

Prepared By:



Pinnacle Building Group Corp.

Hydrogeological Study for Rowhouse Development: 209806 and 209808 HWY 26

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PINNACLE BUILDING GROUP CORP.**HYDROGEOLOGICAL STUDY FOR ROWHOUSE DEVELOPMENT: 209806 AND 209808 HWY 26****GMBP FILE: 221418****AUGUST 4, 2022**

1. INTRODUCTION

GM BluePlan Engineering Limited (GMBP) have been retained by Pinnacle Building Group Corp (the Client) to provide hydrogeological services in support of planning and development applications (e.g. Official Plan Amendment) for a proposed residential development to be located at 209806 and 209808 Highway 26, Town of the Blue Mountains (the “Site”). Figure 1 shows the location of the Site in a sub-regional context.

1.1 Purpose and Scope

The purposes of this hydrogeological study report are to characterize the hydrogeological condition of the Site, to identify potential hydrogeological impacts that may result due to the proposed development, and to propose monitoring and mitigation measures, as appropriate.

The scope of the hydrogeological study includes:

- Desktop study, including review of various maps, reports, and provincial databases and publications with respect to the geological and hydrogeological setting of the Site
- Completion of a field investigation, including sampling and analysis of groundwater samples, monitoring of groundwater levels, and completion of slug testing on monitoring wells installed by the geotechnical engineering consultant.
- Construction dewatering assessment to identify potential requirements for approvals (e.g. Permit to Take Water or Environmental Activity and Sector Registry)
- Impact assessment to identify potential impacts with respect the construction and/or operation of the proposed development.

2. BACKGROUND**2.1 Site Location and Setting**

The Site is approximately 0.66 ha in size, is located in the Town of the Blue Mountains, and is described as follows:

- 209806 and 209808 Highway 26, Town of the Blue Mountains
- Part of Lot 20, Concession 1, Geographic Township of Collingwood

- Assessment Roll Numbers: 42420000030340103406 and 42420000030341000000

Nottawasaga Bay (part of Lake Huron) is located approximately 300 m to the north of the Site and the Niagara Escarpment is located approximately 2.3 km southwest of the Site.

Land use in the vicinity of the Site is primarily residential, with some commercial services and accommodations (e.g. hotels). Adjacent to the east side of the Site is a gas station.

Figure 2 shows an aerial view of the Site and Study Area (the area within 500 m of the Site).

2.2 Proposed Development

The Site is proposed to be developed for residential use featuring two 5-unit townhouse buildings, one 4-unit townhouse building and one 3-unit townhouse building as well as associated visitor parking areas. There will be three open space blocks combining for a total open space area of approximately 2,325 m².

A conceptual plan of the proposed development is provided in Appendix A.

2.3 Local Relief and Drainage

The lands in the vicinity of the Site are relatively flat, with ground elevation in the range of 183 masl along the railway line that passes to the south of the Site to about 176 masl at the shore of Nottawasaga Bay (Ontario, 2021)

Locally, drainage is dominated by the Niagara Escarpment. Well-defined gullies and stream channels descend the face of or emerge at the toe of the Escarpment, and the pattern of streams in the lowland appear to indicate influence from bedrock, with flow directions generally being tangent or perpendicular to the toe of Escarpment (Ontario, 2021). These streams ultimately discharge to Nottawasaga Bay.

Wetland features belonging to the Silver Creek wetland complex lie to the south of the Site at a distance of about 200 m and to the northeast of the Site at a distance of about 250 m (Ontario, 2021). A small stream, which originates from the toe of the Niagara Escarpment and passes through the wetland area to the south, flows northward at a distance of about 270 m to the west of the Site and discharges to Nottawasaga Bay.

2.4 Geology and Physiography

The Site is located within the Simcoe Lowlands physiographic region (Chapman & Putnam, 2007), which is characterized by lacustrine and deltaic deposits owing to inundation by earlier lakes (e.g. Lake Algonquin, Lake Nipissing) (Chapman & Putnam, 1984). The physiographic landforms of the Site are mainly beaches and sand plains, with the Site overlying a beach feature and sand plans covering the space between the Site and Nottawasaga Bay (Chapman & Putnam, 2007). Figure 3 shows the distribution of physiographic landforms in the vicinity of the Site.

The surficial geology of the Site is glaciolacustrine sand, though to the south and west of the Site are outcrops of the Whitby Formation bedrock (Ontario Geological Survey, 2010). Figure 4 shows the distribution of the surficial geological materials in the vicinity of the Site.

The bedrock that subcrops below the Site belongs to the Simcoe Group (Ontario Geological Survey, 2011). The Simcoe Group is a set of five rock formations (Lindsay, Verulam, Bobcaygeon, Gull River,

and Shadow Lake) of the Middle Ordovician period which are generally argillaceous limestones or calcareous shales (Armstrong & Dodge, 2007). Local water well records (Ministry of the Environment, Conservation and Parks, 2021) indicate that bedrock lies approximately 7 mbgs (metres below ground surface).

2.5 Local Use of Groundwater

It is understood that municipal services are generally available in the area. However, there are numerous water well records located within 500 m of the Site (see Figure 5).

Table 1 provides a summary of information from the local water wells. It is noted that most of the wells are bedrock wells, including all of those identified to be for supply (e.g. domestic, commercial) uses.

2.6 Source Protection

A review of the MECP Source Protection Information Atlas (Ministry of the Environment, Conservation and Parks, 2021) indicates that the Site does not overlap the following types of vulnerable areas:

- Intake Protection Zones (IPZ)
- Wellhead Protection Areas (WHPA)
- Groundwater Under the Direct Influence of Surface Water (GUDI)
- Event Based Areas (EBA)
- Issue Contributing Areas (ICA)

Based on this condition, and following confirmation by correspondence with the Grey Sauble Conservation Authority, it is understood that the proposed development will not require a Section 59 clearance notice.

2.7 Relevant Local and Site-Specific Reports

2.7.1 Geotechnical Report (February 2022) – CMT Engineering Ltd.

CMT Engineering Limited completed a report documenting the findings of a geotechnical investigation completed at the Site (CMT, 2022). The investigation included the advancement of six boreholes (BH1 through BH6) to varying depths (about 4.4 mbgs to 6.5 mbgs) on the Site. Four of the boreholes were completed as monitoring wells. The drilling was completed in collaboration with GMBP and with Rubicon Environmental (2008) Limited to support the requirements of the concurrent hydrogeological and environmental investigations, respectively.

The monitoring well and borehole logs (prepared by CMT) are provided in Appendix B. The locations of the monitoring wells and boreholes are shown on Figure 6.

Generally, the stratigraphy on-Site is described as:

- Topsoil, overlying
- Fill, overlying,
- Sand, overlying
- Sandy Silt

The Fill was generally of sandy consistency with trace silt and clay and some to no gravel. The Fill material was not encountered at BH3 or BH4. Where it was encountered, it was in the range of 0.97 m to 1.52 m thick.

The Sand unit was brown to grey with trace silt and clay. It had varying density from very loose to very dense. It was encountered in all borehole locations, with thickness varying from about 3 to 4 m in locations where the Sandy Silt was encountered: in some locations it extended to the full depth of investigation (e.g. BH3, BH4, and BH5, which were each terminated at depths of about 4.5 mbgs). It is noted that groundwater level measurements corresponded to elevations above or near the top of the Sand layer, indicating that across the Site this unit is generally saturated.

The Sandy Silt unit was reported to be grey sandy silt with some clay and trace gravel. It was found below the Sand layer in BH1, BH2, and BH6 and was generally compact to very dense.

Though bedrock was not recovered from sampling nor directly observed during investigation, CMT notes that it is possible that bedrock was the cause of drill refusal at BH1, BH2, and BH6 at depths of about 6.5 mbgs, 6.1 mbgs, and 6.2 mbgs, respectively. CMT notes that this corresponds relatively well with the depth to bedrock noted in nearby MECP water well records.

CMT also completed grain-size distribution analyses on four samples: three on samples taken from the Sand layer and one on a sample taken from the Sandy Silt. The grain-size distribution plots are provided in Appendix B. From these grain-size analyses, CMT interpreted approximate hydraulic conductivity ("coefficient of permeability") of the Sand material to be on the order of 10^{-4} m/s and of the Silty Sand layer to be on the order of 10^{-7} m/s. Though the surficial sand materials are very permeable, CMT notes that "potential infiltration rates will be significantly reduced due to the typically wet state of the native soils in the boreholes".

2.7.2 Environmental Testing (January 2022) – Rubicon Environmental (2008) Ltd.

Due to the proximity of the Site to the adjacent gas station, Rubicon Environmental (2008) Ltd. was retained by the Client to undertake environmental investigations of the Site, including the collection and laboratory analysis of groundwater samples for select Contaminants of Potential Concern.

Samples were collected from monitoring wells MW1, MW2 and MW3 (these correspond to the BH1, BH2, and BH3 monitoring wells as installed by CMT, respectively) and submitted to PH Quantum analytical laboratory (a member of CALA) in Mississauga for analyses of the following parameter sets per *Ontario Regulation 153/04*:

- Metals
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Volatile Organic Compounds (VOCs, including BTEX)
- Petroleum Hydrocarbon Fractions F1 through F4 (PHCs F1-F4)

The certificate of analysis is provided in Appendix C.

The analyses showed that the concentrations of all PAH, VOC, and PHC parameters fell below the method detection limit. Some metals were detected but the concentrations identified appear to be typical of overburden groundwater chemistry and do not indicate environmental impacts.

3. FIELD INVESTIGATION

3.1 Methodology

On January 12, 2022, Corbin Sweet, P.Geo., of GMBP attended the Site to conduct an investigation to characterize the hydrogeological conditions on the Site. The investigation included the following:

- i. Collection of groundwater samples from the onsite monitoring wells installed in the boreholes completed by CMT Engineering (i.e. BH-1, BH-2, BH-3, and BH-6),
- ii. Completion of hydraulic conductivity testing in each of the four onsite monitoring wells via slug tests.
- iii. Analysis of slug testing data using AquiferTest 9.0 software to model the soil permeability in each monitoring well, and
- iv. Precise measurement of groundwater table elevations and survey of monitoring well components in order to accurately determine the direction of groundwater flow and infer the depth to groundwater across the Site.

3.1.1 Groundwater Sampling

At the time of the GMBP Site visit on January 12, 2022, 5/8" polyethylene tubing and Waterra foot valves were installed in each of the monitoring wells. Each of the monitoring wells on the Site (i.e., BH1, BH2, BH3, and BH6) were sampled as part of this program.

Prior to sampling, each of the wells were purged of three well volumes of water. After purging, monitoring wells were allowed to recharge with fresh groundwater before sampling occurred. Samples were collected using standard laboratory supplied containers appropriate for the required analyses. Samples submitted for dissolved metals were filtered with Waterra water filters and placed in dedicated, preserved bottles. Additionally, field analysis of pH, oxygen reduction potential (ORP), dissolved oxygen (DO), and conductivity was also collected.

Each of the water and sediment/soil samples were placed in a cooler with ice following the collection of each of the samples, which was subsequently sealed and sent via courier to BVL in Mississauga, ON for express next-day delivery under standard Chain of Custody protocols.

3.1.2 Hydraulic Conductivity Testing and Analysis

Slug tests were completed on each of the four existing monitoring wells noted above, which were installed within the sand overburden, overlying the sandy silt on the site.

The overburden is most appropriately described as an unconfined or water-table system. As such, the water level data from each slug test was analyzed using both the Bouwer-Rice (1976) and the Hvorslev (1951) methods to determine the hydraulic conductivity of the sand material at each of the monitoring well locations. The slug test data and analysis are provided in Appendix D.

The table below provides a summary of the slug test results.

The “test mode” described in the table below indicates whether the test was begun by increasing the water column in the well (i.e., falling head test) or by decreasing the water column in the well (i.e., rising head test). Water level data was collected by Solinst-brand datalogging pressure transducers.

Summary of Slug Test Results

Monitoring Well	Test Mode	Analysis Method	Hydraulic Conductivity (m/s)
BH-1	Rising Head	Hvorslev	5.6×10^{-4}
	Falling Head	Bouwer & Rice	3.9×10^{-4}
	Rising Head	Hvorslev	1.9×10^{-4}
	Falling Head	Bouwer & Rice	1.6×10^{-4}
	Rising Head	Hvorslev	3.5×10^{-4}
	Falling Head	Bouwer & Rice	3.3×10^{-4}
BH-2	Rising Head	Hvorslev	5.4×10^{-5}
	Falling Head	Bouwer & Rice	4.3×10^{-5}
	Rising Head	Hvorslev	1.8×10^{-4}
	Falling Head	Bouwer & Rice	1.2×10^{-4}
	Rising Head	Hvorslev	2.0×10^{-4}
	Falling Head	Bouwer & Rice	1.6×10^{-4}
BH-3	Rising Head	Hvorslev	1.3×10^{-4}
	Falling Head	Bouwer & Rice	9.3×10^{-5}
	Rising Head	Hvorslev	7.1×10^{-4}
	Falling Head	Bouwer & Rice	5.2×10^{-4}
	Rising Head	Hvorslev	6.4×10^{-4}
	Falling Head	Bouwer & Rice	4.8×10^{-4}
BH-6	Rising Head	Hvorslev	2.6×10^{-4}
	Falling Head	Bouwer & Rice	2.0×10^{-4}
	Rising Head	Hvorslev	4.3×10^{-4}
	Falling Head	Bouwer & Rice	3.0×10^{-4}

The geometric mean hydraulic conductivity for the testing is 2.3×10^{-4} m/s.

3.2 Groundwater Level Elevations

Prior to the installation of Waterra tubing and foot valves in each of the wells, the static water levels were measured with a Heron water level measurement tape referenced to the top of the PVC risers in each well. Following the collection of these water levels, each well was surveyed with a Trimble robotic total station with references to previously surveyed property bars with known elevation.

The geodetic elevations from the previously completed topographic survey were provided by Tatham Engineering Ltd., the initial Site surveyors. The geodetic water table elevations, as measured on January 12 and April 7, 2022 are presented in the attached Table 2.

Pressure transducers were installed in each of the four monitoring wells on April 7, 2022. Monitoring is proposed to continue for a period of 12 consecutive months to provide additional certainty in determining the seasonal high groundwater table elevation.

Based on the groundwater elevations measured to date, the April 2022 measurements are considered to be the preliminary seasonal high groundwater elevation. The groundwater table on April 7, 2022 was measured to be approximately 0.15 mbgs in the lower northeastern portion of the Site and 0.85 mbgs in the elevated southwestern portion of the site in the vicinity of the existing onsite structure. Overall, the water table elevation is inferred to decline from approximately 179.7 masl in the southern portion of the property (i.e., the location of the onsite structure) to approximately 179.0 masl in the northwestern portion of the property.

Figure 7 shows a plan view of the Site with the groundwater elevations measured on April 7, 2022 along with the corresponding interpreted water table contours and groundwater flow direction.

3.3 Groundwater Quality

As discussed, a groundwater sample was collected from each of the four onsite monitoring wells (i.e., samples BH-1, BH-2, BH-3, and BH-6) and submitted for laboratory analyses of general water chemistry parameters. The results of analyses were compared to the Ontario Drinking Water Quality Standards (ODWS) as well as the Provincial Water Quality Objectives (PWQO) for reference. See Table 3 for a summary of the laboratory analyses on the samples collected by GMBP. The laboratory certificate of analysis is provided in Appendix E.

Based on the reported analytical results, each of the samples are reported to meet the maximum allowable concentration for drinking water parameters. Iron and manganese were reported to be above their respective Provincial Water Quality Objectives in each of the monitoring wells: this is a common occurrence in background groundwater concentrations in southern Ontario and in this case does not appear to be indicative of environmental impacts.

Sodium and chloride concentrations were reported to be elevated in BH-1, BH-2, and BH-3, which is likely associated with historical and current de-icing activities that have occurred in the vicinity of these wells (i.e. proximity to the highway or access driveway).

Groundwater quality analyses were also completed at the Site by Rubicon (see Section 2.7.2, laboratory certificate of analysis in Appendix C): those analyses indicated that all VOC, PAH, and PHC parameters analyzed were in concentrations below the method detection limit.

Overall, the shallow groundwater quality across the Site is considered to be generally reflective of typical background concentrations with no evidence of elevated parameters that would be expected to pose significant environmental concerns with respect to dewatering discharge.

4. HYDROGEOLOGICAL CONCEPTUAL MODEL

A “conceptual model” of a site describes its physical setting and provides an interpreted overview of the hydrogeological behaviour of the Site. It provides a basis for general understanding of groundwater flows and other hydrogeological phenomena as well as a basis for assessment of potential impacts.

The topography of the Site is relatively flat, gently-sloping in a northerly direction.

In terms of hydrostratigraphy, the Site is generally characterized as follows:

- Topsoil (variable thickness from 0.1 m to nearly 1 m), overlying
- Fill (variable thickness up to 1.5 m, though absent in some locations on-Site), overlying
- Sand (typically around 4 m thick), overlying
- Sandy Silt (to the deepest extent of investigation).

The Sand layer is generally saturated and therefore behaves as a water-table or unconfined aquifer. Slug tests and grain-size analyses completed by GMBP have confirmed that the Sand layer has a relatively high hydraulic conductivity (on the order of 10^{-4} m/s). The underlying Sandy Silt, based on its density and relatively high proportion of silt, is expected to be of substantially lower hydraulic conductivity and would be characterized as an aquitard with respect to the overlying Sand aquifer. The finding of coarse sand materials is consistent with the surficial geological maps (“glaciolacustrine sand”) and the sequence of coarse sand material over fine silt material is also consistent with the physiographic mapping, which indicates lacustrine, shoreline and deltaic deposits.

Groundwater level measurements indicate that the horizontal direction of groundwater flow is north-northwesterly across the Site. This is consistent with the expectation that groundwater would flow toward Nottawasaga Bay.

Measurements also indicate that groundwater levels are relatively shallow on-Site, with water levels commonly around 0.6 mbgs to 0.8 mbgs across the Site, even reaching as shallow as 0.16 mbgs. The combination of the Sand aquifer and high groundwater levels indicates the possibility for construction dewatering for even shallow excavations, such as for servicing.

Groundwater chemistry in the Sand aquifer is within the range of expected conditions for overburden aquifers in southwestern Ontario. The groundwater is moderately mineralized, with elevated calcium and magnesium concentrations which reflect the local geological materials which are largely calcareous. The elevated sodium and chloride concentrations appear to indicate some influence by the application of road salt in the vicinity of the Site.

5. IMPACT ASSESSMENT

A proposed development may result in hydrogeological impacts due to the effects it may have on the hydrogeological system. Hydrogeological impacts generally fall into two categories: water quality impacts or water quantity impacts. A given receptor may be impacted by both, either, or neither of these types of impacts depending on the potential severity of the effect, whether there is a pathway between the source and the receptor, and whether the receptor is sensitive to that type of impact.

The following sections discuss the potential for the project to cause water quality and/or water quantity impacts with respect to the following receptors:

- source protection and municipal water resources
- private water wells
- construction activities
- the proposed development (i.e., operation of the structures post-construction).

5.1 Source Protection and Municipal Water Resources

As previously discussed in Section 2.6, the Site does not overlap with the most critical types of vulnerable areas (i.e., Wellhead Protection Areas, Intake Protection Zones or Groundwater Under the Direct Influence of Surface Water areas).

Generally, the type of land use activities that will occur at the proposed development (i.e., residential use) carry relatively low potential for impacting groundwater and/or surface water resources.

Correspondence with the Grey Sauble Conservation Authority has confirmed that a Section 59 clearance notice is not required for the proposed development.

As a result, it is expected that the potential for the proposed development to impact local municipal water resources is low. It is not expected that any project-specific mitigative strategies must be implemented in the design or construction of the proposed project to prevent impacts to municipal water resources.

5.2 Private Water Wells

Private water wells may, in some cases, be affected by a new development. However, the potential for impacts depends on the construction of the well and the nature of the proposed development.

In objective terms, the potential for the proposed development to affect the quantity of water available to local wells is low. The proposed development will be municipally-serviced, so there will be no new private water wells to cause interference with existing local wells. Though the proposed development will involve a substantial increase in impervious area relative to the current condition, it is not expected that this will result in a loss of recharge that would be detrimental to local groundwater supplies. This is because local stormwater is managed by roadside ditches, which will allow or encourage substantial infiltration via the highly permeable surficial sand soils. In addition, the increase in impervious surfaces typically also results in a net decrease of evapotranspiration. This leaves additional water available for infiltration, which mitigates the overall loss of recharge to some degree.

Furthermore, it is understood that municipal water supply is available in the area. Although numerous water wells have been identified to lie within 500 m of the Site, it is expected that few, if any, of these wells remain in use due to the availability of municipal water services. As such, the overall potential for risk is further decreased.

The main cause of potential impacts will be the use of road salt to maintain trafficability of the paved areas of the new development. Due to a combination of factors (i.e., distance from Site, bedrock installations rather than overburden) it is not expected that this will impact local groundwater users. As such, the potential for the proposed development to cause water quality impacts to private water wells is considered to be low.

5.3 Construction Activities

Construction activities may be impacted by hydrogeological conditions in a number of ways, such as:

- affecting grading and design decisions where it is seen as necessary or beneficial to avoid construction below the water table;
- having to meet regulatory requirements with respect to dewatering activities;
- having to provide waterproof construction and/or sufficient drainage for occupiable spaces set below groundwater; and others.

Because the proposed development will not involve the construction of basements, it is expected that waterproofed basements will not be required.

However, due to the occurrence of shallow groundwater on-Site, it is expected that some degree of construction dewatering will be required to complete the proposed development including the installation of services (i.e., trenching for water mains and sanitary sewers) and potentially for the construction of building foundations.

A more fulsome assessment of construction dewatering, its impacts and relevant approvals requirements is provided in Section 6.

5.4 Proposed Development

Hydrogeological conditions may also affect the completed development and may require mitigation activities to be undertaken as part of the routine operation or upkeep of the development.

5.4.1 Residential Structures

Because the proposed development will not include basements, there will be no need for continuous drainage and/or waterproofing of foundations to prevent against seepage into dwelling spaces or other occupiable areas in the proposed buildings. Therefore, this is not expected to be a potential source of impacts to the hydrogeological system or to the operation of the development (i.e., sump operation).

5.4.2 Stormwater Management

Due to the shallow depth to groundwater it is expected that it will not be feasible to construct enhanced infiltration facilities in-ground (i.e., infiltration galleries). Bio-swales, infiltration ditches, and other best-management practices that encourage infiltration at the surface may be considered but where possible should be designed so that the base elevation is above groundwater levels to avoid standing water, which may be a nuisance.

However, from a hydrogeological perspective, it is not expected that this development must include enhanced recharge facilities because it is not expected that the development will have a detrimental effect on groundwater quantity or groundwater levels (see Section 5.2).

6. CONSTRUCTION DEWATERING ASSESSMENT

The requirement for dewatering depends mainly upon the extent of excavation relative to the groundwater levels on-Site as well as the hydraulic properties of the soil materials. Presently, it is expected that there will be two main types of excavation that may occur as part of this project:

1. Servicing Excavations (i.e., trenches for watermain and sanitary sewer)
2. Foundation Excavations

Servicing excavations may involve trenching to depths around 2.5 to 3 m deep, possibly deeper depending on the elevation of the existing services on Highway 26.

Foundation excavations, if constructed as conventional footings or strip footings, would likely require excavation to similar depths as required by the servicing: CMT has identified that soils suitable for supporting foundations are found at depths ranging from 2.41 m to 3.66 m below ground surface. However, CMT also notes that due to the high groundwater levels and the presence of non-cohesive, loose sand soils, it may be difficult to construct these types of foundations. As a result, CMT suggests alternatives including the use of deep foundations or raising the grade of the Site through the placement of structural fill.

Due to the high groundwater levels on-Site and the predominance of sand soils, it is expected that some degree of construction dewatering will be required at some point over the course of the project. As such, the approvals requirements for construction dewatering will be discussed, followed by an assessment of potential dewatering rates.

6.1 Dewatering - Regulatory Framework

The taking of water in excess of 50,000 litres per day is regulated through the Ontario Water Resources Act (OWRA).

Ontario Regulation 63/16 identifies certain types of dewatering activities for which approval can be sought through the Environmental Activity Site Registry (EASR) process. EASR is a streamlined approvals process in which direct review of the project by the Ministry of the Environment, Conservation and Parks is not required. Confirmation of the EASR registration is immediate upon submission. However, to be eligible for approval under the EASR program, dewatering is limited to 400,000 L per day from a project source area under normal operations. The EASR registration requires adherence to certain operating conditions, not least of which is the preparation by a “qualified person” (as defined in *O.Reg. 63/16*) of Water-Taking and Discharge Plans which must be followed during the construction process.

Construction dewatering that is expected to exceed 400,000 L on any given day under normal operation is regulated through the Permit to Take Water (PTTW) program under the *Ontario Water Resources Act*. The Permit to Take Water program requires applications to be reviewed by the Ministry of the Environment, Conservation and Parks. Applications must be accompanied by dewatering, monitoring, and mitigation plans to the satisfaction of the MECP reviewers and are generally more elaborate than the documentation required by the EASR process. The PTTW review period may take up to 90 days and so if a PTTW is required this review time should be factored into the project schedule.

6.2 Dewatering Rates

As previously mentioned, there are two types of excavations that are anticipated for this project:

1. Servicing excavations
2. Foundation excavations

For both types of excavations, dewatering rates may be estimated using an analytical model for flow in an unconfined aquifer. The analytical models that have been used for these estimates has been taken from the construction dewatering literature (Powers, Corwin, Schmall, & Kaeck, 2007), which assumes that the system has an impermeable base set at a depth “H” below the static groundwater level.

For the purposes of these estimates, it will be assumed that:

- the Sandy Silt layer serves as the impermeable base, and that it lies at a depth (“H”) of 4 m below the static groundwater level;
- the Sand layer (i.e., the aquifer) will be taken to have a hydraulic conductivity (“k”) of 5×10^{-4} m/s;
- the target drawdown will be 0.5 m below the base of the excavation in question;
- the radius of influence (“ R_0 ”) is provided by the Sichardt formula.

Worksheets that provide detailed calculations, formulae, inputs and assumptions are provided in Appendix F. It is noted that the hydraulic conductivity accounts for a factor of safety of approximately 2 relative to the geometric mean of the collection of hydraulic conductivity estimates determined through slug testing at the monitoring wells on-Site (see Section 3.1.2).

It must be noted that the following discussion is based on a set of assumptions which may be refined or revised as design progresses and more information about the project becomes available. The conclusions regarding dewatering intensity, expected regulatory approvals, monitoring and mitigation are therefore tentative and should be confirmed at the preliminary design or detailed design stage.

6.2.1 Servicing

Servicing will require the excavation of trenches to depths up to 3 m below ground surface, potentially deeper if the main service on Highway 26 is located at a greater depth. Noting that groundwater levels are typically around 0.5 to 1 m below ground surface, and accounting for a target groundwater level during excavation of 0.5 m below the base of excavation, the total estimated drawdown would be approximately 3 m.

The servicing scenario is best represented using a model that describes flow to a finite trench. For the purposes of this estimate, it will be assumed that the trench length can be limited to 15 m at a time and that the trench width will be approximately 3 m wide. The details of calculation are provided in Appendix.

Based on the above, it is expected that the dewatering requirement to facilitate servicing could be on the order of 500,000 L/d.

This exceeds the 400,000 L/d regulatory threshold and so a Permit to Take Water may be required for this dewatering activity.

6.2.2 Foundations

The staging of foundation construction and the type of foundation design may substantially affect the amount of dewatering expected. For this assessment, three scenarios of conventional foundation construction will be considered:

- Spread Footings
- Strip Footings, monolithic or single-stage construction
- Strip Footings, staged construction.

Spread footings consist of a pier on a load-bearing pad, which in turn bears down on the founding soil below. Because these footings are separate and discrete from each other, they can theoretically be constructed one at a time, which would limit the amount of dewatering required at a given time.

Strip footings consist of a wall on a load-bearing strip, which in turn bears down on the founding soil below. Construction of strip footing foundations requires a trench to be opened to the target depth and would be a much larger excavation than might be required for spread footings. In terms of staging, the strip footing foundation may be constructed in a single stage (e.g. with a trench around the perimeter of the building) or in multiple stages (e.g. with the foundation for each side of the structure being constructed separately).

For either spread or strip footings, the depth of excavation is assumed to be similar: approximately 3 m below ground surface. Assuming a target groundwater level of 0.5 m below the base of excavation and a static water level of 0.5 m below ground surface, the target drawdown required would be approximately 3 m.

In terms of dewatering, the major differences between the three scenarios are the size and shape of the excavations, which in turn affects the type of analytical model that might be applicable.

Spread footings would be best modeled as unconfined flow to a well. For the purposes of computation, the model “well” would be taken to have a radius such that the area of the anticipated excavation (assumed to be approximately 2.5 m by 2.5 m, or 6.3 m²) would be the same as the cross-sectional area of the model well (i.e., radius of 1.4 m).

Strip footings would best be modeled as unconfined flow to a trench. The size of the trench used in the model would depend on the staging of construction. A single-stage approach would assume a trench length equal to the length of the longest side of one of the townhouse structures (32 m) and a trench width equal to the width of the building (17 m). A multi-stage approach would incur maximum dewatering when the footing was constructed for the long side of the building and so would be represented in the model with a trench width of 1.5 m and length of 32 m.

The estimated dewatering rates for each of these scenarios have been calculated (see Appendix F for detailed calculation worksheets and formulae) to be as follows:

- | | |
|------------------------------------|-------------|
| 1. Spread Footings | 410,000 L/d |
| 2. Strip Footings (single-stage) | 850,000 L/d |
| 3. Strip Footings (multiple-stage) | 571,000 L/d |

As can be seen, the expected dewatering quantity for any of the footing construction approaches is reasonably expected to exceed 400,000 L/d, indicating that a Permit to Take Water would be required to obtain approval from the MECP for the construction dewatering activity.

6.2.3 Alternative Foundations

CMT provided some potential alternatives for foundations for the proposed structures, including:

- Deep foundations (e.g. helical piles)
- Structural fill

Deep foundations, or pile foundations, are installed by powered-mobile equipment that drills or drives the piles into place from the surface. In the project geotechnical report, CMT notes helical piles as being one potential option for deep foundations. These types of foundations can be completed without excavation and as such would not require dewatering.

The structural fill approach would involve the placement and compaction of fill to specified densities to achieve the necessary bearing capacities. Because this would involve the raising of the grades on-Site, it would mean that foundations could be constructed at a higher elevation relative to groundwater. Depending on municipal requirements for grading, maximum allowable slopes, and/or permission for retaining walls, this proposed approach may not be feasible, or the achievable grades may still be too low to rise entirely out of the groundwater: some dewatering may be required but due to the decreased drawdown it would be at a lower rate than would be expected if no structural fill was provided.

6.3 Dewatering Approaches

Due to the loose, non-cohesive soils in the project area, as well as the relatively shallow target groundwater depth (i.e., less than about 4.5 m below ground), it is recommended that wellpoints be considered for dewatering.

Sump dewatering may be feasible but due to the type of soils in the project area it may require excavations to be very large, which may cause staging issues, requirements for specialty excavation equipment, and site accessibility difficulties. It also has the potential to allow for subgrade soils to be disturbed, which may result in additional effort to rehabilitate, re-compact or replace founding soils.

Dewatering systems, especially wellpoint systems, should be designed and installed by a contractor that specializes in and has applicable experience with construction dewatering.

6.4 Potential Impacts of Dewatering

Though there may be alternatives to foundation construction that would reduce overall project dewatering, it is expected that servicing construction would require a dewatering rate in excess of 400,000 L/d. As such it is expected that a Permit to Take Water will be required for this project.

However, despite the potential intensity of dewatering, it is expected that most dewatering impacts will be minimal and/or manageable with appropriate mitigation practices.

Due to the availability of the municipal water system in the area, it is expected that dewatering-induced drawdowns will not affect local private well users. Risks to private well users can be mitigated by conducting a water well survey for properties within approximately 200 m of the Site (i.e., the estimated zone of influence) to confirm the presence of wells. Where wells are present, a water monitoring program may be implemented and a contingency plan to provide temporary replacement water service can be developed in the unlikely event that the dewatering affects the quality or quantity of water available to the user.

A geotechnical assessment of dewatering-induced settlement should be undertaken to ensure that the proposed dewatering will not result in excessive soil settlement and potential structural damage to nearby buildings and/or infrastructure.

Surface water bodies in the area, with the closest being about 200 m away from Site, do not appear to be close enough to the Site and potential excavation areas for there to be a concern about loss of water due to drawdowns.

Dewatering discharge would not be required to be transferred to another catchment or watershed basin and so there is no concern regarding loss of water within the hydrological catchment. Furthermore, the dewatering duration would be relatively short (likely on the order of a few weeks) and the potential for impacts would be accordingly minimal.

The groundwater quality analyses indicate no apparent groundwater impacts on-Site and so chemical treatment of the construction dewatering discharge is not expected to be required. To protect the receiving system from sediment, the management of discharge will require the preparation of and adherence to an erosion and sediment control plan to mitigate against potential impacts caused by the release of discharge water overland. Ontario Provincial Standard Specifications (OPSS) 517, 518, and 805 should be followed in the management of dewatering and discharge activities.

Due to the proximity to the gas station to the east, there may be potential for intensive dewatering to cause migration of fuel-impacted groundwater onto the Site. Construction dewatering should therefore include the monitoring of monitoring well BH1 (and possibly additional wells) for evidence of fuel impacts. A contingency plan should be prepared to provide direction on what to do if migration of fuel-impacts is detected (e.g. provide specialty treatment at the point of discharge, or change the construction approach to avoid or minimize reliance on dewatering).

It is expected that the dewatering discharge would be released to the roadside ditch on Highway 26 and that dewatering discharge would flow overland to an outfall at the stream located west of Timmons Street (approximately 300 m west of the Site). Permission from the municipality and/or the MTO may be required so it is recommended that these organizations be contacted to confirm their acceptance and/or approval of the proposed discharge management plans.

7. SUMMARY

A hydrogeological study has been undertaken in assessment of a proposed residential development to be located at 209806 and 209808 Highway 26, in the settlement area known as Craighleith in the Town of the Blue Mountains, Ontario. The hydrogeological system and regulatory setting have been characterized and, based on that characterization, an impact assessment has been completed.

The findings of the hydrogeological study are summarized as follows:

- The Site is approximately 0.66 ha in size and is located in an area that is mainly under residential and commercial use. Adjacent to the east side of the Site is a gas station.
- The proposed development will consist of four blocks of townhouses containing a combined total of 17 dwellings. The development is also proposed to include open space blocks and visitor parking areas.
- The proposed development will be municipally serviced for water and sewage.

- In its current condition, there is a one-storey motel building lies in the southern portion of the Site: this building will be demolished to make way for the proposed development.
- The shoreline of Lake Huron / Nottawasaga Bay is located approximately 300 m north of the Site.
- The topography of the Site is generally flat. Locally, the lands are generally gently sloped toward Nottawasaga Bay.
- No surface water features were identified on-Site, though some wetland features lie south, and northeast of the Site at distances of over 200 m.
- There are numerous water well records in the area but it is assumed that most are no longer in use due to the availability of municipal water supply. All water well records identified for supply usage were noted to be bedrock (rather than overburden) wells.
- The Site does not overlap with existing Wellhead Protection Areas (WHPA), Groundwater Under the Direct Influence of Surface Water (GUDI) areas, or Intake Protection Zones. A Section 59 clearance notice is not expected to be required for the proposed development.
- Storm drainage in the area appears to be provided by roadside ditches along Highway 26.
- The Site is situated within the Simcoe Lowlands physiographic region. The Site and area are dominated by beach and sand plains physiographic landforms. Surficial geological mapping indicates that the Site is underlain by glaciolacustrine sand deposits.
- Geotechnical borings at the Site have indicated stratigraphy consisting of:
 - Topsoil overlying
 - Fill (mainly sand, up to 1.5 m thick, though not present in all parts of the Site), overlying
 - Sand (typically about 4 m thick), overlying
 - Sandy Silt (extending to the deepest point of investigation), overlying
 - Bedrock (subcrop at a depth of approximately 6 to 6.5 m below ground surface).
- Environmental testing completed by others indicates that the groundwater on-Site exhibits no impacts from VOCs, PAHs, PHCs, or BTEX compounds.
- Groundwater sampling completed by GMBP indicates that the groundwater quality on-Site is typical of background conditions in overburden aquifers, though there appears to be some minor influence due to road salt application.
- Hydraulic conductivity testing of monitoring wells indicates that the Sand layer on-Site has a hydraulic conductivity on the order of 10^{-4} m/s, which is relatively high.
- Groundwater levels in the surficial sand aquifer have been recorded at depths between 0.15 m and about 1 m below ground surface.
- The development is not expected to cause impacts to surface water bodies, local private water well users, or municipal drinking water resources.
- Due to the high groundwater levels on-Site, it is expected that in-ground enhanced recharge structures (e.g. in-ground infiltration galleries) will not be feasible, though due to the soils of high hydraulic conductivity there may be some potential for the application of best management practices at surface, such as bio-swales or infiltrator ditches.
- Construction of servicing for the proposed development, by virtue of the high hydraulic conductivity of the on-Site soils and the high groundwater table, has the potential to require construction dewatering in excess of 400,000 L/d. Dewatering activities that exceed 400,000 L/d typically require a Permit to Take Water to be obtained from the MECP.
- Construction of strip or spread footings for foundations for the proposed structures may also require dewatering in excess of 400,000 L/d, though alternative foundations (e.g. deep

foundations like helical piles) may eliminate the need for dewatering for this aspect of the project.

- Despite the intensity of potential dewatering, it is expected that impacts due to dewatering will be minimal or otherwise suitably mitigated by following typical construction dewatering and discharge management practices (e.g. OPSS 805, 517 and 518).
- Due to proximity to a gas station and the predominance of soils of high hydraulic conductivity, dewatering activities should include ongoing monitoring to confirm that fuel-impacted groundwater will not migrate onto the Site during dewatering.

8. CONCLUSIONS AND RECOMMENDATIONS

Concerning the proposed development of the parcels at 209808 and 209806 Highway 26, Town of the Blue Mountains, for townhouse residential use, the hydrogeological study has concluded that:

- The proposed development is not expected to cause impacts to the local hydrogeological system or to the receptors dependent upon it, including local water well users, municipal water resources (i.e., per source protection policies), or surface water bodies.
- The construction of the proposed development can, while adhering to project-appropriate monitoring and mitigation practices, be undertaken in a way that will avoid impacts to the local hydrogeological system during construction and construction dewatering.

With respect to the proposed development and its construction, we recommend that:

1. The construction dewatering requirements for the project be re-assessed at the preliminary or detailed design stage to confirm the expected intensity of dewatering, the applicable approaches to dewatering (including monitoring and mitigation plans), and the necessary approvals that would apply.
2. Dewatering be conducted following *Ontario Provincial Standard Specifications 805, 517, and 518* and in accordance with the requirements of the approval that applies to the project (e.g. Permit to Take Water, with corresponding monitoring and mitigation plan; or EASR with corresponding water-taking and discharge plan).
3. Wellpoints be considered for dewatering, especially for the construction of foundations, to preserve the stability and condition of subgrade and/or founding soils.
4. Dewatering systems be designed, constructed and operated by a dewatering specialty contractor.
5. The Ministry of Transportation of Ontario and the Town of the Blue Mountains be contacted to confirm permission to release dewatering discharge to the roadside ditch on Highway 26, which appears to be the only suitable drainage infrastructure to receive dewatering discharge from the project area.
6. Alternatives to strip or spread footing foundations be considered, especially deep foundations (e.g. helical piles) which would avoid or limit excavation below groundwater and therefore limit the overall requirement for construction dewatering.
7. In-ground structures for enhanced recharge (e.g. infiltration galleries) be avoided due to the high groundwater levels that persist on-Site.

9. STATEMENT OF LIMITATIONS

The information in this report is intended for the sole use of Pinnacle Building Group Corp. GM BluePlan Engineering Limited accepts no liability for use of this information by third parties. Any decisions made by third parties on the basis of information provided in this report are made at the sole risk of the third parties.

GM BluePlan Engineering Limited cannot guarantee the accuracy or reliability of information provided by others. GM BluePlan Engineering Limited does not accept liability for unknown, unidentified, undisclosed, or unforeseen surface or sub-surface conditions that may be later identified.

The conclusions pertaining to the condition of soils and/or groundwater identified at the site are based on the visual observations at the locations of the investigative boreholes/monitoring wells and on the reported laboratory results for the selected soil and/or groundwater samples. GM BluePlan Engineering Limited cannot guarantee the condition of soil and/or groundwater that may be encountered at the site in locations that were not specifically investigated as part of this investigation. This report is considered to be representative of the condition of the Site as of April 7, 2022.

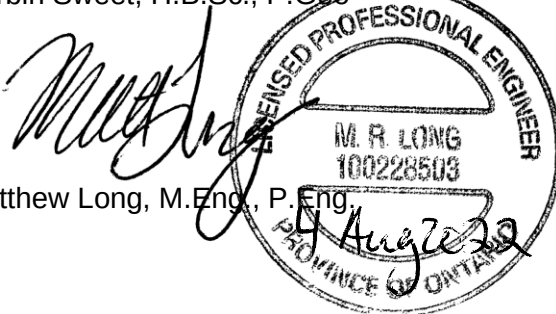
All of which is respectfully submitted.

GM BLUEPLAN ENGINEERING LIMITED

Per:

A handwritten signature in blue ink, appearing to read 'Corbin Sweet'.

Corbin Sweet, H.B.Sc., P. Geo

A handwritten signature in black ink, appearing to read 'Matthew Long', is written over a circular professional engineer stamp. The stamp contains the text 'LICENSED PROFESSIONAL ENGINEER', 'M. R. LONG', '100228503', and 'PROVINCE OF ONTARIO'. There is also a handwritten date '4 Aug 2022' across the stamp.

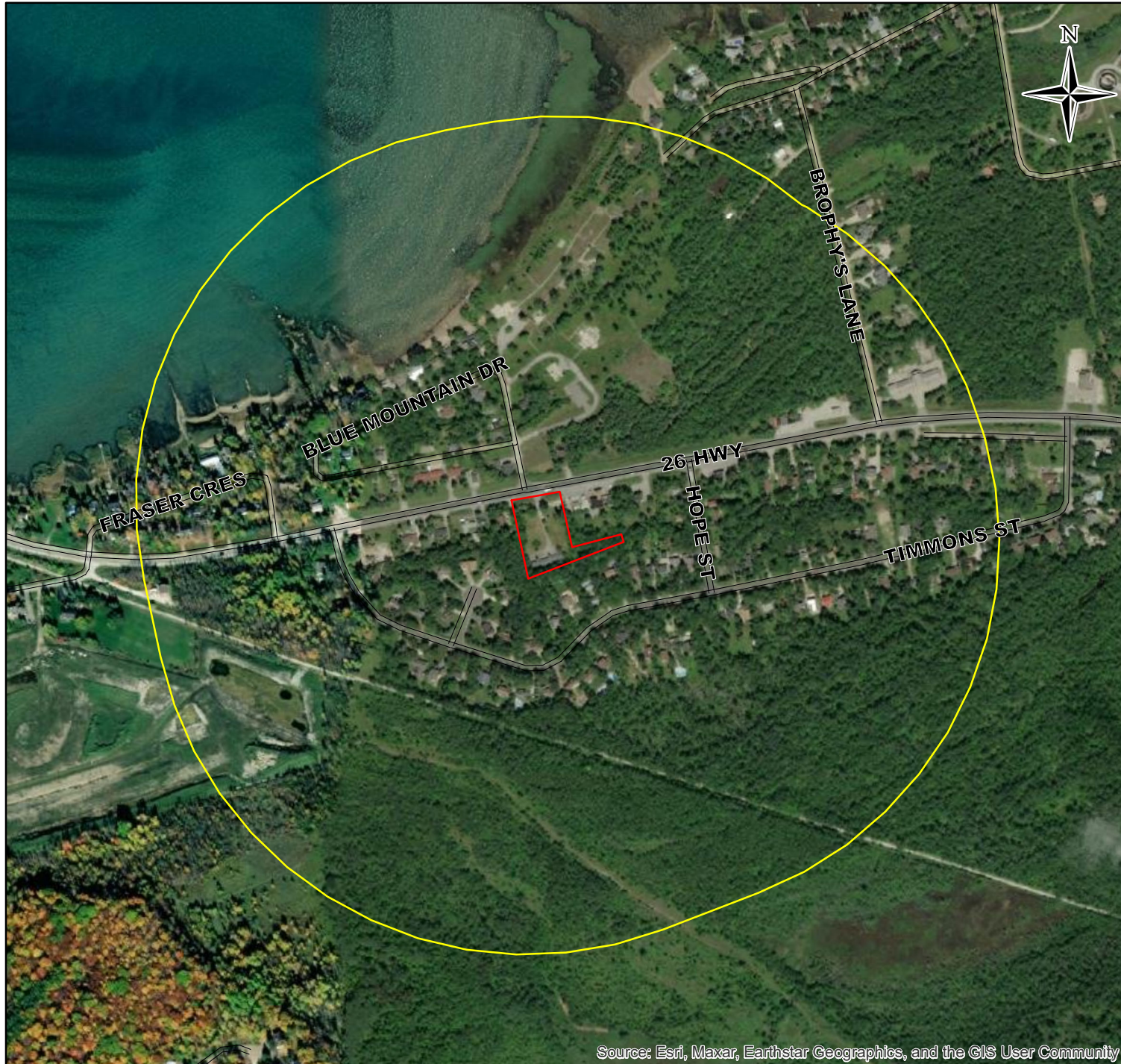
Matthew Long, M. Eng., P. Eng.

10. REFERENCES

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FIGURES





Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Project: 221418
Hydrogeological Study
209806/209808 HWY 26
Town of the
Blue Mountains

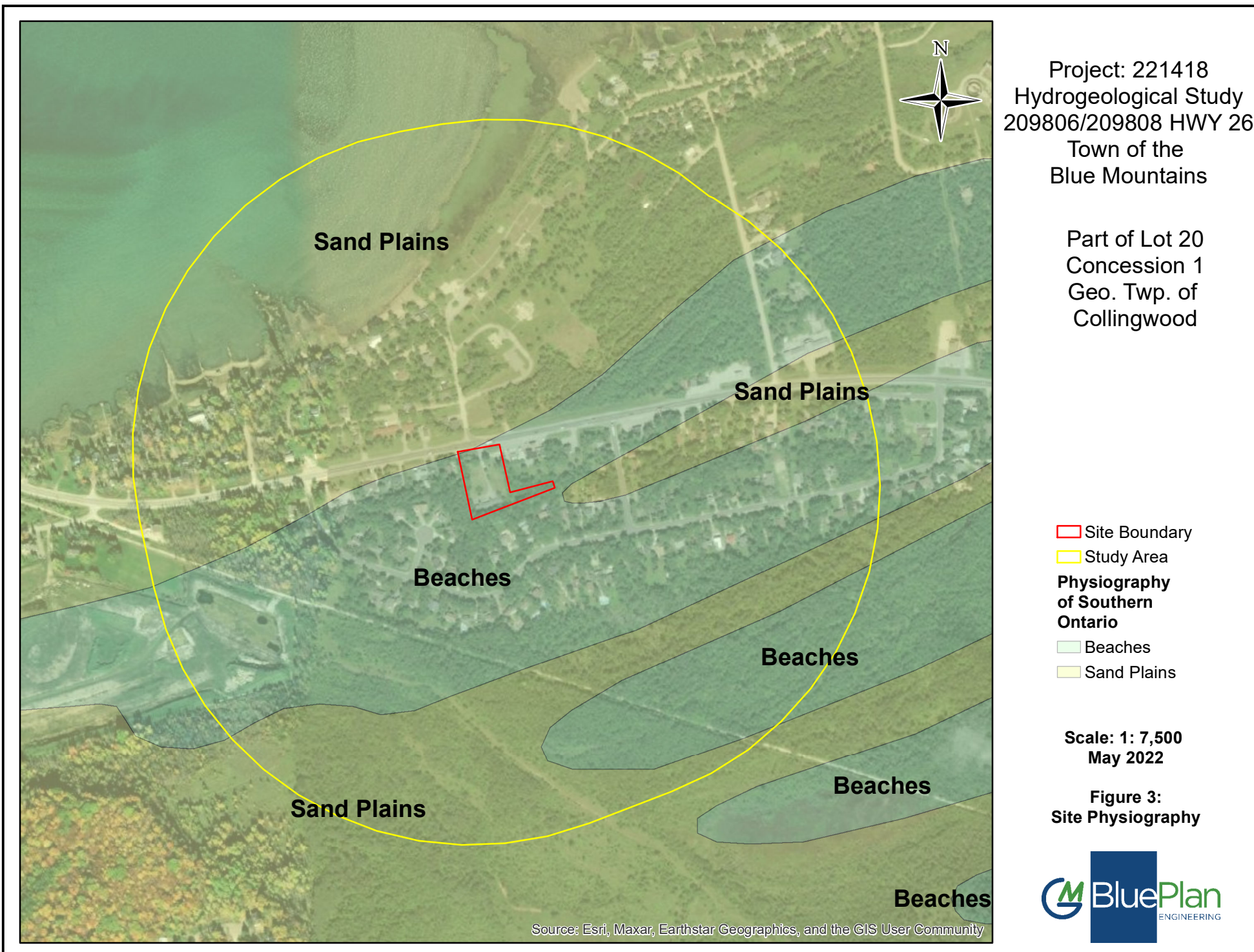
Part of Lot 20
Concession 1
Geo. Twp. of
Collingwood

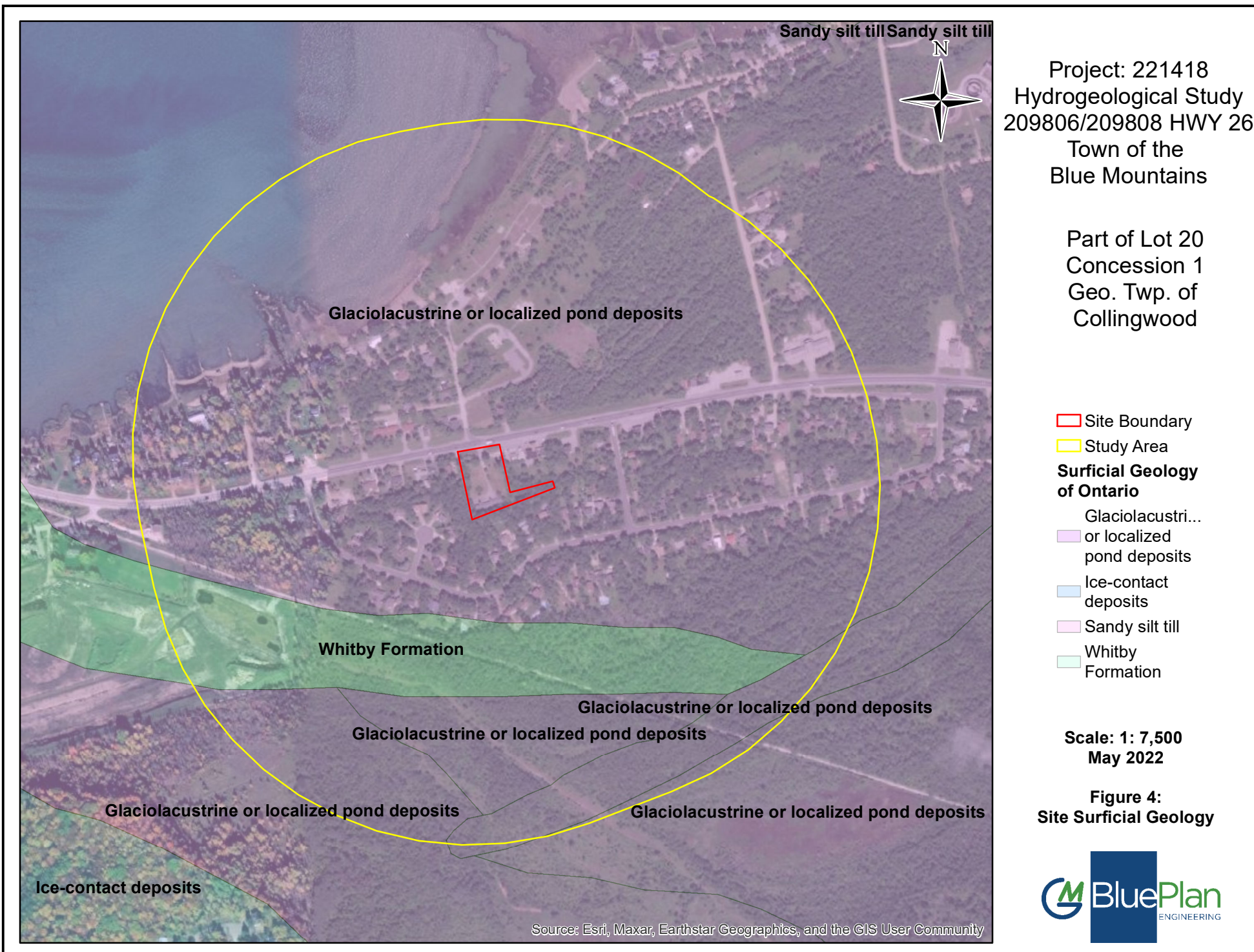
□ Site Boundary
○ Study Area
— Roads

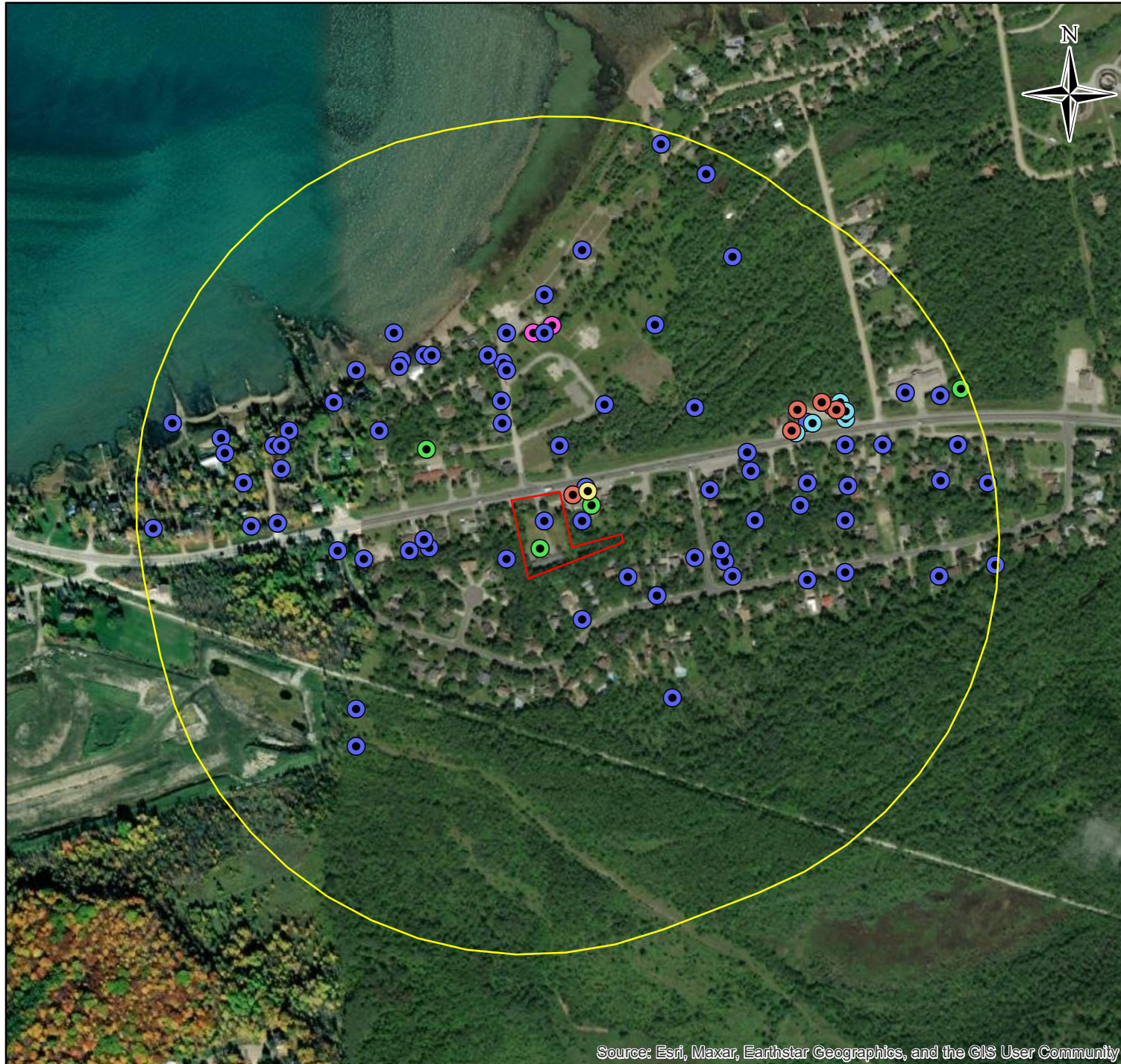
Scale: 1: 7,500
May 2022

Figure 2:
Study Area Layout









Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Project: 221418
Hydrogeological Study
209806/209808 HWY 26
Town of the
Blue Mountains

Part of Lot 20
Concession 1
Geo. Twp. of
Collingwood

Site Boundary

Study Area

**MECP Well
Records (by
Use)**



Commercial



Domestic



Monitoring



Other

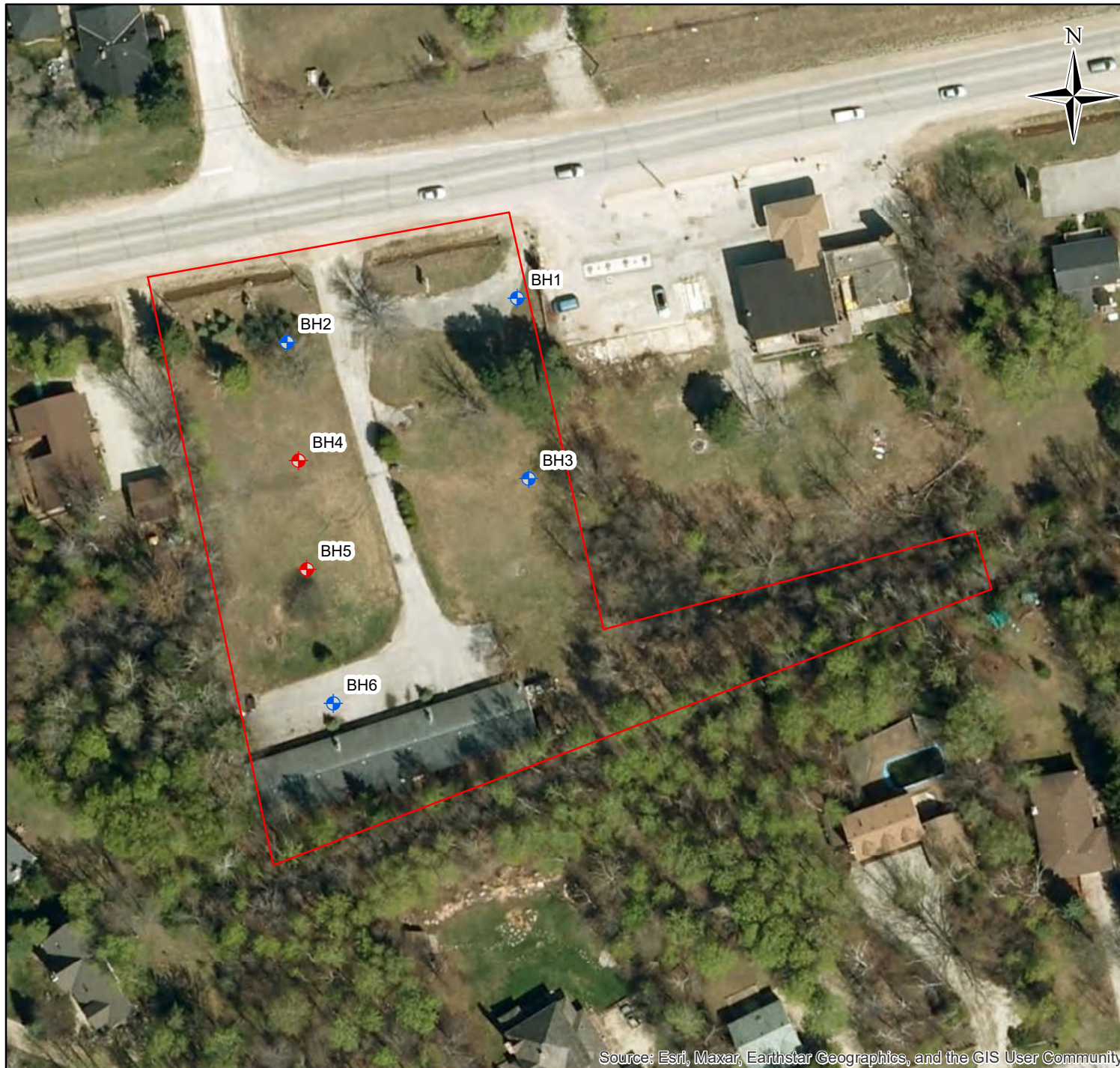


Public

Scale: 1: 7,500
May 2022

**Figure 5:
MECP Water
Well Records**





Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Project: 221418
Hydrogeological Study
209806/209808 HWY 26
Town of the
Blue Mountains

Part of Lot 20
Concession 1
Geo. Twp. of
Collingwood

Site Boundary
Study Area
**Investigation
Points**
Borehole
Monitoring Well

Scale: 1: 1,000
May 2022

Figure 6:
Investigation Plan





Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Project: 221418
Hydrogeological Study
209806/209808 HWY 26
Town of the
Blue Mountains

Part of Lot 20
Concession 1
Geo. Twp. of
Collingwood

- Site Boundary
- Study Area
- Investigation Points**
 - ◆ Borehole
 - ◆ Monitoring Well
- Groundwater Contours (April 2022, metres above sea level)

Scale: 1: 1,000
May 2022

Figure 7:
Groundwater Levels



TABLES

Table 1: Water Well Records Summary

WELL ID	LOT	CON	GEO. TOWNSHIP	EASTING	NORTHING	USAGE	WELL TYPE	STATIC WATER		DEPTH TO BEDROCK
								LEVEL	TOTAL DEPTH	
								(mbgs)	(mbgs)	(mbgs)
2500366	20	1	COLLINGWOOD	555074.3	4930023	Domestic	Bedrock	2.4	12.8	1.8
2500367	20	1	COLLINGWOOD	555369.3	4930118	Domestic	Bedrock	2.4	12.2	7.3
2500368	20	1	COLLINGWOOD	555039.3	4930033	Domestic	Bedrock	2.4	10.1	6.7
2500369	20	1	COLLINGWOOD	555377.3	4930093	Commerical	Bedrock	1.5	10.4	6.7
2500371	20	1	COLLINGWOOD	555554.3	4930019	Domestic	Bedrock	4.3	9.4	8.2
2500372	20	1	COLLINGWOOD	555549.3	4930034	Domestic	Bedrock	4.3	12.5	6.1
2500373	20	1	COLLINGWOOD	555161.3	4930037	Domestic	Bedrock	1.8	8.2	4.6
2500374	20	1	COLLINGWOOD	555589.3	4930139	Domestic	Bedrock	3.7	10.1	7.6
2500375	20	1	COLLINGWOOD	555308.3	4930036	Commerical	Bedrock	4	13.1	10
2500376	20	1	COLLINGWOOD	555154.3	4930048	Domestic	Bedrock	1.5	11.9	5.2
2500377	20	1	COLLINGWOOD	555564.3	4929999	Domestic	Bedrock	5.5	11.6	8.5
2500378	21	1	COLLINGWOOD	555258.3	4930203	Domestic	Bedrock	2.4	9.8	7.6
2500379	21	1	COLLINGWOOD	554954.3	4930173	Domestic	Bedrock	0.6	7.6	1.5
2500380	21	1	COLLINGWOOD	555034.3	4930231	Domestic	Bedrock	1.2	8.5	4.9
2500381	21	1	COLLINGWOOD	555154.3	4930293	Domestic	Bedrock	1.2	8.5	4.9
2500382	21	1	COLLINGWOOD	555461.3	4930334	Domestic	Bedrock	1.2	8.5	4.9
2500384	21	1	COLLINGWOOD	555364.3	4930433	Domestic	Bedrock	1.8	16.2	4.3
2500387	21	1	COLLINGWOOD	555529.3	4930534	Domestic	Bedrock	1.8	9.1	6.7
2500388	21	1	COLLINGWOOD	555394.3	4930227	Domestic	Bedrock	2.4	12.2	5.2
2500394	21	1	COLLINGWOOD	555157.3	4930168	Commerical	Bedrock	2.4	12.2	7
2500395	21	1	COLLINGWOOD	555164.3	4930293	Domestic	Bedrock	2.7	8.5	5.8
2500398	21	1	COLLINGWOOD	555299.3	4930323	Public	Bedrock	3	14	5.8
2500399	21	1	COLLINGWOOD	555324.3	4930333	Public	Bedrock	3	15.5	5.8
2500400	21	1	COLLINGWOOD	555257.3	4930233	Domestic	Bedrock	2.1	7.3	6.7
2500401	21	1	COLLINGWOOD	555259.3	4930283	Domestic	Bedrock	2.1	7.3	6.4
2500402	21	1	COLLINGWOOD	555094.3	4930193	Domestic	Bedrock	1.2	9.4	3.4
2500403	21	1	COLLINGWOOD	555239.3	4930293	Domestic	Bedrock	0.6	14	3
2500404	21	1	COLLINGWOOD	554964.3	4930143	Domestic	Bedrock	0.6	9.8	2.1
2500405	21	1	COLLINGWOOD	555124.3	4930286	Domestic	Bedrock	0.9	11.3	4.3
2500406	21	1	COLLINGWOOD	555121.3	4930278	Domestic	Bedrock	1.8	11.3	4.3
2500420	21	2	COLLINGWOOD	554819.3	4930203	Domestic	Bedrock	6.7	8.2	5.5
2500429	21	2	COLLINGWOOD	554884.3	4930183	Domestic	Bedrock	1.8	8.5	2.1
2500433	21	2	COLLINGWOOD	554924.3	4930066	Domestic	Bedrock	1.2	11	1.8
2500434	21	2	COLLINGWOOD	554889.3	4930163	Domestic	Bedrock	1.8	7.3	3.7
2500435	21	2	COLLINGWOOD	554959.3	4930070	Domestic	Bedrock	0.6	18.3	3
2502678	21	2	COLLINGWOOD	554794.3	4930063	Domestic	Bedrock	1.2	4.9	1.5
2502679	20	1	COLLINGWOOD	555134.3	4930033	Domestic	Bedrock	1.5	8.8	4.3
2503057	20	1	COLLINGWOOD	555664.3	4930204	Domestic	Bedrock	2.4	8.5	5.2
2503058	20	1	COLLINGWOOD	555714.3	4930074	Domestic	Bedrock	3.7	9.4	5.5
2503061	20	1	COLLINGWOOD	555764.3	4930174	Domestic	Bedrock	2.7	9.4	5.8
2503081	20	1	COLLINGWOOD	555584.3	4930164	Domestic	Bedrock	2.7	10.7	5.5
2503279	20	1	COLLINGWOOD	555534.3	4930114	Domestic	Bedrock	4.3	9.8	6.1
2503299	20	1	COLLINGWOOD	555714.3	4930004	Domestic	Bedrock	4.3	15.2	6.1
2503300	21	1	COLLINGWOOD	555334.3	4930173	Domestic	Bedrock	2.7	10.1	6.1
2503301	20	1	COLLINGWOOD	555654.3	4930094	Domestic	Bedrock	3.7	13.4	6.7
2503359	21	1	COLLINGWOOD	554974.3	4930193	Domestic	Bedrock	1.8	11	2.4
2503398	20	1	COLLINGWOOD	555714.3	4930174	Domestic	Bedrock	1.5	8.5	4
2503474	20	1	COLLINGWOOD	555794.3	4930244	Domestic	Bedrock	2.7	13.4	6.1
2503566	20	1	COLLINGWOOD	555594.3	4930074	Domestic	Bedrock	3.7	14	7.9

Table 1: Water Well Records Summary

2503567	20	1	COLLINGWOOD	555904.3	4930124	Domestic	Bedrock	2.4	10.4	4.6
2503694	20	1	COLLINGWOOD	555514.3	4930024	Domestic	Bedrock	4	12.8	6.1
2503787	20	1	COLLINGWOOD	555839.3	4929999	Domestic	Bedrock	2.4	14	7.3
2503867	20	1	COLLINGWOOD	555914.3	4930014	Domestic	Bedrock	0.9	12.2	3.7
2504024	20	1	COLLINGWOOD	555664.3	4930124	Domestic	Bedrock	2.7	13.1	7.9
2504195	20	1	COLLINGWOOD	555364.3	4929942	Domestic	Bedrock	2.4	20.1	8.5
2504308	20	1	COLLINGWOOD	555464.3	4929974	Domestic	Bedrock	4.3	13.1	7.6
2505106	20	1	COLLINGWOOD	555841.3	4930127	Domestic	Bedrock	12.2	15.2	6.1
2505395	20	1	COLLINGWOOD	555718.3	4930120	Domestic	Bedrock	3	8.8	6.7
2505412	20	1	COLLINGWOOD	555840.3	4930240	Domestic	Bedrock	3.7	9.8	7.9
2505494	20	1	COLLINGWOOD	555868.3	4930249	Commerical	Bedrock	3	12.5	6.4
2505749	20	1	COLLINGWOOD	555664.3	4929994	Domestic	Bedrock	4.3	15.2	7.3
2506099	21	1	COLLINGWOOD	555314.3	4930373	Domestic	Bedrock	1.2	11.6	3.7
2506122	20	1	COLLINGWOOD	555364.3	4930073	Domestic	Bedrock	12.2	24.1	6.1
2506127	21	1	COLLINGWOOD	555114.3	4930323	Domestic	Bedrock	0.9	13.1	3.4
2506229	21	1	COLLINGWOOD	555064.3	4930273	Domestic	Bedrock	10.7	11	4.3
2506832	21	1	COLLINGWOOD	555314.3	4930323	Domestic	Bedrock	1.2	17.7	4.3
2507058	21	1	COLLINGWOOD	555314.3	4930073	Domestic	Bedrock	3.4	11.6	7
2507059	20	1	COLLINGWOOD	555064.3	4929773	Domestic	Bedrock	4	16.8	2.1
2507060	20	1	COLLINGWOOD	555064.3	4929823	Domestic	Bedrock	3.7	16.8	1.8
2507316	21	2	COLLINGWOOD	554914.3	4930123	Domestic	Bedrock	3	12.5	6.1
2507379	21	1	COLLINGWOOD	554964.3	4930173	Domestic	Bedrock	2.7	12.5	6.1
2507449	21	1	COLLINGWOOD	555564.3	4930424	Domestic	Bedrock	2.4	9.1	5.7
2507551	21	1	COLLINGWOOD	555514.3	4930224	Domestic	Bedrock	3	12.8	6.4
2507556	20	1	COLLINGWOOD	555864.3	4930174	Domestic	Bedrock	1.8	24.4	3
2507592	21	1	COLLINGWOOD	555264.3	4930273	Domestic	Bedrock	1.8	13.1	4.5
2507593	20	1	COLLINGWOOD	555864.3	4930174	Domestic	Bedrock	2.1	6.7	3
2508384	20	1	COLLINGWOOD	555364.3	4930073	Domestic	Bedrock	4.3	11.6	5.8
2508416	21	1	COLLINGWOOD	555264.3	4930323	Domestic	Bedrock	1.8	18.9	6.4
2508432	20	1	COLLINGWOOD	555264.3	4930023	Domestic	Bedrock	2.4	12.5	7.9
2508700	21	2	COLLINGWOOD	555425.3	4929998	Domestic	Bedrock	4	14.6	11.6
2509221	1	9	COLLINGWOOD	555469.3	4930574	Domestic	Bedrock	1.8	12.2	2.7
2509519	30	9	COLLINGWOOD	555484.3	4929838	Domestic	Bedrock	13.4	45.1	10
2516794	151		COLLINGWOOD	555352	4930108	Monitoring	Overburden	~	3	~
7041618			COLLINGWOOD	555697	4930226	Other	Overburden	1.5	4.3	~
7128380			COLLINGWOOD	555372	4930113	Other	Overburden	~	3.5	~
7357138	20	1	COLLINGWOOD	555708	4930231	Monitoring	Overburden	~	5.2	~
7357139	20	1	COLLINGWOOD	555649	4930190	Monitoring	Overburden	~	4.6	~
7357140	20	1	COLLINGWOOD	555715	4930209	Monitoring	Overburden	~	3.7	~
7357141	20	1	COLLINGWOOD	555671	4930203	Monitoring	Overburden	~	3.4	~
7357142	20	1	COLLINGWOOD	555715	4930218	Monitoring	Overburden	~	3.7	~
7369440			COLLINGWOOD	555703	4930220	Monitoring	Bedrock	1.5	8.2	4.9
7369441			COLLINGWOOD	555683	4930231	Monitoring	Bedrock	1.5	9	4.3
7369442			COLLINGWOOD	555651	4930221	Monitoring	Overburden	1.5	3.8	~
7369443			COLLINGWOOD	555643	4930193	Monitoring	Bedrock	1.5	6.9	5.3

Table 2: Onsite Water Level Elevations

Well ID	Ground Surface Elevation (masl)	Top of Pipe (TOP)		Groundwater Level [12-Jan-2022]			Groundwater Level [7-Apr-2022]		
		(mags)	(masl)	(mbTOP)	(mbgs)	(masl)	(mbTOP)	(mbgs)	(masl)
BH-1	179.98	1.1	181.08	1.83	0.73	179.25	1.66	0.56	179.42
BH-2	179.79	1.13	180.92	1.84	0.71	179.08	1.73	0.60	179.19
BH-3	179.92	1.27	181.19	1.68	0.41	179.51	1.43	0.16	179.76
BH-4	179.36	-- No Well Installed --							
BH-5	179.96	-- No Well Installed --							
BH-6	180.6	1.14	181.74	2.19	1.05	179.55	1.99	0.85	179.75

mags - metres above ground surface

mbgs - metres below ground surface

masl - elevation in metres above sea level

TOP - top of pipe.

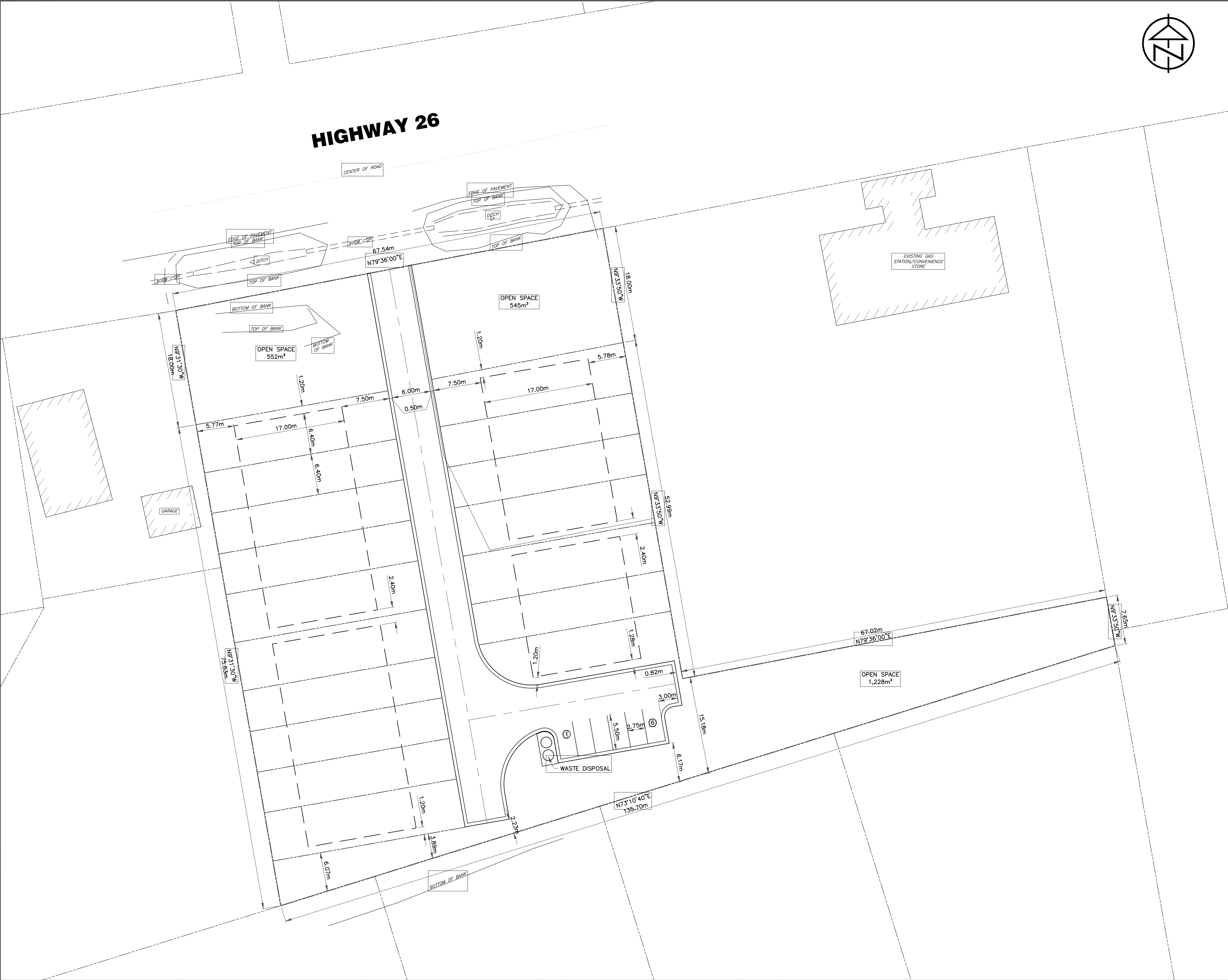
TABLE 3 - RESULTS OF ANALYSIS FOR ROUTINE GROUNDWATER QUALITY PARAMETERS

Parameter	ODWS (MAC)	ODWS (AO)	ODWS (OG)	PWQO	BH-1	BH-2	BH-3	BH-6
Well Construction								
Top of Screen (mbgs)					1.5	1.6	1.6	1.5
Bottom of Screen (mbgs)					4.5	4.6	4.6	4.5
General Chemistry (mg/L)								
Calculated TDS		500			530	450	530	170
Hardness (CaCO3)			80 - 100		450	370	460	150
Total Ammonia-N					0.50	0.50	0.37	0.21
Conductivity (umho/cm)					870	760	890	290
Dissolved Organic Carbon		5			5.9	3.7	5.9	0.92
Orthophosphate (P)					<0.010	<0.010	<0.010	<0.010
pH			6.5 - 8.5		7.70	7.65	7.62	8.15
Dissolved Sulphate (SO4)		500			20	11	4.3	16
Alkalinity (Total as CaCO3)			30 - 500		420	370	440	130
Dissolved Chloride (Cl)		250			33	27	37	11
Nitrite (N)	1				<0.010	<0.010	<0.010	<0.010
Nitrate (N)	10				<0.10	<0.10	<0.10	<0.10
Nitrate + Nitrite (N)	10				<0.10	<0.10	<0.10	<0.10
Dissolved Metals (ug/L)								
Dissolved Aluminum (Al)			100	75	8.5	14	<25	190
Dissolved Antimony (Sb)	6			20	<0.50	<0.50	<0.50	<0.50
Dissolved Arsenic (As)	25			5	<1.0	<1.0	1.6	<1.0
Dissolved Barium (Ba)	1000				46	50	41	8.5
Dissolved Beryllium (Be)				1100	<0.40	<0.40	<0.40	<0.40
Dissolved Boron (B)	5000			200	47	42	49	16
Dissolved Cadmium (Cd)	5			0.5	<0.090	<0.090	<0.090	<0.090
Dissolved Calcium (Ca)					150000	130000	150000	48000
Dissolved Chromium (Cr)	50			1	<5.0	<5.0	<5.0	<5.0
Dissolved Cobalt (Co)				0.9	0.64	<0.50	0.55	0.76
Dissolved Copper (Cu)		1000		5	2.3	1.8	3.6	3.2
Dissolved Iron (Fe)		300		300	7900	7000	7400	520
Dissolved Lead (Pb)	10			5	<0.50	<0.50	<0.50	<0.50
Dissolved Magnesium (Mg)					21000	15000	19000	8500
Dissolved Manganese (Mn)		50			430	280	300	110
Dissolved Molybdenum (Mo)				40	3.3	2.8	1.9	11
Dissolved Nickel (Ni)				25	2.5	2.3	2.2	2.2
Dissolved Phosphorus (P)				10	<100	<100	<100	<100
Dissolved Potassium (K)					2500	2200	2000	1100
Dissolved Selenium (Se)				100	<2.0	<2.0	<2.0	<2.0
Dissolved Silicon (Si)					5100	5100	5800	1700
Dissolved Silver (Ag)				0.1	<0.090	<0.090	<0.090	<0.090
Dissolved Sodium (Na)	20000	200000			28000	23000	29000	5100
Dissolved Strontium (Sr)					310	300	390	120
Dissolved Thallium (Tl)				0.3	<0.050	<0.050	<0.050	<0.050
Dissolved Titanium (Ti)					<5.0	<5.0	<5.0	5.6
Dissolved Uranium (U)	20			5	<0.10	<0.10	<0.10	0.19
Dissolved Vanadium (V)				6	<0.50	<0.50	<0.50	<0.50
Dissolved Zinc (Zn)		5000		30	<5.0	<5.0	<5.0	<5.0

Notes:

- 1. ODWS = Ontario Drinking Water Standards
- 2. MAC = Maximum Acceptable Criteria; health based criteria
- 3. AO = Aesthetic Objective; aesthetic criteria
- 4. OG = Operational Guideline; criteria to facilitate effective treatment, disinfection, and distribution of water
- 5. PWQO = Provincial Water Quality Objectives from Table 2: "Table of PWQOs and Interim PWQOs" from the 1994 Ministry of Environment and Energy document titled, "Water Management: Policies, Guidelines, Provincial Water Quality Objectives."
- 6. Values in **bold** exceed the ODWS AO or OG
- 7. Values in shaded exceed the ODWS MAC
- 8. Values that are underlined exceed the PWQO.
- 9. The aesthetic objective for sodium in drinking water is 200 mg/L. However, the local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.

**APPENDIX A:
CONCEPTUAL SITE PLAN**



KEYPLAN

LEGEND

	PROPERTY BOUNDARY
	LOT BOUNDARY
	BUILDING ENVELOPE

RESIDENTIAL ZONE STANDARDS
(TOWN OF THE BLUE MOUNTAINS ZONING BY-LAW 2018-65)

ROWHOUSE DWELLING			
ZONING STANDARD	R2/R3	PROVIDED	
MINIMUM LOT AREA (m ²)	190	181	
MINIMUM FRONTAGE (m)	6	6.4	
MINIMUM FRONT YARD (m)	6	6.4	
MINIMUM EXTERIOR SIDE YARD (m)	4	4	
MINIMUM INTERIOR SIDE YARD (m)	1.2	1.2	
MINIMUM REAR YARD (m)	7.5	5.8	
MAXIMUM HEIGHT (m)	11	11	
MAXIMUM HEIGHT (STOREYS)	3	3	

ADDITIONAL PARAMETERS:

MINIMUM PARKING REQUIREMENTS FOR ROWHOUSE UNITS:
- 2 PARKING SPACES PER DWELLING UNIT
- 0.25 VISITOR PARKING SPACES PER DWELLING UNIT

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BENCHMARKS

NOTES

1. ALL DIMENSIONS IN METRES UNLESS OTHERWISE NOTED.

No.	REVISION DESCRIPTION	DATE

ENGINEER STAMP

DRAFT FOR DISCUSSION

209806 & 209808 HIGHWAY 26

CONCEPT PLAN

THE TOWN OF THE BLUE MOUNTAINS

PRELIMINARY SITE PLAN

DESIGN: MM	FILE: 121258	DWG: SP-1
DRAWN: MM	DATE: JUN 2022	
CHECK: AS	SCALE: 1:300	

APPENDIX B:
BOREHOLE LOGS AND GRAIN-SIZE DISTRIBUTIONS – BY CMT



CMT Engineering Inc.
1011 Industrial Crescent. St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 1

PAGE 1 OF 1

PROJECT: Proposed Residential Development

PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigleith, Ontario

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-16

DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

GROUND ELEVATION: 179.98 m

LOGGED BY: BL

SAMPLING METHOD: SPT/MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲				WELL DIAGRAM	
							10	20	30	40		
							⊗ POCKET PEN. (kPa) ⊗					
							90	180	270	360		
							● MOISTURE CONTENT (%) ●					
							12	24	36	48		
1		TOPSOIL: Loose, dark brown silty topsoil, moist (80 mm)	0.00, 179.98	SS 1	75	1-4-2-3 (6)	6	15				38mm Riser
		FILL: Loose, dark brown sand fill, moist	0.08, 179.90									
2		buried topsoil and rootlets encountered, occasional intermixed clayey silt	0.91, 179.07	SS 2	50	3-1-5-6 (6)	6					
		SAND: Very loose, grey sand, trace silt and clay, wet	1.52, 178.46									
3		becoming compact	2.59, 177.39	SS 4	100	1-5-7-9 (12)	12	24.1				#2 Sand Pack
4				SS 5	75	6-11-15-12 (26)	20.4	26				38mm Screen
5		SANDY SILT: Compact to very dense, grey sandy silt, some clay, trace gravel, moist	4.62, 175.36	SS 7	75	12-11-11-10 (22)	11.3	22				
6		-refusal on presumed bedrock		SS 8	100	26-43-50-50/-0.077	5					

Bottom of borehole at 6.48 m, Elevation 173.50 m.

The monitoring well was installed at an elevation of approximately 175.41 m.

Water level measured at about 0.73 m (Elev 179.25 m) on Jan. 12, 2022.

BOREHOLE LOG WITH WELL2 21-767.GPJ CMT_TEMPLATE_2020-05-15.GDT 22-2-15



CMT Engineering Inc.
1011 Industrial Crescent, St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 2

PAGE 1 OF 1

PROJECT: Proposed Residential Development

PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigeleith, Ontario

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-16

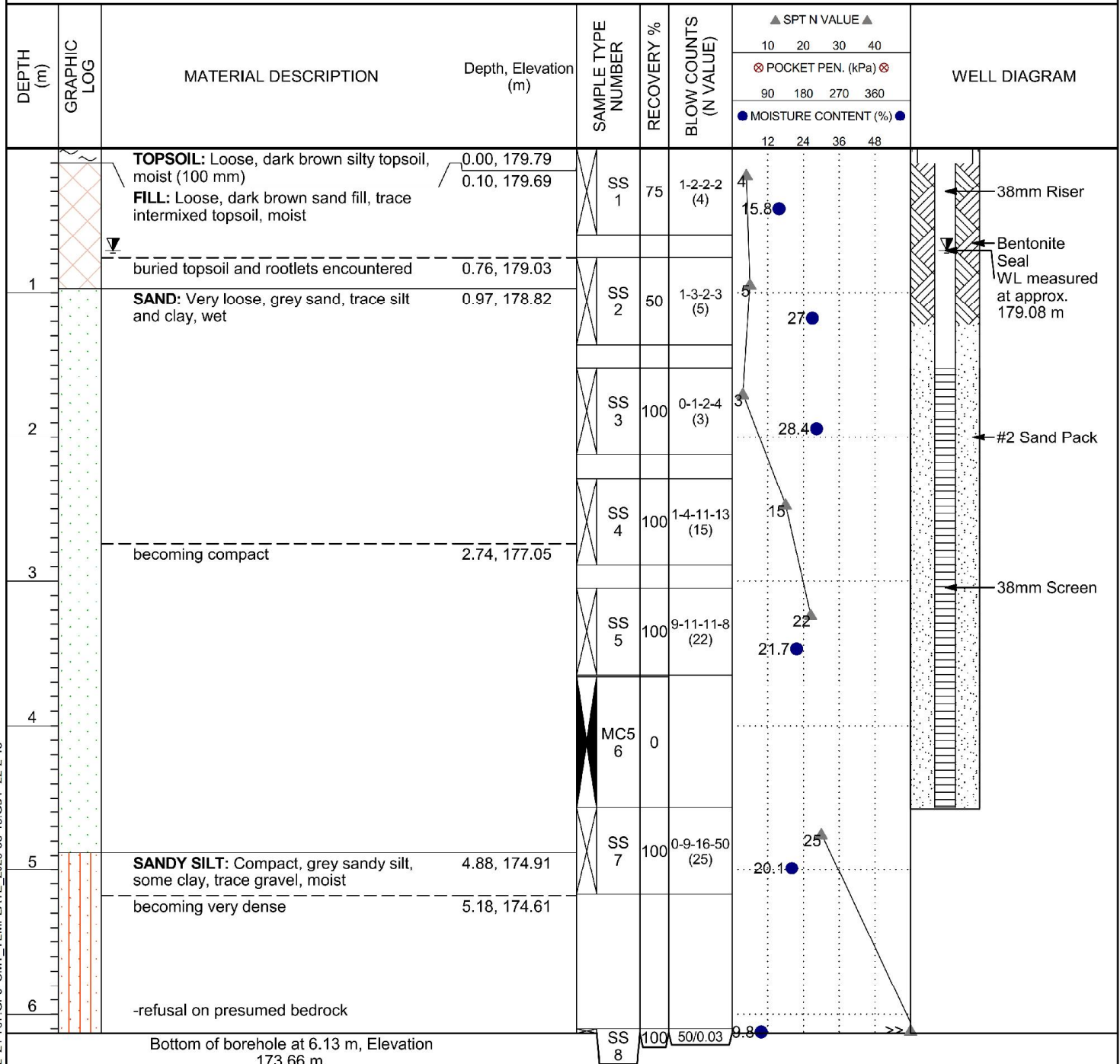
DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

GROUND ELEVATION: 179.79 m

LOGGED BY: BL

SAMPLING METHOD: SPT/MC5



Bottom of borehole at 6.13 m, Elevation 173.66 m.

The monitoring well was installed at an elevation of approximately 175.22 m.

Water level measured at about 0.71 m (Elev 179.08 m) on Jan. 12, 2022.

BOREHOLE LOG WITH WELL2 21-767.GPJ CMT_TEMPLATE_2020-05-15.GDT 22-2-15



CMT Engineering Inc.
1011 Industrial Crescent, St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 3

PAGE 1 OF 1

PROJECT: Proposed Residential Development

PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigleith, Ontario

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-16

DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

GROUND ELEVATION: 179.92 m

LOGGED BY: BL

SAMPLING METHOD: SPT/MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲				WELL DIAGRAM
							10	20	30	40	
							⊗ POCKET PEN. (kPa) ⊗				
							90	180	270	360	
							● MOISTURE CONTENT (%) ●				
							12	24	36	48	
1		TOPSOIL: Loose, dark brown silty topsoil, moist (100 mm)	0.00, 179.92	SS 1	50	0-1-0-1 (1)					
		SAND: Very loose, brown sand, trace silt, clay and rootlets, moist	0.08, 179.84								
2		becoming loose, wet	0.76, 179.16	SS 2	50	2-2-5-5 (7)					
3		becoming compact	2.44, 177.48	SS 3	100	0-2-3-3 (5)					
4		becoming dense to very dense	3.96, 175.96	○ NR		11-0 (11)					
				○ NR		21-0 (21)					
				○ NR		27-0 (27)					
				○ NR		30-0 (30)					
				○ NR		26-0 (26)					
				○ NR		44-0 (44)					
5				○ NR		32-0 (32)					
				○ NR							

Bottom of borehole at 4.57 m, Elevation 175.35 m.

The monitoring well was installed at an elevation of approximately 175.35 m.

Water level measured at about 0.41 m (Elev 179.51 m) on Jan. 12, 2022.



CMT Engineering Inc.
1011 Industrial Crescent. St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 4

PAGE 1 OF 1

PROJECT: Proposed Residential Development

PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigleith, Ontario

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-16

DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

GROUND ELEVATION: 179.36 m

LOGGED BY: BL

SAMPLING METHOD: SPT/MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲				WELL DIAGRAM
							10	20	30	40	
							⊗ POCKET PEN. (kPa) ⊗				
							90	180	270	360	
							● MOISTURE CONTENT (%) ●				
							12	24	36	48	
1 											

Bottom of borehole at 4.45 m, Elevation
174.91 m.



CMT Engineering Inc.
1011 Industrial Crescent. St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 5

PAGE 1 OF 1

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-17

DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

PROJECT: Proposed Residential Development

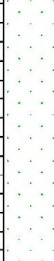
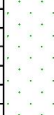
PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigleith, Ontario

GROUND ELEVATION: 179.96 m

LOGGED BY: BL

SAMPLING METHOD: SPT/MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲				WELL DIAGRAM
							10	20	30	40	
							⊗ POCKET PEN. (kPa) ⊗				
							90	180	270	360	
							● MOISTURE CONTENT (%) ●				
							12	24	36	48	
1		TOPSOIL: Loose, dark brown silty topsoil, moist (80 mm)	0.00, 179.96	SS 1	25	1-1-2-2 (3)	3				
		FILL: Loose, dark brown sand fill, trace intermixed topsoil, moist	0.08, 179.88								
		buried topsoil and rootlets encountered	0.91, 179.05	SS 2	75	0-3-4-4 (7)	7				
2		SAND: Very loose to compact, grey sand, trace silt and clay, wet	1.07, 178.89	SS 3	100	2-3-4-5 (7)					
3				NR		0-0 (0)	0				
				NR		2-0 (2)	2				
4				NR		1-0 (1)					
				NR		13-0 (13)	13				
		becoming dense to very dense	3.66, 176.30	NR		31-0 (31)	31				
				NR		59-0 (59)	>>				
				NR		100-0 (100)	>>				

Bottom of borehole at 4.47 m, Elevation 175.49 m.



CMT Engineering Inc.
1011 Industrial Crescent, St. Clements
N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 6

PAGE 1 OF 1

PROJECT: Proposed Residential Development

PROJECT ADDRESS: 209806 and 209808 Highway 26

PROJECT LOCATION: Craigeleith, Ontario

PROJECT NUMBER: 21-767

DRILLING DATE: 21-9-17

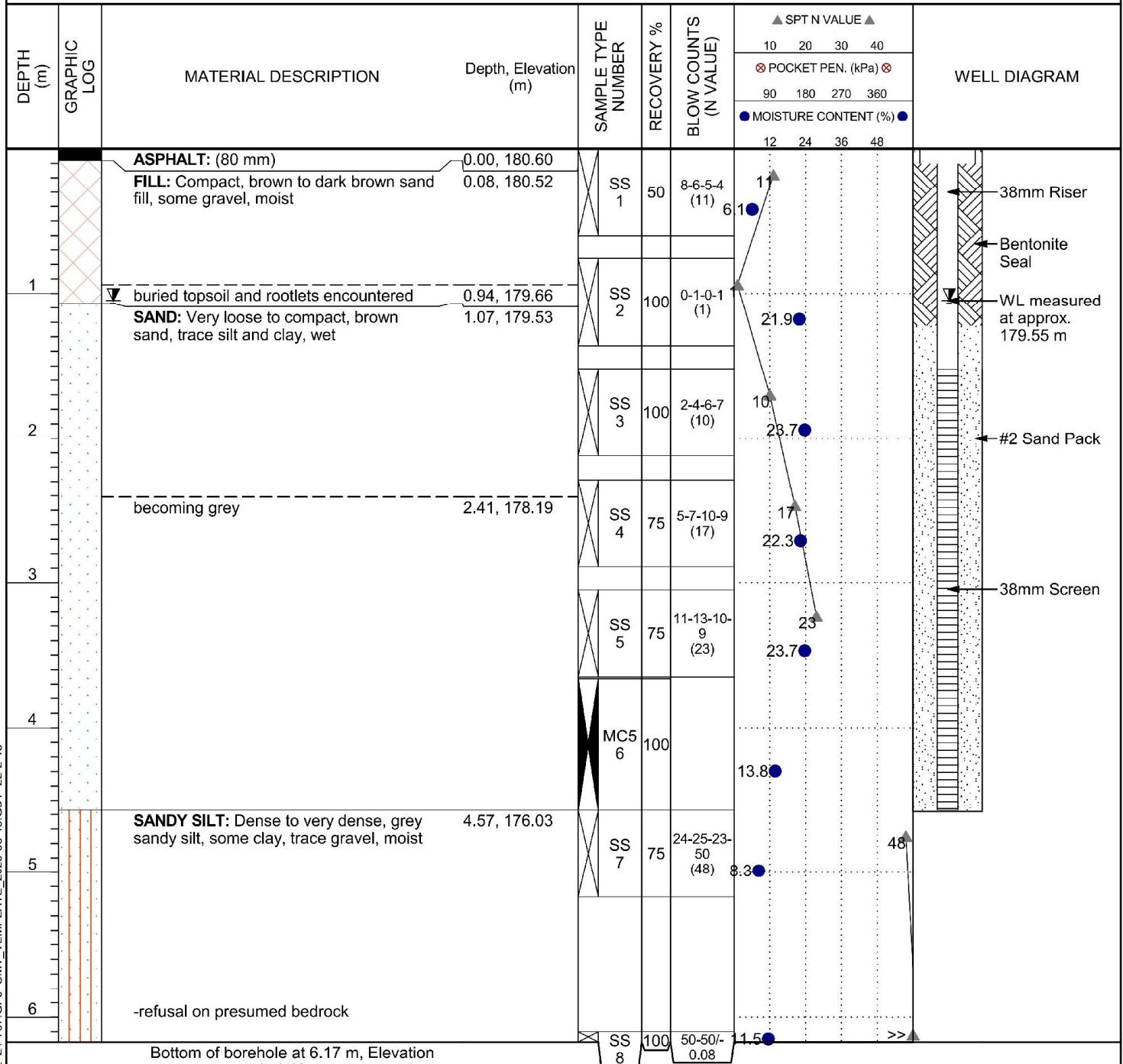
DRILLING CONTRACTOR: CMT DRILLING INC.

DRILLING EQUIPMENT: Geoprobe 7822DT

GROUND ELEVATION: 180.60 m

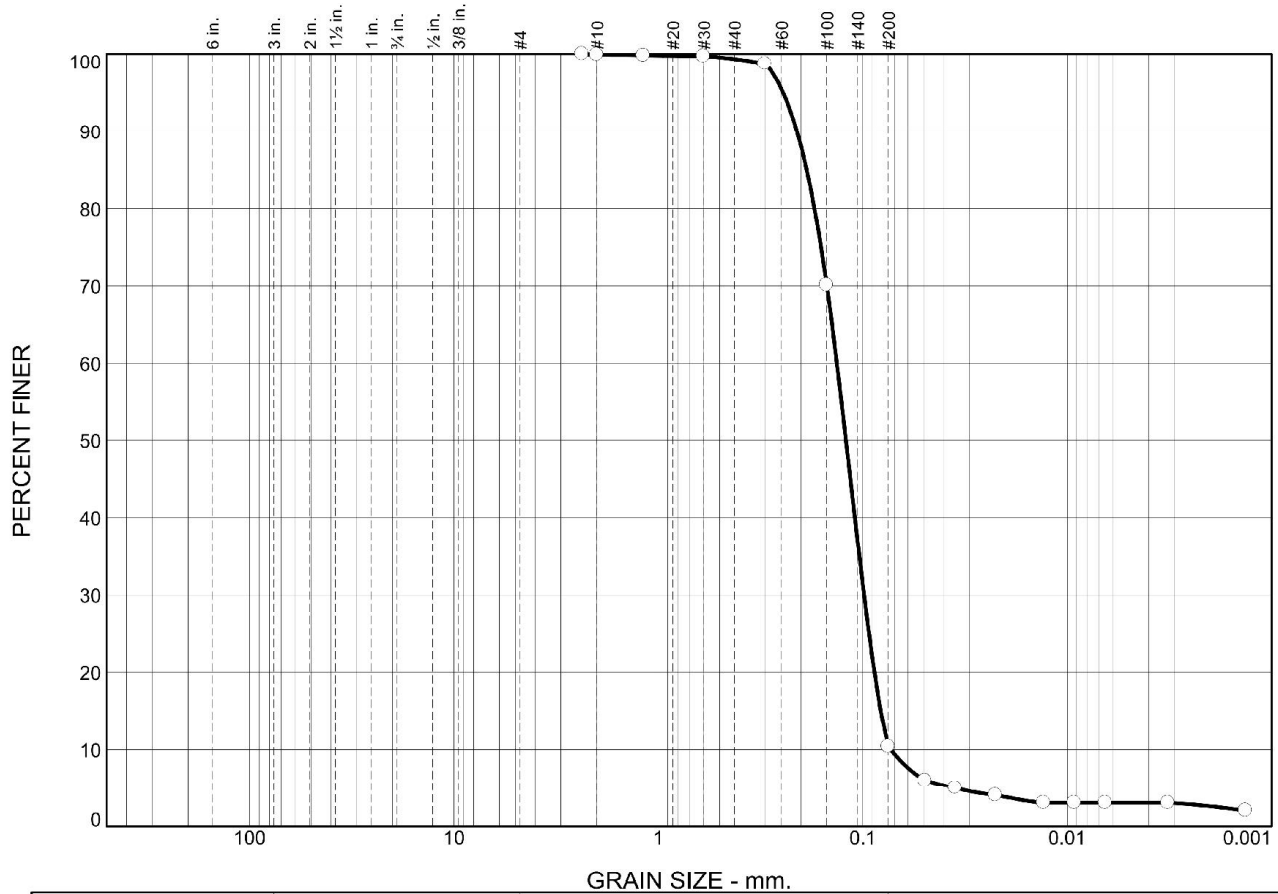
LOGGED BY: BL

SAMPLING METHOD: SPT/MC5



BOREHOLE LOG WITH WELL2 21-767.GPJ CMT_TEMPLATE_2020-05-15.GDT 22-2-15

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.6	88.9	7.8	2.6

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH1	4	2.29-2.90m	sand, trace silt and clay	SP-SM
				Estimated Coefficient of Permeability; $k = 6.0 \times 10^{-3}$ cm/sec	
				Sampled by BL of CMT Engineering Inc., December 16, 2021	
				Tested by MS of CMT Engineering Inc., December 22, 2021	

CMT Engineering Inc.

St. Clements, ON

Client: Pinnacle Building Group

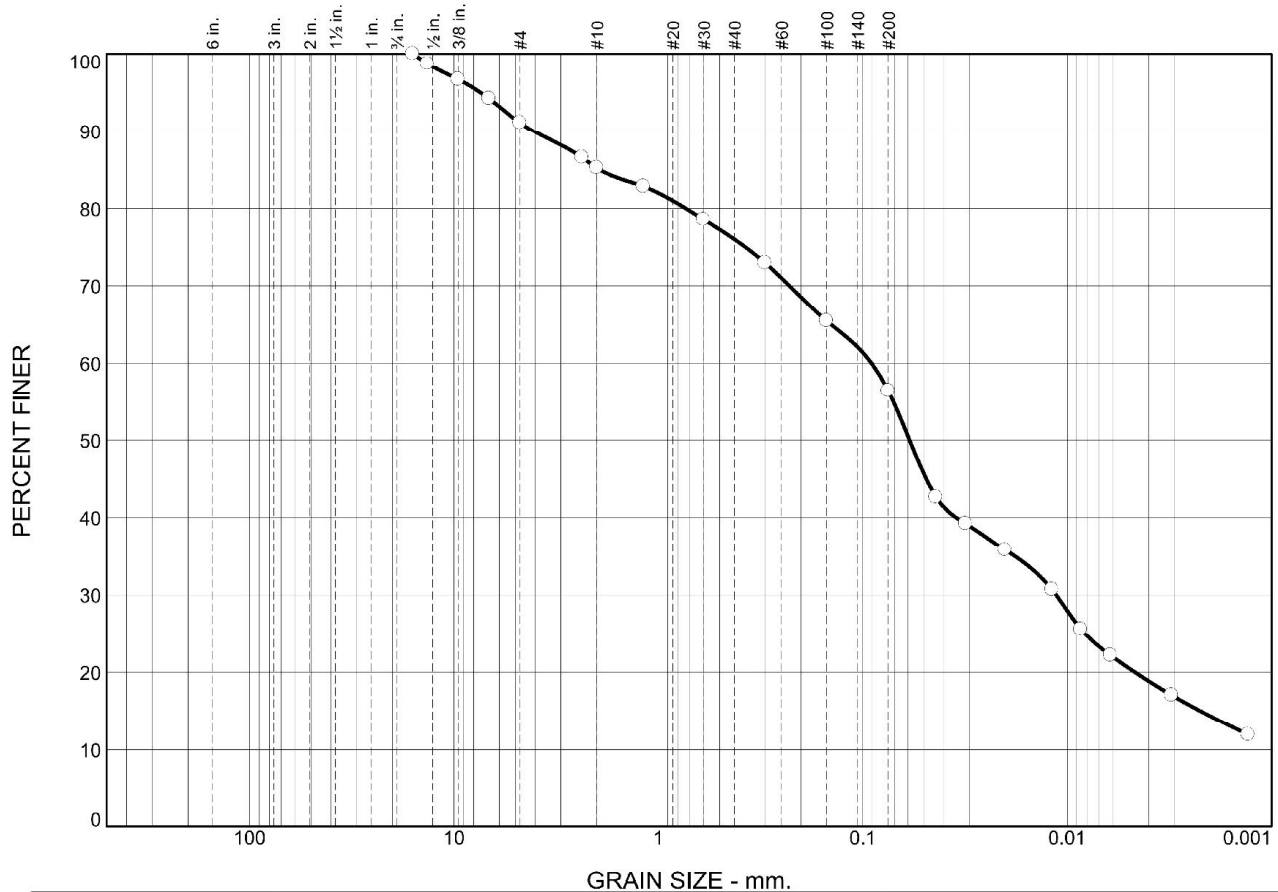
Project: Residential Development

209806 and 209808 Highway 26, Craigeleith, Ontario

Project No.: 21-767

Figure 1

Particle Size Distribution Report



GRAIN SIZE - mm.							
% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.9	5.9	9.2	19.6	42.0	14.4

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH2	6	4.57-5.18m	sandy silt, some clay, trace gravel	ML
				Estimated Coefficient of Permeability; $k = 1.0 \times 10^{-5}$ cm/sec	
				Sampled by BL of CMT Engineering Inc., December 16, 2021	
				Tested by MS of CMT Engineering Inc., December 22, 2021	

CMT Engineering Inc.

St. Clements, ON

Client: Pinnacle Building Group

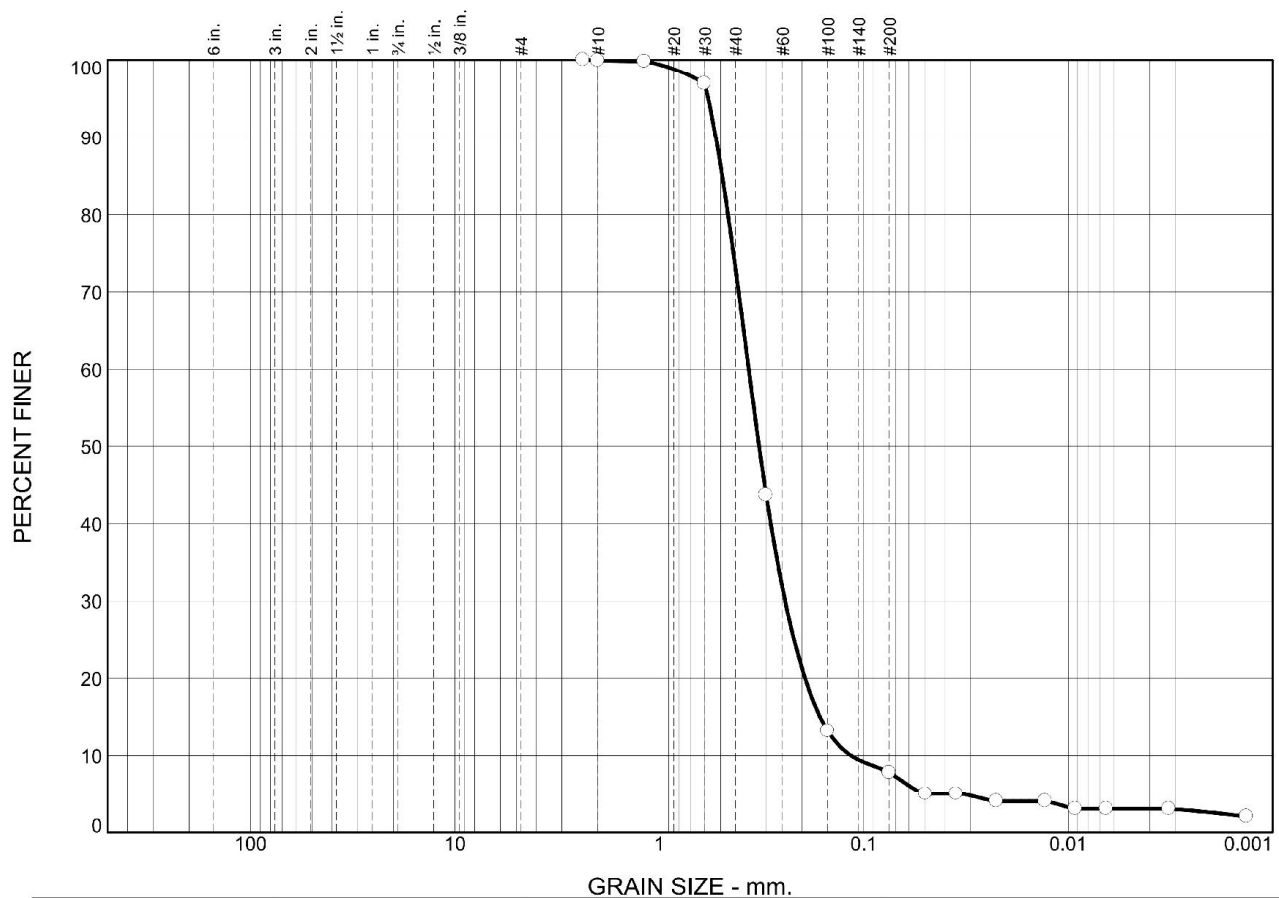
Project: Residential Development

209806 and 209808 Highway 26, Craigleith, Ontario

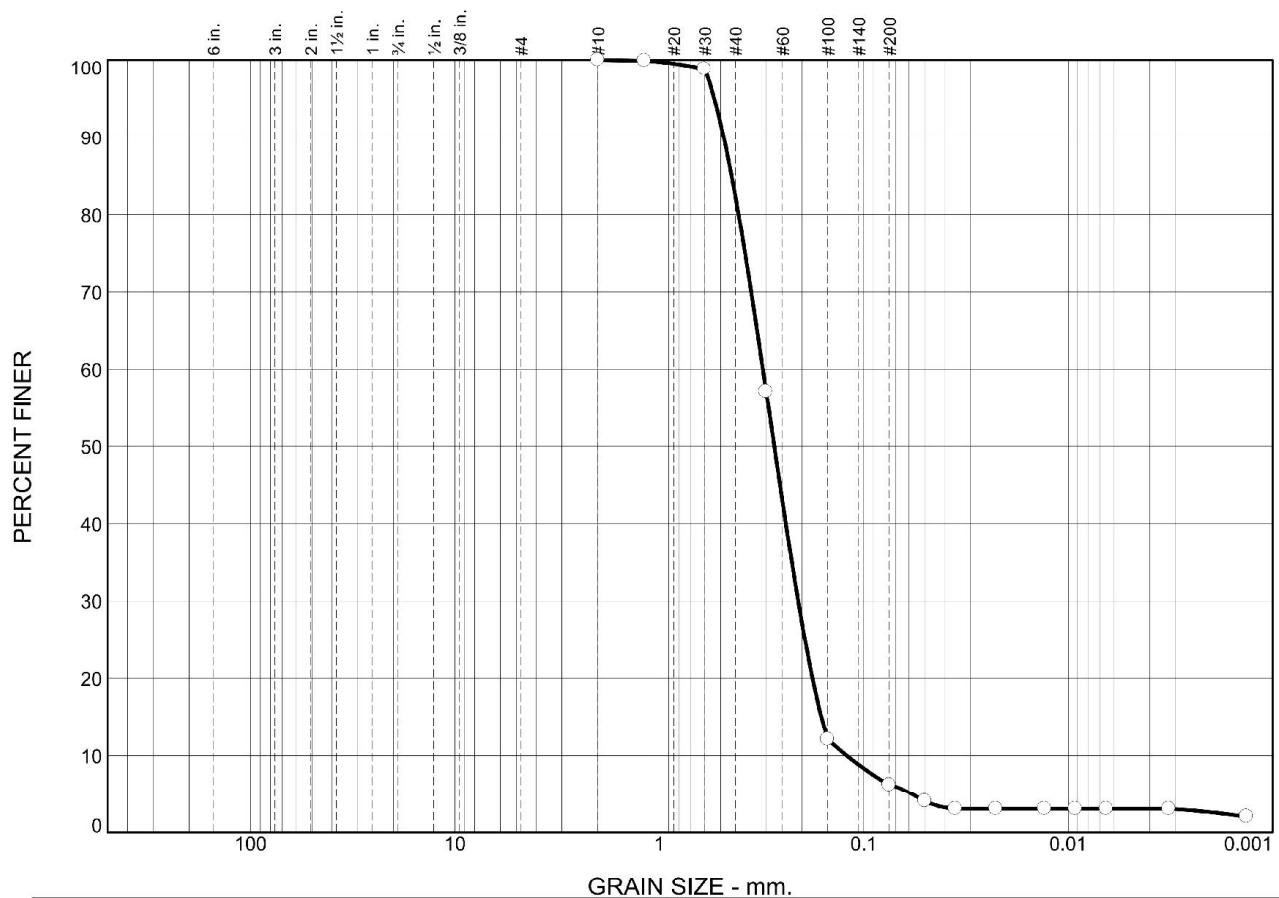
Project No.: 21-767

Figure 2

Particle Size Distribution Report



Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	17.6	76.2	3.6	2.6

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH6	3	1.52-2.13m	sand, trace silt and clay	SP-SM
				Estimated Coefficient of Permeability; $k = 1.7 \times 10^{-2}$ cm/sec	
				Sampled by BL of CMT Engineering Inc., December 17, 2021	
				Tested by MS of CMT Engineering Inc., December 22, 2021	

CMT Engineering Inc.

St. Clements, ON

Client: Pinnacle Building Group

Project: Residential Development

209806 and 209808 Highway 26, Craigeleith, Ontario

Project No.: 21-767

Figure 4

APPENDIX C:
LABORATORY CERTIFICATE OF ANALYSES – SAMPLING BY
RUBICON



PH Quantum

Member of Canadian Association for Laboratory Accreditation Inc (CALA)

January 12, 2022

Dear Mr. Rew,

Please find attached the Report of Analysis for your project No. R63160.

Sincerely,


Victor Hurem Bs.C.Chem.

REPORT OF ANALYSIS

Page 1 of 5

LABORATORY I.D. :	13829-22	CLIENT:	Rubicon Environmental
SAMPLE MATRIX :	water	JOB/PROJECT No. :	R63160
REPORT NUMBER :	13829	DATE SUBMITTED:	January-10-22
REPORT TO :	Mr. Paul Rew	DATE REPORTED:	January-12-22

PARAMETER	UNITS	M.D.L.	CONTROL SAMPLE			SAMPLE DATA		
			expected conc.	found conc.	recovery %	MW1	MW2	MW3
<i>Elements by ICP</i>								
Aluminum	mg/l	0.001	10.000	9.605	96	0.075	0.069	0.063
Antimony	mg/l	0.001	10.000	9.498	95	<M.D.L	<M.D.L	<M.D.L
Arsenic	mg/l	0.001	10.000	9.603	96	<M.D.L	<M.D.L	<M.D.L
Barium	mg/l	0.001	10.000	9.638	96	0.089	0.095	0.082
Beryllium	mg/l	0.001	10.000	9.784	98	<M.D.L	<M.D.L	<M.D.L
Boron (total)	mg/l	0.001	10.000	9.639	96	0.005	0.008	0.006
Cadmium	mg/l	0.001	10.000	9.735	97	<M.D.L	<M.D.L	<M.D.L
Calcium	mg/l	0.001	10.000	9.786	98	155	142	158
Chromium	mg/l	0.001	10.000	9.605	96	0.001	0.001	0.001
Cobalt	mg/l	0.001	10.000	9.804	98	0.001	0.001	0.001
Copper	mg/l	0.001	10.000	9.735	97	0.008	0.012	0.015
Iron	mg/l	0.001	10.000	9.625	96	0.115	0.108	0.112
Lead	mg/l	0.001	10.000	9.692	97	0.001	0.002	0.001
Magnesium	mg/l	0.001	10.000	9.508	95	42.8	46.7	45.4
Manganese	mg/l	0.001	10.000	9.658	97	0.748	0.685	0.708
Mercury	mg/l	0.0001	1.0000	0.9480	95	<M.D.L	<M.D.L	<M.D.L
Molybdenum	mg/l	0.001	10.000	9.545	95	<M.D.L	<M.D.L	<M.D.L
Nickel	mg/l	0.001	10.000	9.678	97	0.004	0.006	0.003
Phosphorus	mg/l	0.001	10.000	9.762	98	0.081	0.071	0.076
Potassium	mg/l	0.001	10.000	9.703	97	7.45	8.01	7.09
Selenium	mg/l	0.001	10.000	9.802	98	<M.D.L	<M.D.L	<M.D.L
Silicon	mg/l	0.001	10.000	9.658	97	7.65	7.92	7.35
Silver	mg/l	0.001	10.000	9.841	98	<M.D.L	<M.D.L	<M.D.L
Sodium	mg/l	0.001	10.000	9.552	96	168	175	143
Strontium	mg/l	0.001	10.000	9.589	96	0.595	0.602	0.582
Thallium	mg/l	0.001	10.000	9.625	96	<M.D.L	<M.D.L	<M.D.L
Tin	mg/l	0.001	10.000	9.609	96	0.001	0.001	0.001
Titanium	mg/l	0.001	10.000	9.636	96	0.049	0.053	0.048
Uranium	mg/l	0.001	10.000	9.658	97	<M.D.L	<M.D.L	<M.D.L
Vanadium	mg/l	0.001	10.000	9.731	97	<M.D.L	<M.D.L	<M.D.L
Zinc	mg/l	0.001	10.000	9.778	98	0.038	0.045	0.051

M.D.L. = Method Detection Limit

REPORT OF ANALYSIS

Page 2 of 5

LABORATORY I.D. :	13829-22	CLIENT:	Rubicon Environmental
SAMPLE MATRIX :	water	JOB/PROJECT No. :	R63160
REPORT NUMBER :	13829	DATE SUBMITTED:	January-10-22
REPORT TO :	Mr. Paul Rew	DATE REPORTED:	January-12-22

PARAMETER	UNIT	M.D.L.	CONTROL SAMPLE			SAMPLE DATA		
			expected conc.	found conc.	recovery %	MW1	MW2	MW3
VOCs - EPA 624								
Dichlorofluoromethane	µg/l	0.1	42.7	40.8	96	<M.D.L.	<M.D.L.	<M.D.L.
Chloromethane	µg/l	0.1	42.2	41.2	98	<M.D.L.	<M.D.L.	<M.D.L.
Vinyl Chloride	µg/l	0.1	28.9	27.8	96	<M.D.L.	<M.D.L.	<M.D.L.
Bromomethane	µg/l	0.1	71.4	70.2	98	<M.D.L.	<M.D.L.	<M.D.L.
Chloroethane	µg/l	0.1	43.1	41.5	96	<M.D.L.	<M.D.L.	<M.D.L.
Trichlorofluoromethane	µg/l	0.1	40.7	39.5	97	<M.D.L.	<M.D.L.	<M.D.L.
Acetone	µg/l	0.1	75.2	71.2	95	<M.D.L.	<M.D.L.	<M.D.L.
1,1 Dichloroethylene	µg/l	0.1	26.1	25.1	96	<M.D.L.	<M.D.L.	<M.D.L.
Methyl-tert. Butyl Ether	µg/l	0.1	70.8	66.2	94	<M.D.L.	<M.D.L.	<M.D.L.
Methylene chloride	µg/l	0.1	42.2	41.2	98	<M.D.L.	<M.D.L.	<M.D.L.
t-1,2 Dichloroethylene	µg/l	0.1	41.1	39.4	96	<M.D.L.	<M.D.L.	<M.D.L.
1,1 Dichloroethane	µg/l	0.1	40.8	38.8	95	<M.D.L.	<M.D.L.	<M.D.L.
2,2 Dichloropropane	µg/l	0.1	41.5	38.5	93	<M.D.L.	<M.D.L.	<M.D.L.
c-1,2 Dichloroethylene	µg/l	0.1	42.3	39.8	94	<M.D.L.	<M.D.L.	<M.D.L.
n-hexane	µg/l	0.1	44.6	42.5	95	<M.D.L.	<M.D.L.	<M.D.L.
Methyl Ethyl Ketone	µg/l	0.1	73.8	68.9	93	<M.D.L.	<M.D.L.	<M.D.L.
Chloroform	µg/l	0.1	40.8	38.6	95	<M.D.L.	<M.D.L.	<M.D.L.
Bis(2-Chloroethyl)ether	µg/l	0.1	100	93.8	94	<M.D.L.	<M.D.L.	<M.D.L.
Bis(2-Chloroisopropyl)ether	µg/l	0.1	100	94.2	94	<M.D.L.	<M.D.L.	<M.D.L.
1,4 Dioxane	µg/l	0.1	100	94.5	95	<M.D.L.	<M.D.L.	<M.D.L.
Bromochloromethane	µg/l	0.1	68.9	65.7	95	<M.D.L.	<M.D.L.	<M.D.L.
1,1,1 Trichloroethane	µg/l	0.1	40.6	38.1	94	<M.D.L.	<M.D.L.	<M.D.L.
1,1 Dichloropropene	µg/l	0.1	43.2	40.8	94	<M.D.L.	<M.D.L.	<M.D.L.
Carbon Tetrachloride	µg/l	0.1	40.6	37.9	93	<M.D.L.	<M.D.L.	<M.D.L.
1,2 Dichloroethane	µg/l	0.1	44.1	41.3	94	<M.D.L.	<M.D.L.	<M.D.L.
Benzene	µg/l	0.1	45.2	41.8	92	<M.D.L.	<M.D.L.	<M.D.L.
Trichloroethylene	µg/l	0.1	40.7	37.9	93	<M.D.L.	<M.D.L.	<M.D.L.
Metyl Isobutyl Ketone	µg/l	0.1	75.2	70.6	94	<M.D.L.	<M.D.L.	<M.D.L.
1,2 Dichloropropane	µg/l	0.1	40.7	37.9	93	<M.D.L.	<M.D.L.	<M.D.L.

M.D.L. = Method Detection Limit

REPORT OF ANALYSIS

Page 3 of 5

LABORATORY I.D. :	13829-22	CLIENT:	Rubicon Environmental
SAMPLE MATRIX :	water	JOB/PROJECT No. :	R63160
REPORT NUMBER :	13829	DATE SUBMITTED:	January-10-22
REPORT TO :	Mr. Paul Rew	DATE REPORTED:	January-12-22

PARAMETER	UNIT	M.D.L.	CONTROL SAMPLE			SAMPLE DATA		
			expected conc.	found conc.	recovery %	MW1	MW2	MW3
VOCs - EPA 624								
Dichlorobromomethane	µg/l	0.1	72.1	70.3	98	<M.D.L.	<M.D.L.	<M.D.L.
Dibromomethane	µg/l	0.1	69.8	66.9	96	<M.D.L.	<M.D.L.	<M.D.L.
Toluene	µg/l	0.1	45.8	43.2	94	<M.D.L.	<M.D.L.	<M.D.L.
t-1,3 Dichloropropene	µg/l	0.1	42.6	40.1	94	<M.D.L.	<M.D.L.	<M.D.L.
1,1,2 Trichloroethane	µg/l	0.1	40.8	39.1	96	<M.D.L.	<M.D.L.	<M.D.L.
1,3 Dichloropropane	µg/l	0.1	40.1	37.9	95	<M.D.L.	<M.D.L.	<M.D.L.
Tetrachloroethylene	µg/l	0.1	40.6	38.2	94	<M.D.L.	<M.D.L.	<M.D.L.
Dibromochloromethane	µg/l	0.1	69.3	66.4	96	<M.D.L.	<M.D.L.	<M.D.L.
1,2 Dibromoethane	µg/l	0.1	69.8	66.3	95	<M.D.L.	<M.D.L.	<M.D.L.
c-1,3 Dichloropropene	µg/l	0.1	40.3	38.1	95	<M.D.L.	<M.D.L.	<M.D.L.
Chlorobenzene	µg/l	0.1	28.3	26.9	95	<M.D.L.	<M.D.L.	<M.D.L.
1,1,1,2 Tetrachloroethane	µg/l	0.1	42.6	40.2	94	<M.D.L.	<M.D.L.	<M.D.L.
Ethylbenzene	µg/l	0.1	45.1	42.8	95	<M.D.L.	<M.D.L.	<M.D.L.
m/p-Xylene	µg/l	0.1	72.4	69.8	96	<M.D.L.	<M.D.L.	<M.D.L.
o-Xylene	µg/l	0.1	44.8	42.4	95	<M.D.L.	<M.D.L.	<M.D.L.
Styrene	µg/l	0.1	42.5	40.6	96	<M.D.L.	<M.D.L.	<M.D.L.
Bromoform	µg/l	0.1	78.2	73.5	94	<M.D.L.	<M.D.L.	<M.D.L.
1,1,2,2 Tetrachloroethane	µg/l	0.1	46.2	42.8	93	<M.D.L.	<M.D.L.	<M.D.L.
1,2,3 Trichloropropane	µg/l	0.1	43.8	41.6	95	<M.D.L.	<M.D.L.	<M.D.L.
Bromobenzene	µg/l	0.1	43.2	40.7	94	<M.D.L.	<M.D.L.	<M.D.L.
2-Chlorotoluene	µg/l	0.1	41.6	40.2	97	<M.D.L.	<M.D.L.	<M.D.L.
4-Chlorotoluene	µg/l	0.1	41.2	40.1	97	<M.D.L.	<M.D.L.	<M.D.L.
1,3 Dichlorobenzene	µg/l	0.1	42.8	40.8	95	<M.D.L.	<M.D.L.	<M.D.L.
1,4 Dichlorobenzene	µg/l	0.1	42.3	40.3	95	<M.D.L.	<M.D.L.	<M.D.L.
1,2 Dichlorobenzene	µg/l	0.1	42.1	40.2	95	<M.D.L.	<M.D.L.	<M.D.L.
1,2 Dibromo 3 Chloropropane	µg/l	0.1	43.1	41.4	96	<M.D.L.	<M.D.L.	<M.D.L.
1,2,4 Trichlorobenzene	µg/l	0.1	68.8	64.1	93	<M.D.L.	<M.D.L.	<M.D.L.
Hexachlorobutadiene	µg/l	0.1	70.2	66.1	94	<M.D.L.	<M.D.L.	<M.D.L.
1,2,3 Trichlorobenzene	µg/l	0.1	75.1	70.8	94	<M.D.L.	<M.D.L.	<M.D.L.

M.D.L. = Method Detection Limit

REPORT OF ANALYSIS

Page 4 of 5

LABORATORY I.D. :	13829-22	CLIENT:	Rubicon Environmental
SAMPLE MATRIX :	water	JOB\PROJECT No. :	R63160
REPORT NUMBER :	13829	DATE SUBMITTED:	January-10-22
REPORT TO :	Mr. Paul Rew	DATE REPORTED:	January-12-22

PARAMETER	UNIT	M.D.L.	CONTROL SAMPLE			SAMPLE DATA		
			expected conc.	found conc.	recovery %	MW1	MW2	MW3
EPA 8310								
Naphthalene	µg/l	1	10.00	9.56	96	<M.D.L.	<M.D.L.	<M.D.L.
1-Methyl-Naphthalene	µg/l	1	10.00	9.56	96	<M.D.L.	<M.D.L.	<M.D.L.
2-Methyl-Naphthalene	µg/l	1	10.00	9.56	96	<M.D.L.	<M.D.L.	<M.D.L.
Acenaphthylene	µg/l	1	10.00	9.54	95	<M.D.L.	<M.D.L.	<M.D.L.
Acenaphthene	µg/l	1	10.00	9.72	97	<M.D.L.	<M.D.L.	<M.D.L.
Fluorene	µg/l	1	10.00	9.85	99	<M.D.L.	<M.D.L.	<M.D.L.
Phenanthrene	µg/l	0.1	10.00	9.40	94	<M.D.L.	<M.D.L.	<M.D.L.
Anthracene	µg/l	0.1	10.00	9.74	97	<M.D.L.	<M.D.L.	<M.D.L.
Fluoranthene	µg/l	0.1	10.00	9.63	96	<M.D.L.	<M.D.L.	<M.D.L.
Pyrene	µg/l	0.1	10.00	9.62	96	<M.D.L.	<M.D.L.	<M.D.L.
Chrysene	µg/l	0.1	10.00	9.81	98	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(a)anthracene	µg/l	0.1	10.00	9.67	97	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(b)fluoranthene	µg/l	0.1	10.00	9.73	97	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(k)fluoranthene	µg/l	0.1	10.00	9.55	96	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(b,j)fluoranthene	µg/l	0.1	10.00	9.55	96	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(a)pyrene	µg/l	0.01	10.00	9.70	97	<M.D.L.	<M.D.L.	<M.D.L.
Indeno(1,2,3-c,d)pyrene	µg/l	0.1	10.00	9.51	95	<M.D.L.	<M.D.L.	<M.D.L.
Dibenzo(a,h)anthracene	µg/l	0.1	10.00	9.64	96	<M.D.L.	<M.D.L.	<M.D.L.
Benzo(g,h,i)perylene	µg/l	0.1	10.00	9.71	97	<M.D.L.	<M.D.L.	<M.D.L.
Surrogate recovery	%	0.1				94	94	94
2- Fluorobiphenyl								

M.D.L. = Method Detection Limit

REPORT OF ANALYSIS

Page 5 of 5

LABORATORY I.D. :	13829-22	CLIENT:	Rubicon Environmental
SAMPLE MATRIX :	water	JOB/PROJECT No. :	R63160
REPORT NUMBER :	13829	DATE SUBMITTED:	January-10-22
REPORT TO :	Mr. Paul Rew	DATE REPORTED:	January-12-22

PARAMETER	UNITS	M.D.L.	CONTROL SAMPLE			SAMPLE DATA		
			expected conc.	found conc.	recovery %	MW1	MW2	MW3
Petroleum Hydrocarbons								
F1, PHC range C6 - C10 * (Volatile Petroleum Hydroc	µg/l	10	500	482	96	<M.D.L.	<M.D.L.	<M.D.L.
F2, PHC range C10 - C16** (Extractable Hydrocarbons	µg/l	50	2790	2659	95	<M.D.L.	<M.D.L.	<M.D.L.
F3, PHC range C16 - C34** (Heavy Extractable Hydroc	µg/l	100	5000	4785	96	<M.D.L.	<M.D.L.	<M.D.L.
F4, PHC range C34 - C50 (Hot Extractable Hydrocarb	µg/l	500	5000	4716	94	<M.D.L.	<M.D.L.	<M.D.L.
pH	pH Unit	0.01	7.00	7.00	100	7.08	n.r.	n.r.

M.D.L. = Method Detection Limit

* - excludes BTEX

** - includes PAH

n.r. = not requested


Victor Hurem B. Sc. Chem.

APPENDIX D: SLUG TEST RESULTS



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

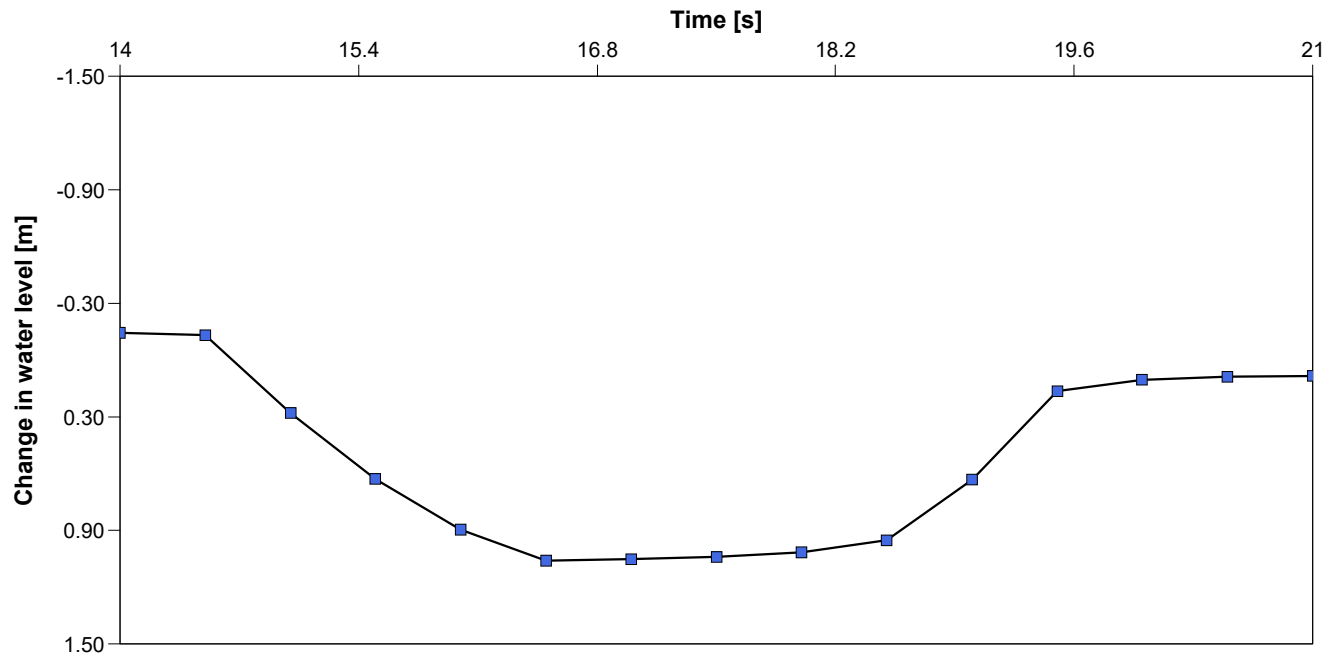
Test Date: 1/12/2022

Analysis Performed by: Corbin Sweet

Time vs. Change in W.L. 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigleith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

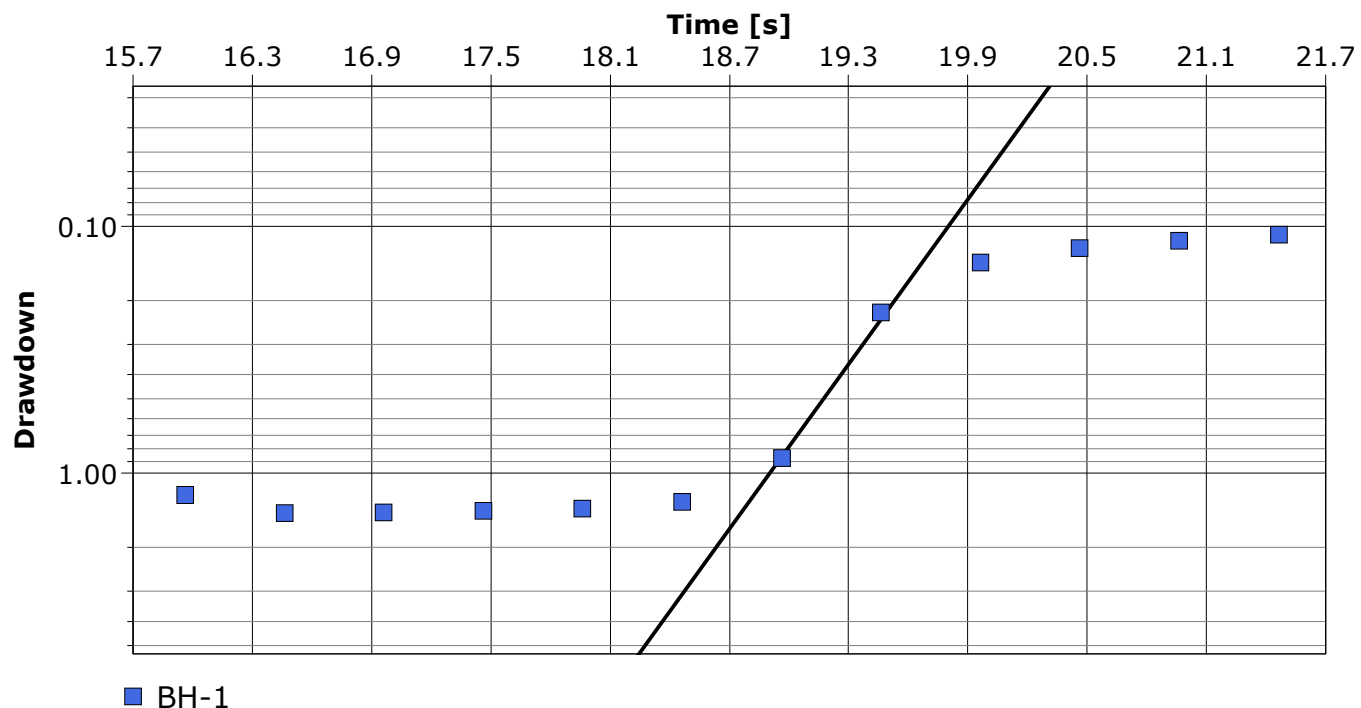
Test Date: 1/12/2022

Analysis Performed by: Corbin Sweet

Hvorslev 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-1

5.64×10^{-4}



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

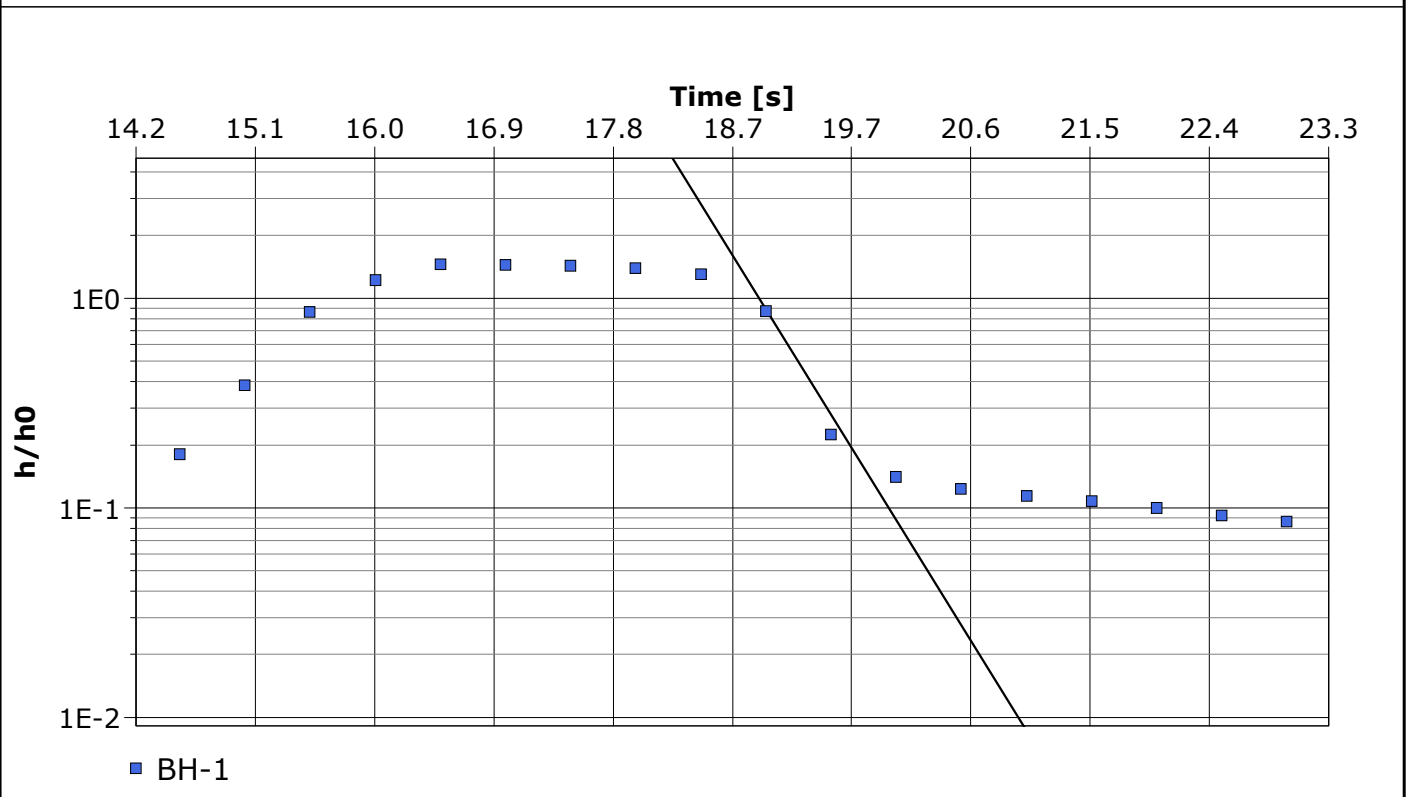
Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith	Slug Test: BH-1 Slug Testing	Test Well: BH-1
Test Conducted by: Corbin Sweet		Test Date: 1/12/2022
Analysis Performed by:	Bouwer & Rice 1	Analysis Date: 1/20/2022
Aquifer Thickness: 3.00 m		



Calculation using Bouwer & Rice		
Observation Well	Hydraulic Conductivity [m/s]	
BH-1	3.88×10^{-4}	



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

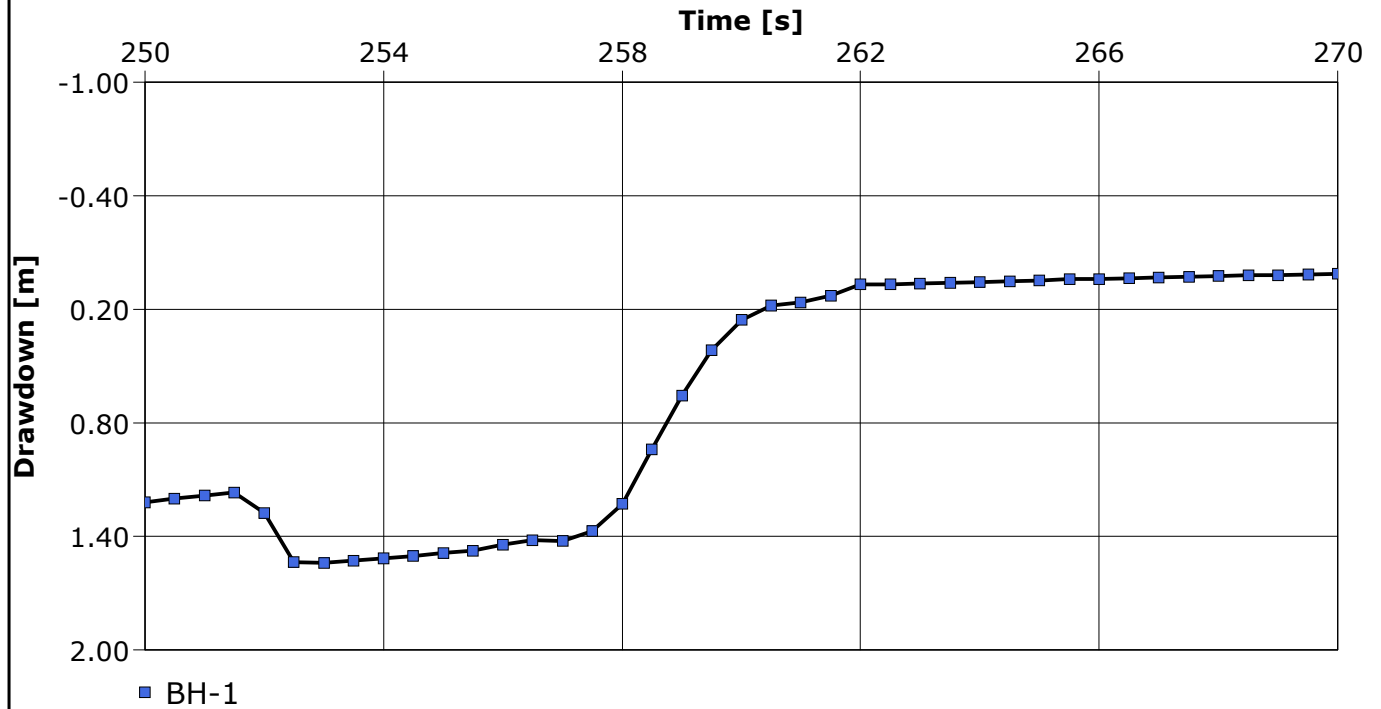
Test Date: 1/12/2022

Analysis Performed by: Corbin Sweet

Time vs. Change in W.L. 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

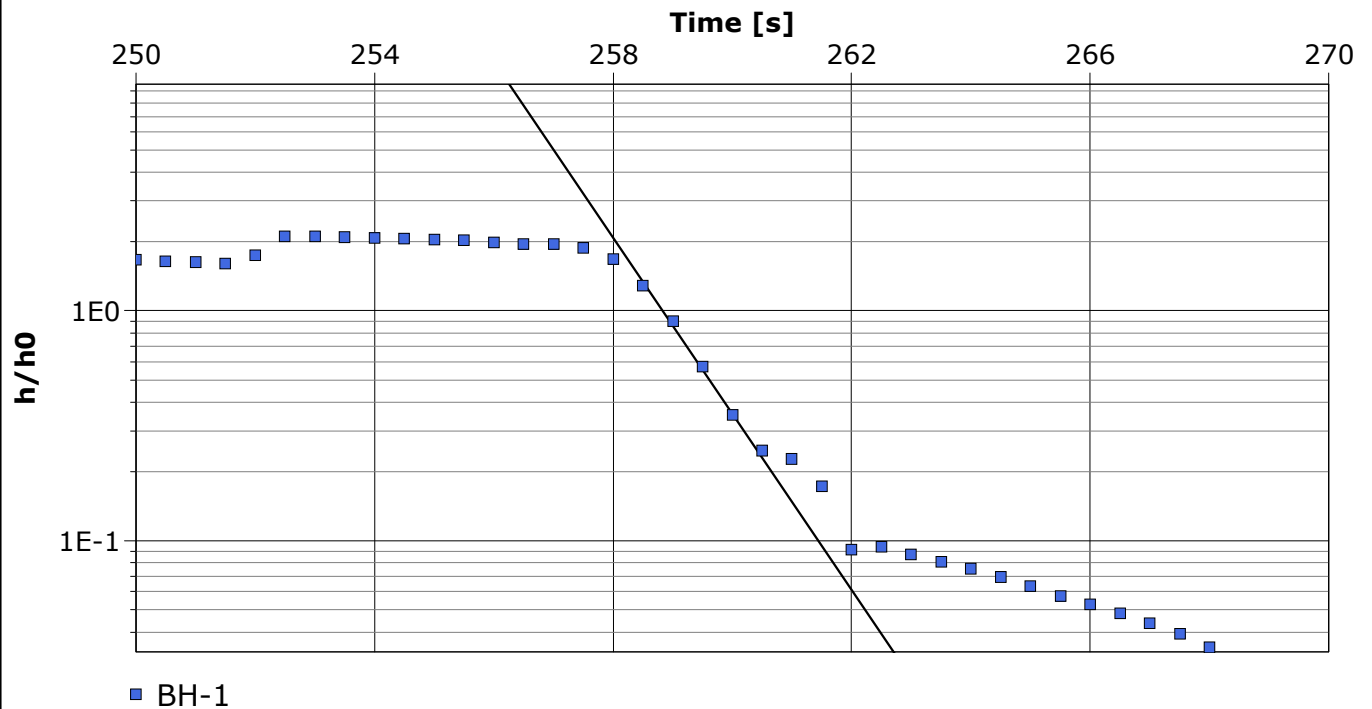
Test Date: 1/12/2022

Analysis Performed by:

Hvorslev 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-1

1.94×10^{-4}



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

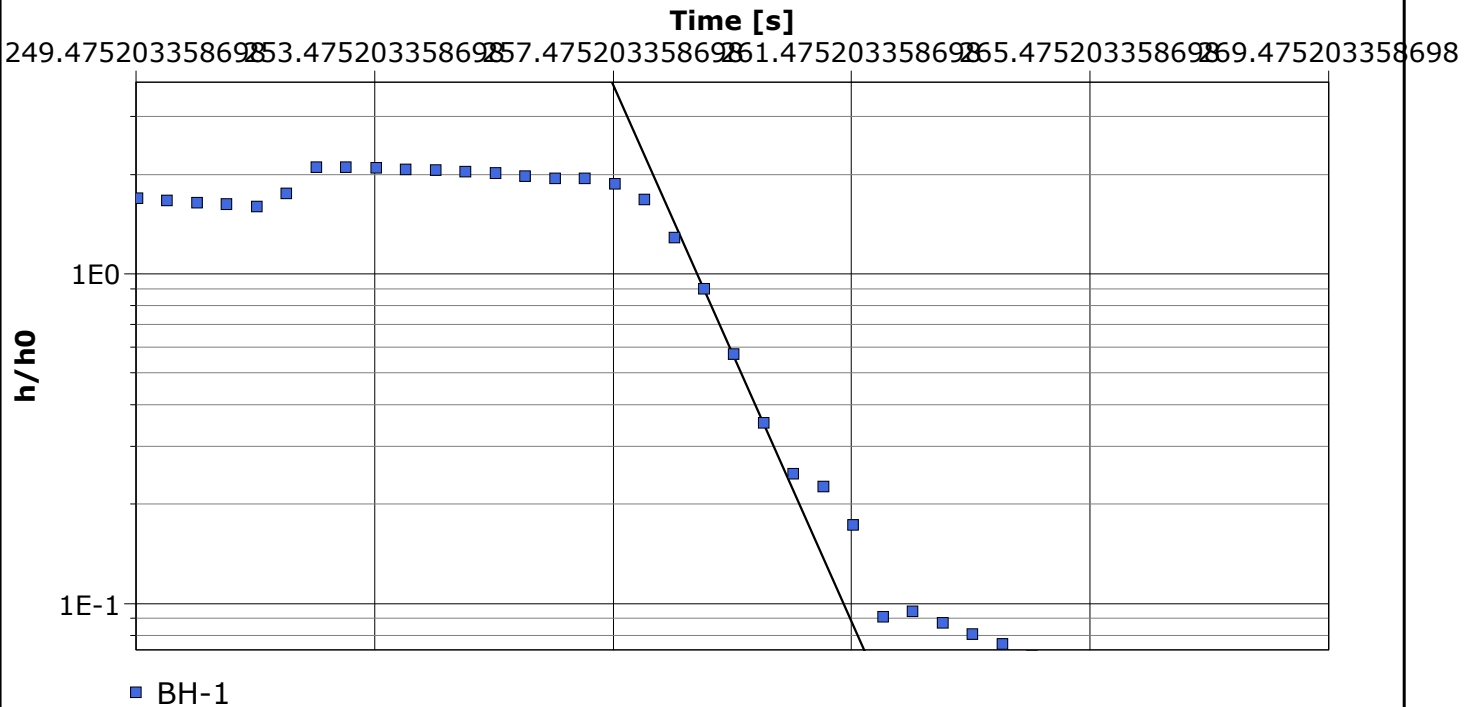
Test Date: 1/12/2022

Analysis Performed by: Corbin Sweet

Bouwer & Rice 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-1

1.57×10^{-4}



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N4K 2J3

Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

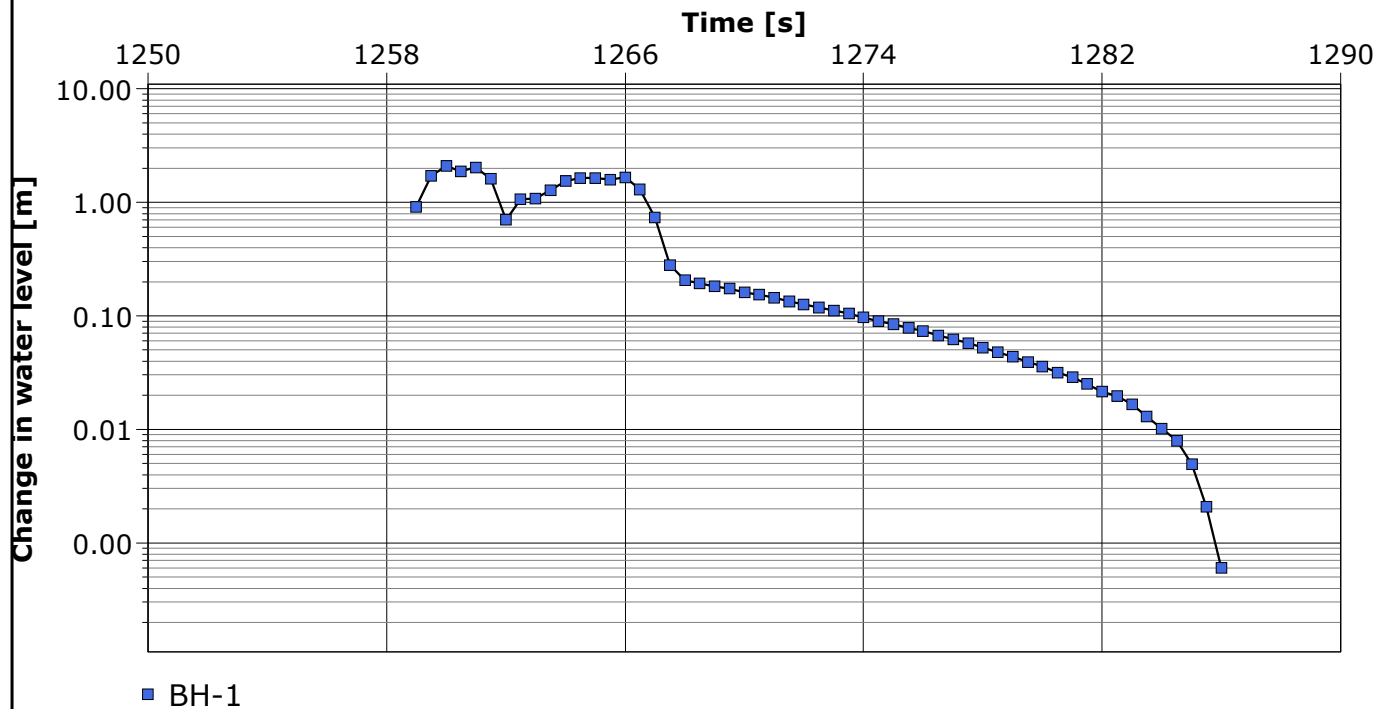
Test Date: 1/12/2022

Analysis Performed by: Corbin Sweet

Time vs. Change in W.L. 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

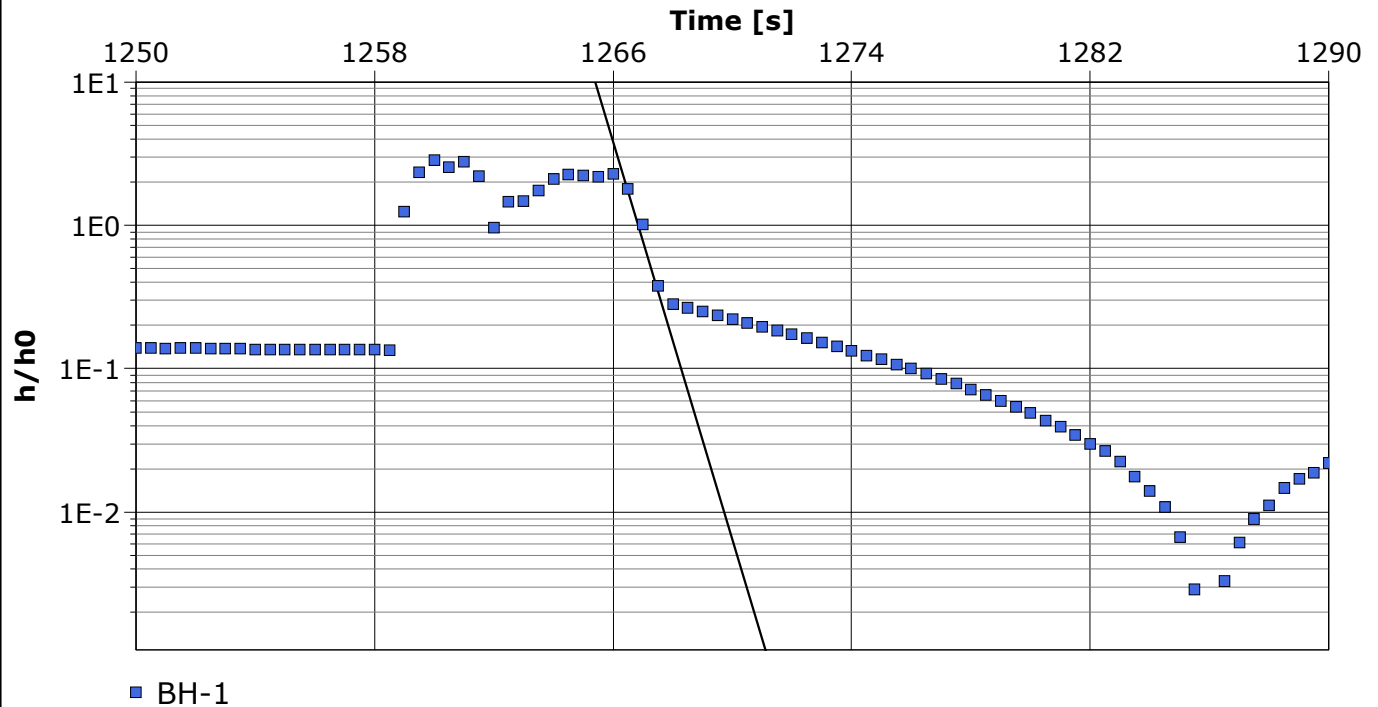
Test Date: 1/12/2022

Analysis Performed by: C.S.

Hvorslev 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
BH-1	3.51×10^{-4}	



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

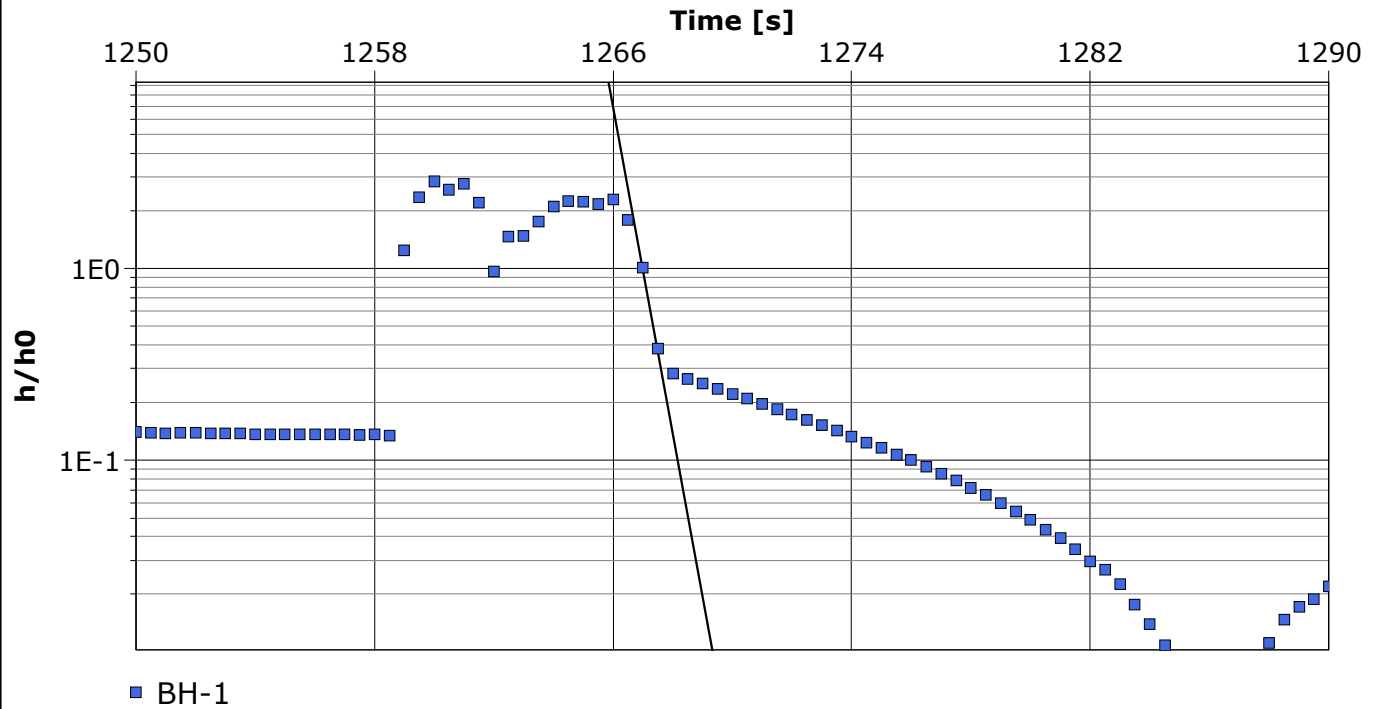
Test Date: 1/12/2022

Analysis Performed by: C.S.

Bouwer & Rice 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH-1	3.29×10^{-4}	



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Slug Test - Analyses Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-1 Slug Testing

Test Well: BH-1

Test Conducted by: Corbin Sweet

Test Date: 1/12/2022

Aquifer Thickness: 3.00 m

	Analysis Name	Analysis Performed by	Analysis Date	Method name	Well	T [m ² /s]	K [m/s]	S
1	Hvorslev 1	Corbin Sweet	1/20/2022	Hvorslev	BH-1		5.64×10^{-4}	
2	Bouwer & Rice 1		1/20/2022	Bouwer & Rice	BH-1		3.88×10^{-4}	
3	Hvorslev 2		1/20/2022	Hvorslev	BH-1		1.94×10^{-4}	
4	Bouwer & Rice 2	Corbin Sweet	1/20/2022	Bouwer & Rice	BH-1		1.57×10^{-4}	
5	Hvorslev 3	C.S.	1/20/2022	Hvorslev	BH-1		3.51×10^{-4}	
6	Bouwer & Rice 3	C.S.	1/20/2022	Bouwer & Rice	BH-1		3.29×10^{-4}	



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

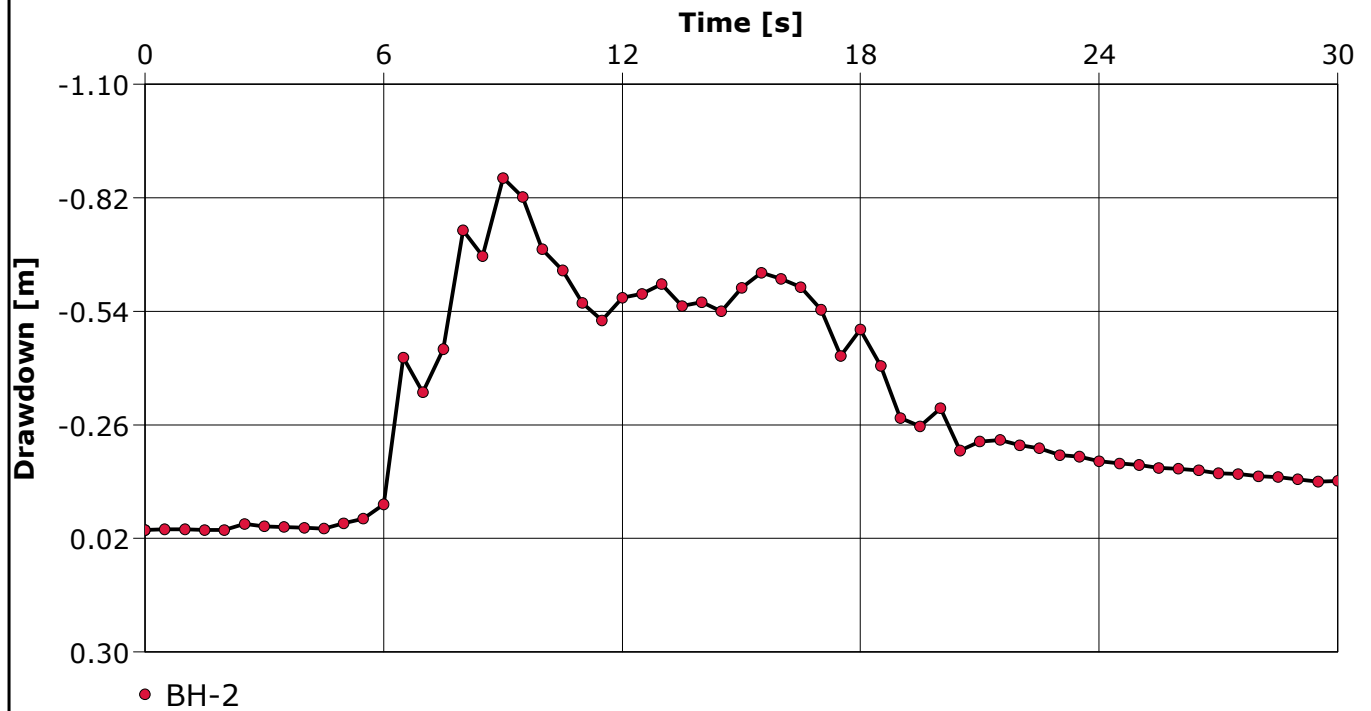
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

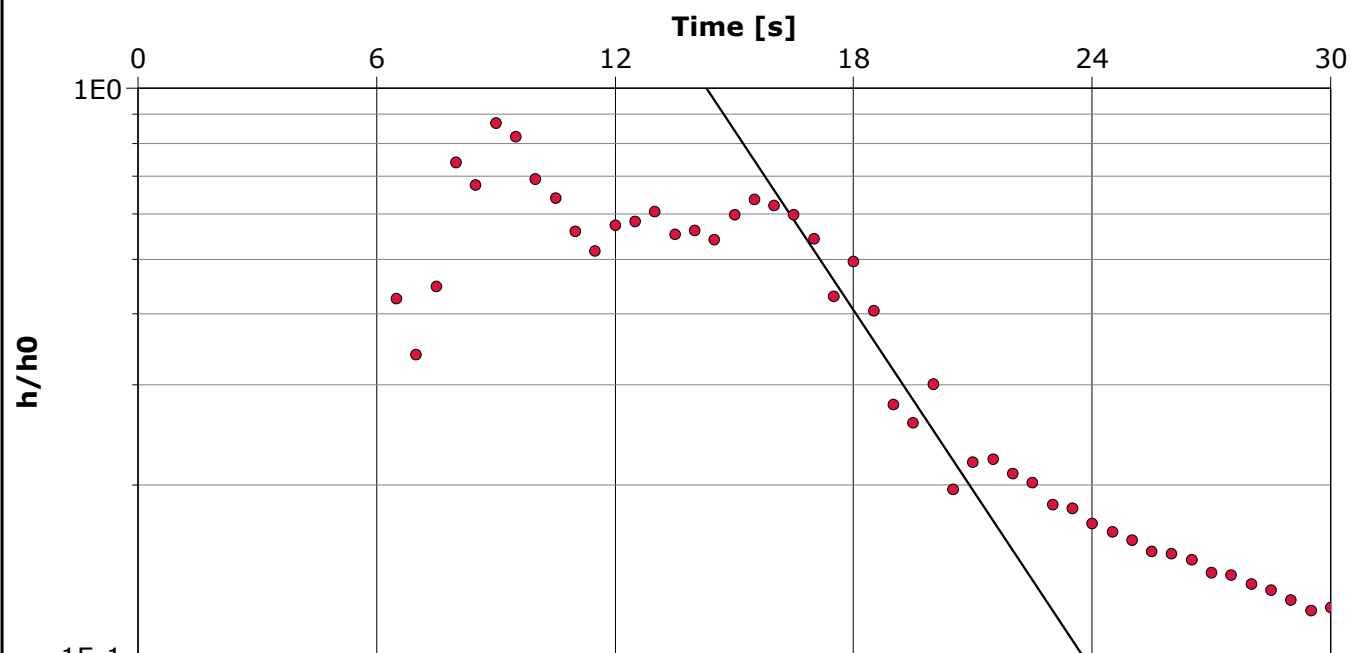
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



• BH-2

Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

5.35×10^{-5}



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

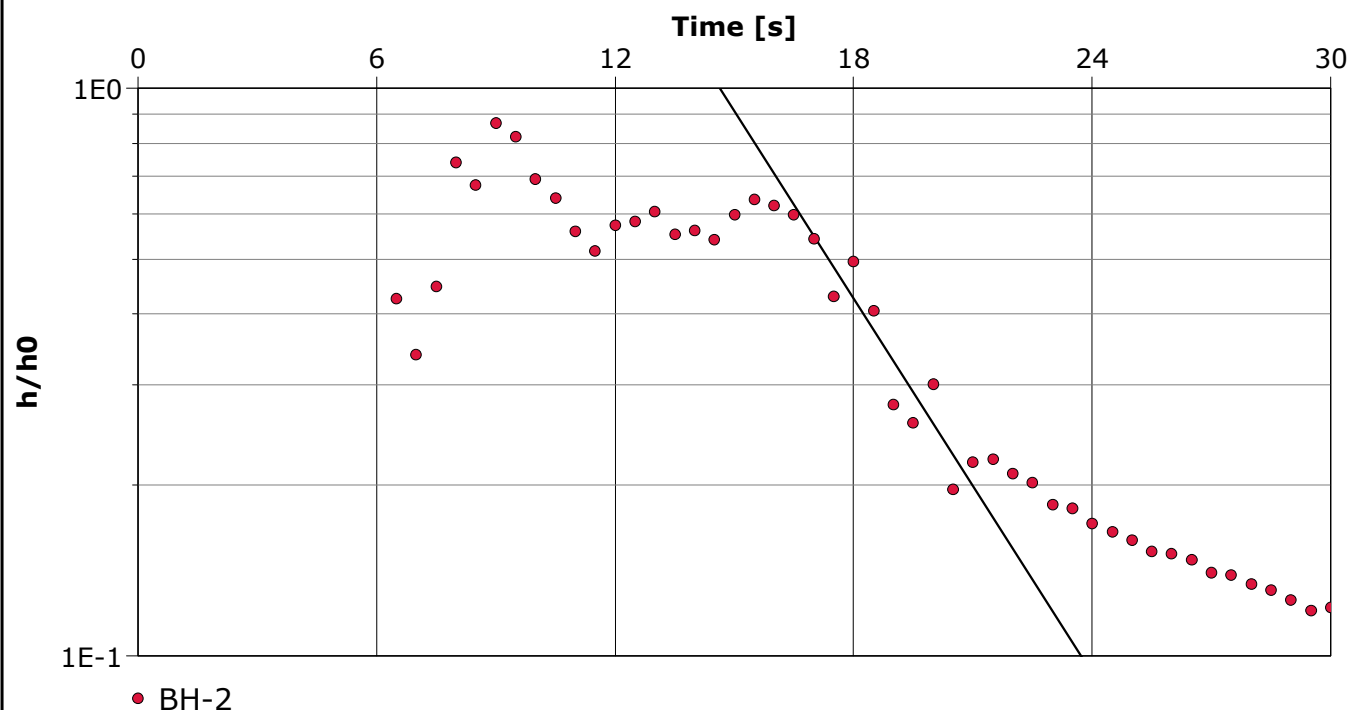
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

4.25×10^{-5}



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

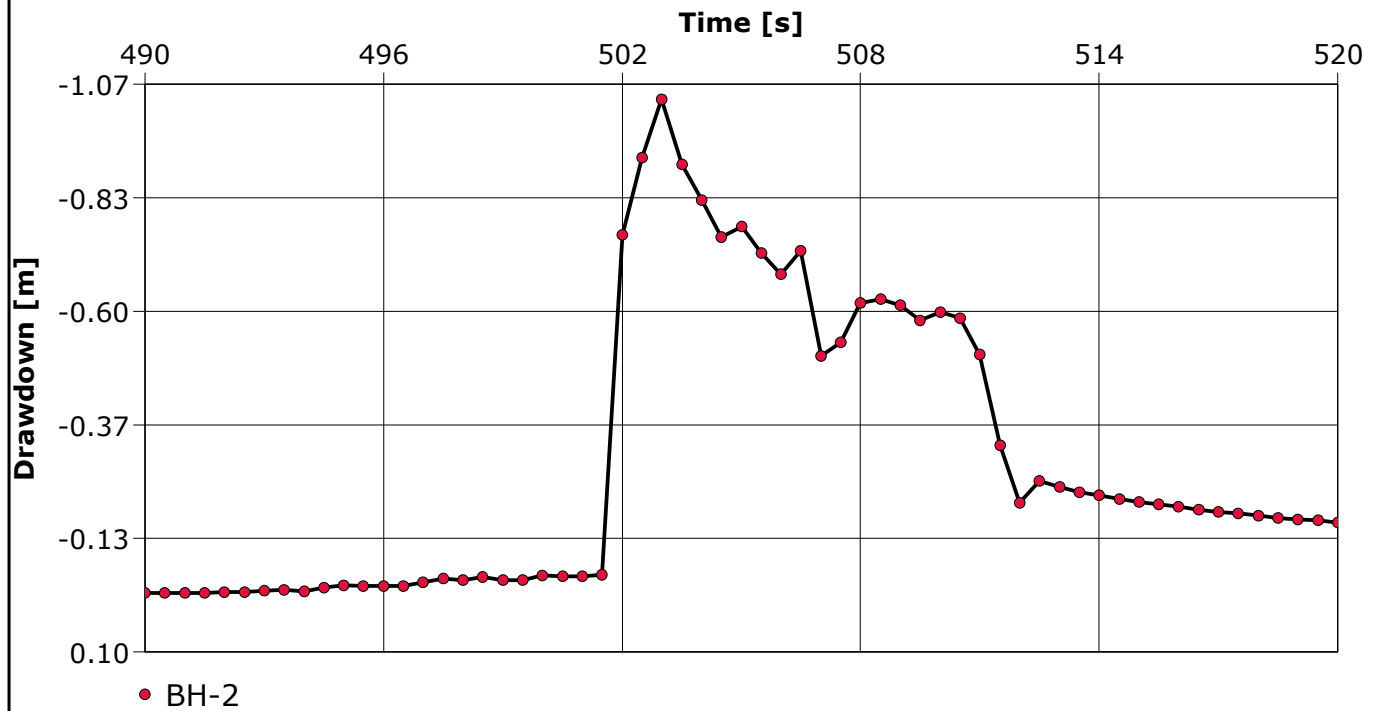
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

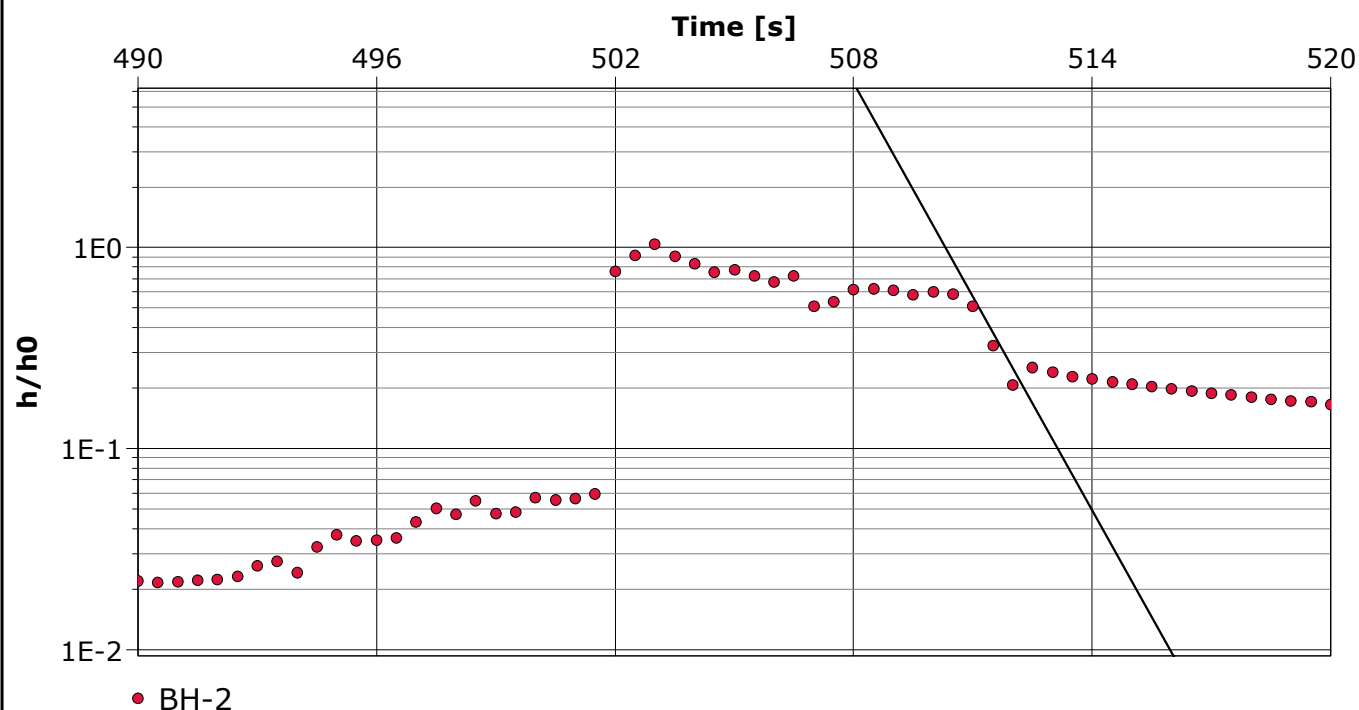
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

1.79×10^{-4}



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

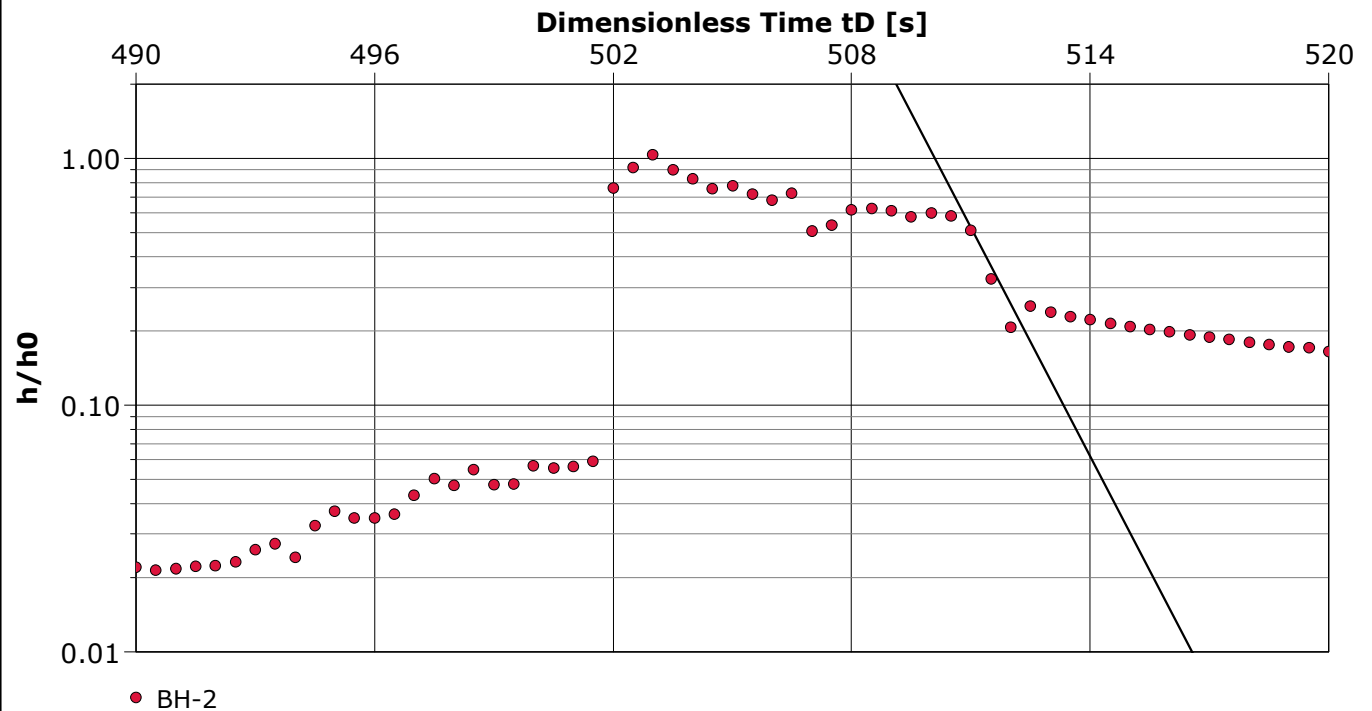
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

1.19×10^{-4}



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

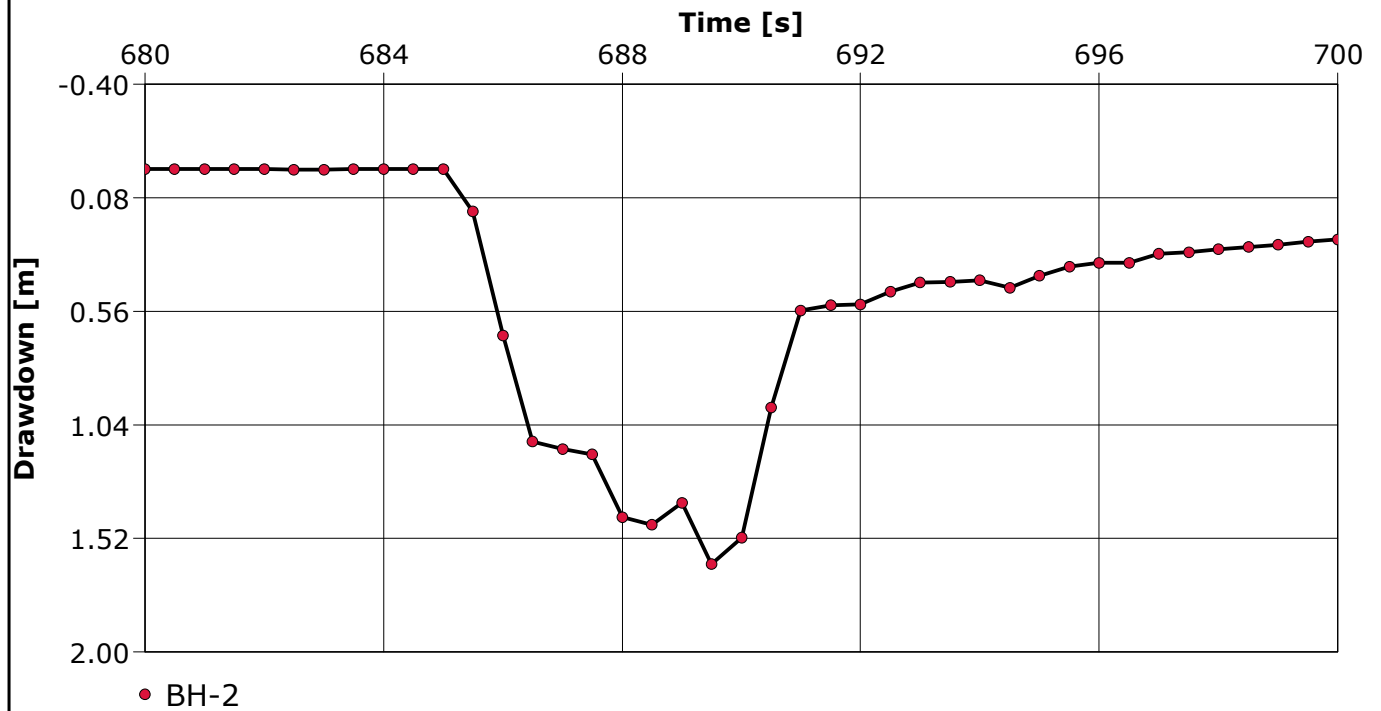
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

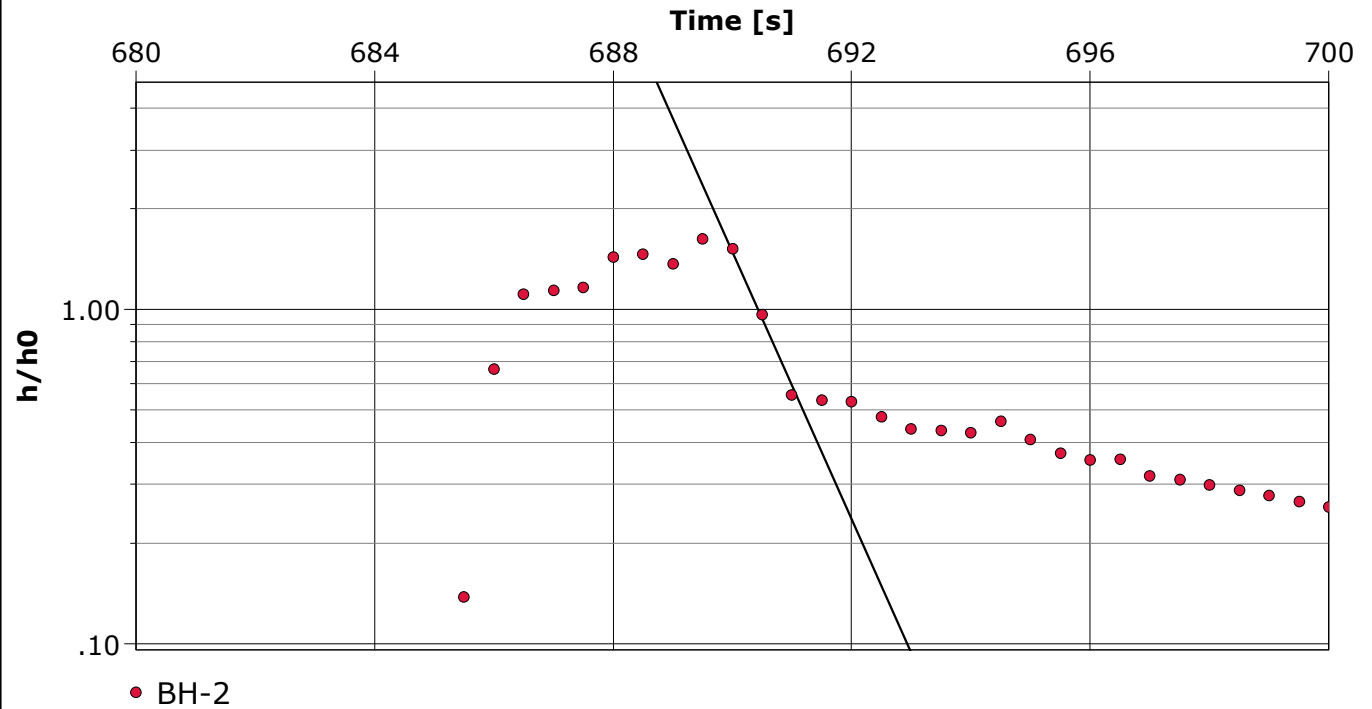
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

2.03×10^{-4}



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

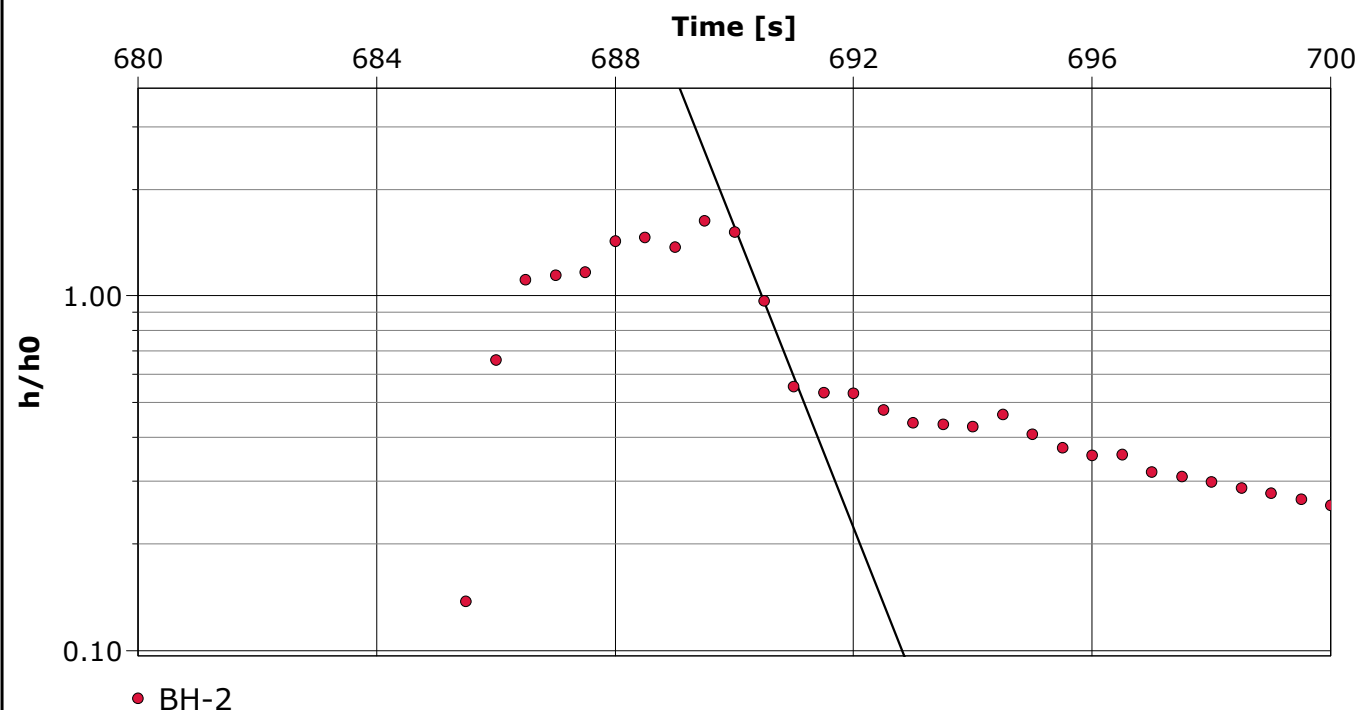
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-2

1.64×10^{-4}



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Slug Test - Analyses Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-2 Slug Testing

Test Well: BH-2

Test Conducted by:

Test Date: 1/20/2022

Aquifer Thickness: 3.00 m

	Analysis Name	Analysis Performed by	Analysis Date	Method name	Well	T [m ² /s]	K [m/s]	S
1	Hvorslev 1	C.S.	1/20/2022	Hvorslev	BH-2		5.35×10^{-5}	
2	Bouwer & Rice 1	C.S.	1/20/2022	Bouwer & Rice	BH-2		4.25×10^{-5}	
3	Hvorslev 2	C.S.	1/20/2022	Hvorslev	BH-2		1.79×10^{-4}	
4	Bouwer & Rice 2	C.S.	1/20/2022	Bouwer & Rice	BH-2		1.19×10^{-4}	
5	Hvorslev 3	C.S.	1/20/2022	Hvorslev	BH-2		2.03×10^{-4}	
6	Bouwer & Rice 3	C.S.	1/20/2022	Bouwer & Rice	BH-2		1.64×10^{-4}	



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

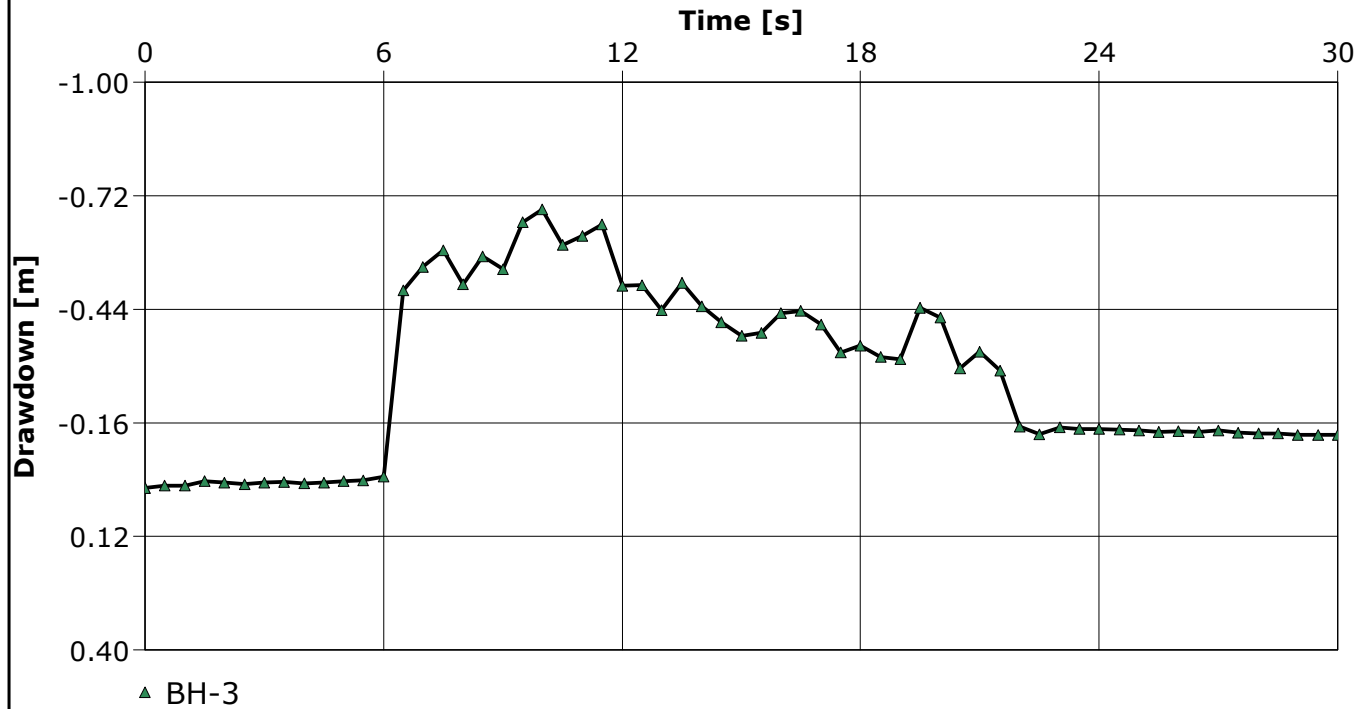
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

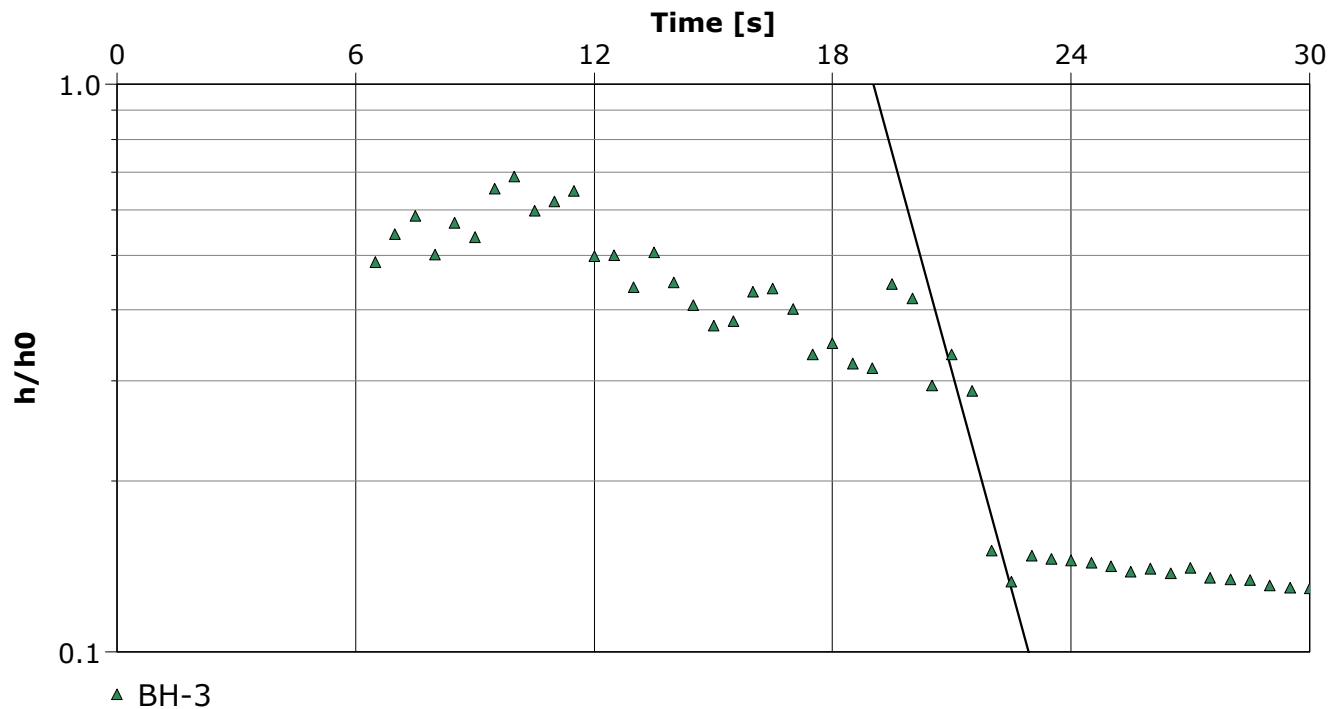
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-3

1.30×10^{-4}



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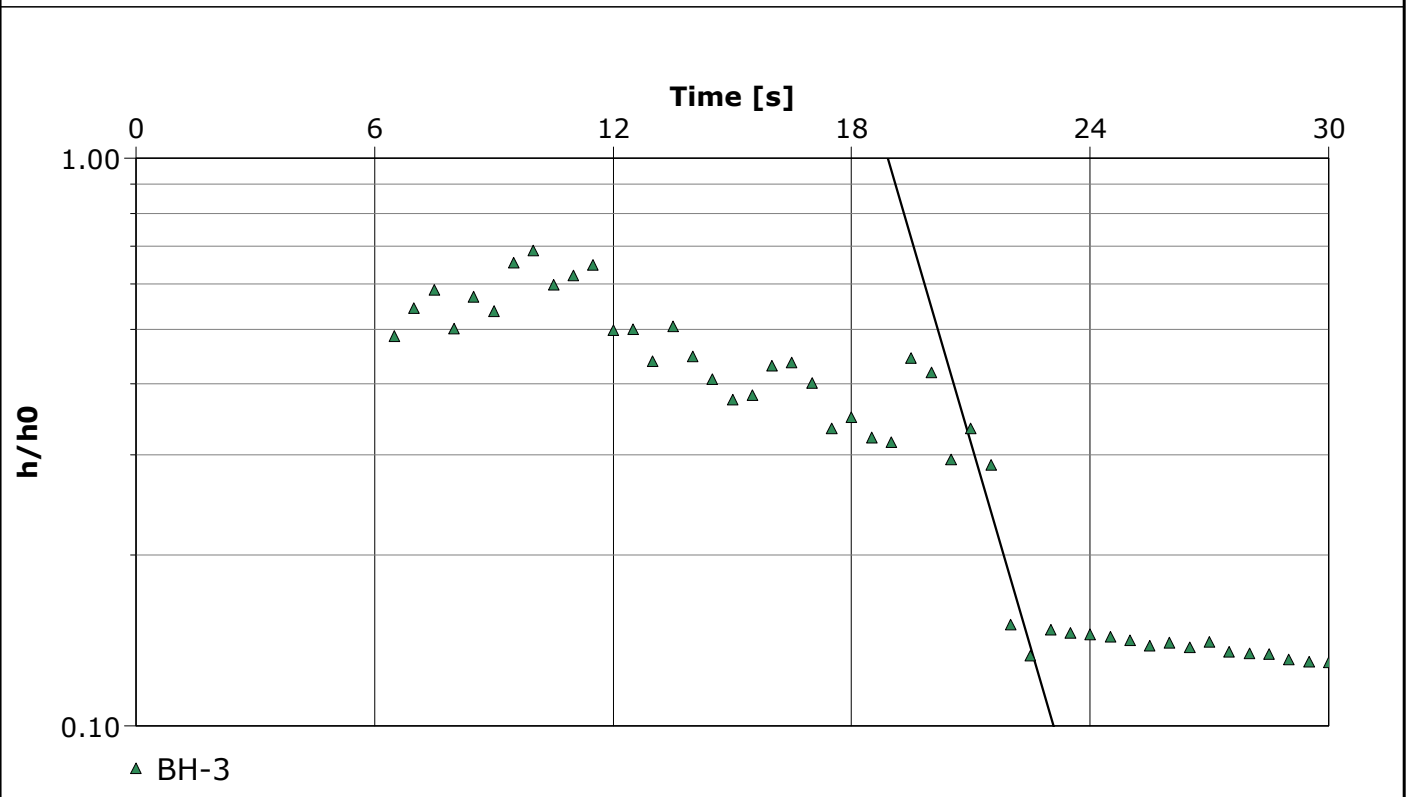
Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith	Slug Test: BH-3 Slug Testing	Test Well: BH-3
Test Conducted by: Corbin Sweet		Test Date: 1/20/2022
Analysis Performed by: C.S.	Bouwer & Rice 1	Analysis Date: 1/20/2022
Aquifer Thickness: 3.00 m		



Calculation using Bouwer & Rice		
Observation Well	Hydraulic Conductivity [m/s]	
BH-3	9.27×10^{-5}	



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

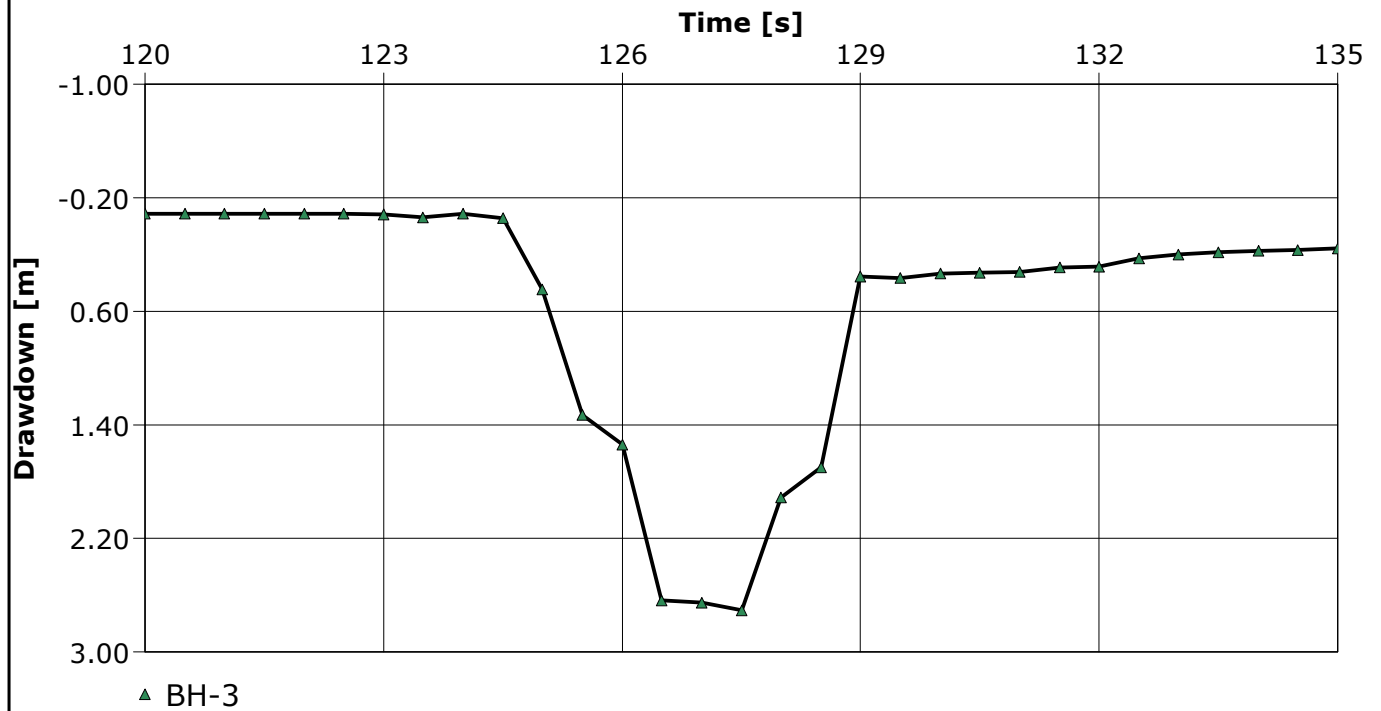
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

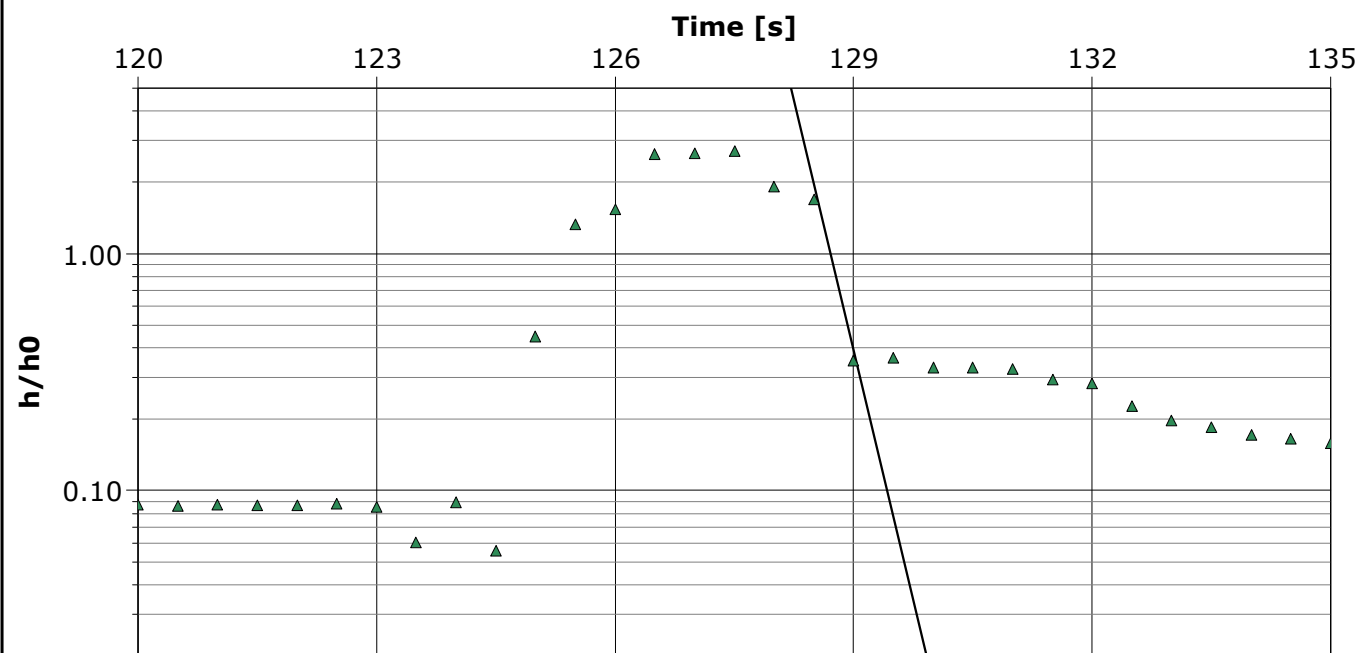
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



▲ BH-3

Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-3

7.12×10^{-4}



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

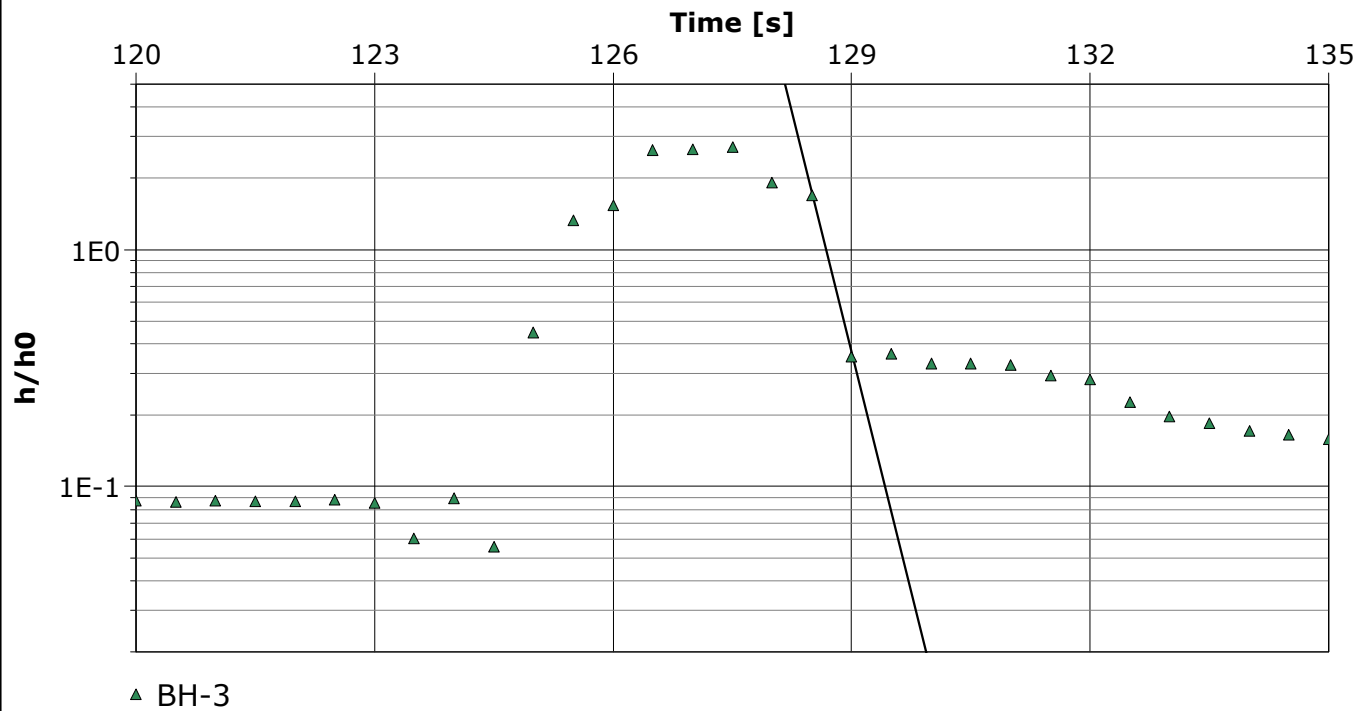
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 2

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-3

5.22×10^{-4}



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

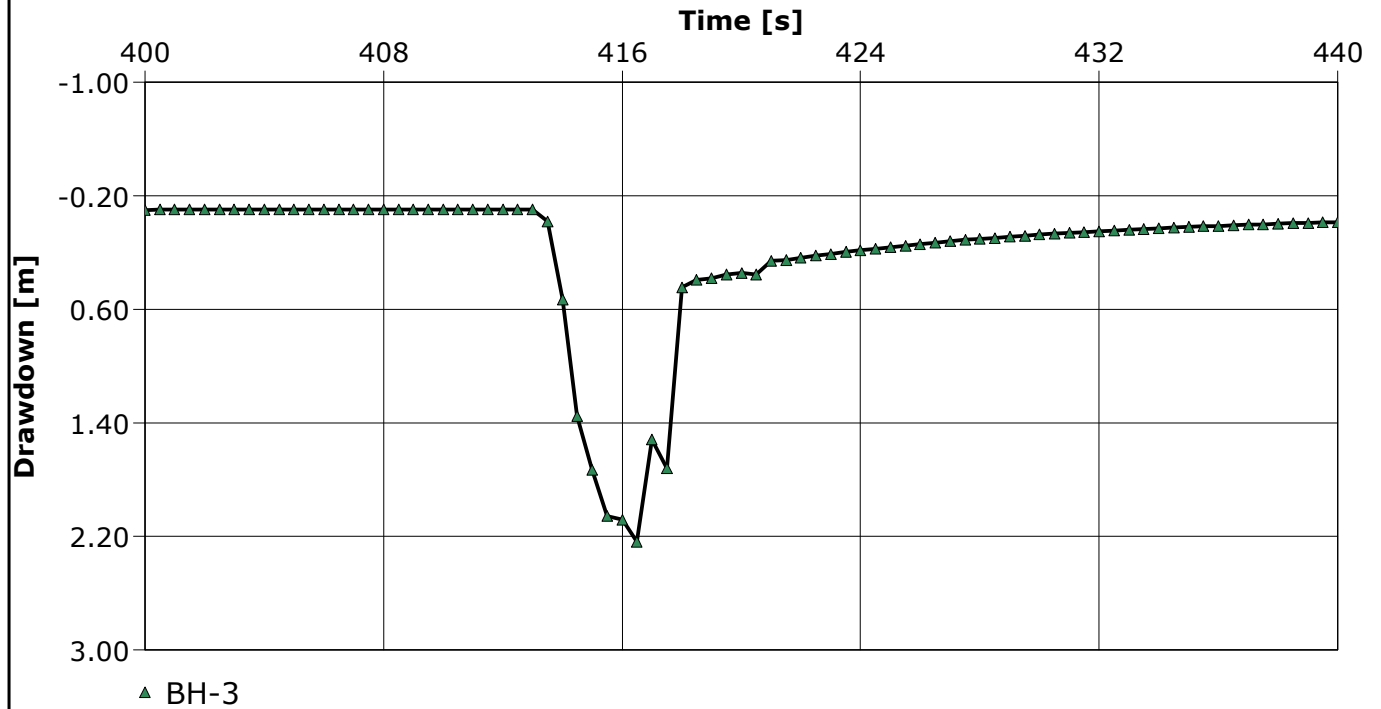
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

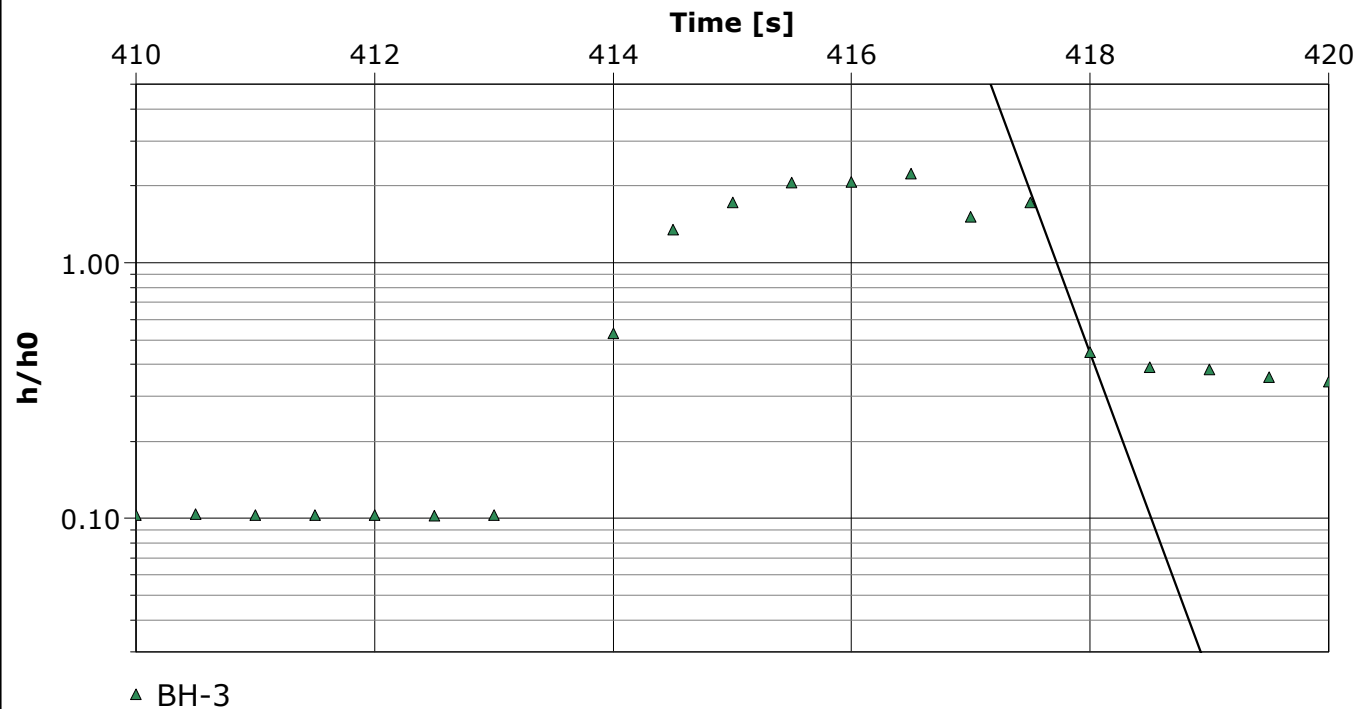
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-3

6.39×10^{-4}



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

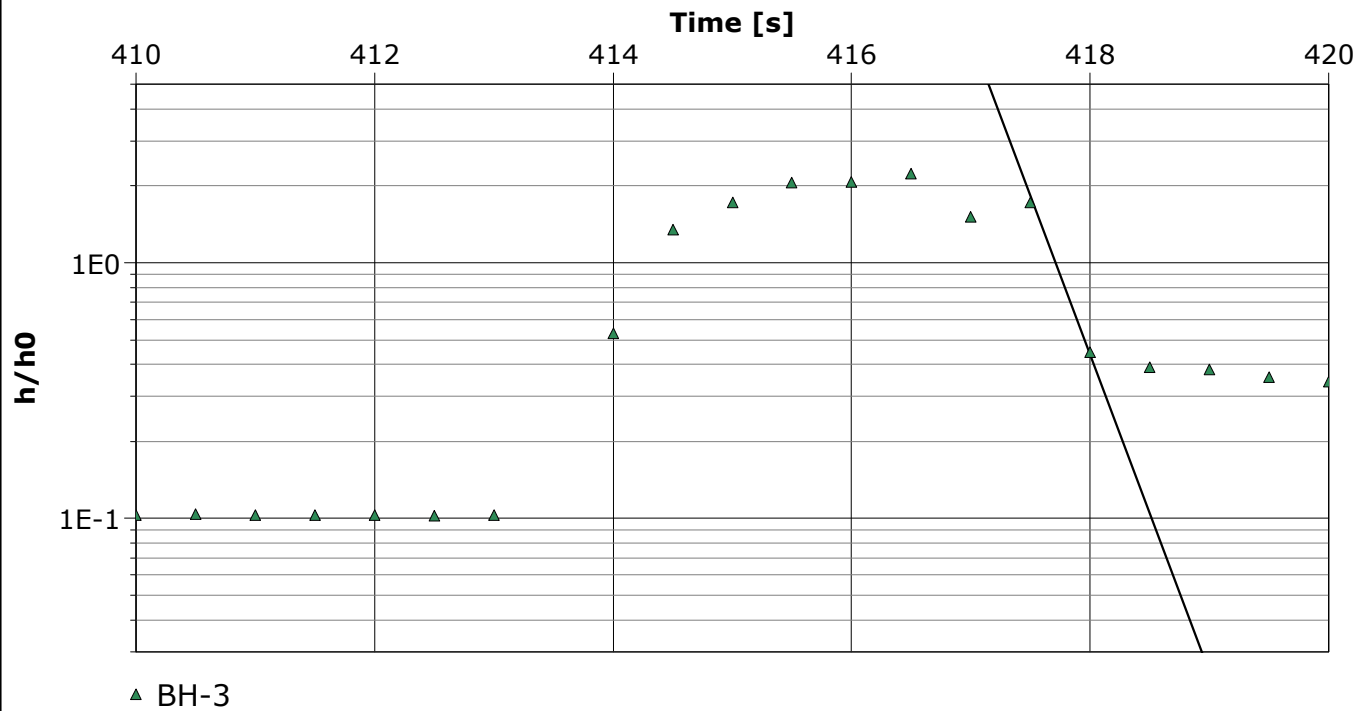
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 3

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-3

4.80×10^{-4}



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Slug Test - Analyses Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-3 Slug Testing

Test Well: BH-3

Test Conducted by: Corbin Sweet

Test Date: 1/20/2022

Aquifer Thickness: 3.00 m

	Analysis Name	Analysis Performed by	Analysis Date	Method name	Well	T [m ² /s]	K [m/s]	S
1	Hvorslev 1	C.S.	1/20/2022	Hvorslev	BH-3		1.30×10^{-4}	
2	Bouwer & Rice 1	C.S.	1/20/2022	Bouwer & Rice	BH-3		9.27×10^{-5}	
3	Hvorslev 2	C.S.	1/20/2022	Hvorslev	BH-3		7.12×10^{-4}	
4	Bouwer & Rice 2	C.S.	1/20/2022	Bouwer & Rice	BH-3		5.22×10^{-4}	
5	Hvorslev 3	C.S.	1/20/2022	Hvorslev	BH-3		6.39×10^{-4}	
6	Bouwer & Rice 3	C.S.	1/20/2022	Bouwer & Rice	BH-3		4.80×10^{-4}	



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

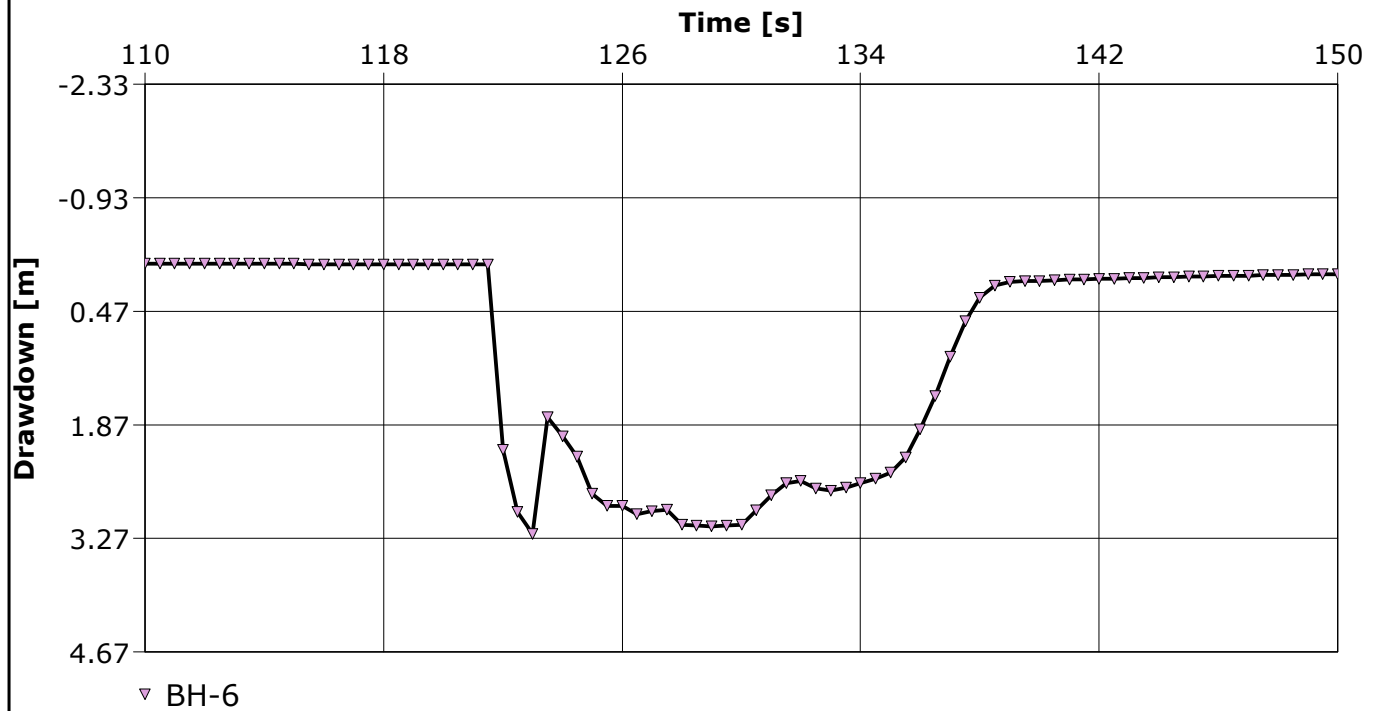
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 1

Analysis Date: 1/20/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

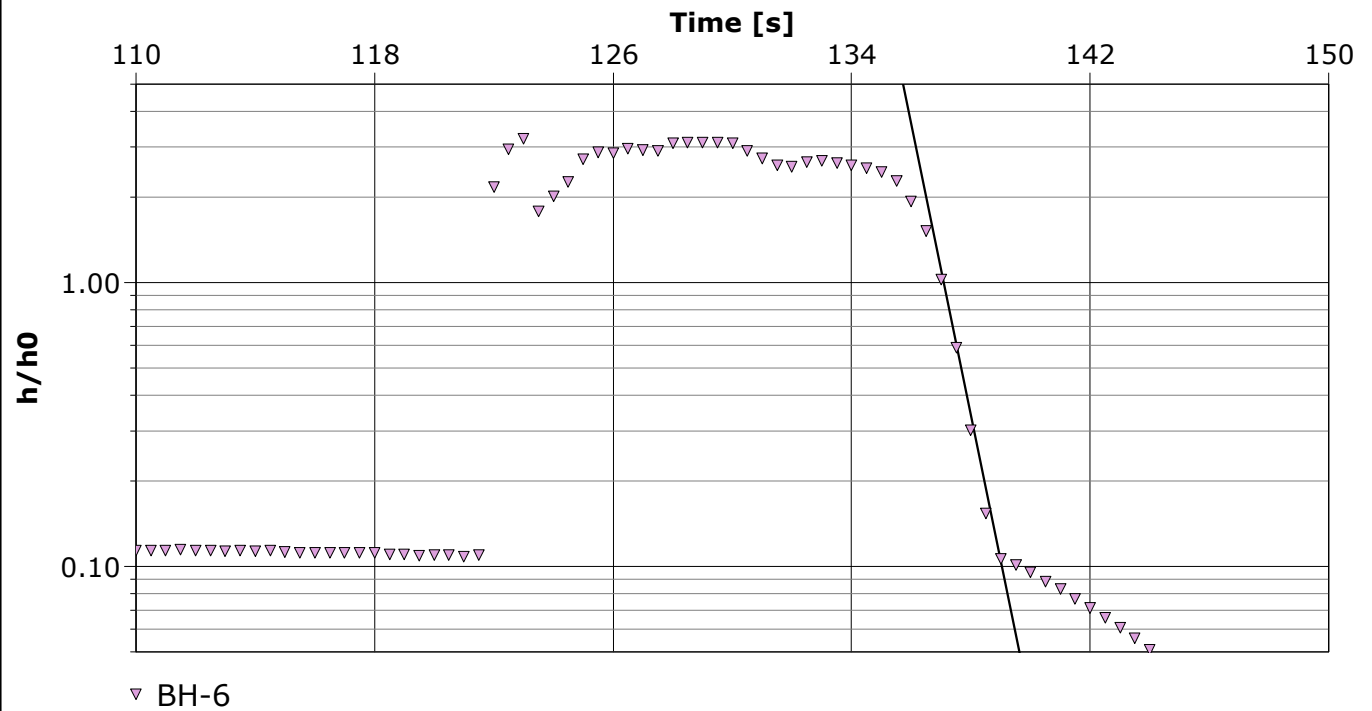
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 1

Analysis Date: 1/21/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
BH-6	2.60×10^{-4}	



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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

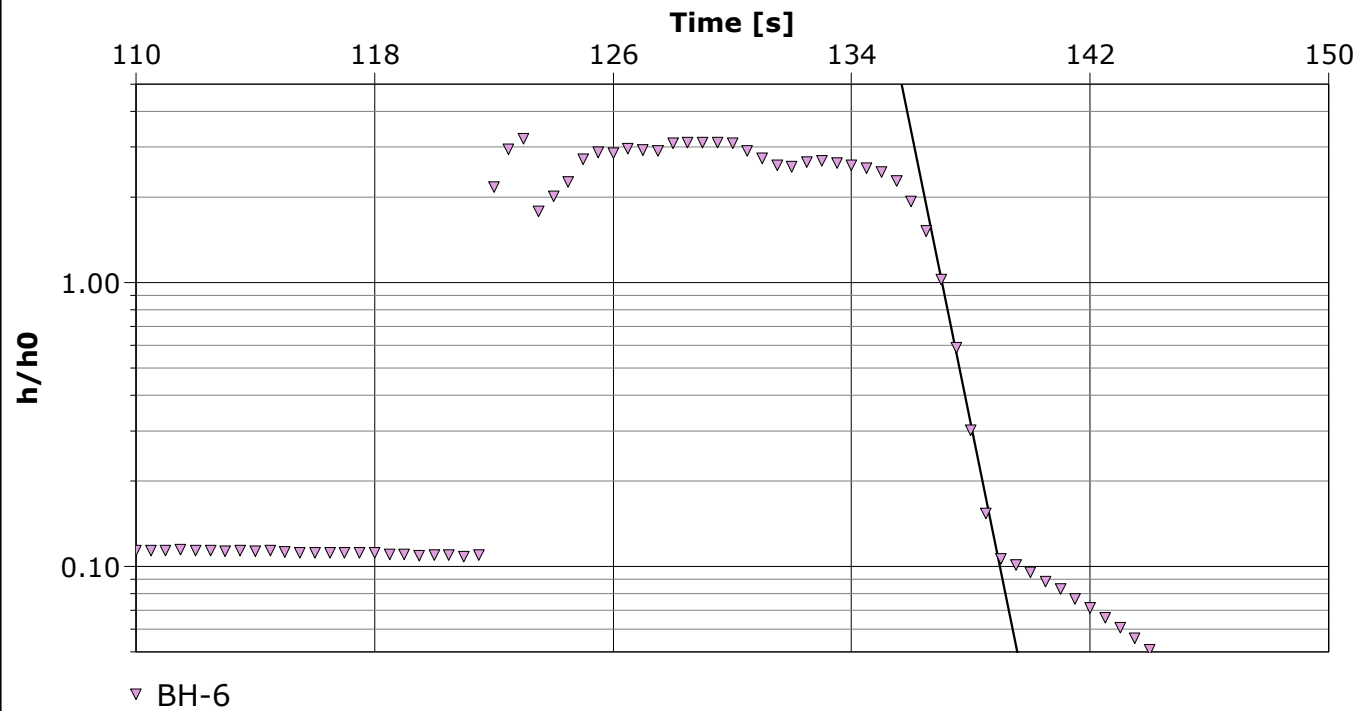
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 1

Analysis Date: 1/21/2022

Aquifer Thickness: 3.00 m



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH-6	1.99×10^{-4}	



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Slug Test Analysis Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

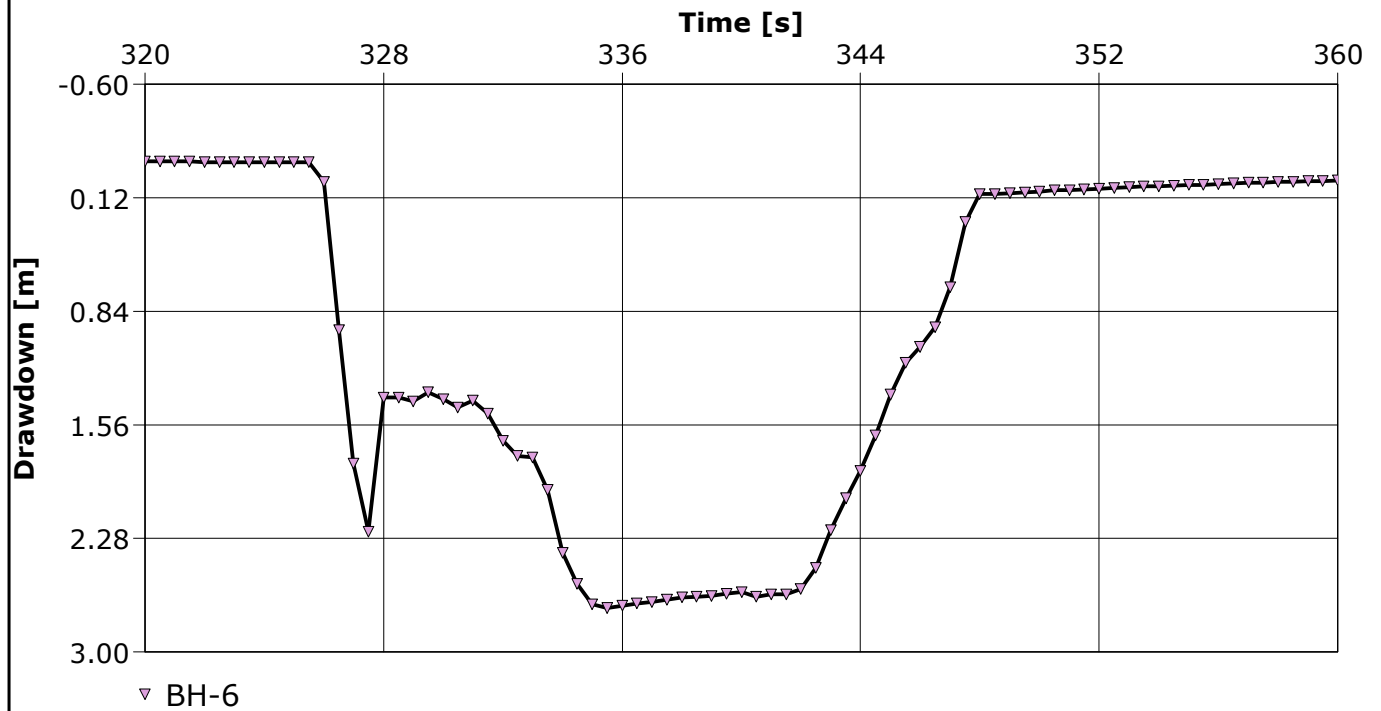
Test Date: 1/20/2022

Analysis Performed by: C.S.

Time vs. Drawdown 2

Analysis Date: 1/21/2022

Aquifer Thickness: 3.00 m





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Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

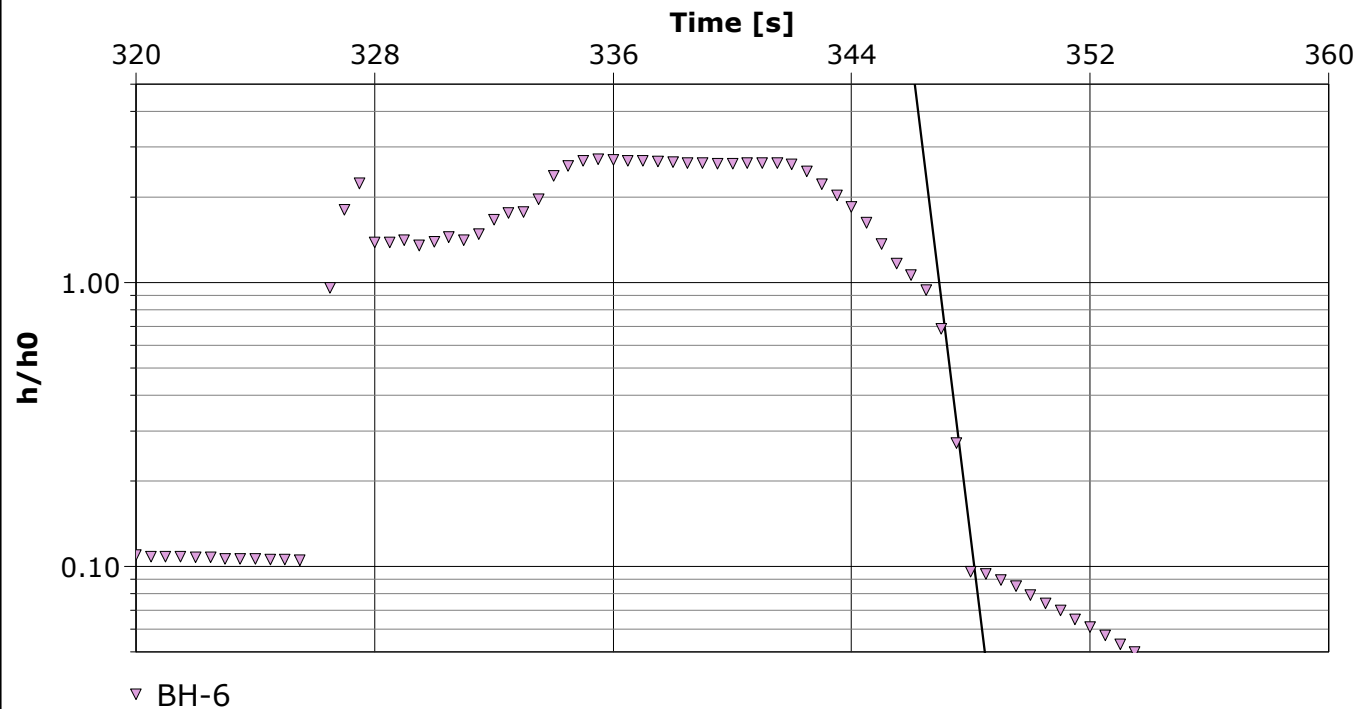
Test Date: 1/20/2022

Analysis Performed by: C.S.

Hvorslev 2

Analysis Date: 1/21/2022

Aquifer Thickness: 3.00 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH-6

4.31×10^{-4}



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test Analysis Report

Project: Craigeleith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeleith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

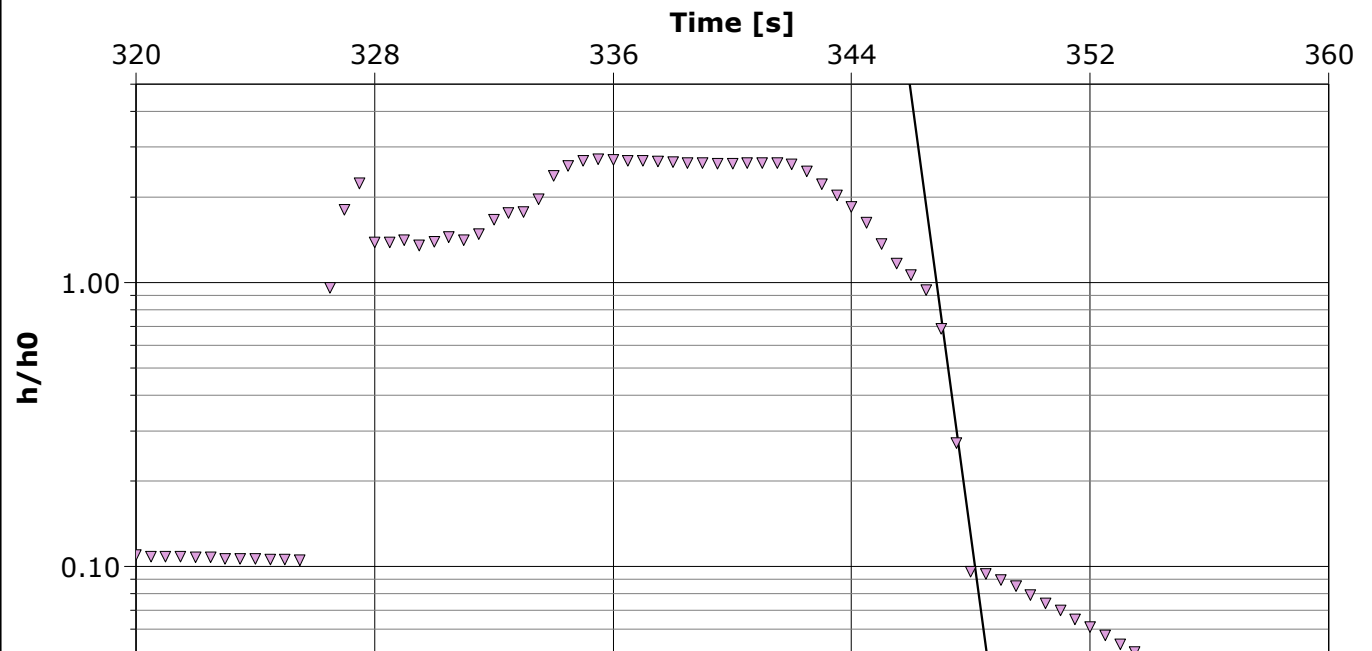
Test Date: 1/20/2022

Analysis Performed by: C.S.

Bouwer & Rice 2

Analysis Date: 1/21/2022

Aquifer Thickness: 3.00 m



▼ BH-6

Calculation using Bouwer & Rice

Observation Well

Hydraulic Conductivity
[m/s]

BH-6

3.00×10^{-4}



GM BluePlan Engineering Ltd.
1260 - 2nd Avenue East
Owen Sound, ON
N4K 2J3

Slug Test - Analyses Report

Project: Craigeith Hydro Study

Number: 221418

Client: Pinnacle Building Group Corp.

Location: Hwy 26, Craigeith

Slug Test: BH-6 Slug Testing

Test Well: BH-6

Test Conducted by:

Test Date: 1/20/2022

Aquifer Thickness: 3.00 m

	Analysis Name	Analysis Performed by	Analysis Date	Method name	Well	T [m ² /s]	K [m/s]	S
1	Hvorslev 1	C.S.	1/21/2022	Hvorslev	BH-6		2.60×10^{-4}	
2	Bouwer & Rice 1	C.S.	1/21/2022	Bouwer & Rice	BH-6		1.99×10^{-4}	
3	Hvorselv 2	C.S.	1/21/2022	Hvorslev	BH-6		4.31×10^{-4}	
4	Bouwer & Rice 2	C.S.	1/21/2022	Bouwer & Rice	BH-6		3.00×10^{-4}	

APPENDIX E:
LABORATORY CERTIFICATE OF ANALYSIS FOR GENERAL
GROUNDWATER QUALITY ANALYSIS



Your Project #: 221418
Your C.O.C. #: 860771-01-01

Attention: Reporting Contacts

GM BluePlan Engineering Limited
1260 - 2nd Ave E
Unit 1
Owen Sound, ON
CANADA N4K 2J3

Report Date: 2022/01/20
Report #: R6969560
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C209480

Received: 2022/01/13, 08:56

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity	4	N/A	2022/01/14	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	4	N/A	2022/01/18	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	4	N/A	2022/01/17	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	4	N/A	2022/01/14	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	3	N/A	2022/01/18	CAM SOP-00446	SM 23 5310 B m
Dissolved Organic Carbon (DOC) (1)	1	N/A	2022/01/19	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	4	N/A	2022/01/14	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	4	N/A	2022/01/14	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	4	N/A	2022/01/18		
Anion and Cation Sum	4	N/A	2022/01/18		
Total Ammonia-N	4	N/A	2022/01/18	CAM SOP-00441	USGS I-2522-90 m
Nitrate & Nitrite as Nitrogen in Water (2)	4	N/A	2022/01/14	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	4	2022/01/14	2022/01/14	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	4	N/A	2022/01/18	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	4	N/A	2022/01/18		Auto Calc
Sat. pH and Langelier Index (@ 4C)	4	N/A	2022/01/18		Auto Calc
Sulphate by Automated Colourimetry	4	N/A	2022/01/18	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	4	N/A	2022/01/18		Auto Calc

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or



Your Project #: 221418
Your C.O.C. #: 860771-01-01

Attention: Reporting Contacts

GM BluePlan Engineering Limited
1260 - 2nd Ave E
Unit 1
Owen Sound, ON
CANADA N4K 2J3

Report Date: 2022/01/20
Report #: R6969560
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C209480

Received: 2022/01/13, 08:56

implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.

(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ashton Gibson, Project Manager

Email: Ashton.Gibson@bureauveritas.com

Phone# (905)817-5765

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This report has been generated and distributed using a secure automated process.

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BUREAU
VERITAS

Bureau Veritas Job #: C209480

Report Date: 2022/01/20

GM BluePlan Engineering Limited

Client Project #: 221418

Sampler Initials: CS

RCAP - COMPREHENSIVE (WATER)

Bureau Veritas ID		RPN873		RPN874		RPN875		RPN876		
Sampling Date		2022/01/12		2022/01/12		2022/01/12		2022/01/12		
COC Number		860771-01-01		860771-01-01		860771-01-01		860771-01-01		
	UNITS	BH-1	QC Batch	BH-2	RDL	BH-3	RDL	BH-6	RDL	QC Batch

Calculated Parameters										
Anion Sum	me/L	9.78	7779334	8.49	N/A	9.91	N/A	3.18	N/A	7779334
Bicarb. Alkalinity (calc. as CaCO ₃)	mg/L	420	7779329	370	1.0	440	1.0	130	1.0	7779329
Calculated TDS	mg/L	530	7779328	450	1.0	530	1.0	170	1.0	7779328
Carb. Alkalinity (calc. as CaCO ₃)	mg/L	2.0	7779329	1.6	1.0	1.7	1.0	1.7	1.0	7779329
Cation Sum	me/L	10.7	7779334	8.83	N/A	10.8	N/A	3.38	N/A	7779334
Hardness (CaCO ₃)	mg/L	450	7779331	370	1.0	460	1.0	150	1.0	7779331
Ion Balance (% Difference)	%	4.48	7779333	1.96	N/A	4.54	N/A	2.96	N/A	7779333
Langelier Index (@ 20C)	N/A	1.02	7779335	0.860		0.971		0.558		7779335
Langelier Index (@ 4C)	N/A	0.773	7779336	0.612		0.723		0.308		7779336
Saturation pH (@ 20C)	N/A	6.68	7779335	6.79		6.65		7.59		7779335
Saturation pH (@ 4C)	N/A	6.93	7779336	7.03		6.89		7.84		7779336

Inorganics										
Total Ammonia-N	mg/L	0.50	7786254	0.50	0.050	0.37	0.050	0.21	0.050	7786254
Conductivity	umho/cm	870	7782127	760	1.0	890	1.0	290	1.0	7782127
Dissolved Organic Carbon	mg/L	5.9	7783033	3.7	0.40	5.9	0.40	0.92	0.40	7782037
Orthophosphate (P)	mg/L	<0.010	7783401	<0.010	0.010	<0.010	0.010	<0.010	0.010	7783401
pH	pH	7.70	7782146	7.65		7.62		8.15		7782146
Dissolved Sulphate (SO ₄)	mg/L	20	7783423	11	1.0	4.3	1.0	16	1.0	7783423
Alkalinity (Total as CaCO ₃)	mg/L	420	7782138	370	1.0	440	1.0	130	1.0	7782138
Dissolved Chloride (Cl ⁻)	mg/L	33	7783425	27	1.0	37	1.0	11	1.0	7783425
Nitrite (N)	mg/L	<0.010	7782062	<0.010	0.010	<0.010	0.010	<0.010	0.010	7782062
Nitrate (N)	mg/L	<0.10	7782062	<0.10	0.10	<0.10	0.10	<0.10	0.10	7782062
Nitrate + Nitrite (N)	mg/L	<0.10	7782062	<0.10	0.10	<0.10	0.10	<0.10	0.10	7782062

Metals										
Dissolved Aluminum (Al)	ug/L	8.5	7781711	14	4.9	<25 (1)	25	190	4.9	7781711
Dissolved Antimony (Sb)	ug/L	<0.50	7781711	<0.50	0.50	<0.50	0.50	<0.50	0.50	7781711
Dissolved Arsenic (As)	ug/L	<1.0	7781711	<1.0	1.0	1.6	1.0	<1.0	1.0	7781711
Dissolved Barium (Ba)	ug/L	46	7781711	50	2.0	41	2.0	8.5	2.0	7781711
Dissolved Beryllium (Be)	ug/L	<0.40	7781711	<0.40	0.40	<0.40	0.40	<0.40	0.40	7781711
Dissolved Boron (B)	ug/L	47	7781711	42	10	49	10	16	10	7781711
Dissolved Cadmium (Cd)	ug/L	<0.090	7781711	<0.090	0.090	<0.090	0.090	<0.090	0.090	7781711
Dissolved Calcium (Ca)	ug/L	150000	7781711	130000	200	150000	200	48000	200	7781711
Dissolved Chromium (Cr)	ug/L	<5.0	7781711	<5.0	5.0	<5.0	5.0	<5.0	5.0	7781711
Dissolved Cobalt (Co)	ug/L	0.64	7781711	<0.50	0.50	0.55	0.50	0.76	0.50	7781711

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

N/A = Not Applicable

(1) Metals Analysis: Detection Limit was raised due to matrix interferences.



**BUREAU
VERITAS**

Bureau Veritas Job #: C209480
Report Date: 2022/01/20

GM BluePlan Engineering Limited
Client Project #: 221418
Sampler Initials: CS

RCAP - COMPREHENSIVE (WATER)

Bureau Veritas ID		RPN873		RPN874		RPN875		RPN876		
Sampling Date		2022/01/12		2022/01/12		2022/01/12		2022/01/12		
COC Number		860771-01-01		860771-01-01		860771-01-01		860771-01-01		
	UNITS	BH-1	QC Batch	BH-2	RDL	BH-3	RDL	BH-6	RDL	QC Batch
Dissolved Copper (Cu)	ug/L	2.3	7781711	1.8	0.90	3.6	0.90	3.2	0.90	7781711
Dissolved Iron (Fe)	ug/L	7900	7781711	7000	100	7400	100	520	100	7781711
Dissolved Lead (Pb)	ug/L	<0.50	7781711	<0.50	0.50	<0.50	0.50	<0.50	0.50	7781711
Dissolved Magnesium (Mg)	ug/L	21000	7781711	15000	50	19000	50	8500	50	7781711
Dissolved Manganese (Mn)	ug/L	430	7781711	280	2.0	300	2.0	110	2.0	7781711
Dissolved Molybdenum (Mo)	ug/L	3.3	7781711	2.8	0.50	1.9	0.50	11	0.50	7781711
Dissolved Nickel (Ni)	ug/L	2.5	7781711	2.3	1.0	2.2	1.0	2.2	1.0	7781711
Dissolved Phosphorus (P)	ug/L	<100	7781711	<100	100	<100	100	<100	100	7781711
Dissolved Potassium (K)	ug/L	2500	7781711	2200	200	2000	200	1100	200	7781711
Dissolved Selenium (Se)	ug/L	<2.0	7781711	<2.0	2.0	<2.0	2.0	<2.0	2.0	7781711
Dissolved Silicon (Si)	ug/L	5100	7781711	5100	50	5800	50	1700	50	7781711
Dissolved Silver (Ag)	ug/L	<0.090	7781711	<0.090	0.090	<0.090	0.090	<0.090	0.090	7781711
Dissolved Sodium (Na)	ug/L	28000	7781711	23000	100	29000	100	5100	100	7781711
Dissolved Strontium (Sr)	ug/L	310	7781711	300	1.0	390	1.0	120	1.0	7781711
Dissolved Thallium (Tl)	ug/L	<0.050	7781711	<0.050	0.050	<0.050	0.050	<0.050	0.050	7781711
Dissolved Titanium (Ti)	ug/L	<5.0	7781711	<5.0	5.0	<5.0	5.0	5.6	5.0	7781711
Dissolved Uranium (U)	ug/L	<0.10	7781711	<0.10	0.10	<0.10	0.10	0.19	0.10	7781711
Dissolved Vanadium (V)	ug/L	<0.50	7781711	<0.50	0.50	<0.50	0.50	<0.50	0.50	7781711
Dissolved Zinc (Zn)	ug/L	<5.0	7781711	<5.0	5.0	<5.0	5.0	<5.0	5.0	7781711
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										



**BUREAU
VERITAS**

Bureau Veritas Job #: C209480

Report Date: 2022/01/20

GM BluePlan Engineering Limited

Client Project #: 221418

Sampler Initials: CS

TEST SUMMARY

Bureau Veritas ID: RPN873

Sample ID: BH-1

Matrix: Water

Collected: 2022/01/12

Shipped:

Received: 2022/01/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	7782138	N/A	2022/01/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	7779329	N/A	2022/01/18	Automated Statchk
Chloride by Automated Colourimetry	KONE	7783425	N/A	2022/01/17	Alina Dobreanu
Conductivity	AT	7782127	N/A	2022/01/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	7783033	N/A	2022/01/19	Anna-Kay Gooden
Hardness (calculated as CaCO ₃)		7779331	N/A	2022/01/14	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	7781711	N/A	2022/01/14	Arefa Dabhad
Ion Balance (% Difference)	CALC	7779333	N/A	2022/01/18	Automated Statchk
Anion and Cation Sum	CALC	7779334	N/A	2022/01/18	Automated Statchk
Total Ammonia-N	LACH/NH ₄	7786254	N/A	2022/01/18	Amanpreet Sappal
Nitrate & Nitrite as Nitrogen in Water	LACH	7782062	N/A	2022/01/14	Chandra Nandlal
pH	AT	7782146	2022/01/14	2022/01/14	Surinder Rai
Orthophosphate	KONE	7783401	N/A	2022/01/18	Avneet Kour Sudan
Sat. pH and Langelier Index (@ 20C)	CALC	7779335	N/A	2022/01/18	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	7779336	N/A	2022/01/18	Automated Statchk
Sulphate by Automated Colourimetry	KONE	7783423	N/A	2022/01/18	Avneet Kour Sudan
Total Dissolved Solids (TDS calc)	CALC	7779328	N/A	2022/01/18	Automated Statchk

Bureau Veritas ID: RPN874

Sample ID: BH-2

Matrix: Water

Collected: 2022/01/12

Shipped:

Received: 2022/01/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	7782138	N/A	2022/01/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	7779329	N/A	2022/01/18	Automated Statchk
Chloride by Automated Colourimetry	KONE	7783425	N/A	2022/01/17	Alina Dobreanu
Conductivity	AT	7782127	N/A	2022/01/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	7782037	N/A	2022/01/18	Anna-Kay Gooden
Hardness (calculated as CaCO ₃)		7779331	N/A	2022/01/14	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	7781711	N/A	2022/01/14	Arefa Dabhad
Ion Balance (% Difference)	CALC	7779333	N/A	2022/01/18	Automated Statchk
Anion and Cation Sum	CALC	7779334	N/A	2022/01/18	Automated Statchk
Total Ammonia-N	LACH/NH ₄	7786254	N/A	2022/01/18	Amanpreet Sappal
Nitrate & Nitrite as Nitrogen in Water	LACH	7782062	N/A	2022/01/14	Chandra Nandlal
pH	AT	7782146	2022/01/14	2022/01/14	Surinder Rai
Orthophosphate	KONE	7783401	N/A	2022/01/18	Avneet Kour Sudan
Sat. pH and Langelier Index (@ 20C)	CALC	7779335	N/A	2022/01/18	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	7779336	N/A	2022/01/18	Automated Statchk
Sulphate by Automated Colourimetry	KONE	7783423	N/A	2022/01/18	Avneet Kour Sudan
Total Dissolved Solids (TDS calc)	CALC	7779328	N/A	2022/01/18	Automated Statchk



**BUREAU
VERITAS**

Bureau Veritas Job #: C209480

Report Date: 2022/01/20

GM BluePlan Engineering Limited

Client Project #: 221418

Sampler Initials: CS

TEST SUMMARY

Bureau Veritas ID: RPN875

Sample ID: BH-3

Matrix: Water

Collected: 2022/01/12

Shipped:

Received: 2022/01/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	7782138	N/A	2022/01/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	7779329	N/A	2022/01/18	Automated Statchk
Chloride by Automated Colourimetry	KONE	7783425	N/A	2022/01/17	Alina Dobreanu
Conductivity	AT	7782127	N/A	2022/01/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	7782037	N/A	2022/01/18	Anna-Kay Gooden
Hardness (calculated as CaCO ₃)		7779331	N/A	2022/01/14	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	7781711	N/A	2022/01/14	Arefa Dabhad
Ion Balance (% Difference)	CALC	7779333	N/A	2022/01/18	Automated Statchk
Anion and Cation Sum	CALC	7779334	N/A	2022/01/18	Automated Statchk
Total Ammonia-N	LACH/NH ₄	7786254	N/A	2022/01/18	Amanpreet Sappal
Nitrate & Nitrite as Nitrogen in Water	LACH	7782062	N/A	2022/01/14	Chandra Nandlal
pH	AT	7782146	2022/01/14	2022/01/14	Surinder Rai
Orthophosphate	KONE	7783401	N/A	2022/01/18	Avneet Kour Sudan
Sat. pH and Langelier Index (@ 20C)	CALC	7779335	N/A	2022/01/18	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	7779336	N/A	2022/01/18	Automated Statchk
Sulphate by Automated Colourimetry	KONE	7783423	N/A	2022/01/18	Avneet Kour Sudan
Total Dissolved Solids (TDS calc)	CALC	7779328	N/A	2022/01/18	Automated Statchk

Bureau Veritas ID: RPN876

Sample ID: BH-6

Matrix: Water

Collected: 2022/01/12

Shipped:

Received: 2022/01/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	7782138	N/A	2022/01/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	7779329	N/A	2022/01/18	Automated Statchk
Chloride by Automated Colourimetry	KONE	7783425	N/A	2022/01/17	Alina Dobreanu
Conductivity	AT	7782127	N/A	2022/01/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	7782037	N/A	2022/01/18	Anna-Kay Gooden
Hardness (calculated as CaCO ₃)		7779331	N/A	2022/01/14	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	7781711	N/A	2022/01/14	Arefa Dabhad
Ion Balance (% Difference)	CALC	7779333	N/A	2022/01/18	Automated Statchk
Anion and Cation Sum	CALC	7779334	N/A	2022/01/18	Automated Statchk
Total Ammonia-N	LACH/NH ₄	7786254	N/A	2022/01/18	Amanpreet Sappal
Nitrate & Nitrite as Nitrogen in Water	LACH	7782062	N/A	2022/01/14	Chandra Nandlal
pH	AT	7782146	2022/01/14	2022/01/14	Surinder Rai
Orthophosphate	KONE	7783401	N/A	2022/01/18	Avneet Kour Sudan
Sat. pH and Langelier Index (@ 20C)	CALC	7779335	N/A	2022/01/18	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	7779336	N/A	2022/01/18	Automated Statchk
Sulphate by Automated Colourimetry	KONE	7783423	N/A	2022/01/18	Avneet Kour Sudan
Total Dissolved Solids (TDS calc)	CALC	7779328	N/A	2022/01/18	Automated Statchk



**BUREAU
VERITAS**

Bureau Veritas Job #: C209480
Report Date: 2022/01/20

GM BluePlan Engineering Limited
Client Project #: 221418
Sampler Initials: CS

GENERAL COMMENTS

Results relate only to the items tested.

BUREAU
VERITAS

Bureau Veritas Job #: C209480

Report Date: 2022/01/20

QUALITY ASSURANCE REPORT

GM BluePlan Engineering Limited

Client Project #: 221418

Sampler Initials: CS

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7781711	Dissolved Aluminum (Al)	2022/01/14	110	80 - 120	104	80 - 120	<4.9	ug/L		
7781711	Dissolved Antimony (Sb)	2022/01/14	109	80 - 120	103	80 - 120	<0.50	ug/L		
7781711	Dissolved Arsenic (As)	2022/01/14	105	80 - 120	99	80 - 120	<1.0	ug/L		
7781711	Dissolved Barium (Ba)	2022/01/14	107	80 - 120	99	80 - 120	<2.0	ug/L		
7781711	Dissolved Beryllium (Be)	2022/01/14	104	80 - 120	100	80 - 120	<0.40	ug/L		
7781711	Dissolved Boron (B)	2022/01/14	98	80 - 120	92	80 - 120	<10	ug/L		
7781711	Dissolved Cadmium (Cd)	2022/01/14	107	80 - 120	101	80 - 120	<0.090	ug/L		
7781711	Dissolved Calcium (Ca)	2022/01/14	NC	80 - 120	102	80 - 120	<200	ug/L		
7781711	Dissolved Chromium (Cr)	2022/01/14	100	80 - 120	94	80 - 120	<5.0	ug/L		
7781711	Dissolved Cobalt (Co)	2022/01/14	102	80 - 120	100	80 - 120	<0.50	ug/L		
7781711	Dissolved Copper (Cu)	2022/01/14	106	80 - 120	98	80 - 120	<0.90	ug/L		
7781711	Dissolved Iron (Fe)	2022/01/14	106	80 - 120	100	80 - 120	<100	ug/L	NC	20
7781711	Dissolved Lead (Pb)	2022/01/14	103	80 - 120	101	80 - 120	<0.50	ug/L		
7781711	Dissolved Magnesium (Mg)	2022/01/14	NC	80 - 120	101	80 - 120	<50	ug/L		
7781711	Dissolved Manganese (Mn)	2022/01/14	105	80 - 120	100	80 - 120	<2.0	ug/L	1.5	20
7781711	Dissolved Molybdenum (Mo)	2022/01/14	108	80 - 120	98	80 - 120	<0.50	ug/L		
7781711	Dissolved Nickel (Ni)	2022/01/14	100	80 - 120	97	80 - 120	<1.0	ug/L		
7781711	Dissolved Phosphorus (P)	2022/01/14	108	80 - 120	111	80 - 120	<100	ug/L		
7781711	Dissolved Potassium (K)	2022/01/14	107	80 - 120	102	80 - 120	<200	ug/L		
7781711	Dissolved Selenium (Se)	2022/01/14	110	80 - 120	102	80 - 120	<2.0	ug/L		
7781711	Dissolved Silicon (Si)	2022/01/14	106	80 - 120	101	80 - 120	<50	ug/L		
7781711	Dissolved Silver (Ag)	2022/01/14	85	80 - 120	95	80 - 120	<0.090	ug/L		
7781711	Dissolved Sodium (Na)	2022/01/14	NC	80 - 120	100	80 - 120	<100	ug/L		
7781711	Dissolved Strontium (Sr)	2022/01/14	NC	80 - 120	99	80 - 120	<1.0	ug/L		
7781711	Dissolved Thallium (Tl)	2022/01/14	103	80 - 120	98	80 - 120	<0.050	ug/L		
7781711	Dissolved Titanium (Ti)	2022/01/14	107	80 - 120	97	80 - 120	<5.0	ug/L		
7781711	Dissolved Uranium (U)	2022/01/14	105	80 - 120	101	80 - 120	<0.10	ug/L		
7781711	Dissolved Vanadium (V)	2022/01/14	103	80 - 120	97	80 - 120	<0.50	ug/L		
7781711	Dissolved Zinc (Zn)	2022/01/14	101	80 - 120	98	80 - 120	<5.0	ug/L		
7782037	Dissolved Organic Carbon	2022/01/18	93	80 - 120	98	80 - 120	<0.40	mg/L	0.085	20
7782062	Nitrate (N)	2022/01/14	95	80 - 120	98	80 - 120	<0.10	mg/L	NC	20

BUREAU
VERITAS

Bureau Veritas Job #: C209480

Report Date: 2022/01/20

QUALITY ASSURANCE REPORT(CONT'D)

GM BluePlan Engineering Limited

Client Project #: 221418

Sampler Initials: CS

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7782062	Nitrite (N)	2022/01/14	117	80 - 120	104	80 - 120	<0.010	mg/L	1.2	20
7782127	Conductivity	2022/01/14			100	85 - 115	<1.0	umho/cm	0	25
7782138	Alkalinity (Total as CaCO3)	2022/01/14			95	85 - 115	<1.0	mg/L	0.19	20
7782146	pH	2022/01/14			102	98 - 103			0.13	N/A
7783033	Dissolved Organic Carbon	2022/01/19	97	80 - 120	99	80 - 120	<0.40	mg/L	1.6	20
7783401	Orthophosphate (P)	2022/01/18	107	75 - 125	98	80 - 120	<0.010	mg/L	2.1	25
7783423	Dissolved Sulphate (SO4)	2022/01/18	NC	75 - 125	99	80 - 120	<1.0	mg/L	0.27	20
7783425	Dissolved Chloride (Cl-)	2022/01/17	NC	80 - 120	105	80 - 120	<1.0	mg/L	1.3	20
7786254	Total Ammonia-N	2022/01/18	98	75 - 125	99	80 - 120	<0.050	mg/L	15	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference $\leq 2 \times$ RDL).



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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

A handwritten signature in black ink, appearing to read 'Brad Newman'.

Brad Newman, B.Sc., C.Chem., Scientific Service Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

APPENDIX F: DEWATERING CALCULATIONS

Hydrogeological Calculations for Dewatering Estimates

Project: 209806/209808 Highway 26 Rowhouse Development
Project Number: 221418 **Engineer/Technician:** MRL

Description of Project:

Construction dewatering assessment for servicing and foundations.

Description of Conceptual Model for Dewatering Estimation:

Part 1) Servicing

Model: Unconfined flow to a finite trench.

$H = 4$ m (height of static groundwater level above impermeable base)

$h = 0.5$ m (height of target groundwater level above impermeable base)

$x = 15$ m (length of trench)

$k = 5 \times 10^{-4}$ m/s (conservative estimate of hydraulic conductivity of the aquifer)

Part 2) Foundations

Model: Unconfined flow to a well.

$H = 4$ m (height of static groundwater level above impermeable base)

$h = 0.5$ m (height of target groundwater level above impermeable base)

$k = 5 \times 10^{-4}$ m/s (conservative estimate of hydraulic conductivity of the aquifer)

In two scenarios

1) Spread Footings

2) Strip Footings - Single Stage (entire building foundation placed at one time)

Hydrogeological Calculations for Dewatering Estimates

Project: 209806/209808 Highway 26 Rowhouse Development
 Project Number: 221418 Engineer/Technician: MRL

PART 1) SERVICING

Radius of Influence

Sichart (Unconfined)

$$R_o = 3000(H - h)\sqrt{k}$$

R ₀ =	201	m (Radius of Influence)
H=	4	m (Initial Head)
h=	1	m (Head at Drawdown)
k=	5.00E-04	m/s (Hydraulic Conductivity)

Flow Estimation

Aquifer Type: Unconfined (Water Table)

Calculation Approach: Flow to Finite Trench

Governing Equation:

$$Q = \pi k \frac{(H^2 - h^2)}{\ln \frac{R_o}{r_w}} + xk \frac{(H^2 - h^2)}{L}$$

Q=	512,137	L/d (Dewatering Flow)	(1)
x=	15	m (Length of Trench)	
k=	5.00E-04	m/s (Hydraulic Conductivity)	
H=	4	m (Initial Head)	
h=	1	m (Head at Drawdown)	
L=	101	m (Distance to "Source")	
R ₀ =	201	m (Radius of Influence)	
r _w =	1.5	m (Radius of Well or System, the half-width of the trench)	

Hydrogeological Calculations for Dewatering Estimates

Project: 209806/209808 Highway 26 Rowhouse Development
 Project Number: 221418 Engineer/Technician: MRL

PART 2) FOUNDATIONS

Scenario 1: Spread Footings

Radius of Influence

Sichart (Unconfined)

$$R_o = 3000(H - h)\sqrt{k}$$

R ₀ =	201	m (Radius of Influence)
H=	4	m (Initial Head)
h=	1	m (Head at Drawdown)
k=	5.00E-04	m/s (Hydraulic Conductivity)

Aquifer Type: Unconfined (Water Table)

Calculation Approach: Flow to Well

Governing Equation:

$$Q = \pi k \frac{(H^2 - h^2)}{\ln \frac{R_o}{r_w}}$$

Q=	409,768	L/d (Dewatering Flow)	(2.1)
k=	5.00E-04	m/s (Hydraulic Conductivity)	
H=	4	m (Initial Head)	
h=	1	m (Head at Drawdown)	
R ₀ =	201	m (Radius of Influence)	
r _w =	1.4	m (Radius of Well or System)	

Hydrogeological Calculations for Dewatering Estimates

Project: 209806/209808 Highway 26 Rowhouse Development
 Project Number: 221418 Engineer/Technician: MRL

PART 2) FOUNDATIONS (ctd)

Scenario 2: Strip Footings, Single-Stage

Radius of Influence

Sichart (Unconfined)

$$R_o = 3000(H - h)\sqrt{k}$$

R ₀ =	201	m (Radius of Influence)
H=	4	m (Initial Head)
h=	1	m (Head at Drawdown)
k=	5.00E-04	m/s (Hydraulic Conductivity)

Aquifer Type: Unconfined (Water Table)

Calculation Approach: Flow to Finite Trench

Governing Equation:

$$Q = \pi k \frac{(H^2 - h^2)}{\ln \frac{R_o}{r_w}} + xk \frac{(H^2 - h^2)}{L}$$

Q=	849,393	L/d (Dewatering Flow)	(2.2)
x=	32	m (Length of Trench)	
k=	5.00E-04	m/s (Hydraulic Conductivity)	
H=	4	m (Initial Head)	
h=	1	m (Head at Drawdown)	
L=	101	m (Distance to "Source")	
R ₀ =	201	m (Radius of Influence)	
r _w =	8.5	m (Radius of Well or System, half the width of the building)	

Hydrogeological Calculations for Dewatering Estimates

Project: 209806/209808 Highway 26 Rowhouse Development
 Project Number: 221418 Engineer/Technician: MRL

PART 2) FOUNDATIONS (ctd)

Scenario 3: Strip Footings, Multiple Stage

Radius of Influence

Sichart (Unconfined)

$$R_o = 3000(H - h)\sqrt{k}$$

R ₀ =	201	m (Radius of Influence)
H=	4	m (Initial Head)
h=	1	m (Head at Drawdown)
k=	5.00E-04	m/s (Hydraulic Conductivity)

Aquifer Type: Unconfined (Water Table)

Calculation Approach: Flow to Finite Trench

Governing Equation:

$$Q = \pi k \frac{(H^2 - h^2)}{\ln \frac{R_o}{r_w}} + xk \frac{(H^2 - h^2)}{L}$$

Q=	570,110	m ³ /s (Dewatering Flow)	(2.3)
x=	32	m (Length of Trench)	
k=	5.00E-04	m/s (Hydraulic Conductivity)	
H=	4	m (Initial Head)	
h=	1	m (Head at Drawdown)	
L=	101	m (Distance to "Source")	
R ₀ =	201	m (Radius of Influence)	
r _w =	0.75	m (Radius of Well or System, half the width of the trench)	

SUMMARY

(1) Servicing	513,000 L/d
(2.1) Spread Footings (single footing)	410,000 L/d
(2.2) Strip Footings (single stage, i.e., entire building)	850,000 L/d
(2.3) Strip Footings (multi-stage, i.e. long side of building)	571,000 L/d