



Hydrogeological Assessment Report, 103 & 107 Napier Street and 95 Cook Street, Barrie, Ontario - Revision 1

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Prepared for:
2556055 Ontario Inc

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1.0 Introduction

Cambium Inc. (Cambium) was retained by 2556055 Ontario Inc (the Client) c/o Innovative Planning Solutions to complete a hydrogeological assessment of the property located at 103 and 107 Napier Street and 95 Cook Street, City of Barrie, Ontario (the Site).

The hydrogeological assessment is required as part of the application process for Official Plan Amendment and Zoning By-law Amendment for the proposed residential development which includes 34 townhouses, 4 single-detached dwellings, and associated infrastructure. The total area of the three properties is 11,338.5 m² (2.80 acres). It is noted that two of the properties (103 and 107 Napier Street) are already developed with existing single-detached dwellings, and these houses will remain upon development.

The purpose of the hydrogeological assessment is to assess the subsurface conditions at the Site in terms of soil and groundwater conditions, water levels and elevations to characterize the local groundwater regime for the construction of a townhouse complex and two single-family dwellings, along with associated parking, driveways, and landscaped areas.

1.1 Scope of Work

This hydrogeological assessment was conducted with the following tasks:

- **Review of available background information:** a review of available geological and hydrogeological information for the site and surrounding areas and the previous investigation reports completed for the Site, was conducted to provide background information to allow for characterization of the Site's soil and groundwater conditions.
- **Detailed site inspection:** an inspection of the Site was completed to review existing site conditions including identification of any hydrogeological features such as significant areas of potential groundwater recharge or areas of groundwater discharge.
- **Measurement of groundwater levels:** groundwater levels were measured in the existing monitoring wells to establish and/or confirm the general groundwater flow condition. Long-term, four-season water level monitoring is also being completed.



- **In-Situ Hydraulic Conductivity Tests:** completed in-situ hydraulic conductivity tests or Sigle well Response Tests (SWRTs) in three monitoring wells to estimate the hydraulic conductivity of the underlying soils and/or bedrock, which will be used for assessing the potential dewatering requirements.
- **Preliminary dewatering assessment:** The need for short-term and long-term dewatering was assessed, assuming that each residential unit will have a one level basement.
- **Water Balance (Preliminary):** a preliminary water balance study was completed for the proposed development using the Thornthwaite-Mather approach and the climatic data obtained from Environment Canada.
- **Source Water Protection:** an assessment of Source Water Protection and Site development will be completed to estimate likely impacts of the development on City's water supply.
- **Report Preparation:** a hydrogeological report was prepared presenting the results, findings, and recommendations of this investigation.

It should be noted that a geotechnical investigation is being completed concurrently at the Site by Cambium (Cambium, 2022). The data or information obtained in the current and former investigations has been incorporated into this hydrogeological assessment report.

1.2 Site Description and Site Development

The total area of the property is approximately 11,338.5 m² (2.80 acres) in size and is located southeast of the corner of Cook Street and Napier Street. At the time of this hydrogeological assessment study, the Site was developed as three separate parcels which consisted of the following:

- 95 Cook Street: an existing church, with associated parking areas on the west side of the property and a cleared area on the southeast side of the property.
- 103 Napier Street: an existing dwelling with two sheds on the north side of the property and an open grassy area on the south side of the property.
- 107 Napier Street: an existing dwelling with one shed on the south side of the property.



The current zoning for 95 Cook Street is as an Institutional (I) Zone, and the current zoning for 103 and 107 Napier Street is as a Residential Single Detached Dwelling Second Density (R2) Zone. The zoning for each of these lots will be updated as part of the Zoning By-law Amendment for the proposed development.

It is proposed that the Site be developed into a residential development consisting of 34 townhouses, 4 single-detached dwellings, and associated infrastructure including, but not limited to, internal roadways, and amenity area, sidewalks, etc. Water and wastewater services are being provided by the City of Barrie.

It is understood that the existing dwellings on 103 and 107 Napier Street will remain upon development; however, the southern portion of each lot will be included in the proposed residential development described above. For this hydrogeological assessment, only the area on the Site included in the proposed residential development will be considered (i.e. 10,274 m²).

The regional location of the Site is outlined on Figure 1, the property and surrounding areas outlined on Figure 2 and the proposed development plan is included in Appendix A.



2.0 Environmental Features

To assess environmental features, databases maintained by the Ministry of Natural Resources and Forestry (MNR), the Ministry of Environment, Conservation and Parks (MECP), and the Lake Simcoe Region Conservation Authority (LSRCA) were reviewed (Appendix A).

Based on the data reviewed, the Site is situated within Barrie Creeks Subwatershed, under the authority of the LSRCA Source Protection Area. The local drainage continues south and southeastward discharging into the Lake Simcoe which is situated at about 600 m south of the Site.

No wetlands or woodlands are situated on the Site. The majority of the Site is covered with built up and paved areas. The Site is not situated within the LSRCA regulated areas as per Ont. Reg. 41/24 and therefore, development restrictions do not apply to the proposed development.

As per MNR Natural Heritage System database the Site does not have any Areas of Environmental Significance or Areas of Natural and Scientific Interest (ANSI).

As shown on the Ministry of Environment, Conservation and Parks (MECP) Source Water Protection Atlas map and Lake Simcoe Source Protection Plan, the Site is not located in groundwater vulnerable areas such as

- Wellhead Protection Area (WHPA-A, B, C and D),
- Highly Vulnerable Area (HVA)
- Issue Contributing Area (ISA), or
- Significant Groundwater Recharge Area (SGRA).

However, the Site is within a WHPA-Q1 and -Q2, related to groundwater recharge management area surrounding a municipal water supply aquifer (Appendix A). Further discussion on source water protection is included in Section 8.0.



3.0 Physical Setting

3.1 Topography and Drainage

The Site is located within the Barrie Creeks subwatershed of the Lake Simcoe watershed area. Based on the regional topographic map of the area, the general slope of the terrain is south and southeastwards with an elevation of about 270 meters above sea level (masl) in the north and northwest to about 265 masl in the east and southeast with gradual slope towards Lake Simcoe (Appendix A).

Based on the borehole location survey, the highest elevation of about 270.6 masl was noted in the northwest, with ground sloping southeast to the lowest elevation of about 268.9 masl, indicating generally a flat to gently sloping topography across the Site. As per the site and context plan provided (Appendix A), the lowest existing ground elevation at the Site is 266.8 masl.

3.2 Physiography

The Site is located in the physiographic region known as Simcoe Uplands in the northern portion of the Barrie Creeks subwatershed and is defined as distinct upland areas of rolling till plains that are broken up by steep-sided, flat-floored valleys. In the Barrie area, these valleys tend to be oriented from east to west. The Simcoe Uplands generally make up the topographic highs, rising up to 100 m above the adjacent Simcoe Lowlands. Simcoe Uplands are characterized by a deposition of a variety of coarse- and fine-grained sediments (Chapman & Putnam, 1984).

3.3 Overburden Geology

In general, the study area is characterized by glaciolacustrine deposits, interpreted to have been deposited by the Laurentide Ice Sheet during the Wisconsinian glaciations. The Paleozoic bedrock topography appears to strongly influence the overlying Quaternary sediment thickness and distribution. The overburden is primarily consisting of stone-poor, carbonate-derived silty to sandy till (OGS, 2010).



3.4 Bedrock Geology

According to Miscellaneous Release – Data 219 from the Ontario Geological Survey (OGS, 2007), the bedrock in the area of the Site consists of Middle Ordovician rocks from the Simcoe Group. The Simcoe Group consists of four formations that dip gently towards the southwest: Gull River Formation, Bobcaygeon Formation, Verulam Formation, and the Lindsay Formation from oldest to youngest. Simcoe Group primarily composed of limestone, dolostone, shale, arkose, and sandstone formations.



4.0 MECP Well Records Assessment

The Ministry of Environment Conservation and Parks (MECP) Water Well Information System (WWIS) was accessed to review water well records in the area of the Site. There were nine well records located within approximately 500 m radius of the Site (Figure 3). Well records are presented in Appendix B.

As per the MECP records, the wells were installed between 1977 and 2022 to depth ranging from 6.1 metres below ground surface (mbgs) to 128.3 mbgs. Overburden generally consisted of brown to grey fine to coarse sand and silt with gravel and cobbles, trace clay.

MWCP Well Records #7188109, #7262481, and #7409631 were installed as monitoring wells, while #5714857 was installed as water supply well; however, the well was dry and was later abandoned. The remaining well records did not contain any information. No data was available about the static water levels and/or recommended yield rates.

It is noted that well record #7409631 is plotted within the Site boundaries. This is the well record associated with the monitoring well installation for this hydrogeological assessment (See Section 5.0 for more details). Upon development, if the monitoring wells at Site (or any other well within the site boundaries) is not intended for continued use, they should be decommissioned as per O. Reg. 903.



5.0 Borehole Drilling and Monitoring Well Installation

5.1 Borehole Investigation - Geotechnical

Cambium completed a geotechnical investigation at the Site on December 8, 2021 (Cambium, 2022). A total of four boreholes, designated as BH101-21 through BH104-21, were advanced to depths ranging from 6.2 m to 6.6 mbgs. Three of the boreholes were outfitted as monitoring wells and designated as MW101-21, MW102-21, and MW104-21. Borehole locations are depicted on Figure 4 . Borehole logs are included in Appendix C.

Following is the general stratigraphy as encountered at the Site during the investigation.

Topsoil

Topsoil with some organic content was encountered in three of the boreholes advanced throughout the site (MW101-21, MW102-21, and MW104-21). BH103-21 was advanced through the asphalt parking lot east of the existing church.

The topsoil consisted of a black silt with some sand and organics and was found to be up to 760 mm thick.

Fill

Inferred fill soils were found underlying the topsoil in MW101-21 and beneath the asphalt in BH103-21. No fill material was encountered within MW102-21 or MW104-21, which were advanced in grassy areas to the east and south of the parcel.

The inferred fill soils consisted of a brown sand with some silt and trace organics in MW101-21 and a brown silt with some sand, and trace gravel in BH103-21. The fill soils ranged in thickness from 760 mm to 850 mm and extended to depths ranging from 0.9 mbgs to 1.5 mbgs.

Sand to Silty Sand

Native sand to silty sand materials were encountered in all boreholes beginning at depths ranging from 0.8 mbgs to 1.5 mbgs. The sand to silty sand soils extended to the termination depths of all boreholes except MW102-21 and were found to contain varying amounts of gravel and clay.



Silt to Sandy Silt

A layer of silt was found underlying the native sandy soils in MW102-21 and extended to the termination depth of 6.6 mbgs. The silt was found to contain some clay with traces of sand and gravel. In BH104-21, a layer of sandy silt with trace amounts of gravel and clay was encountered below the topsoil, between depths of approximately 0.8 mbgs and 1.5 mbgs.

Clayey Silt

A layer of clayey silt was found within the sandy soils in BH103-21 at a depth of 2.3 mbgs, extending to approximately 3.0 mbgs. The clayey silt was found to contain some sand and trace gravel.

Bedrock

Bedrock was not encountered during the geotechnical investigation. Drilling was terminated at depths of between 6.2 mbgs and 6.6 mbgs.

Well construction details are presented below in Table 1.

Table 1 Monitoring Well Installation Details

Borehole	Borehole Termination Depth (mbgs)	Monitoring Well Termination Depth (mbgs)	Screen Details		
			Ground Elevation (masl)	Screen Top (masl)	Screen Bottom (masl)
MW101-21	6.50	6.10	270.36	267.26	264.26
MW102-21	6.60	6.10	269.08	265.98	262.98
MW104-21	6.20	6.10	268.17	265.07	262.07

5.2 Groundwater Elevations

As part of hydrogeological assessment, a long-term twelve-month water level monitoring program was completed at the Site to characterize the seasonal water table elevations across the Site. Groundwater levels were measured on ten occasions between December of 2021 and October of 2022, capturing the seasonal high and low water levels. The recorded groundwater levels are presented in Table 2 below.



Table 2 Measured Groundwater Levels

Well		MW101-21	MW102-21	MW104-21
Top of Pipe Elevation (masl)		271.34	270.03	269.13
Ground Surface Elevation (masl)		270.36	269.08	268.17
Stick-up (m)		0.98	0.95	0.96
Dec. 20, 2021	Water Level (mbgs)	Dry	5.40	5.19
	Groundwater Elev.(masl)	-	263.68	262.98
Jan. 27, 2022	Water Level (mbgs)	Dry	5.75	5.27
	Groundwater Elev.(masl)	-	263.33	262.93
Feb. 18, 2022	Water Level (mbgs)	Dry	5.93	5.24
	Groundwater Elev.(masl)	-	263.15	262.93
Mar. 21, 2022	Water Level (mbgs)	Dry	5.77	5.22
	Groundwater Elev.(masl)	-	263.15	262.95
Apr. 21, 2022	Water Level (mbgs)	Dry	5.58	5.19
	Groundwater Elev.(masl)	-	263.50	262.98
May 16, 2022	Water Level (mbgs)	Dry	5.63	5.12
	Groundwater Elev.(masl)	-	263.45	263.05
Jun. 17, 2022	Water Level (mbgs)	Dry	5.85	5.21
	Groundwater Elev.(masl)	-	263.22	262.96
Aug. 8,2022	Water Level (mbgs)	Dry	5.95	5.26
	Groundwater Elev.(masl)	-	263.13	262.91
Sept. 14, 2022	Water Level (mbgs)	Dry	6.04	5.35
	Groundwater Elev.(masl)	-	263.04	262.82
Oct. 19, 2022	Water Level (mbgs)	Dry	Dry	5.43
	Groundwater Elev.(masl)	-	-	262.74

As presented above, monitoring well MW101-21 was dry during all the monitoring events, while groundwater levels in wells MW102-21 and MW104-21 ranged from 5.12 mbgs to 6.04 mbgs, and the elevations ranged from 262.74 masl to 263.68 masl, respectively.

The spring water levels (March through June of 2022) ranged from 5.12 mbgs to 5.85 mbgs, while the elevation was between 262.95 masl and 263.50 masl.

The water level fluctuations (i.e. difference between the highest and the lowest water levels) were minimal, with 0.63 m at MW101-21 and 0.23 at MW104-21.



5.3 Direction of Groundwater Flow

Based on the groundwater elevation data obtained from the monitoring events, a site-specific groundwater configuration map could not be constructed as only two monitoring wells had defined water levels. Based on the water table elevations at MW101-21 and MW104-21, a horizontal hydraulic gradient of 0.005 m/m was estimated, with the general water table was assumed to be sloping towards the southeast.

5.4 Particle Size Distribution

Physical soil laboratory testing was completed on four samples collected during the geotechnical drilling and percolation times (T-Times) were estimated based on the Unified Soil Classification System (USCS). Gradation charts for the particle size distribution tests are provided in Appendix D and are summarized in Table 3 below.

Table 3 Grain Size Analysis Data

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay	Percolation Rate (min/cm)
MW101-21-SS3	1.5 – 2.0	Silty Sand trace Clay	0	70	27	3	18
MW102-21-SS7	6.1 – 6.6	Clayey Silt, trace sand and gravel	1	4	77	18	40
BH103-21-SS4	2.3 – 2.7	Clayey Silt, some sand and trace gravel	1	13	63	23	45
MW104-21-SS5	3.0 – 3.5	Sand trace Silt trace Clay	0	88	9	3	10

Based on the data above, the percolation times (T-Times) ranged from as low as 45 min/cm to as high as 10 min/cm, with a geometric average of 23.85 min/cm.

Where applicable, the hydraulic conductivity values were calculated with Puckett's method for fine grained soil and Hazen's formula for granular soil. The estimated percolation time and hydraulic conductivity rates are provided in Table 4.



Table 4 Percolation Times and Hydraulic Conductivity

Borehole/Sample	Sample Depth (mbgs)	Percolation Time (min/cm)	Hydraulic Conductivity (m/s)
MW101-21-SS3	1.5 – 2.0	18	7.8×10^{-4}
MW102-21-SS7	6.1 – 6.6	40	1.2×10^{-6}
BH103-21-SS4	2.3 – 2.7	45	4.6×10^{-7}
MW104-21-SS5	3.0 – 3.5	10	2.0×10^{-3}

Based on the above, the geometric mean hydraulic conductivity was calculated at 3.05×10^{-5} m/sec.

Based on the results of the hydraulic conductivity (cm/s), the corresponding infiltration rate (mm/hr) will be estimated using the approximate relationship presented in the *Low Impact Development Stormwater Management Planning and Design Guide* (TRCA and CVCA, 2010, Appendix C). Accordingly, the infiltration rates ranged from as low as 4 mm/hr to as high as 38 mm/hr.



6.0 Construction Dewatering

Construction dewatering is intended to lower the groundwater levels in the excavation area in order to ensure a dry and safe working condition.

The requirements for construction dewatering generally depend on the Site's soil and groundwater conditions including soil type, soil permeability or hydraulic conductivity, local groundwater levels, and the design of the proposed development, such as the foundation and/or basement elevation, as well as the size of proposed structure.

Proposed Development, Anticipated Excavation and Dewatering

The proposed development will include construction of 34 townhouse units organized into six separate blocks and 4 single-detached dwellings with associated driveways landscape areas and parking areas. The proposed townhouses and single-detached dwellings might include a one level basement (Appendix A).

As per the notes outlined in the site and context plan (Appendix A), the foundations of the residential units are 1.2 m in depth. The lowest existing grade elevation at the Site is 266.8 masl, which would result in minimum foundation elevation of 265.6 masl. Assuming the excavation depth for the foundations is 0.5 m deeper to accommodate for the basement slab thickness and underneath granular base, the minimum excavation elevation would be 265.1 masl. As the maximum groundwater elevation measured at the Site was 263.68 masl, there is still at least 1.4 m between the highest water table elevation and the lowest foundation excavation elevation and therefore, temporary short-term groundwater control (construction dewatering) will not be anticipated during the excavation for the one level basement.

Additionally, the lowest one level basement slab elevation was estimated at 265.6 masl, which is well above the maximum water table elevation of 263.68 masl and therefore, long-term permanent sub-drain drainage is not expected at the Site.



7.0 Water Balance Assessment

Based on the Thornthwaite and Mather methodology (1957), the water balance is an accounting of water in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can run off towards lakes and streams (R), infiltrate to the groundwater table (I), or evaporate from ground or evapotranspiration by vegetation (ET). When long-term average values of P, R, I, and ET are used, there is minimal or no net change to groundwater storage (ΔS).

The annual water budget can be expressed as:

$$P = ET + R + I + \Delta S$$

Where:

P = Precipitation (mm/year)

ET = Evapotranspiration (mm/year)

R = Run-off (mm/year)

I = Infiltration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

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.

As the northern portions of 103 and 107 Napier Street will not be changed during the proposed development and the existing single-detached dwellings will remain, this area was not included in the water balance. As was outlined above, the total site area for the hydrogeological assessment is 10,274 m².

The pre-development portion of the Site consists of the smaller sheds within the southern portion of 103 and 107 Napier Street, and the church building and associated paved areas off of 95 Cook Street. The remainder of the Site is designated as landscaped area.

It is understood that the Site be developed into a residential development consisting of 34 townhouses, 4 single-detached dwellings, and associated infrastructure including, but not limited to, internal roadways, and amenity area, sidewalks, etc.



Based on the available design information, the development area at the Site can be generally categorized into three types as paved area, roof area, and landscape areas. The pre- and post-development plans of the proposed development are shown in Figure 5 and Figure 6. respectively. A summary of the surface areas of the development is listed in Table 5.

Table 5 Pre- and Post-Development Site Statistics

Type of Land Coverage	Pre-Development Areas (m ²)	Post Development Areas (m ²)
Paved Area	2,729	2,895
Building Roof Area	604	3,581
Landscape/Vegetated Area	6,941	3,798
Total (m ²)	10,274	10,274

Supporting information referenced herein (including detailed water balance calculations) is attached in Appendix E.

7.1 Water Surplus

Water surplus is calculated by determining the difference between precipitation and evapotranspiration (changes in soil water storage was assumed to be negligible over the course of a year). The volume of water surplus is further sub-divided into portions that infiltrate the on-site soils and that are directed off-site as runoff.

The climatic data including monthly average temperature and precipitation were obtained from Environment Canada for the Barrie WPCC weather station (Climate Identifier: 6110557) located about 5 km from the Site. The data were available between the years 1973 to 2006 (i.e. 33 years). Accordingly, the average annual evapotranspiration was estimated to be about 537 mm/year using the USGS Thornthwaite Monthly Water Balance methodology (Appendix E), and the average annual precipitation was recorded to be 933 mm/year. Therefore, the available water surplus of the Site was calculated to be 396 mm/yr.



Evapotranspiration does not occur from structures, paved areas, or gravel surfaces. It was assumed that 10% of precipitation falling on these surfaces is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted to infiltration and/or runoff.

7.2 Infiltration Rates

The volume of surplus water that infiltrates through pervious surfaces on-site was determined by applying an infiltration factor to the surplus depth. The surplus water that does not infiltrate into pervious surfaces will leave the Site as surface water runoff. The infiltration factor varies from 0 to 1 and is estimated based on topography, soils, and vegetation cover as per the *Stormwater Management Planning and Design Manual* (Ministry of the Environment, 2003). The rate of infiltration at a site is expected to vary, based on a number of factors to be considered in any infiltration model. To partition the available water surpluses into infiltration and surface run-off, the Ministry of Environment, Conservation and Parks (MECP) infiltration factor was used. The MECP Storm Water Management Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding run-off component was calculated for the soil moisture storage conditions. The infiltration factor calculated for the Site is included in Table 6.

Table 6 Infiltration Factor

Category	Infiltration Factor
Topography	Flat to gently sloping land = 0.30
Soils	Silty sand to sandy silt = 0.25
Cover	Cultivated land = 0.10
Total	0.65

The calculation of infiltration and runoff in the stages of pre-development and post-development is provided in Appendix E, and are presented in Table 7 and Table 10, below.



7.3 Pre-Development Water Balance

The water balance for the existing conditions of the Site is summarized in Table 7. The pre-development infiltration rate was calculated to be 1,787 m³/yr and the runoff rate was 3,761 m³/yr.

Table 7 Pre-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	2,729	2,546	255	-	2,292
	Roof Area	604	564	56	-	507
Pervious Areas	Landscape Area	6,941	6,476	3,727	1,787	962
Total		10,274	9,586	4,038	1,787	3,761
Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.						

7.4 Post-Development Water Balance

The post-development water balance is summarized in Table 8. The post-development infiltration rate was calculated to be 978 m³/yr, and the runoff volume was estimated at 5,964 m³/yr.

Table 8 Post-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	2,895	2,701	270	-	2,431
	Roof Area	3,581	3,341	334	-	3,007
Pervious Areas	Landscape Area	3,798	3,544	2,040	978	526
Total		10,274	9,586	2,644	978	5,964

7.5 Water Balance Comparison

The water balances of the pre-development and post-development scenarios are summarized below in Table 9.



Table 9 Water Balance Comparison

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Pre-Development	9,586	4,038	1,787	3,761
Post-Development	9,586	2,644	978	5,964
Change in Volume		- 1,395	- 809	2,204
Change in %		- 35	- 45	59

Based on the above, there is an infiltration deficit of about 809 m³/year compared to the pre-development infiltration. The runoff rate upon development of the Site will increase by 2,204 m³/year.

Table 10 Requirement of Infiltration from Roof Run-off

Volume of Pre-Development Infiltration (m³/year)	1,787
Volume of Post-Development Infiltration (m³/year)	978
Deficit from Pre to Post Development Infiltration (m³/year)	809
% of Roof Runoff required to match the pre-development Infiltration	27

Based on the above calculations, a summary of the water balance could be provided as follows:

- 1) There is a net increase in run-off at the Site of about 2,204 m³/year, from 3,761 m³/year to 5,964 m³/year. This increase is a result of the development of the Site with more impervious areas such as roof and paved areas and decrease in pervious landscape areas.
- 2) Post-development landscape area was decreased by about 3,143 m², when compared to the pre-development landscape, resulting in less infiltration across the Site.
- 3) Without implementing any mitigation measures, there is a net deficit of about 809 m³ /year in the post-development infiltration on a yearly basis.
- 4) Based on the estimation, a diversion of about 27% general roof water for infiltration, the proposed development would maintain the pre-development infiltration after the development. Therefore, Cambium would recommend the implementation of any suitable Low Impact Development (LID) measures at the Site in its present design to account for the infiltration deficit.



7.6 Discussions on LID Measures

It is known that low impact development (LID) practices have received increasing attention as these strategies attempt to capture the runoff and mimic the natural hydrologic cycle.

In general, there are two primary categories of LIDs. The first promotes the infiltration of Stormwater close to the source. These infiltration type LIDs are preferred when hydrogeological and physical conditions are optimal and allow for their emplacement. The proposed development does not include any Stormwater management pond to enhance the lost infiltration due to the Site development with paved and roof areas. Therefore, the second option described below could be considered.

The second option captures and slowly releases the water to the groundwater water system through the process of storage and filtration by infiltration LIDs.

The conceptual water balance indicates that there will be an infiltration deficit of about 809 m³/year in the post-development infiltration upon development of the Site, compared to the pre-development. Based on the estimation, a diversion of 27% of the general roof runoff for infiltration would allow the proposed development to maintain an enhanced infiltration after the development.

As per the Function Servicing and Preliminary Stormwater Management Report prepared by WMI & Associated Limited (2022), the infiltration deficit will be mitigated through drainage from approximately one-half of the rooftop area to be directed to infiltration trenches. Additional LID measures will also include a clear stone base of the underground storm pipes.

It is noted that a minimum vertical separation of 1.0 m is required between the maximum groundwater elevation and the bottom invert elevation of any proposed LID measure. Given the deeper groundwater conditions encountered (shallowest of 5.12 mbgs and 263.68 masl), LIDs are considered to be feasible at the Site.

If requested, Cambium can complete in-situ infiltration testing using a Guelph Permeameter, which will provide a general characterization of soil infiltration rates at the invert level of any proposed infiltration facility and will help for the design and placement of LID measures across the Site.



8.0 Source Water Protection and Risk Management

As per the LSRCA Source Protection Plan (SPP), the Subject Site is located in a groundwater vulnerable area such as Wellhead Protection Area Q1/Q2 (WHPA-Q1/Q2) (Appendix A).

8.1 WHPA-Q1/Q2

WHPA-Q1 refers to the area where activities that take water without returning it to the same source may be a threat; while WHPA-Q2 refers to the area where activities that reduce recharge may be a threat. WHPA-Q1 (area affected by groundwater use) and WHPA-Q2 (area affected by recharge reduction) for the municipal wells in Barrie area were delineated through the application of a numerical groundwater flow model that considered all known high volume groundwater users. In other words, WHPA-Q2 delineates an area where there is potential for threats from reductions in groundwater recharge (i.e. new development).

In the present development scenario, the proposed development is for residential development and therefore, more impervious areas will be generated compared to the pre-development, thereby reducing groundwater recharge to the municipal aquifer.

Due to the proposed infiltration deficit in the post-development scenario, there is a chance for impact to the groundwater recharge due to the proposed nature of the development in the study area. The water balance assessment for the proposed development indicated an infiltration deficit of 809 m³/year. Therefore, it is required to meet the pre-development water balance by implementing the LID measures where practicable, demonstrating recharge will be maintained across the Site (refer to Section 7.6 for more discussion).

If requested, Cambium can complete in-situ infiltration testing using a Guelph Permeameter, which will provide a general characterization of soil infiltration rates at the invert level of any proposed infiltration facility and will help for the design and placement of LID measures across the Site.

Cambium also recommends using the Best Management Practices (BMPs) so as to avoid overland flow of any contaminants to the natural environment, especially to the Lake Simcoe.

The Site will be under municipal sewage service and as such is not expected to cause any groundwater contamination by nitrates.



The major land use practices at the proposed development do not include the storage & handling of large quantities of road salt and snow storage and handling, hence, the development of Salt Management Plans and Snow Storage Plans is not required for the proposed development.



9.0 Assessment of Potential Impacts

Based on the information available, the residential development at the Site is proposed to be developed with townhouse units and single-detached dwellings with a possible one level basement. There is no construction dewatering, either short-term or long-term involved at the Site due to deep water table conditions. The potential impacts due to the Site development were assessed as below.

9.1 Natural Features

As discussed, no natural features such as wetlands, woodlands, ponds, and creeks located on the Site, there should be no impacts on the local natural features, due to the Site development. The Site is not situated within the LSRCA regulated areas as per Ont. Reg. 41/24 and therefore, development restrictions do not apply to the proposed development.

9.2 Water Supply Wells near the Site

The proposed development is being developed with one level basement for each residential unit; due to deep groundwater conditions, no dewatering will be required for the completion of the proposed development; therefore, impacts on the local water wells (private or public), if any will not be anticipated to be associated with the dewatering activity.

9.3 Considerations on Drinking Water Vulnerability

Based on the MECP Source Protection Information Atlas, the Site is situated within WHPA-Q1/Q2 area related to groundwater recharge management; therefore, it is required to meet the pre-development water balance by implementing the suitable LID measures, demonstrating recharge will be maintained across the Site. Section 8.0 of this report has a detailed discussion on the issue of source water protection and all the land use policies such as following BMPs and utilizing LIDs to compensate for the post-development infiltration deficit.



10.0 Conclusions And Recommendations

Cambium Inc. (Cambium) was retained by 2556055 Ontario Inc (the Client) to complete a hydrogeological assessment of the property located at 103 and 107 Napier Street and 95 Cook Street, City of Barrie, ON (the Site).

The Site has no wetlands or woodlands or any regulated areas that overlap the Site. As such, the proposed development restrictions under Ont. Reg. 41/24 made under the *Conservation Authorities Act, 1990*, do not apply to the proposed development.

The measured spring groundwater levels in the monitoring wells ranged from 5.12 mbgs to 5.58 mbgs, while the elevation was between 262.95 masl and 263.50 masl. The water level fluctuations (i.e. difference between the highest and the lowest water levels) were minimal with 0.63 m at MW101-21 and 0.23 at MW104-21. Groundwater flow direction could not be determined as only two monitoring wells had defined water levels and the third monitoring well was consistently dry.

Site development plan proposes the construction of a townhouse complex and 4 single-detached dwellings with a possible one level basement. The proposed development is not anticipated to involve any short-term construction dewatering or a permanent long-term sub-drain dewatering due to deep water table conditions across the Site. The highest water table elevation of 263.68 masl is situated at about 1.4 m below the deepest excavation elevation of 265.1 masl and therefore, no dewatering is expected at the Site.

The conceptual water balance indicates that there will be an infiltration deficit of about 809 m³/year in the post-development infiltration upon development of the Site, compared to the pre-development. Based on the estimation, a diversion of 27% of general roof water for infiltration, the proposed development would maintain an enhanced infiltration after the development. It is understood that this infiltration deficit will be accommodated from through infiltration trenches.

If requested, Cambium can complete in-situ infiltration testing using a Guelph Permeameter, which will provide a general characterization of soil infiltration rates at the invert level of any proposed infiltration facility and will help for the design and placement of LID measures across the Site.



Since the Site is situated within a WHPA Q1/Q2, it is required to meet the pre-development water balance by implementing the LID measures (i.e. infiltration trenches), demonstrating pre-development recharge will be maintained across the Site.

Based on the hydrogeological investigation, no environmental impacts were anticipated due to the proposed Site development.



11.0 Closing

We trust that the information in this submission meets your current requirements. If you have any questions regarding the contents of this report, please contact the undersigned.

Respectfully submitted,

Cambium Inc.

DocuSigned by:

6AAA0661AAA8459

Nicole Latimer, GIT, M.Sc.
Project Coordinator

DocuSigned by:

3611FDDBEA134BF

Sudhakar Kurli, M.Sc. P.Geo.
Project Manager

DS



2024-09-12



12.0 References

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- WMI. (2022). *Functional Servicing and Preliminary Stormwater Management Report, 95 Cook Street and 103 Napier Street, City of Barrie*. WMI & Associates Limited.



13.0 Standard Limitations

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In performing work on behalf of a client, Cambium relies on its client to provide instructions on the scope of its retainer, and, on that basis, Cambium determines the precise nature of the work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards. Unless required under local laws, other than as expressly stated herein, no other warranties or conditions, either expressed or implied, are made regarding the services, work or reports provided.

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A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work or report considers any locations or times other than those from which information, sample results and data was specifically received, the work or report is based on a reasonable extrapolation from such information, sample results and data but the actual conditions encountered may vary from those extrapolations.

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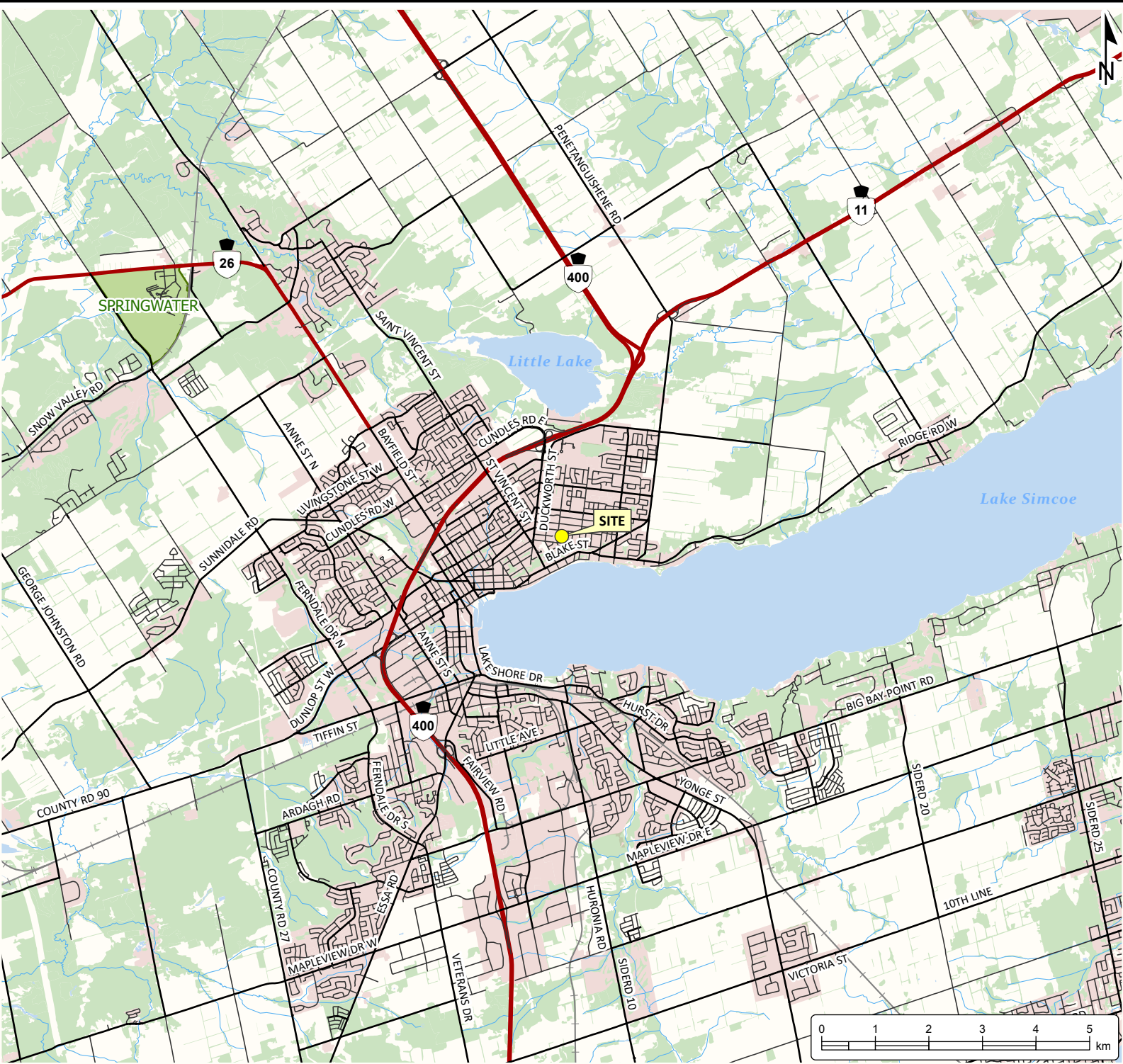
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Appended Figures



**HYDROGEOLOGICAL
ASSESSMENT**
2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Provincial Park
- Built Up Area
- Wooded Area
- Water Area

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194 Sophia Street
Peterborough, Ontario, K9H 1E5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

SITE LOCATION PLAN

Project No.: 12345-001	Date: July 2024
Scale: 1:100,000	Projection: NAD 1983 UTM Zone 17N
Created by: LD	Checked by: SK
Figure: 1	



**HYDROGEOLOGICAL
ASSESSMENT**
2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

Site (approximate)

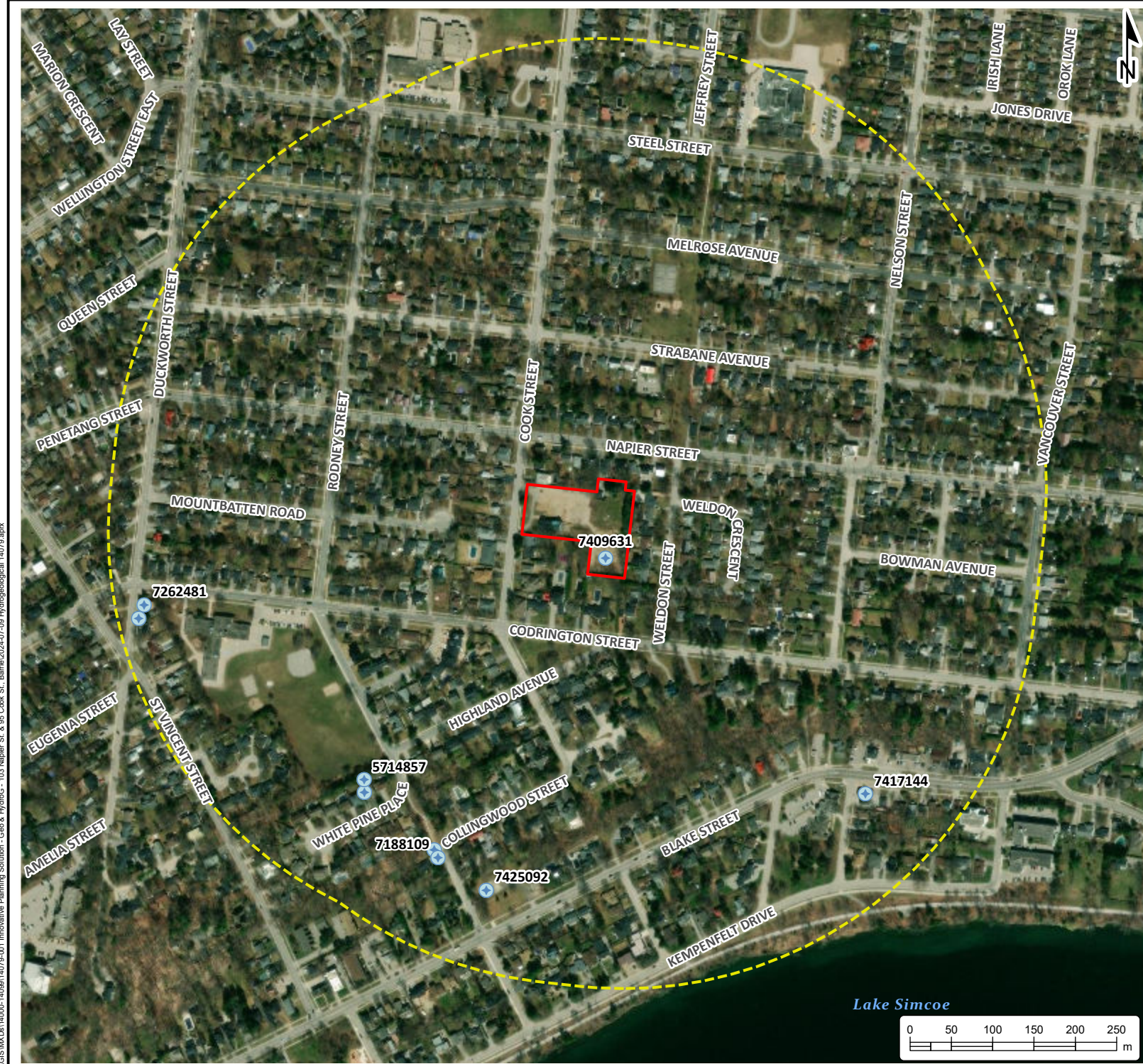
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SITE PLAN

Project No.: 12345-001		Date: July 2024	
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 17N	
Created by: LD	Checked by: SK	Figure: 2	



**HYDROGEOLOGICAL
ASSESSMENT**

2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

- Water Well Record
- Study Area (500m)
- Site (approximate)

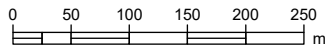
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**MECP
WELL RECORDS WITHIN 500m**

Project No.:	12345-001	Date:	July 2024
Scale:	1:6,500	Rev.:	
Created by:	LD	Checked by:	SK
Figure:	3		





**HYDROGEOLOGICAL
ASSESSMENT**
2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

-  Borehole
-  Monitoring Well
-  Site (approximate)

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BOREHOLE LOCATION PLAN

Project No.: 12345-001		Date: July 2024	
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 17N	
Created by: LD	Checked by: SK	Figure: 4	

Pre-Development	Area (m2)
Roofed	604
Paved	2,729
Landscaped	6,942
Total	10,274



**HYDROGEOLOGICAL
ASSESSMENT**
2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

- Roofed
- Paved
- Landscaped
- Site (approximate)

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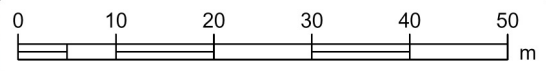
PRE-DEVELOPMENT PLAN

Project No.: 12345-001	Date: July 2024
Scale: 1:1,000	Rev.: NAD 1983 UTM Zone 17N
Created by: LD	Checked by: SK
Figure: 5	

Post-Development	Area (m2)
Roofed	3,581
Paved	2,895
Landscaped	3,798
Total	10,274



CONCEPTUAL SITE PLAN (38 units)
103 & 107 Napier Street & 95 Cook Street, Barrie



HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

- Roofed
- Paved
- Landscaped
- Site (approximate)

Notes:
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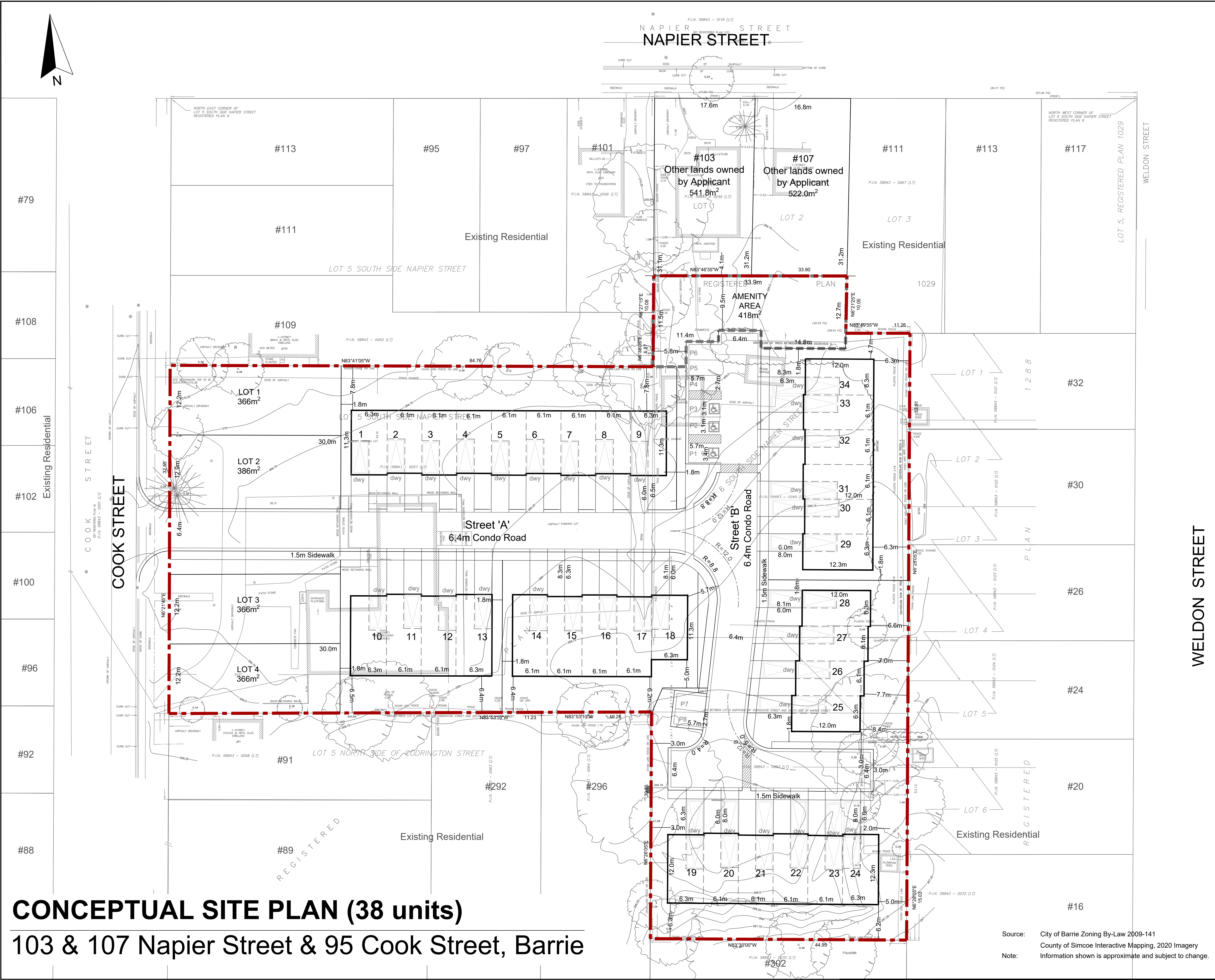
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POST-DEVELOPMENT PLAN

Project No.:	12345-001	Date:	July 2024
Scale:	1:1,000	Rev.:	
Created by:	LD	Projection:	NAD 1983 UTM Zone 17N
Checked by:	SK	Figure:	6



Appendix A
Site Development Plans



KEY MAP

Subject Site

CONCEPTUAL SITE PLAN

103 & 107 Napier Street & 95 Cook Street, Barrie

Scale 1:300

LEGEND

 SUBJECT LANDS (8,789m²)

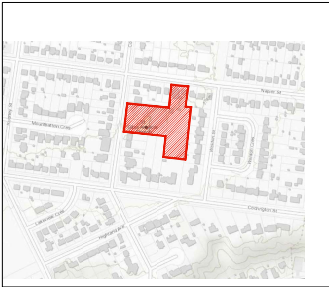
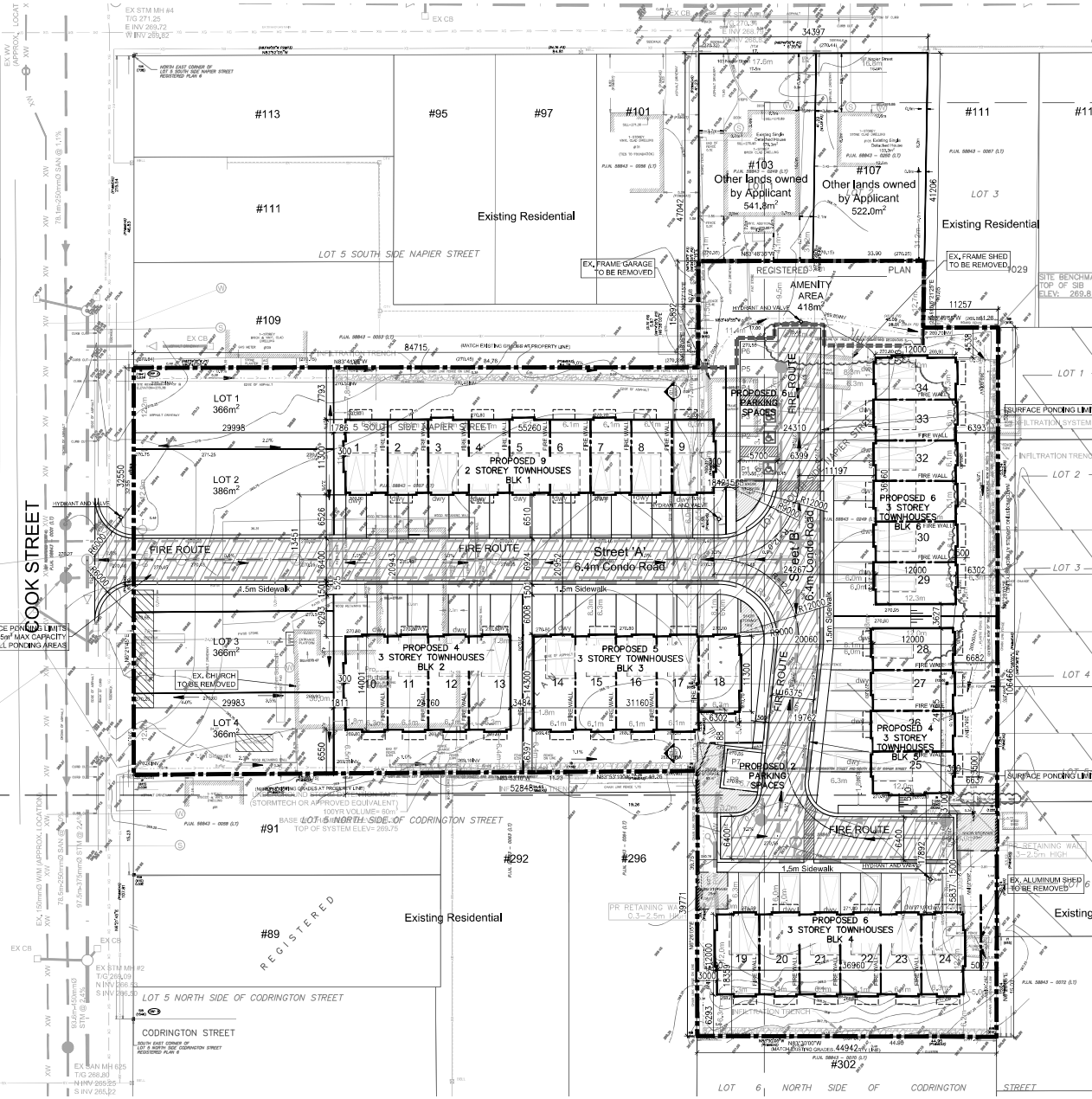
34 6.1m / 20' TOWNHOUSES
4 12.2m / 40' SINGLE DETACHED LOTS

95 COOK STREET (7,532.1m²)
 103 NAPIER STREET (3,115.9m²)
 107 NAPIER STREET (690.5m²)

FOR DISCUSSION PURPOSES ONLY
JUNE 7, 2023

INNOVATIVE PLANNING SOLUTIONS
PLANNERS • PROJECT MANAGERS • LAND DEVELOPERS
647 WELHAM ROAD, UNIT 9A, BARRIE, ONTARIO, L4N 0B7
tel: 705 • 812 • 3281 fax: 705 • 812 • 3438 e: info@ipsconsultinginc.com www.ipsconsultinginc.com

Date:	June 7, 2022	Drawn By:	B.H.
File:	20-1006	Checked:	C.S.



2
A101 context plan

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notes:

notes:

- The highest water table elevation as per the hydrogeological report dated December 20, 2021 by Cambium is 263.68 msl. The lowest ground existing elevation on site is 266.80 msl. Foundations have a depth of 1.2m. Therefore the distance between the aquifer and the building foundations is at least 1.8m.
- No foundation support to be constructed within the municipal supply aquifer.

2 issued for rezoning
1 issued for rezoning
revisions:

12-09-24
17-11-23
d-m-yr

architect unfolded				
STATISTICS - 95 Cook				
February 5th, 2024				
	m2	ft2	acres	density (PS)
ZONING	RM2			
SITE AREA	TOTAL	10,274.4	110.592	2.54 1.5
SALEABLE AREA	PROPOSED			
	BLK 1	1,729.0	18,613	
	BLK 2	1,053.0	11,334	
	BLK 3	1,248.0	13,443	
	BLK 4	1,346.9	14,498	
	BLK 5	1,922.5	20,806	
	BLK 6	1,348.9	14,520	
GRAND TOTAL		7,619.2	82,012	
		15,238.3	164,024	
UNITS	PROPOSED			
	BLK 1	5	0	9
	BLK 2	4	4	4
	BLK 3	5	5	5
	BLK 4	5	5	6
	BLK 5	4	4	4
	BLK 6	6	6	0
GRAND TOTAL		5	15	34
		33	38 + FAMILY RM	
		(2 STOREY)	(3 STOREY)	
HEIGHT	PROPOSED			
	BLK 1	10M		
	BLK 2	<10M		
	BLK 3			
	BLK 4			
	BLK 5			
	BLK 6			
GRAND TOTAL		10M		
		10M		
PARKING	REQUIRED	1.5 parking per unit		11
	PROPOSED			
	RESIDENTIAL			
	TH OUTDOOR		16	
	TH INDOOR		14	
	OPTIONAL 2ND P. INDOOR		14	
	Total		74	
VISITORS	SURFACE	8 (includes 3 BP spaces)		
	Total	8		
	GRAND TOTAL (residential)	32		

architectural team :

mark zwicker
maïna onorato
ernesto sosa

drawing:

structural

electrical

mechanical

landscape

site services

owner:

project:

95 Cook St

barrie, ontario

site and context
plan

aug. 12, 2024

as indicated

22-39

ma

1
A101 site plan
scale: 1:300

3
A101 statistics

A101



Lake Simcoe Region
conservation authority

LSRCA Regulated Area



Features

- LSRCA Watershed Boundary
- V_MASK_WATERSHED_1
- Watercourse
- Regulation Limit
- Address Labels
- Road Labels
- LSRCA Watershed Boundary
- Assessment Parcel
- Roads
 - Hwy 400 Series
 - Highway, Arterials
 - Local Road
- Railway

Printed On:
7/19/2024

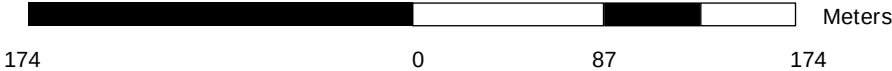


WGS_1984_Web_Mercator_
Auxiliary_Sphere

Mapped By:

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Scale 1: 3,430

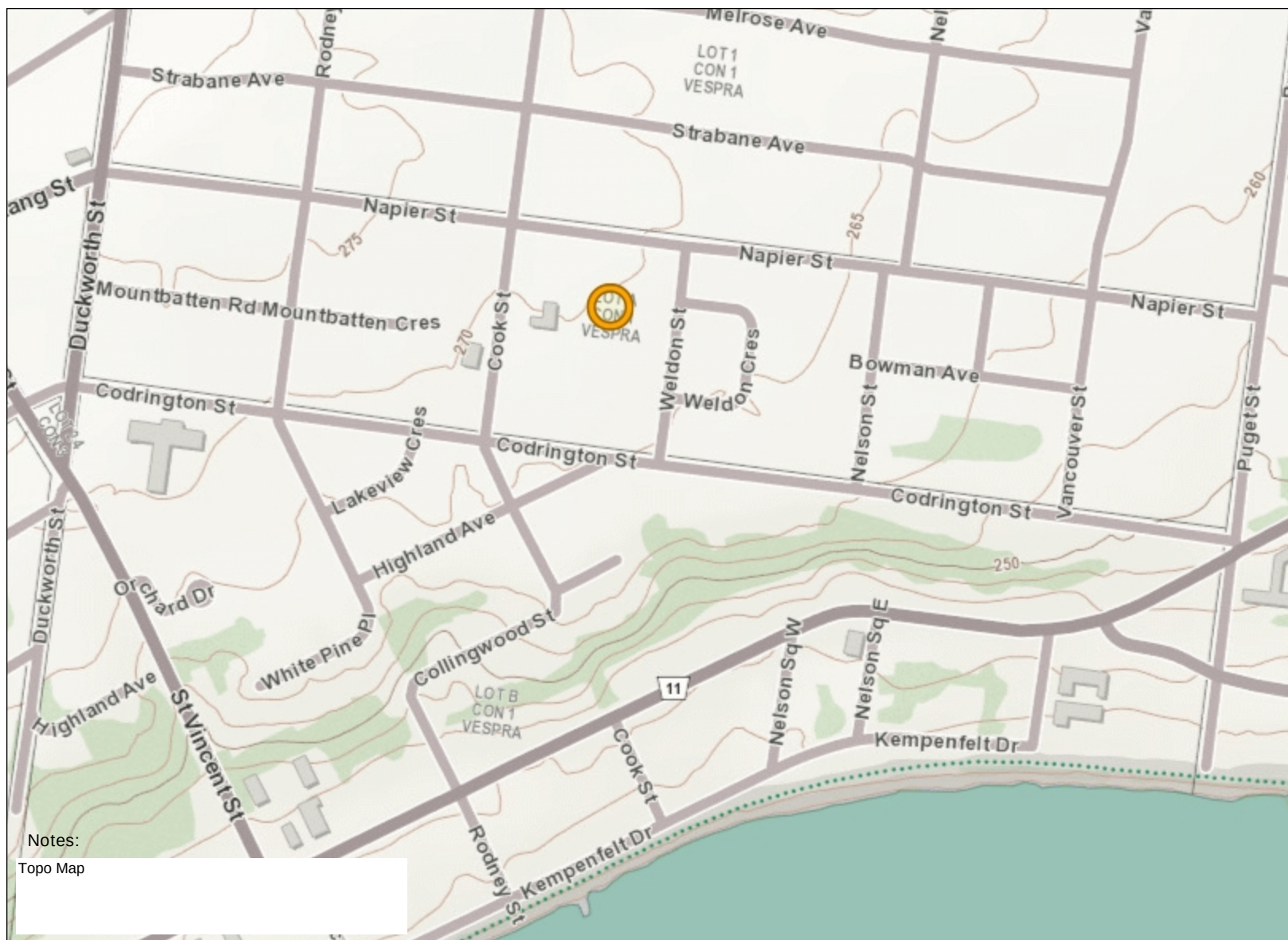




Ministry of Natural Resources and Forestry
Make-a-Map: Natural Heritage Areas

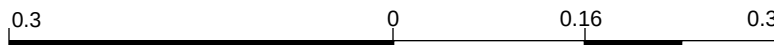
Regional Topo Map

Map created:2/7/2022



Notes:

Topo Map



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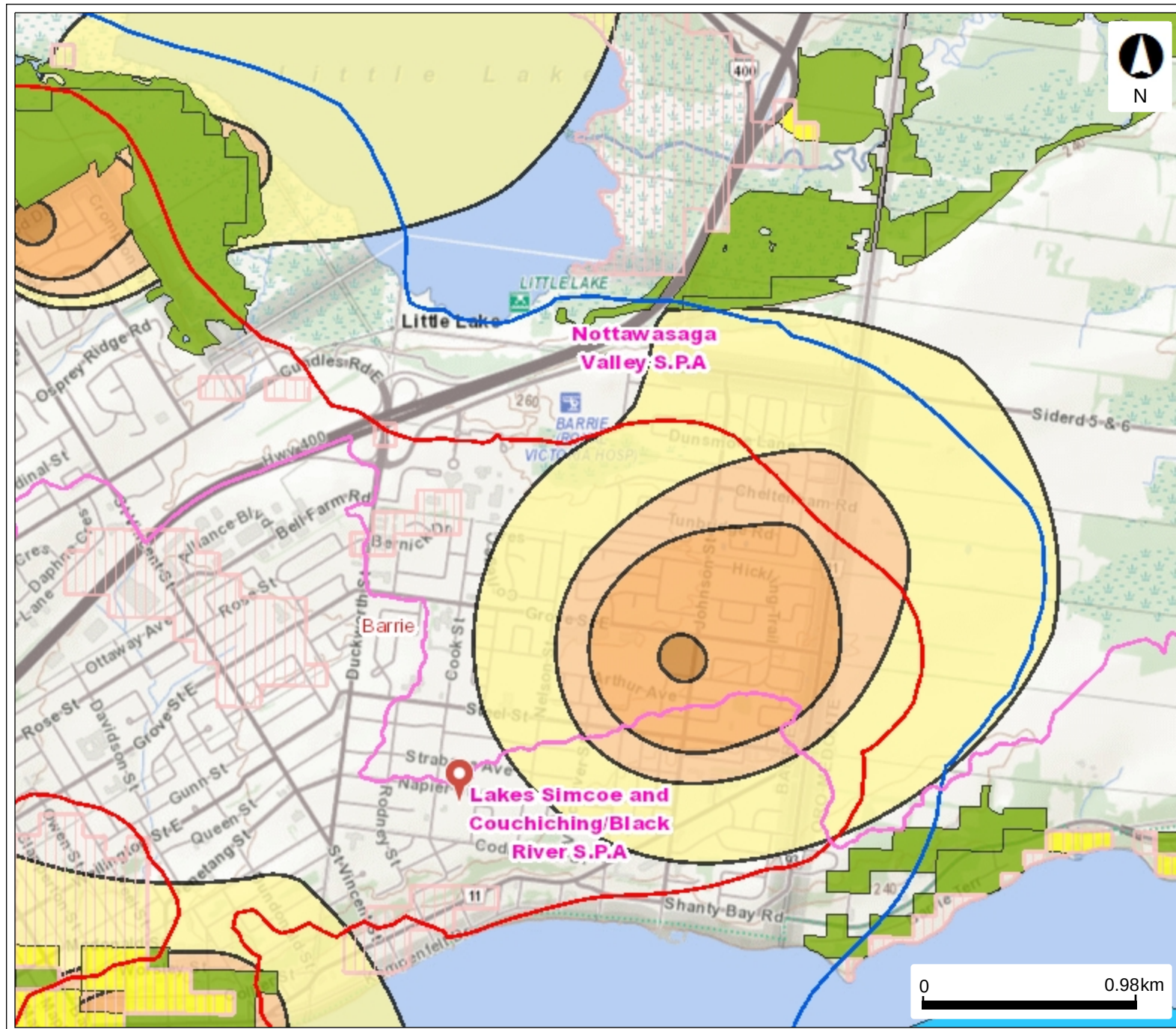
Legend

ANSI

- Earth Science Provincially Significant/sciences de la terre d'importance provinciale
- Earth Science Regionally Significant/sciences de la terre d'importance régionale
- Life Science Provincially Significant/sciences de la vie d'importance provinciale
- Life Science Regionally Significant/sciences de la vie d'importance régionale
- Conservation Reserve
- Provincial Park
- Natural Heritage System



WHPA Q1/Q2 Areas



Legend

- Source Protection Areas
- Wellhead Protection Area Q1
- Wellhead Protection Area Q2
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Area
 - 0
 - 2
 - 4
 - 6
- Wellhead Protection Area
 - A
 - B
 - C
 - C1
 - D
 - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.



Appendix B
MECP Well Records



WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

5714857

MUNICIPALITY 57501

CON.

COUNTY OR DISTRICT Simcoe	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Barrie	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
OWNER (SURNAME FIRST) BARRIE PUC	ADDRESS Bayfield St Barrie	DATE COMPLETED DAY 28 MO 11 YR 77	
1-2-07	605700	4916400	5
0850	5	22	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET	
				FROM	TO
Brown	clay	gravel & boulders	stiff	0	19
Brown	clay	gravel	stiff	19	27
Grey	clay		hard	27	43
Grey	clay	gravel	stiff	43	49
Grey	clay	sand	layers	49	73
Blue	clay		hard	73	186
Grey	clay	sand	layers	186	248
Grey	clay		stiff	248	253
Grey	clay		hard	253	277
Grey	sand	(silty)	packed	277	324
Grey	clay		hard	324	333
Grey	clay	sand	layers	333	345

31	00196051113	002760511173	004340573	004920511173	00732052874	018630573	1
32	02482052874	027720573	03242288479	033320573	03452052874	03852280679	1

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
10-13	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
15-18	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
20-23	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
25-28	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
30-33	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET
10-11	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		13-16
17-18	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		20-23
24-25	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		27-30

FIVE

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
31-33	34-38	39-40
MATERIAL AND TYPE		DEPTH TO TOP OF SCREEN
		41-44
		FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET	MATERIAL AND TYPE	CEMENT GROUT LEAD PACKER ETC.
10-13	14-17	
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD 1 ☐ PUMP 2 ☐ BAILER	PUMPING RATE GPM	DURATION OF PUMPING 15-16 HOURS 17-18 MINS
STATIC LEVEL 19-21	WATER LEVEL END OF PUMPING 22-24	WATER LEVEL DURING 15 MINUTES 26-28 30 MINUTES 29-31 45 MINUTES 32-34 60 MINUTES 35-37
IF FLOWING, GIVE RATE	PUMP IN TAKE SET AT 38-41	WATER AT END OF TEST 42
RECOMMENDED PUMP TYPE ☐ SHALLOW ☐ DEEP	RECOMMENDED PUMP SETTING 43-45	RECOMMENDED PUMPING RATE 46-49

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

DRILLER'S REMARKS:

FINAL STATUS OF WELL

1 ☐ WATER SUPPLY 2 ☒ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL	5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED
---	--

WATER USE

1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL 5 ☐ OTHER	5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED
---	--

METHOD OF DRILLING

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION	6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING
--	---

CONTRACTOR

NAME OF WELL CONTRACTOR Int'l. Water Supply Co.	LICENCE NUMBER 2801
ADDRESS Box 310 Barrie	
NAME OF DRILLER OR BORER A. Petersman	LICENCE NUMBER
SIGNATURE OF CONTRACTOR John Wal	SUBMISSION DATE DAY 9 MO 12 YR 77

OFFICE USE ONLY

DATA SOURCE 1	CONTRACTOR 2801	DATE RECEIVED 040178
DATE OF INSPECTION		INSPECTOR
REMARKS:		

CSS.ES

Ontario Ministry of the Environment

Well Tag No. A 132118

Well Record Regulation 903 Ontario Water Resources Act Page 1 of 1

Measurements recorded in: Metric Imperial

Well Owner's Information

First Name Last Name / Organization E-mail Address Well Constructed by Well Owner

Mailing Address (Street Number/Name) Municipality Province Postal Code Telephone No. (inc. area code)

Well Location

Address of Well Location (Street Number/Name) Township Lot Concession

County/District/Municipality City/Town/Village Province Ontario Postal Code

UTM Coordinates Zone Easting Northing Municipal Plan and Sublot Number Other

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
brown	sand	silt	dense	0'	20'

Annular Space		
Depth Set at (m/ft) From	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0' 8'	Bontanko chips	8'
8' 20'	silica sand	12'

Method of Construction		Well Use	
☒ Cable Tool	☐ Diamond	☐ Public	☐ Commercial
☒ Rotary (Conventional)	☐ Jetting	☐ Domestic	☐ Municipal
☐ Rotary (Reverse)	☐ Driving	☐ Livestock	☐ Test Hole
☐ Boring	☐ Digging	☐ Irrigation	☐ Cooling & Air Conditioning
☐ Air percussion		☐ Industrial	
☐ Other, specify		☐ Other, specify	

Construction Record - Casing			Status of Well	
Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
2"	Plastic	3/16	0'	10'

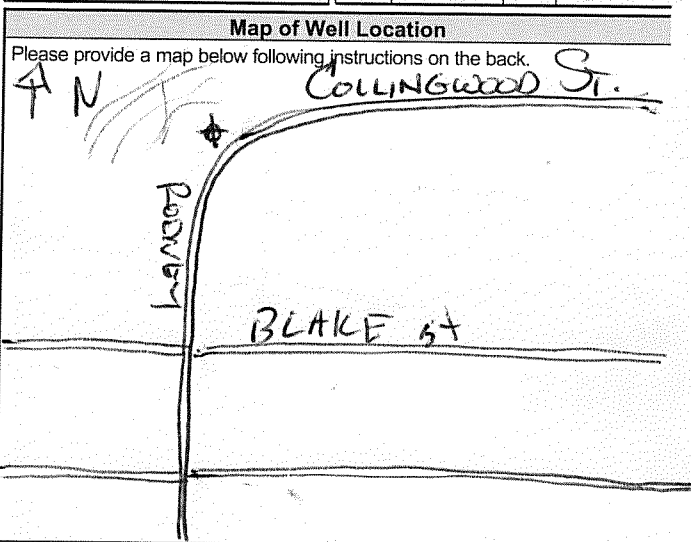
☐ Water Supply	☐ Replacement Well	☐ Test Hole	☐ Recharge Well	☐ Dewatering Well
☒ Observation and/or Monitoring Hole	☐ Alteration (Construction)	☐ Abandoned, Insufficient Supply	☐ Abandoned, Poor Water Quality	☐ Abandoned, other, specify
☐ Other, specify				

Construction Record - Screen		
Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.
2"	Plastic	010

Water Details		Hole Diameter	
Water found at Depth (m/ft)	Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify	Depth (m/ft) From	Depth (m/ft) To
Water found at Depth (m/ft)	Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify	0'	20'

Well Contractor and Well Technician Information			
Business Name of Well Contractor		Well Contractor's Licence No.	
LONDON SOIL TEST LTD		7190	
Business Address (Street Number/Name)		Municipality	
B.R.6		DUNDALK	
Province	Postal Code	Business E-mail Address	
ON	N6C1B0		
Bus. Telephone No. (inc. area code)		Name of Well Technician (Last Name, First Name)	
5194555777		COLLETTE RAYMOND	
Well Technician's Licence No.		Signature of Technician and/or Contractor	
3552			
		Date Submitted	
		20120906	

Results of Well Yield Testing				
After test of well yield, water was: ☐ Clear and sand free ☐ Other, <i>specify</i> _____	Draw Down		Recovery	
	Time (min)	Water Level (m/ft)	Time (min)	Water Level (m/ft)
If pumping discontinued, give reason:	Static Level			
	1		1	
Pump intake set at (m/ft)	2		2	
Pumping rate (l/min / GPM)	3		3	
	4		4	
Duration of pumping ____ hrs + ____ min	5		5	
Final water level end of pumping (m/ft)	10		10	
If flowing give rate (l/min / GPM)	15		15	
	20		20	
Recommended pump depth (m/ft)	25		25	
	30		30	
Recommended pump rate (l/min / GPM)	40		40	
	50		50	
Well production (l/min / GPM)	60		60	
Disinfected? ☐ Yes ☐ No				



Comments:		Ministry Use Only	
STICK-UP CASING		Audit No.	
		Z146878	
		Received	SEP 27 2012

☐ Well Constructed
by Well Owner

Telephone No. (inc. area code)

Concession

Postal Code

Municipal Plan and Sublot Number

Municipal Plan and Sublot Number

Other

Comments:		
Well owner's information package delivered	Date Package Delivered 20160429	Ministry Use Only
☒ Yes	Date Work Completed 20160411	Audit No. Z232439
☐ No		MAY 04 2016
		Received

Map: Well records

This map allows you to search and view well record information from reported wells in Ontario.

Full dataset is available in the Open Data catalogue (<https://data.ontario.ca/dataset/well-records>) .



[Go Back to Map](#)

Well ID

Well ID Number: 7409631

Well Audit Number: C53141

Well Tag Number: A338862

This table contains information from the original well record and any subsequent updates.

Well Location

Address of Well Location		
Township	BARRIE CITY (VESPRA)	
Lot		

Concession	
County/District/Municipality	SIMCOE
City/Town/Village	
Province	ON
Postal Code	n/a
UTM Coordinates	NAD83 — Zone 17 Easting: 606002.00 Northing: 4916904.00
Municipal Plan and Sublot Number	
Other	

Overburden and Bedrock Materials Interval

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To

Annular Space/Abandonment Sealing Record

Depth From	Depth To	Type of Sealant Used (Material and Type)	Volume Placed	

Method of Construction & Well Use

Method of Construction	Well Use	

Status of Well

Construction Record - Casing

Inside Diameter	Open Hole or material	Depth From	Depth To	

Construction Record - Screen

Outside Diameter	Material	Depth From	Depth To	

Well Contractor and Well Technician Information

Well Contractor's Licence Number: 7464

Results of Well Yield Testing

After test of well yield, water was		
If pumping discontinued, give reason		
Pump intake set at		
Pumping Rate		
Duration of Pumping		
Final water level		
If flowing give rate		
Recommended pump depth		

Recommended pump rate	
Well Production	
Disinfected?	

Draw Down & Recovery

Draw Down Time(min)	Draw Down Water level	Recovery Time(min)	Recovery Water level
SWL			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	

25		25	
30		30	
40		40	
45		45	
50		50	
60		60	

Water Details

Water Found at Depth	Kind	

Hole Diameter

Depth From	Depth To	Diameter	

Audit Number: C53141

Date Well Completed: December 08, 2021

Date Well Record Received by MOE: February 02, 2022

Related

How to use a Ministry of the Environment map (<https://www.ontario.ca/page/how-use-ministry-environment-map#wells>)

Technical documentation: Metadata record (<https://data.ontario.ca/dataset/well-records/resource/3031344e-e3f2-48d5-888c-c1deadfd2f77>)

Updated: January 10, 2024
Published: March 20, 2014



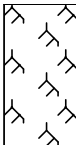
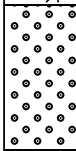
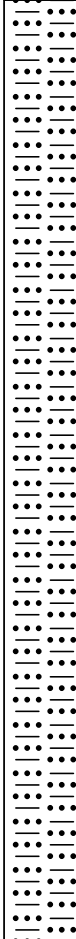
Appendix C
Borehole Logs



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

Client: Innovative Planning Solutions
Contractor: Landshark Drilling
Location: 95 Cook Street, Barrie, Ontario

Project Name:	103 Napier Street and 95 Cook Street, Barrie, ON	Project No.:	14079-001
Method:	Hollow Stem Auger	Date Completed:	December 8, 2021
UTM:	17T: 4916983 m north, 605915 m east	Elevation:	270.36 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture 25 50 75			SPT (N) 10 20 30 40				Well Installation	Remarks
270	0		Topsoil: Black silt, some sand, some organics, loose, moist [TOPSOIL]	1	SS	40	4								Monument Cap	Top of Pipe (TOP) elevation: 271.34 mASL Well dry when measured on December 20, 2021
269	1		Sand: Brown sand, some silt, trace organics, loose, moist [FILL]	2	SS	80	7								Bentonite Plug PVC Standpipe	GSA SS3: 0% Gravel 70% Sand 27% Silt 3% Clay
268	2		Silty Sand: Brown silty sand, trace clay, very dense, dry	3	SS	60	50/280 mm									
267	3															
266	4															
265	5															
264	6		-more silt, moist	6	SS	70	50/280 mm								Sand Pack PVC Screen	
			Borehole terminated at 6.5 mbgs in silty sand due to target depth												Cap	
264	7															

Logged By: BW

Input By: BW



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Kingston
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Log of Borehole:

MW102-21

Page 1 of 1

Client: Innovative Planning Solutions

Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON **Project No.:** 14079-001

Contractor: Landshark Drilling

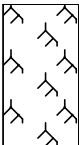
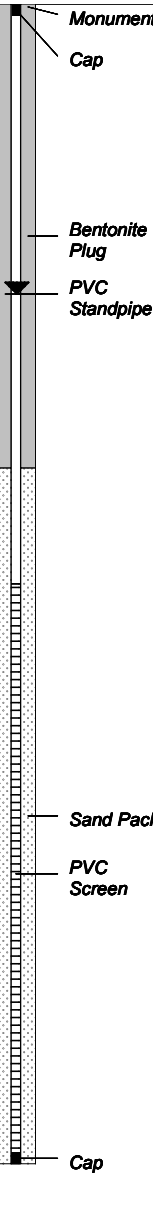
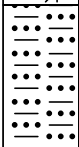
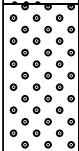
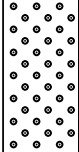
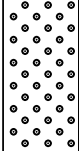
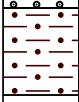
Method: Hollow Stem Auger

Date Completed: December 8, 2021

Location: 103 Napier Street, Barrie, Ontario

UTM: 17T: 4916970 m north, 606025 m east

Elevation: 269.08 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)			Well Installation	Remarks	
								25	50	75	10	20	30	40		
269	0		Topsoil: Black silt, some sand, some organics, trace gravel, loose, moist [TOPSOIL]	1	SS	20	6								 Monument Cap Bentonite Plug PVC Standpipe Sand Pack PVC Screen Cap	Top of Pipe (TOP) elevation: 270.03 mASL Groundwater measured at 5.4 mbgs (263.68 mASL) on December 20, 2021
268	1		Silty Sand: Brown silty sand, some gravel, compact, moist	2	SS	60	27									
267	2		Sand: Brown sand, some gravel, trace silt, very dense, saturated	3	SS	50	50									
			-less gravel, wet	4	SS	50	50/280 mm									
266	3		-dense	5	SS	60	45									
265	4		-moist	6	SS	50	50									
264	5															
263	6		Silt: Brown, silt, some clay, trace sand, trace gravel, dense, wet	7	SS	80	50								GSA SS7: 1% Gravel 4% Sand 77% Silt 18% Clay	
			Borehole terminated at 6.6 mbgs in silt due to target depth achieved.													
	7															

Logged By: BW

Input By: BW



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Kingston
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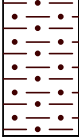
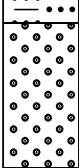
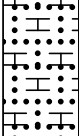
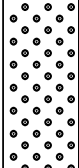
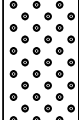
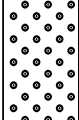
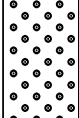
Log of Borehole:

BH103-21

Page 1 of 1

Client: Innovative Planning Solutions
Contractor: Landshark Drilling
Location: 95 Cook Street, Barrie, Ontario

Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON **Project No.:** 14079-001
Method: Hollow Stem Auger **Date Completed:** December 8, 2021
UTM: 17T: 4916952 m north, 605975 m east **Elevation:** 269.30 mASL

SUBSURFACE PROFILE				SAMPLE											
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)			Well Installation	Remarks
								25	50	75	10	20	30	40	
269	0		Asphalt: Asphalt thickness: 50 mm												Borehole open and dry upon completion
			Silt: Brown silt, some sand, trace gravel, loose, moist [FILL]	1	SS	60	5								
			-compact	2A											
268	1		Silty Sand: Brown silty sand, trace gravel, compact, moist	2B	SS	80	12								GSA SS4: 1% Gravel 13% Sand 63% Silt 23% Clay
			Sand: Brown sand, some gravel, trace silt, dense, dry	3	SS	70	49								
267	2		Clayey Silt: Brown clayey silt, some sand, trace gravel, very stiff, moist	4	SS	90	30								
			Sand: Brown sand, trace gravel, trace silt, very dense, dry	5	SS	70	50/205 mm								
266	3														
265	4			6	SS	0	50/50 mm								broken cobbles in spoon
264	5														
263	6		-grey, more gravel	7	SS	20	50/100 mm								
263	7		Borehole terminated at 6.2 mbgs in sand due to target depth achieved.												

Logged By: BW

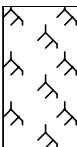
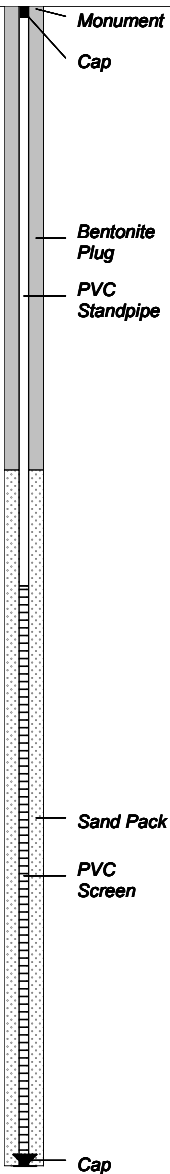
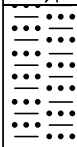
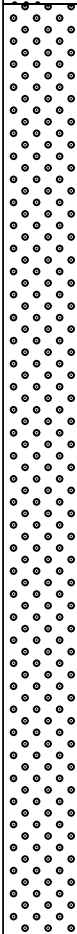
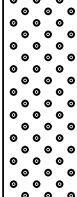
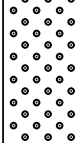
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Client: Innovative Planning Solutions
Contractor: Landshark Drilling
Location: 95 Cook Street, Barrie, Ontario

Project Name:	103 Napier Street and 95 Cook Street, Barrie, ON	Project No.:	14079-001
Method:	Hollow Stem Auger	Date Completed:	December 8, 2021
UTM:	17T: 4916905 m north, 606003 m east	Elevation:	268.17 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture 25 50 75			SPT (N) 10 20 30 40				Well Installation	Remarks
268	0		Topsoil: Black silt, some sand, some organics, loose, moist [TOPSOIL]	1	SS	20	7									Top of Pipe (TOP) elevation: 269.13 mASL Groundwater measured at 5.19 mbgs (262.98 mASL) on December 20, 2021
267	1		Sandy Silt: Brown sandy silt, trace organics, trace gravel, trace clay, loose, wet	2	SS	70	9									
266	2		Sand: Brown sand, trace silt, trace clay, dense, wet	3	SS	50	33									
				4	SS	60	37									
265	3			5	SS	70	50									
264	4		-very dense													
263	5			6	SS	60	50/255 mm									
262	6		-saturated													
				7	SS	90	50/180 mm									
			Borehole terminated at 6.4 mbgs in sand due to target depth achieved.													
262	7															

Logged By: BW

Input By: BW



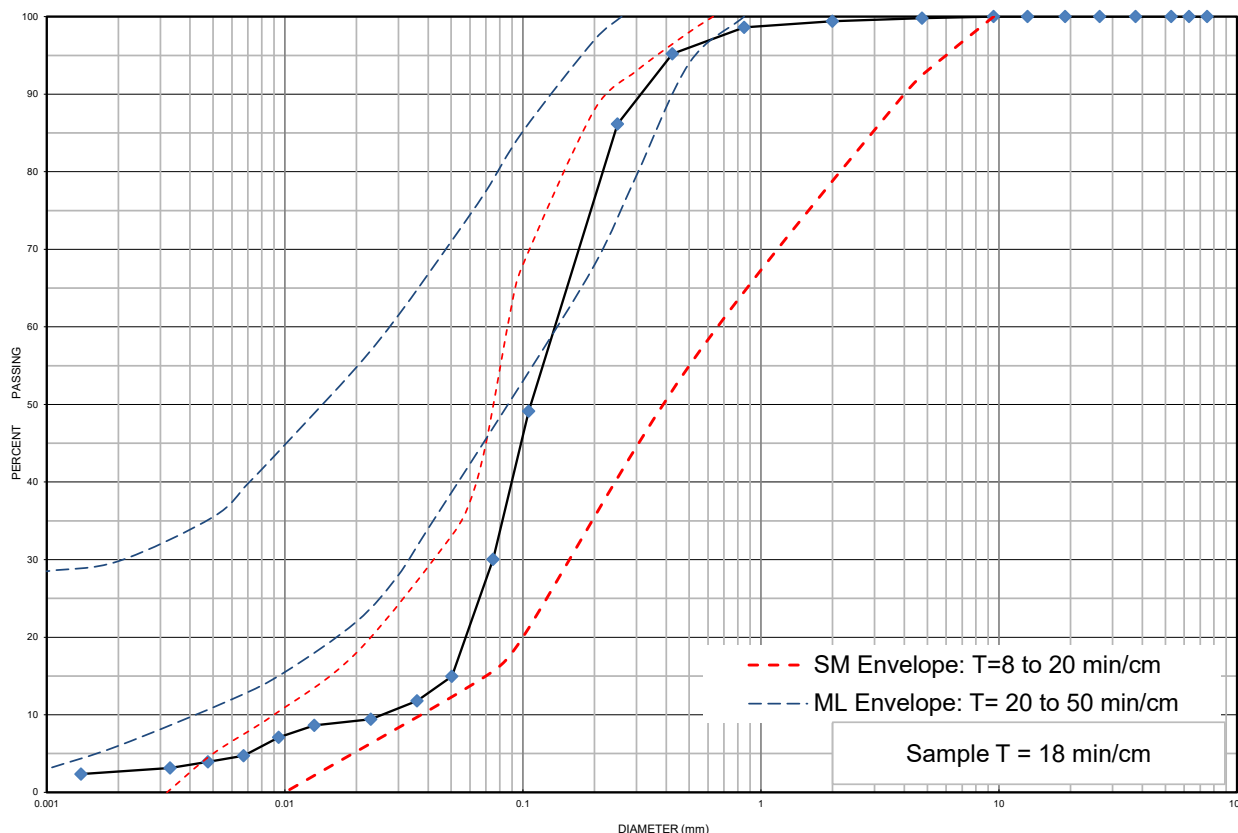
Appendix D
Grain Size Analysis Data



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 101-21 SS 3 **Depth:** 1.5 m to 2 m **Lab Sample No:** S-21-1686

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 101-21	SS 3	1.5 m to 2 m	0	70	27	3	6.6
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand trace Clay		SM	0.145	0.0750	0.0	5.58	1.49

Additional information available upon request

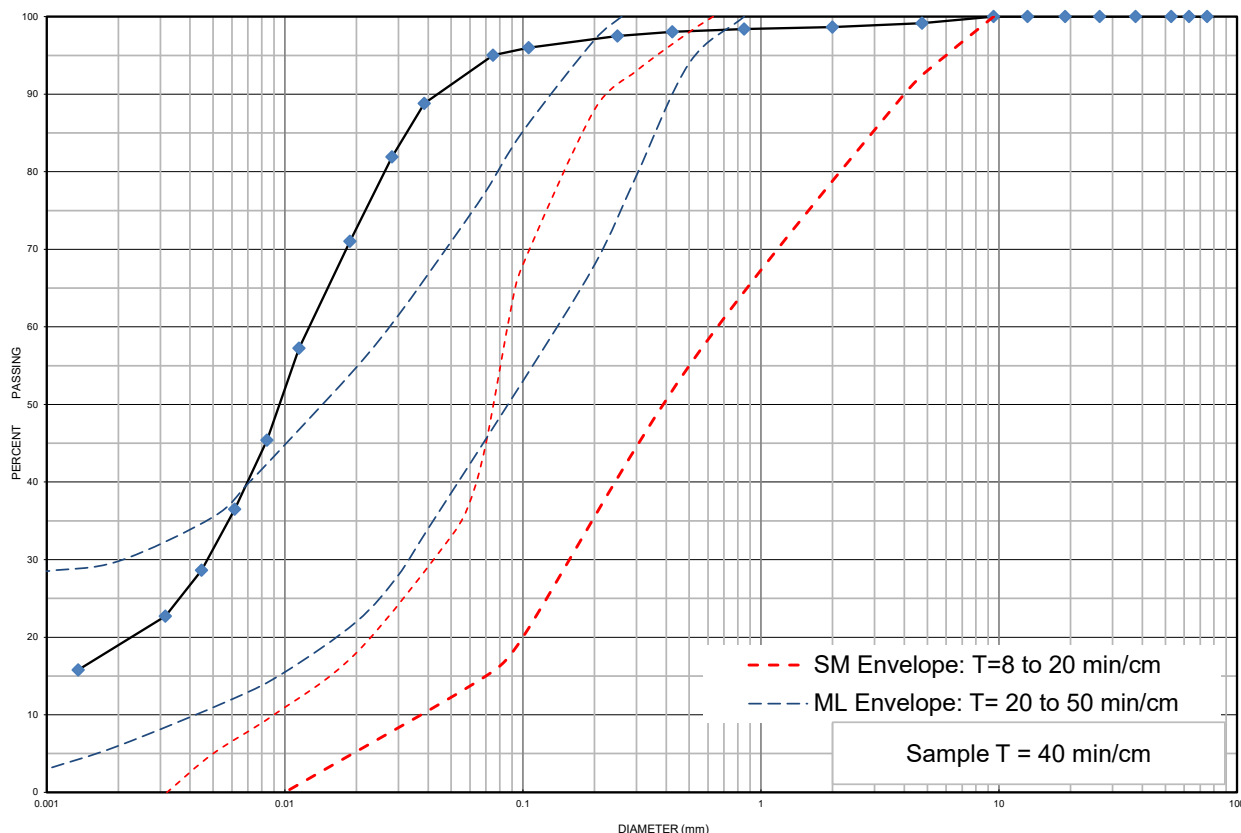
Issued By:  **Date Issued:** January 24, 2022
 (Senior Project Manager)



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 102-21 SS 7 **Depth:** 6.1 m to 6.6 m **Lab Sample No:** S-21-1687

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 102-21	SS 7	6.1 m to 6.6 m	1	4	77	18	17.0
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silt some Clay trace Sand trace Gravel		ML	0.014	0.0047	-	-	-

Additional information available upon request

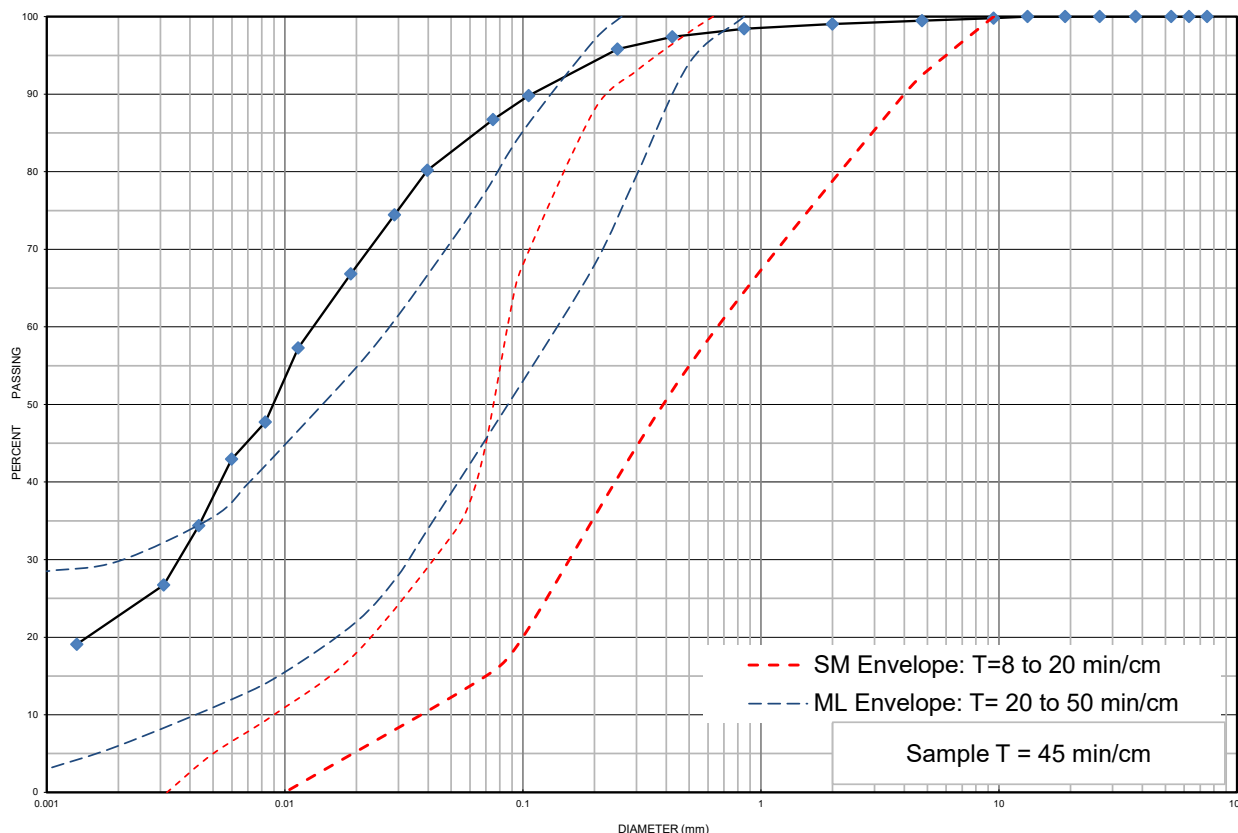
Issued By:  **Date Issued:** January 24, 2022
 (Senior Project Manager)



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 103-21 SS 4 **Depth:** 2.3 m to 2.7 m **Lab Sample No:** S-21-1688

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 103-21	SS 4	2.3 m to 2.7 m	1	13	63	23	16.8
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Clayey Silt some Sand trace Gravel		ML	0.014	0.0036	-	-	-

Additional information available upon request

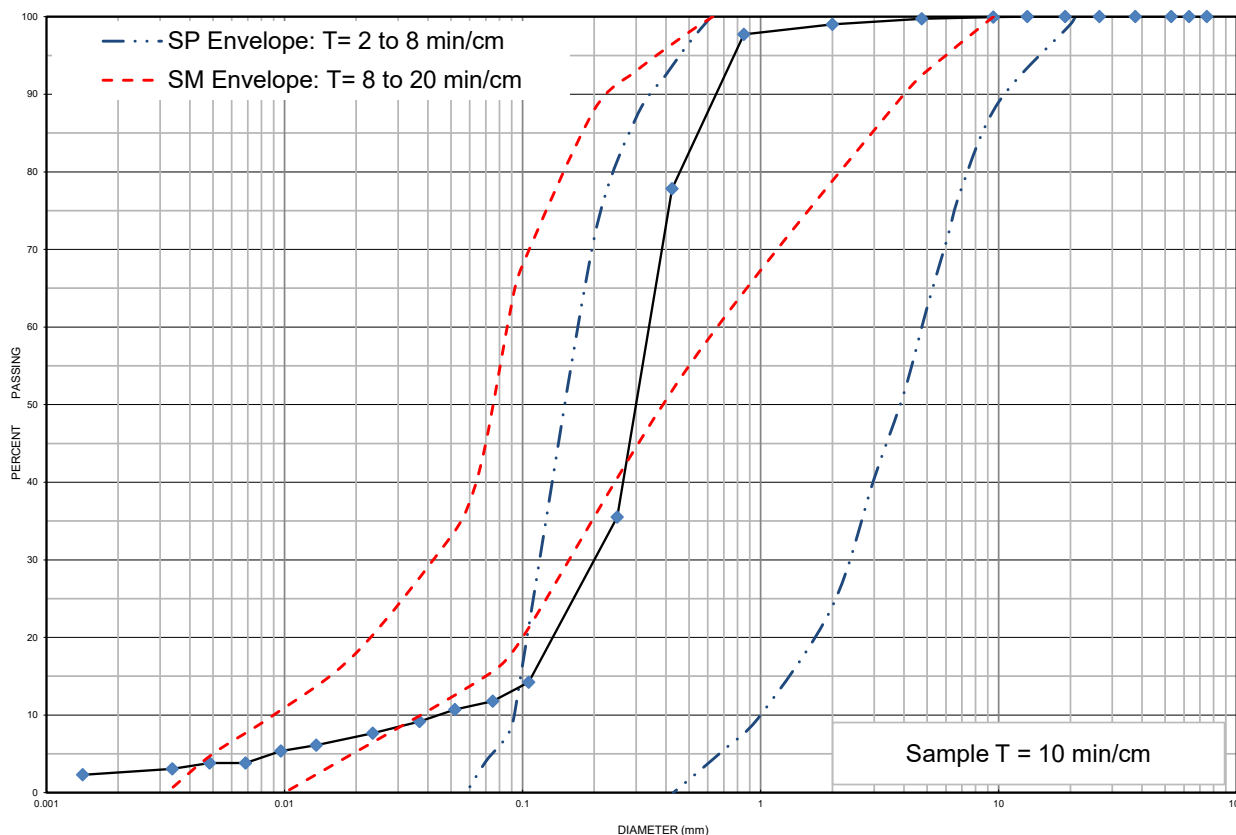
Issued By:  **Date Issued:** January 24, 2022
 (Senior Project Manager)



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 104-21 SS 5 **Depth:** 3 m to 3.5 m **Lab Sample No:** S-21-1689

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 104-21	SS 5	3 m to 3.5 m	0	88	9	3	6.4
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand trace Silt trace Clay		SW	0.345	0.2000	0.0	7.67	2.58

Additional information available upon request

Issued By:  (Senior Project Manager) **Date Issued:** January 24, 2022



Appendix E
Thornthwaite Water Balance



Pre- and Post-Development Water Balance Calculations

95 Cook Street and 103 & 107 Napier Street, Barrie, Ontario

1 Climate Information

Precipitation	933 mm/yr
Actual Evapotranspiration	537 mm/yr
Water Surplus	396 mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors

Topography: Flat Lying to Gently Sloping	0.3
Soil Type: Silty Sand to Sandy Silt	0.25
Cover: Cultivated Land	0.1
Total Infiltration Factor	0.65

Infiltration (Water Surplus * Infiltration Factor)	257 mm/yr
Run-off (Water Surplus - Infiltration)	139 mm/yr

Table 3 Approach - Typical Recharge Rates

Coarse Sand and Gravel	>250	mm/yr
Fine to medium sand	200-250	mm/yr
Silty sand to sandy silt	150-200	mm/yr
Silt	125-150	mm/yr
Clayey Silt	100- 125	mm/yr
Clay	<100	mm/yr

Site development area is underlain predominantly by sandy silt to silty sand

Based on the above, the recharge rate is typically 150-200 mm/yr

3 Pre-Development Property Statistics

	ha	m ²
Total Paved Area	0.27	2,729
Total Roof Area	0.06	604
Total Landscape Area	0.69	6,941
Total	1.03	10,274

4 Post-Development Property Statistics

	ha	m ²
Total Paved Area	0.41	2,895
Total Roof Area	0.28	3,581
Total Landscape Area	0.31	3,798
Total	1.01	10,274



Pre- and Post-Development Water Balance Calculations

95 Cook Street and 103 & 107 Napier Street, Barrie, Ontario

5 Pre-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	2,729	2,546	255	-	2,292
	Roof Area	604	564	56	-	507
Pervious Areas	Landscape Area	6,941	6,476	3,727	1,787	962
Totals		10,274	9,586	4,038	1,787	3,761

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6 Post-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	2,895	2,701	270	-	2,431
	Roof Area	3,581	3,341	334	-	3,007
Pervious Areas	Landscape Area	3,798	3,544	2,040	978	526
Totals		10,274	9,586	2,644	978	5,964

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

7 Comparison of Pre- and Post -Development

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Pre-Development	9,586	4,038	1,787	3,761
Post-Development	9,586	2,644	978	5,964
Change in Volume	-	-	809	2,204
Change in %	-	-	45	59

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m ³ /yr)	1,787
Volume of Post-Development Infiltration (m ³ /yr)	978
Deficit from Pre to Post Development Infiltration (m ³ /yr)	809
Percentage of Roof Runoff required to match the pre-development infiltration (%)	27