



Hydrogeological Assessment Report - 505 Yonge Street, Barrie, Ontario

2021-12-14

Prepared for:
Core Group

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CAMBIUM INC.

866.217.7900
cambium-inc.com

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1.0 Introduction

In 2019 Cambium Inc. was retained by the owner of 505, 511, 515 and 533 Yonge St., Barrie, Ontario (referred to hereafter as the Site) to complete a hydrogeological assessment of the property in support of proposed re-development. The proposed re-development included condominium buildings, commercial units and underground parking.

In 2021, Core Group (the Client) purchased the Site with intention to proceed with a different development plan than that proposed by the previous owner. Cambium was retained by the Client to update the previously hydrogeological assessment report to reflect the updated development plan.

This hydrogeological assessment characterizes the hydrogeological setting of the Site with the information collected/generated as part of the previous assessment. Additional field investigations were completed at the Site which provided more information to support the new development plan. The additional field investigations included drilling, well installations and hydraulic testing. This updated hydrogeological assessment include revised dewatering calculation based off the new specifications, hydraulic testing of newly installed monitoring wells and a conceptual water balance to account for the new development plan.

A revised geotechnical investigation (Cambium Inc., 2021) was completed concurrently with the hydrogeological assessment and is referenced herein when appropriate.

1.1 Site Description

The Site is approximately 27,000 m² and fronts onto the east side of Yonge Street. The Site southwestern area of the Site is currently developed. Existing development includes a parking area, a two (2) storey brick commercial building, one (1) single storey frame dwelling, one (1) single storey brick dwelling and one (1) two (2) storey stucco dwelling. The remaining northern and eastern areas of the Site are undeveloped. The Site descends in grade from approximately +/- 248 m above sea level (masl) in the northwestern area of the Site to +/- 233 masl at the east portion of the property (approximately +/- 15 m grade differential). Tollendale



Creek is located directly east of the eastern property limits and has an edge of water elevation of approximately 231.55 masl.

The updated development plan includes four multi-story apartment buildings with above and below ground parking areas. At the time of preparing this report two of the proposed buildings are to be 8 storey buildings, one is to be 10 storeys, and one is to be 12 storeys. The proposed 10 storey building will also include commercial space at the ground level. The underground parking structure will span to the extents of the proposed footprint of all four buildings, and will consist of two underground levels. There also associated green spaces and amenity areas. The proposed development plan is attached in Appendix A.

2.0 Methodology

The methodologies of the field investigation program are outlined in this section.

2.1 Drilling Program

Cambium completed a geotechnical investigation at the Site on August 15, 16, 26, 27 and October 16, 2019. A total of eight boreholes, designated as BH101-19 through BH108-19 were advanced at predetermined locations throughout the Site to depths between 5.0 metres below ground surface (mbgs) and 15.7 mbgs. Cambium returned to Site on September 15 and 22, 2021 to advance three additional boreholes, designated as BH109-21 through BH111-21. The additional boreholes were advanced to depths ranging from 3.5 to 14.0 mbgs.

On November 4, 2021 Cambium staff returned to the Site and installed a piezometer in the northeastern area of the property to confirm shallow groundwater conditions. The piezometer was labelled as MW112-21 and was installed with 0.019 m diameter stainless steel pipe and a 0.15 m long screen. The piezometer was installed with hand tools to a depth of 1.5 mbgs.

Boreholes and monitoring wells were surveyed with a TOPCON Hiper II Survey Unit relative to benchmarks provided by the Client. A Site Plan, including borehole locations is attached as Figure 1. Borehole logs are attached as Appendix B.

2.2 Physical Laboratory Testing

Physical laboratory testing, including seven (7) particle size distribution analyses (LS-702,705), were completed on selected soil samples from boreholes advanced in 2019 and 2021 to confirm textural classification and to assess geotechnical parameters. Moisture content testing was completed on all soil samples. The testing results are presented in Appendix C and are discussed in Section 3.1.1.

2.3 Hydrogeological Field Tasks

Single Well Hydraulic Tests (SWHTs) were completed at wells MW102-19, MW106-19 and MW108-19 between October 24 and 28, 2019. The hydraulic conductivity of water bearing



units screened in each well were estimated using AquiferTest Pro™ software, the results of which are attached in Appendix D and are discussed further in Section 4.1.

On October 24, 2019 one groundwater sample was collected from well BH106-19 and analyzed for those parameters outlined in the City of Barrie Sewer Use-Bylaw 2012-172. The groundwater analyses results are attached in Appendix E.

On October 25, 2019, Cambium staff visited the Site to complete infiltration testing of the shallow surficial soils at six locations. Infiltration testing was completed using a Guelph Permeameter. The results of the infiltration testing are discussed in Section 4.2.

On October 5, 2021 Cambium staff visited the Site to complete SWHTs on monitoring wells BH109-21, BH110-21 and BH111-21. Testing results are attached in Appendix D.

3.0 Geological and Hydrogeological Setting

Tollendale Creek is located directly east of the eastern property limits and has an edge of water elevation of approximately 231.55 masl. Drainage across the Site is generally directed eastwards, towards the creek.

The Site is located in the physiographic region known as Peterborough Drumlin Field. The Peterborough Drumlin Field is approximately 4,530 km² and extends from Hastings County in the east to Simcoe County in the west. This physiographic region contains approximately 3,000 drumlins in addition to many other drumlinoid hills and surface flutings of the till sheet. In general, the drumlins are composed of sand, gravel and boulder till and are separated by low-lying wetlands areas composed of fine grained soils (Chapman, L.J. and D.F. Putnam, 1984).

According to Map 2556 of the Ontario Geological Survey (Barnett, P.J., Cowan, W.R. and Henry, A.P., 1991), the following soils are located in the area of the Site:

- Till consisting of gravel/cobbles, sandy silt to silty sand-textured till on Paleozoic Terrain.
- Modern alluvial deposits consisting of clay, silt, sand, gravel and possibly organics.

According to the *Bedrock Geology of Ontario, southern sheet*; Ontario Geological Survey, Map 2544, scale 1:1 000 000 (Ontario Geological Survey, 1991), the bedrock in the area of the Site consists of limestone, dolostone, shale, arkose and sandstone of the Ottawa Group, Simcoe Group and the Shadow Lake Formation.

3.1 Subsurface Investigation

Based on the results of the geotechnical investigation, subsurface conditions at the Site generally consists of silty sand material (some of which was interpreted as fill) overlying silty sand to sandy silt glacial till soils. Bedrock was not encountered during this geotechnical investigation.

3.1.1 Grain Size Analyses

Laboratory grain size distribution analyses were completed on samples collected from five boreholes. A summary of the grain size analyses results is outlined below in Table 1.

Table 1 Grain Size Analysis Results

Borehole	Depth (mbgs)	Material	%Gravel	%Sand	%Silt	%Clay
BH101-19-SS12	13.7 – 14.2	Silty Sand some clay trace gravel	2	51	30	17
BH103-19-SS4	2.3 – 2.7	Silty Gravelly Sand, trace clay	23	42	25	10
BH104-19-SS7	6.1 – 6.6	Silty Sand some clay trace gravel	3	55	32	10
BH106-19-SS6	4.6 – 5.0	Silty Sand some gravel trace clay	11	58	23	8
BH107-19-SS2	0.8 – 1.2	Silty Sand trace gravel trace clay	6	60	26	8
BH109-21-SS6	4.5 – 5	Sandy Silt some Clay trace Gravel	5	29	55	11
BH111-21-SS3	1.5 – 1.9	Gravelly Sand some Silt	32	53	15	

3.1.2 Regulated and Vulnerable Areas

As per the Lake Simcoe Region Conservation Authority (LSRCA) mapping, the eastern and southern portions of the Site are located within regulated areas (because of the presence of Tollendale Creek). As Cambium understands appropriate set-back distances from the Tollendale Creek have already been established to and are included in the proposed development plan (see Appendix A).

As per the Ministry of Environment, Conservation and Parks (MECP) Source Water Protection Information Atlas (SPIA) the Site is located within the following areas:

- WHPA Q2.

The WHPA Q2 is where a reduction to ground groundwater recharge may influence nearby municipal supply wells. In these areas, groundwater recharge must be maintained (as reasonably possible) to the pre-development recharge rate by Low Impact Development (LID) measures and other best management practices. Further discussion of the water balance is outlined in Section 6.0.

- Intake Protection Zone – 2 (IPZ-2) of Barrie Drinking Water System 220001192. The “Intake Protection Zone” is the area around a surface water intake that is defined to protect the source water for a municipal residential drinking water system. It is the vulnerable area where potential contaminants could pose a significant risk or threat to the source water. In most cases, the protection zone includes the water and the land

that surrounds the intake and takes into account the influence of land use and water activities.

IPZ -1 is the zone closest to the intake with the highest concern for vulnerability to the source water. In this zone, there would be little or no dilution before the potential contaminant reached the intake. IPZ-1 is usually a 1-kilometre radius around the intake. The influence of land use activities is taken into consideration with setback on land of 120 metres from the shoreline.

IPZ-2 is the next zone of protection and is determined in three parts: in-water and along shore, upland and up-tributary. In addition, consideration is given to a time of travel calculation to the intake. A two-hour time of travel is considered appropriate to allow a water plant operator time to shut down the intake to deal with a potential spill or threat to the source water supply.

As per the SPIA mapping, the Site is not located within a Highly Vulnerable Aquifer (HVA) or a Significant Groundwater Recharge Area. Mapping provided from the LSRCA and the SPIA is included in Appendix A.

Pre-consultation comments from the City of Barrie dated March 2, 2021 confirm that the Site is located within an IPZ-2, however no policies within the South Georgian Bay Lake Simcoe Protection Plan apply to the Site. Re-infiltration of runoff from paved areas and rooftops is acceptable.

The comments indicate that the City of Barrie Official Plan includes policies relating to snow storage that apply to the Site. The snow storage policies were developed in response to rising sodium and chloride concentrations within local groundwater resources.

The pre-consultation comments indicate that the Site is located within an HVA. The public mapping available through the SPIA contradicts the City's conclusion since the Site does not appear to be located within an HVA.

3.2 Water Well Records

The MECP's Water Well Information System (WWIS) was accessed to review water well records located within 500 m of the Site. Water well records located within 500 m of the Site boundaries are outlined on Figure 2.

There are approximately 60 water well records located within 500 m of the Site boundaries. Of these records 41 detailed the installation of drilled wells, 8 detailed the installation of dug wells, 2 detailed the installation of monitoring wells and 8 detailed well abandonments.

The well records indicate that the soil stratigraphy varied between fine grained (clay material) and coarse grained (sand and gravel). In many cases a coarse grained water aquifer unit was encountered at depth beneath an aquitard comprised of finer grained sediments. The depths of the aquitards and aquifers varied, indicating that a complex subsurface environment exists in the area of the Site. Bedrock was not recorded on any of the water well records.

Information pertaining to the dug and drilled wells is summarized below in Table 2.

Table 2 Water Well Info Summary

		Depth (mbgs)	Water Encountered (mbgs)	Static Water Level	Flow Rate (gpm)
Dug Wells Count: 8	Max	17.07	9.15	7.32	4.0
	Min	5.18	3.05	1.52	2.0
	Avg	9.07	4.95	3.77	2.7
Drilled Wells Count: 41	Max	85.06	81.40	25.91	10.0
	Min	14.02	11.89	1.52	6.0
	Avg	33.88	28.43	8.08	1.5

3.2.1 Records Within Site Boundaries

As per the MECP WWIS there were 8 water well records plotted within the property boundaries. None of the 8 water well records are interpreted to be actually installed within property boundaries. The well records plotted within the property boundaries are listed below in Table 3, along with their location (not on-site).

Historical wells may still be installed on-site, however available water well records do not suggest any supply well installations. If a historical private supply well is found on-site (and is no longer used) it should be decommissioned according to O.Reg. 903.

Table 3 Water Well Records Plotted Within Site Boundary

Record No.	Location (as per description in well record)	Conclusion
5715834	Located on Concession 12	Not located on-site
5725624	Located on Cox Mill Rd.	Not located on-site
5732538	Located 47 m south of Concession 14	Not located on-site
5735739	Abandonment at 440 Big Bay Point Rd.	Not located on-site
5735740	Abandonment at 440 Big Bay Point Rd.	Not located on-site
5735741	Abandonment at 458 Big Bay Point Rd.	Not located on-site
5735742	Abandonment at 440 Big Bay Point Rd.	Not located on-site
5737080	New well installed at 47 Big Bay Point Rd.	Not located on-site

3.2.2 Water Servicing

A water servicing map was acquired from the City of Barrie which outlines those properties that are provided water servicing by the City. The map indicates that all properties surrounding the Site are provided potable water by the City of Barrie (and none are provided potable water servicing by a private supply well, according to the map). A cropped version of the water servicing map is attached in Appendix A.

3.3 Hydrogeological Conditions

The overburden generally consists of silty sand material (some of which was interpreted as fill) overlying silty sand to sandy silt glacial till soils. A shallow, unconfined overburden aquifer was identified on-site. The depth of the silty sand material was variable and extended up to approximately 6 mbgs in depth in some areas.

Groundwater levels at wells BH102-19, BH106-19 and BH108-19 have been measured regularly between August 2019 and November 2021. Groundwater levels from wells BH109-21, BH110-21 and BH111-21 have been measured monthly between September and November of 2021.

In November of 2021 three wells installed as part of a previous assessment were found on-site. Water levels were measured from these three wells on two occasions in November of 2021. There is limited information pertaining to these wells other than a rough map of their location and identification label (being BH3, BH6 and BH7). A well record from BH7 was also



available to review and is attached in Appendix B. These wells were captured in well surveys at the Site.

The depth to groundwater varied between 4.55 mbgs to 0.54 mbgs. Groundwater elevations ranged from 245.27 masl to 237.75 masl, with the highest groundwater elevations being reported along the western boundary of the Site. Groundwater flow was eastwards towards Tollendale Creek. Groundwater level and elevation information is attached in Appendix F.

The edge of water of Tollendale Creek was surveyed to be 231.55 masl on September 1, 2017. Available information indicates that the bottom of Tollendale Creek varies between approximately 235 masl and 231 masl in the area of the Site. The groundwater elevations at the Site are greater than the edge of water and the creek bottom; therefore, groundwater likely discharges to Tollendale Creek.

4.0 Results

This section outlines the results of the hydrogeological field-testing tasks.

4.1 Single Well Hydraulic Testing

SWHTs were completed on wells MW102-19, MW106-19 and MW108-19 through MW111-21. The data generated from the bail tests was processed by AquiferTest Pro™ software, the results of which are summarized in Table 4 and Table 5 below.

The hydraulic conductivity results of the SWHTs ranged between 3.80×10^{-8} m/s and 1.30×10^{-5} m/s. The monitoring wells were screened in sandy silt to silt sand soils. The hydraulic conductivity results are similar to those outlined in literature (J.P.Powers, 2007) (Fetter, 2001). The hydraulic testing results are attached in Appendix D.

Table 4 2019 - Slug Testing Results (Hydraulic Conductivity expressed in m/s)

Test #		Test 1	Test 2
MW102-19	Slug In	3.98×10^{-8}	3.80×10^{-8}
	Slug Out	4.41×10^{-8}	4.60×10^{-8}
MW106-19	Slug In	8.38×10^{-7}	1.30×10^{-6}
	Slug Out	1.23×10^{-6}	1.20×10^{-6}
MW108-19	Slug Out	4.40×10^{-8}	5.05×10^{-8}

Table 5 2021 – Bail Testing Results (Hydraulic Conductivity expressed in m/s)

	Test 1	Test 2	Test 3	Test 4	Test 5
MW109-21	1.08×10^{-5}	1.08×10^{-5}	1.20×10^{-5}	1.30×10^{-5}	1.20×10^{-5}
MW110-21	2.99×10^{-6}	2.12×10^{-6}	1.60×10^{-6}	1.08×10^{-6}	-
MW111-21	1.46×10^{-7}	1.24×10^{-7}	1.13×10^{-7}	1.05×10^{-7}	-

4.2 Infiltration Testing

On October 25, 2019 in-situ infiltration testing was completed at six locations across the Site. The infiltration tests were completed at depths ranging between 0.43 mbgs and 0.69 mbgs. The soils encountered ranged between sand to silty sand (as corroborated by the shallow surficial grain size analysis of sample 2 from borehole BH107-19, see Table 1). The average shallow surficial infiltration rates range between 40 mm/hr and 92 mm/hr (as outlined below in Table 6). A safety correction factor was not incorporated into the infiltration rates outlined

below. The infiltration rates should be referenced for LID screening purposes only, and not for design purposes. Additional infiltration testing may be required for the detailed design of any LID features.

Table 6 Average Infiltration Testing Results

Test #	IT1	IT2	IT3	IT4	IT5	IT6
Depth of test (mbgs)	0.56	0.61	0.61	0.43	0.69	0.43
Avg. Infiltration Rate (mm/hr)	73	40	92	38	64	70

4.3 Groundwater Quality

On October 24, 2019 a groundwater sample was collected from well MW106-19. The sample was analyzed for those parameters outlined in the City of Barrie Sewer Use-Bylaw 2012-172. The certificate of analysis of the testing is attached in Appendix E.

At the time this document was prepared the receiver of construction dewatering discharge water was not known. As such the groundwater quality was compared against the City of Barrie Sewer Use-Bylaw criteria and the Provincial Water Quality Objectives (PWQO) (Ministry of the Environment, 1994). Parameters reported at concentrations greater than associated guideline criteria are summarized below in Table 7.

The concentration of included Total Suspended Solids (TSS) was reported in greater than both the sanitary and storm sewer use criteria. The total concentration of several metals were reported greater than sanitary and storm sewer use criteria. The dissolved concentrations of those same metals were less than corresponding sanitary and storm sewer use criteria.

The total concentration of several metals, and phosphorus were reported at concentrations greater than PWQO criteria. In most cases the dissolved fraction of those same metals was less than the corresponding PWQO criteria.

All other parameters were reported at concentrations less than detectable limits and/or less than corresponding guideline criteria.



The parameters reported at concentrations greater than applicable criteria can be treated by filtration of discharge water and/or inline settling tanks (or similar). A sample of treated water should be collected to confirm treatment efficacy prior to disposal.

Table 7 Water Quality Results

Parameter	Concentration in Sample (mg/L)	Sanitary Sewer Use Criteria (mg/L)
Total Suspended Solids	8,400	350
Total Iron	102 (0.035)	50
Parameter	Concentration in Sample (mg/L)	Storm Sewer Use Criteria (mg/L)
Total Suspended Solids	8,400	15
Total Chromium	0.225 (<0.002)	0.08
Total Copper	0.129 (<0.002)	0.01
Total Nickel	0.08 (<0.01)	0.05
Total Zinc	0.407 (0.023)	0.04
Parameter	Concentration in Sample (mg/L)	PWQO Criteria (mg/L)
Total Phosphorus	7.5	0.03
Total Aluminum	46.9 (0.06)	0.075
Total Cadmium	0.000347 (0.000015)	0.0001
Total Chromium	0.225 (<0.002)	0.001
Total Cobalt	0.041 (<0.005)	0.0009
Total Copper	0.129 (<0.002)	0.005
Total Iron	102 (0.035)	0.3
Total Lead	0.04 (<0.02)	0.005
Total Nickel	0.08 (<0.01)	0.025
Total Vanadium	0.117 (<0.005)	0.006
Total Zinc	0.407 (0.023)	0.02
Total Zirconium	0.029 (<0.003)	0.004

1. The dissolved fraction of metals are included in parentheses.

5.0 Dewatering Estimates

The proposed development will include four apartment/retirement/condominium buildings and two underground levels for parking. The underground parking structure was assumed to have a continuous footprint of approximately 130 m x 90 m. The underground parking structure will have two levels and is anticipated to have a lower finished floor elevation of approximately 237 masl. The maximum elevation of the developable area of the Site, under existing conditions, is approximately 248 masl; therefore, the excavation for the underground parking structure will extend to a maximum depth of 11 mbgs (in some areas, particularly in the western/northwestern area of the property).

The total depth of the excavation (or excavations) advanced during construction of the proposed development was not known at this time this document was prepared. Presumably groundwater would need to be lowered 0.5 m below the bottom of the finished floor elevation (i.e., to an elevation of 236.5 masl) to facilitate safe working conditions. The highest groundwater elevation was recorded to be 245.27 masl. As such, during high groundwater conditions, the shallow overburden water table will need to be lowered 8.77 m (i.e., 245.27 masl – 236.5 masl).

The hydraulic conductivity of the shallow overburden soils is moderate to low and ranged from 1.30×10^{-5} m/s and 3.80×10^{-8} m/s. The hydraulic conductivity rates were used to provide a range of construction dewatering estimates.

To calculate inflow into the excavation, the methods outlined in the Construction Dewatering and Groundwater Control (J.P.Powers, 2007) were utilized.

The estimated daily construction dewatering rate for the modelled construction excavation ranged between 1 m³/day to 94 m³/day. Dewatering estimate calculations are included in Appendix G. The modelled construction dewatering rates indicate that daily groundwater inflow rates could exceed 50 m³/day (50,000 L/day). If daily dewatering rates exceed 50,000 L/day then the dewatering activities are required to be registered on the Environmental Activity and Sector Registry (EASR).

Due to the size of the excavation and variability in soil composition (specifically the thickness of coarser grained, permeable sediments which overlie the glacial till) Cambium recommends that the Client register dewatering activities on the EASR. Registering construction dewatering on the EASR will allow for dewatering rates of up to 400 m³/day (400,000 L/day). A dewatering and discharge management plan will be required to register construction dewatering activities on the EASR. If more than 400,000 L/day of water is withdrawn from the construction excavation then a Category 3 Permit To Take Water (PTTW) will be required.

The daily dewatering estimates outlined herein model the daily inflow rates into construction excavations once equilibrium of groundwater inflow into the excavation has been achieved. The initial dewatering rate during groundwater inflow stabilization period (prior to equilibrium) is not included in the dewatering estimates. Further, the initial dewatering efforts of an open excavation (i.e., dewatering a construction excavation after it has been allowed to fill with groundwater/stormwater over a prolonged period of time) are also not included in the dewatering calculations.

It is imperative that daily dewatering rates be monitored (or the dewatering of stagnant water in the construction excavation estimated) to determine appropriate water taking permitting / registration requirements.

Further, the method of disposal of water removed from the construction excavation should be determined prior to the commencement of water withdrawal. A dewatering and discharge management plan should be prepared as necessary which includes sediment and erosion control measures to protect sensitive receivers of discharge water. A dewatering plan is required for registration of construction dewatering activities on the EASR.

5.1 Surface Water Inputs

Once the excavation is advanced into the subsurface it will require dewatering to maintain dry working conditions (as discussed in the previous section). The excavation will also collect precipitation/stormwater runoff flows. Stormwater runoff that mixes with groundwater will contribute to the maximum daily discharge rate of 400 m³/day (as prescribed by the EASR) when pumped out of the excavation. For example, the footprint of the excavation was assumed

to be 130 m x 90 m (11,700 m²). According to the Ministry of Transportation Intensity-Duration-Frequency rainfall curves, the 24 hour storm, with a return period of 2 years, will produce 56.2 mm of rain.

A single 56.2 mm rainfall event will result in approximately 660 m³ of stormwater runoff (assuming there is no infiltration, evaporation or additional runoff flows that discharge into or out of the excavation). The stormwater flows will mix with groundwater inflows, therefore the combined daily dewatering rate could be up to 749 m³/day, which is greater than the allowable EASR rate of 400 m³/day. If water withdrawal rates greater than 400 m³/day then a Category 3 Permit To Take Water is required. The Client should review available stormwater management strategies that can be included during construction and determine what type of water taking permitting is most appropriate.

A potential construction/stormwater management scenario in which registration of construction dewatering activities on the EASR is still viable is as follows:

Excavate a trench around the perimeter of the excavation floor. The trench can be built to collect all groundwater inflow through the walls of the excavation. Water collected in the trench will be discharged to an appropriate receiver for disposal (after treatment). The interior perimeter of the trench can be built up with a berm. Doing so will isolate groundwater flows in the perimeter trench and stormwater runoff will be collected in the area encircled by the berm. Water that collects within the berms can be identified as 100% stormwater flows. Water discharged from excavations that is 100% derived from stormwater does not count towards the daily quota for water taking (as per the EASR regulation), as such only the groundwater discharge rates would be subject to regulation. Appropriate stormwater management flows for stormwater runoff disposal would still be required in this scenario. (The dewatering scenario described above is conceptual in nature. The feasibility of this scenario is dependant on Site conditions during construction.)

5.2 Operational Dewatering

Operational dewatering rates the structures are anticipated to be similar to construction dewatering rates. The underground parking garages will be advanced into the water table, as

such dewatering of the basements is expected overtime. Actual dewatering rates measured during construction will aid in determining the scope of dewatering needs during operation.

5.2.1 Zone of Influence

The dewatering calculations include estimates of the horizontal distance away from the walls of each excavation where the influence of water withdrawal will be negligible (i.e., the length to zero drawdown (Kyrieleis, W., Sichardt, W, 1930). The area included within the length of zero drawdown from the excavation is the zone of influence (ZOI). The maximum lengths to zero drawdown of the construction excavation at the Site is 95 m. See Figure 3. The ZOI was mapped extending away from the Site towards the northwest and southwest. Tollendale Creek will act as a hydraulic barrier to water withdrawal influences extending east from the Site, as such the ZOI was not mapped extending east past the creek.

Available information indicates that there are eight (8) private supply wells located within the ZOI. All of the wells have been mapped on-site (as per Table 3), but have been determined to be located off-site.

There are no anticipated private groundwater users in the area as all properties are presumably provided water servicing by the City of Barrie.

The ZOI intercepts adjacent roadways and structures. Land settlement should be monitored regularly during construction to determine if there are any influences that extend off-site.

6.0 Water Balance

Cambium completed pre- and post-development water balances to assess the potential impact of the development on local groundwater and surface water resources. To complete the assessment the following equations were utilized:

$$QI = A \times S \times I$$

Where: QI - Infiltration Volume (m³/yr)
 A - Area (m²)
 S - Water surplus (m/yr)
 I - Infiltration factor
 (dimensionless)

$$QR = A \times S \times (1-I)$$

Where: QR - Runoff Volume (m³/yr)
 A - Area (m²)
 S - Water surplus (m/yr)
 I - Infiltration factor
 (dimensionless)

It is noted that the water balance described herein does not account for catchment areas that extend off-site. The calculations compare the pre- and post-development water balance changes within the Site boundaries (and conceptually determine if changes in groundwater infiltration can be mitigated wholly by on-site LID measures).

The Site is 26,839 m² and has a developable area of 15,925 m². The Site is currently developed with several structures, paved areas and gravel areas. The surface areas included in the proposed development plan are outlined below in Table 8. A summary of the water balance calculations is outlined in the following sections of this report. A detailed analysis of the pre- and post-development water balance of the Site is attached as Appendix H.

Table 8 Proposed Development Surfaces

Surface	Area (m ²)
Roof Area (Building 1)	835
Roof Area (Building 2)	1,472
Roof Area (Building 3)	835
Roof Area (Building 4)	1,820
Total Roof Area	4,962
Asphalt	5,433
Pavement (sidewalk)	2,487
Total Impervious Surfaces	12,882
Landscaped Area (Pervious Surfaces)	3,043

6.1 Surplus Water

To determine the pre-development water balance, the volume of water that is typically available as a surplus to the on-Site hydraulic system must be calculated. For the calculations outlined herein, surplus water is defined as being the difference between precipitation and evapotranspiration. Once calculated, the volume of surplus water is further sub-divided into portions that infiltrate into the soil on-Site and are directed off-Site as runoff.

According to the Environment Canada Climatic Normals (1981-2010) for the Barrie WPC station (Environment Canada, 2021), the average annual precipitation depth was recorded as 933 mm/year. A copy of the long-term climatic normal data is attached in Appendix H.

To determine the amount of evapotranspiration that will occur at the Site, the Thornthwaite method was used (as described in the text titled *Physical Hydrology*, Second Edition (S. Lawrence Dingman, 2008)). The equivalent depth of evapotranspiration was calculated to be 557 mm/year. The evapotranspiration calculations have been attached as Appendix G. The water surplus of the Site (i.e. the difference between annual precipitation and evapotranspiration) was calculated to be 376 mm/year.

6.2 Infiltration Factor

To determine the fraction of surplus water that infiltrates into the soil on-Site, the volume of surplus water was multiplied by an infiltration factor. The infiltration factor varies between 0 and 1 and can be estimated based on topography, soils and cover (as per the *Stormwater Management Planning and Design Manual*, (Ministry of the Environment, 2003)).

The portion of the Site that will be developed exhibits a slight grade downwards to the south and east. The topography of the Site slopes down significantly downwards to Tollendale Creek along the southern and eastern boundaries (no development will occur on this slope). These two areas of the Site were modelled separately, as described below. The structures and paved areas associated with the existing and proposed land-use are considered impervious surfaces. Gravel areas were assumed to have an infiltration rate of 0.1. The slope to Tollendale Creek was assumed to have an infiltration factor of 0.5. The landscaped and vegetated areas of the

existing and proposed development were assumed to have an infiltration factor of 0.6. Impervious surfaces were assumed to an infiltration factor of 0. The calculations for the infiltration factor of the pre- and post- development conditions of the Site have been outlined in Table 9.

Table 9 Infiltration Factor

	Slope to Tollendale Creek ⁽¹⁾	Pre-Development			Post-Development	
		Landscaped/ Vegetated Areas	Gravel Areas	Impervious Surfaces	Landscaped Areas	Impervious Surfaces
Topography	0.10	0.25	-	-	0.25	-
Soil	0.20	0.20	-	-	0.20	-
Cover	0.20	0.15	-	-	0.15	-
Infiltration Factor (I)	0.50	0.60	0.10	0	0.60	0

1. This area will not be developed

6.3 Pre-Development Water Balance

The pre-development water balance is summarized in Table 10. It was assumed that 10% of precipitation falling on impervious surfaces (i.e., asphalt/paved/roof areas) and gravel areas is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted to infiltration and/or runoff (estimated to be 840 mm/yr). The pre-development water balance conditions result in approximately 4,812 m³/year of infiltration and 7,170 m³/year of runoff.

Table 10 Pre-Development Water Balance

Portion	Area (m ²)	Surplus (m/yr)	Infiltration Factor (dimensionless)	Groundwater Infiltration (QI) (m ³ /yr)	Surface Water Runoff (QR) (m ³ /yr)
Slope to Tollendale Creek	10,914	0.376	0.5	2,052	2,052
Gravel Areas	1,032	0.840	0.1	87	780
Pavement	2,255	0.840	0	0	1,894
Roof Areas	790	0.840	0	0	663
Vegetated Areas	11,848	0.376	0.6	2,673	1,782
Total	26,839	-	-	4,812	7,170
Sum of QI and QR (m³/year)					11,983

6.4 Post-Development Water Balance

The results of the pre-development water balance are included in Table 11. It was assumed that 10% of precipitation falling on walkways, pavement and rooftops is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted to infiltration and/or runoff. The equivalent surplus depth from impervious surfaces was estimated to be 840 mm/yr. The post-development water balance conditions result in approximately 2,751 m³/year of infiltration and 13,287 m³/year of runoff.

Table 11 Post-Development Water Balance

Portion	Area (m ²)	Surplus (m/yr)	Infiltration Factor (dimensionless)	Groundwater Infiltration (QI) (m ³ /yr)	Surface Water Runoff (QR) (m ³ /yr)
Slope to Tollendale Creek	10,914	0.376	0.5	2,052	2,052
Pavement	2,487	0.840	0	0	2,088
Asphalt	5,433	0.840	0	0	4,562
Roof Areas	4,962	0.840	0	0	4,167
Landscaped Areas	3,043	0.376	0.6	687	458
Total	26,839	-	-	2,738	13,326
Sum of QI and QR (m³/year)					16,065

6.5 Water Balance Comparison

The water balances of the pre-development, post-development and post-development scenarios have been summarized in Table 12.

Table 12 Water Balance Comparison

Scenario	QI (m ³ /yr)	QI Difference From Pre-Development Scenario	QR (m ³ /yr)	QR Difference From Pre-Development Scenario
Pre-Development	4,812	-	7,170	-
Post-Development	2,738	-43% (-2,074 m ³ /yr)	13,326	+86% (+6,155 m ³ /yr)

Upon development, groundwater infiltration will by decrease 43% (a 2,074 m³/year deficit) and runoff will increase by 85% (a 6,155 m³/year surplus), when compared to pre-development conditions.

Tatham Engineering (Tatham) prepared a stormwater management plan for the Site which includes a re-infiltration feature. According to information provided by Tatham the feature can



re-infiltrate approximately 6,800 m³ of runoff in a single year. Therefore, the proposed re-infiltration feature can satisfy the infiltration deficit.

The information outlined herein indicates that the Site is suitable to the proposed development and there are not anticipated to be influences to adjacent groundwater and surface water systems.

7.0 Conclusions and Recommendations

Cambium completed a hydrogeological assessment of the property at 505 Yonge St., Barrie, Ontario. The findings of the assessment are summarized below:

- Subsurface conditions at the Site generally consists of silty sand material (some of which was interpreted as fill) overlying silty sand to sandy silt glacial till soils. Bedrock was not encountered during this geotechnical investigation.
- Pre-consultation comments indicate that City of Barrie Official Plan snow storage policies apply to the Site. However, the Site does not appear to be located within an HVA.
- An unconfined, overburden aquifer was encountered at the Site. Groundwater flow was eastwards, and was interpreted to discharge to Tollendale Creek. The depth to groundwater varied between 4.55 mbgs to 0.54 mbgs. Groundwater elevations ranged from 245.27 masl to 237.75 masl.
- The concentration of TSS and the total fraction of several metals exceeded the City of Barrie Sewer Use-Bylaw 2012-172 criteria, and PWQO criteria. Dewatering discharge will require treatment depending on where the water is disposed to. A sample of the discharge water should be collected, after treatment, to confirm treatment efficacy.
- The projected construction dewatering rates could extend up to 94 m³/day. Due to the size of the project excavation and the variability in soil conditions, Cambium recommends that construction dewatering activities are registered on the EASR. Depending on stormwater management strategies employed during construction, stormwater runoff flows that combine with groundwater inflow could increase the daily discharge rate greater than 400 m³/day. The Client should determine the stormwater management strategies that will be employed on-site during construction and determine what type of water taking permitting is most appropriate.



- The water balance analysis indicates that there will be an infiltration deficit upon development of the property. The proposed runoff re-infiltration feature will account for the projected infiltration deficit.

In summary the proposed development is considered suitable at the Site. Adjacent groundwater and surface water systems are not anticipated to be influenced from the proposed development.

7.1 Closing

If you have any questions about the information provided herein please contact the undersigned at 705-742-7900.

Respectfully submitted,

Cambium Inc.

Cameron MacDougall, P.Geo.
Project Manager



CJM

P:\9500 to 9599\9574-004 Renaissance Retirement Barrie Trust - Geo & Hydro G - 505 Yonge Street, Barrie\Deliverables\REPORT - Hydro GI\Update\2021-12-29 Hydrogeological Assessment, 505 Yonge St Barrie, ON.docx

8.0 References

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Appended Figures



HYDROGEOLOGICAL ASSESSMENT REPORT

CORE GROUP

505, 511, 515 and 533 Yonge Street,
Barrie, Ontario

LEGEND

- Benchmark
- Borehole
- Monitoring Well
- Groundwater Contour (1m intervals)
- Site (approximate)
- (243.53) Groundwater Elevation (masl) (Nov. 16, 2021)
- Groundwater Flow Direction

Notes:

- Benchmark is the top nut of a fire hydrant.
- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
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SITE PLAN

Project No.:	9574-004	Date:	November 2021
Scale:	1:1,500	Rev.:	
Created by:	MAT	Checked by:	CM
Figure:			1



HYDROGEOLOGICAL ASSESSMENT REPORT

CORE GROUP

505, 511, 515 and 533 Yonge Street,
Barrie, Ontario

LEGEND

-  MECP Well Records
-  500m Study Area
-  Site (approximate)

Notes:

- Benchmark is the top nut of a fire hydrant.
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WATER WELL RECORDS WITHIN 500m OF SITE

Project No.:	9574-004	Date:	November 2021
Scale:	1:7,000	Rev.:	
Created by:	MAT	Checked by:	CM
Figure:	2		



HYDROGEOLOGICAL ASSESSMENT REPORT

CORE GROUP
505, 511, 515 and 533 Yonge Street,
Barrie, Ontario

LEGEND

- MECP Well Records
- 95m Zone of Influence
- Site (approximate)

Notes:
- Benchmark is the top nut of a fire hydrant.
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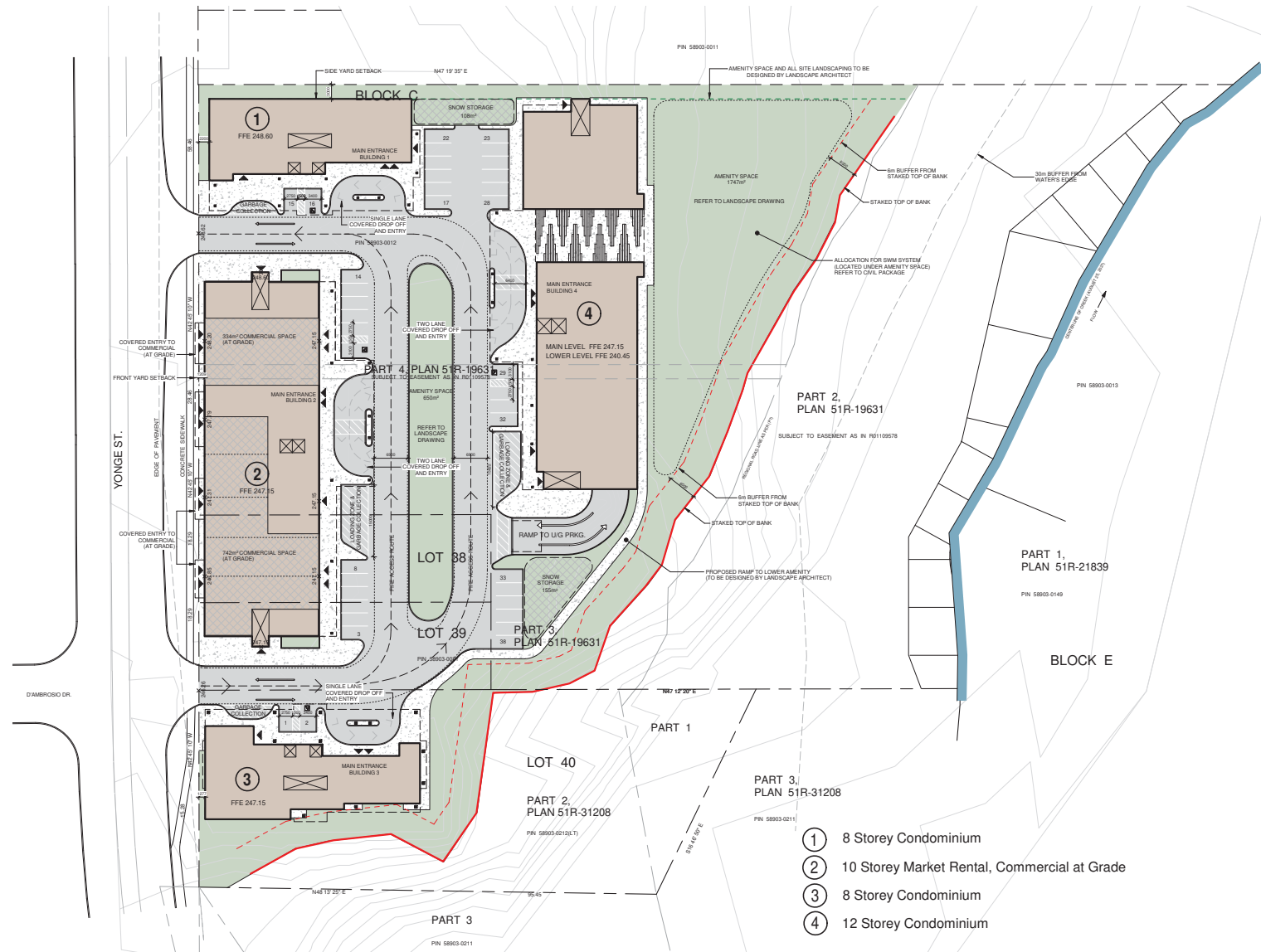
ZONE OF INFLUENCE - CONSTRUCTION EXCAVATIONS

Project No.:	9574-004	Date:	November 2021
Scale:	1:2,500	Rev.:	
Created by:	MAT	Projection:	NAD 1983 UTM Zone 17N
Checked by:	CM	Figure:	3



Appendix A

Proposed Development Plan and Land Information

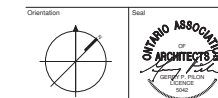


KEY PLAN

SITE PLAN LEGEND:

---	PROPERTY LINE
- - -	PART LOT / EASEMENT LINE
---	STABLE TOP OF SLOPE AS STAKED
---	CENTRELINE OF LOWERS CREEK
---	PROPERTY SETBACK
---	COMMERCIAL (1 STOREY @ GRADE)
---	SNOW STORAGE
---	CONCRETE PAVING / SIDEWALK
---	ASPHALT PAVEMENT
---	GRASS / DEVELOPABLE LIMIT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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All dimensions to be checked and verified on the job by the Contractor. Any discrepancies are to be reported to the Consultant prior to action. Only the latest approved drawings to be used for construction in accordance with all applicable codes, by-laws and regulations. All drawings remain the property of the Consultant.

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Project Information
505 to 533 Yonge St

505 to 533 Yonge St., Barrie, ON

Owner

Drawing Title

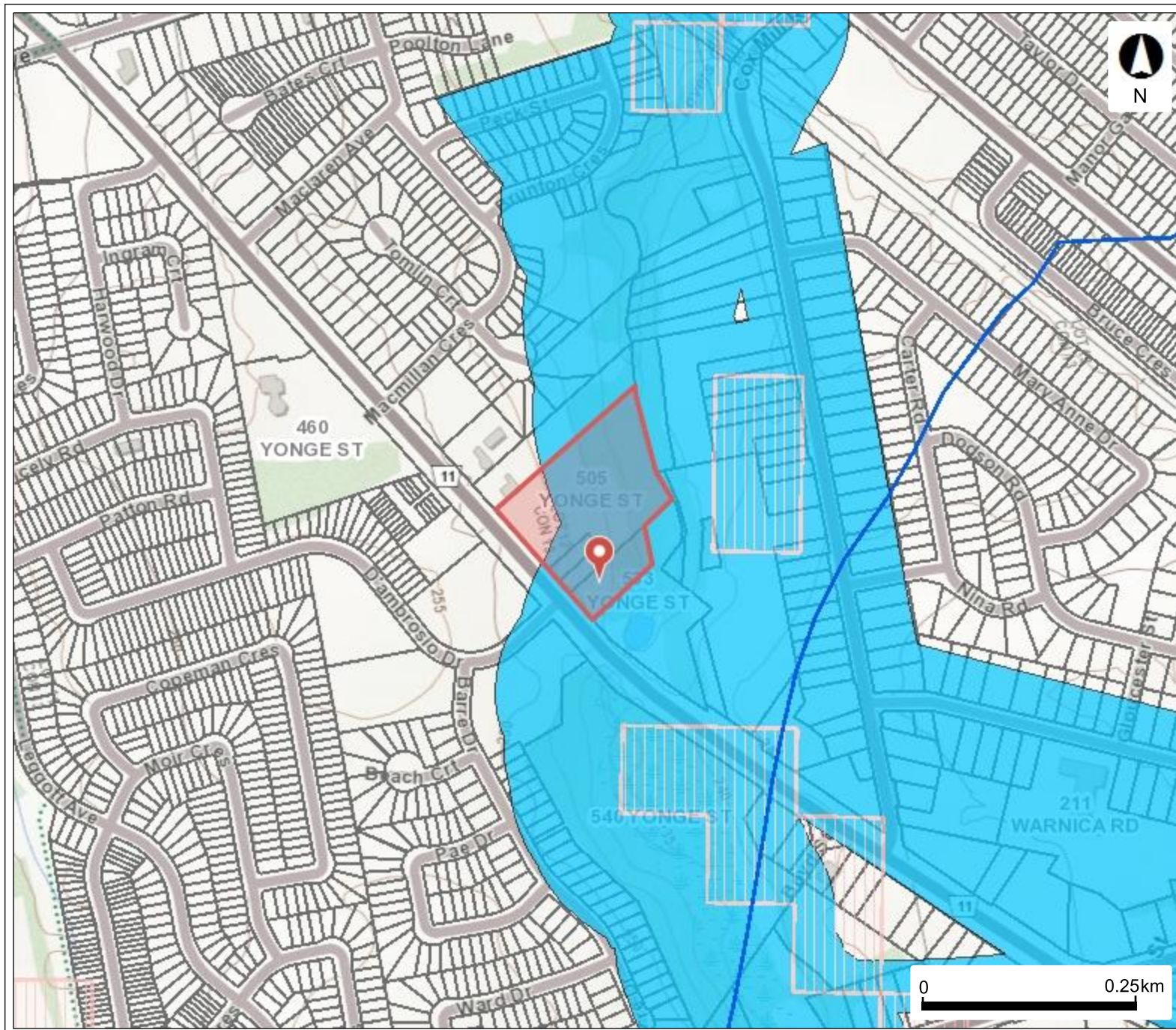
Site Plan

Date	Project No	Drawing No
Drawn by KT	20033	A101
Scale	As indicated	

2 Site Plan
A101 1 : 400

- 8 Storey Condominium
- 10 Storey Market Rental, Commercial at Grade
- 8 Storey Condominium
- 12 Storey Condominium

SPIA Mapping



Legend

- Intake Protection Zone Q
- Wellhead Protection Area Q2
- Highly Vulnerable Aquifers
- Intake Protection Zone 1
- Intake Protection Zone 2
- Assessment Parcel

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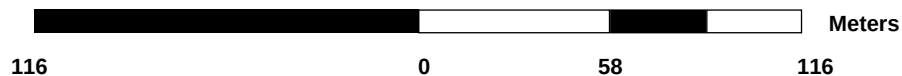
Regulated Areas

Features

- Regulation Map Index
- LSRCA Watershed Boundary
- Watercourse
- Regulated Area Boundary
- Regulated Area
- Address Labels
- Assessment Parcel
- Lot and Concession
- Roads
 - Hwy 400 Series
 - Highway, Arterials
 - Local Road
- Railway



Scale 1: 2,290



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Auxiliary_Sphere

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Appendix B

Borehole Logs



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Log of Borehole:

BH101-19

Page 1 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607082, 4912922

Project No.: 9574-001
Date Completed: August 15, 2019
Elevation: 247.79 mASL

SUBSURFACE PROFILE				SAMPLE													
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks	
								25	50	75	10	20	30	40			
0			Gravelly Sand: Brown gravelly sand, some silt, trace clay, occasional cobbles, moist, compact, FILL	1	SS	40	19										
247	1			2	SS	40	23										
			Sand: Brown sand, some silt, some gravel, trace clay, occasional cobbles, moist, compact, FILL	3	SS	80	22										
246	2																
			Silty Sand: Brown silty sand, trace gravel, trace clay, occasional cobbles, moist, dense	4	SS	90	43										
245	3																
				5	SS	90	40										
244	4																
243	5		Wet, very dense	6	SS	50	50/ 205 mm										
242																	

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Log of Borehole:

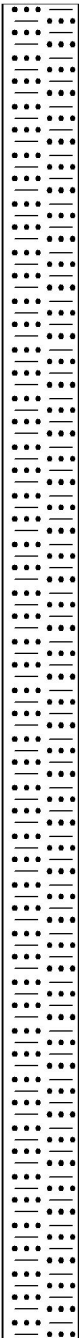
BH101-19

Page 2 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607082, 4912922

Project No.: 9574-001
Date Completed: August 15, 2019
Elevation: 247.79 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
241	6			7	SS	60	50/ 280 mm									Spoon bouncing at 6.1 mbgs
	7															
240	8			8	SS	60	50/ 205 mm									
239	9															
				9	SS	50	50/ 205 mm									
238	10															
237	11				10	SS	60	50/ 205 mm								
236																Spoon bouncing at 11 mbgs

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Log of Borehole:

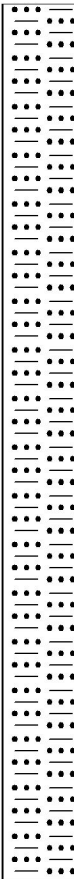
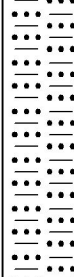
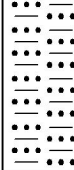
BH101-19

Page 3 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607082, 4912922

Project No.: 9574-001
Date Completed: August 15, 2019
Elevation: 247.79 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
12			Compact	11	SS	50	50/ 230 mm									GSA SS12: 2% Gravel 51% Sand 30% Silt 17% Clay
235																
13																
234			Very dense	12	SS	100	26									Spoon bouncing at 15.4 mbgs
14																
233																
15				13	SS	40	50/ 205 mm									Groundwater observed at 8.2 mbgs and caving measured at 8.5 mbgs upon completion
232																
16		Borehole terminated at 15.7 mbgs														

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Log of Borehole:

BH102-19

Page 1 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607110, 4912895

Project No.: 9574-001
Date Completed: August 16, 2019
Elevation: 247.57 mASL

SUBSURFACE PROFILE				SAMPLE													
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks	
								25	50	75	10	20	30	40			
0			Asphalt: (25 mm)													Cap	Top of Standpipe (TOS) elevation: 247.46 mASL. Groundwater measured at 4.10 mbgs (243.47 mASL) on November 19, 2019.
247			Gravelly Sand: Brown gravelly sand, with silt, trace clay, occasional cobbles, moist, compact, FILL	1	GS	-	-									Cuttings	
	1			2	SS	30	15										
246				3	SS	50	20										
	2																
245			Dense	4	SS	90	38										
	3																
244			Silty Sand: Brown silty sand, some gravel, trace clay, occasional cobbles, moist, very dense	5	SS	100	50/ 230 mm									Bentonite Plug	
	4																
243																	
	5		Sandy Silt: Brown sandy silt, with gravel, trace clay, moist, very dense	6	SS	75	50/ 205 mm										
																	
242																	

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Log of Borehole:

BH102-19

Page 2 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607110, 4912895

Project No.: 9574-001
Date Completed: August 16, 2019
Elevation: 247.57 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
6			Grey													
241				7	SS	20	50/ 75 mm									
7																
240																
8			Wet	8	SS	70	50/ 255 mm									
239																
9				9	SS	50	50/ 230 mm									Spoon bouncing at 9.1 mbgs
238																
10																
237																
11				10	SS	0	50/ 125 mm									Tip of spoon came off when it was being pulled out of hole, thus no sample was acquired
236																

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Log of Borehole:

BH102-19

Page 3 of 3

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607110, 4912895

Project No.: 9574-001
Date Completed: August 16, 2019
Elevation: 247.57 mASL

SUBSURFACE PROFILE				SAMPLE														
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks		
								25	50	75	10	20	30	40				
235	12		Moist, trace gravel, occasional cobbles	11	SS	100	50/205 mm											
	13																	
234	14			12	SS	100	50/230 mm											
	15																	
233			Borehole terminated at 15.7 mbgs													Groundwater first observed at 8.2 mbgs		
	16			13	SS	100	50/305 mm											
232		Borehole terminated at 15.7 mbgs													Groundwater first observed at 8.2 mbgs			
231																		

Logged By: CM

Input By: CM



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Log of Borehole:

BH103-19

Page 1 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607113, 4912942

Project No.: 9574-001
Date Completed: August 26, 2019
Elevation: 246.14 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
246	0		Sand: Brown sand, with gravel, some topsoil, trace silt, trace organics, occasional cobbles, moist, compact, FILL	1	SS	40	14									
			Silty Sand: Brown silty sand, trace gravel, trace organics, trace clay, moist, loose, FILL	2	SS	70	9									
245	1															
			Sand: Brown sand, some silt, some gravel, trace clay, moist, compact	3	SS	60	23									
244	2		Wet													
			Dense	4	SS	5	44									
243	3			5	SS	95	41									
			Moist													
242	4															
			Sandy Silt: Brown sandy silt, some gravel, moist, very dense	6	SS	60	50/ 205 mm									
241	5															

GSA SS4:
23% Gravel
42% Sand
25% Silt
10% Clay

Logged By: CM

Input By: CM



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Log of Borehole:

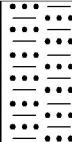
BH103-19

Page 2 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607113, 4912942

Project No.: 9574-001
Date Completed: August 26, 2019
Elevation: 246.14 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
240	6		Occasional cobbles													Groundwater observed at 5.8 mbgs and caving measured at 5.9 mbgs upon completion
			7	SS	70	50/230 mm										
239	7		Borehole terminated at 6.6 mbgs													

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Input By: CM



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Log of Borehole:

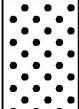
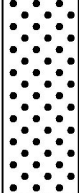
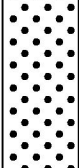
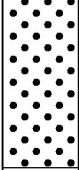
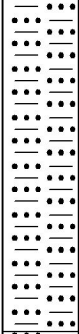
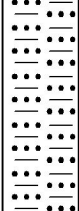
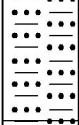
BH104-19

Page 1 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607178, 4912908

Project No.: 9574-001
Date Completed: August 26, 2019
Elevation: 243.60 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
0			Asphalt: (50) mm													
			Sand: Brown sand, trace silt, trace gravel, some asphalt fragments, occasional cobbles, moist, compact, FILL	1	GS	-	-									
243																
	1		Loose	2	SS	50	12									
242																
	2		Some silt, trace clay, wet, very loose	3	SS	60	8									
241																
	3		Silty Sand: Grey silty sand, some gravel, trace clay, moist, compact	4	SS	40	2									
240																
	4		Sandy Silt: Grey sandy silt, some clay, some gravel, moist, dense	5	SS	65	14									
239																
	5		Sandy Silt: Grey sandy silt, some clay, some gravel, moist, dense	6	SS	100	36									
238																
	6															

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Log of Borehole:

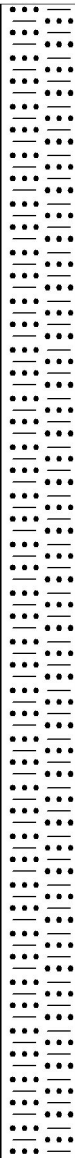
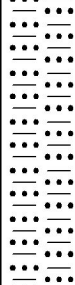
BH104-19

Page 2 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607178, 4912908

Project No.: 9574-001
Date Completed: August 26, 2019
Elevation: 243.60 mASL

SUBSURFACE PROFILE				SAMPLE													
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks	
								25	50	75	10	20	30	40			
237	7		Silty Sand: Brown silty sand, some gravel, trace clay, occasional cobbles, moist, very dense	7	SS	100	50/230 mm									GSA SS7: 3% Gravel 55% Sand 32% Silt 10% Clay	
			Dense														
236	8				8	SS	5	46									
235	9																
					9	SS	80	43									
234	10																
233	11		Very dense, wet														
					10	SS	20	50/75 mm									
232	12		Borehole terminated at 11.4 mbgs due practical refusal													Borehole open and groundwater at 11.0 mbgs upon completion	

Logged By: CM

Input By: CM



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Log of Borehole:

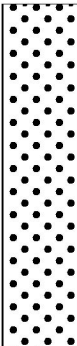
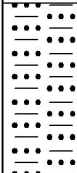
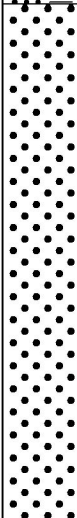
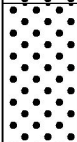
BH105-19

Page 1 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607143, 4912886

Project No.: 9574-001
Date Completed: August 27, 2019
Elevation: 246.64 mASL

SUBSURFACE PROFILE				SAMPLE													
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks	
								25	50	75	10	20	30	40			
0			Sand: Brown sand with silt, some topsoil, trace gravel, occasional organics, trace cobbles, moist, loose, FILL	1	SS	20	5										
246																	
	1			2	SS	10	6										
245			Sandy Silt: Brown sandy silt, some gravel, trace clay, occasional cobbles, moist, compact, FILL	3	SS	35	14										
	2																
244			Sand: Brown sand, some gravel, trace silt, trace clay, occasional cobbles, moist, dense	4	SS	50	43										
	3																
				5	SS	60	46										
243																	
	4																
242			Sand: Brown sand, some gravel, some silt, trace clay, occasional cobbles, moist, very dense	6	SS	50	50/ 255 mm										
	5																
			Wet														
241																	

Logged By: CM

Input By: CM



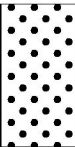
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Log of Borehole:

BH105-19

Page 2 of 2

Client: Park City Inc. **Project Name:** Geotech Investigation - 505 Yonge Street **Project No.:** 9574-001
Contractor: Walker Drilling **Method:** Hollow Stem Augers **Date Completed:** August 27, 2019
Location: 505 Yonge Street, Barrie, ON **UTM:** 17T 607143, 4912886 **Elevation:** 246.64 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
240	6															Groundwater observed at 4.0 mbgs and caving measured at 5.2 mbgs upon completion
			7	SS	90	50/ 230 mm										
	7		Borehole terminated at 6.6 mbgs													

Logged By: CM

Input By: CM



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Log of Borehole:

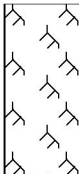
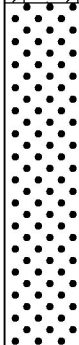
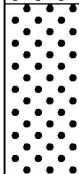
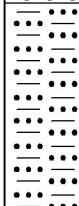
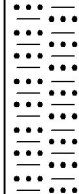
BH106-19

Page 1 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607159, 4912841

Project No.: 9574-001
Date Completed: August 27, 2019
Elevation: 244.45 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT			Well Installation	Remarks	
								25	50	75	10	20	30	40		
0			Topsoil: Brown sandy topsoil, moist, compact, FILL	1	SS	50	24								Cap Cuttings Bentonite Plug	Top of Standpipe (TOS) elevation: 244.35 mASL. Groundwater measured at 3.60 mbgs (240.85 mASL) on November 19, 2019.
244																
	1		Sand: Brown sand, some silt, trace gravel, trace clay, occasional organics, moist, loose, FILL	2	SS	5	6									
243			Dense	3	SS	80	33									
	2															
242			Sand: Brown sand, some silt, trace gravel, trace clay, occasional cobbles, moist, dense	4	SS	60	47								PVC Standpipe Cuttings Bentonite Plug	
	3															
241			Silty Sand: Brown silty sand, some gravel, trace clay, occasional cobbles, moist, dense	5	SS	70	45									
	4															
240			Grey, very dense	6	SS	60	50/205 mm									GSA SS6: 11% Gravel 58% Sand 23% Silt 8% Clay
	5															
239																

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Input By: CM



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Log of Borehole:

BH106-19

Page 2 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607159, 4912841

Project No.: 9574-001
Date Completed: August 27, 2019
Elevation: 244.45 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
238	6		Dense, wet	7	SS	55	50/ 180 mm									Groundwater first observed at 7.6 mbgs
237	7															
236	8			8	SS	60	48									
			Borehole terminated at 8.1 mbgs due to practical refusal													
	9															

Logged By: CM

Input By: CM



BH107-19

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607176, 4912875

Project No.: 9574-001
Date Completed: August 27, 2019
Elevation: 241.33 mASL

Logged By: CM **Input By:** CM



BH108-19

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607143, 4912886

Project No.: 9574-001
Date Completed: October 16, 2019
Elevation: 242.59 mASL

Logged By: CM **Input By:** CM



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Log of Borehole:

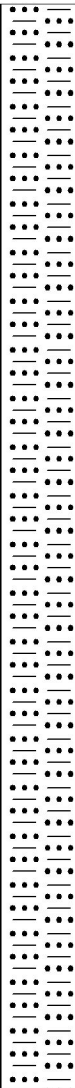
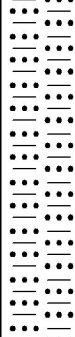
BH108-19

Page 2 of 2

Client: Park City Inc.
Contractor: Walker Drilling
Location: 505 Yonge Street, Barrie, ON

Project Name: Geotech Investigation - 505 Yonge Street
Method: Hollow Stem Augers
UTM: 17T 607143, 4912886

Project No.: 9574-001
Date Completed: October 16, 2019
Elevation: 242.59 mASL

SUBSURFACE PROFILE				SAMPLE											
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT		Well Installation	Remarks	
								25	50	75	10	20	30	40	
236	7		Silty Sand: Grey silty sand, some gravel, occasional cobbles, moist, very dense	7	SS	50	50/230 mm								
			Less cobbles												
			8	SS	60	50/180 mm									
			Trace clay, wet, dense												
			9	SS	100	38									
233	10		Occasional cobbles, moist, very dense	10	SS	100	50/305 mm								Groundwater first observed at 8.5 mbgs
			Borehole terminated at 11.1 mbgs												
231	12														

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Logged By: CM

Input By: CM



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Log of Borehole:

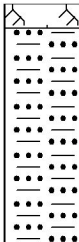
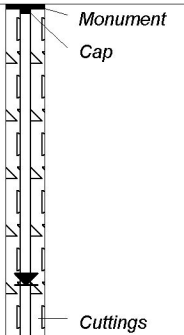
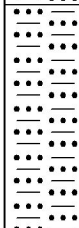
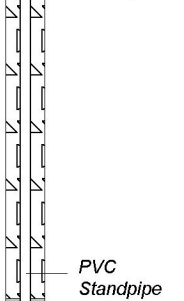
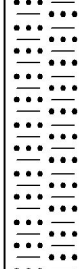
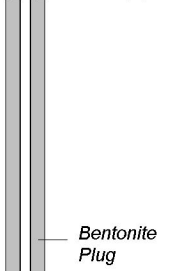
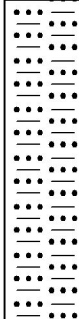
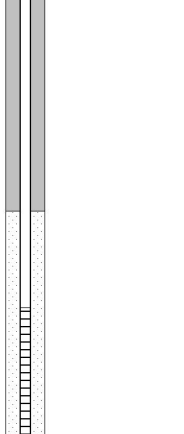
BH/MW109-21

Page 1 of 2

Client: Core Group (2570974 Ontario Inc.)
Contractor: Landshark Drilling
Location: 505 Yonge St., Barrie, ON

Project Name: Geotechnical Investigation
Method: Hollow Stem Auger
UTM: 17T, 4912949 m N, 607084 m E

Project No.: 9574-004
Date Completed: September 16, 2021
Elevation: 247.04 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
247	0		TOPSOIL: Black topsoil, some organics, compact, moist	1A	SS	95	12									Top of Standpipe (TOS) elevation: 248.19 mASL. Groundwater measured at 1.77 mbgs (245.27 mASL.) on September 24, 2021
			SANDY SILT: Brown sandy silt, trace gravel, compact, moist, FILL	1B												
246	1				2	SS	95	13								
			SANDY SILT: Brown sandy silt, some clay, trace gravel, compact, moist	3	SS	100	18									Wet soils encountered at 3.0 mbgs during the investigation
245	2		-dense	4	SS	70	43									
244	3		-wet	5	SS	65	44									GSA SS6: 5% Gravel 29% Sand 55% Silt 11% Clay
243	4		-grey	6	SS	75	48									
242	5															
241	6		SILTY SAND: Grey silty sand, trace gravel, very dense, wet	7	SS	40	50/ 175 mm									
240	7															
239	8			8	SS	80	50/ 225 mm									

Logged By: C. Malliaros

Input By: C. Malliaros



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Log of Borehole:

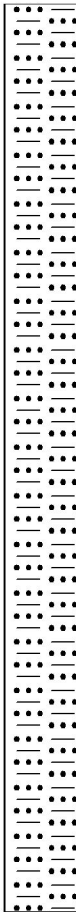
BH/MW109-21

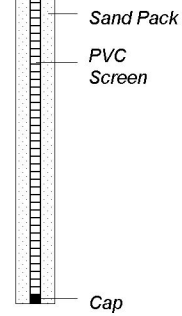
Page 2 of 2

Client: Core Group (2570974 Ontario Inc.)
Contractor: Landshark Drilling
Location: 505 Yonge St., Barrie, ON

Project Name: Geotechnical Investigation
Method: Hollow Stem Auger
UTM: 17T, 4912949 m N, 607084 m E

Project No.: 9574-004
Date Completed: September 16, 2021
Elevation: 247.04 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT				Well Installation	Remarks
								25	50	75	10	20	30	40		
238	9			9	SS	80	50/ 125 mm								 Sand Pack PVC Screen Cap	
237	10															
236	11			10	SS	100	50/ 250 mm									
235	12															
234	13			11	SS	100	50/ 225 mm									
233	14			12	SS	100	50/ 250 mm									
232	15		Borehole terminated in SILTY SAND at 14.0 mbgs due to exploration depth achieved													



Logged By: C. Malliaros

Input By: C. Malliaros



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Log of Borehole:

BH/MW110-21

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Client: Core Group (2570974 Ontario Inc.)
Contractor: Landshark Drilling
Location: 505 Yonge St., Barrie, ON

Project Name: Geotechnical Investigation
Method: Hollow Stem Auger
UTM: 17T, 4912935 m N, 607174 m E

Project No.: 9574-004
Date Completed: September 16, 2021
Elevation: 243.90 mASL

SUBSURFACE PROFILE				SAMPLE										
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT	Well Installation	Remarks	
								25	50	75	10	20	30	40
0			ASPHALT: (75 mm)	1A	GS	-	-							
			GRAVELLY SAND: Brown gravelly sand, compact, moist, FILL	1B										
243	1		SAND: Brown sand, some gravel, very loose, moist, FILL	2	SS	80	4							
			-loose											
242	2		-very loose	3	SS	60	6							
				4	SS	90	2							
241	3		SAND: Grey sand, some silt, very loose, moist	5	SS	80	2							
240	4		-compact	6	SS	100	22							
239	5													
238	6		SILTY SAND: Grey silty sand, dense, moist	7	SS	90	35							
237	7		-compact	8	SS	90	29							
236	8													
235	9		Borehole terminated in SILTY SAND at 8.0 mbgs due to exploration depth achieved											

Flushmount
Cap

Cuttings

PVC
Standpipe
Bentonite
Plug

Sand Pack

PVC
Screen

Cap

Top of Standpipe (TOS) elevation: 243.73 mASL. Groundwater measured at 4.33 mbgs (239.58 mASL.) on September 24, 2021

No wet soils encountered during the investigation

Logged By: C. Malliaros

Input By: C. Malliaros



Peterborough
Barrie
Oshawa
Kingston
T: 866-217-7900
www.cambium-inc.com

Log of Borehole:

BH/MW111-21

Page 1 of 1

Client: Core Group (2570974 Ontario Inc.)
Contractor: Walker Drilling
Location: 505 Yonge St., Barrie, ON

Project Name: Geotechnical Investigation
Method: Tripod
UTM: 17T, 4912971 m N, 607162 m E

Project No.: 9574-004
Date Completed: September 22, 2021
Elevation: 239.61 mASL

SUBSURFACE PROFILE				SAMPLE										
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture			SPT (N) / DCPT	Well Installation	Remarks	
								25	50	75	10	20	30	40
0			TOPSOIL: Black topsoil, some sand, some silt, some organics, wet, compact	1A										
239				1B	SS	50	11							
			SAND: Brown sand, trace gravel, trace silt, compact, moist											
1			-saturated	2	SS	10	29							
238														
			GRAVELLY SAND: Grey gravelly sand, some silt, very dense, saturated	3	SS	60	50/ 230 mm							
2														
237				4	SS	20	50/ 75 mm							
3														
				5	SS	40	50/ 75 mm							
236			Borehole terminated in GRAVELLY SAND at 3.5 mbgs due to exploration depth achieved											
4														
235														
5														
234														
6														
233														
7														
232														
8														
231														
9														

Monument

Cap

Bentonite Plug

PVC Standpipe

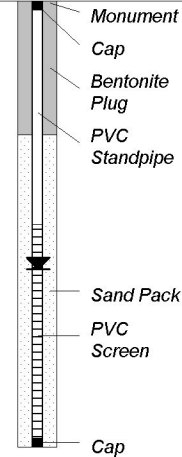
Sand Pack

PVC Screen

Cap

Top of Standpipe (TOS) elevation: 239.78 mASL. Groundwater measured at 1.83 mbgs (237.93 mASL.) on September 24, 2021

Wet soils encountered at 1.5 mbgs during the investigation
GSA SS3:
32% Gravel
53% Sand
15% Silt and Clay



Top of Standpipe (TOS) elevation: 239.78 mASL. Groundwater measured at 1.83 mbgs (237.93 mASL.) on September 24, 2021

Wet soils encountered at 1.5 mbgs during the investigation
GSA SS3:
32% Gravel
53% Sand
15% Silt and Clay

Logged By: B. White

Input By: C. Malliaros



Terraprobe

PROJECT NAME: 505 Yonge Street
 CLIENT: Melchior Management Corp
 LOCATION: Barrie, Ontario

LOG OF BOREHOLE ..7..

PROJECT No.: 3-09-5016
 BORING DATE: March 30, 2009
 ELEVATION DATUM: Geodetic

BORING METHOD DEPTH SCALE IN METRES	SOIL PROFILE			SAMPLES			PENETRATION RESISTANCE PLOT				WATER CONTENT (%)	INSTALLATION INFORMATION
	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	"N" VALUE	X X X X					
							20 40 60 80					
							SHEAR STRENGTH kPa					
							net.V - + 0 - + rem.V - @ U - O 20 40 60 80					
20 40 60 80				10 20 30								
D50 Crawler-mounted Drill Rig / Solid Stem Augers	0	GROUND SURFACE		242.9								
		75mm - TOPSOIL Brown Loose Moist to Wet		0.0	1	SS	17	x				O
	1	SAND & SILT, trace gravel, trace organics, FILL			2	SS	8	x				O
	2		240.8	3	SS	8	x				O	
		Brown Dense to Very Dense Moist		2.1								
					4	SS	36	x				O
	3	SAND & SILT, trace gravel, trace clay, TILL			5	SS	50/150mm					O
4												
				6	SS	46	x				O	
5												
6												
				7	SS	50/150mm					O	
7												
8			234.8	8	SS	50/75mm					O	
	End of Borehole		8.1									
9												



Appendix C

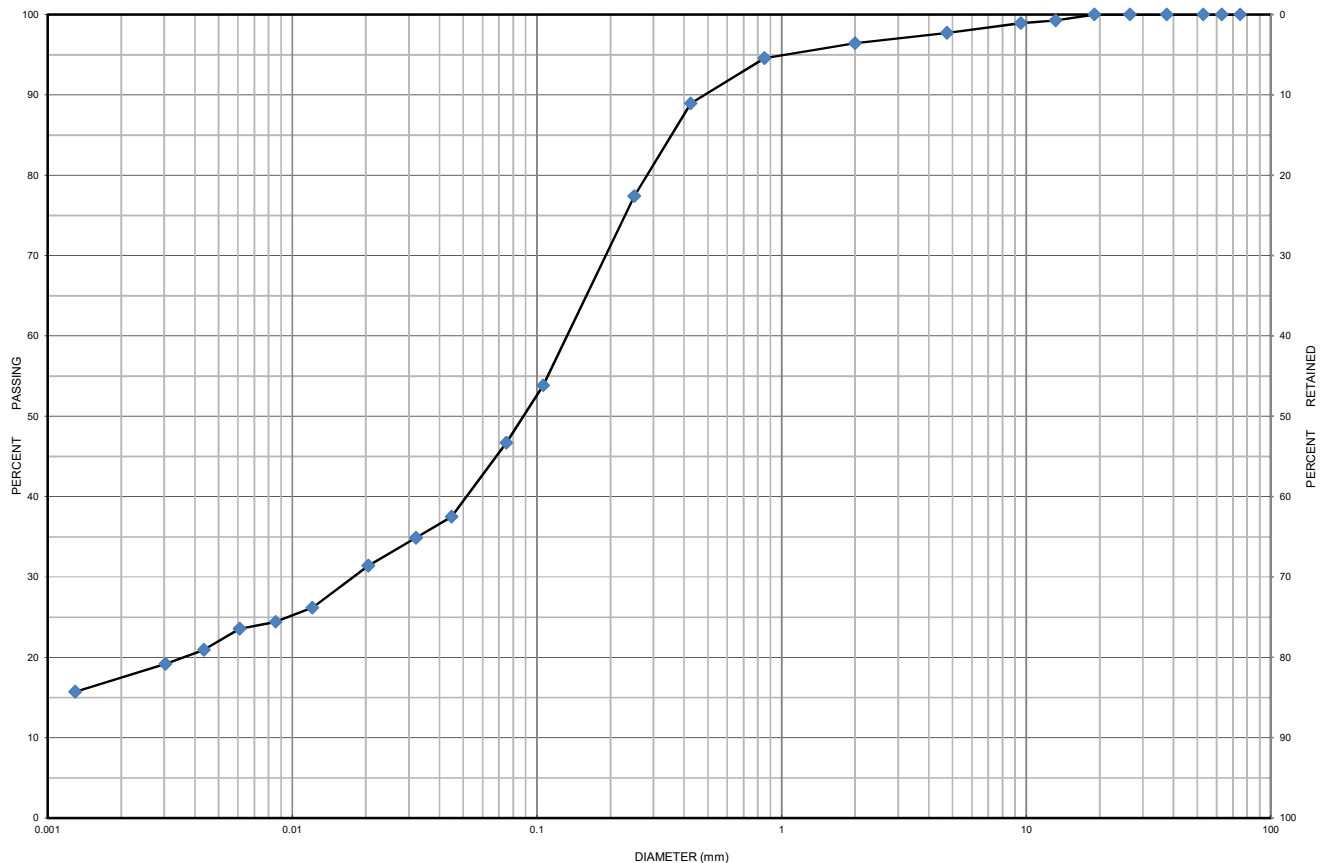
Grain Size Analyses



Grain Size Distribution Chart

Project Number: 9574-001 **Client:** iViva Homes
Project Name: Geotechnical - 505 Yonge St, Barrie, ON
Sample Date: Aug 14, 15, 26, 27, Oct 15, 2019 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 101-19 SS 12 **Depth:** 13.7 m to 14.2 m **Lab Sample No:** S-19-0886

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-19	SS 12	13.7 m to 14.2 m	2	51	47		8.6
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand some Clay trace Gravel			0.140	0.0180	0.0		

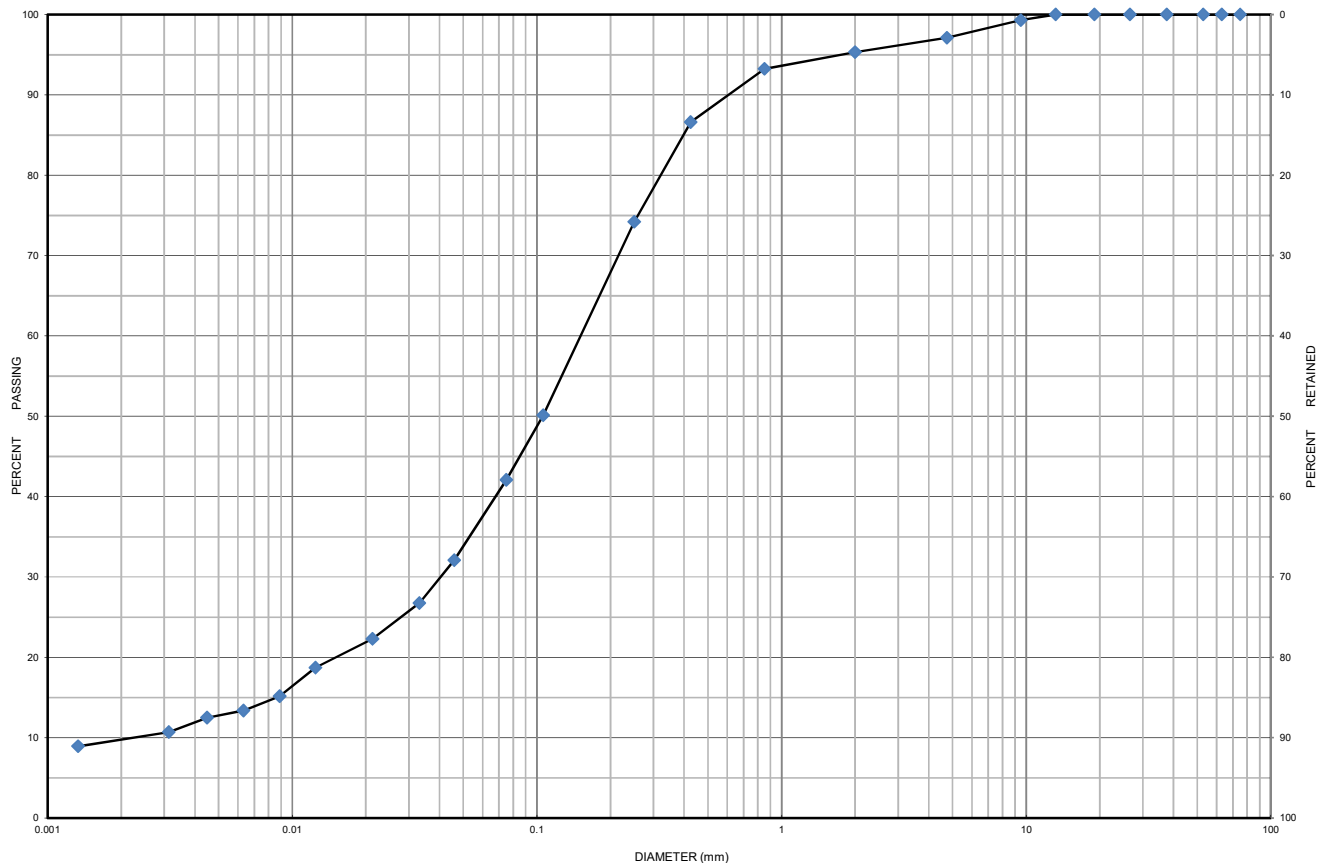
Issued By: *Shane Baird* **Date Issued:** October 31, 2019
 (Senior Project Manager)



Grain Size Distribution Chart

Project Number: 9574-001 **Client:** iViva Homes
Project Name: Geotechnical - 505 Yonge St, Barrie, ON
Sample Date: Aug 14, 15, 26, 27, Oct 15, 2019 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 104-19 SS 7 **Depth:** 6.1 m to 6.6 m **Lab Sample No:** S-19-0887

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 104-19	SS 7	6.1 m to 6.6 m	3	55	42		7.5
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand some Clay trace Gravel			0.160	0.0400	0.0	80.00	5.00

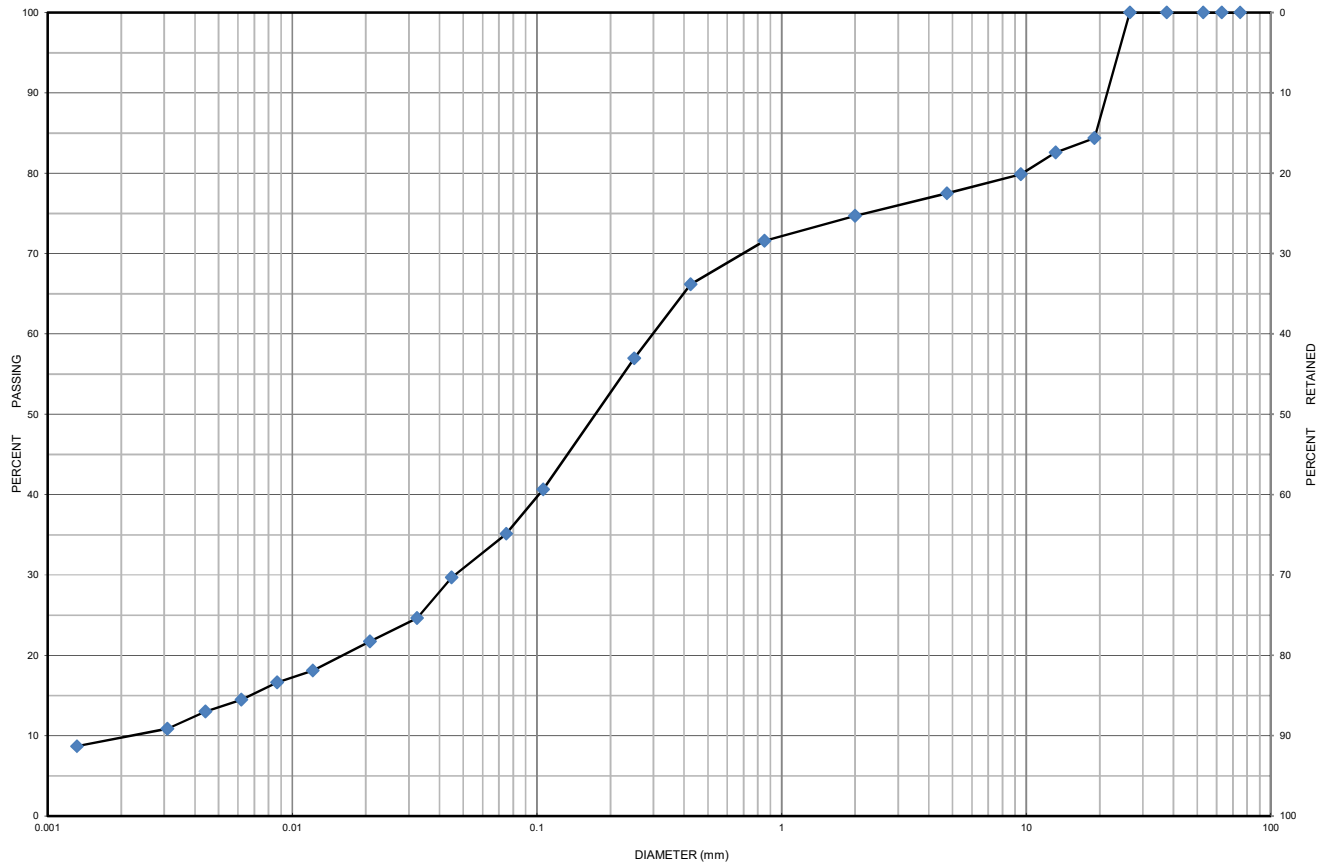
Issued By:  (Senior Project Manager) **Date Issued:** October 31, 2019



Grain Size Distribution Chart

Project Number: 9574-001 **Client:** iViva Homes
Project Name: Geotechnical - 505 Yonge St, Barrie, ON
Sample Date: Aug 14, 15, 26, 27, Oct 15, 2019 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 103-19 SS 4 **Depth:** 2.3 m to 2.7 m **Lab Sample No:** S-19-0888

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-19	SS 4	2.3 m to 2.7 m	23	42	35		11.0
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Silty Sand trace Clay			0.300	0.0450	0.002	150.00	3.38

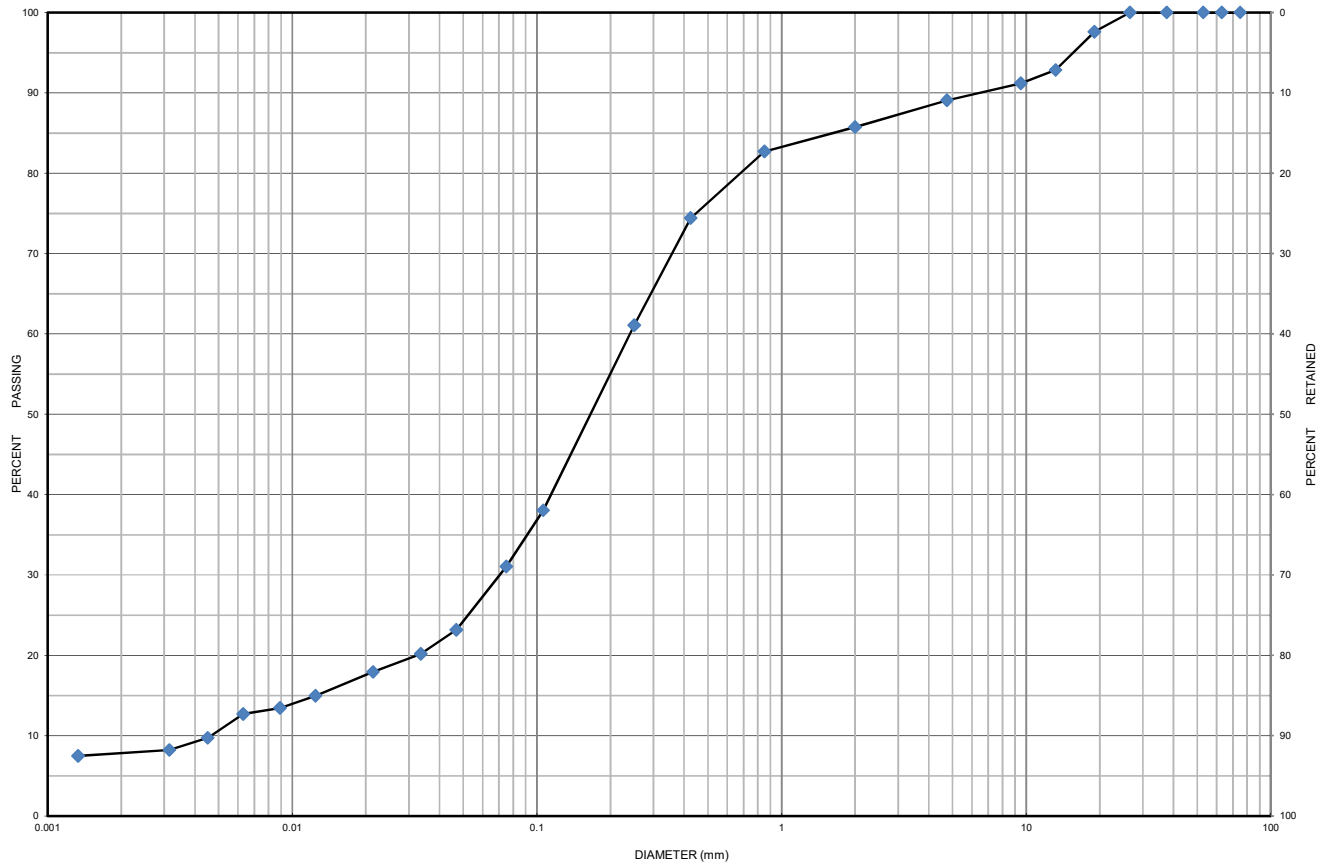
Issued By:  (Senior Project Manager) **Date Issued:** October 31, 2019



Grain Size Distribution Chart

Project Number: 9574-001 **Client:** iViva Homes
Project Name: Geotechnical - 505 Yonge St, Barrie, ON
Sample Date: Aug 14, 15, 26, 27, Oct 15, 2019 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 106-19 SS 6 **Depth:** 4.6 m to 5 m **Lab Sample No:** S-19-0889

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 106-19	SS 6	4.6 m to 5 m	11	58	31		8.6
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand some Gravel trace Clay			0.240	0.0700	0.0045	53.33	4.54

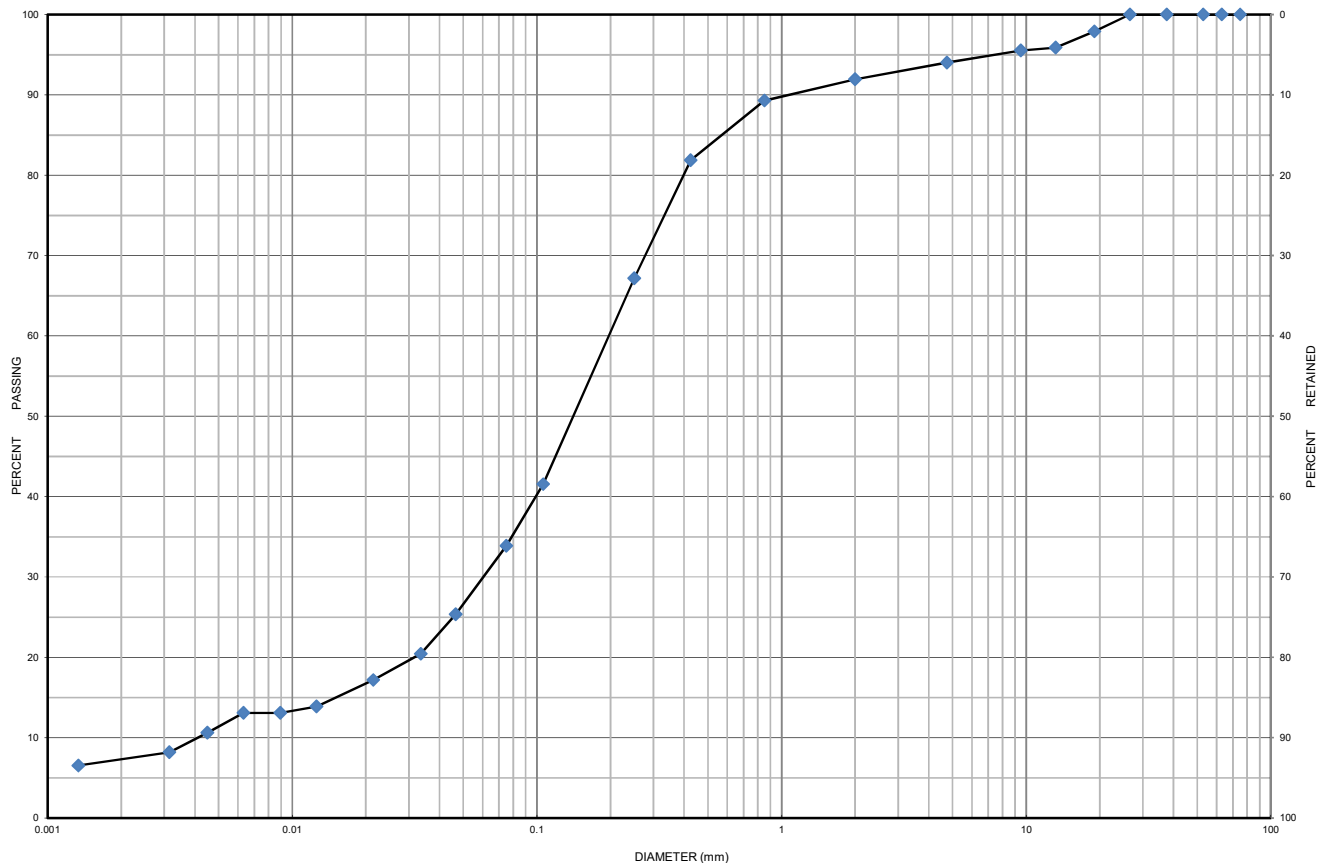
Issued By:  (Senior Project Manager) **Date Issued:** October 31, 2019



Grain Size Distribution Chart

Project Number: 9574-001 **Client:** iViva Homes
Project Name: Geotechnical - 505 Yonge St, Barrie, ON
Sample Date: Aug 14, 15, 26, 27, Oct 15, 2019 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 107-19 SS 2 **Depth:** 0.8 m to 1.2 m **Lab Sample No:** S-19-0890

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 107-19	SS 2	0.8 m to 1.2 m	6	60	34		9.4
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand trace Gravel trace Clay			0.190	0.0500	0.003	63.33	4.39

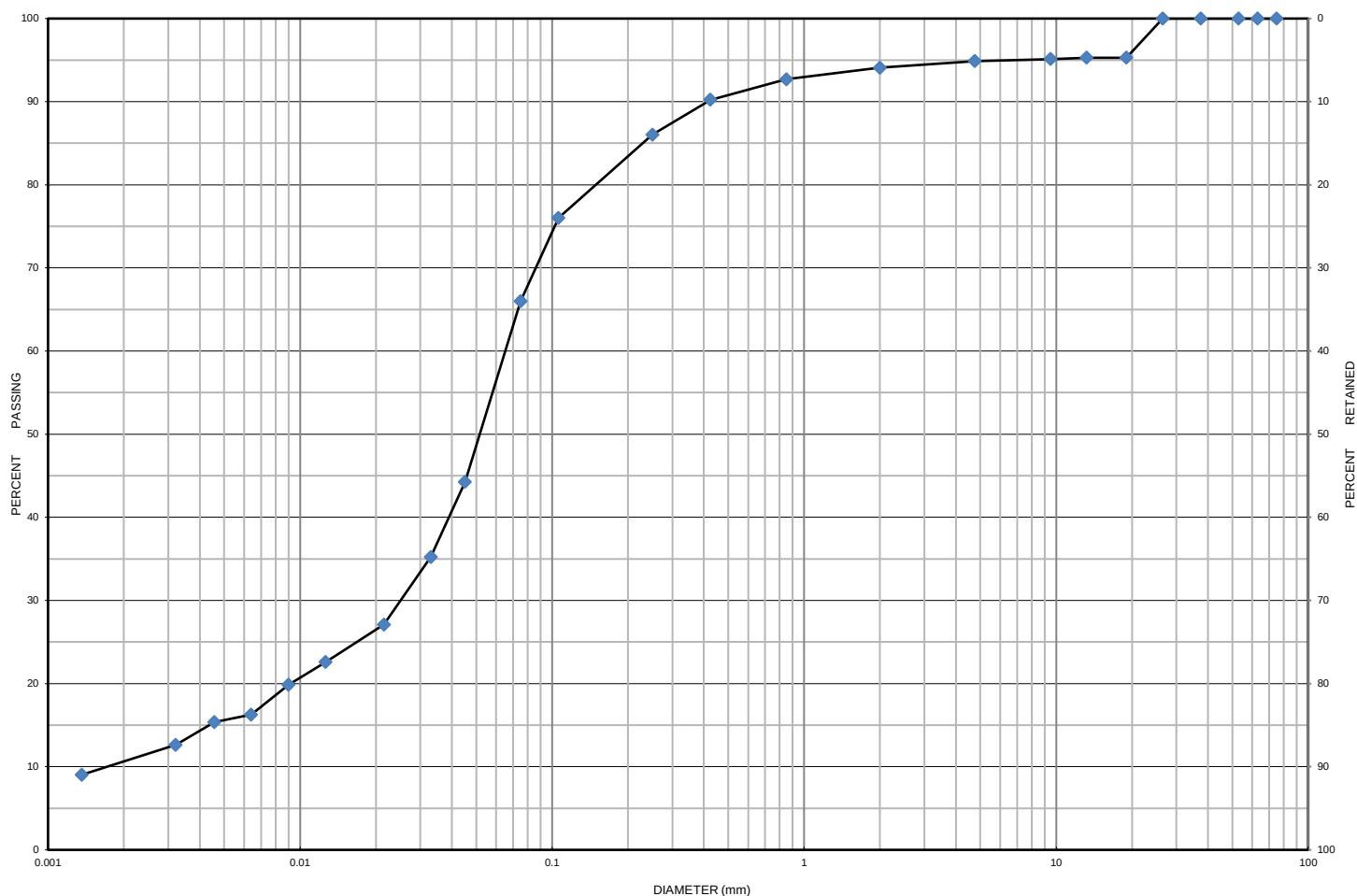
Issued By:  (Senior Project Manager) **Date Issued:** October 31, 2019



Grain Size Distribution Chart

Project Number: 9574-004 **Client:** Renaissance Retirement Barrie Trust
Project Name: 505 Yonge Street, Barrie
Sample Date: September 16, 2021 **Sampled By:** Chris Malliaros - Cambium Inc.
Location: BH 109-21 SS 6 **Depth:** 4.6 m to 5 m **Lab Sample No:** S-21-1181

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDER
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 109-21	SS 6	4.6 m to 5 m	5	29	55	11	14.0
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sandy Silt some Clay trace Gravel		ML	0.0660	0.0150	0.0017	38.82	2.01

Additional information available upon request

Issued By: 
(Senior Project Manager)

Date Issued: October 1, 2021

Cambium Inc. (Laboratory)
866.217.7900 | cambium-inc.com
194 Sophia St. | Peterborough | ON | K9H 1E5

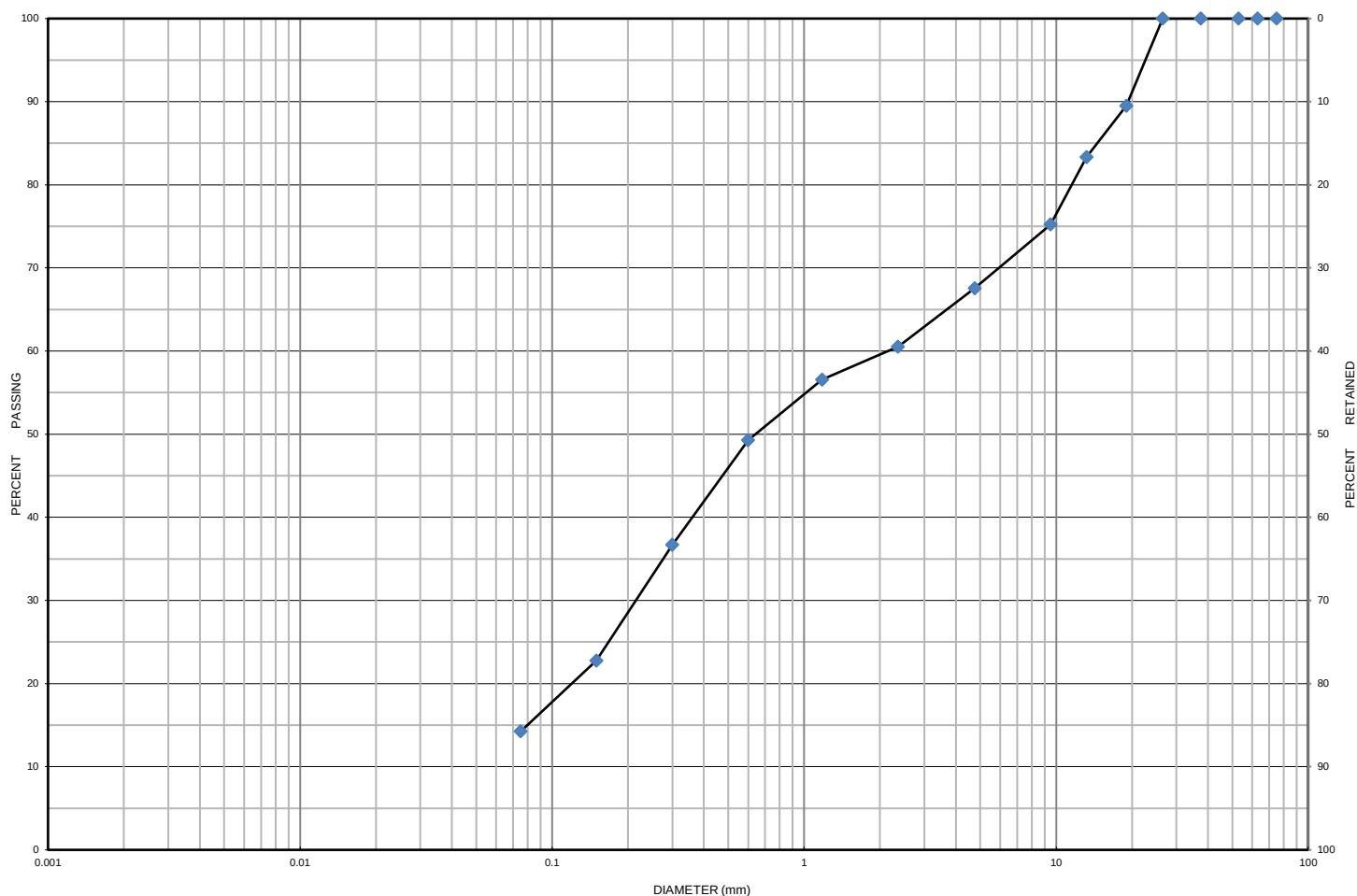
Form: L6V.2 - Grad.Hydo



Grain Size Distribution Chart

Project Number: 9574-004 **Client:** Renaissance Retirement Barrie Trust
Project Name: 505 Yonge Street, Barrie
Sample Date: September 22, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 111-21 SS 3 **Depth:** 1.5 m to 1.9 m **Lab Sample No:** S-21-1182

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDER
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 111-21	SS 3	1.5 m to 1.9 m	32	53	15		9.7
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Sand some Silt		SM	2.115	0.220	-	-	-

Additional information available upon request

Issued By:

(Senior Project Manager)

Date Issued:

October 1, 2021

Cambium Inc. (Laboratory)
866.217.7900 | cambium-inc.com
194 Sophia St. | Peterborough | ON | K9H 1E5

Form: L6V.2 - Grad.Hydo



Appendix D

Aquifer Test Analyses



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW102-19

Test Well: MW102-19

Test Conducted by: Brenden H

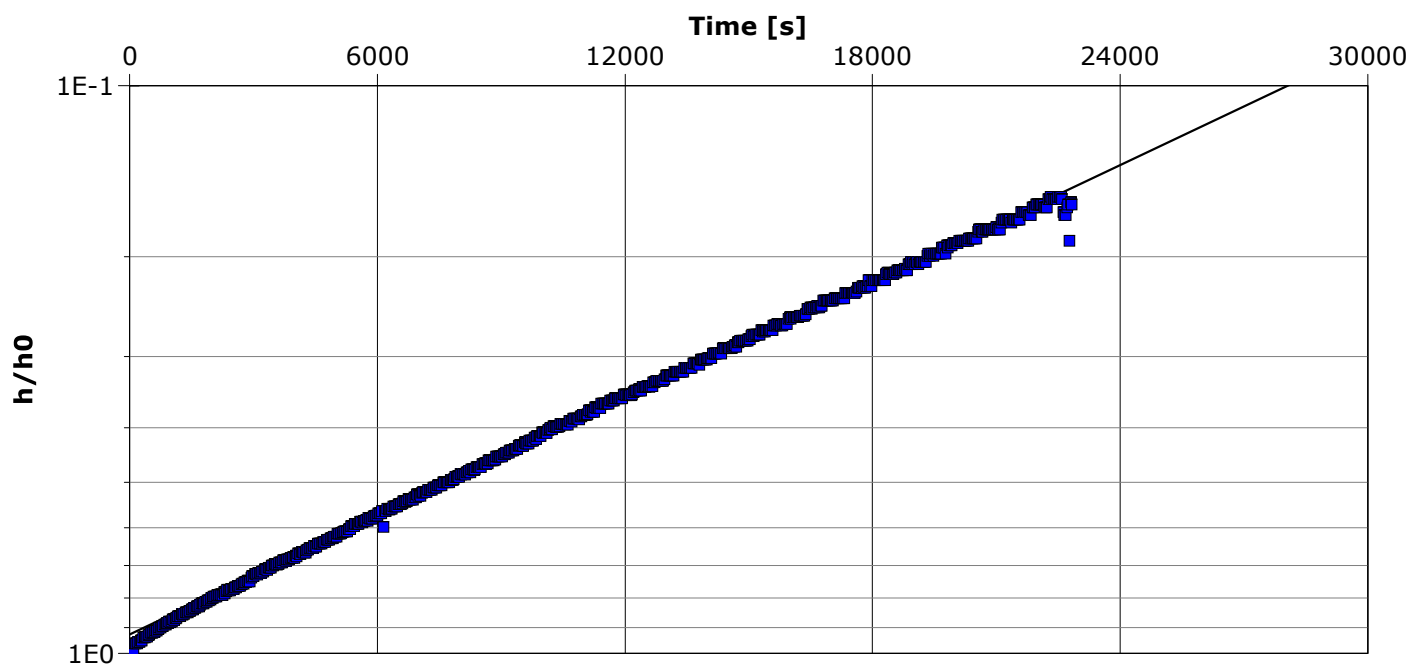
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW102-19 Slug 1 In

Analysis Date: 11/13/19

Aquifer Thickness: 10.73 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW102-19

3.98×10^{-8}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW102-19 Slug 1 Out

Test Well: MW102-19

Test Conducted by: Benden H

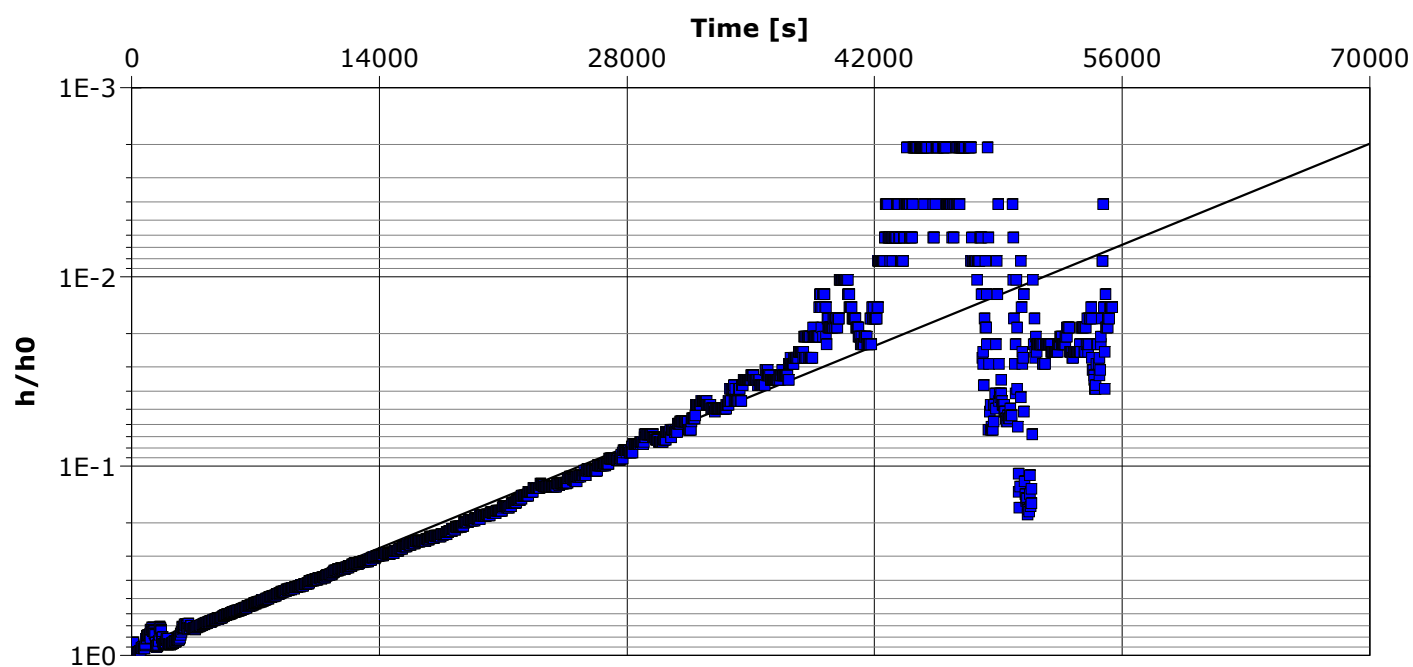
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW 102-19 Slug 1 Out

Analysis Date: 11/13/19

Aquifer Thickness: 10.73 m



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]
------------------	---------------------------------

MW102-19	4.41×10^{-8}
----------	-----------------------



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW102-19 Slug 2 In

Test Well: MW102-19

Test Conducted by: Brenden H

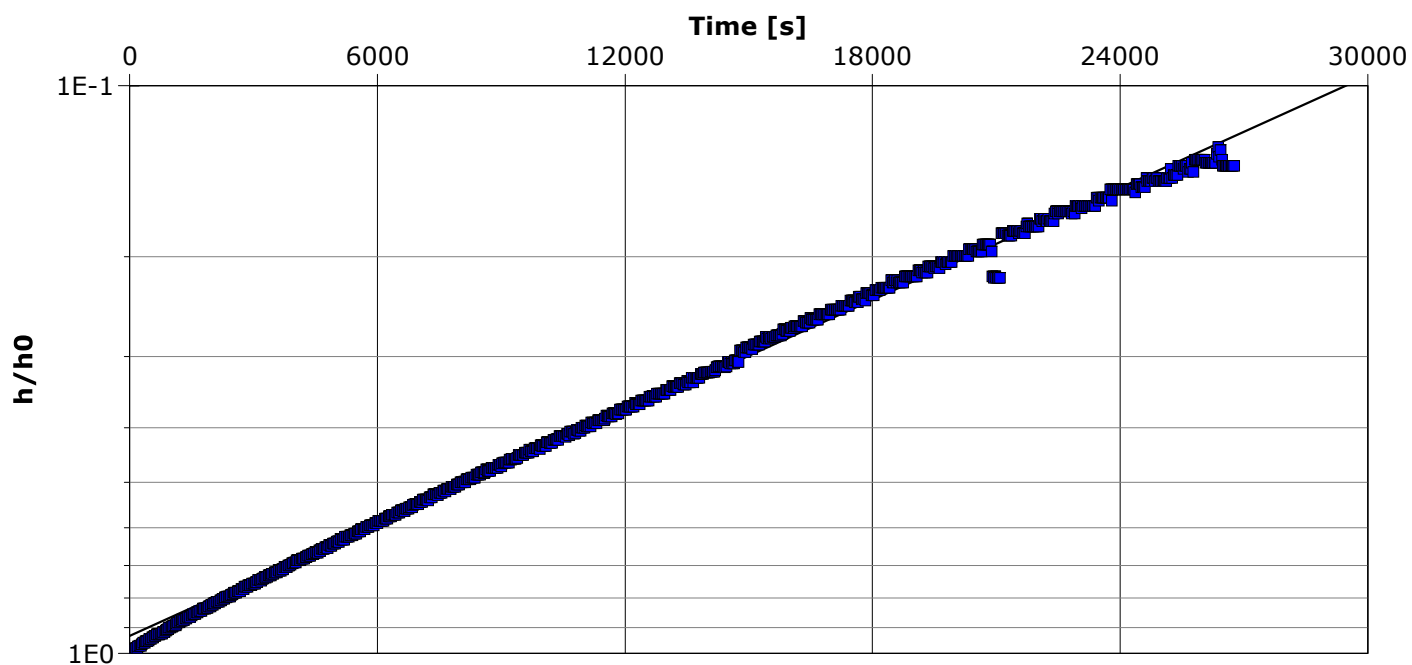
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW102-19 Slug 2 In

Analysis Date: 11/13/19

Aquifer Thickness: 10.73 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW102-19

3.80×10^{-8}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW102-19 Slug 2 Out

Test Well: MW102-19

Test Conducted by: Brenden H

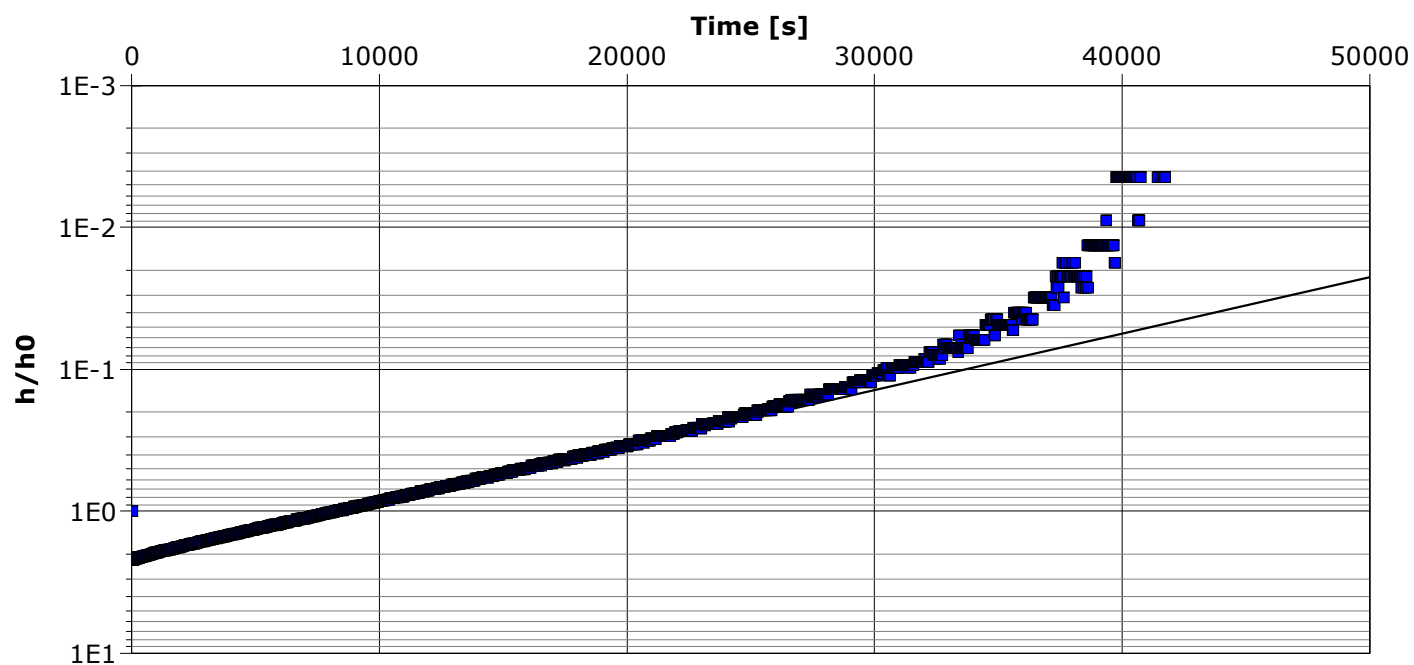
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW102-19 Slug 2 Out

Analysis Date: 11/13/19

Aquifer Thickness: 10.73 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW102-19

4.60×10^{-8}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW106-19 Slug 1 In

Test Well: MW106-19

Test Conducted by: Brenden H

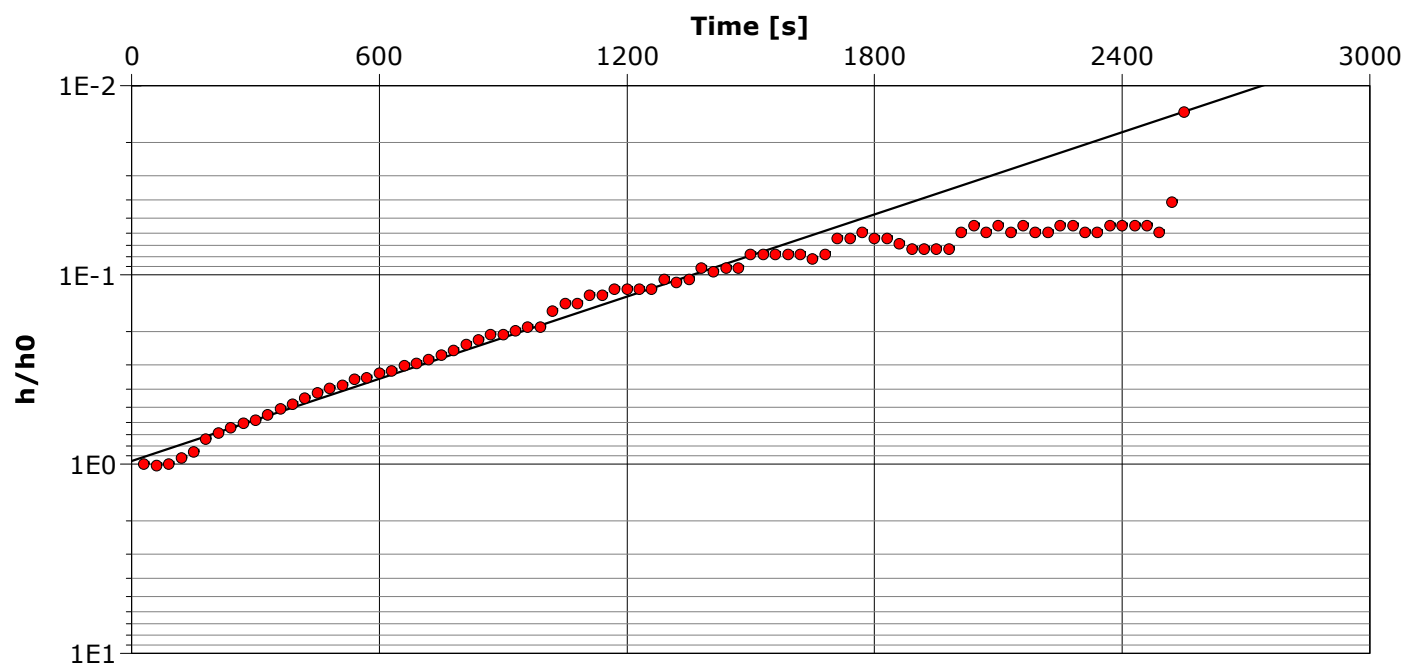
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW106-19 Slug 1 In

Analysis Date: 11/13/19

Aquifer Thickness: 3.84 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW106-19

8.38×10^{-7}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW106-19 Slug 1 Out

Test Well: MW106-19

Test Conducted by: Brenden H

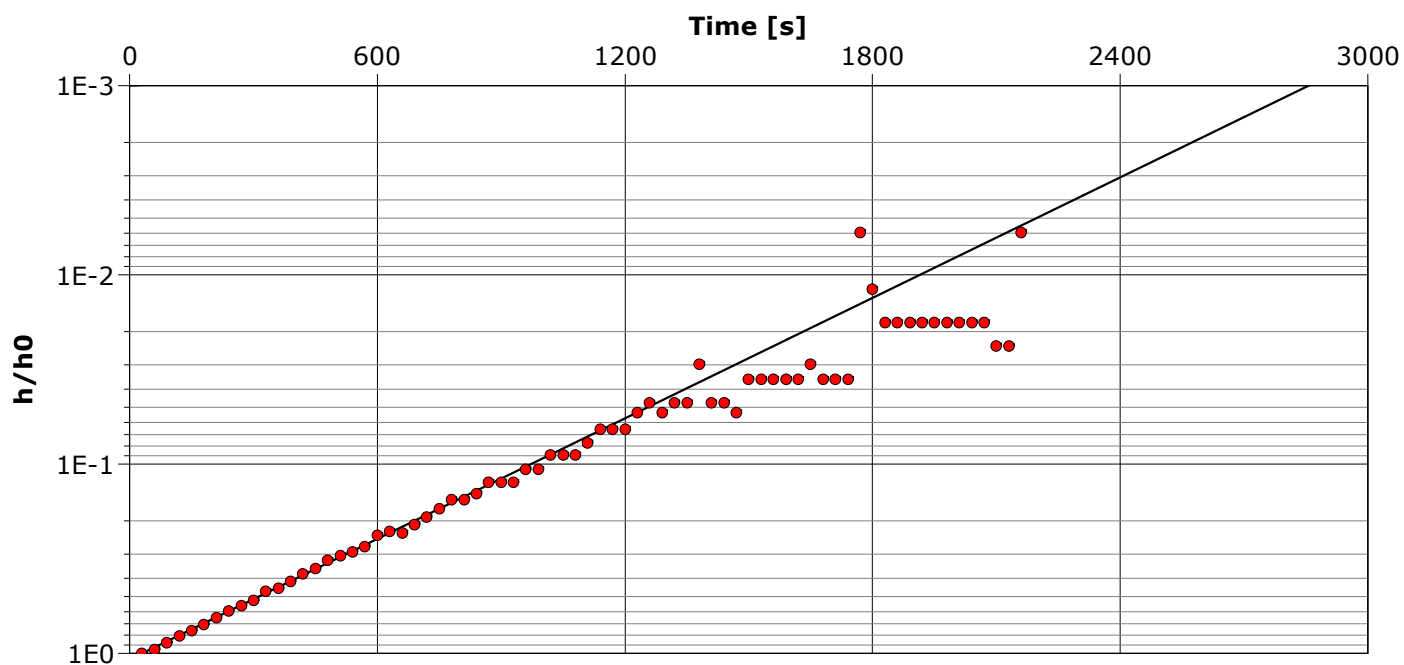
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW106-16 Slug 1 Out

Analysis Date: 11/13/19

Aquifer Thickness: 3.84 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW106-19

1.23×10^{-6}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW106-19 Slug 2 In

Test Well: MW106-19

Test Conducted by: Brenden H

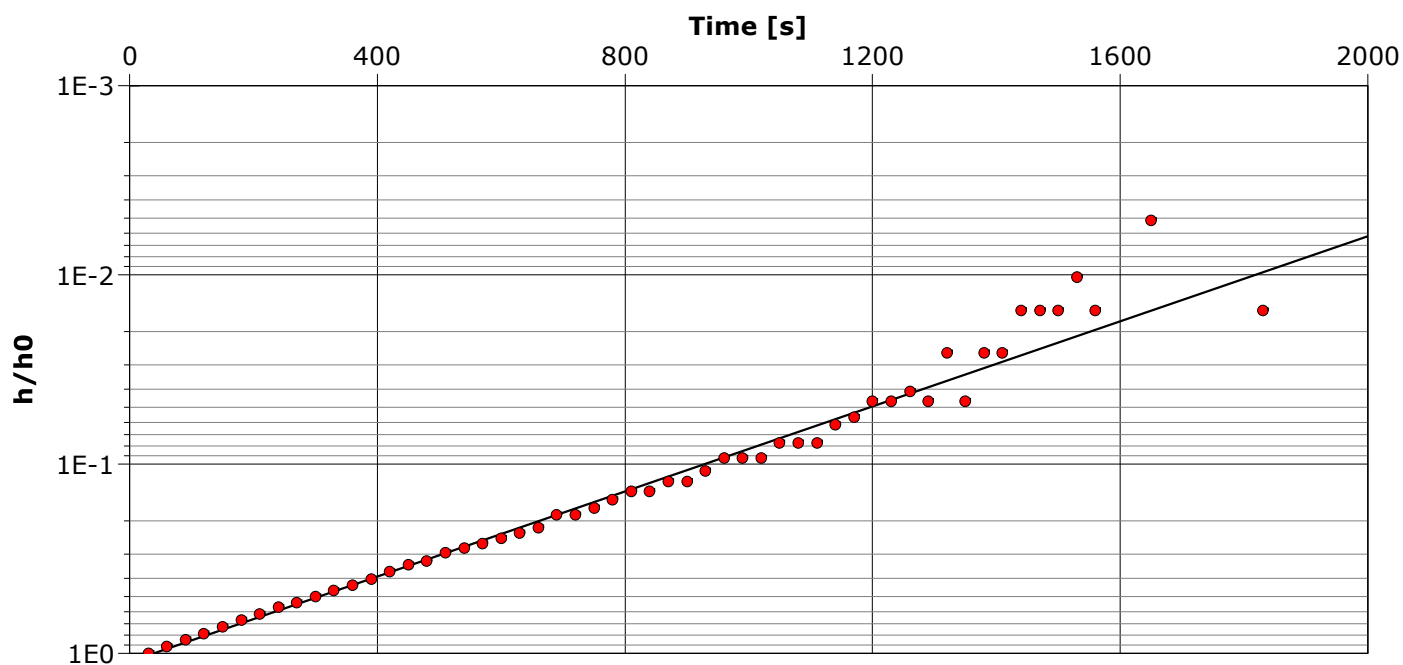
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW106-19 Slug 2 In

Analysis Date: 11/13/19

Aquifer Thickness: 3.84 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW106-19

1.30×10^{-6}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW106-19 Slug 2 Out

Test Well: MW106-19

Test Conducted by: Cameron M

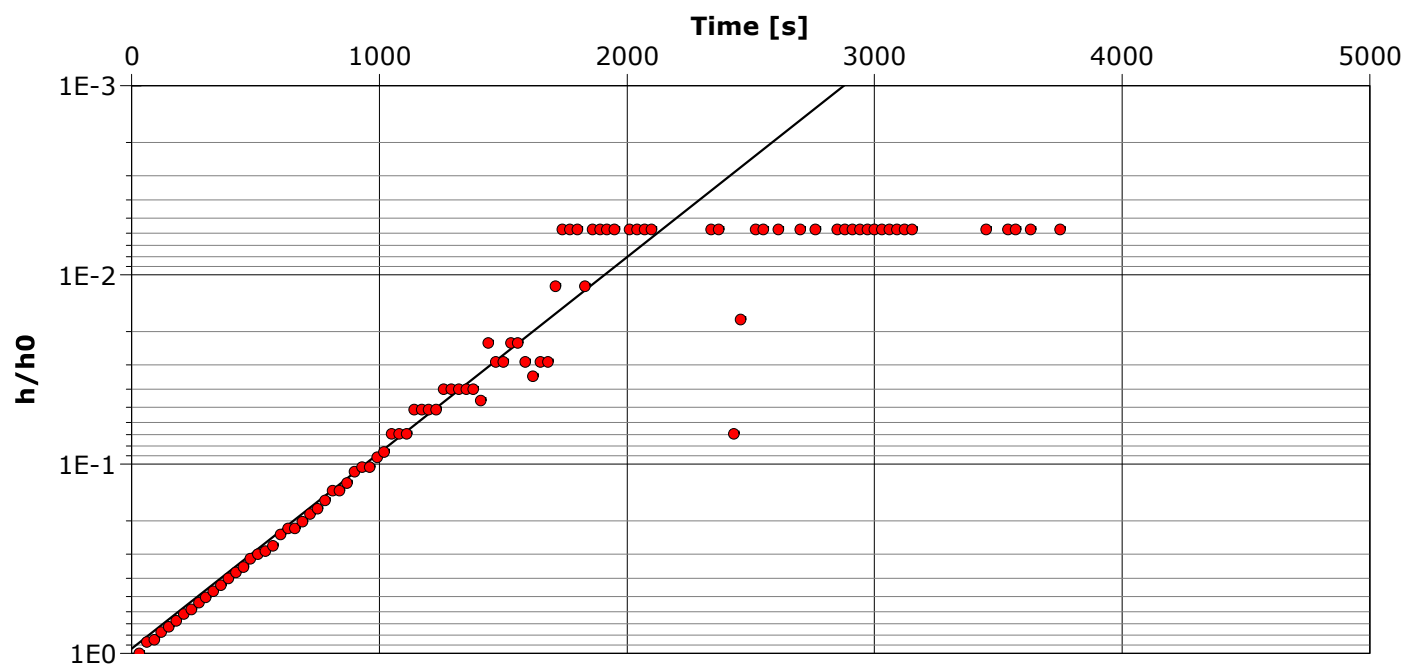
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW106-19 Slug 2 Out

Analysis Date: 11/13/19

Aquifer Thickness: 3.84 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW106-19

1.20×10^{-6}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW108-19 Slug 1 Out

Test Well: MW108-19

Test Conducted by: Brenden H

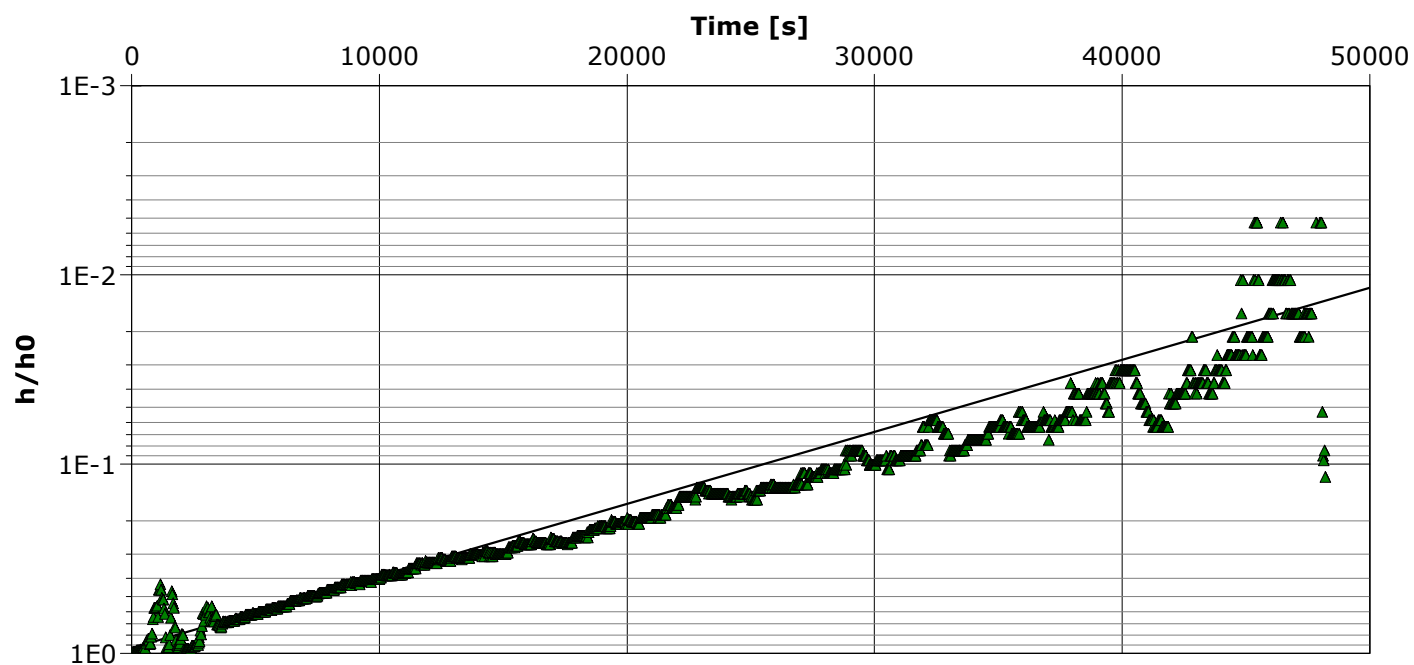
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW108-19 Slug 1 Out

Analysis Date: 11/13/19

Aquifer Thickness: 8.99 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW108-19

4.40×10^{-8}



Cambium Inc.
52 Hunter St. East
Peterborough, Ontario, Canada
K9H 1G5

Slug Test Analysis Report

Project: Hydro G Assess.

Number: 9574-001

Client: iViva Homes

Location: 505 Yonge St. Barrie, ON

Slug Test: MW108-19 Slug 2 Out

Test Well: MW108-19

Test Conducted by: Brenden H

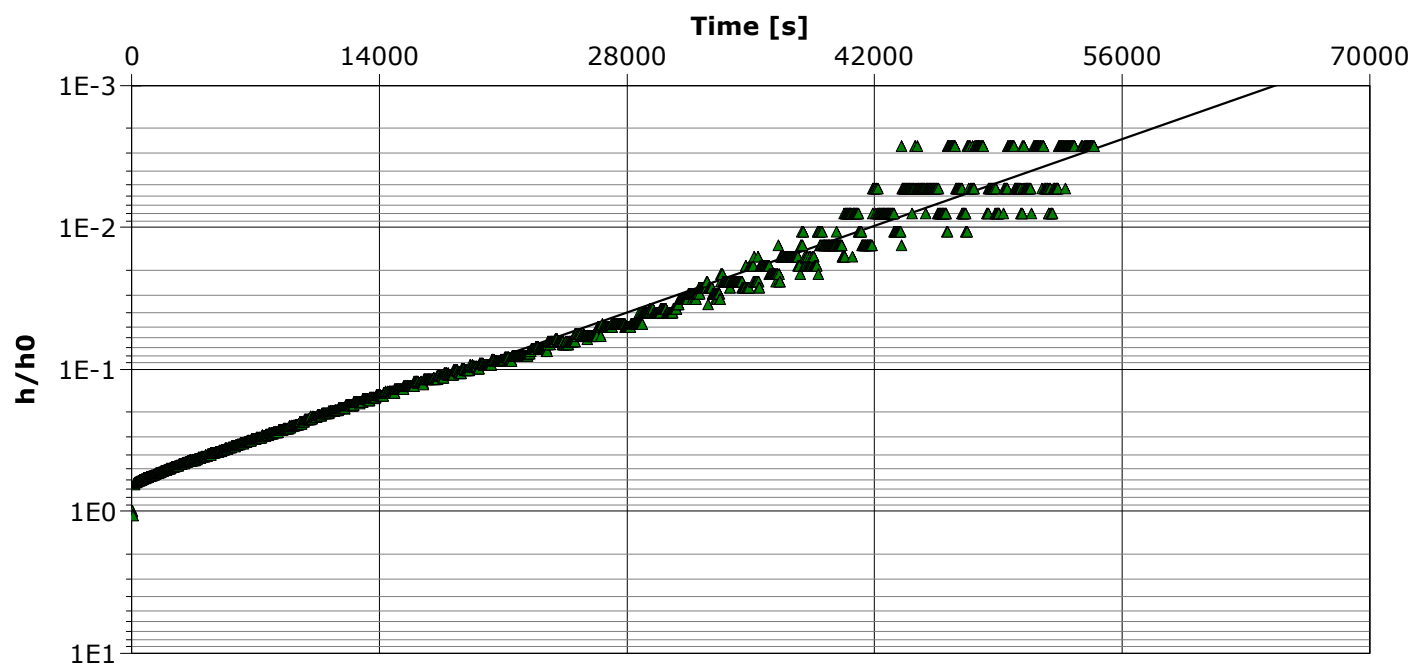
Test Date: 10/24/19

Analysis Performed by: Cameron M

MW108-19 Slug 2 Out

Analysis Date: 11/13/19

Aquifer Thickness: 8.99 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

MW108-19

5.05×10^{-8}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH109-21 Slug Test 1

Test Well: BH109-21

Test Conducted by: C. Malliaros

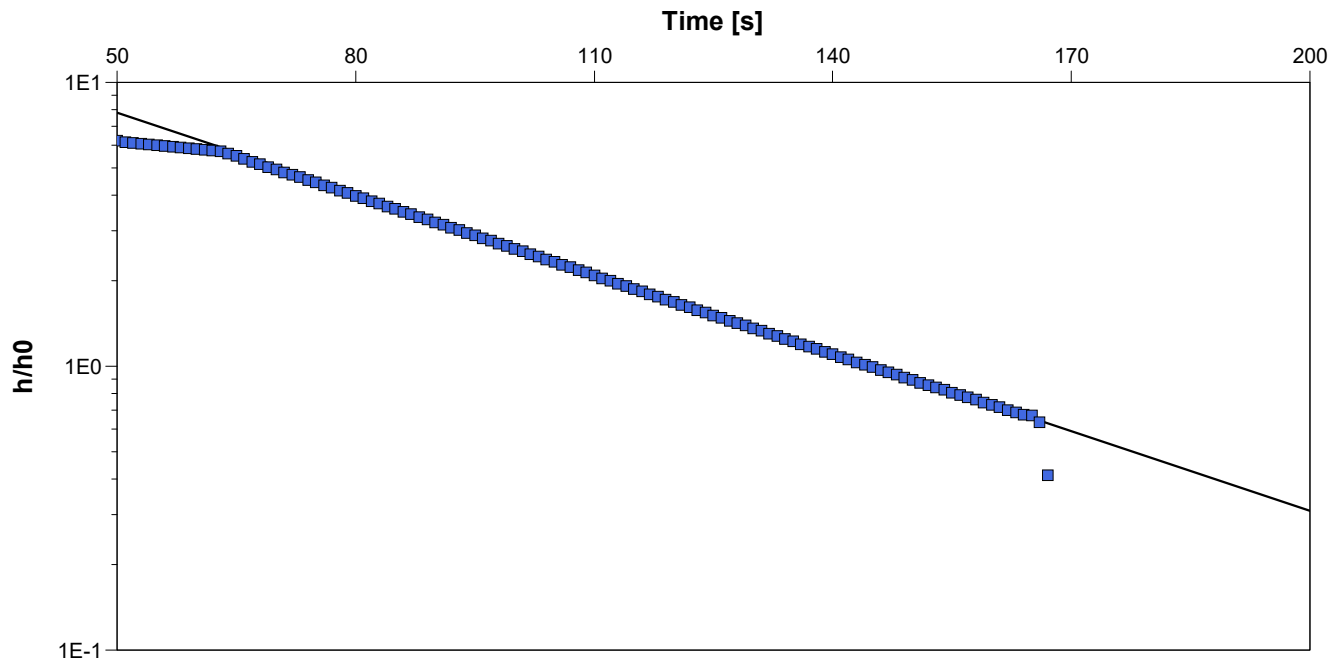
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH109-21 Test 1

Analysis Date: 10/20/2021

Aquifer Thickness: 8.49 m



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
BH109-21	1.08×10^{-5}	



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH109-21 Slug Test 2

Test Well: BH109-21

Test Conducted by: C. Malliaros

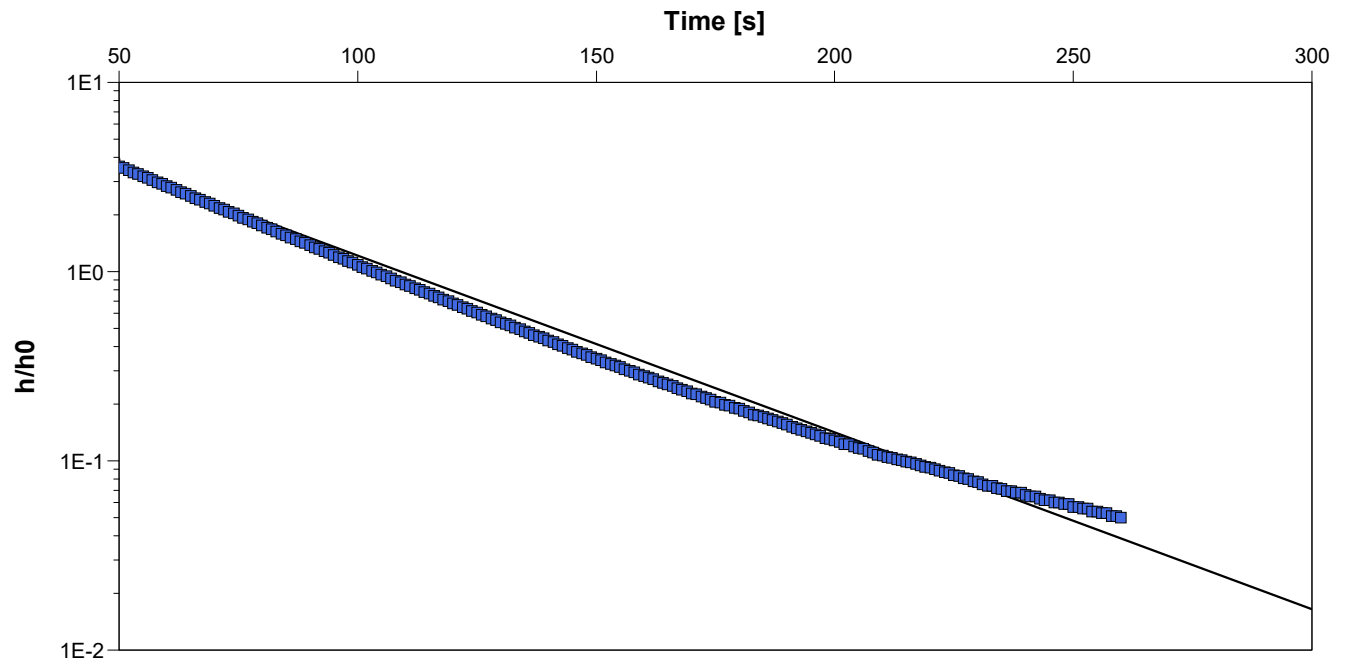
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH109-21 Test 2

Analysis Date: 10/20/2021

Aquifer Thickness: 8.49 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH109-21

1.08×10^{-5}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH109-21 Slug Test 3

Test Well: BH109-21

Test Conducted by: C. Malliaros

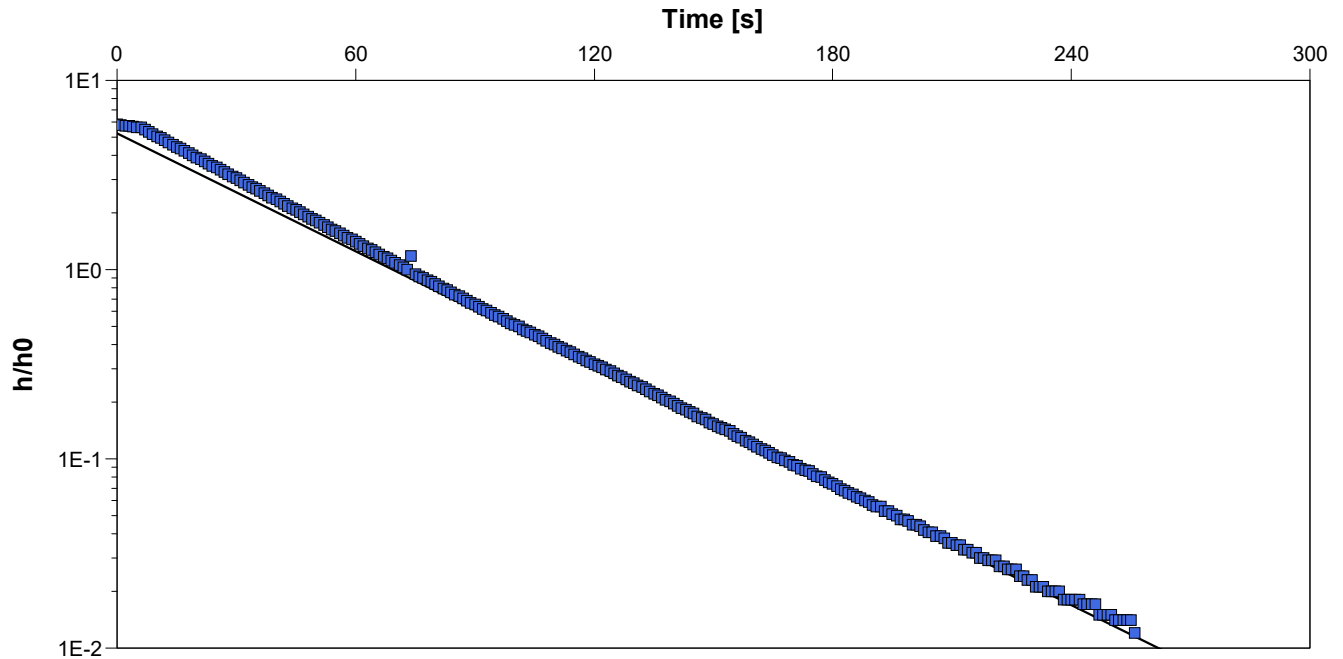
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH109-21 Test 3

Analysis Date: 10/20/2021

Aquifer Thickness: 8.49 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH109-21

1.20×10^{-5}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH109-21 Slug Test 4

Test Well: BH109-21

Test Conducted by: C. Malliaros

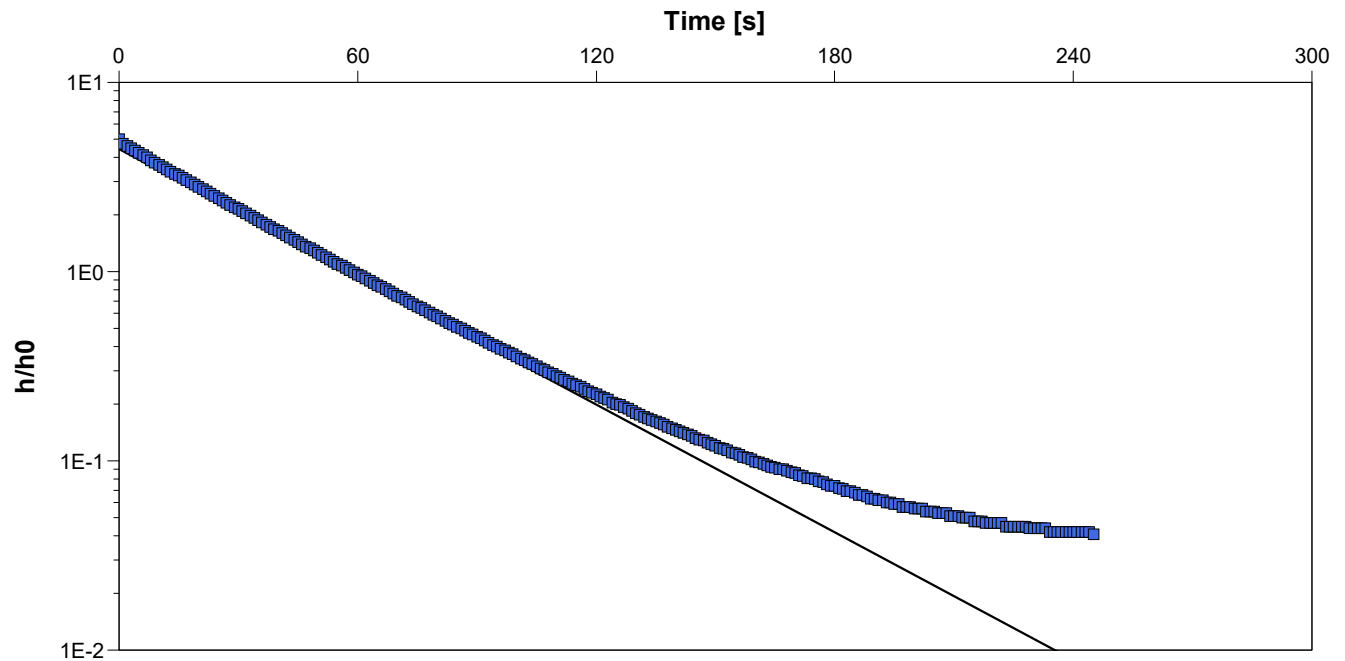
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH109-21 Test 4

Analysis Date: 10/20/2021

Aquifer Thickness: 8.49 m



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
BH109-21	1.30×10^{-5}	



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH109-21 Slug Test 5

Test Well: BH109-21

Test Conducted by: C. Malliaros

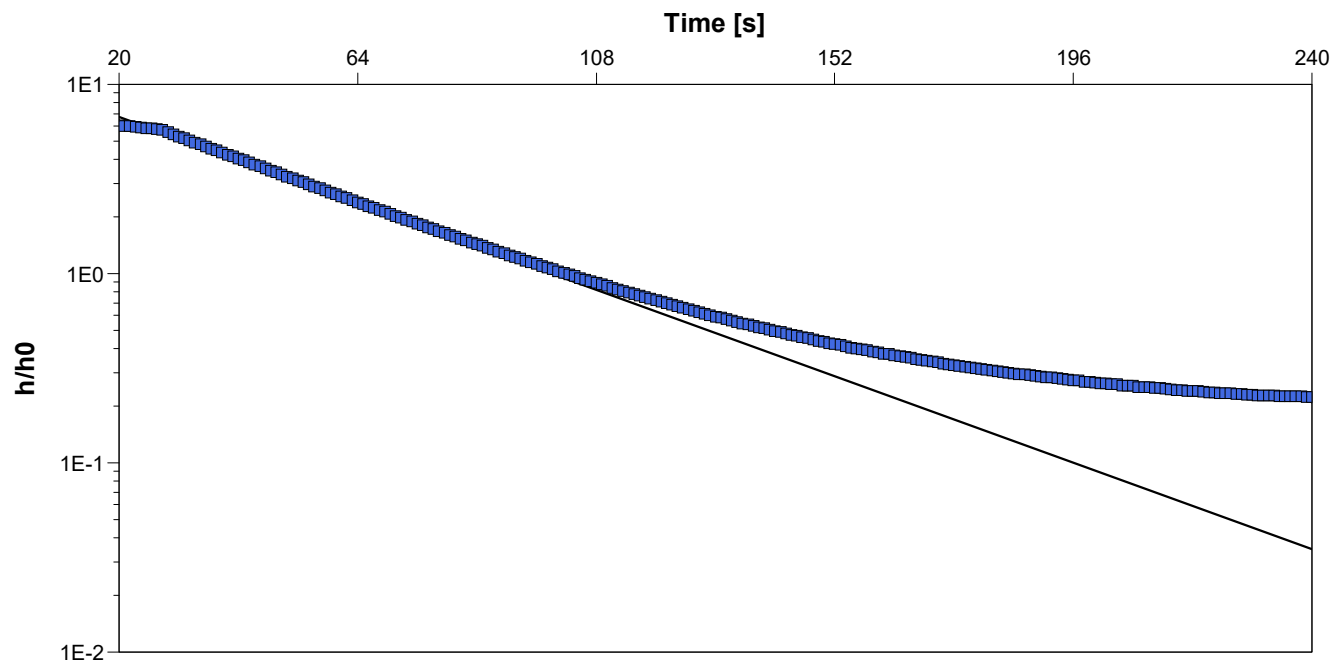
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH109-21 Test 5

Analysis Date: 10/20/2021

Aquifer Thickness: 8.49 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH109-21

1.20×10^{-5}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH110-21 Slug Test 1

Test Well: BH110-21

Test Conducted by: C. Malliaros

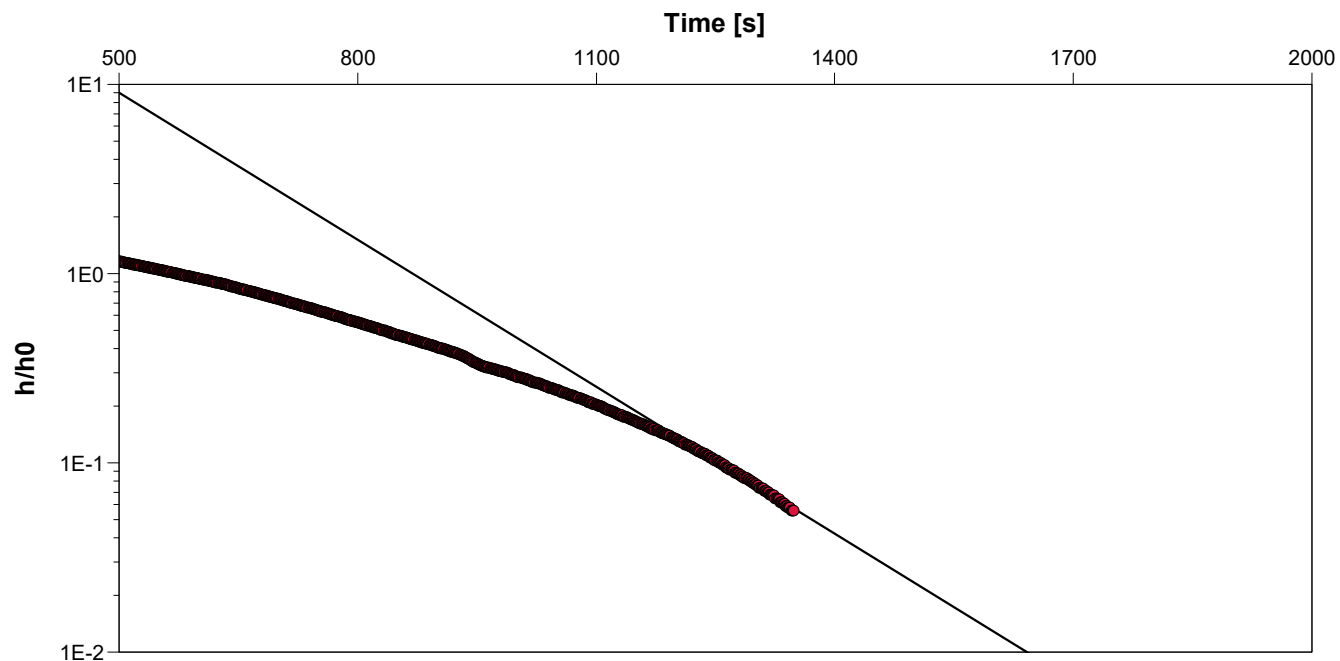
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH110-21 Test 1

Analysis Date: 10/20/2021

Aquifer Thickness: 3.38 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH110-21

2.99×10^{-6}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH110-21 Slug Test 2

Test Well: BH110-21

Test Conducted by: C. Malliaros

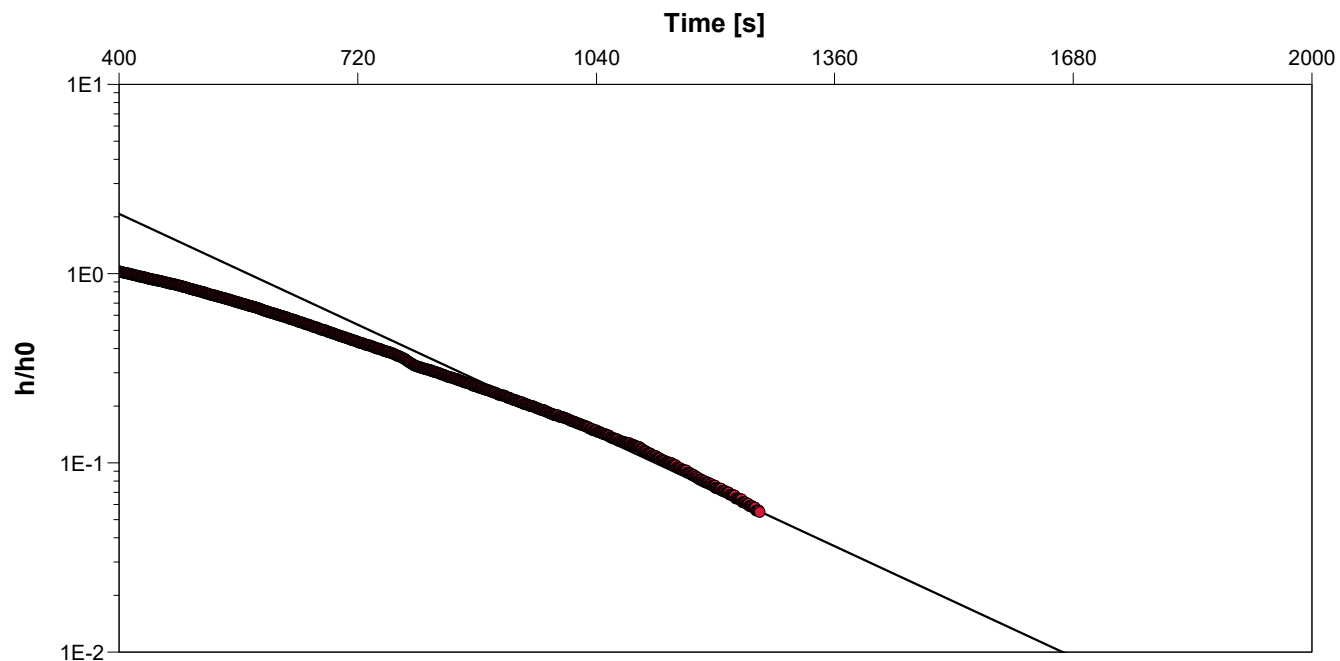
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH110-21 Test 2

Analysis Date: 10/20/2021

Aquifer Thickness: 3.38 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH110-21

2.12×10^{-6}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH110-21 Slug Test 3

Test Well: BH110-21

Test Conducted by: C. Malliaros

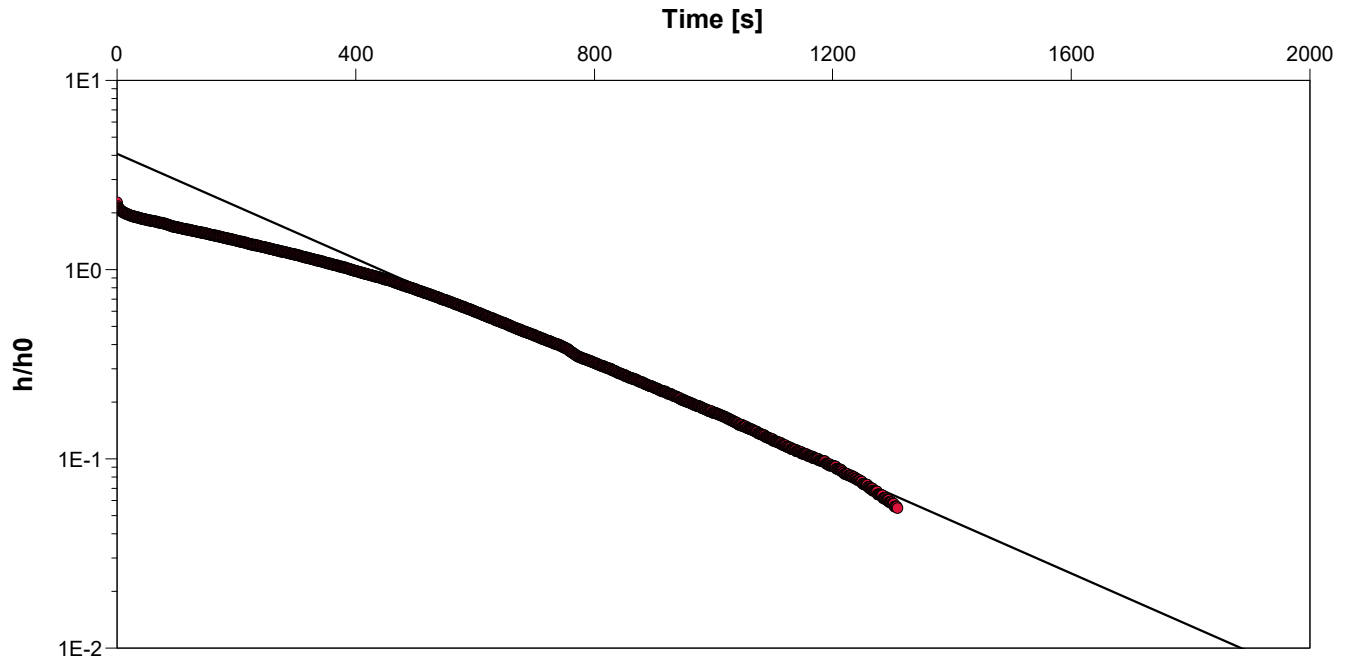
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH110-21 Test 3

Analysis Date: 10/20/2021

Aquifer Thickness: 3.38 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH110-21

1.60×10^{-6}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH110-21 Slug Test 4

Test Well: BH110-21

Test Conducted by: C. Malliaros

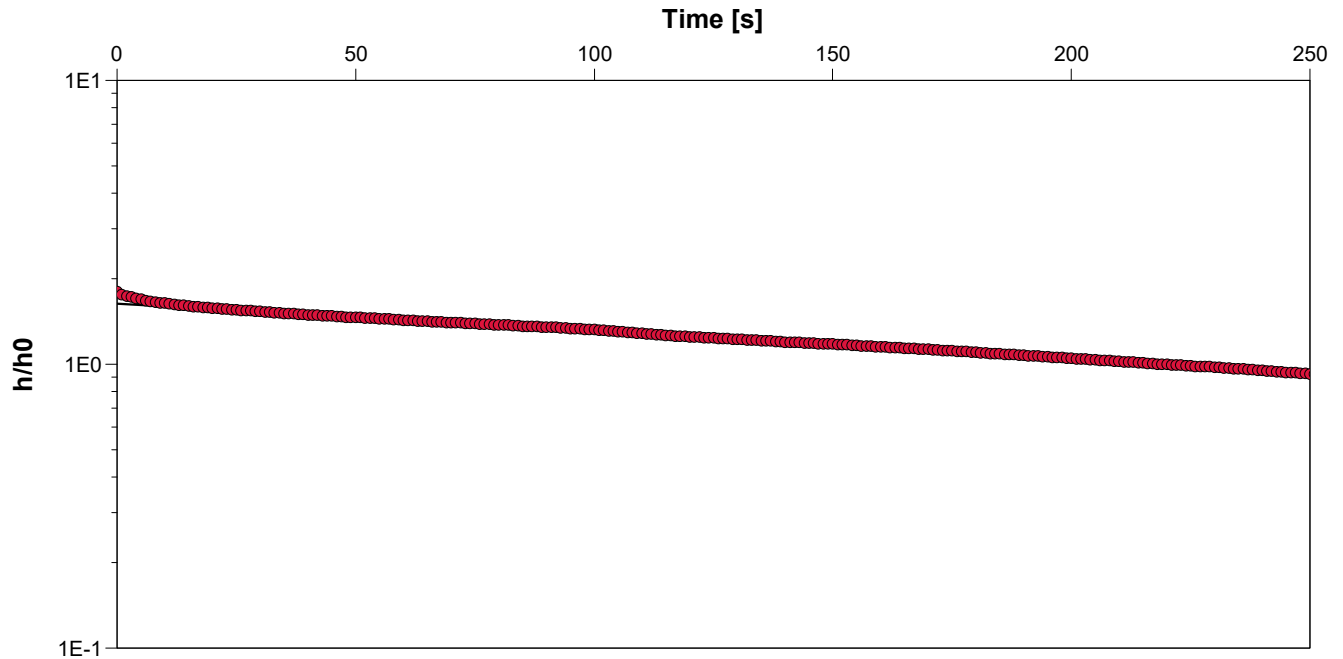
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH110-21 Test 4

Analysis Date: 10/20/2021

Aquifer Thickness: 3.38 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH110-21

1.08×10^{-6}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH111-21 Slug Test 1

Test Well: BH111-21

Test Conducted by: C. Malliaros

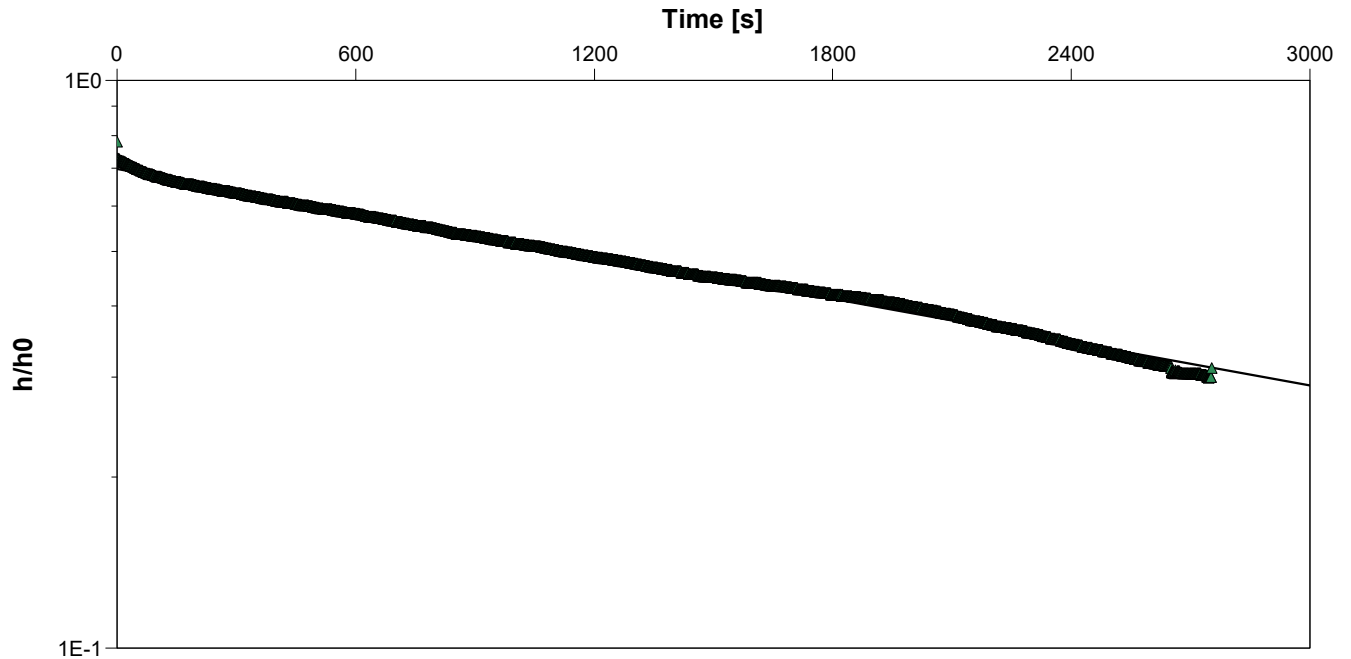
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH111-21 Test 1

Analysis Date: 10/20/2021

Aquifer Thickness: 1.34 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH111-21

1.46×10^{-7}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH111-21 Slug Test 2

Test Well: BH111-21

Test Conducted by: C. Malliaros

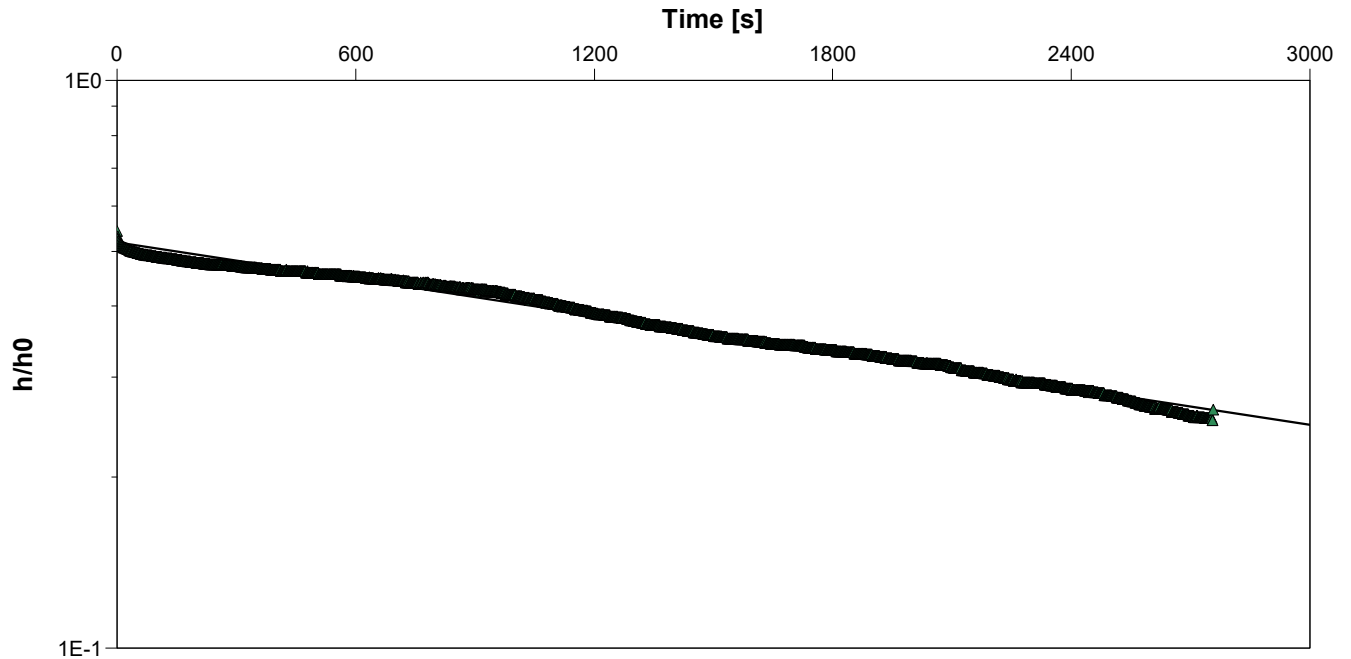
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH111-21 Test 2

Analysis Date: 10/20/2021

Aquifer Thickness: 1.34 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH111-21

1.24×10^{-7}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH111-21 Slug Test 3

Test Well: BH111-21

Test Conducted by: C. Malliaros

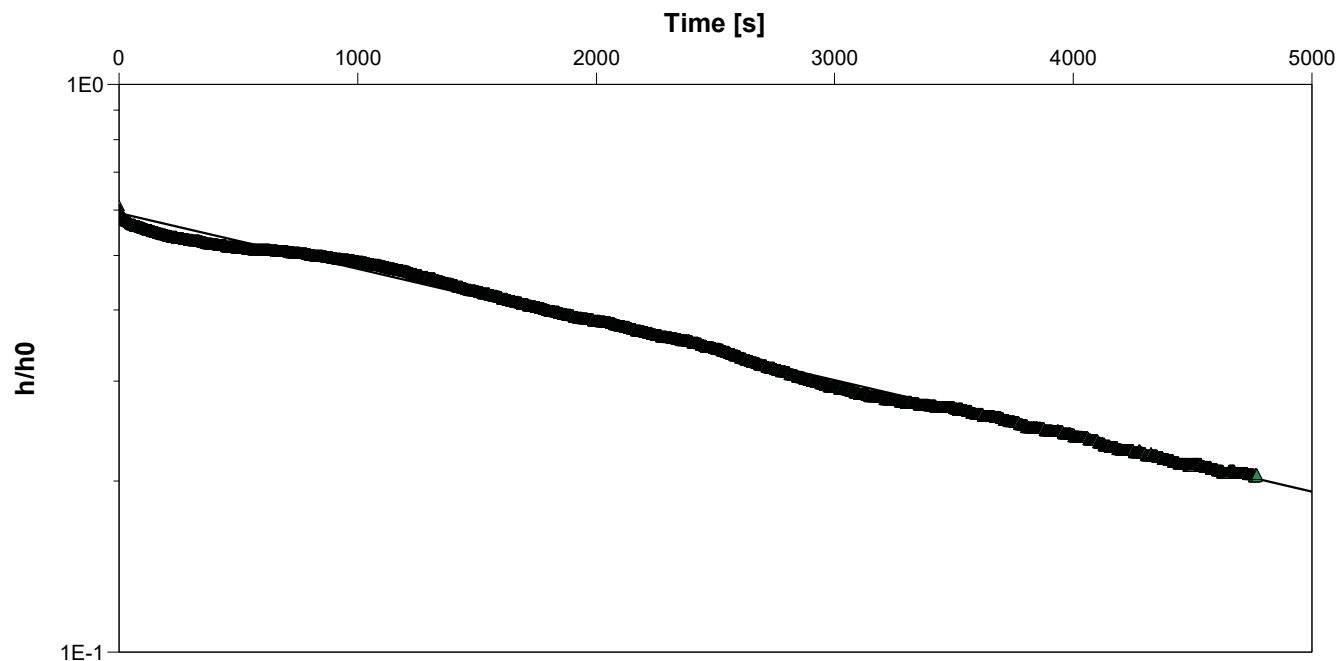
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH111-21 Test 3

Analysis Date: 10/20/2021

Aquifer Thickness: 1.34 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH111-21

1.13×10^{-7}



194 Sophia St.
Peterborough, ON
K9H1E5

Slug Test Analysis Report

Project: Hydrogeological Assessment, 505 Yonge St.

Number: 9574-004

Client: Renaissance Retirement Barrie Trust

Location: 505 Yonge St., Barrie, ON

Slug Test: BH111-21 Slug Test 4

Test Well: BH111-21

Test Conducted by: C. Malliaros

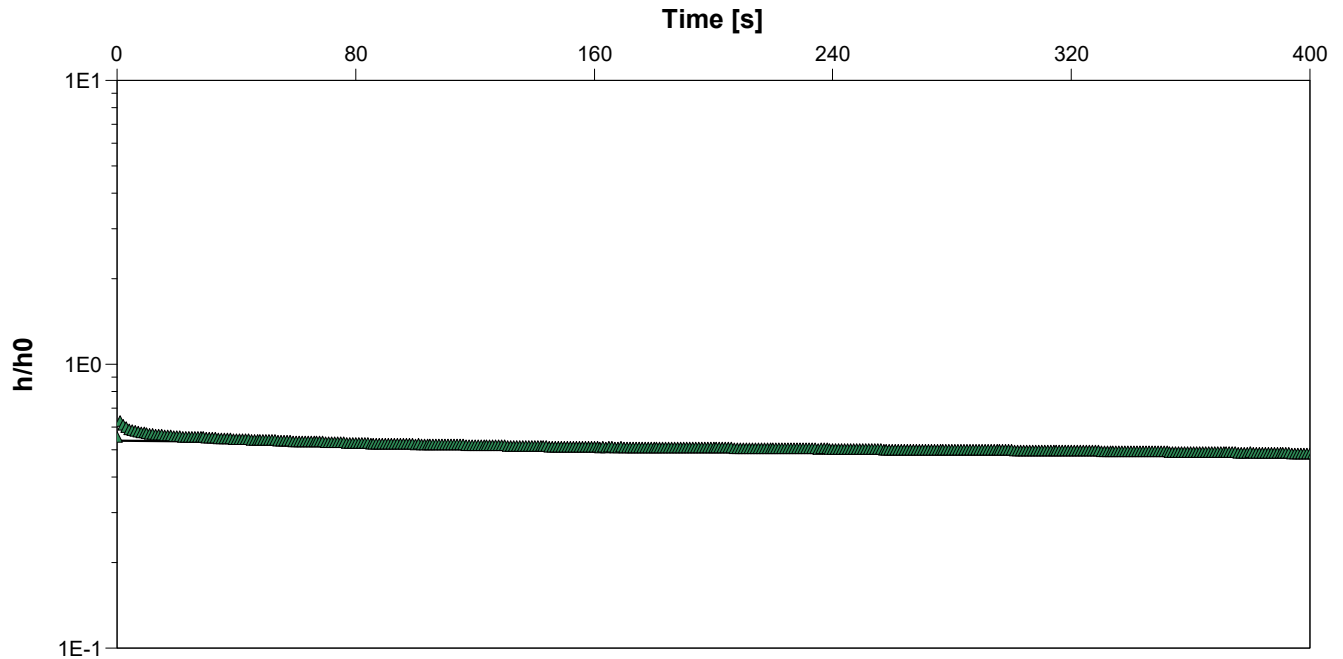
Test Date: 10/5/2021

Analysis Performed by: N. Heikoop

BH111-21 Test 4

Analysis Date: 10/20/2021

Aquifer Thickness: 1.34 m



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

BH111-21

1.05×10^{-7}



Appendix E

Certificates of Analysis

C.O.C.: G85505

REPORT No. B19-34738 (i)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

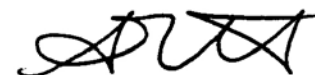
SAMPLE MATRIX: Groundwater

P.O. NUMBER: 9574-001

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Cyanide	1	Kingston	US	29-Oct-19	A-CN-001 (k)	SM 4500CN
Anions	1	Holly Lane	VK	05-Nov-19	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	SYL	31-Oct-19	A-PH-01 (o)	SM 4500H
Sulphide	1	Kingston	TK	29-Oct-19	A-S2	SM4500-S2
A - Wet Chem	1	Kingston	SHU	31-Oct-19	A-TPTKN-001 (N)(k)	E3199A.1
A - Wet Chem	1	Kingston	SHU	31-Oct-19	A-TPTKN-001 (P)(k)	E3199A.1
Total Suspended Solids	1	Kingston	LSE	29-Oct-19	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	30-Oct-19	C-BOD-001 (k)	SM 5210B
COD	1	Holly Lane	ST	06-Nov-19	C-COD-01 (o)	SM 5220D
Oil & Grease	1	Kingston	MLY	30-Oct-19	C-O&G-001 (k)	SM 5520
Phenolics (4-aap)	1	Kingston	TK	31-Oct-19	C-PHEN-01 (k)	MOEE 3179
Mercury	1	Holly Lane	PBK	31-Oct-19	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	AHM	05-Nov-19	D-ICP-01 (o)	SM 3120
Metals-ICP-MS	2	Holly Lane	TPR	05-Nov-19	D-ICPMS Dissolved 7800	EPA 200.8
Metals - ICP-MS	2	Holly Lane	TPR	31-Oct-19	D-ICPMS-01 (o)	EPA 200.8

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett

Director of Laboratory Services

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

C.O.C.: G85505

REPORT No. B19-34738 (i)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

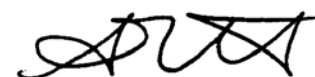
WATERWORKS NO.

Parameter	Client I.D.		BH 106	BH 106 - Filtered			Barrie Sanitary	
	Sample I.D.	Date Collected	B19-34738-1 24-Oct-19	B19-34738-2 24-Oct-19			Barrie- Sanitary/Co mbined	Barrie- Storm Sewer
Units	R.L.							
pH @25°C	pH Units		8.02				9.5	9.5
BOD(5 day)	mg/L	3	3				300	15
COD	mg/L	5	122				600	
Total Kjeldahl Nitrogen	mg/L	0.1	1.3				100	
Total Suspended Solids	mg/L	3	8400				350	15
Oil and Grease-Mineral	mg/L	1.0	< 1.0				15	
Oil and Grease-Anim/Veg.	mg/L	1.0	< 1.0				150	
Phosphorus-Total	mg/L	0.01	7.50				10	
Cyanide (Total)	mg/L	0.005	< 0.005				1.2	
Chloride	mg/L	0.5	134				1500	
Fluoride	mg/L	0.1	< 0.1				10	
Sulphate	mg/L	1	23				1500	
Aluminum (total)	mg/L	0.01	46.9	0.06			50	
Antimony	mg/L	0.0001	< 0.0005	0.0003			5.0	
Arsenic	mg/L	0.0001	0.0099	0.0008			1.0	
Barium	mg/L	0.001	1.09	0.115			5.0	
Bismuth	mg/L	0.02	< 0.02	< 0.02			5.0	
Cadmium	mg/L	0.000015	0.000347	0.000015			0.7	0.001
Chromium	mg/L	0.002	0.225	< 0.002			2.0	0.08
Cobalt	mg/L	0.005	0.041	< 0.005			5.0	
Copper	mg/L	0.002	0.129	< 0.002			2.0	0.01
Gold	mg/L	0.0007	< 0.0007	< 0.0007			5.0	
Iron	mg/L	0.005	102	0.035			50	
Lead	mg/L	0.02	0.04	< 0.02			0.7	0.05
Manganese (Total)	mg/L	0.001	2.36	0.061			5.0	
Mercury	mg/L	0.00002	0.00011				0.01	
Molybdenum	mg/L	0.01	0.03	< 0.01			5.0	

Barrie Sanitary - Barrie Sanitary & Combined and Storm

Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines

Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett

Director of Laboratory Services

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C.O.C.: G85505

REPORT No. B19-34738 (i)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

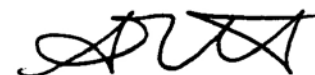
WATERWORKS NO.

Parameter	Client I.D.		BH 106	BH 106 - Filtered			Barrie Sanitary	
	Sample I.D.	Date Collected	B19-34738-1	B19-34738-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Units	R.L.						
Nickel	mg/L	0.01	0.08	< 0.01			2.0	0.05
Phenolics	mg/L	0.002	< 0.002				0.1	
Platinum	mg/L	0.00004	< 0.00004	< 0.00004			5.0	
Rhodium	mg/L	0.00002	< 0.00002	< 0.00002			5.0	
Selenium	mg/L	0.001	< 0.005	< 0.001			1.0	
Silver	mg/L	0.005	< 0.005	< 0.005			0.4	
Sulphide	mg/L	0.01	< 0.5				1.0	
Tin	mg/L	0.05	< 0.05	< 0.05			5.0	
Vanadium	mg/L	0.005	0.117	< 0.005			5.0	
Zinc	mg/L	0.005	0.407	0.023			2.0	0.04
Titanium	mg/L	0.005	3.84	< 0.005				
Zirconium	mg/L	0.003	0.029	< 0.003				

1. Elevated detection limit due to dilution

2. solids present in Hg bottle

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett
Director of Laboratory Services

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C.O.C.: G85505

REPORT No. B19-34738 (i)

Report To:

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PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

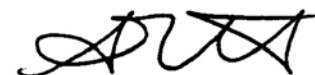
WATERWORKS NO.

Summary of Exceedances

Sanitary/Combined Sewer Guidelines		
BH 106	Found Value	Limit
Total Suspended Solids (mg/L)	8400	350
Iron (mg/L)	102	50

Storm Sewer Guidelines		
BH 106	Found Value	Limit
Zinc (mg/L)	0.407	0.04
Total Suspended Solids (mg/L)	8400	15
Nickel (mg/L)	0.08	0.05
Copper (mg/L)	0.129	0.01
Chromium (mg/L)	0.225	0.08

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett

Director of Laboratory Services

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C.O.C.: G85505

REPORT No. B19-34738 (ii)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

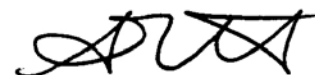
SAMPLE MATRIX: Groundwater

P.O. NUMBER: 9574-001

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
PHC(F2-F4)	1	Kingston	KPR	29-Oct-19	C-PHC-W-001 (k)	MOE E3421
VOC's	1	Richmond Hill	FAL	30-Oct-19	C-VOC-02 (rh)	EPA 8260
PHC(F1)	1	Richmond Hill	FAL	30-Oct-19	C-VPHW-01 (rh)	MOE E3421

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett

Director of Laboratory Services

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C.O.C.: G85505

REPORT No. B19-34738 (ii)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

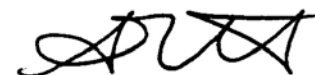
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Client I.D. Sample I.D. Date Collected		BH 106 B19-34738-1 24-Oct-19		Barrie Sanitary Barrie-Sanitary/Combined Barrie-Storm Sewer	
Parameter	Units	R.L.			
Benzene	mg/L	0.0005	< 0.0005	0.01	
Dichlorobenzene, 1,2-	mg/L	0.0005	< 0.0005	0.05	
Dichlorobenzene, 1,4-	mg/L	0.0005	< 0.0005	0.08	
Ethylbenzene	mg/L	0.0005	< 0.0005	0.06	
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	0.09	
Tetrachloroethane, 1,1,2,2-	mg/L	0.0005	< 0.0005	0.06	
Tetrachloroethylene	mg/L	0.0005	< 0.0005	0.06	
Toluene	mg/L	0.0005	< 0.0005	0.02	
Trichloroethylene	mg/L	0.0005	< 0.0005	0.05	
Xylene, m,p,o-	mg/L	0.0011	< 0.0011	0.3	
PHC F1 (C6-C10)	mg/L	0.05	< 0.05		
PHC F2 (>C10-C16)	mg/L	0.05	< 0.05		
PHC F3 (>C16-C34)	mg/L	0.4	< 0.4		
PHC F4 (>C34-C50)	mg/L	0.4	< 0.4		

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



R.L. = Reporting Limit

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Steve Garrett

Director of Laboratory Services

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C.O.C.: G85505

REPORT No. B19-34738 (ii)

Report To:

Cambium Environmental

PO Box 325, 52 Hunter Street East
Peterborough ON K9H 1G5 Canada

Attention: Cameron MacDougall

Caduceon Environmental Laboratories

112 Commerce Park Drive

Barrie ON L4N 8W8

Tel: 705-252-5743

Fax: 705-252-5746

DATE RECEIVED: 25-Oct-19

JOB/PROJECT NO.:

DATE REPORTED: 07-Nov-19

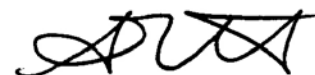
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Summary of Exceedances

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



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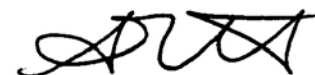
SAMPLE MATRIX: Groundwater

P.O. NUMBER: 9574-001

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Comment	1	Default Site	CS	31-Oct-19	C-Arochlor Comment	-
PCB's	1	Kingston	CS	31-Oct-19	C-PCB-03 K	EPA 8082
OC Pesticides	1	Kingston	CS	01-Nov-19	C-PESTCL-01 K	EPA 8080

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



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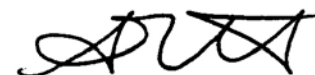
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Client I.D. Sample I.D. Date Collected		BH 106 B19-34738-1 24-Oct-19					Barrie Sanitary Barrie- Sanitary/Co mbined	Barrie- Storm Sewer
Parameter	Units	R.L.						
Aldrin	mg/L	0.00001	< 0.00001					
Chlordane (alpha)	mg/L	0.00005	< 0.00005					
Chlordane (Gamma)	mg/L	0.00005	< 0.00005					
Chlordane Total (alpha+gamma)	mg/L	0.00005	< 0.00005					
DDD, 2,4-	mg/L	0.00005	< 0.00005					
DDD, 4,4-	mg/L	0.00005	< 0.00005					
DDD Total Water	mg/L	0.00005	< 0.00005					
DDE, 2,4-	mg/L	0.00001	< 0.00001					
DDE, 4,4-	mg/L	0.00001	< 0.00001					
DDE Total water	mg/L	0.00001	< 0.00001					
DDT, 2,4-	mg/L	0.00005	< 0.00005					
DDT, 4,4-	mg/L	0.00005	< 0.00005					
DDT Total water	mg/L	0.00005	< 0.00005					
Dieldrin	mg/L	0.00005	< 0.00005					
Lindane (Hexachlorocyclohexane, Gamma)	mg/L	0.00001	< 0.00001					
Endosulfan I	mg/L	0.00005	< 0.00005					
Endosulfan II	mg/L	0.00005	< 0.00005					
Endosulfan I/II	mg/L	0.00005	< 0.00005					
Endrin	mg/L	0.00005	< 0.00005					
Heptachlor	mg/L	0.00001	< 0.00001					
Heptachlor Epoxide	mg/L	0.00001	< 0.00001					
Hexachlorobenzene	mg/L	0.00001	< 0.00001				0.0001	
Hexachlorobutadiene	mg/L	0.00001	< 0.00001					
Hexachloroethane	mg/L	0.00002	< 0.00002					

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



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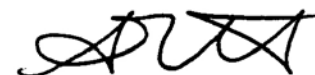
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Client I.D. Sample I.D. Date Collected			BH 106 B19-34738-1 24-Oct-19				Barrie Sanitary Barrie-Sanitary/Co mbined		Barrie-Storm Sewer	
Parameter	Units	R.L.								
Methoxychlor	mg/L	0.00005	< 0.00005							
Poly-Chlorinated Biphenyls (PCB's)	mg/L	0.00005	< 0.00005							
Aroclor	-	-	-							

Barrie Sanitary - Barrie Sanitary & Combined and Storm
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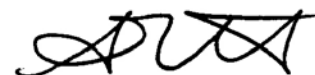
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SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Summary of Exceedances

Barrie Sanitary - Barrie Sanitary & Combined and Storm
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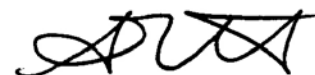
SAMPLE MATRIX: Groundwater

P.O. NUMBER: 9574-001

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
SVOC	1	Kingston	sge	01-Nov-19	C-NAB-W-001 (k)	EPA 8270

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines



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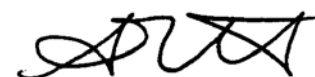
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Client I.D. Sample I.D. Date Collected			BH 106 B19-34738-1 24-Oct-19		Barrie Sanitary Barrie- Sanitary/Co mbined		Barrie- Storm Sewer	
Parameter	Units	R.L.						
Hexachlorobenzene	mg/L	0.0001	< 0.0001			0.0001		
Total PAH	mg/L	0.0001	< 0.0001			0.005		
Acenaphthene	mg/L	0.00005	< 0.00005					
Acenaphthylene	mg/L	0.00005	< 0.00005					
Anthracene	mg/L	0.00005	< 0.00005					
Benzo(a)anthracene	mg/L	0.00005	< 0.00005					
Benzo(a)pyrene	mg/L	0.00001	< 0.00001					
Benzo(b+k)fluoranthene	mg/L	0.0001	< 0.0001					
Benzo(g,h,i)perylene	mg/L	0.00005	< 0.00005					
Dibenzo(a,h)anthracene	mg/L	0.00005	< 0.00005					
Chrysene	mg/L	0.00005	< 0.00005					
Fluoranthene	mg/L	0.00005	< 0.00005					
Fluorene	mg/L	0.00005	< 0.00005					
Indeno(1,2,3,-cd)pyrene	mg/L	0.00005	< 0.00005					
Methylnaphthalene,1-	mg/L	0.00005	< 0.00005					
Methylnaphthalene,2-	mg/L	0.00008	< 0.00008					
Naphthalene	mg/L	0.00005	< 0.00005					
Phenanthrene	mg/L	0.00005	< 0.00005					
Pyrene	mg/L	0.00005	< 0.00005					

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Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
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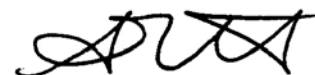
P.O. NUMBER: 9574-001

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

Summary of Exceedances

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Appendix F

Groundwater Level and Elevation Information



Groundwater Elevations (metres above sea level)

Well	Ground Surface (masl)	TOP (masl)	Depth (mbgs)	27-Aug-19	16-Oct-19	24-Oct-19	19-Nov-19	10-Dec-19	10-Jan-20	11-Feb-20	11-Mar-20	02-Apr-20	08-May-20	17-Jun-20	24-Sep-21	05-Oct-21	04-Nov-21	09-Nov-21	16-Nov-21
102-19	247.57	247.46	14.96	243.13	243.02	243.04	243.47	243.67	243.92	243.92	244.10	244.21	243.80	243.67	243.41	243.58	243.58	-	243.53
106-19	244.45	244.35	11.43	-	240.19	240.32	240.85	-	241.38	241.28	242.08	241.42	241.14	241.10	242.08	241.04	241.01	-	240.93
108-19	242.59	243.38	7.14	-	240.84	240.98	241.62	241.99	241.74	241.62	242.05	241.83	241.50	241.40	241.92	241.64	241.73	-	241.60
109-21	247.04	248.22	10.67	-	-	-	-	-	-	-	-	-	-	-	245.27	245.10	245.23	-	245.13
110-21	243.90	243.75	7.62	-	-	-	-	-	-	-	-	-	-	-	239.59	239.68	239.67	-	239.60
111-21	239.61	239.78	3.05	-	-	-	-	-	-	-	-	-	-	-	237.78	237.93	238.23	-	238.06
112-21	238.85	239.44	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	Dry	Dry	237.75
BH3	246.62	247.85	4.79	-	-	-	-	-	-	-	-	-	-	-	-	-	245.18	-	245.14
BH6	245.04	245.76	5.20	-	-	-	-	-	-	-	-	-	-	-	-	-	244.04	-	243.93
BH7	242.85	243.69	5.14	-	-	-	-	-	-	-	-	-	-	-	-	-	242.28	-	242.22

Groundwater Levels (metres below ground surface)

Well	Ground Surface (masl)	TOP (masl)	Depth (mbgs)	27-Aug-19	16-Oct-19	24-Oct-19	19-Nov-19	10-Dec-19	10-Jan-20	11-Feb-20	11-Mar-20	02-Apr-20	08-May-20	17-Jun-20	24-Sep-21	05-Oct-21	04-Nov-21	09-Nov-21	16-Nov-21
102-19	247.57	247.46	14.96	4.45	4.55	4.53	4.10	3.91	3.65	3.65	3.47	3.36	3.78	3.90	4.16	3.99	3.99	-	4.04
106-19	244.45	244.35	11.43	-	4.26	4.13	3.60	-	3.07	3.17	2.37	3.03	3.31	3.35	2.37	3.41	3.44	-	3.52
108-19	242.59	243.38	7.14	-	1.75	1.61	0.97	0.61	0.85	0.97	0.54	0.76	1.10	1.19	0.67	0.95	0.86	-	0.99
109-21	247.04	248.22	10.67	-	-	-	-	-	-	-	-	-	-	-	1.77	1.94	1.81	-	1.91
110-21	243.90	243.75	7.62	-	-	-	-	-	-	-	-	-	-	-	4.31	4.22	4.23	-	4.30
111-21	239.61	239.78	3.05	-	-	-	-	-	-	-	-	-	-	-	1.83	1.68	1.38	-	1.55
112-21	238.85	239.44	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	Dry	Dry	1.69
BH3	246.62	247.85	4.79	-	-	-	-	-	-	-	-	-	-	-	-	-	2.67	-	2.71
BH6	245.04	245.76	5.20	-	-	-	-	-	-	-	-	-	-	-	-	-	1.72	-	1.83
BH7	242.85	243.69	5.14	-	-	-	-	-	-	-	-	-	-	-	-	-	1.41	-	1.47



Appendix G

Dewatering Calculations



Construction Dewatering Estimates

Scenario	Depth	Equivalent Radius	Static Level	Dewatered level	Bottom of Aquifer	Drawdown	Conductivity (K)	Length to Zero Drawdown (R ₀)	Est. Inflow	
	(mbgs)	(m)	(m)	(m)	(m)	(m)	(m/s)	(m)	(L/min)	(m ³ /day)
High Hydraulic Conductivity	11	70	2.7	11.5	14	8.8	1.30E-05	95	65	94
Low Hydraulic Conductivity	11	70	2.7	11.5	14	8.8	3.80E-08	5	0	1

ln(R₀/rw) (high) 4.57

ln(R₀/rw) (low) 1.82

Hydraulic Conductivity (m/s) (high) 1.30E-05

Hydraulic Conductivity (m/s) (low) 3.80E-08

Length to Zero Drawdown	Equivalent Radius + 3000*(DRAWDOWN)*(HYDRAULIC CONDUCTIVITY^0.5)
(H²-h²)	((AQUIFER THICKNESS-STATIC LEVEL)^2)-((AQUIFER THICKNESS-DEWATERED LEVEL)^2)
Estimated Inflow	((K(H ² -h ²))/(5.31E-6(ln(R ₀ /Equivalent Radius)))



Appendix H

Water Balance Information

Climate Normals 1981-2010 Station Data

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID
STATION_N PROVINCE LATITUDE LONGITUDE ELEVATION CLIMATE_ID WMO_ID TC_ID
BARRIE WP ON 44°22'33.0 79°41'23.0 221.0 m 6110557

Legend
A = WMO "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation)
B = At least 25 years
C = At least 20 years
D = At least 15 years

1981 to 2010 Canadian Climate Normals station data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Temperature														
Daily Avera	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	6.9	C
Standard D	3.4	2.6	2.2	1.6	1.9	1.4	1.3	1.5	1.4	1.2	1.6	3	1.4	C
Daily Maxir	-2.9	-1.5	3.2	11	18.1	23.6	26.3	25.1	20.7	13.5	6.5	0.4	12	C
Daily Minin	-12.4	-11.7	-7.4	0.2	6.5	12.3	15.3	14.3	10	3.9	-1	-7.3	1.9	C
Extreme M	14	14	24	30.5	35	35	36	36.5	34.5	30	21.5	19.5		
Date (yyyy/ 1995/14	1984/23	1998/30	2002/16	2006/30	1994/17	1988/06	2006/01	2002/09	2005/05	1978/05	1982/03			
Extreme M	-35	-33	-30.5	-15	-4	1	6	0	-1.5	-6.5	-19.5	-33		
Date (yyyy/ 1981/04	1979/18	1984/08	2003/07	2006/07	1980/09	1984/08	2004/22	1993/30	1988/31	1989/29	2004/20			
Precipitation														
Rainfall (m)	16.6	16	29.2	56.6	82.3	84.8	77.2	89.9	94	75.2	66	22.2	709.9	C
Snowfall (c	65.9	45.9	29	5.7	0.1	0	0	0	0	2.3	22.8	51.4	223	C
Precipitatic	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94	77.5	88.9	73.6	932.9	C
Average Sn	16	17	8	1	0	0	0	0	0	0	2	9	4	D
Median Sn	17	17	8	0	0	0	0	0	0	0	1	8	4	D
Snow Dept	17	15	1	0	0	0	0	0	0	0	4	11	4	C
Extreme D	27	35	43	40	54.4	96	75	79	80	48.8	50	28.6		
Date (yyyy/ 1998/05	1997/21	1990/11	1995/21	2004/23	1995/02	1980/20	1995/31	1986/11	1995/05	1999/02	1979/24			
Extreme D	65	32.4	22	17	2	0	0	0	0	12	27	44		
Date (yyyy/ 1978/09	1984/29	1984/10	1979/04	1989/07	1978/01	1978/01	1978/01	1977/01	1997/26	2000/21	1995/10			
Extreme D	65	35	43	40	54.4	96	75	79	80	48.8	52	44		
Date (yyyy/ 1978/09	1997/21	1990/11	1995/21	2004/23	1995/02	1980/20	1995/31	1986/11	1995/05	1999/02	1995/10			
Extreme Sn	57	59	50	21	0	0	0	0	0	8	29	54		
Date (yyyy/ 1981/07	2001/09	2003/05	1987/01	1981/01	1981/01	1981/01	1981/01	1981/01	1997/27	1995/28	1995/11			
Days with Maximum Temperature														
<= 0 °C	21	16.6	10	0.92	0	0	0	0	0	0	3.5	14.6	66.6	C
> 0 °C	10	11.6	21	29.1	31	30	31	31	30	31	26.5	16.4	298.6	C
> 10 °C	0.36	0.48	3.8	14.9	28.2	29.9	31	31	29.5	21.8	6.4	1	198.2	C
> 20 °C	0	0	0.54	3.1	10.6	22.6	29.1	27.3	15.6	3.6	0.08	0	112.5	C
> 30 °C	0	0	0	0.04	0.4	2.5	4.4	2.4	0.63	0	0	0	10.4	C
> 35 °C	0	0	0	0	0	0	0.04	0.04	0	0	0	0	0.08	C
Days with Minimum Temperature														
> 0 °C	0.84	1	2.9	13.9	29	30	31	31	29.8	24.8	10.6	3	207.8	C
<= 2 °C	30.9	28.1	30.2	21.7	5.2	0.12	0	0.09	0.96	12.3	23.7	29.9	183	C
<= 0 °C	30.2	27.2	28.1	16.1	2	0	0	0.04	0.21	6.3	19.4	28	157.5	C
< -2 °C	27	24.6	22.9	7.1	0.12	0	0	0	0	0.92	10.6	22.6	115.8	C
< -10 °C	17	15.6	9.1	0.52	0	0	0	0	0	0	0.79	9.6	52.6	C
< -20 °C	6	3.9	0.96	0	0	0	0	0	0	0	0	1.3	12.2	C
< -30 °C	0.56	0.13	0.04	0	0	0	0	0	0	0	0	0.04	0.77	C
Days with Rainfall														
>= 0.2 mm	2.8	3	5.4	11.3	12.9	11.4	11.1	11.8	13.3	15.5	11.3	4.6	114.4	C
>= 5 mm	1	1.2	2.2	3.9	5.8	4.4	4.7	5.1	5.4	5.5	4.6	1.9	45.5	C
>= 10 mm	0.64	0.58	0.88	1.6	2.7	2.9	2.5	3.4	3	1.9	2.2	0.46	22.8	C
>= 25 mm	0.04	0.08	0.04	0.27	0.36	0.73	0.62	0.81	0.73	0.15	0.28	0.04	4.2	C
Days With Snowfall														
>= 0.2 cm	12.4	10	6.8	1.5	0.04	0	0	0	0	0.54	4.5	9.6	45.5	C
>= 5 cm	5	3.4	2.2	0.35	0	0	0	0	0	0.19	1.6	3.8	16.5	C
>= 10 cm	1.8	1	0.64	0.12	0	0	0	0	0	0.04	0.46	1.6	5.7	C
>= 25 cm	0.08	0.15	0	0.04	0	0	0	0	0	0	0.08	0.08	0.43	C
Days with Precipitation														
>= 0.2 mm	14.9	12.3	11.6	12.2	12.9	11.4	11.1	11.8	13.3	15.6	15.4	13.8	156.1	C
>= 5 mm	6	4.5	4.3	4.2	5.8	4.4	4.7	5.1	5.4	5.7	6.2	5.8	62	C
>= 10 mm	2.4	1.8	1.6	1.7	2.7	2.9	2.5	3.4	3	2	2.7	2.1	28.9	C
>= 25 mm	0.12	0.23	0.04	0.31	0.36	0.73	0.62	0.81	0.73	0.19	0.44	0.13	4.7	C
Degree Days														
Above 24 °i	0	0	0	0	0.1	2.5	8.3	4.2	0.4	0	0	0	15.5	C
Above 18 °i	0	0	0	0.8	8	45.5	95.8	71.4	19.6	1	0	0	242	C
Above 15 °i	0	0	0	3.4	25.6	103.1	180.5	149.2	56.1	5.1	0	0	523	C
Above 10 °i	0	0	1.5	16.8	97.6	239.8	334.6	301.4	165.9	36.1	2.2	0.3	1196.3	C
Above 5 °C	0.4	0.5	10.1	66.1	227.7	389.2	489.6	456.3	310.6	126.9	26.1	3.9	2107.4	C
Above 0 °C	7.7	10.1	44.4	176.1	381.7	539.2	644.6	611.3	460.5	272.9	101.1	25.4	3274.9	C
Below 0 °C	245.7	194.9	110	7.9	0	0	0	0	0	0	21.7	132.5	712.8	C
Below 5 °C	393.4	326.4	230.8	47.9	1.1	0	0	0	0.1	9.1	96.6	266	1371.3	C
Below 10 °i	548	466.9	377.1	148.6	25.9	0.6	0	0.1	5.4	73.2	222.8	417.4	2286.2	C
Below 15 °i	703	608	530.7	285.3	108.9	14	0.9	2.8	45.6	197.2	370.6	572.1	3439.1	C
Below 18 °i	796	692.6	623.7	372.6	184.3	46.3	9.1	18	99	286.2	460.6	665.1	4253.7	C

1981 to 2010 Canadian Climate Normals station data (Frost-Free)

Frost-Free: Code														
Average Da	07-May	D												
Average Da	09-Oct	D												
Average Le 153 Days	D													
Probability	10%	25%	33%	50%	66%	75%	90%							
Date	19-May	16-May	12-May	05-May	03-May	30-Apr	27-Apr							
Probability	10%	25%	33%	50%	66%	75%	90%							
Date	20-Sep	02-Oct	07-Oct	10-Oct	14-Oct	18-Oct	23-Oct							
Probability	10%	25%	33%	50%	66%	75%	90%							
Days	126	147	154	156	159	161	169							

Barrie

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL													
Location	Barrie, ON			Barrie WPCC									
Latitude	44.2												
Declination (deg)	-21.30	-13.30	-2.00	9.80	18.90	23.30	21.30	13.70	3.00	-9.00	-18.60	-23.30	
Declination (rad)	-0.37	-0.23	-0.03	0.17	0.33	0.41	0.37	0.24	0.05	-0.16	-0.32	-0.41	
DayLength (hr)*	9.03	10.23	11.74	13.29	14.59	15.30	14.97	13.83	12.39	10.82	9.45	8.70	
Precipitation (mm)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94	77.5	88.9	73.6	933
Temperature (°C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	-
Potential Evapotranspiration (mm)	0	0	0	40.1	67.7	99.9	116	100	69.1	39.9	23.5	0	557
Surplus	376	mm/yr											
PET Calc													
IF(T>0,924*DayLength*0.611*EXP(17.3*T/(T+237.3)))/(T+273.2),0)													

Pre-Development Water Balance

Catchment Designation	Slope to Tollendale Creek	Gravel Areas	Pavement	Roof Areas	Vegetated Areas
Area (m ²)	10,914	1,032	2,255	790	11,848
Pervious Area (m ²)	10,914	0	0	0	11,848
Impervious Area (m ²)	0	1,032	2,255	790	0

Infiltration Factors

Topography	0.10	-	-	-	0.25
Soil	0.20	-	-	-	0.20
Land Cover	0.20	-	-	-	0.15
Infiltration Factor	0.50	0.10	0.00	0.00	0.60
Run-Off Coefficient	0.50	0.90	1.00	1.00	0.40

Inputs

Precipitation (mm/year)	933	933	933	933	933
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Outputs (per Unit Area)

Evapotranspiration (mm/year)	557	0	0	0	557
Evaporation (mm/year)(assumed to be 10% of Precipitation if evapotranspiration does not occur)	0	93	93	93	0
Precipitation Surplus (mm/year)	376	840	840	840	376
Infiltration (mm/year)	188	84	0	0	226
Rooftop Infiltration (mm/year)	0	0	0	0	0
Total Infiltration (mm/year)	188	84	0	0	226
Runoff Pervious Area (mm/year)	188	756	0	0	150
Runoff Impervious Areas (mm/year)	0	0	840	840	0
Total Outputs (mm/year)	933	933	933	933	933
Difference (Inputs-Outputs)	0	0	0	0	0

Inputs (Volumes)

Precipitation (m ³ /year)	10,182	963	2,104	737	11,054
Total Inputs (m ³ /year)	10,182	963	2,104	737	11,054

Outputs (Volumes)

Evapotranspiration (m³/year)	6079	0	0	0	6599
Evaporation (m³/year)	0	96	210	74	0
Precipitation Surplus (m³/year)	4103	867	1894	663	4455
Infiltration (m³/year)	2052	87	0	0	2673
Rooftop Infiltration (m³/year)	0	0	0	0	0
Total Infiltration (m³/year)	2052	87	0	0	2673
Runoff Pervious Area (m³/year)	2052	780	0	0	1782
Runoff Impervious Areas (m³/year)	0	0	1894	663	0
<i>Runoff To Storm Sewer (m³/year)</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Total Runoff (m³/year)	2052	780	1894	663	1782
Total Outputs (m³/year)	10182	963	2104	737	11054
Difference (Inputs-Outputs)	0	0	0	0	0

Total Infiltration (QI)	4812
Total Runoff (QR)	7170
Sum of QI and QR	11983



Post-Development Water Balance

Catchment Designation	Slope to Tollendale Creek	Pavement	Asphalt	Roof Areas	Landscaped Areas
Area (m ²)	10,914	2,487	5,433	4,962	3,043
Pervious Area (m ²)	10,914	0	0	0	3,043
Impervious Area (m ²)	0	2,487	5,433	4,962	0

Infiltration Factors

Topography	0.10	-	-	-	0.25
Soil	0.20	-	-	-	0.20
Land Cover	0.20	-	-	-	0.15
Infiltration Factor	0.50	0.00	0.00	0.00	0.60
Run-Off Coefficient	0.50	1.00	1.00	1.00	0.40

Inputs

Precipitation (mm/year)	933	933	933	933	933
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Outputs (per Unit Area)

Evapotranspiration (mm/year)	557	0	0	0	557
Evaporation (mm/year)(assumed to be 10% of Precipitation if evapotranspiration does not occur)	0	93	93	93	0
Precipitation Surplus (mm/year)	376	840	840	840	376
Infiltration (mm/year)	188	0	0	0	226
Rooftop Infiltration (mm/year)	0	0	0	0	0
Total Infiltration (mm/year)	188	0	0	0	226
Runoff Pervious Area (mm/year)	188	0	0	0	150
Runoff Impervious Areas (mm/year)	0	840	840	840	0
Total Outputs (mm/year)	933	933	933	933	933
Difference (Inputs-Outputs)	0	0	0	0	0

Inputs (Volumes)

Precipitation (m ³ /year)	10,182	2,320	5,069	4,630	2,839
Total Inputs (m ³ /year)	10,182	2,320	5,069	4,630	2,839

Outputs (Volumes)

Evapotranspiration (m ³ /year)	6079	0	0	0	1695
Evaporation (m ³ /year)	0	232	507	463	0
Precipitation Surplus (m ³ /year)	4103	2088	4562	4167	1144
Infiltration (m ³ /year)	2052	0	0	0	687
Rooftop Infiltration (m ³ /year)	0	0	0	0	0
Total Infiltration (m³/year)	2052	0	0	0	687
Runoff Pervious Area (m ³ /year)	2052	0	0	0	458
Runoff Impervious Areas (m ³ /year)	0	2088	4562	4167	0
<i>Runoff To Storm Sewer (m³/year)</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Total Runoff (m³/year)	2052	2088	4562	4167	458
Total Outputs (m ³ /year)	10182	2320	5069	4630	2839
Difference (Inputs-Outputs)	0	0	0	0	0

Total Infiltration (QI)	2738
Total Runoff (QR)	13326
Sum of QI and QR	16065