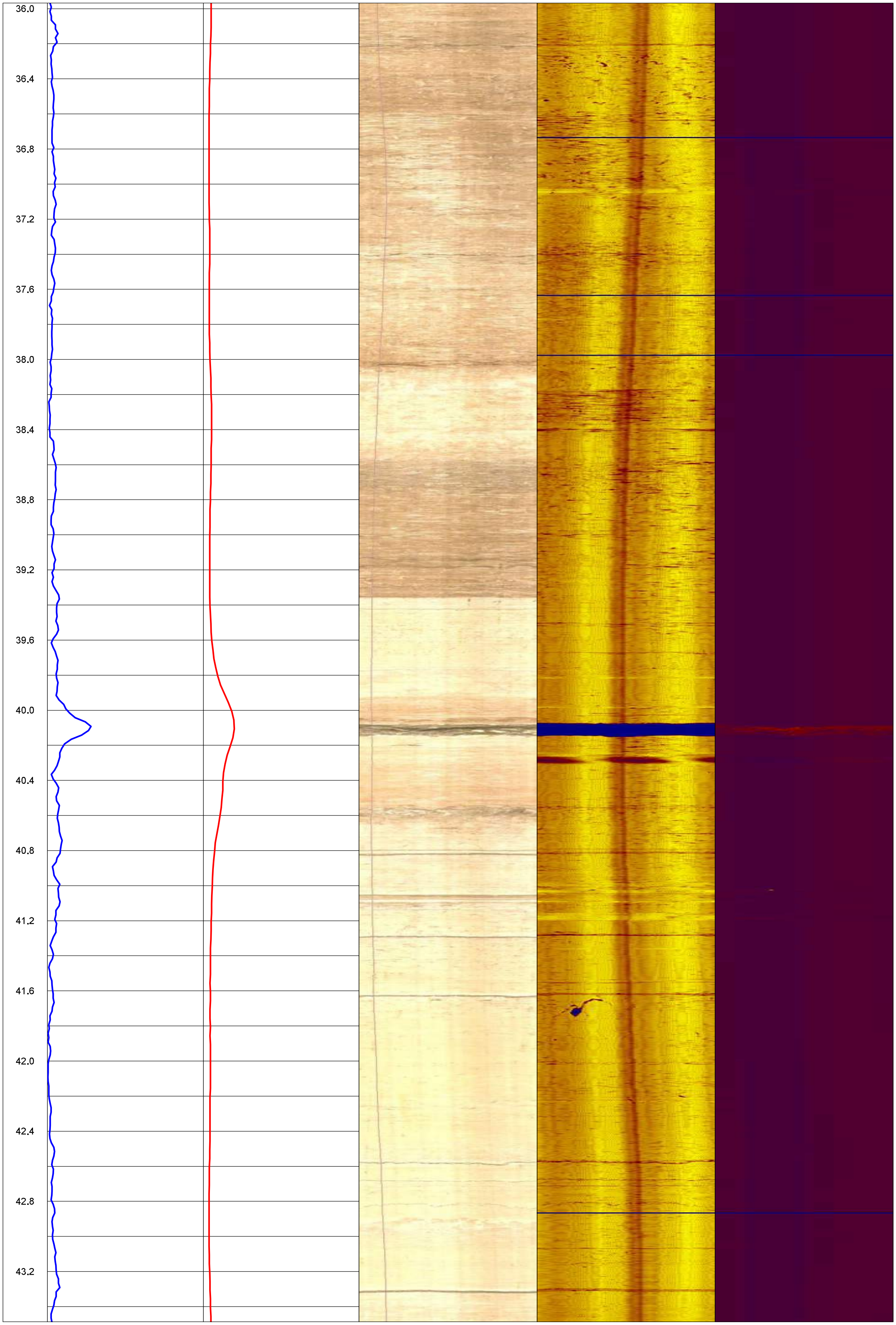
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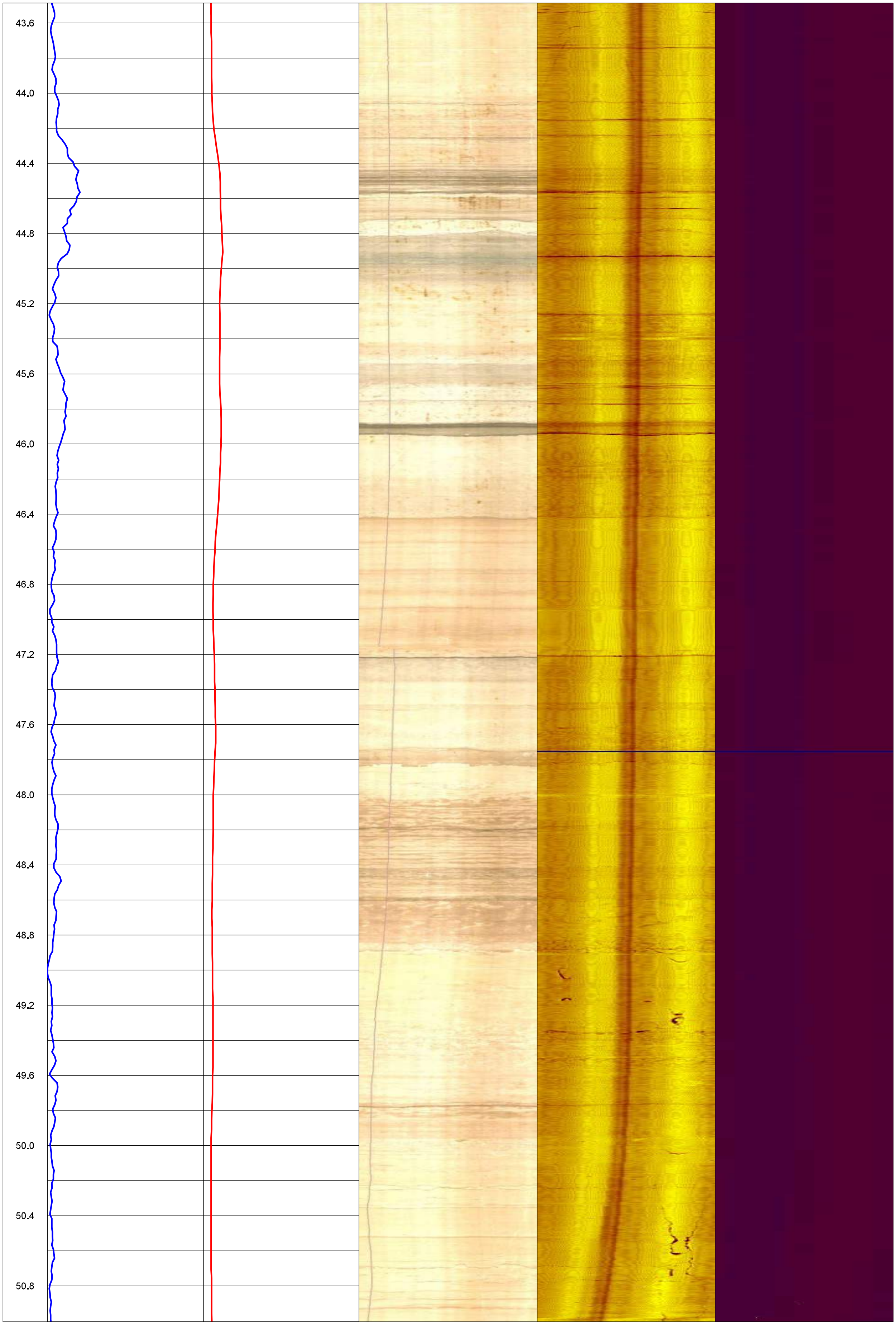
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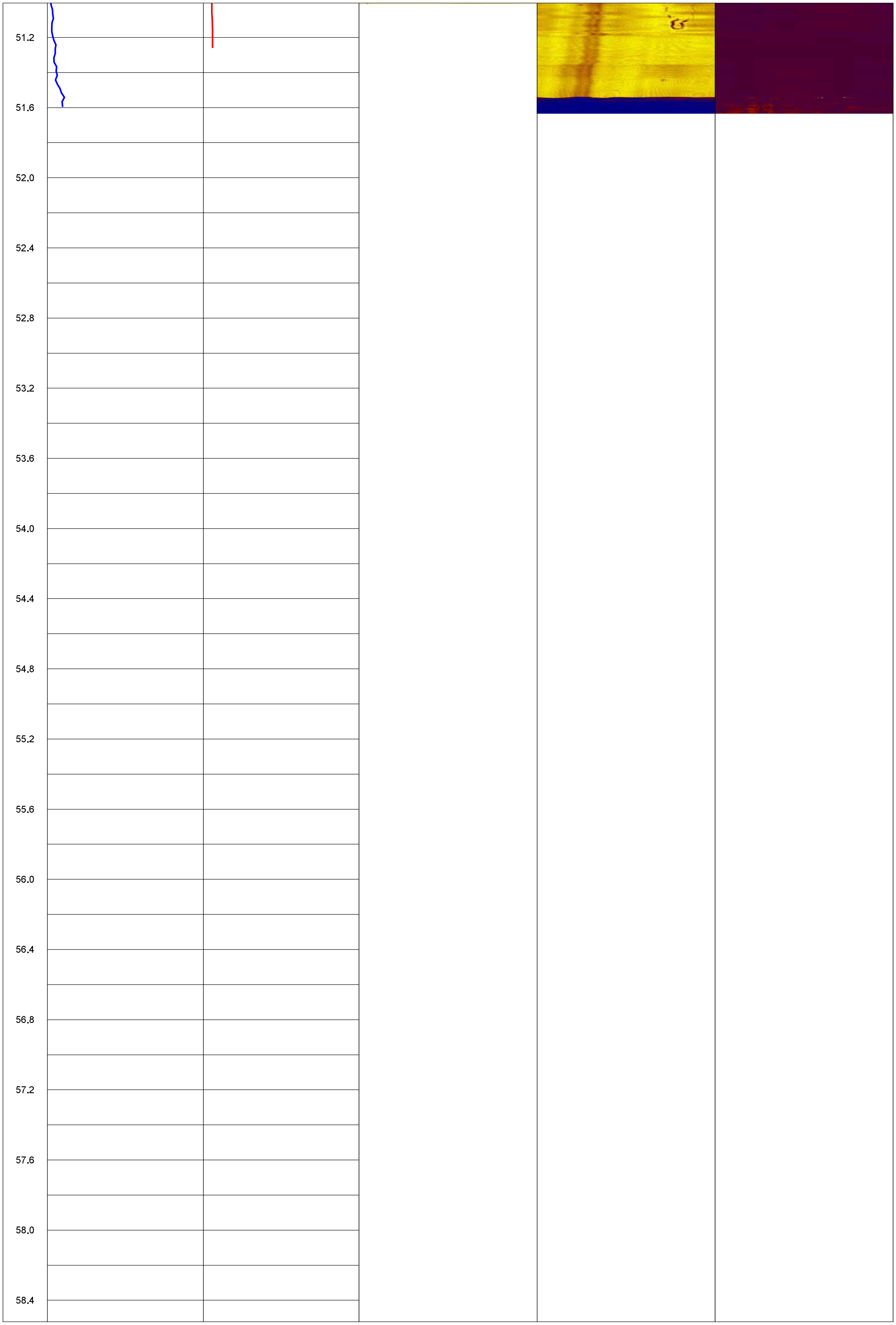
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54,8
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55,6
56,0
56,4
56,8
57,2
57,6
58,0
58,4

58,8					
59,2					
59,6					
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60,8					
61,2					
61,6					
62,0					
62,4					
62,8					
63,2					
63,6					
64,0					
64,4					
64,8					
65,2					
65,6					
66,0					

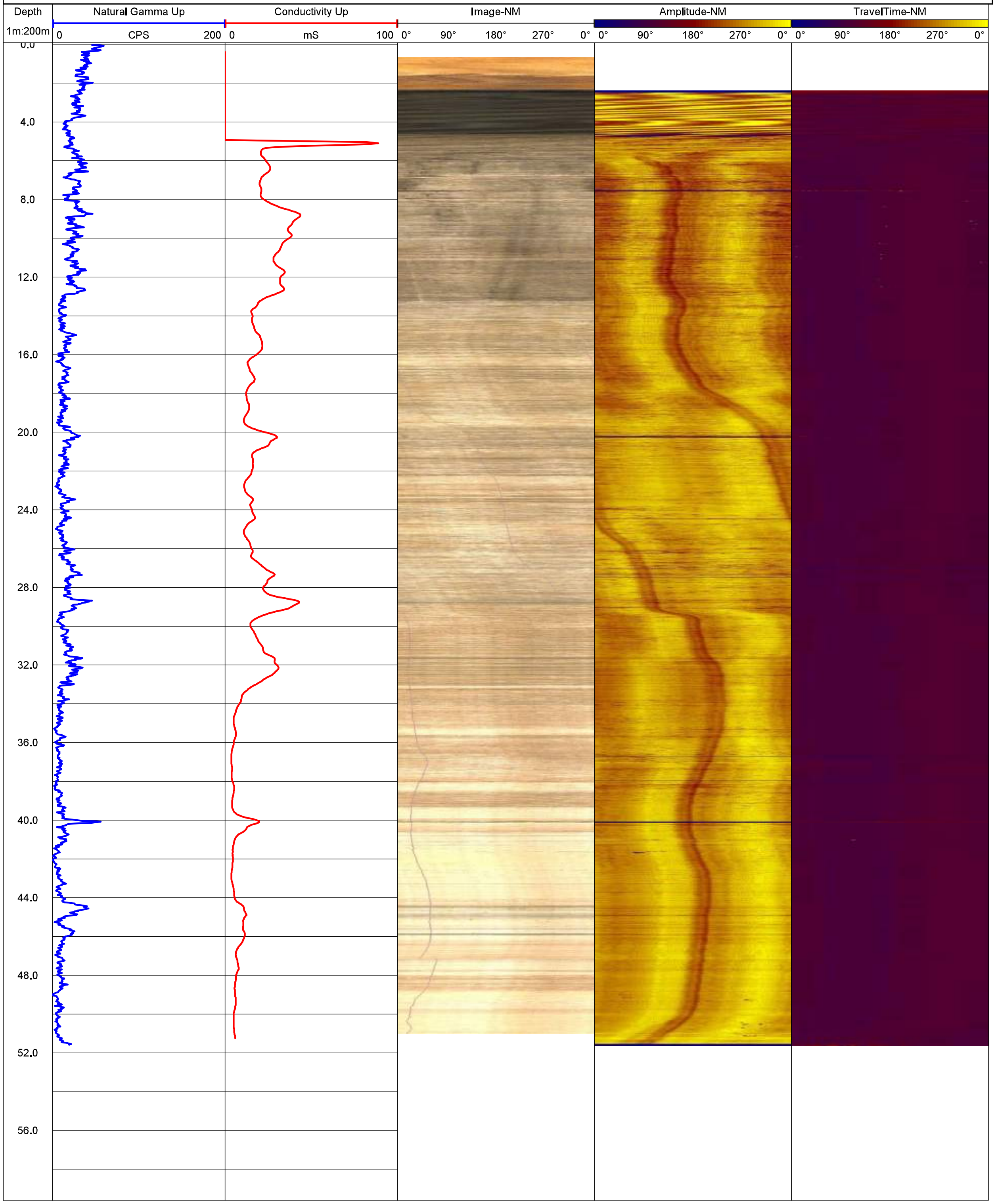
66.4					
66.8					
67.2					
67.6					
68.0					
68.4					
68.8					
69.2					
69.6					
70.0					
70.4					
70.8					

GOLDER

Geophysical Record of Borehole: BH-5

Log Title: BH-5
Project Number: 19122839
Client: Talisker Quarry
Date: September 2019

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	Sept 21, 2019
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PL



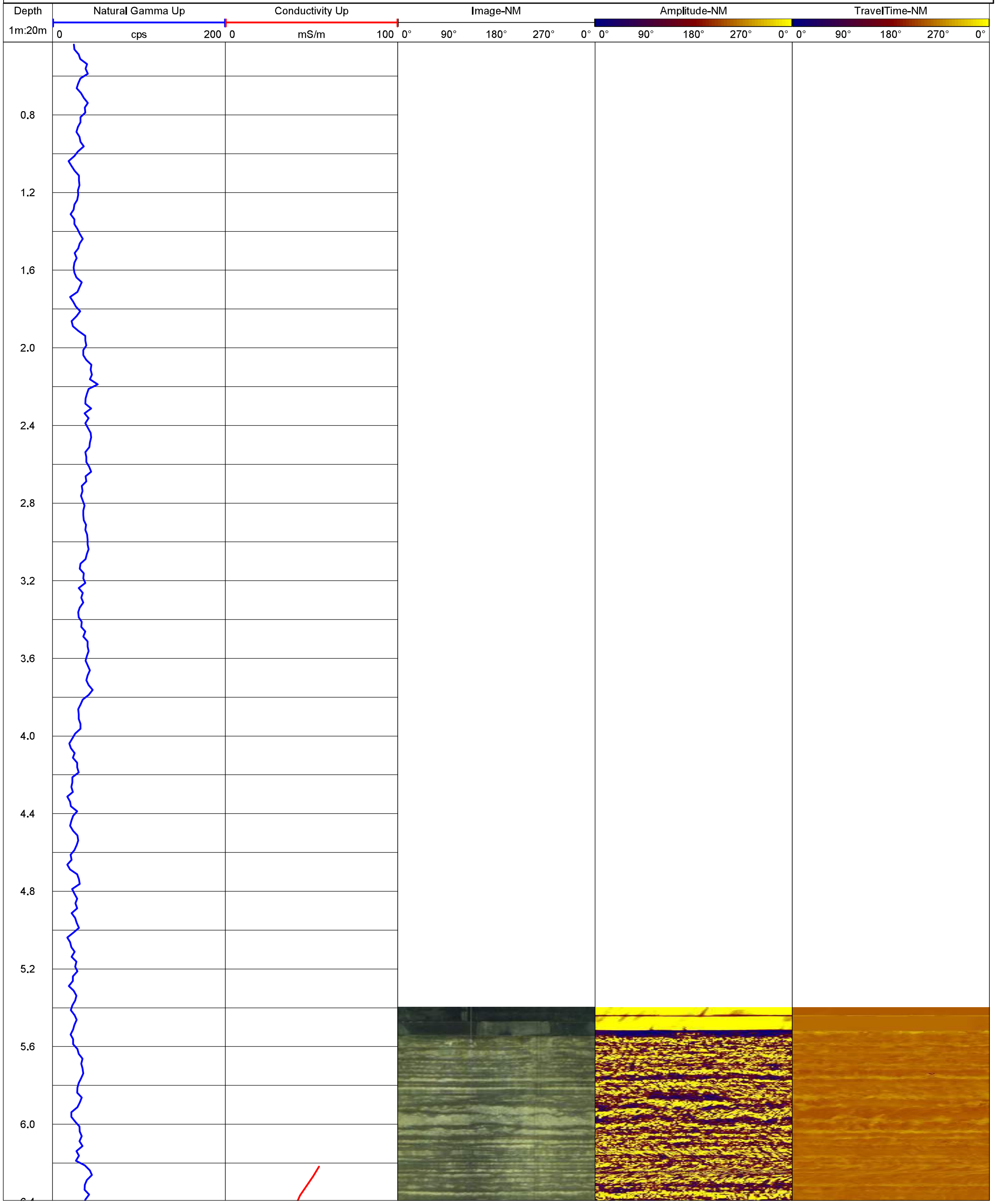
60.0					
64.0					
68.0					

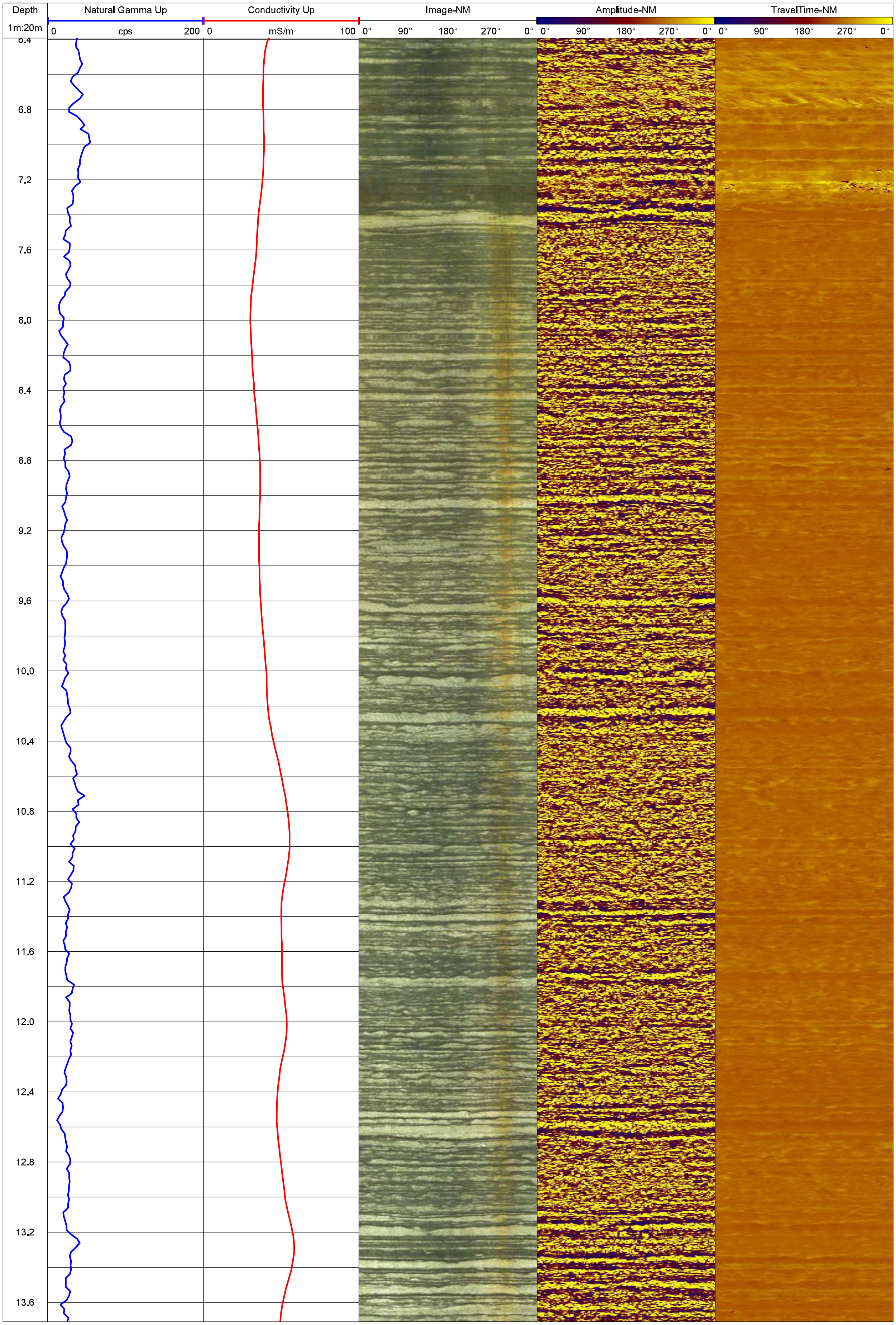
GOLDER

Geophysical Record of Borehole: BH-6

Log Title: BH-6
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	September 23, 2020
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PG




Depth
1m:20m
Natural Gamma Up
0
cps
200
Conductivity Up
0
mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
6,8
7,2
7,6
8,0
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8,8
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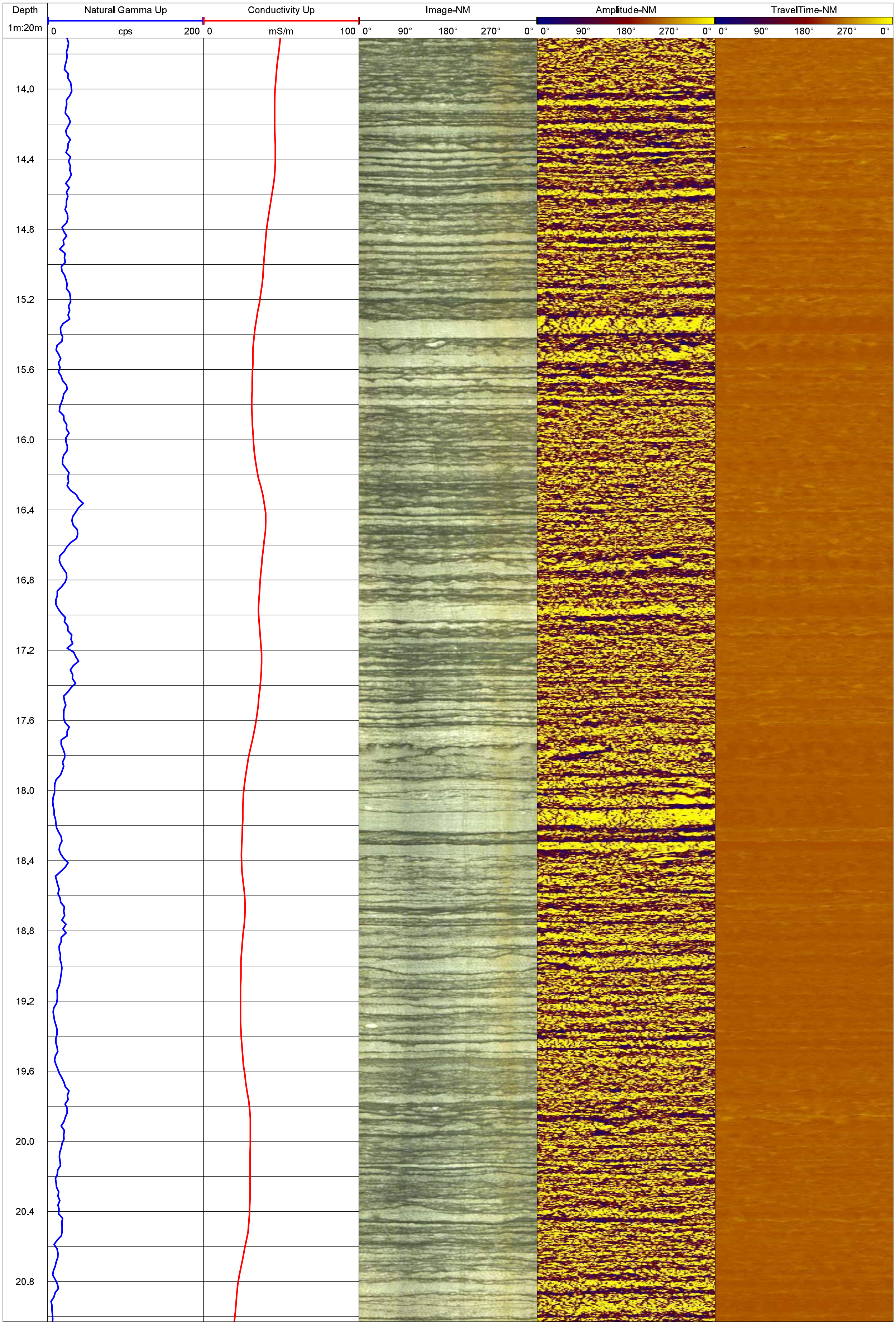
12,4
12,8
13,2
13,6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cps
200
Conductivity Up
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mS/m
100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
14.0
14.4
14.8
15.2
15.6
16.0
16.4
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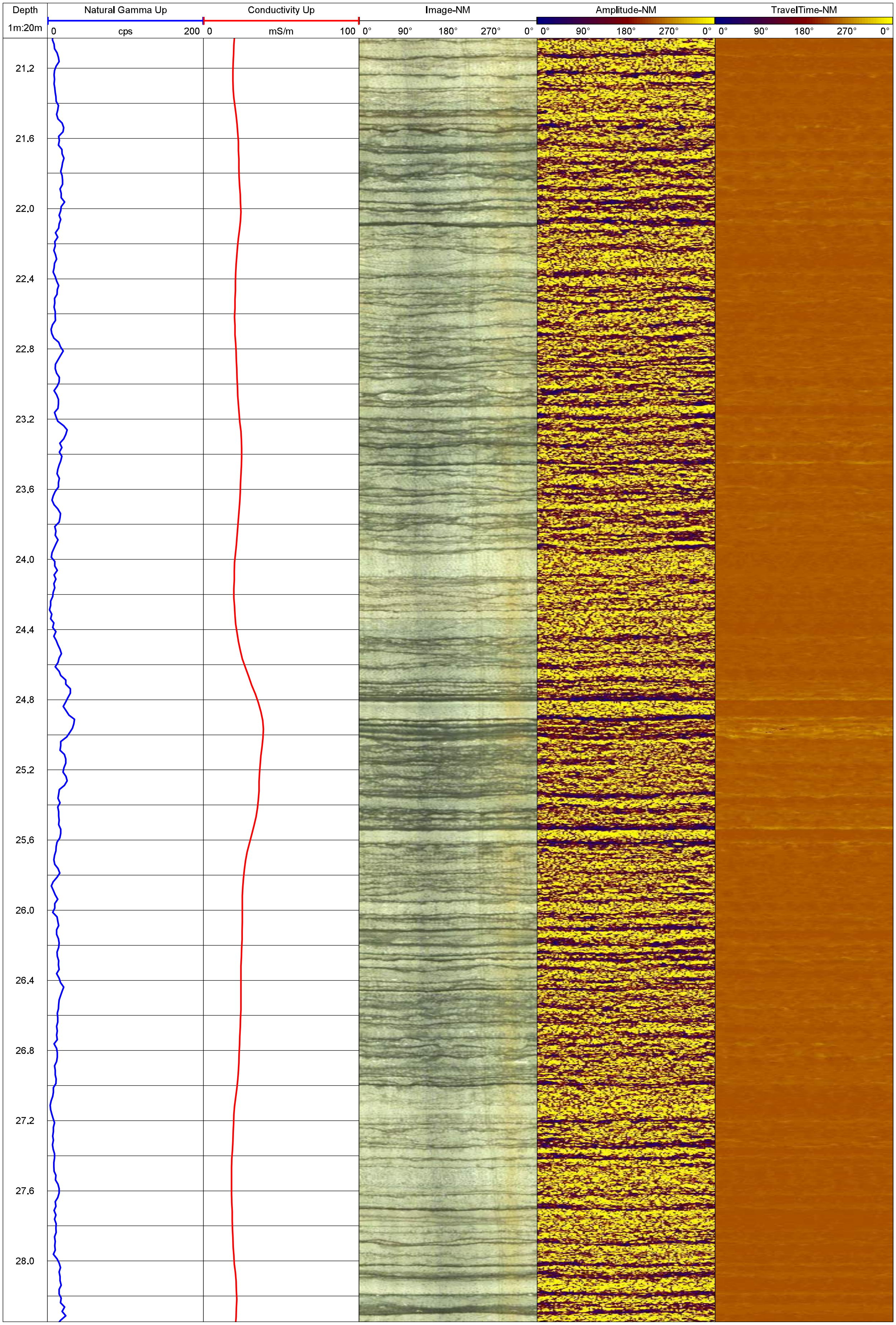
17.6
18.0
18.4
18.8
19.2
19.6
20.0
20.4
20.8


Depth
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Natural Gamma Up
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cps
200
Conductivity Up
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mS/m
100
Image-NM
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90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
21.2
21.6
22.0
22.4
22.8
23.2
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24.0
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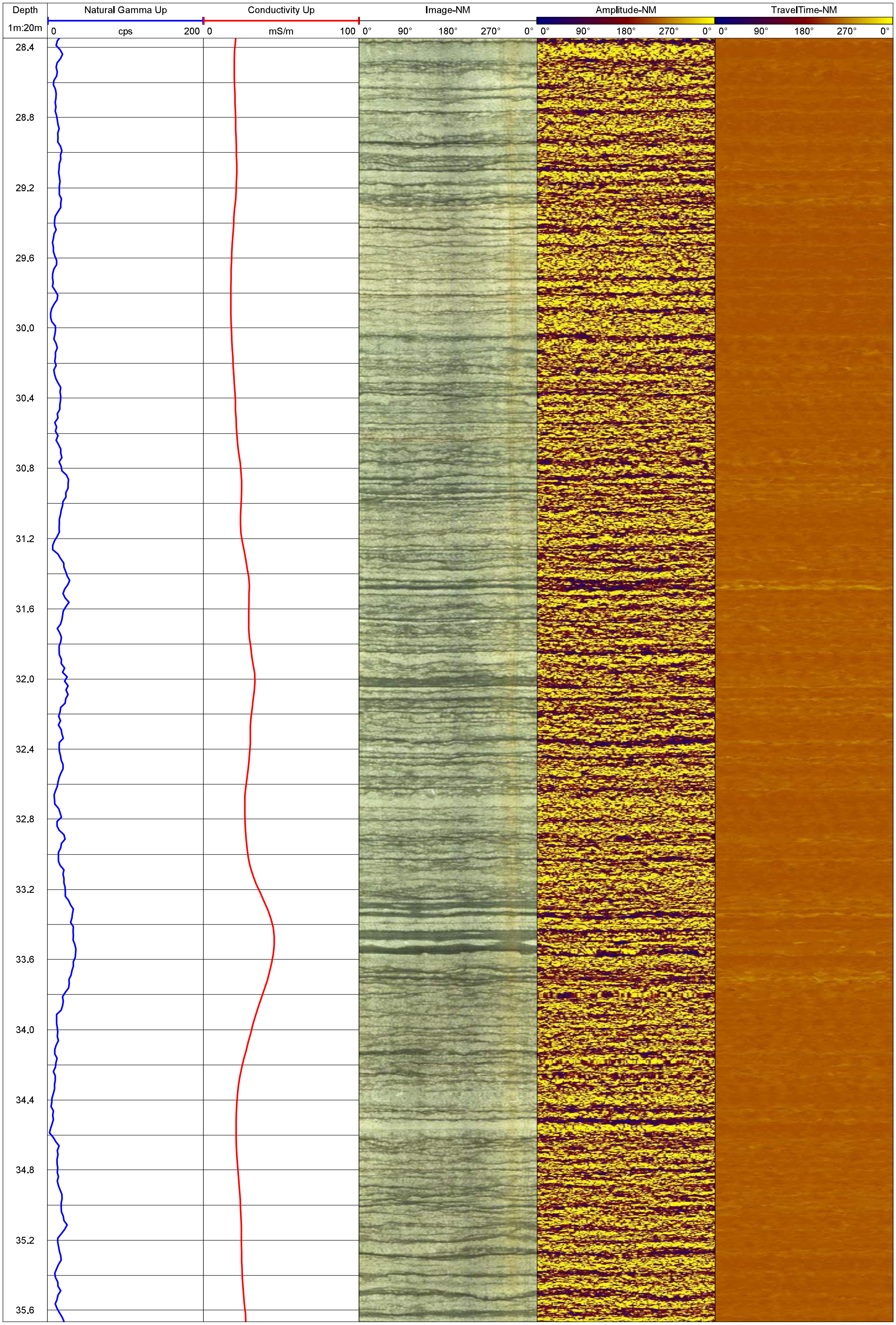
25.6
26.0
26.4
26.8
27.2
27.6
28.0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cps
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Conductivity Up
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mS/m
100
Image-NM
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180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
28,4
28,8
29,2
29,6
30,0
30,4
30,8
31,2
31,6
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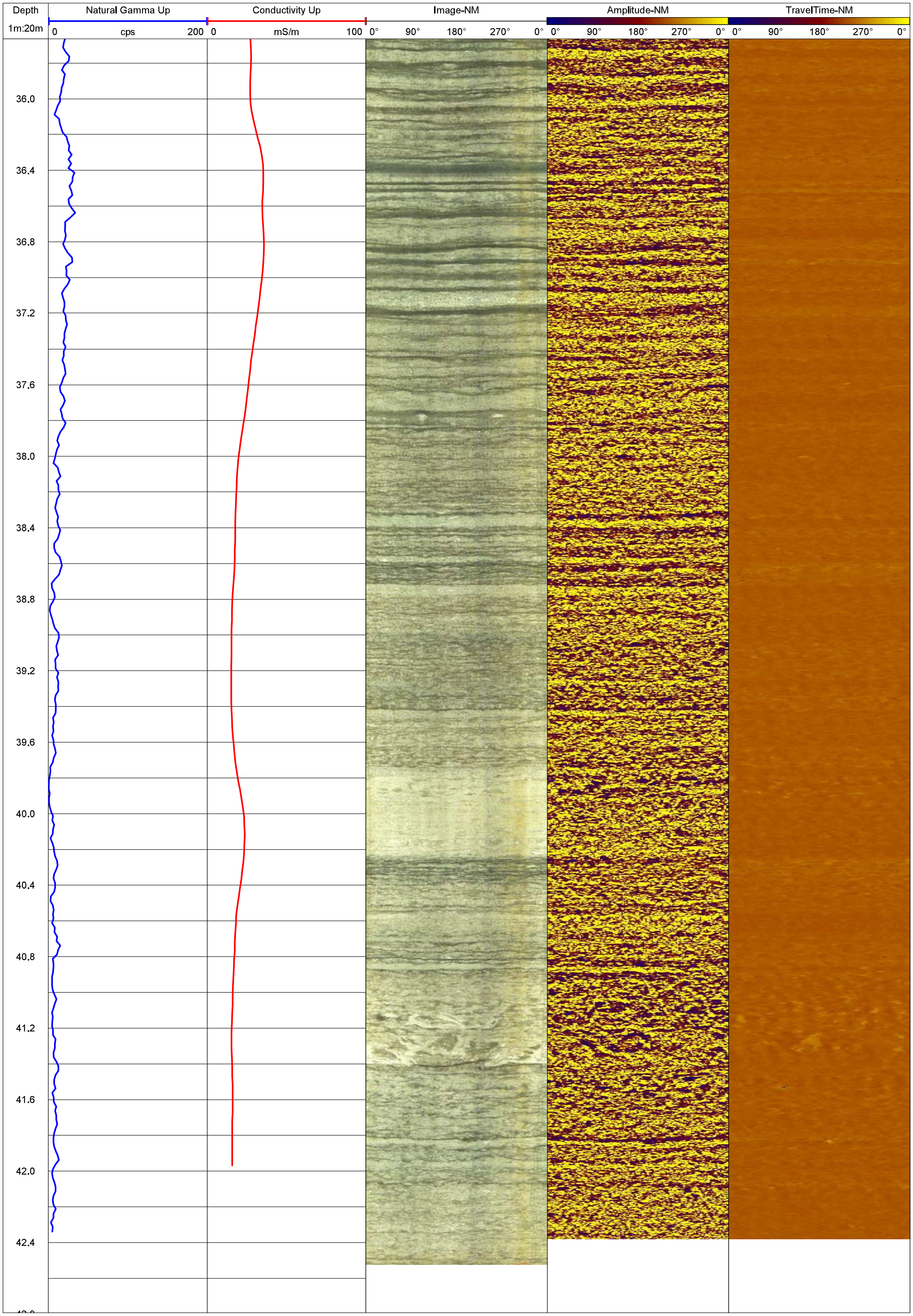
32,4
32,8
33,2
33,6
34,0
34,4
34,8
35,2
35,6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Natural Gamma Up
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cps
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Conductivity Up
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mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
36.0
36.4
36.8
37.2
37.6
38.0
38.4
38.8
39.2
39.6
40.0
40.4
40.8
41.2
41.6
42.0
42.4

GOLDER

Geophysical Record of Borehole: BH-6

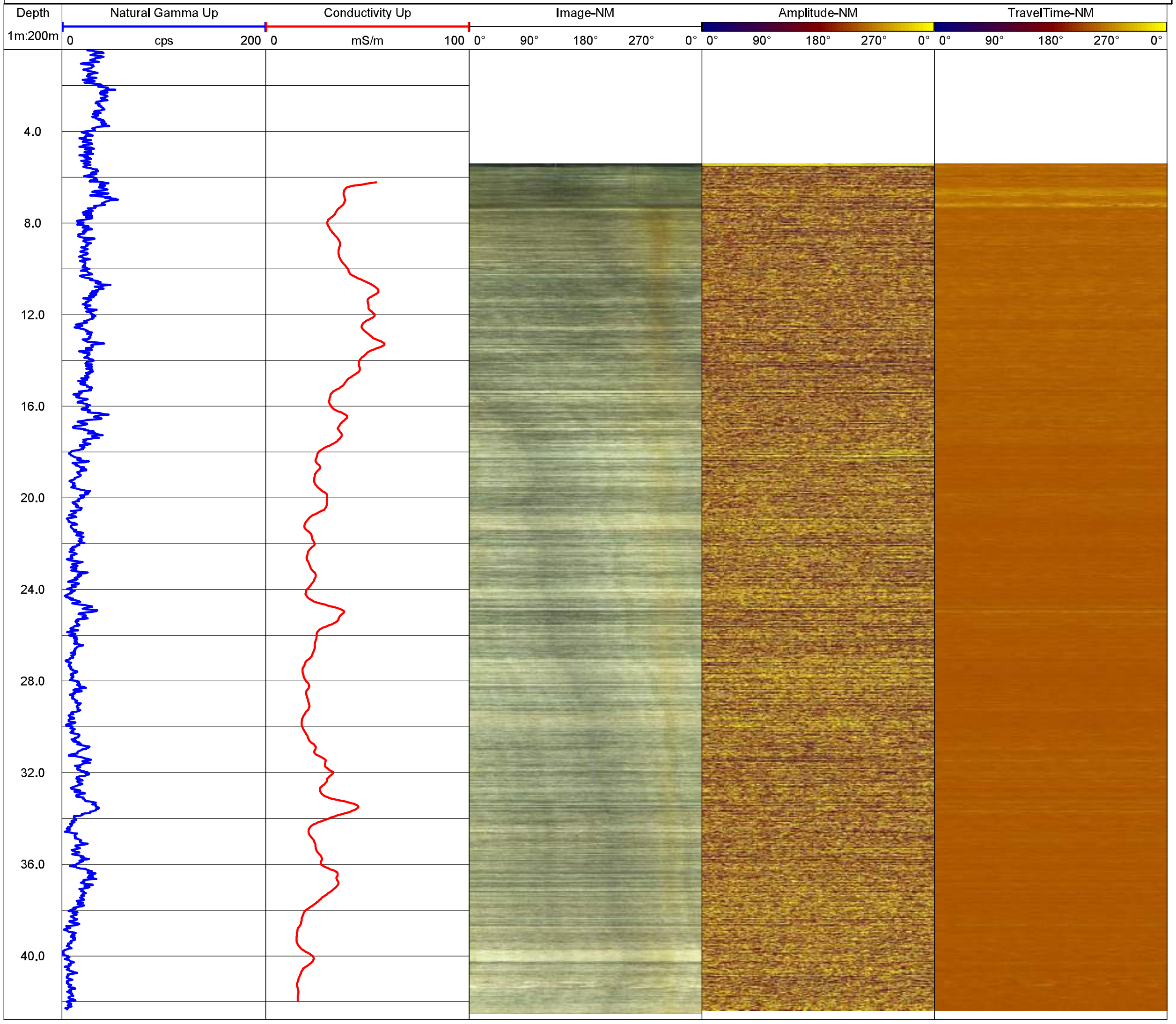
Log Title: BH-6
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: September 23, 2020
Logged By: PG



Geophysical Record of Borehole: BH-7

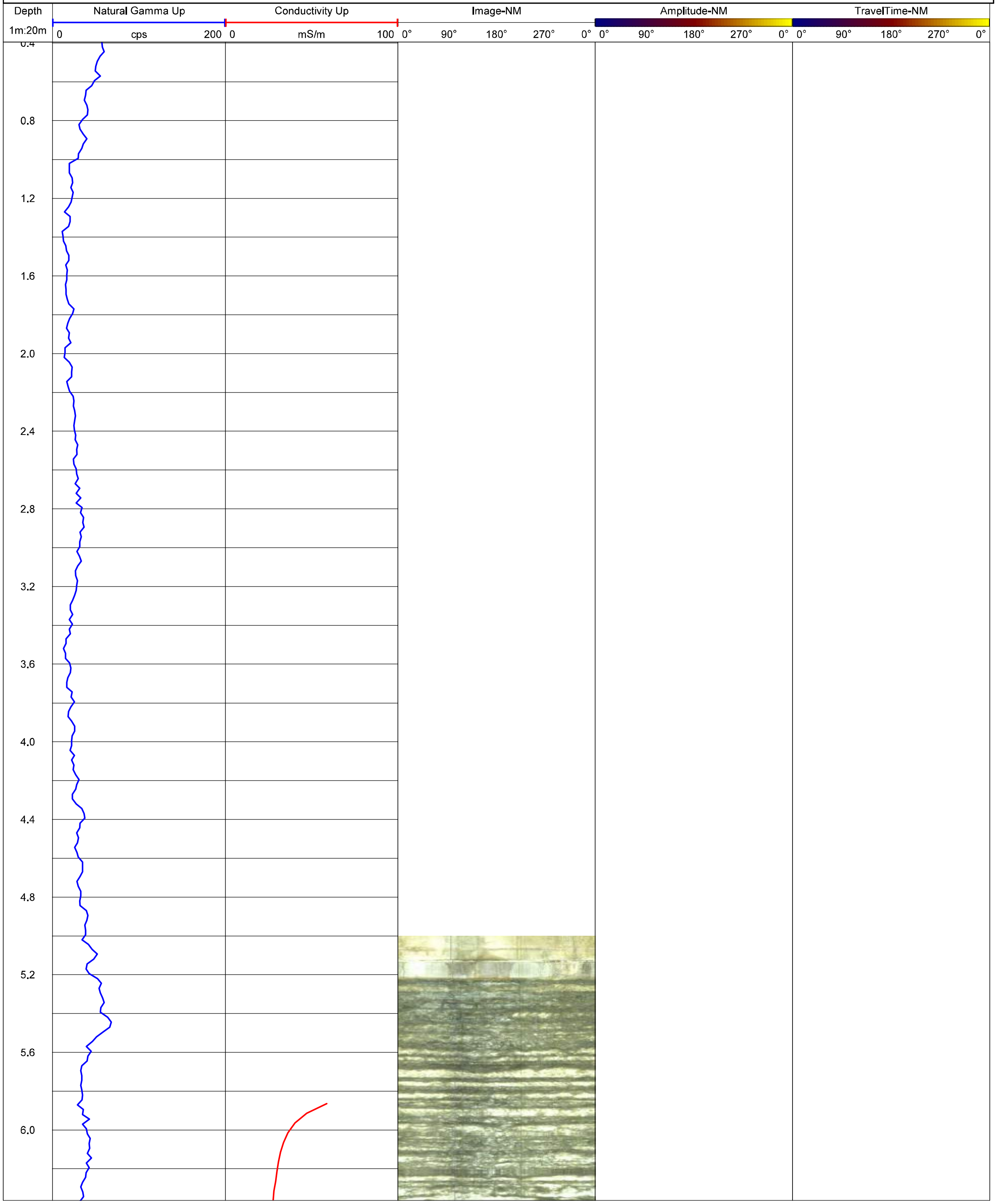
Log Title: BH-7
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

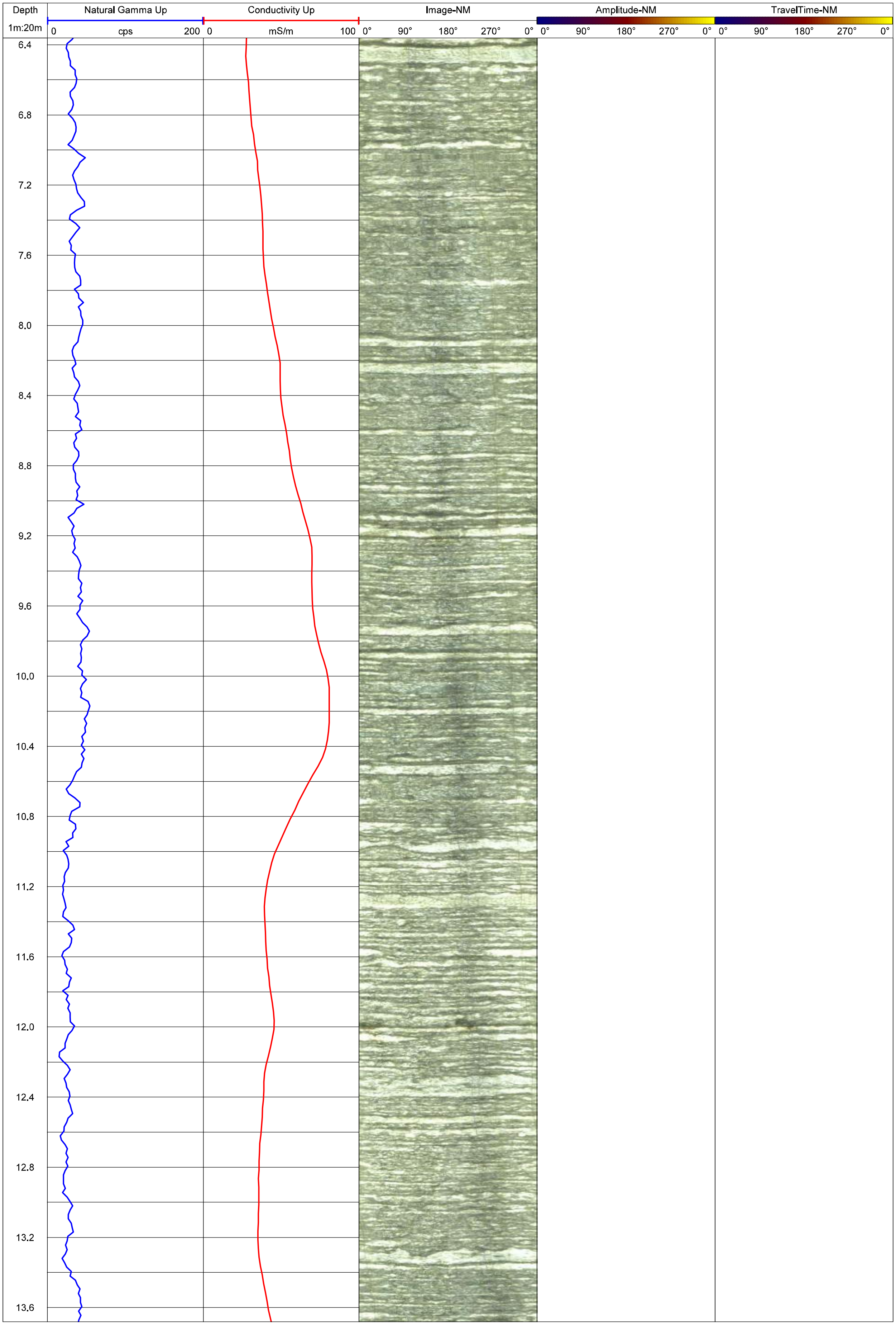
Datum:
Easting:
Northing:
Elevation:

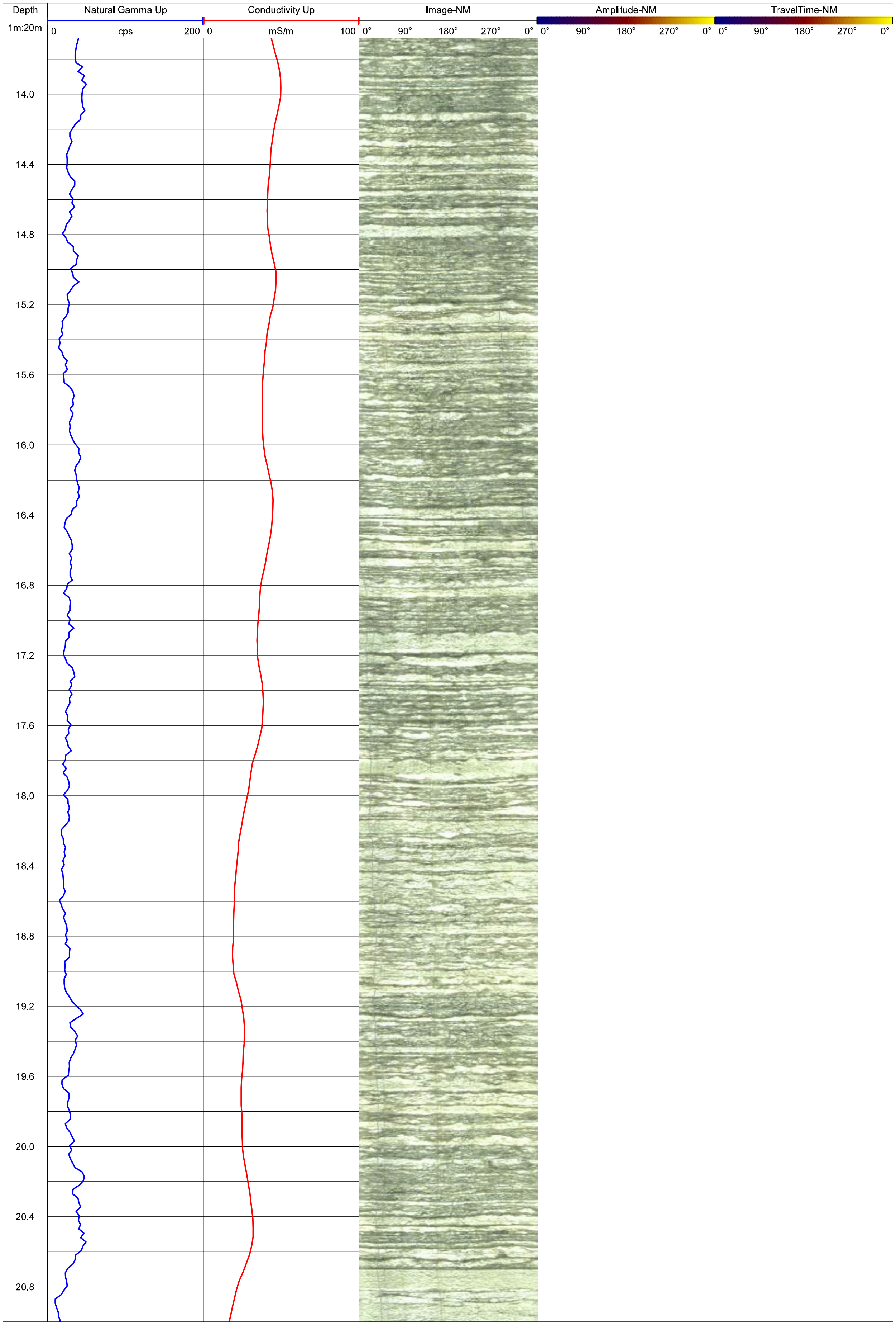
Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: September 23, 2020
Logged By: PG




Depth
1m:20m
Natural Gamma Up
0
cps
200
Conductivity Up
0
mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6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Natural Gamma Up
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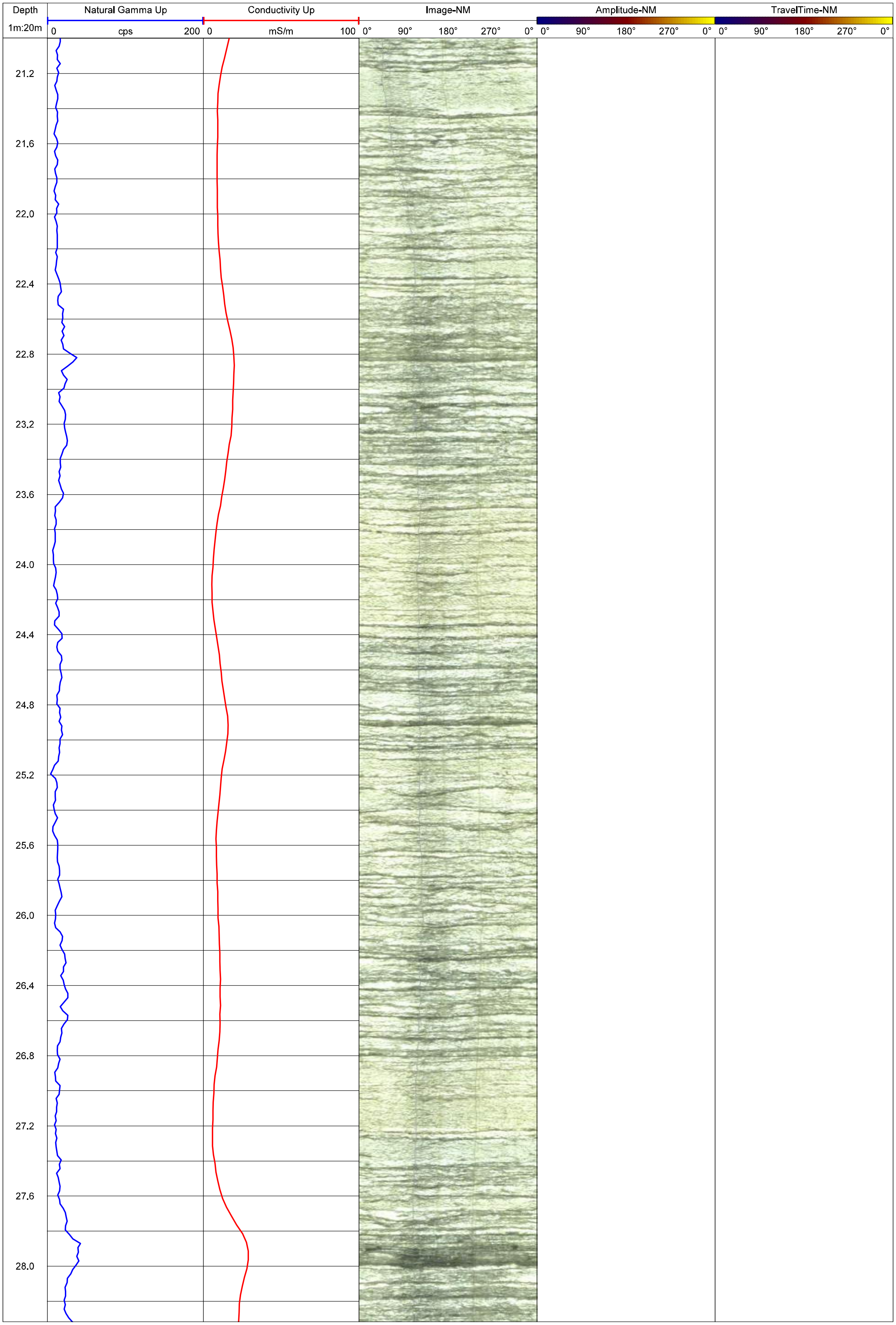
cps
200
Conductivity Up
0
mS/m
100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
19.2
19.6
20.0
20.4
20.8


Depth
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Natural Gamma Up
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cps
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Conductivity Up
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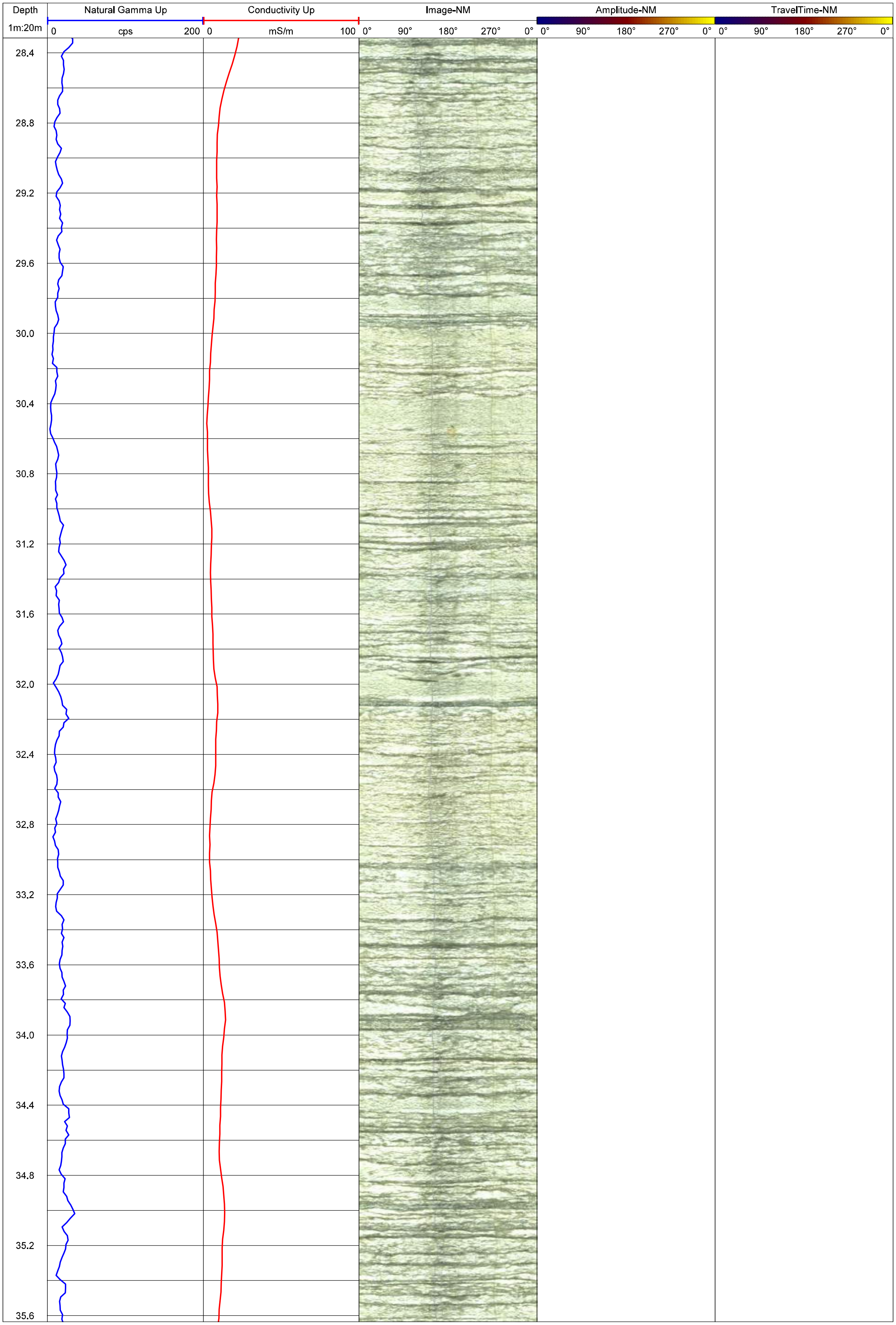
mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
21.2
21.6
22.0
22.4
22.8
23.2
23.6
24.0
24.4
24.8
25.2
25.6
26.0
26.4
26.8
27.2
27.6
28.0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cps
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Conductivity Up
0
mS/m
100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
28.4
28.8
29.2
29.6
30.0
30.4
30.8
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33.6
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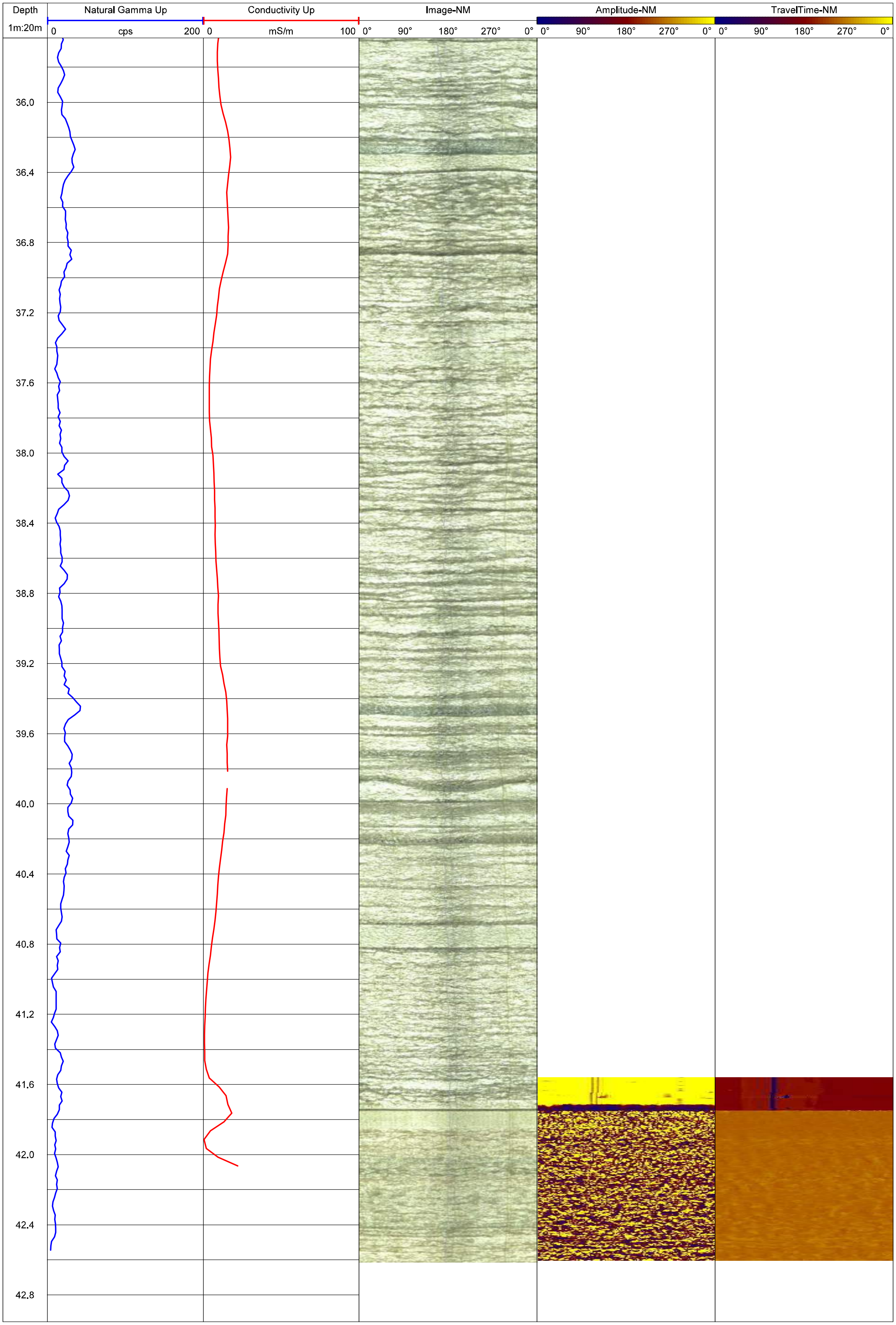
34.4
34.8
35.2
35.6


Depth
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Natural Gamma Up
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cps
200
Conductivity Up
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mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
36.0
36.4
36.8
37.2
37.6
38.0
38.4
38.8
39.2
39.6
40.0
40.4
40.8
41.2
41.6
42.0
42.4
42.8

GOLDER

Geophysical Record of Borehole: BH-7

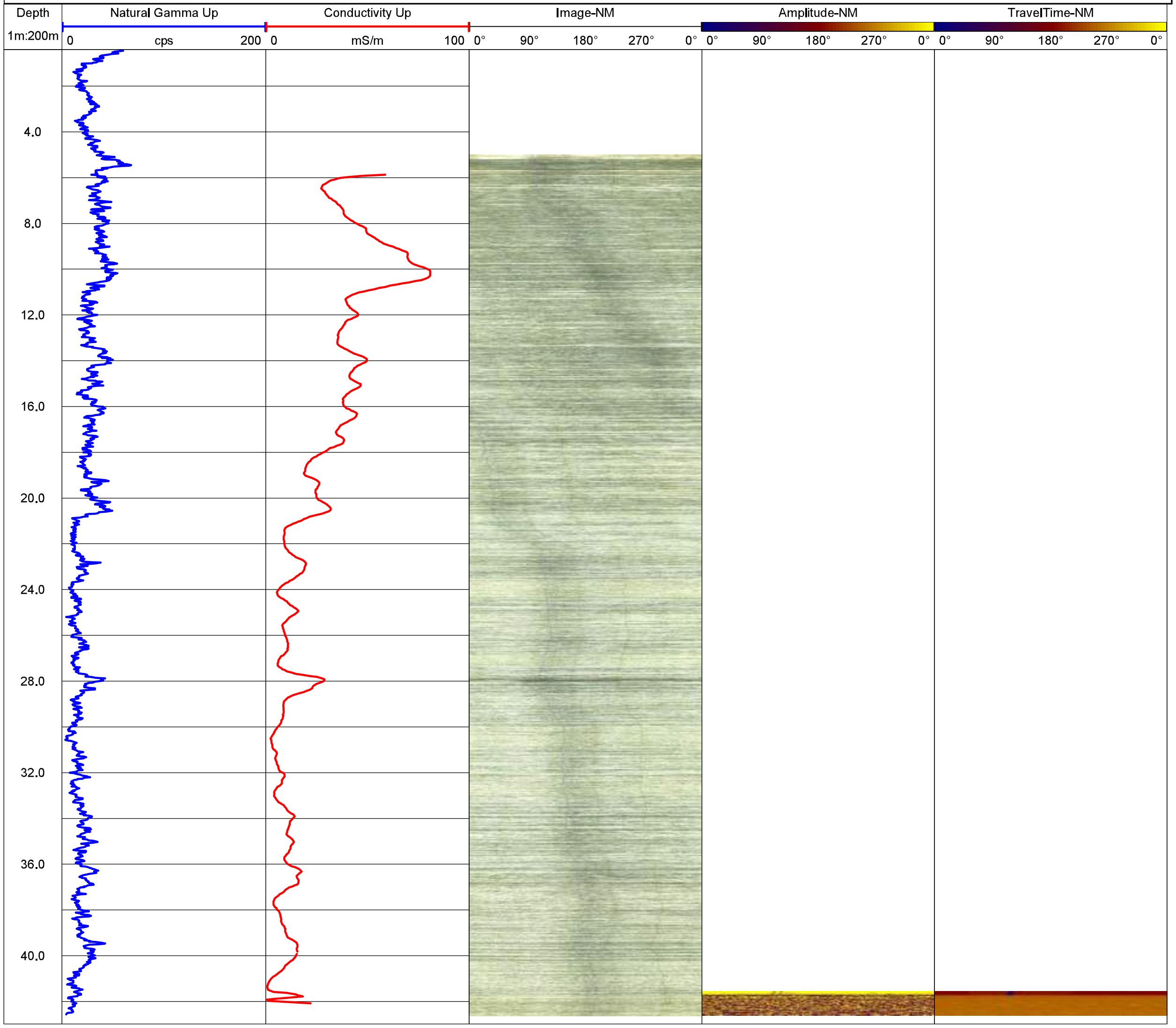
Log Title: BH-7
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: September 23, 2020
Logged By: PG



GOLDER

Geophysical Record of Borehole: BH-8

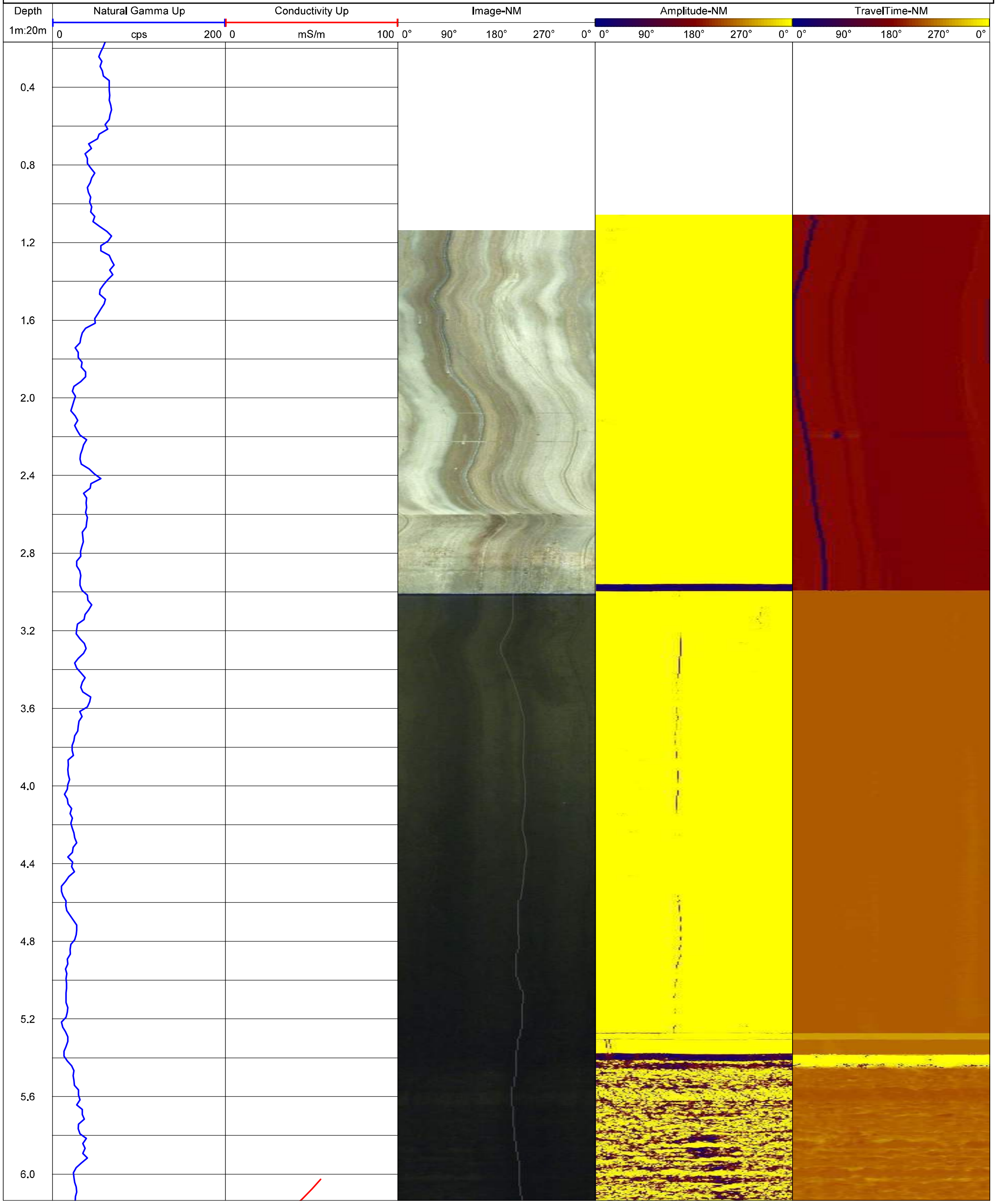
Log Title: BH-8
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

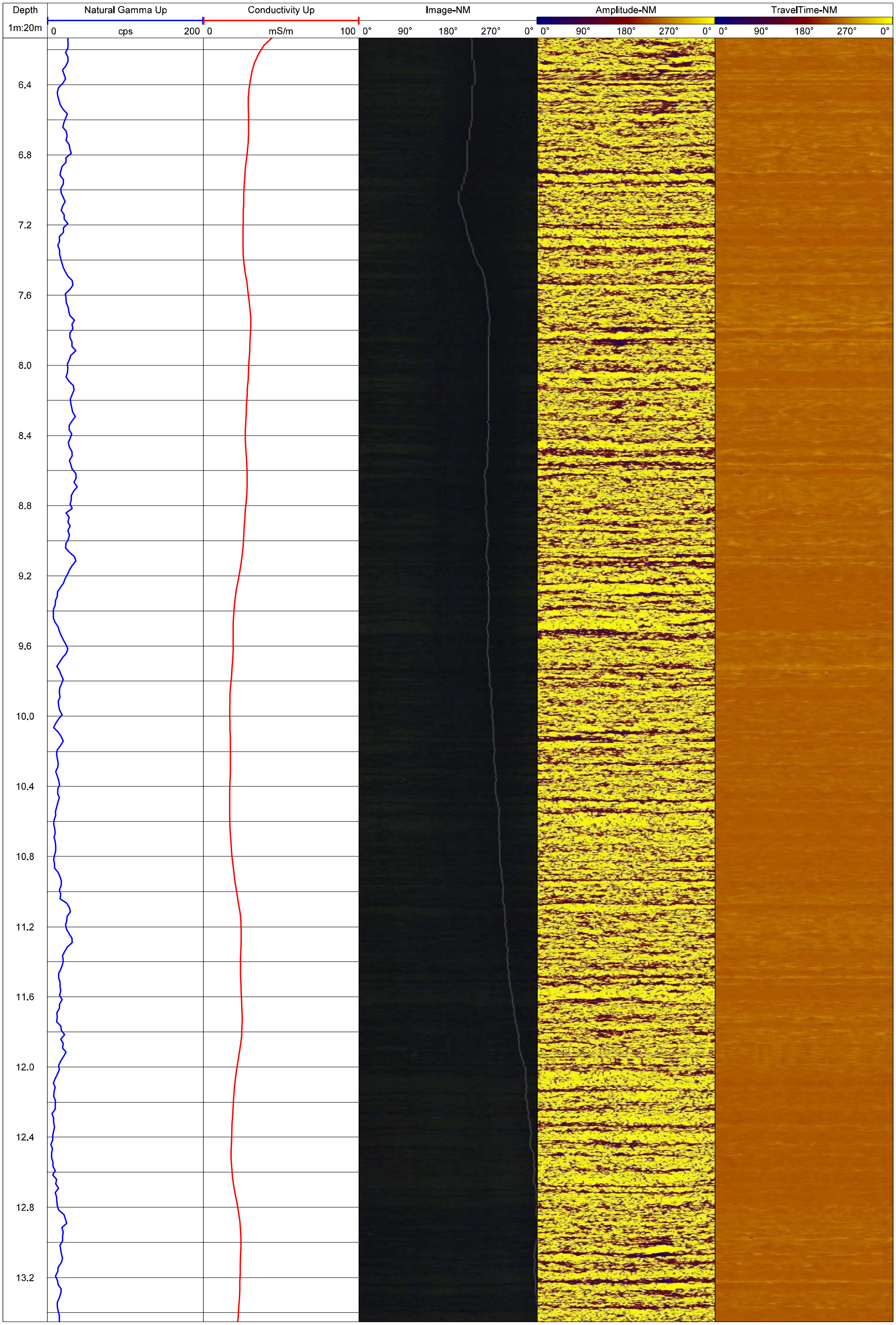
Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: September 24, 2020
Logged By: PG

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Natural Gamma Up
0 cps 200
Conductivity Up
0 mS/m 100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
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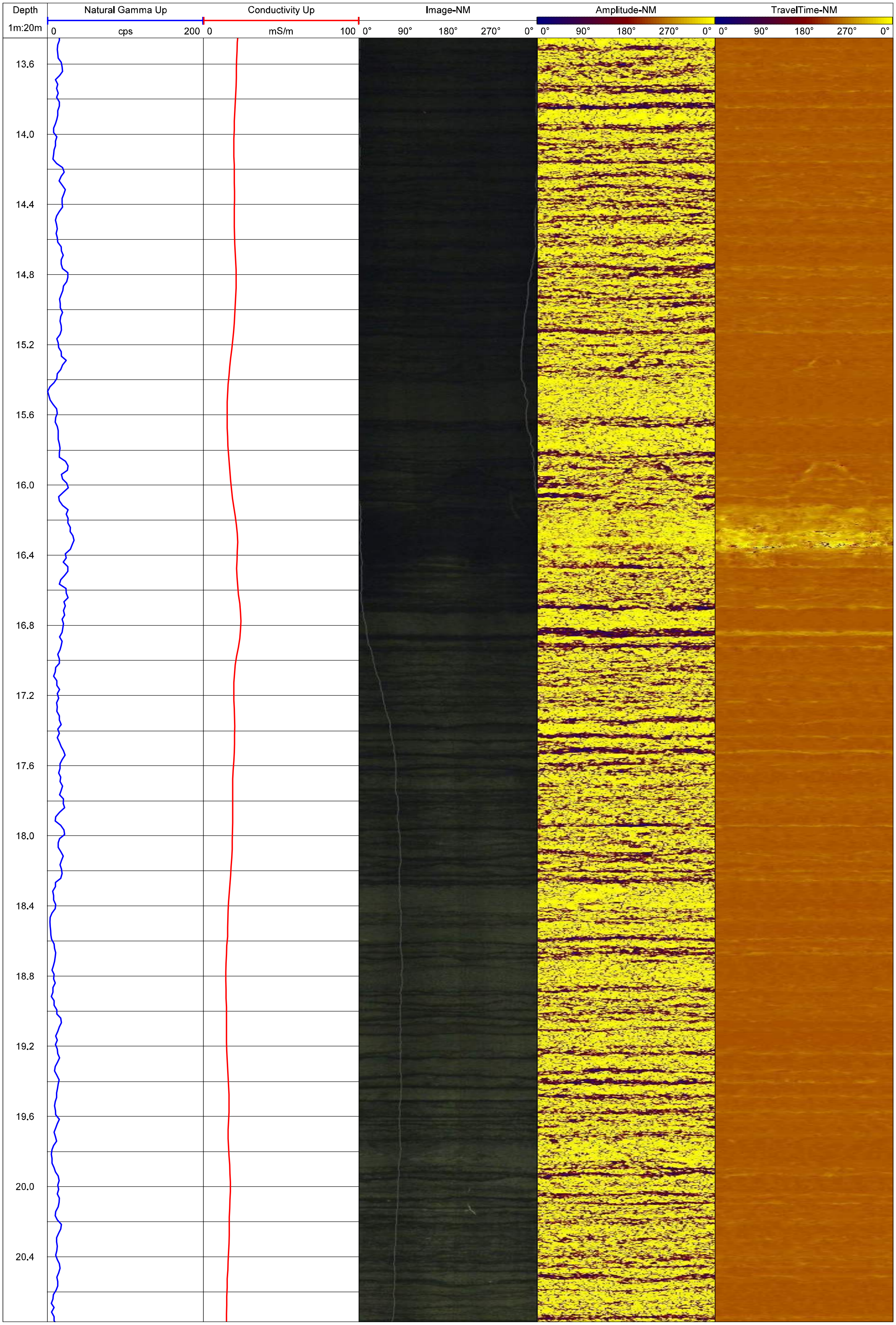
10.8
11.2
11.6
12.0
12.4
12.8
13.2


Depth
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Natural Gamma Up
0 cps 200
Conductivity Up
0 mS/m 100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
13.6
14.0
14.4
14.8
15.2
15.6
16.0
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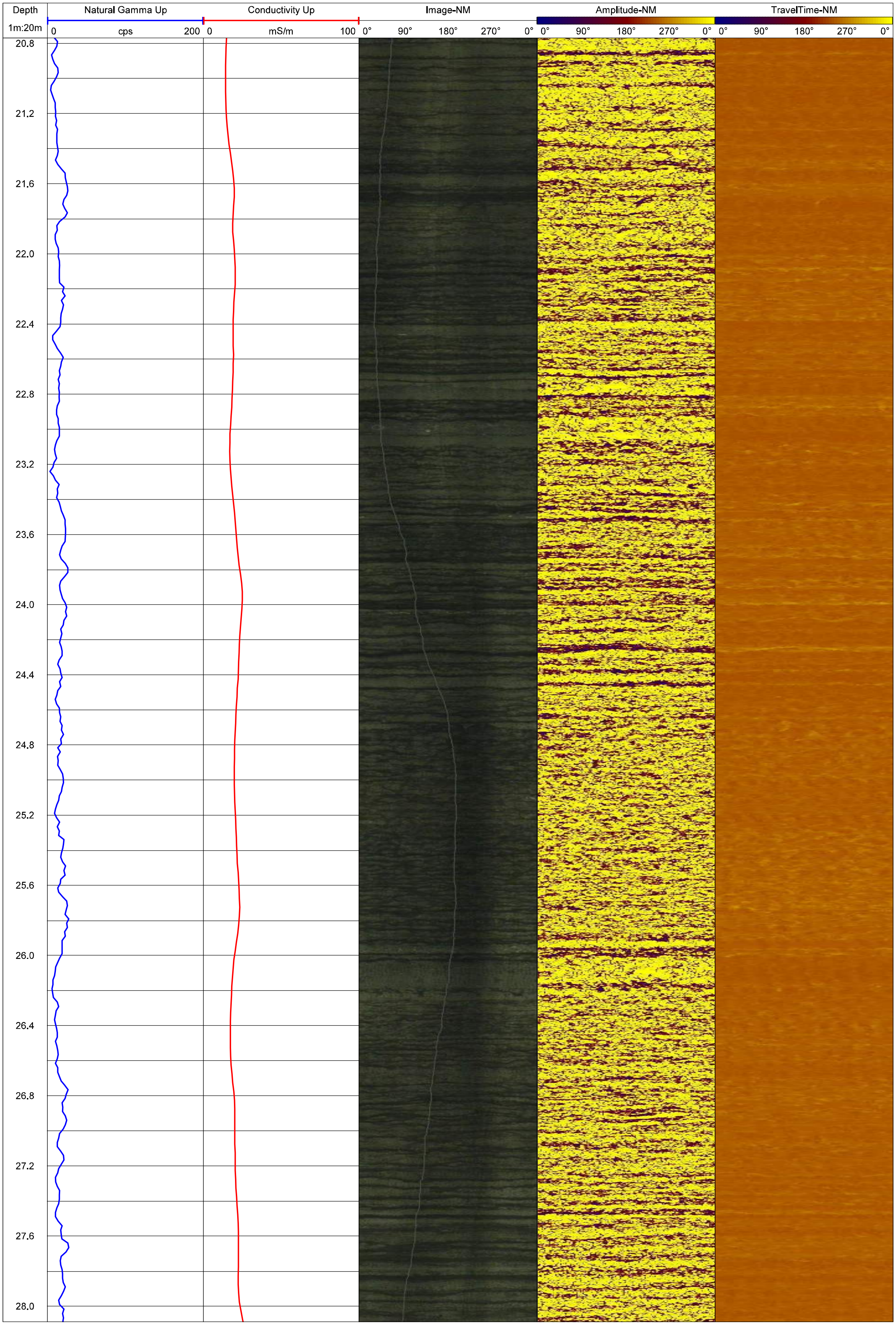
17.2
17.6
18.0
18.4
18.8
19.2
19.6
20.0
20.4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cps
200
Conductivity Up
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mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
20,8
21,2
21,6
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22,8
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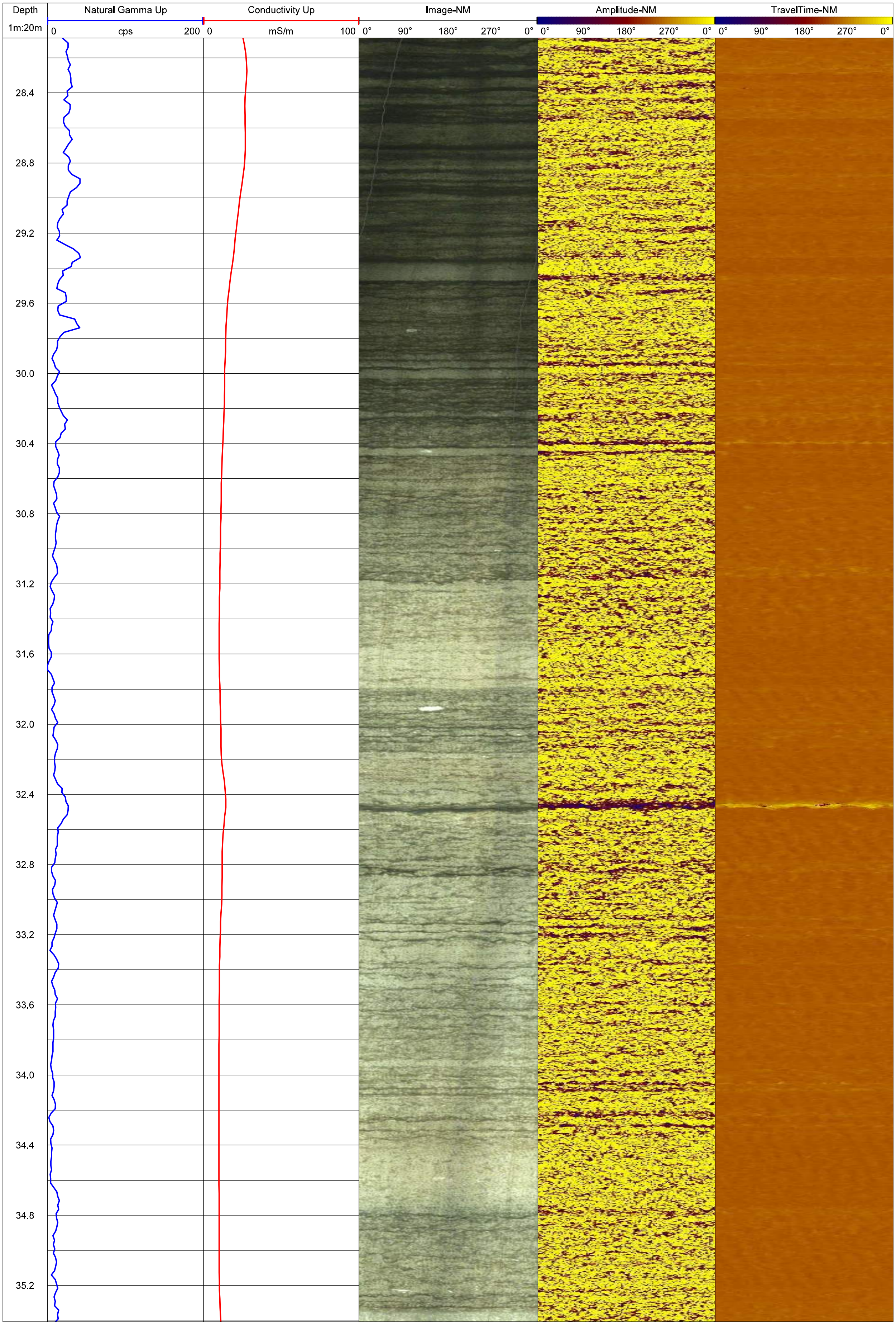
26,8
27,2
27,6
28,0


Depth
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Natural Gamma Up
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Conductivity Up
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mS/m
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Image-NM
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180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
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180°
270°
0°
28,4
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29,2
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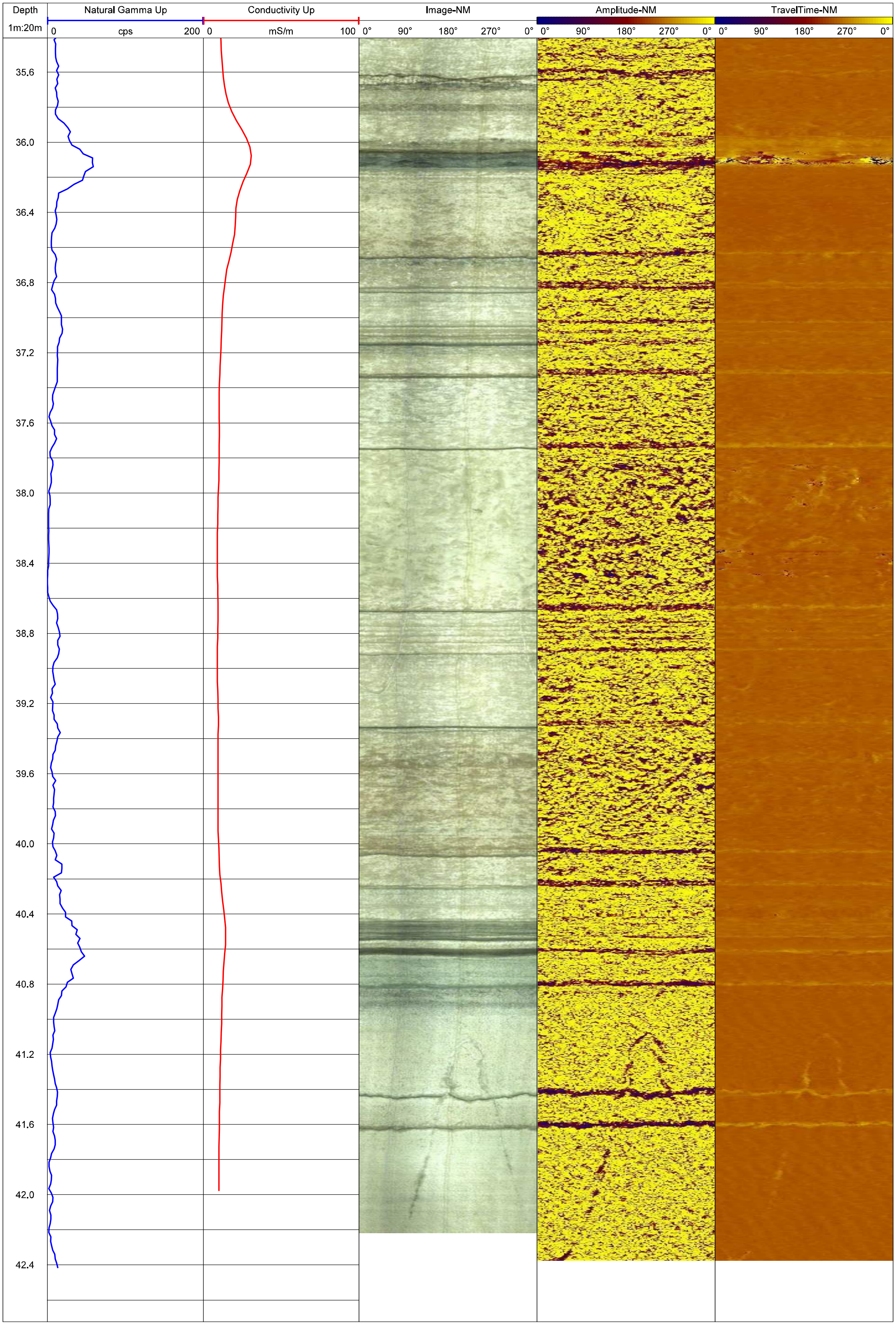
34,8
35,2


Depth
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Natural Gamma Up
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cps
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Conductivity Up
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mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
35,6
36,0
36,4
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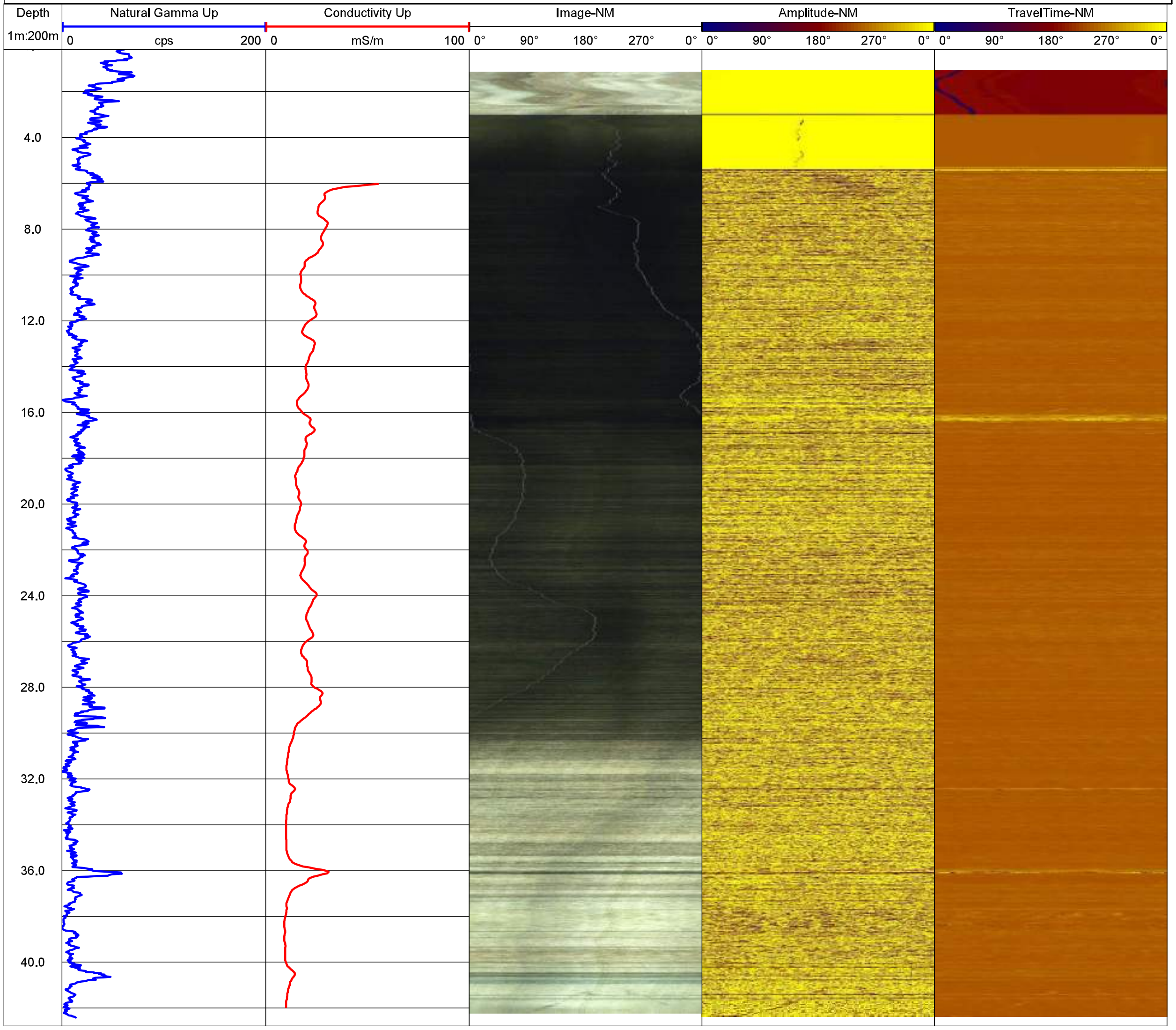
37,2
37,6
38,0
38,4
38,8
39,2
39,6
40,0
40,4
40,8
41,2
41,6
42,0
42,4

GOLDER

Geophysical Record of Borehole: BH-8

Log Title: BH-8
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

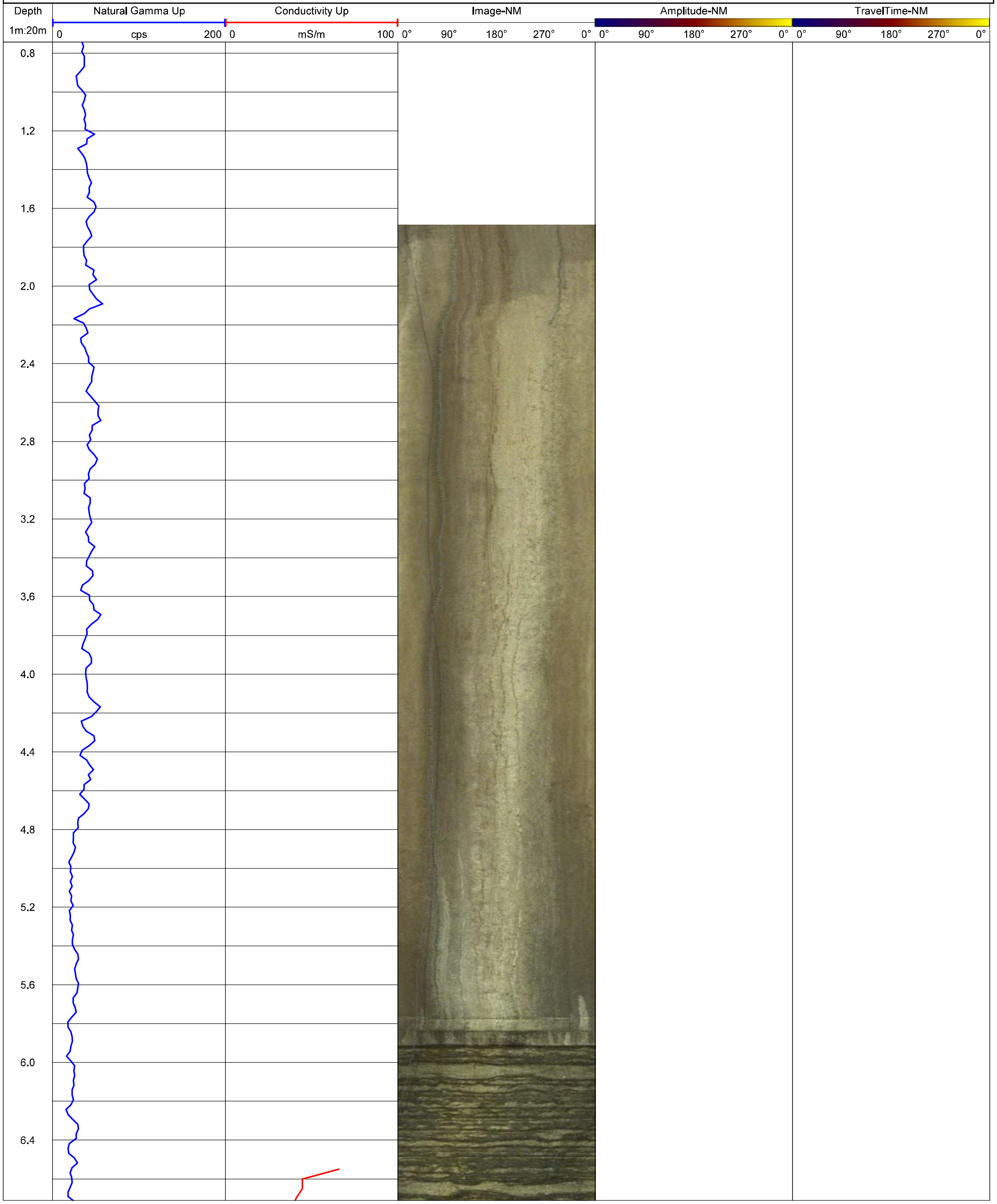
Datum:
Easting:
Northing:
Elevation:
Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:
Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:
Location: Brechin, Ontario
Log Date: September 24, 2020
Logged By: PG

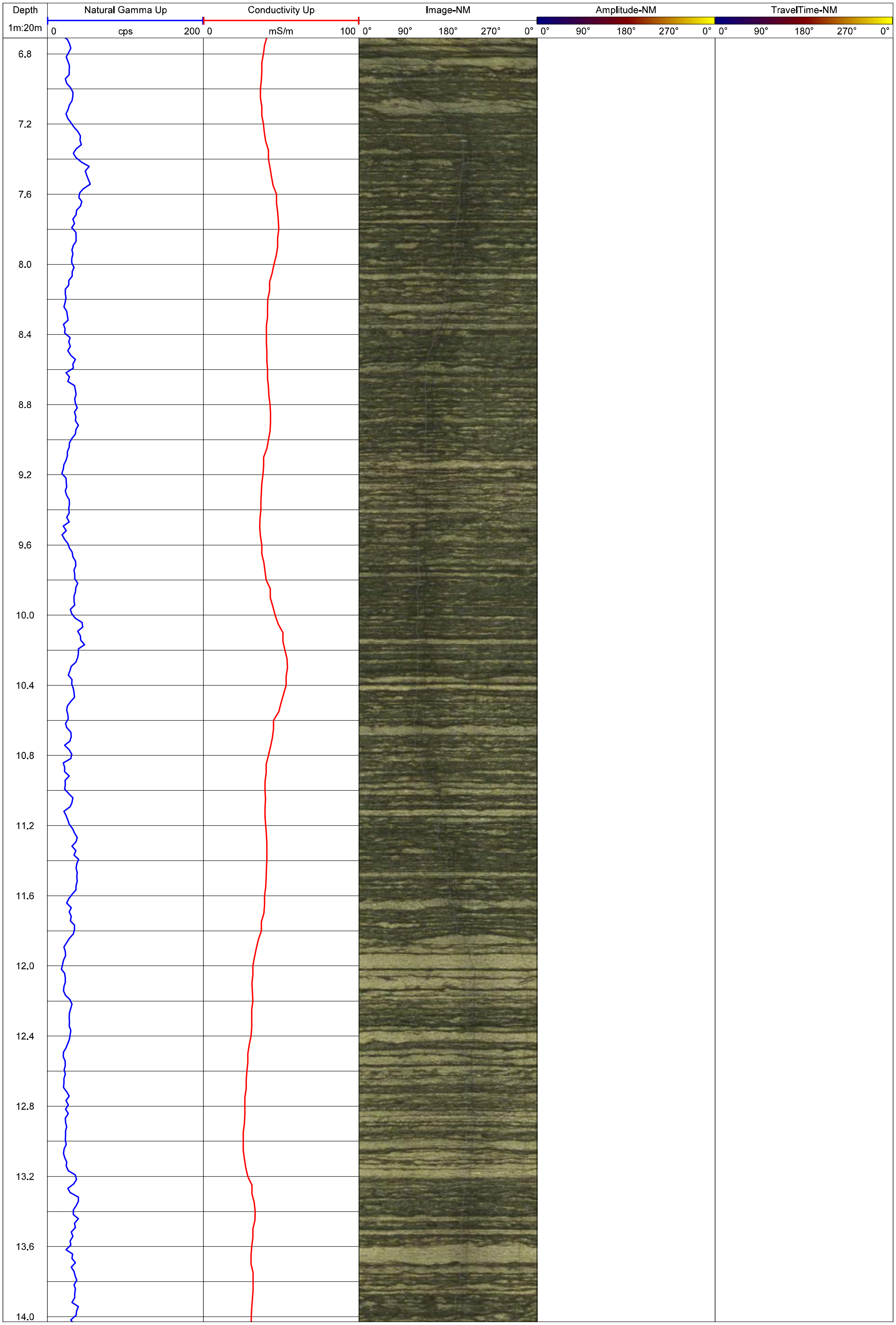


Geophysical Record of Borehole: BH-9

Log Title: BH-9
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

Datum:		**Depth Reference:**	"0" at Ground	**Casing Depth:**		**Location:**	Brechin, Ontario
Easting:		**Drilled Depth:**		**Water Level:**		**Log Date:**	September 24, 2020
Northing:		**Borehole Diameter:**		**Borehole Inclination:**			
Elevation:		**Casing Diameter:**		**Borehole Azimuth:**		**Logged By:**	PG

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Natural Gamma Up
0
cps
200
Conductivity Up
0
mS/m
100
Image-NM
0° 90° 180° 270° 0°
Amplitude-NM
0° 90° 180° 270° 0°
TravelTime-NM
0° 90° 180° 270° 0°
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
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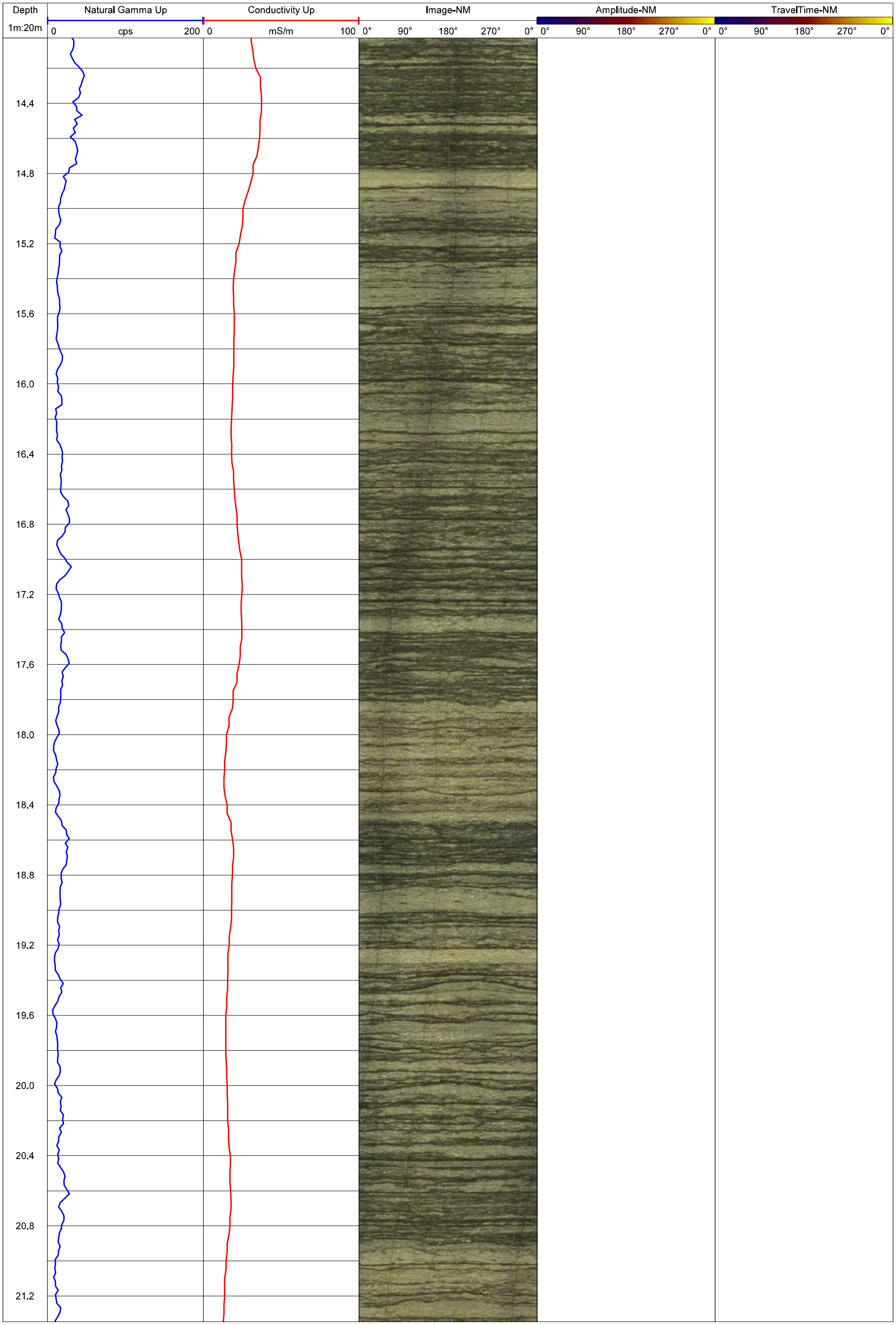
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0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cps
200
Conductivity Up
0
mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
14,4
14,8
15,2
15,6
16,0
16,4
16,8
17,2
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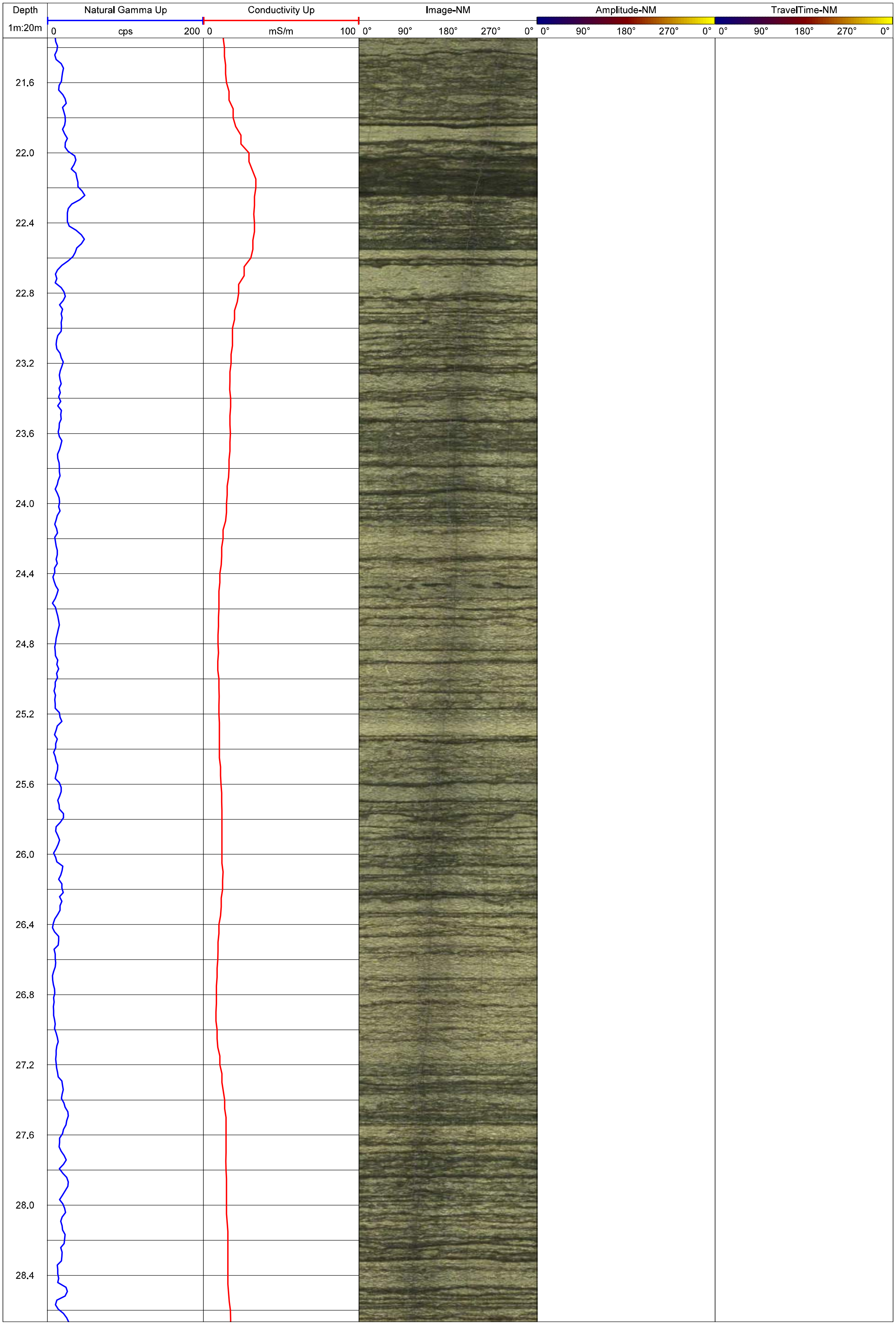
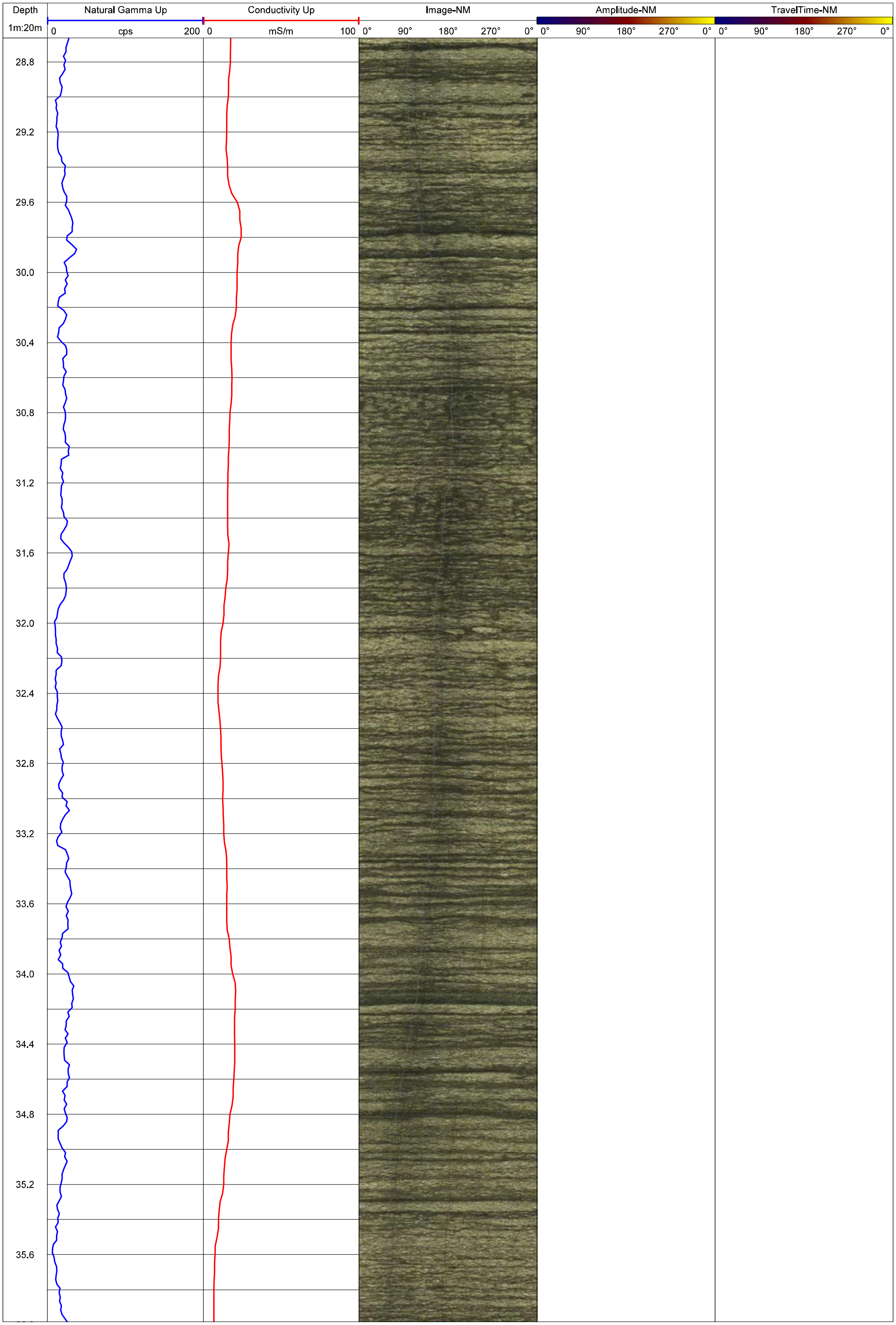
18,0
18,4
18,8
19,2
19,6
20,0
20,4
20,8
21,2


Depth
1m:20m
Natural Gamma Up
0
cps
200
Conductivity Up
0
mS/m
100
Image-NM
0°
90°
180°
270°
0°
Amplitude-NM
0°
90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
21.6
22.0
22.4
22.8
23.2
23.6
24.0
24.4
24.8
25.2
25.6
26.0
26.4
26.8
27.2
27.6
28.0
28.4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cps
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Conductivity Up
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mS/m
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Amplitude-NM
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90°
180°
270°
0°
TravelTime-NM
0°
90°
180°
270°
0°
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29.2
29.6
30.0
30.4
30.8
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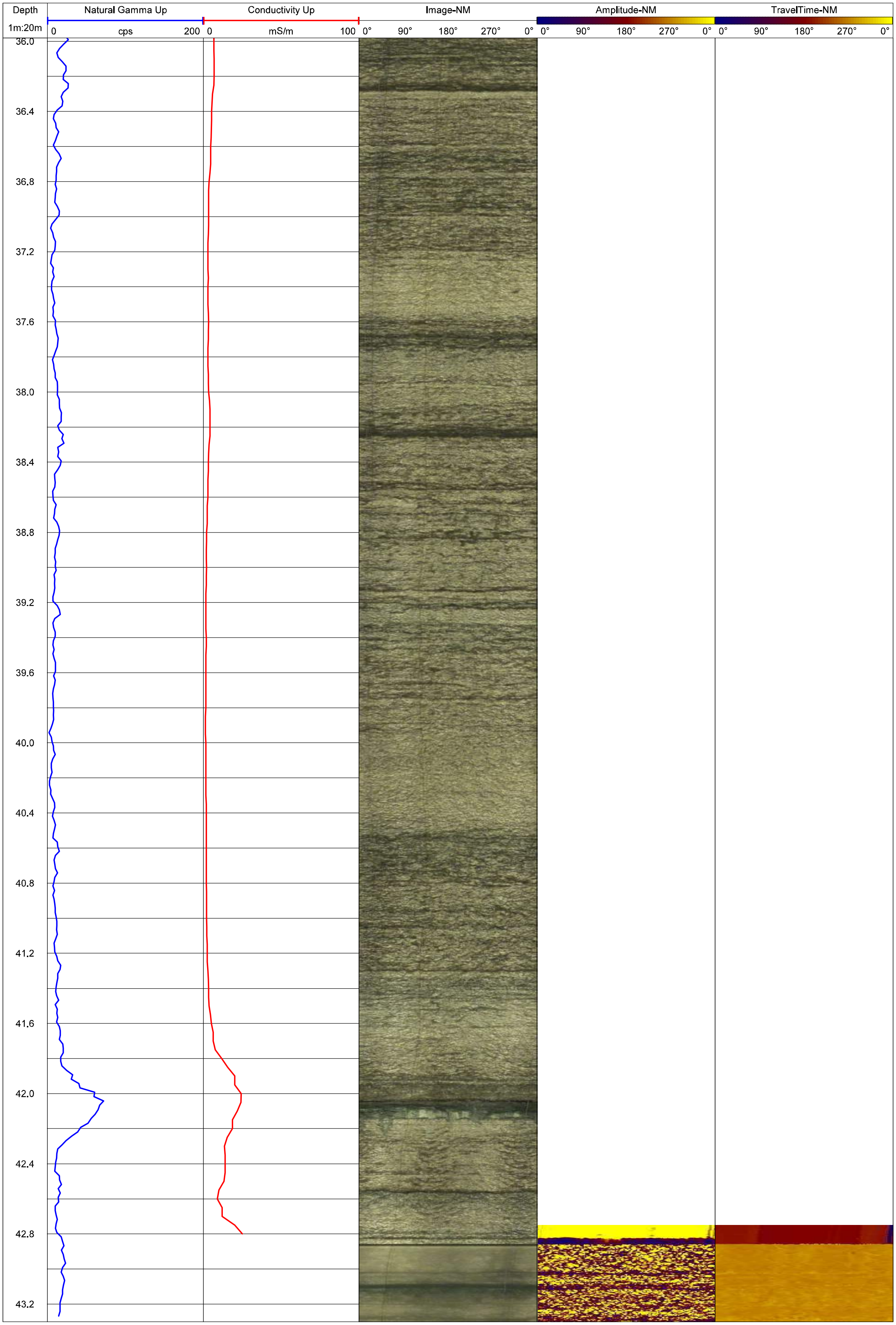
35.2
35.6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Conductivity Up
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Amplitude-NM
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TravelTime-NM
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38.0
38.4
38.8
39.2
39.6
40.0
40.4
40.8
41.2
41.6
42.0
42.4
42.8
43.2

GOLDER

Geophysical Record of Borehole: BH-9

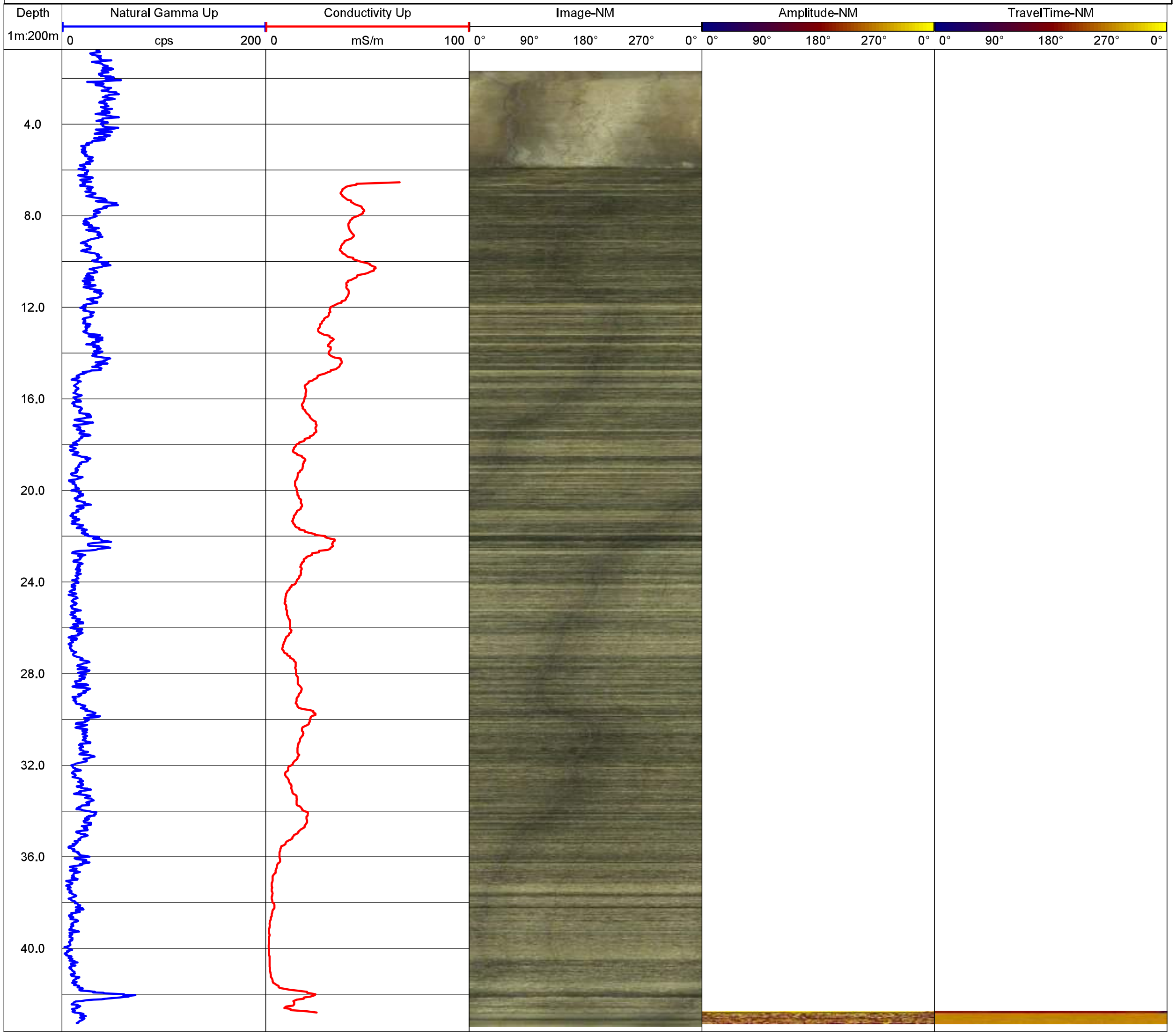
Log Title: BH-9
Project Number: 19122839
Client: Talisker Quarry
Date: September 2020

Datum:
Easting:
Northing:
Elevation:

Depth Reference: "0" at Ground
Drilled Depth:
Borehole Diameter:
Casing Diameter:

Casing Depth:
Water Level:
Borehole Inclination:
Borehole Azimuth:

Location: Brechin, Ontario
Log Date: September 24, 2020
Logged By: PG



APPENDIX D

Azimuth Environmental Consulting Inc.
Brechin Quarry – Measured Well Details

Brechin Quarry - Measured Well Details

Monitoring Well	Hydrostratographic Unit[1]	Hydrostratigraphic Unit Identifier[1]	Easting	Northing	Ground Elevation (masl)[2]	Bore Collar Elevation (masl)[2]	Bottom Well Depth (mbtoc)	Overburden Thickness (m)	Bottom Well Depth (masl)	Overburden Thickness (masl)	Bore Casing Stickup (m)	Bore Diameter	Well Casing Diameter	Well Stickup (m)	Screen Interval (mbgs)		Sand Pack Interval (mbgs)		Screen Interval (masl)		Sand Pack Interval (masl)	
												mm	mm		bottom	top	bottom	top	bottom	top	bottom	top
BH-1	Shadow Lake/ Precambrian Contact Zone	B	645411.333	4931533.149	231.555	232.572	65.01	2.14	167.562	229.415	1.02	96	12.7	-0.07	64.1	61.0	64.1	58.4	167.5	170.5	167.5	173.2
BH-1	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645411.333	4931533.149	231.555	232.572	45.81	2.14	186.762	229.415	1.02	96	12.7	-0.04	44.8	41.8	45.1	36.8	186.7	189.8	186.4	194.8
BH-1	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645411.333	4931533.149	231.555	232.572	31.45	2.14	201.122	229.415	1.02	96	-	0	30.43	0	-	-	201.12	231.555	-	-
BH-2	Shadow Lake Formation	C	645918.939	4930985.711	238.843	239.758	64.89	0.91	174.868	237.933	0.92	96	12.7	-0.09	64.1	61.0	64.0	59.9	174.8	177.8	174.8	178.9
BH-2	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645918.939	4930985.711	238.843	239.758	51.53	0.91	188.228	237.933	0.92	96	12.7	-0.03	50.6	47.6	51.1	43.0	188.2	191.2	187.7	195.8
BH-2	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645918.939	4930985.711	238.843	239.758	31.6	0.91	208.158	237.933	0.92	96	-	0	30.69	0	-	-	208.16	238.843	-	-
BH-3	Lower Green Beds of Gull River Formation	D	645585.646	4930189.284	236.695	237.69	64.02	0.46	173.67	236.235	1.00	96	12.7	-0.1	63.1	60.1	63.1	57.9	173.6	176.6	173.6	178.8
BH-3	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645585.646	4930189.284	236.695	237.69	54.46	0.46	183.23	236.235	1.00	96	12.7	-0.04	53.5	50.5	53.6	48.0	183.2	186.2	183.1	188.7
BH-3	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645585.646	4930189.284	236.695	237.69	35.95	0.46	201.74	236.235	1.00	96	-	0	34.96	0	-	-	201.74	236.695	-	-
BH-4	Shadow Lake/ Precambrian Contact Zone	B	644876.573	4930501.079	236.078	237.077	71.29	1.68	165.787	234.398	1.00	96	12.7	-0.07	70.4	67.3	70.0	65.1	165.7	168.8	166.1	171.0
BH-4	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	644876.573	4930501.079	236.078	237.077	50.92	1.68	186.157	234.398	1.00	96	12.7	-0.03	50.0	46.9	50.0	44.1	186.1	189.2	186.1	192.0
BH-4	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	644876.573	4930501.079	236.078	237.077	31.24	1.68	205.837	234.398	1.00	96	-	0	30.24	0	-	-	205.84	236.078	-	-
BH-5	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	644322.975	4930363.051	231.981	232.987	52.73	3.66	180.257	228.321	1.01	96	12.7	-0.1	51.8	48.8	51.8	44.0	180.2	183.2	180.2	188.0
BH-5	Weathered Shale/clay zone at Bobcaygeon/Gull River formationa contact	H	644322.975	4930363.051	231.981	232.987	41.83	3.66	191.157	228.321	1.01	96	12.7	-0.04	40.9	37.8	41.0	38.0	191.1	194.2	191.0	194.0
BH-5	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	644322.975	4930363.051	231.981	232.987	31.36	3.66	201.627	228.321	1.01	96	-	0	30.35	0	-	-	201.63	231.981	-	-
BH-6	Bobcaygeon Formation	I	644672.845	4930121.664	234.186	234.835	43.10	0.91	191.735	233.276	0.65	96	25.4	-0.06	42.5	39.5	42.5	35.1	191.7	194.7	191.7	199.1
BH-6	Bobcaygeon Formatkon	K	644672.845	4930121.664	234.186	234.835	30.81	0.91	204.025	233.276	0.65	96	25.4	-0.07	30.2	27.2	30.2	20.1	204.0	207.0	204.0	214.1
BH-6	Verulam Formation	L	644672.845	4930121.664	234.186	234.835	15.63	0.91	219.205	233.276	0.65	96	25.4	-0.05	15.0	12.0	15.0	7.9	219.2	222.2	219.2	226.3
BH-7	Bobcaygeon Formation	I	645166.401	4930103.280	239.659	240.176	43.34	2.13	196.836	237.529	0.52	152	25.4	-0.05	42.9	39.8	42.9	36.9	196.8	199.8	196.8	202.8
BH-7	Bobcaygeon Formatkon	K	645166.401	4930103.280	239.659	240.176	32.44	2.13	207.736	237.529	0.52	152	25.4	-0.13	32.1	29.0	32.1	22.9	207.6	210.7	207.6	216.8
BH-7	Verulam Formation	L	645166.401	4930103.280	239.659	240.176	18.41	2.13	221.766	237.529	0.52	152	25.4	-0.01	17.9	14.9	17.9	11.0	221.8	224.8	221.8	228.7
BH-8	Upper Gull River Formation	G	646052.641	4930562.409	232.304	232.973	43.39	3.05	189.583	229.254	0.67	152	25.4	-0.07	42.8	39.7	42.8	35.1	189.5	192.6	189.5	197.3
BH-8	Bobcaygeon Formation	K	646052.641	4930562.409	232.304	232.973	22.59	3.05	210.383	229.254	0.67	152	25.4	-0.03	22.0	18.9	22.0	11.9	210.4	213.4	210.4	220.4
BH-8	Verulam Formation	L	646052.641	4930562.409	232.304	232.973	8.47	3.05	224.503	229.254	0.67	152	25.4	-0.05	7.9	4.8	7.9	6.1	224.5	227.5	224.5	226.2
BH-9	Upper Gull River Formation	G	645871.983	4931210.093	238.367	238.599	43.71	1.52	194.889	236.847	0.23	152	25.4	-0.06	43.5	40.5	43.5	39.9	194.8	197.9	194.8	198.4
BH-9	Bobcaygeon Formation	K	645871.983	4931210.093	238.367	238.599	23.14	1.52	215.459	236.847	0.23	152	25.4	-0.06	23.0	19.9	23.0	18.0	215.4	218.4	215.4	220.4
BH-9	Verulam Formation	L	645871.983	4931210.093	238.367	238.599	12.14	1.52	226.459	236.847	0.23	152	25.4	-0.05	12.0	8.9	12.0	6.4	226.4	229.5	226.4	232.0

Notes:

[1] Hydrostratigraphic reference from Golder Associates Inc. Technical Memorandum dated January 2, 2019 and email dated March 4, 2021

[2] Ground and collar elevations determined using a differential Global Positioning System (dGPS≤ 0.05 m accuracy)

masl: meters above sea level

mbtoc: meters below top of casing

mbgs: meters below ground surface

APPENDIX E

Azimuth Environmental Consulting Inc.
Brechin Quarry – Water Elevation Summary

Brechin Quarry - Water Elevation Summary

Monitoring Well ID		BH-1	BH-1	BH-1	BH-2	BH-2	BH-2	BH-3	BH-3	BH-3	BH-4	BH-4	BH-4	BH-5	BH-5	BH-5	BH-6	BH-6	BH-6	BH-7	BH-7	BH-7	BH-8	BH-8	BH-8	BH-9	BH-9	BH-9
Hydrostratigraphic Unit Identifier		**B**	**F**	**Z**	**C**	**F**	**Z**	**D**	**F**	**Z**	**B**	**F**	**Z**	**F**	**H**	**Z**	**I**	**K**	**L**	**I**	**K**	**L**	**G**	**K**	**L**	**G**	**K**	**L**
Ground Elevation (masl)		231.555	231.555	231.555	238.843	238.843	238.843	236.695	236.695	236.695	236.078	236.078	236.078	231.981	231.981	231.981	234.186	234.186	234.186	239.659	239.659	239.659	232.304	232.304	232.304	238.367	238.367	238.367
Collar Elevation (masl)		232.572	232.572	232.572	239.758	239.758	239.758	237.69	237.69	237.69	237.077	237.077	237.077	232.987	232.987	232.987	234.835	234.835	234.835	240.176	240.176	240.176	232.973	232.973	232.973	238.599	238.599	238.599
Total Bore Depth (mbgs)		64.13	64.13	64.13	70.31	70.31	70.31	70.95	70.95	70.95	70.59	70.59	70.59	52.01	52.01	52.01	43.321	43.321	43.321	43.189	43.189	43.189	43.341	43.341	43.341	42.904	42.904	42.904
Bore Casing Stickup (m)		1.02	1.02	1.02	0.92	0.92	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	0.65	0.65	0.65	0.52	0.52	0.52	0.67	0.67	0.67	0.23	0.23	0.23
Bottom Well Depth (mbtoc)		65.01	45.81	31.45	64.89	51.53	31.60	64.02	54.46	35.95	71.29	50.92	31.24	52.73	41.83	31.36	43.10	30.81	15.63	43.34	32.44	18.41	43.39	22.59	8.47	43.71	23.14	12.14
Well Stickup (m)		-0.07	-0.04	0.00	-0.09	-0.03	0.00	-0.10	-0.04	0.00	-0.07	-0.03	0.00	-0.10	-0.04	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
Statistics																												
Water Level (masl)	Minimum	219.17	220.11	230.75	220.17	220.11	222.94	222.15	223.17	232.36	226.70	221.92	230.67	227.96	227.71	229.93	233.20	233.11	233.01	-	-	-	225.23	229.03	229.03	-	-	-
Water Level (masl)	Maximum	222.70	223.05	231.53	222.21	220.91	232.50	226.60	228.82	234.56	234.70	231.28	235.18	231.42	231.40	231.41	233.29	234.48	233.67	-	-	-	227.23	230.56	229.95	-	-	-
Water Level (masl)	Mean	220.43	220.80	231.25	220.75	220.61	227.64	223.51	224.25	233.59	231.76	227.73	233.45	229.79	229.63	231.06	233.25	233.60	233.32	-	-	-	226.05	229.75	229.50	-	-	-
Water Level (masl)	2019-12-09	222.70	223.05	231.43	220.87	220.72	227.46							231.37	231.37	231.39												
Water Level (masl)	2019-12-20	221.33	221.11	231.32	220.70	220.62	229.77	226.60	228.82	233.04	234.70	231.28	235.18	231.22	231.30	231.31												
Water Level (masl)	2020-01-08	221.26	221.05	231.42	221.17	220.75	232.50	223.50	224.19	233.87	234.62	229.59	235.09	231.38	231.35	231.38												
Water Level (masl)	2020-02-06	221.23	220.99	231.53	221.48	220.91	232.45	223.26	223.90	234.42	234.52	229.33	234.78	231.42	231.40	231.41												
Water Level (masl)	2020-05-12	220.40	220.11	231.34	222.21	220.84	232.47	223.61	223.62	233.70	233.28	229.13	233.68	231.22	231.23	231.28												
Water Level (masl)	2020-07-29	219.17	220.70	230.75	220.18	220.11	224.13	223.54	223.51	232.36	230.07	226.32	230.67	228.65	228.32	229.93												
Water Level (masl)	2020-08-28	219.53	220.26	231.16	220.17	220.38	222.94	223.16	223.17	232.59	226.70	221.92	231.99	227.96	227.85	230.52												
Water Level (masl)	2020-11-03	219.85	220.20	231.17	220.18	220.58	225.26	223.48	223.50	234.30	228.43	226.18	233.62	228.31	227.89	231.26												
Water Level (masl)	2021-03-09	219.33	220.16	231.41	220.21	220.50	224.32	222.29	223.76	234.56	231.00	228.53	233.15	228.24	227.91	231.21	233.29	234.48	233.67	DRY	DRY	DRY	227.23	230.56	229.95	DRY	DRY	DRY
Water Level (masl)	2021-04-23																233.26	233.23	233.30				225.67	229.66	229.51			
Water Level (masl)	2021-05-27	219.45	220.31	230.97	220.34	220.67	225.10	222.15	223.75	233.47	232.55	227.29	232.88	228.19	227.71	230.94	233.20	233.11	233.01	235.16	237.00	237.17	225.23	229.03	229.03	217.62	220.35	DRY

GOLDER
MEMBER OF WSP

golder.com

APPENDIX E

Groundwater Modelling Report (WSP, 2023)

REPORT

Groundwater Modelling and Private Well Impact Assessment

LCP Quarry Limited Proposed Brechin Quarry, Township of Ramara, Ontario

Submitted to:

Azimuth Environmental Consulting Inc.

642 Welham Road
Barrie, Ontario
L4N 9A1

Submitted by:

WSP Canada Inc.
1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada

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19122839-2

December 2023

Distribution List

1 e-copy –	Azimuth Environmental Consulting Inc.
1 e-copy –	WSP Canada Inc.

Executive Summary

The LCP Quarry Limited (LCP) proposed Brechin Quarry is located approximately 1 to 1.5 kilometres east of Lake Simcoe bordering the west side of Highway 12. The area proposed to be licenced under the *Aggregate Resources Act* is 151.4 hectares (ha) and the proposed extraction area is 91.5 ha. The final quarry floor for the proposed LCP Brechin Quarry will slope from approximately 207.6 metres above sea level (ASL) in the northeast to approximately 202.6 metres ASL in the southwest which generally follows the planar surface established at 10 metres above the contact between the Bobcaygeon Formation and Gull River Formation. The base of the quarry excavation is below the average position of the groundwater table. Following the extraction of material, the property will be rehabilitated by allowing the quarry excavation to flood forming a quarry lake with shoreline wetland features. A quarry owned by Lafarge Canada Inc. (Lafarge) is located to the northeast of the LCP site and a quarry owned by James Dick Construction Limited (James Dick) is located to the south of the LCP site.

All hydrogeological field work and monitoring activities at the LCP site were completed by Azimuth Environmental Consulting Inc. WSP Canada Inc. (formerly Golder Associates Ltd.) was retained to log the rock core recovered from the on-site diamond drillholes, complete the downhole geophysical logging of all on-site boreholes and to develop a stratigraphic and hydrostratigraphic interpretation for the site. WSP was also retained for the purpose of developing a numerical groundwater model for the LCP site and surrounding area and to use this model to complete a private well impact assessment.

This report describes the development of the regional numerical groundwater model for the LCP site based on the hydrogeological data provided by Azimuth, data contained in the Golder Associates Ltd. (2021) geological study report for the site, experience with these formations in the region (Golder, 2012) and information in the Ministry of Environment, Conservation and Parks Water Well Information System. The regional numerical groundwater model was developed to estimate the groundwater level drawdown associated with the development of the LCP quarry as well as the Lafarge quarry and James Dick quarry. This report also presents the results of the private well impact assessment.

The primary hydrogeological concern with respect to nearest private water supply wells is the development of the groundwater drawdown cone that is associated with quarry dewatering, and the potential for drawdown to cause an interruption of the water supply at nearby homes as a result of the lowering of water levels in the private water supply wells.

Based on the results of the groundwater modelling and the review of local water supply wells, it is concluded that there will be no interference with water supply wells as a result of the proposed full development of the LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact).

Overall, it is expected that the development of the proposed LCP quarry will have no negative impact on private wells. During the development of the LCP quarry, a monitoring program will be implemented for the purpose of verifying that the operation of the proposed LCP quarry does not adversely impact private wells.

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Background

The LCP Quarry Limited (LCP) proposed Brechin Quarry (hereafter referred to as the “LCP site”, “LCP Brechin Quarry", “LCP quarry” or “site”) is located approximately 1 to 1.5 kilometres east of Lake Simcoe bordering the west side of Highway 12 as shown on Figure 1.

WSP Canada Inc. (WSP) was retained by LCP to participate in specific components of the hydrogeological studies being undertaken by Azimuth Environmental Consulting Inc. (Azimuth) as part of an application under the *Aggregate Resources Act* (ARA). The qualifications and experience of the WSP report authors are presented in **Appendix A**.

All hydrogeological field work and monitoring activities at the LCP site were completed by Azimuth. WSP (formerly Golder Associates Ltd.) was retained to log the rock core recovered from the on-site diamond drillholes, complete the downhole geophysical logging of all on-site boreholes and to develop a stratigraphic and hydrostratigraphic interpretation for the site. WSP was also retained for the purpose of developing a numerical groundwater model for the LCP site and surrounding area and to use this model to complete a private well impact assessment.

The Golder Associates Ltd. report entitled “*Geological Study, Talisker Corporation Proposed Brechin Quarry, Township of Ramara, Ontario*” dated June 2021 (Rev.1) [hereafter referred to as Golder (2021)] presents the results of the core logging and geophysical investigation and presents the stratigraphic and hydrostratigraphic interpretation for the site. Golder (2021) is included as **Appendix B**.

This report describes the development of the numerical groundwater model for the LCP site based on the hydrogeological data provided by Azimuth and data contained in Golder (2021) and presents the results of the private well impact assessment.

1.2 Site Description

The proposed LCP Brechin Quarry is located in the Township of Ramara, Ontario. The proposed quarry property is located in Part of Lots 11, 12 and 13, Concession 1 (former geographic Township of Mara). The general location of the proposed LCP Brechin Quarry is shown on Figure 1. The property is bounded by Provincial Highway 12 to the east, Concession Road 2 to the north and Concession Road 1 to the south. An existing quarry owned and operated by Lafarge Canada Inc. (Lafarge) is located to the northeast of the LCP site (hereafter referred to as the “Lafarge Brechin Quarry” or “Lafarge quarry”) and an existing quarry owned and operated by James Dick Construction Limited (James Dick) is located to the south of the LCP site (hereafter referred to as the “James Dick Gamebridge Quarry” or “James Dick quarry”).

The area proposed to be licenced under the ARA is 151.4 hectares (ha) and the proposed extraction area is 91.5 ha. The boundaries of the licenced area and the limit of extraction for the proposed LCP Brechin Quarry are shown on Figure 2. The LCP Brechin Quarry will be developed in three lifts. The final quarry floor for the proposed LCP quarry will slope from approximately 207.6 metres above sea level (ASL) in the northeast to approximately 202.6 metres ASL in the southwest which generally follows the planar surface established at 10 metres above the contact between the Bobcaygeon Formation and Gull River Formation. The base of the quarry excavation is below the groundwater table. Following the extraction of material, the property will be rehabilitated by allowing the quarry excavation to flood forming a quarry lake with shoreline wetland features.

The nearest residents are located east of the site along Provincial Highway 12.

2.0 LOCAL SETTING

2.1 Geology

The geological setting of the LCP site and surrounding area is described in Golder (2021) which is provided in **Appendix B**.

2.2 Hydrogeology

The hydrogeological setting of the site and surrounding area is described in the Level 1 and Level 2 Water Report (Azimuth, 2023).

2.3 Surrounding Land Use - Existing Quarries

As previously described, a number of licenced aggregate quarries currently exist in the area of the LCP site. Lafarge owns the Brechin Quarry located to the northeast whereas James Dick owns the Gamebridge Quarry located to the south of the proposed LCP quarry. The locations of the existing quarries are shown on Figure 3.

Details regarding the general properties of the existing quarry sites from their approved Ministry of Natural Resources and Forestry (MNRF) Site Plans are included in the following table:

Table 1: Summary of Existing Quarries as Per MNRF Site Plans

Quarry Operator	Quarry Name	Approximate Licenced Area (hectares)	Approximate Extraction Area (hectares)	Approved Final Quarry Floor Elevation (metres above sea level)	Rehabilitation Plan
Lafarge	Brechin Quarry	332.3	308	181	Rehabilitate to a lake with level at 224 metres ASL
James Dick	Gamebridge Quarry	90.3	83.8	165	Rehabilitate to a lake with level at 236 metres ASL

In considering the potential hydrogeological impacts from quarry dewatering at the proposed LCP quarry, a cumulative impacts assessment including all of the quarries in the area was completed. For the existing conditions, the quarry floor elevations were assumed as follows:

Table 2: Summary of Existing Quarries Under Existing Conditions

Quarry Operator	Quarry Name	Simulated Quarry Floor Elevation
Lafarge	Brechin Quarry	Quarry floor elevations within the excavated area were set at 190 metres ASL
James Dick	Gamebridge Quarry	Quarry floor elevations within the excavated area were set at 210 metres ASL

As the adjacent quarry sites are being operated independently, it is not possible to predict depth and breadth of excavations at any given point in the future. For this reason, cumulative impacts are assessed with all quarries at full development.

2.4 Geological and Hydrogeological Conceptual Model

Data from a variety of sources were considered during the development of the conceptual model for the site including:

- Mapping data from the Natural Resources Values Information System, maps from the MNRF, and published geological mapping.
- Site-specific information was obtained from on-site drilling programs, groundwater level monitoring and hydraulic conductivity testing completed by Azimuth (Azimuth, 2023).
- The geological and hydrogeological interpretation presented in the Geological Study prepared by Golder Associates Ltd. (Golder, 2021) and provided in **Appendix B**.
- Off-site geological and hydrogeological information contained within the Ministry of the Environment, Conservation and Parks (MECP) Water Well Information System (WWIS).

The data from the above sources formed the basis for the development of the site conceptual model described below.

2.4.1 Geology

The ground surface of the LCP site is relatively flat varying in elevation from approximately 230 metres ASL to 240 metres ASL sloping gently westward towards Lake Simcoe (elevation approximately 219 metres ASL). The results of the drilling completed by Azimuth (Azimuth, 2023) indicates that the site is underlain by approximately 0.5 m to 3.7 m of lacustrine clay and glacial till soil deposits overlying bedrock. This overburden thickness is based on the overburden thickness reported at borehole locations BH1 through BH9 (see locations on Figure 2). The average depth of the overburden measured at the nine borehole locations was 1.8 metres.

The bedrock sequence consists of four Paleozoic Ordovician age formations including, in descending order, the Verulam Formation, Bobcaygeon Formation, Gull River Formation and the basal Shadow Lake Formation which lies in unconformity upon the underlying crystalline Precambrian basement. The on-site drilling has indicated that the combined thickness of the Paleozoic Ordovician sequence is approximately 59 metres to 69 metres subject to the gentle southwestern dip of the strata and elevation variation within the eroded Precambrian bedrock surface.

The Verulam Formation is a shaley limestone sequence that forms the bedrock surface and varies in thickness from approximately 6.0 metres to 19.0 metres. The Verulam Formation is weathered within 0.5 metres to 1.5 metres of the bedrock surface. The Verulam Formation has been subdivided into a lower Unit 1 and an upper Unit 2 based on the shale content. The Bobcaygeon Formation has a consistent thickness of approximately 26 metres to 27 metres and has been further subdivided into four lithological units based on the core logging. The Gull River Formation is comprised of four units of interbedded limestone (Units 2 and 4) and dolostone (Units 1 and 3) with a combined thickness of approximately 18.5 metres to 19.0 metres. The Shadow Lake Formation is the basal clastic sequence beneath the flat-lying Paleozoic Ordovician limestone/dolostone and lies in unconformity on the Precambrian crystalline basement. The formation varies in thickness between approximately 7.5 metres and 8.5 metres beneath the LCP site. The local stratigraphy of the Shadow Lake Formation is subdivided into three main beds. The Precambrian basement was penetrated between approximately 0.5 metres and 3.0 metres in boreholes BH-1 to BH-4 to define the base of the overlying sedimentary sequence.

2.4.2 Hydrostratigraphic Units and Nomenclature

Based on site stratigraphy defined from the core logging/geophysics, the results of the packer testing data analysis conducted by Azimuth, the hydrogeological data collected by Azimuth during site monitoring program and well response tests and WSP's experience in the area, the hydrostratigraphic units and monitoring well nomenclature for the LCP site was developed as presented in Section 6.2 of Golder (2021) (see **Appendix B**). Subsequent to the completion of Golder (2021), an additional hydrostratigraphic identifier "Z" was added by Azimuth to represent the 30 to 35 metres open borehole portions in boreholes BH-1 through BH-3. This unit represents the cumulative contribution from all of the "upper zones" (i.e., Bobcaygeon Formation, Verulam Formation and the upper weathered bedrock zone).

2.4.3 Estimates of Hydraulic Conductivity

Hydrogeological testing at the site included single well response test at monitoring well locations and packer testing in boreholes BH1 thorough BH5 (Azimuth, 2023). Table 4 provides the ranges of hydraulic conductivity for the hydrostratigraphic units to be included in the groundwater flow model.

Table 3: Hydraulic Conductivity Ranges for Hydrostratigraphic Units

Hydrostratigraphic Unit	Single Well Response Test Range in Hydraulic Conductivity (m/s)	Packer Testing Range in Hydraulic Conductivity (m/s)(1)
Upper Weathered Zone	no testing completed	$6x10^{-5}$ to $4x10^{-4}$
Verulam Formation	$≤1X10^{-9}$ to $3x10^{-7}$ (2)	$3x10^{-8}$ to $2x10^{-4}$
Bobcaygeon Formation	≤1X10-9 to $7x10^{-7}$ (2)	$3x10^{-8}$ to $9x10^{-5}$
Gull River Formation Unit 4	$≤1x10^{-9}$ to $2x10^{-8}$ (2)	$3x10^{-8}$ to $2x10^{-6}$
Gull River Formation Unit 3	$1x10^{-9}$ to $1x10^{-6}$	$3x10^{-8}$ to $1x10^{-4}$
Gull River Formation Unit 2	no testing completed	$3x10^{-8}$ to $6x10^{-6}$
Gull River Formation Unit 1	$6x10^{-9}$ (only one test completed)	$2x10^{-8}$ to $2x10^{-6}$
Shadow Lake Formation	$1x10^{-7}$ (only one test completed)	$1x10^{-7}$ to $5x10^{-6}$
Shadow Lake/Upper Precambrian	$6x10^{-9}$ to $2x10^{-8}$	$3x10^{-8}$ to $5x10^{-7}$

Notes: (1) – the packer test hydraulic conductivity ranges are based on result provided by Azimuth. During packer testing, there were zones of 'no take' where the hydraulic conductivity of the bedrock would be lower than the ranges presented in Table 4 above.

(2) – single well response tests could not be completed at the monitoring wells constructed in the Verulam Formation and the Bobcaygeon Formation at BH7 and BH9 and in upper Gull River Formation at BH9. The driller identified these boreholes as dry at the time of drilling and the water level recovering in these monitoring wells was very slow. The estimated hydraulic conductivity for these locations is $≤1x10^{-9}$ m/s.

The ranges of the hydraulic conductivity results for the various formations were used as a starting point during the construction and calibration of the numerical model.

2.4.4 Local Water Supply

Azimuth completed a review of the water wells within 3 kilometres of the LCP site (Azimuth, 2023). Based on their review, the majority of water wells in the MECP database are constructed between 15 and 60 metres below ground surface (mbgs), and approximately 84 percent of the private wells obtain their water supply from within the Bobcaygeon Formation (65 percent) or the Gull River Formation (19 percent). Within 500 metres of the LCP site, recommended well yields range between 1.9 Litres per minute (L/min) to 94.5 L/min, and the median yield is 7.6 L/min. The general information on local water supply (i.e., typical well depths and aquifers targeted) has been incorporated into the site conceptual model.

2.4.5 Groundwater Elevations

Azimuth installed monitoring wells in the nine boreholes completed at the site. The available groundwater elevation data for the on-site monitoring wells was provided to WSP by Azimuth for use in the model development. This data included manual groundwater level measurements as well as datalogger measurement from selected monitoring intervals. Detailed discussion of the groundwater elevation data is provided in the Level 1 and Level 2 Water Report (Azimuth, 2023). A representative set of the available on-site groundwater elevation data was incorporated into the groundwater model through the calibration process.

Available off-site groundwater elevation data included in the MECP WWIS was also used to understand the groundwater flow direction beyond the LCP site.

The above information was used to develop the groundwater flow model as described in Section 4.0.

3.0 PRIVATE WELL RECEPTOR IDENTIFICATION

Potential groundwater users in the vicinity of the LCP site that could be affected by the progressive quarry development were identified. As part of their assessment of local water supply, Azimuth completed a detailed review of the well record database in the vicinity of the LCP site. The information included in the database was examined and vetted to confirm accuracy (to the extent possible). This included adjusting well locations by replotting mislocated records or removing some records that were incorrectly plotted (Azimuth, 2023). The reviewed well locations were provided to WSP by Azimuth and were plotted on a map centred on the proposed LCP site to aid in the assessment of groundwater use within the area (see well locations on Figure 3). The water well records were examined to determine the general yield and depth of identified private supply wells. There are no municipal services in the vicinity of the site, and water supply is obtained exclusively from private water supply wells.

Extensive deposits of coarse and permeable overburden, capable of supplying sufficient quantities of groundwater for domestic use, are not prevalent in the vicinity of the LCP site. For this reason, the bedrock is considered the principal aquifer for water supply.

During the review of the available water well locations, it was noted that the well record database did not include water well records for a number of the properties located within one kilometre of the LCP site. To address this issue, assumed well locations were identified to use as receptor locations during the private well impact assessment. These assumed well locations are identified as PW1 through PW7 (see location on Figure 3).

Azimuth contacted landowners to complete a private well survey to gather additional information for the wells closest to the site (i.e., PW-2, PW-4, PW-5 and PW-6). Permission was granted to measure the total well depth and the water level at PW-4 only. The water level was measured at 12.31 mbgs and the total depth of the well was 41 metres. Based on the interpretation of the local stratigraphy, the well at PW-4 is completed near the base of the Bobcaygeon Formation. Azimuth was not granted access to measure water levels or well depths at any of the other nearby wells (Azimuth, 2023).

Based on the analysis of well records completed by Azimuth, 84 percent of wells are completed in the Bobcaygeon Formation (65 percent) or the Gull River Formation (19 percent). For the purpose of completing the impact assessment, it was assumed that the PW series wells are completed several metres above the Bobcaygeon/Gull River formational contact. This is consistent with the review of the well records which indicate the majority of wells in the vicinity of the site are completed in the Bobcaygeon Formation and is consistent with the well depth measured at PW-4. For the private well impact assessment, it is assumed that the PW series wells are completed to this depth or could be deepened to this depth, if necessary.

The primary hydrogeological consideration with respect to nearest water supply wells is the development of the groundwater drawdown cone that is associated with quarry dewatering, and the potential for drawdown (depressurization) to cause an interruption of the water supply because of the lowering of water levels in the water supply wells. The potential for impacts to private wells is assessed as part of the impact assessment presented in Section 5.4.

4.0 GROUNDWATER FLOW MODELLING

4.1 Model Approach

A numerical model was developed to simulate the three-dimensional (3-D) distribution of groundwater hydraulic head in the study area, using MODFLOW-NWT (Newton-Raphson formulation) (Niswonger et. al, 2011). The use of MODFLOW implies that an equivalent porous media approach was adopted for this work. Although groundwater flow in bedrock aquifers is typically governed by the presence of fractures, such individual discrete features are not explicitly defined in the model. Rather, the bulk material properties are established based on large scale characteristics of the bedrock.

A calibrated flow model was developed through the establishment of a finite difference grid, distribution of hydraulic conductivity, distribution of boundary conditions, with adjustments, as necessary, to match the output of the model to observed conditions (i.e., observed groundwater head elevations). The calibrated flow model was then used to estimate potential future conditions surrounding the LCP quarry site. Visual MODFLOW Version 4.6.0.169 was used as a pre- and post-processor for MODFLOW for the results presented herein.

4.1.1 Data Review and Processing

Based on a review of the available data, a ten-kilometre by nine-kilometre study area was chosen, centred on the LCP site. The data was reviewed and processed as follows:

- Review of the geological information (Golder, 2021) and hydrogeological information collected as part of the LCP field programs (Azimuth, 2023).
- Review of the WWIS for available geological information (i.e., depth to bedrock from driller observations) and hydrogeological information (elevation of water found and elevation of static water level in the WWIS).
- Comparison of site-specific data to data from previous studies completed for the region including the Carden Plain Cumulative Impact Assessment (Golder, 2012).

- Development of a geological model consistent with the geology described in the geological report completed for the study area (Golder, 2021).

The hydrogeological information contained in the MECP WWIS represents water level data collected during different years, different seasons and from different formations depending on the date of well completion and the depth of the well. At some locations, the reported static water levels may not be representative of actual static conditions as they are likely measured shortly after completion of the drilling of the well (i.e., before the water level in the well returned to static conditions). On an individual basis, the information cannot be relied upon to be representative of actual current conditions; however, when multiple wells are considered together, trends in water levels can be observed and outliers can be identified. It is recognized that the information in the MECP WWIS should be used with an acknowledgement of its limitations.

4.1.2 Model Extents and Layering

The model domain and grid are presented in Figure 4. The model grid cells were set with a uniform 50-metre horizontal spacing within the domain. There was a total of 17 layers and 403,376 total active grid blocks defined in the model. Layer thicknesses ranged from approximately 0.3 metres to 20 metres. Figure 5 illustrates the relationship between the 17 numerical model layers and the hydrostratigraphic units.

Based on the information in the MECP WWIS, the geology as described in the geological report (Golder, 2021) and experience with these formations in the region (Golder, 2012), the hydrostratigraphic units in the model were divided as follows:

Layer 1 – Overburden

- Variable thickness layer present across the model domain. The layer is generally thin, particularly in the area of the LCP quarry (minimum thickness of 2 metres used in model) and has isolated pockets of thicker deposits (15 to 20 metres). The top of this unit is defined by topography and the bottom is defined by depth to bedrock information from the MECP WWIS and the boreholes completed for the LCP field program.

Layer 2 – Weathered Bedrock

- Continuous unit present across entire model domain with a constant 2 metre thickness.

Layer 3 to 5 – Verulam Formation

- This unit is discontinuous across the model domain and is generally thicker to the south. The presence of the Verulam Formation in plan within the model domain is shown on the inset image of Figure 5.

Layer 6 to 10 – Bobcaygeon Formation

- A thick unit (up to 27 metres in the vicinity of the LCP site) that is present across the entire model domain. The Bobcaygeon Formation was represented in the model with one set of material properties.

Layer 11 to 14 – Gull River Formation

- The Gull River Formation was divided into four units (vertically) based on the descriptions in the geological report (Golder, 2021). The four units of the Gull River Formation are continuous across the model domain with the thickness of each unit ranging between approximately 1 and 6 metres. Gull River Unit 3 and 1 (Layer 12 and 14) are comprised of primarily dolostone and considered to be more permeable. Gull River Unit 4 and 2 (Layer 11 and 13) are comprised of primarily limestone and considered to be less permeable.

Layer 15 to 16 – Shadow Lake Formation

- The Shadow Lake Formation is continuous across the model domain with thicknesses ranging from approximately 6 to 15 metres. The Shadow Lake Formation was represented in the model with one set of material properties.

Layer 17 – Shadow Lake / Precambrian Contact

- Constant 5-metre-thick layer draped below the Precambrian rock surface. The base of this layer forms the base of the numerical model as it is assumed that the competent Precambrian bedrock found below this zone would be relatively impermeable.

4.1.3 Boundary Conditions

Figure 6 illustrates the boundary conditions that were applied in the model, a summary of which is provided below:

- Recharge boundary conditions were established on the top layer which were consistent with previous groundwater flow modelling completed in this area (Golder, 2012). A recharge rate of 75 millimetres per year (mm/year) was applied in areas where the weathered bedrock was relatively close to the surface and a recharge rate of 65 mm/year was applied elsewhere.
- A constant head boundary condition was applied to represent Lake Simcoe on the western and southern boundaries of the model. The north boundary was set as a no-flow boundary and the east boundary was set as a constant head boundary to allow groundwater inflow into the model based on the regional head contours presented in previous studies in the area (Golder, 2012).
- Drain boundary conditions were applied to the upper surface of the model at the locations shown on Figure 6. These boundary conditions were applied to mapped streams and rivers within the model domain with the drain elevation based on topography.
- The quarry excavations are simulated using drain boundary conditions. The elevation of the drain cells representing the bottom of the quarry excavation are set equal to the base elevation of the quarry. The elevation of the drain cells above the quarry floor are set equal to the bottom of the cell block plus one tenth of the total thickness of the finite difference grid block. The boundary conditions for the quarry excavations are shown on Figure 7.

4.1.4 Hydraulic Conductivity and Storativity

Hydraulic conductivity is assigned to the individual grid blocks based on their location within the assumed hydrostratigraphic model. Initial hydraulic conductivity values are assigned based on measured values from the LCP field program (Section 2.4.3), and professional experience with the specific hydrostratigraphic units in this area (Golder, 2012). Adjustments were then made during the model calibration exercise to establish the final values in the model.

Details regarding the hydraulic conductivity values assigned for the calibrated numerical model are provided in Figure 5.

The numerical model is run to steady state conditions during the calibration process as well as in the forecast simulations (as a conservative approach); therefore, storativity was not assigned in the numerical model.

4.1.5 Model Calibration

Model calibration was completed by adjusting model properties and boundary conditions (generally referred to as “parameters”), within reasonable bounds, to match the model output to the observed conditions (i.e., measured groundwater elevations from the LCP site and the MECP WWIS).

Observed groundwater elevations (i.e., hydraulic heads) considered during model calibration were calculated by subtracting the depth-to-water from the ground surface elevation, while the measuring point (i.e., elevation head) was inferred from information about the well, as shown in Table 4.

Table 4: Groundwater Elevation Data Sources for Calibration

Data Source	Ground Surface Elevation	Depth to Water	Measurement Point (i.e., Elevation Head)
MECP WWIS	Interpolated from digital elevation model	In database	Lowest elevation of “water found”
LCP Field Data (Azimuth, 2022)	Surveyed to Geodetic datum	Measured using water level tape	Centre of monitoring interval

For comparison to the observed values, simulated groundwater elevations (from the numerical model) at each measurement point were interpolated from the simulated groundwater elevations in the surrounding grid blocks. The match between the observed and simulated groundwater elevations was assessed from plots of simulated versus observed groundwater elevations and from calibration statistics: residual mean, absolute residual mean, root mean square (RMS) and normalized RMS.

Contours of simulated head elevations and observed water levels are presented in Figure 8, along with calibration plots and statistics. The results of the calibration of Scenario 0 (i.e., approximating current conditions in the study area) indicate a reasonable agreement between the simulated groundwater elevations and the observed groundwater elevations, based on the following observations:

- The majority of the simulated groundwater elevations are within 3 metres of the observed elevations, with an absolute residual mean error of 1.8 metres.
- A strong bias was not present in the simulated groundwater elevations, as indicated by the residual mean, which was 0.73 metres.
- The normalized root mean squared error (nRMS) was 10 percent.
- Simulated water levels from the LCP monitoring wells generally compare well to the observed values at these locations with an absolute residual mean error of 2.7 metres and a residual mean of -0.80 metres.
- Groundwater flow directions simulated by the model are similar to those inferred from the observed water levels across the model area (Figure 8).

4.2 Forecast Simulations

Following calibration, the model was used to simulate the potential drawdown associated with the development of the proposed LCP quarry. In order to estimate the total drawdown associated with quarry development in the area, the existing Lafarge and James Dick quarries were removed from the calibrated model for the purpose of defining a pre-quarry development simulation (i.e., zero quarry-related drawdown over the model domain). The predevelopment groundwater head elevation was then used as a reference to calculate total drawdown for the following simulation scenarios:

- Scenario 0 - Existing conditions (see Model Calibration, Section 4.1.5)
- Scenario 1 – Full development of Lafarge and James Dick quarries with no development of the LCP quarry (i.e., currently approved condition).
- Scenario 2 – Full development of LCP quarry with Lafarge and James Dick quarries at existing conditions.
- Scenario 3 - Full development of LCP quarry with Lafarge and James Dick quarries at full development.

Table 5 below describes the full development states of the proposed LCP quarry site and each currently licenced quarry considered in the model. The full development conditions for the proposed LCP quarry site were selected based on the proposed quarry development plan outlined in Section 1.2.

Table 5: Full Development Quarry Floor Elevations

Quarry Operator	Quarry Name	Quarry Floor Elevation (metres above sea level)
LCP	Brechin Quarry	202.6 to 207.6
Lafarge	Brechin Quarry	181
James Dick	Gamebridge Quarry	165

4.3 Forecast Simulation Results

4.3.1 Predicted Groundwater Drawdown

The results of the groundwater flow model simulations for each of the scenarios are presented on Figures 9 through 14. The results are presented as the change in hydraulic head (referred to herein as “drawdown contours”) in the Verulam Formation (Layer 4 of the numerical model), the Bobcaygeon Formation (Layer 8 of the numerical model) and the Gull River Formation Unit 3 (Layer 12 of the numerical model). The maximum extent of drawdown discussed is based on the 1-metre drawdown contour.

Scenario 0: Existing Conditions for Lafarge and James Dick Quarries with no LCP Quarry

Figure 9 shows the contours of simulated groundwater level drawdown in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the existing conditions. The contours are produced by subtracting the simulated groundwater elevations in Scenario 0 from the simulated predevelopment groundwater elevations.

The simulated drawdown in the Bobcaygeon and Gull River Formations extends beneath the proposed LCP extraction area, whereas the drawdown in the Verulam Formation does not reach the LCP site. The drawdown in this scenario is primarily from the Lafarge Brechin quarry to the northeast of the site.

Scenario 1: Full Development of Lafarge and James Dick Quarries with no LCP Quarry

Figure 10 shows the contours of simulated groundwater level drawdown in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the full development of the Lafarge and James Dick quarries with no development of the LCP site. The contours are produced by subtracting the simulated groundwater elevations in Scenario 1 from the simulated predevelopment groundwater elevations.

The simulated drawdown in the Verulam, Bobcaygeon and Gull River Formations extends beneath the proposed LCP extraction area. The drawdown at the LCP extraction area is between approximately 3 metres (Verulam) and 30 metres (Gull River) with higher drawdown present at the south part of the site which is located in close proximity to the James Dick quarry.

Scenario 2: Full development of LCP Quarry with Lafarge and James Dick Quarries at Existing Conditions

Figure 11 shows the contours of simulated groundwater level drawdown in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the full development of the LCP Quarry with the Lafarge and James Dick quarries remaining at their existing conditions. The contours are produced by subtracting the simulated groundwater elevations in Scenario 2 from the simulated predevelopment groundwater elevations.

The maximum extent of drawdown in the Verulam Formation and the Bobcaygeon Formation extends between 500 metres and 750 metres to the west of the LCP quarry, respectively. In the other directions (north, south and east), there are more cumulative drawdown impacts with the other quarries. The drawdown in the Gull River Formation is similar to existing conditions.

Scenario 3: Full development of LCP Quarry with Lafarge and James Dick Quarries at Full Development

Figure 12 shows the contours of simulated groundwater level drawdown in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the full development of the LCP Quarry with the Lafarge and James Dick quarries at full development. The contours are produced by subtracting the simulated groundwater elevations in Scenario 3 from the simulated predevelopment groundwater elevations.

The drawdown in the Verulam Formation extends approximately 1,000 metres to the west of the LCP quarry. In the other directions (north, south and east), there are more cumulative drawdown impacts with the other quarries. The drawdown in the Bobcaygeon and Gull River Formations extends throughout the model domain.

Incremental Drawdown Contributed by the LCP Quarry with Lafarge and James Dick Quarries at Existing Conditions

Figure 13 shows the contours of the simulated incremental drawdown contributed by LCP in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the full development of the LCP Quarry with the Lafarge and James Dick quarries at existing conditions. The contours are produced by subtracting the simulated groundwater elevations in Scenario 2 from the groundwater elevations in Scenario 0.

The maximum extent of the additional drawdown related to the development of the LCP quarry extends up to approximately 600 metres, 700 metres and 1,100 metres from the LCP extraction area in the Verulam Formation, Bobcaygeon Formation and Gull River Formation, respectively.

Incremental Drawdown Contributed by the LCP Quarry with Lafarge and James Dick Quarries at Full Development

Figure 14 shows the contours of the simulated incremental drawdown contributed by LCP in the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) of the numerical model, induced by the full development of the LCP quarry with the Lafarge and James Dick quarries at full development. The contours are produced by subtracting the simulated groundwater elevations in Scenario 3 from the groundwater elevations in Scenario 1.

The maximum extent of the additional drawdown related to the development of the LCP quarry extends up to approximately 400 metres from the LCP extraction area in the Verulam Formation, Bobcaygeon Formation and Gull River Formation.

4.4 Sensitivity Analysis

It is recognized that there is inherently some uncertainty associated with the calibrated groundwater model, which stems from limitations in the available subsurface information and can be related to variability in the aquifer properties and uncertainties with the conceptual model. To gain some understanding of the potential impact of this uncertainty in the groundwater model forecasts, a sensitivity analysis was completed for the Bobcaygeon Formation as this is the primary unit that will be quarried by the proposed LCP quarry and also where the majority of private wells in the area are located (Azimuth, 2023). The sensitivity analysis included an increase and a decrease by a factor of five in the hydraulic conductivity of the Bobcaygeon Formation. The incremental drawdown contribution from the development of the LCP quarry with the other quarries staying at their existing conditions was calculated for the sensitivity runs (i.e., Scenario 2 – Scenario 0). The results of the sensitivity analysis are presented on Figure 15 which shows that the extent of the 1-metre drawdown contour is increased by a maximum of approximately 200 metres in Gull River Formation Unit 3. The increase in the extent of the 1-metre drawdown contour in the Bobcaygeon Formation and Verulam Formation are less than what is observed in the Gull River Formation Unit 3 (see Figure 15).

4.4.1 Water Balance

The overall water balance for each model run was checked and is presented in Figure 16. The simulation for each scenario converged and had a low mass balance error (< 0.1 %).

5.0 GROUNDWATER MODEL RESULTS

5.1 Scenario 1 - Full Development of Lafarge and James Dick Quarries with no LCP Quarry (Currently Approved Condition)

Figure 10 presents the predicted drawdown within the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) associated with the full development of the existing Lafarge and James Dick quarries with no development at the LCP site (i.e., Scenario 1).

Based on a review of the Scenario 1 modelling results, the proposed depth of the LCP quarry was designed to limit the potential additional drawdown that would occur as a result of the proposed LCP quarry development. Rather than extracting through the full sequence of the Verulam, Bobcaygeon and Gull River Formations, the base of the LCP quarry was proposed to be established at 10 metres above the contact between the Bobcaygeon and Gull River Formations.

5.2 Scenario 2 Full Development of the Proposed LCP Brechin Quarry – Incremental Drawdown Assessment

Figure 11 presents the predicted drawdown within the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) associated with the full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with the Lafarge and James Dick quarries at existing conditions (i.e., Scenario 2). Because Scenario 2 assumes that the Lafarge and James Dick quarries remain at existing conditions and the LCP quarry is fully extracted, this is the scenario where the LCP quarry has the greatest potential to impact groundwater level drawdown. As such, Scenario 2 is considered the worst-case scenario for groundwater level drawdown resulting from the development of the LCP quarry.

Figure 13 presents the incremental drawdown within the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) associated with the development of the LCP quarry assuming the Lafarge and James Dick quarries remain at existing conditions (i.e., scenario with the worst-case for drawdown contribution from the proposed LCP quarry). Incremental drawdown for this scenario refers to the additional drawdown resulting from the development of the LCP quarry (i.e., above and beyond the drawdown associated with dewatering of the Lafarge and James Dick quarries under existing conditions). The incremental drawdown presented on Figure 13 was calculated by contouring the remaining drawdown after subtracting the Scenario 0 (existing conditions – Figure 9) from Scenario 2 (full development of LCP quarry and Lafarge and James Dick quarries under existing conditions – Figure 11).

The incremental drawdown contours on Figure 13 identify the areas within the formations where the development of the proposed LCP quarry will have the greatest impact on groundwater levels (i.e., will impact groundwater levels by one metre or more). The ‘zone of incremental drawdown’ is defined as the area within the 1-metre incremental drawdown contour. As shown on Figure 13, for Scenario 2, largest zone of incremental drawdown is found in the most transmissive unit in the groundwater model (i.e., Gull River Formation Unit 3).

As discussed in Section 4.4, to gain some understanding of the potential impact of this uncertainty in the groundwater model forecasts, a sensitivity analysis was completed for the Bobcaygeon Formation as this is the primary unit that will be quarried by the proposed LCP quarry and also where the majority of private wells in the area are located (Azimuth, 2023). The envelope of the 1-metre incremental drawdown contours associated with the sensitivity runs is shown on Figure 15. To remain conservative, the impact assessment presented in Section 5.4 focuses on predicted impacts to wells that fall within the area defined by the outmost extent of the 1-metre incremental drawdown envelope for Gull River Formation Unit 3 shown on Figure 15 (i.e., the largest predicted zone of incremental drawdown).

5.3 Scenario 3 Full Development of LCP Quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with Lafarge and James Dick Quarries at Full Development – Incremental Drawdown Assessment

Figure 12 presents the predicted drawdown within the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) associated with the full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with the Lafarge and James Dick quarries at full development (i.e., Scenario 3).

Figure 14 presents the incremental drawdown within the Verulam Formation (Layer 4), Bobcaygeon Formation (Layer 8) and Gull River Formation Unit 3 (Layer 12) associated with the development of the LCP quarry when the Lafarge and James Dick quarries are at full development. Incremental drawdown for this scenario refers to the additional drawdown resulting from the development of the LCP quarry (i.e., above and beyond the drawdown associated with dewatering of the Lafarge and James Dick quarries under full development conditions). The incremental drawdown presented on Figure 14 was calculated by contouring the remaining drawdown after subtracting the Scenario 1 (full development of Lafarge and James Dick quarries – Figure 10) from Scenario 3 (full development of LCP quarry and Lafarge and James Dick quarries – Figure 12).

Because the LCP quarry was designed to limit additional groundwater level drawdown by establishing the depth of the quarry floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact, the incremental drawdown contributed by the LCP quarry under Scenario 3 is minimal.

5.4 LCP Quarry Development Private Well Impact Assessment

As discussed in Section 5.3, because the LCP quarry is relatively shallow, when the Lafarge and James Dick quarries are at full development the contribution of the LCP quarry to groundwater level drawdown under Scenario 3 is minimal. As such, the impact assessment present below for the proposed LCP quarry focuses on Scenario 2 where the LCP quarry has the greatest influence on groundwater levels in the vicinity of the site (see discussion in Section 5.2). This scenario assumes that the LCP quarry proceeds to full development while the Lafarge and James Dick quarries remain at existing conditions. The impact assessment focuses on the wells within the largest one-metre incremental drawdown contour (zone of incremental drawdown) plus the envelope for the sensitivity runs (referred to as the sensitivity envelope) shown on Figure 15. The wells within this combined area are shown on Figure 17 and include PW1 through PW7, 5737418, 5727526, 4600685, 4600686, 4600687, 4605360, 5713292, 5714004 and 5715549. .

Table 6 presents the estimated available drawdown, the predicted Scenario 2 drawdown and the remaining available drawdown for the wells within the zone of incremental drawdown plus the sensitivity envelope.

Table 6: Scenario 2 - Predicted Drawdown and Predicted Reduction of Available Drawdown (wells within zone of incremental drawdown plus sensitivity envelope)

Well Location	Estimated Available Drawdown (m)	Scenario 2 Predicted Drawdown (m)	Scenario 2 Remaining Available Drawdown Following Full Development of LCP Brechin Quarry (m)
PW1	30.8	1.4	29.4
PW2	33.0	6.5	26.5

Well Location	Estimated Available Drawdown (m)	Scenario 2 Predicted Drawdown (m)	Scenario 2 Remaining Available Drawdown Following Full Development of LCP Brechin Quarry (m)
PW3	29.9	4.4	25.6
PW4	28.7	8.4	20.3
PW5	32.8	8.3	24.5
PW6	32.7	7.6	25.1
PW7	27.9	3.0	24.9
5737418	34.1	5.6	28.5
5727526	31.7	3.2	28.5
4600685	13.1	1.6	11.5
4600686	12.5	1.0	11.5
4600687	14.9	0.9	14.0
4605360	29.6	1.3	28.3
5713292	32.0	1.1	30.9
5714004	10.1	0.2	9.9
5715549	43.3	2.5	40.8

As shown in Table 7, the predicted available drawdown following full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with the Lafarge and James Dick quarries at existing conditions (Scenario 2) is greater than 20 metres for all locations except 4600685, 4600686, 4600687 and 5714004. Well interference at water supply wells having greater than 20 metres of available drawdown remaining is not predicted. The potential for impacts at water supply wells 4600685, 4600686, 4600687 and 5714004 are discussed below. For reference, water well records for locations 4600685, 4600686, 4600687 and 5714004 are provided in **Appendix C**.

5.4.1 Private Well 4600685

Based on the groundwater modelling results for Scenario 2, the predicted remaining available drawdown for private well 4600685 is 11.5 metres. At the time of drilling in 1961, supply well 4600685 was pumped at a rate of approximately 23 L/min for one hour. Based on the results of the pumping test, the recommended pumping rate noted on the well record was 23 L/min (6 gallons per minute). Based on the recommended pumping rate, supply well 4600685 is not considered to be a low yield well. The remaining 11.5 metres of available drawdown is considered sufficient and well interference is not predicted at 4600685.

5.4.2 Private Wells 4600686 and 4600687

Based on the well records for 4600686 and 4600687, both wells were drilled in 1959 and are located on the same property approximately 120 metres apart. Based on the groundwater modelling results for Scenario 2, the predicted remaining available drawdown for private well 4600686 and 4600687 are 11.5 metres and 14.0 metres, respectively. This results in a combined predicted available drawdown for this property of 25.5 metres between the two wells. The minimal drawdown at 4600686 (1.0 metre) and 4600687 (0.9 metres) as a result of the development of the LCP quarry are not predicted to result in well interference issues. Both 4600686 and 4600687 are relatively shallow (i.e., less than 18 metres deep). If necessary, one or both of these wells could be deepened to provide additional storage and potentially additional yield.

5.4.3 Private Well 5714004

Based on the groundwater modelling results for Scenario 2, the predicted remaining available drawdown for private well 5714004 is 9.9 metres. The initial estimate of available drawdown at private well 5714004 is 10.1 metres and the predicted drawdown as a result of the development of the LCP quarry is 0.2 metres. The predicted drawdown represents approximately 2 percent of the available drawdown at location 5714004. The minimal drawdown at 5714004 (0.2 metres) as a result of the development of the LCP quarry is not predicted to result in well interference issues at this location. Private well 5714004 is a shallow well (i.e., 11 metres deep). If necessary, the well could be deepened to provide additional storage and potentially additional yield.

5.4.4 Summary

Based on the above impact assessment, interference with private water supply wells as a result of the full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) is not predicted. As discussed in Azimuth (2023), the proposed groundwater level monitoring program will permit the collection of long-term groundwater level data as the LCP Brechin Quarry develops. These data will show the actual changes in groundwater levels within the monitoring wells completed around the extraction area as the quarry expands laterally and vertically and can be used to further assess the propagation of the drawdown cone. In the unlikely event that complaints are received regarding interference to water wells in the vicinity of the site, the complaints response plan discussed in Azimuth (2023) would be implemented.

5.5 Cumulative Impact Assessment

Under Scenario 1 (full development of the existing Lafarge and James Dick quarries with no development at the LCP site), the current calibrated model indicates significant groundwater drawdown. Based on these results, the depth of the LCP Brechin Quarry was developed to limit the potential additional drawdown that would occur at the nearby wells as a result of the proposed LCP quarry development. Rather than extracting through the full sequence of the Verulam, Bobcaygeon and Gull River Formations, the base of the LCP quarry was proposed at 10 metres above the contact between the Bobcaygeon and Gull River Formations to limit the potential contribution to cumulative impacts on water supply wells.

6.0 SUMMARY AND CONCLUSIONS

The proposed LCP quarry is located approximately 1 to 1.5 kilometres east of Lake Simcoe bordering the west side of Highway 12. WSP was retained by LCP to participate in specific components of the hydrogeological studies being undertaken by Azimuth in support of an application under the ARA.

The proposed LCP Brechin Quarry is located in the Township of Ramara, Ontario. The proposed quarry property is located in Part of Lots 11, 12 and 13, Concession 1 (former geographic Township of Mara). The property is bounded by Provincial Highway 12 to the east, Concession Road 2 to the north and Concession Road 1 to the south.

All hydrogeological field work and monitoring activities at the LCP site were completed by Azimuth. WSP (formerly Golder Associates Ltd.) was retained to log the rock core recovered from the on-site diamond drillholes, complete the downhole geophysical logging of all on-site boreholes and to develop a stratigraphic and hydrostratigraphic interpretation for the site. WSP was also retained for the purpose of developing a numerical groundwater model for the LCP site and surrounding area and to use this model to complete a private well impact assessment.

Golder (2021) presents the results of the core logging and geophysical investigation and presents the stratigraphic and hydrostratigraphic interpretation for the site. Golder (2021) is included as **Appendix B**.

This report describes the development of the numerical groundwater model for the LCP site based on the hydrogeological data provided by Azimuth and data contained in Golder (2021) and presents the results of the private well impact assessment.

The area proposed to be licenced under the ARA is 151.4 ha and the proposed extraction area is 91.5 ha. The LCP Brechin Quarry will be developed in three lifts. The final quarry floor for the proposed LCP Brechin Quarry will slope from approximately 207.6 metres ASL in the northeast to approximately 202.6 metres ASL in the southwest which generally follows the planar surface established at 10 metres above the contact between the Bobcaygeon Formation and Gull River Formation. The base of the quarry excavation is below the average position of the groundwater table. Following the extraction of material, the property will be rehabilitated by allowing the quarry excavation to flood forming a quarry lake with shoreline wetland features.

A number of licenced aggregate quarries currently exist in the area of the LCP site. Lafarge owns the Brechin Quarry located to the northeast whereas James Dick owns the Gamebridge Quarry located to the south of the proposed LCP quarry site.

A regional numerical groundwater model was developed to estimate the groundwater level drawdown associated with the development of the LCP quarry and the Lafarge quarry and James Dick quarry. The numerical model was developed and calibrated based on the site-specific data, information in the MECP WWIS and experience with these formations in the region (Golder, 2012).

A number of model scenarios were developed to assess additional drawdown associated with the development of the proposed LCP quarry as compared to the already licenced quarries in the immediate area. The scenarios included:

- Scenario 0 - Calibration to Existing Conditions
- Scenario 1 – Full development of Lafarge and James Dick quarries with no LCP quarry (i.e., currently approved condition).
- Scenario 2 – Full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with Lafarge and James Dick quarries at existing conditions (i.e., LCP “worst case” condition).
- Scenario 3 - Full development of LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) with Lafarge and James Dick quarries at full development.

Once the model was calibrated to existing conditions (i.e., Scenario 0), the Lafarge and James Dick quarries were removed from the model for the purpose of defining a pre-quarry development simulation (i.e., zero quarry-related drawdown over the model domain). This pre-quarry development state (i.e., zero quarry-related drawdown) was then used to calculate total drawdown for quarry development Scenarios 1, 2 and 3.

From the modelling output for Scenario 0 and Scenario 2, the incremental drawdown contributed by the LCP site with Lafarge and James Dick quarries at existing conditions was calculated (i.e., Scenario 2 minus Scenario 0) which represents the “worst case” groundwater impact scenario for the LCP site (i.e., the scenario where the proposed LCP quarry can have the greatest impacts on groundwater levels in the vicinity of the site).

From the modelling output for Scenario 1 and Scenario 3, the incremental drawdown contributed by the LCP site with Lafarge and James Dick quarries at full development was calculated (i.e., Scenario 3 minus Scenario 1)

The primary hydrogeological concern with respect to nearest private water supply wells is the development of the groundwater drawdown cone that is associated with quarry dewatering, and the potential for drawdown to cause an interruption of the water supply at nearby homes as a result of the lowering of water levels in the private water supply wells.

Based on the results of the groundwater modelling and the review of local water supply wells, it is concluded that interference with water supply wells as a result of the proposed full development of the LCP quarry (floor at 10 metres above Bobcaygeon Formation/Gull River Formation contact) is not predicted. The LCP quarry has been specifically designed to limit the potential contribution to cumulative impacts on water supply wells in the vicinity of the quarry by limiting the depth of the proposed quarry to 10 metres above Bobcaygeon Formation/Gull River Formation contact.

Overall, it is expected that the development of the proposed LCP quarry will not have a negative impact on private wells. During the development of the LCP quarry, a monitoring program will be implemented for the purpose of verifying that the operation of the proposed LCP quarry does not adversely impact private wells.

7.0 LIMITATIONS AND USE OF REPORT

This report was prepared for the exclusive use of LCP Quarry Limited and Azimuth Environmental Consulting Inc. The report, which specifically includes all tables, figures and appendices, is based on data and information collected by WSP Canada Inc. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by WSP Canada Inc. as described in this report. Each of these reports must be read and understood collectively and can only be relied upon in their totality.

Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore authenticity of any electronic media versions of WSP’s report should be verified.

WSP Canada Inc. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The assessment of environmental conditions and possible hazards at this site has been made using the results of physical measurements and chemical analyses of liquids from a limited number of locations. The site conditions between sampling locations have been inferred based on conditions observed at groundwater sampling locations. Conditions may vary from these sampled locations.

The services performed, as described in this report, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. WSP Canada Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The groundwater level lowering, and groundwater inflow/seepage estimates developed from the groundwater model described in this report are considered to represent reasonable "theoretical" estimates based on the available data. There is uncertainty inherently associated with the (subsequent) forecasts by the groundwater model, stemming from limitations in the available subsurface information and can be related to variability in the bedrock properties (e.g., hydraulic conductivity, porosity, etc.) or uncertainties with the conceptual model (e.g., groundwater-surface water interactions, location of flow boundaries, recharge rates, continuity in aquitards, direction of regional groundwater flow, etc.). It is the intention of WSP Canada Inc. that the model results be used as a screening tool to predict groundwater inflow/seepage rates and groundwater level lowering for the purposes of this license application process and not for any other purposes.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, WSP Canada Inc. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

8.0 CLOSURE

We trust the information presented in this report meets your requirements. Should you have any questions or concerns, please contact the undersigned.

WSP Canada Inc.

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https://golderassociates.sharepoint.com/sites/108830/project files/6 deliverables/2023 modelling report & pw impact assessment/19122839-r-rev0-lcp quarry limited gw modelling & pw impact assessment report_15dec2023.docx

9.0 REFERENCES

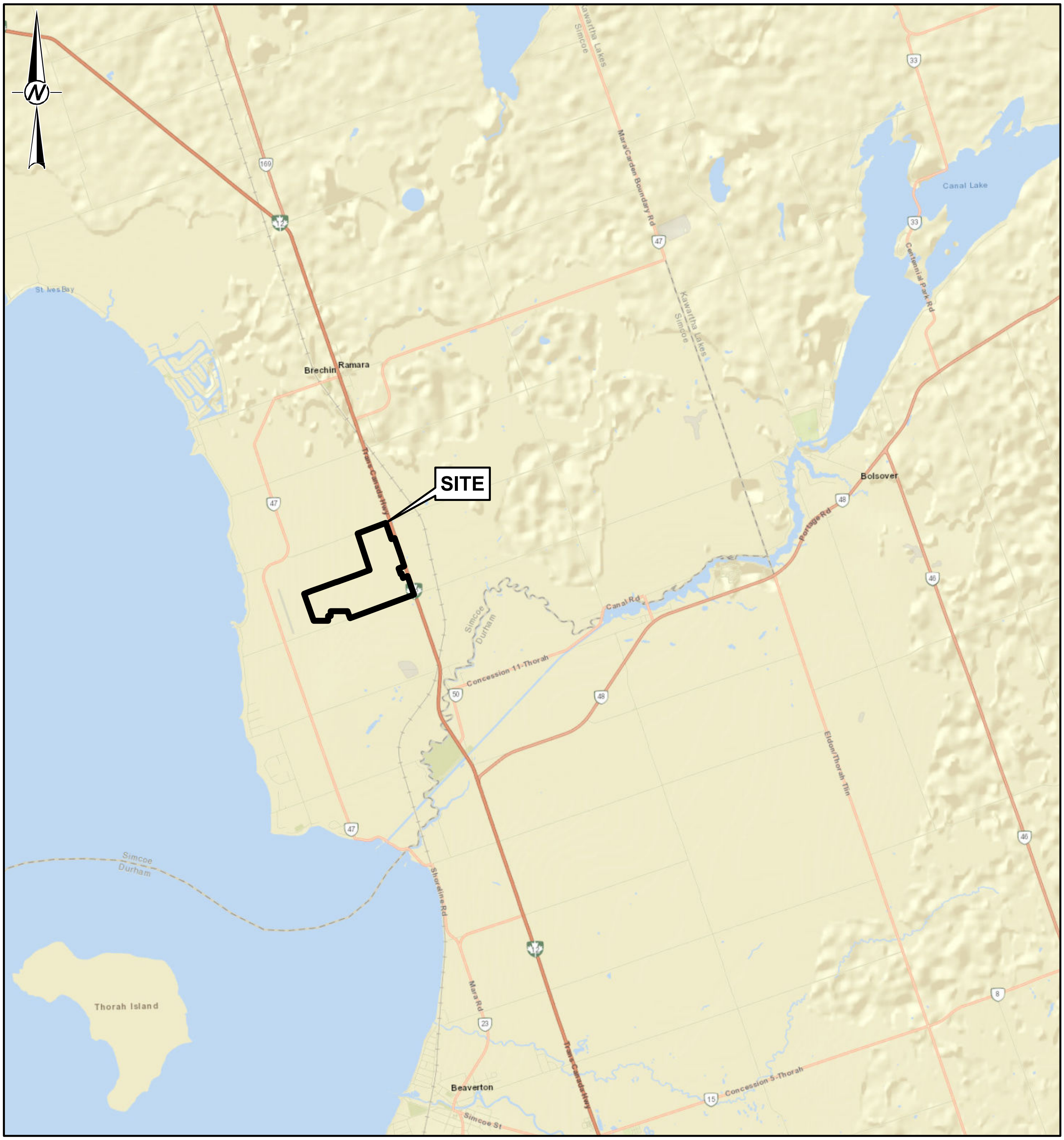
Azimuth Environmental Consulting Inc., 2022. *RE: LCP Groundwater Level Monitoring Data*, Received by Kris Marentette August 18, 2022.

Azimuth Environmental Consulting Inc., 2023. Level 1 and 2 Hydrogeological and Hydrological Assessment, Proposed Brechin Quarry, Township of Ramara, County of Simcoe. Prepared for LCP Quarry Limited. December 2023.

Golder Associates Ltd., 2012. *Cumulative Impacts Assessment for Groundwater Takings in the Carden Plain Area,* September 2012.

Golder Associates Ltd., 2021. *Geological Study, Talisker Corporation Proposed Brechin Quarry, Township of Ramara, Ontario*" June 2021 (Rev. 1).

Niswonger, R.G., Panday, S., and M. Ibaraki, 2011. MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6–A37, 44 p.



LEGEND

▭ PROPOSED LCP BRECHIN QUARRY LICENCE BOUNDARY

0 1,000 2,000 4,000

1:100,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: ESRI, HERE, GARMIN, NGA, USGS, NPS, NRCAN
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
LCP QUARRY LIMITED

PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT, LCP PROPOSED BRECHIN QUARRY

TITLE
KEY PLAN

CONSULTANT

YYYY-MM-DD	2023-12-12
DESIGNED	----
PREPARED	JEM
REVIEWED	JPAO
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
19122839	0004	0	1

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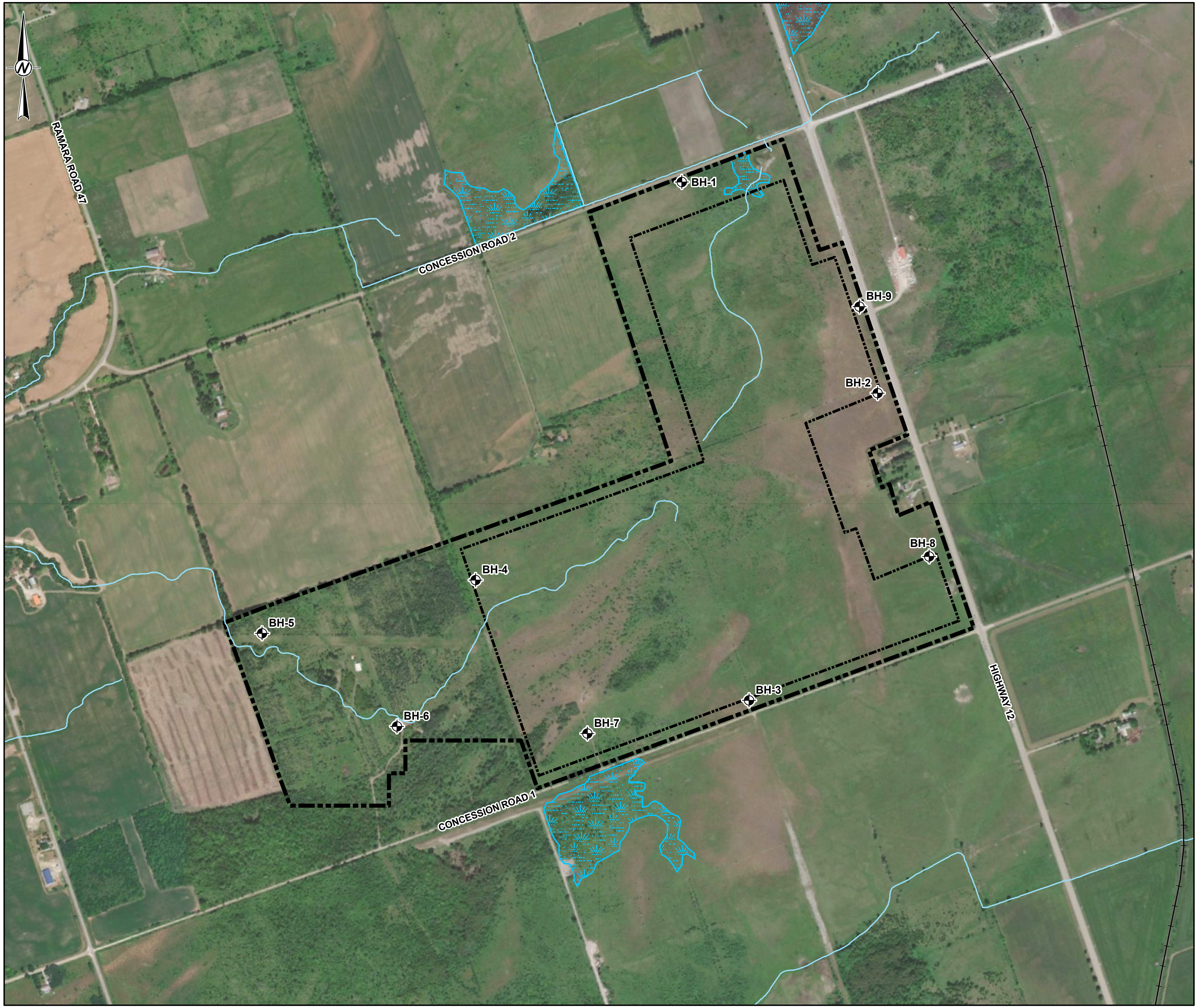
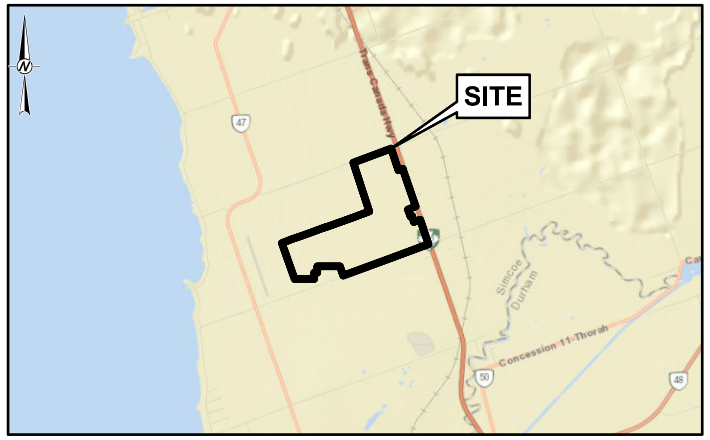


KEY MAP



SCALE: 1:100,000

LEGEND

⊕ APPROXIMATE BOREHOLE LOCATION

┼ RAILWAY

— WATERCOURSE

▨ WETLAND

▭ PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT

▭ PROPOSED LCP BRECHIN QUARRY LICENCE BOUNDARY

0 100 200 400

1:10,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: ESRI, HERE, GARMIN, INCREMENT P, NGA, USGS, NRCAN, MAXAR
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
LCP QUARRY LIMITED

PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT, LCP PROPOSED BRECHIN QUARRY

TITLE
SITE PLAN

CONSULTANT

YYYY-MM-DD	2023-12-12
DESIGNED	----
PREPARED	JEM/BR
REVIEWED	JPAO
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
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25mm
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LEGEND

●	ASSUMED PRIVATE WELL LOCATION
●	WATER WELL LOCATION (MECP WWIS)
┼	RAILWAY
🟧	JAMES DICK GAMEBRIDGE QUARRY LICENCE BOUNDARY
🟥	LAFARGE BRECHIN QUARRY LICENCE BOUNDARY
▭	PROPOSED LCP BRECHIN QUARRY LICENCE BOUNDARY

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: MAXAR
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT

LCP QUARRY LIMTED

PROJECT

GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT, LCP PROPOSED BRECHIN QUARRY

TITLE

LOCAL SETTING

CONSULTANT

wsp

YYYY-MM-DD	2023-12-12
DESIGNED	----
PREPARED	JEM/BR
REVIEWED	JPAO
APPROVED	KAM

PROJECT NO.	CONTROL	REV.	FIGURE
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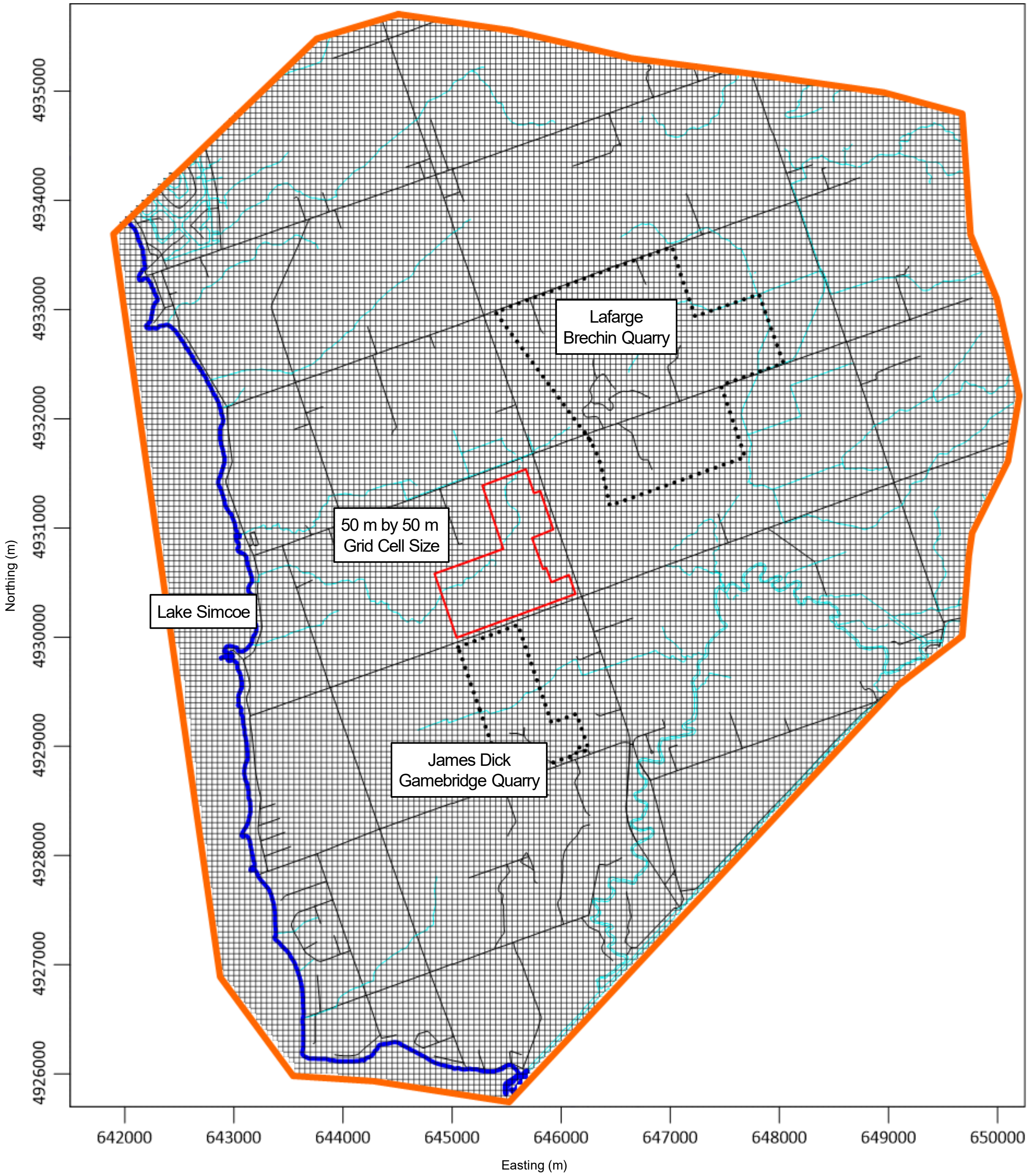

LEGEND

🟧	MODEL DOMAIN
🟦	SHORELINE
—	WATERCOURSE
—	ROADS
🟥	PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯⋯	APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)

Notes

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. 17 model layers
3. 403,376 total active grid blocks

CLIENT
LCP QUARRY LIMITED

PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT
wsp

YYYY-MM-DD	2023-03-22
PREPARED	SPS
DESIGN	SPS
REVIEW	JPAO
APPROVED	JPAO

TITLE
MODEL GRID

PROJECT No.	PHASE	Rev.	FIGURE
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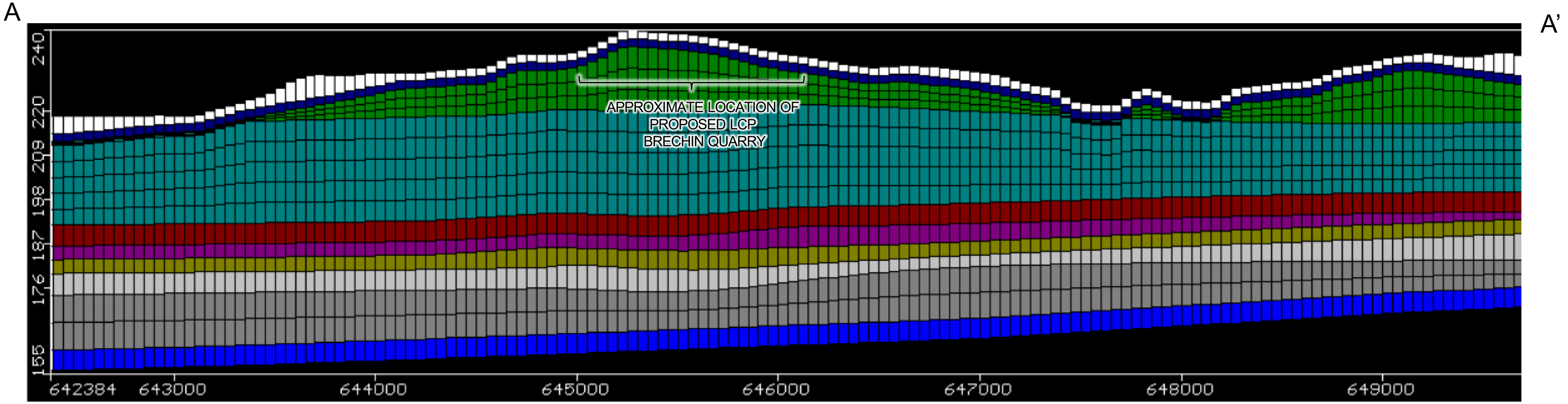
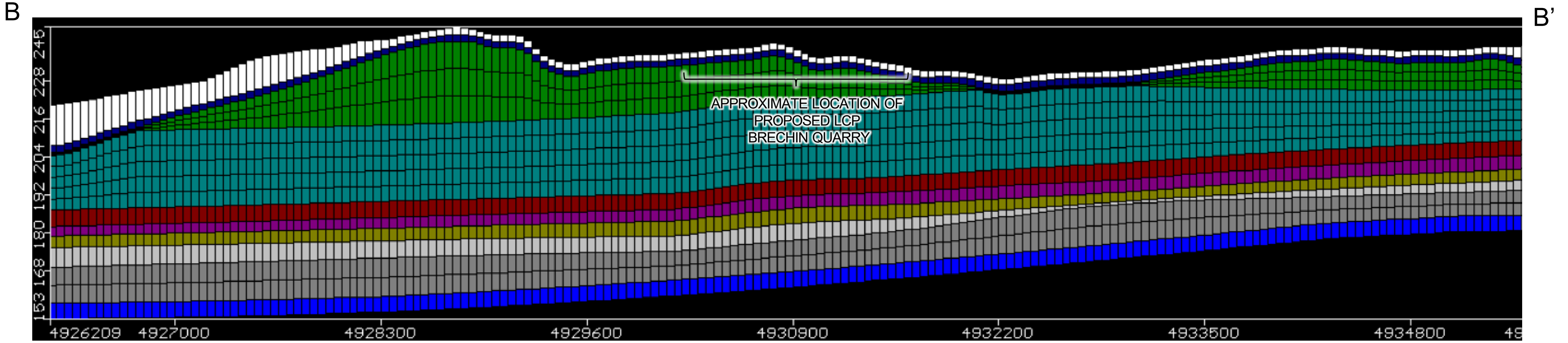
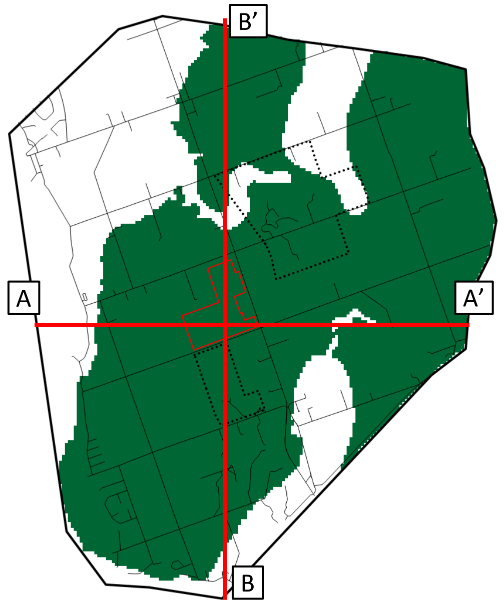






KEY MAP

Notes

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Hydraulic conductivity presented is the horizontal hydraulic conductivity (K_H). Vertical hydraulic conductivity for all units is $0.05{*}K_H$.
3. Key map shows the presence of the Verulam Formation (green) in plan. Other hydrostratigraphic units are present across entire model domain.

HYDROSTRATIGRAPHIC UNITS

⬜ Overburden ($2\text{x}10^{-5}$ m/s)
🟦 Upper Weathered Zone ($1\text{x}10^{-4}$ m/s)
🟩 Verulam Formation ($1\text{x}10^{-8}$ m/s)
🟦 Bobcaygeon Formation ($1\text{x}10^{-8}$ m/s)
🟥 Gull River Formation Unit 4 ($1\text{x}10^{-9}$ m/s)
🟪 Gull River Formation Unit 3 ($1\text{x}10^{-6}$ m/s)
🟨 Gull River Formation Unit 2 ($1\text{x}10^{-8}$ m/s)
⬜ Gull River Formation Unit 1 ($5\text{x}10^{-7}$) m/s
⬛ Shadow Lake Formation ($5\text{x}10^{-7}$ m/s)
🟦 Shadow Lake / Precambrian Contact Zone ($5\text{x}10^{-7}$ m/s)

CLIENT
LCP QUARRY LIMITED

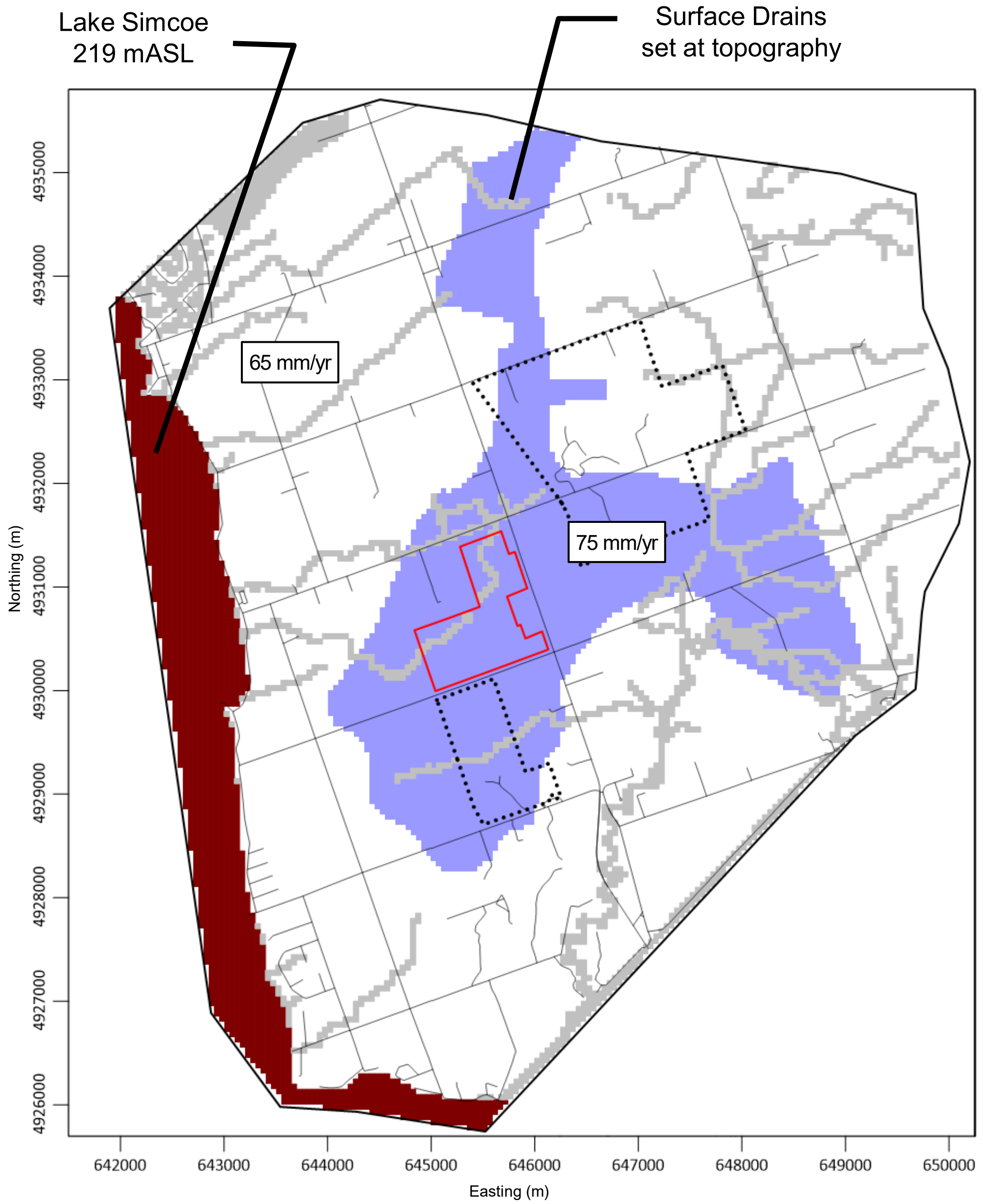
CONSULTANT
wsp

YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

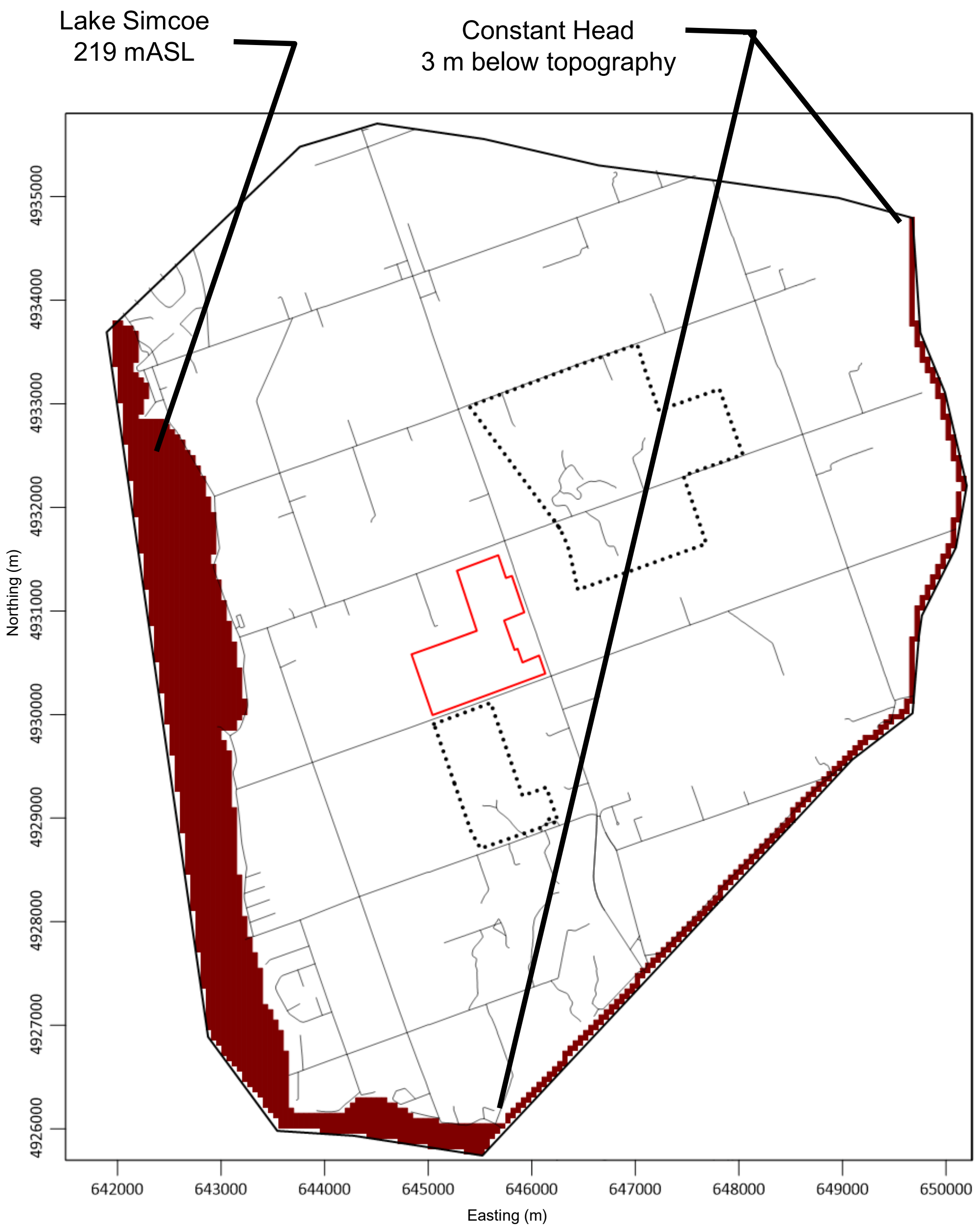
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
MODEL HYDRAULIC CONDUCTIVITY AND CROSS-SECTIONS

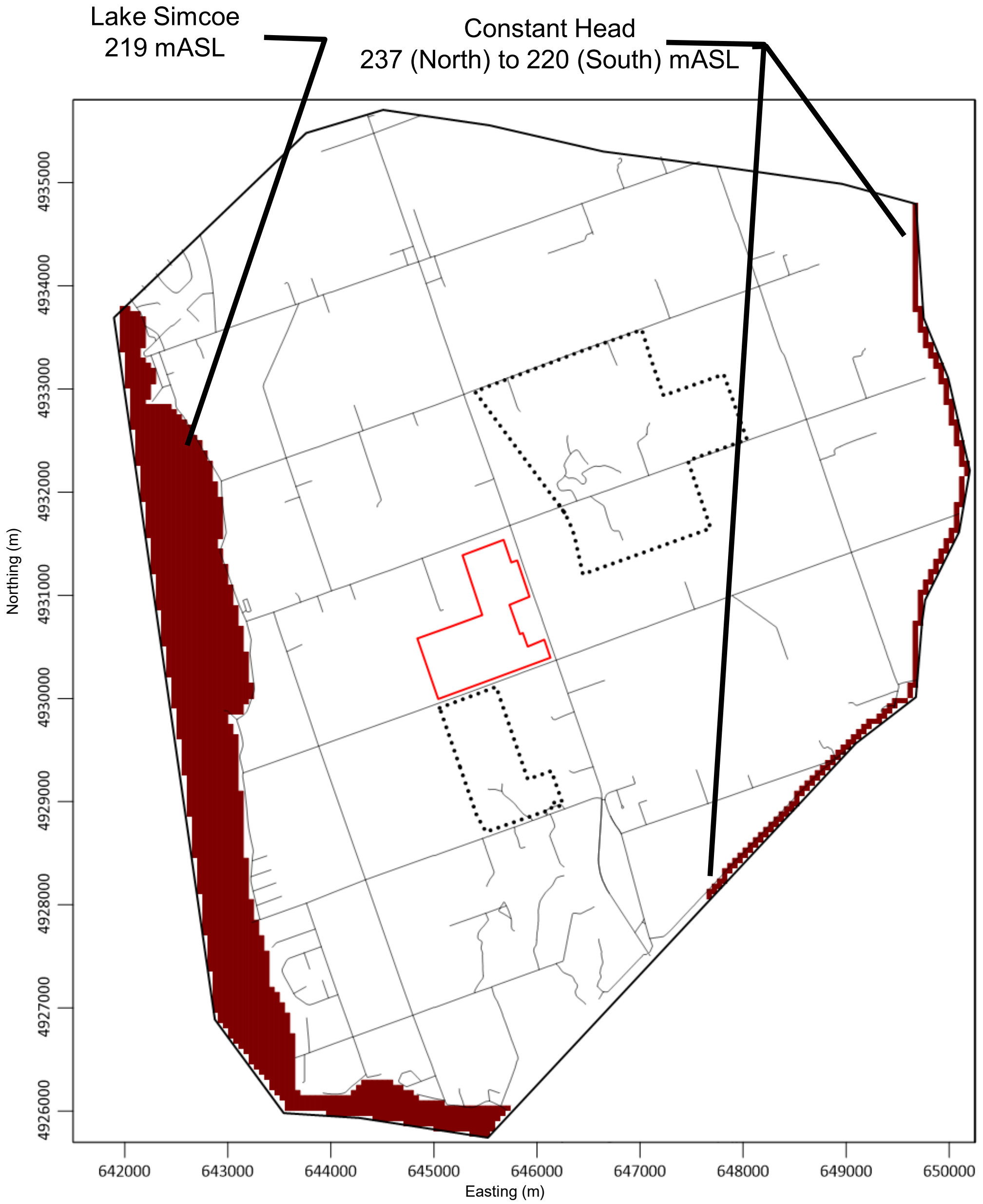
PROJECT NO. 19122839
REV.
FIGURE 5



Layer 1 (Overburden) Boundaries



Layer 2 (Weathered Bedrock) Boundaries



Layer 12 to 17 (Gull River Unit 3 and Below) Boundaries

LEGEND

— ROADS
— PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯ APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
▨ MODEL DRAIN BOUNDARY
🟥 MODEL CONSTANT HEAD BOUNDARY
🟦 RECHARGE ZONE

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Lake Simcoe constant head boundary set in all layers (layer 1 to 17), and other boundaries set only in layers specified

CLIENT
LCP QUARRY LIMITED

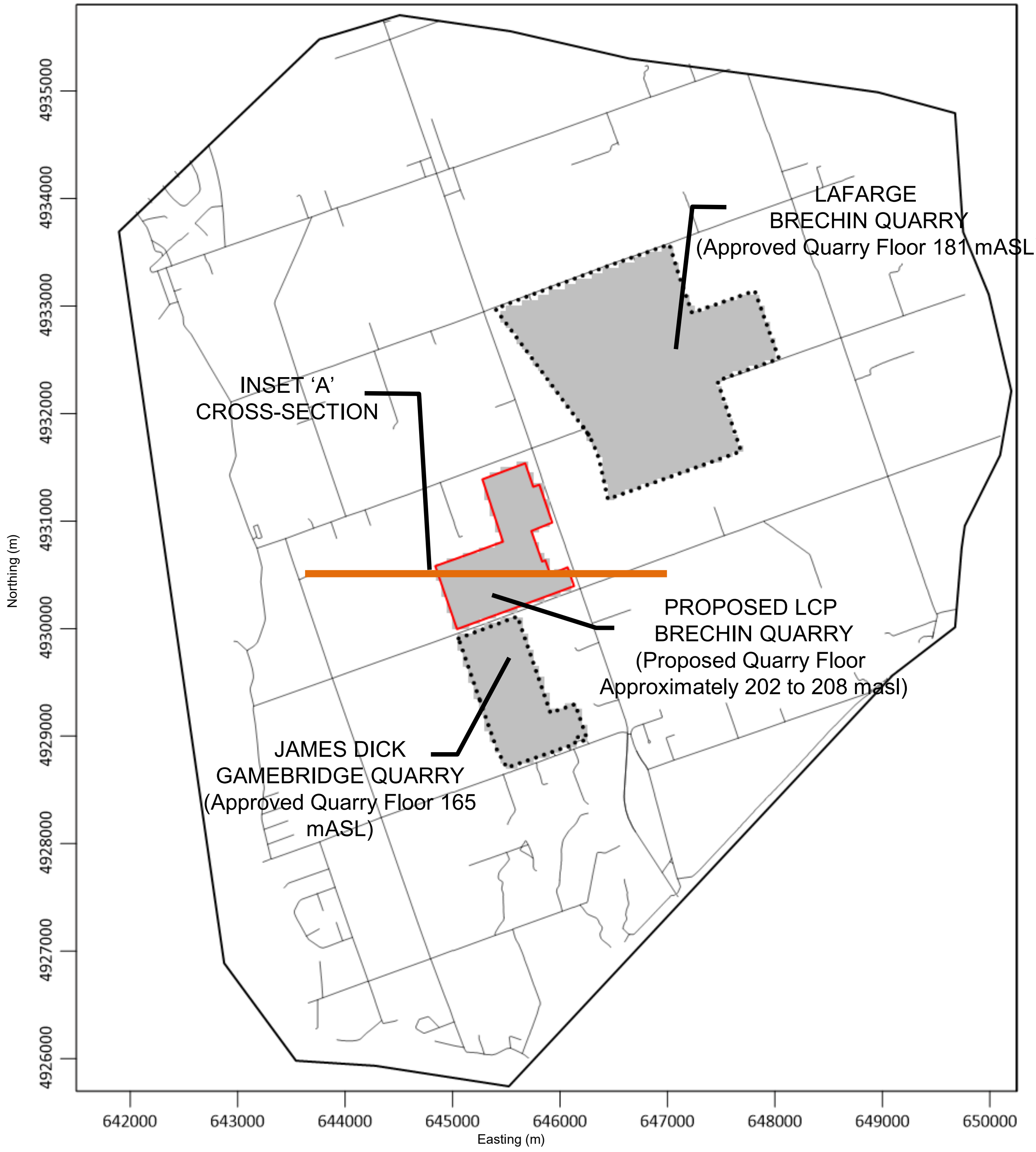
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT
wsp

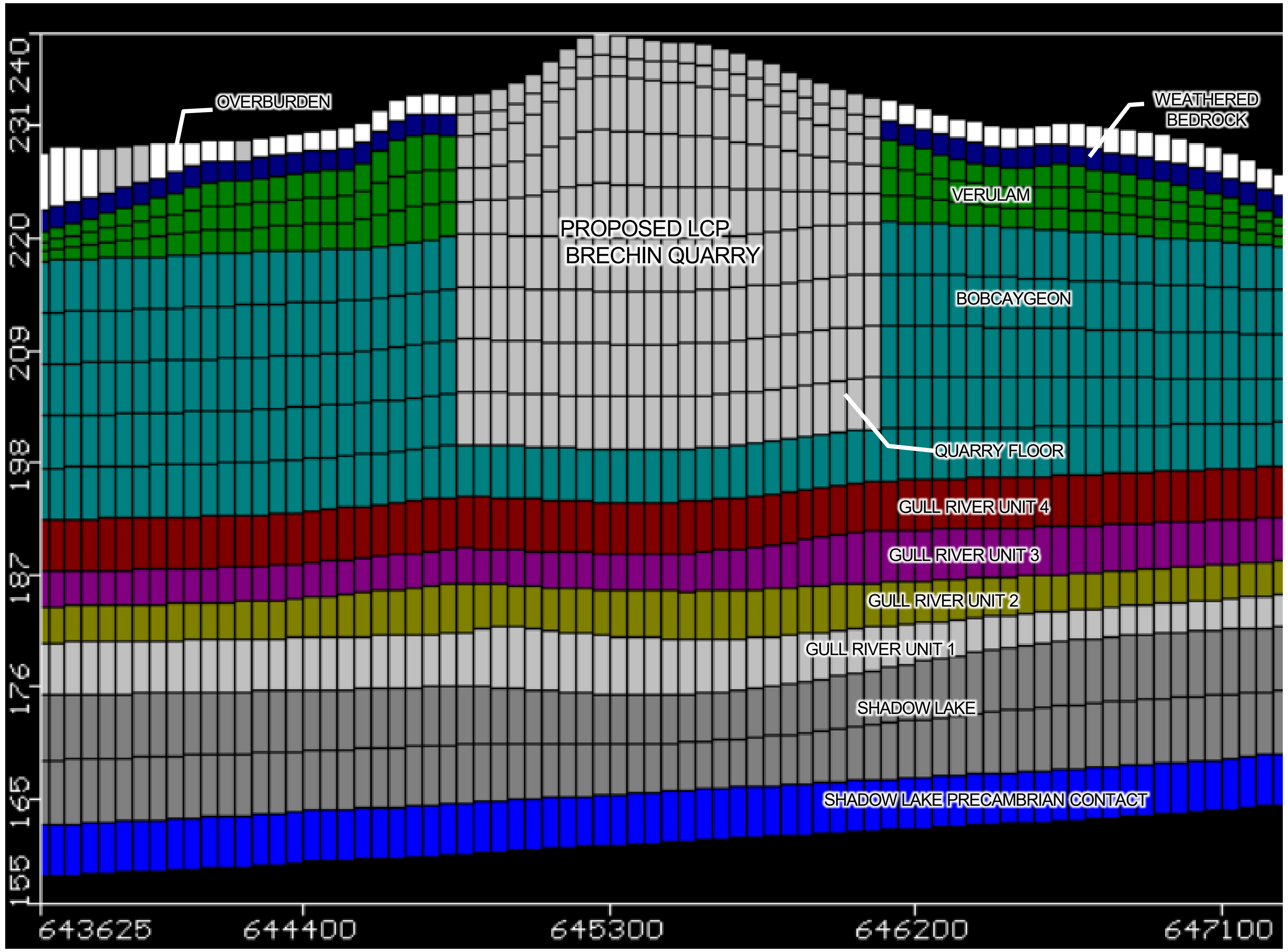
YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

TITLE
MODEL BOUNDARY CONDITIONS

PROJECT NO. 19122839
REV.
FIGURE 6



PLAN VIEW OF STUDY AREA



INSET 'A' CROSS-SECTION

LEGEND

— ROADS
— PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯ APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
▨ MODEL DRAIN BOUNDARY (FULL QUARRY DEVELOPMENT)

Notes

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Elevations specified are final approved quarry floor elevations which were used in forecast scenarios. Existing conditions (calibrated model) used approximate current extraction areas for quarries.

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PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT

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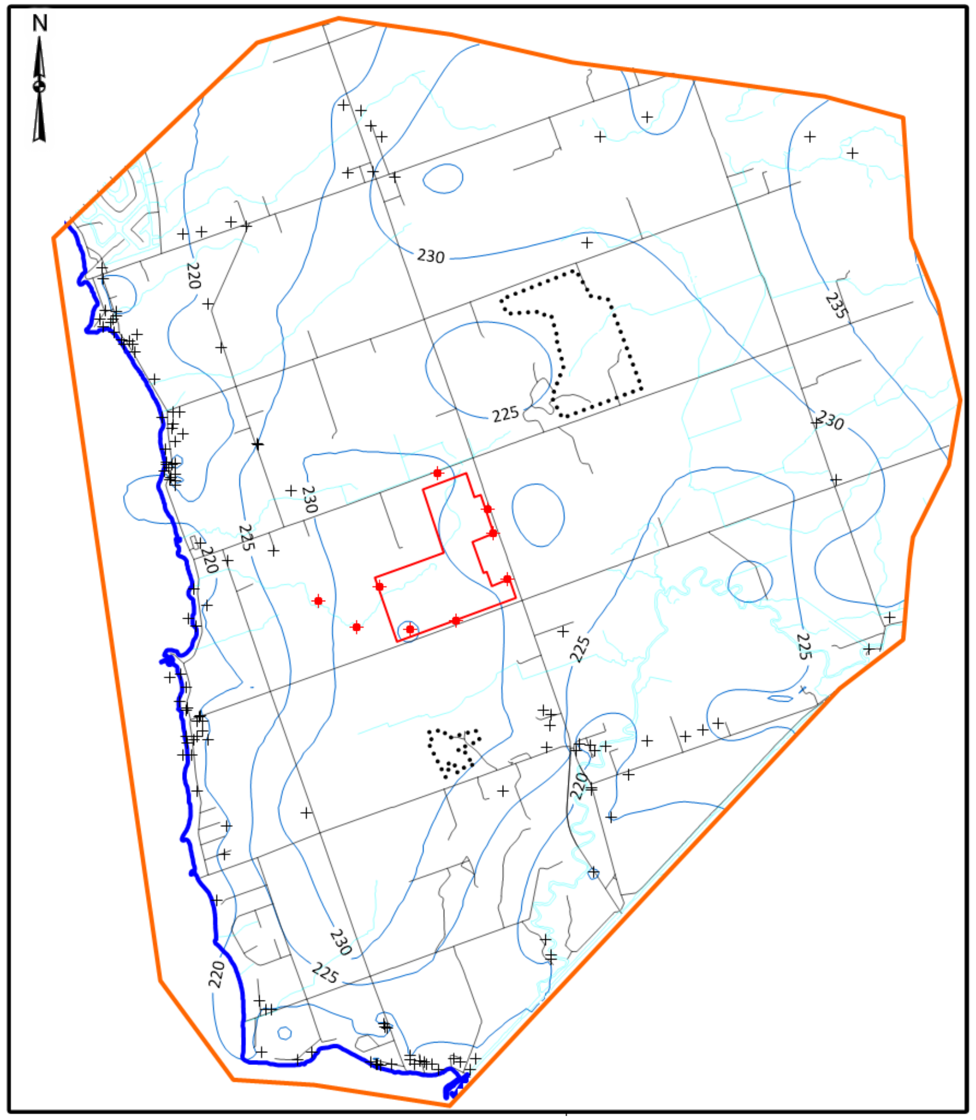
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

TITLE
MODEL QUARRY BOUNDARIES

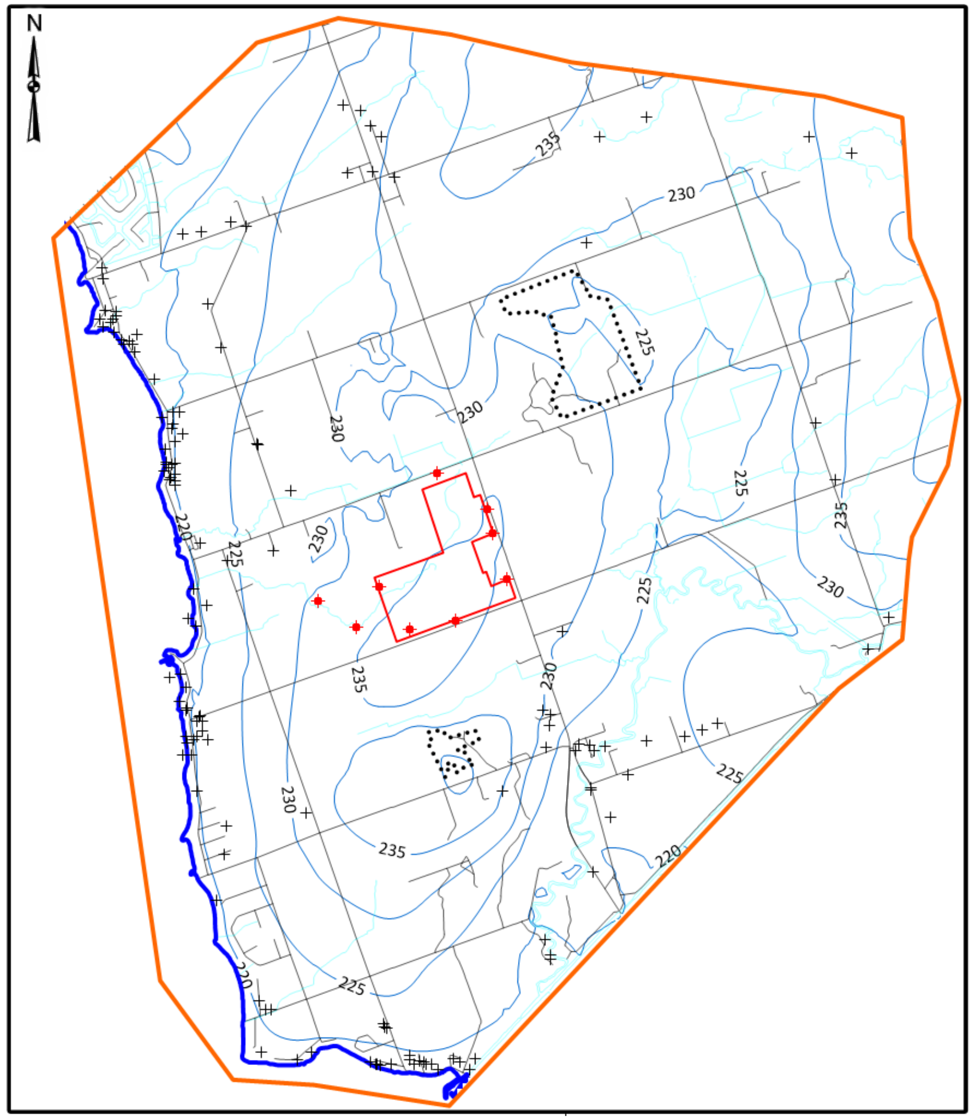
PROJECT NO.
19122839

REV.

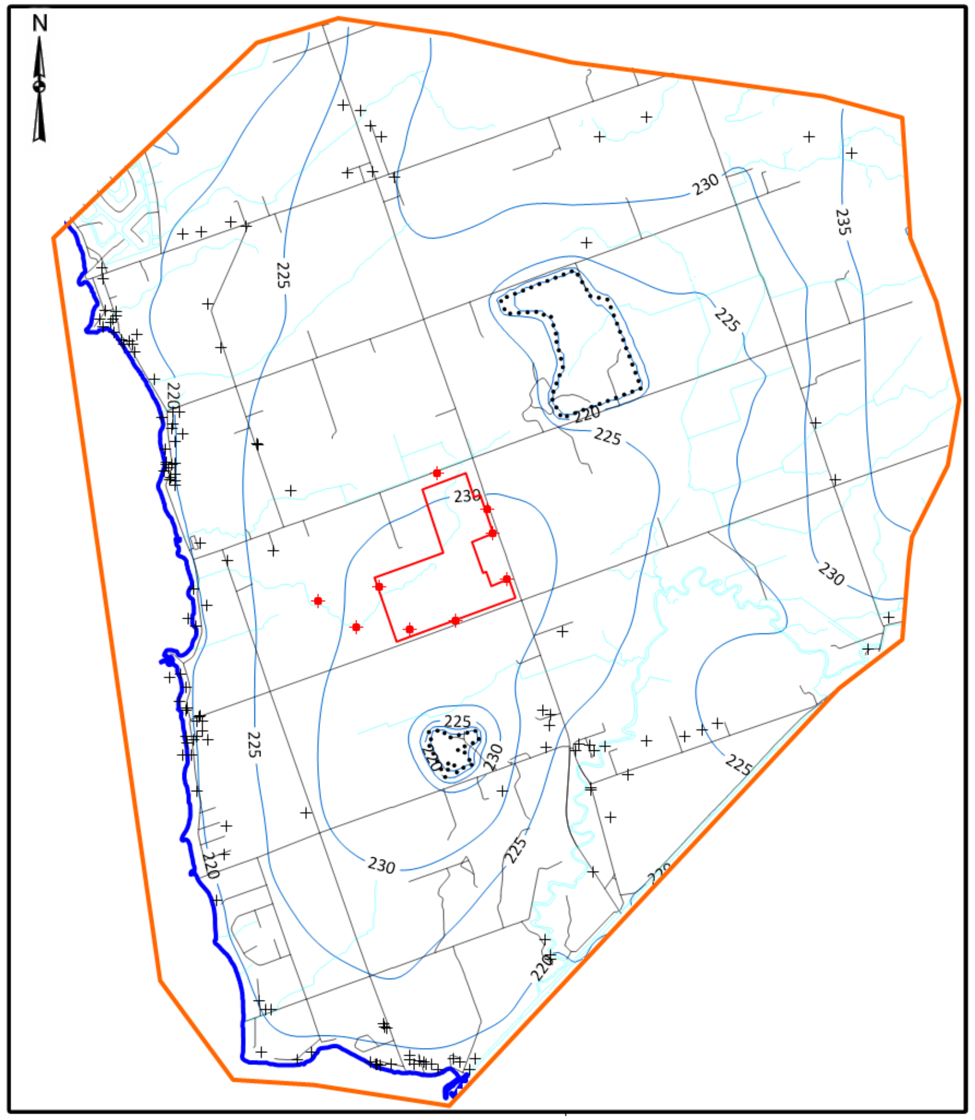
FIGURE
7



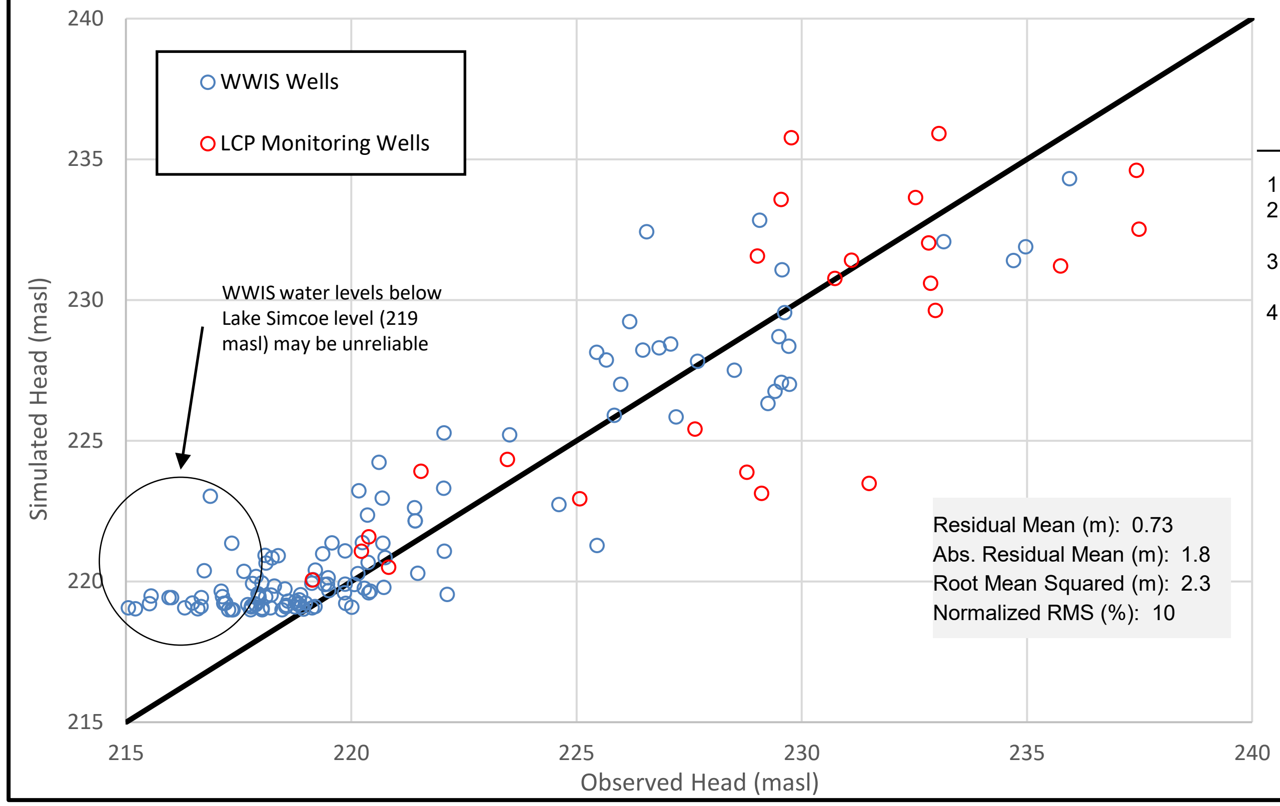
OBSERVED WWIS WELL AND SHALLOW MONITORING WELL HEAD ELEVATION



NUMERICAL MODEL SIMULATED WATER TABLE ELEVATION



NUMERICAL MODEL SIMULATED BOBCAYGEON (LAYER 8) HEAD ELEVATION



NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. LCP Monitoring Well water levels from July 2022 provided by Azimuth (2022)
3. WWIS Wells water levels from MECP water well database (WWIS) accessed in 2022.
4. Shallow monitoring well head elevation represents the water levels in the LCP monitoring wells completed in the Bobcaygeon Formation and above.

LEGEND

— ROADS
— PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯ EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
— MODEL DOMAIN
— SHORELINE
— WATERCOURSE
— ROADS
- 100 - GROUNDWATER ELEVATION CONTOUR (m)
✦ LCP MONITORING WELL LOCATION
+ WATER WELL LOCATION (MECP WWIS)

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REVIEWED	JPAO
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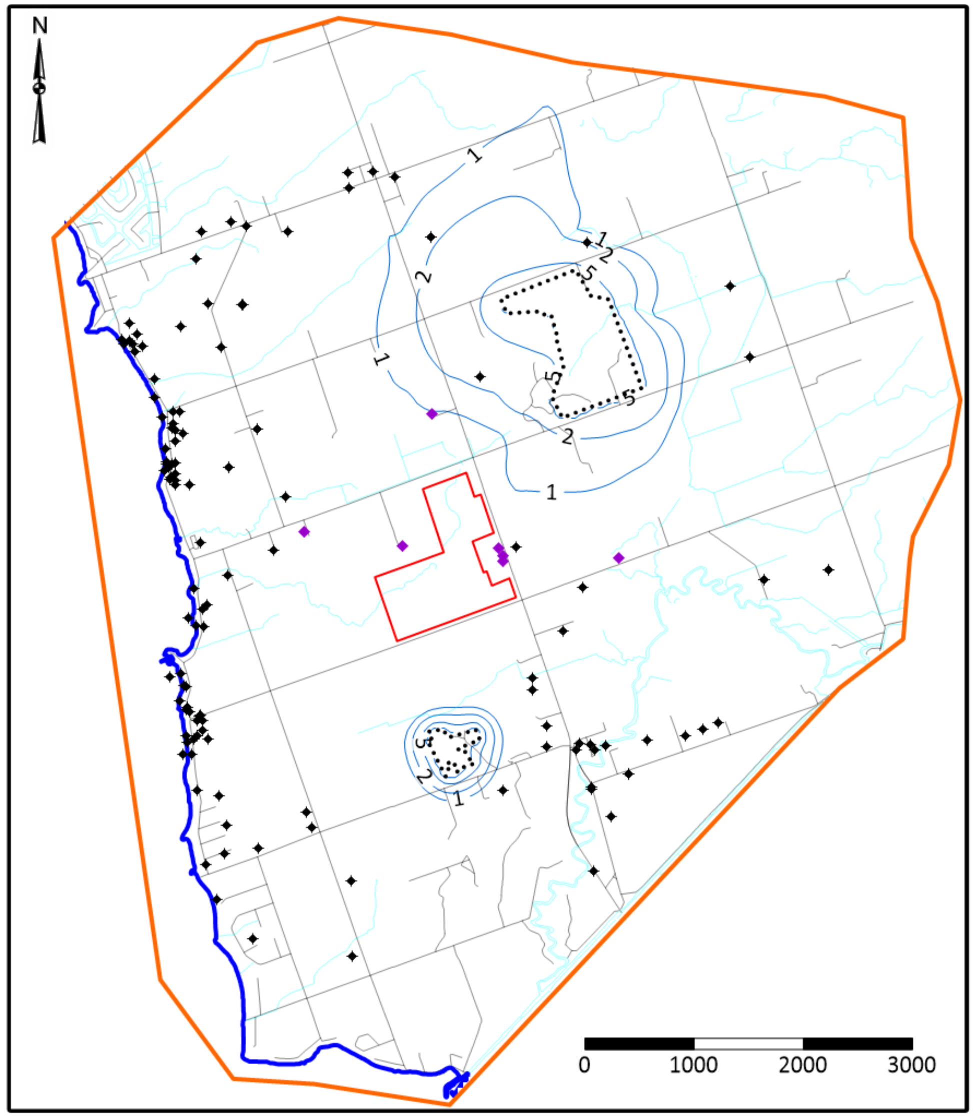
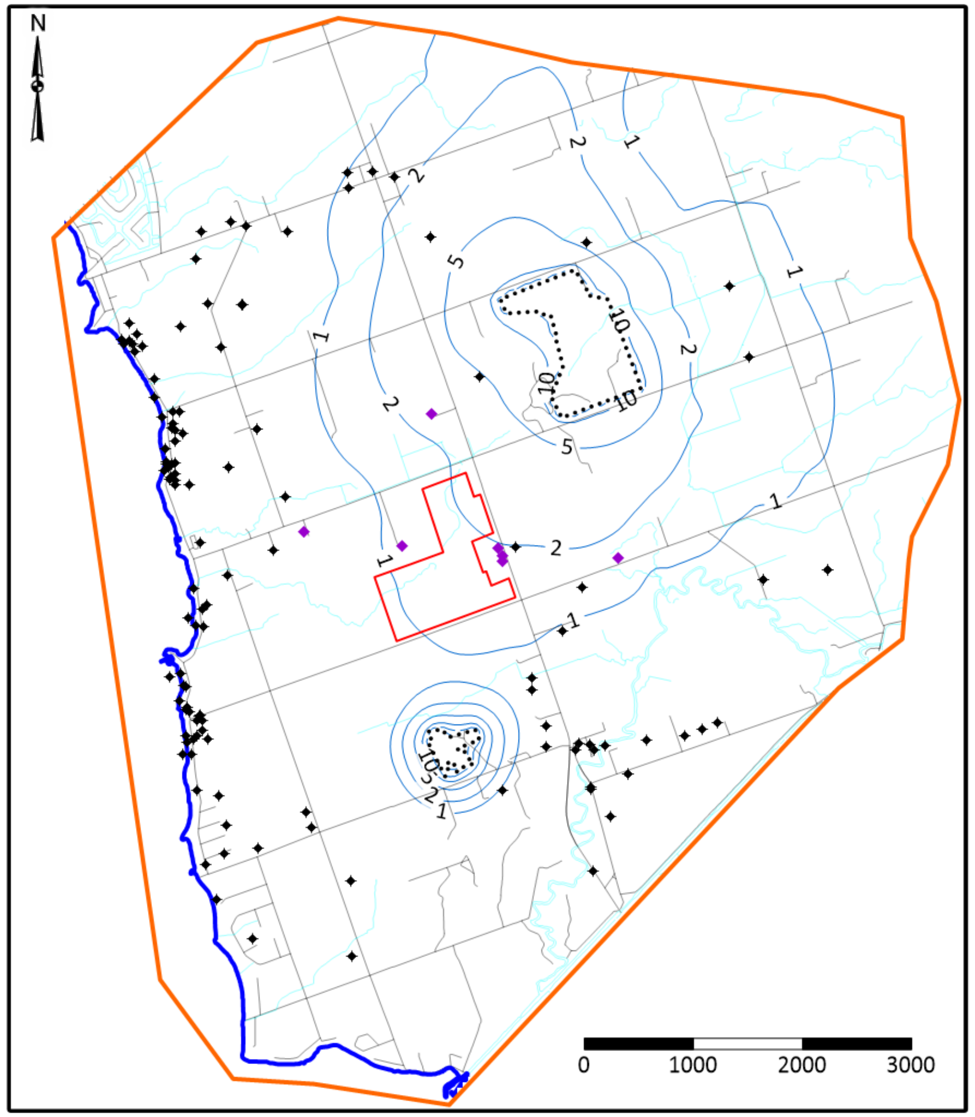
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
MEASURED AND SIMULATED GROUNDWATER ELEVATION CONTOURS UNDER SCENARIO 0
(EXISTING CONDITIONS - CALIBRATION)

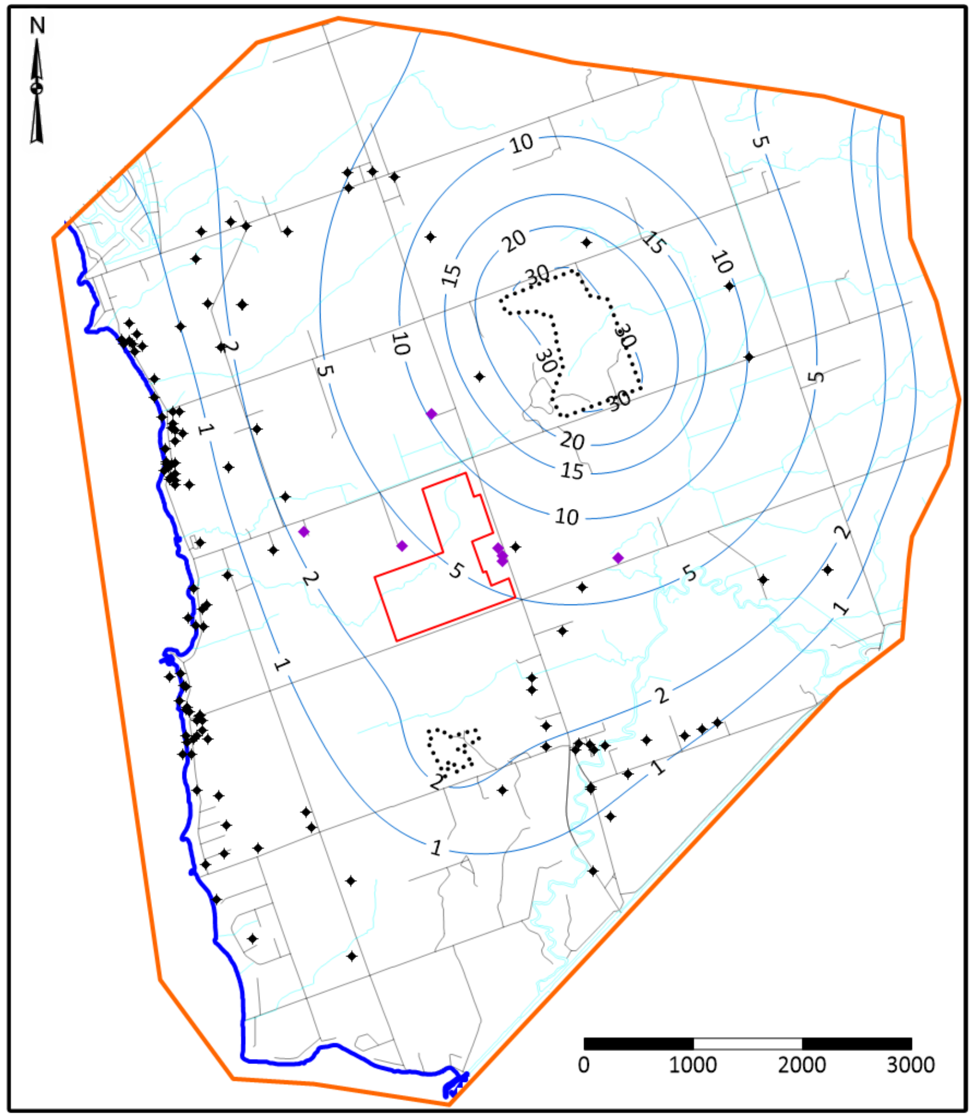
PROJECT NO. 19122839
REV.
FIGURE 8



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

- MODEL DOMAIN
- SHORELINE
- WATERCOURSE
- ROADS
- PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
- EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
- –1– SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
- ✦ WATER WELL LOCATION (MECP WWIS)
- ◆ ASSUMED PRIVATE WELL LOCATION

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LCP QUARRY LIMITED

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PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

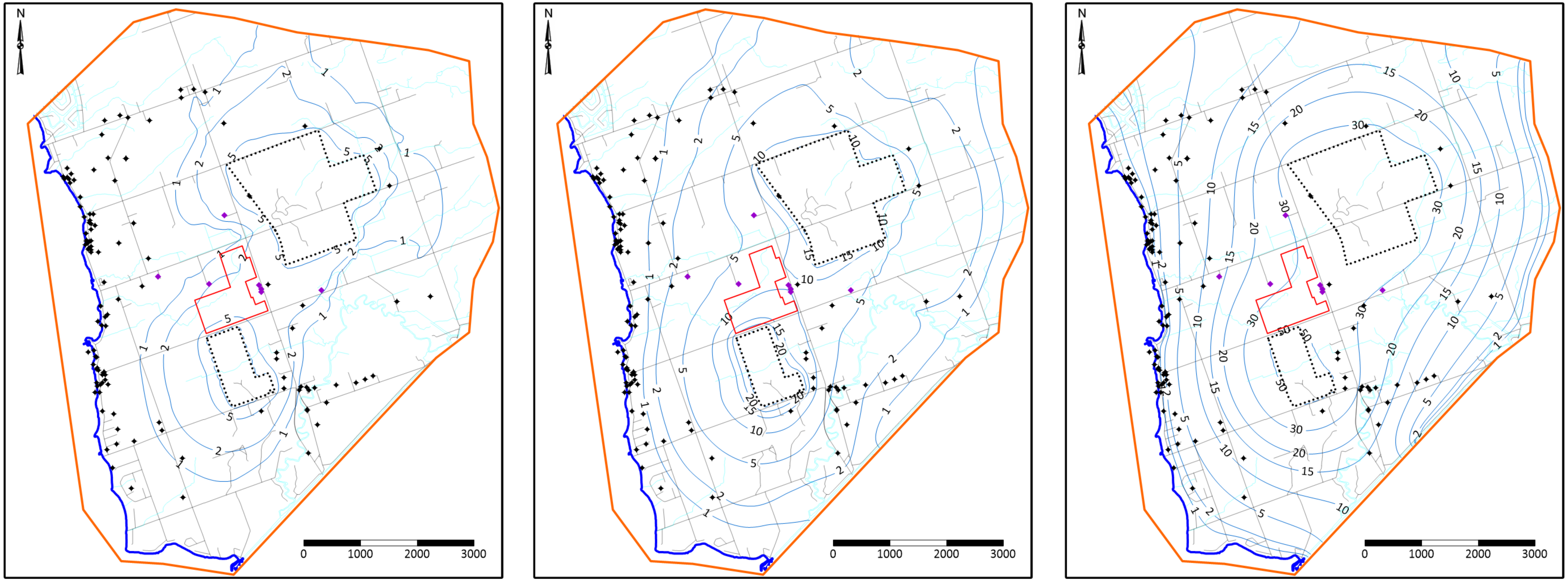
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
SIMULATED GROUNDWATER DRAWDOWN – SCENARIO 0 (EXISTING CONDITIONS) COMPARED TO PREDEVELOPMENT CONDITION

PROJECT NO.
19122839

REV.

FIGURE
9



VERULAM FORMATION (LAYER 4)

BOBCAYGEON FORMATION (LAYER 8)

GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

━ MODEL DOMAIN
━ SHORELINE
━ WATERCOURSE
━ ROADS
━ PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
┅ APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
–1– SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
✦ WATER WELL LOCATION (MECP WWIS)
◆ ASSUMED PRIVATE WELL LOCATION

CLIENT
LCP QUARRY LIMITED

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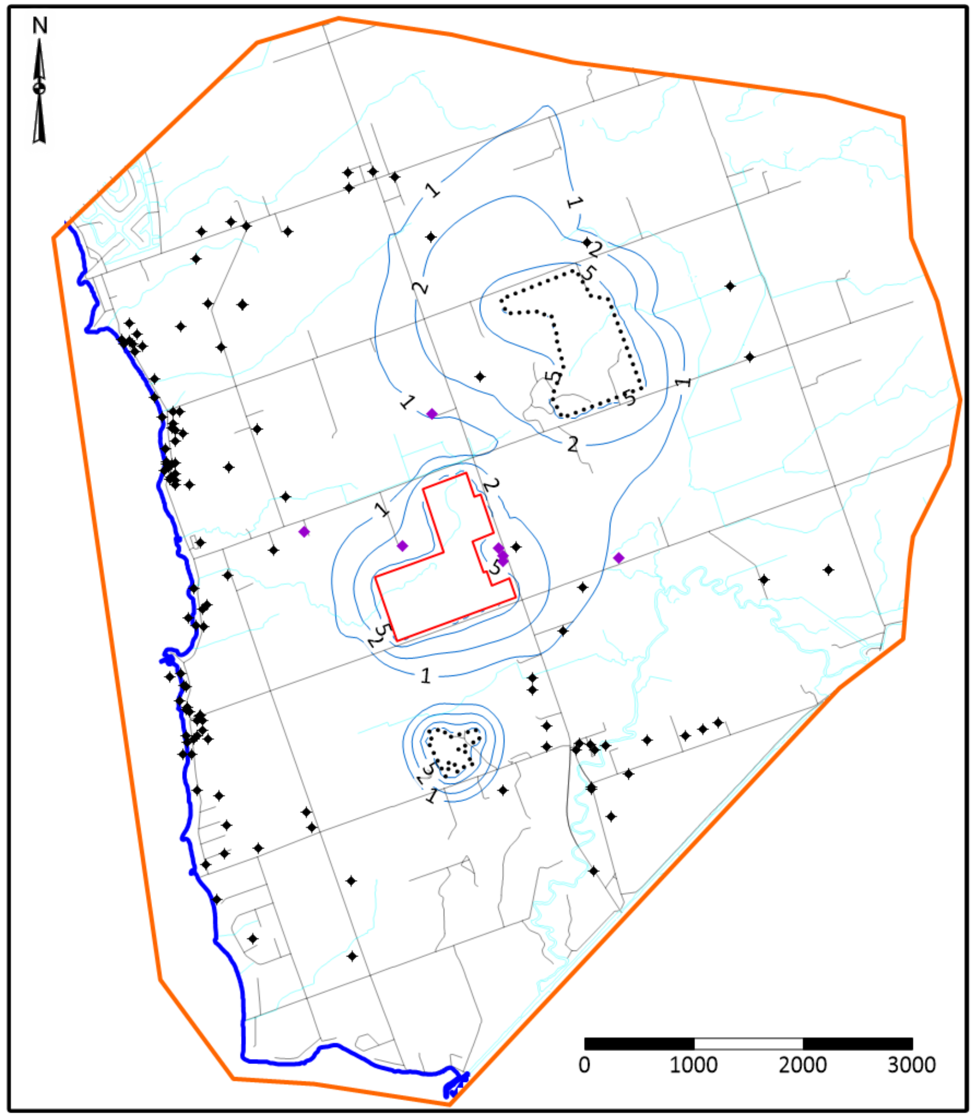
YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

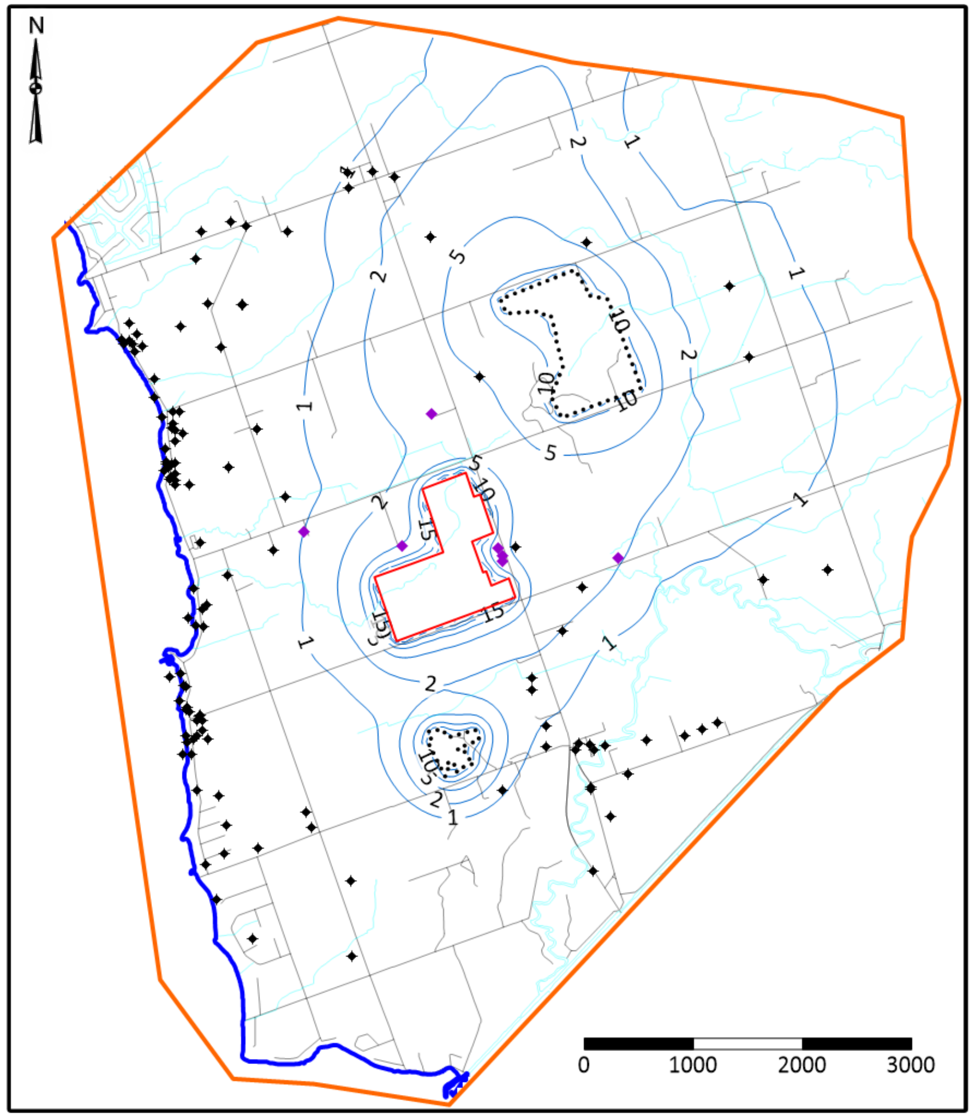
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
SIMULATED GROUNDWATER DRAWDOWN – SCENARIO 1
(OTHER QUARRIES AT FULL DEVELOPMENT WITH NO LCP)
COMPARED TO PREDEVELOPMENT CONDITION

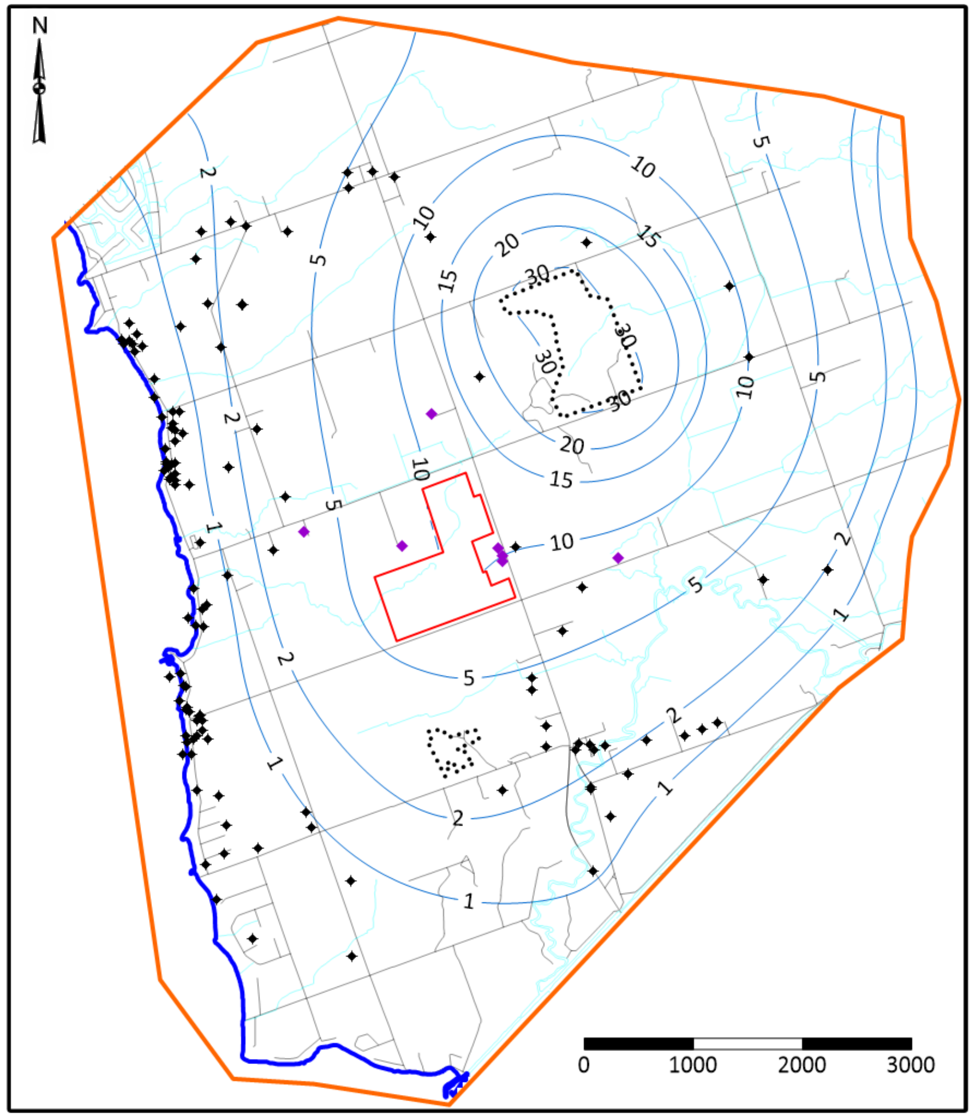
PROJECT NO.	REV.	FIGURE
19122839		10



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

— MODEL DOMAIN
— SHORELINE
— WATERCOURSE
— ROADS
— PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯⋯ EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
–1– SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
✦ WATER WELL LOCATION (MECP WWIS)
◆ ASSUMED PRIVATE WELL LOCATION

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LCP QUARRY LIMITED

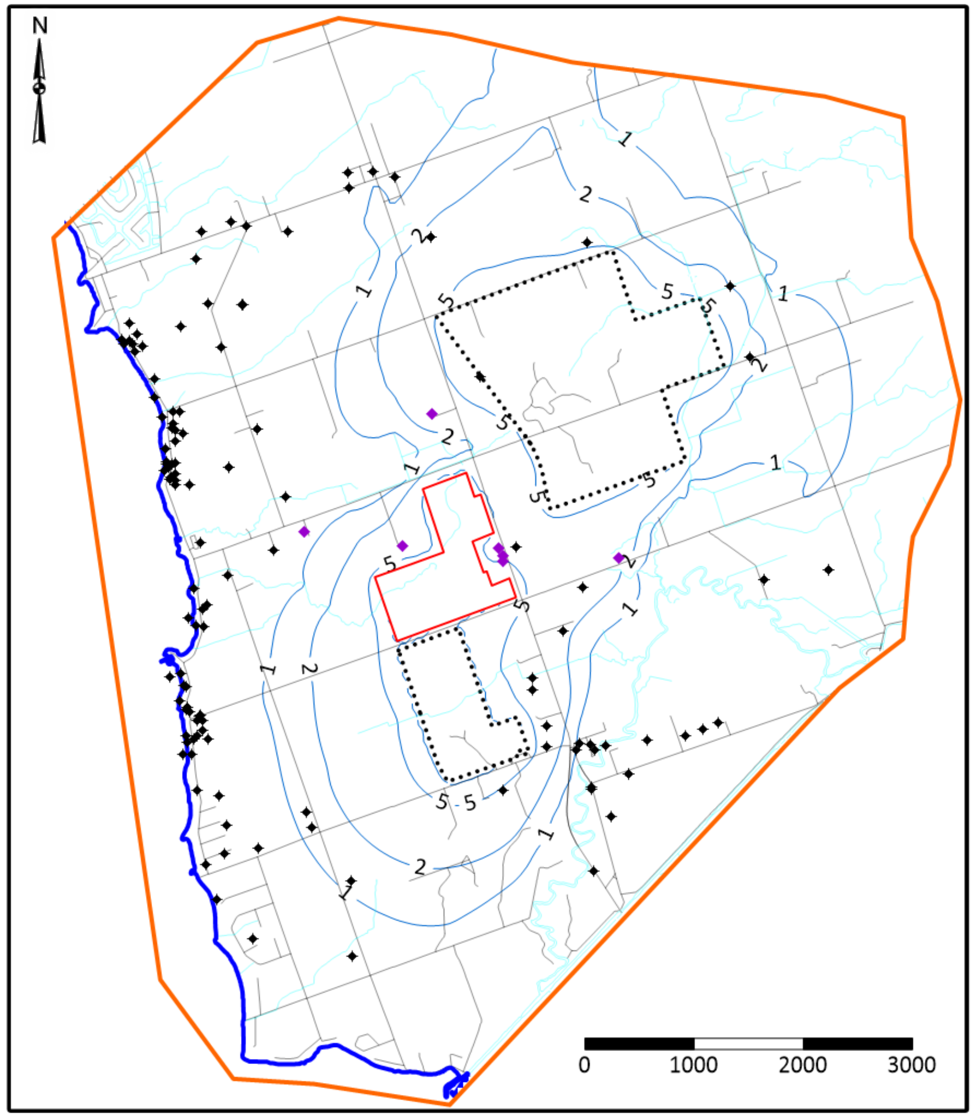
CONSULTANT

YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

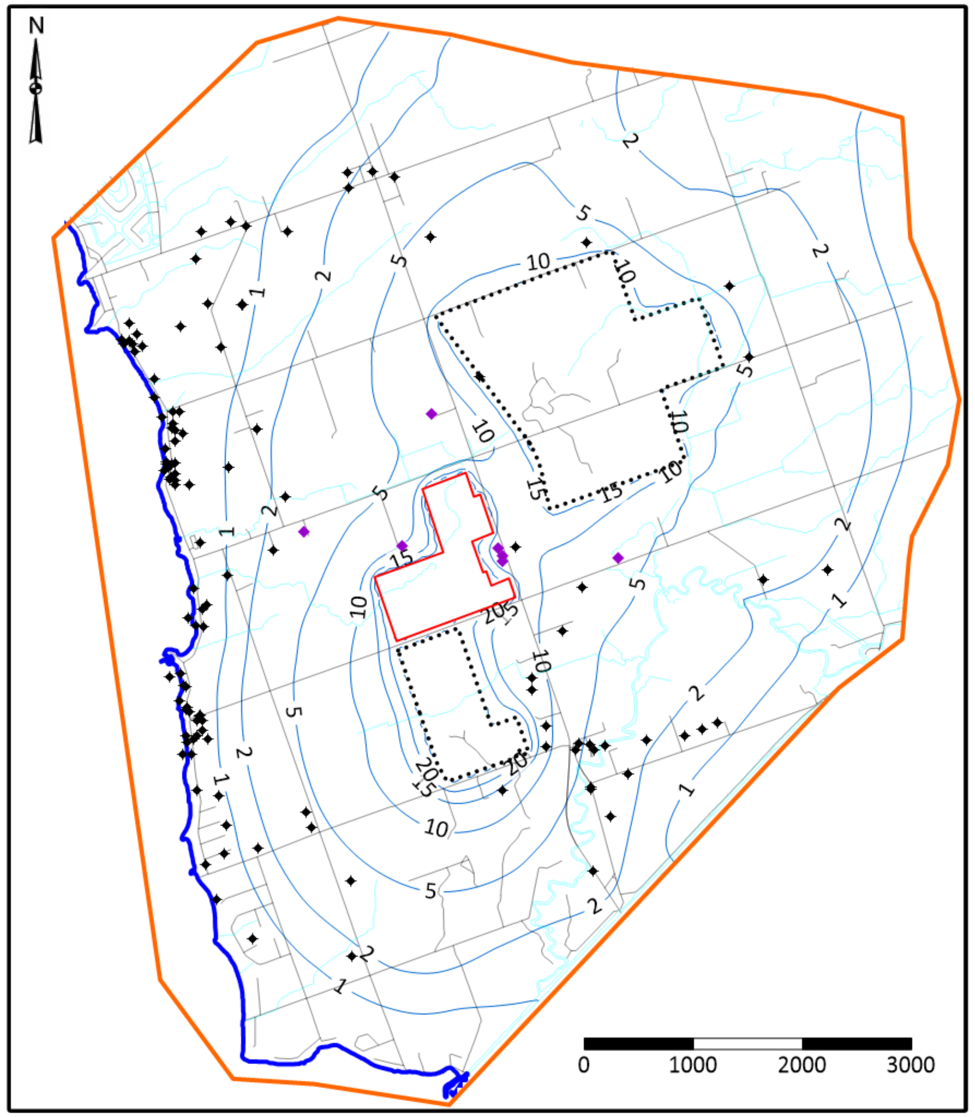
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
SIMULATED GROUNDWATER DRAWDOWN – SCENARIO 2 (LCP FULL DEVELOPMENT OTHER QUARRIES AT EXISTING CONDITIONS) COMPARED TO PREDEVELOPMENT CONDITION

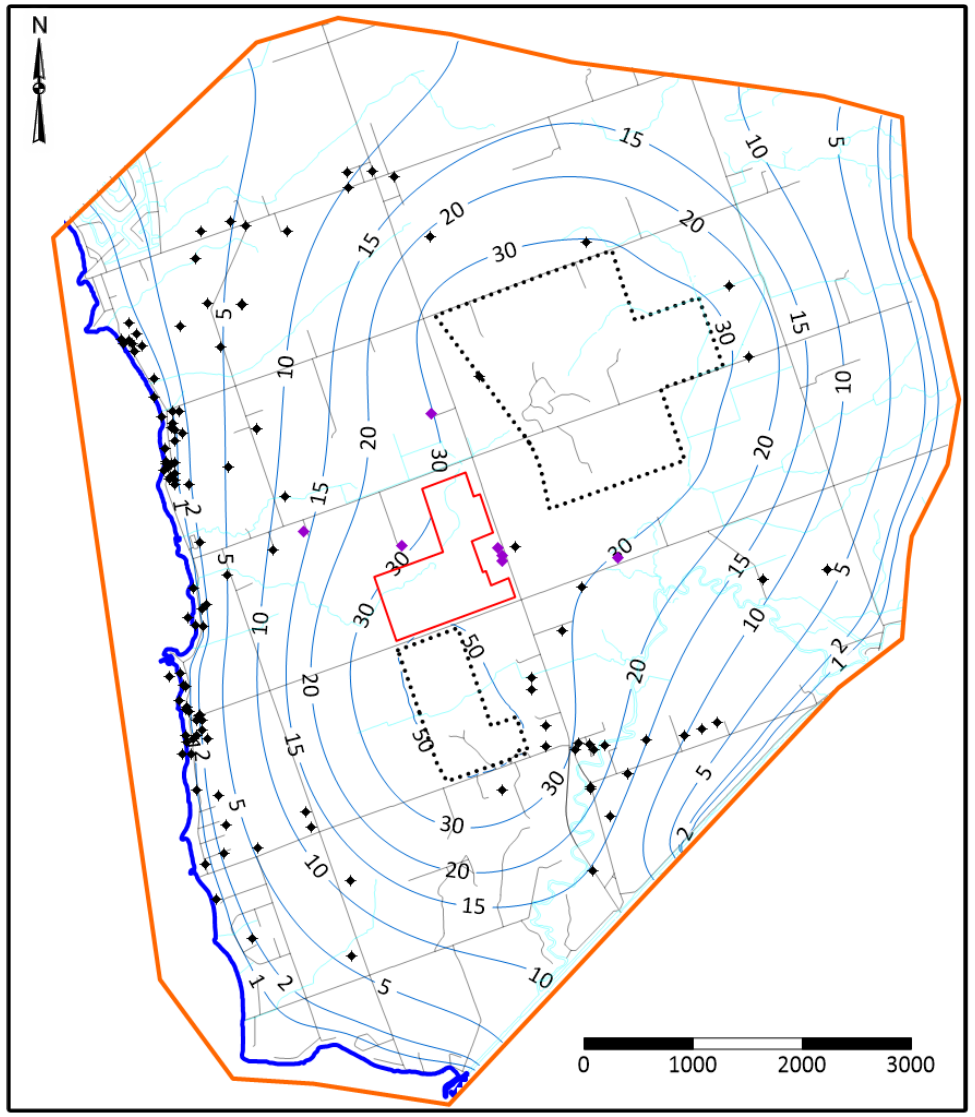
PROJECT NO. 19122839
REV.
FIGURE 11



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

- MODEL DOMAIN
- SHORELINE
- WATERCOURSE
- ROADS
- PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
- APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
- SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
- ✦ WATER WELL LOCATION (MECP WWIS)
- ◆ ASSUMED PRIVATE WELL LOCATION

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CONSULTANT
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YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

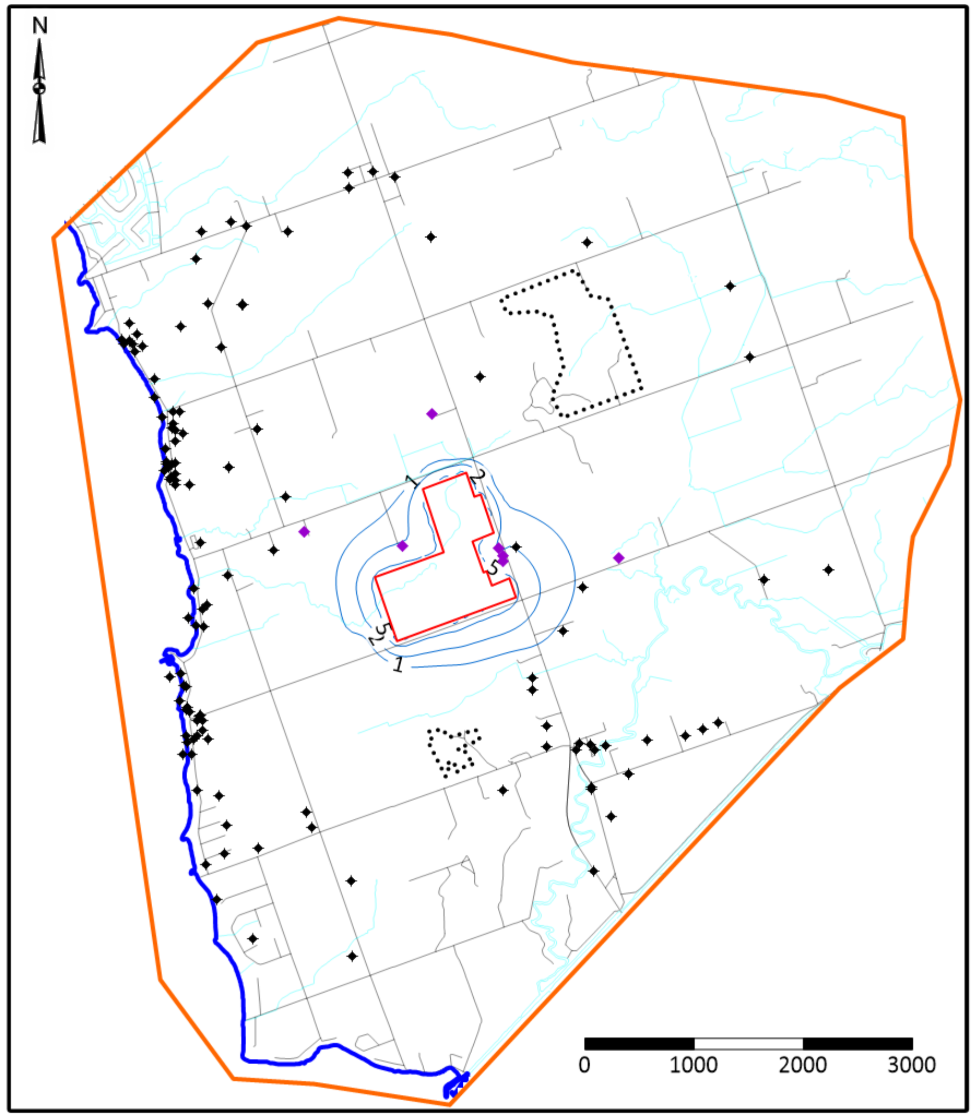
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
SIMULATED GROUNDWATER DRAWDOWN – SCENARIO 3 (ALL QUARRIES AT FULL DEVELOPMENT) COMPARED TO PREDEVELOPMENT CONDITION

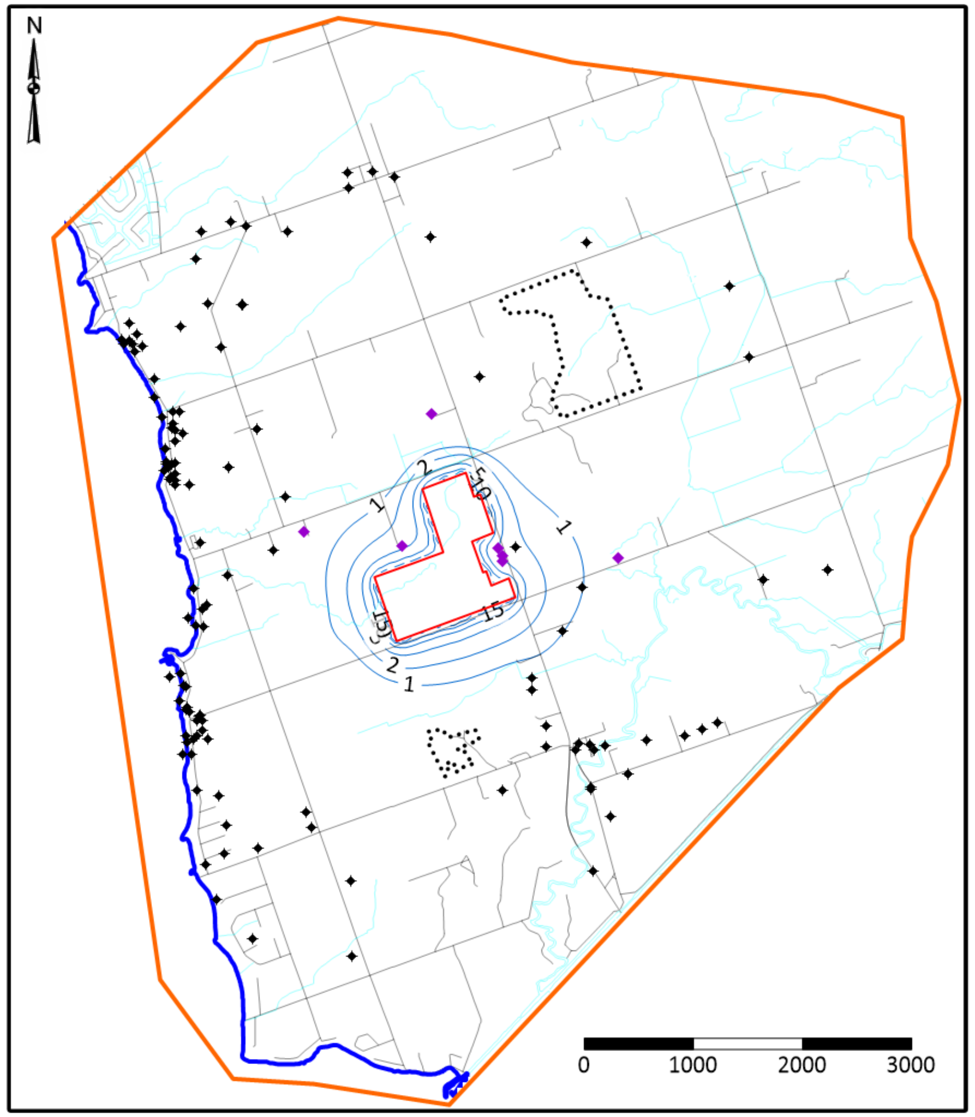
PROJECT NO.
19122839

REV.

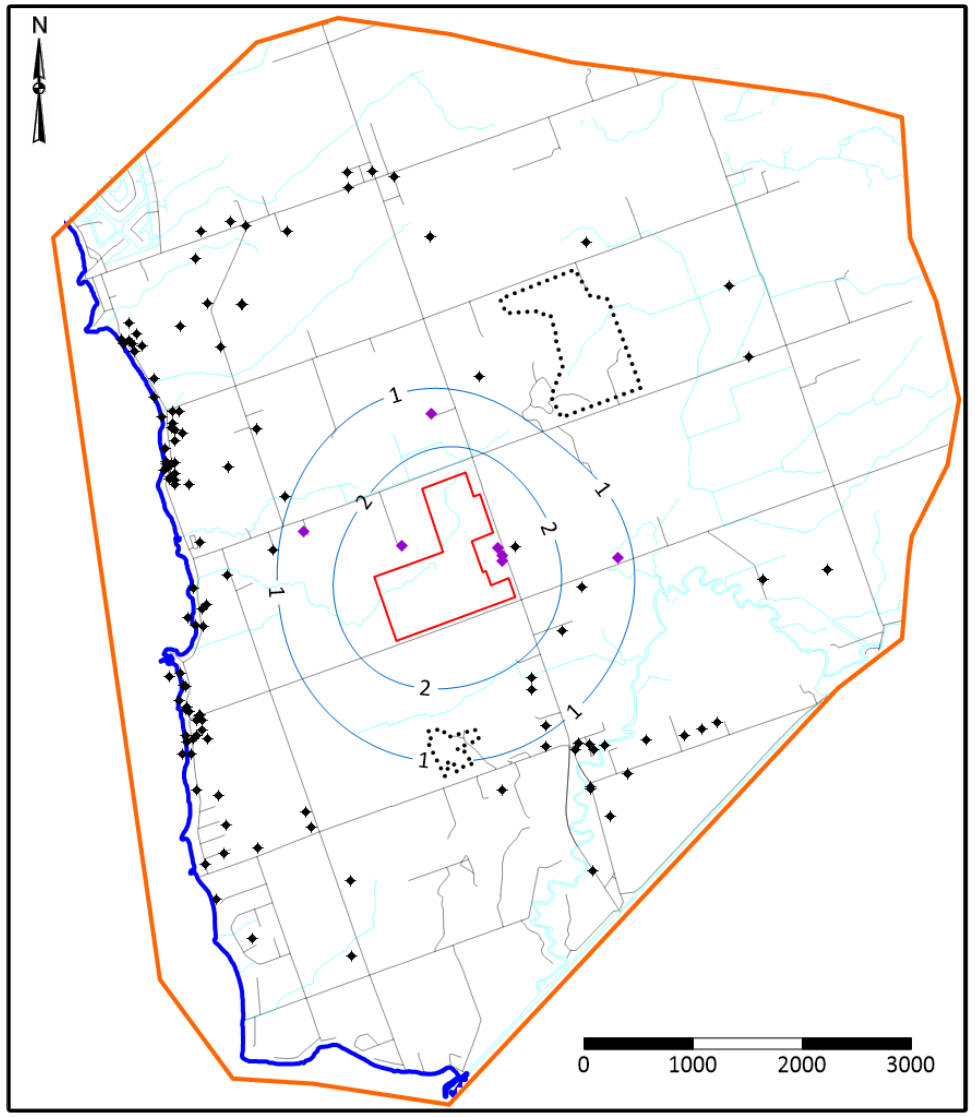
FIGURE
12



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

━	MODEL DOMAIN
━	SHORELINE
━	WATERCOURSE
━	ROADS
━	PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
┅	EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
–1–	SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
✦	WATER WELL LOCATION (MECP WWIS)
◆	ASSUMED PRIVATE WELL LOCATION

CLIENT
LCP QUARRY LIMITED

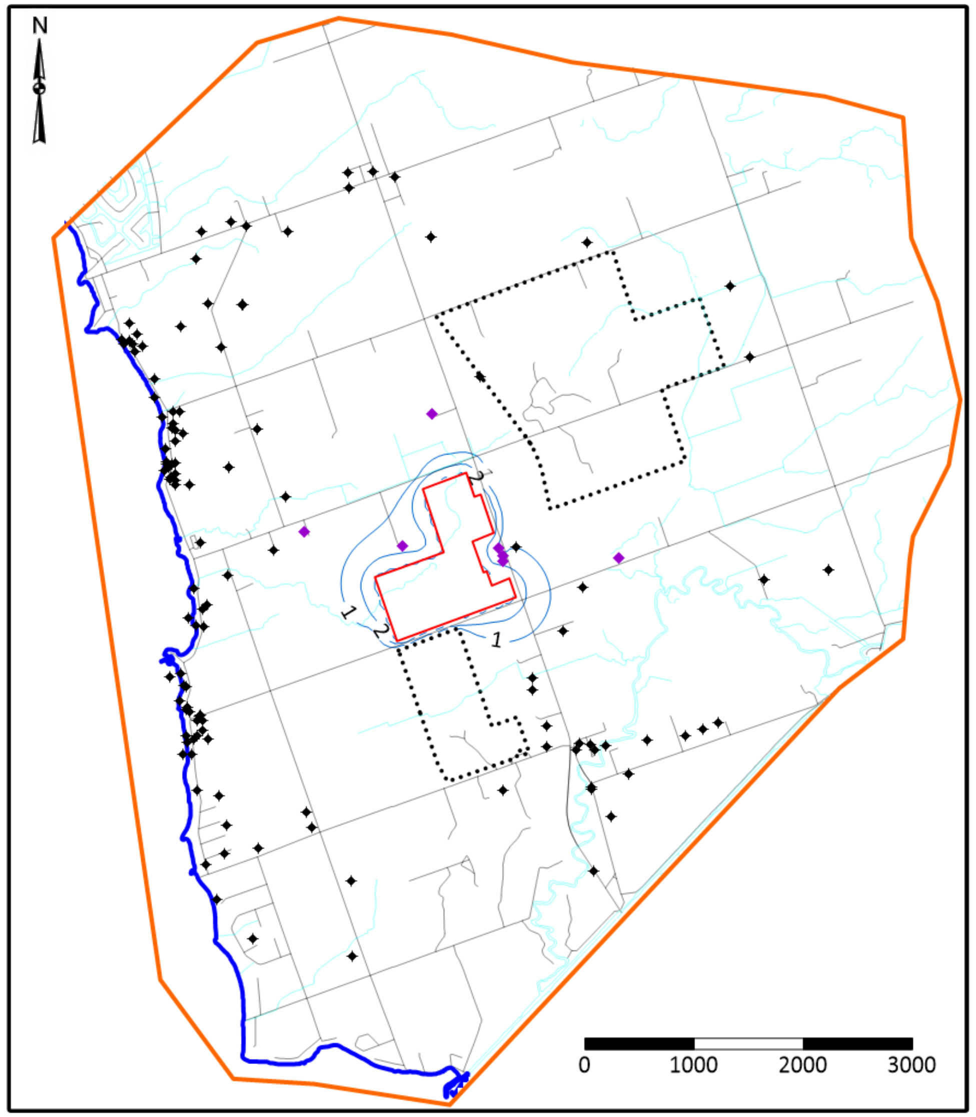
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT
wsp

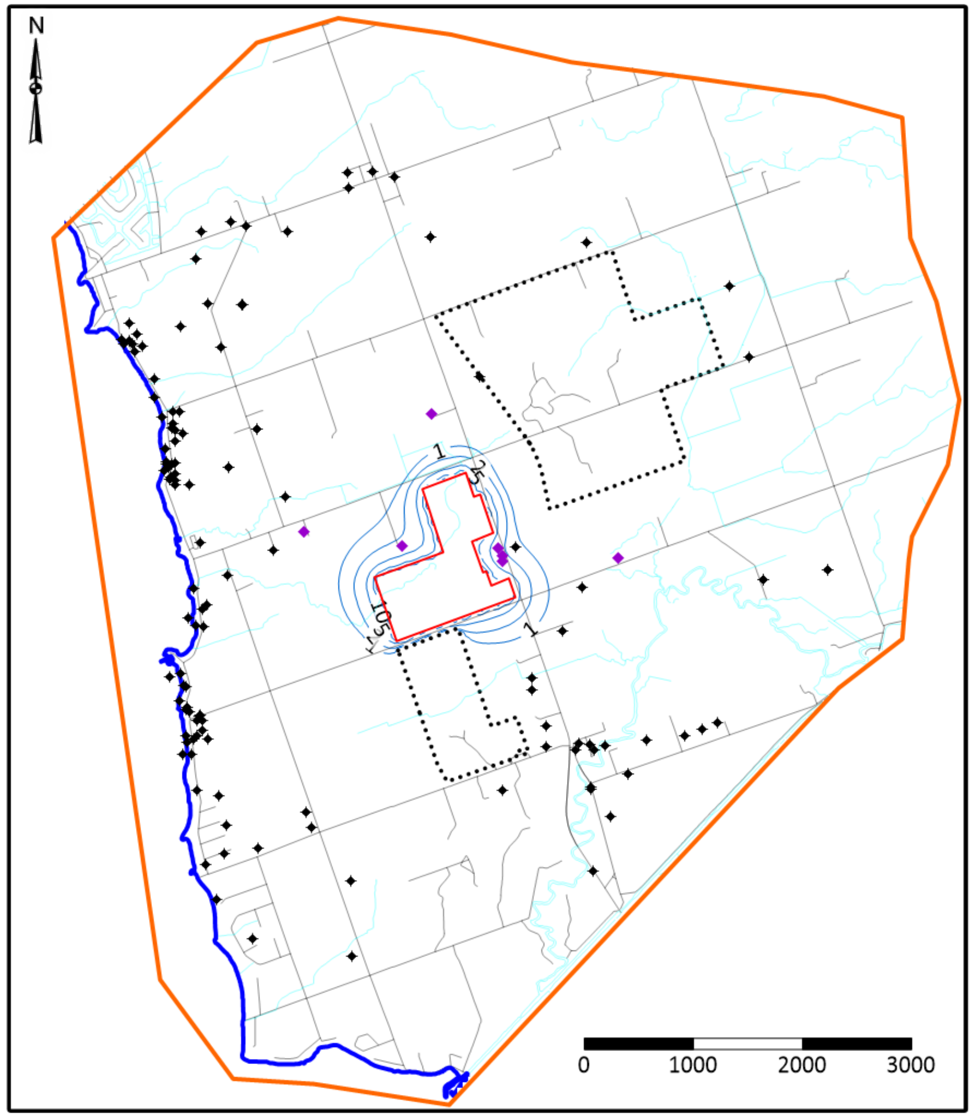
YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

TITLE
SIMULATED GROUNDWATER DRAWDOWN CONTRIBUTION BY LCP QUARRY (INCREMENTAL DRAWDOWN) WITH OTHER QUARRIES AT EXISTING CONDITIONS (SCENARIO 0 MINUS SCENARIO 2)

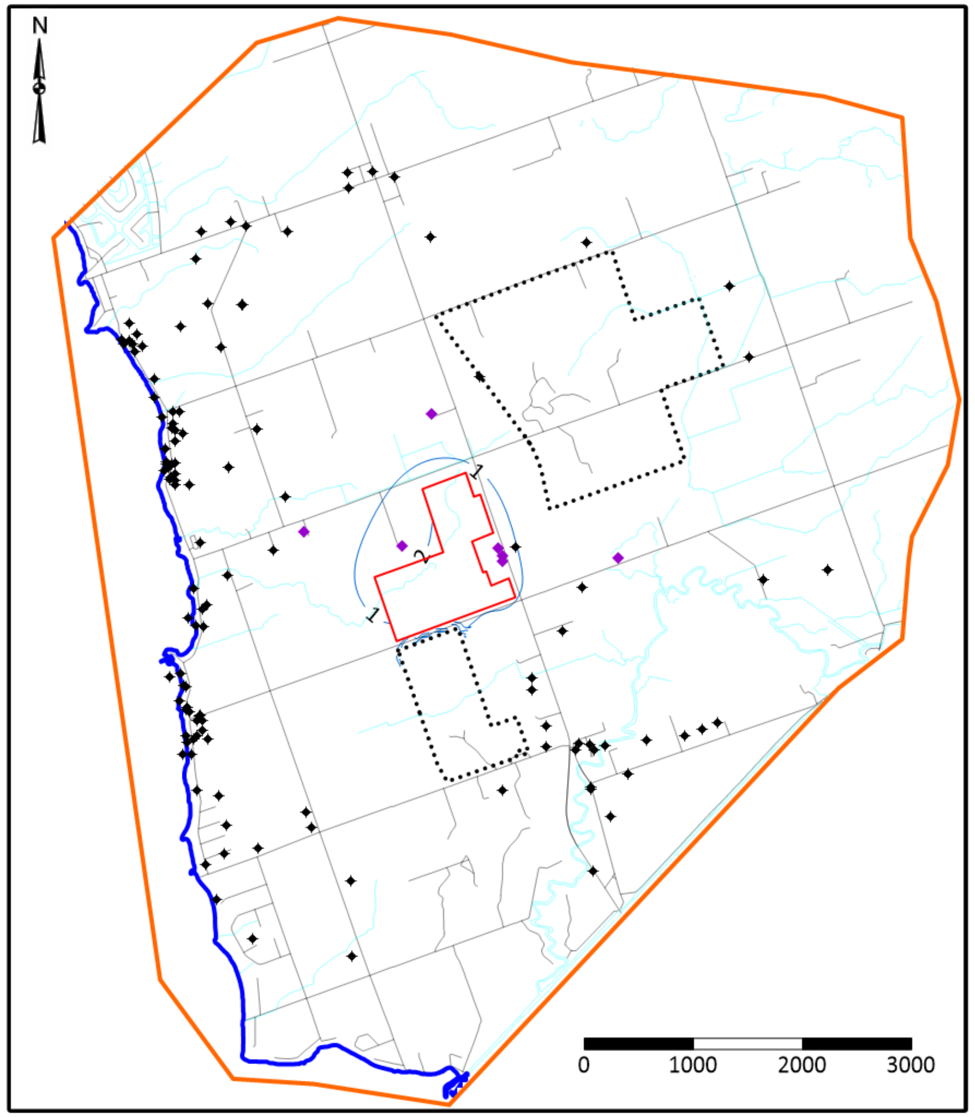
PROJECT NO.	REV.	FIGURE
19122839		13



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.

LEGEND

━	MODEL DOMAIN
━	SHORELINE
━	WATERCOURSE
━	ROADS
━	PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯	APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
–1–	SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
✦	WATER WELL LOCATION (MECP WWIS)
◆	ASSUMED PRIVATE WELL LOCATION

CLIENT
LCP QUARRY LIMITED

CONSULTANT
wsp

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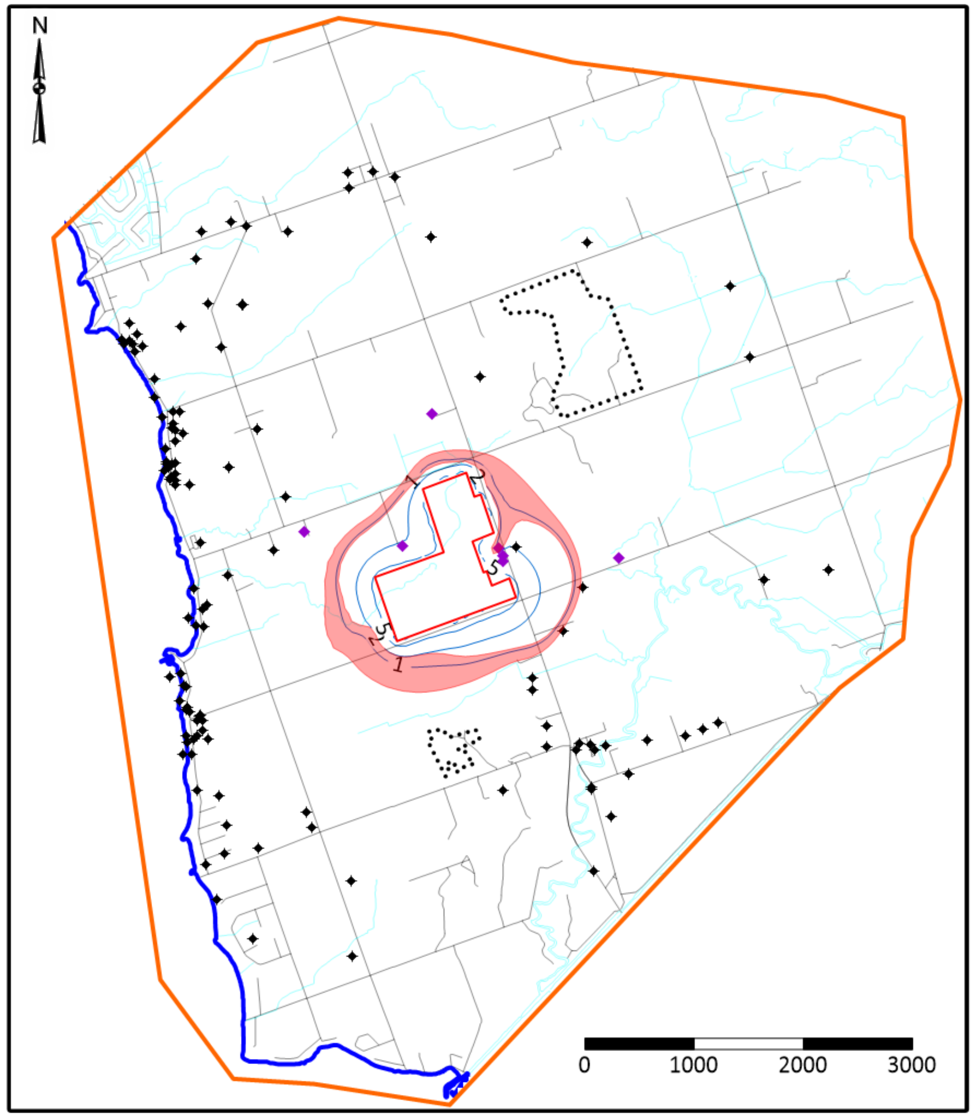
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

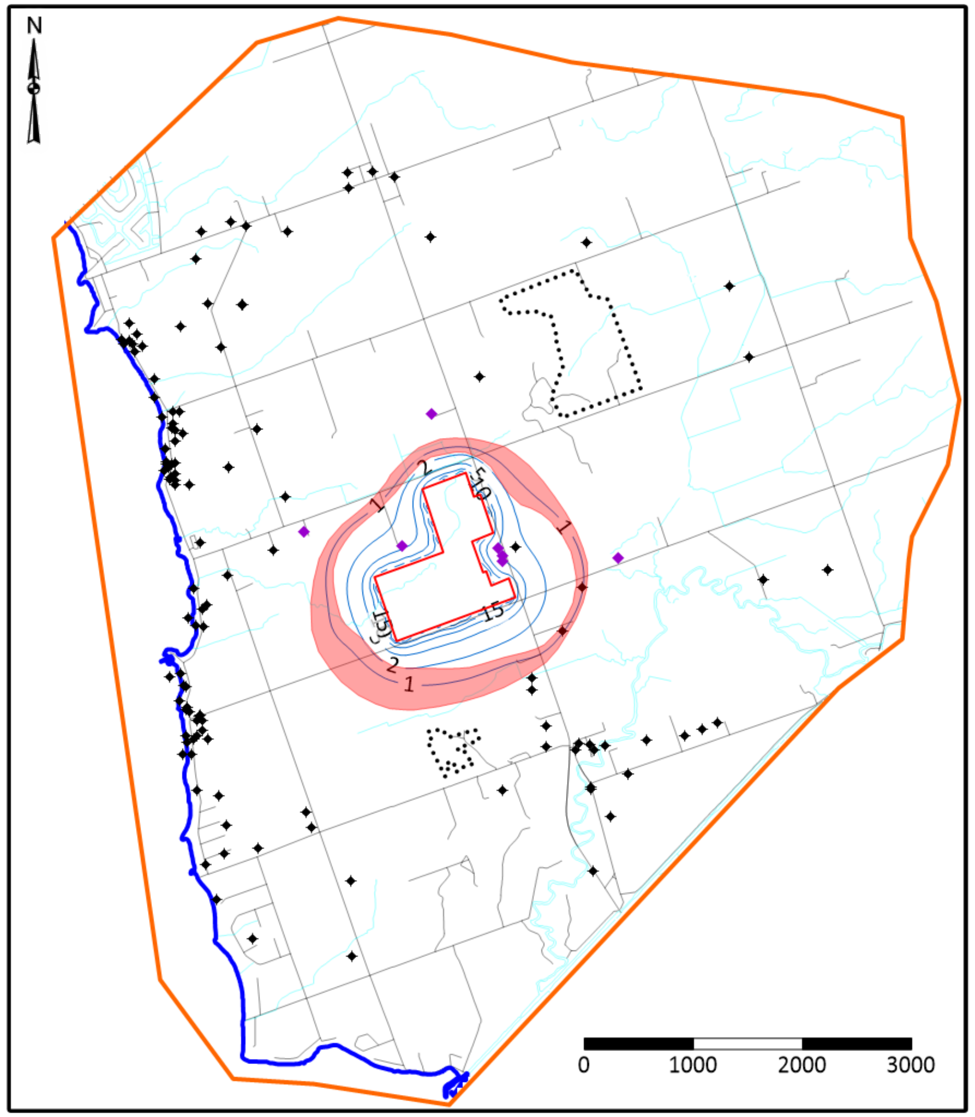
PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

TITLE
SIMULATED GROUNDWATER DRAWDOWN CONTRIBUTION BY LCP (INCREMENTAL DRAWDOWN) WITH OTHER QUARRIES AT FULL DEVELOPMENT (SCENARIO 1 MINUS SCENARIO 3)

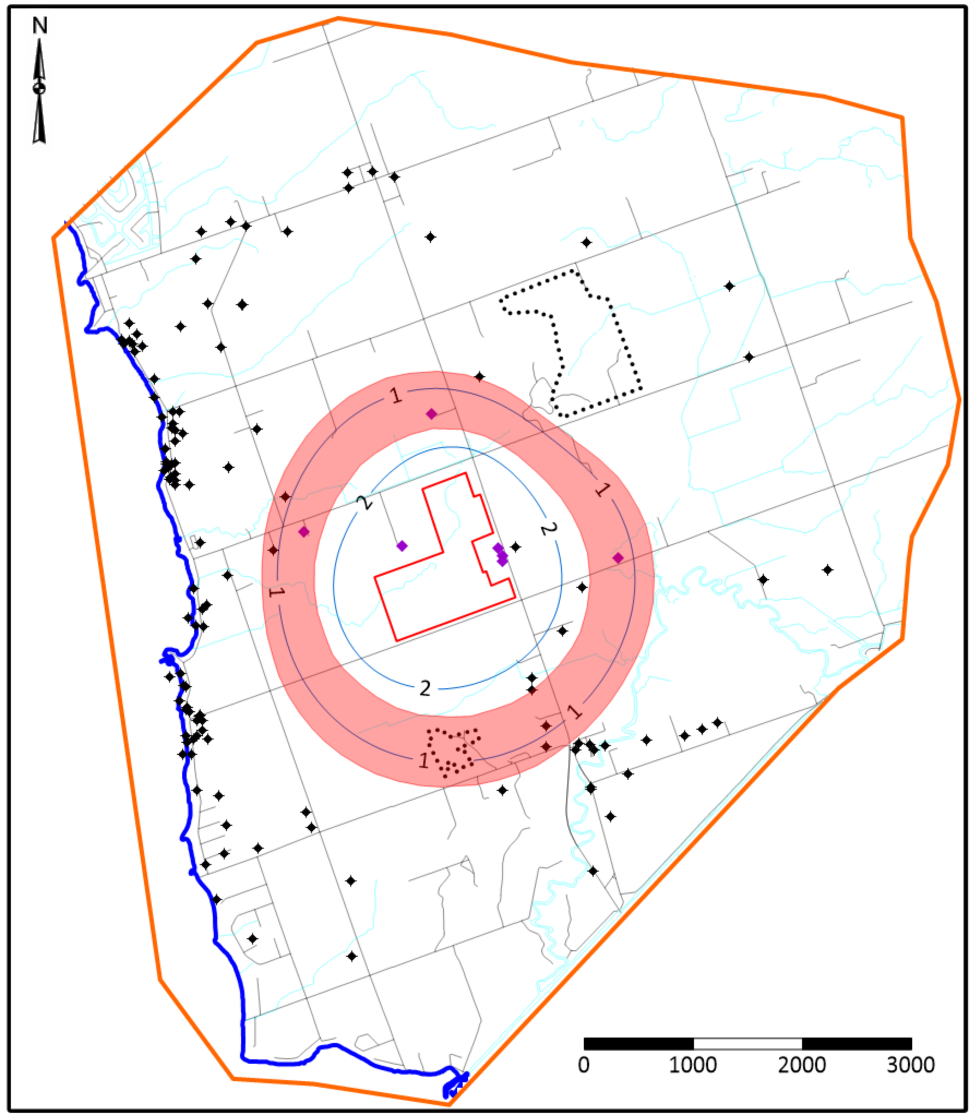
PROJECT NO.	REV.	FIGURE
19122839		14



VERULAM FORMATION (LAYER 4)



BOBCAYGEON FORMATION (LAYER 8)



GULL RIVER FORMATION UNIT 3 (LAYER 12)

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Water Well Locations (MECP WWIS) are based on well records data provided by Azimuth for Wells located within 3 km of the Proposed LCP Quarry. The location of some wells have been corrected by Azimuth.
3. Assumed private well locations represent private residences within vicinity of Proposed LCP Quarry with no associated well record.
4. Model Runs with an increase and decrease by a factor of 5 of the hydraulic conductivity of the Bobcaygeon Formation were completed as part of the sensitivity analysis.
5. Drawdown presented is the drawdown contribution by LCP if the other Quarries remained at existing conditions (Scenario 2 – Scenario 0)

LEGEND

- — MODEL DOMAIN
- — SHORELINE
- — WATERCOURSE
- — ROADS
- — PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
- ⋯ EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
- -1- SIMULATED GROUNDWATER DRAWDOWN CONTOUR (m)
- 🟥 ENVELOPE OF 1 m DRAWDOWN CONTOURS FROM SENSITIVTY RUNS
- ✦ WATER WELL LOCATION (MECP WWIS)
- ◆ ASSUMED PRIVATE WELL LOCATION

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LCP QUARRY LIMITED

PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT

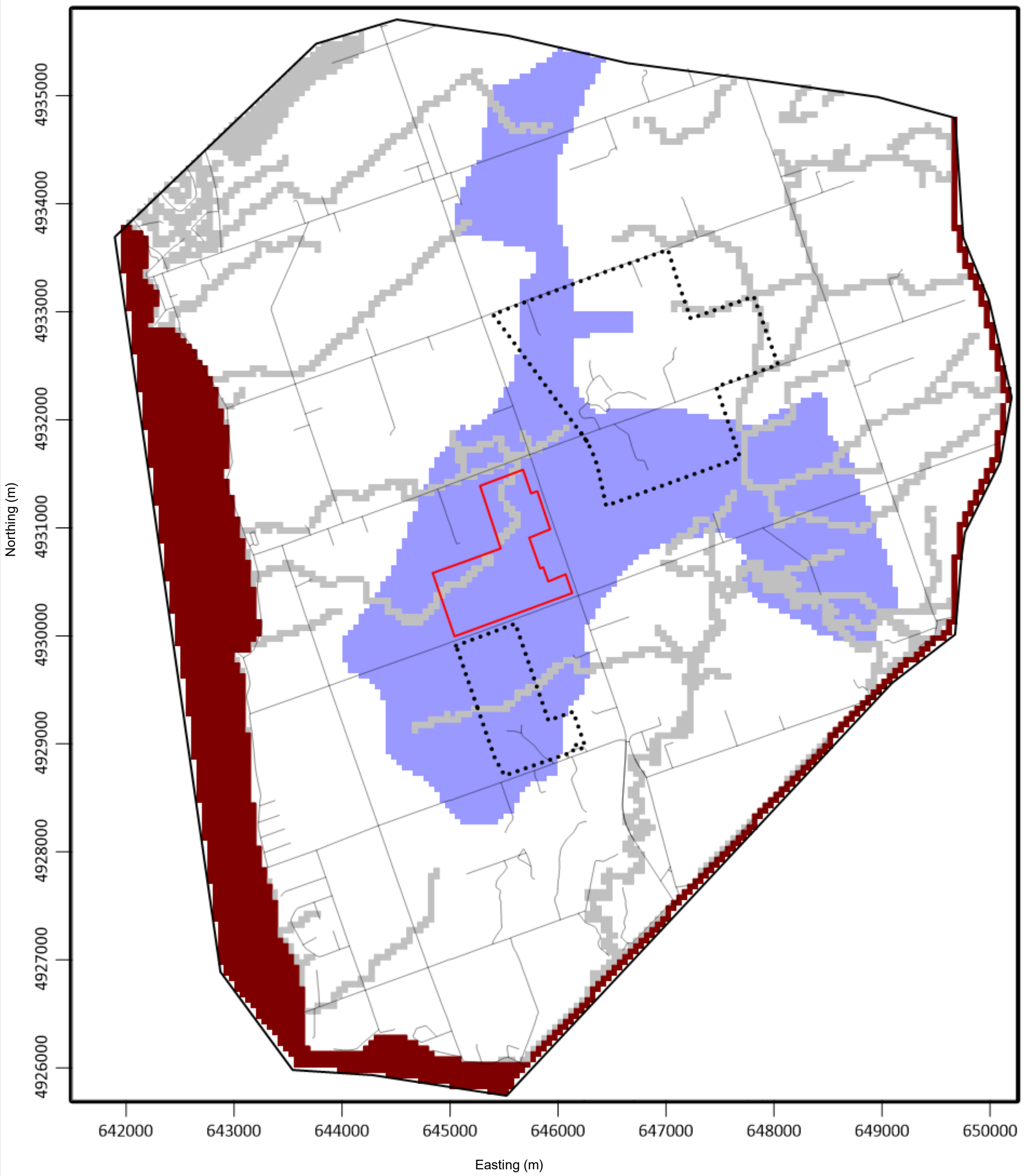
YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

TITLE
SENSITIVITY ANALYSIS – HYDRAULIC CONDUCTIVITY OF BOBCAYGEON FORMATION

PROJECT NO.
19122839

REV.

FIGURE
15



BOUNDARY CONDITIONS

	Predevelopment		Scenario 0		Scenario 1		Scenario 2		Scenario 3	
	Inflow (m^3/day)	Outflow (m^3/day)	Inflow (m^3/day)	Outflow (m^3/day)	Inflow (m^3/day)	Outflow (m^3/day)	Inflow (m^3/day)	Outflow (m^3/day)	Inflow (m^3/day)	Outflow (m^3/day)
Recharge	10,045	--	10,045	--	10,045	--	10,045	--	10,045	--
Constant Head	723	3,062	742	3,035	871	2,943	742	3,017	873	2,933
Surface Drains	--	7,707	--	6,703	--	4,762	--	6,286	--	4,514
Proposed LCP Brechin Quarry	--	--	--	--	--	--	--	450	--	342
Quarries Owned By Others	--	--	--	1,049	--	3,212	--	1,035	--	3,129
Mass Balance Error (%)	<0.01		<0.01		0.01		<0.01		0.01	

Scenario	Description
Predevelopment	Pre-quarry development in the area (i.e., quarry boundary conditions removed from model).
Scenario 0	Existing conditions scenario with quarries owned by others at their current state of extraction and no development of the LCP site.
Scenario 1	Full development of the quarries owned by Lafarge and James Dick with no development of the LCP Quarry.
Scenario 2	Full development of the LCP Quarry with the quarries owned by Lafarge and James Dick remaining at existing conditions.
Scenario 3	Full development of the LCP Quarry and the quarries owned by Lafarge and James Dick.

LEGEND

— ROADS
▬ PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
⋯ APPROXIMATE QUARRY LICENCE LIMIT (OWNED BY OTHERS)
⬜ MODEL DRAIN BOUNDARY
🟥 MODEL CONSTANT HEAD BOUNDARY
🟦 RECHARGE ZONE

NOTES

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Values presented in Mass Balance Table are rounded to the nearest 1 m^3/day.
3. Inflows to the quarries represent groundwater discharge and do not account for direct precipitation and surface water runoff

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PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT

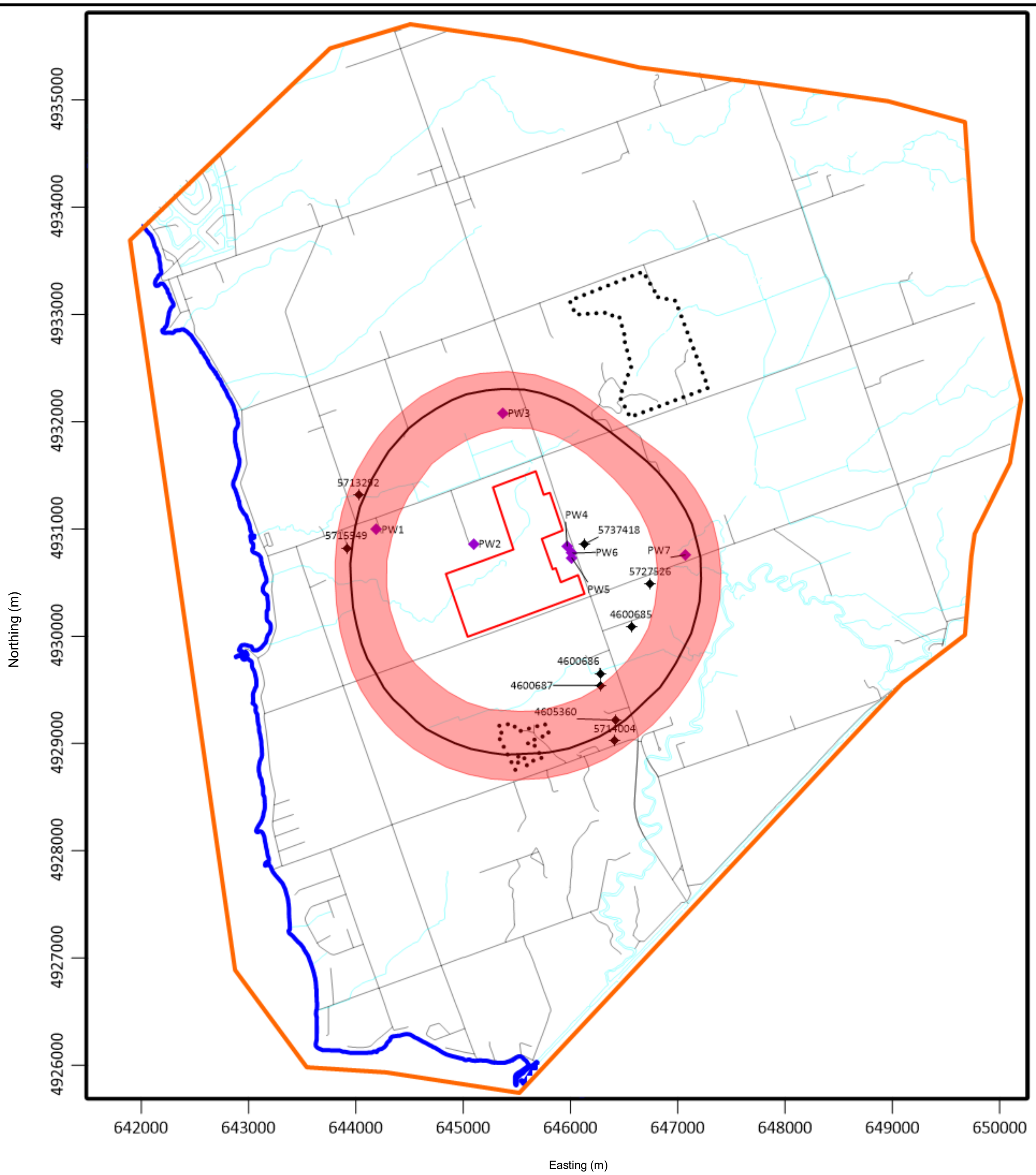
YYYY-MM-DD	2023/03/22
PREPARED	SPS
DESIGNED	SPS
REVIEWED	JPAO
APPROVED	JPAO

TITLE
MODEL WATER BALANCE SUMMARY

PROJECT NO.
19122839

REV.

FIGURE
16



LEGEND

🟧 MODEL DOMAIN
🟦 SHORELINE
— WATERCOURSE
— ROADS
🟥 PROPOSED LCP BRECHIN QUARRY EXTRACTION LIMIT
▪▪▪▪ EXISTING QUARRY (OWNED BY OTHERS) - APPROXIMATE LIMIT OF CURRENT EXTRACTION
— LCP QUARRY ZONE OF IMPACT
▨ ENVELOPE OF 1 m DRAWDOWN CONTOURS FROM SENSITIVTY RUNS
✦ WATER WELL LOCATION (MECP WWIS)
◆ ASSUMED PRIVATE WELL LOCATION

Notes

1. Coordinate System: UTM Zone 17 Datum: NAD 1983
2. Zone of impact and envelope of drawdown from sensitivity runs presented in the figure are from Layer 12 (Gull River Unit 3) and represent the 1 m drawdown contour for the LCP contribution to drawdown compared to existing conditions (Scenario 2 – Scenario 0)

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PROJECT
GROUNDWATER MODELLING AND PRIVATE WELL IMPACT ASSESSMENT
LCP PROPOSED BRECHIN QUARRY

CONSULTANT
wsp

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PREPARED	SPS
DESIGN	SPS
REVIEW	JPAO
APPROVED	JPAO

TITLE
PRIVATE WELLS WITHIN ZONE OF INCREMENTAL DRAWDOWN AND SENSITIVITY ENVELOPE

PROJECT No.	PHASE	Rev.	FIGURE
19122839		0	17

APPENDIX A

Author Qualifications and Experience

WSP Canada Inc. – Ottawa

Education

M.Sc. Civil Engineering: Hydrogeology
Queen’s University
Kingston, Ontario, 2001

B.Sc. Environmental Science: Earth Sciences Stream, Honours
Brock University
St. Catharines, Ontario
1998

Certifications

Registered Professional Geoscientist Ontario

Senior Hydrogeologist

Jaime Oxtobee has over 20 years of broad experience in the field of physical hydrogeology that includes hydrogeological impact assessments in support of the licensing of pits and quarries under the *Aggregate Resources Act*, water supply development and regional scale groundwater studies.

Employment History

WSP Canada Inc. (Previously Golder Associates Ltd.) – Ottawa

Associate and Senior Hydrogeologist (2001 to Present)

Jaime is responsible for project management, technical analysis and reporting for a variety of hydrogeological and environmental projects. Jaime is also often responsible for senior technical review of hydrogeological investigations.

Projects have included groundwater resources studies; hydrogeological investigation programs in support of licensing/permitting pits and quarries and in support of Permit to Take Water applications for local construction dewatering projects, ready-mix concrete plants, golf courses and quarries; communal water supply investigations; wellhead protection studies; contaminated site investigations; and, providing senior review for landfill, pit and quarry monitoring reports.

Queen’s University – Kingston, Ontario

Teaching Assistant (2000 to 2001)

Teaching assistant for university courses relating to groundwater flow and contaminant transport in porous media and fractured rock environments.

Phase IV Bedrock Remediation Program – Smithville, Ontario

Project Manager (1999)

Coordinated and conducted a groundwater/surface water interaction study downgradient from the PCB-contaminated site in Smithville, Ontario. The study involved detailed numerical modelling, as well as an extensive field program including stream surveys, stream gauging, construction and installation of mini-piezometers, seepage meters and weirs, fracture mapping, groundwater and surface water sampling.

SELECTED PROJECT EXPERIENCE – AGGREGATE INDUSTRY

Hydrogeological and Hydrological Assessments for Quarry Licensing
Township of Drummond-North Elmsley, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological ecological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing the extension of an existing quarry. The application was for two new below water quarries on either side of an existing below water quarry. Jaime led the hydrogeological and hydrological assessment component of the project, and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessments for Pit Licensing
Township of Lanark, Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing a new pit above the water table. Jaime led the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program and preparing the required reporting.

Hydrogeological and Hydrological Assessments for Quarry Licensing
Ramara, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing the extension of an existing quarry. The application was for one new below water quarry adjacent to an existing below water quarry. Jaime led the hydrogeological and hydrological assessment component of the project. Jaime was responsible for development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting.

Hydrogeological Assessments for Pit Licensing
Township of Leeds and Thousand Islands, Ontario, Canada

Golder carried out the necessary hydrogeological studies to support an application under the *Aggregate Resource Act* for licensing a new pit below the water table. Jaime led the hydrogeological assessment component of the project. Jaime was responsible for the development and execution of the hydrogeology field program and completing the hydrogeological impact assessment/reporting.

Hydrogeological Assessment for Quarry Permitting
Township of Bomby

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new quarry. The application was for a below water quarry located on Crown Land. Jaime led the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessment for Pit Permitting
District of Kenora, Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new pit. The application was for a below water pit located on Crown Land. Jaime provided input to the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development of the site conceptual model in the vicinity of the pit and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessment for Quarry Permitting
District of Kenora, Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new quarry. The application was for a below water quarry located on Crown Land. Jaime provided input to the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development of the site conceptual model in the vicinity of the quarry and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological and Hydrological Assessment for Quarry Licensing
City of Kawartha Lakes, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological and ecological studies to support an application under the *Aggregate Resource Act* for licensing a new quarry. The application was for a below water quarry located adjacent to a provincially significant wetland. Jaime provided input to the hydrogeological assessment component of the project, which included the installation of over 80 monitoring intervals and the completing of three pumping tests. Jaime was involved in data analysis and the completion of the impact assessment and reporting for the hydrogeology assessment.

TRAINING

Beyond Data: Conceptual Site Models in Environmental Site Assessments
Golder U, 2011

Health and Safety Modules 1, 2, 3 and 4
Golder U, various years

Critical Thinking in Aquifer Test Interpretation
Golder U, 2011

HydroBench (Proprietary Aquifer Test Interpretation Software)
Golder U, 2011

Project Management
Golder U, 2007

Short course: Environmental Isotopes in Groundwater Resource and Contaminant Hydrogeology
2007

Short course: Hydrogeology of Fractured Rock – Characterization, Monitoring, Assessment and Remediation
2002

OSHA 40 Hour Hazardous Waste Site Worker Training
2002

PROFESSIONAL AFFILIATIONS

Member, Association of Professional Geoscientist of Ontario Member,

Ottawa Geotechnical Group

PUBLICATIONS

Conference Proceedings	West, A.L., K.A. Marentette and J.P.A. Oxtobee. 2009. *Quantifying Cumulative Effects of Multiple Rock Quarries on Aquifers*. 2009 Joint Assembly, May. Toronto, Canada.
	Novakowski, K.S., P.A. Lapcivic, J.P.A. Oxtobee and L. Zanini. 2000. *Groundwater Flow in the Lockport Formation Underlying the Smithville Ontario Area*. 1st IAH-CNC and CGS Groundwater Specialty Conference, October. Montreal, Canada.
	Oxtobee, J.P.A. and K.S. Novakowski. 2001. *A Study of groundwater/Surface Water Interaction in a Fractured Bedrock Environment*. Fractured Rock 2001 Conference, March. Toronto, Canada.
Journal Articles	Oxtobee, J.P.A. and K.S. Novakowski. Groundwater/Surface Water Interaction in a Fractured Rock Aquifer. *Journal of Ground Water*, 41(5) (2003), 667-681.
	Oxtobee, J.P.A. and K.S. Novakowski. A Field Investigation of Groundwater/Surface Water Interaction in a Fractured Bedrock Environment. *Journal of Hydrology*, 269 (2002), 169-193.
Other	Oxtobee, J.P.A., 1998. Environmental Assessment of Grapeview, Francis and Richardson's Creeks, St. Catharines, Ontario. B.Sc. Thesis, Brock University, Earth Sciences Department pp.119.

Education

M.Sc. Geology, University of Windsor, Windsor, Ontario, 1988

B.Sc. Geology, Honours, University of Windsor, Windsor, Ontario, 1986

Certifications

Registered Professional Geoscientist, 2002

Languages

English – Fluent

WSP Canada Inc. – Ottawa, Ontario

Employment History

Career Summary

Principal/Senior Hydrogeologist (1997 to Present)

Mr. Kris A. Marentette, M.Sc., P.Geo., is a Principal and Senior Hydrogeologist in the Ottawa office of WSP Canada Inc. (previously Golder Associates), and has 20 years of broad experience in the fields of water supply development, physical hydrogeological characterization studies, regional scale groundwater studies, waste management, contaminated sites assessment /remediation, aggregate resource evaluations and the licensing and permitting of quarry development and expansion projects. Kris is responsible for business development, project management, and senior technical review of hydrogeology, quarry and sand and gravel pit development and expansion, golf course irrigation, site assessment and remediation projects, and waste facility siting, design, operation and environmental compliance monitoring assignments from the Ottawa office.

From 1997 to 2001, Mr. Marentette was Project Manager for Golder Associates' component of one of the largest Environmental Site Assessment (ESA) contracts in Canada which involved the assessment of over 780 sites which were being transferred from Transport Canada to NAV CANADA. Golder Associates completed Phase I ESA of approximately 400 sites of which about 130 sites required Phase II ESA activities. The sites ranged from small antennas towers to large, complex international airports. Project involved considerable logistic planning to mobilize personnel across the country, familiarity with federal and provincial soil and groundwater remediation criteria, development of site-specific remediation options (including permafrost sites), and ongoing interaction with consultant team and Transport Canada/NAV CANADA.

Kris has also been involved as principal consultant or senior reviewer for over 100 Phase I ESAs and over 50 Phase II ESAs completed by the Ottawa office. These projects included industrial, commercial, and residential properties ranging from former coal gasification plants to microcircuit manufacturers. Projects have included an evaluation of permitting requirements related to waste water discharges and air emissions as well as designated substances surveys. Kris has also conducted subsurface investigations at numerous bulk storage, fuel dispensing and pipeline sites; development of groundwater and soil vapour monitoring programs; design and permitting of remedial measures including product recovery and excavation of contaminated soil; supervision and verification of site remediation.

Kris has provided environmental consultation services to many wood product manufacturers in Renfrew County and Lanark County in the context of assessing environmental impacts of wood waste storage and lumber yard and sawmill operations on the natural environment. While working for the wood product manufacturers, Kris established a consistent approach to site investigations and set a focused list of leachate indicator parameters for groundwater and surface water assessments which has met with Ontario Ministry of Environment (MOE) approval.

Kris has been the Golder Associates Project Manager on a number of Ministry of Natural Resources quarry and pit licensing projects for both new operations and expansions to existing operations and has extensive experience in managing these complex, multi-disciplinary projects. Participated in comprehensive aggregate resource evaluations of Paleozoic sedimentary sequences (limestone) and Precambrian marble deposits at quarries in eastern Ottawa for the purpose of developing preferred site development plans to maximize the production of high quality aggregate products. The aggregate resource evaluations have typically included borehole coring, geological core logging, geophysical evaluations and comprehensive laboratory testing programs. Participated in other quarry-related projects associated with the Ministry of Environment Permit to Take Water Program and the issuance of Certificates of Approval (Industrial Sewage Works) under Section 53 of the Ontario Water Resources Act as well as studies undertaken for the purpose of complying with requirements under the Aggregate Resources Act. In the case of the Permit to Take Water approvals and industrial sewage works applications under Sections 34 and 53 of the Ontario Water Resources Act, Kris has consulted with, and interacted extensively, with MOE personnel in both the local District and Regional offices and with key personnel within the Environmental Assessment and Approvals Branch of the MOE in Toronto. Kris was the Project Manager assigned to assist the City of Ottawa in a comprehensive project focused on assisting City staff in understanding the intricate details of the MOE's Permit to Take Water Program. Kris is also well known to the local conservation authorities (Rideau Valley Conservation Authority, Mississippi Valley Conservation Authority and South Nation Conservation) as a result of involvement in water supply and quarry-related projects in the Ottawa area and has interacted with the Ontario Stone, Sand & Gravel Association on various issues related to the aggregate industry (e.g., addressing the MOE concern associated with the potential presence of dinitrotoluene in quarry discharge water, source water protection, etc.). Kris has appeared as an expert witness before the Ontario Municipal Board on quarry-related applications.

Golder Associates Ltd. – Ottawa, Ontario

Hydrogeologist/Senior Hydrogeologist (1988 to 1997)

Responsible for business development and the initiation, implementation and direction of hydrogeological investigations from the Ottawa office. Projects have included test well drilling programs for private services developments; subsurface investigations as related to the installation of subsurface sewage disposal systems; communal water supply investigations; and, regional hydrogeological studies to assist in establishing planning policies for future private services developments and to develop standards for water well construction.

Project manager for numerous hydrogeological studies of existing/proposed landfill sites including the assessment of impacts on water resources and developing and implementing monitoring programs and contingency and remedial action plans. Participated in hydrogeological aspects of waste management studies, preparation and submission of documentation to obtain Emergency Certificates of Approval and Site Interim Expansions of landfill sites under both the Environmental Assessment Act and Environmental Protection Act. Projects have included preparation of landfill site development and operations plans including evaluations of landfill final cover design options. Expert testimony at hearings before the Environmental Assessment Board.

Also responsible for investigation, design and implementation of soil and groundwater remediation programs at hydrocarbons, metals, solvents, and PAH contaminated sites including the risk assessment approach to site management. Projects have included third party peer review of site remediation programs.

Conducted hydrogeological assessments of quarry developments/expansions and pre-acquisition environmental site audits.

PROJECT EXPERIENCE – WATER RESOURCES MANAGEMENT

Village of Winchester Water Supply Project Ontario, Canada	Project Hydrogeologist for the Village of Winchester Water Supply Expansion Project. This project included the preliminary evaluation of potential target aquifers followed by a comprehensive test well investigation and aquifer characterization program. Participated in the development of a comprehensive Water Resources Protection Strategy.
Rural Subdivision Development Ontario, Canada	Supervised test well drilling programs for numerous residential, industrial and commercial private services subdivision developments including evaluation and selection of target aquifers, development of site specific well construction requirements, analysis and interpretation of physical hydrogeological data and groundwater chemical data and preparation and submission of detailed hydrogeological reports. Responsible for conducting many subsurface investigations as related to the installation of small and large subsurface septic sewage disposal systems for private services developments including projects subject to the Ontario Ministry of the Environment Reasonable Use Guideline B-7.
Communal / Commercial Water Supply Evaluation Ontario, Canada	Project Manager for communal water supply investigations for non-profit housing developments in Elgin and Clayton, Ontario and time share condominium development in Cobden, Ontario; responsible for groundwater resource evaluation with respect to project specific water supply requirements. Conducted hydrogeological assessment of the Evergreen Spring Water Site in the Township of Sebastopol, Ontario for Cott Beverages Ltd.; assessment included characterization of geological setting, quantity, quality and age of spring water and evaluation of potential sources of contamination in the vicinity of the spring.
Township of Kingston Planning Study Ontario	Conducted hydrogeological study and general terrain analysis of rural Kingston Township to characterize the present status of the Township's groundwater resources to assist in establishing planning policies for locating new developments on private services and to provide standards for water well construction within the Municipality.
Land Development Evaluation Ontario	Conducted a preliminary hydrogeological and terrain evaluation of a 400 acre parcel of land south of the Ottawa International Airport with respect to the feasibility of developing the site as a rural residential subdivision on private services.

PROJECT EXPERIENCE – WASTE MANAGEMENT

Township of Clarence Landfill Buchanan Landfill Bourget, Ontario/Chalk River, Ontario, Canada	Preparation and submission of documentation to the Ontario Ministry of the Environment to obtain an exemption from the Environmental Assessment Act and approval under the Environmental Protection Act for interim expansions of the Township of Clarence Landfill and Buchanan Landfill. Project involved detailed hydrogeological and geophysical site characterization studies, development of mitigation measures to address existing off-site impacts on groundwater and surface water resources and participation in the preparation of the site development and operations reports, trigger mechanisms, and contingency measures, site closure plans, public participation/presentations, document preparation and representation to regulatory agencies. Expert testimony at the Environmental Assessment Board hearings resulting in successful applications.
Dodge Landfill Espanola, Ontario, Canada	Project Hydrogeologist responsible for hydrogeological studies of existing landfill in support of an application to the Ontario Ministry of Environment for a long-term site expansion.
Lanark County Waste Management Master Plan City/Township of Kingston Waste Management Master Plan Ontario, Canada	Hydrogeological consultant on the master plan study teams involving technical aspects and document preparation, Environmental Assessment process, EA level field investigations and evaluation of site-specific engineered containment system requirements at the preferred sites and presentations to the steering committees and the public.
Armbro Mine Landfill Development Marmora, Ontario, Canada	Project Hydrogeologist as part of the Metro Toronto area landfill site search, for hydrogeological assessment, conceptual design and technical feasibility evaluation of constructing a municipal landfill in the 250 metre deep former open pit iron ore mine.
Township of Clarence Waste Management Planning Study Ontario, Canada	As part of a multi-disciplinary team, responsible for the hydrogeological aspects of a long term waste management planning study under the Environmental Assessment Act and Environmental Protection Act, including development and evaluation of alternative waste management components and systems, a systematic landfill site selection process and interaction with the Public Liaison Committee, municipal council and the public.
Municipal Waste Management Planning Studies Ontario, Canada	Participated in hydrogeological aspects of waste management planning studies to identify potentially suitable areas for landfill development to satisfy the long term waste disposal requirements for the Township of Grattan, Township of Pittsburgh and the Townships of Palmerston, North and South Canonto.

Various Landfill Sites Eastern and Northern Ontario, Canada	Responsible for undertaking and/or managing hydrogeological and waste management studies at in excess of 50 municipal landfill sites. The typical objectives of these studies have been to define the physical and contaminant hydrogeology including use of geophysical methods; undertake site-specific impact assessments on groundwater and surface water resources and gas migration; complete site performance evaluations in terms of current regulatory requirements; develop site-specific remedial action plans; design and implement annual hydrogeological monitoring programs; assist in the preparation of site development, operations and contingency and remedial action plans; and, to assemble the necessary documentation required to apply to the Ontario Ministry of Environment for Certificate of Approval revisions to permit continued disposal. Conducted evaluations of final cover design options using the Hydrologic Evaluation of Landfill Performance (HELP) computer model for the purpose of selecting the most appropriate final cover design for numerous landfills based on hydrogeological considerations, economics and availability of construction materials in the vicinity of the sites.

PROJECT EXPERIENCE – CONTAMINATED SITES INVESTIGATION AND REMEDIATION

Nation-Wide Environmental Site Assessments Canada	Project Manager for Golder Associates' component of one of the largest environmental site assessment contracts in Canada which involved the assessment of over 780 sites which were being transferred from Transport Canada to NAV CANADA. Golder Associates completed Phase I ESAs of approximately 400 sites of which about 130 sites required Phase II ESA activities. The sites ranged from small antenna towers to large, complex international airports. Project involved considerable logistic planning to mobilize personnel across the country, familiarity with federal and provincial soil and groundwater remediation criteria, development of site-specific remediation options (including permafrost sites), and ongoing interaction with consultant team and Transport Canada/NAV CANADA.
Assessment of Rockcliffe Airbase Lands Ottawa, Ontario, Canada	Project Manager to participate as part of a multi-disciplinary team assembled to conduct an existing conditions assessment related to potential redevelopment of the Rockcliffe site for residential land use. Completed a review of subsurface environmental investigation reports in terms of identifying potential development constraints associated with soil and groundwater conditions at the site. Presented recommended actions for evaluating issues of potential environmental concern including development of cost estimates to address these concerns.
Environmental Site Assessments Eastern Ontario, Canada	Senior Reviewer for over 100 Phase I ESAs and over 50 Phase II ESAs completed by the Ottawa office. These projects included industrial, commercial and residential properties ranging from former coal gasification plants to microcircuit manufacturers. Projects have included an evaluation of permitting requirements related to waste-water discharges and air emissions as well as designated substances surveys.

Assessment of Diesel Fuel Release
Smiths Falls, Ontario, Canada

Project Manager for an environmental impact study which focused on a diesel fuel leak at a large industrial site and included the delineation of the areal extent of contamination, assessment with respect to current soil and groundwater remediation criteria and participation in the development and implementation of a site specific monitoring program and evaluation of remedial options.

Petroleum Hydrocarbon Releases
Eastern Ontario, Canada

Conducted subsurface investigations at numerous bulk storage, fuel dispensing and pipeline sites; development of groundwater and soil vapour monitoring programs; design and permitting of remedial measures including product recovery and excavation of contaminated soil; supervision and verification of site remediation.

Investigation of Salt Storage Facilities
Eastern Ontario, Canada

Project Manager for hydrogeological investigation relating to an assessment of poor groundwater quality adjacent to a salt dome near Almonte, Ontario. Project involved an evaluation of existing water quality data, development and implementation of a replacement well drilling program and long term groundwater quality monitoring program; project involved extensive consultation with municipal officials, affected homeowners and representatives from the Ontario Ministry of the Environment. Responsible for hydrogeological impact assessments relating to salt storage facilities near Eganville and Deep River, Ontario. Investigations included reconnaissance level geophysical surveys to characterize general dimension of the contaminant plumes followed by confirmation drilling, monitoring well installation and groundwater sampling programs to delineate the nature and extent of the contaminant plumes originating from the salt storage facilities and to differentiate between groundwater impacts from the salt storage facilities and that from nearby landfill sites.

PROJECT EXPERIENCE – AGGREGATE INDUSTRY

Stittsville Quarry
Township of Goulbourn (Ottawa), Ontario, Canada

Project Manager and Project Hydrogeologist retained by R.W. Tomlinson Limited to provide geoscience and engineering services and to co-ordinate a multi-disciplinary study team in the preparation of the supporting documents, for a submission to the Ontario Ministry of Natural Resources, in support of an application for a Category 2, Class “A” quarry license to extract limestone from below the established groundwater table. Assignment also included preparation and submission of applications to the Ontario Ministry of Environment for approval under Section 34 (Permit to Take Water) and Section 53 (Industrial Sewage Works) of the Ontario Water Resources Act. All required approvals were obtained and the quarry became operational in September 2002. Kris continues to be involved as Project Director on all environmental compliance monitoring requirements associated with the Ministry of Natural Resources aggregate license and the Ministry of Environment approvals under Section 34 and 53 on the Ontario Water Resources Act.

Rideau Road Quarries City of Gloucester (Ottawa), Ontario, Canada	In 2003, Golder Associates was retained by R.W. Tomlinson Limited to provide geoscience and engineering services and to co-ordinate a multi-disciplinary study team in the preparation of the supporting documents, for a submission to the Ontario Ministry of Natural Resources, in support of an application for a Category 2, Class “A” quarry license for a parcel of land adjacent to Tomlinson’s existing quarry operations. The quarry was designed to extract limestone from below the established groundwater table for the production of high quality aggregate suitable for all types of asphalt pavements. Kris was Project Director and Project Hydrogeologist for this assignment and Golder Associates’ primary responsibilities included preparation of Level 1 and Level 2 Hydrogeological studies and Natural Environment evaluations of the property. Of particular significant for this project was the innovative approach develop by Golder Associates (in consultation with the Ministry of Natural Resources) for the purpose of addressing the presence of the American ginseng plant species and butternut trees on the property. The aggregate license was issued by the Ministry of Natural Resources in 2006.
Tatlock Quarry Township of Lanark Highlands, Ontario, Canada	Project Director and Project Hydrogeologist retained in 2002 by Omya Canada Inc. to conduct Level 1 and Level 2 hydrogeological studies in support of an application to the Ministry of Natural Resources for a Category 2, Class “A” license for the extraction of calcitic marble (crystalline limestone) at the Omya Tatlock Quarry located northwest of Perth, Ontario. Golder Associates was also responsible for the preparation of an application for an industrial sewage works approval under Section 53 of the Ontario Water Resources Act. The quarry license application was issued by the Ministry of Natural Resources in April 2006 and the industrial sewage works approval was issued by the Ministry of Environment in March 2006. Kris continues to advise Omya Canada Inc. on matters related to environmental compliance monitoring and other issues pertaining to Ministry of Natural Resources aggregate license and the Ministry of Environment approvals under Section 34 and 53 on the Ontario Water Resources Act.
Dunvegan Quarry Township of North Glengarry, Ontario, Canada	Project Hydrogeologist retained by the Township of North Glengarry to conducted a peer review of the hydrogeological aspects of the Cornwall Gravel Company Ltd. Dunvegan Quarry license application. The peer review focused on developing an opinion as to whether the Hydrogeological Assessment Report addressed the various components specified as part of a Hydrogeological Level 1 study and Hydrogeological Level 2 study in the context of a Category 2, Class “A” Quarry Below Water.
Klock Quarry Aylmer, Quebec, Canada	Golder Associates was retained by Lafarge Canada Inc. to conduct the hydrogeological and natural environment assessments associated with obtaining approval for the extraction of limestone from a property situated adjacent to the existing Klock Quarry. Kris is responsible for overall project co-ordination and direction of a multi-disciplinary team.

Brechin Quarry
City of Kawartha Lakes,
Ontario, Canada

Project Manager and Project Hydrogeologist retained by R.W. Tomlinson Limited to complete the necessary hydrogeological, hydrological and ecological studies to support an application under the Aggregate Resources Act. The proposed Brechin Quarry is located in the former Township of Carden within the City of Kawartha Lakes, Ontario. The assignment involves a comprehensive assessment of the potential effects of quarry development on private water supply wells and an adjacent Provincially Significant Wetland and other natural environment (biological) features as well as consideration of the potential cumulative impacts associated with multiple quarry developments in the area of the proposed Tomlinson Brechin Quarry. This project involves extensive municipal and public consultation as well as interaction with representatives of the Ontario Ministry of Natural Resources and Ontario Ministry of Environment. The aggregate license was issued by the Ministry of Natural Resources in 2009.

TRAINING

Ministry of Environment Approvals Reform and Air Emission Summary and Dispersion Modelling Report Workshop
Ministry of the Environment, 1998

Site Specific Risk Assessment Seminar
Ottawa, 1998

Contaminated and Hazardous Waste Site Management
1997

Occupational Health and Safety Course
1989, 1995

Groundwater Protection in Ontario Conference
Toronto, 1991

Short Course in Dense, Immiscible Phase Liquid Contaminants (DNAPLs) in Porous and Fractured Media
Waterloo Centre for Groundwater Research, 1990

PROFESSIONAL AFFILIATIONS

Associate Member, Ontario Stone Sand and Gravel Association (OSSGA)

Member, Association of Groundwater Scientists and Engineers (N.G.W.A.)

Member, International Association of Hydrogeologists

Member, Ottawa Geotechnical Group, The Canadian Geotechnical Society

Member, Ontario Water Well Association

Education

M.A.Sc. Civil Engineering, University of Toronto, Toronto, Ontario, 2017

B.A.Sc. Environmental Engineering, University of Windsor, Windsor, Ontario, 2015

Certifications

Registered Professional Engineer, Professional Engineers of Ontario, 2021

WSP Canada Inc. – Ottawa

Environmental Consultant

Sean Spanik is an environmental engineer that joined the WSP (previously Golder Associates Ltd.) team in December 2017. Sean assists with technical analysis, groundwater modelling and reporting on a variety of hydrogeological and environmental projects. This includes hydrogeological investigations in support of infrastructure development; annual reporting for Environmental Compliance Approval (ECA) and Permit to Take Water monitoring programs at quarry sites; and preparation of PTTW applications and Environmental Activity Sector Registry (EASR) Water Taking Plans for construction dewatering projects. In addition to technical analysis and reporting, Sean also assists in the development and execution of field programs, including groundwater and surface water sampling, monitoring well installations, hydraulic conductivity testing, pumping tests, packer tests and infiltration testing.

Employment History

WSP Canada Inc. (Previously Golder Associates Ltd.) – Ottawa, Ontario

Environmental Engineer (2017 to Present)

Environmental engineer within the Geosciences group. Assists with technical analysis and reporting, groundwater flow modelling and the development and execution of field programs.

EXP Services – Windsor, Ontario

Geotechnical Field Technician (Co-op) (2014 to 2014)

Performing compaction and concrete testing for a major infrastructure project.

PROFESSIONAL AFFILIATIONS

Member of the Association of Professional Engineers of Ontario

PROJECT EXPERIENCE – HYDROGEOLOGY

Permit to Take Water Application Cavanagh Goulbourn Quarry Ontario, Canada	Assisted with updating and calibrating a groundwater flow model in MODFLOW. The model was used to run quarry development forecast scenarios for a permit to take water impact assessment.
Drawdown Assessment Spring Valley Trails Ontario, Canada	Constructed a two-dimensional groundwater flow model in FEFLOW to assess the magnitude of water level drawdown that would result from a proposed underground stormwater storage gallery for a residential development.
Source Water Protection Study Braestone Development Ontario, Canada	Assisted with the construction and calibration of a groundwater flow model in MODFLOW based on a conceptual hydrogeological model of the Oro Moraine. The model was used to delineate time-of-travel capture zones for communal water supply wells at the Braestone development.
Troilus Mine Project Quebec, Canada	Developed and calibrated a three-dimensional groundwater flow model in FEFLOW to predict drawdown and groundwater inflow for an open pit mining project.
Landfill Monitoring, Brockville Landfill Ontario, Canada	Golder carried out monitoring of groundwater and surface water at the City of Brockville Landfill Site and an adjacent former landfill and scrap yard. Sean assisted in coordinating the field program and preparing a comprehensive report. He also assessed compliance of the site with provincial regulations and site-specific triggers.
Integrated Road, Sewer and Watermain Construction Ontario, Canada	Assisted in the execution of the field program for various linear infrastructure projects, which involved taking water levels, hydraulic conductivity testing and sampling from monitoring wells along the proposed alignment. Sean helped to analyze field data and determine the water taking requirements for the projects. Sean has also assisted in the preparation of Category 3 Permit to Take Water Applications for construction dewatering activities.
Lebreton Flats Redevelopment Ontario, Canada	Sean was involved with a drilling program and completed rock coring, packer testing and the installation of monitoring wells. After the completion of the drilling program, Sean completed hydraulic conductivity testing and sampling of the monitoring wells.
Permit to Take Water and Environmental Compliance Approval Annual Monitoring Reports Ontario, Canada	Sean has prepared the annual monitoring reports for various quarry sites for both their Environmental Compliance Approval (ECA) and Permit to Take Water (PTTW) monitoring programs. This involved presenting, discussing, and analyzing the monitoring data to assess for potential impacts from quarry activities.
Infiltration Rate Assessment Ontario, Canada	Sean carried out infiltration testing at the site of a proposed development in Ottawa, Ontario. He analyzed the data and prepared a memo to detail the results and how they relate to the potential for low impact development (LID) measures to be implemented.

APPENDIX B

Geological Study, Talisker Corporation Proposed Brechin Quarry, Township of Ramara, Ontario” dated June 2021 (Rev. 1)

PLEASE SEE APPENDIX D OF THIS REPORT FOR THE GEOLOGICAL REPORT

APPENDIX C

Water Well Records - Predicted Available Drawdown Less Than 20 Metres

4600685

UTM 17 Z 6465512 E

5 R 4929863 N

Elev. 5 R

Basin ~~22AA~~

Lot 10

GROUND WATER BRANCH 46 No 685
APR 11 1961
ONTARIO WATER
RESOURCES COMMISSION

The Ontario Water Resources Commission Act, 1957

WATER WELL RECORD

County or District Ontario Township, Village, Town or City Mara

Con. A Lot 10 Date completed 31 (day) March (month) 61 (year)

Owner [redacted] (print in block letters) Address Gambridge Ont.

[redacted]

Casing and Screen Record		**Pumping Test**	
Inside diameter of casing	6 1/4	Static level	14'
Total length of casing	22'	Test-pumping rate	6 G.P.M.
Type of screen	none	Pumping level	46'
Length of screen	—	Duration of test pumping	1 hr
Depth to top of screen	—	Water clear or cloudy at end of test	clear
Diameter of finished hole	6 1/4	Recommended pumping rate	6 G.P.M.
		with pumping level of	46'

Well Log | **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
Dug 24' clay	0	18'	53'	39'	sulphur
grey limestone	18'	24'			
Drilled grey limestone	24'	57			

For what purpose(s) is the water to be used? Farm

Is well on upland, in valley, or on hillside? [✓ upland]

Drilling Firm Baldwin Well Drilling

Address RR#1 Kirkfield

Licence Number 604

Name of Driller Larry Baldwin

Address RR#1 Kirkfield

Date April 5/61

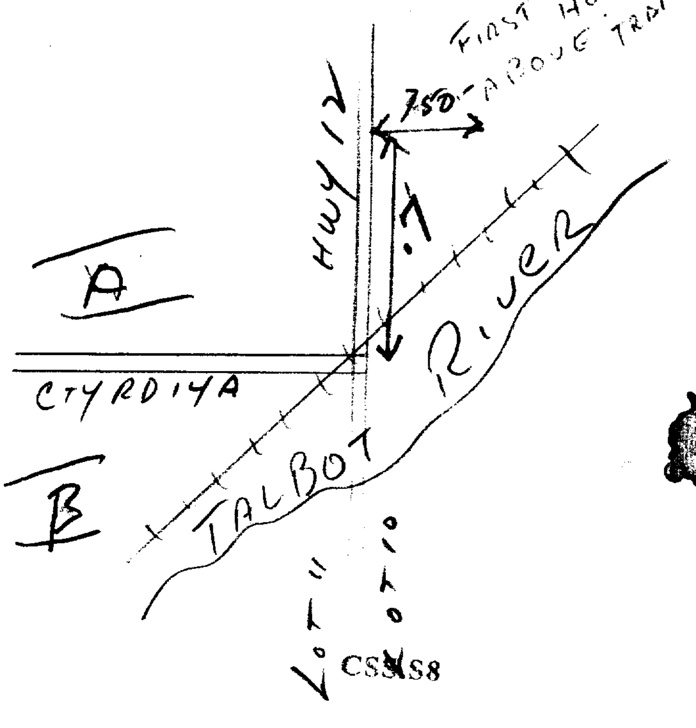
Carl Baldwin
(Signature of Licensed Drilling Contractor)

Form 5

Location of Well

RL

In diagram below show distances of well from road and lot line. Indicate north by arrow.



CSS S8

4600686

UTM 17 Z 646439 E

5 R 4929104 N

Elev. 5 R 0 0 7 4 0

Basin 2 8 7 11

ONTARIO

The Water-well Drillers Act, 1954
Department of Mines

GROUND WATER BRANCH 16 No.
JAN 1[illegible] 1959
ONTARIO WATER RESOURCES COMMISSION

~~686~~

Water-Well Record

County or Territorial District Ontario Township, Village, Town or City Mara

[redacted] n Village, Town or City)

Address Gambridge Ont.

(day) (month) (year)

Pipe and Casing Record

Casing diameter(s) 7"

Length(s) 12

Type of screen —

Length of screen —

Pumping Test

Static level 12'

Pumping rate 1 gal per min

Pumping level 53'

Duration of test 1 hr

1 St. Well **Well Log**

Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
Clay & stone	0	12'	40'	28'	fresh
Limestone	11'	53'			

For what purpose(s) is the water to be used? farm stock

Is water clear or cloudy? clear

Is well on upland, in valley, or on hillside? upland

Drilling firm Wm H Baldwin & Sons

Address Beaverton Ont

Name of Driller Carl Baldwin

Address Beaverton Ont

Licence Number 1157

I certify that the foregoing statements of fact are true.

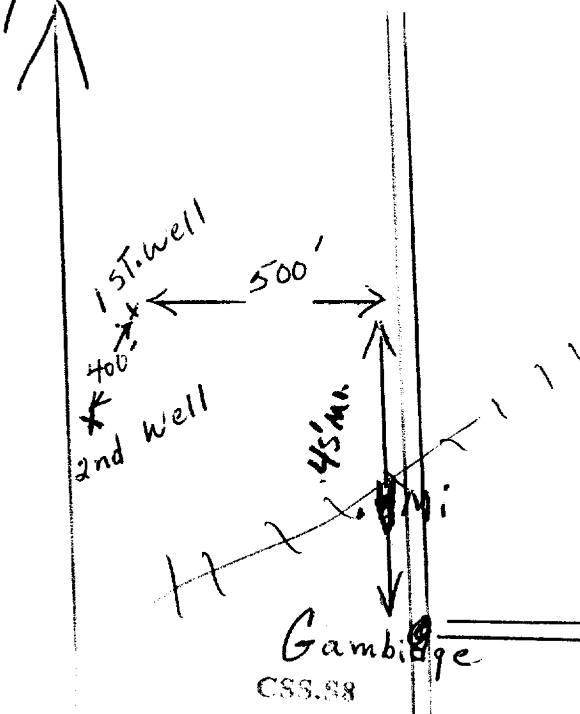
Date Jan 5/59 Carl Baldwin
Signature of Licensee

Form 5

way

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



CSS.88

4600687

UTM 17 Z 646424 E
5 R 4928998 N
Elev. 5 R 9N A
Basin ~~2~~ 11
22

ONTARIO

GROUND WATER BRANCH
46 №
JAN 19 1959
ONTARIO WATER
RESOURCES COMMISSION

~~687~~

The Water-well Drillers Act, 1954
Department of Mines

Water-Well Record

County or Territorial District Ontario Township, Village, Town or City Mara
[redacted]
Village, Town or City) ...
Address Gambridge
(day) (month) (year)

Pipe and Casing Record	Pumping Test
Casing diameter(s) 3	Static level 6'
Length(s) 15'	Pumping rate 1 gal per min
Type of screen —	Pumping level 52'
Length of screen —	Duration of test 1 hr

2 ND Well **Well Log** **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
Clay & stone	0	14'	45'	37'	fresh
Limestone	14	57'			

For what purpose(s) is the water to be used? house

Is water clear or cloudy? clear

Is well on upland, in valley, or on hillside? upland

Drilling firm Wm H Baldwin & Sons

Address Bexley Ont.

Name of Driller Carl Baldwin

Address Bexley Ont.

Licence Number 1157

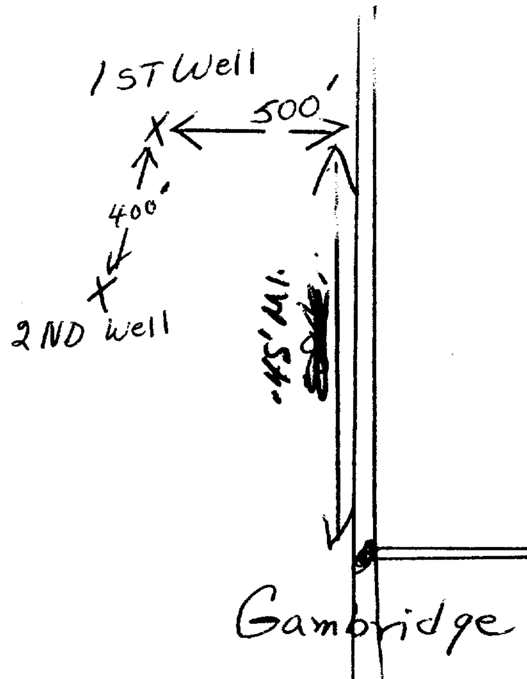
I certify that the foregoing statements of fact are true.

Date Jan 15/59 Carl Baldwin
Signature of Licensee

Form 5

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



C59168

Ontario

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

5714004

WATER WELL RECORD

31D/6E ?
31D6E

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

(11) 5714004 MUNICIP 57020 CON. CON A

COUNTY OR DISTRICT [redacted]

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: MARA

CON., BLOCK, TRACT, SURVEY, ETC.: ~~A~~ ~~C~~ ~~A~~ A GY

LOT: 011 GY

[redacted] AMEBRIGDE ONT

DATE COMPLETED: DAY 02 MO. 11 YR. 76

28800 RC 5 ELEVATION 0760 BASIN CODE 22

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Broken	Limestone			0	10
Grey	Limestone			10	36

(31) 0010 1571 0036215

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0034 ~~34~~	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06 ~~6~~	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	1/8	0	0010 ~~10~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)
DIAMETER INCHES
LENGTH FEET
MATERIAL AND TYPE
DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 0003 GPM.
DURATION OF PUMPING: 02 HOURS 00 MINS

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
003 FEET	030 FEET	030 FEET	030 FEET	030 FEET	030 FEET

IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: 30 FEET
WATER AT END OF TEST: 1 ☑ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☑ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING: 030 FEET
RECOMMENDED PUMPING RATE: 0003 GPM
GPM./FT. SPECIFIC CAPACITY

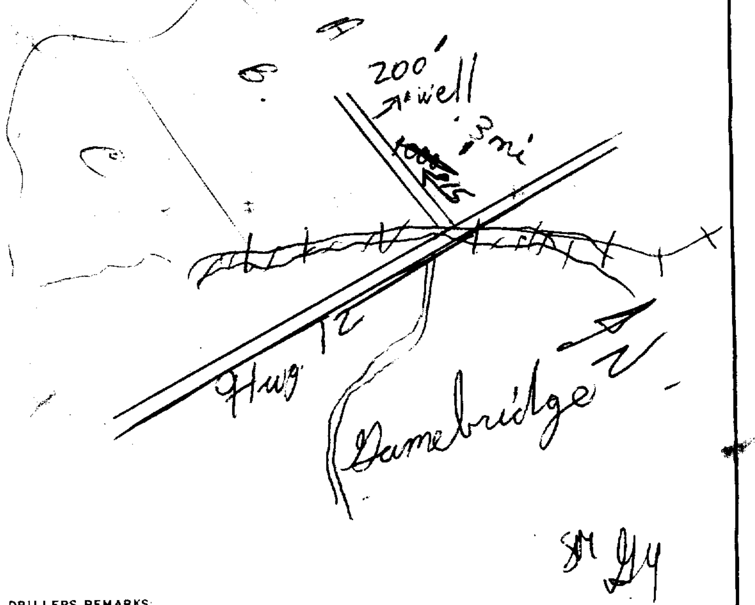
FINAL STATUS OF WELL 1
- 1 ☑ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE 01
- 1 ☑ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☐ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING 1
- 1 ☑ CABLE TOOL
- 2 ☐ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR: Gordon Weaver
LICENCE NUMBER: 5415
ADDRESS: Coboconk
NAME OF DRILLER OR BORER: Weavers Welldrilling
LICENCE NUMBER: 5415
SIGNATURE OF CONTRACTOR: Gordon Weaver
SUBMISSION DATE: DAY 1 MO. 11 YR. 76

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 5415
DATE RECEIVED: 090377
DATE OF INSPECTION: 30/10/78
INSPECTOR
June 7/78
REMARKS: not capped, sealed properly CSS.S8
P Aug 23/7
WI

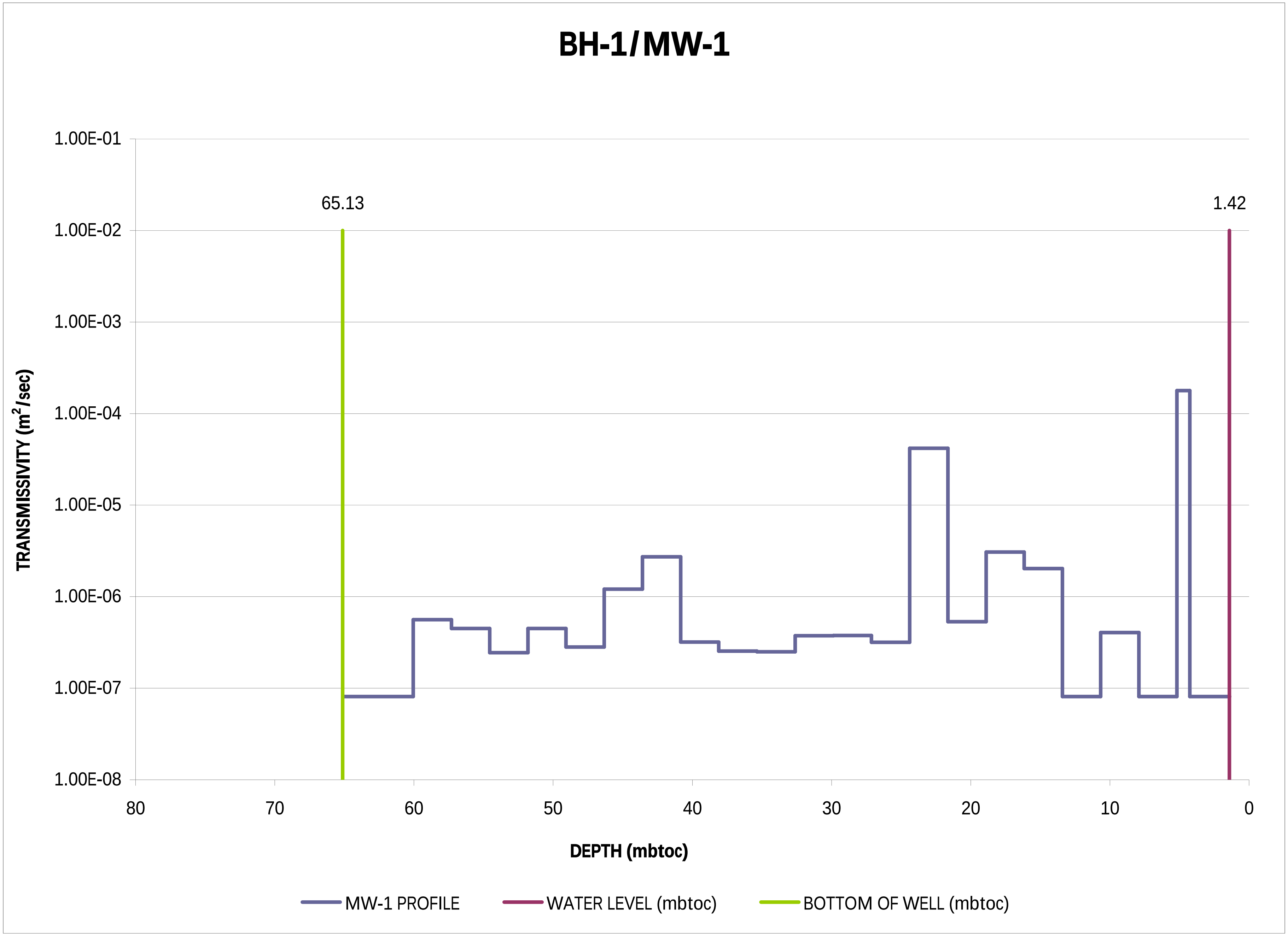
FORM 7 MOE 07-091

MINISTRY OF THE ENVIRONMENT COPY

wsp.com

APPENDIX F

Packer Testing Results


BH-1/MW-1
TRANSMISSIVITY (m^2/sec)
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
65.13
1.42
80
70
60
50
40
30
20
10
0
DEPTH (mbtoc)
MW-1 PROFILE
WATER LEVEL (mbtoc)
BOTTOM OF WELL (mbtoc)

Proposed Brechin Quarry

AEC Project Number:	18-288	Location: Brechin, ON	Ground Elevation (masl): 231.5		
Total Depth (mbtoc):	65.13	Static Water Level (mbtoc):	1.40	Stick-up (m):	1.00

BH1/MW1

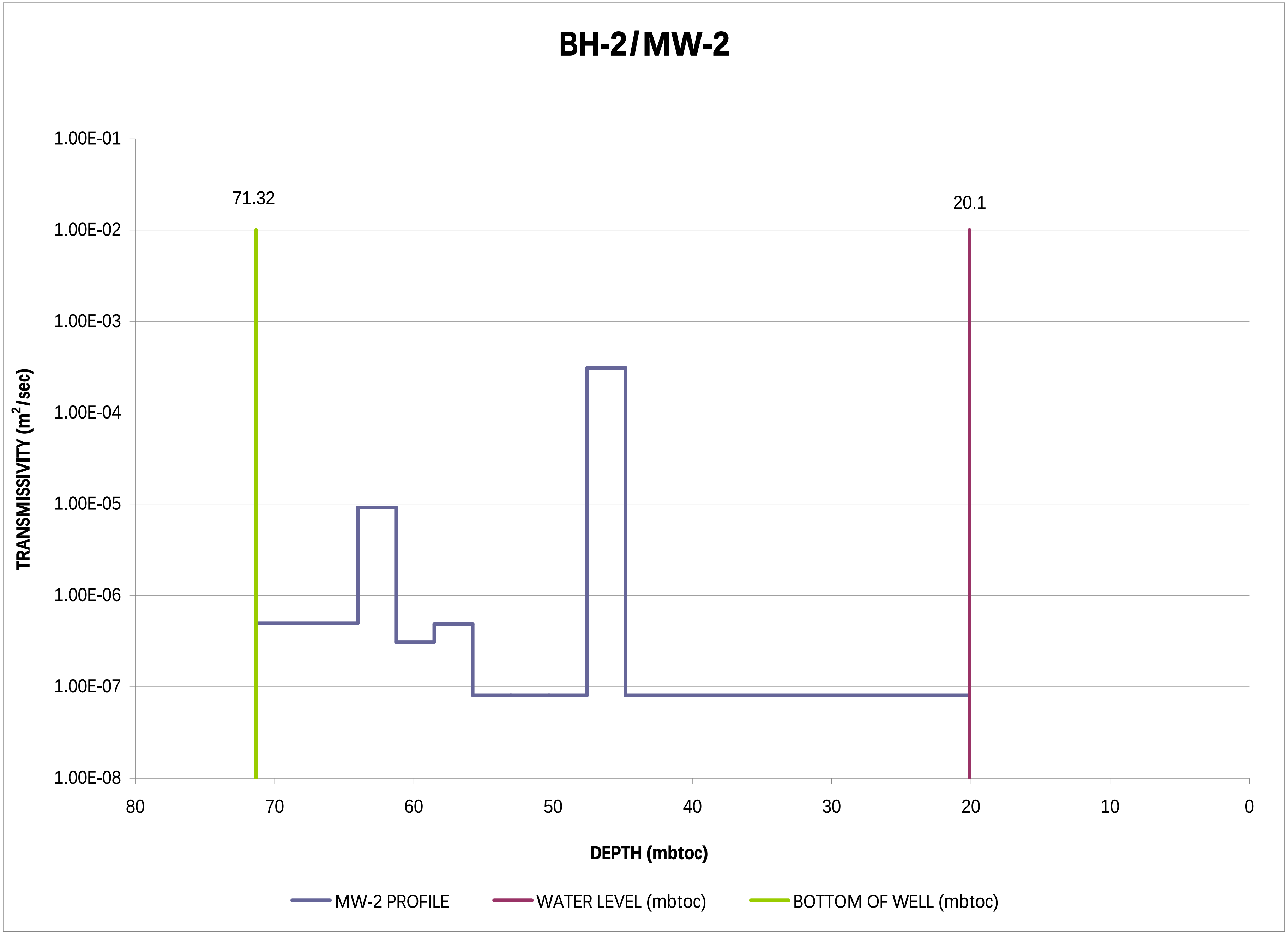
TEST NUMBER	TOP OF PACK ZONE (FT)	TOP OF PACK ZONE (M)	BOTTOM OF PACK ZONE (M)	SATURATED THICKNESS (M)	HYDRAULIC CONDUCTIVITY (M/S)	TRANSMISSIVITY (M^2/S)
1	197	60.0	63.1	61.7	2.65E-08	8.09E-08
2	188	57.3	60.4	58.9	1.84E-07	5.60E-07
3	179	54.6	57.6	56.2	1.47E-07	4.48E-07
4	170	51.8	54.9	53.4	8.00E-08	2.44E-07
5	161	49.1	52.1	50.7	1.47E-07	4.48E-07
6	152	46.3	49.4	48.0	9.27E-08	2.83E-07
7	143	43.6	46.6	45.2	3.97E-07	1.21E-06
8	134	40.8	43.9	42.5	8.96E-07	2.73E-06
9	125	38.1	41.1	39.7	1.05E-07	3.20E-07
10	116	35.4	38.4	37.0	8.36E-08	2.55E-07
11	107	32.6	35.7	34.2	8.18E-08	2.49E-07
12	98	29.9	32.9	31.5	1.23E-07	3.74E-07
13	89	27.1	30.2	28.8	1.23E-07	3.76E-07
14	80	24.4	27.4	26.0	1.04E-07	3.17E-07
15W*	71	21.6	24.7	23.3	1.37E-05	4.18E-05
16W*	74	22.6	25.6	24.2	1.33E-05	4.04E-05
17W*	77	23.5	26.5	25.1	1.57E-05	4.79E-05
18	62	18.9	21.9	20.5	1.75E-07	5.32E-07
19	53	16.2	19.2	17.8	1.01E-06	3.06E-06
20	44	13.4	16.5	15.0	6.66E-07	2.03E-06
21	35	10.7	13.7	12.3	2.65E-08	8.09E-08
22	26	7.9	11.0	9.6	1.33E-07	4.05E-07
23	17	5.2	8.2	6.8	2.65E-08	8.09E-08
24	14	4.3	7.3	5.9	5.83E-05	1.78E-04
-	-	-	-	-	-	-

Notes:

*15W, 16W and 17W represent packer intervals where rising/falling head tests were performed, which correspond to most conductive fracture.

Hydraulic conductivities determined using the confined Hvorslev method

Ground elevation referenced from First Base Solutions Inc. (2019)


BH-2/MW-2
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
TRANSMISSIVITY (m^2/sec)
71.32
20.1
80
70
60
50
40
30
20
10
0
DEPTH (mbtoc)
MW-2 PROFILE
WATER LEVEL (mbtoc)
BOTTOM OF WELL (mbtoc)

Proposed Brechin Quarry

AEC Project Number:	18-288	Location: Brechin, ON	Ground Elevation (masl): 238		
Total Depth (mbtoc):	71.32	Static Water Level (mbtoc):	20.10	Stick-up (m):	1.01

BH2/MW2

TEST NUMBER	TOP OF PACK ZONE (FT)	TOP OF PACK ZONE (M)	BOTTOM OF PACK ZONE (M)	SATURATED THICKNESS (M)	HYDRAULIC CONDUCTIVITY (M/S)	TRANSMISSIVITY (M^2/S)
1	210	64.0	67.1	47.0	1.63E-07	4.97E-07
2	201	61.3	64.3	44.2	3.02E-06	9.22E-06
3	192	58.5	61.6	41.5	1.01E-07	3.08E-07
4	183	55.8	58.8	38.7	1.60E-07	4.88E-07
5	174	53.0	56.1	36.0	2.65E-08	8.09E-08
6	165	50.3	53.3	33.2	2.65E-08	8.09E-08
7	156	47.5	50.6	30.5	2.65E-08	8.09E-08
8.1*	147	44.8	47.9	27.8	7.58E-05	2.31E-04
8.2*	147	44.8	47.9	27.8	1.02E-04	3.11E-04
8.3*	147	44.8	47.9	27.8	1.96E-05	5.97E-05
8.A**	147	20.1	44.8	24.7	2.65E-08	8.09E-08
9	150	45.7	48.8	28.7	1.05E-04	3.20E-04
10	153	46.6	49.7	29.6	2.65E-08	8.09E-08
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

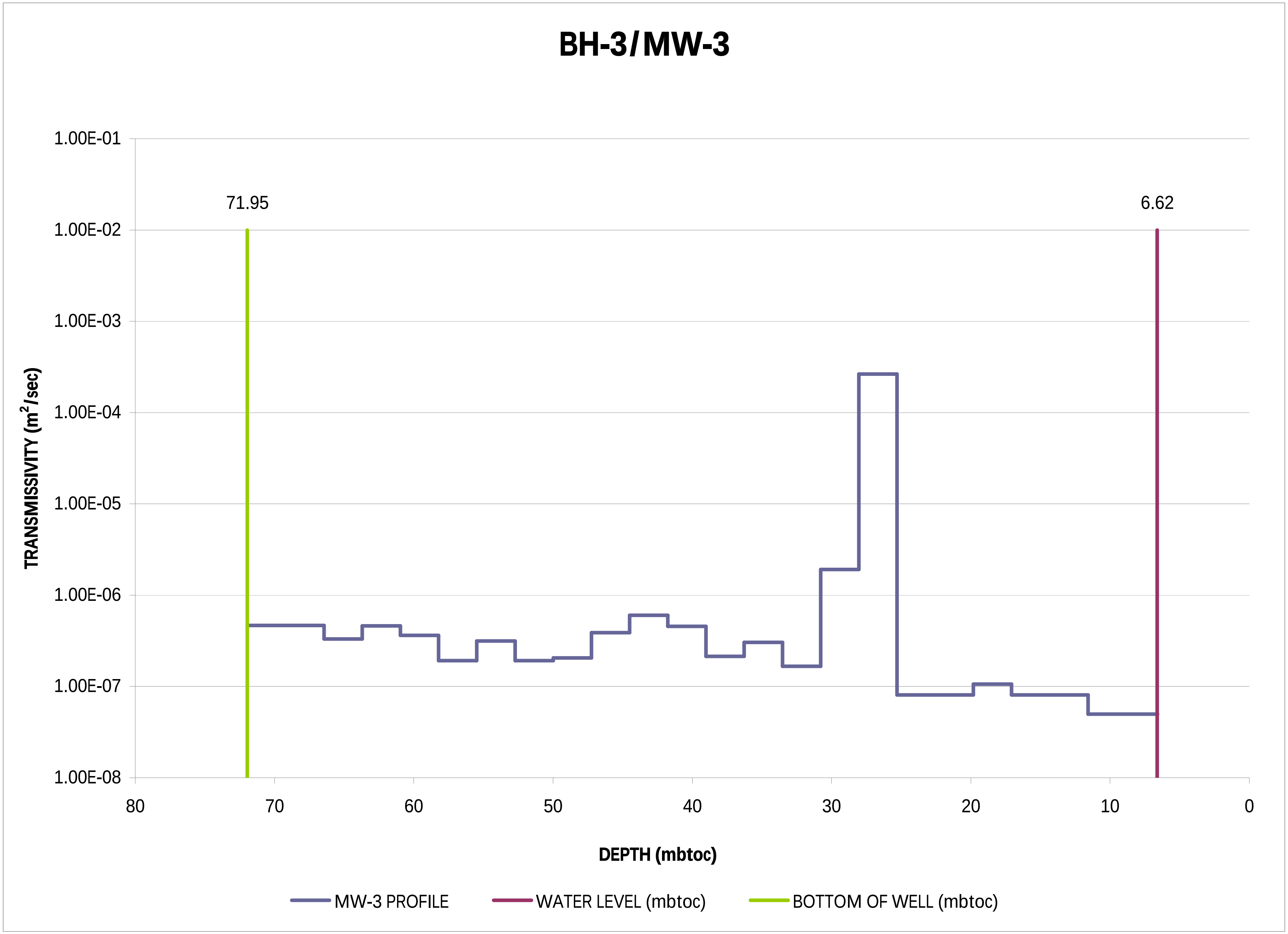
Notes:

* Multiple hydraulic tests performed at interval and most representative utilized in chart

** Annulus test represents water column from 47.9 mbtoc to static water level 20.1 m btoc

Hydraulic conductivities determined using the confined Hvorslev method

Ground elevation referenced from First Base Solutions Inc. (2019)


BH-3/MW-3
TRANSMISSIVITY (m^2/sec)
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
71.95
6.62
80
70
60
50
40
30
20
10
0
DEPTH (mbtoc)
MW-3 PROFILE
WATER LEVEL (mbtoc)
BOTTOM OF WELL (mbtoc)

Proposed Brechin Quarry

AEC Project Number:	18-288	Location: Brechin, ON	Ground Elevation (masl): 236.5		
Total Depth (mbtoc):	71.95	Static Water Level (mbtoc):	6.62	Stick-up (m):	1.00

BH3/MW3

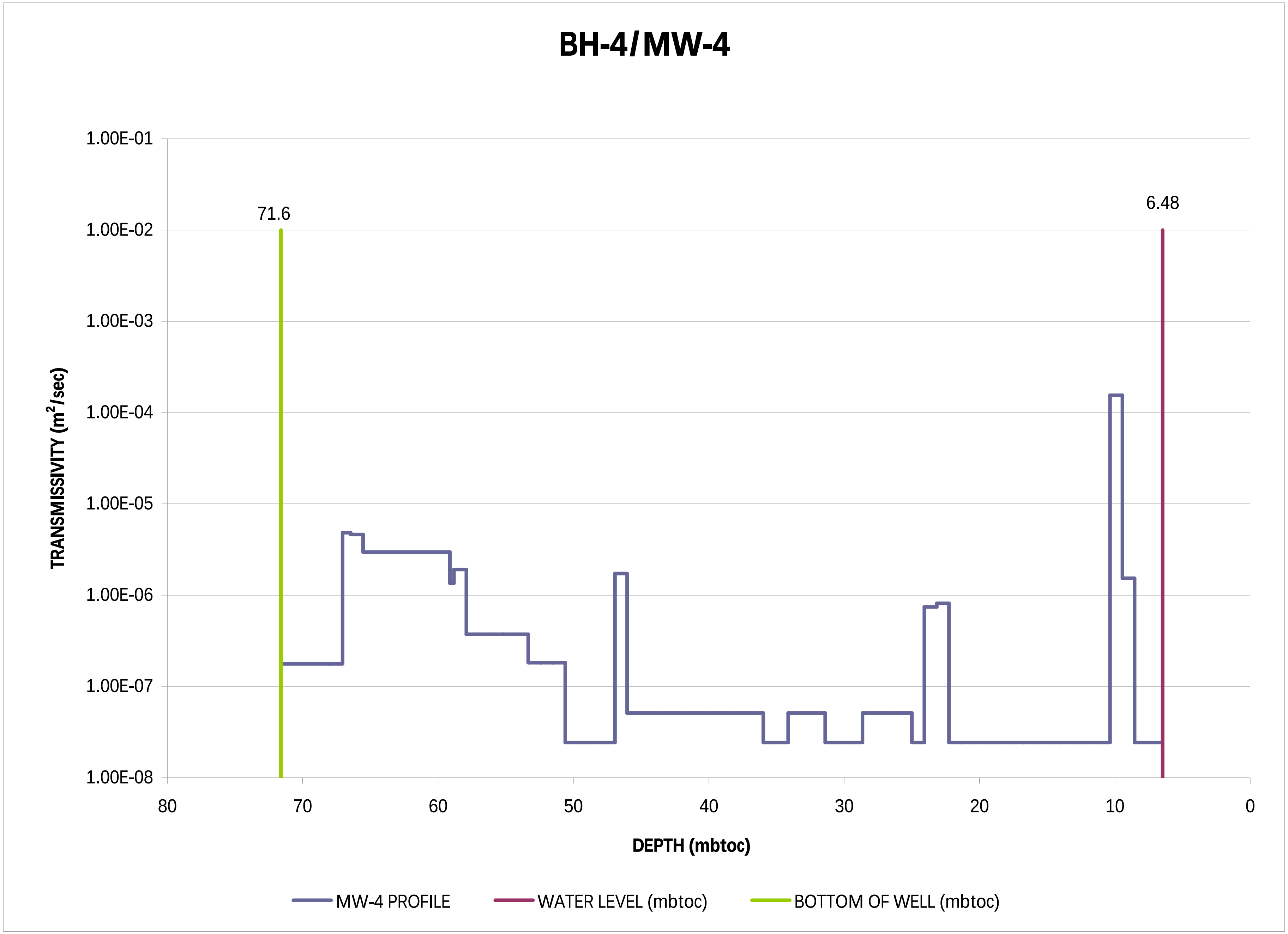
TEST NUMBER	TOP OF PACK ZONE (FT)	TOP OF PACK ZONE (M)	BOTTOM OF PACK ZONE (M)	SATURATED THICKNESS (M)	HYDRAULIC CONDUCTIVITY (M/S)	TRANSMISSIVITY (M^2/S)
1*	30	9.1	12.2	5.6	5.45E-08	4.99E-08
2*	33	10.1	13.1	6.5	5.45E-08	4.99E-08
3*	36	11.0	14.0	7.4	5.45E-08	4.99E-08
4*	39	11.9	14.9	8.3	5.45E-08	4.99E-08
5	218	66.4	69.5	62.9	1.53E-07	4.65E-07
6	209	63.7	66.8	60.1	1.09E-07	3.32E-07
7	200	61.0	64.0	57.4	1.51E-07	4.61E-07
8	191	58.2	61.3	54.6	1.19E-07	3.62E-07
9	182	55.5	58.5	51.9	6.29E-08	1.92E-07
10	173	52.7	55.8	49.2	1.03E-07	3.15E-07
11	164	50.0	53.0	46.4	6.29E-08	1.92E-07
12	155	47.2	50.3	43.7	6.72E-08	2.05E-07
13	146	44.5	47.5	40.9	1.28E-07	3.89E-07
14	137	41.8	44.8	38.2	1.98E-07	6.03E-07
15	128	39.0	42.1	35.4	1.50E-07	4.56E-07
16	119	36.3	39.3	32.7	7.02E-08	2.14E-07
17	110	33.5	36.6	30.0	9.98E-08	3.04E-07
18	101	30.8	33.8	27.2	5.45E-08	1.66E-07
19	92	28.0	31.1	24.5	6.27E-07	1.91E-06
20	83	25.3	28.3	21.7	8.68E-05	2.64E-04
21	74	22.6	25.6	19.0	2.65E-08	8.09E-08
22	65	19.8	22.9	16.2	2.65E-08	8.09E-08
23	56	17.1	20.1	13.5	3.48E-08	1.06E-07
24	47	14.3	17.4	10.8	2.65E-08	8.09E-08
25	38	11.6	14.6	8.0	2.65E-08	8.09E-08

Notes:

*Hydraulic tests were completed using a 3 ft (0.91 m) packer spacing

Hydraulic conductivities determined using the confined Hvorslev method

Ground elevation referenced from First Base Solutions Inc. (2019)


BH-4/MW-4
TRANSMISSIVITY (m²/sec)
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
71.6
6.48
80
70
60
50
40
30
20
10
0
DEPTH (mbtoc)
MW-4 PROFILE
WATER LEVEL (mbtoc)
BOTTOM OF WELL (mbtoc)

Proposed Brechin Quarry

AEC Project Number:	18-288	Location: Brechin, ON	Ground Elevation (masl): 236		
Total Depth (mbtoc):	71.60	Static Water Level (mbtoc):	6.48	Stick-up (m):	1.01

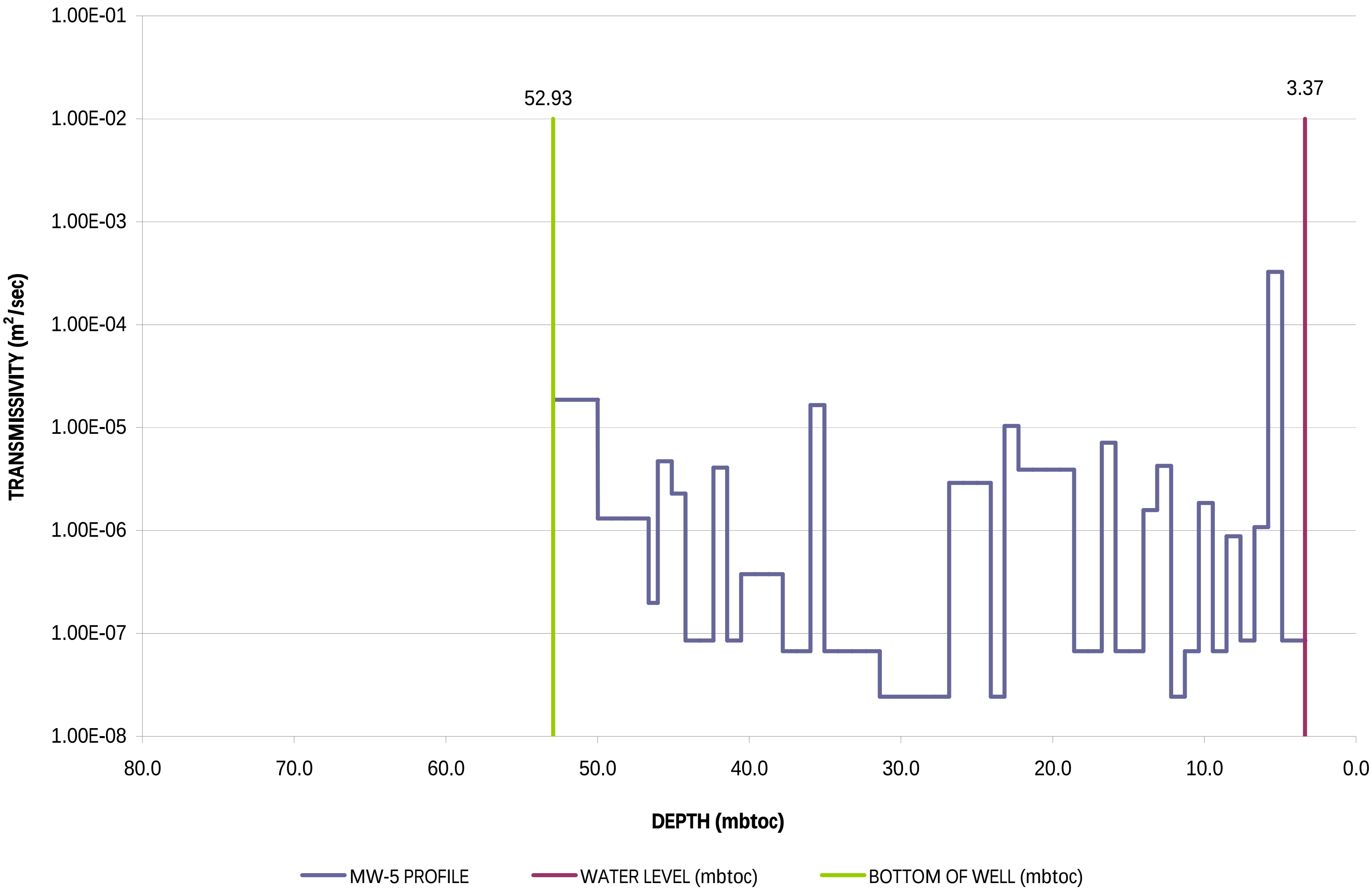
BH4/MW4

TEST NUMBER	TOP OF PACK ZONE (FT)	TOP OF PACK ZONE (M)	BOTTOM OF PACK ZONE (M)	SATURATED THICKNESS (M)	HYDRAULIC CONDUCTIVITY (M/S)	TRANSMISSIVITY (M^2/S)
65B	223	68.0	71.6	65.1	4.90E-07	1.76E-06
65	220	67.1	68.0	61.5	1.94E-07	1.77E-07
66	218	66.4	67.4	60.9	5.28E-06	4.83E-06
67	215	65.5	66.4	60.0	5.06E-06	4.62E-06
48.1	212	64.6	65.5	59.1	3.23E-06	2.95E-06
49.1	209	63.7	64.6	58.1	3.23E-06	2.95E-06
50.1	206	62.8	63.7	57.2	3.23E-06	2.95E-06
51.1	203	61.9	62.8	56.3	3.23E-06	2.95E-06
52.1	200	61.0	61.9	55.4	3.23E-06	2.95E-06
53.1	197	60.0	61.0	54.5	3.23E-06	2.95E-06
54	194	59.1	60.0	53.6	3.23E-06	2.95E-06
1	193	58.8	59.7	53.3	1.48E-06	1.35E-06
2	190	57.9	58.8	52.3	2.09E-06	1.91E-06
3	187	57.0	57.9	51.4	4.09E-07	3.74E-07
4	184	56.1	57.0	50.5	4.09E-07	3.74E-07
5	181	55.2	56.1	49.6	4.09E-07	3.74E-07
6	178	54.3	55.2	48.7	4.09E-07	3.74E-07
7	175	53.3	54.3	47.8	4.09E-07	3.74E-07
8	172	52.4	53.3	46.9	2.00E-07	1.82E-07
9	169	51.5	52.4	45.9	2.00E-07	1.82E-07
10	166	50.6	51.5	45.0	2.00E-07	1.82E-07
11	163	49.7	50.6	44.1	2.65E-08	2.42E-08
12	160	48.8	49.7	43.2	2.65E-08	2.42E-08
13	157	47.9	48.8	42.3	2.65E-08	2.42E-08
14	154	46.9	47.9	41.4	2.65E-08	2.42E-08
15	151	46.0	46.9	40.5	1.89E-06	1.73E-06
16	148	45.1	46.0	39.5	5.60E-08	5.12E-08
17	145	44.2	45.1	38.6	5.60E-08	5.12E-08
18	142	43.3	44.2	37.7	5.60E-08	5.12E-08
19	139	42.4	43.3	36.8	5.60E-08	5.12E-08
20	136	41.5	42.4	35.9	5.60E-08	5.12E-08

21	133	40.5	41.5	35.0	5.60E-08	5.12E-08
22	130	39.6	40.5	34.1	5.60E-08	5.12E-08
23	127	38.7	39.6	33.1	5.60E-08	5.12E-08
24	124	37.8	38.7	32.2	5.60E-08	5.12E-08
25	121	36.9	37.8	31.3	5.60E-08	5.12E-08
26	118	36.0	36.9	30.4	5.60E-08	5.12E-08
27	115	35.1	36.0	29.5	2.65E-08	2.42E-08
28	112	34.1	35.1	28.6	2.65E-08	2.42E-08
29	109	33.2	34.1	27.7	5.60E-08	5.12E-08
30	106	32.3	33.2	26.7	5.60E-08	5.12E-08
31	103	31.4	32.3	25.8	5.60E-08	5.12E-08
32	100	30.5	31.4	24.9	2.65E-08	2.42E-08
33	97	29.6	30.5	24.0	2.65E-08	2.42E-08
34	94	28.7	29.6	23.1	2.65E-08	2.42E-08
35	91	27.7	28.7	22.2	5.60E-08	5.12E-08
36	88	26.8	27.7	21.3	5.60E-08	5.12E-08
37	85	25.9	26.8	20.3	5.60E-08	5.12E-08
38	82	25.0	25.9	19.4	5.60E-08	5.12E-08
39	79	24.1	25.0	18.5	2.65E-08	2.42E-08
40	76	23.2	24.1	17.6	8.11E-07	7.41E-07
41	73	22.3	23.2	16.7	8.93E-07	8.16E-07
42	70	21.3	22.3	15.8	2.65E-08	2.42E-08
43	67	20.4	21.3	14.9	2.65E-08	2.42E-08
44	64	19.5	20.4	13.9	2.65E-08	2.42E-08
45	61	18.6	19.5	13.0	2.65E-08	2.42E-08
46	58	17.7	18.6	12.1	2.65E-08	2.42E-08
47	55	16.8	17.7	11.2	2.65E-08	2.42E-08
55	52	15.8	16.8	10.3	2.65E-08	2.42E-08
56	49	14.9	15.8	9.4	2.65E-08	2.42E-08
57	46	14.0	14.9	8.5	2.65E-08	2.42E-08
58	43	13.1	14.0	7.5	2.65E-08	2.42E-08
59	40	12.2	13.1	6.6	2.65E-08	2.42E-08
60	37	11.3	12.2	5.7	2.65E-08	2.42E-08
61	34	10.4	11.3	4.8	2.65E-08	2.42E-08
62	31	9.4	10.4	3.9	1.69E-04	1.55E-04
63	28	8.5	9.4	3.0	1.68E-06	1.54E-06
62A	28	8.5	6.5	0.0	2.65E-08	2.42E-08

Notes:
Hydraulic tests were completed using a 3 ft (0.91 m) packer spacing
Hydraulic conductivities determined using the confined Hvorslev method
Ground elevation referenced from First Base Solutions Inc. (2019)

BH-5/ MW-5



1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
TRANSMISSIVITY (m^2/sec)
52.93
3.37
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
DEPTH (mbtoc)
MW-5 PROFILE
WATER LEVEL (mbtoc)
BOTTOM OF WELL (mbtoc)

Proposed Brechin Quarry

AEC Project Number:		18-288	Location: Brechin, ON	Ground Elevation (masl): 232		
Total Depth (mbtoc):		52.93	Static Water Level (mbtoc):	3.37	Stick-up (m):	0.92

BH5/MW5

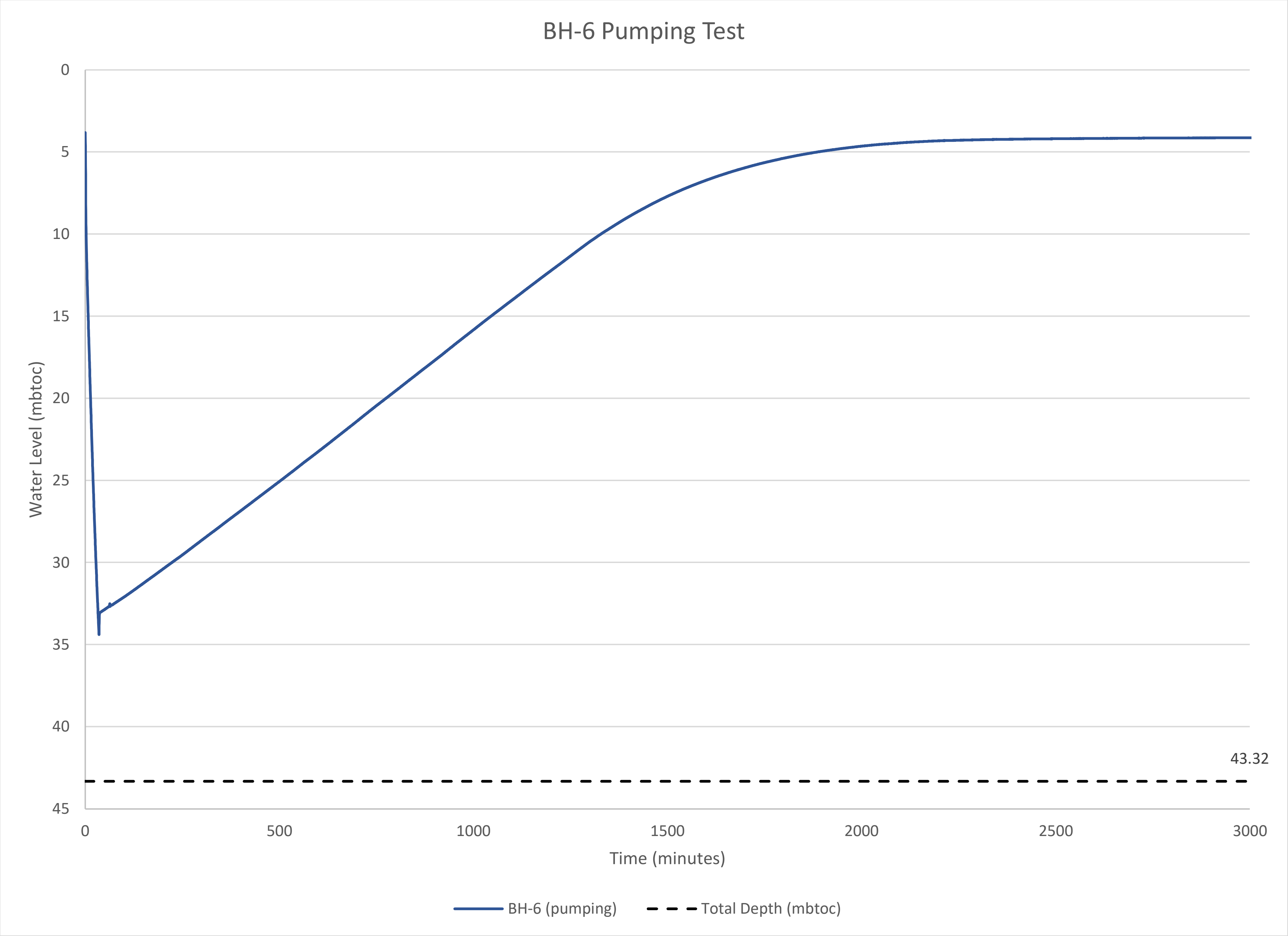
TEST NUMBER	TOP OF PACK ZONE (FT)	TOP OF PACK ZONE (M)	BOTTOM OF PACK ZONE (M)	SATURATED THICKNESS (M)	HYDRAULIC CONDUCTIVITY (M/S)	TRANSMISSIVITY (M^2/S)
1	169.8	51.8	52.9	49.5	NA	-
2	166.8	50.8	52.9	49.6	NA	-
3	163.8	49.9	52.9	49.5	6.21E-06	1.86E-05
4	19	5.8	6.7	3.3	NA	-
5	164	50.0	50.9	47.5	1.43E-06	1.31E-06
6	161	49.1	50.0	46.6	1.43E-06	1.31E-06
7	158	48.2	49.1	45.7	1.43E-06	1.31E-06
8	153	46.6	47.5	44.2	1.43E-06	1.31E-06
9	151	46.0	46.9	43.6	2.17E-07	1.98E-07
10	148	45.1	46.0	42.7	5.14E-06	4.70E-06
11	145	44.2	45.1	41.7	2.50E-06	2.29E-06
12	142	43.3	44.2	40.8	9.34E-08	8.54E-08
13	139	42.4	43.3	39.9	9.34E-08	8.54E-08
14	136	41.5	42.4	39.0	4.46E-06	4.08E-06
15	133	40.5	41.5	38.1	9.34E-08	8.54E-08
16	130	39.6	40.5	37.2	4.12E-07	3.77E-07
17	127	38.7	39.6	36.3	4.12E-07	3.77E-07
18	124	37.8	38.7	35.3	4.12E-07	3.77E-07
19	121	36.9	37.8	34.4	7.37E-08	6.73E-08
20	118	36.0	36.9	33.5	7.37E-08	6.73E-08
21	115	35.1	36.0	32.6	1.81E-05	1.66E-05
22	112	34.1	35.1	31.7	7.37E-08	6.73E-08
23	109	33.2	34.1	30.8	7.37E-08	6.73E-08
24	106	32.3	33.2	29.9	7.37E-08	6.73E-08
25	103	31.4	32.3	28.9	7.37E-08	6.73E-08
26	100	30.5	31.4	28.0	2.65E-08	2.43E-08
27	97	29.6	30.5	27.1	2.65E-08	2.43E-08
28	94	28.7	29.6	26.2	2.65E-08	2.43E-08
29	91	27.7	28.7	25.3	2.65E-08	2.43E-08
30	88	26.8	27.7	24.4	2.65E-08	2.43E-08
31	85	25.9	26.8	23.5	3.17E-06	2.90E-06

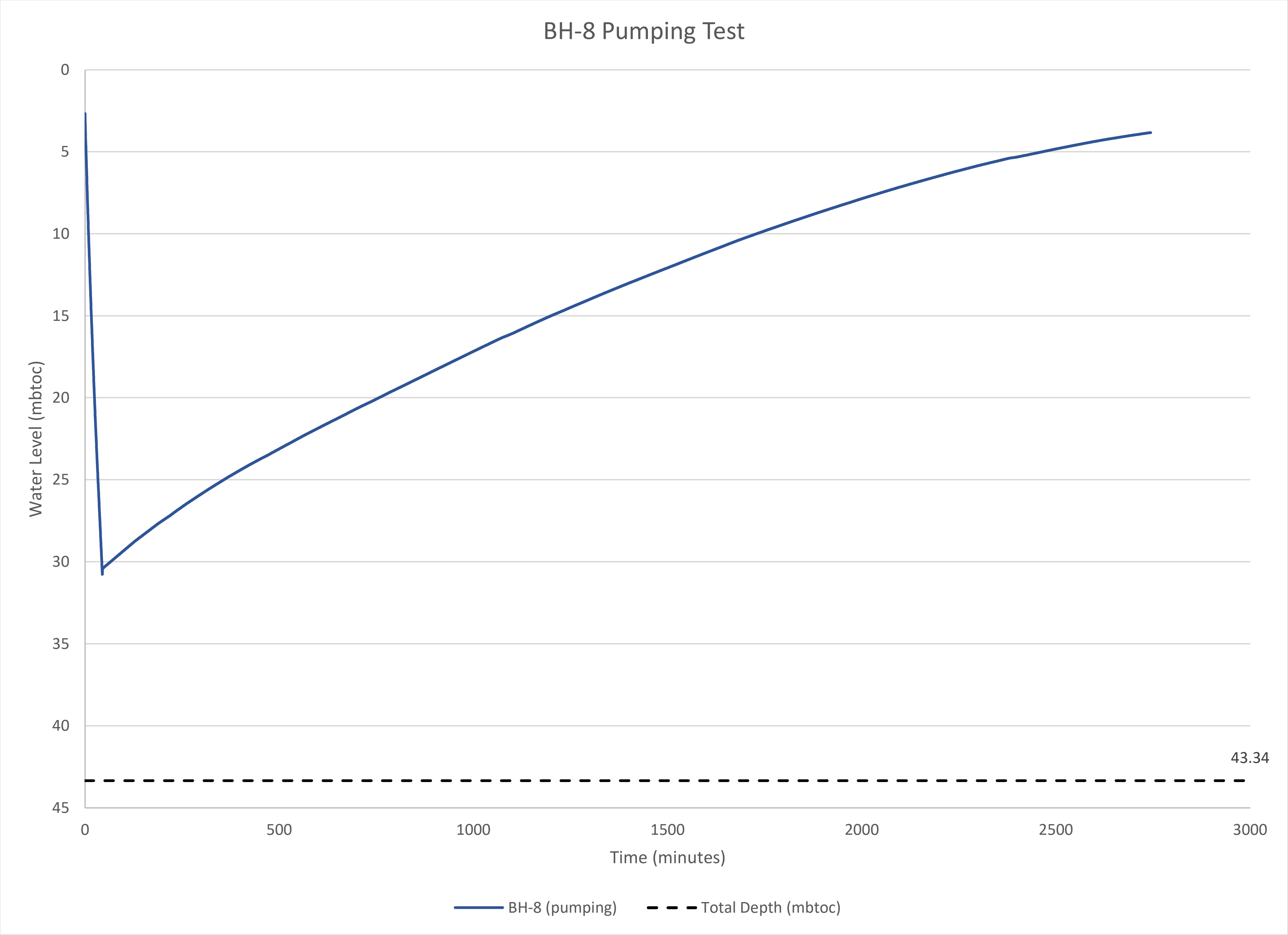
32	82	25.0	25.9	22.5	3.17E-06	2.90E-06
33	79	24.1	25.0	21.6	3.17E-06	2.90E-06
34	76	23.2	24.1	20.7	2.65E-08	2.43E-08
35	73	22.3	23.2	19.8	1.13E-05	1.04E-05
36	70	21.3	22.3	18.9	4.26E-06	3.90E-06
37	67	20.4	21.3	18.0	4.26E-06	3.90E-06
38	64	19.5	20.4	17.1	4.26E-06	3.90E-06
39	61	18.6	19.5	16.1	4.26E-06	3.90E-06
40	58	17.7	18.6	15.2	7.37E-08	6.73E-08
41	55	16.8	17.7	14.3	7.37E-08	6.73E-08
42	52	15.8	16.8	13.4	7.77E-06	7.11E-06
43	49	14.9	15.8	12.5	7.37E-08	6.73E-08
44	46	14.0	14.9	11.6	7.37E-08	6.73E-08
45	43	13.1	14.0	10.7	1.72E-06	1.58E-06
46	40	12.2	13.1	9.7	4.64E-06	4.24E-06
47	37	11.3	12.2	8.8	2.65E-08	2.43E-08
48	34	10.4	11.3	7.9	7.37E-08	6.73E-08
49	31	9.4	10.4	7.0	2.03E-06	1.85E-06
50	28	8.5	9.4	6.1	7.37E-08	6.73E-08
51	25	7.6	8.5	5.2	9.60E-07	8.78E-07
52	22	6.7	7.6	4.3	9.34E-08	8.54E-08
53	19	5.8	6.7	3.3	1.18E-06	1.08E-06
54	16	4.9	5.8	2.4	3.56E-04	3.26E-04
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

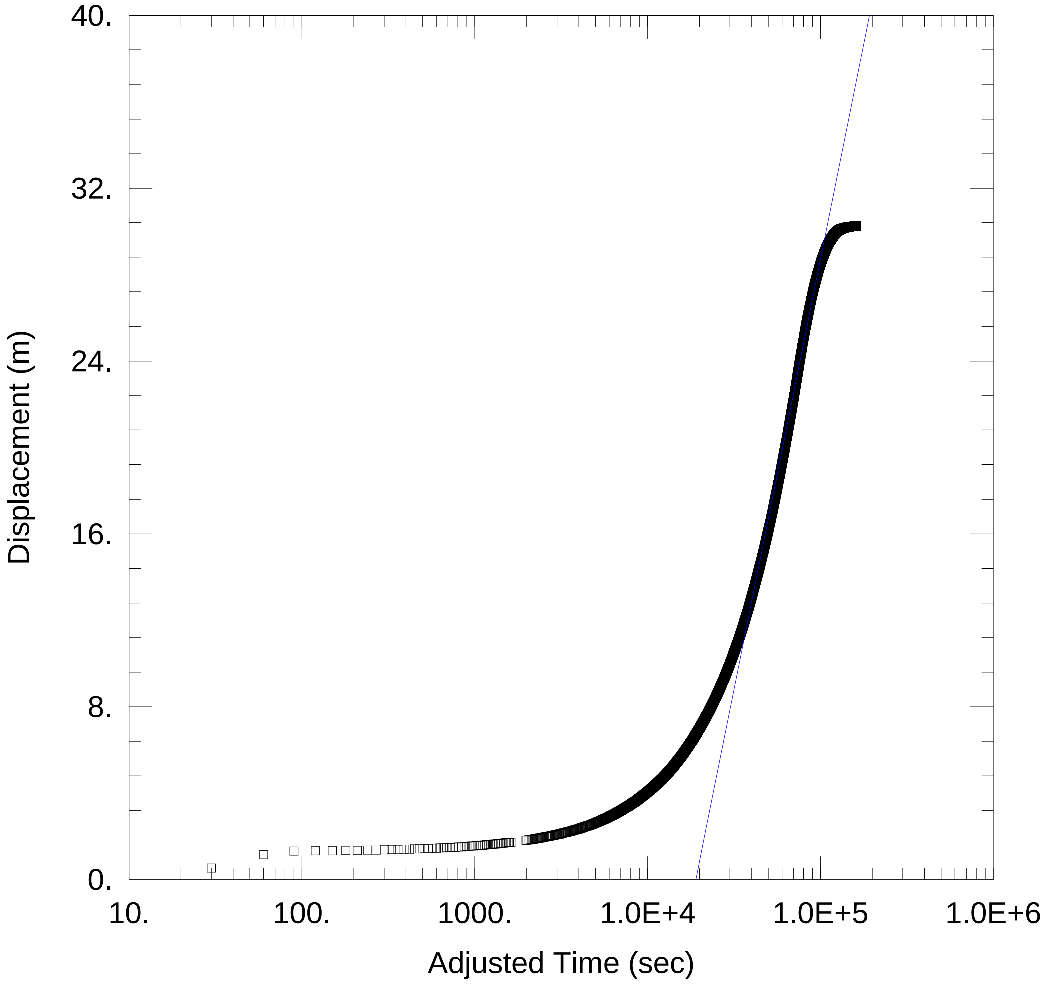
Notes:
Hydraulic tests were completed using a 3 ft (0.91 m) packer spacing
Hydraulic conductivities determined using the confined Hvorslev method
Ground elevation referenced from First Base Solutions Inc. (2019)

APPENDIX G

Pumping Test Data


BH-6 Pumping Test
Water Level (mbtoc)
0
5
10
15
20
25
30
35
40
45
43.32
0
500
1000
1500
2000
2500
3000
Time (minutes)
BH-6 (pumping)
Total Depth (mbtoc)


BH-8 Pumping Test
Water Level (mbtoc)
0
5
10
15
20
25
30
35
40
45
43.34
0
500
1000
1500
2000
2500
3000
Time (minutes)
BH-8 (pumping)
Total Depth (mbtoc)



BRECHIN QUARRY PUMPING TEST

Data Set: L:\...\BH-6 - Recovery - Cooper-Jacob - Late Time.aqt
Date: 01/26/22 Time: 09:51:05

PROJECT INFORMATION

Company: Azimuth
Client: Talisker
Project: 18-288
Location: Brechin, ON
Test Well: BH-6
Test Date: 2020

AQUIFER DATA

Saturated Thickness: 43.32 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
BH-6	0	0

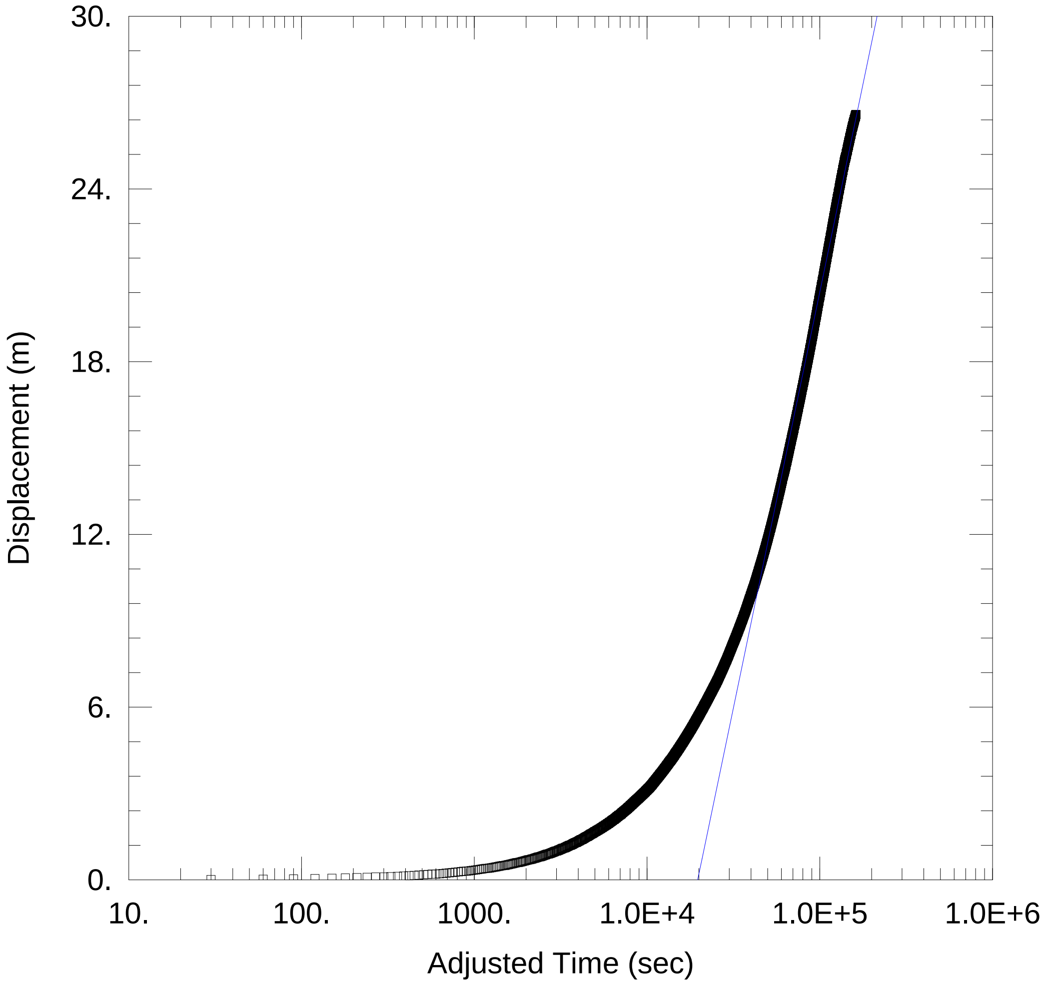
Observation Wells

Well Name	X (m)	Y (m)
□ BH-6	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 2.763E-6 m^2/sec S = 11.81



BRECHIN QUARRY PUMPING TEST

Data Set: L:\...\BH-8 - Recovery - Cooper-Jacob - Late Time.aqt
Date: 01/26/22 Time: 09:56:49

PROJECT INFORMATION

Company: Azimuth
Client: Talisker
Project: 18-288
Location: Brechin, ON
Test Well: BH-8
Test Date: 2020

AQUIFER DATA

Saturated Thickness: 43.34 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
BH-8	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ BH-8	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 3.806E-6 m^2/sec
S = 16.83

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-35102

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20
DATE REPORTED: 25-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6	BH-8		
			Sample I.D.		B20-35102-1	B20-35102-2		
			Date Collected		04-Nov-20	04-Nov-20		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	13-Nov-20/O	7.38	7.64		
pH @25°C	pH Units		SM 4500H	10-Nov-20/O	8.47	8.31		
Langelier Index(25°C)	S.I.		Calc.	13-Nov-20/O	1.09	0.668		
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	10-Nov-20/O	278	336		
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	10-Nov-20/O	267	330		
Carbonate (as CaCO3)	mg/L	5	SM 2320B	10-Nov-20/O	11	6		
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	10-Nov-20/O	< 5	< 5		
Conductivity @25°C	µmho/cm	1	SM 2510B	10-Nov-20/O	1410	1990		
Fluoride	mg/L	0.1	SM4110C	11-Nov-20/O	0.4	5.9		
Chloride	mg/L	0.5	SM4110C	11-Nov-20/O	282	416		
Nitrate (N)	mg/L	0.05	SM4110C	11-Nov-20/O	< 0.05	< 0.05		
Nitrite (N)	mg/L	0.05	SM4110C	11-Nov-20/O	< 0.05	< 0.05		
Bromide	mg/L	0.4	SM4110C	11-Nov-20/O	2.8	2.8		
Sulphate	mg/L	1	SM4110C	11-Nov-20/O	4	14		
Calcium	mg/L	0.02	SM 3120	10-Nov-20/O	45.9	22.1		
Magnesium	mg/L	0.02	SM 3120	10-Nov-20/O	18.9	10.0		
Sodium	mg/L	0.2	SM 3120	10-Nov-20/O	240	380		
Potassium	mg/L	0.1	SM 3120	10-Nov-20/O	12.2	7.2		
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Nov-20/K	1.53	0.62		
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Nov-20/K	0.016	< 0.002		
Phosphorus-Total	mg/L	0.01	E3199A.1	18-Nov-20/K	0.11	0.05		
Silica	mg/L	0.02	SM 3120	10-Nov-20/O	6.27	5.39		
Colour	TCU	2	SM 2120C	09-Nov-20/O	< 2	< 2		
Turbidity	NTU	0.1	SM 2130	09-Nov-20/O	208	62.2		
Aluminum (total)	mg/L	0.01	SM 3120	10-Nov-20/O	0.94	0.25		
Arsenic	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0004	0.0003		
Barium	mg/L	0.001	SM 3120	10-Nov-20/O	0.014	0.031		

Steve Garrett
Director of Laboratory Services

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-35102**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20
DATE REPORTED: 25-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6	BH-8		
			Sample I.D.		B20-35102-1	B20-35102-2		
			Date Collected		04-Nov-20	04-Nov-20		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Boron	mg/L	0.005	SM 3120	10-Nov-20/O	0.885	2.78		
Cadmium	mg/L	0.000015	EPA 200.8	20-Nov-20/O	0.000047	< 0.000015		
Chromium	mg/L	0.001	SM 3120	10-Nov-20/O	0.003	0.001		
Copper	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0027	0.0007		
Iron	mg/L	0.005	SM 3120	10-Nov-20/O	11.3	5.01		
Lead	mg/L	0.00002	EPA 200.8	20-Nov-20/O	0.0281	0.00528		
Manganese	mg/L	0.001	SM 3120	10-Nov-20/O	0.157	0.072		
Molybdenum	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0026	0.0017		
Nickel	mg/L	0.01	SM 3120	10-Nov-20/O	< 0.01	< 0.01		
Selenium	mg/L	0.001	EPA 200.8	20-Nov-20/O	0.005	0.006		
Silver	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0001	< 0.0001		
Strontium	mg/L	0.001	SM 3120	10-Nov-20/O	1.62	1.31		
Thallium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	< 0.00005	< 0.00005		
Tin	mg/L	0.05	SM 3120	10-Nov-20/O	< 0.05	< 0.05		
Titanium	mg/L	0.005	SM 3120	10-Nov-20/O	0.036	0.006		
Uranium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00010	0.00026		
Vanadium	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0009	0.0002		
Zinc	mg/L	0.005	SM 3120	10-Nov-20/O	0.029	0.009		
TDS(ion sum calc.)	mg/L	1	Calc.	13-Nov-20/O	783	1062		
Hardness (as CaCO3)	mg/L	1	SM 3120	10-Nov-20/O	192	96		
% Difference	%		Calc.	13-Nov-20/O	5.90	0.210		
Sulphide	mg/L	0.01	SM4500-S2	10-Nov-20/K	0.15	0.22		
Total Organic Carbon	mg/L	0.2	EPA 415.2	12-Nov-20/O	1.4	0.6		

Steve Garrett
Director of Laboratory Services

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

APPENDIX H

Instrumentation and Monitoring Well Details

Instrumentation and Measured Well Details

Monitoring Well	Hydrostratographic Unit[1]	Hydrostratigraphic Unit Identifier[1]	Easting	Northing	Ground Elevation (masl)[2]	Bore Collar Elevation (masl)[2]	Bottom Well Depth (mbtoc)	Overburden Thickness (m)	Bottom Well Depth (masl)	Overburden Thickness (masl)	Bore Casing Stickup (m)	Bore Diameter	Well Casing Diameter	Well Stickup (m)	Screen Interval (mbgs)		Sand Pack Interval (mbgs)		Screen Interval (masl)		Sand Pack Interval (masl)	
												mm	mm		bottom	top	bottom	top	bottom	top	bottom	top
BH-1	Shadow Lake/ Precambrian Contact Zone	B	645411.333	4931533.149	231.555	232.572	65.01	2.14	167.562	229.415	1.02	96	12.7	-0.07	64.1	61.0	64.1	58.4	167.5	170.5	167.5	173.2
BH-1	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645411.333	4931533.149	231.555	232.572	45.81	2.14	186.762	229.415	1.02	96	12.7	-0.04	44.8	41.8	45.1	36.8	186.7	189.8	186.4	194.8
BH-1	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645411.333	4931533.149	231.555	232.572	31.45	2.14	201.122	229.415	1.02	96	-	0	30.43	0	-	-	201.12	231.555	-	-
BH-2	Shadow Lake Formation	C	645918.939	4930985.711	238.843	239.758	64.89	0.91	174.868	237.933	0.92	96	12.7	-0.09	64.1	61.0	64.0	59.9	174.8	177.8	174.8	178.9
BH-2	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645918.939	4930985.711	238.843	239.758	51.53	0.91	188.228	237.933	0.92	96	12.7	-0.03	50.6	47.6	51.1	43.0	188.2	191.2	187.7	195.8
BH-2	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645918.939	4930985.711	238.843	239.758	31.6	0.91	208.158	237.933	0.92	96	-	0	30.69	0	-	-	208.16	238.843	-	-
BH-3	Lower Green Beds of Gull River Formation	D	645585.646	4930189.284	236.695	237.69	64.02	0.46	173.67	236.235	1.00	96	12.7	-0.1	63.1	60.1	63.1	57.9	173.6	176.6	173.6	178.8
BH-3	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	645585.646	4930189.284	236.695	237.69	54.46	0.46	183.23	236.235	1.00	96	12.7	-0.04	53.5	50.5	53.6	48.0	183.2	186.2	183.1	188.7
BH-3	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	645585.646	4930189.284	236.695	237.69	35.95	0.46	201.74	236.235	1.00	96	-	0	34.96	0	-	-	201.74	236.695	-	-
BH-4	Shadow Lake/ Precambrian Contact Zone	B	644876.573	4930501.079	236.078	237.077	71.29	1.68	165.787	234.398	1.00	96	12.7	-0.07	70.4	67.3	70.0	65.1	165.7	168.8	166.1	171.0
BH-4	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	644876.573	4930501.079	236.078	237.077	50.92	1.68	186.157	234.398	1.00	96	12.7	-0.03	50.0	46.9	50.0	44.1	186.1	189.2	186.1	192.0
BH-4	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	644876.573	4930501.079	236.078	237.077	31.24	1.68	205.837	234.398	1.00	96	-	0	30.24	0	-	-	205.84	236.078	-	-
BH-5	Upper Green Bed of Gull River Formation/Upper Gull River Formation	F	644322.975	4930363.051	231.981	232.987	52.73	3.66	180.257	228.321	1.01	96	12.7	-0.1	51.8	48.8	51.8	44.0	180.2	183.2	180.2	188.0
BH-5	Weathered Shale/clay zone at Bobcaygeon/Gull River formationa contact	H	644322.975	4930363.051	231.981	232.987	41.83	3.66	191.157	228.321	1.01	96	12.7	-0.04	40.9	37.8	41.0	38.0	191.1	194.2	191.0	194.0
BH-5	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	Z	644322.975	4930363.051	231.981	232.987	31.36	3.66	201.627	228.321	1.01	96	-	0	30.35	0	-	-	201.63	231.981	-	-
BH-6	Bobcaygeon Formation	I	644672.845	4930121.664	234.186	234.835	43.10	0.91	191.735	233.276	0.65	96	25.4	-0.06	42.5	39.5	42.5	35.1	191.7	194.7	191.7	199.1
BH-6	Bobcaygeon Formatkon	K	644672.845	4930121.664	234.186	234.835	30.81	0.91	204.025	233.276	0.65	96	25.4	-0.07	30.2	27.2	30.2	20.1	204.0	207.0	204.0	214.1
BH-6	Verulam Formation	L	644672.845	4930121.664	234.186	234.835	15.63	0.91	219.205	233.276	0.65	96	25.4	-0.05	15.0	12.0	15.0	7.9	219.2	222.2	219.2	226.3
BH-7	Bobcaygeon Formation	I	645166.401	4930103.280	239.659	240.176	43.34	2.13	196.836	237.529	0.52	152	25.4	-0.05	42.9	39.8	42.9	36.9	196.8	199.8	196.8	202.8
BH-7	Bobcaygeon Formatkon	K	645166.401	4930103.280	239.659	240.176	32.44	2.13	207.736	237.529	0.52	152	25.4	-0.13	32.1	29.0	32.1	22.9	207.6	210.7	207.6	216.8
BH-7	Verulam Formation	L	645166.401	4930103.280	239.659	240.176	18.41	2.13	221.766	237.529	0.52	152	25.4	-0.01	17.9	14.9	17.9	11.0	221.8	224.8	221.8	228.7
BH-8	Upper Gull River Formation	G	646052.641	4930562.409	232.304	232.973	43.39	3.05	189.583	229.254	0.67	152	25.4	-0.07	42.8	39.7	42.8	35.1	189.5	192.6	189.5	197.3
BH-8	Bobcaygeon Formation	K	646052.641	4930562.409	232.304	232.973	22.59	3.05	210.383	229.254	0.67	152	25.4	-0.03	22.0	18.9	22.0	11.9	210.4	213.4	210.4	220.4
BH-8	Verulam Formation	L	646052.641	4930562.409	232.304	232.973	8.47	3.05	224.503	229.254	0.67	152	25.4	-0.05	7.9	4.8	7.9	6.1	224.5	227.5	224.5	226.2
BH-9	Upper Gull River Formation	G	645871.983	4931210.093	238.367	238.599	43.71	1.52	194.889	236.847	0.23	152	25.4	-0.06	43.5	40.5	43.5	39.9	194.8	197.9	194.8	198.4
BH-9	Bobcaygeon Formation	K	645871.983	4931210.093	238.367	238.599	23.14	1.52	215.459	236.847	0.23	152	25.4	-0.06	23.0	19.9	23.0	18.0	215.4	218.4	215.4	220.4
BH-9	Verulam Formation	L	645871.983	4931210.093	238.367	238.599	12.14	1.52	226.459	236.847	0.23	152	25.4	-0.05	12.0	8.9	12.0	6.4	226.4	229.5	226.4	232.0

Notes:

[1] Hydrostratigraphic reference from Golder Associates Inc. Technical Memorandum dated January 2, 2019 and email dated March 4, 2021

[2] Ground and collar elevations determined using a differential Global Positioning System (dGPS ≤ 0.05 m accuracy)

masl: meters above sea level

mbtoc: meters below top of casing

mbgs: meters below ground surface

APPENDIX I

Hydraulic Testing Results

Hydraulic Testing Details

Monitoring Well	Hydrostratigraphic Unit Identifier[1]	Hydrostratographic Unit[1]	Ground Elevation (masl)[2]	Bore Collar Elevation (masl)[2]	Bore Casing Stickup (m)	Bottom Well Depth (mbtoc)	Monitor Stickup (m)	Screen Length (m)	Screen Interval (mbgs)		Sand Pack Interval (mbgs)		Screen Interval (masl)		Sand Pack Interval (masl)		Test Date	Test Method	Hydraulic Conductivity (m/sec)[3]	Interval transmissivity (m^2/sec)
									bottom	top	bottom	top	bottom	top	bottom	top				
BH-1	B	Shadow Lake/ Precambrian Contact Zone	231.555	232.572	1.02	65.01	-0.07	3.1	64.1	61.0	64.1	58.4	167.5	170.5	167.5	173.2	12-May-20	Rising Head	2.34E-08	1.33E-07
BH-1	F	Upper Green Beds of Gull River Formation	231.555	232.572	1.02	45.81	-0.04	3.1	44.8	41.8	45.1	36.8	186.7	189.8	186.4	194.8	12-May-20	Rising Head	5.21E-09	4.33E-08
BH-1	Z	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	231.555	232.572	1.02	31.45	0	30.4	30.4	0.0	-	-	201.1	231.6	-	-	-	Not Tested	-	-
BH-2	C	Shadow Lake Formation	238.843	239.758	0.92	64.89	-0.09	3.1	64.1	61.0	64.0	59.9	174.8	177.8	174.8	178.9	12-May-20	Rising Head	1.31E-07	5.37E-07
BH-2	F	Upper Green Beds of Gull River Formation	238.843	239.758	0.92	51.53	-0.03	3.1	50.6	47.6	51.1	43.0	188.2	191.2	187.7	195.8	12-May-20	Rising Head	1.26E-06	1.02E-05
BH-2	Z	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	238.843	239.758	0.92	31.6	0	30.7	30.7	0.0	-	-	208.2	238.8	-	-	-	Not Tested	-	-
BH-3	D	Lower Green Beds of Gull River Formation	236.695	237.69	1.00	64.02	-0.1	3.1	63.1	60.1	63.1	57.9	173.6	176.6	173.6	178.8	12-May-20	Rising Head	5.89E-09	3.06E-08
BH-3	F	Upper Green Beds of Gull River Formation	236.695	237.69	1.00	54.46	-0.04	3.1	53.5	50.5	53.6	48.0	183.2	186.2	183.1	188.7	12-May-20	Rising Head	3.34E-09	1.87E-08
BH-3	Z	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	236.695	237.69	1.00	35.95	0	35.0	35.0	0.0	-	-	201.7	236.7	-	-	-	Not Tested	-	-
BH-4	B	Shadow Lake/ Precambrian Contact Zone	236.078	237.077	1.00	71.29	-0.07	3.1	70.4	67.3	70.0	65.1	165.7	168.8	166.1	171.0	12-May-20	Rising Head	5.94E-09	2.91E-08
BH-4	F	Upper Green Beds of Gull River Formation	236.078	237.077	1.00	50.92	-0.03	3.1	50.0	46.9	50.0	44.1	186.1	189.2	186.1	192.0	12-May-20	Rising Head	1.15E-09	6.76E-09
BH-4	Z	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	236.078	237.077	1.00	31.24	0	30.2	30.2	0.0	-	-	205.8	236.1	-	-	-	Not Tested	-	-
BH-5	F	Upper Green Beds of Gull River Formation	231.981	232.987	1.01	52.73	-0.1	3.1	51.8	48.8	51.8	44.0	180.2	183.2	180.2	188.0	12-May-20	Rising Head	1.01E-09	7.89E-09
BH-5	H	Weathered Shale/clay zone at Bobcaygeon/Gull River formation contact	231.981	232.987	1.01	41.83	-0.04	3.1	40.9	37.8	41.0	38.0	191.1	194.2	191.0	194.0	12-May-20	Rising Head	2.67E-09	8.01E-09
BH-5	Z	Bobcaygeon Formation, Verulam Formation and Upper weathered bedrock	231.981	232.987	1.01	31.36	0	30.4	30.4	0.0	-	-	201.6	232.0	-	-	-	Not Tested	-	-
BH-6	I	Bobcaygeon Formation	234.186	234.835	0.65	43.10	-0.06	3.1	42.5	39.5	42.5	35.1	191.7	194.7	191.7	199.1	08-Mar-21	Rising Head	2.67E-08	1.99E-07
BH-6	K	Bobcaygeon Formatkon	234.186	234.835	0.65	30.81	-0.07	3.1	30.2	27.2	30.2	20.1	204.0	207.0	204.0	214.1	08-Mar-21	Rising Head	6.37E-08	6.44E-07
BH-6	L	Verulam Formation	234.186	234.835	0.65	15.63	-0.05	3.1	15.0	12.0	15.0	7.9	219.2	222.2	219.2	226.3	08-Mar-21	Rising Head	3.46E-07	2.46E-06
BH-7	I	Bobcaygeon Formation	239.659	240.176	0.52	43.34	-0.05	3.1	42.9	39.8	42.9	36.9	196.8	199.8	196.8	202.8	Dry Hole			
BH-7	K	Bobcaygeon Formatkon	239.659	240.176	0.52	32.44	-0.13	3.1	32.1	29.0	32.1	22.9	207.6	210.7	207.6	216.8	Dry Hole			
BH-7	L	Verulam Formation	239.659	240.176	0.52	18.41	-0.01	3.1	17.9	14.9	17.9	11.0	221.8	224.8	221.8	228.7	Dry Hole			
BH-8	G	Upper Gull River Formation Limestone	232.304	232.973	0.67	43.39	-0.07	3.1	42.8	39.7	42.8	35.1	189.5	192.6	189.5	197.3	09-Mar-21	Rising Head	1.661E-08	1.29E-07
BH-8	K	Bobcaygeon Formation	232.304	232.973	0.67	22.59	-0.03	3.1	22.0	18.9	22.0	11.9	210.4	213.4	210.4	220.4	09-Mar-21	Rising Head	7.096E-07	7.14E-06
BH-8	L	Verulam Formation	232.304	232.973	0.67	8.47	-0.05	3.1	7.9	4.8	7.9	6.1	224.5	227.5	224.5	226.2	09-Mar-21	Rising Head	5.351E-08	9.39E-08
BH-9	G	Upper Gull River Formation Limestone	238.367	238.599	0.23	43.71	-0.06	3.1	43.5	40.5	43.5	39.9	194.8	197.9	194.8	198.4	Dry Hole			
BH-9	K	Bobcaygeon Formation	238.367	238.599	0.23	23.14	-0.06	3.1	23.0	19.9	23.0	18.0	215.4	218.4	215.4	220.4	Dry Hole			
BH-9	L	Verulam Formation	238.367	238.599	0.23	12.14	-0.05	3.1	12.0	8.9	12.0	6.4	226.4	229.5	226.4	232.0	Dry Hole			

Notes:

[1] Hydrostratigraphic reference from Golder Associates Inc. Technical Memorandum dated January 2, 2019, and email dated March 4, 2021

[2] Ground and collar elevations determined using a differential Global Positioning System (dGPS ≤ 0.05 m accuracy)

[3] Hydraulic conductivity (K) estimates determined using a standard Hvorslev Slug Test Solution for confined aquifers using AQTESOLV.

masl: meters above sea level

mbtoc: meters below top of casing

mbgs: meters below ground surface

APPENDIX J

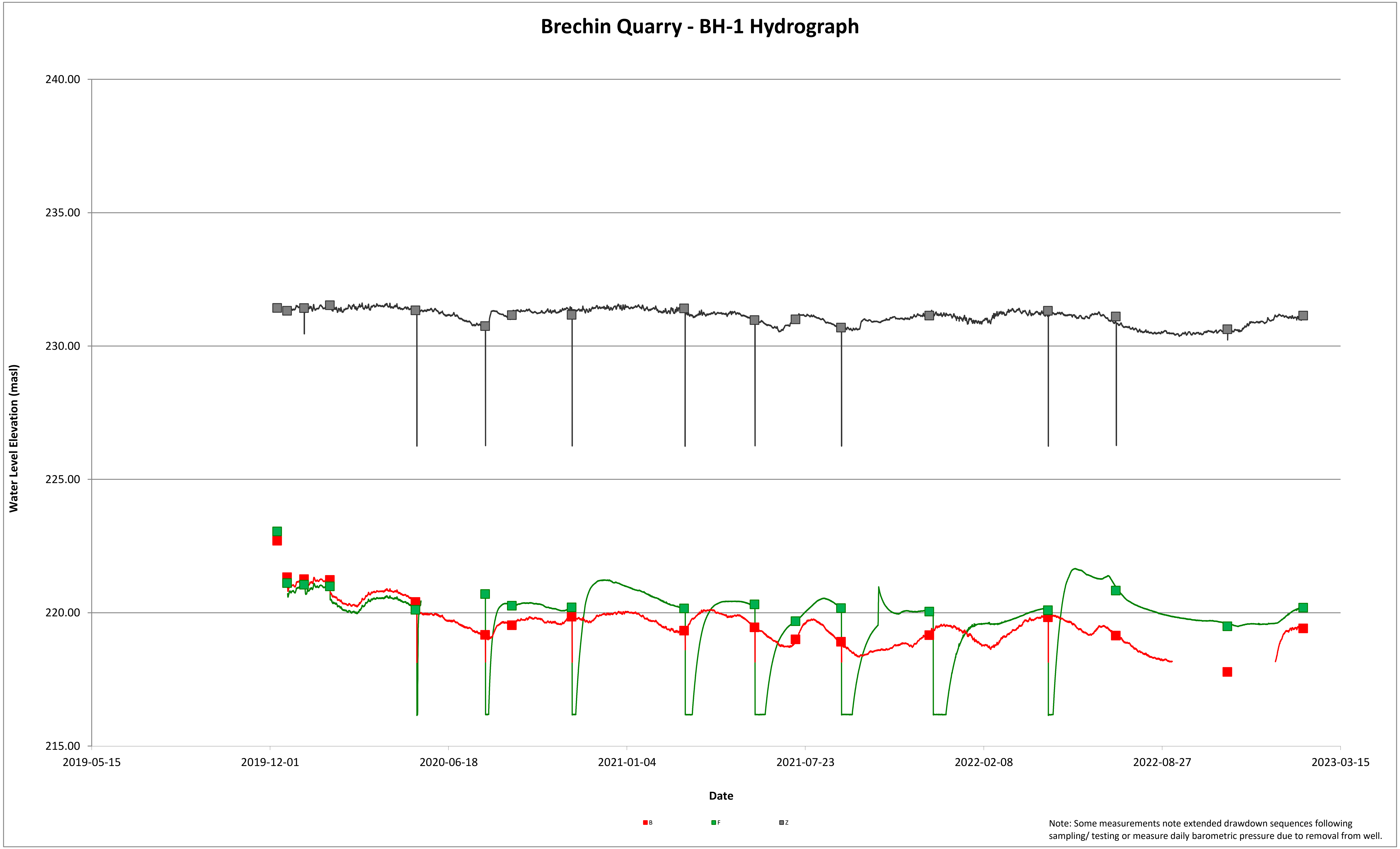
Ground Water Monitoring Results and Hydrographs

Brechin Quarry - Water Level Summary

Monitoring Well ID		BH-1	BH-1	BH-1	BH-2	BH-2	BH-2	BH-3	BH-3	BH-3	BH-4	BH-4	BH-4	BH-5	BH-5	BH-5	BH-6	BH-6	BH-6	BH-7	BH-7	BH-7	BH-8	BH-8	BH-8	BH-9	BH-9	BH-9
Hydrostratigraphic Unit Identifier		B	F	Z	C	F	Z	D	F	Z	B	F	Z	F	H	Z	I	K	L	I	K	L	G	K	L	G	K	L
Ground Elevation (masl)		231.555	231.555	231.555	238.843	238.843	238.843	236.695	236.695	236.695	236.078	236.078	236.078	231.981	231.981	231.981	234.186	234.186	234.186	239.659	239.659	239.659	232.304	232.304	232.304	238.367	238.367	238.367
Collar Elevation (masl)		232.572	232.572	232.572	239.758	239.758	239.758	237.69	237.69	237.69	237.077	237.077	237.077	232.987	232.987	232.987	234.835	234.835	234.835	240.176	240.176	240.176	232.973	232.973	232.973	238.599	238.599	238.599
Total Bore Depth (mbgs)		64.13	64.13	64.13	70.31	70.31	70.31	70.95	70.95	70.95	70.59	70.59	70.59	52.01	52.01	52.01	43.321	43.321	43.321	43.189	43.189	43.189	43.341	43.341	43.341	42.904	42.904	42.904
Bore Casing Stickup (m)		1.02	1.02	1.02	0.92	0.92	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	0.65	0.65	0.65	0.52	0.52	0.52	0.67	0.67	0.67	0.23	0.23	0.23
Bottom Well Depth (mbtoc)		65.01	45.81	31.45	64.89	51.53	31.60	64.02	54.46	35.95	71.29	50.92	31.24	52.73	41.83	31.36	43.10	30.81	15.63	43.34	32.44	18.41	43.39	22.59	8.47	43.71	23.14	12.14
Well Stickup (m)		-0.07	-0.04	0.00	-0.09	-0.03	0.00	-0.10	-0.04	0.00	-0.07	-0.03	0.00	-0.10	-0.04	0.00	-0.06	-0.07	-0.05	-0.05	-0.13	-0.01	-0.07	-0.03	-0.05	-0.06	-0.06	-0.05
Statistics																												
Water Level (mbtoc)	Minimum	9.80	9.48	1.04	17.46	18.71	6.09	10.99	8.83	3.13	2.31	5.77	1.90	1.09	1.55	1.54	1.28	0.29	1.12	3.95	1.91	2.16	5.67	2.38	2.79	16.80	11.04	11.11
Water Level (mbtoc)	Maximum	14.72	13.04	1.94	20.59	20.51	16.82	16.04	14.87	6.94	10.31	15.13	7.24	4.93	5.49	4.44	3.73	3.83	3.95	5.34	3.81	3.76	9.48	5.27	4.77	20.92	18.19	11.84
Water Level (mbtoc)	Mean	12.65	12.03	1.42	19.23	19.27	11.92	14.59	13.86	4.41	5.65	9.00	3.95	2.79	4.05	2.06	1.90	1.82	1.97	4.52	2.77	2.79	7.62	3.69	3.50	18.27	13.90	0.00
Water Level (mbtoc)	2019-12-09	9.80	9.48	1.14	18.80	19.01	12.30	-	-	-	-	-	-	1.52	1.58	1.60	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2019-12-20	11.17	11.42	1.25	18.97	19.11	9.99	10.99	8.83	4.65	2.31	5.77	1.90	1.67	1.65	1.68	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-01-08	11.24	11.48	1.15	18.50	18.98	7.26	14.09	13.46	3.82	2.39	7.46	1.99	1.51	1.60	1.61	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-02-06	11.27	11.54	1.04	18.19	18.82	7.31	14.33	13.75	3.27	2.49	7.72	2.30	1.47	1.55	1.58	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-05-12	12.10	12.42	1.23	17.46	18.89	7.29	13.98	14.03	3.99	3.73	7.92	3.40	1.67	1.72	1.71	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-07-29	13.33	11.83	1.82	19.49	19.62	15.63	14.05	14.14	5.33	6.94	10.73	6.41	4.24	4.63	3.06	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-08-28	12.97	12.27	1.41	19.50	19.35	16.82	14.43	14.48	5.10	10.31	15.13	5.09	4.93	5.10	2.47	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2020-11-03	12.65	12.33	1.40	19.49	19.15	14.50	14.11	14.15	3.39	8.58	10.87	3.46	4.58	5.06	1.73	-	-	-	-	-	-	-	-	-	-	-	-
Water Level (mbtoc)	2021-03-09	13.17	12.37	1.16	19.46	19.23	15.44	15.3	13.89	3.13	6.01	8.52	3.93	4.65	5.04	1.78	1.49	0.29	1.12	DRY	DRY	DRY	5.67	2.38	2.97	DRY	DRY	DRY
Water Level (mbtoc)	2021-04-23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.52	1.54	1.49	-	-	-	7.23	3.28	3.41	-	-	-
Water Level (mbtoc)	2021-05-27	13.05	12.22	1.60	19.33	19.06	14.66	15.44	13.9	4.22	4.46	9.76	4.2	4.7	5.24	2.05	1.58	1.66	1.78	4.97	3.05	3	7.67	3.91	3.89	20.92	18.19	DRY
Water Level (mbtoc)	2021-07-12	13.5	12.85	1.57	19.65	19.49	14.88	15.80	14.09	5.03	4.97	10.04	4.07	1.18	5.11	1.7	1.55	1.65	1.72	4.67	2.68	2.78	7.81	3.41	3.20	19.36	16.5	DRY
Water Level (mbtoc)	2021-09-01	13.59	12.36	1.88	19.56	19.34	13.99	15.83	14.14	4.73	5.98	8.68	5.42	2.02	4.94	2.52	2.05	2.17	2.23	4.41	2.74	2.94	7.69	4.24	4.07	18.03	15.66	DRY
Water Level (mbtoc)	2021-12-09	13.34	12.49	1.43	19.65	19.16	6.09	14.7	14.59	3.78	5.87	8.54	2.88	1.12	4.73	1.57	1.28	1.43	1.54	3.95	2.01	2.17	7.00	3.09	2.87	17.17	14.32	DRY
Water Level (mbtoc)	2022-04-21	12.67	12.44	1.25	18.98	18.71	11.15	-	14.46	-	8.38	7.78	2.74	3.7	5.25	1.54	1.33	1.4	1.48	3.98	1.91	2.16	7.11	3.16	3.13	16.8	12.85	DRY
Water Level (mbtoc)	2022-07-06	13.36	11.7	1.46	19.44	19.34	9.99	16.04	14.18	4.64	4.68	8.27	4.55	3.78	5.32	2.25	1.81	1.91	1.97	4.38	2.56	2.74	7.83	3.92	3.38	17.19	12.62	DRY
Water Level (mbtoc)	2022-08-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.63	2.71	2.82	4.29	3.46	2.81	8.6	4.59	4.07	17.49	12.14	DRY
Water Level (mbtoc)	2022-11-08	14.72	13.04	1.94	20.59	20.51	15	14.84	14.87	6.94	7.93	8.62	7.24	3.68	5.49	4.44	3.73	3.83	3.95	5.34	3.81	3.76	9.48	5.27	4.77	18.93	11.76	11.84
Water Level (mbtoc)	2023-02-01	13.09	12.34	1.43	19.91	19.76	10.4	14.89	14.78	4.14	5.36	8.11	3.68	1.09	4.81	1.79	-	1.44	1.53	4.72	2.73	2.73	7.7	3.3	2.79	18.53	11.04	11.11

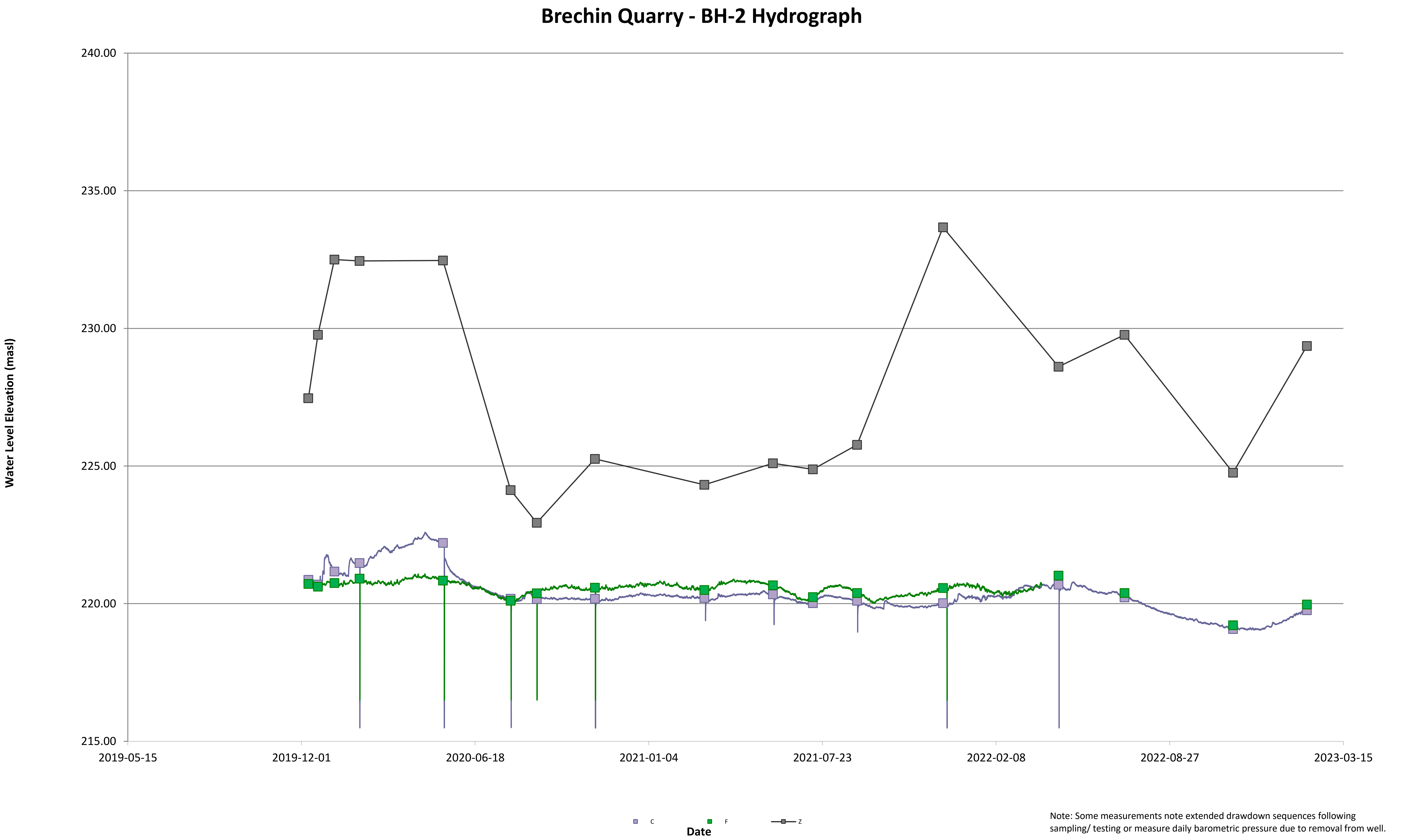
Brechin Quarry - Water Elevation Summary

Monitoring Well ID		**BH-1**	**BH-1**	**BH-1**	**BH-2**	**BH-2**	**BH-2**	**BH-3**	**BH-3**	**BH-3**	**BH-4**	**BH-4**	**BH-4**	**BH-5**	**BH-5**	**BH-5**	**BH-6**	**BH-6**	**BH-6**	**BH-7**	**BH-7**	**BH-7**	**BH-8**	**BH-8**	**BH-8**	**BH-9**	**BH-9**	**BH-9**
Hydrostratigraphic Unit Identifier		**B**	**F**	**Z**	**C**	**F**	**Z**	**D**	**F**	**Z**	**B**	**F**	**Z**	**F**	**H**	**Z**	**I**	**K**	**L**	**I**	**K**	**L**	**G**	**K**	**L**	**G**	**K**	**L**
Ground Elevation (masl)		231.555	231.555	231.555	238.843	238.843	238.843	236.695	236.695	236.695	236.078	236.078	236.078	231.981	231.981	231.981	234.186	234.186	234.186	239.659	239.659	239.659	232.304	232.304	232.304	238.367	238.367	238.367
Collar Elevation (masl)		232.572	232.572	232.572	239.758	239.758	239.758	237.69	237.69	237.69	237.077	237.077	237.077	232.987	232.987	232.987	234.835	234.835	234.835	240.176	240.176	240.176	232.973	232.973	232.973	238.599	238.599	238.599
Total Bore Depth (mbgs)		64.13	64.13	64.13	70.31	70.31	70.31	70.95	70.95	70.95	70.59	70.59	70.59	52.01	52.01	52.01	43.321	43.321	43.321	43.189	43.189	43.189	43.341	43.341	43.341	42.904	42.904	42.904
Bore Casing Stickup (m)		1.02	1.02	1.02	0.92	0.92	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	0.65	0.65	0.65	0.52	0.52	0.52	0.67	0.67	0.67	0.23	0.23	0.23
Bottom Well Depth (mbtoc)		65.01	45.81	31.45	64.89	51.53	31.60	64.02	54.46	35.95	71.29	50.92	31.24	52.73	41.83	31.36	43.10	30.81	15.63	43.34	32.44	18.41	43.39	22.59	8.47	43.71	23.14	12.14
Well Stickup (m)		-0.07	-0.04	0.00	-0.09	-0.03	0.00	-0.10	-0.04	0.00	-0.07	-0.03	0.00	-0.10	-0.04	0.00	-0.06	-0.07	-0.05	-0.05	-0.13	-0.01	-0.07	-0.03	-0.05	-0.06	-0.06	-0.05
Statistics																												
Water Level (masl)	Minimum	217.78	219.49	230.63	219.08	219.22	222.94	221.55	222.78	230.75	226.70	221.92	229.84	227.96	227.46	228.55	231.05	230.94	230.84	-	-	-	223.42	227.67	228.15	-	-	-
Water Level (masl)	Maximum	222.70	223.05	231.53	222.21	221.02	233.67	226.60	228.82	234.56	234.70	231.28	235.18	231.80	231.40	231.45	233.50	234.48	233.67	-	-	-	227.23	230.56	230.13	-	-	-
Water Level (masl)	Mean	219.85	220.50	231.15	220.43	220.46	227.83	223.00	223.79	233.28	231.36	228.05	233.12	230.09	228.90	230.92	232.88	232.94	232.82	-	-	-	225.29	229.26	229.42	-	-	-
Water Level (masl)	2019-12-09	222.70	223.05	231.43	220.87	220.72	227.46							231.37	231.37	231.39												
Water Level (masl)	2019-12-20	221.33	221.11	231.32	220.70	220.62	229.77	226.60	228.82	233.04	234.70	231.28	235.18	231.22	231.30	231.31												
Water Level (masl)	2020-01-08	221.26	221.05	231.42	221.17	220.75	232.50	223.50	224.19	233.87	234.62	229.59	235.09	231.38	231.35	231.38												
Water Level (masl)	2020-02-06	221.23	220.99	231.53	221.48	220.91	232.45	223.26	223.90	234.42	234.52	229.33	234.78	231.42	231.40	231.41												
Water Level (masl)	2020-05-12	220.40	220.11	231.34	222.21	220.84	232.47	223.61	223.62	233.70	233.28	229.13	233.68	231.22	231.23	231.28												
Water Level (masl)	2020-07-29	219.17	220.70	230.75	220.18	220.11	224.13	223.54	223.51	232.36	230.07	226.32	230.67	228.65	228.32	229.93												
Water Level (masl)	2020-08-28	219.53	220.26	231.16	220.17	220.38	222.94	223.16	223.17	232.59	226.70	221.92	231.99	227.96	227.85	230.52												
Water Level (masl)	2020-11-03	219.85	220.20	231.17	220.18	220.58	225.26	223.48	223.50	234.30	228.43	226.18	233.62	228.31	227.89	231.26												
Water Level (masl)	2021-03-09	219.33	220.16	231.41	220.21	220.50	224.32	222.29	223.76	234.56	231.00	228.53	233.15	228.24	227.91	231.21	233.29	234.48	233.67	DRY	DRY	DRY	227.23	230.56	229.95	DRY	DRY	DRY
Water Level (masl)	2021-04-23																233.26	233.23	233.30				225.67	229.66	229.51			
Water Level (masl)	2021-05-27	219.45	220.31	230.97	220.34	220.67	225.10	222.15	223.75	233.47	232.55	227.29	232.88	228.19	227.71	230.94	233.20	233.11	233.01	235.16	237.00	237.17	225.23	229.03	229.03	217.62	220.35	DRY
Water Level (masl)	2021-07-12	219.00	219.68	231.00	220.02	220.24	224.88	221.79	223.56	232.66	232.04	227.01	233.01	231.71	227.84	231.29	233.23	233.12	233.07	235.46	237.37	237.39	225.09	229.53	229.72	219.18	222.04	DRY
Water Level (masl)	2021-09-01	218.91	220.17	230.69	220.11	220.39	225.77	221.76	223.51	232.96	231.03	228.37	231.66	230.87	228.01	230.47	232.73	232.60	232.56	235.72	237.31	237.23	225.21	228.70	228.85	220.51	222.88	DRY
Water Level (masl)	2021-12-09	219.16	220.04	231.14	220.02	220.57	233.67	222.89	223.06	233.91	231.14	228.51	234.20	231.77	228.22	231.42	233.50	233.34	233.25	236.18	238.04	238.00	225.90	229.85	230.05	221.37	224.22	DRY
Water Level (masl)	2022-04-21	219.83	220.09	231.32	220.69	221.02	228.61		223.19		228.63	229.27	234.34	229.19	227.70	231.45	233.45	233.37	233.31	236.15	238.14	238.01	225.79	229.78	229.79	221.74	225.69	DRY
Water Level (masl)	2022-07-06	219.14	220.83	231.11	220.23	220.39	229.77	221.55	223.47	233.05	232.33	228.78	232.53	229.11	227.63	230.74	232.97	232.86	232.82	235.75	237.49	237.43	225.07	229.02	229.54	221.35	225.92	DRY
Water Level (masl)	2022-08-09																232.15	232.06	231.97	235.84	236.59	237.36	224.30	228.35	228.85	221.05	226.40	DRY
Water Level (masl)	2022-11-08	217.78	219.49	230.63	219.08	219.22	224.76	222.75	222.78	230.75	229.08	228.43	229.84	229.21	227.46	228.55	231.05	230.94	230.84	234.79	236.24	236.41	223.42	227.67	228.15	219.61	226.78	226.71
Water Level (masl)	2023-02-01	219.41	220.19	231.14	219.76	219.97	229.36	222.70	222.87	233.55	231.65	228.94	233.40	231.80	228.14	231.20	-	233.33	233.26	235.41	237.32	237.44	225.20	229.64	230.13	220.01	227.50	227.44

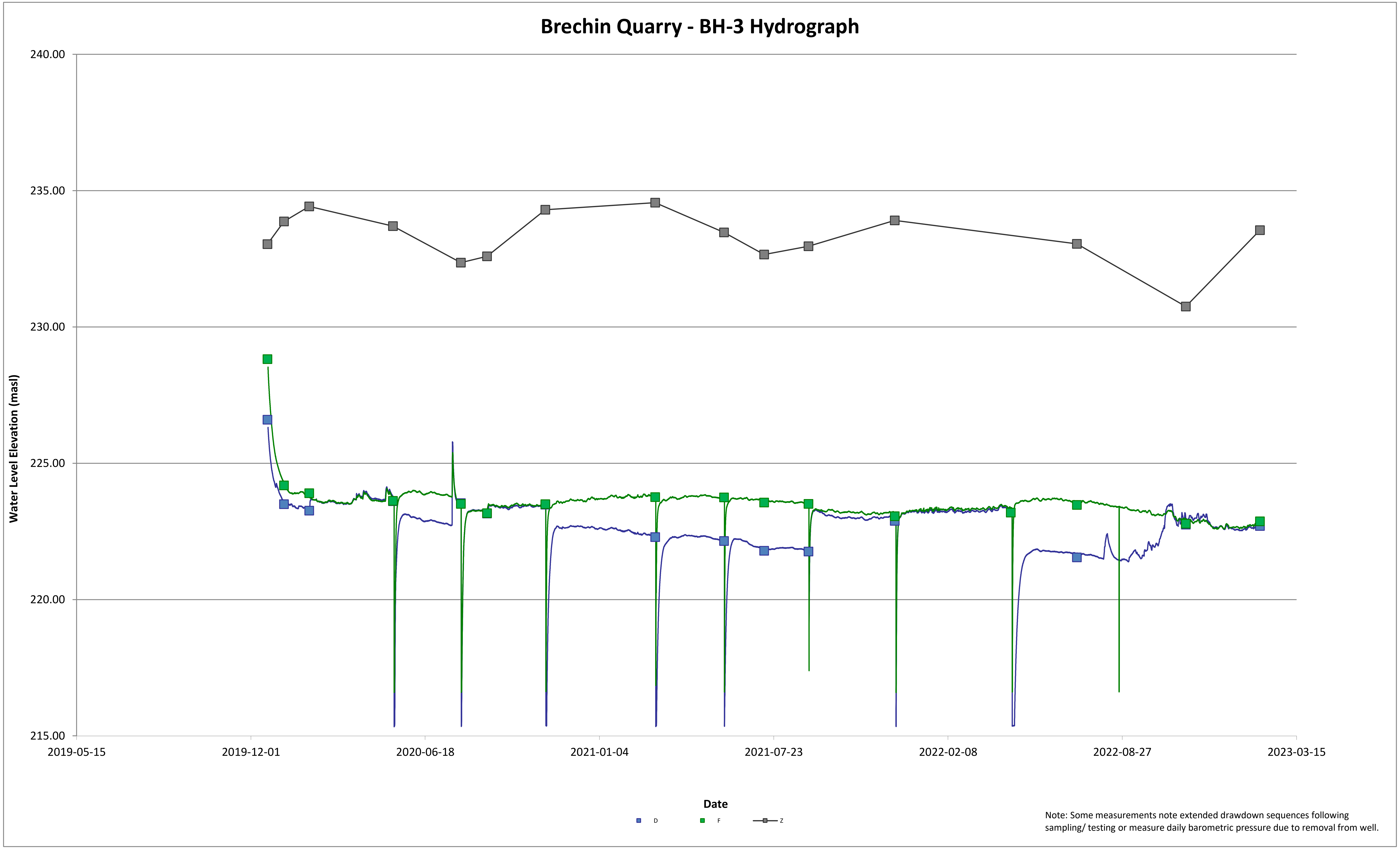


Brechin Quarry - BH-1 Hydrograph

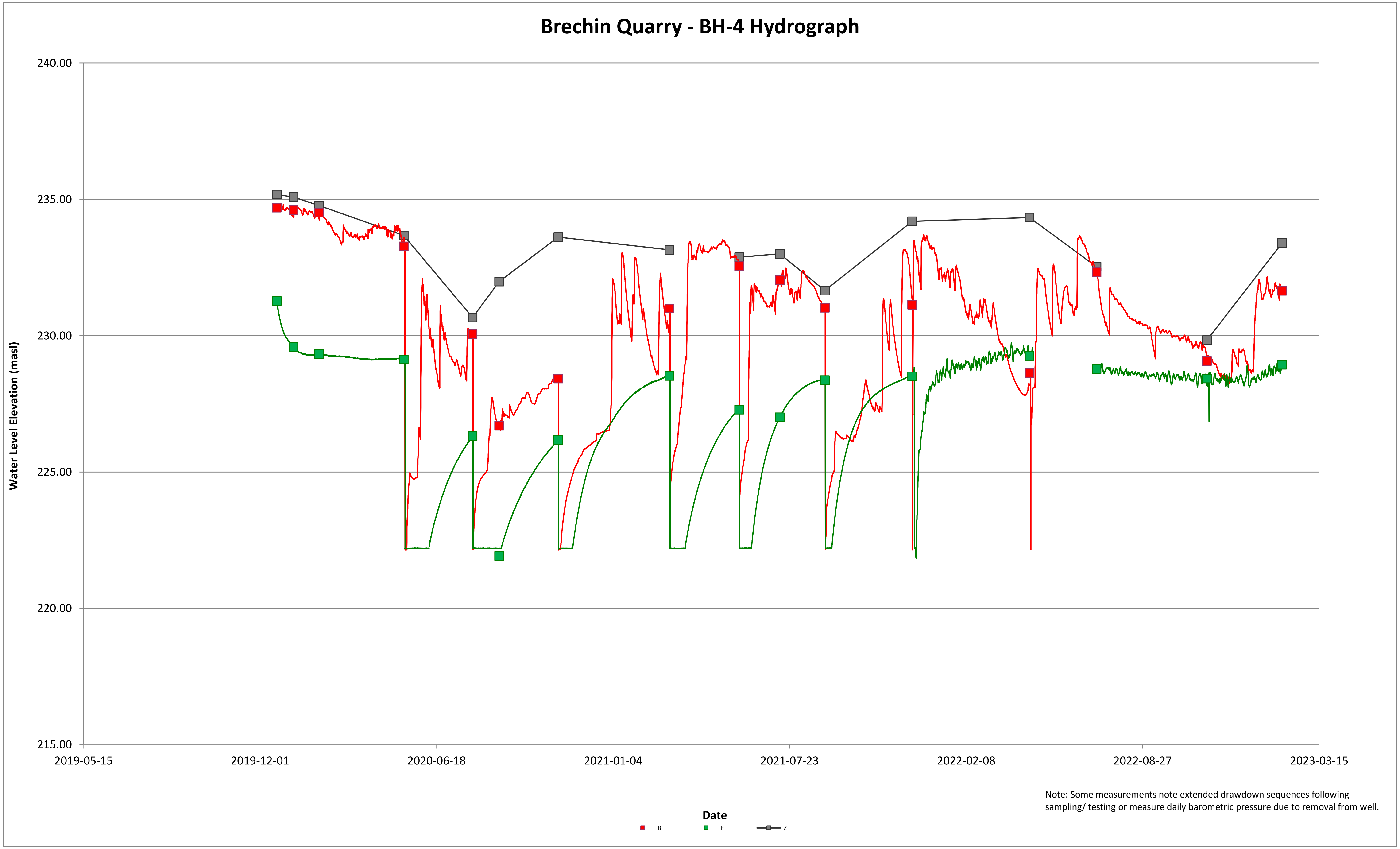
Note: Some measurements note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.



Note: Some measurements note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.

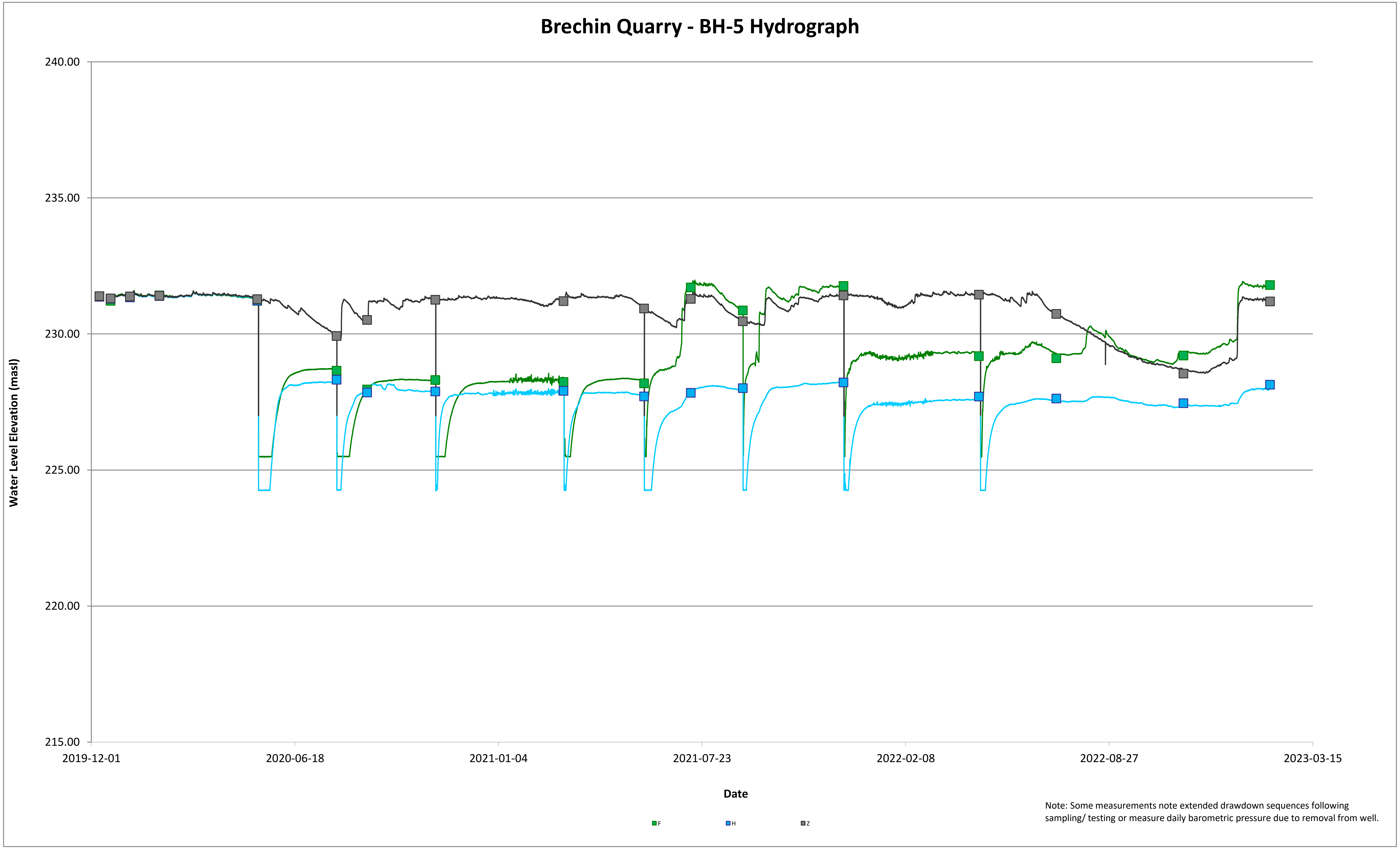


Note: Some measurements note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.



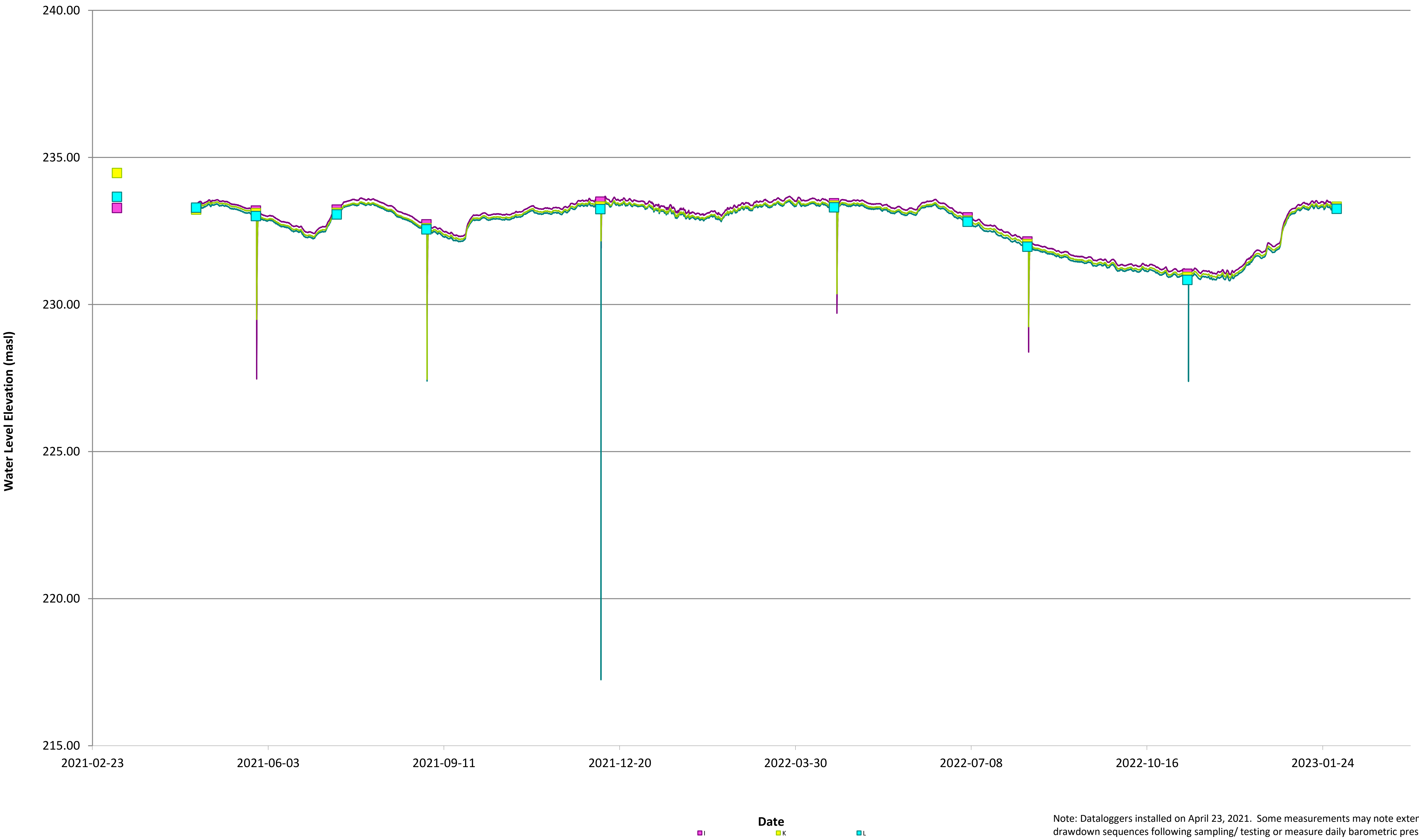
Brechin Quarry - BH-4 Hydrograph

Note: Some measurements note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.



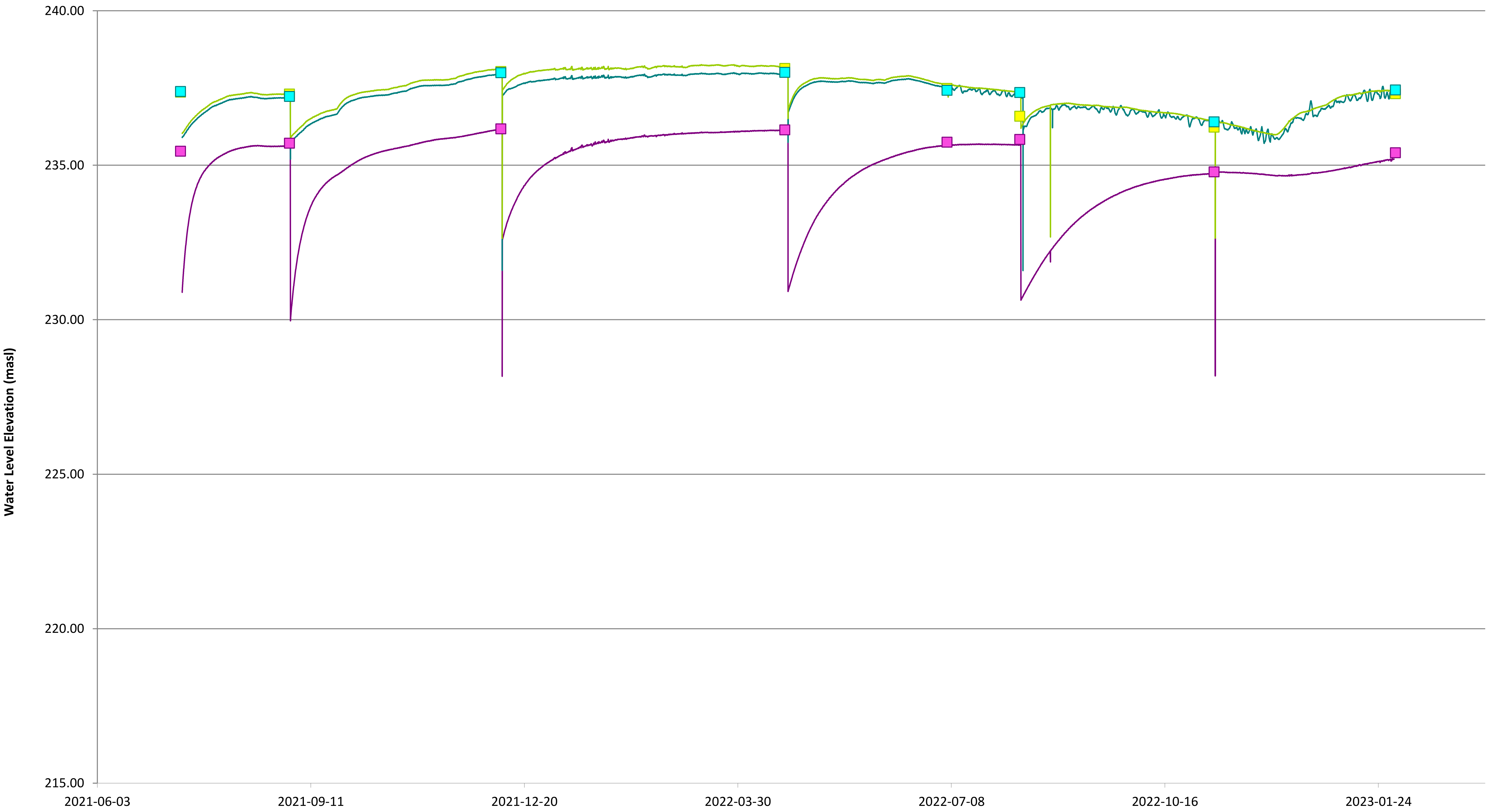
Note: Some measurements note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.

Brechin Quarry - BH-6 Hydrograph

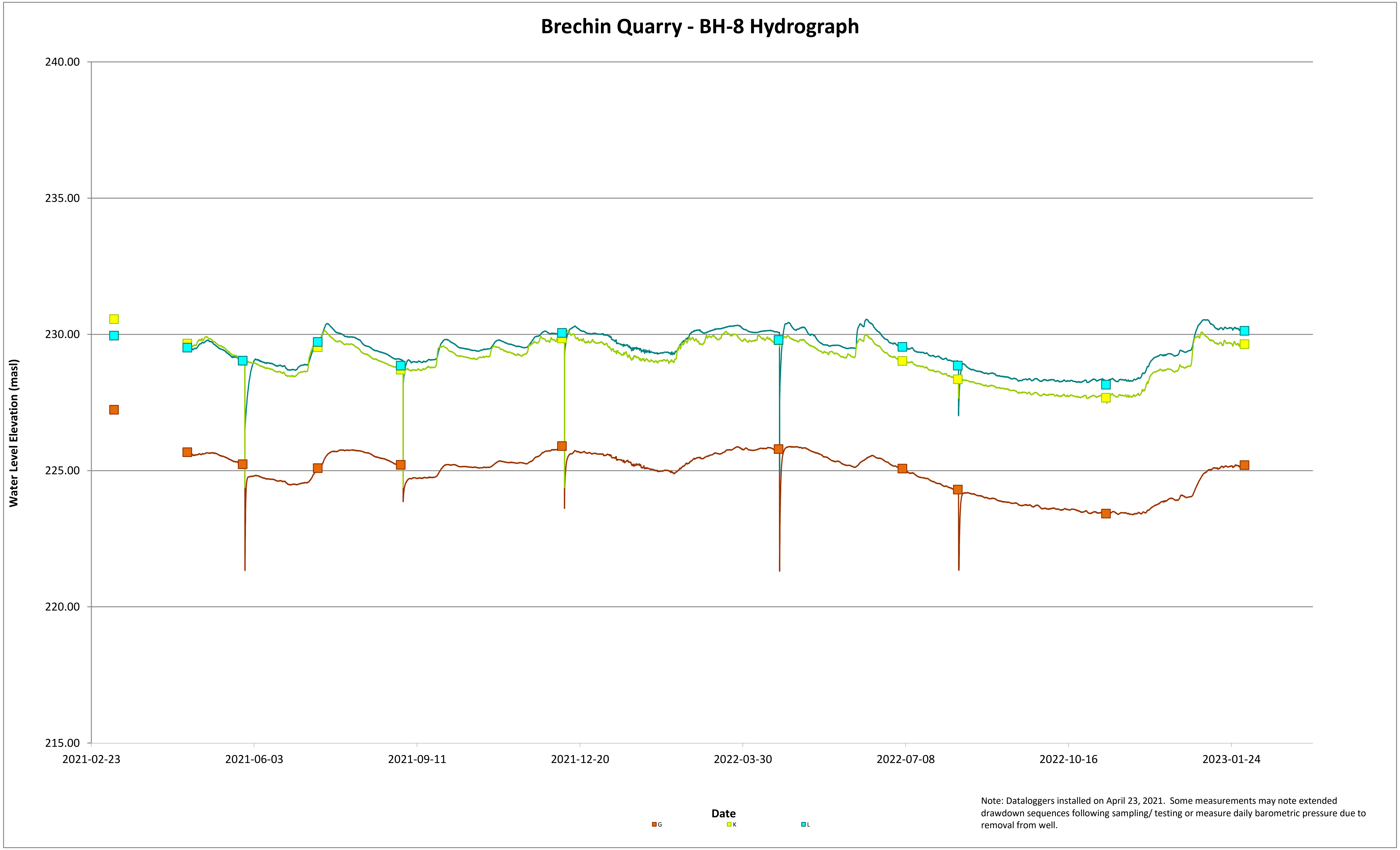


Note: Dataloggers installed on April 23, 2021. Some measurements may note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.

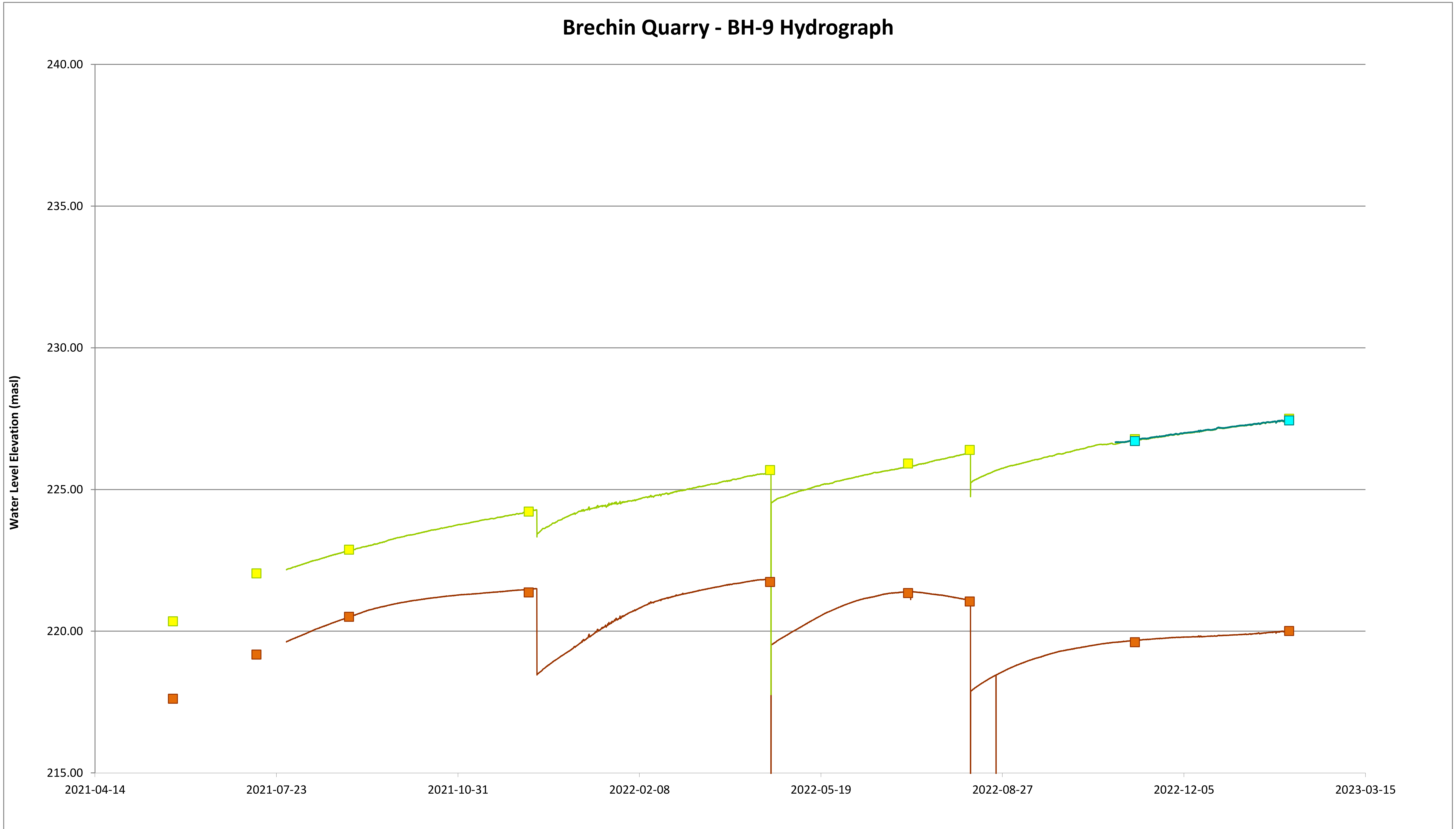
Brechin Quarry - BH-7 Hydrograph



Note: Dataloggers installed on July 12, 2021. Some measurements may note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.



Note: Dataloggers installed on April 23, 2021. Some measurements may note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.



Note: Dataloggers installed on July 28, 2021. Some measurements may note extended drawdown sequences following sampling/ testing or measure daily barometric pressure due to removal from well.

APPENDIX K

Geochemical Database

Parameter	Units	ODWQS	BH-1 B	BH-1 B	BH-1 B	BH-1 B	BH-1 B	BH-1 B	BH-1 B	BH-1 B	BH-1 F	BH-1 F	BH-1 F	BH-1 F	BH-1 F	BH-1 F	BH-1 F	BH-1 F	BH-1 Z
			13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	13-Dec-21	21-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	13-Dec-21	21-Apr-22	13-May-20
Saturation pH (25°C)	-	-	6.85	6.85	6.38	6.22	6.31	6.38	6.35	6.51	6.96	6.71	6.71	6.76	6.52	6.6	6.46	6.65	6.43
pH @25°C	pH Units	6.5-8.5	7.95	7.8	7.47	7.35	7.42	7.2	7.38	7.37	7.8	7.77	7.64	7.64	7.67	7.37	7.44	7.43	7.75
Langelier Index(25°C)	S.I.	-	1.1	0.948	1.09	1.13	1.11	0.819	1.03	0.863	0.841	1.06	0.926	0.88	1.15	0.766	0.979	0.785	1.32
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	315	296	335	334	285	259	277	226	305	266	242	225	212	179	199	172	213
Bicarbonate(as CaCO3)	mg/L	-	315	296	335	334	285	259	277	226	305	266	242	225	212	179	199	172	213
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	4050	4760	13500	17900	16600	16000	16400	14400	3830	7920	9020	8510	15800	15100	19100	13700	17100
Fluoride	mg/L	1.5	< 1	< 1	< 10	< 5	< 0.1	< 5	< 5	< 10	< 1	< 3	< 5	< 3	< 0.1	< 5	< 5	< 10	< 3
Chloride	mg/L	250	1090	1530	4310	6050	5880	5250	5700	4890	1020	2900	3020	2740	5610	4980	6880	4600	6420
Nitrate (N)	mg/L	10	< 1	< 1	< 10	< 5	4.2	< 5	< 5	< 10	< 1	< 3	< 5	3.2	3.5	< 5	< 5	< 10	< 3
Nitrite (N)	mg/L	1	< 1	< 1	< 10	< 5	< 1	< 5	< 5	< 10	< 1	< 3	< 5	< 3	< 1	< 5	< 5	< 10	< 3
Bromide	mg/L	-	11.3	14.5	< 40	78.7	11.4	< 20	70.3	< 40	10.6	27.4	22.7	36	28.8	< 20	82.5	< 40	68.7
Sulphate	mg/L	500	28	38	300	175	118	91	113	< 100	35	27	< 50	62	19	34	61	< 100	26
Calcium	mg/L	-	149	158	446	647	619	572	581	491	120	263	285	275	503	496	620	469	620
Magnesium	mg/L	-	98.8	107	191	240	220	238	260	291	79.2	172	205	192	362	353	446	346	443
Sodium	mg/L	20 / 200	556	718	2100	3070	2760	2440	2500	2100	539	1040	1210	1320	2290	2170	2650	2060	2990
Potassium	mg/L	-	21	18.8	25.8	25.4	27.7	25.5	24.1	25	18.7	27.6	31	29.9	48.8	43.3	47.1	38.9	54.8
Ammonia (N)-Total	mg/L	-	1.86	1.84	1.9	1.86	1.85	1.91	2.42	2.7	1.66	2.73	3.08	3.35	5.73	4.81	5.05	5.01	5.75
o-Phosphate (P)	mg/L	-	< 0.002	0.004	0.006	0.017	0.012	0.008	0.017	0.009	< 0.002	0.004	< 0.002	0.012	0.005	0.005	< 0.002	0.009	< 0.002
Phosphorus-Total	mg/L	-	< 0.01	0.02	0.02	0.04	0.05	0.05	0.02	0.05	< 0.01	< 0.01	0.01	0.02	< 0.01	0.02	0.01	0.11	0.04
Silica	mg/L	-	10.2	8.02	16.2	19.3	17.1	16.7	11.7	14.2	10.3	7.81	6.85	6.53	8.07	6.87	< 2	5.82	8.19
Dissolved Organic Carbon	mg/L	5	2.8	3.7	< 0.2	2.8	2.3	1.5	1.3	0.8	5	1.7	3.6	1.3	1.2	0.8	0.6	0.6	0.8
Colour	TCU	5	< 2	2	6	3	2	4	4	< 2	< 2	3	< 2	< 2	< 2	< 2	2	< 2	44
Turbidity	NTU	5	3.1	18.2	220	182	98.2	108	97.2	138	19.7	32.8	86.1	52.8	58.8	129	62.4	357	61.8
Aluminum	mg/L	0.1	0.06	0.06	0.17	0.52	0.2	0.2	< 0.5	0.33	0.02	0.11	0.13	0.16	0.2	0.18	< 0.5	0.34	0.14
Arsenic	mg/L	0.025	< 0.0005	< 0.0005	< 0.001	< 0.003	0.0133	< 0.003	0.002	0.0015	< 0.0003	< 0.0005	< 0.001	< 0.001	< 0.003	< 0.003	< 0.003	< 0.001	< 0.003
Barium	mg/L	1.0	0.205	0.185	0.375	0.5	0.965	1.38	1.1	2.43	0.178	0.283	0.291	0.255	0.551	0.667	0.39	0.44	0.56
Boron	mg/L	5	1.84	1.82	3.28	4.18	3.83	3.76	3.31	3.51	1.79	2.23	2.41	2.96	3.69	3.49	3.13	3.37	4.66
Cadmium	mg/L	0.005	< 0.000059	< 0.000059	< 0.00012	< 0.00030	0.0378	< 0.00030	< 0.00012	< 0.00012	< 0.000029	< 0.000059	< 0.00012	< 0.00012	< 0.00030	0.000329	0.000753	< 0.00012	< 0.00030
Chromium	mg/L	0.05	< 0.001	< 0.001	< 0.001	< 0.003	0.035	< 0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.003	< 0.003	0.003	0.003	< 0.003
Copper	mg/L	1	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002	< 0.2	< 0.02	< 0.002	< 0.002	< 0.002	< 0.01	< 0.002	< 0.002	< 0.2	< 0.02	< 0.002
Iron	mg/L	0.3	0.296	1.48	0.054	< 0.05	8.38	0.438	12.9	0.25	3.82	2.7	< 0.005	2.4	5.5	2.09	20.9	8	0.067
Lead	mg/L	0.01	< 0.0002	< 0.0002	0.00075	< 0.0009	0.0358	< 0.0009	< 0.0004	< 0.0004	< 0.00009	< 0.0002	0.00063	< 0.0004	< 0.0009	< 0.0009	0.00199	< 0.0004	< 0.0009
Manganese	mg/L	0.05	0.068	0.129	1.92	3.02	2.61	2.53	2.38	1.46	0.112	0.091	0.126	0.215	0.156	0.241	0.21	0.25	0.078
Molybdenum	mg/L	-	< 0.01	< 0.01	< 0.01	< 0.1	0.03	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.05	0.01	< 0.01	< 1	< 0.1	< 0.01
Nickel	mg/L	-	< 0.01	< 0.01	< 0.01	< 0.1	< 0.01	< 0.01	< 1	< 0.1	< 0.01	< 0.01	0.02	< 0.05	< 0.01	0.03	< 1	< 0.1	< 0.01
Selenium	mg/L	0.01	< 0.01	< 0.02	0.027	0.059	< 0.03	< 0.03	< 0.02	< 0.15	< 0.02	< 0.02	0.026	0.042	< 0.02	< 0.02	< 0.02	< 0.2	< 0.02
Silver	mg/L	-	< 0.0002	< 0.0002	0.001	< 0.001	0.0145	< 0.001	< 0.0005	< 0.0005	< 0.0001	< 0.0002	0.0011	< 0.0005	< 0.001	< 0.001	< 0.001	< 0.0005	< 0.001
Strontium	mg/L	-	20.8	21.9	55.4	73.5	80.1	86.1	80.4	90.7	15.8	42.3	48.7	45.4	93.5	96.7	91.6	87.9	131
Thallium	mg/L	-	< 0.00005	0.00006	0.00016	0.00022	0.046	0.00049	< 0.00008	< 0.00008	< 0.00005	< 0.00005	0.00008	< 0.00008	0.0012	0.00026	0.00072	< 0.00008	< 0.0002
Tin	mg/L	-	< 0.05	< 0.05	< 0.05	< 0.5	< 0.05	< 0.05	< 5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.3	< 0.05	< 0.05	< 5	< 0.5	< 0.05
Titanium	mg/L	-	< 0.005	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.03	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005
Uranium	mg/L	0.02	0.00066	0.00304	0.00159	0.00762	0.00705	0.00524	0.00328	0.00295	0.00202	0.00064	0.00029	0.00054	0.00055	0.00073	0.00081	0.00011	0.00031
Vanadium	mg/L	-	< 0.0007	< 0.0007	< 0.001	< 0.004	0.036	< 0.004	< 0.001	< 0.001	< 0.0004	< 0.0007	< 0.001	< 0.001	< 0.004	< 0.004	0.0039	< 0.001	< 0.004
Zinc	mg/L	5	0.361	0.167	0.018	< 0.05	0.005	< 0.005	< 0.5	< 0.05	6.09	0.009	0.008	< 0.03	< 0.005	0.006	< 0.5	< 0.05	< 0.005
TDS(ion sum calc.)	mg/L	500	2136	2753	7576	10411	9821	8781	9353	7937	2004	4593	4902	4775	8980	8197	10826	7631	10693
Hardness (as CaCO3)	mg/L	80-100	778	836	1900	2600	2450	2410	2520	2420	626	1360	1560	1470	2750	2690	3380	2590	3470
Total Kjeldahl Nitrogen	mg/L	-	2.2	2.5	-	-	1.28			-	2	3.5	-	-	2.17			-	6.2
Sulphide	mg/L	-	< 0.01	0.34	-	11.3	18.4	4.99	0.02	2.26	0.13	0.01	-	< 0.01	5.39	0.01	< 0.01	< 0.1	9.2

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-1 Z	BH-1 Z	BH-1 Z	BH-1 Z	BH-1 Z	BH-1 Z	BH-1 Z	BH-2 C	BH-2 C	BH-2 C	BH-2 C	BH-2 C	BH-2 C	BH-2 C	BH-2 C	BH-2 F	BH-2 F
			29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	13-Dec-21	21-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	13-Dec-21	21-Apr-22	13-May-20	29-Jul-20
Saturation pH (25°C)	-	-	6.47	6.86	6.58	6.41	6.38	6.8	6.4	7.66	7.67	7.43	7.34	7.36	7.52	7.41	7.46	7.6	7.64
pH @25°C	pH Units	6.5-8.5	7.62	7.81	7.62	7.72	7.65	7.62	7.7	8.14	8.09	8.04	7.97	8.13	8.03	8.14	8.06	8.07	7.99
Langelier Index(25°C)	S.I.	-	1.15	0.952	1.04	1.31	1.27	0.817	1.3	0.483	0.422	0.61	0.632	0.766	0.508	0.726	0.598	0.472	0.352
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	205	276	198	195	201	269	215	249	244	241	246	261	288	302	265	288	284
Bicarbonate(as CaCO3)	mg/L	-	205	276	198	195	201	269	215	249	244	241	246	261	288	302	265	288	284
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	15400	5380	13900	19400	19100	7700	17500	1450	1330	2780	3400	2810	1880	2200	2610	1620	1620
Fluoride	mg/L	1.5	< 5	< 5	< 5	< 1	< 10	< 1	< 10	< 0.1	0.7	2.5	< 1	< 1	1.6	0.8	< 1	0.2	0.8
Chloride	mg/L	250	6240	1600	4810	9400	7470	2370	6720	267	287	753	916	681	405	488	673	276	319
Nitrate (N)	mg/L	10	< 5	< 5	< 5	< 1	< 10	< 1	< 10	< 0.1	< 0.1	< 1	< 1	< 1	< 0.1	< 0.2	< 1	< 0.1	< 0.1
Nitrite (N)	mg/L	1	< 5	< 5	< 5	< 1	< 10	< 1	< 10	0.1	< 0.1	< 1	< 1	< 1	< 0.1	< 0.2	< 1	0.1	< 0.1
Bromide	mg/L	-	59.4	< 20	66.1	95.4	< 40	26.2	56.7	2.7	2.5	5.9	12.5	7.3	< 0.4	5.3	< 4	2.7	3
Sulphate	mg/L	500	< 50	< 50	52	10	< 10	35	< 100	25	32	18	26	14	12	11	21	50	58
Calcium	mg/L	-	584	168	472	720	747	209	660	26.9	26.7	50.1	60.8	54	33.2	41.6	42.4	27.2	25.2
Magnesium	mg/L	-	413	118	344	582	563	154	490	12.4	12	29.2	37	32.3	19.3	25	24.8	6.77	6.37
Sodium	mg/L	20 / 200	2270	725	2050	3620	3110	1090	2820	232	218	465	586	542	336	372	406	339	308
Potassium	mg/L	-	48	25.6	39	61.2	56.2	25	48.8	7.1	6.7	11	12.7	11.9	8.7	9.4	9.7	6.2	5.8
Ammonia (N)-Total	mg/L	-	5.32	2.85	4.72	6.97	6.56	2.97	6.05	0.57	0.69	0.71	1.2	1.01	0.78	0.76	1.06	0.32	0.3
o-Phosphate (P)	mg/L	-	0.014	< 0.002	0.011	< 0.002	0.004	< 0.002	0.009	< 0.002	0.008	< 0.002	0.007	< 0.002	0.003	0.004	0.008	0.002	< 0.002
Phosphorus-Total	mg/L	-	0.01	0.02	0.03	0.04	0.03	0.02	0.02	< 0.01	0.01	0.06	0.03	< 0.01	0.03	0.04	0.03	< 0.01	0.03
Silica	mg/L	-	9.03	10.3	7.73	6.83	6.98	8.37	8.13	6.88	5.44	5.95	6.29	6.7	6.72	5.99	6.42	10.9	8.97
Dissolved Organic Carbon	mg/L	5	0.9	1	1.1	0.2	0.3	0.8	0.5	1.8	2.1	1.4	2	1.1	1.3	1.2	0.8	3.4	3.3
Colour	TCU	5	5	2	3	2	6	3	4	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	3
Turbidity	NTU	5	70.4	70.2	106	47.2	76.5	35.6	72.2	1.3	17.8	13.1	15.4	5.4	14.4	60.7	5.2	6	63.1
Aluminum	mg/L	0.1	0.16	0.05	0.34	0.21	0.14	< 0.05	0.3	< 0.01	0.03	0.04	0.05	0.04	0.15	0.12	0.05	0.02	0.02
Arsenic	mg/L	0.025	< 0.005	< 0.0005	< 0.003	< 0.003	< 0.003	< 0.0005	< 0.001	< 0.0001	< 0.0001	0.0004	< 0.0003	< 0.0003	< 0.0001	< 0.0003	< 0.0003	0.0007	0.0002
Barium	mg/L	1.0	0.771	0.2	0.52	0.699	0.693	0.181	0.57	0.013	0.017	0.033	0.042	0.035	0.021	0.032	0.026	0.043	0.039
Boron	mg/L	5	3.05	2.41	3.09	4.85	4.36	2.4	4.3	1.39	1.26	1.77	2	1.99	2.28	2.03	1.84	1.43	1.27
Cadmium	mg/L	0.005	< 0.00059	0.000063	< 0.00030	< 0.00030	< 0.00030	< 0.000059	< 0.00012	< 0.000015	< 0.000015	< 0.000029	< 0.000029	< 0.000029	< 0.000015	< 0.000029	< 0.000029	< 0.000015	< 0.000015
Chromium	mg/L	0.05	< 0.006	0.001	< 0.003	< 0.003	< 0.003	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002	< 0.02	< 0.02	0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002
Iron	mg/L	0.3	0.112	0.069	0.13	0.035	0.047	0.067	0.19	0.46	2.11	< 0.005	< 0.01	1.07	0.828	0.27	1.35	0.114	0.034
Lead	mg/L	0.01	< 0.002	0.00528	< 0.0009	< 0.0009	< 0.0009	0.00032	0.00049	< 0.00004	< 0.00004	0.00019	< 0.00009	< 0.00009	0.00011	0.00013	< 0.00009	< 0.00004	< 0.00004
Manganese	mg/L	0.05	0.107	0.027	0.2	0.039	0.045	0.02	0.04	0.01	0.016	0.016	0.018	0.009	0.008	0.026	0.012	0.094	0.08
Molybdenum	mg/L	-	< 0.01	< 0.01	< 0.1	< 0.01	< 0.01	< 0.1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
Nickel	mg/L	-	< 0.01	< 0.01	< 0.1	< 0.01	< 0.01	< 0.1	< 0.1	0.01	0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
Selenium	mg/L	0.01	< 0.02	0.031	0.071	< 0.06	< 0.045	< 0.02	< 0.15	0.003	< 0.02	0.005	0.006	< 0.02	< 0.010	< 0.02	< 0.02	0.004	< 0.02
Silver	mg/L	-	< 0.002	0.0005	< 0.001	0.0033	< 0.001	< 0.0002	< 0.0005	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Strontium	mg/L	-	81.7	24.1	81.1	175	155	29.8	132	1.23	1.17	3.16	4.08	3.8	2.12	2.81	2.7	1.82	1.65
Thallium	mg/L	-	< 0.0004	< 0.00005	< 0.0002	0.00041	< 0.0002	< 0.00005	< 0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	-	< 0.05	< 0.05	< 0.5	< 0.05	< 0.05	< 0.5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05
Titanium	mg/L	-	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005
Uranium	mg/L	0.02	0.0004	0.00006	< 0.0002	0.00033	< 0.0002	0.00005	< 0.00008	< 0.00005	< 0.00005	0.00009	0.00009	< 0.00005	< 0.00005	0.00014	< 0.00005	0.0133	0.0124
Vanadium	mg/L	-	< 0.007	< 0.0007	< 0.004	< 0.004	< 0.004	< 0.0007	< 0.001	< 0.0001	< 0.0001	< 0.0004	< 0.0004	< 0.0004	< 0.0001	< 0.0004	< 0.0004	< 0.0001	< 0.0001
Zinc	mg/L	5	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.05	< 0.05	0.121	0.014	0.019	0.022	0.006	0.096	0.032	< 0.01	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	500	9685	2809	7889	14524	12072	4052	10877	722	732	1475	1788	1494	990	1129	1339	879	894
Hardness (as CaCO3)	mg/L	80-100	3160	902	2590	4190	4180	1160	3660	118	116	245	304	268	162	207	208	96	89
Total Kjeldahl Nitrogen	mg/L	-	6.8	-	-	5.09				0.8	1.2	-	-	8.58				0.5	0.7
Sulphide	mg/L	-	9.94	-	5.1	14.3	25.9	0.77	26.8	< 0.01	0.41	-	0.17	< 0.01	0.48	< 0.01		1.23	3.76

Notes:

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In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-2 F	BH-2 F	BH-2 F	BH-2 F	BH-2 F	BH-2 F	BH-2 Z	BH-2 Z	BH-2 Z	BH-2 Z	BH-2 Z	BH-2 Z	BH-2 Z	BH-3 D	BH-3 D	BH-3 D	BH-3 D
			03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	13-Dec-21	21-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	21-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21
Saturation pH (25°C)	-	-	7.28	7.26	7.29	7.37	7.21	7.47	7.52	7.28	7.41	7.39	7.24	7.35	7.41	6.8	6.8	6.83	6.94
pH @25°C	pH Units	6.5-8.5	8.11	8.15	8.07	7.94	7.94	8	8.1	8.04	8.02	8.05	8.01	7.92	7.96	7.88	7.81	7.88	7.59
Langelier Index(25°C)	S.I.	-	0.833	0.886	0.783	0.575	0.73	0.531	0.583	0.765	0.611	0.664	0.766	0.573	0.549	1.08	1.01	1.05	0.655
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	354	302	261	288	286	270	248	247	249	217	254	301	273	279	247	243	222
Bicarbonate(as CaCO3)	mg/L	-	354	302	261	288	286	270	248	247	249	217	254	301	273	279	247	243	222
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	3380	3420	3320	2680	2370	2450	1500	3740	2350	2370	3660	2970	2720	5830	6770	7290	7080
Fluoride	mg/L	1.5	3.2	1.3	< 1	1.1	1	< 1	< 0.1	< 1	2.5	0.6	< 1	< 1	< 1	< 1	< 1	< 10	< 3
Chloride	mg/L	250	695	899	960	692	562	617	279	1220	589	593	1170	707	696	1700	2320	2350	2360
Nitrate (N)	mg/L	10	< 3	< 1	< 1	< 0.1	< 0.1	< 1	< 0.1	< 1	< 1	0.2	< 1	< 1	< 1	< 1	< 1	< 10	< 3
Nitrite (N)	mg/L	1	< 3	< 1	< 1	< 0.1	< 0.1	< 1	0.1	< 1	< 1	0.2	< 1	< 1	< 1	< 1	< 1	< 10	< 3
Bromide	mg/L	-	< 10	12.3	10.2	1.7	5.8	< 4	2.8	11.5	4.1	6.5	12.5	< 4	< 4	17.9	22.7	< 40	32.9
Sulphate	mg/L	500	241	84	24	21	24	23	26	< 10	25	50	16	< 10	20	26	24	< 100	60
Calcium	mg/L	-	48.5	58.6	64.4	48.8	70.3	41	37.3	71.5	51	61.6	74.8	48.6	46.4	188	219	207	179
Magnesium	mg/L	-	18.8	32.4	39.5	29.9	40.5	23	18.2	39.9	26.7	34.4	48.9	29.3	25.8	90.4	124	118	107
Sodium	mg/L	20 / 200	527	612	621	467	454	402	265	575	418	422	711	410	450	713	1080	1040	990
Potassium	mg/L	-	8.1	11.4	13.2	10.5	12.2	9.7	7.8	14.9	11.1	10.5	13.7	10.2	10.4	19	24.1	26.3	22
Ammonia (N)-Total	mg/L	-	0.35	1.26	1.16	0.95	0.74	1.01	0.58	1.24	0.74	0.8	1.03	0.85	1.09	2.11	2.38	2.73	2.56
o-Phosphate (P)	mg/L	-	0.009	0.009	< 0.002	0.002	0.005	0.007	< 0.002	0.008	0.007	0.01	< 0.002	< 0.002	0.008	< 0.002	0.004	< 0.002	0.005
Phosphorus-Total	mg/L	-	0.09	0.04	0.02	0.01	0.06	0.01	0.02	0.02	0.11	0.05	0.07	0.04	0.05	< 0.01	< 0.01	0.03	0.02
Silica	mg/L	-	9.2	7.28	7.15	6.87	6.52	6.46	7.04	6.18	7.29	6.08	6.91	7.19	6.46	6.61	5.63	5.65	3.23
Dissolved Organic Carbon	mg/L	5	2.3	3	1.1	1.4	1	0.8	1.1	1.2	10	0.8	0.6	1	0.7	2	1.5	1	1.6
Colour	TCU	5	3	< 2	< 2	< 2	4	< 2	< 2	< 2	< 2	< 2	2	< 2	< 2	< 2	< 2	< 2	< 2
Turbidity	NTU	5	151	141	14.3	3.9	38.5	12.4	6.5	7.3	30.4	20.8	115	29.6	42.4	12.2	32.5	18.3	162
Aluminum	mg/L	0.1	0.03	0.05	0.07	0.03	0.02	0.03	< 0.01	0.05	< 0.01	0.05	0.06	0.03	0.04	0.05	0.09	0.11	0.17
Arsenic	mg/L	0.025	0.0016	0.0006	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0001	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.001	0.0007	0.0009	< 0.001
Barium	mg/L	1.0	0.069	0.078	0.064	0.053	0.051	0.028	0.019	0.056	0.036	0.048	0.042	0.029	0.032	0.151	0.192	0.188	0.15
Boron	mg/L	5	1.67	1.89	2.06	2.22	1.73	1.64	1.43	2.13	1.98	1.48	2.14	2.96	1.73	1.55	1.67	2.22	1.94
Cadmium	mg/L	0.005	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.000015	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.000029	< 0.00012	< 0.000059	0.000064	< 0.00012
Chromium	mg/L	0.05	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.002	< 0.004	< 0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002	< 0.002	< 0.01
Iron	mg/L	0.3	0.072	< 0.01	0.376	0.331	0.027	1.1	0.021	< 0.005	< 0.005	0.012	0.029	0.019	0.02	0.902	4.17	6.28	29.5
Lead	mg/L	0.01	0.00015	< 0.00009	< 0.00009	< 0.00009	0.00009	< 0.00009	< 0.00004	< 0.00009	0.00013	< 0.00009	< 0.00009	< 0.00009	< 0.00009	< 0.0004	< 0.0002	0.00035	< 0.0004
Manganese	mg/L	0.05	0.06	0.056	0.025	0.031	0.021	0.006	0.005	0.001	< 0.001	0.006	0.004	0.001	0.002	0.044	0.061	0.056	0.185
Molybdenum	mg/L	-	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.05
Nickel	mg/L	-	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.02	< 0.01	0.03	0.02	< 0.05
Selenium	mg/L	0.01	0.005	0.009	< 0.03	< 0.015	< 0.02	< 0.02	0.004	< 0.02	0.011	0.01	< 0.03	< 0.015	< 0.02	< 0.02	< 0.02	0.046	0.033
Silver	mg/L	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0005	< 0.0002	0.0005	< 0.0005
Strontium	mg/L	-	5.72	5.22	4.9	3.88	6.74	2.52	1.87	4.49	2.99	3.76	5.72	3.28	2.84	9.45	11.3	14.3	11.6
Thallium	mg/L	-	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00009	< 0.00005	< 0.00005	< 0.00008
Tin	mg/L	-	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.3
Titanium	mg/L	-	< 0.005	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.005	< 0.03
Uranium	mg/L	0.02	0.00375	0.0059	0.00031	0.00033	0.00027	0.00032	0.00015	0.00019	0.00009	0.00024	< 0.00005	< 0.00005	< 0.00005	0.00065	0.00014	0.00018	< 0.00008
Vanadium	mg/L	-	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0001	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.001	< 0.0007	< 0.0007	< 0.001
Zinc	mg/L	5	< 0.005	< 0.01	0.011	< 0.005	0.018	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.01	2.53	4.02	1.03	0.99
TDS(ion sum calc.)	mg/L	500	1755	1882	1880	1444	1336	1280	783	2072	1273	1305	2185	1386	1413	2911	3934	3901	3884
Hardness (as CaCO3)	mg/L	80-100	199	280	323	245	342	197	168	343	237	295	388	242	222	841	1060	1000	884
Total Kjeldahl Nitrogen	mg/L	-	-	-	1.68			-	0.8	1.9	-	-	1.02		-	2.5	3.3	-	-
Sulphide	mg/L	-	-	8.9	0.67	0.1	< 0.01	0.01	0.02	< 0.01	-	0.04	0.02	< 0.01	0.02	< 0.01	< 0.01	-	< 0.1

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-3 D	BH-3 D	BH-3 D	BH-3 D	BH-3 F	BH-3 F	BH-3 F	BH-3 F	BH-3 F	BH-3 F	BH-3 F	BH-3 F	BH-3 Z	BH-3 Z	BH-3 Z	BH-3 Z	BH-3 Z
			27-May-21	01-Sep-21	10-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	10-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21
Saturation pH (25°C)	-	-	6.7	6.18	6.28	5.84	6.76	6.77	6.78	6.49	6.28	6.2	6.09	5.95	6.89	6.8	6.76	6.77	6.94
pH @25°C	pH Units	6.5-8.5	7.95	7.72	8.05	7.86	7.9	7.78	7.79	7.52	7.91	7.64	7.95	7.76	7.9	7.84	7.82	7.62	7.92
Langelier Index(25°C)	S.I.	-	1.25	1.54	1.77	2.02	1.14	1.01	1.01	1.03	1.63	1.44	1.86	1.81	1.01	1.04	1.06	0.855	0.982
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	287	349	479	697	270	244	244	267	332	303	430	448	249	239	337	346	273
Bicarbonate(as CaCO3)	mg/L	-	287	349	479	697	270	244	244	267	332	303	430	448	249	239	337	346	273
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	8510	18000	13300	17800	7580	7780	8290	13400	16500	18200	18600	19600	6480	7620	4460	1670	5850
Fluoride	mg/L	1.5	< 0.1	< 10	< 3	< 10	< 1	< 1	< 10	< 5	0.1	< 10	< 5	< 10	< 1	< 3	< 5	< 0.1	< 1
Chloride	mg/L	250	2540	6100	3740	6170	2270	2890	2880	4000	6030	6080	7460	7250	1960	2780	1310	289	1820
Nitrate (N)	mg/L	10	< 0.1	< 10	< 3	< 10	< 1	< 1	< 10	< 5	0.2	< 10	< 5	< 10	< 1	< 3	< 5	< 0.1	< 1
Nitrite (N)	mg/L	1	< 1	< 10	< 3	< 10	< 1	< 1	< 10	< 5	< 1	< 10	< 5	< 10	< 1	< 3	< 5	0.1	< 1
Bromide	mg/L	-	13.4	< 40	41.1	< 40	23.9	27.5	< 40	56.7	12.8	< 40	88.5	47.2	20.5	25.9	< 20	3.5	19.6
Sulphate	mg/L	500	289	1190	1600	1420	29	41	121	1230	520	1070	983	938	14	< 30	< 50	27	13
Calcium	mg/L	-	245	674	388	740	219	246	241	432	566	742	676	885	175	236	173	154	144
Magnesium	mg/L	-	116	390	158	368	114	135	130	234	298	445	471	535	103	121	71.7	29.3	87.8
Sodium	mg/L	20 / 200	1440	3130	2440	3520	1080	1250	1200	2410	3070	3090	2930	3570	966	1070	637	182	980
Potassium	mg/L	-	27.6	37.9	24.9	32.8	26.3	26.2	29.1	29.8	38	41.2	34.6	39.6	23.5	27	17.9	4.6	22.8
Ammonia (N)-Total	mg/L	-	2.37	3.41	1.43	2.92	2.72	2.69	2.83	1.99	2.12	2.97	3.06	3.1	2.31	2.75	1.81	0.45	2.36
o-Phosphate (P)	mg/L	-	< 0.002	0.098	0.013	0.162	< 0.002	0.003	< 0.002	0.004	< 0.002	0.015	0.009	0.026	0.011	0.039	0.009	0.012	0.01
Phosphorus-Total	mg/L	-	< 0.01	0.03	0.03	0.04	< 0.01	< 0.01	0.02	0.03	0.04	0.05	0.04	0.06	0.08	0.04	0.08	0.09	0.05
Silica	mg/L	-	7.32	6.38	4.22	15.6	7.55	5.71	5.32	7.25	5.91	7.88	4.77	15.5	7	6.61	7.8	5.26	6.78
Dissolved Organic Carbon	mg/L	5	1.5	4	34.5	4.4	2	1.3	1.2	1.8	4.1	3.7	13.1	3.1	1	0.8	1	2.7	1.4
Colour	TCU	5	4	8	15	317	< 2	< 2	2	6	10	7	20	4	< 2	< 2	8	4	2
Turbidity	NTU	5	50.6	600	370	363	2.7	40	52.3	246	314	675	650	429	44.1	69.5	104	249	111
Aluminum	mg/L	0.1	0.13	0.22	< 0.5	0.52	0.07	0.1	0.12	1.32	0.21	0.22	< 0.5	0.5	0.05	0.1	0.06	0.09	0.09
Arsenic	mg/L	0.025	< 0.0005	< 0.003	0.0013	0.0044	< 0.001	0.0008	< 0.001	< 0.003	0.0028	< 0.003	0.0028	< 0.003	< 0.001	< 0.0005	< 0.0005	0.0002	< 0.0005
Barium	mg/L	1.0	0.21	0.141	0.13	0.16	0.234	0.28	0.285	0.18	0.154	0.13	< 0.1	0.1	0.168	0.208	0.105	0.039	0.132
Boron	mg/L	5	2.02	3.95	2.25	4.05	2.01	1.92	2.16	2.96	3.36	4.38	4	5.05	1.99	2.22	1.83	0.4	2.22
Cadmium	mg/L	0.005	< 0.000059	< 0.00030	< 0.00012	< 0.00012	< 0.00012	< 0.000059	< 0.00012	< 0.00030	0.00759	< 0.00030	0.000554	< 0.00030	< 0.00012	< 0.000059	< 0.000059	< 0.000015	< 0.000059
Chromium	mg/L	0.05	< 0.001	< 0.003	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.003	0.007	< 0.003	< 0.003	< 0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.002	< 0.002	< 0.2	< 0.02	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002	< 0.2	< 0.02	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.3	29.8	4.22	19.7	< 0.05	0.542	5.41	6.76	10.4	13	0.255	< 0.5	< 0.05	0.062	0.061	0.018	0.616	0.074
Lead	mg/L	0.01	< 0.0002	< 0.0009	< 0.0004	< 0.0004	< 0.0004	< 0.0002	0.00231	< 0.0009	0.00593	< 0.0009	0.00138	< 0.0009	< 0.0004	< 0.0002	0.00028	0.00006	< 0.0002
Manganese	mg/L	0.05	0.101	0.522	0.59	1.28	0.058	0.074	0.088	0.39	0.459	0.494	0.71	1.46	0.013	0.02	0.034	0.105	0.009
Molybdenum	mg/L	-	0.02	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.1	0.02	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	-	< 0.01	< 0.01	< 1	< 0.1	< 0.01	0.05	0.03	< 0.1	< 0.01	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.01	< 0.02	< 0.02	< 0.02	< 0.15	< 0.02	< 0.02	0.052	0.039	< 0.04	< 0.05	< 0.02	< 0.1	< 0.02	< 0.02	0.026	0.005	< 0.03
Silver	mg/L	-	< 0.0002	< 0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0002	0.0007	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0005	< 0.0002	< 0.0002	< 0.0001	< 0.0002
Strontium	mg/L	-	14.3	46.9	14.9	48.9	13.3	13.8	16	29	37.9	58.5	54	67.5	11.5	13.9	8.15	2.55	10.5
Thallium	mg/L	-	< 0.00005	< 0.0002	< 0.00008	< 0.00008	< 0.00008	< 0.00005	< 0.00008	< 0.0002	0.00696	< 0.0002	0.00059	0.00027	< 0.00008	< 0.00005	< 0.00005	< 0.00005	0.00006
Tin	mg/L	-	< 0.05	< 0.05	< 5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.5	< 0.05	< 0.05	< 5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	-	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.02	0.00026	0.00133	0.00547	0.0204	0.00218	0.00037	0.0003	< 0.0002	0.00039	0.0113	0.00156	0.0114	0.00013	< 0.00005	0.00026	0.0002	< 0.00005
Vanadium	mg/L	-	< 0.0007	< 0.004	< 0.001	0.0047	< 0.001	< 0.0007	< 0.001	< 0.004	0.0054	< 0.004	0.0054	0.0036	< 0.001	< 0.0007	< 0.0007	< 0.0001	< 0.0007
Zinc	mg/L	5	< 0.005	0.005	< 0.5	< 0.05	5.8	4.23	0.378	0.48	< 0.005	0.02	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	500	4837	11739	8644	12680	3907	4735	4759	8508	10729	11657	12818	13493	3397	4381	2410	895	3238
Hardness (as CaCO3)	mg/L	80-100	1090	3290	1620	3360	1020	1170	1140	2040	2640	3680	3630	4410	860	1090	727	505	721
Total Kjeldahl Nitrogen	mg/L	-	1.05			-	3.2	3.8	-	-	0.0762			-	3.4	4.1	-	-	0.536
Sulphide	mg/L	-	0.06	29.8	< 0.05	30.8	< 0.01	< 0.01	-	0.48	6.29	18.5	7.8	29.7	0.02	0.04	-	< 0.1	0.03

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-3 Z	BH-3 Z	BH-3 Z	BH-4 B	BH-4 B	BH-4 B	BH-4 B	BH-4 B	BH-4 B	BH-4 B	BH-4 B	BH-4 F	BH-4 F	BH-4 F	BH-4 F	BH-4 F	BH-4 F
			01-Sep-21	10-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21
Saturation pH (25°C)	-	-	6.97	7.01	6.13	6.99	6.75	6.79	6.82	6.79	6.76	6.87	6.9	6.87	7.04	6.61	6.43	6.29	6.24
pH @25°C	pH Units	6.5-8.5	7.84	7.82	7.4	7.94	7.7	7.69	7.59	7.84	7.57	7.5	7.94	7.87	7.91	7.92	8.16	8.1	7.92
Langelier Index(25°C)	S.I.	-	0.873	0.81	1.27	0.95	0.954	0.902	0.775	1.05	0.807	0.633	1.04	1	0.874	1.31	1.73	1.81	1.68
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	272	297	220	338	289	315	343	344	337	322	295	305	318	495	693	764	810
Bicarbonate(as CaCO3)	mg/L	-	272	297	220	338	289	315	343	344	337	322	295	305	318	495	693	764	810
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	6560	4570	20000	1610	3380	2720	1900	1730	3620	1440	669	645	1850	6550	7450	8990	12500
Fluoride	mg/L	1.5	< 1	0.2	< 10	< 0.1	0.2	< 1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1	0.2	7	< 3	< 1	< 5
Chloride	mg/L	250	1920	1330	8550	275	989	669	427	367	924	256	25.3	18.4	404	1270	1420	2040	2540
Nitrate (N)	mg/L	10	< 1	< 0.1	< 10	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1	< 0.1	< 3	< 3	< 1	< 5
Nitrite (N)	mg/L	1	< 1	< 0.1	< 10	0.1	< 0.1	< 1	0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1	< 0.1	< 3	< 3	< 1	< 5
Bromide	mg/L	-	12.6	14.3	51.5	2.7	10.6	5.2	4.7	4.2	< 4	2.8	< 0.4	< 0.4	4.1	< 10	21.1	19.6	< 20
Sulphate	mg/L	500	< 10	22	< 100	21	25	< 10	3	3	< 10	7	5	5	25	1150	1100	1350	1850
Calcium	mg/L	-	135	110	1200	94.2	202	169	159	150	166	128	120	126	94.2	178	191	240	254
Magnesium	mg/L	-	85.5	61.9	699	22.3	71.8	46.3	28.6	23.8	55.1	20.8	8.73	9.96	24	61.2	71.5	94.1	101
Sodium	mg/L	20 / 200	969	613	3040	248	407	289	165	140	487	133	17	14.9	261	1230	1480	2150	1960
Potassium	mg/L	-	25.6	15.9	49.4	7.7	8.2	7.3	3.8	3.5	9	3.3	0.7	1.1	8.1	16.5	16.3	19.8	20.7
Ammonia (N)-Total	mg/L	-	2.94	1.89	5.04	0.52	0.94	0.79	0.68	0.31	1.19	0.34	0.12	0.05	0.6	0.73	1.09	0.68	1.85
o-Phosphate (P)	mg/L	-	0.008	< 0.002	0.018	0.002	0.01	< 0.002	0.007	< 0.002	0.005	0.004	0.01	< 0.002	0.011	0.087	0.073	0.169	0.014
Phosphorus-Total	mg/L	-	0.03	0.03	0.14	0.01	0.03	0.03	0.02	0.01	0.02	0.02	0.01	0.02	< 0.01	0.09	0.08	0.09	0.14
Silica	mg/L	-	7.7	6.92	7.51	8.32	5.97	8.44	7.04	8	6.92	6.2	5.31	7.15	7.08	9.03	9.02	9.48	9.63
Dissolved Organic Carbon	mg/L	5	0.7	0.5	1.3	6	2.6	1.9	2.6	2.4	2.3	1.6	4	5.7	4.1	17.6	36	8.2	10.5
Colour	TCU	5	< 2	6	< 2	< 2	2	3	< 2	3	2	2	< 2	< 2	2	12	20	48	36
Turbidity	NTU	5	31.9	54.6	341	5.9	113	122	177	69.5	62.5	38.2	114	85.6	4	233	445	1230	972
Aluminum	mg/L	0.1	0.08	< 0.05	0.64	0.03	0.07	0.07	0.09	0.08	0.05	0.03	0.07	0.04	0.05	0.1	0.19	0.12	0.13
Arsenic	mg/L	0.025	< 0.0005	< 0.0005	0.0095	0.0001	< 0.0003	< 0.0003	0.0001	0.0001	< 0.0003	0.0002	0.0001	0.0001	0.0002	0.009	0.0668	0.145	0.0126
Barium	mg/L	1.0	0.17	0.074	0.31	0.11	0.074	0.09	0.054	0.049	0.073	0.039	0.025	0.033	0.121	0.168	0.17	0.202	0.188
Boron	mg/L	5	2.85	1.69	2.32	0.474	0.302	0.532	0.263	0.272	1.01	0.298	0.037	0.032	0.5	1.05	1.16	1.52	1.52
Cadmium	mg/L	0.005	< 0.000059	< 0.000059	0.00372	< 0.000015	< 0.000029	< 0.000029	< 0.000015	< 0.000015	< 0.000029	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000059	0.000868	< 0.000059	< 0.00012
Chromium	mg/L	0.05	< 0.001	< 0.001	0.007	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003
Copper	mg/L	1	< 0.002	< 0.02	< 0.02	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.007	< 0.002	< 0.01	< 0.002	< 0.002
Iron	mg/L	0.3	0.018	< 0.05	6.43	0.029	13.1	13.3	5.62	7.15	< 0.005	2.48	1.19	6.2	0.215	0.011	0.03	0.019	0.048
Lead	mg/L	0.01	< 0.0002	0.00019	0.00475	< 0.00004	< 0.00009	0.00012	0.00004	0.00006	< 0.00009	< 0.00004	< 0.00002	0.00004	< 0.00004	< 0.0002	< 0.0004	< 0.0002	< 0.0004
Manganese	mg/L	0.05	0.01	0.013	0.26	0.096	0.133	0.109	0.23	0.495	0.149	0.054	0.061	0.129	0.093	0.117	0.125	0.159	0.198
Molybdenum	mg/L	-	< 0.01	< 0.1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01
Nickel	mg/L	-	< 0.01	< 0.1	< 0.1	< 0.01	0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	0.02
Selenium	mg/L	0.01	< 0.025	< 0.02	< 0.1	0.004	< 0.02	0.011	0.005	< 0.02	< 0.01	< 0.01	0.001	< 0.001	< 0.02	0.018	0.023	< 0.02	< 0.040
Silver	mg/L	-	< 0.0002	< 0.0002	0.0032	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	< 0.0005	< 0.0002	< 0.0005
Strontium	mg/L	-	9.7	6.29	84.7	3.43	4.36	6.33	3.28	2.57	6.73	2.26	0.488	0.617	3.91	19	23.3	32	31.7
Thallium	mg/L	-	< 0.00005	0.00085	0.00604	< 0.00005	0.00008	< 0.00005	< 0.00005	0.00007	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00153	0.00021	0.00026
Tin	mg/L	-	< 0.05	< 0.5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.3	< 0.05	< 0.05
Titanium	mg/L	-	< 0.005	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.03	< 0.005	< 0.005
Uranium	mg/L	0.02	0.00011	0.00032	< 0.0002	0.0054	0.0011	0.00031	0.00036	0.00019	0.00093	0.00025	0.00037	0.00024	0.00477	0.0235	0.03	0.0177	0.0176
Vanadium	mg/L	-	< 0.0007	< 0.0007	0.0049	< 0.0001	< 0.0004	< 0.0004	< 0.0001	< 0.0001	< 0.0004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0015	0.0053	0.0075	0.006
Zinc	mg/L	5	< 0.005	< 0.05	< 0.05	0.083	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005	0.009	0.18	0.132	< 0.005	< 0.03	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	500	3302	2331	13688	871	1878	1384	1000	903	1845	746	355	364	1009	4212	4698	6357	7218
Hardness (as CaCO3)	mg/L	80-100	689	529	5870	327	801	612	515	473	642	406	336	355	334	697	771	987	1050
Total Kjeldahl Nitrogen	mg/L	-			-	0.9	1.5	-	-	3.78			-	0.3	1.1	-	-	5.94	
Sulphide	mg/L	-	0.02	< 0.01	< 0.1	0.01	0.07	-	< 0.1	0.18	0.04	< 0.01	0.05	0.08	0.01	-	80.2	66.6	51.6

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-4 F	BH-4 F	BH-4 Z	BH-4 Z	BH-4 Z	BH-4 Z	BH-4 Z	BH-4 Z	BH-4 Z	BH-4 Z	BH-5 F	BH-5 F	BH-5 F	BH-5 F	BH-5 F	BH-5 F	BH-5 F
			09-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21
Saturation pH (25°C)	-	-	5.84	5.71	6.86	6.51	6.62	6.82	6.65	6.67	6.92	6.89	6.84	6.71	6.28	6.19	6.19	6.51	6.71
pH @25°C	pH Units	6.5-8.5	7.1	7.84	7.87	7.72	7.57	7.61	7.79	7.63	7.47	7.74	7.76	7.71	7.95	7.91	8.02	7.56	7.73
Langelier Index(25°C)	S.I.	-	1.26	2.13	1.01	1.21	0.945	0.787	1.14	0.956	0.548	0.848	0.922	0.997	1.67	1.72	1.83	1.05	1.02
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	855	969	310	211	405	319	281	272	299	299	148	254	697	775	801	320	266
Bicarbonate(as CaCO3)	mg/L	-	855	969	310	211	405	319	281	272	299	299	148	254	697	775	801	320	266
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	17700	20100	670	12000	1060	1220	7220	9310	586	597	7640	7590	12700	12700	12900	10000	8580
Fluoride	mg/L	1.5	< 5	< 10	< 0.1	< 5	< 1	< 0.1	< 1	< 1	< 0.1	< 0.1	< 1	< 1	< 10	< 3	< 1	< 3	< 1
Chloride	mg/L	250	5930	5320	23.5	4750	83.9	188	2180	2980	5.6	4.9	2330	2510	3390	3500	4330	2850	2630
Nitrate (N)	mg/L	10	< 5	< 10	< 0.1	< 5	< 1	< 0.1	< 1	< 1	< 0.1	< 0.1	< 1	< 1	< 10	< 3	< 1	< 3	< 1
Nitrite (N)	mg/L	1	< 5	< 10	< 0.1	< 5	< 1	< 0.1	< 1	< 1	< 0.1	< 0.1	< 1	< 1	< 10	< 3	< 1	< 3	< 1
Bromide	mg/L	-	70.7	40.2	< 0.4	46.2	< 4	2.4	23.6	25.2	1.5	< 0.4	25.3	25.3	< 40	43.8	38.4	10.8	30.5
Sulphate	mg/L	500	1810	1610	5	< 50	< 10	6	10	< 10	6	4	26	122	1320	1030	894	149	58
Calcium	mg/L	-	601	718	126	522	174	140	272	278	111	119	335	272	222	295	286	343	262
Magnesium	mg/L	-	286	314	10.7	302	16	20.5	128	139	6.88	7.48	198	157	132	171	166	182	152
Sodium	mg/L	20 / 200	3720	4110	18	1640	51.8	104	1160	1160	5.7	5	983	1120	2390	2400	2780	1480	1090
Potassium	mg/L	-	30.8	32.1	1.2	30.1	1.6	2.4	21.9	23.4	0.4	0.2	22.1	19.9	18.1	22.3	28.1	26	23.3
Ammonia (N)-Total	mg/L	-	2.07	1.61	0.08	3.48	0.09	0.23	2.36	2.59	0.01	0.03	2	2.14	0.42	1.09	1.15	2.76	3.06
o-Phosphate (P)	mg/L	-	0.06	0.276	< 0.002	0.011	< 0.002	0.008	0.005	0.015	< 0.002	0.021	< 0.002	0.008	0.007	< 0.002	0.1	0.005	< 0.002
Phosphorus-Total	mg/L	-	0.46	0.33	0.09	0.11	0.07	0.05	0.07	0.03	0.01	0.6	0.01	< 0.01	0.04	0.13	0.16	0.03	< 0.01
Silica	mg/L	-	10.2	14.5	7.74	5.97	8.71	6.85	7.45	7.06	5.28	5.82	4.76	4.15	5.94	7.9	7.94	9.37	7.51
Dissolved Organic Carbon	mg/L	5	43	54.8	4.6	0.4	6.2	3	2.3	1.9	4.7	6.7	0.9	2.2	0.8	1.9	6.1	3.4	1.3
Colour	TCU	5	50	495	< 2	< 2	4	< 2	2	< 2	4	< 2	3	3	81	17	193	< 2	< 2
Turbidity	NTU	5	1170	370	125	147	61.8	96.9	30.4	38.7	27.6	392	21.3	53.3	14.2	371	176	134	202
Aluminum	mg/L	0.1	< 0.5	0.39	0.04	0.15	0.05	0.08	0.12	0.11	0.01	0.06	0.09	0.05	0.12	0.65	0.13	0.12	< 0.05
Arsenic	mg/L	0.025	0.0203	0.0139	0.0001	< 0.005	0.0002	0.0002	< 0.0005	< 0.001	0.0001	0.0001	< 0.001	< 0.0005	< 0.001	< 0.003	0.0363	0.0011	0.0013
Barium	mg/L	1.0	0.19	0.21	0.032	0.429	0.045	0.035	0.177	0.185	0.024	0.025	1.94	0.149	0.099	0.17	0.248	0.286	0.178
Boron	mg/L	5	2.28	2.86	0.041	1.91	0.093	0.173	1.86	2.3	0.011	0.012	0.815	0.95	0.893	1.98	2.37	1.48	1.14
Cadmium	mg/L	0.005	< 0.00012	0.000523	< 0.000015	< 0.00059	< 0.000015	< 0.000015	< 0.000059	< 0.00012	< 0.000015	< 0.000015	< 0.00012	< 0.000059	< 0.00012	< 0.00030	< 0.00012	< 0.00012	< 0.00012
Chromium	mg/L	0.05	0.003	< 0.003	< 0.001	< 0.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.003	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.2	< 0.02	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002	< 0.02
Iron	mg/L	0.3	< 0.5	0.07	1.46	0.488	3.84	0.125	1.17	0.278	0.072	0.045	0.066	0.871	0.029	0.9	< 0.005	0.479	0.692
Lead	mg/L	0.01	0.00067	0.00135	< 0.00002	< 0.002	0.00008	0.00006	< 0.0002	< 0.0004	0.00002	0.00003	< 0.0004	< 0.0002	< 0.0004	< 0.0009	< 0.0004	< 0.0004	0.00039
Manganese	mg/L	0.05	0.76	1.37	0.104	0.039	0.171	0.412	0.21	0.055	0.051	0.052	0.051	0.03	0.049	0.2	0.186	0.302	0.091
Molybdenum	mg/L	-	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.1	0.05	< 0.01	< 0.1
Nickel	mg/L	-	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.01	< 0.01	< 0.1
Selenium	mg/L	0.01	< 0.02	< 0.2	< 0.001	< 0.02	0.002	0.003	< 0.02	< 0.02	< 0.001	< 0.001	< 0.02	< 0.02	0.036	0.034	< 0.05	< 0.035	< 0.02
Silver	mg/L	-	< 0.0005	< 0.001	< 0.0001	< 0.002	< 0.0001	< 0.0001	< 0.0002	< 0.0005	< 0.0001	< 0.0001	< 0.0005	< 0.0002	0.0005	< 0.001	< 0.0005	< 0.0005	< 0.0005
Strontium	mg/L	-	71.6	92.2	0.705	35.2	1.31	2.08	17.7	19	0.298	0.332	50.7	9.56	34.6	37.9	41.5	45.7	34.6
Thallium	mg/L	-	0.00048	0.00098	< 0.00005	< 0.0004	< 0.00005	< 0.00005	0.00006	0.00009	< 0.00005	< 0.00005	< 0.00008	< 0.00005	< 0.00008	< 0.0002	< 0.00008	< 0.00008	0.00018
Tin	mg/L	-	< 5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.5	< 0.05	< 0.05	< 0.5
Titanium	mg/L	-	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.05
Uranium	mg/L	0.02	0.0148	0.0293	0.00026	0.00162	0.00036	0.00028	0.00016	0.00042	0.00019	0.00024	0.00066	0.00015	0.00044	0.00071	0.00396	0.0011	0.00057
Vanadium	mg/L	-	0.0113	0.0099	< 0.0001	< 0.007	< 0.0001	< 0.0001	< 0.0007	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.0007	< 0.001	< 0.004	0.0048	< 0.001	< 0.001
Zinc	mg/L	5	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.054	0.109	< 0.005	0.36	< 0.005	0.006	< 0.05
TDS(ion sum calc.)	mg/L	500	12894	12687	372	7377	574	653	3946	4743	315	320	3990	4359	7980	7879	8969	5228	4388
Hardness (as CaCO3)	mg/L	80-100	2680	3090	359	2550	500	434	1210	1270	306	328	1650	1330	1100	1440	1400	1610	1280
Total Kjeldahl Nitrogen	mg/L	-			0.4	4.9	-	-	5.6				2.4	2.4	-	-	2.35		
Sulphide	mg/L	-	11.4	51.6	0.12	< 0.1	-	< 0.1	0.05	0.02	< 0.01	< 0.5	0.02	< 0.01	-	14.7	44.2	12.9	0.09

Notes:

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Parameter	Units	ODWQS	BH-5 F	BH-5 H	BH-5 H	BH-5 H	BH-5 H	BH-5 H	BH-5 H	BH-5 H	BH-5 H	BH-5 Z	BH-5 Z	BH-5 Z	BH-5 Z	BH-5 Z	BH-5 Z	BH-5 Z	BH-5 Z	BH-6-I
			22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	13-May-20	29-Jul-20	03-Nov-20	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	10-Mar-21
Saturation pH (25°C)	-	-	6.59	6.99	6.88	6.55	6.62	6.26	6.22	6.18	6.17	6.69	6.56	6.46	7.08	6.37	6.81	6.95	7	7.11
pH @25°C	pH Units	6.5-8.5	7.77	7.99	7.72	7.67	7.63	7.72	7.86	8	7.98	7.6	7.53	7.46	7.97	7.53	7.8	7.94	7.92	7.82
Langelier Index(25°C)	S.I.	-	1.18	1	0.842	1.12	1.01	1.46	1.64	1.82	1.81	0.914	0.969	1	0.888	1.16	0.994	0.99	0.924	0.711
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	254	255	140	243	339	437	814	812	763	143	142	122	257	140	252	267	238	273
Bicarbonate(as CaCO3)	mg/L	-	254	255	140	243	339	437	814	812	763	143	142	122	257	140	252	267	238	273
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	10600	4060	7760	11100	8430	12000	13100	13300	13700	12400	14900	19800	4020	20900	6010	4020	4400	3900
Fluoride	mg/L	1.5	< 10	< 1	< 3	< 10	< 3	< 1	< 5	< 3	< 10	< 3	< 5	< 20	< 1	< 1	< 1	< 1	< 3	< 1
Chloride	mg/L	250	3340	1140	2850	3960	2470	4100	3460	3910	3910	4170	5980	8840	1110	10500	1810	1110	1230	1060
Nitrate (N)	mg/L	10	< 10	< 1	< 3	< 10	< 3	< 1	< 5	< 3	< 10	< 3	< 5	< 20	< 1	< 1	< 1	< 1	< 3	1.5
Nitrite (N)	mg/L	1	< 10	< 1	< 3	< 10	< 3	< 1	< 5	< 3	< 10	< 3	< 5	< 20	< 1	< 1	< 1	< 1	< 3	< 1
Bromide	mg/L	-	< 40	12.6	27.6	< 40	34.3	38.5	< 20	45.6	< 40	45.5	57.5	< 80	14.9	118	12.3	20.5	11.1	14.3
Sulphate	mg/L	500	< 100	16	26	128	241	368	972	864	679	43	< 50	13	21	10	< 10	20	< 30	61
Calcium	mg/L	-	358	135	337	416	254	448	265	291	317	516	692	1020	107	1080	211	140	141	95
Magnesium	mg/L	-	201	78.8	203	239	144	224	155	179	220	300	334	690	60	719	109	76.1	78	61.6
Sodium	mg/L	20 / 200	1360	618	1040	1550	1080	2320	2160	2480	2830	1680	2020	3550	644	4160	847	601	636	620
Potassium	mg/L	-	26.6	15.9	21.2	28.6	19	27.9	23.8	24	28.5	32.7	37.7	59.4	16.2	63.7	22.7	17.4	19.3	17.2
Ammonia (N)-Total	mg/L	-	3.35	1.56	1.92	2.14	1.85	2.19	0.7	1.12	1.68	3.25	4.22	6.84	2	7.25	2.87	2.18	2.5	1.77
o-Phosphate (P)	mg/L	-	0.009	< 0.002	0.004	< 0.002	0.032	0.018	0.012	0.007	0.125	< 0.002	0.005	< 0.002	0.005	0.002	0.002	< 0.002	0.011	0.01
Phosphorus-Total	mg/L	-	0.02	0.02	0.01	0.03	0.06	0.05	0.12	0.06	0.12	0.04	0.01	0.02	0.02	0.03	0.03	0.01	0.01	0.03
Silica	mg/L	-	9.01	6.37	4.26	8.05	6.02	12.6	7.17	3.51	10.8	5.59	5.37	5.75	7.36	5.93	7.94	7.25	8.35	6.81
Dissolved Organic Carbon	mg/L	5	1.5	2.2	0.4	3.9	3	4.4	7	6	4.6	1	0.3	< 0.2	1.3	0.2	1	0.9	1.3	1
Colour	TCU	5	< 2	< 2	6	3	4	11	49	11	8	< 2	< 2	< 2	< 2	9	< 2	3	< 2	< 2
Turbidity	NTU	5	85.6	9.6	11.3	58.4	162	373	439	342	407	88.6	98.4	72.1	20.9	85.9	35.4	35	55.2	67.5
Aluminum	mg/L	0.1	0.18	0.04	0.11	0.13	0.17	0.19	0.11	< 0.5	0.23	0.13	0.16	0.19	0.06	0.59	0.09	< 0.05	0.08	0.06
Arsenic	mg/L	0.025	0.0017	< 0.0005	< 0.0005	0.002	0.0017	0.018	0.0033	0.0029	0.006	< 0.003	< 0.005	< 0.003	< 0.0005	< 0.003	< 0.0005	< 0.0005	< 0.0005	0.0006
Barium	mg/L	1.0	0.265	0.391	1.79	0.649	0.345	0.384	0.343	0.24	0.43	1.33	1.12	1.58	0.08	1.39	0.123	0.065	0.072	0.118
Boron	mg/L	5	1.32	1.03	0.733	1.31	1.19	1.83	1.99	1.31	3.34	1.13	1.3	2.02	1.08	2.34	1.16	0.871	1	1.37
Cadmium	mg/L	0.005	< 0.00012	< 0.000059	< 0.000059	< 0.00012	< 0.00012	< 0.00012	< 0.00012	< 0.00012	< 0.00012	< 0.00030	< 0.00059	< 0.00030	< 0.000059	< 0.00030	< 0.000059	< 0.000059	< 0.000059	< 0.000059
Chromium	mg/L	0.05	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.003	< 0.006	< 0.003	< 0.001	< 0.003	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.002	< 0.002	< 0.2	< 0.02	< 0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.002	< 0.02	< 0.004	< 0.004
Iron	mg/L	0.3	0.54	1.95	0.407	0.646	3.84	0.115	0.135	< 0.5	< 0.05	5.62	6.43	5.71	1.03	4.84	1.57	1.19	1.66	0.168
Lead	mg/L	0.01	< 0.0004	0.00079	< 0.0002	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	0.00071	< 0.0009	< 0.002	< 0.0009	< 0.0002	< 0.0009	< 0.0002	< 0.0002	0.00024	< 0.0002
Manganese	mg/L	0.05	0.09	0.028	0.054	0.313	0.175	0.742	0.176	0.19	0.23	0.068	0.059	0.068	0.01	0.062	0.018	< 0.01	0.012	0.014
Molybdenum	mg/L	-	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.1	< 0.02	< 0.02
Nickel	mg/L	-	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.1	< 0.02	< 0.02
Selenium	mg/L	0.01	< 0.02	< 0.02	< 0.02	0.079	0.037	< 0.05	< 0.02	< 0.02	< 0.1	< 0.02	< 0.02	0.215	0.018	< 0.03	< 0.02	< 0.02	< 0.02	0.017
Silver	mg/L	-	< 0.0005	< 0.0002	< 0.0002	0.0009	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.001	< 0.002	0.0021	< 0.0002	< 0.001	< 0.0002	< 0.0002	0.0003	< 0.0002
Strontium	mg/L	-	50.5	18.9	43	64.7	37.3	65.6	36.6	23.7	51.7	88.3	98.2	194	13.9	210	22.7	14.9	16.3	15.9
Thallium	mg/L	-	< 0.00008	< 0.00005	< 0.00005	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.0002	< 0.0004	< 0.0002	< 0.00005	< 0.0002	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	-	< 0.3	< 0.05	< 0.05	< 0.05	< 0.3	< 0.05	< 0.05	< 5	< 0.5	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.5	< 0.1	< 0.1
Titanium	mg/L	-	< 0.03	< 0.005	< 0.005	< 0.005	< 0.03	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.05	< 0.01	< 0.01
Uranium	mg/L	0.02	0.0004	0.0005	0.00046	0.00034	0.00086	0.00314	0.00178	0.00075	0.00253	0.00134	< 0.0004	0.00032	0.00006	< 0.0002	0.00006	0.00005	< 0.00005	0.00148
Vanadium	mg/L	-	< 0.001	< 0.0007	< 0.0007	< 0.001	< 0.001	0.0023	0.0025	0.0017	0.0045	< 0.004	< 0.007	< 0.004	< 0.0007	< 0.004	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Zinc	mg/L	5	< 0.03	0.763	0.384	< 0.005	< 0.03	< 0.005	< 0.005	< 0.5	< 0.05	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	0.006	< 0.05	< 0.01	< 0.01
TDS(ion sum calc.)	mg/L	500	5435	2165	4559	6476	4415	7753	7524	8239	8449	6837	9156	14253	2112	16631	3156	2132	2255	2089
Hardness (as CaCO3)	mg/L	80-100	1720	661	1680	2020	1220	2040	1300	1460	1700	2520	3100	5380	515	5660	975	662	674	491
Total Kjeldahl Nitrogen	mg/L	-		2	2.7	-	-	3.84				3.8	5.5	-	-	0.48			-	-
Sulphide	mg/L	-	5	< 0.01	< 0.01	-	10.1	10.5	44	2.83	28.9	0.04	0.01	-	0.03	0.01	0.03	< 0.01	0.23	< 0.1

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-6-I	BH-6-I	BH-6-I	BH-6-I	BH-6-I	BH-6-K	BH-6-K	BH-6-K	BH-6-K	BH-6-K	BH-6-K	BH-6-L	BH-6-L	BH-6-L	BH-6-L	BH-6-L	BH-6-L	BH-7-I
			27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	09-Sep-22	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	09-Sep-22	10-Mar-21	27-May-21	01-Sep-21	09-Dec-21	22-Apr-22	09-Sep-22	02-Sep-21
Saturation pH (25°C)	-	-	6.92	6.38	6.47	6.16	5.97	7.22	6.65	6.43	6.44	6.27	6.11	7.24	7.1	7.08	6.94	6.97	7.11	6.07
pH @25°C	pH Units	6.5-8.5	7.83	7.46	8.05	7.55	7.41	7.9	7.73	7.49	8.09	7.67	7.5	7.86	8.01	7.8	7.75	7.95	7.94	7.07
Langelier Index(25°C)	S.I.	-	0.909	1.08	1.58	1.39	1.44	0.682	1.08	1.06	1.65	1.4	1.39	0.622	0.908	0.724	0.814	0.976	0.831	0.999
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	301	528	562	794	950	284	373	472	568	617	715	285	313	316	311	311	348	64
Bicarbonate(as CaCO3)	mg/L	-	301	528	562	794	950	284	373	472	568	617	715	285	313	316	311	311	348	64
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	4970	10800	9580	13000	14100	2810	8350	10200	9490	11600	12800	2910	3060	3260	5320	4450	3380	56700
Fluoride	mg/L	1.5	< 1	< 3	< 3	< 10	< 3	0.5	< 1	< 1	< 3	< 10	< 5	0.4	< 1	< 1	< 1	< 3	< 1	< 10
Chloride	mg/L	250	1190	2030	1800	2270	2780	707	1410	1840	1670	2200	2810	808	805	928	1600	1280	818	29700
Nitrate (N)	mg/L	10	< 1	< 3	< 3	< 10	< 3	< 0.1	< 1	< 1	< 3	< 10	< 5	< 0.1	< 1	< 1	< 1	< 3	< 1	< 10
Nitrite (N)	mg/L	1	< 1	< 3	< 3	< 10	< 3	0.2	< 1	< 1	< 3	< 10	< 5	0.2	< 1	< 1	< 1	< 3	< 1	< 10
Bromide	mg/L	-	12.6	< 10	22.4	< 40	25.9	8.3	12.7	8.8	27.4	< 40	26.8	8.4	8.9	< 4	21.4	11.1	8.4	295
Sulphate	mg/L	500	471	2660	2050	2780	3130	21	2060	2180	2140	2370	2390	24	22	< 10	25	< 30	11	329
Calcium	mg/L	-	136	279	215	309	405	69.4	216	281	231	309	389	66	82.4	86.5	124	114	72.8	4720
Magnesium	mg/L	-	73.5	108	90.6	121	146	43.2	78.1	106	89.4	118	151	40	49	47.1	72.2	63.2	39.6	2480
Sodium	mg/L	20 / 200	957	2190	1680	2480	3140	478	2070	2120	1780	2330	2720	484	542	529	751	714	526	13000
Potassium	mg/L	-	21.6	22.8	20	24.1	25.7	15.3	22.5	23.2	21.1	26.3	27.9	15.3	18.9	16.4	18.9	18.9	14	125
Ammonia (N)-Total	mg/L	-	1.68	1.27	0.75	1.94	2.29	1.72	1.98	1.81	1.34	1.92	2.92	1.67	1.99	2.08	2.74	2.45	1.92	20
o-Phosphate (P)	mg/L	-	< 0.002	0.004	0.008	0.076	0.032	0.011	0.007	0.018	0.034	0.089	0.067	0.013	< 0.002	0.002	< 0.002	0.015	0.008	0.009
Phosphorus-Total	mg/L	-	0.04	0.12	0.05	0.44	0.16	0.09	0.12	0.12	0.04	0.09	0.14	0.21	0.18	0.04	0.13	0.15	0.09	0.18
Silica	mg/L	-	7.04	9.42	7.9	12.4	10.1	5.91	7.15	7.7	7.69	10.5	8.05	5.61	6.81	7.02	6.67	7.19	4.17	3.27
Dissolved Organic Carbon	mg/L	5	4.3	10.5	13.7	8.4	9.4	1.9	35.3	11.8	15	9.5	10.1	2.1	1.8	1.8	2.4	2.3	2	< 0.2
Colour	TCU	5	4	23	43	41	34	< 2	10	19	21	27	26	< 2	< 2	< 2	2	< 2	< 2	4
Turbidity	NTU	5	66.5	104	204	212	149	81.4	125	58.2	428	230	88.5	342	237	262	130	127	95.7	57.1
Aluminum	mg/L	0.1	0.09	0.8	< 0.05	0.31	0.36	0.05	0.12	1.1	< 0.05	0.17	0.38	0.06	0.06	0.11	< 0.05	0.07	0.09	1.16
Arsenic	mg/L	0.025	0.0072	0.0368	0.0082	0.0472	0.0487	0.0004	0.0339	0.0248	0.0084	0.0245	0.0164	0.0005	0.0022	0.0034	0.0065	0.0055	0.004	< 0.005
Barium	mg/L	1.0	0.253	0.1	0.134	0.1	0.09	0.122	0.193	0.2	0.153	0.16	0.13	0.16	0.142	0.106	0.088	0.09	0.064	1.3
Boron	mg/L	5	1.48	2	1.37	2.11	2.66	1.14	1.34	1.7	1.28	1.81	2.24	1.12	1.2	1.12	1.05	1.17	1.08	1.95
Cadmium	mg/L	0.005	< 0.000059	< 0.00012	< 0.00012	< 0.00012	< 0.00012	< 0.000029	< 0.000059	< 0.00012	< 0.00012	< 0.00012	< 0.00012	< 0.000029	< 0.000029	< 0.000029	< 0.000059	< 0.000059	< 0.000029	< 0.00059
Chromium	mg/L	0.05	< 0.001	0.001	0.001	0.003	0.114	< 0.001	< 0.001	< 0.001	0.001	0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.006
Copper	mg/L	1	< 0.002	< 0.2	< 0.02	< 0.02	< 0.02	< 0.004	< 0.002	< 0.2	< 0.02	< 0.01	< 0.02	< 0.004	< 0.002	< 0.002	< 0.02	< 0.004	< 0.004	< 0.002
Iron	mg/L	0.3	5.29	1.7	< 0.05	0.06	0.13	0.114	10.6	5.7	< 0.05	0.05	0.38	0.046	0.89	0.97	1.19	1.09	0.67	0.519
Lead	mg/L	0.01	< 0.0002	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.00009	< 0.0002	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.00009	< 0.00009	0.00017	< 0.0002	< 0.0002	< 0.00009	< 0.002
Manganese	mg/L	0.05	0.082	0.3	0.216	0.34	0.6	0.046	0.156	0.2	0.168	0.19	0.22	0.08	0.056	0.039	0.015	0.016	0.022	0.295
Molybdenum	mg/L	-	< 0.01	< 1	< 0.1	< 0.1	< 0.1	< 0.02	0.03	< 1	< 0.1	< 0.05	< 0.1	< 0.02	< 0.01	< 0.01	< 0.1	< 0.02	< 0.02	0.21
Nickel	mg/L	-	< 0.01	< 1	< 0.1	< 0.1	< 0.1	< 0.02	< 0.01	< 1	< 0.1	< 0.05	< 0.1	< 0.02	0.02	< 0.01	< 0.1	< 0.02	< 0.02	0.04
Selenium	mg/L	0.01	< 0.02	< 0.035	< 0.02	< 0.1	< 0.07	0.013	< 0.03	< 0.040	< 0.02	< 0.1	< 0.07	0.012	< 0.02	< 0.020	< 0.02	< 0.04	< 0.02	< 0.11
Silver	mg/L	-	< 0.0002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0001	< 0.0002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0002	< 0.0001	< 0.002
Strontium	mg/L	-	19.9	30.1	23.7	33.5	41.8	9.68	21.7	28.2	22.3	31.8	41.7	8.6	10.3	9.41	14.5	13	7.96	411
Thallium	mg/L	-	< 0.00005	< 0.00008	< 0.00008	< 0.00008	0.0001	< 0.00005	< 0.00005	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00109
Tin	mg/L	-	< 0.05	< 5	< 0.5	< 0.5	< 0.5	< 0.1	< 0.05	< 5	< 0.5	< 0.3	< 0.5	< 0.1	< 0.05	< 0.05	< 0.5	< 0.1	< 0.1	< 0.05
Titanium	mg/L	-	< 0.005	< 0.5	< 0.05	< 0.05	< 0.05	< 0.01	< 0.005	< 0.5	< 0.05	< 0.03	< 0.05	< 0.01	< 0.005	< 0.005	< 0.05	< 0.01	< 0.01	< 0.005
Uranium	mg/L	0.02	0.0102	0.0118	0.0131	0.0161	0.0125	0.00111	0.0268	0.00828	0.0137	0.0135	0.0108	0.00162	0.00128	0.0018	0.00183	0.00184	0.00124	0.00809
Vanadium	mg/L	-	0.0008	0.0093	0.0071	0.0194	0.0293	< 0.0004	0.0035	0.007	0.0065	0.0087	0.01	< 0.0004	< 0.0004	0.0007	0.0008	< 0.0007	< 0.0004	< 0.007
Zinc	mg/L	5	< 0.005	< 0.5	< 0.05	< 0.05	< 0.05	< 0.01	0.005	< 0.5	< 0.05	< 0.03	< 0.05	< 0.01	< 0.005	< 0.005	< 0.05	< 0.01	< 0.01	0.014
TDS(ion sum calc.)	mg/L	500	3041	7610	6190	8464	10197	1508	6097	6836	6268	7731	8925	1611	1710	1800	2783	2385	1693	55712
Hardness (as CaCO3)	mg/L	80-100	642	1140	909	1270	1610	351	861	1140	944	1260	1590	329	407	410	607	544	345	22000
Total Kjeldahl Nitrogen	mg/L	-	5.63				3.2	-	9.24				4.4	-	4.8				2.5	
Sulphide	mg/L	-	0.12	1.68	19.4	17.8	19.4	< 0.1	< 0.1	1.27	24.7	20.4	4.87	0.3	< 0.1	< 0.1	< 0.01	< 0.1	< 0.5	< 0.1

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-7-I	BH-7-I	BH-7-I	BH-7-K	BH-7-K	BH-7-K	BH-7-K	BH-7-L	BH-7-L	BH-7-L	BH-7-L	BH-8-G	BH-8-G	BH-8-G	BH-8-G	BH-8-G	BH-8-G	BH-8-K
			09-Dec-21	22-Apr-22	09-Sep-22	02-Sep-21	09-Dec-21	22-Apr-22	09-Sep-22	02-Sep-21	09-Dec-21	22-Apr-22	09-Sep-22	10-Mar-21	28-May-21	02-Sep-21	10-Dec-21	21-Apr-22	09-Sep-22	10-Mar-21
Saturation pH (25°C)	-	-	5.99	6	6	6.88	6.88	6.94	6.86	6.89	6.94	6.9	6.8	6.99	6.95	6.97	7.07	6.95	7.03	7.74
pH @25°C	pH Units	6.5-8.5	6.91	7.05	7.1	7.67	7.76	7.82	7.86	7.7	7.78	7.83	7.88	7.9	8.09	7.88	8	7.78	7.8	8.12
Langelier Index(25°C)	S.I.	-	0.923	1.05	1.1	0.789	0.881	0.884	0.996	0.814	0.837	0.934	1.08	0.914	1.14	0.906	0.929	0.833	0.768	0.384
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	80	79	74	199	252	236	246	243	279	250	265	349	523	520	586	541	507	325
Bicarbonate(as CaCO3)	mg/L	-	80	79	74	199	252	236	246	243	279	250	265	349	523	520	586	541	507	325
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	59500	56600	75800	9040	7220	5630	6060	5010	3960	4370	4420	5460	4740	4700	3980	4100	3940	2280
Fluoride	mg/L	1.5	< 10	< 10	< 10	< 3	< 1	< 5	< 1	< 1	< 1	< 5	< 1	3	2.6	2.8	< 1	< 5	2.9	4.3
Chloride	mg/L	250	36000	38300	33200	2750	2200	1630	1630	1520	1140	1230	1180	699	599	543	656	909	860	518
Nitrate (N)	mg/L	10	< 10	< 10	< 10	< 3	< 1	< 5	< 1	< 1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	< 5	< 1	< 0.1
Nitrite (N)	mg/L	1	< 10	< 10	< 10	< 3	< 1	< 5	< 1	< 1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	< 5	< 1	0.2
Bromide	mg/L	-	446	381	360	10.5	26.1	< 20	18.5	8.6	14.7	< 20	12.8	7.8	5	< 4	8.2	< 20	8	4.3
Sulphate	mg/L	500	417	396	436	31	55	< 50	22	< 10	21	< 50	< 10	1460	1140	1060	558	138	130	29
Calcium	mg/L	-	4590	4490	4790	236	179	164	190	178	136	170	198	101	73.4	69.5	48.4	69.6	61	18.4
Magnesium	mg/L	-	2520	2440	2500	119	95.6	89	104	93.9	74.5	89.6	106	23.4	14.3	13.1	12.1	14.9	13	11.1
Sodium	mg/L	20 / 200	12500	13200	13200	1480	1130	910	920	717	472	534	590	1340	1180	1000	776	848	762	466
Potassium	mg/L	-	117	118	116	20.7	15.3	15.1	15.5	15.4	12.2	13.5	13.3	9.9	7.8	12.5	6.1	6.1	5.1	7.3
Ammonia (N)-Total	mg/L	-	17.5	18	16.5	3.47	2.65	2.8	2.97	2.14	1.84	1.99	1.97	0.55	0.37	0.06	0.01	0.31	0.32	0.63
o-Phosphate (P)	mg/L	-	0.014	0.014	0.004	0.005	0.014	0.012	0.01	0.003	0.014	0.017	0.004	0.011	0.012	0.018	0.019	0.029	0.038	0.016
Phosphorus-Total	mg/L	-	1.9	0.15	0.17	0.65	0.58	0.17	0.17	0.27	0.81	0.1	0.11	0.13	0.18	0.12	0.13	0.09	0.09	0.1
Silica	mg/L	-	2.33	4.71	< 1	10.7	9.16	11.4	6.27	8.45	7.9	7.66	4.6	9.65	15.1	14.1	13.7	19.7	13.1	4.22
Dissolved Organic Carbon	mg/L	5	< 0.2	0.9	< 0.2	0.4	0.5	1	0.4	1.2	0.9	0.7	0.4	73.2	7	19.4	7.2	5.1	5.1	3.1
Colour	TCU	5	4	39	5	4	2	< 2	< 2	< 2	< 2	< 2	< 2	8	7	8	6	2	34	< 2
Turbidity	NTU	5	394	72.4	31	529	8230	218	162	424	917	287	111	192	63.4	32.3	27.6	49.2	33	107
Aluminum	mg/L	0.1	< 0.5	2.55	2.75	0.23	< 0.05	0.2	0.2	0.1	< 0.05	0.11	0.19	0.73	0.07	< 0.5	< 0.05	0.07	0.05	0.02
Arsenic	mg/L	0.025	< 0.005	< 0.005	< 0.005	0.0033	0.0031	0.0063	0.006	0.0017	0.004	0.0035	0.0037	0.0139	0.0207	0.0094	0.0067	0.0089	0.005	0.0012
Barium	mg/L	1.0	0.97	1	1.1	0.261	0.269	0.175	0.2	0.181	0.118	0.124	0.135	0.13	0.047	0.1	0.042	0.108	0.104	0.108
Boron	mg/L	5	2.15	2.6	2.55	0.894	0.777	0.505	0.435	0.591	0.423	0.348	0.315	3.38	3.16	2.9	2.63	3.56	3.38	2.86
Cadmium	mg/L	0.005	< 0.00059	< 0.00059	0.00292	< 0.00012	0.00008	< 0.000059	< 0.000059	< 0.000059	< 0.000029	< 0.000059	0.000037	0.000297	< 0.000059	< 0.000059	< 0.000029	< 0.000059	< 0.000029	< 0.000029
Chromium	mg/L	0.05	< 0.006	< 0.006	0.012	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	1	< 0.2	< 0.1	< 0.1	< 0.002	< 0.02	< 0.01	< 0.01	< 0.002	< 0.02	< 0.004	< 0.01	< 0.02	< 0.002	< 0.2	< 0.02	< 0.004	< 0.004	< 0.004
Iron	mg/L	0.3	1.8	2.6	4.25	0.457	0.091	1.07	1.92	0.05	1.06	0.88	1.35	17.1	2.05	< 0.5	< 0.05	0.046	0.044	0.168
Lead	mg/L	0.01	< 0.002	< 0.002	0.00197	0.00076	< 0.0002	0.00057	< 0.0002	< 0.0002	< 0.00009	< 0.0002	< 0.00009	0.0002	< 0.0002	< 0.0002	< 0.00009	< 0.0002	< 0.00009	< 0.00009
Manganese	mg/L	0.05	0.3	0.3	0.35	0.042	< 0.01	0.03	0.03	0.027	0.028	0.034	0.04	0.16	0.145	0.2	0.084	0.196	0.214	0.048
Molybdenum	mg/L	-	< 1	< 0.5	< 0.5	0.05	< 0.1	< 0.05	< 0.05	0.02	< 0.1	< 0.02	< 0.05	< 0.1	0.05	< 1	< 0.1	< 0.02	< 0.02	< 0.02
Nickel	mg/L	-	< 1	< 0.5	< 0.5	< 0.01	< 0.1	< 0.05	< 0.05	< 0.01	< 0.1	< 0.02	< 0.05	< 0.1	< 0.01	< 1	< 0.1	< 0.02	< 0.02	< 0.02
Selenium	mg/L	0.01	< 0.02	< 0.3	< 0.3	< 0.02	< 0.02	< 0.02	< 0.05	< 0.02	< 0.02	< 0.04	< 0.05	0.035	< 0.02	< 0.010	< 0.02	< 0.02	< 0.02	0.007
Silver	mg/L	-	< 0.002	< 0.002	< 0.002	< 0.0005	< 0.0002	0.0006	< 0.0002	< 0.0002	< 0.0001	< 0.0002	< 0.0001	< 0.0002	< 0.0002	< 0.0002	< 0.0001	< 0.0002	< 0.0001	< 0.0001
Strontium	mg/L	-	407	411	419	16.6	17.1	10.9	13	12	8.75	10.9	13.1	4	3.11	2.7	2.36	4.82	4.52	1.44
Thallium	mg/L	-	0.00072	< 0.0004	0.00142	< 0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00006	< 0.00005	< 0.00005	0.00019	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	-	< 5	< 3	< 3	< 0.05	< 0.5	< 0.3	< 0.3	< 0.05	< 0.5	< 0.1	< 0.3	< 0.5	< 0.05	< 5	< 0.5	< 0.1	< 0.1	< 0.1
Titanium	mg/L	-	< 0.5	< 0.3	< 0.3	0.007	< 0.05	< 0.03	< 0.03	< 0.005	< 0.05	< 0.01	< 0.03	< 0.05	< 0.005	< 0.5	< 0.05	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.02	0.0089	0.00617	0.0125	0.00528	0.00614	0.00979	0.00929	0.00681	0.00866	0.00758	0.00657	0.426	0.0129	0.0548	0.0535	0.0316	0.0269	0.0038
Vanadium	mg/L	-	< 0.007	< 0.007	0.0093	< 0.001	< 0.0007	< 0.0007	< 0.0007	< 0.0007	0.0004	< 0.0007	< 0.0004	0.0034	0.0029	0.0027	0.0037	0.0029	0.0023	< 0.0004
Zinc	mg/L	5	< 0.5	< 0.3	< 0.3	0.006	< 0.05	< 0.03	< 0.03	0.007	< 0.05	0.01	< 0.03	< 0.05	< 0.005	< 0.5	< 0.05	< 0.01	< 0.01	< 0.01
TDS(ion sum calc.)	mg/L	500	56271	58982	54246	4756	3826	2958	3037	2678	2032	2185	2245	3860	3331	3017	2408	2311	2138	1251
Hardness (as CaCO3)	mg/L	80-100	21800	21200	22200	1080	840	775	901	831	646	792	927	349	242	228	171	235	206	92
Total Kjeldahl Nitrogen	mg/L	-			21.1				3.7				2.6	-	4.94				0.8	-
Sulphide	mg/L	-	0.02	< 0.1	< 0.1	< 0.1	< 0.01	< 0.1	< 0.5	< 0.1	< 0.01	< 0.1	< 0.2	1.47	1.04	2.45	6.24	7.9	7.98	0.12

Notes:

Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

Parameter	Units	ODWQS	BH-8-K	BH-8-K	BH-8-K	BH-8-K	BH-8-K	BH-8-L	BH-8-L	BH-8-L	BH-8-L	BH-8-L	BH-8-L	BH-9 G	BH-9 G	BH-9 G	BH-9 K	BH-9 K	BH-9 K
			28-May-21	02-Sep-21	10-Dec-21	21-Apr-22	09-Sep-22	10-Mar-21	28-May-21	02-Sep-21	10-Dec-21	21-Apr-22	09-Sep-22	13-Dec-21	21-Apr-22	09-Sep-22	13-Dec-21	21-Apr-22	09-Sep-22
Saturation pH (25°C)	-	-	7.44	7.19	7.25	7.1	7.23	7.81	7.78	7.92	7.51	7.42	8.13	6.35	6.31	6.26	6.34	6.37	6.36
pH @25°C	pH Units	6.5-8.5	8.18	7.78	7.34	8.01	8.05	8.34	8.28	8.22	7.96	8.16	8.54	7.31	7.36	7.47	7.01	6.91	7.18
Langelier Index(25°C)	S.I.	-	0.735	0.589	0.0935	0.908	0.817	0.532	0.495	0.303	0.448	0.744	0.412	0.957	1.05	1.21	0.665	0.537	0.816
Alkalinity(CaCO3) to pH4.5	mg/L	30-500	351	369	320	400	363	320	326	318	307	309	337	171	157	164	80	69	65
Bicarbonate(as CaCO3)	mg/L	-	351	369	320	400	363	313	326	318	307	309	314	171	157	164	80	69	65
Carbonate (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	7	< 5	< 5	< 5	< 5	22	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	-	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	-	2970	4080	4320	4290	3110	2290	2350	1850	2930	3140	934	21900	24200	31800	40800	43500	63500
Fluoride	mg/L	1.5	3.2	< 1	5.4	< 3	2.7	4.5	3.3	< 1	2.6	< 3	1.6	< 10	< 10	< 10	< 10	< 10	< 10
Chloride	mg/L	250	680	863	1070	1020	694	533	520	276	698	750	89.7	9990	12400	11600	23500	25900	25300
Nitrate (N)	mg/L	10	< 1	< 1	< 1	< 3	< 1	< 0.1	< 1	< 1	< 0.2	< 3	< 0.1	< 10	< 10	< 10	< 10	< 10	< 10
Nitrite (N)	mg/L	1	< 1	< 1	< 1	< 3	< 1	0.1	< 1	< 1	< 0.2	< 3	< 0.1	< 10	< 10	< 10	< 10	< 10	< 10
Bromide	mg/L	-	6.2	< 4	16.2	< 10	6.5	4.2	4.7	< 4	6.9	< 10	0.8	127	112	121	266	272	269
Sulphate	mg/L	500	51	145	211	164	53	73	98	97	82	72	12	389	362	312	391	493	405
Calcium	mg/L	-	33.3	58.1	59	65.8	52.4	15.8	16.4	12.1	32.6	40.4	6.42	926	1120	1200	2010	2210	2390
Magnesium	mg/L	-	21	35.7	38.1	36.6	31.4	8.96	9.71	7.12	21.5	28.4	3.74	635	728	772	1250	1200	1210
Sodium	mg/L	20 / 200	642	764	733	788	542	494	508	344	467	560	204	3960	4780	5320	9120	11800	12200
Potassium	mg/L	-	9.7	11.8	11.9	11.8	7.9	6.4	6.9	5	9.3	9.9	3.9	52	54.8	52.8	87.7	61.5	61
Ammonia (N)-Total	mg/L	-	0.69	0.71	1.06	1.07	0.82	0.8	0.8	0.51	0.96	0.28	0.55	6.49	8.03	7.9	16.2	21.3	20.4
o-Phosphate (P)	mg/L	-	< 0.002	0.004	0.012	0.013	0.011	0.081	0.157	0.053	0.031	0.01	0.13	0.01	0.013	0.004	0.01	0.043	0.013
Phosphorus-Total	mg/L	-	0.13	2.09	0.52	0.07	0.09	3.13	0.3	0.05	0.18	0.09	0.29	0.05	0.05	0.05	0.21	0.17	0.31
Silica	mg/L	-	6.25	6.42	7.64	9.42	4.96	4.79	5.44	6.33	7.06	7.7	4.24	6.74	9.01	3.81	5.59	11.7	3.96
Dissolved Organic Carbon	mg/L	5	2.4	2.3	2.4	2.3	1.1	2.8	2.1	2.1	1.5	1.3	1.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Colour	TCU	5	2	2	3	< 2	< 2	3	4	3	< 2	< 2	< 2	5	< 2	9	5	4	3
Turbidity	NTU	5	108	1730	337	16.9	25.9	4710	557	450	453	260	598	31.9	66.6	52.3	96.2	178	160
Aluminum	mg/L	0.1	0.03	0.02	< 0.05	0.04	0.07	0.1	0.03	0.02	0.01	0.14	0.07	< 0.5	0.6	0.62	< 0.5	1.9	1.65
Arsenic	mg/L	0.025	0.0036	0.0038	0.0088	0.0089	0.0046	0.0012	0.0017	0.0033	0.0053	0.0041	0.0025	0.0183	0.0044	0.0031	< 0.005	0.0126	0.0119
Barium	mg/L	1.0	0.119	0.153	0.14	0.13	0.074	0.108	0.053	0.027	0.06	0.068	0.011	0.21	0.27	0.28	0.71	0.3	0.3
Boron	mg/L	5	3.45	3.79	3.39	3.78	2.4	2.84	2.65	1.71	1.63	1.86	1.59	3.7	3.85	3.82	2.86	2.7	2.4
Cadmium	mg/L	0.005	< 0.000029	< 0.000059	< 0.000059	< 0.000059	0.000032	< 0.000029	0.000056	0.000052	0.000064	0.00006	0.000015	0.00332	0.00181	< 0.00030	< 0.00059	< 0.00059	< 0.00059
Chromium	mg/L	0.05	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.004	0.003	< 0.003	0.019	< 0.006	0.01
Copper	mg/L	1	< 0.002	< 0.002	< 0.02	< 0.004	< 0.004	< 0.004	< 0.002	< 0.002	< 0.002	< 0.004	< 0.002	< 0.2	< 0.02	< 0.04	< 0.2	< 0.1	< 0.1
Iron	mg/L	0.3	0.412	0.133	2.39	1.05	0.33	0.334	0.081	0.163	0.745	0.714	0.05	1.84	4.8	5.1	0.7	2.25	2.05
Lead	mg/L	0.01	< 0.00009	< 0.0002	< 0.0002	0.00029	< 0.00009	0.00011	< 0.00009	< 0.00004	< 0.00009	0.00027	0.00007	0.00138	0.00219	< 0.0009	< 0.002	< 0.002	< 0.002
Manganese	mg/L	0.05	0.043	0.128	0.049	0.028	0.016	0.068	0.05	0.022	0.037	0.034	0.006	0.11	0.15	0.16	0.18	0.35	0.3
Molybdenum	mg/L	-	0.01	< 0.01	< 0.1	< 0.02	< 0.02	< 0.02	0.04	0.05	0.03	0.04	< 0.01	< 1	< 0.1	< 0.2	< 1	< 0.5	< 0.5
Nickel	mg/L	-	< 0.01	< 0.01	< 0.1	< 0.02	< 0.02	< 0.02	0.03	< 0.01	< 0.01	< 0.02	< 0.01	< 1	< 0.1	< 0.2	< 1	< 0.5	< 0.5
Selenium	mg/L	0.01	< 0.02	< 0.015	< 0.02	< 0.04	< 0.02	0.007	< 0.02	< 0.006	< 0.02	< 0.04	0.002	< 0.02	< 0.1	< 0.3	< 0.02	< 0.5	< 0.6
Silver	mg/L	-	< 0.0001	< 0.0002	< 0.0002	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.001	0.0124	< 0.001	< 0.002	0.0142	< 0.002
Strontium	mg/L	-	2.97	4.99	5.25	5.44	4.42	1.17	1.3	0.929	2.75	3.64	0.454	87.7	105	112	146	140	141
Thallium	mg/L	-	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00008	< 0.00005	0.00352	0.00217	< 0.0002	< 0.0004	< 0.0004	< 0.0004
Tin	mg/L	-	< 0.05	< 0.05	< 0.5	< 0.1	< 0.1	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 5	< 0.5	< 1	< 5	< 3	< 3
Titanium	mg/L	-	< 0.005	< 0.005	< 0.05	< 0.01	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.5	< 0.05	< 0.1	< 0.5	< 0.3	< 0.3
Uranium	mg/L	0.02	0.00371	0.00468	0.00532	0.00301	0.00507	0.00277	0.00371	0.00688	0.00654	0.00618	0.00231	0.0206	0.0157	0.0119	0.0336	0.0598	0.0501
Vanadium	mg/L	-	< 0.0004	< 0.0007	0.0012	< 0.0007	0.0004	< 0.0004	< 0.0004	< 0.0001	0.0005	0.0005	0.0002	0.0117	< 0.004	< 0.004	< 0.007	< 0.007	< 0.007
Zinc	mg/L	5	< 0.005	< 0.005	< 0.05	< 0.01	< 0.01	< 0.01	< 0.005	< 0.005	0.006	< 0.01	< 0.005	< 0.5	< 0.05	< 0.1	< 0.5	< 0.3	< 0.3
TDS(ion sum calc.)	mg/L	500	1652	2100	2325	2329	1603	1329	1360	933	1500	1647	524	16066	19523	19388	36413	41719	41585
Hardness (as CaCO3)	mg/L	80-100	170	292	304	315	260	76	81	60	170	218	31	4920	5790	6180	10200	10400	10900
Total Kjeldahl Nitrogen	mg/L	-	7.13				1.4	-	1.13				0.9			10.8			26.3
Sulphide	mg/L	-	< 0.1	6.2	0.02	0.03	0.04	18.5	< 0.1	< 0.1	0.01	0.45	< 2	0.04	0.02	0.01	0.01	< 0.2	< 0.1

Notes:

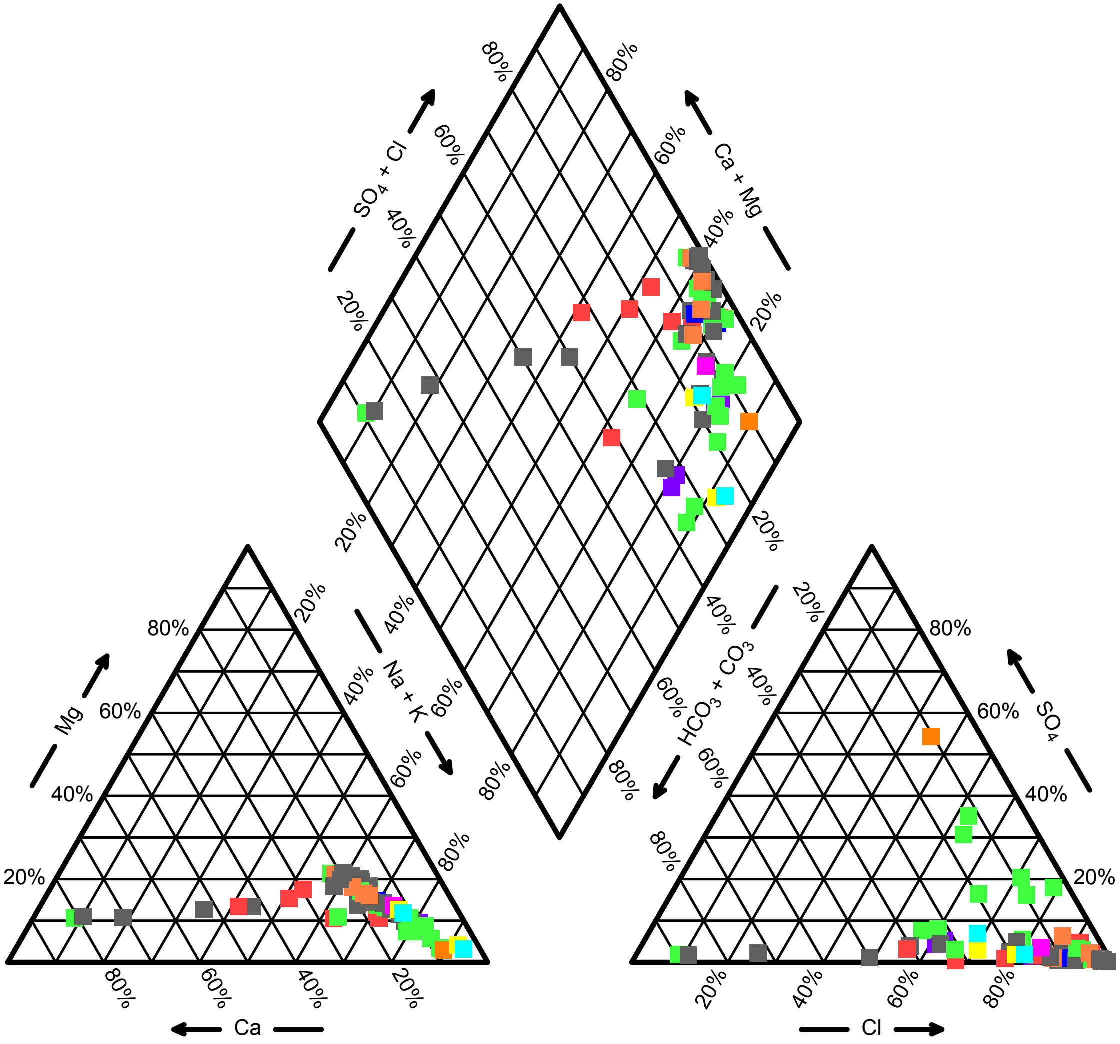
Highlighted cells indicate exceedance above the Ontario Drinking Water Standards (ODWS)

In general elevated laboratory detection limits may be present due to sample matrix interference with instrumentation (increased halide concentration) as indicated on Laboratory Reports.

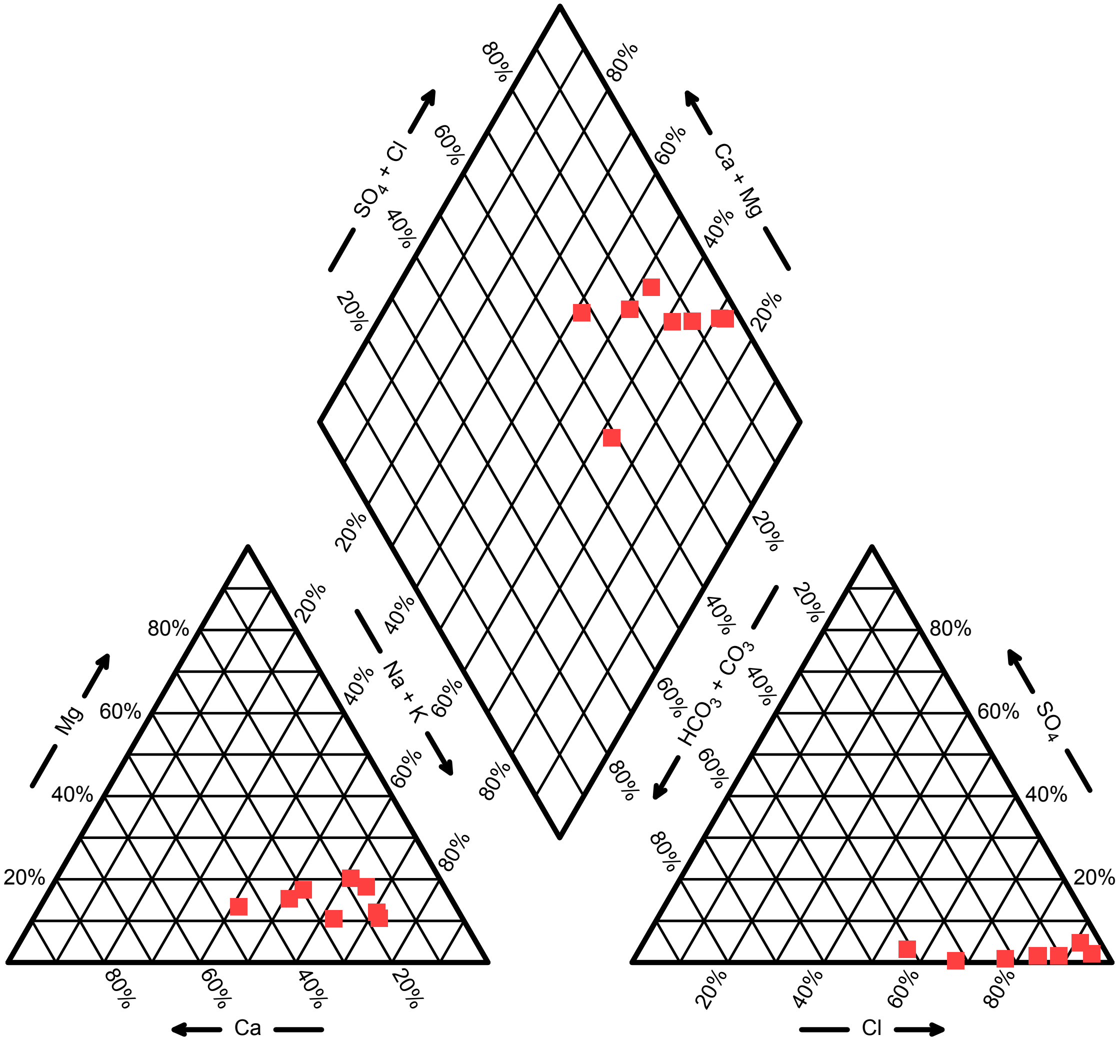
APPENDIX L

Piper Plots

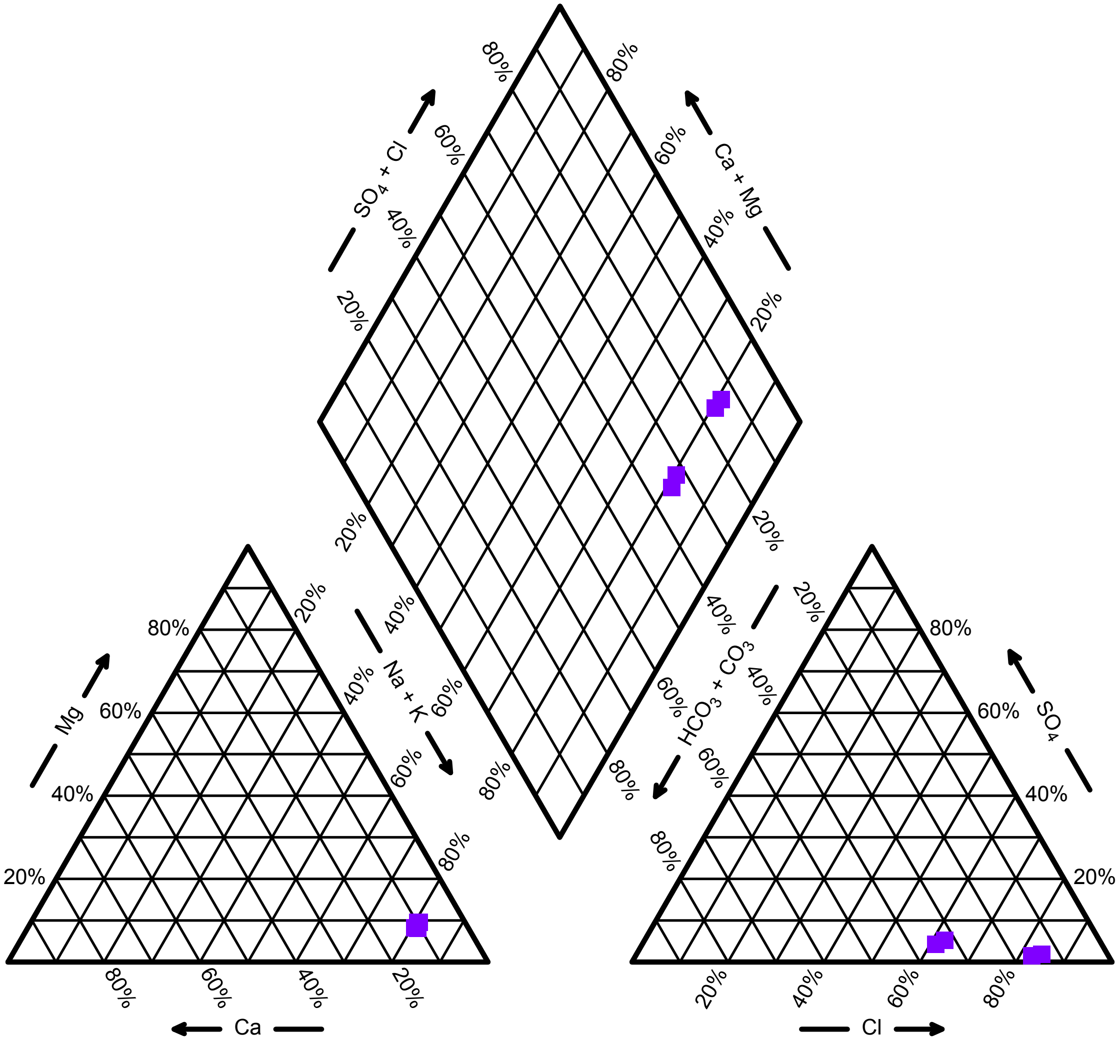
Piper Diagram - Brechin Quarry All Wells



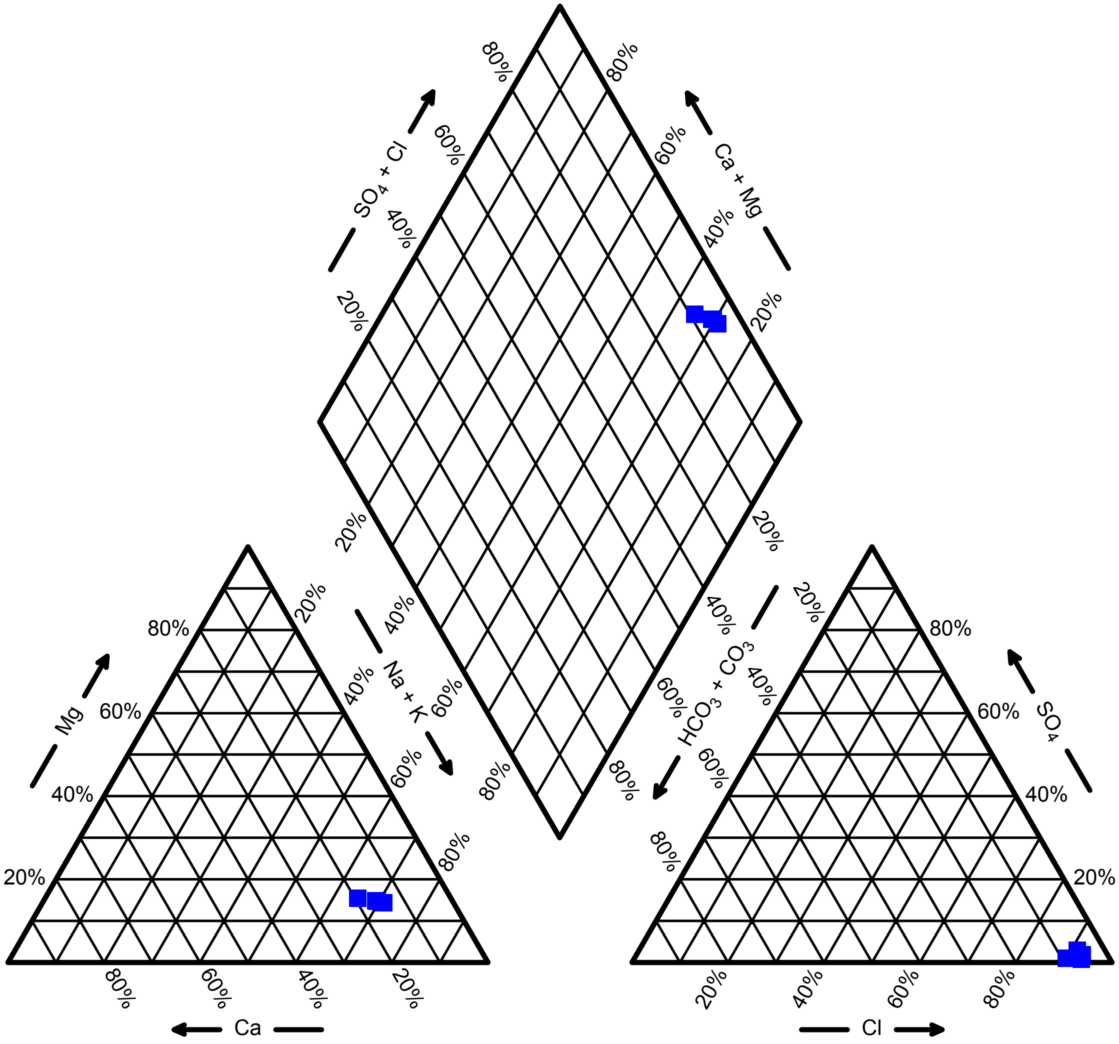
Piper Diagram - "B" Wells



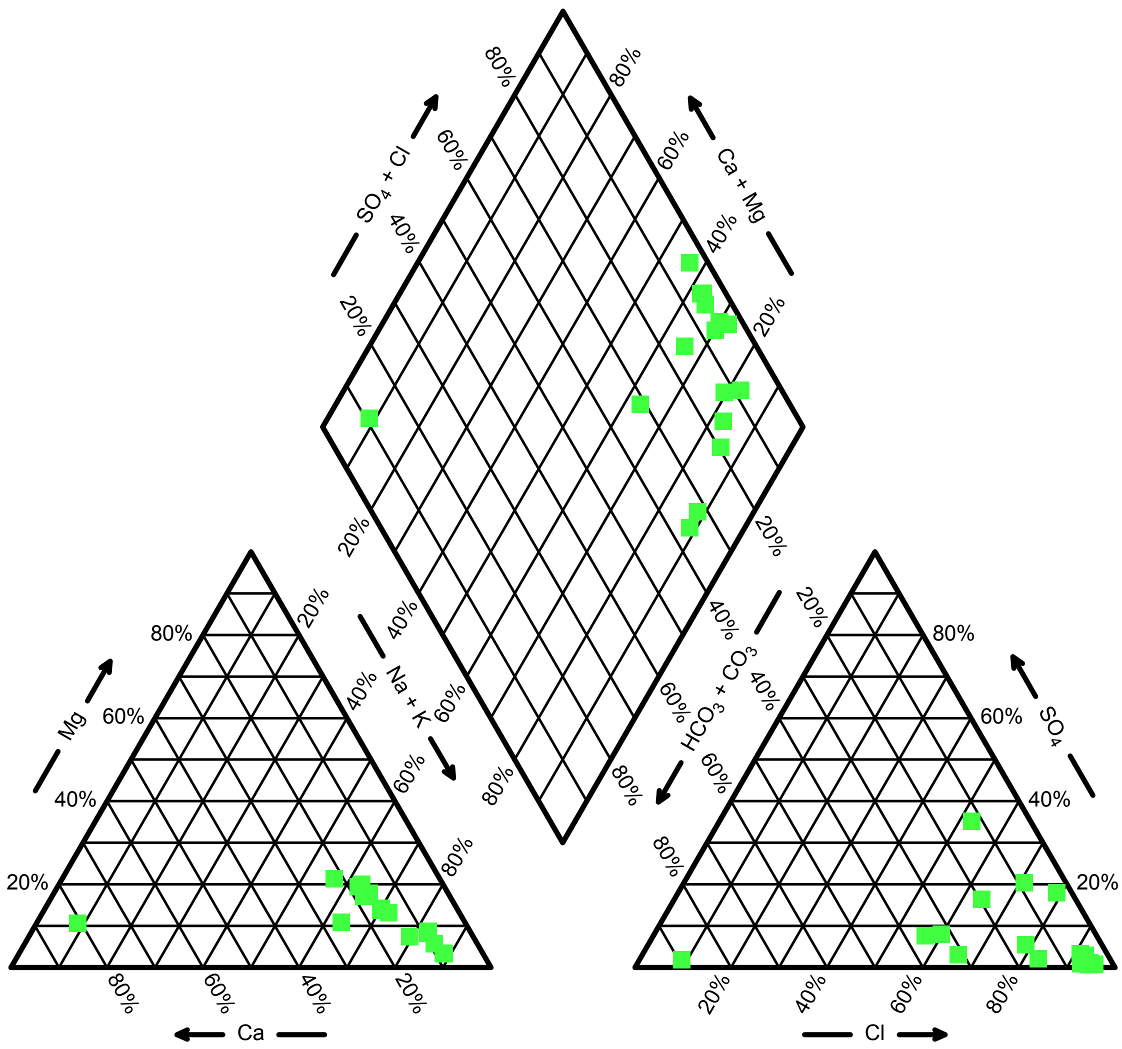
Piper Diagram - "C" Wells



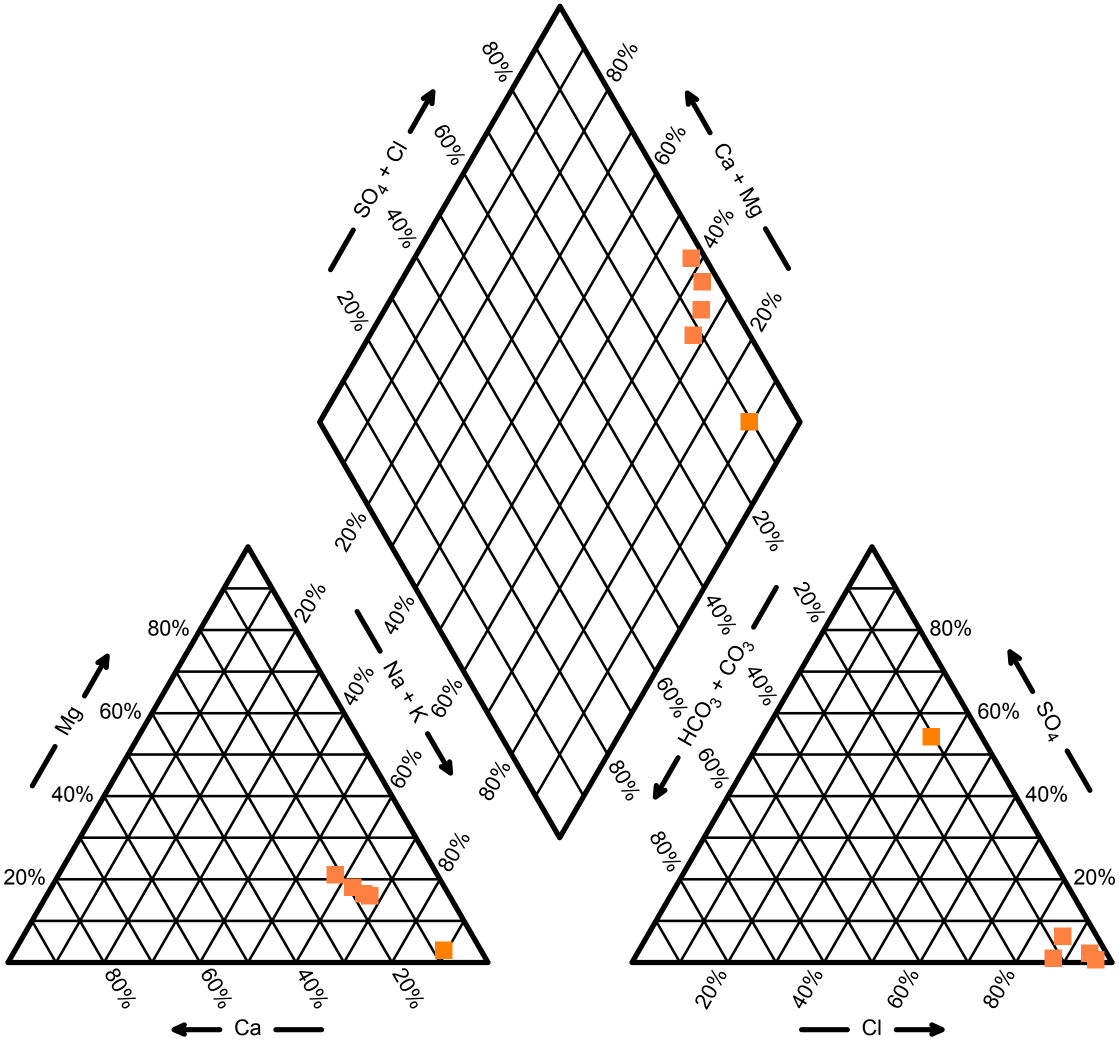
Piper Diagram - "D" Wells



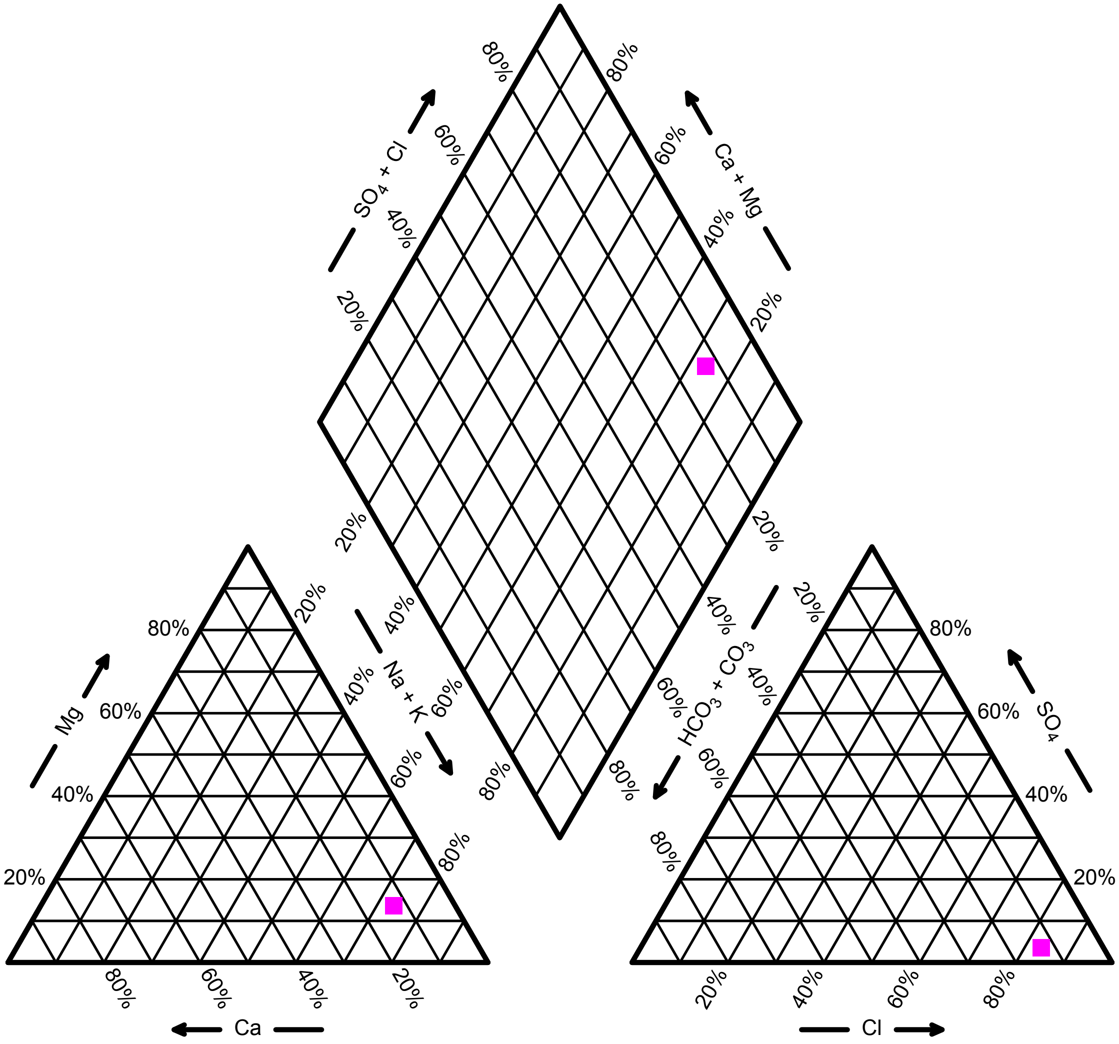
Piper Diagram - "E" Wells



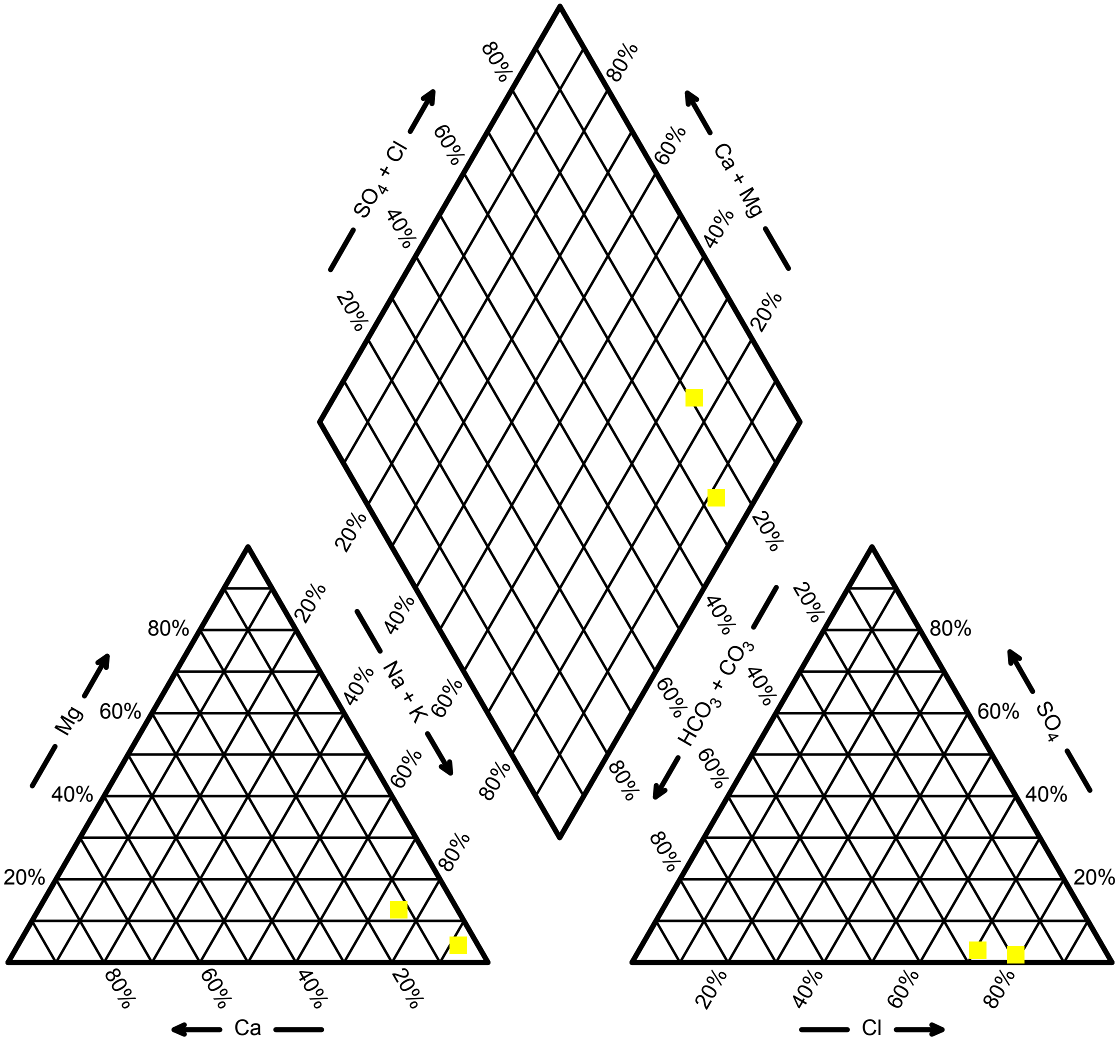
Piper Diagram - "G" Wells



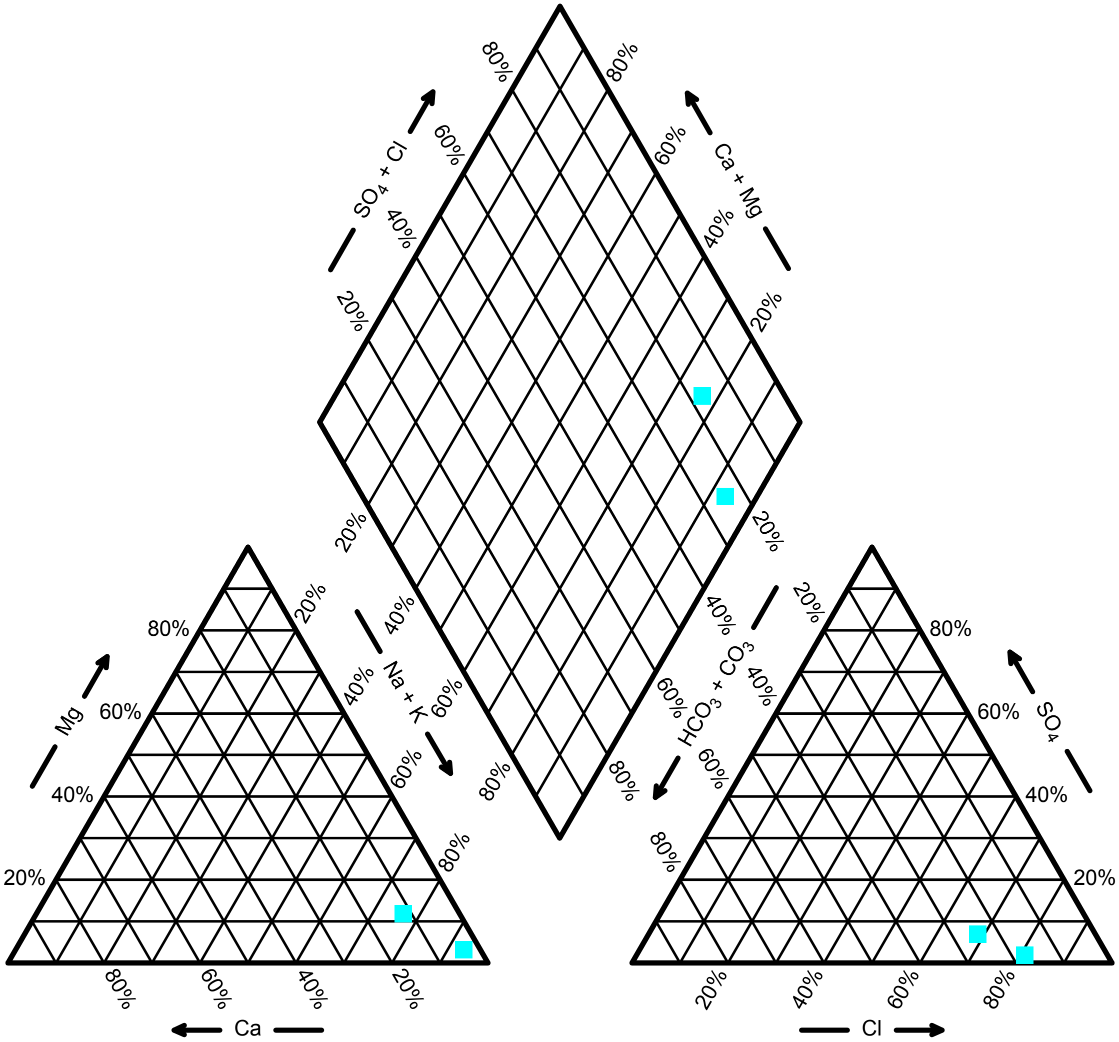
Piper Diagram - "I" Wells



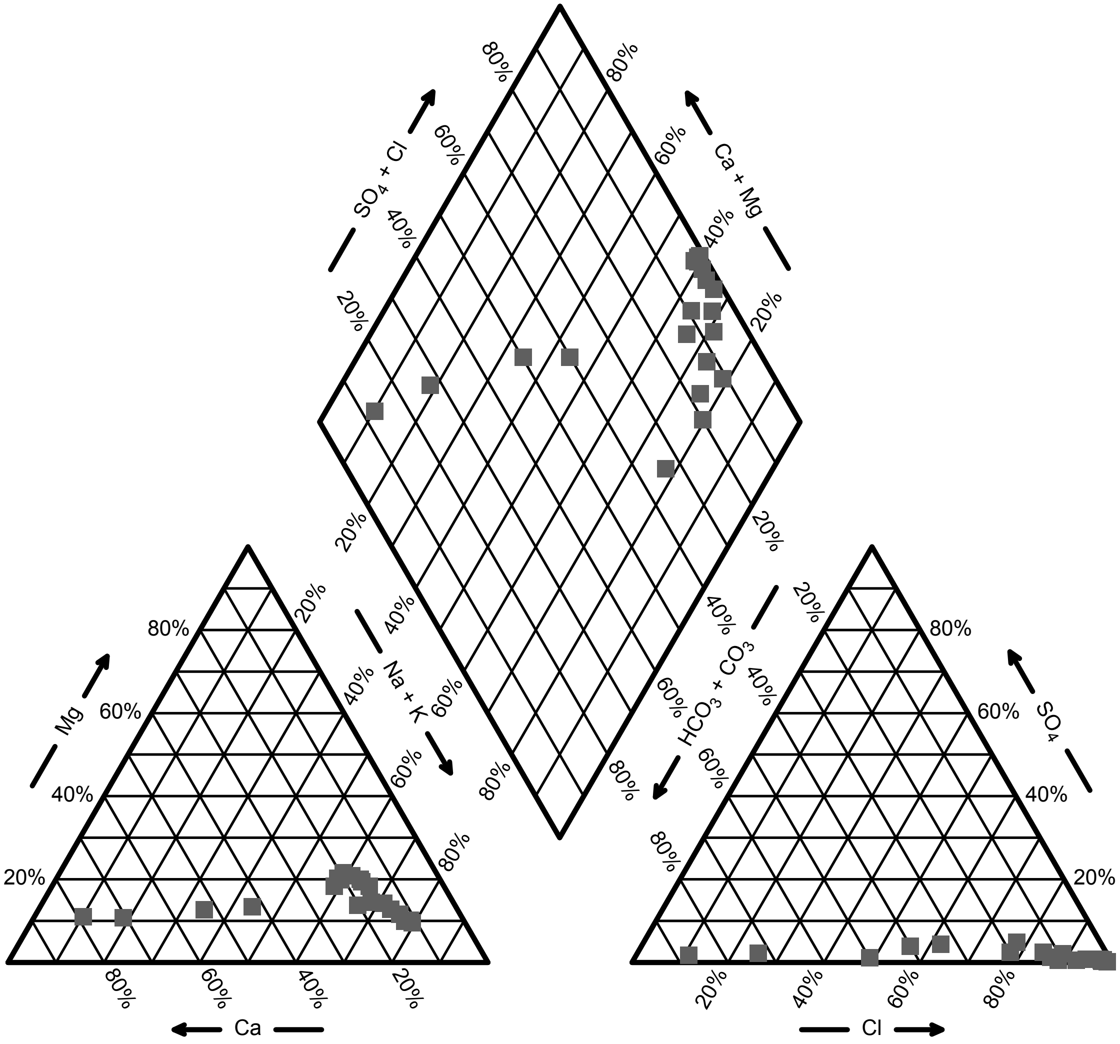
Piper Diagram - "K" Wells



Piper Diagram - "L" Wells



Piper Diagram - "Z" Wells



APPENDIX M

Laboratory Reports

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-22161**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-22161-1	B20-22161-2	B20-22161-3	B20-22161-4
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	06-Aug-20/O	6.85	6.71	6.47	7.67
pH @25°C	pH Units		SM 4500H	31-Jul-20/O	7.80	7.77	7.62	8.09
Langelier Index(25°C)	S.I.		Calc.	06-Aug-20/O	0.948	1.06	1.15	0.422
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	31-Jul-20/O	296	266	205	244
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	296	266	205	244
Carbonate (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	31-Jul-20/O	4760	7920	15400	1330
Fluoride	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	0.7
Chloride	mg/L	0.5	SM4110C	31-Jul-20/O	1530	2900	6240	287
Nitrate (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	< 0.1
Bromide	mg/L	0.4	SM4110C	31-Jul-20/O	14.5	27.4	59.4	2.5
Sulphate	mg/L	1	SM4110C	31-Jul-20/O	38	27	< 50	32
Calcium	mg/L	0.02	SM 3120	06-Aug-20/O	158	263	584	26.7
Magnesium	mg/L	0.02	SM 3120	06-Aug-20/O	107	172	413	12.0
Sodium	mg/L	0.2	SM 3120	06-Aug-20/O	718	1040	2270	218
Potassium	mg/L	0.1	SM 3120	06-Aug-20/O	18.8	27.6	48.0	6.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	31-Jul-20/K	1.84	2.73	5.32	0.69
o-Phosphate (P)	mg/L	0.002	PE4500-S	31-Jul-20/K	0.004	0.004	0.014	0.008
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-20/K	0.02	< 0.01	0.01	0.01
Silica	mg/L	0.02	SM 3120	06-Aug-20/O	8.02	7.81	9.03	5.44
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	31-Jul-20/O	3.7	1.7	0.9	2.1
Colour	TCU	2	SM 2120C	31-Jul-20/O	2	3	5	< 2

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

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Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

				Client I.D.	BH-1 B	BH-1 E	BH-1 Z	BH-2 C
				Sample I.D.	B20-22161-1	B20-22161-2	B20-22161-3	B20-22161-4
				Date Collected	29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	31-Jul-20/O	18.2	32.8	70.4	17.8
Aluminum	mg/L	0.01	SM 3120	06-Aug-20/O	0.06	0.11	0.16	0.03
Arsenic	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0005	< 0.0005	< 0.005	< 0.0001
Barium	mg/L	0.001	SM 3120	06-Aug-20/O	0.185	0.283	0.771	0.017
Boron	mg/L	0.005	SM 3120	06-Aug-20/O	1.82	2.23	3.05	1.26
Cadmium	mg/L	0.000015	EPA 200.8	05-Aug-20/O	< 0.000059	< 0.000059	< 0.00059	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	05-Aug-20/O	< 0.001	< 0.001	< 0.006	< 0.001
Copper	mg/L	0.002	SM 3120	06-Aug-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	06-Aug-20/O	1.48	2.70	0.112	2.11
Lead	mg/L	0.00002	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.0002	< 0.002	< 0.00004
Manganese	mg/L	0.001	SM 3120	06-Aug-20/O	0.129	0.091	0.107	0.016
Molybdenum	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	0.01
Selenium	mg/L	0.001	EPA 200.8	05-Aug-20/O	<0.02	<0.02	<0.02	<0.02
Silver	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.0002	< 0.002	< 0.0001
Strontium	mg/L	0.001	SM 3120	06-Aug-20/O	21.9	42.3	81.7	1.17
Thallium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	0.00006	< 0.00005	< 0.0004	< 0.00005
Tin	mg/L	0.05	SM 3120	06-Aug-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	0.00304	0.00064	0.00040	< 0.00005
Vanadium	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0007	< 0.0007	< 0.007	< 0.0001
Zinc	mg/L	0.005	SM 3120	06-Aug-20/O	0.167	0.009	< 0.005	0.014
TDS(ion sum calc.)	mg/L	1	Calc.	06-Aug-20/O	2753	4593	9685	732
Hardness (as CaCO3)	mg/L	1	SM 3120	06-Aug-20/O	836	1360	3160	116
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	31-Jul-20/K	2.5	3.5	6.8	1.2

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-22161

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-22161-1	B20-22161-2	B20-22161-3	B20-22161-4
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Sulphide	mg/L	0.01	SM4500-S2	04-Aug-20/K	0.34	0.01	9.94	0.41
Anion Sum	meq/L		Calc.	06-Aug-20/O	50.0	87.6	180	13.7
Cation Sum	meq/L		Calc.	06-Aug-20/O	48.5	73.5	163	12.1
% Difference	%		Calc.	06-Aug-20/O	1.45	8.73	4.96	5.94

1 . Elevated RL due to sample matrix interference

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Christine Burke
Lab Manager

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DATE RECEIVED: 29-Jul-20
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-22161-5	B20-22161-6	B20-22161-7	B20-22161-8
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	06-Aug-20/O	7.64	7.28	6.80	6.77
pH @25°C	pH Units		SM 4500H	31-Jul-20/O	7.99	8.04	7.81	7.78
Langelier Index(25°C)	S.I.		Calc.	06-Aug-20/O	0.352	0.765	1.01	1.01
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	31-Jul-20/O	284	247	247	244
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	284	247	247	244
Carbonate (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	31-Jul-20/O	1620	3740	6770	7780
Fluoride	mg/L	0.1	SM4110C	31-Jul-20/O	0.8	< 1	< 1	< 1
Chloride	mg/L	0.5	SM4110C	31-Jul-20/O	319	1220	2320	2890
Nitrate (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 0.1	< 1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 0.1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	31-Jul-20/O	3.0	11.5	22.7	27.5
Sulphate	mg/L	1	SM4110C	31-Jul-20/O	58	< 10	24	41
Calcium	mg/L	0.02	SM 3120	06-Aug-20/O	25.2	71.5	219	246
Magnesium	mg/L	0.02	SM 3120	06-Aug-20/O	6.37	39.9	124	135
Sodium	mg/L	0.2	SM 3120	06-Aug-20/O	308	575	1080	1250
Potassium	mg/L	0.1	SM 3120	06-Aug-20/O	5.8	14.9	24.1	26.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	31-Jul-20/K	0.30	1.24	2.38	2.69
o-Phosphate (P)	mg/L	0.002	PE4500-S	31-Jul-20/K	< 0.002	0.008	0.004	0.003
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-20/K	0.03	0.02	< 0.01	< 0.01
Silica	mg/L	0.02	SM 3120	06-Aug-20/O	8.97	6.18	5.63	5.71
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	31-Jul-20/O	3.3	1.2	1.5	1.3
Colour	TCU	2	SM 2120C	31-Jul-20/O	3	< 2	< 2	< 2

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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DATE RECEIVED: 29-Jul-20

DATE REPORTED: 18-Aug-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-22161-5	B20-22161-6	B20-22161-7	B20-22161-8
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	31-Jul-20/O	63.1	7.3	32.5	40.0
Aluminum	mg/L	0.01	SM 3120	06-Aug-20/O	0.02	0.05	0.09	0.10
Arsenic	mg/L	0.0001	EPA 200.8	05-Aug-20/O	0.0002	< 0.0003	0.0007	0.0008
Barium	mg/L	0.001	SM 3120	06-Aug-20/O	0.039	0.056	0.192	0.280
Boron	mg/L	0.005	SM 3120	06-Aug-20/O	1.27	2.13	1.67	1.92
Cadmium	mg/L	0.000015	EPA 200.8	05-Aug-20/O	< 0.000015	< 0.000029	< 0.000059	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	05-Aug-20/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	06-Aug-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	06-Aug-20/O	0.034	< 0.005	4.17	5.41
Lead	mg/L	0.00002	EPA 200.8	05-Aug-20/O	< 0.00004	< 0.00009	< 0.0002	< 0.0002
Manganese	mg/L	0.001	SM 3120	06-Aug-20/O	0.080	0.001	0.061	0.074
Molybdenum	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	0.03	0.05
Selenium	mg/L	0.001	EPA 200.8	05-Aug-20/O	<0.02	<0.02	<0.02	<0.02
Silver	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0001	< 0.0001	< 0.0002	< 0.0002
Strontium	mg/L	0.001	SM 3120	06-Aug-20/O	1.65	4.49	11.3	13.8
Thallium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	06-Aug-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	0.0124	0.00019	0.00014	0.00037
Vanadium	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0001	< 0.0004	< 0.0007	< 0.0007
Zinc	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	4.02	4.23
TDS(ion sum calc.)	mg/L	1	Calc.	06-Aug-20/O	894	2072	3934	4735
Hardness (as CaCO3)	mg/L	1	SM 3120	06-Aug-20/O	89	343	1060	1170
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	31-Jul-20/K	0.7	1.9	3.3	3.8

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 29-Jul-20

DATE REPORTED: 18-Aug-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-22161-5	B20-22161-6	B20-22161-7	B20-22161-8
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Sulphide	mg/L	0.01	SM4500-S2	04-Aug-20/K	3.76	< 0.01	< 0.01	< 0.01
Anion Sum	meq/L		Calc.	06-Aug-20/O	15.9	39.4	70.8	87.1
Cation Sum	meq/L		Calc.	06-Aug-20/O	15.4	32.3	68.6	78.7
% Difference	%		Calc.	06-Aug-20/O	1.84	9.82	1.56	5.11

1 . Elevated RL due to sample matrix interference

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DATE RECEIVED: 29-Jul-20
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-22161-9	B20-22161-10	B20-22161-11	B20-22161-12
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	06-Aug-20/O	6.80	6.75	7.04	6.51
pH @25°C	pH Units		SM 4500H	31-Jul-20/O	7.84	7.70	7.91	7.72
Langelier Index(25°C)	S.I.		Calc.	06-Aug-20/O	1.04	0.954	0.874	1.21
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	31-Jul-20/O	239	289	318	211
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	239	289	318	211
Carbonate (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	31-Jul-20/O	7620	3380	1850	12000
Fluoride	mg/L	0.1	SM4110C	31-Jul-20/O	< 3	0.2	0.2	< 5
Chloride	mg/L	0.5	SM4110C	31-Jul-20/O	2780	989	404	4750
Nitrate (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 3	< 0.1	< 0.1	< 5
Nitrite (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 3	< 0.1	< 0.1	< 5
Bromide	mg/L	0.4	SM4110C	31-Jul-20/O	25.9	10.6	4.1	46.2
Sulphate	mg/L	1	SM4110C	31-Jul-20/O	< 30	25	25	< 50
Calcium	mg/L	0.02	SM 3120	06-Aug-20/O	236	202	94.2	522
Magnesium	mg/L	0.02	SM 3120	06-Aug-20/O	121	71.8	24.0	302
Sodium	mg/L	0.2	SM 3120	06-Aug-20/O	1070	407	261	1640
Potassium	mg/L	0.1	SM 3120	06-Aug-20/O	27.0	8.2	8.1	30.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	31-Jul-20/K	2.75	0.94	0.60	3.48
o-Phosphate (P)	mg/L	0.002	PE4500-S	31-Jul-20/K	0.039	0.010	0.011	0.011
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-20/K	0.04	0.03	< 0.01	0.11
Silica	mg/L	0.02	SM 3120	06-Aug-20/O	6.61	5.97	7.08	5.97
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	31-Jul-20/O	0.8	2.6	4.1	0.4

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-22161

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20

DATE REPORTED: 18-Aug-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-22161-9	B20-22161-10	B20-22161-11	B20-22161-12
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	31-Jul-20/O	< 2	2	2	< 2
Turbidity	NTU	0.1	SM 2130	31-Jul-20/O	69.5	113	4.0	147
Aluminum	mg/L	0.01	SM 3120	06-Aug-20/O	0.10	0.07	0.05	0.15
Arsenic	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0005	< 0.0003	0.0002	< 0.005
Barium	mg/L	0.001	SM 3120	06-Aug-20/O	0.208	0.074	0.121	0.429
Boron	mg/L	0.005	SM 3120	06-Aug-20/O	2.22	0.302	0.500	1.91
Cadmium	mg/L	.000015	EPA 200.8	05-Aug-20/O	< 0.000059	< 0.000029	< 0.000015	< 0.00059
Chromium	mg/L	0.001	EPA 200.8	05-Aug-20/O	< 0.001	< 0.001	< 0.001	< 0.006
Copper	mg/L	0.002	SM 3120	06-Aug-20/O	< 0.002	< 0.002	0.007	< 0.002
Iron	mg/L	0.005	SM 3120	06-Aug-20/O	0.061	13.1	0.215	0.488
Lead	mg/L	0.00002	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.00009	< 0.00004	< 0.002
Manganese	mg/L	0.001	SM 3120	06-Aug-20/O	0.020	0.133	0.093	0.039
Molybdenum	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	05-Aug-20/O	<0.02	<0.02	<0.02	<0.02
Silver	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.0001	< 0.0001	< 0.002
Strontium	mg/L	0.001	SM 3120	06-Aug-20/O	13.9	4.36	3.91	35.2
Thallium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	< 0.00005	0.00008	< 0.00005	< 0.0004
Tin	mg/L	0.05	SM 3120	06-Aug-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	< 0.00005	0.00110	0.00477	0.00162
Vanadium	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0007	< 0.0004	< 0.0001	< 0.007
Zinc	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	0.132	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	06-Aug-20/O	4381	1878	1009	7377

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-22161

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-22161-9	B20-22161-10	B20-22161-11	B20-22161-12
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	29-Jul-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	06-Aug-20/O	1090	801	334	2550
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	31-Jul-20/K	4.1	1.5	1.1	4.9
Sulphide	mg/L	0.01	SM4500-S2	04-Aug-20/K	0.04	0.07	0.01	< 0.1
Anion Sum	meq/L		Calc.	06-Aug-20/O	83.2	34.2	18.3	138
Cation Sum	meq/L		Calc.	06-Aug-20/O	69.2	34.0	18.3	123
% Difference	%		Calc.	06-Aug-20/O	9.21	0.371	0.0202	5.67

1 . Elevated RL due to sample matrix interference

Christine Burke
Lab Manager

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Tel: 705-252-5743
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DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-22161-13	B20-22161-14	B20-22161-15	
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	06-Aug-20/O	6.71	6.88	6.56	
pH @25°C	pH Units		SM 4500H	31-Jul-20/O	7.71	7.72	7.53	
Langelier Index(25°C)	S.I.		Calc.	06-Aug-20/O	0.997	0.842	0.969	
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	31-Jul-20/O	254	140	142	
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	254	140	142	
Carbonate (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	31-Jul-20/O	< 5	< 5	< 5	
Conductivity @25°C	µS/cm	1	SM 2510B	31-Jul-20/O	7590	7760	14900	
Fluoride	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	
Chloride	mg/L	0.5	SM4110C	31-Jul-20/O	2510	2850	5980	
Nitrate (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	
Nitrite (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 1	< 3	< 5	
Bromide	mg/L	0.4	SM4110C	31-Jul-20/O	25.3	27.6	57.5	
Sulphate	mg/L	1	SM4110C	31-Jul-20/O	122	26	< 50	
Calcium	mg/L	0.02	SM 3120	06-Aug-20/O	272	337	692	
Magnesium	mg/L	0.02	SM 3120	06-Aug-20/O	157	203	334	
Sodium	mg/L	0.2	SM 3120	06-Aug-20/O	1120	1040	2020	
Potassium	mg/L	0.1	SM 3120	06-Aug-20/O	19.9	21.2	37.7	
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	31-Jul-20/K	2.14	1.92	4.22	
o-Phosphate (P)	mg/L	0.002	PE4500-S	31-Jul-20/K	0.008	0.004	0.005	
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-20/K	< 0.01	0.01	0.01	
Silica	mg/L	0.02	SM 3120	06-Aug-20/O	4.15	4.26	5.37	
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	31-Jul-20/O	2.2	0.4	0.3	

Christine Burke
Lab Manager

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Final Report

C.O.C.: --- **REPORT No. B20-22161**

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-22161-13	B20-22161-14	B20-22161-15	
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	31-Jul-20/O	3	6	< 2	
Turbidity	NTU	0.1	SM 2130	31-Jul-20/O	53.3	11.3	98.4	
Aluminum	mg/L	0.01	SM 3120	06-Aug-20/O	0.05	0.11	0.16	
Arsenic	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0005	< 0.0005	< 0.005	
Barium	mg/L	0.001	SM 3120	06-Aug-20/O	0.149	1.79	1.12	
Boron	mg/L	0.005	SM 3120	06-Aug-20/O	0.950	0.733	1.30	
Cadmium	mg/L	).000015	EPA 200.8	05-Aug-20/O	< 0.000059	< 0.000059	< 0.00059	
Chromium	mg/L	0.001	EPA 200.8	05-Aug-20/O	< 0.001	< 0.001	< 0.006	
Copper	mg/L	0.002	SM 3120	06-Aug-20/O	< 0.002	< 0.002	< 0.002	
Iron	mg/L	0.005	SM 3120	06-Aug-20/O	0.871	0.407	6.43	
Lead	mg/L	0.00002	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.0002	< 0.002	
Manganese	mg/L	0.001	SM 3120	06-Aug-20/O	0.030	0.054	0.059	
Molybdenum	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	
Nickel	mg/L	0.01	SM 3120	06-Aug-20/O	< 0.01	< 0.01	< 0.01	
Selenium	mg/L	0.001	EPA 200.8	05-Aug-20/O	<0.02	<0.02	<0.02	
Silver	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0002	< 0.0002	< 0.002	
Strontium	mg/L	0.001	SM 3120	06-Aug-20/O	9.56	43.0	98.2	
Thallium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	< 0.00005	< 0.00005	< 0.0004	
Tin	mg/L	0.05	SM 3120	06-Aug-20/O	< 0.05	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	06-Aug-20/O	< 0.005	< 0.005	< 0.005	
Uranium	mg/L	0.00005	EPA 200.8	05-Aug-20/O	0.00015	0.00046	< 0.0004	
Vanadium	mg/L	0.0001	EPA 200.8	05-Aug-20/O	< 0.0007	< 0.0007	< 0.007	
Zinc	mg/L	0.005	SM 3120	06-Aug-20/O	0.109	0.384	< 0.005	
TDS(ion sum calc.)	mg/L	1	Calc.	06-Aug-20/O	4359	4559	9156	

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-22161

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 29-Jul-20
DATE REPORTED: 18-Aug-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-22161-13	B20-22161-14	B20-22161-15	
			Date Collected		29-Jul-20	29-Jul-20	29-Jul-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	06-Aug-20/O	1330	1680	3100	
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	31-Jul-20/K	2.4	2.7	5.5	
Sulphide	mg/L	0.01	SM4500-S2	04-Aug-20/K	< 0.01	< 0.01	0.01	
Anion Sum	meq/L		Calc.	06-Aug-20/O	78.5	83.6	171	
Cation Sum	meq/L		Calc.	06-Aug-20/O	75.8	79.4	151	
% Difference	%		Calc.	06-Aug-20/O	1.78	2.56	6.18	

1 . Elevated RL due to sample matrix interference

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-13070**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-13070-1	B20-13070-2	B20-13070-3	B20-13070-4
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	25-May-20/O	6.85	6.96	6.43	7.66
pH @25°C	pH Units		SM 4500H	20-May-20/O	7.95	7.80	7.75	8.14
Langelier Index(25°C)	S.I.		Calc.	25-May-20/O	1.10	0.841	1.32	0.483
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	20-May-20/O	315	305	213	249
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	315	305	213	249
Carbonate (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	20-May-20/O	4050	3830	17100	1450
Fluoride	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	< 0.1
Chloride	mg/L	0.5	SM4110C	23-May-20/O	1090	1020	6420	267
Nitrate (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	0.1
Bromide	mg/L	0.4	SM4110C	23-May-20/O	11.3	10.6	68.7	2.7
Sulphate	mg/L	1	SM4110C	23-May-20/O	28	35	26	25
Calcium	mg/L	0.02	SM 3120	21-May-20/O	149	120	620	26.9
Magnesium	mg/L	0.02	SM 3120	21-May-20/O	98.8	79.2	443	12.4
Sodium	mg/L	0.2	SM 3120	21-May-20/O	556	539	2990	232
Potassium	mg/L	0.1	SM 3120	21-May-20/O	21.0	18.7	54.8	7.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	20-May-20/K	1.86	1.66	5.75	0.57
o-Phosphate (P)	mg/L	0.002	PE4500-S	20-May-20/K	< 0.002	< 0.002	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-May-20/K	< 0.01	< 0.01	0.04	< 0.01
Silica	mg/L	0.02	SM 3120	21-May-20/O	10.2	10.3	8.19	6.88
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	20-May-20/O	2.8	5.0	0.8	1.8
Colour	TCU	2	SM 2120C	19-May-20/O	< 2	< 2	44	< 2

CBurke

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-13070**

Report To:

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

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112 Commerce Park Drive
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-13070-1	B20-13070-2	B20-13070-3	B20-13070-4
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	19-May-20/O	3.1	19.7	61.8	1.3
Aluminum	mg/L	0.01	SM 3120	21-May-20/O	0.06	0.02	0.14	< 0.01
Arsenic	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0005	< 0.0003	< 0.003	< 0.0001
Barium	mg/L	0.001	SM 3120	21-May-20/O	0.205	0.178	0.560	0.013
Boron	mg/L	0.005	SM 3120	21-May-20/O	1.84	1.79	4.66	1.39
Cadmium	mg/L	0.000015	EPA 200.8	22-May-20/O	< 0.000059	< 0.000029	< 0.00030	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.001	< 0.001	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	21-May-20/O	< 0.002	< 0.002	< 0.002	0.002
Iron	mg/L	0.005	SM 3120	21-May-20/O	0.296	3.82	0.067	0.460
Lead	mg/L	0.00002	EPA 200.8	22-May-20/O	< 0.0002	< 0.00009	< 0.0009	< 0.00004
Manganese	mg/L	0.001	SM 3120	21-May-20/O	0.068	0.112	0.078	0.010
Molybdenum	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	0.01
Selenium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.01	< 0.02	< 0.02	0.003
Silver	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0002	< 0.0001	< 0.001	< 0.0001
Strontium	mg/L	0.001	SM 3120	21-May-20/O	20.8	15.8	131	1.23
Thallium	mg/L	0.00005	EPA 200.8	22-May-20/O	< 0.00005	< 0.00005	< 0.0002	< 0.00005
Tin	mg/L	0.05	SM 3120	21-May-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	22-May-20/O	0.00066	0.00202	0.00031	< 0.00005
Vanadium	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0007	< 0.0004	< 0.004	< 0.0001
Zinc	mg/L	0.005	SM 3120	21-May-20/O	0.361	6.09	< 0.005	0.121
TDS(ion sum calc.)	mg/L	1	Calc.	25-May-20/O	2136	2004	10693	722
Hardness (as CaCO3)	mg/L	1	SM 3120	21-May-20/O	778	626	3470	118
Anion Sum	meq/L		Calc.	25-May-20/O	37.7	35.7	186	13.0

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-13070**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-13070-1	B20-13070-2	B20-13070-3	B20-13070-4
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	25-May-20/O	40.4	36.8	199	12.7
% Difference	%		Calc.	25-May-20/O	3.49	1.49	3.43	1.31
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	22-May-20/K	2.2	2.0	6.2	0.8
Sulphide	mg/L	0.01	SM4500-S2	19-May-20/K	< 0.01	0.13	9.20	< 0.01

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-13070-5	B20-13070-6	B20-13070-7	B20-13070-8
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	25-May-20/O	7.60	7.52	6.80	6.76
pH @25°C	pH Units		SM 4500H	20-May-20/O	8.07	8.10	7.88	7.90
Langelier Index(25°C)	S.I.		Calc.	25-May-20/O	0.472	0.583	1.08	1.14
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	20-May-20/O	288	248	279	270
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	288	248	279	270
Carbonate (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	20-May-20/O	1620	1500	5830	7580
Fluoride	mg/L	0.1	SM4110C	23-May-20/O	0.2	< 0.1	< 1	< 1
Chloride	mg/L	0.5	SM4110C	23-May-20/O	276	279	1700	2270
Nitrate (N)	mg/L	0.1	SM4110C	23-May-20/O	< 0.1	< 0.1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	23-May-20/O	0.1	0.1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	23-May-20/O	2.7	2.8	17.9	23.9
Sulphate	mg/L	1	SM4110C	23-May-20/O	50	26	26	29
Calcium	mg/L	0.02	SM 3120	21-May-20/O	27.2	37.3	188	219
Magnesium	mg/L	0.02	SM 3120	21-May-20/O	6.77	18.2	90.4	114
Sodium	mg/L	0.2	SM 3120	21-May-20/O	339	265	713	1080
Potassium	mg/L	0.1	SM 3120	21-May-20/O	6.2	7.8	19.0	26.3
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	20-May-20/K	0.32	0.58	2.11	2.72
o-Phosphate (P)	mg/L	0.002	PE4500-S	20-May-20/K	0.002	< 0.002	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-May-20/K	< 0.01	0.02	< 0.01	< 0.01
Silica	mg/L	0.02	SM 3120	21-May-20/O	10.9	7.04	6.61	7.55
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	20-May-20/O	3.4	1.1	2.0	2.0
Colour	TCU	2	SM 2120C	19-May-20/O	< 2	< 2	< 2	< 2

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-13070-5	B20-13070-6	B20-13070-7	B20-13070-8
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	19-May-20/O	6.0	6.5	12.2	2.7
Aluminum	mg/L	0.01	SM 3120	21-May-20/O	0.02	< 0.01	0.05	0.07
Arsenic	mg/L	0.0001	EPA 200.8	22-May-20/O	0.0007	< 0.0001	< 0.001	< 0.001
Barium	mg/L	0.001	SM 3120	21-May-20/O	0.043	0.019	0.151	0.234
Boron	mg/L	0.005	SM 3120	21-May-20/O	1.43	1.43	1.55	2.01
Cadmium	mg/L	0.000015	EPA 200.8	22-May-20/O	< 0.000015	< 0.000015	< 0.00012	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	21-May-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	21-May-20/O	0.114	0.021	0.902	0.542
Lead	mg/L	0.00002	EPA 200.8	22-May-20/O	< 0.00004	< 0.00004	< 0.0004	< 0.0004
Manganese	mg/L	0.001	SM 3120	21-May-20/O	0.094	0.005	0.044	0.058
Molybdenum	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	22-May-20/O	0.004	0.004	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0001	< 0.0001	< 0.0005	< 0.0005
Strontium	mg/L	0.001	SM 3120	21-May-20/O	1.82	1.87	9.45	13.3
Thallium	mg/L	0.00005	EPA 200.8	22-May-20/O	< 0.00005	< 0.00005	0.00009	< 0.00008
Tin	mg/L	0.05	SM 3120	21-May-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	22-May-20/O	0.0133	0.00015	0.00065	0.00218
Vanadium	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0001	< 0.0001	< 0.001	< 0.001
Zinc	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	< 0.005	2.53	5.80
TDS(ion sum calc.)	mg/L	1	Calc.	25-May-20/O	879	783	2911	3907
Hardness (as CaCO3)	mg/L	1	SM 3120	21-May-20/O	96	168	841	1020
Anion Sum	meq/L		Calc.	25-May-20/O	14.6	13.4	54.2	70.1

CBurke

Christine Burke
Lab Manager

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Final Report

C.O.C.: --- **REPORT No. B20-13070**

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Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-13070-5	B20-13070-6	B20-13070-7	B20-13070-8
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	25-May-20/O	16.8	15.1	48.5	68.2
% Difference	%		Calc.	25-May-20/O	7.11	6.20	5.54	1.43
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	22-May-20/K	0.5	0.8	2.5	3.2
Sulphide	mg/L	0.01	SM4500-S2	19-May-20/K	1.23	0.02	< 0.01	< 0.01

CBurke

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-13070-9	B20-13070-10	B20-13070-11	B20-13070-12
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	25-May-20/O	6.89	6.99	6.87	6.86
pH @25°C	pH Units		SM 4500H	20-May-20/O	7.90	7.94	7.87	7.87
Langelier Index(25°C)	S.I.		Calc.	25-May-20/O	1.01	0.950	1.00	1.01
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	20-May-20/O	249	338	305	310
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	249	338	305	310
Carbonate (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	20-May-20/O	6480	1610	645	670
Fluoride	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 0.1	< 0.1	< 0.1
Chloride	mg/L	0.5	SM4110C	23-May-20/O	1960	275	18.4	23.5
Nitrate (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 0.1	< 0.1	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	0.1	< 0.1	< 0.1
Bromide	mg/L	0.4	SM4110C	23-May-20/O	20.5	2.7	< 0.4	< 0.4
Sulphate	mg/L	1	SM4110C	23-May-20/O	14	21	5	5
Calcium	mg/L	0.02	SM 3120	21-May-20/O	175	94.2	126	126
Magnesium	mg/L	0.02	SM 3120	21-May-20/O	103	22.3	9.96	10.7
Sodium	mg/L	0.2	SM 3120	21-May-20/O	966	248	14.9	18.0
Potassium	mg/L	0.1	SM 3120	21-May-20/O	23.5	7.7	1.1	1.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	20-May-20/K	2.31	0.52	0.05	0.08
o-Phosphate (P)	mg/L	0.002	PE4500-S	20-May-20/K	0.011	0.002	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-May-20/K	0.08	0.01	0.02	0.09
Silica	mg/L	0.02	SM 3120	21-May-20/O	7.00	8.32	7.15	7.74
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	20-May-20/O	1.0	6.0	5.7	4.6

Christine Burke
Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-13070-9	B20-13070-10	B20-13070-11	B20-13070-12
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	19-May-20/O	< 2	< 2	< 2	< 2
Turbidity	NTU	0.1	SM 2130	19-May-20/O	44.1	5.9	85.6	125
Aluminum	mg/L	0.01	SM 3120	21-May-20/O	0.05	0.03	0.04	0.04
Arsenic	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.001	0.0001	0.0001	0.0001
Barium	mg/L	0.001	SM 3120	21-May-20/O	0.168	0.110	0.033	0.032
Boron	mg/L	0.005	SM 3120	21-May-20/O	1.99	0.474	0.032	0.041
Cadmium	mg/L	).000015	EPA 200.8	22-May-20/O	< 0.00012	< 0.000015	< 0.000015	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	21-May-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	21-May-20/O	0.062	0.029	6.20	1.46
Lead	mg/L	0.00002	EPA 200.8	22-May-20/O	< 0.0004	< 0.00004	0.00004	< 0.00002
Manganese	mg/L	0.001	SM 3120	21-May-20/O	0.013	0.096	0.129	0.104
Molybdenum	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.02	0.004	< 0.001	< 0.001
Silver	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0005	< 0.0001	< 0.0001	< 0.0001
Strontium	mg/L	0.001	SM 3120	21-May-20/O	11.5	3.43	0.617	0.705
Thallium	mg/L	0.00005	EPA 200.8	22-May-20/O	< 0.00008	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	21-May-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	22-May-20/O	0.00013	0.00540	0.00024	0.00026
Vanadium	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.001	< 0.0001	< 0.0001	< 0.0001
Zinc	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	0.083	0.180	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	25-May-20/O	3397	871	364	372

CBurke

Christine Burke
Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-13070-9	B20-13070-10	B20-13070-11	B20-13070-12
			Date Collected		13-May-20	13-May-20	13-May-20	13-May-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	21-May-20/O	860	327	355	359
Anion Sum	meq/L		Calc.	25-May-20/O	60.7	14.9	6.71	6.96
Cation Sum	meq/L		Calc.	25-May-20/O	60.0	17.5	8.11	8.06
% Difference	%		Calc.	25-May-20/O	0.573	8.03	9.40	7.32
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	22-May-20/K	3.4	0.9	0.3	0.4
Sulphide	mg/L	0.01	SM4500-S2	19-May-20/K	0.02	0.01	0.08	0.12

CBurke

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-13070

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-13070-13	B20-13070-14	B20-13070-15	
			Date Collected		13-May-20	13-May-20	13-May-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	25-May-20/O	6.84	6.99	6.69	
pH @25°C	pH Units		SM 4500H	20-May-20/O	7.76	7.99	7.60	
Langelier Index(25°C)	S.I.		Calc.	25-May-20/O	0.922	1.00	0.914	
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	20-May-20/O	148	255	143	
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	148	255	143	
Carbonate (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	20-May-20/O	< 5	< 5	< 5	
Conductivity @25°C	µS/cm	1	SM 2510B	20-May-20/O	7640	4060	12400	
Fluoride	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	
Chloride	mg/L	0.5	SM4110C	23-May-20/O	2330	1140	4170	
Nitrate (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	
Nitrite (N)	mg/L	0.1	SM4110C	23-May-20/O	< 1	< 1	< 3	
Bromide	mg/L	0.4	SM4110C	23-May-20/O	25.3	12.6	45.5	
Sulphate	mg/L	1	SM4110C	23-May-20/O	26	16	43	
Calcium	mg/L	0.02	SM 3120	21-May-20/O	335	135	516	
Magnesium	mg/L	0.02	SM 3120	21-May-20/O	198	78.8	300	
Sodium	mg/L	0.2	SM 3120	21-May-20/O	983	618	1680	
Potassium	mg/L	0.1	SM 3120	21-May-20/O	22.1	15.9	32.7	
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	20-May-20/K	2.00	1.56	3.25	
o-Phosphate (P)	mg/L	0.002	PE4500-S	20-May-20/K	< 0.002	< 0.002	< 0.002	
Phosphorus-Total	mg/L	0.01	E3199A.1	22-May-20/K	0.01	0.02	0.04	
Silica	mg/L	0.02	SM 3120	21-May-20/O	4.76	6.37	5.59	
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	20-May-20/O	0.9	2.2	1.0	

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20
DATE REPORTED: 28-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-13070-13	B20-13070-14	B20-13070-15	
			Date Collected		13-May-20	13-May-20	13-May-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	19-May-20/O	3	< 2	< 2	
Turbidity	NTU	0.1	SM 2130	19-May-20/O	21.3	9.6	88.6	
Aluminum	mg/L	0.01	SM 3120	21-May-20/O	0.09	0.04	0.13	
Arsenic	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.001	< 0.0005	< 0.003	
Barium	mg/L	0.001	SM 3120	21-May-20/O	1.94	0.391	1.33	
Boron	mg/L	0.005	SM 3120	21-May-20/O	0.815	1.03	1.13	
Cadmium	mg/L	).000015	EPA 200.8	22-May-20/O	< 0.00012	< 0.000059	< 0.00030	
Chromium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.001	< 0.001	< 0.003	
Copper	mg/L	0.002	SM 3120	21-May-20/O	< 0.002	< 0.002	< 0.002	
Iron	mg/L	0.005	SM 3120	21-May-20/O	0.066	1.95	5.62	
Lead	mg/L	0.00002	EPA 200.8	22-May-20/O	< 0.0004	0.00079	< 0.0009	
Manganese	mg/L	0.001	SM 3120	21-May-20/O	0.051	0.028	0.068	
Molybdenum	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	
Nickel	mg/L	0.01	SM 3120	21-May-20/O	< 0.01	< 0.01	< 0.01	
Selenium	mg/L	0.001	EPA 200.8	22-May-20/O	< 0.02	< 0.02	< 0.02	
Silver	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.0005	< 0.0002	< 0.001	
Strontium	mg/L	0.001	SM 3120	21-May-20/O	50.7	18.9	88.3	
Thallium	mg/L	0.00005	EPA 200.8	22-May-20/O	< 0.00008	< 0.00005	< 0.0002	
Tin	mg/L	0.05	SM 3120	21-May-20/O	< 0.05	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	21-May-20/O	< 0.005	< 0.005	< 0.005	
Uranium	mg/L	0.00005	EPA 200.8	22-May-20/O	0.00066	0.00050	0.00134	
Vanadium	mg/L	0.0001	EPA 200.8	22-May-20/O	< 0.001	< 0.0007	< 0.004	
Zinc	mg/L	0.005	SM 3120	21-May-20/O	0.054	0.763	< 0.005	
TDS(ion sum calc.)	mg/L	1	Calc.	25-May-20/O	3990	2165	6837	

CBurke

Christine Burke
Lab Manager

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Final Report

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Report To:

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-May-20

DATE REPORTED: 28-May-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-13070-13	B20-13070-14	B20-13070-15	
			Date Collected		13-May-20	13-May-20	13-May-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	21-May-20/O	1650	661	2520	
Anion Sum	meq/L		Calc.	25-May-20/O	69.4	37.7	121	
Cation Sum	meq/L		Calc.	25-May-20/O	76.4	40.7	125	
% Difference	%		Calc.	25-May-20/O	4.83	3.85	1.41	
Total Kjeldahl Nitrogen	mg/L	0.1	E3199A.1	22-May-20/K	2.4	2.0	3.8	
Sulphide	mg/L	0.01	SM4500-S2	19-May-20/K	0.02	< 0.01	0.04	

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-35071**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20
DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-35071-1	B20-35071-2	B20-35071-3	B20-35071-4
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	16-Nov-20/O	6.38	6.71	6.86	7.43
pH @25°C	pH Units		SM 4500H	11-Nov-20/O	7.47	7.64	7.81	8.04
Langelier Index(25°C)	S.I.		Calc.	16-Nov-20/O	1.09	0.926	0.952	0.610
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Nov-20/O	335	242	276	241
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	335	242	276	241
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Nov-20/O	13500	9020	5380	2780
Fluoride	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 5	< 5	2.5
Chloride	mg/L	0.5	SM4110C	12-Nov-20/O	4310	3020	1600	753
Nitrate (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 5	< 5	< 1
Nitrite (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 5	< 5	< 1
Bromide	mg/L	0.4	SM4110C	12-Nov-20/O	< 40	22.7	< 20	5.9
Sulphate	mg/L	1	SM4110C	12-Nov-20/O	300	< 50	< 50	18
Calcium	mg/L	0.02	SM 3120	11-Nov-20/O	446	285	168	50.1
Magnesium	mg/L	0.02	SM 3120	11-Nov-20/O	191	205	118	29.2
Sodium	mg/L	0.2	SM 3120	11-Nov-20/O	2100	1210	725	465
Potassium	mg/L	0.1	SM 3120	11-Nov-20/O	25.8	31.0	25.6	11.0
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Nov-20/K	1.90	3.08	2.85	0.71
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Nov-20/K	0.006	< 0.002	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	19-Nov-20/K	0.02	0.01	0.02	0.06
Silica	mg/L	0.02	SM 3120	11-Nov-20/O	16.2	6.85	10.3	5.95
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	12-Nov-20/O	< 0.2	3.6	1.0	1.4
Colour	TCU	2	SM 2120C	10-Nov-20/O	6	< 2	2	< 2

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-35071**

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DATE RECEIVED: 05-Nov-20
DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-35071-1	B20-35071-2	B20-35071-3	B20-35071-4
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
Turbidity	NTU	0.1	SM 2130	09-Nov-20/O	220	86.1	70.2	13.1
Aluminum	mg/L	0.01	SM 3120	11-Nov-20/O	0.17	0.13	0.05	0.04
Arsenic	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.0005	0.0004
Barium	mg/L	0.001	SM 3120	11-Nov-20/O	0.375	0.291	0.200	0.033
Boron	mg/L	0.005	SM 3120	11-Nov-20/O	3.28	2.41	2.41	1.77
Cadmium	mg/L	0.000015	EPA 200.8	20-Nov-20/O	< 0.00012	< 0.00012	0.000063	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	0.001	< 0.001
Copper	mg/L	0.002	SM 3120	11-Nov-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	11-Nov-20/O	0.054	< 0.005	0.069	< 0.005
Lead	mg/L	0.00002	EPA 200.8	20-Nov-20/O	0.00075	0.00063	0.00528	0.00019
Manganese	mg/L	0.001	SM 3120	11-Nov-20/O	1.92	0.126	0.027	0.016
Molybdenum	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	0.02	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	20-Nov-20/O	0.027	0.026	0.031	0.005
Silver	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0010	0.0011	0.0005	0.0001
Strontium	mg/L	0.001	SM 3120	11-Nov-20/O	55.4	48.7	24.1	3.16
Thallium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00016	0.00008	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	11-Nov-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00159	0.00029	0.00006	0.00009
Vanadium	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.0007	< 0.0004
TDS(ion sum calc.)	mg/L	1	Calc.	16-Nov-20/O	7576	4902	2809	1475
Zinc	mg/L	0.005	SM 3120	11-Nov-20/O	0.018	0.008	< 0.005	0.019
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Nov-20/O	1900	1560	902	245
% Difference	%		Calc.	16-Nov-20/O	1.62 [1]	3.06 [1]	0.309	2.16 [1]

Christine Burke
Lab Manager

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DATE RECEIVED: 05-Nov-20

DATE REPORTED: 26-Nov-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B20-35071-1	B20-35071-2	B20-35071-3	B20-35071-4
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

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Christine Burke
Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-35071-5	B20-35071-6	B20-35071-7	B20-35071-8
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	16-Nov-20/O	7.28	7.41	6.83	6.78
pH @25°C	pH Units		SM 4500H	11-Nov-20/O	8.11	8.02	7.88	7.79
Langelier Index(25°C)	S.I.		Calc.	16-Nov-20/O	0.833	0.611	1.05	1.01
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Nov-20/O	354	249	243	244
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	354	249	243	244
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Nov-20/O	3380	2350	7290	8290
Fluoride	mg/L	0.1	SM4110C	12-Nov-20/O	3.2	2.5	< 10	< 10
Chloride	mg/L	0.5	SM4110C	12-Nov-20/O	695	589	2350	2880
Nitrate (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 3	< 1	< 10	< 10
Nitrite (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 3	< 1	< 10	< 10
Bromide	mg/L	0.4	SM4110C	12-Nov-20/O	< 10	4.1	< 40	< 40
Sulphate	mg/L	1	SM4110C	12-Nov-20/O	241	25	< 100	121
Calcium	mg/L	0.02	SM 3120	11-Nov-20/O	48.5	51.0	207	241
Magnesium	mg/L	0.02	SM 3120	11-Nov-20/O	18.8	26.7	118	130
Sodium	mg/L	0.2	SM 3120	11-Nov-20/O	527	418	1040	1200
Potassium	mg/L	0.1	SM 3120	11-Nov-20/O	8.1	11.1	26.3	29.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Nov-20/K	0.35	0.74	2.73	2.83
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Nov-20/K	0.009	0.007	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	19-Nov-20/K	0.09	0.11	0.03	0.02
Silica	mg/L	0.02	SM 3120	11-Nov-20/O	9.20	7.29	5.65	5.32
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	12-Nov-20/O	2.3	10.0	1.0	1.2
Colour	TCU	2	SM 2120C	10-Nov-20/O	3	< 2	< 2	2

CBurke

Christine Burke
Lab Manager

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DATE REPORTED: 26-Nov-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-35071-5	B20-35071-6	B20-35071-7	B20-35071-8
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	09-Nov-20/O	151	30.4	18.3	52.3
Aluminum	mg/L	0.01	SM 3120	11-Nov-20/O	0.03	< 0.01	0.11	0.12
Arsenic	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0016	< 0.0003	0.0009	< 0.001
Barium	mg/L	0.001	SM 3120	11-Nov-20/O	0.069	0.036	0.188	0.285
Boron	mg/L	0.005	SM 3120	11-Nov-20/O	1.67	1.98	2.22	2.16
Cadmium	mg/L	0.000015	EPA 200.8	20-Nov-20/O	< 0.000029	< 0.000029	0.000064	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	11-Nov-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	11-Nov-20/O	0.072	< 0.005	6.28	6.76
Lead	mg/L	0.00002	EPA 200.8	20-Nov-20/O	0.00015	0.00013	0.00035	0.00231
Manganese	mg/L	0.001	SM 3120	11-Nov-20/O	0.060	< 0.001	0.056	0.088
Molybdenum	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	0.02	0.03
Selenium	mg/L	0.001	EPA 200.8	20-Nov-20/O	0.005	0.011	0.046	0.052
Silver	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0001	0.0002	0.0005	0.0007
Strontium	mg/L	0.001	SM 3120	11-Nov-20/O	5.72	2.99	14.3	16.0
Thallium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	< 0.00005	< 0.00005	< 0.00005	< 0.00008
Tin	mg/L	0.05	SM 3120	11-Nov-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00375	0.00009	0.00018	0.00030
Vanadium	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0004	< 0.0004	< 0.0007	< 0.001
TDS(ion sum calc.)	mg/L	1	Calc.	16-Nov-20/O	1755	1273	3901	4759
Zinc	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	1.03	0.378
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Nov-20/O	199	237	1000	1140
% Difference	%		Calc.	16-Nov-20/O	8.09	2.21	3.38	7.44

CBurke

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

C.O.C.: ---

REPORT No. B20-35071

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20
DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B20-35071-5	B20-35071-6	B20-35071-7	B20-35071-8
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

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Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

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DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-35071-9	B20-35071-10	B20-35071-11	B20-35071-12
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	16-Nov-20/O	6.76	6.79	6.61	6.62
pH @25°C	pH Units		SM 4500H	11-Nov-20/O	7.82	7.69	7.92	7.57
Langelier Index(25°C)	S.I.		Calc.	16-Nov-20/O	1.06	0.902	1.31	0.945
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Nov-20/O	337	315	495	405
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	337	315	495	405
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Nov-20/O	4460	2720	6550	1060
Fluoride	mg/L	0.1	SM4110C	12-Nov-20/O	< 5	< 1	7.0	< 1
Chloride	mg/L	0.5	SM4110C	12-Nov-20/O	1310	669	1270	83.9
Nitrate (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 5	< 1	< 3	< 1
Nitrite (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 5	< 1	< 3	< 1
Bromide	mg/L	0.4	SM4110C	12-Nov-20/O	< 20	5.2	< 10	< 4
Sulphate	mg/L	1	SM4110C	12-Nov-20/O	< 50	< 10	1150	< 10
Calcium	mg/L	0.02	SM 3120	11-Nov-20/O	173	169	178	174
Magnesium	mg/L	0.02	SM 3120	11-Nov-20/O	71.7	46.3	61.2	16.0
Sodium	mg/L	0.2	SM 3120	11-Nov-20/O	637	289	1230	51.8
Potassium	mg/L	0.1	SM 3120	11-Nov-20/O	17.9	7.3	16.5	1.6
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Nov-20/K	1.81	0.79	0.73	0.09
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Nov-20/K	0.009	< 0.002	0.087	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	19-Nov-20/K	0.08	0.03	0.09	0.07
Silica	mg/L	0.02	SM 3120	11-Nov-20/O	7.80	8.44	9.03	8.71
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	12-Nov-20/O	1.0	1.9	17.6	6.2

Christine Burke
Lab Manager

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Final Report

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Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20

DATE REPORTED: 26-Nov-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-35071-9	B20-35071-10	B20-35071-11	B20-35071-12
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	10-Nov-20/O	8	3	12	4
Turbidity	NTU	0.1	SM 2130	09-Nov-20/O	104	122	233	61.8
Aluminum	mg/L	0.01	SM 3120	11-Nov-20/O	0.06	0.07	0.10	0.05
Arsenic	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0005	< 0.0003	0.0090	0.0002
Barium	mg/L	0.001	SM 3120	11-Nov-20/O	0.105	0.090	0.168	0.045
Boron	mg/L	0.005	SM 3120	11-Nov-20/O	1.83	0.532	1.05	0.093
Cadmium	mg/L	).000015	EPA 200.8	20-Nov-20/O	< 0.000059	< 0.000029	< 0.000059	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	11-Nov-20/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	11-Nov-20/O	0.018	13.3	0.011	3.84
Lead	mg/L	0.00002	EPA 200.8	20-Nov-20/O	0.00028	0.00012	< 0.0002	0.00008
Manganese	mg/L	0.001	SM 3120	11-Nov-20/O	0.034	0.109	0.117	0.171
Molybdenum	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	20-Nov-20/O	0.026	0.011	0.018	0.002
Silver	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0002	0.0003	0.0003	< 0.0001
Strontium	mg/L	0.001	SM 3120	11-Nov-20/O	8.15	6.33	19.0	1.31
Thallium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	11-Nov-20/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00026	0.00031	0.0235	0.00036
Vanadium	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.0007	< 0.0004	0.0015	< 0.0001
TDS(ion sum calc.)	mg/L	1	Calc.	16-Nov-20/O	2410	1384	4212	574
Zinc	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	< 0.005

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B20-35071**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20
DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B20-35071-9	B20-35071-10	B20-35071-11	B20-35071-12
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	03-Nov-20
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Nov-20/O	727	612	697	500
% Difference	%		Calc.	16-Nov-20/O	0.866	1.20	1.55 [1]	8.86

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 05-Nov-20
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-35071-13	B20-35071-14	B20-35071-15	
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	16-Nov-20/O	6.28	6.55	6.46	
pH @25°C	pH Units		SM 4500H	11-Nov-20/O	7.95	7.67	7.46	
Langelier Index(25°C)	S.I.		Calc.	16-Nov-20/O	1.67	1.12	1.000	
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Nov-20/O	697	243	122	
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	697	243	122	
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Nov-20/O	< 5	< 5	< 5	
Conductivity @25°C	µS/cm	1	SM 2510B	11-Nov-20/O	12700	11100	19800	
Fluoride	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 10	< 20	
Chloride	mg/L	0.5	SM4110C	12-Nov-20/O	3390	3960	8840	
Nitrate (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 10	< 20	
Nitrite (N)	mg/L	0.1	SM4110C	12-Nov-20/O	< 10	< 10	< 20	
Bromide	mg/L	0.4	SM4110C	12-Nov-20/O	< 40	< 40	< 80	
Sulphate	mg/L	1	SM4110C	12-Nov-20/O	1320	128	13	
Calcium	mg/L	0.02	SM 3120	11-Nov-20/O	222	416	1020	
Magnesium	mg/L	0.02	SM 3120	11-Nov-20/O	132	239	690	
Sodium	mg/L	0.2	SM 3120	11-Nov-20/O	2390	1550	3550	
Potassium	mg/L	0.1	SM 3120	11-Nov-20/O	18.1	28.6	59.4	
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Nov-20/K	0.42	2.14	6.84	
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Nov-20/K	0.007	< 0.002	< 0.002	
Phosphorus-Total	mg/L	0.01	E3199A.1	19-Nov-20/K	0.04	0.03	0.02	
Silica	mg/L	0.02	SM 3120	11-Nov-20/O	5.94	8.05	5.75	
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	12-Nov-20/O	0.8	3.9	< 0.2	

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 05-Nov-20
DATE REPORTED: 26-Nov-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-35071-13	B20-35071-14	B20-35071-15	
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	10-Nov-20/O	81	3	< 2	
Turbidity	NTU	0.1	SM 2130	09-Nov-20/O	14.2	58.4	72.1	
Aluminum	mg/L	0.01	SM 3120	11-Nov-20/O	0.12	0.13	0.19	
Arsenic	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.001	0.0020	< 0.003	
Barium	mg/L	0.001	SM 3120	11-Nov-20/O	0.099	0.649	1.58	
Boron	mg/L	0.005	SM 3120	11-Nov-20/O	0.893	1.31	2.02	
Cadmium	mg/L	0.000015	EPA 200.8	20-Nov-20/O	< 0.00012	< 0.00012	< 0.00030	
Chromium	mg/L	0.001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.003	
Copper	mg/L	0.002	SM 3120	11-Nov-20/O	< 0.002	< 0.002	< 0.002	
Iron	mg/L	0.005	SM 3120	11-Nov-20/O	0.029	0.646	5.71	
Lead	mg/L	0.00002	EPA 200.8	20-Nov-20/O	< 0.0004	< 0.0004	< 0.0009	
Manganese	mg/L	0.001	SM 3120	11-Nov-20/O	0.049	0.313	0.068	
Molybdenum	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	
Nickel	mg/L	0.01	SM 3120	11-Nov-20/O	< 0.01	< 0.01	< 0.01	
Selenium	mg/L	0.001	EPA 200.8	20-Nov-20/O	0.036	0.079	0.215	
Silver	mg/L	0.0001	EPA 200.8	20-Nov-20/O	0.0005	0.0009	0.0021	
Strontium	mg/L	0.001	SM 3120	11-Nov-20/O	34.6	64.7	194	
Thallium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	< 0.00008	< 0.00008	< 0.0002	
Tin	mg/L	0.05	SM 3120	11-Nov-20/O	< 0.05	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	
Uranium	mg/L	0.00005	EPA 200.8	20-Nov-20/O	0.00044	0.00034	0.00032	
Vanadium	mg/L	0.0001	EPA 200.8	20-Nov-20/O	< 0.001	< 0.001	< 0.004	
TDS(ion sum calc.)	mg/L	1	Calc.	16-Nov-20/O	7980	6476	14253	
Zinc	mg/L	0.005	SM 3120	11-Nov-20/O	< 0.005	< 0.005	< 0.005	

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B20-35071

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 05-Nov-20

DATE REPORTED: 26-Nov-20

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	
			Sample I.D.		B20-35071-13	B20-35071-14	B20-35071-15	
			Date Collected		03-Nov-20	03-Nov-20	03-Nov-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Nov-20/O	1100	2020	5380	
% Difference	%		Calc.	16-Nov-20/O	2.33 [1]	4.62	2.33	

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-06848

Report To:

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21

DATE REPORTED: 18-Mar-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B21-06848-1	B21-06848-2	B21-06848-3	B21-06848-4
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	6.22	6.76	6.58	7.34
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	7.35	7.64	7.62	7.97
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	1.13	0.880	1.04	0.632
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	334	225	198	246
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	334	225	198	246
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	17900	8510	13900	3400
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	< 5	< 3	< 5	< 1
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	6050	2740	4810	916
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 5	3.2	< 5	< 1
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 5	< 3	< 5	< 1
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	78.7	36.0	66.1	12.5
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	175	62	52	26
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	647	275	472	60.8
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	240	192	344	37.0
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	3070	1320	2050	586
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	25.4	29.9	39.0	12.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	1.86	3.35	4.72	1.20
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	0.017	0.012	0.011	0.007
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	0.04	0.02	0.03	0.03
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	19.3	6.53	7.73	6.29
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	2.8	1.3	1.1	2.0
Colour	TCU	2	SM 2120C	12-Mar-21/O	3	< 2	3	< 2

Steve Garrett
Director of Laboratory Services

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-06848

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B21-06848-1	B21-06848-2	B21-06848-3	B21-06848-4
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	182	52.8	106	15.4
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.52	0.16	0.34	0.05
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.003	< 0.001	< 0.003	< 0.0003
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.500	0.255	0.520	0.042
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	4.18	2.96	3.09	2.00
Cadmium	mg/L	0.000015	EPA 200.8	16-Mar-21/O	< 0.00030	< 0.00012	< 0.00030	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.003	< 0.001	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.02	< 0.01	< 0.02	< 0.004
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.05	2.40	0.130	< 0.01
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	< 0.0009	< 0.0004	< 0.0009	< 0.00009
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	3.02	0.215	0.200	0.018
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.1	< 0.05	< 0.1	< 0.02
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.1	< 0.05	< 0.1	< 0.02
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.059	0.042	0.071	0.006
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.001	< 0.0005	< 0.001	< 0.0001
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	73.5	45.4	81.1	4.08
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00022	< 0.00008	< 0.0002	< 0.00005
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.5	< 0.3	< 0.5	< 0.1
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.05	< 0.03	< 0.05	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00762	0.00054	< 0.0002	0.00009
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.004	< 0.001	< 0.004	< 0.0004
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.05	< 0.03	< 0.05	0.022
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	10411	4775	7889	1788
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	2600	1470	2590	304
Anion Sum	meq/L		Calc.	15-Mar-21/O	181	83.3	141	31.3

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett
Director of Laboratory Services

CADUCEON
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-06848

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B21-06848-1	B21-06848-2	B21-06848-3	B21-06848-4
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	186	88.0	142	32.0
% Difference	%		Calc.	15-Mar-21/O	1.51 [1]	2.74	0.604	1.07 [1]
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	11.3	< 0.01	5.10	0.17

1 Cations Run from unpreserved bottle
2 Elevated RL due to sample matrix interference

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DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B21-06848-5	B21-06848-6	B21-06848-7	B21-06848-8
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	7.26	7.39	6.94	6.49
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	8.15	8.05	7.59	7.52
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	0.886	0.664	0.655	1.03
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	302	217	222	267
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	302	217	222	267
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	3420	2370	7080	13400
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	1.3	0.6	< 3	< 5
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	899	593	2360	4000
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 1	0.2	< 3	< 5
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 1	0.2	< 3	< 5
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	12.3	6.5	32.9	56.7
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	84	50	60	1230
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	58.6	61.6	179	432
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	32.4	34.4	107	234
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	612	422	990	2410
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	11.4	10.5	22.0	29.8
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	1.26	0.80	2.56	1.99
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	0.009	0.010	0.005	0.004
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	0.04	0.05	0.02	0.03
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	7.28	6.08	3.23	7.25
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	3.0	0.8	1.6	1.8
Colour	TCU	2	SM 2120C	12-Mar-21/O	< 2	< 2	< 2	6

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Steve Garrett
Director of Laboratory Services

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DATE RECEIVED: 10-Mar-21
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B21-06848-5	B21-06848-6	B21-06848-7	B21-06848-8
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	141	20.8	162	246
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.05	0.05	0.17	1.32
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	0.0006	< 0.0003	< 0.001	< 0.003
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.078	0.048	0.150	0.180
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	1.89	1.48	1.94	2.96
Cadmium	mg/L	0.000015	EPA 200.8	16-Mar-21/O	< 0.000029	< 0.000029	< 0.00012	< 0.00030
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.001	< 0.001	< 0.001	< 0.003
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.004	< 0.004	< 0.01	< 0.02
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01	0.012	29.5	10.4
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	< 0.00009	< 0.00009	< 0.0004	< 0.0009
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	0.056	0.006	0.185	0.390
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02	< 0.02	< 0.05	< 0.1
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02	< 0.02	< 0.05	< 0.1
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.009	0.010	0.033	0.039
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0001	< 0.0001	< 0.0005	< 0.001
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	5.22	3.76	11.6	29.0
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	< 0.00005	< 0.00005	< 0.00008	< 0.0002
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.1	< 0.1	< 0.3	< 0.5
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01	< 0.01	< 0.03	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00590	0.00024	< 0.00008	< 0.0002
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0004	< 0.0004	< 0.001	< 0.004
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01	< 0.01	0.990	0.480
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	1882	1305	3884	8508
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	280	295	884	2040
Anion Sum	meq/L		Calc.	15-Mar-21/O	33.2	22.2	72.3	144

Steve Garrett
Director of Laboratory Services

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

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112 Commerce Park Drive
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DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

				Client I.D.	BH-2 E	BH-2 Z	BH-3 D	BH-3 E
				Sample I.D.	B21-06848-5	B21-06848-6	B21-06848-7	B21-06848-8
				Date Collected	10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	32.6	24.6	63.1	147
% Difference	%		Calc.	15-Mar-21/O	0.973 [1]	5.18	6.81	1.13 [1]
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	8.90	0.04	< 0.1 [2]	0.48

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

R.L. = Reporting Limit
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Steve Garrett
Director of Laboratory Services

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Client committed. Quality assured.

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B21-06848-9	B21-06848-10	B21-06848-11	B21-06848-12
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	6.77	6.82	6.43	6.82
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	7.62	7.59	8.16	7.61
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	0.855	0.775	1.73	0.787
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	346	343	693	319
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	346	343	693	319
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	1670	1900	7450	1220
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	< 0.1	< 0.1	< 3	< 0.1
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	289	427	1420	188
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 0.1	< 0.1	< 3	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	0.1	0.1	< 3	< 0.1
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	3.5	4.7	21.1	2.4
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	27	3	1100	6
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	154	159	191	140
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	29.3	28.6	71.5	20.5
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	182	165	1480	104
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	4.6	3.8	16.3	2.4
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	0.45	0.68	1.09	0.23
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	0.012	0.007	0.073	0.008
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	0.09	0.02	0.08	0.05
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	5.26	7.04	9.02	6.85
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	2.7	2.6	36.0	3.0
Colour	TCU	2	SM 2120C	12-Mar-21/O	4	< 2	20	< 2

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett
Director of Laboratory Services

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B21-06848-9	B21-06848-10	B21-06848-11	B21-06848-12
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	249	177	445	96.9
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.09	0.09	0.19	0.08
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	0.0002	0.0001	0.0668	0.0002
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.039	0.054	0.170	0.035
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	0.400	0.263	1.16	0.173
Cadmium	mg/L	.000015	EPA 200.8	16-Mar-21/O	< 0.000015	< 0.000015	0.000868	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.002	< 0.002	< 0.01	< 0.002
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	0.616	5.62	0.030	0.125
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	0.00006	0.00004	< 0.0004	0.00006
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	0.105	0.230	0.125	0.412
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.01	< 0.01	< 0.05	< 0.01
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.01	0.05	< 0.05	< 0.01
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.005	0.005	0.023	0.003
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0001	< 0.0001	< 0.0005	< 0.0001
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	2.55	3.28	23.3	2.08
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	< 0.00005	< 0.00005	0.00153	< 0.00005
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.05	< 0.05	< 0.3	< 0.05
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.005	< 0.005	< 0.03	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00020	0.00036	0.0300	0.00028
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0001	< 0.0001	0.0053	< 0.0001
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.005	0.006	< 0.03	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	895	1000	4698	653
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	505	515	771	434
Anion Sum	meq/L		Calc.	15-Mar-21/O	15.6	19.0	76.9	11.8

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett
Director of Laboratory Services

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-06848**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B21-06848-9	B21-06848-10	B21-06848-11	B21-06848-12
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	18.2	17.9	80.3	13.3
% Difference	%		Calc.	15-Mar-21/O	7.58	2.89	2.17	5.98
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	< 0.1 [2]	< 0.1 [2]	80.2	< 0.1 [2]

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

Steve Garrett
Director of Laboratory Services

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-06848-13	B21-06848-14	B21-06848-15	B21-06848-16
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	6.19	6.62	7.08	7.11
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	7.91	7.63	7.97	7.82
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	1.72	1.01	0.888	0.711
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	775	339	257	273
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	775	339	257	273
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	12700	8430	4020	3900
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	< 3	< 3	< 1	< 1
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	3500	2470	1110	1060
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 3	< 3	< 1	1.5
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 3	< 3	< 1	< 1
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	43.8	34.3	14.9	14.3
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	1030	241	21	61
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	295	254	107	95.0
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	171	144	60.0	61.6
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	2400	1080	644	620
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	22.3	19.0	16.2	17.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	1.09	1.85	2.00	1.77
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	< 0.002	0.032	0.005	0.010
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	0.13	0.06	0.02	0.03
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	7.90	6.02	7.36	6.81
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	1.9	3.0	1.3	1.0
Colour	TCU	2	SM 2120C	12-Mar-21/O	17	4	< 2	< 2

Steve Garrett
Director of Laboratory Services

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DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-06848-13	B21-06848-14	B21-06848-15	B21-06848-16
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	371	162	20.9	67.5
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.65	0.17	0.06	0.06
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.003	0.0017	< 0.0005	0.0006
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.170	0.345	0.080	0.118
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	1.98	1.19	1.08	1.37
Cadmium	mg/L	0.000015	EPA 200.8	16-Mar-21/O	< 0.00030	< 0.00012	< 0.000059	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.003	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.02	< 0.01	< 0.004	< 0.004
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	0.900	3.84	1.03	0.168
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	< 0.0009	< 0.0004	< 0.0002	< 0.0002
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	0.200	0.175	0.010	0.014
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.1	< 0.05	< 0.02	< 0.02
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.1	< 0.05	< 0.02	< 0.02
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.034	0.037	0.018	0.017
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.001	< 0.0005	< 0.0002	< 0.0002
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	37.9	37.3	13.9	15.9
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	< 0.0002	< 0.00008	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.5	< 0.3	< 0.1	< 0.1
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.05	< 0.03	< 0.01	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00071	0.00086	0.00006	0.00148
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.004	< 0.001	< 0.0007	< 0.0007
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	0.360	< 0.03	< 0.01	< 0.01
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	7879	4415	2112	2089
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	1440	1220	515	491
Anion Sum	meq/L		Calc.	15-Mar-21/O	135	81.4	36.8	36.8

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Steve Garrett
Director of Laboratory Services

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DATE RECEIVED: 10-Mar-21

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-06848-13	B21-06848-14	B21-06848-15	B21-06848-16
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	134	72.3	38.9	37.3
% Difference	%		Calc.	15-Mar-21/O	0.604 [1]	5.97	2.83	0.763
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	14.7	10.1	0.03	< 0.1 [2]

1. Cations Run from unpreserved bottle

2. Elevated RL due to sample matrix interference

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-8-G	BH-8-K
			Sample I.D.		B21-06848-17	B21-06848-18	B21-06848-19	B21-06848-20
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	7.22	7.24	6.99	7.74
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	7.90	7.86	7.90	8.12
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	0.682	0.622	0.914	0.384
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	284	285	349	325
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	284	285	349	325
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	2810	2910	5460	2280
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	0.5	0.4	3.0	4.3
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	707	808	699	518
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 0.1	< 0.1	< 1	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	0.2	0.2	< 1	0.2
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	8.3	8.4	7.8	4.3
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	21	24	1460	29
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	69.4	66.0	101	18.4
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	43.2	40.0	23.4	11.1
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	478	484	1340	466
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	15.3	15.3	9.9	7.3
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	1.72	1.67	0.55	0.63
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	0.011	0.013	0.011	0.016
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	0.09	0.21	0.13	0.10
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	5.91	5.61	9.65	4.22
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	1.9	2.1	73.2	3.1
Colour	TCU	2	SM 2120C	12-Mar-21/O	< 2	< 2	8	< 2

Steve Garrett
Director of Laboratory Services

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-8-G	BH-8-K
			Sample I.D.		B21-06848-17	B21-06848-18	B21-06848-19	B21-06848-20
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	81.4	342	192	107
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.05	0.06	0.73	0.02
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	0.0004	0.0005	0.0139	0.0012
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.122	0.160	0.130	0.108
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	1.14	1.12	3.38	2.86
Cadmium	mg/L	0.000015	EPA 200.8	16-Mar-21/O	< 0.000029	< 0.000029	0.000297	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.001	< 0.001	0.001	< 0.001
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.004	< 0.004	< 0.02	< 0.004
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	0.114	0.046	17.1	0.168
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	< 0.00009	< 0.00009	0.00020	< 0.00009
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	0.046	0.080	0.160	0.048
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02	< 0.02	< 0.1	< 0.02
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02	< 0.02	< 0.1	< 0.02
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.013	0.012	0.035	0.007
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0001	< 0.0001	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	9.68	8.60	4.00	1.44
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.1	< 0.1	< 0.5	< 0.1
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01	< 0.01	< 0.05	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00111	0.00162	0.426	0.00380
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0004	< 0.0004	0.0034	< 0.0004
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01	< 0.01	< 0.05	< 0.01
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	1508	1611	3860	1251
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	351	329	349	92
Anion Sum	meq/L		Calc.	15-Mar-21/O	26.1	29.0	57.2	21.9

Steve Garrett
Director of Laboratory Services

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-06848**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21

DATE REPORTED: 18-Mar-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-8-G	BH-8-K
			Sample I.D.		B21-06848-17	B21-06848-18	B21-06848-19	B21-06848-20
			Date Collected		10-Mar-21	10-Mar-21	10-Mar-21	10-Mar-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	28.3	28.1	66.5	22.3
% Difference	%		Calc.	15-Mar-21/O	4.11	1.52	7.52 [1]	0.883
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	< 0.1 [2]	0.30	1.47	0.12

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

R.L. = Reporting Limit
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Steve Garrett
Director of Laboratory Services

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DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

Client I.D.	BH-8-L			
Sample I.D.	B21-06848-21			
Date Collected	10-Mar-21			

Parameter	Units	R.L.	Reference Method	Date/Site Analyzed	BH-8-L			
Saturation pH (25°C)	-		Calc.	15-Mar-21/O	7.81			
pH @25°C	pH Units		SM 4500H	11-Mar-21/O	8.34			
Langelier Index(25°C)	S.I.		Calc.	15-Mar-21/O	0.532			
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Mar-21/O	320			
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	313			
Carbonate (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	7			
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	11-Mar-21/O	< 5			
Conductivity @25°C	µS/cm	1	SM 2510B	11-Mar-21/O	2290			
Fluoride	mg/L	0.1	SM4110C	12-Mar-21/O	4.5			
Chloride	mg/L	0.5	SM4110C	12-Mar-21/O	533			
Nitrate (N)	mg/L	0.1	SM4110C	12-Mar-21/O	< 0.1			
Nitrite (N)	mg/L	0.1	SM4110C	12-Mar-21/O	0.1			
Bromide	mg/L	0.4	SM4110C	12-Mar-21/O	4.2			
Sulphate	mg/L	1	SM4110C	12-Mar-21/O	73			
Calcium	mg/L	0.02	SM 3120	12-Mar-21/O	15.8			
Magnesium	mg/L	0.02	SM 3120	12-Mar-21/O	8.96			
Sodium	mg/L	0.2	SM 3120	12-Mar-21/O	494			
Potassium	mg/L	0.1	SM 3120	12-Mar-21/O	6.4			
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	12-Mar-21/K	0.80			
o-Phosphate (P)	mg/L	0.002	PE4500-S	12-Mar-21/K	0.081			
Phosphorus-Total	mg/L	0.01	E3199A.1	12-Mar-21/K	3.13			
Silica	mg/L	0.02	SM 3120	12-Mar-21/O	4.79			
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Mar-21/O	2.8			
Colour	TCU	2	SM 2120C	12-Mar-21/O	3			

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Steve Garrett
Director of Laboratory Services

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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21

DATE REPORTED: 18-Mar-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-8-L			
			Sample I.D.		B21-06848-21			
			Date Collected		10-Mar-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	11-Mar-21/O	4710			
Aluminum	mg/L	0.01	SM 3120	12-Mar-21/O	0.10			
Arsenic	mg/L	0.0001	EPA 200.8	16-Mar-21/O	0.0012			
Barium	mg/L	0.001	SM 3120	12-Mar-21/O	0.108			
Boron	mg/L	0.005	SM 3120	12-Mar-21/O	2.84			
Cadmium	mg/L	.000015	EPA 200.8	16-Mar-21/O	< 0.000029			
Chromium	mg/L	0.001	EPA 200.8	16-Mar-21/O	< 0.001			
Copper	mg/L	0.002	SM 3120	12-Mar-21/O	< 0.004			
Iron	mg/L	0.005	SM 3120	12-Mar-21/O	0.334			
Lead	mg/L	0.00002	EPA 200.8	16-Mar-21/O	0.00011			
Manganese	mg/L	0.001	SM 3120	12-Mar-21/O	0.068			
Molybdenum	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02			
Nickel	mg/L	0.01	SM 3120	12-Mar-21/O	< 0.02			
Selenium	mg/L	0.001	EPA 200.8	16-Mar-21/O	0.007			
Silver	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	12-Mar-21/O	1.17			
Thallium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	< 0.00005			
Tin	mg/L	0.05	SM 3120	12-Mar-21/O	< 0.1			
Titanium	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01			
Uranium	mg/L	0.00005	EPA 200.8	16-Mar-21/O	0.00277			
Vanadium	mg/L	0.0001	EPA 200.8	16-Mar-21/O	< 0.0004			
Zinc	mg/L	0.005	SM 3120	12-Mar-21/O	< 0.01			
TDS(ion sum calc.)	mg/L	1	Calc.	15-Mar-21/O	1329			
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Mar-21/O	76			
Anion Sum	meq/L		Calc.	15-Mar-21/O	23.2			

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Director of Laboratory Services

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Mar-21
DATE REPORTED: 18-Mar-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L			
			Sample I.D.		B21-06848-21			
			Date Collected		10-Mar-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	15-Mar-21/O	23.3			
% Difference	%		Calc.	15-Mar-21/O	0.131			
Sulphide	mg/L	0.01	SM4500-S2	12-Mar-21/K	18.5			

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

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Steve Garrett
Director of Laboratory Services

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C.O.C.: --- **REPORT No. B21-16142**

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B21-16142-1	B21-16142-2	B21-16142-3	B21-16142-4
			Date Collected		27-May-21	27-May-21	27-May-21	28-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	6.31	6.52	6.41	7.36
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	7.42	7.67	7.72	8.13
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	1.11	1.15	1.31	0.766
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	285	212	195	261
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	285	212	195	261
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	16600	15800	19400	2810
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	5880	5610	9400	681
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	< 0.1	< 0.1	< 1	< 1
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	4.2	3.5	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	11.4	28.8	95.4	7.3
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	118	19	10	14
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	619	503	720	54.0
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	220	362	582	32.3
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	2760	2290	3620	542
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	27.7	48.8	61.2	11.9
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	1.85	5.73	6.97	1.01
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	0.012	0.005	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.05	< 0.01	0.04	< 0.01
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	17.1	8.07	6.83	6.70
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	2.3	1.2	0.2	1.1
Colour	TCU	2	SM 2120C	01-Jun-21/O	2	< 2	2	< 2
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	98.2	58.8	47.2	5.4
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.20	0.20	0.21	0.04
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0133	< 0.003	< 0.003	< 0.0003

Steve Garrett
Director of Laboratory Services

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-16142**

Report To:

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 E	BH-1 Z	BH-2 C
			Sample I.D.		B21-16142-1	B21-16142-2	B21-16142-3	B21-16142-4
			Date Collected		27-May-21	27-May-21	27-May-21	28-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.965	0.551	0.699	0.035
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	3.83	3.69	4.85	1.99
Cadmium	mg/L	0.000015	EPA 200.8	11-Jun-21/O	0.0378	< 0.00030	< 0.00030	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	0.035	< 0.003	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	8.38	5.50	0.035	1.07
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	0.0358	< 0.0009	< 0.0009	< 0.00009
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	2.61	0.156	0.039	0.009
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	0.03	0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.03 [4]	<0.02 [4]	<0.06 [4]	<0.02 [4]
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0145	< 0.001	0.0033	< 0.0001
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	80.1	93.5	175	3.80
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.0460	0.00120	0.00041	< 0.00005
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.00705	0.00055	0.00033	< 0.00005
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0360	< 0.004	< 0.004	< 0.0004
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	0.005	< 0.005	< 0.005	0.006
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	9821	8980	14524	1494
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	2450	2750	4190	268
% Difference	%		Calc.	09-Jun-21/O	1.28 [1]	2.17 [1]	5.09	8.58
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	18.4	5.39	14.3	< 0.01

1. Cations Run from unpreserved bottle
2. Digested
3. Elevated detection limit due to dilution
4. Elevated RL due to Bromide interference

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Director of Laboratory Services

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REPORT No. B21-16142

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DATE RECEIVED: 28-May-21

DATE REPORTED: 24-Jun-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B21-16142-5	B21-16142-6	B21-16142-7	B21-16142-8
			Date Collected		28-May-21	28-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	7.29	7.24	6.70	6.28
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	8.07	8.01	7.95	7.91
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	0.783	0.766	1.25	1.63
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	261	254	287	332
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	261	254	287	332
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	3320	3660	8510	16500
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	960	1170	2540	6030
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 0.1	0.1
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 0.1	0.2
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	10.2	12.5	13.4	12.8
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	24	16	289	520
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	64.4	74.8	245	566
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	39.5	48.9	116	298
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	621	711	1440	3070
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	13.2	13.7	27.6	38.0
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	1.16	1.03	2.37	2.12
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	< 0.002	< 0.002	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.02	0.07	< 0.01	0.04
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	7.15	6.91	7.32	5.91
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	1.1	0.6	1.5	4.1
Colour	TCU	2	SM 2120C	01-Jun-21/O	< 2	2	4	10
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	14.3	115	50.6	314
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.07	0.06	0.13	0.21
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0003	< 0.0003	< 0.0005	0.0028

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Director of Laboratory Services

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DATE RECEIVED: 28-May-21

DATE REPORTED: 24-Jun-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 E	BH-2 Z	BH-3 D	BH-3 E
			Sample I.D.		B21-16142-5	B21-16142-6	B21-16142-7	B21-16142-8
			Date Collected		28-May-21	28-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.064	0.042	0.210	0.154
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	2.06	2.14	2.02	3.36
Cadmium	mg/L	.000015	EPA 200.8	11-Jun-21/O	< 0.000029	< 0.000029	< 0.000059	0.00759
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	< 0.001	< 0.001	< 0.001	0.007
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	0.376	0.029	29.8	13.0
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	< 0.00009	< 0.00009	< 0.0002	0.00593
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	0.025	0.004	0.101	0.459
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	0.02	0.02
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.03 [4]	<0.03 [4]	<0.02 [4]	<0.04 [4]
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0001	< 0.0001	< 0.0002	< 0.001
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	4.90	5.72	14.3	37.9
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	< 0.00005	< 0.00005	< 0.00005	0.00696
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.00031	< 0.00005	0.00026	0.00039
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0004	< 0.0004	< 0.0007	0.0054
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	0.011	< 0.005	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	1880	2185	4837	10729
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	323	388	1090	2640
% Difference	%		Calc.	09-Jun-21/O	1.68	1.02	1.05 [1]	0.0762 [1]
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	0.67	0.02	0.06	6.29

1. Cations Run from unpreserved bottle
2. Digested
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4. Elevated RL due to Bromide interference

Steve Garrett
Director of Laboratory Services

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-16142**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

				Client I.D.	BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
				Sample I.D.	B21-16142-9	B21-16142-10	B21-16142-11	B21-16142-12
				Date Collected	27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	6.94	6.79	6.29	6.65
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	7.92	7.84	8.10	7.79
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	0.982	1.05	1.81	1.14
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	273	344	764	281
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	273	344	764	281
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	5850	1730	8990	7220
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	1820	367	2040	2180
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 0.1	< 1	< 1
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 0.1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 0.1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	19.6	4.2	19.6	23.6
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	13	3	1350	10
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	144	150	240	272
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	87.8	23.8	94.1	128
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	980	140	2150	1160
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	22.8	3.5	19.8	21.9
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	2.36	0.31	0.68	2.36
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	0.010	< 0.002	0.169	0.005
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.05	0.01	0.09	0.07
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	6.78	8.00	9.48	7.45
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	1.4	2.4	8.2	2.3
Colour	TCU	2	SM 2120C	01-Jun-21/O	2	3	48	2
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	111	69.5	1230	30.4
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.09	0.08	0.12 [2]	0.12

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Steve Garrett
Director of Laboratory Services

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B21-16142-9	B21-16142-10	B21-16142-11	B21-16142-12
			Date Collected		27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0005	0.0001	0.145	< 0.0005
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.132	0.049	0.202	0.177
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	2.22	0.272	1.52	1.86
Cadmium	mg/L	.000015	EPA 200.8	11-Jun-21/O	< 0.000059	< 0.000015	< 0.000059	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	0.074	7.15	0.019	1.17
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	< 0.0002	0.00006	< 0.0002	< 0.0002
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	0.009	0.495	0.159	0.210
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.03 [4]	<0.02 [4]	<0.02 [4]	<0.02 [4]
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0002	< 0.0001	< 0.0002	< 0.0002
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	10.5	2.57	32.0	17.7
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.00006	0.00007	0.00021	0.00006
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	< 0.00005	0.00019	0.0177	0.00016
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0007	< 0.0001	0.0075	< 0.0007
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	0.005
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	3238	903	6357	3946
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	721	473	987	1210
% Difference	%		Calc.	09-Jun-21/O	0.536	3.78	5.94	5.60
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	0.03	0.18	66.6	0.05

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Steve Garrett
Director of Laboratory Services

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 E	BH-4 Z
			Sample I.D.		B21-16142-9	B21-16142-10	B21-16142-11	B21-16142-12
			Date Collected		27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1 Cations Run from unpreserved bottle
2 Digested
3 Elevated detection limit due to dilution
4 Elevated RL due to Bromide interference

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DATE RECEIVED: 28-May-21
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-16142-13	B21-16142-14	B21-16142-15	B21-16142-16
			Date Collected		27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	6.19	6.26	6.37	6.92
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	8.02	7.72	7.53	7.83
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	1.83	1.46	1.16	0.909
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	801	437	140	301
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	801	437	140	301
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	12900	12000	20900	4970
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	4330	4100	10500	1190
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	38.4	38.5	118	12.6
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	894	368	10	471
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	286	448	1080	136
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	166	224	719	73.5
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	2780	2320	4160	957
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	28.1	27.9	63.7	21.6
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	1.15	2.19	7.25	1.68
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	0.100	0.018	0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.16	0.05	0.03	0.04
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	7.94	12.6	5.93	7.04
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	6.1	4.4	0.2	4.3
Colour	TCU	2	SM 2120C	01-Jun-21/O	193	11	9	4
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	176	373	85.9	66.5
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.13	0.19	0.59	0.09

Steve Garrett
Director of Laboratory Services

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-16142-13	B21-16142-14	B21-16142-15	B21-16142-16
			Date Collected		27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0363	0.0180	< 0.003	0.0072
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.248	0.384	1.39	0.253
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	2.37	1.83	2.34	1.48
Cadmium	mg/L	0.000015	EPA 200.8	11-Jun-21/O	< 0.00012	< 0.00012	< 0.00030	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	< 0.001	< 0.001	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	0.115	4.84	5.29
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	< 0.0004	< 0.0004	< 0.0009	< 0.0002
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	0.186	0.742	0.062	0.082
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	0.05	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.05 [4]	<0.05 [4]	<0.03 [4]	<0.02 [4]
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0005	< 0.0005	< 0.001	< 0.0002
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	41.5	65.6	210	19.9
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	< 0.00008	< 0.00008	< 0.0002	< 0.00005
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.00396	0.00314	< 0.0002	0.0102
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0048	0.0023	< 0.004	0.0008
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	8969	7753	16631	3041
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	1400	2040	5660	642
% Difference	%		Calc.	09-Jun-21/O	2.35	3.84	0.480	5.63
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	44.2	10.5	0.01	0.12

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Director of Laboratory Services

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DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 E	BH-5 G	BH-5 Z	BH-6-I
			Sample I.D.		B21-16142-13	B21-16142-14	B21-16142-15	B21-16142-16
			Date Collected		27-May-21	27-May-21	27-May-21	27-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1. Cations Run from unpreserved bottle
2. Digested
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6- L	BH-8-G	BH-8-K
			Sample I.D.		B21-16142-17	B21-16142-18	B21-16142-19	B21-16142-20
			Date Collected		27-May-21	27-May-21	28-May-21	28-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	6.65	7.10	6.95	7.44
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	7.73	8.01	8.09	8.18
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	1.08	0.908	1.14	0.735
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	373	313	523	351
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	373	313	523	351
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	8350	3060	4740	2970
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	1410	805	599	680
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	2.6	3.2
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	12.7	8.9	5.0	6.2
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	2060	22	1140	51
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	216	82.4	73.4	33.3
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	78.1	49.0	14.3	21.0
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	2070	542	1180	642
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	22.5	18.9	7.8	9.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	1.98	1.99	0.37	0.69
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	0.007	< 0.002	0.012	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.12	0.18	0.18	0.13
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	7.15	6.81	15.1	6.25
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	35.3	1.8	7.0	2.4
Colour	TCU	2	SM 2120C	01-Jun-21/O	10	< 2	7	2
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	125	237	63.4	108
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.12 [2]	0.06	0.07	0.03

Steve Garrett
Director of Laboratory Services

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-16142**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6- L	BH-8-G	BH-8-K
			Sample I.D.		B21-16142-17	B21-16142-18	B21-16142-19	B21-16142-20
			Date Collected		27-May-21	27-May-21	28-May-21	28-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0339	0.0022	0.0207	0.0036
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.193	0.142	0.047	0.119
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	1.34	1.20	3.16	3.45
Cadmium	mg/L	0.000015	EPA 200.8	11-Jun-21/O	< 0.000059	< 0.000029	< 0.000059	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	10.6	0.890	2.05	0.412
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	< 0.0002	< 0.00009	< 0.0002	< 0.00009
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	0.156	0.056	0.145	0.043
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	0.03	< 0.01	0.05	0.01
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	< 0.01	0.02	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.03 [4]	<0.02 [4]	<0.02 [4]	<0.02 [4]
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0002	< 0.0001	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	21.7	10.3	3.11	2.97
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	< 0.00005	< 0.00005	0.00019	< 0.00005
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.0268	0.00128	0.0129	0.00371
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0035	< 0.0004	0.0029	< 0.0004
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	0.005	< 0.005	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	6097	1710	3331	1652
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	861	407	242	170
% Difference	%		Calc.	09-Jun-21/O	9.24	4.80	4.94	7.13
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	< 0.1 [3]	< 0.1 [3]	1.04	< 0.1 [3]

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Steve Garrett
Director of Laboratory Services

C.O.C.: --- **REPORT No. B21-16142**

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Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6- L	BH-8-G	BH-8-K
			Sample I.D.		B21-16142-17	B21-16142-18	B21-16142-19	B21-16142-20
			Date Collected		27-May-21	27-May-21	28-May-21	28-May-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1. Cations Run from unpreserved bottle
2. Digested
3. Elevated detection limit due to dilution
4. Elevated RL due to Bromide interference

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Steve Garrett
Director of Laboratory Services

CERTIFICATE OF ANALYSIS

Final Report

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DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L			
			Sample I.D.		B21-16142-21			
			Date Collected		28-May-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	09-Jun-21/O	7.78			
pH @25°C	pH Units		SM 4500H	08-Jun-21/O	8.28			
Langelier Index(25°C)	S.I.		Calc.	09-Jun-21/O	0.495			
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	08-Jun-21/O	326			
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	326			
Carbonate (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5			
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	08-Jun-21/O	< 5			
Conductivity @25°C	µS/cm	1	SM 2510B	08-Jun-21/O	2350			
Chloride	mg/L	0.5	SM4110C	03-Jun-21/O	520			
Fluoride	mg/L	0.1	SM4110C	03-Jun-21/O	3.3			
Nitrate (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1			
Nitrite (N)	mg/L	0.1	SM4110C	03-Jun-21/O	< 1			
Bromide	mg/L	0.4	SM4110C	03-Jun-21/O	4.7			
Sulphate	mg/L	1	SM4110C	03-Jun-21/O	98			
Calcium	mg/L	0.02	SM 3120	02-Jun-21/O	16.4			
Magnesium	mg/L	0.02	SM 3120	02-Jun-21/O	9.71			
Sodium	mg/L	0.2	SM 3120	02-Jun-21/O	508			
Potassium	mg/L	0.1	SM 3120	02-Jun-21/O	6.9			
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	03-Jun-21/K	0.80			
o-Phosphate (P)	mg/L	0.002	PE4500-S	03-Jun-21/K	0.157			
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Jun-21/K	0.30			
Silica	mg/L	0.02	SM 3120	02-Jun-21/O	5.44			
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	02-Jun-21/O	2.1			
Colour	TCU	2	SM 2120C	01-Jun-21/O	4			
Turbidity	NTU	0.1	SM 2130	02-Jun-21/O	557			
Aluminum	mg/L	0.01	SM 3120	02-Jun-21/O	0.03			

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Director of Laboratory Services

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L			
			Sample I.D.		B21-16142-21			
			Date Collected		28-May-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Arsenic	mg/L	0.0001	EPA 200.8	11-Jun-21/O	0.0017			
Barium	mg/L	0.001	SM 3120	02-Jun-21/O	0.053			
Boron	mg/L	0.005	SM 3120	02-Jun-21/O	2.65			
Cadmium	mg/L	).000015	EPA 200.8	11-Jun-21/O	0.000056			
Chromium	mg/L	0.001	EPA 200.8	11-Jun-21/O	< 0.001			
Copper	mg/L	0.002	SM 3120	02-Jun-21/O	< 0.002			
Iron	mg/L	0.005	SM 3120	02-Jun-21/O	0.081			
Lead	mg/L	0.00002	EPA 200.8	11-Jun-21/O	< 0.00009			
Manganese	mg/L	0.001	SM 3120	02-Jun-21/O	0.050			
Molybdenum	mg/L	0.01	SM 3120	02-Jun-21/O	0.04			
Nickel	mg/L	0.01	SM 3120	02-Jun-21/O	0.03			
Selenium	mg/L	0.001	EPA 200.8	11-Jun-21/O	<0.02 [4]			
Silver	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	02-Jun-21/O	1.30			
Thallium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	< 0.00005			
Tin	mg/L	0.05	SM 3120	02-Jun-21/O	< 0.05			
Titanium	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005			
Uranium	mg/L	0.00005	EPA 200.8	11-Jun-21/O	0.00371			
Vanadium	mg/L	0.0001	EPA 200.8	11-Jun-21/O	< 0.0004			
Zinc	mg/L	0.005	SM 3120	02-Jun-21/O	< 0.005			
TDS(ion sum calc.)	mg/L	1	Calc.	09-Jun-21/O	1360			
Hardness (as CaCO3)	mg/L	1	SM 3120	02-Jun-21/O	81			
% Difference	%		Calc.	09-Jun-21/O	1.13			
Sulphide	mg/L	0.01	SM4500-S2	02-Jun-21/K	< 0.1 [3]			

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Steve Garrett
Director of Laboratory Services

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Attention: Brad Pettersone

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112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 28-May-21
DATE REPORTED: 24-Jun-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L			
			Sample I.D.		B21-16142-21			
			Date Collected		28-May-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				

1 Cations Run from unpreserved bottle
2 Digested
3 Elevated detection limit due to dilution
4 Elevated RL due to Bromide interference

Steve Garrett
Director of Laboratory Services

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Final Report

C.O.C.: ---

REPORT No. B21-28262

Report To:

Azimuth Environmental
642 Welham Rd,
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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21

DATE REPORTED: 30-Sep-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-28262-1	B21-28262-2	B21-28262-3	B21-28262-4
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	6.38	6.60	6.38	7.52
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.20	7.37	7.65	8.03
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	0.819	0.766	1.27	0.508
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	259	179	201	288
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	259	179	201	288
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	16000	15100	19100	1880
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	5250	4980	7470	405
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	< 5	< 5	< 10	1.6
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 5	< 5	< 10	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 5	< 5	< 10	< 0.1
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	< 20	< 20	< 40	< 0.4
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	91	34	< 10	12
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	572	496	747	33.2
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	238	353	563	19.3
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	2440	2170	3110	336
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	25.5	43.3	56.2	8.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	1.91	4.81	6.56	0.78
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.008	0.005	0.004	0.003
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.05	0.02	0.03	0.03
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	16.7	6.87	6.98	6.72
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	1.5	0.8	0.3	1.3
Colour	TCU	2	SM 2120C	08-Sep-21/O	4	< 2	6	< 2

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

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REPORT No. B21-28262

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112 Commerce Park Drive
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21
DATE REPORTED: 30-Sep-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-28262-1	B21-28262-2	B21-28262-3	B21-28262-4
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	108	129	76.5	14.4
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	0.20	0.18	0.14	0.15
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.003	< 0.003	< 0.003	< 0.0001
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	1.38	0.667	0.693	0.021
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	3.76	3.49	4.36	2.28
Cadmium	mg/L	0.000015	EPA 200.8	15-Sep-21/O	< 0.00030	0.000329	< 0.00030	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.003	< 0.003	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	0.438	2.09	0.047	0.828
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.0009	< 0.0009	< 0.0009	0.00011
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	2.53	0.241	0.045	0.008
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	0.03	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.03	<0.02	<0.045	<0.010
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	< 0.001	< 0.0001
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	86.1	96.7	155	2.12
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00049	0.00026	< 0.0002	< 0.00005
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00524	0.00073	< 0.0002	< 0.00005
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.004	< 0.004	< 0.004	< 0.0001
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	0.006	< 0.005	0.096
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	8781	8197	12072	990
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	2410	2690	4180	162
% Difference	%		Calc.	10-Sep-21/O	0.0359	1.64	1.40	1.90

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-28262

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21

DATE REPORTED: 30-Sep-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-28262-1	B21-28262-2	B21-28262-3	B21-28262-4
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	4.99	0.01	25.9	0.48

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

CBurke

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Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B21-28262-5	B21-28262-6	B21-28262-7	B21-28262-8
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	7.37	7.35	6.18	6.20
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.94	7.92	7.72	7.64
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	0.575	0.573	1.54	1.44
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	288	301	349	303
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	288	301	349	303
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	2680	2970	18000	18200
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	692	707	6100	6080
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	1.1	< 1	< 10	< 10
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 0.1	< 1	< 10	< 10
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 0.1	< 1	< 10	< 10
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	1.7	< 4	< 40	< 40
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	21	< 10	1190	1070
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	48.8	48.6	674	742
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	29.9	29.3	390	445
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	467	410	3130	3090
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	10.5	10.2	37.9	41.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	0.95	0.85	3.41	2.97
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.002	< 0.002	0.098	0.015
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.01	0.04	0.03	0.05
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	6.87	7.19	6.38	7.88
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	1.4	1.0	4.0	3.7
Colour	TCU	2	SM 2120C	08-Sep-21/O	< 2	< 2	8	7

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 03-Sep-21

DATE REPORTED: 30-Sep-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B21-28262-5	B21-28262-6	B21-28262-7	B21-28262-8
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	3.9	29.6	600	675
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	0.03	0.03	0.22	0.22
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0003	< 0.0003	< 0.003	< 0.003
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	0.053	0.029	0.141	0.130
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	2.22	2.96	3.95	4.38
Cadmium	mg/L	).000015	EPA 200.8	15-Sep-21/O	< 0.000029	< 0.000029	< 0.00030	< 0.00030
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	< 0.003	< 0.003
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	0.331	0.019	4.22	0.255
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.00009	< 0.00009	< 0.0009	< 0.0009
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	0.031	0.001	0.522	0.494
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.015	<0.015	<0.02	<0.05
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0001	< 0.0001	< 0.001	< 0.001
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	3.88	3.28	46.9	58.5
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	< 0.00005	< 0.00005	< 0.0002	< 0.0002
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00033	< 0.00005	0.00133	0.0113
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0004	< 0.0004	< 0.004	< 0.004
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	0.005	0.020
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	1444	1386	11739	11657
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	245	242	3290	3680
% Difference	%		Calc.	10-Sep-21/O	0.383	6.04	0.126	2.30

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-28262

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21
DATE REPORTED: 30-Sep-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B21-28262-5	B21-28262-6	B21-28262-7	B21-28262-8
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	0.10	< 0.01	29.8	18.5

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

				Client I.D.	BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
				Sample I.D.	B21-28262-9	B21-28262-10	B21-28262-11	B21-28262-12
				Date Collected	01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	6.97	6.76	6.24	6.67
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.84	7.57	7.92	7.63
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	0.873	0.807	1.68	0.956
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	272	337	810	272
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	272	337	810	272
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	6560	3620	12500	9310
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	1920	924	2540	2980
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 5	< 1
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 5	< 1
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 5	< 1
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	12.6	< 4	< 20	25.2
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	< 10	< 10	1850	< 10
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	135	166	254	278
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	85.5	55.1	101	139
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	969	487	1960	1160
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	25.6	9.0	20.7	23.4
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	2.94	1.19	1.85	2.59
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.008	0.005	0.014	0.015
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.03	0.02	0.14	0.03
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	7.70	6.92	9.63	7.06
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	0.7	2.3	10.5	1.9

CBurke

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Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
			Sample I.D.		B21-28262-9	B21-28262-10	B21-28262-11	B21-28262-12
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	08-Sep-21/O	< 2	2	36	< 2
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	31.9	62.5	972	38.7
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	0.08	0.05	0.13	0.11
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0005	< 0.0003	0.0126	< 0.001
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	0.170	0.073	0.188	0.185
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	2.85	1.01	1.52	2.30
Cadmium	mg/L	0.000015	EPA 200.8	15-Sep-21/O	< 0.000059	< 0.000029	< 0.00012	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	0.003	< 0.001
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.002	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	0.018	< 0.005	0.048	0.278
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.0002	< 0.00009	< 0.0004	< 0.0004
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	0.010	0.149	0.198	0.055
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	0.02	< 0.01
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.025	<0.01	<0.040	<0.02
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0002	< 0.0001	< 0.0005	< 0.0005
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	9.70	6.73	31.7	19.0
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	< 0.00005	< 0.00005	0.00026	0.00009
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 0.05	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00011	0.00093	0.0176	0.00042
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0007	< 0.0004	0.0060	< 0.001
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	3302	1845	7218	4743

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 03-Sep-21

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
			Sample I.D.		B21-28262-9	B21-28262-10	B21-28262-11	B21-28262-12
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	689	642	1050	1270
% Difference	%		Calc.	10-Sep-21/O	2.43	2.28 [1]	8.38	7.73
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	0.02	0.04	51.6	0.02

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6-I
			Sample I.D.		B21-28262-13	B21-28262-14	B21-28262-15	B21-28262-16
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	6.51	6.22	6.81	6.38
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.56	7.86	7.80	7.46
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	1.05	1.64	0.994	1.08
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	320	814	252	528
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	320	814	252	528
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	10000	13100	6010	10800
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	2850	3460	1810	2030
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	< 3	< 5	< 1	< 3
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 3	< 5	< 1	< 3
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 3	< 5	< 1	< 3
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	10.8	< 20	12.3	< 10
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	149	972	< 10	2660
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	343	265	211	279
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	182	155	109	108
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	1480	2160	847	2190
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	26.0	23.8	22.7	22.8
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	2.76	0.70	2.87	1.27
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.005	0.012	0.002	0.004
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.03	0.12	0.03	0.12
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	9.37	7.17	7.94	9.42
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	3.4	7.0	1.0	10.5

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-28262**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21
DATE REPORTED: 30-Sep-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6-I
			Sample I.D.		B21-28262-13	B21-28262-14	B21-28262-15	B21-28262-16
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	08-Sep-21/O	< 2	49	< 2	23
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	134	439	35.4	104
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	0.12	0.11	0.09	0.80
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	0.0011	0.0033	< 0.0005	0.0368
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	0.286	0.343	0.123	0.100
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	1.48	1.99	1.16	2.00
Cadmium	mg/L	).000015	EPA 200.8	15-Sep-21/O	< 0.00012	< 0.00012	< 0.000059	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	< 0.001	0.001
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.002	< 0.002	< 0.002	< 0.2
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	0.479	0.135	1.57	1.70
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.0004	< 0.0004	< 0.0002	< 0.0004
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	0.302	0.176	0.018	0.300
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 1
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 0.01	< 0.01	< 1
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.035	<0.02	<0.02	<0.035
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0005	< 0.0005	< 0.0002	< 0.0005
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	45.7	36.6	22.7	30.1
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	< 0.00008	< 0.00008	< 0.00005	< 0.00008
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 0.05	< 0.05	< 0.05	< 5
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.005	< 0.005	< 0.5
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00110	0.00178	0.00006	0.0118
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.001	0.0025	< 0.0007	0.0093
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	0.006	< 0.005	0.006	< 0.5
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	5228	7524	3156	7610

CBurke

Christine Burke
Lab Manager

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Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21

DATE REPORTED: 30-Sep-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6-I
			Sample I.D.		B21-28262-13	B21-28262-14	B21-28262-15	B21-28262-16
			Date Collected		01-Sep-21	01-Sep-21	01-Sep-21	01-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	1610	1300	975	1140
% Difference	%		Calc.	10-Sep-21/O	3.96	5.29	0.978	1.80
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	12.9	44.0	0.03	1.68

1 Cations Run from unpreserved bottle

2 Elevated RL due to sample matrix interference

CBurke

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Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-7-I	BH-7-K
			Sample I.D.		B21-28262-17	B21-28262-18	B21-28262-19	B21-28262-20
			Date Collected		01-Sep-21	01-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	6.43	7.08	6.07	6.88
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.49	7.80	7.07	7.67
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	1.06	0.724	0.999	0.789
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	472	316	64	199
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	472	316	64	199
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	10200	3260	56700	9040
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	1840	928	29700	2750
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 10	< 3
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 10	< 3
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 10	< 3
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	8.8	< 4	295	10.5
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	2180	< 10	329	31
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	281	86.5	4720	236
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	106	47.1	2480	119
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	2120	529	13000	1480
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	23.2	16.4	125	20.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	1.81	2.08	20.0	3.47
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.018	0.002	0.009	0.005
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.12	0.04	0.18	0.65
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	7.70	7.02	3.27	10.7
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	11.8	1.8	< 0.2	0.4

Christine Burke
Lab Manager

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Attention: Brad Pettersone

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21
DATE REPORTED: 30-Sep-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-7-I	BH-7-K
			Sample I.D.		B21-28262-17	B21-28262-18	B21-28262-19	B21-28262-20
			Date Collected		01-Sep-21	01-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	08-Sep-21/O	19	< 2	4	4
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	58.2	262	57.1	529
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	1.10	0.11	1.16	0.23
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	0.0248	0.0034	< 0.005	0.0033
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	0.200	0.106	1.30	0.261
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	1.70	1.12	1.95	0.894
Cadmium	mg/L	).000015	EPA 200.8	15-Sep-21/O	< 0.00012	< 0.000029	< 0.00059	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	< 0.006	< 0.001
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.2	< 0.002	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	5.70	0.970	0.519	0.457
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.0004	0.00017	< 0.002	0.00076
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	0.200	0.039	0.295	0.042
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	< 1	< 0.01	0.21	0.05
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 1	< 0.01	0.04	< 0.01
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.040	<0.020	<0.11	<0.02
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0005	< 0.0001	< 0.002	< 0.0005
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	28.2	9.41	411	16.6
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	< 0.00008	< 0.00005	0.00109	< 0.00008
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 5	< 0.05	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.5	< 0.005	< 0.005	0.007
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00828	0.00180	0.00809	0.00528
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	0.0070	0.0007	< 0.007	< 0.001
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.5	< 0.005	0.014	0.006
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	6836	1800	55712	4756

Christine Burke
Lab Manager

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Attention: Brad Pettersone

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DATE RECEIVED: 03-Sep-21
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-K	BH-6-L	BH-7-I	BH-7-K
			Sample I.D.		B21-28262-17	B21-28262-18	B21-28262-19	B21-28262-20
			Date Collected		01-Sep-21	01-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	1140	410	22000	1080
% Difference	%		Calc.	10-Sep-21/O	4.22	1.03	0.712	2.76
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	1.27	< 0.1	< 0.1	< 0.1

1 . Cations Run from unpreserved bottle

2 . Elevated RL due to sample matrix interference

CBurke

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Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-7-L	BH-8-G	BH-8-K	BH-8-L
			Sample I.D.		B21-28262-21	B21-28262-22	B21-28262-23	B21-28262-24
			Date Collected		02-Sep-21	02-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	10-Sep-21/O	6.89	6.97	7.19	7.92
pH @25°C	pH Units		SM 4500H	07-Sep-21/O	7.70	7.88	7.78	8.22
Langelier Index(25°C)	S.I.		Calc.	10-Sep-21/O	0.814	0.906	0.589	0.303
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	07-Sep-21/O	243	520	369	318
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	243	520	369	318
Carbonate (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	07-Sep-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	07-Sep-21/O	5010	4700	4080	1850
Chloride	mg/L	0.5	SM4110C	08-Sep-21/O	1520	543	863	276
Fluoride	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	2.8	< 1	< 1
Nitrate (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	08-Sep-21/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	08-Sep-21/O	8.6	< 4	< 4	< 4
Sulphate	mg/L	1	SM4110C	08-Sep-21/O	< 10	1060	145	97
Calcium	mg/L	0.02	SM 3120	09-Sep-21/O	178	69.5	58.1	12.1
Magnesium	mg/L	0.02	SM 3120	09-Sep-21/O	93.9	13.1	35.7	7.12
Sodium	mg/L	0.2	SM 3120	09-Sep-21/O	717	1000	764	344
Potassium	mg/L	0.1	SM 3120	09-Sep-21/O	15.4	12.5	11.8	5.0
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	09-Sep-21/K	2.14	0.06	0.71	0.51
o-Phosphate (P)	mg/L	0.002	PE4500-S	09-Sep-21/K	0.003	0.018	0.004	0.053
Phosphorus-Total	mg/L	0.01	E3199A.1	08-Sep-21/K	0.27	0.12	2.09	0.05
Silica	mg/L	0.02	SM 3120	09-Sep-21/O	8.45	14.1	6.42	6.33
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	08-Sep-21/O	1.2	19.4	2.3	2.1

CBurke

Christine Burke
Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7-L	BH-8-G	BH-8-K	BH-8-L
			Sample I.D.		B21-28262-21	B21-28262-22	B21-28262-23	B21-28262-24
			Date Collected		02-Sep-21	02-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	08-Sep-21/O	< 2	8	2	3
Turbidity	NTU	0.1	SM 2130	09-Sep-21/O	424	32.3	1730	450
Aluminum	mg/L	0.01	SM 3120	09-Sep-21/O	0.10	< 0.5	0.02	0.02
Arsenic	mg/L	0.0001	EPA 200.8	15-Sep-21/O	0.0017	0.0094	0.0038	0.0033
Barium	mg/L	0.001	SM 3120	09-Sep-21/O	0.181	0.100	0.153	0.027
Boron	mg/L	0.005	SM 3120	09-Sep-21/O	0.591	2.90	3.79	1.71
Cadmium	mg/L	.000015	EPA 200.8	15-Sep-21/O	< 0.000059	< 0.000059	< 0.000059	0.000052
Chromium	mg/L	0.001	EPA 200.8	15-Sep-21/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	09-Sep-21/O	< 0.002	< 0.2	< 0.002	< 0.002
Iron	mg/L	0.005	SM 3120	09-Sep-21/O	0.050	< 0.5	0.133	0.163
Lead	mg/L	0.00002	EPA 200.8	15-Sep-21/O	< 0.0002	< 0.0002	< 0.0002	< 0.00004
Manganese	mg/L	0.001	SM 3120	09-Sep-21/O	0.027	0.200	0.128	0.022
Molybdenum	mg/L	0.01	SM 3120	09-Sep-21/O	0.02	< 1	< 0.01	0.05
Nickel	mg/L	0.01	SM 3120	09-Sep-21/O	< 0.01	< 1	< 0.01	< 0.01
Selenium	mg/L	0.001	EPA 200.8	15-Sep-21/O	<0.02	<0.010	<0.015	<0.006
Silver	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0002	< 0.0002	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	09-Sep-21/O	12.0	2.70	4.99	0.929
Thallium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	09-Sep-21/O	< 0.05	< 5	< 0.05	< 0.05
Titanium	mg/L	0.005	SM 3120	09-Sep-21/O	< 0.005	< 0.5	< 0.005	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	15-Sep-21/O	0.00681	0.0548	0.00468	0.00688
Vanadium	mg/L	0.0001	EPA 200.8	15-Sep-21/O	< 0.0007	0.0027	< 0.0007	< 0.0001
Zinc	mg/L	0.005	SM 3120	09-Sep-21/O	0.007	< 0.5	< 0.005	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	10-Sep-21/O	2678	3017	2100	933

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-28262**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 03-Sep-21
DATE REPORTED: 30-Sep-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7-L	BH-8-G	BH-8-K	BH-8-L
			Sample I.D.		B21-28262-21	B21-28262-22	B21-28262-23	B21-28262-24
			Date Collected		02-Sep-21	02-Sep-21	02-Sep-21	02-Sep-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	09-Sep-21/O	831	228	292	60
% Difference	%		Calc.	10-Sep-21/O	0.491	0.376	6.33 [1]	0.463
Sulphide	mg/L	0.01	SM4500-S2	07-Sep-21/K	< 0.1	2.45	6.20	< 0.1

1 Cations Run from unpreserved bottle

2 Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-40693**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21

DATE REPORTED: 13-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-40693-1	B21-40693-2	B21-40693-3	B21-40693-4
			Date Collected		13-Dec-21	13-Dec-21	13-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	6.35	6.46	6.80	7.41
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	7.38	7.44	7.62	8.14
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	1.03	0.979	0.817	0.726
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	277	199	269	302
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	277	199	269	302
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	16400	19100	7700	2200
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 5	< 5	< 1	0.8
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	5700	6880	2370	488
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 5	< 5	< 1	< 0.2
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 5	< 5	< 1	< 0.2
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	70.3	82.5	26.2	5.3
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	113	61	35	11
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	581	620	209	41.6
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	260	446	154	25.0
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	2500	2650	1090	372
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	24.1	47.1	25.0	9.4
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	2.42	5.05	2.97	0.76
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.017	< 0.002	< 0.002	0.004
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.02	0.01	0.02	0.04
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	11.7	< 2	8.37	5.99
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	1.3	0.6	0.8	1.2
Colour	TCU	2	SM 2120C	17-Dec-21/O	4	2	3	< 2

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-40693**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-40693-1	B21-40693-2	B21-40693-3	B21-40693-4
			Date Collected		13-Dec-21	13-Dec-21	13-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	97.2	62.4	35.6	60.7
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.5	< 0.5	< 0.05	0.12
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0020	< 0.003	< 0.0005	< 0.0003
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	1.10	0.390	0.181	0.032
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	3.31	3.13	2.40	2.03
Cadmium	mg/L	0.000015	EPA 200.8	17-Dec-21/O	< 0.00012	0.000753	< 0.000059	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	0.003	0.003	0.001
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.2	< 0.2	< 0.02	< 0.002
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	12.9	20.9	0.067	0.270
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.0004	0.00199	0.00032	0.00013
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	2.38	0.210	0.020	0.026
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 1	< 1	< 0.1	< 0.01
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 1	< 1	< 0.1	< 0.01
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02	< 0.02	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0005	< 0.001	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	80.4	91.6	29.8	2.81
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00008	0.00072	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 5	< 5	< 0.5	< 0.05
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5	< 0.5	< 0.05	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.00328	0.00081	0.00005	0.00014
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.001	0.0039	< 0.0007	< 0.0004
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5	< 0.5	< 0.05	0.032
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	9353	10826	4052	1129
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	2520	3380	1160	207
Anion Sum	meq/L		Calc.	17-Dec-21/O	169	199	73.1	20.1

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-40693

Report To:
Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B21-40693-1	B21-40693-2	B21-40693-3	B21-40693-4
			Date Collected		13-Dec-21	13-Dec-21	13-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	17-Dec-21/O	160	184	71.3	20.6
% Difference	%		Calc.	17-Dec-21/O	2.67 [1]	3.85 [1]	1.19 [1]	1.38
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	0.02	< 0.01	0.77	< 0.01

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 13-Dec-21

DATE REPORTED: 13-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 F	BH-3 D	BH-3 F	BH-3 Z
			Sample I.D.		B21-40693-5	B21-40693-6	B21-40693-7	B21-40693-8
			Date Collected		13-Dec-21	10-Dec-21	10-Dec-21	10-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	7.21	6.28	6.09	7.01
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	7.94	8.05	7.95	7.82
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	0.730	1.77	1.86	0.810
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	286	479	430	297
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	286	479	430	297
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	2370	13300	18600	4570
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	1.0	< 3	< 5	0.2
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	562	3740	7460	1330
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 0.1	< 3	< 5	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 0.1	< 3	< 5	< 0.1
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	5.8	41.1	88.5	14.3
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	24	1600	983	22
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	70.3	388	676	110
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	40.5	158	471	61.9
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	454	2440	2930	613
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	12.2	24.9	34.6	15.9
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	0.74	1.43	3.06	1.89
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.005	0.013	0.009	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.06	0.03	0.04	0.03
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	6.52	4.22	4.77	6.92
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	1.0	34.5	13.1	0.5
Colour	TCU	2	SM 2120C	17-Dec-21/O	4	15	20	6

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

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Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-3 D	BH-3 F	BH-3 Z
			Sample I.D.		B21-40693-5	B21-40693-6	B21-40693-7	B21-40693-8
			Date Collected		13-Dec-21	10-Dec-21	10-Dec-21	10-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	38.5	370	650	54.6
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	0.02	< 0.5	< 0.5	< 0.05
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0003	0.0013	0.0028	< 0.0005
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.051	0.130	< 0.1	0.074
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	1.73	2.25	4.00	1.69
Cadmium	mg/L	0.000015	EPA 200.8	17-Dec-21/O	< 0.000029	< 0.00012	0.000554	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	0.003	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.002	< 0.2	< 0.2	< 0.02
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	0.027	19.7	< 0.5	< 0.05
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	0.00009	< 0.0004	0.00138	0.00019
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.021	0.590	0.710	0.013
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01	< 1	< 1	< 0.1
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01	< 1	< 1	< 0.1
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02	< 0.02	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0001	< 0.0005	< 0.001	< 0.0002
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	6.74	14.9	54.0	6.29
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00005	< 0.00008	0.00059	0.00085
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 0.05	< 5	< 5	< 0.5
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.005	< 0.5	< 0.5	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.00027	0.00547	0.00156	0.00032
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0004	< 0.001	0.0054	< 0.0007
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	0.018	< 0.5	< 0.5	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	1336	8644	12818	2331
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	342	1620	3630	529
Anion Sum	meq/L		Calc.	17-Dec-21/O	22.1	148	239	43.9

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-40693

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-3 D	BH-3 F	BH-3 Z
			Sample I.D.		B21-40693-5	B21-40693-6	B21-40693-7	B21-40693-8
			Date Collected		13-Dec-21	10-Dec-21	10-Dec-21	10-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	17-Dec-21/O	26.9	139	201	37.8
% Difference	%		Calc.	17-Dec-21/O	9.81	3.20 [1]	8.70	7.48
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	< 0.01	< 0.05	7.80	< 0.01

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Christine Burke
Lab Manager

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B21-40693**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-4 B	BH-4 F	BH-4 Z	BH-5 F
			Sample I.D.		B21-40693-9	B21-40693-10	B21-40693-11	B21-40693-12
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	6.87	5.84	6.92	6.71
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	7.50	7.10	7.47	7.73
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	0.633	1.26	0.548	1.02
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	322	855	299	266
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	322	855	299	266
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	1440	17700	586	8580
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 0.1	< 5	< 0.1	< 1
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	256	5930	5.6	2630
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 0.1	< 5	< 0.1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 0.1	< 5	< 0.1	< 1
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	2.8	70.7	1.5	30.5
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	7	1810	6	58
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	128	601	111	262
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	20.8	286	6.88	152
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	133	3720	5.7	1090
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	3.3	30.8	0.4	23.3
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	0.34	2.07	0.01	3.06
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.004	0.060	< 0.002	< 0.002
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.02	0.46	0.01	< 0.01
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	6.20	10.2	5.28	7.51
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	1.6	43.0	4.7	1.3

CBurke

Christine Burke
Lab Manager

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Final Report

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-4 B	BH-4 F	BH-4 Z	BH-5 F
			Sample I.D.		B21-40693-9	B21-40693-10	B21-40693-11	B21-40693-12
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	17-Dec-21/O	2	50	4	< 2
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	38.2	1170	27.6	202
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	0.03	< 0.5	0.01	< 0.05
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0002	0.0203	0.0001	0.0013
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.039	0.190	0.024	0.178
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	0.298	2.28	0.011	1.14
Cadmium	mg/L	).000015	EPA 200.8	17-Dec-21/O	< 0.000015	< 0.00012	< 0.000015	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	0.003	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.002	< 0.2	< 0.002	< 0.02
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	2.48	< 0.5	0.072	0.692
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.00004	0.00067	0.00002	0.00039
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.054	0.760	0.051	0.091
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01	< 1	< 0.01	< 0.1
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01	< 1	< 0.01	< 0.1
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.01	< 0.02	< 0.001	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0001	< 0.0005	< 0.0001	< 0.0005
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	2.26	71.6	0.298	34.6
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00005	0.00048	< 0.00005	0.00018
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 0.05	< 5	< 0.05	< 0.5
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.005	< 0.5	< 0.005	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.00025	0.0148	0.00019	0.00057
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0001	0.0113	< 0.0001	< 0.001
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.005	< 0.5	< 0.005	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	746	12894	315	4388

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-40693

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Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-4 B	BH-4 F	BH-4 Z	BH-5 F
			Sample I.D.		B21-40693-9	B21-40693-10	B21-40693-11	B21-40693-12
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	406	2680	306	1280
Anion Sum	meq/L		Calc.	17-Dec-21/O	13.8	222	6.26	80.9
Cation Sum	meq/L		Calc.	17-Dec-21/O	14.1	216	6.36	74.0
% Difference	%		Calc.	17-Dec-21/O	1.18	1.32 [1]	0.840	4.43
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	< 0.01	11.4	< 0.01	0.09

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

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Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 H	BH-5 Z	BH-6-I	BH-6-K
			Sample I.D.		B21-40693-13	B21-40693-14	B21-40693-15	B21-40693-16
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	6.18	6.95	6.47	6.44
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	8.00	7.94	8.05	8.09
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	1.82	0.990	1.58	1.65
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	812	267	562	568
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	812	267	562	568
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	13300	4020	9580	9490
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 3	< 1	< 3	< 3
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	3910	1110	1800	1670
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 3	< 1	< 3	< 3
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 3	< 1	< 3	< 3
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	45.6	20.5	22.4	27.4
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	864	20	2050	2140
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	291	140	215	231
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	179	76.1	90.6	89.4
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	2480	601	1680	1780
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	24.0	17.4	20.0	21.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	1.12	2.18	0.75	1.34
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.007	< 0.002	0.008	0.034
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.06	0.01	0.05	0.04
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	3.51	7.25	7.90	7.69
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	6.0	0.9	13.7	15.0

CBurke

Christine Burke
Lab Manager

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Final Report

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
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Barrie ON L4N 8W8
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DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 H	BH-5 Z	BH-6-I	BH-6-K
			Sample I.D.		B21-40693-13	B21-40693-14	B21-40693-15	B21-40693-16
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	17-Dec-21/O	11	3	43	21
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	342	35.0	204	428
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.5	< 0.05	< 0.05	< 0.05
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0029	< 0.0005	0.0082	0.0084
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.240	0.065	0.134	0.153
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	1.31	0.871	1.37	1.28
Cadmium	mg/L	0.000015	EPA 200.8	17-Dec-21/O	< 0.00012	< 0.000059	< 0.00012	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	< 0.001	0.001	0.001
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.2	< 0.02	< 0.02	< 0.02
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5	1.19	< 0.05	< 0.05
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.0004	< 0.0002	< 0.0004	< 0.0004
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.190	< 0.01	0.216	0.168
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 1	< 0.1	< 0.1	< 0.1
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 1	< 0.1	< 0.1	< 0.1
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02	< 0.02	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0005	< 0.0002	< 0.0005	< 0.0005
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	23.7	14.9	23.7	22.3
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00008	< 0.00005	< 0.00008	< 0.00008
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 5	< 0.5	< 0.5	< 0.5
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5	< 0.05	< 0.05	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.00075	0.00005	0.0131	0.0137
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0017	< 0.0007	0.0071	0.0065
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5	< 0.05	< 0.05	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	8239	2132	6190	6268

CBurke

Christine Burke
Lab Manager

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Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 H	BH-5 Z	BH-6-I	BH-6-K
			Sample I.D.		B21-40693-13	B21-40693-14	B21-40693-15	B21-40693-16
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	1460	662	909	944
Anion Sum	meq/L		Calc.	17-Dec-21/O	145	37.2	105	103
Cation Sum	meq/L		Calc.	17-Dec-21/O	138	40.0	91.6	96.7
% Difference	%		Calc.	17-Dec-21/O	2.40 [1]	3.71	6.70	3.11
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	2.83	< 0.01	19.4	24.7

1. Cations Run from unpreserved bottle
2. Elevated RL due to sample matrix interference

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Christine Burke
Lab Manager

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DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-L	BH-7-I	BH-7-K	BH-7-L
			Sample I.D.		B21-40693-17	B21-40693-18	B21-40693-19	B21-40693-20
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	6.94	5.99	6.88	6.94
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	7.75	6.91	7.76	7.78
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	0.814	0.923	0.881	0.837
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	311	80	252	279
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	311	80	252	279
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	5320	59500	7220	3960
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	< 10	< 1	< 1
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	1600	36000	2200	1140
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	< 10	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	< 10	< 1	< 1
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	21.4	446	26.1	14.7
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	25	417	55	21
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	124	4590	179	136
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	72.2	2520	95.6	74.5
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	751	12500	1130	472
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	18.9	117	15.3	12.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	2.74	17.5	2.65	1.84
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	< 0.002	0.014	0.014	0.014
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.13	1.90	0.58	0.81
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	6.67	2.33	9.16	7.90
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	2.4	< 0.2	0.5	0.9

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-40693

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21

DATE REPORTED: 13-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6-L	BH-7-I	BH-7-K	BH-7-L
			Sample I.D.		B21-40693-17	B21-40693-18	B21-40693-19	B21-40693-20
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	17-Dec-21/O	2	4	2	< 2
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	130	394	8230	917
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.05	< 0.5	< 0.05	< 0.05
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0065	< 0.005	0.0031	0.0040
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.088	0.970	0.269	0.118
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	1.05	2.15	0.777	0.423
Cadmium	mg/L	0.000015	EPA 200.8	17-Dec-21/O	< 0.000059	< 0.00059	0.000080	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	< 0.006	0.003	< 0.001
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.02	< 0.2	< 0.02	< 0.02
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	1.19	1.80	0.091	1.06
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.0002	< 0.002	< 0.0002	< 0.00009
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.015	0.300	< 0.01	0.028
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.1	< 1	< 0.1	< 0.1
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.1	< 1	< 0.1	< 0.1
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02	< 0.02	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0002	< 0.002	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	14.5	407	17.1	8.75
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00005	0.00072	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 0.5	< 5	< 0.5	< 0.5
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.05	< 0.5	< 0.05	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.00183	0.00890	0.00614	0.00866
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0008	< 0.007	< 0.0007	0.0004
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.05	< 0.5	< 0.05	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	2783	56271	3826	2032

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

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REPORT No. B21-40693

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21

DATE REPORTED: 13-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6-L	BH-7-I	BH-7-K	BH-7-L
			Sample I.D.		B21-40693-17	B21-40693-18	B21-40693-19	B21-40693-20
			Date Collected		09-Dec-21	09-Dec-21	09-Dec-21	09-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	607	21800	840	646
Anion Sum	meq/L		Calc.	17-Dec-21/O	51.9	1030	68.1	38.3
Cation Sum	meq/L		Calc.	17-Dec-21/O	45.5	986	66.5	34.0
% Difference	%		Calc.	17-Dec-21/O	6.56	2.00	1.20 [1]	6.01
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	< 0.01	0.02	< 0.01	< 0.01

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

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Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-8-G	BH-8-K	BH-8-L	BH-9 G
			Sample I.D.		B21-40693-21	B21-40693-22	B21-40693-23	B21-40693-24
			Date Collected		10-Dec-21	10-Dec-21	10-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	7.07	7.25	7.51	6.35
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	8.00	7.34	7.96	7.31
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	0.929	0.0935	0.448	0.957
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	586	320	307	171
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	586	320	307	171
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	3980	4320	2930	21900
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	5.4	2.6	< 10
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	656	1070	698	9990
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	< 1	< 0.2	< 10
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 1	< 1	< 0.2	< 10
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	8.2	16.2	6.9	127
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	558	211	82	389
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	48.4	59.0	32.6	926
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	12.1	38.1	21.5	635
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	776	733	467	3960
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	6.1	11.9	9.3	52.0
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	0.01	1.06	0.96	6.49
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.019	0.012	0.031	0.010
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.13	0.52	0.18	0.05
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	13.7	7.64	7.06	6.74
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	7.2	2.4	1.5	< 0.2

Christine Burke
Lab Manager

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Final Report

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Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-G	BH-8-K	BH-8-L	BH-9 G
			Sample I.D.		B21-40693-21	B21-40693-22	B21-40693-23	B21-40693-24
			Date Collected		10-Dec-21	10-Dec-21	10-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	17-Dec-21/O	6	3	< 2	5
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	27.6	337	453	31.9
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.05	< 0.05	0.01	< 0.5
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0067	0.0088	0.0053	0.0183
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.042	0.140	0.060	0.210
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	2.63	3.39	1.63	3.70
Cadmium	mg/L	).000015	EPA 200.8	17-Dec-21/O	< 0.000029	< 0.000059	0.000064	0.00332
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.001	0.003	< 0.001	0.004
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.02	< 0.02	< 0.002	< 0.2
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.05	2.39	0.745	1.84
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.00009	< 0.0002	< 0.00009	0.00138
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.084	0.049	0.037	0.110
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.1	< 0.1	0.03	< 1
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.1	< 0.1	< 0.01	< 1
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02	< 0.02	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.0001	< 0.0002	< 0.0001	< 0.001
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	2.36	5.25	2.75	87.7
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.00005	< 0.00005	< 0.00005	0.00352
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 0.5	< 0.5	< 0.05	< 5
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.05	< 0.05	< 0.005	< 0.5
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.0535	0.00532	0.00654	0.0206
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	0.0037	0.0012	0.0005	0.0117
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.05	< 0.05	0.006	< 0.5
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	2408	2325	1500	16066

CBurke

Christine Burke
Lab Manager

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Caduceon Environmental Laboratories
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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-G	BH-8-K	BH-8-L	BH-9 G
			Sample I.D.		B21-40693-21	B21-40693-22	B21-40693-23	B21-40693-24
			Date Collected		10-Dec-21	10-Dec-21	10-Dec-21	13-Dec-21
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	171	304	170	4920
Anion Sum	meq/L		Calc.	17-Dec-21/O	41.8	41.3	27.7	293
Cation Sum	meq/L		Calc.	17-Dec-21/O	37.3	38.4	24.0	272
% Difference	%		Calc.	17-Dec-21/O	5.71	3.59	7.07	3.73
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	6.24	0.02	0.01	0.04

1 Cations Run from unpreserved bottle
2 Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 13-Dec-21
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-9 K			
			Sample I.D.		B21-40693-25			
			Date Collected		13-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Dec-21/O	6.34			
pH @25°C	pH Units		SM 4500H	16-Dec-21/O	7.01			
Langelier Index(25°C)	S.I.		Calc.	17-Dec-21/O	0.665			
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	16-Dec-21/O	80			
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	80			
Carbonate (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5			
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	16-Dec-21/O	< 5			
Conductivity @25°C	µS/cm	1	SM 2510B	16-Dec-21/O	40800			
Fluoride	mg/L	0.1	SM4110C	16-Dec-21/O	< 10			
Chloride	mg/L	0.5	SM4110C	16-Dec-21/O	23500			
Nitrate (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 10			
Nitrite (N)	mg/L	0.1	SM4110C	16-Dec-21/O	< 10			
Bromide	mg/L	0.4	SM4110C	16-Dec-21/O	266			
Sulphate	mg/L	1	SM4110C	16-Dec-21/O	391			
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	2010			
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	1250			
Sodium	mg/L	0.2	SM 3120	17-Dec-21/O	9120			
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	87.7			
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	16-Dec-21/K	16.2			
o-Phosphate (P)	mg/L	0.002	PE4500-S	16-Dec-21/K	0.010			
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.21			
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	5.59			
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	06-Jan-22/O	< 0.2			

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-9 K			
			Sample I.D.		B21-40693-25			
			Date Collected		13-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	17-Dec-21/O	5			
Turbidity	NTU	0.1	SM 2130	20-Dec-21/O	96.2			
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.5			
Arsenic	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.005			
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.710			
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	2.86			
Cadmium	mg/L	0.000015	EPA 200.8	17-Dec-21/O	< 0.00059			
Chromium	mg/L	0.001	EPA 200.8	17-Dec-21/O	0.019			
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.2			
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	0.700			
Lead	mg/L	0.00002	EPA 200.8	17-Dec-21/O	< 0.002			
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.180			
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 1			
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 1			
Selenium	mg/L	0.001	EPA 200.8	17-Dec-21/O	< 0.02			
Silver	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.002			
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	146			
Thallium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	< 0.0004			
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 5			
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5			
Uranium	mg/L	0.00005	EPA 200.8	17-Dec-21/O	0.0336			
Vanadium	mg/L	0.0001	EPA 200.8	17-Dec-21/O	< 0.007			
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.5			
TDS(ion sum calc.)	mg/L	1	Calc.	17-Dec-21/O	36413			

CBurke

Christine Burke
Lab Manager

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Fax: 705-252-5746

DATE RECEIVED: 13-Dec-21
DATE REPORTED: 13-Jan-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-9 K			
			Sample I.D.		B21-40693-25			
			Date Collected		13-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	10200			
Anion Sum	meq/L		Calc.	17-Dec-21/O	672			
Cation Sum	meq/L		Calc.	17-Dec-21/O	603			
% Difference	%		Calc.	17-Dec-21/O	5.41			
Sulphide	mg/L	0.01	SM4500-S2	15-Dec-21/K	0.01			

1 . Cations Run from unpreserved bottle
2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-40965

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 15-Dec-21

DATE REPORTED: 10-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH2-Z			
			Sample I.D.		B21-40965-1			
			Date Collected		15-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	21-Dec-21/O	7.24			
pH @25°C	pH Units		SM 4500H	17-Dec-21/O	8.01			
Langelier Index(25°C)	S.I.		Calc.	21-Dec-21/O	0.765			
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	17-Dec-21/O	274			
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	17-Dec-21/O	274			
Carbonate (as CaCO3)	mg/L	5	SM 2320B	17-Dec-21/O	< 5			
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	17-Dec-21/O	< 5			
Conductivity @25°C	µS/cm	1	SM 2510B	17-Dec-21/O	3450			
Fluoride	mg/L	0.1	SM4110C	17-Dec-21/O	0.5			
Chloride	mg/L	0.5	SM4110C	20-Dec-21/O	942			
Nitrate (N)	mg/L	0.1	SM4110C	17-Dec-21/O	< 0.1			
Nitrite (N)	mg/L	0.1	SM4110C	17-Dec-21/O	0.6			
Bromide	mg/L	0.4	SM4110C	17-Dec-21/O	8.8			
Sulphate	mg/L	1	SM4110C	17-Dec-21/O	23			
Calcium	mg/L	0.02	SM 3120	17-Dec-21/O	67.5			
Magnesium	mg/L	0.02	SM 3120	17-Dec-21/O	41.2			
Sodium	mg/L	0.2	SM 3120	20-Dec-21/O	568			
Potassium	mg/L	0.1	SM 3120	17-Dec-21/O	12.9			
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	20-Dec-21/K	0.97			
o-Phosphate (P)	mg/L	0.002	PE4500-S	20-Dec-21/K	< 0.002			
Phosphorus-Total	mg/L	0.01	E3199A.1	22-Dec-21/K	0.05			
Silica	mg/L	0.02	SM 3120	17-Dec-21/O	6.72			
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	07-Jan-22/O	0.8			
Colour	TCU	2	SM 2120C	17-Dec-21/O	3			

Christine Burke
Lab Manager

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112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 15-Dec-21

DATE REPORTED: 10-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH2-Z			
			Sample I.D.		B21-40965-1			
			Date Collected		15-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	22-Dec-21/O	8.4			
Aluminum	mg/L	0.01	SM 3120	17-Dec-21/O	0.04			
Arsenic	mg/L	0.0001	EPA 200.8	22-Dec-21/O	< 0.0003			
Barium	mg/L	0.001	SM 3120	17-Dec-21/O	0.038			
Boron	mg/L	0.005	SM 3120	17-Dec-21/O	2.10			
Cadmium	mg/L	.000015	EPA 200.8	22-Dec-21/O	< 0.000029			
Chromium	mg/L	0.001	EPA 200.8	22-Dec-21/O	0.001			
Copper	mg/L	0.002	SM 3120	17-Dec-21/O	< 0.002			
Iron	mg/L	0.005	SM 3120	17-Dec-21/O	0.011			
Lead	mg/L	0.00002	EPA 200.8	22-Dec-21/O	0.00010			
Manganese	mg/L	0.001	SM 3120	17-Dec-21/O	0.003			
Molybdenum	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01			
Nickel	mg/L	0.01	SM 3120	17-Dec-21/O	< 0.01			
Selenium	mg/L	0.001	EPA 200.8	22-Dec-21/O	0.030			
Silver	mg/L	0.0001	EPA 200.8	22-Dec-21/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	17-Dec-21/O	4.48			
Thallium	mg/L	0.00005	EPA 200.8	22-Dec-21/O	0.00024			
Tin	mg/L	0.05	SM 3120	17-Dec-21/O	< 0.05			
Titanium	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.005			
Uranium	mg/L	0.00005	EPA 200.8	22-Dec-21/O	0.00008			
Vanadium	mg/L	0.0001	EPA 200.8	22-Dec-21/O	0.0005			
Zinc	mg/L	0.005	SM 3120	17-Dec-21/O	< 0.005			
TDS(ion sum calc.)	mg/L	1	Calc.	21-Dec-21/O	1821			
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Dec-21/O	338			
Anion Sum	meq/L		Calc.	21-Dec-21/O	32.6			

CBurke

Christine Burke
Lab Manager

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112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 15-Dec-21

DATE REPORTED: 10-Jan-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH2-Z			
			Sample I.D.		B21-40965-1			
			Date Collected		15-Dec-21			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	21-Dec-21/O	31.8			
% Difference	%		Calc.	21-Dec-21/O	1.24			
Sulphide	mg/L	0.01	SM4500-S2	20-Dec-21/K	< 0.01			

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-11441**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B22-11441-1	B22-11441-2	B22-11441-3	B22-11441-4
			Date Collected		21-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	6.51	6.65	6.40	7.46
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	7.37	7.43	7.70	8.06
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	0.863	0.785	1.30	0.598
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	226	172	215	265
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	226	172	215	265
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	14400	13700	17500	2610
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 10	< 1
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	4890	4600	6720	673
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 10	< 1
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 10	< 1
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	< 40	< 40	56.7	< 4
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	< 100	< 100	< 100	21
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	491	469	660	42.4
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	291	346	490	24.8
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	2100	2060	2820	406
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	25.0	38.9	48.8	9.7
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	2.70	5.01	6.05	1.06
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.009	0.009	0.009	0.008
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.05	0.11	0.02	0.03
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	14.2	5.82	8.13	6.42
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	0.8	0.6	0.5	0.8
Colour	TCU	2	SM 2120C	28-Apr-22/O	< 2	< 2	4	< 2

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-11441**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B22-11441-1	B22-11441-2	B22-11441-3	B22-11441-4
			Date Collected		21-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	138	357	72.2	5.2
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.33	0.34	0.30	0.05
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0015	< 0.001	< 0.001	< 0.0003
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	2.43	0.440	0.570	0.026
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	3.51	3.37	4.30	1.84
Cadmium	mg/L	0.000015	EPA 200.8	28-Apr-22/O	< 0.00012	< 0.00012	< 0.00012	< 0.000029
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.001	0.003	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.02	< 0.02	< 0.02	< 0.004
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	0.250	8.00	0.190	1.35
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.0004	< 0.0004	0.00049	< 0.00009
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	1.46	0.250	0.040	0.012
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.1	< 0.1	< 0.1	< 0.02
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.1	< 0.1	< 0.1	< 0.02
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.15	< 0.2	< 0.15	< 0.02
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0005	< 0.0005	< 0.0005	< 0.0001
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	90.7	87.9	132	2.70
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.00008	< 0.00008	< 0.00008	< 0.00005
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.5	< 0.5	< 0.5	< 0.1
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.05	< 0.05	< 0.05	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00295	0.00011	< 0.00008	< 0.00005
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.001	< 0.001	< 0.001	< 0.0004
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.05	< 0.05	< 0.05	< 0.01
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	7937	7631	10877	1339
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	2420	2590	3660	208
Anion Sum	meq/L		Calc.	29-Apr-22/O	142	133	194	24.7

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-11441

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-1 B	BH-1 F	BH-1 Z	BH-2 C
			Sample I.D.		B22-11441-1	B22-11441-2	B22-11441-3	B22-11441-4
			Date Collected		21-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	29-Apr-22/O	141	143	198	22.2
% Difference	%		Calc.	29-Apr-22/O	0.629	3.64	0.936	5.37
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	2.26	< 0.1	26.8	0.05

1 . Sample #11 - metals digested due to sediment

2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B22-11441-5	B22-11441-6	B22-11441-7	B22-11441-8
			Date Collected		21-Apr-22	21-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	7.47	7.41	5.84	5.95
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	8.00	7.96	7.86	7.76
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	0.531	0.549	2.02	1.81
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	270	273	697	448
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	270	273	697	448
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	2450	2720	17800	19600
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 1	< 1	< 10	< 10
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	617	696	6170	7250
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 1	< 1	< 10	< 10
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 1	< 1	< 10	< 10
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	< 4	< 4	< 40	47.2
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	23	20	1420	938
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	41.0	46.4	740	885
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	23.0	25.8	368	535
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	402	450	3520	3570
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	9.7	10.4	32.8	39.6
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	1.01	1.09	2.92	3.10
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.007	0.008	0.162	0.026
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.01	0.05	0.04	0.06
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	6.46	6.46	15.6	15.5
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	0.8	0.7	4.4	3.1
Colour	TCU	2	SM 2120C	28-Apr-22/O	< 2	< 2	317	4

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B22-11441-5	B22-11441-6	B22-11441-7	B22-11441-8
			Date Collected		21-Apr-22	21-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	12.4	42.4	363	429
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.03	0.04	0.52	0.50
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0003	< 0.0003	0.0044	< 0.003
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.028	0.032	0.160	0.10
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	1.64	1.73	4.05	5.05
Cadmium	mg/L	).000015	EPA 200.8	28-Apr-22/O	< 0.000029	< 0.000029	< 0.00012	< 0.00030
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.001	< 0.001	< 0.001	< 0.003
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.004	< 0.004	< 0.02	< 0.02
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	1.10	0.020	< 0.05	< 0.05
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.00009	< 0.00009	< 0.0004	< 0.0009
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.006	0.002	1.28	1.46
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.02	< 0.02	< 0.1	< 0.1
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.02	< 0.02	< 0.1	< 0.1
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.02	< 0.02	< 0.15	< 0.1
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0001	< 0.0001	< 0.0005	< 0.001
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	2.52	2.84	48.9	67.5
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.00005	< 0.00005	< 0.00008	0.00027
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.1	< 0.1	< 0.5	< 0.5
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.01	< 0.01	< 0.05	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00032	< 0.00005	0.0204	0.0114
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0004	< 0.0004	0.0047	0.0036
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.01	< 0.01	< 0.05	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	1280	1413	12680	13493
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	197	222	3360	4410
Anion Sum	meq/L		Calc.	29-Apr-22/O	23.3	25.5	218	233

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-11441

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-2 F	BH-2 Z	BH-3 D	BH-3 F
			Sample I.D.		B22-11441-5	B22-11441-6	B22-11441-7	B22-11441-8
			Date Collected		21-Apr-22	21-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	29-Apr-22/O	21.8	24.4	221	245
% Difference	%		Calc.	29-Apr-22/O	3.26	2.27	0.838	2.45
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	0.01	0.02	30.8	29.7

1 . Sample #11 - metals digested due to sediment

2 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
			Sample I.D.		B22-11441-9	B22-11441-10	B22-11441-11	B22-11441-12
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	6.13	6.90	5.71	6.89
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	7.40	7.94	7.84	7.74
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	1.27	1.04	2.13	0.848
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	220	295	969	299
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	220	295	969	299
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	20000	669	20100	597
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 0.1	< 10	< 0.1
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	8550	25.3	5320	4.9
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 0.1	< 10	< 0.1
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 0.1	< 10	< 0.1
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	51.5	< 0.4	40.2	< 0.4
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	< 100	5	1610	4
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	1200	120	718	119
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	699	8.73	314	7.48
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	3040	17.0	4110	5.0
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	49.4	0.7	32.1	0.2
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	5.04	0.12	1.61	0.03
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.018	0.010	0.276	0.021
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.14	0.01	0.33	0.60
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	7.51	5.31	14.5	5.82
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	1.3	4.0	54.8	6.7

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
			Sample I.D.		B22-11441-9	B22-11441-10	B22-11441-11	B22-11441-12
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	28-Apr-22/O	< 2	< 2	495	< 2
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	341	114	370	392
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.64	0.07	0.39	0.06
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0095	0.0001	0.0139	0.0001
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.310	0.025	0.210	0.025
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	2.32	0.037	2.86	0.012
Cadmium	mg/L	).000015	EPA 200.8	28-Apr-22/O	0.00372	< 0.000015	0.000523	< 0.000015
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	0.007	< 0.001	< 0.003	< 0.001
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.02	< 0.002	< 0.02	< 0.002
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	6.43	1.19	0.070	0.045
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	0.00475	< 0.00002	0.00135	0.00003
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.260	0.061	1.37	0.052
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.1	< 0.01	< 0.1	< 0.01
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.1	< 0.01	< 0.1	< 0.01
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.1	0.001	< 0.2	< 0.001
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0032	< 0.0001	< 0.001	< 0.0001
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	84.7	0.488	92.2	0.332
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00604	< 0.00005	0.00098	< 0.00005
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.5	< 0.05	< 0.5	< 0.05
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.05	< 0.005	< 0.05	< 0.005
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.0002	0.00037	0.0293	0.00024
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0049	< 0.0001	0.0099	< 0.0001
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.05	0.009	< 0.05	< 0.005
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	13688	355	12687	320

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-3 Z	BH-4 B	BH-4 F	BH-4 Z
			Sample I.D.		B22-11441-9	B22-11441-10	B22-11441-11	B22-11441-12
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	5870	336	3090	328
Anion Sum	meq/L		Calc.	29-Apr-22/O	246	6.71	203	6.19
Cation Sum	meq/L		Calc.	29-Apr-22/O	252	7.54	241	6.78
% Difference	%		Calc.	29-Apr-22/O	1.17	5.81	8.67	4.53
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	< 0.1	0.05	51.6	< 0.5

1 Sample #11 - metals digested due to sediment

2 Elevated RL due to sample matrix interference

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6 I
			Sample I.D.		B22-11441-13	B22-11441-14	B22-11441-15	B22-11441-16
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	6.59	6.17	7.00	6.16
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	7.77	7.98	7.92	7.55
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	1.18	1.81	0.924	1.39
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	254	763	238	794
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	254	763	238	794
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	10600	13700	4400	13000
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 3	< 10
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	3340	3910	1230	2270
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 3	< 10
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10	< 3	< 10
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	< 40	< 40	11.1	< 40
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	< 100	679	< 30	2780
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	358	317	141	309
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	201	220	78.0	121
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	1360	2830	636	2480
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	26.6	28.5	19.3	24.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	3.35	1.68	2.50	1.94
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.009	0.125	0.011	0.076
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.02	0.12	0.01	0.44
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	9.01	10.8	8.35	12.4
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	1.5	4.6	1.3	8.4

CBurke

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6 I
			Sample I.D.		B22-11441-13	B22-11441-14	B22-11441-15	B22-11441-16
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	28-Apr-22/O	< 2	8	< 2	41
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	85.6	407	55.2	212
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.18	0.23	0.08	0.31
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0017	0.0060	< 0.0005	0.0472
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.265	0.430	0.072	0.10
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	1.32	3.34	1.00	2.11
Cadmium	mg/L	.00001	EPA 200.8	28-Apr-22/O	< 0.00012	< 0.00012	< 0.000059	< 0.00012
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	0.001	0.002	< 0.001	0.003
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.01	< 0.02	< 0.004	< 0.02
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	0.540	< 0.05	1.66	0.060
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.0004	0.00071	0.00024	< 0.0004
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.090	0.230	0.012	0.340
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.05	< 0.1	< 0.02	< 0.1
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.05	< 0.1	< 0.02	< 0.1
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.02	< 0.1	< 0.02	< 0.1
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0005	< 0.0005	0.0003	< 0.0005
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	50.5	51.7	16.3	33.5
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.00008	< 0.00008	< 0.00005	< 0.00008
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.3	< 0.5	< 0.1	< 0.5
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.03	< 0.05	< 0.01	< 0.05
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00040	0.00253	< 0.00005	0.0161
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.001	0.0045	< 0.0007	0.0194
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.03	< 0.05	< 0.01	< 0.05
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	5435	8449	2255	8464

CBurke

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Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-5 F	BH-5 H	BH-5 Z	BH-6 I
			Sample I.D.		B22-11441-13	B22-11441-14	B22-11441-15	B22-11441-16
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	1720	1700	674	1270
Anion Sum	meq/L		Calc.	29-Apr-22/O	99.2	140	39.5	138
Cation Sum	meq/L		Calc.	29-Apr-22/O	94.2	158	41.9	134
% Difference	%		Calc.	29-Apr-22/O	2.58	6.06	2.89	1.39
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	5.00	28.9	0.23	17.8

1 . Sample #11 - metals digested due to sediment
2 . Elevated RL due to sample matrix interference

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-11441

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6 K	BH-6 L	BH-7 I	BH-7 K
			Sample I.D.		B22-11441-17	B22-11441-18	B22-11441-19	B22-11441-20
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	6.27	6.97	6.00	6.94
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	7.67	7.95	7.05	7.82
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	1.40	0.976	1.05	0.884
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	617	311	79	236
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	617	311	79	236
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	11600	4450	56600	5630
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 3	< 10	< 5
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	2200	1280	38300	1630
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 3	< 10	< 5
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 3	< 10	< 5
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	< 40	11.1	381	< 20
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	2370	< 30	396	< 50
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	309	114	4490	164
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	118	63.2	2440	89.0
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	2330	714	13200	910
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	26.3	18.9	118	15.1
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	1.92	2.45	18.0	2.80
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.089	0.015	0.014	0.012
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.09	0.15	0.15	0.17
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	10.5	7.19	4.71	11.4
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	9.5	2.3	0.9	1.0

CBurke

Christine Burke
Lab Manager

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642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6 K	BH-6 L	BH-7 I	BH-7 K
			Sample I.D.		B22-11441-17	B22-11441-18	B22-11441-19	B22-11441-20
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	28-Apr-22/O	27	< 2	39	< 2
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	230	127	72.4	218
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.17	0.07	2.55	0.20
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0245	0.0055	< 0.005	0.0063
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.160	0.090	1.00	0.175
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	1.81	1.17	2.60	0.505
Cadmium	mg/L	).000015	EPA 200.8	28-Apr-22/O	< 0.00012	< 0.000059	< 0.00059	< 0.000059
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	0.001	< 0.001	< 0.006	< 0.001
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.01	< 0.004	< 0.1	< 0.01
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	0.050	1.09	2.60	1.07
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.0004	< 0.0002	< 0.002	0.00057
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.190	0.016	0.300	0.030
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.05	< 0.02	< 0.5	< 0.05
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.05	< 0.02	< 0.5	< 0.05
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.1	< 0.04	< 0.3	< 0.02
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0005	< 0.0002	< 0.002	0.0006
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	31.8	13.0	411	10.9
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.00008	< 0.00005	< 0.0004	< 0.00005
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.3	< 0.1	< 3	< 0.3
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.03	< 0.01	< 0.3	< 0.03
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.0135	0.00184	0.00617	0.00979
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0087	< 0.0007	< 0.007	< 0.0007
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.03	< 0.01	< 0.3	< 0.03
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	7731	2385	58982	2958

CBurke

Christine Burke
Lab Manager

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Final Report

C.O.C.: ---

REPORT No. B22-11441

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Caduceon Environmental Laboratories
112 Commerce Park Drive
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6 K	BH-6 L	BH-7 I	BH-7 K
			Sample I.D.		B22-11441-17	B22-11441-18	B22-11441-19	B22-11441-20
			Date Collected		22-Apr-22	22-Apr-22	22-Apr-22	22-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	1260	544	21200	775
Anion Sum	meq/L		Calc.	29-Apr-22/O	124	42.4	1090	50.8
Cation Sum	meq/L		Calc.	29-Apr-22/O	127	42.6	1000	55.7
% Difference	%		Calc.	29-Apr-22/O	1.36	0.231	4.33	4.59
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	20.4	< 0.1	< 0.1	< 0.1

1. Sample #11 - metals digested due to sediment
2. Elevated RL due to sample matrix interference

CBurke

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7 L	BH-8 G	BH-8 K	BH-8 L
			Sample I.D.		B22-11441-21	B22-11441-22	B22-11441-23	B22-11441-24
			Date Collected		22-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	29-Apr-22/O	6.90	6.95	7.10	7.42
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	7.83	7.78	8.01	8.16
Langelier Index(25°C)	S.I.		Calc.	29-Apr-22/O	0.934	0.833	0.908	0.744
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	250	541	400	309
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	250	541	400	309
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	4370	4100	4290	3140
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 5	< 5	< 3	< 3
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	1230	909	1020	750
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 5	< 5	< 3	< 3
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 5	< 5	< 3	< 3
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	< 20	< 20	< 10	< 10
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	< 50	138	164	72
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	170	69.6	65.8	40.4
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	89.6	14.9	36.6	28.4
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	534	848	788	560
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	13.5	6.1	11.8	9.9
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	1.99	0.31	1.07	0.28
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.017	0.029	0.013	0.010
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.10	0.09	0.07	0.09
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	7.66	19.7	9.42	7.70
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	0.7	5.1	2.3	1.3

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 25-Apr-22
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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7 L	BH-8 G	BH-8 K	BH-8 L
			Sample I.D.		B22-11441-21	B22-11441-22	B22-11441-23	B22-11441-24
			Date Collected		22-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	28-Apr-22/O	< 2	2	< 2	< 2
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	287	49.2	16.9	260
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	0.11	0.07	0.04	0.14
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0035	0.0089	0.0089	0.0041
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.124	0.108	0.130	0.068
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	0.348	3.56	3.78	1.86
Cadmium	mg/L	).000015	EPA 200.8	28-Apr-22/O	< 0.000059	< 0.000059	< 0.000059	0.000060
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.004	< 0.004	< 0.004	< 0.004
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	0.880	0.046	1.05	0.714
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.0002	< 0.0002	0.00029	0.00027
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.034	0.196	0.028	0.034
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.02	< 0.02	< 0.02	0.04
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.02	< 0.02	< 0.02	< 0.02
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.04	< 0.02	< 0.04	< 0.04
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0002	< 0.0002	< 0.0002	< 0.0001
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	10.9	4.82	5.44	3.64
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00006	< 0.00005	< 0.00005	0.00008
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 0.1	< 0.1	< 0.1	< 0.1
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.00758	0.0316	0.00301	0.00618
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.0007	0.0029	< 0.0007	0.0005
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	0.010	< 0.01	< 0.01	< 0.01
TDS(ion sum calc.)	mg/L	1	Calc.	29-Apr-22/O	2185	2311	2329	1647

CBurke

Christine Burke
Lab Manager

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DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7 L	BH-8 G	BH-8 K	BH-8 L
			Sample I.D.		B22-11441-21	B22-11441-22	B22-11441-23	B22-11441-24
			Date Collected		22-Apr-22	21-Apr-22	21-Apr-22	21-Apr-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	792	235	315	218
Anion Sum	meq/L		Calc.	29-Apr-22/O	39.6	39.3	40.2	28.8
Cation Sum	meq/L		Calc.	29-Apr-22/O	39.6	41.8	41.0	29.0
% Difference	%		Calc.	29-Apr-22/O	0.0473	3.02	1.01	0.317
Sulphide	mg/L	0.01	SM4500-S2	26-Apr-22/K	< 0.1	7.90	0.03	0.45

1 . Sample #11 - metals digested due to sediment
2 . Elevated RL due to sample matrix interference

Christine Burke
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-11573**

Report To:

Azimuth Environmental
642 Welham Rd,
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Attention: Spencer Yerbury

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112 Commerce Park Drive
Barrie ON L4N 8W8
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DATE RECEIVED: 25-Apr-22
DATE REPORTED: 05-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-9 K	BH-9 G		
			Sample I.D.		B22-11573-1	B22-11573-2		
			Date Collected		21-Apr-22	21-Apr-22		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	28-Apr-22/O	6.37	6.31		
pH @25°C	pH Units		SM 4500H	27-Apr-22/O	6.91	7.36		
Langelier Index(25°C)	S.I.		Calc.	28-Apr-22/O	0.537	1.05		
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	27-Apr-22/O	69	157		
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	69	157		
Carbonate (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5		
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	27-Apr-22/O	< 5	< 5		
Conductivity @25°C	µS/cm	1	SM 2510B	27-Apr-22/O	43500	24200		
Fluoride	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10		
Chloride	mg/L	0.5	SM4110C	27-Apr-22/O	25900	12400		
Nitrate (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10		
Nitrite (N)	mg/L	0.1	SM4110C	27-Apr-22/O	< 10	< 10		
Bromide	mg/L	0.4	SM4110C	27-Apr-22/O	272	112		
Sulphate	mg/L	1	SM4110C	27-Apr-22/O	493	362		
Calcium	mg/L	0.02	SM 3120	28-Apr-22/O	2210	1120		
Magnesium	mg/L	0.02	SM 3120	28-Apr-22/O	1200	728		
Sodium	mg/L	0.2	SM 3120	28-Apr-22/O	11800	4780		
Potassium	mg/L	0.1	SM 3120	28-Apr-22/O	61.5	54.8		
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	27-Apr-22/K	21.3	8.03		
o-Phosphate (P)	mg/L	0.002	PE4500-S	27-Apr-22/K	0.043	0.013		
Phosphorus-Total	mg/L	0.01	E3516.2	27-Apr-22/K	0.17	0.05		
Silica	mg/L	0.02	SM 3120	28-Apr-22/O	11.7	9.01		
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	27-Apr-22/O	< 0.2	< 0.2		
Colour	TCU	2	SM 2120C	28-Apr-22/O	4	< 2		

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-11573

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-9 K	BH-9 G		
			Sample I.D.		B22-11573-1	B22-11573-2		
			Date Collected		21-Apr-22	21-Apr-22		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	28-Apr-22/O	178	66.6		
Aluminum	mg/L	0.01	SM 3120	28-Apr-22/O	1.90	0.60		
Arsenic	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0126	0.0044		
Barium	mg/L	0.001	SM 3120	28-Apr-22/O	0.300	0.270		
Boron	mg/L	0.005	SM 3120	28-Apr-22/O	2.70	3.85		
Cadmium	mg/L	0.000015	EPA 200.8	28-Apr-22/O	< 0.00059	0.00181		
Chromium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.006	0.003		
Copper	mg/L	0.002	SM 3120	28-Apr-22/O	< 0.1	< 0.02		
Iron	mg/L	0.005	SM 3120	28-Apr-22/O	2.25	4.80		
Lead	mg/L	0.00002	EPA 200.8	28-Apr-22/O	< 0.002	0.00219		
Manganese	mg/L	0.001	SM 3120	28-Apr-22/O	0.350	0.150		
Molybdenum	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.5	< 0.1		
Nickel	mg/L	0.01	SM 3120	28-Apr-22/O	< 0.5	< 0.1		
Selenium	mg/L	0.001	EPA 200.8	28-Apr-22/O	< 0.5	< 0.1		
Silver	mg/L	0.0001	EPA 200.8	28-Apr-22/O	0.0142	0.0124		
Strontium	mg/L	0.001	SM 3120	28-Apr-22/O	140	105		
Thallium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	< 0.0004	0.00217		
Tin	mg/L	0.05	SM 3120	28-Apr-22/O	< 3	< 0.5		
Titanium	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.3	< 0.05		
Uranium	mg/L	0.00005	EPA 200.8	28-Apr-22/O	0.0598	0.0157		
Vanadium	mg/L	0.0001	EPA 200.8	28-Apr-22/O	< 0.007	< 0.004		
Zinc	mg/L	0.005	SM 3120	28-Apr-22/O	< 0.3	< 0.05		
TDS(ion sum calc.)	mg/L	1	Calc.	28-Apr-22/O	41719	19523		
Hardness (as CaCO3)	mg/L	1	SM 3120	28-Apr-22/O	10400	5790		
Anion Sum	meq/L		Calc.	28-Apr-22/O	742	360		

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-11573

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 25-Apr-22

DATE REPORTED: 05-May-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

				Client I.D.	BH-9 K	BH-9 G		
				Sample I.D.	B22-11573-1	B22-11573-2		
				Date Collected	21-Apr-22	21-Apr-22		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	28-Apr-22/O	725	326		
% Difference	%		Calc.	28-Apr-22/O	1.18	4.92		
Sulphide	mg/L	0.01	SM4500-S2	03-May-22/K	< 0.2	0.02		

1 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G098984 **REPORT No. B22-18939**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 20-Jun-22
DATE REPORTED: 28-Jun-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		W-1 (1570)			
			Sample I.D.		B22-18939-1			
			Date Collected		18-Jun-22			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	28-Jun-22/O	6.96			
pH @25°C	pH Units		SM 4500H	21-Jun-22/O	7.89			
Langelier Index(25°C)	S.I.		Calc.	28-Jun-22/O	0.926			
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	21-Jun-22/O	271			
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	21-Jun-22/O	271			
Carbonate (as CaCO3)	mg/L	5	SM 2320B	21-Jun-22/O	< 5			
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	21-Jun-22/O	< 5			
Conductivity @25°C	µmho/cm	1	SM 2510B	21-Jun-22/O	556			
Fluoride	mg/L	0.1	SM4110C	22-Jun-22/O	< 0.1			
Chloride	mg/L	0.5	SM4110C	22-Jun-22/O	6.3			
Nitrate (N)	mg/L	0.1	SM4110C	22-Jun-22/O	< 0.1			
Nitrite (N)	mg/L	0.1	SM4110C	22-Jun-22/O	< 0.1			
Bromide	mg/L	0.4	SM4110C	22-Jun-22/O	< 0.4			
Sulphate	mg/L	1	SM4110C	22-Jun-22/O	30			
Calcium	mg/L	0.02	SM 3120	22-Jun-22/O	111			
Magnesium	mg/L	0.02	SM 3120	22-Jun-22/O	6.93			
Sodium	mg/L	0.2	SM 3120	22-Jun-22/O	3.8			
Potassium	mg/L	0.1	SM 3120	22-Jun-22/O	2.5			
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	22-Jun-22/K	< 0.01			
o-Phosphate (P)	mg/L	0.002	PE4500-S	22-Jun-22/K	< 0.002			
Phosphorus-Total	mg/L	0.01	E3516.2	22-Jun-22/K	0.02			
Silica	mg/L	0.02	SM 3120	22-Jun-22/O	4.67			
Colour	TCU	2	SM 2120C	24-Jun-22/O	< 2			
Turbidity	NTU	0.1	SM 2130	24-Jun-22/O	1.4			

CBurke

Christine Burke
Lab Manager

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Final Report

C.O.C.: G098984 **REPORT No. B22-18939**

Report To:
Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 20-Jun-22
DATE REPORTED: 28-Jun-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		W-1 (1570)			
			Sample I.D.		B22-18939-1			
			Date Collected		18-Jun-22			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Aluminum	mg/L	0.01	SM 3120	22-Jun-22/O	0.07			
Arsenic	mg/L	0.0001	EPA 200.8	22-Jun-22/O	0.0002			
Barium	mg/L	0.001	SM 3120	22-Jun-22/O	0.047			
Boron	mg/L	0.005	SM 3120	22-Jun-22/O	0.117			
Cadmium	mg/L	0.000015	EPA 200.8	22-Jun-22/O	0.000030			
Chromium	mg/L	0.001	EPA 200.8	22-Jun-22/O	< 0.001			
Copper	mg/L	0.002	SM 3120	22-Jun-22/O	0.259			
Iron	mg/L	0.005	SM 3120	22-Jun-22/O	0.025			
Lead	mg/L	0.00002	EPA 200.8	22-Jun-22/O	0.0175			
Manganese	mg/L	0.001	SM 3120	22-Jun-22/O	< 0.001			
Molybdenum	mg/L	0.01	SM 3120	22-Jun-22/O	< 0.01			
Nickel	mg/L	0.01	SM 3120	22-Jun-22/O	< 0.01			
Selenium	mg/L	0.001	EPA 200.8	22-Jun-22/O	< 0.001			
Silver	mg/L	0.0001	EPA 200.8	22-Jun-22/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	22-Jun-22/O	0.526			
Thallium	mg/L	0.00005	EPA 200.8	22-Jun-22/O	< 0.00005			
Tin	mg/L	0.05	SM 3120	22-Jun-22/O	< 0.05			
Titanium	mg/L	0.005	SM 3120	22-Jun-22/O	< 0.005			
Uranium	mg/L	0.00005	EPA 200.8	22-Jun-22/O	0.00030			
Vanadium	mg/L	0.0001	EPA 200.8	22-Jun-22/O	< 0.0001			
Zinc	mg/L	0.005	SM 3120	22-Jun-22/O	0.402			
TDS(ion sum calc.)	mg/L	1	Calc.	28-Jun-22/O	323			
Hardness (as CaCO3)	mg/L	1	SM 3120	22-Jun-22/O	306			
Anion Sum	meq/L		Calc.	28-Jun-22/O	6.22			
Cation Sum	meq/L		Calc.	28-Jun-22/O	6.34			

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G098984 **REPORT No. B22-18939**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Brad Pettersone

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 20-Jun-22
DATE REPORTED: 28-Jun-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		W-1 (1570)			
			Sample I.D.		B22-18939-1			
			Date Collected		18-Jun-22			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
% Difference	%		Calc.	28-Jun-22/O	0.961			
Total Kjeldahl Nitrogen	mg/L	0.1	E3516.2	22-Jun-22/K	0.3			
Tannins and Lignins	mg/L	0.5	SM5500B	21-Jun-22/K	< 0.5			
Sulphide	mg/L	0.01	SM4500-S2	22-Jun-22/K	< 0.01			
E coli	cfu/100mL	1	MOE E3407	20-Jun-22/B	0			
Total Coliform	cfu/100mL	1	MOE E3407	20-Jun-22/B	1			
Heterotrophic Plate Count	cfu/mL	10	SM9215D	20-Jun-22/B	40			
Background	cfu/100mL	1	MOE E3407	20-Jun-22/B	> 200			

CBurke

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Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-25479**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Aug-22

DATE REPORTED: 29-Aug-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6-I	BH-6-K	BH-6-L	BH-7-I
			Sample I.D.		B22-25479-1	B22-25479-2	B22-25479-3	B22-25479-4
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Aug-22/O	5.97	6.11	7.11	6.00
pH @25°C	pH Units		SM 4500H	12-Aug-22/O	7.41	7.50	7.94	7.10
Langelier Index(25°C)	S.I.		Calc.	17-Aug-22/O	1.44	1.39	0.831	1.10
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	12-Aug-22/O	950	715	348	74
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	950	715	348	74
Carbonate (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µmho/cm	1	SM 2510B	12-Aug-22/O	14100	12800	3380	75800
Fluoride	mg/L	0.1	SM4110C	15-Aug-22/O	< 3	< 5	< 1	< 10
Chloride	mg/L	0.5	SM4110C	15-Aug-22/O	2780	2810	818	33200
Nitrate (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 3	< 5	< 1	< 10
Nitrite (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 3	< 5	< 1	< 10
Bromide	mg/L	0.4	SM4110C	15-Aug-22/O	25.9	26.8	8.4	360
Sulphate	mg/L	1	SM4110C	15-Aug-22/O	3130	2390	11	436
Calcium	mg/L	0.02	SM 3120	17-Aug-22/O	405	389	72.8	4790
Magnesium	mg/L	0.02	SM 3120	17-Aug-22/O	146	151	39.6	2500
Sodium	mg/L	0.2	SM 3120	17-Aug-22/O	3140	2720	526	13200
Potassium	mg/L	0.1	SM 3120	17-Aug-22/O	25.7	27.9	14.0	116
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	11-Aug-22/K	2.29	2.92	1.92	16.5
o-Phosphate (P)	mg/L	0.002	PE4500-S	11-Aug-22/K	0.032	0.067	0.008	0.004
Phosphorus-Total	mg/L	0.01	E3516.2	18-Aug-22/K	0.16	0.14	0.09	0.17
Silica	mg/L	0.02	SM 3120	17-Aug-22/O	10.1	8.05	4.17	< 1
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Aug-22/O	9.4	10.1	2.0	< 0.2
Colour	TCU	2	SM 2120C	12-Aug-22/O	34	26	< 2	5

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-25479**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Aug-22
DATE REPORTED: 29-Aug-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-6-I	BH-6-K	BH-6-L	BH-7-I
			Sample I.D.		B22-25479-1	B22-25479-2	B22-25479-3	B22-25479-4
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	12-Aug-22/O	149	88.5	95.7	31.0
Aluminum	mg/L	0.01	SM 3120	17-Aug-22/O	0.36	0.38	0.09	2.75
Arsenic	mg/L	0.0001	EPA 200.8	16-Aug-22/O	0.0487	0.0164	0.0040	< 0.005
Barium	mg/L	0.001	SM 3120	17-Aug-22/O	0.090	0.130	0.064	1.10
Boron	mg/L	0.005	SM 3120	17-Aug-22/O	2.66	2.24	1.08	2.55
Cadmium	mg/L	).000015	EPA 200.8	16-Aug-22/O	< 0.00012	< 0.00012	< 0.000029	0.00292
Chromium	mg/L	0.001	EPA 200.8	16-Aug-22/O	0.114	0.002	< 0.001	0.012
Copper	mg/L	0.002	SM 3120	17-Aug-22/O	< 0.02	< 0.02	< 0.004	< 0.1
Iron	mg/L	0.005	SM 3120	17-Aug-22/O	0.130	0.380	0.670	4.25
Lead	mg/L	0.00002	EPA 200.8	16-Aug-22/O	< 0.0004	< 0.0004	< 0.00009	0.00197
Manganese	mg/L	0.001	SM 3120	17-Aug-22/O	0.600	0.220	0.022	0.350
Molybdenum	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.1	< 0.1	< 0.02	< 0.5
Nickel	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.1	< 0.1	< 0.02	< 0.5
Selenium	mg/L	0.001	EPA 200.8	16-Aug-22/O	< 0.07	< 0.07	< 0.02	< 0.3
Silver	mg/L	0.0001	EPA 200.8	16-Aug-22/O	< 0.0005	< 0.0005	< 0.0001	< 0.002
Strontium	mg/L	0.001	SM 3120	17-Aug-22/O	41.8	41.7	7.96	419
Thallium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	0.00010	< 0.00008	< 0.00005	0.00142
Tin	mg/L	0.05	SM 3120	17-Aug-22/O	< 0.5	< 0.5	< 0.1	< 3
Titanium	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.05	< 0.05	< 0.01	< 0.3
Uranium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	0.0125	0.0108	0.00124	0.0125
Vanadium	mg/L	0.0001	EPA 200.8	16-Aug-22/O	0.0293	0.0100	< 0.0004	0.0093
Zinc	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.05	< 0.05	< 0.01	< 0.3
TDS(ion sum calc.)	mg/L	1	Calc.	17-Aug-22/O	10197	8925	1693	54246
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Aug-22/O	1610	1590	345	22200
Anion Sum	meq/L		Calc.	17-Aug-22/O	162	143	30.2	947

CBurke

Christine Burke
Lab Manager

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Final Report

C.O.C.: ---

REPORT No. B22-25479

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Aug-22

DATE REPORTED: 29-Aug-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-6-I	BH-6-K	BH-6-L	BH-7-I
			Sample I.D.		B22-25479-1	B22-25479-2	B22-25479-3	B22-25479-4
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	17-Aug-22/O	170	151	30.3	1020
% Difference	%		Calc.	17-Aug-22/O	2.15	2.61	0.0869	3.73
Total Kjeldahl Nitrogen	mg/L	0.1	E3516.2	18-Aug-22/K	3.2	4.4	2.5	21.1
Tannins and Lignins	mg/L	0.5	SM5500B	12-Aug-22/K	4.5	1.6	< 0.5	0.9
Sulphide	mg/L	0.01	SM4500-S2	11-Aug-22/K	19.4	4.87	< 0.5	< 0.1

1 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: --- **REPORT No. B22-25479**

Report To:

Azimuth Environmental
642 Welham Rd,
Barrie ON L4N9A1 Canada
Attention: Spencer Yerbury

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Aug-22
DATE REPORTED: 29-Aug-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7-K	BH-7-L	BH-8-G	BH-8-K
			Sample I.D.		B22-25479-5	B22-25479-6	B22-25479-7	B22-25479-8
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Aug-22/O	6.86	6.80	7.03	7.23
pH @25°C	pH Units		SM 4500H	12-Aug-22/O	7.86	7.88	7.80	8.05
Langelier Index(25°C)	S.I.		Calc.	17-Aug-22/O	0.996	1.08	0.768	0.817
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	12-Aug-22/O	246	265	507	363
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	246	265	507	363
Carbonate (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	< 5	< 5	< 5	< 5
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	< 5	< 5	< 5	< 5
Conductivity @25°C	µmho/cm	1	SM 2510B	12-Aug-22/O	6060	4420	3940	3110
Fluoride	mg/L	0.1	SM4110C	15-Aug-22/O	< 1	< 1	2.9	2.7
Chloride	mg/L	0.5	SM4110C	15-Aug-22/O	1630	1180	860	694
Nitrate (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 1	< 1	< 1	< 1
Nitrite (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 1	< 1	< 1	< 1
Bromide	mg/L	0.4	SM4110C	15-Aug-22/O	18.5	12.8	8.0	6.5
Sulphate	mg/L	1	SM4110C	15-Aug-22/O	22	< 10	130	53
Calcium	mg/L	0.02	SM 3120	17-Aug-22/O	190	198	61.0	52.4
Magnesium	mg/L	0.02	SM 3120	17-Aug-22/O	104	106	13.0	31.4
Sodium	mg/L	0.2	SM 3120	17-Aug-22/O	920	590	762	542
Potassium	mg/L	0.1	SM 3120	17-Aug-22/O	15.5	13.3	5.1	7.9
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	11-Aug-22/K	2.97	1.97	0.32	0.82
o-Phosphate (P)	mg/L	0.002	PE4500-S	11-Aug-22/K	0.010	0.004	0.038	0.011
Phosphorus-Total	mg/L	0.01	E3516.2	18-Aug-22/K	0.17	0.11	0.09	0.09
Silica	mg/L	0.02	SM 3120	17-Aug-22/O	6.27	4.60	13.1	4.96
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Aug-22/O	0.4	0.4	5.1	1.1
Colour	TCU	2	SM 2120C	12-Aug-22/O	< 2	< 2	34	< 2

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 10-Aug-22
DATE REPORTED: 29-Aug-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7-K	BH-7-L	BH-8-G	BH-8-K
			Sample I.D.		B22-25479-5	B22-25479-6	B22-25479-7	B22-25479-8
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Turbidity	NTU	0.1	SM 2130	12-Aug-22/O	162	111	33.0	25.9
Aluminum	mg/L	0.01	SM 3120	17-Aug-22/O	0.20	0.19	0.05	0.07
Arsenic	mg/L	0.0001	EPA 200.8	16-Aug-22/O	0.0060	0.0037	0.0050	0.0046
Barium	mg/L	0.001	SM 3120	17-Aug-22/O	0.200	0.135	0.104	0.074
Boron	mg/L	0.005	SM 3120	17-Aug-22/O	0.435	0.315	3.38	2.40
Cadmium	mg/L	0.000015	EPA 200.8	16-Aug-22/O	< 0.000059	0.000037	< 0.000029	0.000032
Chromium	mg/L	0.001	EPA 200.8	16-Aug-22/O	< 0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.002	SM 3120	17-Aug-22/O	< 0.01	< 0.01	< 0.004	< 0.004
Iron	mg/L	0.005	SM 3120	17-Aug-22/O	1.92	1.35	0.044	0.330
Lead	mg/L	0.00002	EPA 200.8	16-Aug-22/O	< 0.0002	< 0.00009	< 0.00009	< 0.00009
Manganese	mg/L	0.001	SM 3120	17-Aug-22/O	0.030	0.040	0.214	0.016
Molybdenum	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.05	< 0.05	< 0.02	< 0.02
Nickel	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.05	< 0.05	< 0.02	< 0.02
Selenium	mg/L	0.001	EPA 200.8	16-Aug-22/O	< 0.05	< 0.05	< 0.02	< 0.02
Silver	mg/L	0.0001	EPA 200.8	16-Aug-22/O	< 0.0002	< 0.0001	< 0.0001	< 0.0001
Strontium	mg/L	0.001	SM 3120	17-Aug-22/O	13.0	13.1	4.52	4.42
Thallium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Tin	mg/L	0.05	SM 3120	17-Aug-22/O	< 0.3	< 0.3	< 0.1	< 0.1
Titanium	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.03	< 0.03	< 0.01	< 0.01
Uranium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	0.00929	0.00657	0.0269	0.00507
Vanadium	mg/L	0.0001	EPA 200.8	16-Aug-22/O	< 0.0007	< 0.0004	0.0023	0.0004
Zinc	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.03	< 0.03	< 0.01	< 0.01
TDS(ion sum calc.)	mg/L	1	Calc.	17-Aug-22/O	3037	2245	2138	1603
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Aug-22/O	901	927	206	260
Anion Sum	meq/L		Calc.	17-Aug-22/O	51.4	38.5	37.2	28.1

Christine Burke
Lab Manager

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Final Report

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Attention: Spencer Yerbury

Caduceon Environmental Laboratories
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 10-Aug-22
DATE REPORTED: 29-Aug-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-7-K	BH-7-L	BH-8-G	BH-8-K
			Sample I.D.		B22-25479-5	B22-25479-6	B22-25479-7	B22-25479-8
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	09-Aug-22
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Cation Sum	meq/L		Calc.	17-Aug-22/O	58.7	44.7	37.4	29.0
% Difference	%		Calc.	17-Aug-22/O	6.63	7.53	0.245	1.68
Total Kjeldahl Nitrogen	mg/L	0.1	E3516.2	18-Aug-22/K	3.7	2.6	0.8	1.4
Tannins and Lignins	mg/L	0.5	SM5500B	12-Aug-22/K	< 0.5	< 0.5	< 0.5	< 0.5
Sulphide	mg/L	0.01	SM4500-S2	11-Aug-22/K	< 0.5	< 0.2	7.98	0.04

1 . Elevated RL due to sample matrix interference

CBurke

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Brechin Quarry

P.O. NUMBER: 18-288

WATERWORKS NO.

			Client I.D.		BH-8-L	BH-9-K	BH-9-G	
			Sample I.D.		B22-25479-9	B22-25479-10	B22-25479-11	
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Saturation pH (25°C)	-		Calc.	17-Aug-22/O	8.13	6.36	6.26	
pH @25°C	pH Units		SM 4500H	12-Aug-22/O	8.54	7.18	7.47	
Langelier Index(25°C)	S.I.		Calc.	17-Aug-22/O	0.412	0.816	1.21	
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	12-Aug-22/O	337	65	164	
Bicarbonate(as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	314	65	164	
Carbonate (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	22	< 5	< 5	
Hydroxide (as CaCO3)	mg/L	5	SM 2320B	12-Aug-22/O	< 5	< 5	< 5	
Conductivity @25°C	µmho/cm	1	SM 2510B	12-Aug-22/O	934	63500	31800	
Fluoride	mg/L	0.1	SM4110C	15-Aug-22/O	1.6	< 10	< 10	
Chloride	mg/L	0.5	SM4110C	15-Aug-22/O	89.7	25300	11600	
Nitrate (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 0.1	< 10	< 10	
Nitrite (N)	mg/L	0.1	SM4110C	15-Aug-22/O	< 0.1	< 10	< 10	
Bromide	mg/L	0.4	SM4110C	15-Aug-22/O	0.8	269	121	
Sulphate	mg/L	1	SM4110C	15-Aug-22/O	12	405	312	
Calcium	mg/L	0.02	SM 3120	17-Aug-22/O	6.42	2390	1200	
Magnesium	mg/L	0.02	SM 3120	17-Aug-22/O	3.74	1210	772	
Sodium	mg/L	0.2	SM 3120	17-Aug-22/O	204	12200	5320	
Potassium	mg/L	0.1	SM 3120	17-Aug-22/O	3.9	61.0	52.8	
Ammonia (N)-Total	mg/L	0.01	SM4500-NH3-H	11-Aug-22/K	0.55	20.4	7.90	
o-Phosphate (P)	mg/L	0.002	PE4500-S	11-Aug-22/K	0.130	0.013	0.004	
Phosphorus-Total	mg/L	0.01	E3516.2	18-Aug-22/K	0.29	0.31	0.05	
Silica	mg/L	0.02	SM 3120	17-Aug-22/O	4.24	3.96	3.81	
Dissolved Organic Carbon	mg/L	0.2	EPA 415.2	11-Aug-22/O	1.2	< 0.2	< 0.2	

CBurke

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Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L	BH-9-K	BH-9-G	
			Sample I.D.		B22-25479-9	B22-25479-10	B22-25479-11	
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Colour	TCU	2	SM 2120C	12-Aug-22/O	< 2	3	9	
Turbidity	NTU	0.1	SM 2130	12-Aug-22/O	598	160	52.3	
Aluminum	mg/L	0.01	SM 3120	17-Aug-22/O	0.07	1.65	0.62	
Arsenic	mg/L	0.0001	EPA 200.8	16-Aug-22/O	0.0025	0.0119	0.0031	
Barium	mg/L	0.001	SM 3120	17-Aug-22/O	0.011	0.300	0.280	
Boron	mg/L	0.005	SM 3120	17-Aug-22/O	1.59	2.40	3.82	
Cadmium	mg/L	0.000015	EPA 200.8	16-Aug-22/O	0.000015	< 0.00059	< 0.00030	
Chromium	mg/L	0.001	EPA 200.8	16-Aug-22/O	< 0.001	0.010	< 0.003	
Copper	mg/L	0.002	SM 3120	17-Aug-22/O	< 0.002	< 0.1	< 0.04	
Iron	mg/L	0.005	SM 3120	17-Aug-22/O	0.050	2.05	5.10	
Lead	mg/L	0.00002	EPA 200.8	16-Aug-22/O	0.00007	< 0.002	< 0.0009	
Manganese	mg/L	0.001	SM 3120	17-Aug-22/O	0.006	0.300	0.160	
Molybdenum	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.01	< 0.5	< 0.2	
Nickel	mg/L	0.01	SM 3120	17-Aug-22/O	< 0.01	< 0.5	< 0.2	
Selenium	mg/L	0.001	EPA 200.8	16-Aug-22/O	0.002	< 0.6	< 0.3	
Silver	mg/L	0.0001	EPA 200.8	16-Aug-22/O	< 0.0001	< 0.002	< 0.001	
Strontium	mg/L	0.001	SM 3120	17-Aug-22/O	0.454	141	112	
Thallium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	< 0.00005	< 0.0004	< 0.0002	
Tin	mg/L	0.05	SM 3120	17-Aug-22/O	< 0.05	< 3	< 1	
Titanium	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.005	< 0.3	< 0.1	
Uranium	mg/L	0.00005	EPA 200.8	16-Aug-22/O	0.00231	0.0501	0.0119	
Vanadium	mg/L	0.0001	EPA 200.8	16-Aug-22/O	0.0002	< 0.007	< 0.004	
Zinc	mg/L	0.005	SM 3120	17-Aug-22/O	< 0.005	< 0.3	< 0.1	
TDS(ion sum calc.)	mg/L	1	Calc.	17-Aug-22/O	524	41585	19388	

CBurke

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Lab Manager

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JOB/PROJECT NO.: Brechin Quarry
P.O. NUMBER: 18-288
WATERWORKS NO.

			Client I.D.		BH-8-L	BH-9-K	BH-9-G	
			Sample I.D.		B22-25479-9	B22-25479-10	B22-25479-11	
			Date Collected		09-Aug-22	09-Aug-22	09-Aug-22	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	17-Aug-22/O	31	10900	6180	
Anion Sum	meq/L		Calc.	17-Aug-22/O	9.59	722	337	
Cation Sum	meq/L		Calc.	17-Aug-22/O	9.64	752	357	
% Difference	%		Calc.	17-Aug-22/O	0.261	2.04	2.82	
Total Kjeldahl Nitrogen	mg/L	0.1	E3516.2	18-Aug-22/K	0.9	26.3	10.8	
Tannins and Lignins	mg/L	0.5	SM5500B	12-Aug-22/K	2.7	< 0.5	< 0.5	
Sulphide	mg/L	0.01	SM4500-S2	11-Aug-22/K	< 2	< 0.1	0.01	

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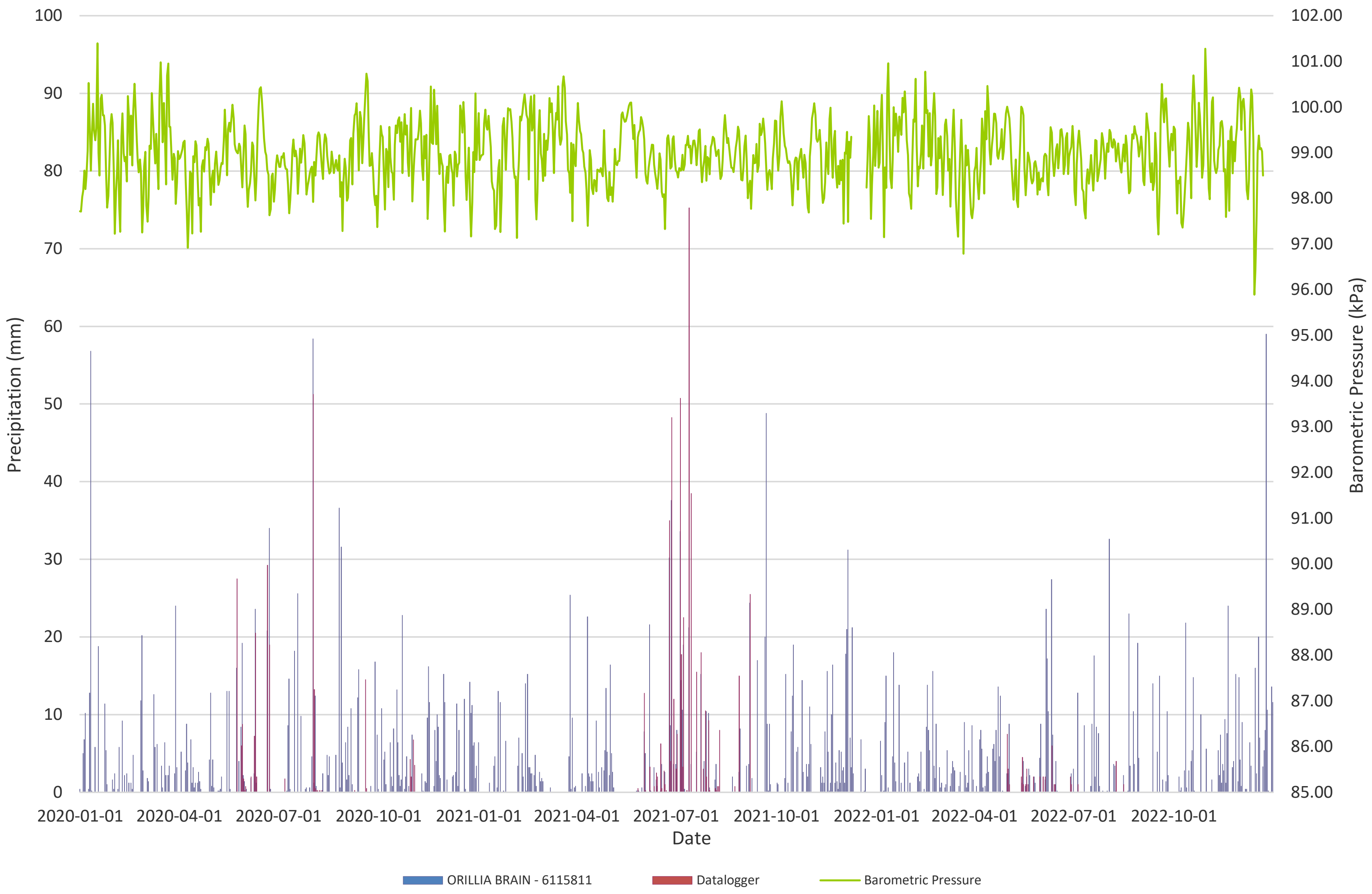
Christine Burke
Lab Manager

APPENDIX N

On-site Climate Data

Note:
- Rain gauge installed from May 20 to November 4 in 2020; May 20 to December 9 in 2021; April 29 to July 7 (logger in for repair).

Brechin Quarry
Meteorological Data



APPENDIX O

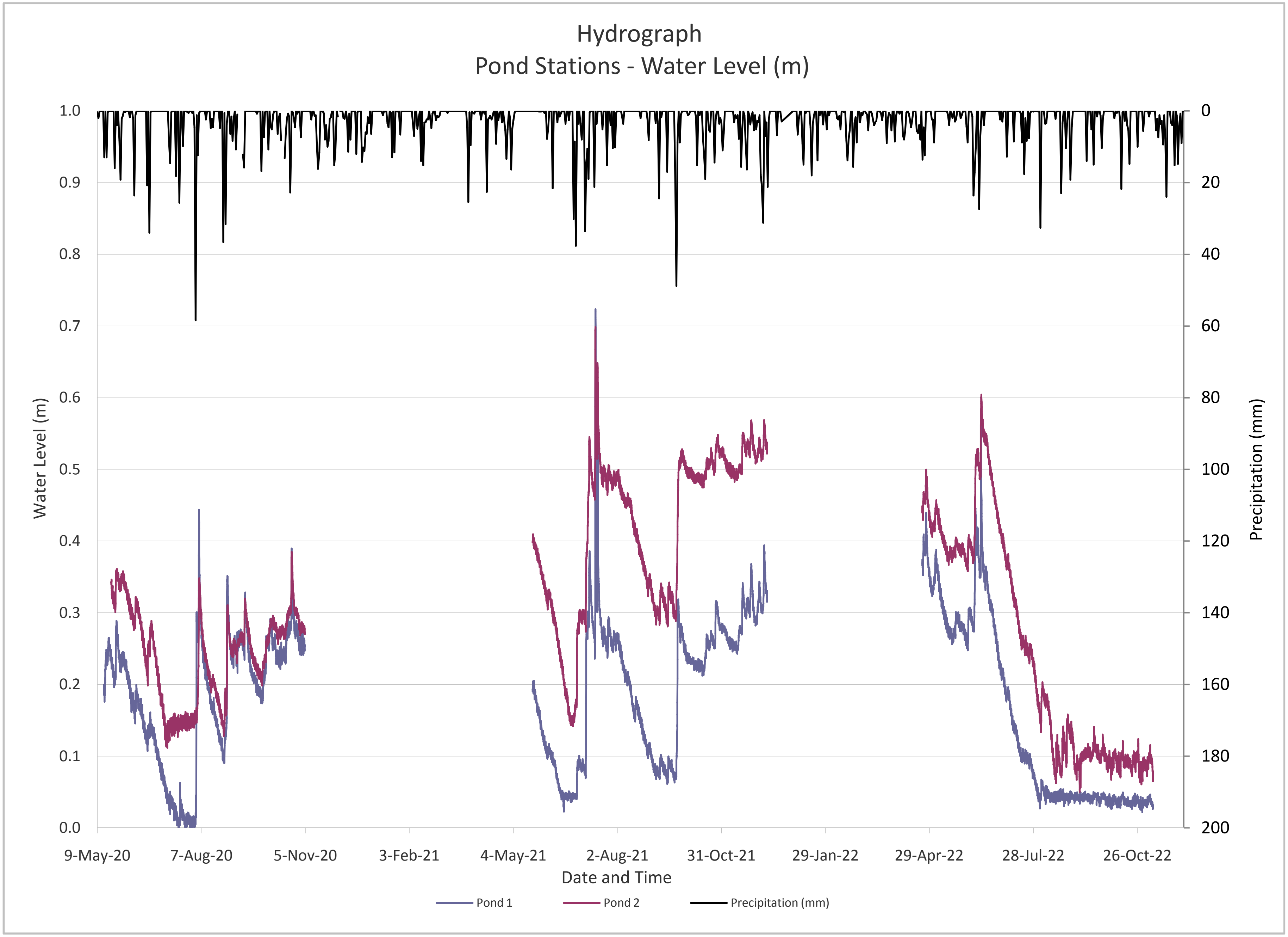
Surface Water Monitoring Database and Hydrographs

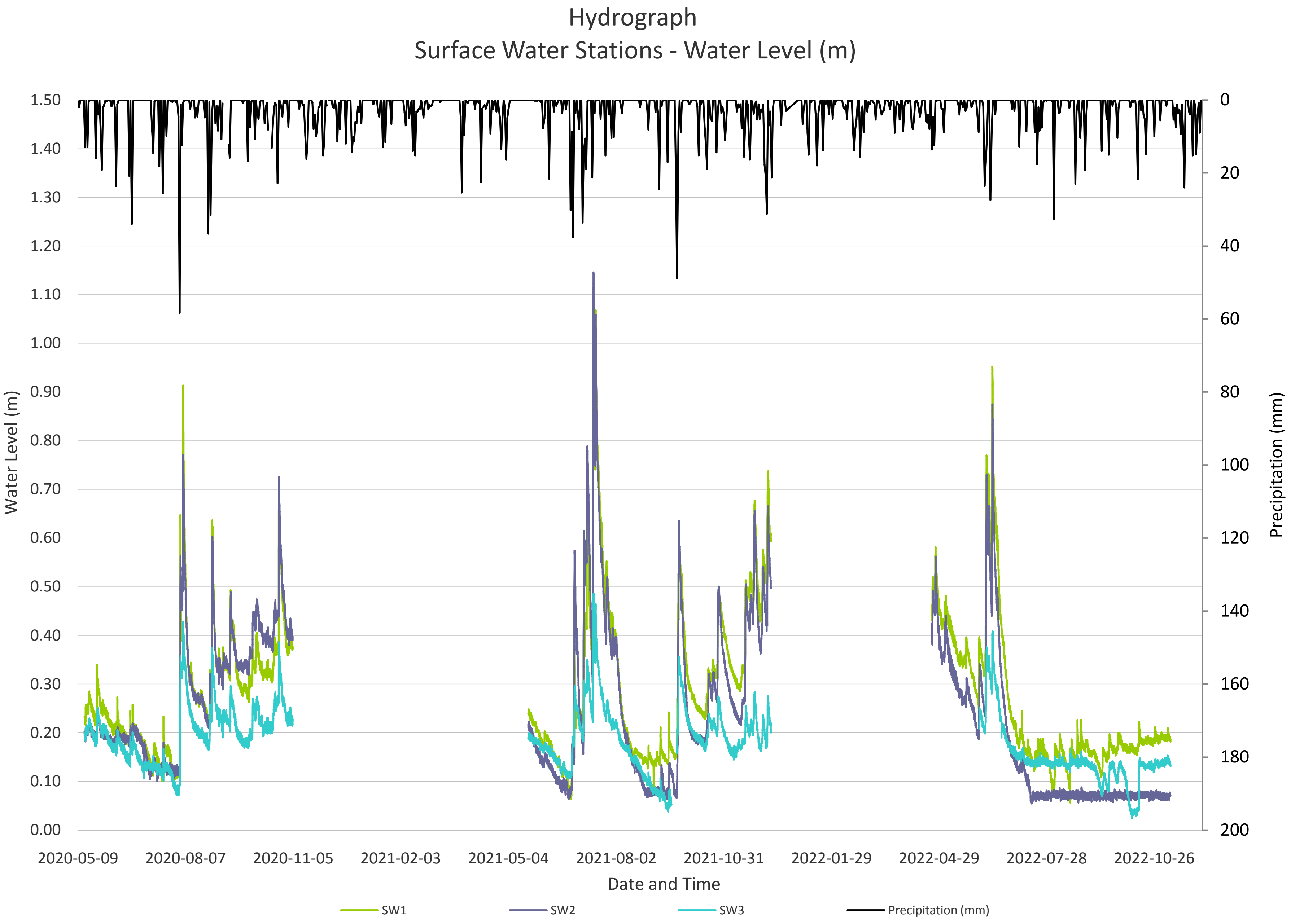
Surface Water Monitoring Station Summary

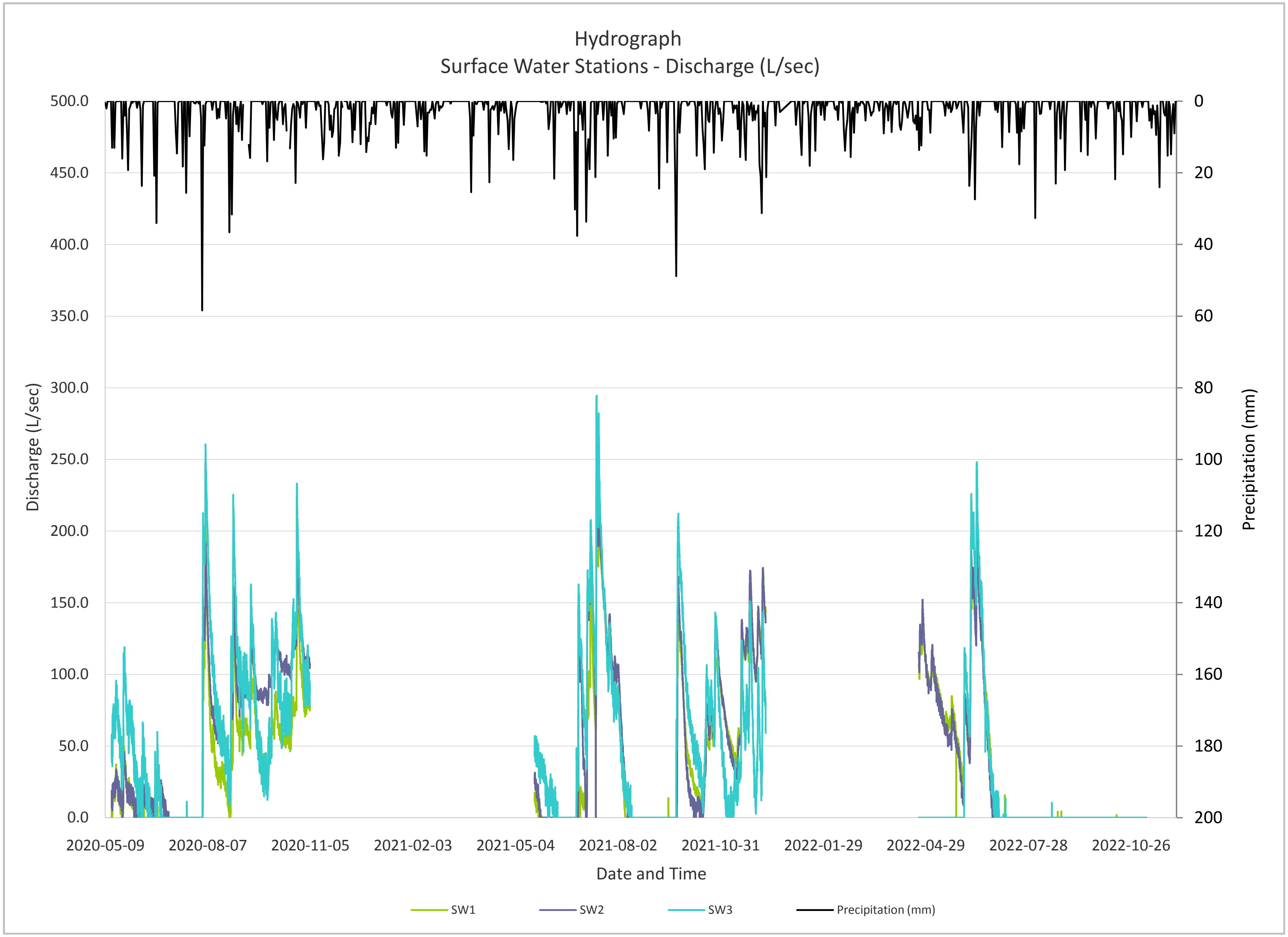
Surface Water Station	Water Level									
	13-May-20		20-May-20		03-Jul-20		28-Aug-20		04-Nov-20	
	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence
SW-1	0.22	Limited Flow	0.25	Limited Flow	0.17	No Flow	0.28	Moderate Flow	0.37	Moderate Flow
SW-2	0.17	Limited Flow	0.21	Limited Flow	0.12	No Flow	0.26	Limited Flow	0.36	Moderate Flow
SW-3	0.18	Limited Flow	0.2	Limited Flow	0.11	No Flow	0.22	Moderate Flow	0.23	Moderate Flow
Pond-1	0.16	Pond Only	0.24	Limited Flood	0.08	Pond Only	0.13	Pond Only	0.26	Limited Flood
Pond-2	-	-	0.34	Limited Flood	0.18	Pond Only	0.18	Pond Only	0.27	Limited Flood
SG-1	DRY	No Flow	0.05	Limited Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow
SG-2	0.64	No Flow	0.61	No Flow	0.34	No Flow	0.3	No Flow	0.36	No Flow
SG-3	0.06	No Flow	0.09	No Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow
SG-4	< 0.01	No Flow	0.05	Reverse Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow

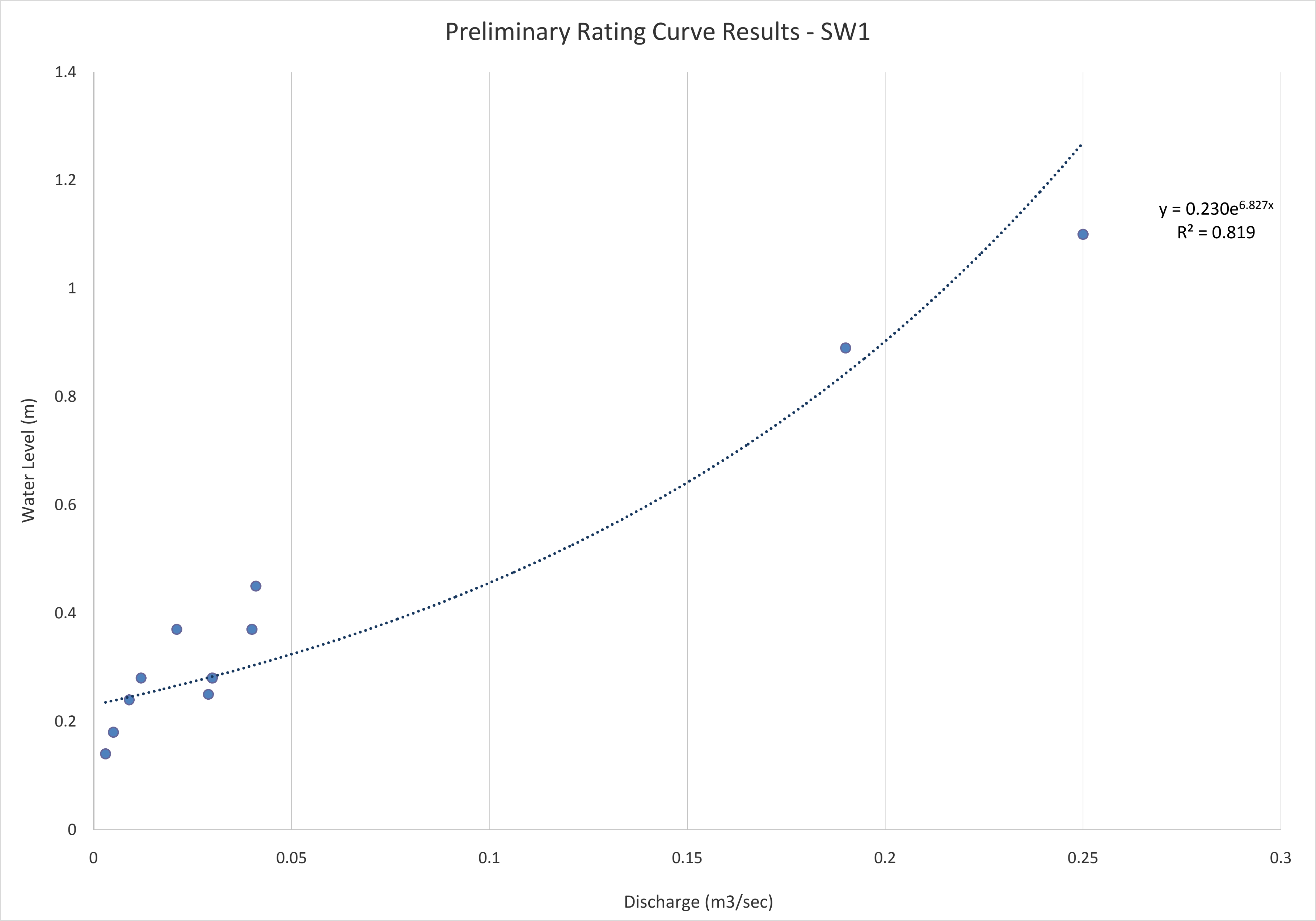
Surface Water Station	Water Level									
	20-May-21		12-Jul-21		17-Aug-21		02-Sep-21		13-Dec-21	
	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence
SW-1	0.24	Limited Flow	0.34	Limited Flow	0.18	Limited Flow	0.14	Limited Flow	0.89	High Flow
SW-2	0.21	Limited Flow	0.29	Limited Flow	0.16	Limited Flow	0.10	Limited Flow	0.93	High Flow
SW-3	0.19	Limited Flow	0.19	Limited Flow	0.15	Limited Flow	0.10	Limited Flow		Moderate Flow
Pond-1	0.19	Pond Only	0.31	Limited Flood	0.08	Pond Only	0.10	Pond Only	0.99	Pond Only
Pond-2	0.4	Limited Flood	0.45	Limited Flood	0.18	Pond Only	0.30	Pond Only	1.09	Pond Only
SG-1	DRY	No Flow	0.01	Limited Flow	DRY	No Flow	DRY	No Flow	0.12	Limited Flow
SG-2	0.65	No Flow	0.38	Limited Flow	0.34	No Flow	0.30	No Flow	0.18	Limited Flow
SG-3	0.16	No Flow	0.11	Limited Flow	DRY	No Flow	DRY	No Flow	0.22	Limited Flow
SG-4	< 0.01	No Flow	0.05	Limited Flow	DRY	No Flow	DRY	No Flow	0.09	Limited Flow

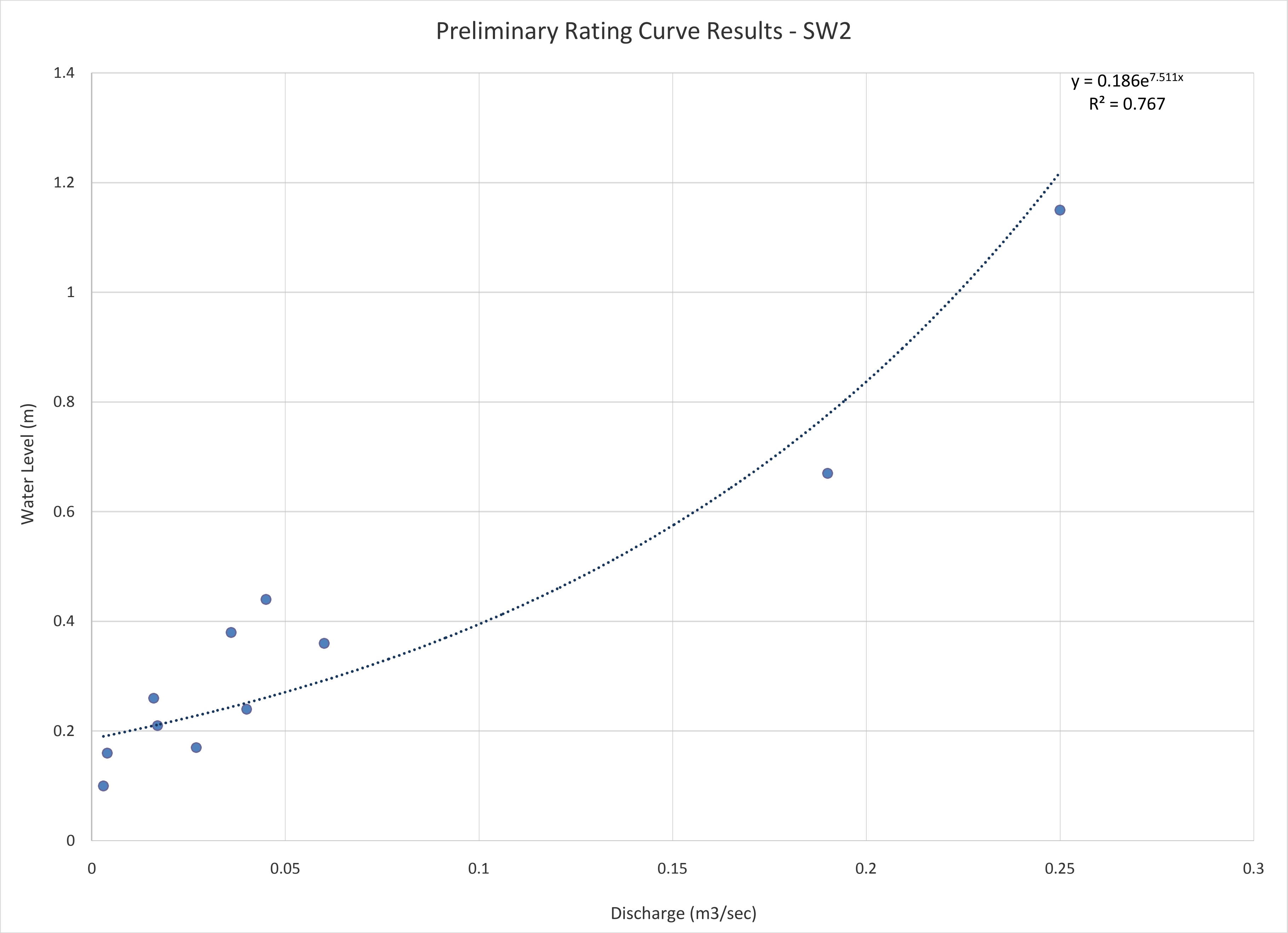
Surface Water Station	Water Level									
	25-May-22		06-Jul-22		20-Sep-22		08-Nov-22		13-Dec-22	
	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence	m	Flow Presence
SW-1	0.33	Limited Flow	0.18	Limited Flow	0.1	No Flow	0.15	No Flow	0.59	Moderate Flow
SW-2	0.26	Limited Flow	0.12	Limited Flow	DRY	No Flow	DRY	No Flow	0.93	Moderate Flow
SW-3	0.21	Limited Flow	0.15	Limited Flow	0.13	No Flow	0.13	No Flow	0.25	Moderate Flow
Pond-1	0.28	Pond Only	0.13	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow
Pond-2	0.38	Pond Only	0.18	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow
SG-1	0.01	No Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow
SG-2	0.55	No Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow
SG-3	0.11	No Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow
SG-4	0.07	No Flow	DRY	No Flow	DRY	No Flow	DRY	No Flow	FROZEN	No Flow

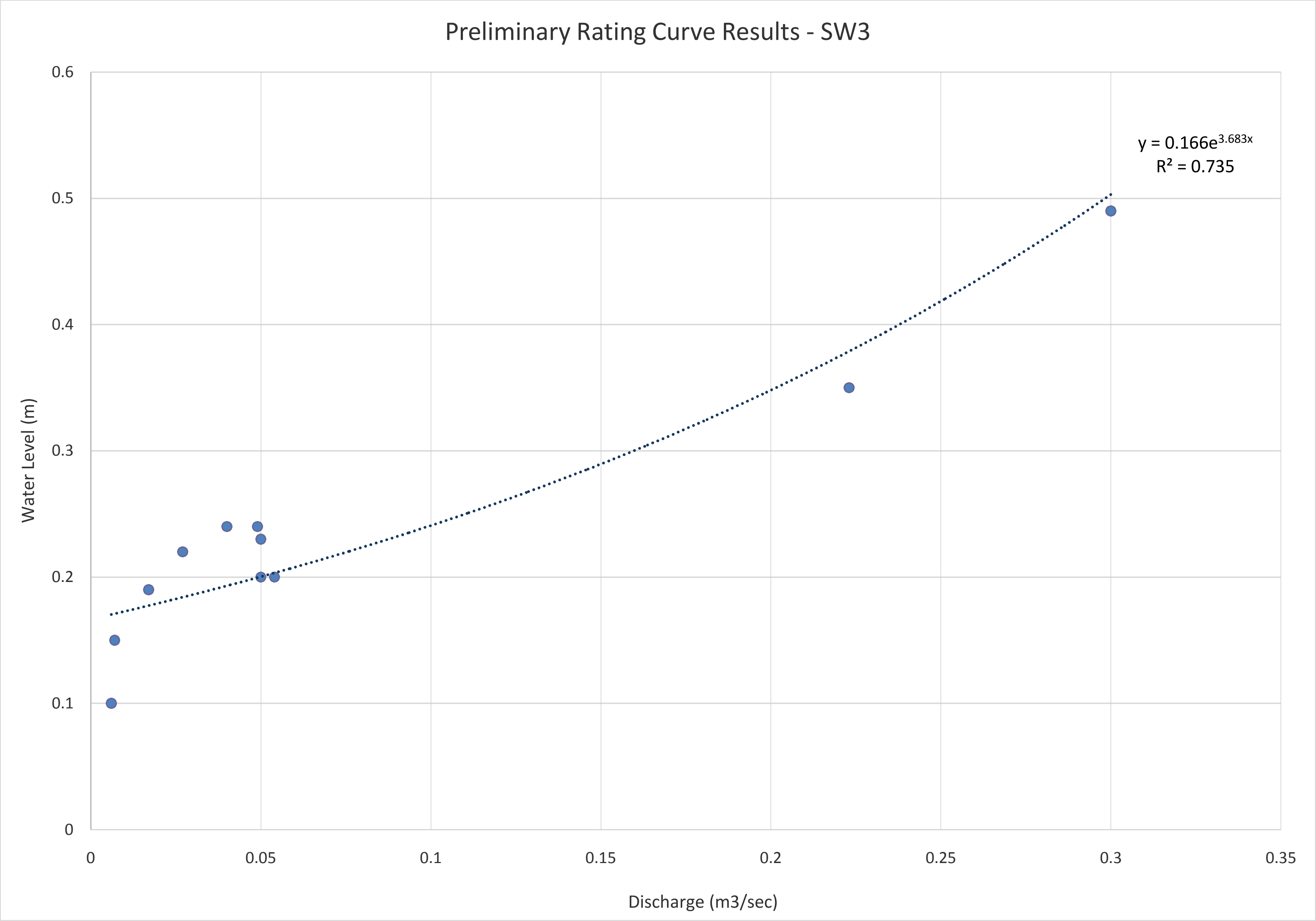

Hydrograph
Pond Stations - Water Level (m)
Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
9-May-20
7-Aug-20
5-Nov-20
3-Feb-21
4-May-21
2-Aug-21
31-Oct-21
29-Jan-22
29-Apr-22
28-Jul-22
26-Oct-22
Date and Time
Pond 1
Pond 2
Precipitation (mm)


Hydrograph
Surface Water Stations - Water Level (m)
Water Level (m)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
2020-05-09
2020-08-07
2020-11-05
2021-02-03
2021-05-04
2021-08-02
2021-10-31
2022-01-29
2022-04-29
2022-07-28
2022-10-26
Date and Time
SW1
SW2
SW3
Precipitation (mm)


Hydrograph
Surface Water Stations - Discharge (L/sec)
Discharge (L/sec)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
2020-05-09
2020-08-07
2020-11-05
2021-02-03
2021-05-04
2021-08-02
2021-10-31
2022-01-29
2022-04-29
2022-07-28
2022-10-26
Date and Time
SW1
SW2
SW3
Precipitation (mm)


Preliminary Rating Curve Results - SW1
Water Level (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Discharge (m3/sec)
0
0.05
0.1
0.15
0.2
0.25
0.3
y = 0.230e^6.827x
R² = 0.819


Preliminary Rating Curve Results - SW2
y = 0.186e^7.511x
R² = 0.767
Water Level (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Discharge (m3/sec)
0
0.05
0.1
0.15
0.2
0.25
0.3


Preliminary Rating Curve Results - SW3
y = 0.166e^3.683x
R² = 0.735
Water Level (m)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
Discharge (m3/sec)

Pond 1: Spring, May 2022

Pond 1: Summer, August 2022

Pond 1: Fall, November 2022

Pond 2: Spring, May 2022

Pond 2: Summer**,** August 2022

Pond 2: Fall, November 2022

SW-1: Spring, May 2022

SW-1: Summer, August 2022

SW-1: Fall, November 2022

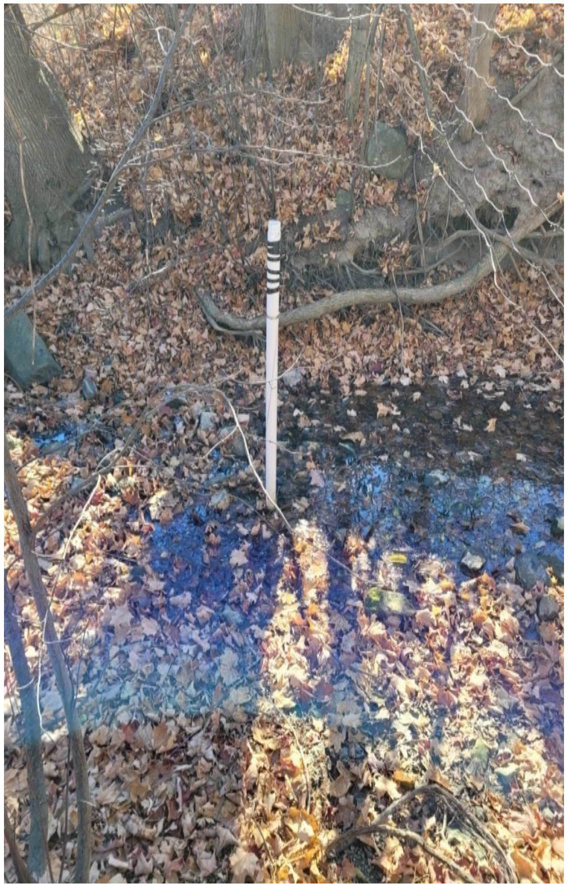
SW-2: Spring, May 2022

SW-2: Summer, August 2022

SW-2: Fall, November 2022

SW-3: Spring, May 2022

SW-3: Summer**,** August 2022



SW-3: Fall, November 2022

SG-1: Spring, May 2022

SG-1: Summer, August 2022

SG-1: Fall, November 2022

SG-2: Spring, May 2022

SG-2: Summer, August 2022

SG-2: Fall, November 2022

SG-3: Spring, May 2022

SG-3: Summer, August 2022

SG-3: Fall, November 2022

SG-4: Spring, May 2022

SG-4: Summer, August 2022

SG-4: Fall, November 2022

APPENDIX P

Author Qualifications and Experience

MICHAEL G. JONES

B.Sc., M.Sc., P.Geo.
Senior Hydrogeochemist
President

PROFILE

1995-Present	President, Azimuth Environmental Consulting, Inc.
2003-2005, 2008-2012	Faculty (part time), Georgian College (Professional Golf Management Program)
1987-1995	Hydrogeochemist, Senior Consultant, Gartner Lee Limited
1985-1987	M.Sc., University of Waterloo, Geology/Geochemistry
1985-1987	Research Assistant, University of Waterloo, Geology Dept.
1983-1985	Technician, University of Waterloo Isotope Research Laboratory
1983	Geophysical Exploration Technician, UMEX Inc.
1980-1985	B.Sc. (Honours Co-op), University of Waterloo, Geology

EXPERIENCE

1995 – Present President, Azimuth Environmental Consulting, Inc.

Mr. Jones is a founding member of Azimuth Environmental Consulting, Inc. Mr. Jones' areas of specialty include water supply and wastewater treatment, ground water geochemistry and contaminant hydrogeology. He provided expert testimony before the Ontario Land Tribunal, the Joint Board, the Ontario Municipal Board, the Environmental Review Tribunal and civil court.

He has undertaken a variety of projects, including:

- Lead hydrogeologist for construction of Highway 407 Phase 2. This project includes assessment of construction dewatering requirements at more than 100 structures and obtaining Permits to Take Water for all activities that may reach the water table. It also includes an active monitoring programme for ground water levels at an extensive well network and at major stream crossings and terrestrial ecology sites to evaluate the potential and actual changes caused by the highway. Participation with BBC staff and in working group meetings, and liaison with key staff at regulatory agencies is required to address potential issues as they arise.
- Project manager and hydrogeologist for the Ministry of Transportation providing an assessment of road salt or construction blasting impacts. These investigations include an assessment of the physiographic setting, surface drainage and hydrogeology. An assessment is made of potential contaminant sources, pathways to the contaminated well and well status. Recommendations are made regarding possible remedial measures. This work has included a broad spectrum of investigations over more than two decades, including regional studies of the Highway 11 and 118 corridors to evaluate whole communities, investigations at salt storage yards and works yards, a review of potential salt impacts in Emsdale pertaining to whole community, which has become a class action lawsuit and approximately 400 well assessments to consider causal relationships for water quality and quantity problems. From this work, Azimuth prepared the MTO protocol for pre-construction well testing and baseline evaluations.

- Lead investigator for a research project to evaluate chloride sources in a small rural watershed. This project was jointly funded by the National Research Council of Canada, MTO and Azimuth. Potential sources include road salt, water softener salt, septic discharge and agrichemicals. The study utilizes inorganic and isotopic analyses to differentiate chloride sources and determine the relative mass contribution from the various sources.
- Lead investigator for water supplies and more than 200 Permits to Take Water. Water-takings have included those for irrigation, potable water, quarries, construction dewatering and commercial taking for spring water, bottled water and beverage production. Work has included hydrogeological evaluations to document the ground water regime for proposed water supplies and consideration of potential impacts from the proposed taking to other users and natural heritage features. For complex environments or large takings, Modflow is used to simulate the takings and predict the potential drawdown for specific receptors.
- Lead investigator and environmental consultant for ClubLink Corporation at 28 of their properties. These studies have focused on aspects of water management, from supply for irrigation and potable needs to sewage treatment. Water management is a central requirement for a successful golf facility, so water issues are incorporated at the beginning of development plans. We have succeeded in finding innovative solutions where site limitations would have precluded a golf facility. Monitoring of potential impacts from chemical products and treated effluent applications is completed routinely and environmental impacts are evaluated. ClubLink is obtaining Audubon Signature designation at their courses so stewardship programs for water management and environmental practices have been developed. Azimuth has assisted ClubLink in obtaining MOE permits to take water, sewage system permitting and to operate potable water treatment systems. Similar work has also been completed for several other golf properties.
- The annual ground water, surface water and leachate monitoring programs at approximately 15 landfills in central and northern Ontario. These programs involve the collection and analysis of samples and site data throughout the year to evaluate the performance of the site. Most of the sites have been designed to naturally attenuate contaminants, so that routine monitoring is important in assessing regulatory compliance. Since 1995, more than 250 annual investigations have been completed.
- Design and approvals for leachate collection and treatment systems at four rural landfill sites. The systems include on-site treatment using a tertiary treatment system and discharge of treated effluent to either a leaching field or direct discharge to wetlands or a small creek. The systems provide contingency mitigation in the event that predicted impacts from natural attenuation become unacceptable. At one site, the LTS provides the main leachate control and has resulted in the reduction of environmental discharges by 95%.
- Phase I/II assessments of commercial and industrial properties. These assessments focus on previous and current land use and the potential for contaminant impact. Assessments typically include test pitting, visual assessment of the lands and premises and the collection of soil and water samples for analysis.

- Project director and environmental consultant for M.A.Q. Quarries. Conducted Level 2 hydrogeologic investigations at prospective quarry sites in Severn, Ramara (Carden Plain), Duntroon and Port Colborne. Work program involves fracture network evaluation using packer testing system, continuous water monitoring using dataloggers, geochemical profiling, surface water monitoring and numerical modeling of the environmental setting. Program provided represent contemporary standards for fractured rock site evaluation as recommended and accepted by the client.
- Project hydrogeologist for approximately 50 geothermal projects. Examples include services for a police headquarters, an MNRF office, an airport terminal, a large federal office tower in downtown Toronto, apartment buildings and seniors complexes. Work included preparation of the drilling ECA or site-specific ECA, preparation of PSP's, high pressure gas training and drilling monitoring and safety checklists.
- Project manager and lead investigator for hydrogeological studies, and water and wastewater system implementation for approximately thirty rural and communal facilities. These projects have included public systems (EAA, EPA and OWRA approvals) as well as private systems (EPA and OWRA approvals). The projects offer complete assessments, from delineation of available water supplies, appropriate potable water treatment needs, sewage and wastewater collection and treatment, discharge of treated effluent, water budgets, implementation of LID's and site monitoring. Opportunities are defined and then approvals are sought to meet provincial and municipal requirements. At several sites, treated effluent has been incorporated into irrigation supply to allow re-use and recognize the additional treatment benefits when treated effluent is applied to turf. The systems have been designed to satisfy water demand from 10 to 2,200m^3/day. Sewage treatment systems have been designed for 10 to 650m^3/day. Examples of these systems include golf clubhouses (e.g. The Rock and Mad River Golf Club), rural subdivisions (e.g. Balsam Lake), new urban subdivisions (e.g. the Greenwood expansion, Westhill (Aurora), Villages of Shakespeare and Minett) and resorts with mixed waste streams (e.g. Red Leaves in Minett, the Muskokan Resort, Lakeside at Rocky Crest).
- Project manager and lead investigator for Class EA approvals for water and wastewater. These projects have included new systems for Baxter, Minett, Aurora, Greenwood, Sebringville and Shakespeare. In a sixth project, I provided peer review of technical reports for Bradford – West Gwillimbury for the proposed Bradford-Bondhead expansion.
- Lead hydrogeologist for the peer review of two proposed gold mine sites in Northern Ontario (Federal Class EA). Our review was completed as part of a multi-disciplinary team on behalf of our clients, two First Nations communities where the mine sites are located within their historical use areas. Susbsequent programmes with the First Nation with implementation of mine facilities and a First Nation Fuel Depot.
- Lead investigator for investigations regarding the alleged parasite (*Giardia*) contamination of the south municipal water supply for the City of Thunder Bay. These forensic investigations were undertaken as the municipality is the defendant in a number of on-going civil court cases. Our investigations identified that *Giardia* in the water source during the alleged period of contamination reflected background conditions consistent with those over the last 90 years, and that an outbreak did not occur.
- Reviewer for the MOE Ground water Under the Influence (GUDI) Water Supply Program. Following the Walkerton Inquiry, the MOE retained thirty individuals across

the province to review GUDI reports on public water supplies. These reports assessed the minimum treatment requirements for public supplies that may be susceptible to surface water infiltration. Mike reviewed seven of these reports for the MOE.

- Lead investigator for a research project to evaluate chloride sources in a small rural watershed. This project was jointly funded by the National Research Council of Canada, MTO and Azimuth. Potential sources include road salt, water softener salt, septic discharge and agrichemicals. The study utilizes inorganic and isotopic analyses to differentiate chloride sources and determine the relative mass contribution from the various sources.

PROFESSIONAL AFFILIATIONS, CERTIFICATION & TRAINING

- Professional Geoscientists of Ontario
- Ontario Onsite Wastewater Association
- Drinking Water System Operator – Limited Ground Water Systems
- Professional Geoscientists of Ontario Discipline Committee 2005 to current, Secretary for 2010-2012, Vice-chair 2012-2014, Chair 2014-2016, 2018-2020
- Association of Ground Water Scientists and Engineers (NGWA) (1990 to present)
- Canadian Water Resources Association (2008 to present)
- International Association of Hydrogeologists - IAH Newsletter Editor from 1989 to 1992
- St. John Ambulance Standard First Aid and CPR
- safety training: WHMIS, confined space hazards, emergency preparedness

PUBLICATIONS AND PRESENTATIONS

Jones, M.G. Thermal Impacts and Mitigation Monitoring for a stormwater pond to protect aquatic species at risk, Presentation to TRCA/MNRF Thermal Mitigation Working Group – Workshop, March 2017

Jones, M.G. Guidelines and Standards for Environmental Site Audits, presentation at Georgian College, annually from 2013 to 2019

Ketcheson, D. and M. Jones, "Quarry Influences on Ground Water Systems in Limestone Environments of Southern Ontario" National Ground Water Association Conference on Ground Water in Fractured Rock and Sediments, September 23-24, 2013, Burlington, VT

Part-time Faculty, Environmental Law, Georgian College, 2003- 2005, 2008-2012 winter terms, teaching in the Professional Golf Management Program

Jones, M.G. Denitrification – the next step in sewage treatment. paper and presentation at Ontario On-Site Wastewater Association annual conference, March 2009.

Jones, M.G. Hydrogeology of the Oro Moraine, presentation to MPP Dunlop's Community Awareness public forum, September 2008.

Jones, M.G. MOE Approvals for Large On-Site Sewage Treatment Systems. paper and presentation at Ontario On-Site Wastewater Association annual conference, March 2008.

Well Aware Seminars, APGO Community Programs in Durham and Haliburton, 2004

Jones, M.G. and McDonald, N. Natural Heritage Planning for the Oro Moraine (the Other Moraine). Presentation at the Power of Place Conference, OPPI/OPLA, Sept 2003

Wallis, P.M., D. Matson, M. Jones, and J. Jamieson. Application of monitoring data for *Giardia* and *Cryptosporidium* to boil water advisories. Risk Analysis. vol 21, no. 6, 2001

Jones M.G. Factors Controlling Leachate Quality and Quantity. Lecture for the MOE Landfill Design Course, 2001.

Jones M.G. Factors Controlling Leachate Quality and Quantity. Lecture for the MOE Landfill Design Course, 2000.

Wallis, P, Matson, D, Jones, M.G. and Jamieson, J., Risk of Waterborne Giardiasis Based on Monitoring Data, paper and presentation at 9th Drinking Water Conference, Regina, May 2000.

Jones, M.G., Descriptive Hydrogeology and Ground Water Issues in New Tecumseh, presentation at the New Tecumseh Environmental Conference 2000, March 2000 (televised)

Jones, M.G., Environmental Issues and Approvals for Golf Course Development, presentation at Georgian College, Barrie, Jan 2000.

Jones, M.G., Golf Course Development: Permitting Requirements, presentation at Georgian College, Barrie, Jan 1999.

Jones, M.G. and Ketcheson, D.R.., Chloride contamination of water supply wells and identification of chloride sources for sites located on the Canadian Shield, presentation and paper, Ground water in a Watershed Context conference, CCIW, December, 1998

Jones M.G. Hydrogeological Considerations, Leachate Quality and Quantity and Landfill Monitoring. Lectures and paper for the MOE Landfill Design Course, 1998.

Zaltsberg, E., Jones, M. and Gehrels, J.. A trigger mechanism for evaluating the landfill impact on water quality. Paper and presentation, GAC/MAC, Quebec, May 1998

Jones, M., Neals, P. and Van Barr, C.C.. “An ounce of prevention...can save a property transfer/ development/purchase” article in BBN Magazine Business and Leisure, June/July 1996

Kassenaar, D., Jones, M. and Gartner, J.. Wellhead Protection. WaterPower Magazine. Fall 1995.

Jones, M.G. Sanitary Landfill Leachate and Gas Management. Chair of seminar, University of Toronto, Educational Program Innovations Center, April 13-14, 1994.

Jones, M.G. Leachate Quality and Characteristics. Paper and Presentation for seminar on "Sanitary Landfill Leachate and Gas Management", University of Toronto, April 13, 1994.

Jones M.G. Factors Controlling Leachate Quality and Quantity. Lecture for the MOE Landfill Design Courses, 1993 and 1991.

Frape, S.K., Blyth, A.R., Jones, M.G., Blomqvist, R., Tullborg, E.L., McNutt, R.H., McDermott, F. and Ivanovich, M. A comparison of calcite fracture mineralogy and geochemistry for the Canadian and Fennoscandian Shields. Presentation and proceedings of the 7th International Symposium on Water-Rock Interaction, WRI-7, Utah, USA, July 1992.

Leech, R.E.J.L., Reynolds, G.W. and Jones, M.G. Protection of Thin, Low Yielding Aquifers through Considerate Landfill Design: The Result of Public Demand. Paper and presentation to the AWWA/OMWA 1992 Joint Annual Conference, April 1992.

Rowe, R.K. and Jones, M.G. Conceptual Design of the Halton Landfill, presentation to the Canadian Geotechnical Society, southern Ontario Section, at the MTO Atrium Tower, Toronto, January 1992.

Jones, M.G. Factors controlling the character of municipal landfill leachate in Ontario. Paper and Presentation for seminar on "Sanitary Landfill Leachate and Gas Management", Technical University of Nova Scotia, September, 1991.

McNutt, R.H., Frape, S.K., Fritz, P., Jones, M.G. and MacDonald, I.M. The $^{87}Sr/^{86}Sr$ values of Canadian Shield brines and fracture minerals with applications to ground water mixing, fracture history and geochronology. Geochimica et Cosmochimica Acta, January 1990.

McNutt, R.H., Frape, S.K., Jones, M.G. and MacDonald, I.M. The $^{87}Sr/^{86}Sr$ of Canadian Shield brines and fracture minerals with applications to ground water monitoring, fracture history and geochronology. Geochemical Cosmochemistry Association 1989.

Love, D., Frape, S.K., Gibson, I. and Jones, M.G. The ^{18}O and ^{13}C isotopic composition of secondary carbonates from basaltic lavas cored during the drilling of hole 642E, Ocean Drilling Program Leg 104. "Part B of the Initial Report for Leg 104", Proceedings of the Ocean Drilling Program, Scientific Results, 1989.

Jones, M.G., Frape, S.K., Fritz, P., and Gibson, I.L. A study of late-stage secondary fracture mineralogy at sites across the Precambrian Canadian Shield and at the Stripa, Sweden site. Internal publication and presentation for the Walker Mineralogical Club, Toronto, 1987.

Jones, M.G., Frape, S.K. and McNutt, R.H.. A study of the geochemistry and isotopic composition of late stage secondary fracture mineralization at the Underground Research Laboratory, Pinawa, Manitoba. Final Report to AECL, June 1987.

Jones, M.G. A study of the late-stage secondary fracture mineralization at sites across the Precambrian Canadian Shield, unpub. M.Sc. Thesis, University of Waterloo, 1987.

McNutt, R.H., Frape, S.K., Jones, M.G. and Fritz, P. The $^{87}Sr/^{86}Sr$ values of brines in rocks of Archean age, Matagami area, Quebec: a contrasting behavior to other Canadian Shield brines. International Association of Geochemistry and Cosmochemistry Fifth International Symposium on Water-Rock Interaction, Reykjavik, Iceland, August 1986. Extended abstract, poster session and presentation, 1986.

Jones, M.G. A study of the late-stage secondary fracture mineralization at sites across the Precambrian Canadian Shield, unpub. B.Sc. Thesis, University of Waterloo, 1985.

BRADLEY PETTERSONE

B.Sc. in Environmental Science
Environmental Scientist

PROFILE

2018 – *Present*	Environmental Scientist, Azimuth Environmental Consulting, Inc. (Azimuth)
2014 - 2018	Senior Environmental Technician, Oakridge Environmental Ltd. (ORE)
2013	Environmental Field Technician *(Contract),* Kawartha Conservation (KRCA)
2011 – 2012	B.Sc. in Environmental Science, Royal Roads University (RRU)
2010	Watershed Monitoring Technician *(Contract)*, Nottawasaga Valley Conservation Authority (NVCA)
2008 – 2011	Advanced Diploma in Environmental Technology, Georgian College (GC)

EXPERIENCE

March 2018 - Present Environmental Scientist, Azimuth Environmental Consulting, Inc.

Primarily undertakes projects related to the field of Environmental Science and Hydrogeology, supporting the Hydrogeology and Engineering team at Azimuth with a focus projects related to water resources and earth science in Ontario.

Professional experience at Azimuth involves projects related to:

- *Landfill monitoring* (groundwater, surface water, leachate and landfill gas) and reporting for historical and active landfill sites in the City of Kawartha Lakes and Parry Sound District;
- *Phase I Environmental Site Assessments* including: historical data analysis, interpretation, site reconnaissance and interviews development of conceptual site models and technical report writing;
- *Phase II Environmental Site Assessments (ESA)*, including: developing sampling and analysis plans, test pit programs, environmental drilling programs, soil and groundwater sampling, database management, remedial activities (*i.e.,* UST removal) and technical report writing;
- *Environmental Remediation and Tank Removal* projects which include developing programs to remedy soil impacts from petroleum hydrocarbons (PHC), heavy metals, and volatile organic compounds (VOC). Includes technical closure reporting.
- *Record of Site Condition (RSC)* projects completed to the Ontario Regulation 153/04 (as amended) for the purpose of filing for Record of Site Condition;
- *Ministry of Environment, Conservation & Parks (MECP) Guideline D-4* (Land Use on or Near Landfills and Dumps) Assessments in conjunction with Municipal policy guidelines for commercial and residential developments near landfills in the County of Simcoe;
- Hydrogeological Studies supporting *Permit To Take Water* applications and Environmental Activity and Sector Registry (EASR) registration for storm water, commercial and construction projects throughout Ontario;
- *Water Supply Assessments* (MECP D-5-5) for commercial, subdivision/severance and residential developments throughout Southern Ontario, which include a review MECP

well records, pumping tests, aquifer assessment and analysis, water quality sampling, database management and technical report writing;

- *Level 1 and 2 Hydrogeological Evaluation* for Aggregate Resource Assessments for proposed aggregate resource developments in Ontario. Field Lead for a proposed limestone quarry expansion in Burlington, ON. Project Coordinator and Field Lead (surface and ground water components) for a proposed limestone quarry in Brechin, ON. Field program and project coordination components include: environmental drilling (HQ coring) and monitoring well installation, hydraulic testing and analysis, packer testing and analysis, pumping tests, long-term ground water monitoring, environmental database management, and technical report writing;
- Hydrogeological Evaluations (and detailed borehole logging) for supporting the construction of *Vertical Closed-loop Geothermal Systems* for projects across Ontario;
- Hydrogeological Evaluations for supporting the construction of *Open-Loop Vertical Geothermal Systems*. Including the implementation at Muskoka Landing Retirement Residence in Huntsville, Ontario. This included in-situ testing of the well field, which was comprised of pumping tests, reinjection testing and a geochemical assessment.
- *Wastewater Design and Assimilative Capacity Studies* for supporting sustainable wastewater disposal and potential impacts to water bodies. Includes: septic sizing and design, impact assessment and field monitoring (i.e., stream flow and surface water sampling); and
- Additional projects and tasks that support the Hydrogeology team include:
  - Technical support for a MTO Chloride investigation in Emsdale, ON;
  - Field and Technical support for Highway 407/ETR surface and ground water monitoring program;

2014 - 2018 Environmental Technician/Senior Environmental Technician, Oakridge Environmental Ltd. (ORE)

Supported Project Managers by organizing, scheduling and completing environmental field investigations for a variety of ecological, compliance and hydrogeological projects. Responsible for developing and maintaining internal/project Geographic Information System (GIS) databases along with preparing maps, figures and other design plans for inclusion into technical reports. Lead technician for all mapping projects using a differential Global Positioning System (dGPS), with data post-processing capabilities. Moreover, office duties also included proposal and budget preparation for new projects, technical report writing and liaising with clients.

Hydrogeological and compliance experience includes:

- Compliance Monitoring: Responsible for completing ground- and surface water monitoring, database management and/or annual reporting activities for:
  - Three (3) "Class A" Aggregate Operators (below the water table) in Eastern Ontario, as per PTTW and ECA permits issued by the MOECC;
  - Two golf course facilities, as per PTTW and ECA permits;
  - Multiple privately owned Large Subsurface Disposal Systems (LSSDS) regulated by ECA permits in Ontario;
  - A bulk waste transfer facility in Bowmanville, ON, as per an ECA permit; and
  - Multiple large-scale construction projects, including the Mississagua Lake Dam Replacement project on the Trent-Severn Waterway for Park's Canada

- Hydrogeological and Site Servicing Studies: Managed and organized soil exploration and drilling (including hydrofracturing) programs, as well as pumping tests using standardized protocols (i.e., D-5-5), which supported many subdivision, condominium and commercial developments applications
- Phase I ESA: Assisted Compliance Specialist in completing projects to both CSA and RSC standards - tasks included: compiling and reviewing background data (i.e., Historical Air Photos, Ecolog ERIS, etc.), initial site inspections, data management and technical report writing
- Phase I ESA: Organized and supervised field investigations for projects, including developing sampling and analysis plans, environmental drilling, soil and groundwater sampling, database management, and technical report writing
- Level 1 and 2 Hydrogeological Investigations: Organized and supervised multiple hydrogeological field investigations for proposed and expanding aggregate resource development projects in Northern and Eastern Ontario; including a diamond drilling program for a Structural Geology Investigation to grade aggregate quality
- Groundwater Supply Investigations: Lead and organized field programs related to multiple groundwater supply investigations for First Nation Communities, including Curve Lake First Nation, Nippising First Nation and Chapleau Cree First Nation.
- Other relevant projects and field investigations include:
    - Project Manager for a Water Table Determination Investigation for an expanding dimensional stone quarry in Madoc, ON;
    - Completed multiple sewage system inventories using ground penetrating radar (GPR) for campgrounds and resorts situated in Eastern Ontario;
    - Proficiently completed many mapping and surveying exercises using a dGPS and survey levels for a wide variety of hydrogeological and compliance projects, including: terrain mapping, private utility surveys and water table determination.

Natural Environment experience includes:

- Project Coordinator for various technical studies including: Environmental Impact Studies (EIS), Natural Environment Assessments (NEA) and Natural Heritage Evaluations (NHE)
- Developed SAR GIS database for Georgina Island First Nation, as part of their community planning initiatives
- Completed Species at Risk (SAR) assessments, including nocturnal surveys for amphibians (i.e., Western Chorus Frog), nightjars (i.e., Eastern Whip-poor-will and Common Nighthawk) and bats (i.e., *Myotis sp.*).
- Routinely conducted wetland delineation (OWES) and vegetation community mapping (ELC), in addition to biological inventories for projects located in Southern Ontario
- Completed bat snag and acoustic surveys using the Ministry of Natural Resources and Forestry (MNRF) protocols for development projects in Southern Ontario
- Additional surveys and activities included:
    - Fish identification and relocation for multiple large-scale construction sites, including the Lock 22 Rehabilitation and the Mississagua Lake Dam Replacement along the Trent-Severn Waterway for Park’s Canada;

    - Assisted in the planning (and supervised) the construction of a permanent turtle fence at the Blue Mountain Mine (operated by Unimin Canada ltd.); and
    - Designed and completed fieldwork, mapping and statistical analysis for a tree loss/retention program for a proposed resort development on Rice Lake, where the objective was to estimate tree loss, tree retention and compensatory planting requirements, including over 100 Butternut trees.

2013 (Contract) Environmental Field Technician, Kawartha Conservation (KRCA)

- Routinely coordinated and conducted water quality and quantity sampling at thirty (30) tributaries and several lakes inventorying results into databases and spreadsheets
- Performed and coordinated groundwater quality sampling at ten (10) long-term monitoring wells following PGMN protocols created by the MOECC
- Installed and maintained environmental monitoring equipment such as: rain gauges, water level loggers, and staff gauges
- Analyzed and interpreted five (5) years worth of water quality data for the CAMC: Oak Ridge Moraine Assessment Plan
- Developed an Access database for inventorying twelve (12) years worth of groundwater quality data for ten long-term monitoring wells
- Prepared an annual report and presentation for the Working Group for a Healthy Lake Scugog and presented actions and key considerations to the Scugog Lake Stewards

2010 (Contract) Watershed Monitoring Technician, Nottawasaga Valley Conservation Authority (NVCA)

- Mapped and identified aquatic macrophyte communities in Orr Lake using a GPS, Ekman dredge, and ArcGIS in partnership with the MNRF
- Collected groundwater quality samples and static water level data for the Environment Canada study outlining the “Hydrogeochemical Characterization of the Eastern Minesing Wetlands”
- Performed groundwater quality sampling as part of the PGMN in partnership with the MOECC
- Regularly collected general water quality data and water samples as part of the PWQMN
- Routinely collected and identified benthic macro-invertebrate specimens using OBBN protocols
- Conducted baseflow surveys throughout subwatersheds during low-flow conditions

AFFILIATIONS, CERTIFICATIONS AND TRAINING

- Sustainability Advisory Committee Member (Chair), Town of Gravenhurst (2022-2026)
- Standard First Aid (Ontario)
- WHMIS
- Pleasure Craft Operator Card
- Assistant Well Technician