March 30, 2023

Project Number 484-032-22

Gerrits
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ENGINEERING | BUILDINGS | RELATIONSHIPS

BARRIE | ONTARIO | 705-737-3303
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FUNCTIONAL SERVICING REPORT

Regarding:

Townhouse Development
159 Huronia Road
Barrie, Ontario

Prepared on behalf of:

N.J. Electric General Contracting
via Innovative Planning Solutions

By:

GERRITS ENGINEERING LIMITED
222 Mapleview Dr. W., Suite 300
Barrie, ON L4N 9E7

Date:

MAR 2023

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1. Introduction

Gerrits Engineering Ltd. (GEL) has been retained by N.J. Electric General Contracting *via Innovative Planning Solutions* (Client) to provide engineering services for a proposed townhouse development located at 159 Huronia Rd. in the City of Barrie (City), located east of Huronia Rd. and north of Little Ave.

This Functional Servicing Report (FSR) will be submitted to the City of Barrie and other required agencies in support of a Zoning By-Law Amendment for the subject land, to demonstrate how the proposed development can be serviced by the surrounding existing municipal infrastructure. In particular, this FSR will examine the property's servicing with relation to: Water Supply, Sanitary Sewerage & Storm Sewerage.

It should be noted that the recommendations provided in this report must be considered preliminary, as the site plan referenced is at the conceptual design stage. As the design progresses & is finalized, further reporting may be required to re-confirm the functional servicing of the site.

1.1. Supporting & Reference Documents

The following documents have been referenced in the preparation of this report:

- Ministry of the Environment, Guidelines for the Design of Sanitary Sewage Works and Water Works – 2008
- Ministry of the Environment, Stormwater Management Planning and Design Manual – March 2003
- LSRCA Technical Guidelines for Stormwater Management Submissions – September 2016
- Hutchison Environmental Sciences Ltd. Phosphorous Budget Tool – March 30, 2012
- Ontario Building Code
- City of Barrie Engineering Standards & Guidelines

1.2. Subject Property

The property of 159 Huronia Rd. is about 0.14 Ha in area and rectangular in shape. It is legally described as Part 1, Lot 5, Registered Plan 1088 in the City of Barrie. In general, the property has an existing building in the center, with gentle slopes along the exterior that directs drainage away from the building and towards the property limits on all sides. The existing building is approximately 80 m^2, while the remaining property is covered via grassed surface & gravel driveway. The topographical information is based on survey completed by KRCMAR and aerial mapping from Google Earth and the LSRCA GIS Mapping.

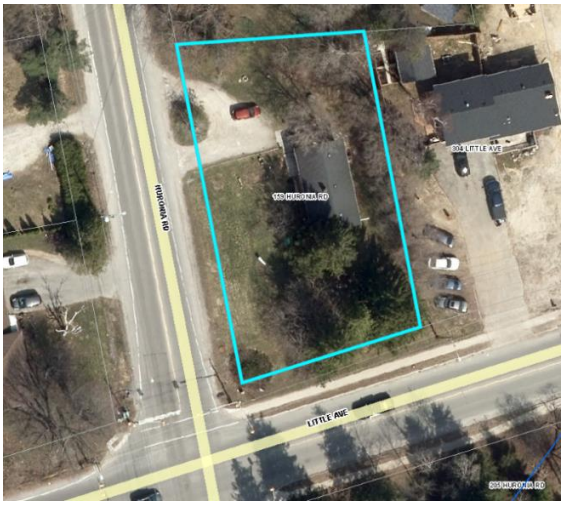


Figure 1 – Subject Property

1.3. Proposed Land Use

It is proposed to construct a 3-storey townhouse residential structure, consisting of 4 units within the property. Each unit will have direct driveway access and entry from Huronia Rd.

2. Servicing

2.1. Overview

It is proposed to service the Development by completing connections to the City's water and sanitary distribution & collection system. The Development's internal collection and distribution system will be constructed as per the City of Barrie and Ministry of Environment (MOE) design guidelines. The site's internal water distribution system will be designed to account for domestic and fire protection requirements.

2.2. Design Criteria

A summary of the water and wastewater design criteria is as follows:

Serviced Population

- Density – Sanitary = 2.34ppu
- Sanitary Development residential population – 4 units x 2.34 ppu = 10pers
- Density – Water = 2.57 ppu
- Water Development residential population – 4 units x 2.57 ppu = 11 pers

Wastewater Criteria

- Average Day Flow (ADF) Residential = 225 L/c/d
- Extraneous flows (peak per developable ha) = 0.1 L/s/ha
- Peak Factor = Harmon

Water Criteria

- Average Day Demand (ADD) Residential = 225 L/c/d
- Max Day Factor (MDF) (MOE: Table 3-3) = 9.50
- Peak Hour factor (PHF) (MOE: Table 3-3) = 14.3
- Minimum pressure in system at MDD = 275 kPa
- Maximum pressure in system at MDD = 700 kPa
- Minimum pressure in system at Peak Hour demand = 275 kPa
- Minimum pressure in system at Fire + MDD = 140 kPa

3. Sanitary Servicing

The projected daily average and peak sewage flows from the subject property are summarized in the table below.

Table 1 – Design Wastewater Flows

Average Daily Demand (Design)	2.33	m^3/d
	0.03	L/s
Peak Hour Flow (Design)	11.23	m^3/d
	0.13	L/s

3.1. Proposed Sanitary Connections

It is proposed to connect each of the (x4) townhouse units directly to the existing 600mm Mainline Sanitary Sewer along Huronia Road. The sanitary service connections shall adhere to the City of Barrie's Sanitary Sewage Collection System Policies and Design Guidelines.

Assuming a 100mm diameter PVC sanitary service connection pipe & 1.0% slope, the pipe will be able to convey approximately 5.1L/s. It is proposed to install the 100mm diameter PVC sanitary service connection pipe at a 2.0% slope (as per the City's Recommended Design Guidelines), which will allow for a conveyance up to 7.3L/s.

The anticipated peak flow of 0.13L/s is well within the capacity range of the proposed sanitary service connection & grade. Therefore, it is proposed to install the (x4) sanitary service connections to the existing 600mm Mainline Sanitary Sewer, as shown on the attached servicing plan in Appendix B. It should also be noted that (x1) existing sanitary service connection is located on site, and it proposed to maintain & utilize the existing connection as one of the (x4) proposed connections.

3.2. Internal Sanitary Collection System

Sanitary sewers & service connections are proposed to be constructed in accordance with the City's Engineering Standards and the MOE guidelines to service the Development. The proposed sewers will consist of PVC DR35 pipe designed to meet minimum and maximum velocities under full flow conditions.

4. Water Supply and Distribution

4.1. Design Criteria

The water servicing of this project has been considered from an internal perspective and the preliminary analysis of the onsite demands has been completed as per the City of Barrie and MOE guidelines. The projected daily average, maximum day, and peak hourly flows from the subject property are summarized in the table below.

Table 2 – Design Water Flows

Average Daily Demand (Design)	2.47	m^3/d
	0.03	L/s
Maximum Day Demand (Design)	23.51	m^3/d
	0.27	L/s
Peak Hour Flow (Design)	35.39	m^3/d
	0.41	L/s

4.2. Internal Water Distribution System

As per section 10.8 of the MOE Design Guidelines for Drinking-Water Systems 2008, the recommended minimum size of service line for single-family residences is 19 mm (¾ in). Larger residences and buildings located far from the watermain connection should have a 25 mm (1 in) or larger service.

As per the City's Pre-Consultation Comments, it is proposed to decommission the existing 19mm Municipal Water Service from Huronia Rd. and install a new 25mm (1in) diameter Copper Water Service for each of the (x4) townhouse units. Therefore (x4) new water service connections are proposed to be connected to the existing 200mm municipal watermain on Huronia Rd. All systems will be constructed and tested in accordance with the City of Barrie Engineering Standards and MOE Guidelines.

4.3. Fire Flow Analysis

As per the City's revised Water Transmission and Distribution Policies and Design Standard, supporting documentation is required to ensure the development meets the City's minimum Fire Flow Requirements. A summary of the fire flow design criteria is as follows:

Table 3 – City's Minimum Fire Flow Requirements

Description	Minimum Required Fire Flow
Residential	100 L/s
Townhouse	155 L/s
High Rise Residential / Downtown / Mixed Use	Development to provide own calculations

It is proposed to utilize the nearest hydrant located at the intersection of Huronia Rd & Little Ave to meet the City's Fire Flow requirements. An FUS calculation was requested. Referencing the Fire Underwriters Survey, the required Fire Flow for the proposed development is approximately 150 L/s. The design or desired fire flows shall be the greater of the calculated FUS flows and the City of Barrie's minimum fire flows. Therefore, based on the above criteria, the minimum fire flows shall be 155L/s. Detailed calculations have been provided in Appendix A. A hydrant flow test will be required to be completed, to verify the flow rate of the existing Hydrant.

5. Storm Drainage and Stormwater Management

A key component of the Development is the need to address environmental and related Stormwater Management (SWM) issues. These are examined in a framework aimed at meeting the City of Barrie, Lake Simcoe Region Conservation Authority (LSRCA), and MECP requirements. SWM parameters have evolved from an understanding of the location and sensitivity of the site's natural systems.

It is understood that the objectives of the SWM plan are to:

- Protect life and property from flooding and erosion.
- Maintain water quality for ecological integrity, recreational opportunities etc.
- Protect and maintain groundwater flow regime(s).
- Protect aquatic and fishery communities and habitats.
- Maintain and protect significant natural features.
- Protect and provide diverse recreational opportunities that are in harmony with the environment.

5.1. Existing Drainage Conditions

Based on the existing as-constructed plans provided by the City of Barrie, it was confirmed that the subject site is part of a larger drainage area that utilizes a stormwater detention pond as the end-of-pipe control facility. Based on the plans provided, the subject site corresponds to (x2) catchment areas, with assigned runoff coefficients of 0.49 & 0.56. Therefore, to analyze the existing drainage condition, the runoff coefficient of 0.49 will be applied for the subject site, for a conservative approach.

5.2. Proposed Drainage Conditions

The proposed development will increase the imperviousness of the site and it is important to quantify this change to determine quantity control requirements and confirm if the existing/allowable condition has been exceeded. As per the proposed site's statistics, the post development weighted runoff coefficient is:

Grass	=	890 m^2	R	=	0.10	AR	=	89.0
Asphalt	=	130 m^2	R	=	0.95	AR	=	123.5
Building	=	380 m^2	R	=	0.95	AR	=	361.0
					Total	AR	=	573.5

Site Area = 1,400 m^2 AR = 573.5 m^2 Weighted R = 0.41

Based on the proposed site statistics, the proposed runoff coefficient of 0.41, will be below the existing/allowed runoff coefficient of 0.49. Therefore, no additional quantity controls are recommended at this time.

5.3. Stormwater Quality Control During Construction

To ensure stormwater quality control during construction, it is imperative that effective environmental and sedimentation controls be in place throughout the entire area subject to construction activities. With the requirement of earth grading, there will be a potential of soil erosion. It is therefore recommended that the following be implemented to assist in achieving acceptable stormwater runoff quality:

- Restoration of exposed surfaces with vegetation and non-vegetative material as soon as construction schedules permit;
- Installation of filter strips, silt fences and rock check dams or other similar facilities throughout the site, and specifically during all construction activities;
- Reduce stormwater drainage velocities where possible;
- Ensure that disturbed areas that are left inactive for more than 30 days shall be vegetated and stabilized as instructed by the Engineer;
- Minimize the amount of existing vegetation removed.

5.4. Permanent Quality Control

The objective of the permanent SWM quality controls will be to meet MECP's Enhanced Protection Level. The proposed development will increase the imperviousness of the site. It is important to quantify this increase to evaluate the potential downstream impacts. As per the site's assumed statistics, the post development Total Imperviousness (TIMP) is:

Impervious Area = 510 m^2
Total Area = 1, 400 m^2

$TIMP = A_{IMP} / A_{Total}$
$= (A_{ASPH} + A_{BLDG}) / A_{Total}$
$= 510\ m^2 / 1{,}400\ m^2$
$= 36.5\%$

Given the nature of the site it is proposed that the MECP's Enhanced Protection Level be achieved through infiltration of the TIMP.

Infiltration Facility

$A_D = 1{,}400\ m^2$ From Table 3.2: $V_{Req'd} = 25 m^3/ha$
TIMP = 36.5% $= 25.4 m^3/ha \times 0.14ha$
$= 3.6 m^3$

Therefore, the Infiltration Facility must provide a minimum volume of $3.6m^3$ to meet MOE Enhanced removal requirements. It is proposed to utilize a soakaway pit for each of the (x4) townhouse units, to promote infiltration for the development. The (x4) proposed pits will use the following minimum dimensions: 5.0m (L) x 2.0m (W) x 0.6m (D). The total volume provided for the subject site will be approximately 9.6 m^3, which exceeds the minimum requirements.

5.5. Volume Control

The LSRCA has defined the subject site as a major development. The subject site can be described as a nonlinear redevelopment; therefore, it is proposed to retain/treat the 25mm rainfall event via infiltration from the proposed building area. This results in a minimum volume of 9.03 m^3 to be infiltrated. As discussed in section 5.4, it is proposed to provide infiltration via soakaway pits for each townhouse unit. Therefore, the total volume provided from the proposed soakaway pits, exceeds the minimum requirement for volume control.

5.6. Erosion and Sediment Control

To ensure Stormwater runoff quality is controlled during construction, an erosion and sediment control strategy will be implemented to mitigate transportation of silt off-site to the existing roads and sewers. It is imperative that effective controls be put in place and maintained until all areas are stabilized with surface cover.

All erosion and sediment control Best Management Practices (BMP) shall be designed, constructed and maintained in accordance with the LSRCA's erosion control requirements.

Items that will be addressed for both temporary and permanent erosion and sediment controls are based on the following:

- Site location description and area;
- Existing and proposed land use;
- Vegetative cover;
- Existing drainage routes;
- Proposed site works;
- Proposed outlets;
- Permits required;
- Sediment filters and barriers - silt fences;
- Construction entrance location;
- Protection to catch basins and ditch inlets;

To prevent construction generated sediments from entering the storm sewers or leaving the site by overland flow, the following measures should be implemented during the construction phase:

- Temporary sediment control fencing should be erected around the perimeter of the grading activities.
- Temporary sediment fabric and stone filters should be installed on existing and proposed catch basins until surface cover has been stabilized.
- A temporary construction access mud mat should be implemented to reduce the amount of materials that may be transported off site.
- Construction during drier months should be monitored for wind-borne transport of sediments. At the direction of the engineer, the contractor may be directed to water down exposed earth areas with an aqueous solution of calcium chloride.
- All disturbed areas not under immediate construction for 30 days, or not intended for building activities within a 3-month time period, should be stabilized with seeding.

Built up sediment should be removed and disposed off-site at least once a month, or more frequently as directed by the engineer. Details have been provided on drawing ESC-1 and can be found in Appendix B.

6. Conclusions

A summary of the servicing recommendations are as follows:

- **Water Servicing** – it is proposed to decommission the existing 19mm Municipal Water service on Huronia Rd. and install (x4) new 25mm (1in) diameter Copper Water Services to provide water servicing for each townhouse unit.
- **Sanitary Servicing** – it is proposed to utilize (x1) existing sanitary service and install (x3) new 100mm PVC Sanitary Services to provide sanitary servicing for each townhouse unit.
- **Stormwater Drainage and Management** – the proposed runoff coefficient will be below the existing/allowed runoff coefficient; therefore, no additional quantity controls are recommended at this time. Quality & Volume control criteria will be satisfied using low impact development methods in a treatment train approach.

The analysis and conceptual design outlined in this report demonstrates that the servicing of this proposed Development is feasible, is based on sound engineering principles and, the development will become a cohesive part of the City of Barrie.

As a reminder, it should be noted that the recommendations provided in this report must be considered preliminary, as the site plan referenced is at the conceptual design stage. As the design progresses & is finalized, further reporting may be required to re-confirm the functional servicing of the site.

All of which is respectfully submitted,

Gerrits Engineering Ltd.

Edward Sanchez, P.Eng.
Civil Engineer

Appendix A
Design Calculations

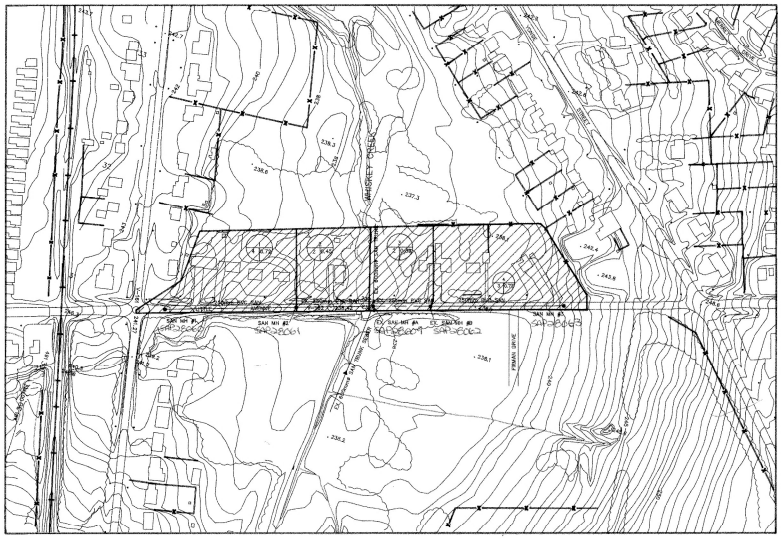
Calculation of Weighted Runoff Coefficient

Post Development Areas and Sub-Areas

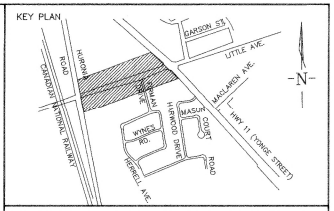
Area ID	Total Area	0.10 Grass	0.95 Asphalt	0.95 Building	0.60 Gravel	0.95 Conc.	Weighted Rational Coefficient
Pre-Development	1400	1189	0	80	99	32	0.49
X - 1	80	0	0	80	0	0	
X - 2	340	332	0	0	8	0	
X - 3	980	857	0	0	91	32	
Post-Development	1400	890	130	380	0	0	0.41
P - 1	380	0	0	380	0	0	0.95
P - 2	300	170	130	0	0	0	0.47
P - 3	670	670	0	0	0	0	0.10
P - 4	50	50	0	0	0	0	0.10

STORM DRAINAGE PLAN

SANITARY DRAINAGE PLAN

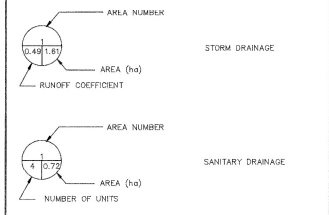


KEY PLAN



GENERAL NOTES:

1. ALL MEASUREMENTS ARE IN METRES UNLESS INDICATED OTHERWISE.



BENCHMARK:

No.	REVISIONS	DATE	APPROVED
1	AREAS REVISED	SEPT 91	S.M.
	CONSTRUCTION ISSUE	JUNE 92	

CITY OF BARRIE
ADOPTED FOR MUNICIPAL PURPOSES
DATE 1992 06 22
R. W. McAdam P.Eng.
CITY ENGINEER
MOTION NO.

LICENSED PROFESSIONAL ENGINEER
T. GARDINER
PROVINCE OF ONTARIO

MUNICIPALITY
CITY OF BARRIE INCORPORATED
CITY of BARRIE
ENGINEERING DEPARTMENT

TITLE

LITTLE AVENUE RECONSTRUCTION

LITTLE AVENUE STORM and SANITARY DRAINAGE AREA

REINDERS
F.J. Reinders and Associates (Barrie) Ltd.
Consulting Engineers, Planners, and Project Managers
80 Bradford St. Suite 18
Barrie, Ontario L4N-6S7 (705) 726-6723

DESIGN	S.M./T.D.	SCALE HOR. 1:2000	VERT.
DRAWN	KC	REVIEWED S.M.	DRAWING No. / CAD FILE 90189-SS
DATE PLOTTED	JAN. 17 92		

1991-013-002 91-13 sh.SS

MOE Quality Sizing Criteria

Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]

Protection Level	SWMP Type	Storage Volume (m³/ha) for Impervious Level			
		35%	55%	70%	85%
Enhanced 80% long-term S.S. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. removal	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. removal	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

Site Area: 1400 m^2

Site Impervious Area: 510 m^2

Impervious Level of Site: 36.4%

Volume Req'd for Quality Control: 25.4 m^3/ha

Volume Required: 3.55 m^3

Volume Required (per unit): 0.89 m^3
^based on (x4) units

Volume Control

Volume = C*drain*A
^based on City of Barrie example calculation (Stm design guidelines)

C = runoff coeffecient
drain = target rainfall event to infiltrate
A = building area

C (bldg) = 0.95

Atotal = 380 sq.m

A / unit = 380 / 4units

A = 95 sq.m

drain = 25 mm (LSRCA target for major development volume control)

Volume = C*drain*A

Volume = 2.26 m^3 per unit

Volume = 9.025 m^3 (Total)

Target Volumes

MOE Quality:	3.55 m^3 (total volume)	3.55 < 9.03
MOE Quality:	0.89 m^3 (per unit, (x4) units total)	.89 < 2.26
LSRCA Volume Control:	9.03 m^3 (total volume)	
LSRCA Volume Control:	2.26 m^3 (per unit, (x4) units total)	

Therefore, the LSRCA Volume Control is the more strict measure.
The LSRCA Volume Control measure will be utilized for infiltration sizing.

Minimum Sizing of Infiltration Measure [per unit basis]

Table 4.4: Minimum Soil Percolation Rates

Soil Type	Percolation Rate (mm/h)
sand	210
loamy sand	60
sandy loam	25
loam	15

Soil Type
Dundonald Sandy Loam

Volume Required: 2.256 m^3
Assumed Porosity of storage media (n): 0.4
Percolation Rate (estimated): 25 mm/h

Area Req'd (24hr): 9.4 m^2
Maximum Depth: 0.6 m
^based on T = 24hr

Equation 4.3: Infiltration Trench Bottom Area

$$A = \frac{1{,}000\,V}{Pn\Delta t}$$

where
A = bottom area of the trench (m^2)
V = runoff volume to be infiltrated (Table 3.2)
P = percolation rate of surrounding native soil (mm/h)
n = porosity of the storage media (0.4 for clear stone)
Δt = retention time (24 to 48 hours)

Equation 4.2: Maximum Allowable Soakaway Pit Depth

$$d = \frac{PT}{1{,}000}$$

where
d = maximum allowable depth of the soakaway pit (m)
P = percolation rate (Table 4.1) (mm/h)
T = drawdown time (24 - 48 h) (h)

Infiltration Measure Sizing

Width of Trench = 2.00 m
Height of Trench = 0.60 m
Length of Trench (L_T) = 5 m

Trench Area (A_T) = 1.2 sq.m

Trench Bottom Area = 10 sq.m

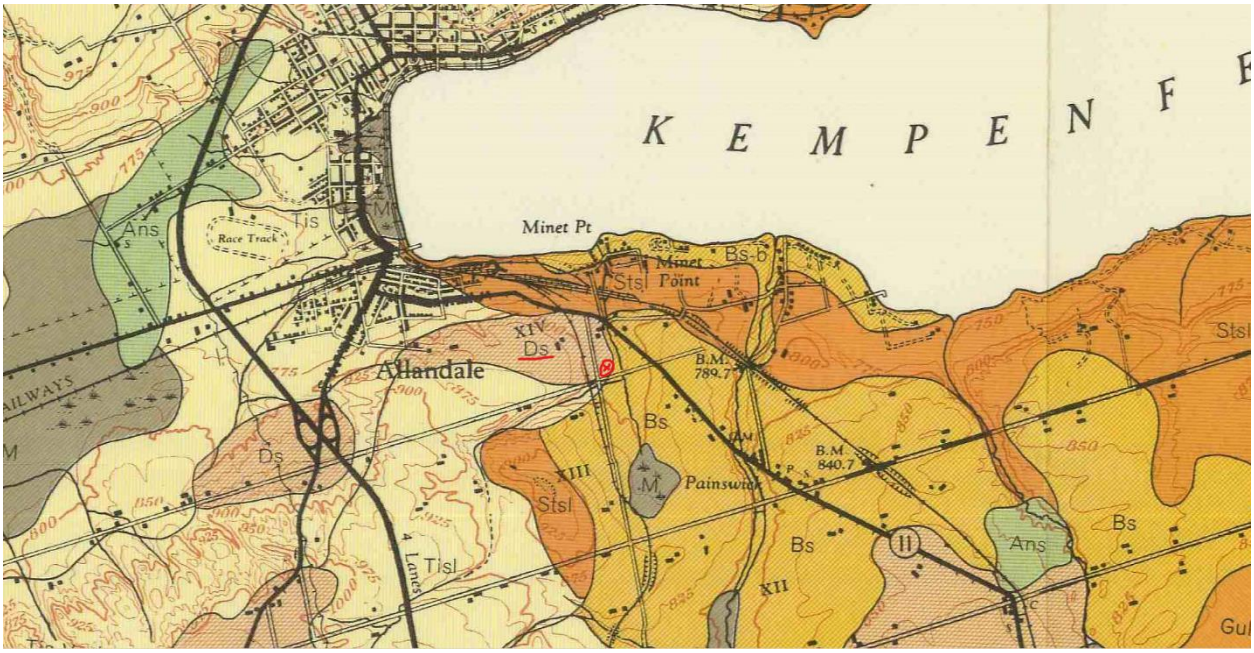
Stone Area (A_{ST}) = $A_T - A_P$
= 1.20 sq.m

Dia. Of Pipe = 0 mm
Pipe Area = 0 sq.m
# of Pipes = 0
Total Pipe Area (A_p) = 0.000 sq.m
Length of Pipe (L_P) = 0 m

Pipe Volume (V_P) = $A_P \times L_P$ = 0.00 m^3
Stone Volume (V_{ST}) = $A_{ST} \times L_T \times n$ = 2.40 m^3

Volume ($V_{P,\ per\ trench}$) = 2.4 m^3 (per infiltration trench)
Total Volume (V_P) = 2.4m3 x 4 units
Total Volume (V_P) = 9.6 m^3; 9.6 > 9.03, therefore Volume Control Achieved

Soil Survey of Simcoe County References



DUNDONALD	EDENVALE
sandy loam Ds 16,000 fine sandy loam Df 1,000	sandy loam Es 2,600
Outwash sand underlain by grey calcareous loam or sandy loam till at depths of 3 feet or less.	
Good.	Imperfect.
Smooth, gently sloping.	Smooth, very gently sloping.
Stonefree.	
Slightly acid.	
Grey-Brown Podzolic.	

Project Number: 484-032
Project Name: #159 Huronia
Location: #159 Huronia Rd, Barrie
Date: 3/30/2023

1 FUS Formula

$RFF = 220\,C\,\sqrt{A}$

where: RFF = required fire flow in litres per minute
C= the Coefficient related to the type of construction; and
A = the total flow area in square metres (including all storeys but excluding basements at least 50% below grade)

Type of Construction: Type V Wood Frame Construction

C = 1.5
A = 754.5
RFF = 9000 L/min
150 L/s

Assumptions
- the following calculation is based on a concept site plan
- 3-storey house
- it is assumed 1 floor lost due to Basement OR Garage access
- therefore 2 full floors (per unit) to be used as total effective area

2 Occupancy Adjustment

Type of Occupancy:	limited combustible	
Hazard Allowance:	-15%	
Fire Flow Adjustment		-1350 L/min
Revised F =		7650 L/min

3 Sprinkler Adjustment

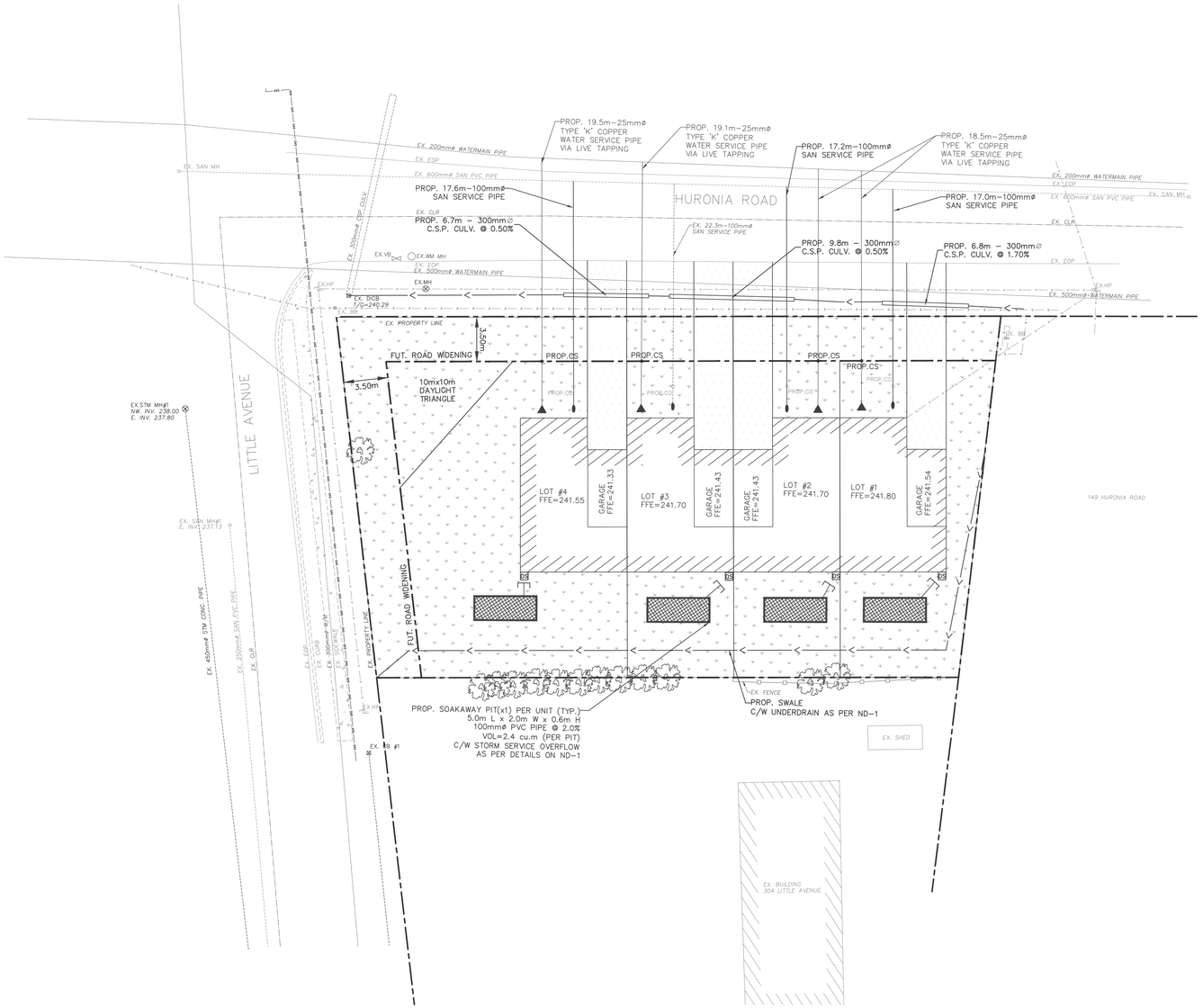
NFPA 13 sprinkler standard:	No	0%	
Standard water supply:	Yes	-10%	
Fully Supervised system:	No	0%	
Sprinkler Credit			-765 L/min

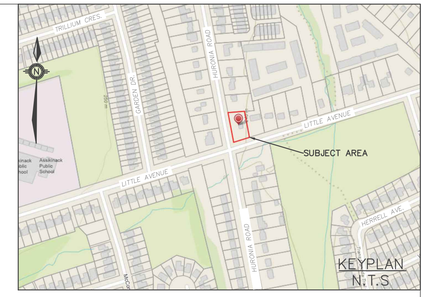
4 Exposure Adjustment

		Charge	
North Side	10.1 to 20m	15%	
East Side	10.1 to 20m	15%	
South Side	>30m	0%	
West Side	>30m	0%	
Exposures Surcharge		2295	L/min

Total Required Fire Flow	9000 L/min
	150.0 L/sec

Appendix B
Figures & Drawings





LEGEND

- PRIVACY FENCE
- ACOUSTIC FENCE
- CHAIN LINK FENCE
- SILT FENCE
- GAS LINE
- HYDRO LINE
- BELL LINE
- EXISTING SANITARY MAINTENANCE HOLE
- PROPOSED SANITARY MAINTENANCE HOLE
- EXISTING CATCH BASIN
- PROPOSED CATCH BASIN
- EXISTING STORM MAINTENANCE HOLE
- PROPOSED STORM MAINTENANCE HOLE
- SERVICE CAP
- DOWN SPOUTS
- FIRE DEPT CONNECTION
- EXISTING FIRE HYDRANT
- PROPOSED FIRE HYDRANT
- EXISTING VALVE BOX
- PROPOSED VALVE BOX
- PROPOSED SIGN
- EXISTING LIGHT POLE
- MANDOOR
- OVERHEAD DOOR
- SANITARY SERVICE
- WATER SERVICE
- LANDSCAPE AREA
- ASPHALT AREA
- CONCRETE AREA

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This drawing may have been reduced.

0 5 10 20 30 40 50mm
0" 1/4" 1/2" 1" 1 1/2" 2"

No.	Issuance Description	YY/MM/DD
1.	ZONING BY-LAW AMENDMENT	23/03/31
2.		

Issued For:

ZONING BY-LAW AMENDMENT

Client: NJ ELECTRIC GENERAL CONTRACTING
182 BIRKSHIRE DRIVE,
AURORA, ON L4G 7R8

Project: PROPOSED TOWNHOUSE DEVELOPMENT
159 HURONIA ROAD,
BARRIE,ON

Drawing:

SITE SERVICING PLAN

Project No.	484-032-22	Designed by: IO	Checked by: KF
Scale:	1:200	Drawn by: IO	Approved by:ES

Orientation

Stamp

Drawing No.

SS-1

NOTES FOR SEDIMENT & EROSION CONTROL

1. DISTURBED AREAS THAT HAVE FAILED TO HAVE STABLE GROUND COVER ESTABLISHED BY OCTOBER 30TH SHALL BE PROTECTED WITH A SILTATION CONTROL FENCE OR STRAW MULCH ETC. AND MAINTAINED BY THE CONTRACTOR UNTIL VEGETATION BECOMES ESTABLISHED IN THE SUBSEQUENT GROWING SEASON.
2. ANY DEWATERING WASTE SHALL BE DISCHARGED TO A VEGETATED AREA AT LEAST 30 M FROM ANY WATERCOURSE AND FILTERED. FILTERING METHODS MUST BE APPROVED BY THE SITE ADMINISTRATOR.
3. SILT FENCE SHALL BE PUT IN PLACE PRIOR TO AND MAINTAINED DURING ALL GRADING. SILT FENCE SHALL COMPLY WITH OPSD 219.110 FOR LIGHT DUTY AND / OR OPSD 219.130 FOR HEAVY DUTY; UNLESS NOTED OTHERWISE. SILT FENCE TO BE INSPECTED PRIOR TO COMMENCEMENT OF EARTH GRADING ACTIVITIES. SILT FENCE TO BE INSPECTED AND REPAIRED OR REPLACED IF DAMAGED AS DIRECTED BY THE SITE ADMINISTRATOR. SILT CONTROLS TO BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY RAIN EVENT. INSTALLATION SHALL BE TO THE MANUFACTURER'S SUGGESTED SPECIFICATIONS.
4. THE CONTRACTOR SHALL BE PREPARED FOR UNEXPECTED CONDITIONS AND ACCORDINGLY HAVE STOCKPILED MATERIALS ON SITE FOR NECESSARY REPAIRS AS A RESULT OF FAILED OR INADEQUATE CONTROL MEASURES. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE A WEEK, AND AFTER EVERY RAINFALL EVENT.
5. MUD MATS WHERE CONSTRUCTION TRAFFIC ENTERS OR LEAVES THE SITE SHALL BE USED. MUD MATS TO BE 300mm IN DEPTH, 5.0m WIDE BY 20.0m LONG, FIRST 10.0m TO 150mmø CLEAR STONE WITH THE REMAINING 10.0m CONSISTING OF 50mmø CLEAR STONE; OR MEET MUNICIPAL STANDARDS WHERE IDENTIFIED.
6. CONTRACTOR SHALL OBTAIN A CURRENT COPY AND BECOME FAMILIAR WITH OPSS 805, CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES AS WELL AS ALL APPLICABLE MUNICIPAL STANDARDS.
7. THE CONTRACTOR MAY CONSIDER ALTERNATIVE SEDIMENT AND EROSION CONTROL MEASURES. SUCH MEASURES SHOULD BE PRESENTED IN WRITING FOR APPROVAL OF THE SITE ADMINISTRATOR AND MUST BE APPROVED IN WRITING BY THE CONSERVATION AUTHORITY.
8. THE TOPS OF ALL FILTER FABRIC MUST BE A MINIMUM OF 1.0 METRES ABOVE THE GROUND LEVEL AND ATTACHED TO THE FENCE WITH A CONTINUOUS STEEL WIRE. ALTERNATIVELY, THE FILTER FABRIC MUST BE FOLDED OVER THE TOP OF THE FENCE AND ATTACHED TO THE FENCE WITH WIRE LOOPED THROUGH THE FABRIC ON BOTH SIDES OF THE FENCE. FILTER FABRIC IS TO BE TERRAFIX 270R OR EQUIVALENT.
9. ALL DISTURBED GROUND LEFT INACTIVE SHALL BE STABILIZED BY SEEDING, SODDING, MULCHING, OR COVERING OR OTHER EQUIVALENT CONTROL MEASURES. THIS PERIOD OF INACTIVITY SHALL BE AT THE DISCRETION OF THE MUNICIPAL DIRECTOR OF ENGINEERING BUT SHALL NOT EXCEED (30) DAYS OR SUCH LONGER PERIOD DEEMED ADVISABLE BY THE MUNICIPAL DIRECTOR OF ENGINEERING.
10. CONTRACTOR SHALL INSTALL AND MAINTAIN CATCHBASIN SEDIMENT BARRIERS THROUGHOUT THE SITE DURING ALL CONSTRUCTION ACTIVITIES IN ORDER TO MITIGATE SEDIMENT ENTERING THE STORM STORM SEWERS.
11. NO FUEL TO BE STORED ON SITE. IN CASE OF A SPILL PLEASE CONTACT: MOECC SPILLS ACTION CENTER 1-800-268-6060.
12. SEDIMENT CONTROLS ARE TO REMAIN IN PLACE UNTIL WRITTEN DIRECTION IS RECEIVED FROM THE ENGINEER REGARDING THEIR REMOVAL.
13. EROSION AND SEDIMENT CONTROLS WILL BE INSPECTED ON AS PER MUNICIPAL REQUIREMENTS OR AFTER SIGNIFICANT RAINFALL EVENTS.

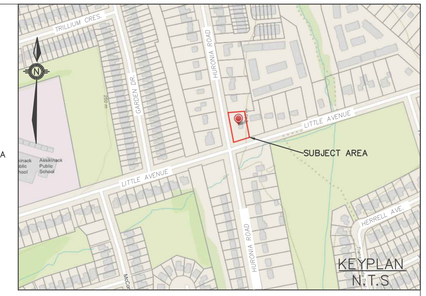
SEQUENCE OF CONSTRUCTION

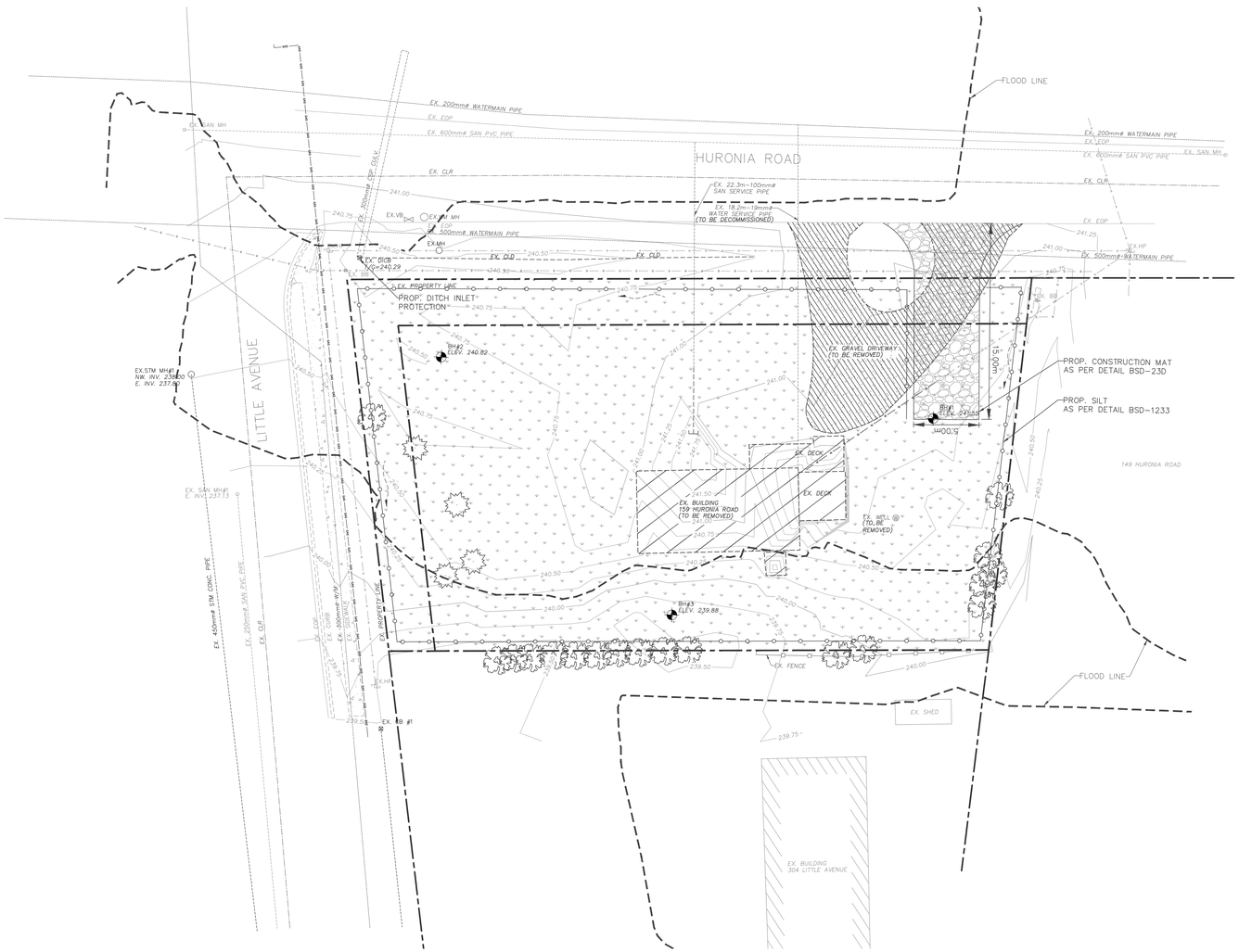
1. ENGINEER TO BE NOTIFIED PRIOR TO INITIATION OF ANY ON SITE WORKS.
2. SILT FENCE AND CONSTRUCTION ACCESS MATS TO BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY WORKS ONSITE.
3. VEGETATION REMOVAL MAY COMMENCE AFTER ALL SILT FENCE IS INSTALLED AND APPROVED BY THE ENGINEER.
4. COMMENCE WITH EARTH EXCAVATION AND SITE SERVICING (TO BE REMOVED FROM SITE – NO STOCKPILE).
5. EROSION CONTROL MEASURES TO BE MAINTAINED AS DIRECTED BY THE ENGINEER DURING THE CONSTRUCTION PERIOD. ADDITIONAL CONTROL MEASURES MAY BE REQUIRED AT THE DISCRETION OF THE ENGINEER.
6. ALL DISTURBED GROUND LEFT INACTIVE FOR MORE THAN 30 DAYS SHALL BE STABILIZED WITH SEED, SOD, MULCH OR OTHER ADEQUATE COVERING, AS INSTRUCTED BY THE ENGINEER.
7. ALL CONSTRUCTION VEHICLES TO ACCESS THE SITE VIA THE DESIGNATED CONSTRUCTION ENTRANCES AS SHOWN.

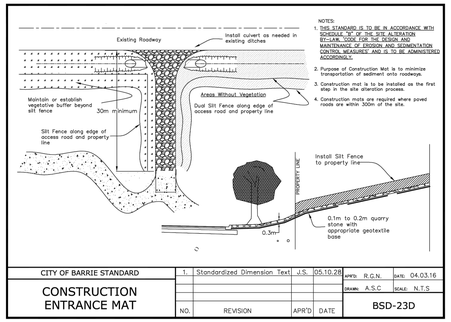
Site Area	1400 sq.m.
Area of Alteration	1400 sq.m.
Existing Land Use	RESIDENTIAL (R1)
Adjoining Property Land Use	RESIDENTIAL
Soil Type	SANDY LOAM (DS)

LEGEND

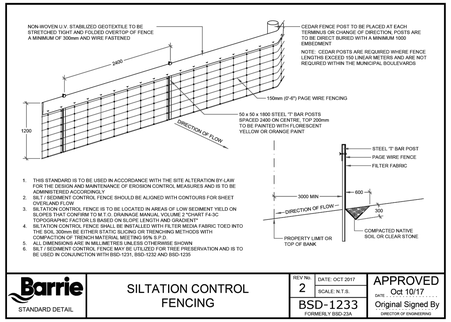
- SILT FENCE
- ROCK CHECK DAM
- STRAW BALE
- SAND BAG BARRIER
- TEMPORARY SWALE
- DIRECTION OF INTERIM OVERLAND FLOW
- NVCA / LSRCA REGULATION LIMIT
- FLOOD LINE
- BUILDING REMOVAL AREA
- GRAVEL REMOVAL AREA
- CONCRETE REMOVAL AREA
- DECIDUOUS TREE
- CONIFEROUS TREE



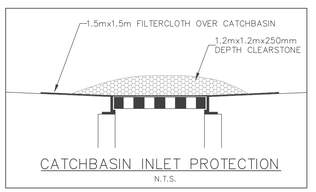




CITY OF BARRIE STANDARD					
CONSTRUCTION ENTRANCE MAT	1.	Standardized Dimension Text	J.S.	05.10.28	APP'D: R.G.N. DATE: 04.03.16
					DRAWN: A.S.C SCALE: N.T.S
	NO.	REVISION	APR'D	DATE	BSD-23D



Barrie STANDARD DETAIL	SILTATION CONTROL FENCING	REV No. 2	DATE: OCT 2017 SCALE: N.T.S.	APPROVED Oct 10/17
		BSD-1233 FORMERLY BSD-230A		Original Signed By DIRECTOR OF ENGINEERING



CATCHBASIN INLET PROTECTION
N.T.S.

Gerrits ENGINEERING
222 Mapleview Drive West, Suite 300
Barrie, ON L4N 9E7 Canada
Tel.:705.737.3303
Fax.: F.705.737.1772
www.gerreng.com

No.	Issuance Description	YY/MM/DD
1.	ZONING BY-LAW AMENDMENT	23/03/31
2.		

Issued For:

ZONING BY-LAW AMENDMENT

Client: NJ ELECTRIC GENERAL CONTRACTING
182 BIRKSHIRE DRIVE,
AURORA, ON L4G 7R8

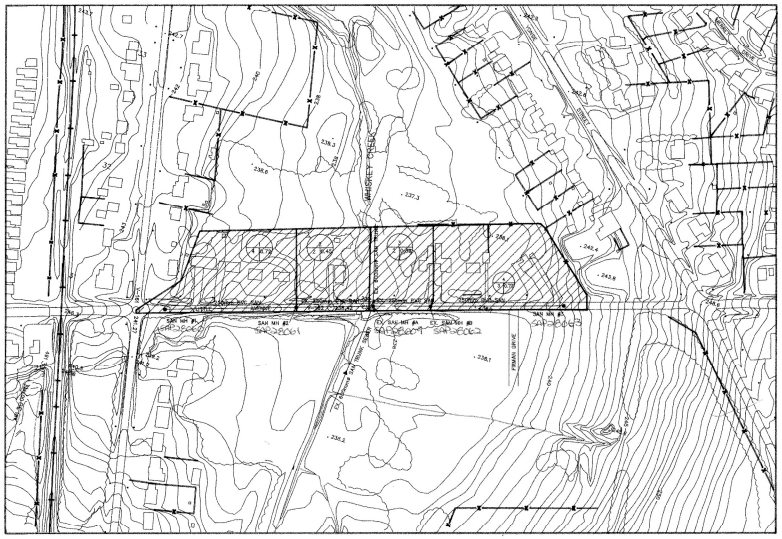
Project: PROPOSED TOWNHOUSE DEVELOPMENT
159 HURONIA ROAD,
BARRIE,ON

Drawing: EROSION & SEDIMENT CONTROL & REMOVALS PLAN

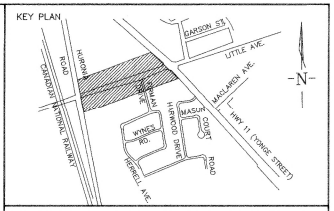
Project No.	484-032-22	Designed by: IO	Checked by: KF
Scale:	1:200	Drawn by: IO	Approved by:ES
Orientation		Stamp	
Drawing No.	ESC-RM-1		

STORM DRAINAGE PLAN

SANITARY DRAINAGE PLAN

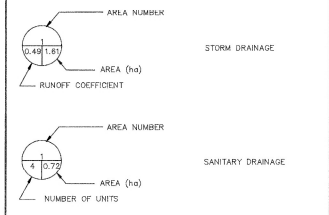


KEY PLAN



GENERAL NOTES:

1. ALL MEASUREMENTS ARE IN METRES UNLESS INDICATED OTHERWISE.



BENCHMARK:

No.	REVISIONS	DATE	APPROVED
1	AREAS REVISED	SEPT 91	S.M.
	CONSTRUCTION ISSUE	JUNE 92	

CITY OF BARRIE
ADOPTED FOR MUNICIPAL PURPOSES
DATE 1992 06 22
R. W. McAdam P.Eng.
CITY ENGINEER
MOTION NO.

LICENSED PROFESSIONAL ENGINEER
T. GARDINER
PROVINCE OF ONTARIO

MUNICIPALITY
CITY OF BARRIE INCORPORATED
CITY of BARRIE
ENGINEERING DEPARTMENT

TITLE

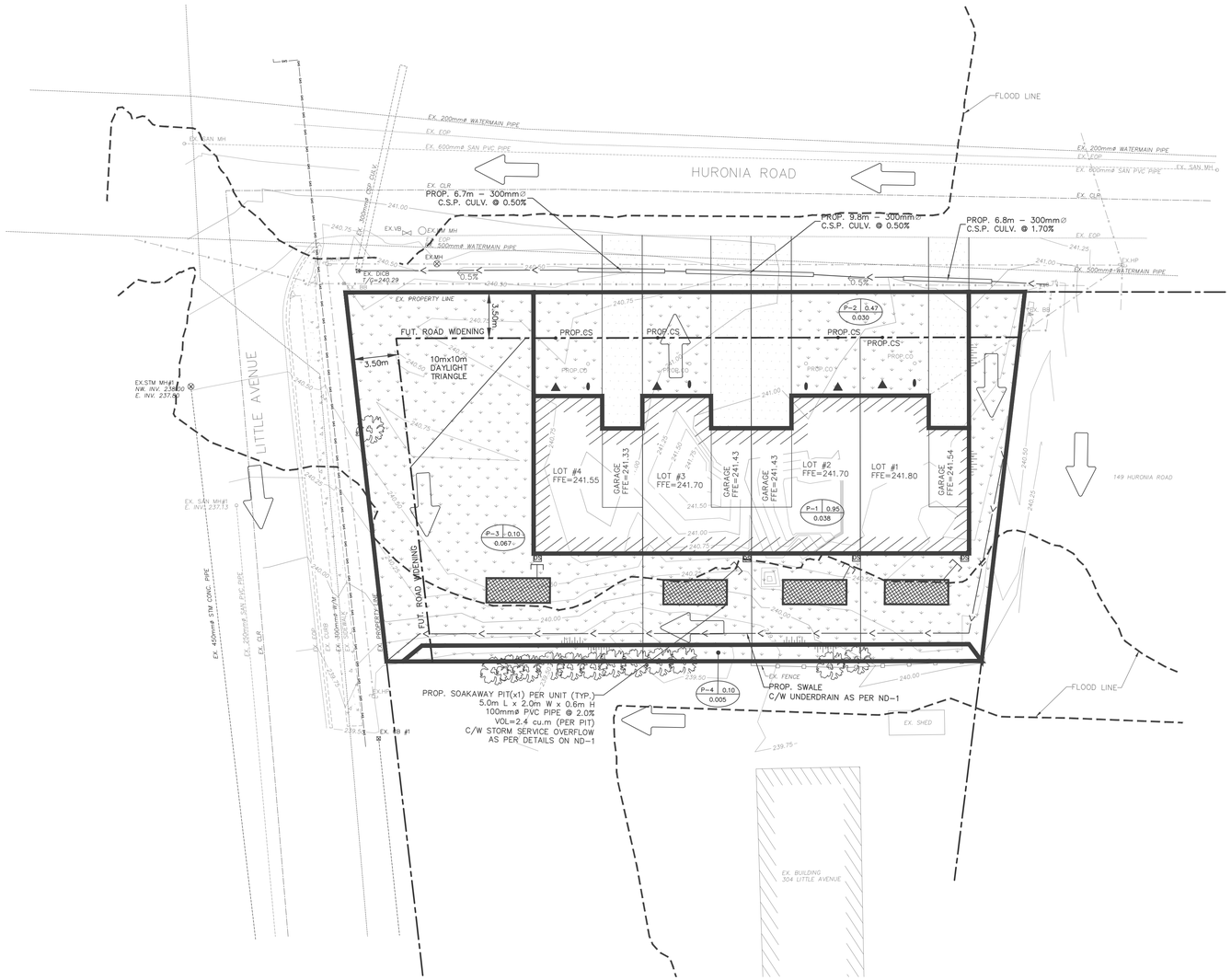
LITTLE AVENUE RECONSTRUCTION

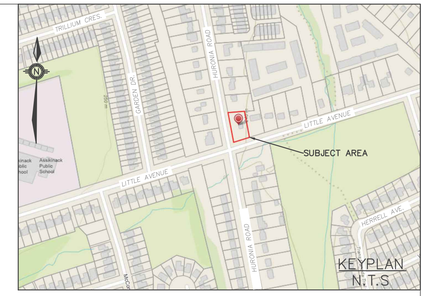
LITTLE AVENUE STORM and SANITARY DRAINAGE AREA

REINDERS
F.J. Reinders and Associates (Barrie) Ltd.
Consulting Engineers, Planners, and Project Managers
80 Bradford St. Suite 18
Barrie, Ontario L4N-6S7 (705) 726-6723

DESIGN	S.M./T.D.	SCALE HOR. 1:2000	VERT.
DRAWN	KC	REVIEWED S.M.	DRAWING No. / CAD FILE 90189-SS
DATE PLOTTED	JAN. 17 92		

1991-013-002 91-13 sh.SS





LEGEND

ID — X/P-1 — 0.75 — 5.55 — AREA (ha) — RUNOFF COEFFICIENT

CATCHMENT BOUNDARY

OVERLAND FLOW ROUTE

100 YEAR PONDING AREA

FLOOD LINE

Gerrits ENGINEERING

222 Mapleview Drive West, Suite 300
Barrie, ON L4N 9E7 Canada
Tel.:705.737.3303
Fax.: F.705.737.1772
www.gerreng.com

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Issued For:

ZONING BY-LAW AMENDMENT

Client: NJ ELECTRIC GENERAL CONTRACTING
182 BIRKSHIRE DRIVE,
AURORA, ON L4G 7R8

Project: PROPOSED TOWNHOUSE DEVELOPMENT
159 HURONIA ROAD,
BARRIE,ON

Drawing:

POST-DEVELOPMENT STORMWATER MANAGEMENT PLAN

Project No. 484-032-22	Designed by: IO	Checked by: KF
Scale: 1:200	Drawn by: IO	Approved by:ES

Orientation

Stamp

Drawing No.

STM-2

Appendix C
Geotechnical Investigation Report

GEI Consultants

Consulting
Engineers and
Scientists

Geotechnical Investigation

Proposed Residential Development

159 Huronia Road, Barrie, Ontario

Submitted to:
N.J Electric General Contracting
182 Birkshire Drive
Aurora, Ontario
L4G 7R8

Submitted by:
GEI Consultants Ltd.
647 Welham Road, Unit 14
Barrie, Ontario, L4N 0B7
www.canada.geiconsultants.com

March 27, 2023
Project No. 2204000

Table of Contents

Figures

Appendices

1. Introduction

GEI Consultants (GEI) was retained by N.J. Electric General Contracting (the Client) to complete a geotechnical investigation and report for a proposed residential development at 159 Huronia Road, in the City of Barrie, Ontario. A site locations plan is enclosed as Figure 1.

A residential development is proposed for the property at 159 Huronia Road, Barrie Ontario. The property is rectangular in shape with a total site area of 0.14 hectares. The site is located in the northeast corner of the intersection of Huronia Road and Little Avenue. The property is currently occupied by one residential dwelling with a single level and a basement, which will be demolished prior to any development. The site lies within a Lake Simcoe Regional Conservation Authority (LSRCA) regulated area, with the southern portion of the site being identified as a "floodplain" and/or "floodplain setback".

The proposed development includes a block of several townhomes with driveways directly connected to Huronia Road. Detailed grading plans are not yet available and details pertaining to the townhome design including the presence of basements (basement are assumed for purposes of this report), is not yet known. The property will be municipally serviced. An aerial image of the site is provided on Figure 2A, and the proposed concept plan is included as Figure 2B.

The purpose of the geotechnical investigation was to assess the subsurface soil conditions at the site, and based on this information, provide geotechnical engineering recommendations in support of the proposed development. This report summarizes the borehole findings, provides design geotechnical engineering recommendations regarding available bearing capacities for foundations, floor slabs, earth pressures and drainage for basements, site servicing and installation. Considerations for constructability such as soil excavation, compaction, on-site backfill suitability and temporary groundwater control are also provided.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further geotechnical review and input may be required which might necessitate the need for additional investigation and/or analysis.

GEI has also been retained to complete a hydrogeological study for the site and the findings and recommendations are provided under separate cover.

It is noted that geoenvironmental assessment, chemical testing, etc. was not part of the current scope. GEI would be please to revise the scope to include geoenvironmental aspects, if requested.

2. Procedures and Methodology

It is noted that all elevations in this report are metric and expressed in metres (m). All measurements are also in metric and expressed in millimetres (mm), metres (m) or kilometres (km).

Prior to the commencement of drilling activities, the borehole locations were staked in the field by GEI. Borehole ground surface elevations of the boreholes and coordinates (referencing NAD 83 geodetic datum) were surveyed by GEI with a Topcon FC – 5000 GPS Survey unit.

Underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public utility locating companies and a private locator prior to drilling.

The fieldwork for the drilling program was carried out on November 22, 2022. Boreholes 1 to 3 were advanced to 6.6 m below existing grade (Elev. 234.2 to 235.4). Borehole logs are provided in Appendix A and the borehole locations are shown on Figure 2A (aerial image) and Figure 2B (proposed plan).

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a track-mounted drill rig, solid stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) "N" Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Monitoring wells were installed in all the boreholes by GEI to facilitate long-term groundwater monitoring, each consisting of 50 mm diameter PVC pipe with a 1.5 m long screen and protective casing. Monitoring well construction is shown on the borehole logs in Appendix A.

The GEI field staff examined, and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials (if any), groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI's laboratory for more detailed examination and classification.

In GEI's laboratory, the samples were classified as to their visual and textural characteristics. Four (4) representative samples of the major soil units were selected and submitted to our laboratory for grain size analysis. Grain size results are provided in Appendix B.

3. Subsurface Conditions

3.1 General Overview

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix A, and the geotechnical laboratory results are included in Appendix B. The borehole locations are shown on Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

3.2 Stratigraphy

3.2.1 Topsoil

A surficial topsoil layer was at the ground surface in Boreholes 1, 2 and 3 ranging in thickness from 75 to 150 mm.

3.2.2 Fill

A fill layer was encountered in all boreholes. The fill layer typically consisted of sand/silty sand in the upper portion and gravelly sand in the bottom portion. The fill was penetrated at 2.3 to 3.0 m depth (Elev. 238.4 to 239.4). The fill had trace to some organics in all boreholes and concrete pieces were observed in Borehole 2. The fill was moist to wet with moisture contents ranging from 8 to 14%. The fill had N values ranging from 8 to 22 (loose to compact).

3.2.3 Silty Sand / Sand / Sandy Silt to Silty Sand

Cohesionless deposits were encountered beneath the fill, locally the clayey silt in Borehole 1. These deposits consisted of silty sand to sand in Borehole 1 from 3.0 to 6.6 m depth (Elev. 238.9 to 235.4), sandy silt to silty sand in Borehole 2 from 3.0 to 6.1 m depth (Elev. 238.7 to 235.6) and sand and gravel in Borehole 3 from 2.3 to 3.0 m depth (Elev. 238.4 to 237.7). The deposits had a till like appearance in Borehole 1 and 2. Three samples of the

various units were submitted to our laboratory for grainsize analysis and the results are provided in Figure B1 in Appendix B. N values ranged from 4 to 35 being loose to dense, typically compact. The soil was typically wet with moisture contents ranging from 8 to 20%.

3.2.4 Clayey Silt / Clayey Silt to Silty Clay

A 400 mm thick clayey silt layer from 2.6 to 3.0 m depth (Elev 238.9 to 239.4) was observed below the fill and above the cohesionless soil in Borehole 1. In Boreholes 2 and 3, clayey silt and clayey silt to silty clay units were present at depths varying from 3.0 to 6.1 (Elev. 235.6 to 237.7) and extended to the 6.6 m depth of exploration (Elev. 234.2 to 235.2). A sample of the clayey silt to silty clay soil was submitted to our laboratory for grain size analsysis and the results are provided in Figure B2 in Appendix B. The soil was grey and moist to very moist with moisture contents ranging from 12 to 28%. N values in the material ranged from 16 to 32 blows indicating a very stiff to hard consistency.

3.3 Groundwater

Unstabilized groundwater level measurements and cave measurements were taken upon the completion of drilling of each borehole as shown on the borehole logs in Appendix A. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. All three (3) boreholes were outfitted with a monitoring well with 50 mm diameter PVC standpipe and 1.5 m long screen. Monitoring well configuration and groundwater observations are noted on the borehole logs in Appendix A, and a summary is below.

Borehole	Depth of Cave (m) / Elev.	First Water Strike (m) / Elev	Unstabilized Groundwater Level Depth (m) / Elev.	Depth (m) / Elev. of Groundwater Table, December 6, 2022
1	5.4 / 236.5	2.3 / 239.6	2.3 / 239.6	2.6 / 239.3
2	Open (6.6 / 235.2)	2.3 / 239.4	2.1 / 239.6	2.3 / 239.4
3	Open (6.6 / 234.2)	1.5 / 239.2	2.1 / 238.6	2.4 / 238.3

The stabilized groundwater level was measured at 2.3 to 2.6 m (Elev. 238.3 to 239.4) below the existing ground surface.

The existing fill, sand, silty sand and sand and gravel are permeable and allow for the free flow of ground water when wet. The sandy silt to silty sand is semi-permeable and is expected to generally allow for the free flow of water when wet. The clayey silt and clayey silt to silty clay are generally not permeable.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

4. Engineering Design Parameters & Analysis

The proposed development includes a block of several townhomes with driveways directly connected to Huronia Road. Detailed grading plans are not yet available and details pertaining to the townhome design including the presence of basements (basement are assumed), is not yet known. The property will be municipally serviced. An aerial image of the site is provided on Figure 2A, and the proposed concept plan is included as Figure 2B.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further geotechnical review and input may be required which might necessitate the need for additional investigation and/or analysis.

4.1 Site Grading

Grading plans were not available for review at the time of this report, however it is speculated that some grade raise is required to keep basements above the ground water level.

It is noted that the existing house on the site only has a partially buried basement with raised grades surrounding the buildings, likely to keep the basements above the groundwater.

The high groundwater level measured in the wells at the time of this report was at Elev. 239.4, about 2.3 m below existing grade. For purposes of this report, and subject to review with further groundwater level monitoring, the lowest basement level is recommended to be at Elev. 239.9, or above (minimum 0.5 m above the high ground water level). Based on this rationale and upon review of the boreholes, the footings would be founded in the fill. The existing fill is unsuitable to support the proposed townhouses due to concerns with settlement. As result removal of the existing fill is required followed by replacement with engineered fill to support the buildings and the servicing infrastructure. It is noted the existing fill thickness at the house may be deeper than indicated in the boreholes and all fill associated with the existing house will have to be removed vertically and laterally prior to engineered fill placement.

When grading is established, GEI should review the drawings for geotechnical requirements.

4.1.1 Engineered Fill

GEI defines “engineered fill” as material that will support foundations, and which is placed and compacted in a specified and controlled manner under full-time supervision of geotechnical engineering staff.

In any location where engineered fill will be placed to raise grades or replace poor/weak soil, the topsoil, vegetation, peat, or existing earth fill must be fully removed down to competent soil. The exposed subgrade soil must be proof-rolled and inspected by the geotechnical engineer to ensure all unsuitable material (e.g., organics, weak or soft soil, weathered / disturbed soil, deleterious materials, existing fill) is removed from the engineered fill footprint. Any unsuitable areas must be further sub-excavated and replaced with fill compacted to targeted 100% Standard Proctor maximum dry density (SPMDD), minimum 98% SPMDD in building areas and 95% SPMDD in road and servicing areas.

Once the subgrade is approved, engineered fill can be placed. Engineered fill must be placed under the full-time supervision of a geotechnical engineer as required in the Ontario Building Code. The engineered fill may consist of excavated on-site inorganic cohesionless soils provided they have been moisture conditioned to a moisture content within 2% of optimum moisture content and do not contain organics, topsoil or deleterious material. Due to the organics in the fill, it is speculated that most of the existing fill will not be suitable for reuse as engineered fill. It is recommended that any imported soil consist of Granular B (OPSS.MUNI 1010) and be first used in building areas, with suitable on-site soil used in landscaped or road areas. Select Subgrade Material (SSM) (OPSS.MUNI.1010) can be imported in areas other than building areas. Engineered fill must be placed in loose lifts of 200 mm or less and compacted as noted above.

The exposed subgrade will likely be wet. In wet subgrade areas, the first lift of engineered fill shall consist of 400 mm of Granular B Type II (OPSS.MUNI 1010). This will help to bridge the weaker subgrade and improve the ability to achieve the compaction specifications for subsequent engineered fill lifts.

The engineered fill must extend a minimum of 1 m out from all sides of the foundations and extend at a 1 horizontal to 1 vertical slope (1H:1V) down to the exposed subgrade. A typical detail for engineered fill pad dimensioning is included in Appendix C.

4.2 Foundation Design

Grading was not established at the time of this report, and it is speculated that a grade raise is required for the site to keep basements above the groundwater level. Footings will likely be founded on engineered fill.

4.2.1 Foundations on Engineered Fill

The foundations will likely be supported on an engineered fill pad, constructed as discussed in Section 4.1.1, and the spread or strip footings can be designed using a maximum of 150 kPa at Serviceability Limit State (SLS) and 225 kPa at Ultimate Limit State (ULS).

It is recommended that nominal reinforcing steel for stiffening of the foundation walls made on engineered fill be provided to help mitigate minor cracking due to minor differential settlement. The reinforcing steel in the poured concrete foundation walls may consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls. Typically, these bars are placed 100 to 200 mm from the top or bottom of the foundation wall, respectively. The reinforcing steel should extend a minimum of 3 m past any transition zones between engineered fill and native soil. A typical reinforcing steel detail for foundation walls placed on engineered fill is provided within Appendix C. The recommended nominal reinforcing steel should not be considered a structural design. The need for different or additional reinforcement should be reviewed by a structural engineer to ensure the original structural design intent of the structure is maintained.

Where the footings extend down to the native soil, the same bearing resistance as provided above for the engineered fill can be used on the native soil within 3 m of the existing ground surface.

4.2.2 General Foundation Considerations

All footings exposed to ambient air temperature throughout the year must be provided with a minimum of 1.2 m of earth cover or equivalent insulation for frost protection (25 mm of polystyrene insulation is equivalent to 300 mm of soil cover). The minimum strip and spread footing widths to be used shall be dictated as per the Ontario Building Code, regardless of loading considerations. Footings stepped from one level to another must be at a slope not exceeding 7V:10H.

The foundation design parameters provided above are predicated on the assumption that the foundation subgrade surface is undisturbed, and that all earth fill, deleterious, softened, disturbed, organic, and caved material is removed. The foundation excavation must be done in such a way that groundwater is controlled to prevent any disturbance to the foundation base. The groundwater table must be lowered at least 1 m below the founding elevation prior to excavation to prevent disturbance to the foundation subgrade from groundwater seepage.

The foundation subgrade must be reviewed prior to concrete placement to ensure the foundation design parameters provided are applicable, and to provide remedial recommendations if necessary. If the foundation excavation will be open for a prolonged period of time, the foundation subgrade should be protected with a skim coat of lean mix concrete (applied immediately after inspection by the geotechnical engineer), to ensure that no deterioration will occur due to weather effects.

4.3 Basement Wall Earth Pressure Design Parameters

Basement walls must be designed to resist unbalanced lateral earth pressures imparted from the weight of adjacent soils. Lateral earth pressures are calculated using the following equation:

$$\boldsymbol{P = K[\gamma h + q]}$$

where, **P** = the horizontal pressure at depth, **h** (m)
K = the earth pressure coefficient (dimensionless)
h = depth below surface in metres
γ = the bulk unit weight of soil, (kN/m^3)
q = surcharge loading (kPa)

The above equation assumes that a drainage system is present which prevents the build up of any hydrostatic pressure behind the structure subjected to the unbalanced lateral earth pressures. If this is not the case, the equation must be revised to also incorporate the submerged unit weight of the soil multiplied by the earth pressure coefficient, in addition to the water pressure itself.

The values for use in the design of basements subjected to unbalanced lateral earth pressures at this site are as follows:

Soil Type	γ – Bulk Unit Weight (kN/m^3)	φ – Friction Angle (degrees)	Earth Pressure Coefficient (dimensionless)		
			K_a – Active	K_o – At-Rest	K_p – Passive
Granular 'B' (OPSS.MUNI 1010)	21.0	32	0.31	0.47	3.25
Compact to Dense Native Cohesionless or Stiff to Very Stiff Clayey Silt	20.0	30	0.33	0.50	3.00

The calculation of the earth pressure coefficients is based on Rankine theory, which provides a conservative estimate as no friction between the soil and the structure is accounted for. The earth pressure coefficients provided above are only applicable for flat ground surfaces beyond the structure and will change for sloping ground surfaces.

The earth pressure coefficients referenced within the above table are a function of the friction angle of the adjacent soil, and both the degree and direction of movement of the structure subjected to unbalanced lateral earth pressures. For structures that are restrained at the top (such as basement walls), the at-rest earth pressure coefficient will apply. For structures that allow for 0.1 to 1% of movement away from the soil, the full active earth pressure coefficient will apply. For structures that allow for 1 to 10% of movement into the soil, the full passive

earth pressure coefficient will apply. The percentage movement is based on the height of the structure.

Other types of structures such as shoring walls with multiple rows of tiebacks and soil nail walls are subject to different loading conditions and must be analyzed separately.

4.4 Floor Slabs

The native soils or engineered fill are suitable to support lightly loaded residential slabs. Topsoil, vegetation, organics, in-situ earth fill and other soil containing organics, excessive moisture, or deleterious materials are not suitable to support floor slabs.

The exposed subgrade must be proof-rolled and inspected by the geotechnical engineer. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of deleterious/organic material, they must be locally sub-excavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 98% SPMDD within 2% optimum moisture content.

All building floor slabs must be provided with a capillary moisture barrier and drainage layer. This is made by placing the concrete slab on a minimum 200 mm layer of 19 mm clear stone (OPSS.MUNI 1004) compacted by vibration to a dense state. The upper 50 mm of clear stone can be replaced with 19 mm crusher run limestone for a working surface. The clear stone and a cohesionless subgrade must be separated by a geotextile such as Terrafix 270R (or approved equivalent) to prevent the migration of fines into the clear stone layer which could result in loss of support for the slab. Alternatively, Granular A (OPSS.MUNI 1010) compacted to 100% SPMDD can be utilized without filter cloth.

4.5 Drainage

For any new structures that will be slab-on-grade with no basement levels, perimeter and under-slab drainage at the foundation level is not required, provided that the underside of the concrete slab is at least 200 mm above the prevailing grade of the site and the surrounding surfaces slope away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations. To minimize infiltration of surface water, the upper 150 mm of backfill should comprise relatively impervious/cohesive compacted soil material.

All basement foundation walls must be provided with damp-proofing provisions in conformance to the Ontario Building Code. Backfill along the foundation wall must consist of Granular ‘B’ Type I (OPSS.MUNI 1010) for a minimum lateral distance of 600 mm out from the foundation wall. Alternatively, if a filtered cellular drainage media is provided adjacent to the foundation wall, the backfill may consist of common earth fill. The surrounding surfaces slope away from the building at a gradient of at least 2 percent to promote surface water run-

off and to reduce groundwater infiltration. To minimize infiltration of surface water, the upper 150 mm of backfill could comprise relatively impervious compacted soil material (e.g. clayey soil).

For buildings with basements, a perimeter drainage system must be installed that will remove any water that infiltrates into the building backfill, to ensure that any water does not infiltrate into the basement. The perimeter drains must consist of minimum 100 mm diameter perforated pipes wrapped in filter socks, sufficiently covered on all sides by 19 mm clear stone. Perimeter drains should be directed to the sump underneath the basement floor in solid pipes so as not to surcharge any underfloor drainage layer with water. Underfloor drainage is not required provided the basement floor slab is a minimum 1 m above the ground water level. Where basements are less than 1 m but more than 0.5 m above the groundwater level, perforated subfloor drainage pipe, spaced at 6 m centres, surrounded by 19 mm clear stone, surrounded by a geotextile such as Terrafix 270R (or approved equivalent), and trenched into the subgrade is recommended for each townhouse block. All sump pumps should be on emergency power for redundancy in case of a power outage. A typical basement drainage detail is included in Appendix C.

4.6 Site Servicing

It is expected that the proposed townhomes will be serviced with municipal water and sanitary sewers and that only service laterals will be required from Huronia Road. Inverts are assumed to extend as deep as 3 m below the existing grade for the purposes of this report.

4.6.1 Bedding

The type of material and depth of granular bedding below the pipe will, to some extent, depend on the method of construction used by the contractor. Pipe bedding for flexible pipes should follow the requirements in Ontario Provincial Standard Drawing 802.010 or applicable municipal standards. Pipe bedding for rigid pipes should follow the requirements in Ontario Provincial Standard Drawings 802.030 to 802.032 or applicable municipal standards.

A subgrade consisting of the native cohesionless soils or the engineered fill will provide adequate support for pipes with the bedding requirements as laid out in the above referenced OPS drawings. Where disturbance of the trench base has occurred from groundwater seepage, construction traffic, etc., or if in-situ fill is present at the invert level, the material should be sub-excavated and replaced with suitably compacted granular fill. If weak zones are encountered, additional bedding materials and differing construction practices may be required and should be determined during construction. Any zones of peat or organic soil should be subexcavated and replaced with approved earth fill or imported granular material compacted to 95% SPMDD. Details on temporary groundwater control are provided in Section 5.2.

Regardless of whether flexible or rigid pipes are implemented, granular bedding and cover material should consist of a well graded, free draining material, such as Granular "A" (OPSS.MUNI 1010). All granular bedding must be compacted to a minimum of 95% SPMDD.

4.6.2 Backfill

Excavated inorganic fill and native cohesionless soils may be re-used as backfill in trenches, provided they are moisture conditioned so that the moisture content is within 2% of optimum. Additional soil compaction details are provided in Section 5.3. The backfill should be compacted to a minimum of 95% SPMDD. In confined areas the layer thickness will have to be reduced to utilize smaller compaction equipment efficiently or by using granular material instead of locally sourced fill. Any backfill that is frozen, contains a high percentage of organic material (topsoil, peat, etc.) or moisture, or has otherwise unsuitable deleterious inclusion should not be used as backfill. The maximum cobble or boulder size should not exceed half of the loose lift thickness (i.e., all particles with a diameter greater than 100 mm should be removed).

Where trenches are within the traveled portions of a driveway, backfill within the frost penetration depth of 1.2 m should consist of native, non-organic, excavated material consistent with the soils surrounding the trench. If this technique is not undertaken, then frequently problems arise with yearly differential frost heave movements between the trench backfill and the adjacent native soil. This would occur, for example, if imported granular material is used to backfill trenches which is less susceptible to frost effects compared to the native soils on site with a higher silt content (silt is highly frost-susceptible). Alternatively, if different soil is used as the backfill due to issues with achieving compaction, a frost taper of 10H:1V can be implemented to help mitigate the potential for differential settlement and frost heave.

5. Constructability Considerations

5.1 Excavations

At this time, excavations for the project site are anticipated to extend 2.5 to 3.5 m below existing grade to account for engineered fill placement and service connections, possibly basements. Below the surficial topsoil, excavations are anticipated to encounter earth fill, over the cohesionless soil units and locally the clayey silt/ silty clay to clayey silt unit. Harder digging can be expected locally in the dense cohesionless deposits. Cobbles and boulders should be expected in the sand and gravel deposit.

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III - Excavations, Section 222 through 242. Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the OHSA. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. If more than one soil type is encountered in an excavation, the most conservative soil type must be followed for sloping the sidewalls of the excavation. Excavations for the site should be completed considering a Type 3 soil geometry, 1H:1V from the base of the excavation, assuming that the soils are dewatered prior to excavation.

Excavation sidewalls will need to be continuously reviewed for evidence of instability and ground water seepage, particularly following periods of heavy rain or thawing. When required, remedial action must be taken to ensure the continued stability of excavation slopes and the safety of the workers.

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the OHSA and include provisions for timbering, shoring and moveable trench boxes. To reduce the potential for instability of the trench excavations, materials excavated from the service trenches and/or other fill materials or heavy equipment should not be placed near the crest of the trench excavations.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in the boreholes advanced on site. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that GEI be contacted immediately to evaluate the conditions encountered.

5.2 Temporary Construction Groundwater Control

As noted above, excavation is envisioned to extend to about 2.5 to 3.5 m below existing grade for the project.

The stabilized groundwater level was measured at 2.3 to 2.6 m (Elev. 238.3 to 239.4) below the existing ground surface. For excavation as described above the excavation will extend to the ground water level to about 1.0 m below the ground water level.

The exact scenario where certain groundwater control techniques will work are directly correlated to how coarse/fine the native soils are in an excavation, and both the lateral and vertical extent of the wet cohesionless deposits encountered as noted above. If the groundwater table is not controlled during construction, the base of the excavations will be unstable, leading to difficulties in excavating and placement of pipes, footings or engineered fill, and providing safety for the workers. Conventional sump pumping should be sufficient to control ground water seepage for excavation to the ground water level. Multiple pumps or sumps created with a corrugated steel pipe filled with gravel, will be required to control the ground water where excavation extended below the ground water level, considering the highly permeable cohesionless soils. Dewatering through vacuum wells may also be required.

It is recommended to carry out the work during the dry time of the year when the ground water table is lowest, to mitigate groundwater control measures. Also reducing the size of the excavation that is open at any one time will aid in reducing groundwater control requirements.

Based on the above, a Permit-to-Take-Water (PTTW) is not anticipated, however registry on the Environmental Activity and Sector Registry (EASR) system is likely required for multiple excavations or deep excavations and may be a prudent, to allow for areas of greater groundwater seepage with no work stoppage.

GEI's hydrogeological study under a separate cover provides further details regarding water taking analysis, regulatory requirements, impact assessments, monitoring plans, etc. for the site and must be referenced for groundwater control considerations.

5.3 Compaction Specifications

Standard Proctor Maximum Dry Density the specification to indicate the degree to which soil or aggregate is compacted. To achieve the specified SPMDD as indicated in this report, all soils or aggregates must be placed in lift thicknesses no greater than 200 mm. If this is not the case, only the upper portion of the lift will be adequately compacted, and the lower portion of the lift has a high probability of not meeting compaction specifications. In addition, industry standard equipment used to determine the degree of compaction consists of nuclear densometers. These devices have an inherent limitation in that they cannot test beyond

300 mm in depth, and so the degree of compaction beyond this depth cannot be quantitatively determined.

Along with lift thickness, ensuring that the soil or aggregate is within 2% of its optimum moisture content ensures that the specified compaction can be reached. If the soil or aggregate is too dry/wet, it is either very difficult or impossible to reach the specified compaction. This is especially true for when higher compaction specifications such as 98% and 100% SPMDD are required.

Moisture can be increased by adding water and mixing the soil prior to re-use, blending the soil with wetter material, or by importing soil to the site that is at optimum and can be readily compacted.

Moisture can be reduced by tilling or spreading out the soil to dry or blending it with drier material. In-situ moisture contents can change based on the season and local groundwater levels and can also change for stockpiled material due to precipitation. Zones of the fine-grained soil with very high moisture contents may fine moisture conditioning to be difficult to accomplish.

In addition to the above compaction specifications, in any areas where compacted fill will be placed over the exposed native soil subgrade, any loose, soft, wet, organic or unstable areas should be sub-excavated, and backfilled with clean earth fill or Granular 'B' (OPSS.MUNI 1010) compacted to a minimum of 95% SPMDD. This recommendation applies to site servicing and pavement subgrades. Where structures/buildings require upfilling beneath the structure the fill should be compacted to 100% SPMDD.

5.4 Quality Verification Services

On-site quality verification services are an integral part of the geotechnical design function, and for foundations, engineered fill and retaining walls, are required under the Ontario Building Code. Quality verification services are used to confirm that construction is being conducted in general conformance with the requirements as outlined in the drawings, reports and specifications prepared for the proposed development.

GEI Consultants can provide all the on-site quality verification services outlined below:

- The subgrade for shallow foundations for single-lot residential buildings may be field reviewed by the geotechnical engineer as required by the municipal regulating authority. The subgrade for shallow foundations for commercial buildings, retirement homes, or apartment buildings must be reviewed by the geotechnical engineer.

- Installation of retaining structures over 1.0 m high and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required in the OBC.
- Full-time monitoring, testing and inspection of engineered fill placement is required by the geotechnical engineer per the OBC.
- Part-time monitoring of the subgrade support capabilities, material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for the following areas to ensure the recommendations within this report are followed and they perform adequately in the long-term;
    - Slab-on-grades;
    - Pavement structure (granular and asphalt); and
    - Bedding/backfilling of site servicing.
- Testing of the concrete (compressive strength, slump, air content, etc.) and testing of the asphalt (asphalt content and gradation) are recommended to ensure that the quality of the materials being brought to site meet the requirements of the project.

6. Limitations and Conclusions

6.1 Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of N.J. Electric General Contracting (as provided in the signed Standard Professional Services Agreement). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

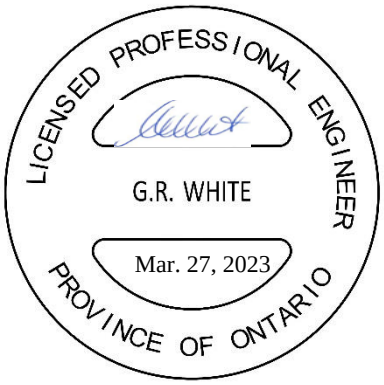
Yours Truly,

GEI Consultants

Prepared By:

Mohammed Razeen
Geotechnical E.I.T.

Reviewed By:

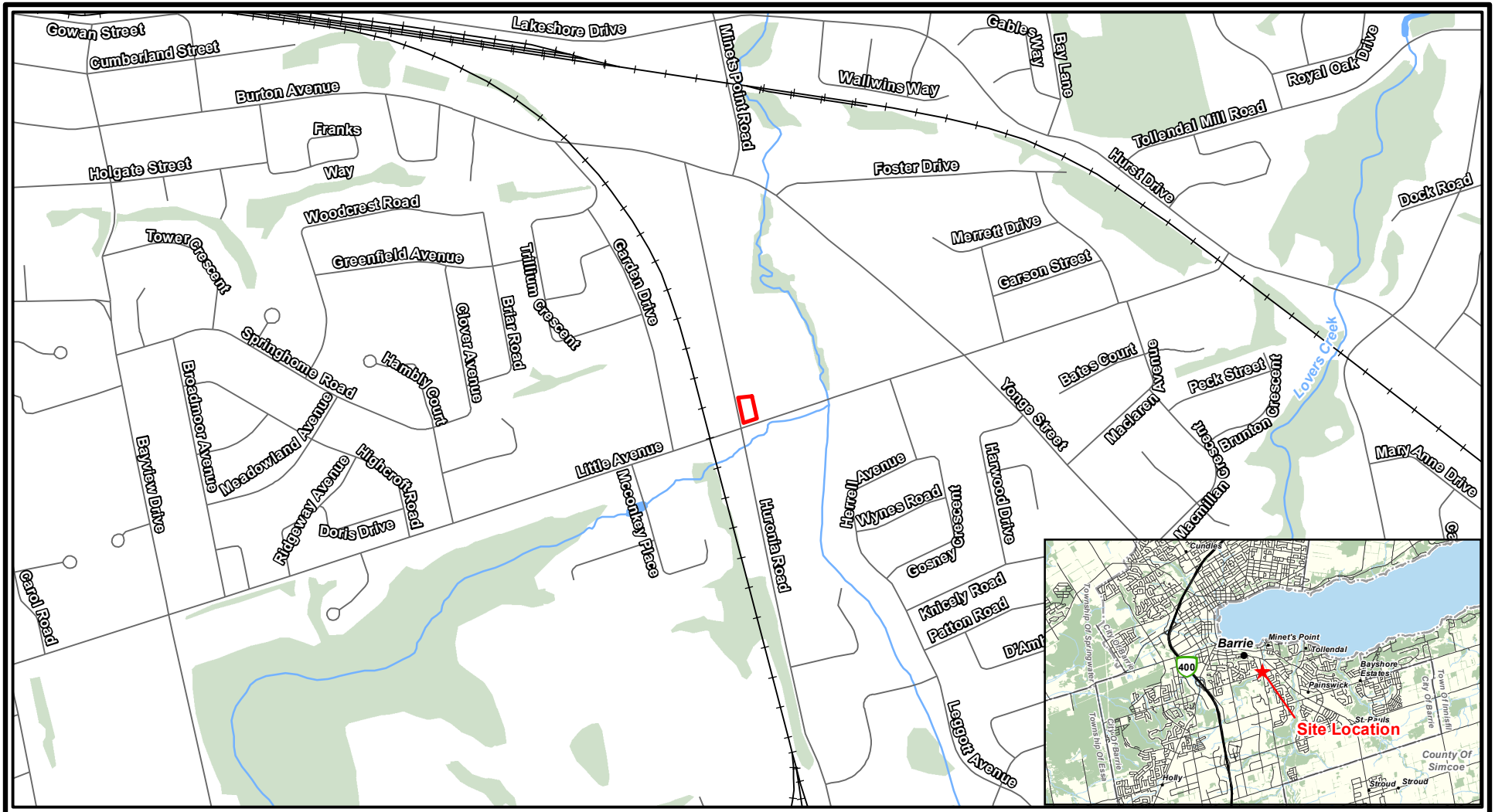


Geoffrey R. White, P.Eng.
Geotechnical Practice Lead

Figures

Site Location Plan

Borehole Location Plans



Legend

- Site Location
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario 2022.

0 150 300 m

1:12,000

N

Proposed Residential Development
159 Huronia Road,
Barrie, ON

Innovative Planning Solutions

GEI Consultants

Project 2204000

SITE LOCATION PLAN

March 2023 Fig. 1

Legend

Site Location

Approximate Borehole/Monitoring Well Location

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2022. Imagery taken in 2021.

0 6 12 m

1:500

N

Proposed Residential Development
159 Huronia Road,
Barrie, ON

Innovative Planning Solutions

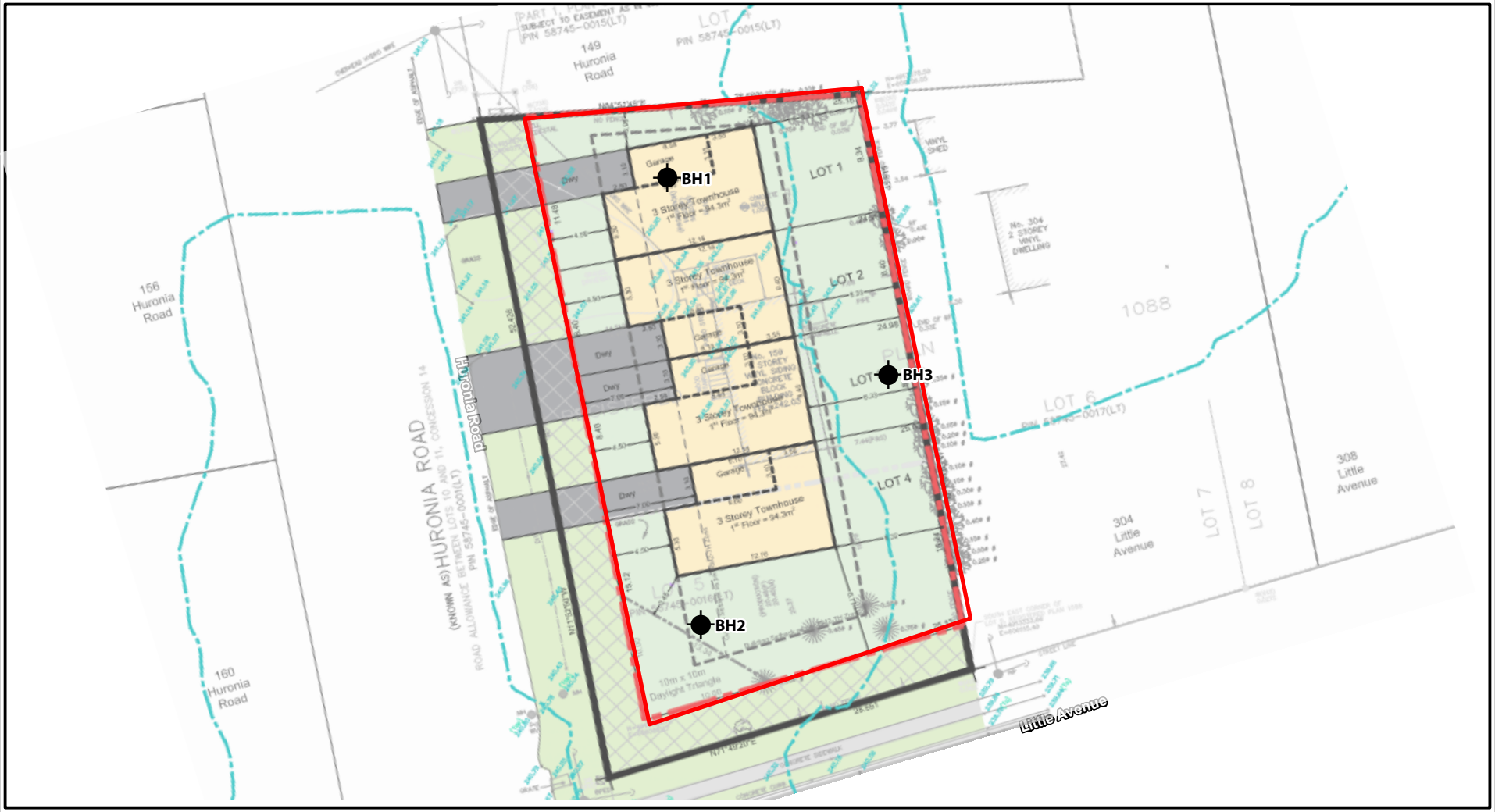
GEI Consultants

Project 2204000

BOREHOLE LOCATION PLAN
(AERIAL)

March 2023

Fig. 2A



Legend

Site Location

Approximate Borehole/Monitoring Well Location

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
3.'Conceptual Site Plan', Innovative Planning Solutions,(Feb., 23, 2023).

0 6 12 m

1:500

N

Proposed Residential Development
159 Huronia Road,
Barrie, ON

Innovative Planning Solutions

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Project 2204000

BOREHOLE LOCATION PLAN
(CONCEPT PLAN)

March 2023 Fig. 2B

Appendix A

Borehole Logs

RECORD OF BOREHOLE No. 1

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **BH** Northing: **4913371.3** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606089.7** Date Completed: **Nov 22/22**

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value
0.1	241.8	TOPSOIL: 100 mm				
		FILL: Sand, some gravel, trace silt, compact, brown, moist	AS	1		
		- - - Trace organics - - -	SS	2	100	11
			SS	3	100	14
		- - - Moist to wet - - -				
2.6	239.4		SS	4	100	12
3.0	238.9	CLAYEY SILT: Some sand, stiff, grey, moist				
		SILTY SAND: Trace gravel, trace clay, till-like, compact, brown, wet	SS	5	100	16
4.6	237.4					
		SAND: Trace gravel, trace clay, trace silt, loose, brown, wet	SS	6	100	4
		- - - Compact - - -	SS	7	100	17
6.6	235.4	Borehole Terminated at 6.6 m				

FIELD TESTING: Shear Strength Testing (kPa) — Other Test; Pocket Penetrometer; Field Vane (Intact); Field Vane (Remolded); 40 80 120 160. Penetration Testing — SPT; DCPT; 10 20 30 40.

LAB TESTING: Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); 100 200 300 400. Atterberg Limits — PL; LL. Water Content (%); 10 20 30 40.

Instrumentation Installation: First water strike SS4

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
7	52	32	9

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Groundwater depth encountered on completion of drilling: 2.3 m. Cave depth after auger removal: 5.4 m.
Groundwater depth observed on: Dec 6/22 at depth of: 2.6 m. Groundwater Elevation: 239.3 m

Scale: **1 :75**

RECORD OF BOREHOLE No. 2

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **BH** Northing: **4913333.4** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606092.5** Date Completed: **Nov 22/22**

Geodetic	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING (Shear Strength Testing (kPa); Penetration Testing SPT/DCPT)	LAB TESTING (Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); Atterberg Limits; Water Content (%))	Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
0.0 / 241.7	0.2 TOPSOIL: 150 mm / 241.6					0	241.5							
	FILL: Silty sand, some gravel, trace organics/topsoil, loose, brown, moist	AS	1						8					
	- - - Sand, some concrete pieces and organics, trace silt - - -	SS	2	100	8	1.5	240	8	12					
	- - - Trace rootlets - - -	SS	3	100	8			8	13					
	- - - Gravelly sand, trace silt, compact, wet - - -	SS	4	35	22	3	238.5	22	14		First water strike SS4			
	SANDY SILT TO SILTY SAND: Some clay, trace gravel, till-like, compact, brown, moist	SS	5	100	21			21	8		4	36	42	18
	- - - Trace clay, dense - - -	SS	6	100	35	4.5	237	35	19					
6.1 / 235.6	CLAYEY SILT: Some sand, very stiff, grey, very moist	SS	7	40	20	6	235.5	20	22					
6.6 / 235.2	Borehole Terminated at 6.6 m													

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Groundwater depth encountered on completion of drilling: 2.1 m. Cave depth after auger removal: Open

Groundwater depth observed on: Dec 6/22 at depth of: 2.3 m. Groundwater Elevation: 239.4 m

RECORD OF BOREHOLE No. 3

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **.** Northing: **4913354.6** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606108.4** Date Completed: **Nov 22/22**

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Field Testing (Shear Strength kPa)	Lab Testing (Water Content %)	Instrumentation	Comments & Grain Size Distribution (%) GR	SA	SI	CL
0.1	240.6	TOPSOIL: 75 mm											
		FILL: Silty sand, trace organics/ topsoil, compact, brown, moist	AS	1				11					
		- - - Gravelly sand, moist to wet ---	SS	2	100	22	22	12					
			SS	3	50	18	18	11		First water strike SS3			
2.3	238.4	SAND AND GRAVEL: Some silt, trace clay, compact, brown, wet	SS	4	100	24	24	11		35	43	17	5
3.0	237.7	CLAYEY SILT TO SILTY CLAY: Trace sand, very stiff, grey, moist	SS	5	60	21	21	20					
			SS	6	35	16	16	25					
		- - - Hard - - -	SS	7	50	32	32	28		0	4	54	42
6.6	234.2	Borehole Terminated at 6.6 m											

Groundwater depth encountered on completion of drilling: 2.1 m. Cave depth after auger removal: Open
Groundwater depth observed on: Dec 6/22 at depth of: 2.4 m. Groundwater Elevation: 238.3 m

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Scale: **1 :75**

Appendix B

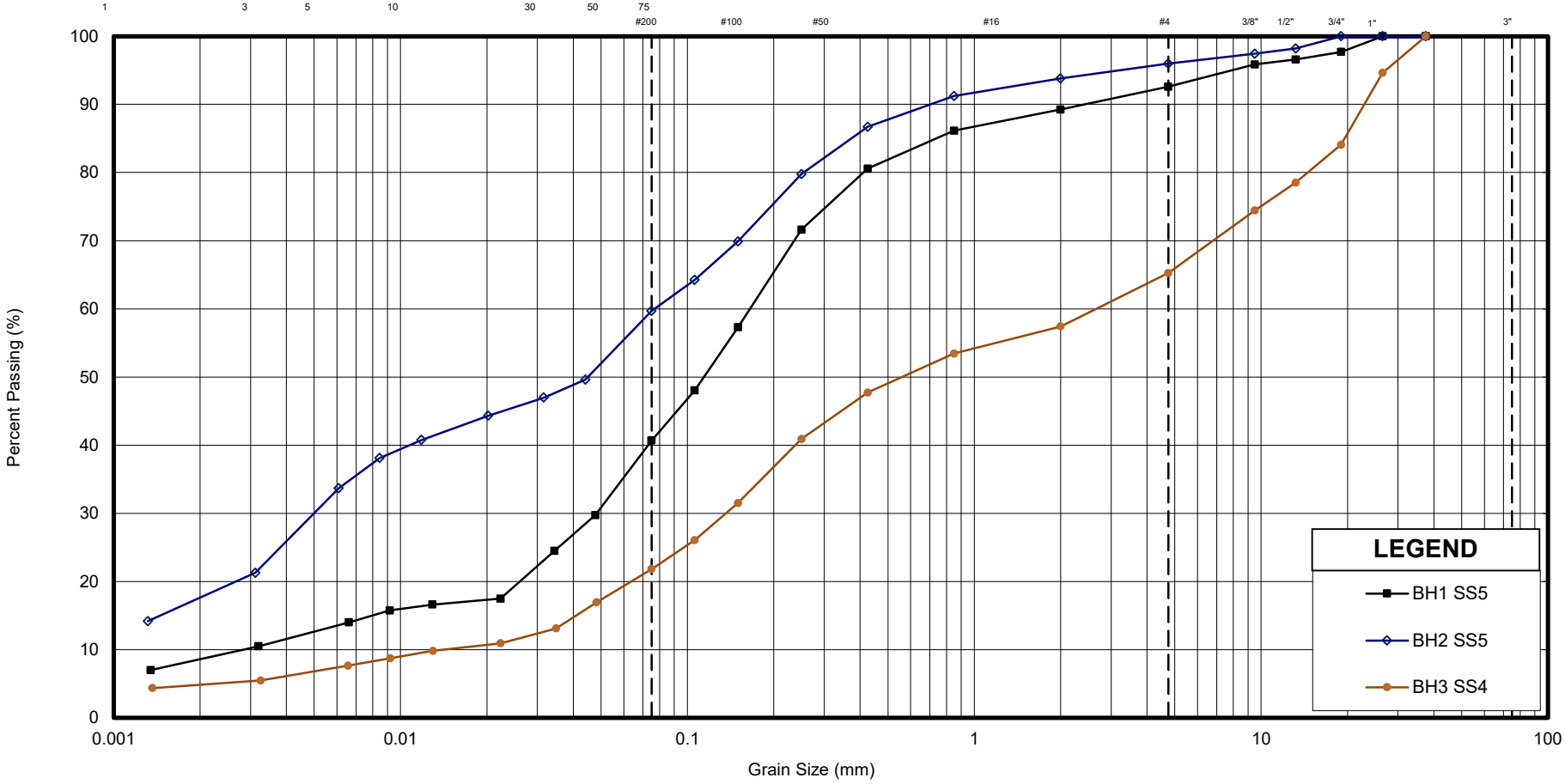
Geotechnical Laboratory Testing

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH1 SS5	SILTY SAND, Trace Clay, Trace Gravel	7	52	32	9	0.003	0.048	0.165	55.0	4.7
BH2 SS5	SAND AND SILT, Some Clay, Trace Gravel	4	36	42	18	-	0.005	0.077	-	-
BH3 SS4	GRAVEL AND SAND, Some Silt, Trace Clay	35	43	17	5	0.014	0.136	2.657	189.8	0.5

GEI Consultants

GRAIN SIZE DISTRIBUTION - 159 Huronia Road

SILTY SAND / SANDY SILT / GRAVEL AND SAND

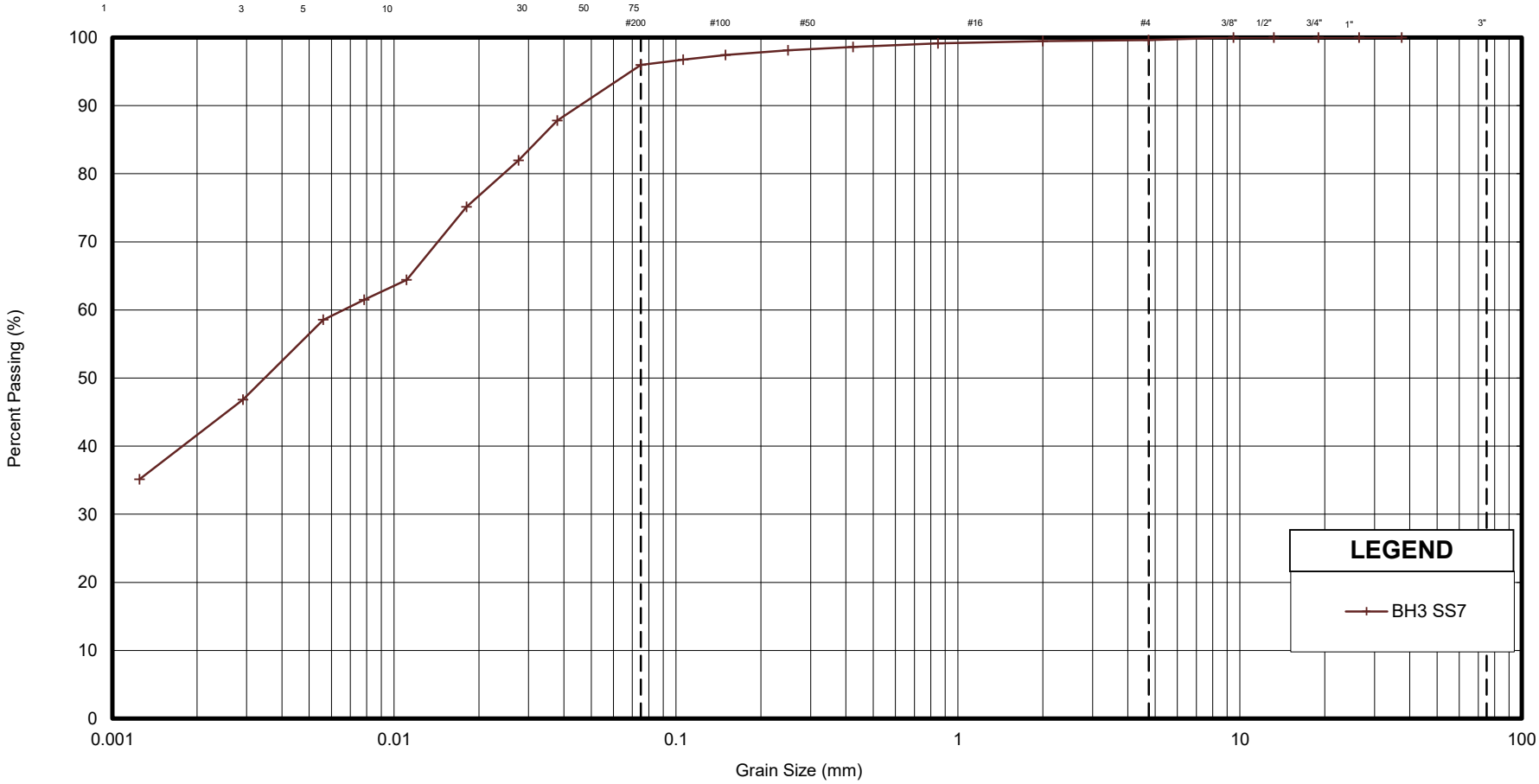
FIGURE No.	B1
REF. No.	2204000
DATE	March 2023

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH3 SS7	CLAY AND SILT, Trace Sand	-	4	54	42	-	-	0.007	-	-

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GRAIN SIZE DISTRIBUTION - 159 Huronia Road

CLAYEY SILT TO SILTY CLAY

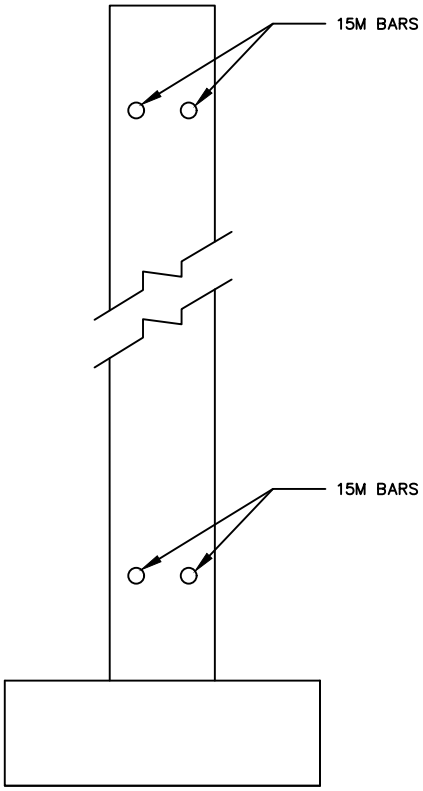
FIGURE No. B2

REF. No. 2204000

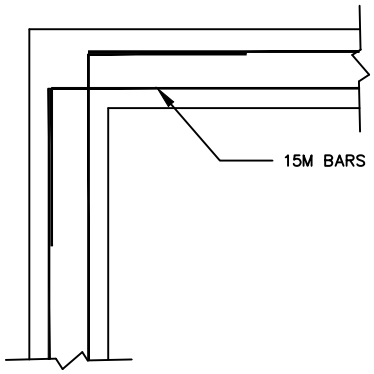
DATE March 2023

Appendix C

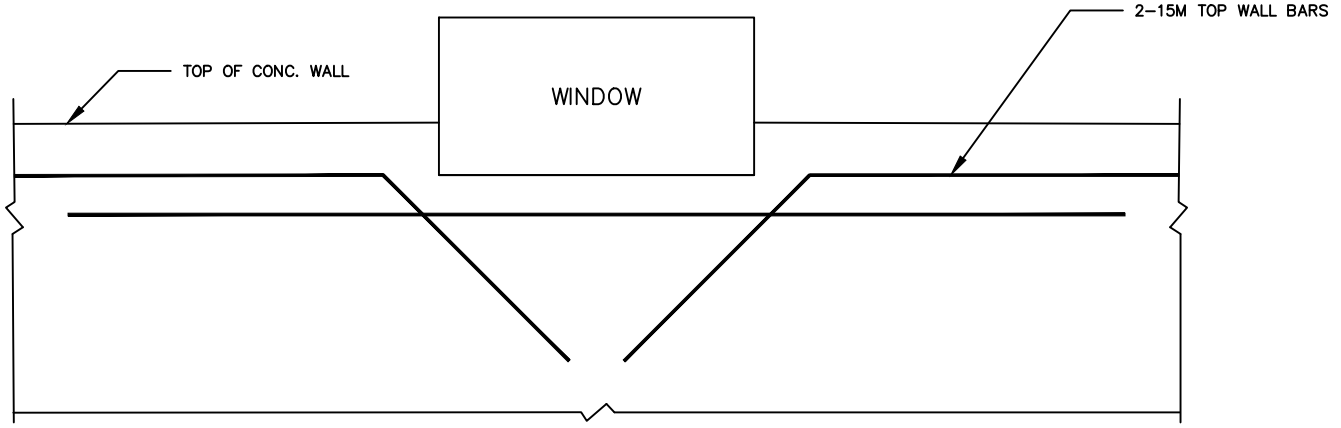
Typical Details



TYPICAL REINFORCED WALL



TYPICAL SPLICING AT CORNERS



TYPICAL WINDOW REINFORCING

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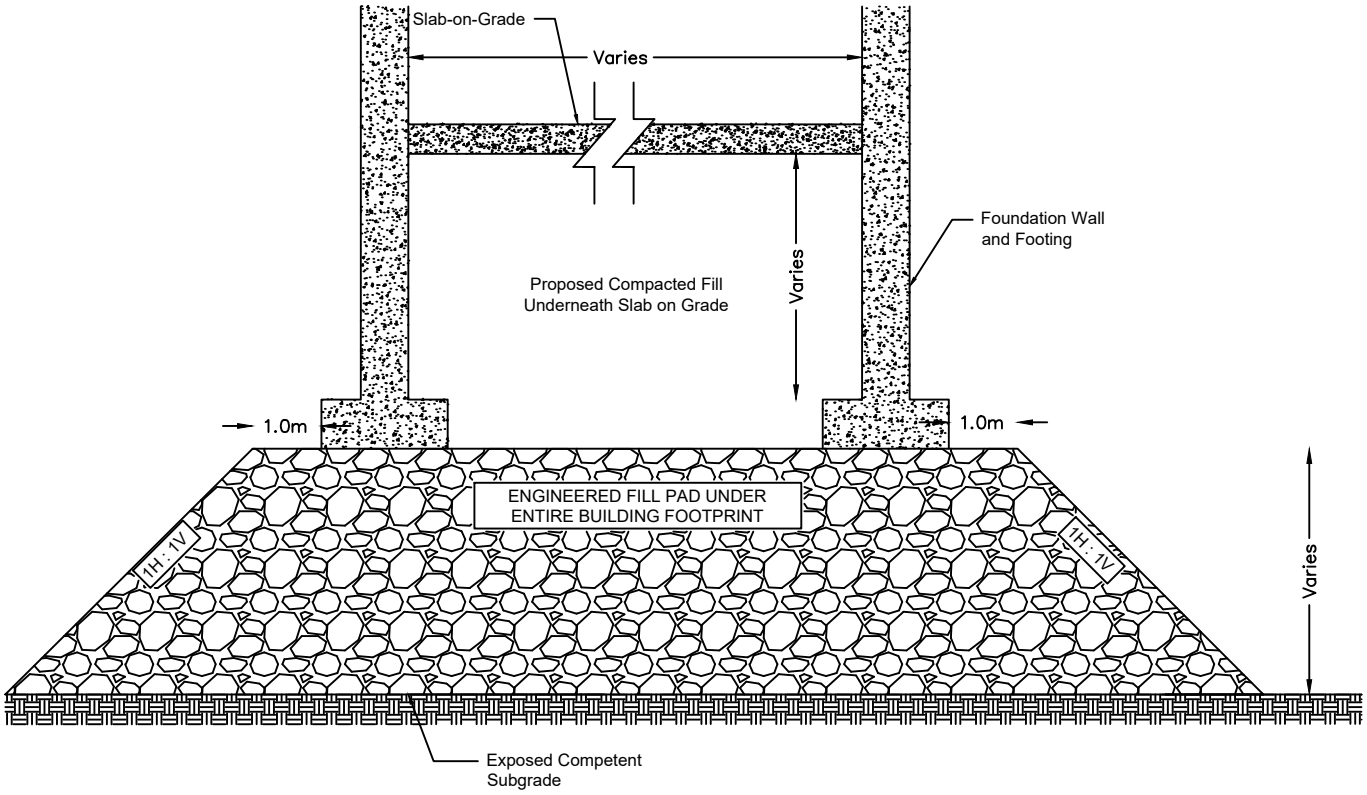
647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7

FOUNDATION WALL REINFORCING ON ENGINEERED FILL TYPICAL DETAIL

Notes:

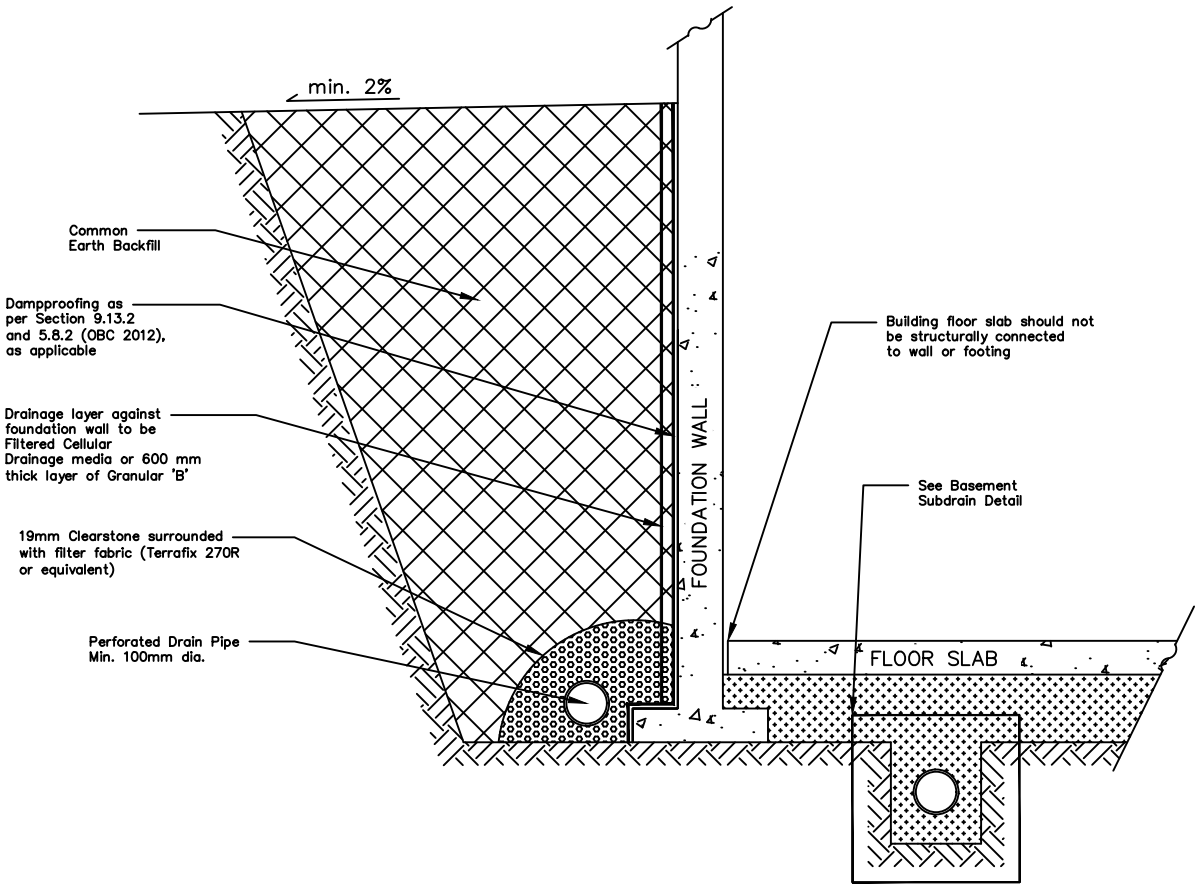
1. Engineered Fill compacted to 98% S.P.M.D.D and inspected under the full time supervision of CEE.
2. Interior non-structural compacted fill compacted to 98% S.P.M.D.D. with recommended part-time inspection.

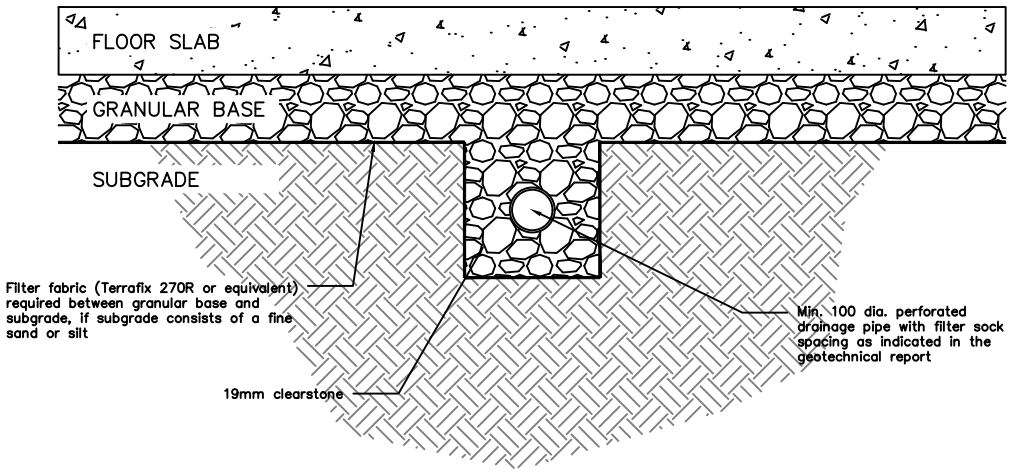
S.P.M.D.D.- Standard Proctor Maximum Dry Density



GEI Consultants
647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7

ENGINEERED FILL PAD DIMENSIONING TYPICAL DETAIL





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647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7

BASEMENT FOUNDATION WALL & SUBFLOOR DRAINAGE TYPICAL DETAIL

Appendix D
Hydrogeological Investigation

GEI Consultants

Consulting Engineers and Scientists

Hydrogeological Investigation

Proposed Residential Development

159 Huronia Road
Barrie, Ontario

Submitted to:
N.J. Electric General Contracting
182 Berkshire Drive
Aurora, Ontario
L4G 7R8

Submitted by:
GEI Consultants Ltd.
647 Welham Road, Unit 14
Barrie, Ontario, L4N 0B7

March 27, 2023
Project No. 2204000

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Appendices

1. Introduction

GEI Consultants (GEI) was retained by N. J. Electric General Contracting (the Client) to complete a subsurface investigation and provide a hydrogeological report for the proposed residential development at 159 Huronia Road, in Barrie, Ontario. A site location plan is provided as Figure 1.

The property located at 159 Huronia Road in Barrie is rectangular in shape with a total site area of 0.14 hectares. The site is located on the northeast corner of the Huronia Road and Little Avenue intersection. The property is currently occupied by one residential dwelling with a single level and a basement, which will be demolished prior to any development. The site lies within a Lake Simcoe Regional Conservation Authority (LSRCA) regulated area, with the eastern portion of the site being identified as a "floodplain" and/or "floodplain setback", however the proposed townhomes are planned to be developed outside of the floodplain.

The proposed development includes multiple townhomes with driveways directly connected to Huronia Road. Detailed site plans are not yet available and details pertaining to the townhome design, including the depth of any of basements, are not yet known. The property will be municipally serviced. An aerial image of the site is provided on Figure 2A, and the proposed concept plan is included as Figure 2B.

GEI was provided with the following correspondence, comments letter, and Conceptual Site Plan for review in preparation of this proposal:

- "Zoning By-Law Amendment Pre-Consultation Review Planning Comments", File No. D28-111-2021, dated February 9, 2022, by the City of Barrie.
- "Conceptual Site Plan – 159 Huronia Road, Ontario", File No. 21-1152, dated December 8, 2021, by Innovative Planning Solutions.
- "159 Huronia Road, Barrie – Floodplain Area and Elevation", email dated February 16, 2022, by LSRCA.
- "159 Huronia Drive, Barrie, Ontario – Hydraulic Analysis and Floodplain Analysis" letter dated August 26, 2022, by Water's Edge Environmental Solutions Team.
- "Conceptual Site Plan – 159 Huronia Road, Ontario", File No. 21-1152, dated February 23, 2023, by Innovative Planning Solutions.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further hydrogeological review and input may be required which might necessitate the need for additional investigation and/or analysis.

GEI has also been retained to complete a geotechnical study for the site and the findings and recommendations are provided under separate cover.

It is noted that geoenvironmental assessment, chemical testing, etc. was not part of the current scope. GEI would be please to revise the scope to include geoenvironmental aspects, if requested.

1.1 Purpose and Scope of Work

The main objectives of the hydrogeological Investigation were to:

a) Establish the local hydrogeological settings of the site;

b) Provide an assessment of anticipated construction dewatering flow rates for a general servicing scenario;

c) Assess use of Low Impact Development (LID) measures;

d) Assess groundwater quality and compare the results to the applicable City of Barrie Storm Sewer Use By-Law Criteria, Provincial Water Quality Objective (PWQO), and O.Reg.153/04, as amended, Site Condition Standards (SCSs);

e) Qualitatively assess the potential impact from dewatering to the nearby structures, water bodies and water uses, if any, and comment on future regulatory agency involvement;

f) Complete a water balance (pre- and post-construction);

g) Complete a preliminary phosphorous budget; and,

h) Prepare a hydrogeological investigation report.

To achieve the investigation objectives, GEI proposed and initiated the following scope of work:

a) Conduct a background desktop review of pertinent geological and hydrogeological resources, Ministry of Environment, Conservation and Parks (MECP) Water Well Records, previous reports, and proposed site plan drawings.

b) Visit the site and note existing site conditions, site setting, topography, drainage, water features, and potential water wells within 500 m of the site, if any.

c) Utilization of the three (3) boreholes and three (3) monitoring wells, completed as part of the concurrent geotechnical investigation.

d) Revisit the site and measure groundwater levels, perform borehole permeability testing in all three (3) monitoring wells, and retrieve representative groundwater samples.

e) Submit one (1) representative unfiltered groundwater sample for laboratory testing to compare against the Town of Barrie Storm Sewer Use By-Law Criteria, PWQO standards for Metals and Total Suspended Solids (TSS) and, O.Reg. 153/04, as amended, for Petroleum Hydrocarbons (PHCs), and Volatile Organic Compounds (VOCs).

f) Submit one (1) representative filtered groundwater sample for laboratory testing to compare against the PWQO standards for Metals and TSS.

g) Test three (3) selected soil samples for particle size distribution (as per Ontario LS standards in reference to ASTM D6913 and D7928).

h) Evaluate the background information, field and laboratory data to assess construction dewatering and permanent dewatering requirements.

i) Complete a water balance (pre- and post-construction) for the proposed development.

j) Complete a preliminary phosphorous budget for the proposed development.

1.2 Regulatory Requirements

1.2.1 Water Taking – Temporary

The volume of water entering the excavation during construction will be based on both groundwater infiltration and precipitation events. Based on O.Reg. 63/16, the following dewatering limits and requirements are as follows:

- Construction Dewatering less than 50,000 L/day: The takings of both groundwater and stormwater does not require a hydrogeological report, does not require registration on the Environmental Activity and Sector Registry (EASR), and does not require a Permit-to-Take-Water (PTTW) from the MECP.
- Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and registration on the EASR but does not require a PTTW from the MECP.
- Construction Dewatering greater than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and requires a PTTW from the MECP.

1.2.2 Source Water Protection

The site is within the jurisdiction of the LSRCA. The site is also within the Lake Simcoe and Couchiching / Black River Source Protection Area, in the South Georgian Bay Lake Simcoe Source Protection Region. The following documents should be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function at this site:

"*Approved South Georgian Bay Lake Simcoe Source Protection Plan",* dated June 16, 2021, by the South Georgian Bay Lake Simcoe source protection region.

Based on Source Water Protection online mapping, the following is noted:

- Wellhead Protection Area (WHPA): The site is located within a WHPA Q2 (WHPA-Q2) (Figure 3). The WHPA-Q2 includes the cone of influence around various Barrie water supply wells and any area where a future reduction in recharge would significantly impact that area.

- Intake Protection Zone (IPZ): The site is located within the Barrie Drinking Water System IPZ-3 (Figure 4).
- Highly Vulnerable Aquifer (HVA): The site is located within an HVA (Figure 5).
- Significant Groundwater Recharge Area (SGRA): The site is not located within an SGRA (Figure 6).
- The site is not located within the Oak Ridges Moraine.
- The site is not located within the Niagara Escarpment.

"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP," (by LSRCA, dated November 2018) Section 6.0 describes the policy hierarchy for water balance required for Lake Simcoe Watershed. The policies from most to least stringent are described below:

- Source Protection Plan Land Use Policy (SPP LUP) 12: *"Planning Approval Authorities shall only permit new major development (excluding single detached residential, barns and non-commercial structures that are accessory to an agricultural operation) in a WHPA-Q2 where the activity would be a significant drinking water threat, where it can be demonstrated through the submission of a hydrogeological study that the existing water balance can be maintained through the use of best management practices such as low impact development. Where necessary, implementation and maximization of off-site recharge enhancement within the same WHPA-Q2 to compensate for any predicted loss of recharge from the development."*
- Designated Policy (DP) 6.40: *"Outside of the Oak Ridges Moraine area, an application for major development within a significant groundwater recharge area (SGRA) shall be accompanied by an environmental impact study that demonstrates that the quality and quantity of groundwater in these areas and the function of the recharge areas will be protected, improved or restored."*
- Designated Policy (DP) 4.8d: *"An application for major development shall be accompanied by a stormwater management plan that demonstrates: through an evaluation of anticipated changes in the water balance between pre-development and post-development, how such changes shall be minimized."*

The site is a "major development," and is within a WHPA Zone Q2, is within an HVA, and is not within an SGRA, therefore only SPP LUP-12 and DP-4.8d apply to the site. A water balance and recommended mitigation measures are discussed in Section 5. Based on Table 2 in *"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,"* infiltration-based practices may not be permitted from parking lots for the development (to be confirmed based on the land use classification). Infiltration of runoff from vegetated areas and rooftops is always permitted.

1.2.3 Phosphorous Loading

As per LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) "Zero Export Target" for post-development phosphorus loadings will be required. The Phosphorous Offsetting Policy is applicable for the following applications under the *Planning Act, Condominium Act and Conservation Authorities Act* as well as to *Environmental Compliance Approvals*:

- Plans of subdivision,
- Plans of condominium,
- Site plans involving a proposed impervious area that is greater than (>) 500m^2,
- Consent applications resulting in the creation of four or more new lots, and/or
- Applications under the *Conservation Authorities Act* where s28.0.1 applies.

Applications made under the Planning Act that facilitate permitted agricultural uses or the construction of an accessory structure or a single-family dwelling on an existing lot of record will not be subject to the Phosphorous Offsetting Policy requirements.

2. Background Review

The site is located on the northeast corner of the Huronia Road and Little Avenue intersection in Barrie, Ontario. The property is rectangular in shape with a total site area of 0.14 hectares. The property is currently occupied by one residential dwelling with a single level and a basement, which will be demolished prior to any development. The site lies within a LSRCA regulated area, with the southern portion of the site being identified as a “floodplain” and/or “floodplain setback”, however the proposed townhomes are planned to be developed outside of the floodplain. The surrounding area is predominantly residential land uses, with parkland located to the southeast, a school located to the west, commercial properties located to the north, and industrial properties located to the south.

2.1 Site Physiographic, Geologic and Hydrogeological Settings

The site is located approximately 150 m west of Whisky Creek and approximately 1 km south of Kempenfelt Bay. A tributary/drain is about 35 m south of the site on the south side of Little Avenue. The site is within the Lake Simcoe subwatershed, within the jurisdiction of the LSRCA.

The site is located within the physiographic region denoted as the Simcoe Lowlands and the local terrain is characterized by sand plains (Chapman and Putnam, 1984). The surficial geology of the site per the Ontario Geological Survey is described as stratified deposits of sand and gravel with minor silt, clay, and till.

The bedrock underlying the general area corresponds to the Verulam Formation, consisting of limestone and shale. Based on the MECP Water Well Records in the area, bedrock is anticipated at a depth of about 100 m below existing grade. Map P.980 from the Ontario Department of Mines, *“Drift Thickness Series, Barrie Area,”* (scale 1:50,000, compiled by G. L. Burwasser and M. J. Ford, 1974) indicates that bedrock could be encountered about 107 m below grade at the site.

2.2 Review of MECP Water Well Records and Existing Water Wells

MECP water well records were obtained within 500 m of the site area to assess the general nature of the groundwater resource in the near vicinity of the site, and historical/current uses of wells in the area. No well record was found on site and twenty-seven (27) well records were found surrounding the site (off-site), the approximate MECP well locations are shown on Figure 7 and a well records summary table is included in Appendix A.

The off-site well(s) was/were installed for the following uses:

- Sixteen (16) of the records indicate domestic use.
- Three (3) of the records indicate public supply and/or municipal use.
- Two (2) of the records indicate commercial use.
- One (1) of the records indicated monitoring and testing use.

- Six (6) of the records indicated “Not Used” use or did not indicate the well use and are assumed to be unknown.

The stratigraphic descriptions within the MECP monitoring well records are typically inaccurate due to the methodology in which they are determined (observations of cuttings and no consistency between descriptions of soil between different drillers). Though this is the case, an overall sense of the deep stratigraphy can be determined by looking at commonalities between most stratigraphic descriptions and where the wells were terminated in an aquifer. The well records typically indicate sand and clay layers with variable silt and gravel over limestone.

The noted domestic water supply wells were typically installed in the sand overburden. It is noted that fresh water was encountered at depths of 3 to 84 m in the domestic water supply wells. As the surrounding area is municipally serviced, it is expected that the domestic wells are no longer in use.

Barrie Municipal Supply Wells 3A, 4, 5, 7, 11, 12, 14, 15, and 17 to 19 are located about 2.0 km northwest of the site. The site is within a WHPA-Q2 related to these wells. The MECP records indicated that wells are installed within the overburden to a depth of 12.5 to 89.3 m below the surface.

2.3 Site Condition Standards

The MECP has developed a set of Soil, Ground water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (April 15, 2011) and O. Reg. 153/04, as amended. The standards consist of nine tables (Table 1 through Table 9) that provide criteria for maximum concentrations of various contaminants. In general, the applicable O. Reg. 153/04, as amended, SCSs depends on the site location, land use, soil texture, bedrock depth and the applicable potable or non-potable ground water condition at the investigation site.

In order to determine the Site Sensitivity, Sections 41 and 43.1 of O. Reg. 153/04, as amended, were evaluated by GEI as shown in the following table:

CRITERIA	RESULT
Current Property Use	Residential
Potable vs. Non-Potable Ground Water	Potable
Proximity of Areas of Natural Significance	> 30 m
Proximity to a Water Body	> 30 m
Shallow Soil Condition	No
Land Use	Residential/Parkland/Institutional (RPI)
Applicable Site Condition Standard	Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2 RPI)

2.4 Visual Inspection of the Site

A visual site inspection was carried out on December 15, 2022, by GEI staff to assess site drainage, topography and presence of surface water features.

The site is located to the northeast corner of the Huronia Road and Little Avenue intersection in Barrie, Ontario. The property is rectangular in shape with a total site area of 0.14 hectares. The surrounding area is predominantly residential land uses, with parkland located to the southeast, a school located to the west, commercial properties located to the north, and industrial properties located to the south.

The topography of the site is relatively flat with a gentle slope down towards the east / southeast such that there is an overall change in elevation of approximately 1 to 2 m from the west site limit to the east site limit and less than 1 m from the north site limit to the south site limit.

No water bodies were identified at the site.

3. Procedures and Methodology

It is noted that all elevations in this report are metric/geodetic and expressed in metres (m). All measurements are also in metric and expressed in millimetres (mm), metres (m) or kilometres (km).

Prior to the commencement of drilling activities, the borehole locations were staked in the field by GEI. Borehole ground surface elevations and coordinates (referencing NAD 83 geodetic datum) were surveyed by GEI with a Topcon HiPer SR GPS Survey unit.

Underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public utility locating companies and a private locator prior to drilling.

The fieldwork for the drilling program was carried out on November 22, 2022. Boreholes 1 to 3 were advanced to 6.6 m below existing grade (Elev. 234.2 to 235.4). Borehole logs are provided in Appendix B and the borehole locations are shown on Figure 2A (aerial image) and Figure 2B (proposed plan).

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a track-mounted drill rig, solid stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) “N” Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Monitoring wells were installed in all the boreholes by GEI to facilitate long-term groundwater monitoring, each consisting of 50 mm diameter PVC pipe with a 1.5 m long screen and protective casing. Monitoring well construction is shown on the borehole logs in Appendix B.

The GEI field staff examined, and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials (if any), groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI’s laboratory for more detailed examination and classification.

In GEI’s laboratory, the samples were classified as to their visual and textural characteristics. Four (4) representative samples of the major soil units were selected and submitted to our laboratory for grain size analysis. Grain size results are provided in Appendix C.

3.1 Borehole Permeability

Rising head tests were completed in the three (3) monitoring wells on site on December 15, 2022. Water was manually purged from monitoring wells using LDPE piping and a foot valve. The static water level was measured prior to the start of testing, and the change in water level was monitored using an electronic level logger. The level loggers were left in the monitoring wells to allow for

adequate recovery of the groundwater. The tests were completed to estimate the horizontal hydraulic conductivity (K) of the soils at the well screen depths.

The semi-log plots for drawdown versus time for the tests are provided in Appendix D.

3.2 Groundwater Sampling

To establish baseline conditions and assess the suitability for discharge of pumped groundwater to surface during potential dewatering activities, the following groundwater samples were collected from BH/MW 1 on December 13th, 2022:

- One (1) unfiltered groundwater sample was collected from BH/MW 1 and analyzed against the City of Barrie Storm Sewer Use By-Law Criteria, and PWQO Metals and TSS
- One (1) filtered groundwater sample was collected from BH/MW 1 analyzed against PWQO Metals and TSS only.

Prior to collection of the samples, approximately three (3) standing well volumes of groundwater were purged from the well. The samples were collected and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The field filtered samples were processed through a 45 µm filter prior to collection in the required vials/bottles. The samples were submitted to CALA- accredited Caduceon Environmental Laboratories for analysis. The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in Appendix E.

4. Subsurface Conditions

4.1 Stratigraphy

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix B, and the geotechnical laboratory results are included in Appendix C. The borehole locations are shown in Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. Cross-sections are provided in Figure 8.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

4.1.1 Topsoil

A surficial topsoil layer was at the ground surface in Boreholes 1, 2 and 3 ranging in thickness from 75 to 150 mm.

4.1.2 Fill

A fill layer was encountered in all boreholes. The fill layer consisted of sand/silty sand in the upper portion and gravelly sand in the bottom portion. The fill was penetrated at 2.3 to 3.0 m depth (Elev. 238.4 to 239.4). The fill had trace to some organics in all boreholes and concrete pieces were observed in Borehole 2. The fill was moist to wet with moisture contents ranging from 8 to 14%. The fill had N values ranging from 8 to 22 (loose to compact).

4.1.3 Silty Sand / Sand / Sandy Silt to Silty Sand /Sand and Gravel

Cohesionless deposits were encountered beneath the fill, locally the clayey silt in Borehole 1. These deposits consisted of silty sand to sand in Borehole 1 from 3.0 to 6.6 m depth (Elev. 238.9 to 235.4), sandy silt to silty sand in Borehole 2 from 3.0 to 6.1 m depth (Elev. 238.7 to 235.6) and sand and gravel in Borehole 3 from 2.3 to 3.0 m depth (Elev. 238.4 to 237.7). The deposits had a till like appearance in Borehole 1 and 2. Three samples of the various units were submitted to our laboratory for grainsize analysis and the results are provided in Figure C1 in Appendix C. N values ranged from 4 to 35 being loose to dense, typically compact. The soil was typically wet with moisture contents ranging from 8 to 20%.

4.1.4 Clayey Silt / Clayey Silt to Silty Clay

A 400 mm thick clayey silt layer from 2.6 to 3.0 m depth (Elev. 238.9 to 239.4) was observed below the fill and above the cohesionless soil in Borehole 1. In Boreholes 2 and 3, clayey silt and clayey silt to silty clay units were present at depths varying from 3.0 to 6.1 (Elev. 235.6 to 237.7) and extended to the 6.6 m depth of exploration (Elev. 234.2 to 235.2). A sample of the clayey silt to silty clay soil was submitted to our laboratory and the results are provided in Figure C2 in Appendix C. The soil was grey and moist to very moist with moisture contents ranging from 12 to 28%. N values in the material ranged from 16 to 32 blows indicating a very stiff to hard consistency.

4.2 Groundwater Level Monitoring

Unstabilized groundwater level measurements and cave measurements were taken upon the completion of drilling of each borehole as shown on the borehole logs in Appendix B. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. All three (3) boreholes were outfitted with a monitoring well with 50 mm diameter PVC standpipe and 1.5 m long screen. Monitoring well configuration and groundwater observations are noted on the borehole logs in Appendix B, and a summary is below.

Borehole / Monitoring Well	Well Screen Location Depth (m) / Elev. (m)	Unit Screened	Depth of Cave Depth (m) / Elev. (m)	First Water Strike (m) / Elev. (m)	Unstabilized Groundwater Level Depth (m) / Elev. (m)	Stabilized Groundwater Level (Dec 6, 2022) Depth (m) / Elev. (m)
1	4.0 to 5.5 / 238.0 to 236.5	Silty Sand / Sand	5.4 / 236.5	2.3 / 239.6	2.3 / 239.6	2.6 / 239.3
2	4.6 to 6.1 / 237.2 to 235.7	Sandy Silt to Silty Sand / Clayey Silt	Open (6.6 / 235.2)	2.3 / 239.4	2.1 / 239.6	2.3 / 239.4
3	4.6 to 6.1 / 236.1 to 234.6	Clayey Silt to Silty Clay	Open (6.6 / 234.2)	1.5 / 239.2	2.1 / 238.6	2.4 / 238.3

The stabilized groundwater level measurements were observed at 2.3 to 2.6 m depth, corresponding to Elev. 238.3 to 239.4 m.

The existing fill, sand, silty sand and sand and gravel are permeable and allow for the free flow of ground water when wet. The sandy silt to silty sand is semi-permeable and is expected to generally allow for the free flow of water when wet. The clayey silt and clayey silt to silty clay are generally not permeable.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

It is anticipated that the local water flow will be east towards Whisky Creek and regional water flow will be north towards Kempenfelt Bay. A groundwater contour map is provided in Figure 9. GEI is measuring groundwater levels in each of the three (3) monitoring wells, monthly for four (4) months at the site to determine the seasonal high levels. The results will be summarized in a future report.

It is noted that typically 12-months is recommended in accordance with the LSRCA requirements; however, at a minimum, groundwater level monitoring between March and June (4 months) is recommended.

4.3 Hydraulic Conductivity

Hydraulic conductivity tests were conducted in all three (3) of the monitoring wells. Values were calculated using AQTESOLV Pro V4.50.002 for Windows as developed by HydroSOLVE, Inc. from the rising head test data using Hvorslev's solution (1951) where the well screen was fully saturated. The semi-log plots for the results are provided in Appendix D and are summarized in the table below.

Borehole / Monitoring Well	Well Screen Location Depth (m) / Elev. (m)	Unit Screened	In-Situ Hydraulic Conductivity (K) (m/s)
1	4.0 to 5.5 / 238.0 to 236.5	Silty Sand / Sand	3.6×10^{-5}
2	4.6 to 6.1 / 237.2 to 235.7	Sandy Silt to Silty Sand / Clayey Silt	8.9×10^{-8}
3	4.6 to 6.1 / 236.1 to 234.6	Clayey Silt to Silty Clay	1.1×10^{-8}

According to Freeze and Cherry (1979), the typical range in hydraulic conductivity is as follows:

- Sand: 10^{-2} m/s to 10^{-6} m/s
- Silty Sand: 10^{-3} m/s to 10^{-7} m/s
- Silt: 10^{-5} m/s to 10^{-9} m/s
- Clay: 10^{-9} m/s to 10^{-12} m/s

The variation in measured and inferred hydraulic conductivities from the typical range in hydraulic conductivity is attributed to the effects of the wells being screened across two distinct units (BH/MW 2).

When considering the values of the measured in-situ hydraulic conductivity for the well screened only in the silty sand / sand soils (BH/MW 1), the results indicate that 4.0×10^{-5} m/s is an appropriate hydraulic conductivity for water taking calculations at this site within the silty sand / sand soils.

When considering the values of measured in-situ hydraulic conductivities for the well screened only in the clayey silt and clayey silt to silty clay soils (BH/MW 3) the results indicate that 1.5×10^{-8} m/s is an appropriate hydraulic conductivity water taking calculations at this site within the clayey silt and clayey silt to silty clay soils.

4.4 Groundwater Quality

To assess the suitability for discharge of pumped groundwater to the land surface during dewatering activities, two (2) groundwater samples, one (1) unfiltered and one (1) filtered, were collected from Borehole / Monitoring Well 1 on December 13, 2022.

For the assessment purposes, the analytical results were compared to the Town of Barrie Storm Sewer Use By-Law Criteria and the PWQO. The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in Appendix E. A summary of the results is presented in the table below for samples relative to the City of Barrie Storm Sewer Use By-Law Criteria and the PWQO.

Monitoring Well Sample Location	Parameters Tested	Exceedances of City of Barrie Storm Sewer Use By-Law Criteria	Exceedances of PWQO
BH/MW 1 (Unfiltered)	City of Barrie Storm Sewer Use By-Law PWQO: Metals, TSS	Storm: Copper, TSS	PWQO: Zinc, Iron Interim PWQO: Zirconium, Zinc, Vanadium, Lead, Copper, Cobalt, Aluminum
BH/MW 1 F (Filtered)	PWQO: Metals, TSS	No Exceedances	No Exceedances

The unfiltered groundwater sample collected from BH/MW 1 met the parameters tested for the City of Barrie Storm Sewer Use By-Law except copper and TSS and met the PWQO except for zinc and iron. It is also noted that the sample exceeded the interim PWQO for zirconium, zinc, vanadium, lead, copper, cobalt, and aluminum.

The filtered groundwater sample met PWQO for Metals and TSS. These chemical results suggest treatment of the dewatering discharge water by filtration may aid in reducing the concentration of metals, however, additional treatment may be required to meet both the PWQO and interim PWQO for dissolved parameters. It is noted that field filtering reduced the TSS concentration from 495 mg/L to less than 3 mg/L which would meet the requirements for Town of Barrie Storm Sewer Use By-Law Criteria of 9.5 mg/L.

If pumped groundwater will be discharged to the City of Barrie Storm Sewer, it must be suitably treated to remove the parameter exceedances prior to discharge (treatment methods to be determined by the dewatering contractor or civil engineer).

Treatment of the dewatering discharge water by filtration or sedimentation to reduce the concentration of suspended solids, and thus reduce the concentrations of non-dissolved metals, is necessary and may be effective in achieving compliance with the PWQO. However, other treatment methods may be necessary to reduce the concentration of dissolved analytes.

It is expected that during construction dewatering, the pumped water is to be first discharged to a sedimentation tank and then a silt/sediment bag, at a minimum, before being discharged to surface.

5. Discussion and Analysis

5.1 Construction Dewatering

5.1.1 Excavations and Temporary Groundwater Control

The site is located on the northeast corner of the Huronia Road and Little Avenue, in Barrie, Ontario. The site is about 52.4 m (north to south) by 28.7 m (east to west), as shown on Figure 2B.

The stabilized groundwater level measurements were observed at 2.3 to 2.6 m depth, corresponding to Elev. 238.3 to 239.4.

It is GEI's understanding that details pertaining to the townhome design, including the presence of basements (basements are assumed for purposes of this report), are not yet known. As the property will be municipally serviced, it is expected that the proposed townhomes will be serviced with municipal water and sanitary sewers and that only service laterals will be required from Huronia Road. Inverts are assumed to extend as deep as 3 m below the existing grade for the purposes of this report.

At this time, excavations for the project site are anticipated to extend 2.5 to 3.5 m below existing grade to account for engineered fill placement, service connections, and possibly basements. Below the surficial topsoil, excavations are anticipated to encounter earth fill, over the cohesionless soil units and locally the clayey silt/ silty clay to clayey silt unit. Harder digging can be expected locally in the dense cohesionless deposits. Cobbles and boulders should be expected in the sand and gravel deposit.

Based on this, excavations at the site are expected to extend approximately 1.0 m below the prevailing groundwater table.

For conservative purposes, the construction dewatering calculation is based on an open cut excavation at the present time. To excavate under dry conditions, the water level is anticipated to be lowered at least to a minimum of approximately 0.5 m below the proposed excavation depth. Based on the subsurface conditions encountered during the field investigation, a hydraulic conductivity of 4.0×10^{-5} m/s has conservatively been applied to the entire site.

Additional dewatering capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. It should be noted that the dewatering estimates provided in this report are based on the assumed site servicing depths. GEI must be provided with final site servicing and grading plans to verify the design assumptions or update the water taking estimates as needed.

The exact scenario where these groundwater control techniques will work are estimates only and are directly correlated to how coarse/fine the native soils are in an excavation, and both the lateral and vertical extent of the cohesionless deposits encountered. If the groundwater table is not controlled during construction, the base of the excavations will probably be unstable, leading to difficulties in excavating and placement of pipes or footings. A dewatering contractor must review

and assess the subsurface conditions to verify which dewatering techniques will work for the site and proposed utility installations, based on their experience and interpretation of the data. A test dig could be carried out to assist prospective contractors determine the most appropriate dewatering methods based on their own means and methods.

Grading plans were not available for review at the time of this report, however it is speculated that some grade raise is required to keep basements above the ground water level.

5.1.2 Construction Dewatering Assumptions

The assumptions used for the calculation of the dewatering rates for the proposed development are presented below:

- Based on the results of the field investigation, a hydraulic conductivity of 4.0 x 10^{-5} m/s has been applied to the entire site.
- Based on the borehole elevation survey on site the lowest ground elevation in the vicinity of the site is approximately Elev. 240.5.
- The general site servicing scenario assumes the site servicing will include service laterals extending 20 m east from Huronia Road to each proposed townhome and will be excavated 4 m wide and 3.5 m deep (Elev. 237.0).
- The general basement scenario assumes that any basements constructed are required to be 1.0 m above the water table and, since it is understood that this approach will be followed no dewatering is anticipated for basement construction/excavation.
- In general, groundwater levels should be lowered a minimum of 0.5 m below the excavation base for servicing.
- The local high groundwater level measurement was observed at 2.3 m depth (Elev. 238.2).

5.1.3 Radius of Influence

The Radius of Influence (ROI) for the construction dewatering is based on the empirical Sichardt Equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible. This equation is empirical and was developed to provide representative flow rates using the steady state flow dewatering equations, as discussed below.

It is noted that in steady state conditions, the radius of influence of pumping will extend until boundary flow conditions are reached and provide sufficient water inputs to the aquifer, such as recharge and surface water bodies. As a result, the distance of influence calculated using the Sichardt equation is used to provide a representative flow rate calculation, but it is not precise in determining the actual radius influenced by pumping.

The ROI of pumping (dewatering) for radial flow was calculated based on the Sichardt equation, which is described as follows:

$$R_0 = 3000\ (\mathrm{H} - \mathrm{h})\sqrt{\mathrm{K}}$$

Where:

K = Hydraulic conductivity (m/s)
H = Static Saturated Head (m)
h = Dynamic Saturated Head (m)
R_0 = Radius of influence (m)

Based on the Sichardt equation, the hydraulic conductivity of 4.0 x 10^{-5} m/s and the total groundwater drawdown required at this site, the ROI is expected to be as much as 32 m from the centre of the excavations for radial flow. Calculation details are provided in Appendix F, and zone-specific ROIs are summarized below:

Dewatering Zone	Description	ROI (m)
1	General Site Servicing Scenario Per Lateral	32

The ROI calculation is a conservative methodology and is calculated based on the assumption of active pumping during the construction dewatering. It should be noted that most of the water will be pumped during the first stage of the construction period or when a rain event occurs.

5.1.4 Temporary Dewatering Flow Rate Calculations

The Dupuit equation for linear flow from an unconfined aquifer for a fully penetrating excavation was used to obtain a flow rate estimate for the proposed linear infrastructure (servicing laterals), and is expressed as follows:

$$\mathrm{Q_w} = Kx\frac{\mathrm{H}^2 - \mathrm{h}^2}{L_0}$$

Where:

$\mathrm{Q_w}$ = Rate of pumping (m^3/s)
X = Length of excavation (m)
L_0 = Length of influence (m) ($L_0 = \frac{R_0}{2}$)
K = Hydraulic conductivity (m/s)
H = Head beyond the influence of pumping (static groundwater elevation) (m)
h = Head above base of aquifer at the excavation (m)

The dewatering rates are expected to decrease once the target water levels are achieved in the excavation footprints as groundwater will have been removed locally from storage resulting in lower seepage rates into the excavations.

Based on the assumptions provided in this report, the results of the dewatering rate estimates are summarized below, and calculation details are provided in Appendix F:

Location and Scenario	Construction Dewatering Flow Rate Without Safety Factor	Construction Dewatering Flow Rate Including Safety Factor of 2	Construction Dewatering Flow Rate Including Safety Factor of 2 with a 10 mm Rainfall Event
	L/day		
1 - General Site Servicing Scenario Per Lateral	14,200	28,400	29,000

As the calculated construction dewatering flow rate for one service lateral is less than 50,000 L/day, a posting on the EASR is not anticipated for the site. However, should more than one servicing lateral are excavated, dewatering rates more than 50,000 L/day are anticipated, such that a posting on the EASR will be required.

The total construction dewatering flow rate includes a factor of safety of 2.0 to account for seasonal fluctuations in the groundwater table and variation in hydrogeological properties beyond those encountered during the course of this study. This total dewatering flow rate also provides additional capacity for the dewatering contractors. A 10 mm rain event was also included in the water taking calculation.

Please note that it is the responsibility of the contractor to ensure dry conditions are maintained within the excavations at all times. Based on the calculated water taking rate, it is expected that conventional sump pump systems and/or keg wells will be adequate to control seepage at this site. Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. The contractor must ensure that water taking rates remain below 400,000 L/day. If the rates exceed 400,000 L/day, a PTTW from the MECP will be required for the site.

The maximum flow calculation is intended to provide a conservative estimate to account for unforeseeable conditions that may arise during construction. It should be noted that the dewatering estimates provided in this report are based on assumptions and details available at the time of this report. If changes to the design are implemented (e.g., increase to planned excavation depths, widening of excavations, etc.), the dewatering estimates must be revised to include and reflect future changes.

5.1.5 Remedial Dewatering Activities

The dewatering contractor is responsible for finalizing and implementing the discharge plan, including information such as the exact discharge location, erosion control methods, method of conveyance, treatment systems, temperature of the discharged groundwater, etc. It is the contractor's responsibility to implement a treatment system to ensure that discharged groundwater meets the PWQO for the necessary parameters. This may be done by examining the hydrogeologic conditions in a test pit (and/or a full-range pumping test by the dewatering subcontractor).

The dewatering discharges should follow the best management practices, including sediment and erosion control measures, removal of suspended solids by a decanting tank, as well as a water quality and quantity control monitoring programs, as mentioned earlier. The contractor should be aware that the purpose of the dewatering system is to maintain stable excavation slopes and dry working conditions during excavation.

The extent and details of the dewatering scheme (trench or well dimensions, spacing, pump levels, screen size and wick gradation) are left solely to the contractor's discretion to achieve the performance objectives for maintaining stable slopes and dry working conditions and will be based on their own interpretation and analysis of site conditions, equipment, experience, and plant efficiency. The contractor should also appreciate that additional dewatering means and modifications may be required as variations in site conditions are encountered. The recommended groundwater taking and discharge plans are provided in Appendices G and H, respectively.

5.1.6 Impact Assessment for Groundwater Dewatering

For the assumed maximum groundwater drawdown of 1.7 m for construction dewatering, settlement of the soil within the zone of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. The maximum settlement will occur adjacent to the dewatering system where the maximum drawdown occurs. Settlement has the potential to damage buried utilities, building foundations, or cause subsidence in adjacent lands. The amount of settlement will decrease exponentially to zero towards the radius of influence limit.

Negligible settlement will occur due to the minimal drawdown within the soil overburden. The radius of influence around the servicing lateral(s) is expected to be 32 m with a portion of the excavation extending from the site to the centre of Huronia Road. The nearby residential houses across the street from the site are approximately 20 m from the assumed dewatering locations (including the centre of Huronia Road). No impacts are expected to nearby structures or land.

Another cause of significant dewatering related settlement is due to pumping of fines through the system. It is imperative that any dewatering systems (e.g., sump pumps) shall be installed adequately to ensure no soil is conveyed through the system. Sufficient filtering techniques are incorporated at the entry point to avoid migration fines in the pumping/dewatering system. The turbidity of pumped water should be monitored daily to ensure that only minimal fines are being conveyed through the system.

There are no surface water features or domestic wells in the radius of influence, so no impacts are expected. Furthermore, the construction dewatering is limited to the near surface only.

5.2 Preliminary Water Balance

5.2.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the summation of the change in groundwater storage (S), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

$$\mathrm{P} = S + I + ET + R$$

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- Precipitation (P): For the purposes of approximating the annual precipitation at this site, the monthly rainfall between 1981 and 2010 was used based on Environment Canada historical weather data for the Barrie WPCC weather station (Climate ID 6117684, Latitude 44.37 N, Longitude 79.68 W, Elevation 221 m), which is located about 2.3 km northwest of the site.
- Storage (S): Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero.
- Evapotranspiration/Evaporation (PET): The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, gravel parking areas, etc.).
- Water Surplus (R + I): The difference between the mean precipitation and evapotranspiration is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the near surface soil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

5.2.2 Water Balance Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development infiltration volumes. The detailed water balance calculation is provided in Appendix I, which is summarized in this and subsequent sections of the report. The following assumptions were used as part of the soil-moisture balance calculations:

- A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists.
- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Considering the nature of the near surface soils (silty sand / sand / sandy silt to silty sand) and vegetation cover, a soil moisture storage capacity of 75 mm was assumed.
- Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

Monthly potential evapotranspiration calculations accounting for latitude, climate and the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions were calculated. The *MECP SWM Planning and Design Manual* (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding infiltration factor was calculated for pre- and post-development conditions. The water surplus was multiplied by the infiltration factor to determine both the pre-existing and post-condition annual volumes for run-off and infiltration for the property.

The pre-development scenario was estimated from the site inspection and aerial images, with 85% being permeable and 15% being impermeable. The post-development water balance scenario was estimated based on *"*Conceptual Site Plan – 159 Huronia Road, Ontario*",* dated December 2021, by Innovative Planning Solutions. As detailed site plans are not yet available and details pertaining to the townhome design are not yet know, the post-construction scenario was assumed to maintain 35% of the site as permeable land to satisfy the Residential Multiple Dwelling Secondary Density (RM2) Zoning requirement for a minimum of 35% landscaped open space. The remaining 65% of the land is assumed to be impermeable and consists of townhomes and driveways. The water balance must be updated following final site configuration to reflect the final site plans.

It is noted that the infiltration and runoff values presented in Appendix I are estimates only. Single values are used for the water balance calculations, but it is important to understand that infiltration rates are dependent upon the hydraulic conductivity of the surficial soils which may vary over several orders of magnitude. As such, the margins of error for the calculated infiltration and runoff component values are potentially quite large. These margins of error are recognized, but for the purposes of this assessment, the numbers used in the water balance calculations are considered reasonable estimates based on the site-specific conditions and useful for comparison of pre- to post-development conditions.

5.2.3 Pre and Post Development Water Balance

Detailed water balance calculations are included in Appendix I. The pre and post development calculations summarized in this section are preliminary only and must be updated once site plans are finalized.

The table below summarizes the pre and post construction water balance as per the proposed site development plans.

Condition	Permeable Areas	Impermeable Areas	Average Annual Runoff Volume (m^3/year)	Average Annual Infiltration Volume (m^3/year)
Pre-Development Land Use	85%	15%	346	270
Post-Development Land Use	35%	65% (residential building and driveways)	796	111

These calculations suggest that, without mitigation such as LID measures, the proposed development will decrease average infiltration by about 159 m^3/year (59% decrease). The proposed development will increase runoff by about 450 m^3/year (130% increase). This means about 159 m^3/year of infiltration is required to maintain the water balance. The potential impacts of these changes and recommended mitigation measures are discussed below.

5.2.4 Recommended Mitigation Measures

The three broad categories which typically need to be mitigated and accounted for are:

- Reducing the volume and speed in which additional surface water runoff occurs;
- Increasing the amount of infiltration to match pre-development conditions; and
- Ensuring that the quality of existing surface water features and groundwater will not be adversely impacted.

5.2.5 Runoff Quantity

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (e.g., roads, parking lots, driveways, rooftops). Impervious surfaces prevent infiltration of water into the underlying soils and the removal of the vegetation reduces the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 15% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (up to two thirds of precipitation). So, the net effect of the urbanization of the site is that most of the precipitation that falls onto impervious surfaces increases the surplus water resulting in more direct runoff from developed areas and reduced natural infiltration.

In conjunction with increased runoff, there is a reduction in infiltration to the shallow groundwater system. A reduction in infiltration can potentially lead to a lowering of the local water table and reduce the potential for this seasonal water table intersection and discharge.

Methods which do not necessarily increase infiltration rate, but decrease the volume and concentration of surface water runoff can be considered at this site include (but are not limited to):

- Increasing the topsoil thickness by about two times the normal thickness (up to 30 cm) to retain more water in storage; and
- Implementation of rainwater harvesting which intercepts, diverts and stores roof runoff (i.e., cisterns) for future use.

5.2.6 Mitigation Measures for Maintaining Infiltration

The increases in surface water runoff that will occur with urban development and mitigation of the potential impacts to the local water table due to reduction of infiltration may be minimized by using appropriate stormwater management and using LID measures to promote infiltration. These measures can be implemented on-site.

The basic premise for LID is to try to minimize changes to runoff and infiltration. As outlined in the *MECP SWMP Design Manual* (2003) and *Low Impact Development Stormwater Management Planning and Design Guide* published by the CVC and TRCA (2010), there are a suite of techniques that may be considered to promote infiltration and reduce runoff.

In order to maintain ground water function at the site the following typical LID measures can be considered as part of typical site developments (can depend on land use):

- Collection of runoff from the building rooftops and redirection to grass areas and overland flow. If feasible, it is recommended that there be a minimum 5 m flow path over pervious areas to allow this mitigation method to be fully effective;
- Provision of gentle slopes in open areas or along grass swales in order to allow time for water infiltration;
- Construction of engineered infiltration measures such as soakaway pits, infiltration galleries or bioswales. Subsurface infiltration methods can only be considered in areas where there is sufficient soil permeability and depth to water table to accommodate the systems within the unsaturated zone (typically the infiltration elevation must be kept 1 m or more above the seasonal high groundwater level).
- Construction of grass channels or filter strips which allow infiltration, discharge at a lower rate and direct roof runoff to overland flow.

Implementation of LID measures will not only allow for infiltration of the surface water into the near-surface groundwater regime but will also allow for increase in natural filtration of surficial runoff, prevent sedimentation transport and potential erosion, and help reduce flooding by increasing the transit time for water on the site. These types of LID techniques promote natural infiltration by providing additional water volumes in the pervious areas. This is particularly effective

in the summer months when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

At this time no details or designs for LID measures have been provided. Should LID measures be implement for the site, the details and designs should demonstrate through plans and sections (including all dimensions, materials used and including the seasonal high groundwater level) how this infiltration deficit will be mitigated.

As it is typically a requirement of maintaining the same levels of infiltration post construction, no appreciable change in the groundwater table elevation should occur over the long-term condition.

It is noted that the infiltration rates calculated by the use of grain size analysis results are estimates only as they do not reflect the compaction, saturation, and/or layering of the soil on site, which affect the infiltration of water on site. Vertical hydraulic conductivity can be measured in-situ with a Guelph Permeameter apparatus to provide more accurate infiltration rates at specific locations and depths to inform LID designs should it be required.

5.2.7 Groundwater Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, phosphorous, bacteria and viruses. For groundwater, generally except for the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater flow through the soils.

LID measures or end treatments such as oil/grit separators or wet ponds also help to remove suspended solids and other contaminants in runoff prior to infiltration or conveying the flows off the site, especially when a treatment train approach is taken for stormwater management. Any stormwater management facilities must be designed such that the water quality is maintained or improved prior to discharging water from the site or infiltrating water into the ground.

Runoff from residential developments (e.g., rooftops, landscaped areas) are typically considered “clean” and can be collected and infiltrated where possible. Further, infiltration-based practices may be permitted for impervious areas such as roads and driveways for lower density residential development.

Since only clean or pre-treated runoff will be infiltrated, the groundwater quality will not be degraded and will not impact nearby domestic wells, the watercourse or other nearby environmental features.

5.3 Low Impact Development

5.3.1 Preliminary Infiltration Assessment

Determination of percolation rates are based on the "*Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SB-6, Percolation Time and Soil Descriptions, 2012*". The boreholes indicate fill was encountered at surface overlying cohesionless deposits of mainly silty sand / sand / sandy silt to silty sand over cohesive deposits of clayey silt / clayey silt to silty clay. The Unified Soil Classification System classifications for the predominant soils encountered on-site are summarized below with the interpreted unfactored percolation rates (T-Time) and unfactored infiltration rates:

Unified Soil Classification System Classification	Unfactored Percolation Rate (T-Time) (mins/cm)	Unfactored Infiltration Rate (mm/hr)
S.M. Silty sands, sand-silt mixtures	8 to 20	30 to 75
C.L. Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	over 50	less than 12

These infiltration rates are not applicable below the groundwater table. Appendix C of "Low Impact Development Stormwater Management and Planning Design Guide" (Version 1.0, 2010, by CVC and TRCA) suggests safety factors to be applied to infiltration rates. The safety factor applicable to the site is expected to be 2.5 but this must be confirmed once the final location and elevation of LID measures are known. If LID infiltration measures will be designed and constructed on site, it is recommended to measure the in-situ infiltration rates by excavating test pits and conducting Guelph Permeameter tests in the exact footprints and elevations of the LID measures.

It is not recommended to design LID or septic measures to infiltrate into the surficial topsoil nor fill layers due to variable soil consistency and the possibility for lower-permeability of the topsoil and/or fill. Infiltration cannot occur below the groundwater table. It is typical for the base of infiltration features to be kept at least 1 m above the seasonally high groundwater level.

5.4 Preliminary Phosphorous Budget

As per LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) "Zero Export Target" for post-development phosphorus loadings will be required. However, restricted by the premature site Storm Water Management (SWM) servicing scheme, a preliminary assessment has been completed in a way that NO on-site phosphorus mitigation measures have been provided. As the site SWM control strategy is available, the post-development Phosphorus loading calculations with Best Management Practices (BMPs) will be updated accordingly. Please note that in situations where the phosphorus load cannot achieve the "Zero Export Target", the developer or proponent will be required to provide phosphorus offsetting compensation fee to the LSRCA.

As per the MECP Lake Simcoe Phosphorus Budget Tool, March 2012, the post-development phosphorus loading is assumed to be 1.32 kg/year/ha for the site without BMPs, for a total of 0.18 kg/year for the 0.14 ha site, with an off-setting compensation fee of $19,005.00, including

the 15% administration fee. The actual cash-in-lieu will be further refined based on the LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) to include proposed BMPs as per the SWM servicing strategy updates.

The preliminary Phosphorous loading calculation details are provided in Appendix J for review.

6. Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of N.J. Electric General Contracting (as provided the signed Standard Professional Services Agreement). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

7. Closure

We trust that this information is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact our office.

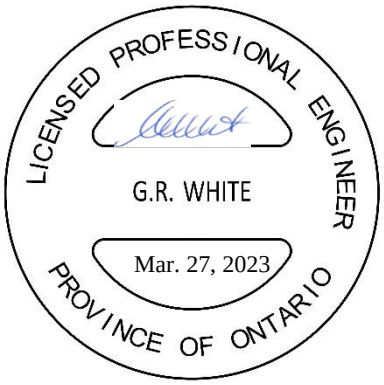
Yours truly,

GEI Consultants

Prepared By:

Sarah Griffith, B.Sc., G.I.T.
Hydrogeologist-in-Training

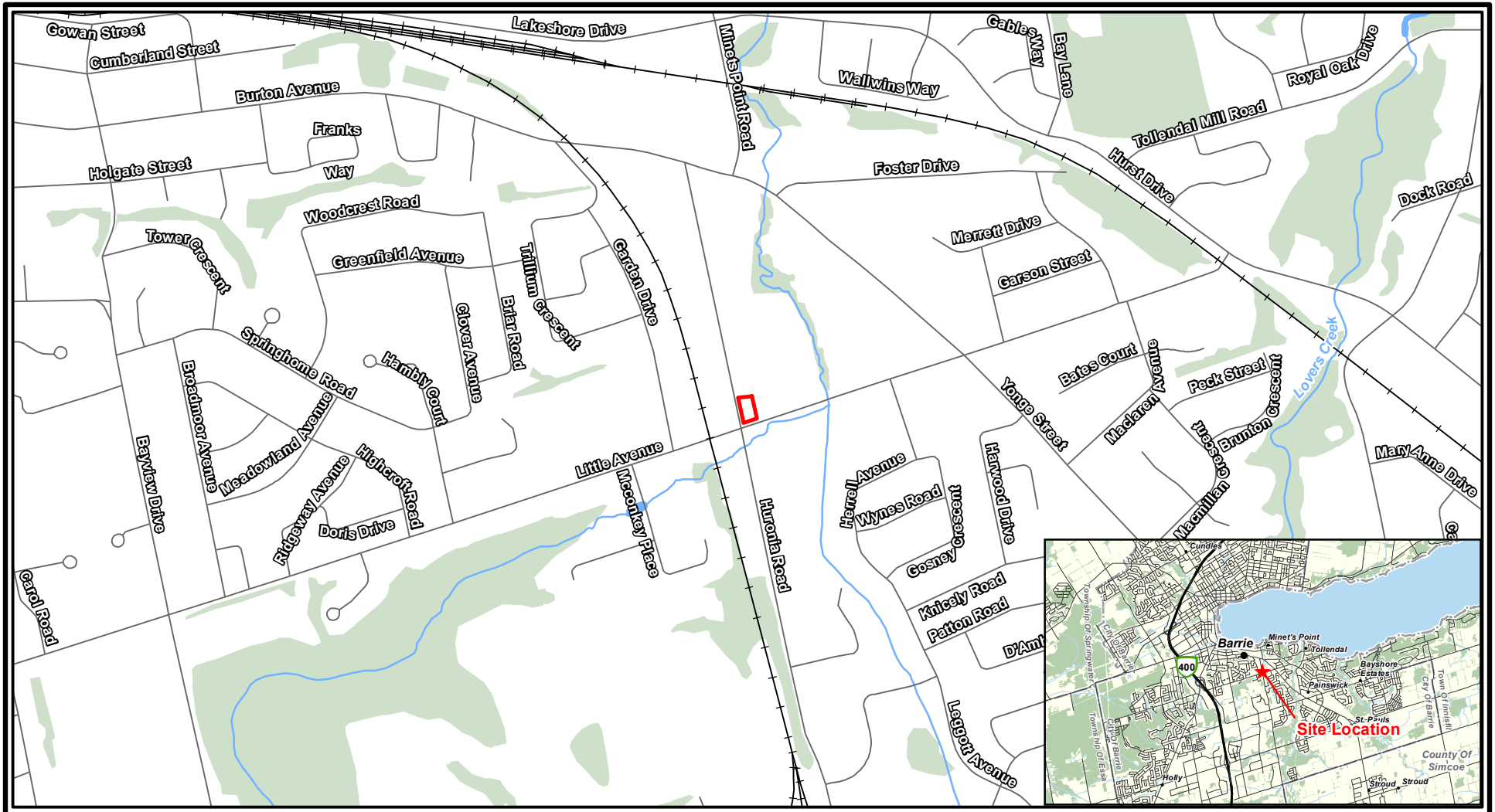
Reviewed By:



Chaodong Sheng, M.Sc., P.Eng.
Senior Water Resource Engineer

Geoffrey R. White, P.Eng.
Geotechnical Practice Lead

Figures



Legend

- Site Location
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario 2023.

0 150 300 m

1:12,000

N

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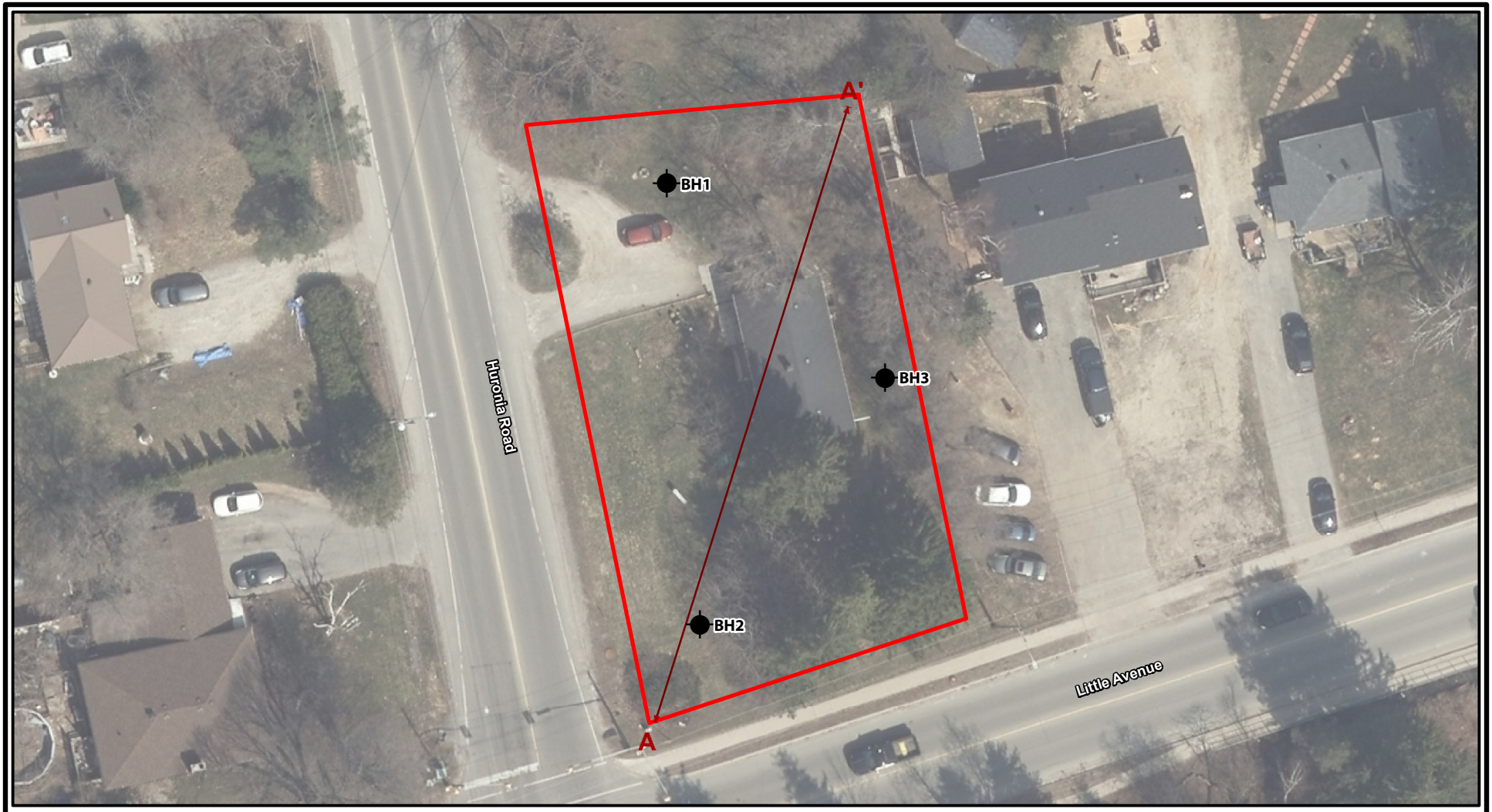
SITE LOCATION PLAN

March 2023

Fig. 1



Legend

Site Location

Approximate Borehole/Monitoring Well Location

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2023. Imagery taken in 2021.

0 6 12 m

1:500

N

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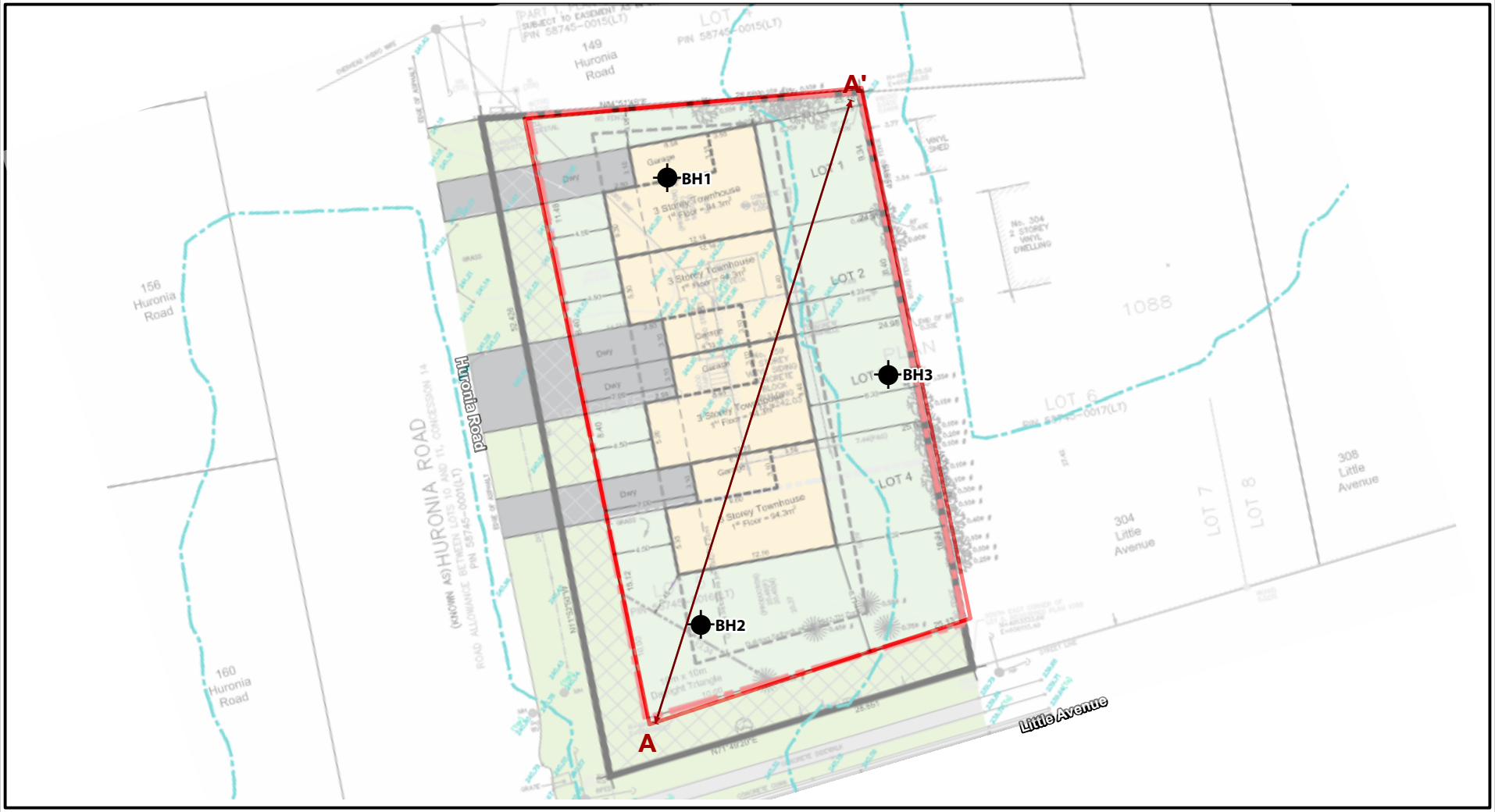
BOREHOLE LOCATION PLAN (AERIAL)

March 2023

Fig. 2A



Legend

- Site Location
- Approximate Borehole/Monitoring Well Location
- Cross Section Location

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
3.'Conceptual Site Plan', Innovative Planning Solutions,(Feb., 23, 2023).

0 6 12 m

1:500

N

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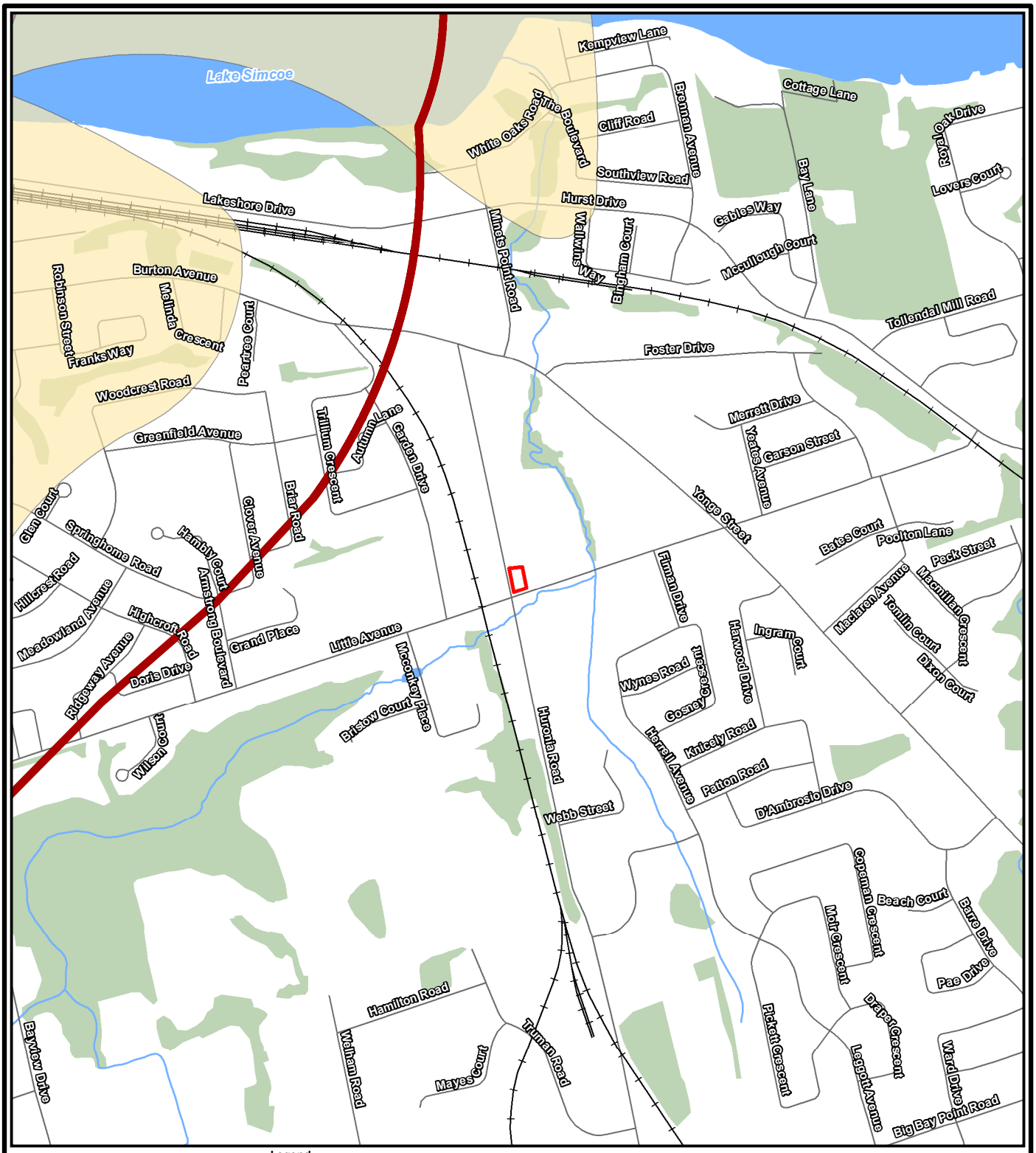
BOREHOLE LOCATION PLAN
(CONCEPT PLAN)

March 2023

Fig. 2B



NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Contains information made available under the Lake Simcoe Region Conservation Authority Open Data Licence v1.0. Q1Q2 features digitized (approximate) from LIO Source Water Protection online map image.

Legend

- Subject Lands
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

Wellhead Protection Area (LSRCA 2023)

Zone

- A
- B
- C
- C1
- D
- Q1
- Q2

N

0 150 300 m

1:12,000

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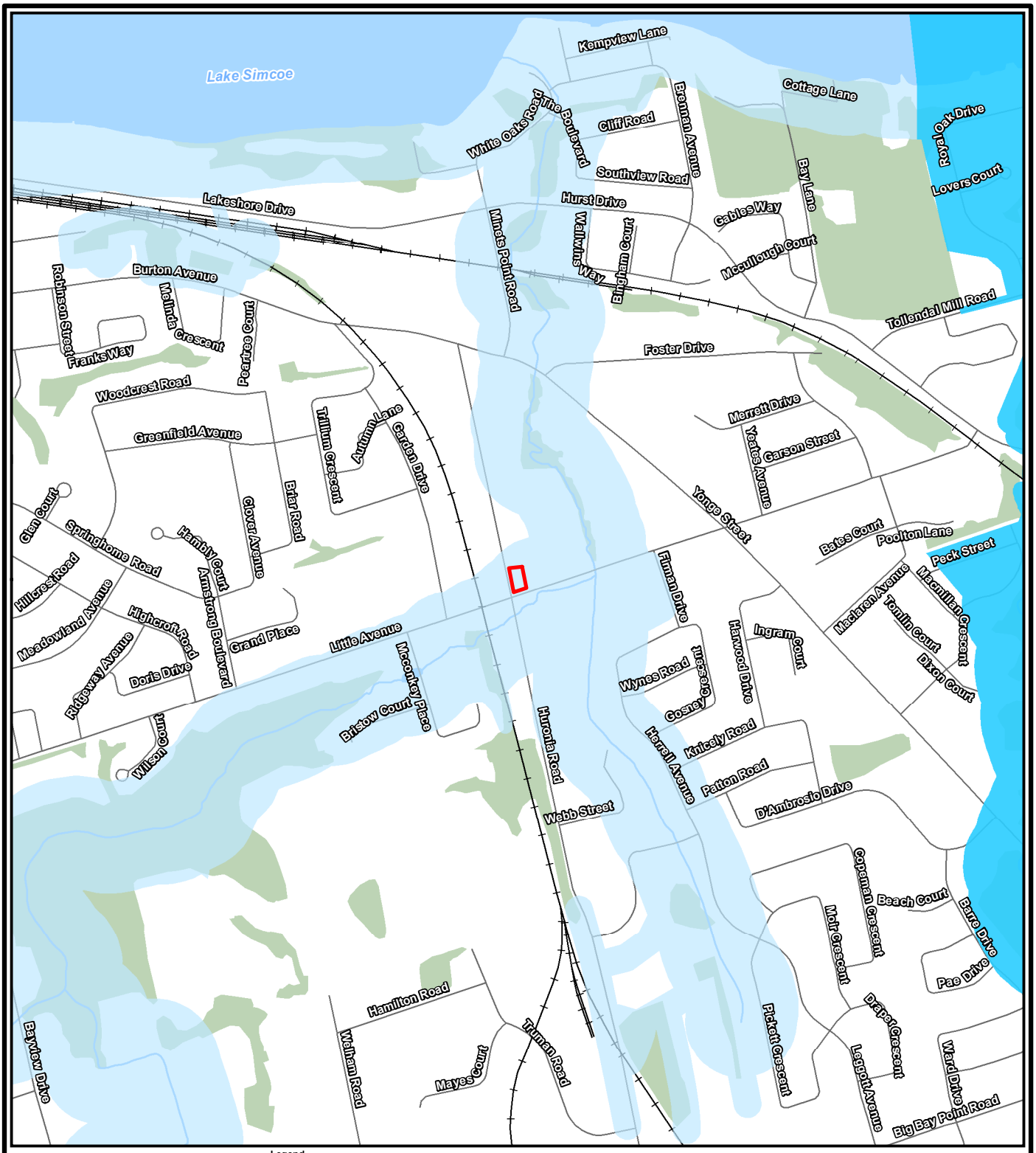
WELLHEAD PROTECTION AREAS

March 2023

Fig. 3



NOTES:

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Legend

- Subject Lands
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

Intake Protection Zone (LSRCA 2023)

Zone

- 1
- 2
- 3

N

0 150 300 m

1:12,000

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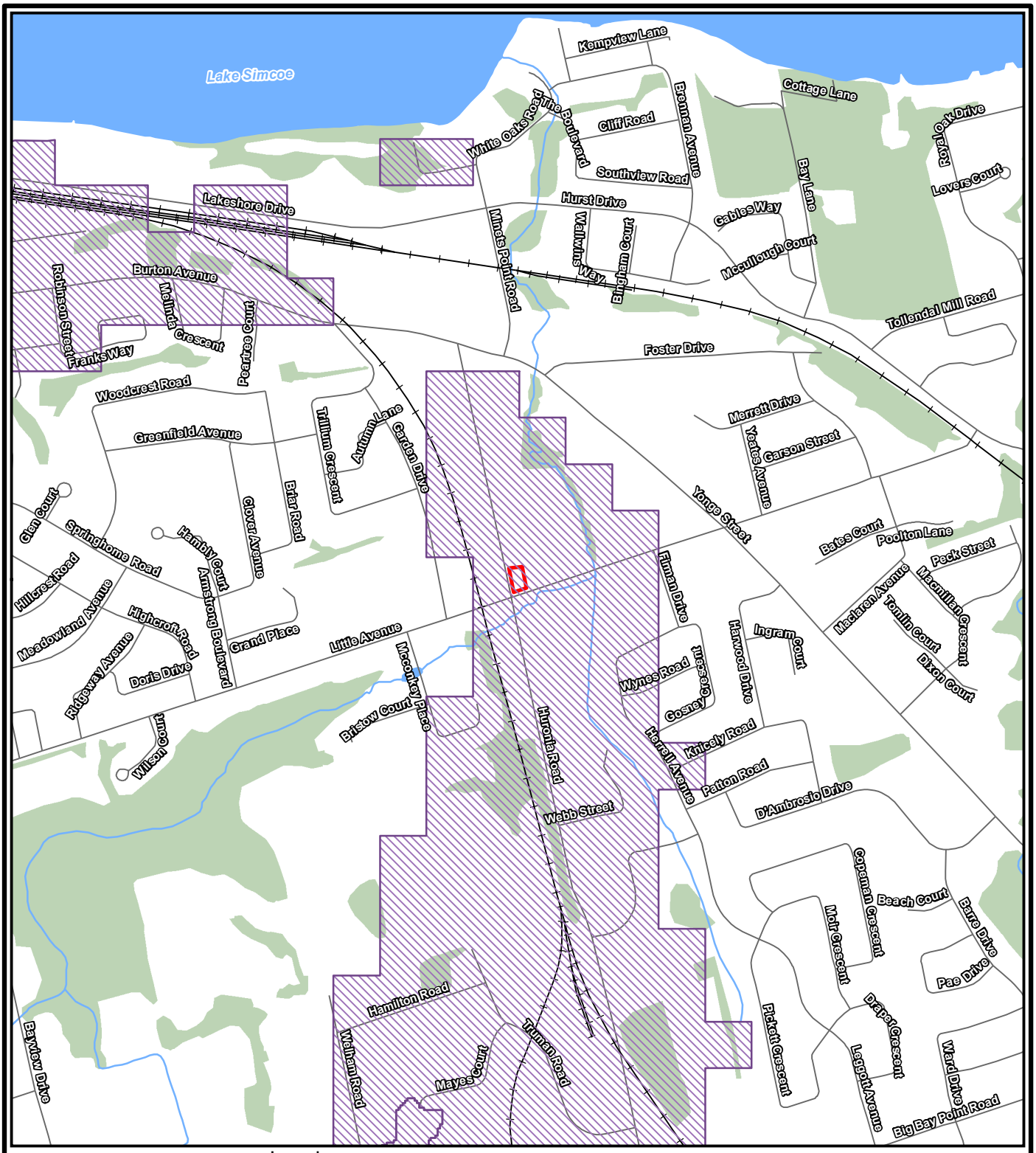
INTAKE PROTECTION ZONES

March 2023

Fig. 4



NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
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Legend

- Subject Lands
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area
- Highly Vulnerable Aquifer (LSRCA 2023)

N

0 150 300 m

1:12,000

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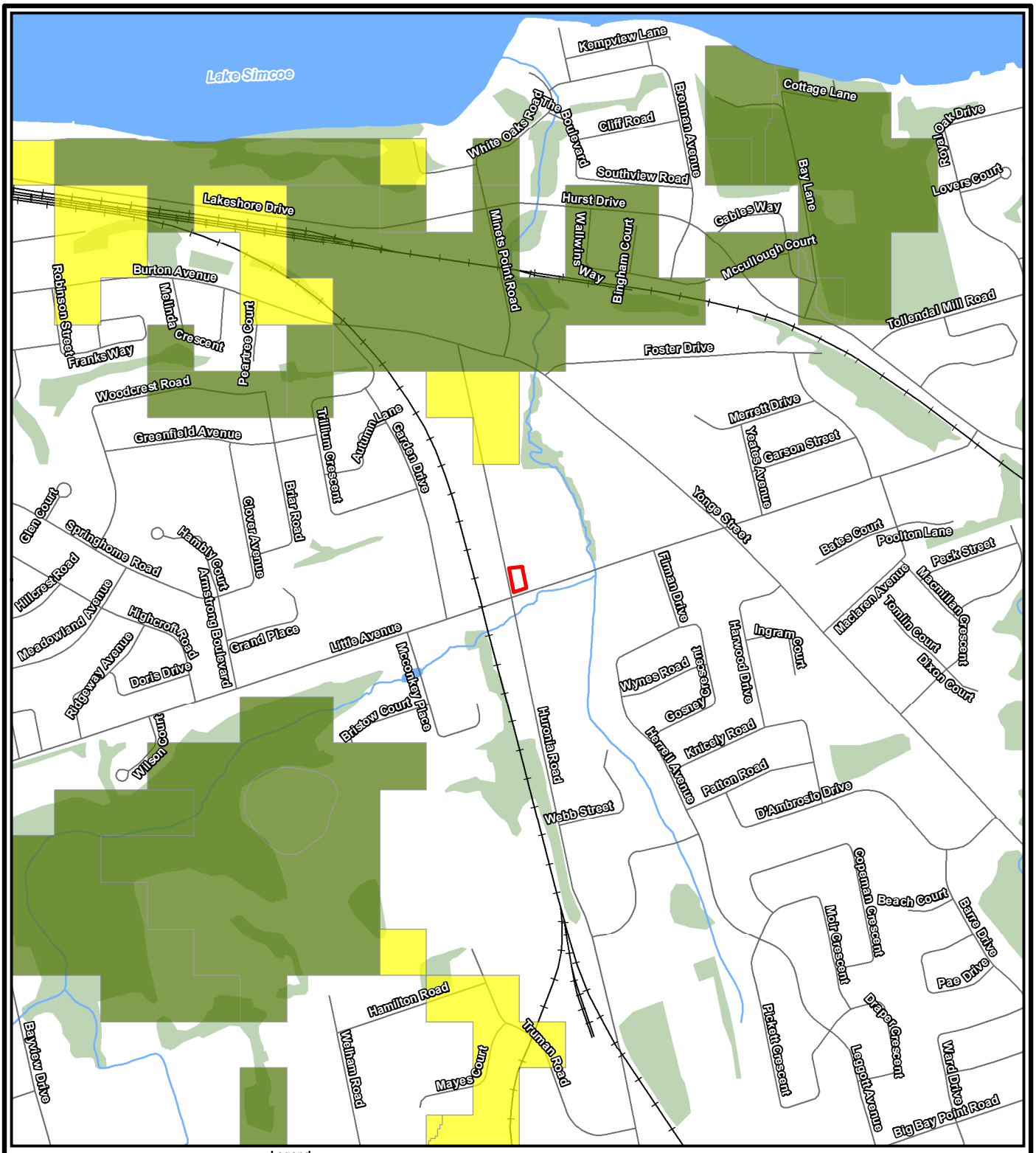
HIGHLY VULNERABLE AQUIFER

March 2023

Fig. 5



NOTES:

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Legend

- Subject Lands
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

Significant Groundwater Recharge Area (LSRCA 2023)

- 2-4
- 6

N

0 150 300 m

1:12,000

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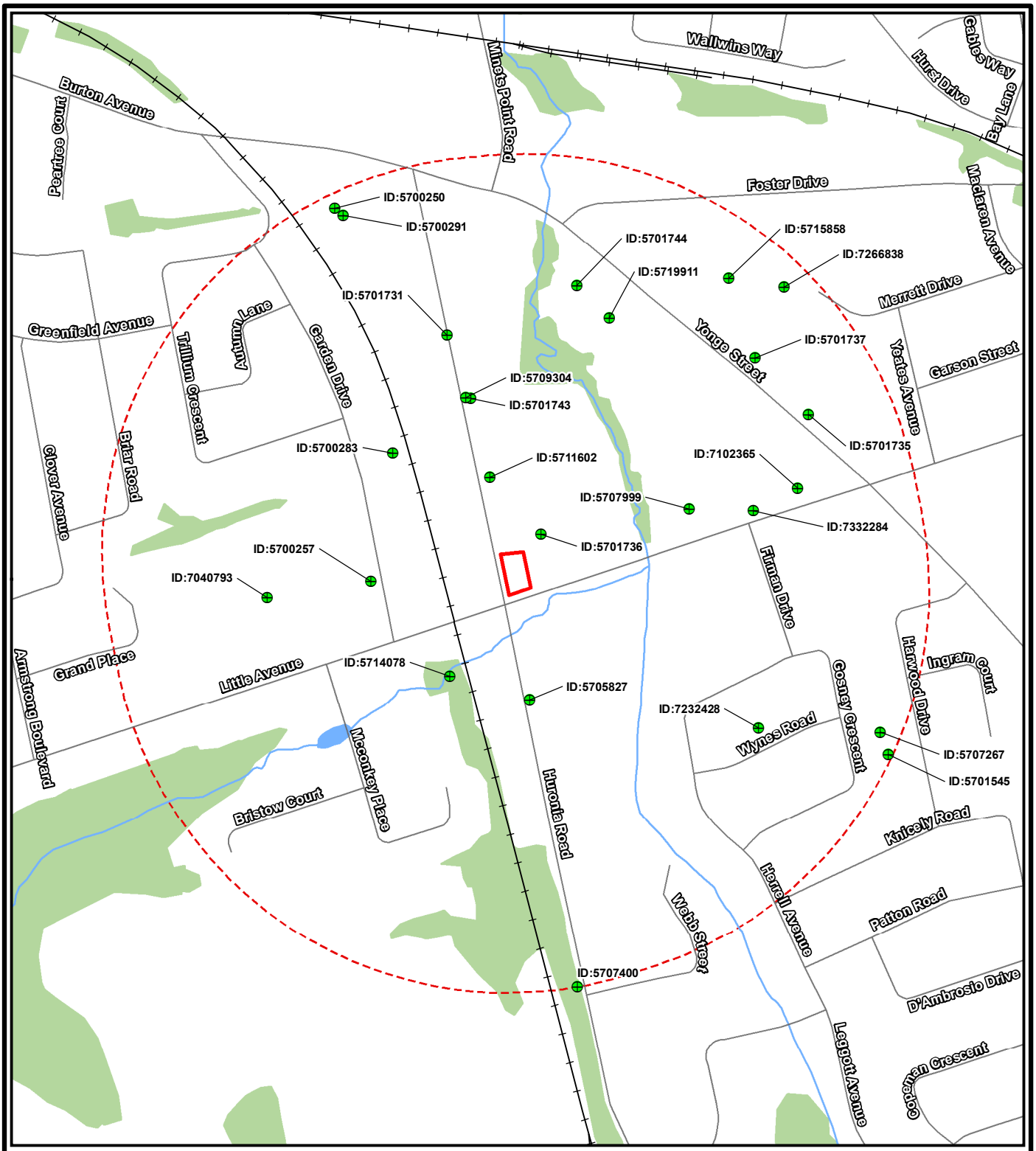
SIGNIFICANT GROUNDWATER RECHARGE AREA

March 2023 Fig. 6



NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.

Legend

- Site Location
- Site Location +500m
- MECP Well Records Within 500m of Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area

N

0 50 100 m

1:7,000

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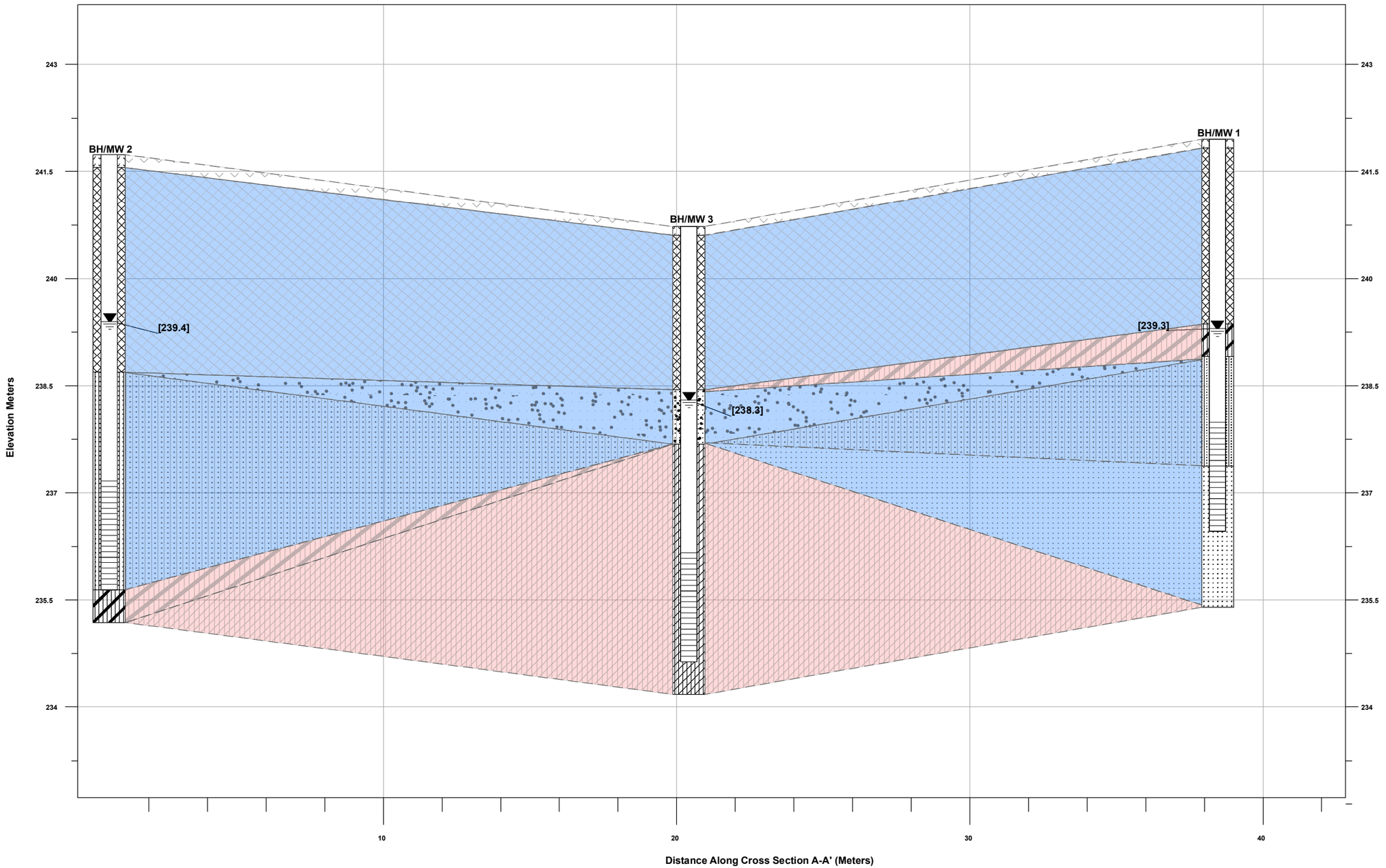
MECP WELL RECORD LOCATIONS

March 2023 Fig. 7



NOTES:
1. Subsurface conditions known only at borehole locations.
2. Horizontal distances are approximate.

Legend

Water Level in Monitoring Well
[xx.xx] Water Levels (masl) Measured December 6, 2022

Strata

- Topsoil
- Fill
- Gravel and Sand
- Clayey Silt
- Clayey Silt to Silty Clay
- Silty Sand
- Sand
- Aquitard
- Aquifer

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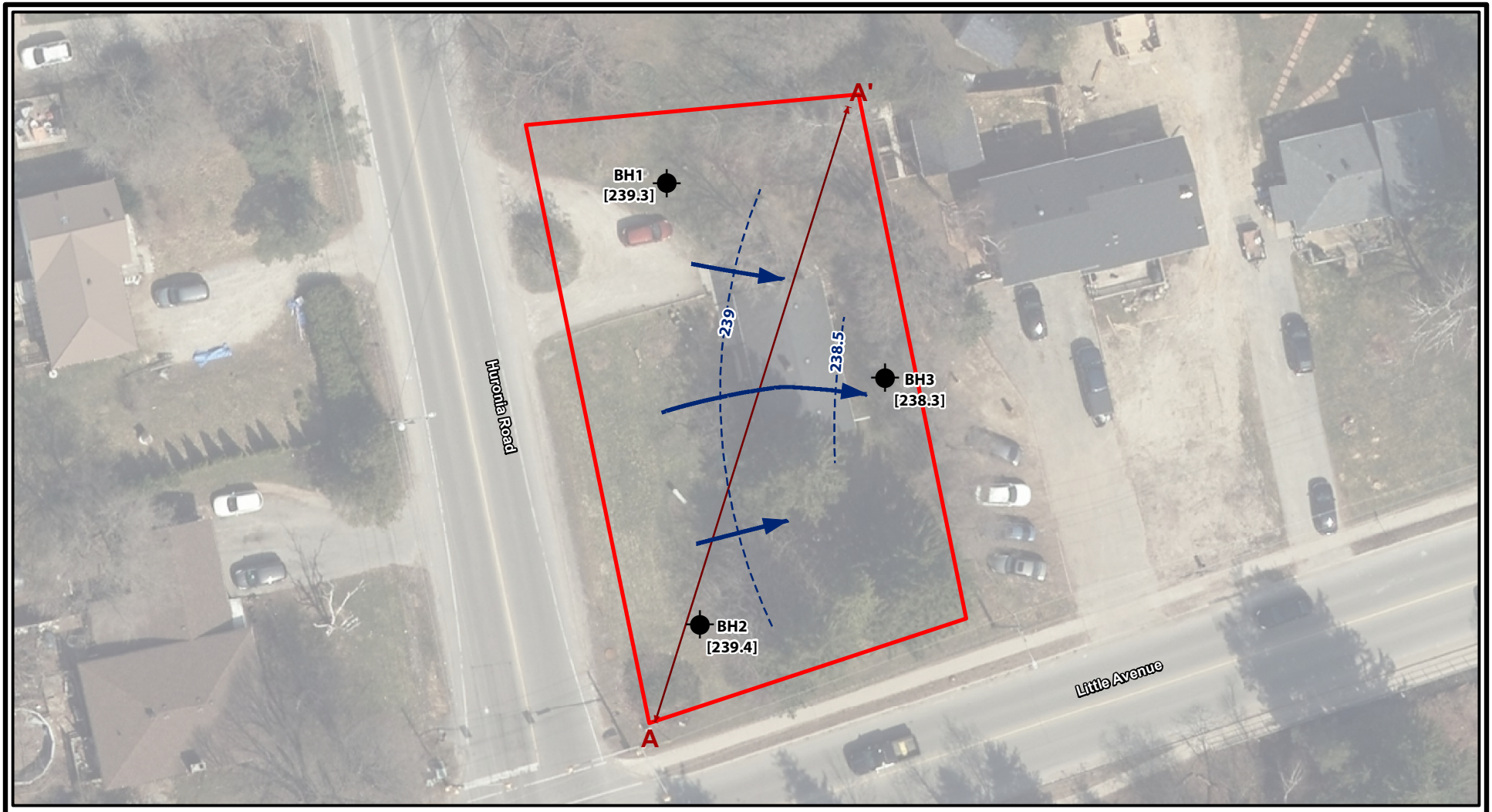
GEOLOGICAL CROSS SECTION A-A'

January 2023 Fig. 8



Legend

- Site Location
- Approximate Borehole/Monitoring Well Location
- Groundwater Contour
- Interpreted Direction of Groundwater Flow
- [xx.xx] Water Level (masl), Measured Dec 6, 2022

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2023. Imagery taken in 2021.

0 6 12 m

1:500

N

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GROUNDWATER CONTOUR MAP

March 2023

Fig. 9

Appendix A

MECP Water Well Records

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TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	Well ID Only	WELL	FORMATION
BARRIE CITY	17 605785 4913322 W	2007/01 7215	2				0010 10	7040793	7040793 (Z64523) A049070	
BARRIE CITY	17 606451 4913460 W	2008/02 7314	1.97	FR 0006		NU	0005 10	7102365	7102365 (Z59752) A066226	GREY FILL LOOS 0005 BRWN FILL SNDY 0015 SILT
BARRIE CITY	17 606014 4913223 W	1977/02 2801	36 20 12		85/148/7 50/49:0	MN CO	0281 25	5714078	5714078 ()	BRWN LOAM 0001 GREY CLAY GRVL PCKD 0020 GREY SAND GRVL LOOS 0048 BRWN CLAY GRVL HARD 0142 GREY SAND CLAY LOOS 0164 GREY CLAY GRVL HARD 0226 GREY SAND CLAY LOOS 0271 GREY CLAY SLTY HARD 0276 GREY SAND GRVL LOOS 0307 GREY CLAY HARD 0308
BARRIE CITY	17 605880 4913802 W	1967/08 1510	4	FR 0085	25/35/10/ 2:0	CO	0105 8	5700291	5700291 ()	PRDG 0006 CLAY GRVL 0035 HPAN 0085 MSND 0115
BARRIE CITY	17 605942 4913503 W	1966/09 4607	30	FR 0010	10//2/:	DO		5700283	5700283 ()	BRWN CLAY 0005 MSND 0018
BARRIE CITY	17 605869 4913811 W	1960/07 1637	4	FR 0105	28/58/4/3 :0	DO	0100 5	5700250	5700250 ()	GRVL FILL 0007 MSND GRVL STNS 0015 GRVL STNS 0042 CLAY 0090 FSND 0100 MSND 0105
BARRIE CITY	17 605915 4913342 W	1960/12 2514	6	FR 0056	33/56/2/6 :0	DO	0056 4	5700257	5700257 ()	LOAM 0002 MSND 0006 BRWN CLAY 0023 CSND 0028 YLLW FSND 0060
BARRIE CITY (INNISFI	17 606395 4913431 W	6946						7332284	7332284 (C44700) A262885 P	
BARRIE CITY (INNISFI	17 606031 4912827 W	2015/12 7241	2			MT	0020 10	7260410	7260410 (Z225045) A183426	BRWN FSND 0020 BRWN FSND WBRG 0030
INNISFIL TOWNSHIP	17 606402 4913158 W	2014/08 7360						7232428	7232428 (C25999) A167912 P	
INNISFIL TOWNSHIP CON 13 011	17 606554 4913153 W	1970/03 2514	6	FR 0275	73/207/9/ 1:30	DO	0275 3	5707267	5707267 ()	LOAM 0001 BRWN MSND CLAY BLDR 0115 BLUE CLAY 0133 GREY CLAY FSND 0177 GREY CLAY 0230 GREY SILT 0264 GREY CLAY 0275 MSND 0278
INNISFIL TOWNSHIP CON 13 011	17 606174 4912833 W	1970/07 4608	30	FR 0024	14/22/5/1 :0	DO		5707400	5707400 ()	BRWN CLAY STNS 0017 GREY CLAY 0022 GREY MSND 0024

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	Well ID Only	WELL	FORMATION
INNISFIL TOWNSHIP CON 13 011	17 606214 4912823 W	1978/10 4608	30	FR 0012	12///:	DO		5715833	5715833 ()	BRWN CLAY STNY 0012 GRVL 0013 GREY CLAY STNY 0024
INNISFIL TOWNSHIP CON 13 011	17 606564 4913125 W	1963/05 2514	6	FR 0026	24/37/2/2 :30	DO	0026 3	5701545	5701545 ()	BRWN CLAY 0019 BRWN CLAY STNS 0024 CSND 0028 BRWN CLAY MSND GRVL 0036 BLUE CLAY 0040
INNISFIL TOWNSHIP CON 13 011	17 606114 4913193 W	1968/10 4608	30	FR 0012	8///:	DO		5705827	5705827 ()	BRWN CLAY STNS 0005 GREY CLAY STNS 0012 GRVL 0020
INNISFIL TOWNSHIP CON 14 011	17 606434 4913712 W	2016/02 7215	2				0006 10	7266838	7266838 (Z229920) A202941	BRWN SILT 0016
INNISFIL TOWNSHIP CON 14 011	17 606064 4913473 W	1974/09 3203	5	FR 0115	38/58/8/1 :0	DO	0119 3	5711602	5711602 ()	PRDG 0009 BRWN SAND 0012 BRWN SAND CLAY 0021 GREY SAND CLAY 0025 GREY CLAY 0115 GREY FSND 0122
INNISFIL TOWNSHIP CON 14 011	17 606034 4913573 W	1972/04 4816	6	FR 0221 FR 0245	32/77/35/ 2:0	PS	0236 4	5709304	5709304 ()	SAND GRVL 0023 GREY CLAY 0110 SAND 0135 GREY CLAY 0190 CLAY SAND 0221 MSND 0245
INNISFIL TOWNSHIP CON 14 011	17 606314 4913433 W	1971/04 3203	5	FR 0089	25/70/6/1 :30	DO	0108 3	5707999	5707999 ()	BRWN LOAM 0001 BRWN MSND 0012 GREY CLAY MSND 0046 GREY CLAY 0089 GREY FSND 0111
INNISFIL TOWNSHIP CON 14 011	17 606364 4913723 W	1978/10 1204	5	FR 0102	30/60/8/1 :0	DO	0105 3	5715858	5715858 ()	PRDG 0024 BRWN SAND GRVL 0040 GREY CLAY 0102 BRWN SAND 0108
INNISFIL TOWNSHIP CON 14 011	17 606214 4913673 W	1984/12 4816	6	FR 0113	40/80/9/2 :0	DO	0106 3	5719911	5719911 ()	SAND GRVL STNS 0035 BRWN FSND 0047 GREY FSND 0075 CLAY 0100 GREY FSND 0113
INNISFIL TOWNSHIP CON 14 011	17 606010 4913651 W	1966/12 4608	30	FR 0014	14//2/:	DO		5701731	5701731 ()	MSND 0027
INNISFIL TOWNSHIP CON 14 011	17 606464 4913552 W	1959/03 1637	4	FR 0215	47/125/1/ :	DO		5701735	5701735 ()	BRWN CLAY 0018 BLDR CLAY 0028 GRVL CLAY 0074 CLAY 0090 QSND CLAY 0213 MSND GRVL 0215
INNISFIL TOWNSHIP CON 14 011	17 606128 4913401 W	1959/05 2801	5					5701736	5701736 ()	LOAM 0001 MSND SILT GRVL 0013 BLUE CLAY 0115 CLAY MSND 0172 CLAY MSND GRVL 0267 BLUE CLAY GRVL BLDR 0331 LMSN 0332
INNISFIL TOWNSHIP CON 14 011	17 606397 4913623 W	1962/06 4102	30	FR 0012	12//2/:	DO		5701737	5701737 ()	MSND 0020

Appendix B

Borehole Logs

RECORD OF BOREHOLE No. 1

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **BH** Northing: **4913371.3** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606089.7** Date Completed: **Nov 22/22**

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value
0.1	241.8	TOPSOIL: 100 mm				
		FILL: Sand, some gravel, trace silt, compact, brown, moist	AS	1		
		- - - Trace organics - - -	SS	2	100	11
			SS	3	100	14
		- - - Moist to wet - - -				
2.6	239.4		SS	4	100	12
3.0	238.9	CLAYEY SILT: Some sand, stiff, grey, moist				
		SILTY SAND: Trace gravel, trace clay, till-like, compact, brown, wet	SS	5	100	16
4.6	237.4					
		SAND: Trace gravel, trace clay, trace silt, loose, brown, wet	SS	6	100	4
		- - - Compact - - -	SS	7	100	17
6.6	235.4	Borehole Terminated at 6.6 m				

FIELD TESTING: Shear Strength Testing (kPa) — Other Test; Pocket Penetrometer; Field Vane (Intact); Field Vane (Remolded); 40 80 120 160. Penetration Testing — SPT; DCPT; 10 20 30 40.

LAB TESTING: Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); 100 200 300 400. Atterberg Limits — PL; LL. Water Content (%); 10 20 30 40.

Instrumentation Installation: First water strike SS4

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
7	52	32	9

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Barrie, Ontario L4N 0B7
T : (705) 719-7994
www.geiconsultants.com

Groundwater depth encountered on completion of drilling: 2.3 m. Cave depth after auger removal: 5.4 m.
Groundwater depth observed on: Dec 6/22 at depth of: 2.6 m. Groundwater Elevation: 239.3 m

Scale: **1 :75**

RECORD OF BOREHOLE No. 2

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **BH** Northing: **4913333.4** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606092.5** Date Completed: **Nov 22/22**

Geodetic	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING (Shear Strength Testing (kPa); Penetration Testing SPT/DCPT)	LAB TESTING (Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); Atterberg Limits; Water Content (%))	Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
0.0 / 241.7	0.2 TOPSOIL: 150 mm / 241.6					0	241.5							
	FILL: Silty sand, some gravel, trace organics/topsoil, loose, brown, moist	AS	1						8					
	- - - Sand, some concrete pieces and organics, trace silt - - -	SS	2	100	8	1.5	240	8	12					
	- - - Trace rootlets - - -	SS	3	100	8			8	13					
	- - - Gravelly sand, trace silt, compact, wet - - -	SS	4	35	22	3	238.5	22	14		First water strike SS4			
	SANDY SILT TO SILTY SAND: Some clay, trace gravel, till-like, compact, brown, moist	SS	5	100	21			21	8		4	36	42	18
	- - - Trace clay, dense - - -	SS	6	100	35	4.5	237	35	19					
6.1 / 235.6	CLAYEY SILT: Some sand, very stiff, grey, very moist	SS	7	40	20	6	235.5	20	22					
6.6 / 235.2	Borehole Terminated at 6.6 m													

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Groundwater depth encountered on completion of drilling: 2.1 m. Cave depth after auger removal: Open

Groundwater depth observed on: Dec 6/22 at depth of: 2.3 m. Groundwater Elevation: 239.4 m

RECORD OF BOREHOLE No. 3

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**
Logged By: **.** Northing: **4913354.6** Date Started: **Nov 22/22**
Reviewed By: **GW** Easting: **606108.4** Date Completed: **Nov 22/22**

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Field Testing (Shear Strength kPa)	Lab Testing (Water Content %)	Instrumentation	Comments & Grain Size Distribution (%) GR	SA	SI	CL
0.1	240.6	TOPSOIL: 75 mm											
		FILL: Silty sand, trace organics/ topsoil, compact, brown, moist	AS	1				11					
		- - - Gravelly sand, moist to wet ---	SS	2	100	22	22	12					
			SS	3	50	18	18	11		First water strike SS3			
2.3	238.4	SAND AND GRAVEL: Some silt, trace clay, compact, brown, wet	SS	4	100	24	24	11		35	43	17	5
3.0	237.7	CLAYEY SILT TO SILTY CLAY: Trace sand, very stiff, grey, moist	SS	5	60	21	21	20					
			SS	6	35	16	16	25					
		- - - Hard - - -	SS	7	50	32	32	28		0	4	54	42
6.6	234.2	Borehole Terminated at 6.6 m											

Groundwater depth encountered on completion of drilling: 2.1 m. Cave depth after auger removal: Open
Groundwater depth observed on: Dec 6/22 at depth of: 2.4 m. Groundwater Elevation: 238.3 m

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www.geiconsultants.com

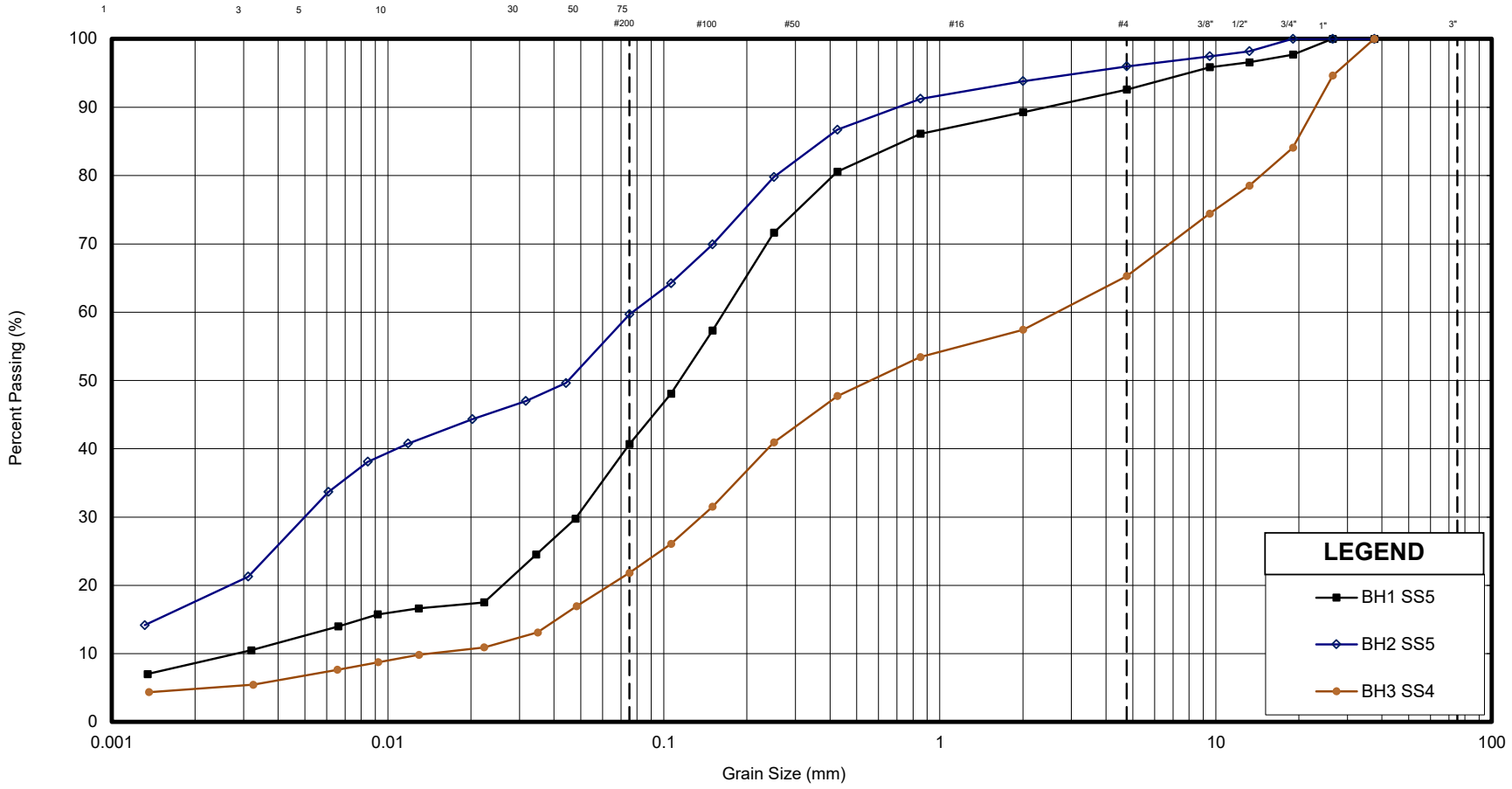
Scale: **1 :75**

Appendix C

Geotechnical Laboratory Testing

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH1 SS5	SILTY SAND, Trace Clay, Trace Gravel	7	52	32	9	0.003	0.048	0.165	55.0	4.7
BH2 SS5	SAND AND SILT, Some Clay, Trace Gravel	4	36	42	18	-	0.005	0.077	-	-
BH3 SS4	GRAVEL AND SAND, Some Silt, Trace Clay	35	43	17	5	0.014	0.136	2.657	189.8	0.5

GEI Consultants

GRAIN SIZE DISTRIBUTION - 159 Huronia Road

SILTY SAND / SANDY SILT / GRAVEL AND SAND

FIGURE No. C1

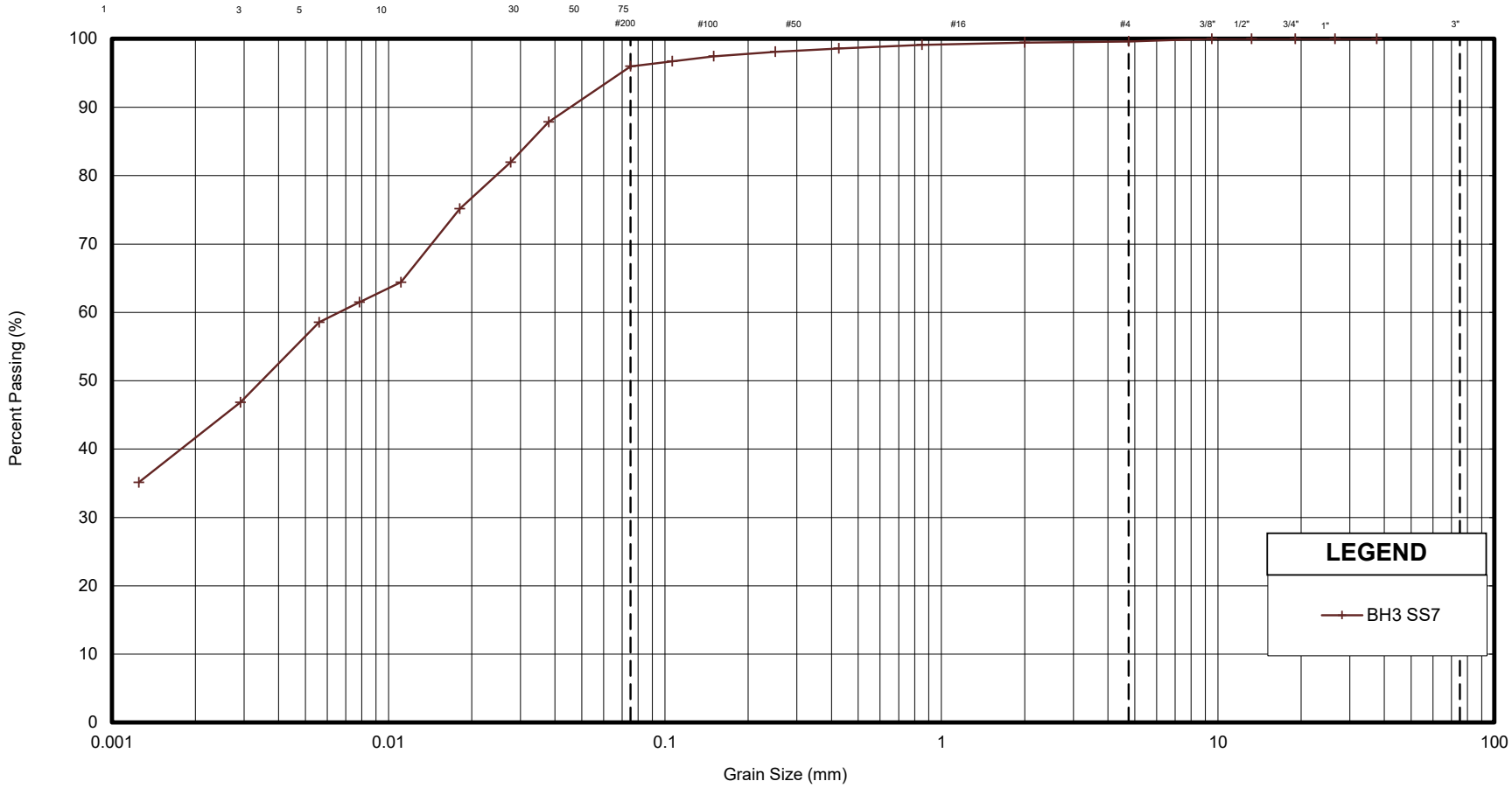
REF. No. 2204000

DATE March 2023

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS — SIEVE DESIGNATION (IMPERIAL)



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH3 SS7	CLAY AND SILT, Trace Sand	-	4	54	42	-	-	0.007	-	-

GEI Consultants

GRAIN SIZE DISTRIBUTION - 159 Huronia Road

CLAYEY SILT TO SILTY CLAY

FIGURE No. C2

REF. No. 2204000

DATE March 2023

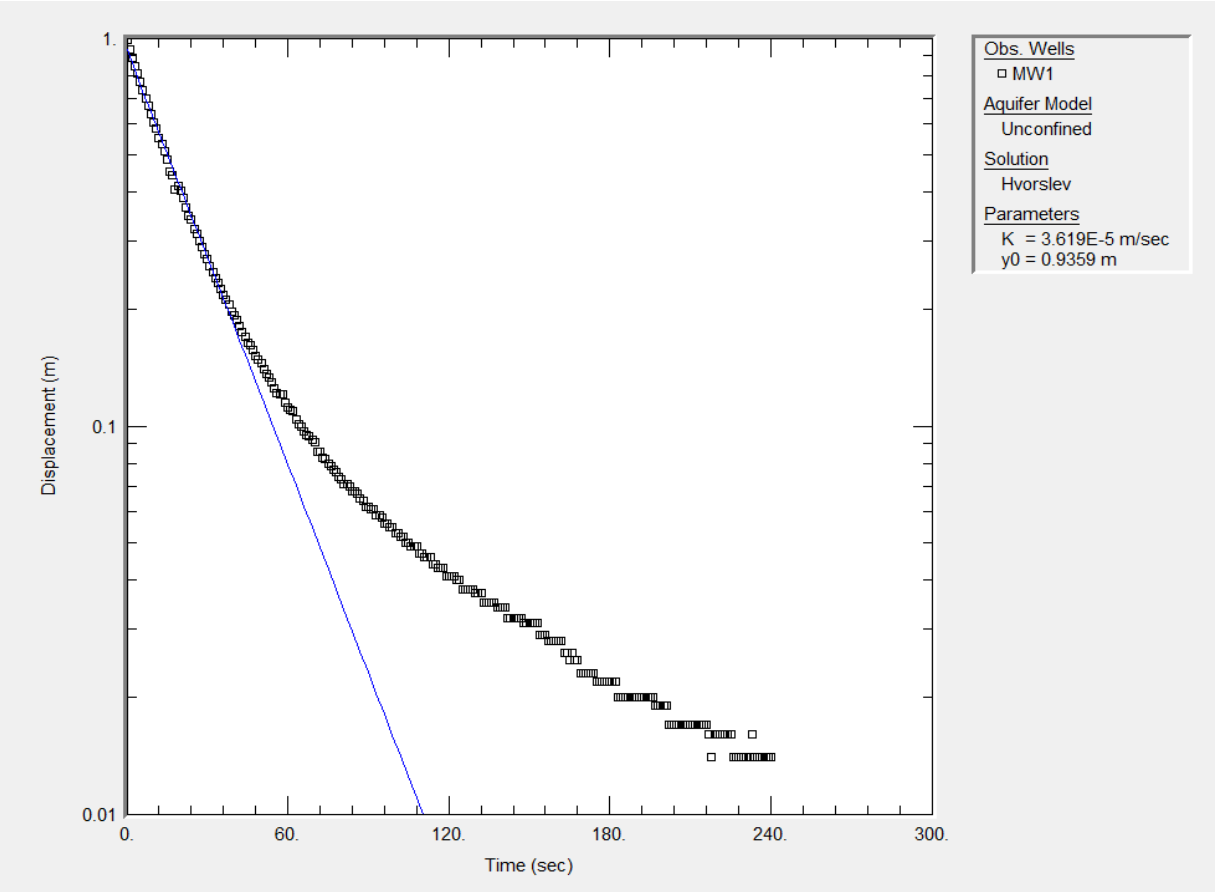
Appendix D

Borehole Permeability Plots

Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

Well Number:	GEI-MW1	
Well Screen Bottom:	5.49	mbgs
Top of Pipe:	0.75	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	242.00	masl
Static Water Level:	2.56	mbgs
$K = r^2\ln(L/R)/(2LTo)$ =	**$3.6x10^{-5}$**	m/s

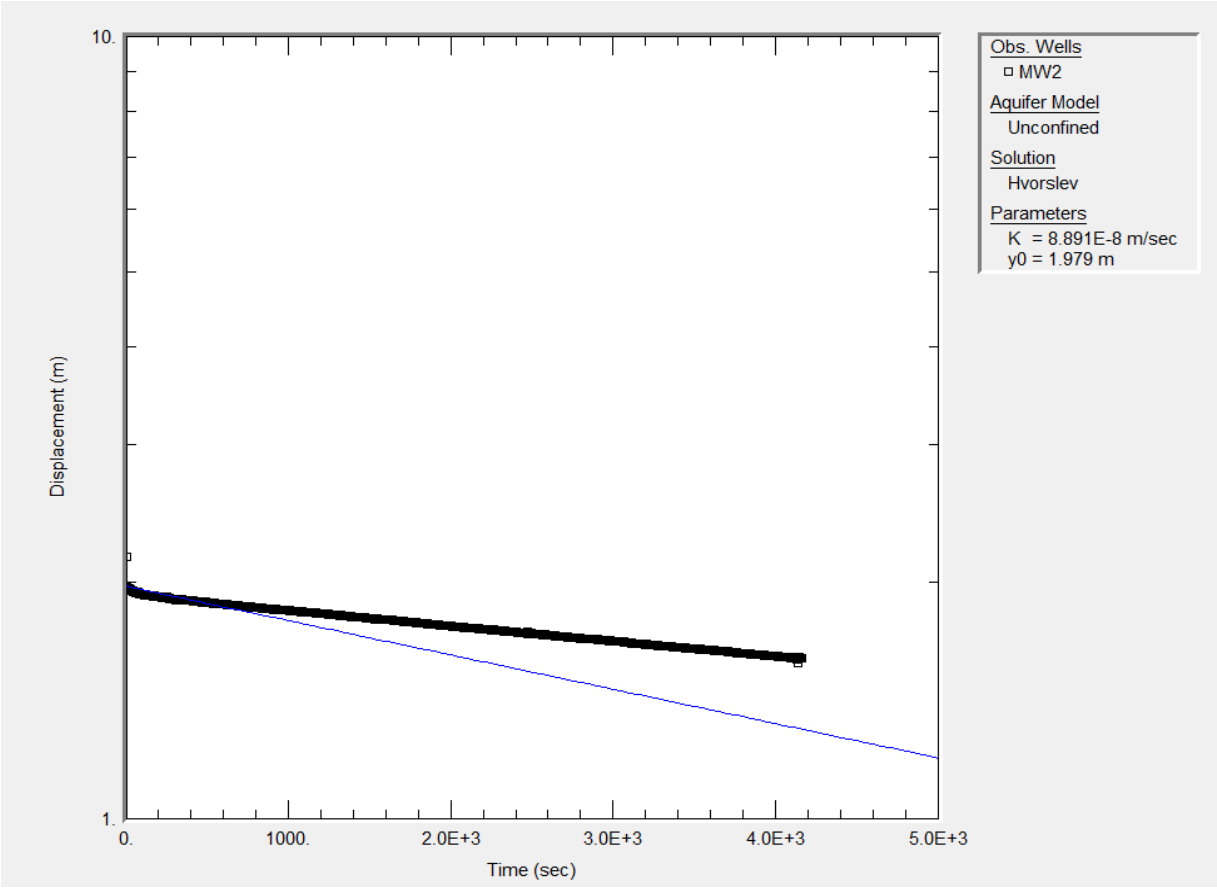


GEI Consultants

Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

Well Number:	GEI-MW2	
Well Screen Bottom:	6.10	mbgs
Top of Pipe:	0.74	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	241.70	masl
Static Water Level:	2.29	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**$8.9x10^{-8}$**	m/s

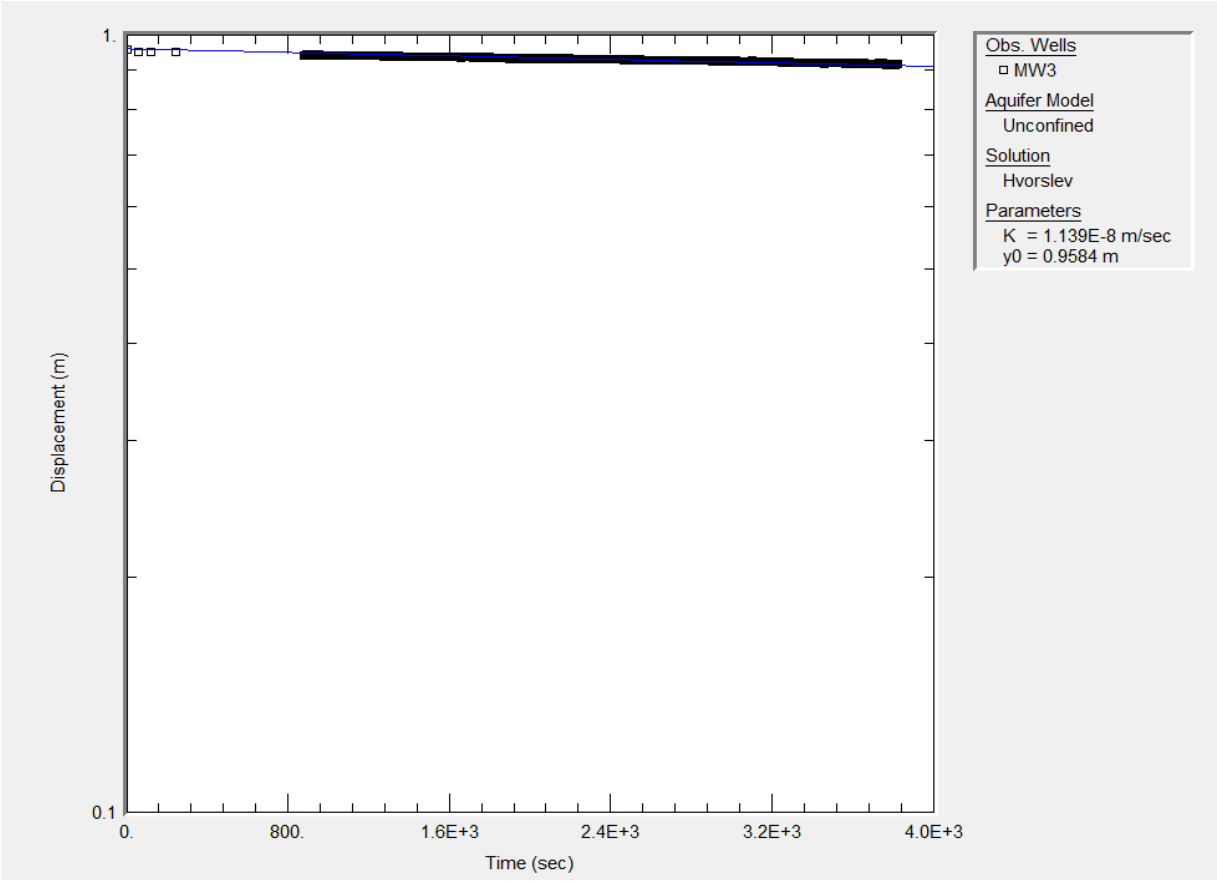


GEI Consultants

Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

Well Number:	GEI-MW3	
Well Screen Bottom:	6.10	mbgs
Top of Pipe:	0.73	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	240.70	masl
Static Water Level:	2.13	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**$1.1x10^{-8}$**	m/s



Appendix E

Water Quality Laboratory Certificate Of Analysis And Chain Of Custody

CADUCEON™ ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-36077

Report To:

GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
Attention: Geoff White

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Anions	1	Holly Lane	VK	20-Dec-22	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	SYL	15-Dec-22	A-PH-01 (o)	SM 4500H
Total Suspended Solids	2	Kingston	ama	15-Dec-22	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	15-Dec-22	C-BOD-001 (k)	SM 5210B
Chromium (VI)	2	Holly Lane	LMG	20-Dec-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	16-Dec-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	NHG	19-Dec-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	ST	20-Dec-22	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

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

	Client I.D.		MW1	MW1F			Barrie Sanitary	
	Sample I.D.		B22-36077-1	B22-36077-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
pH @25°C	pH Units		7.66				9.5	9.5
Total Suspended Solids	mg/L	3	**495**	< 3			350	15
BOD(5 day)	mg/L	3	< 3				300	15
Chloride	mg/L	0.5	792				1500	
Aluminum	mg/L	0.01	7.20	0.05			50	
Antimony	mg/L	0.0001	0.0002	0.0002			5.0	
Arsenic	mg/L	0.0001	0.0012	< 0.0001			1.0	
Beryllium	mg/L	0.002	< 0.002	< 0.002				
Boron	mg/L	0.005	0.029	0.017				
Cadmium	mg/L	0.000015	0.000086	< 0.000015			0.7	0.001
Chromium	mg/L	0.001	0.009	< 0.001			2.0	0.08
Chromium (VI)	mg/L	0.001	< 0.001	< 0.001 [1]				
Cobalt	mg/L	0.0001	0.0055	0.0002			5.0	
Copper	mg/L	0.0001	**0.0128**	0.0010			2.0	0.01
Iron	mg/L	0.005	12.7	< 0.005			50	
Lead	mg/L	0.00002	0.00457	< 0.00002			0.7	0.05
Mercury	mg/L	0.00002	< 0.00002	< 0.00002			0.01	
Molybdenum	mg/L	0.01	< 0.01	< 0.01			5.0	
Nickel	mg/L	0.0002	0.0107	0.0022			2.0	0.05
Selenium	mg/L	0.001	< 0.001	< 0.001			1.0	
Silver	mg/L	0.0001	< 0.0001	< 0.0001			0.4	
Thallium	mg/L	0.00005	0.00011	< 0.00005				
Tungsten	mg/L	0.01	< 0.01	< 0.01				
Uranium	mg/L	0.00005	0.00375	0.00385				

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

Christine Burke
Lab Manager

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Attention: Geoff White

Caduceon Environmental Laboratories
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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

	Client I.D.		MW1	MW1F			Barrie Sanitary	
	Sample I.D.		B22-36077-1	B22-36077-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
Vanadium	mg/L	0.005	0.021	< 0.005			5.0	
Zinc	mg/L	0.005	0.032	< 0.005			2.0	0.04
Zirconium	mg/L	0.003	0.005	< 0.003				

1 . Chromium (VI) result is based on total chromium

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

Christine Burke
Lab Manager

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DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

Summary of Exceedances

Sanitary/Combined Sewer Guidelines

MW1	Found Value	Limit
Total Suspended Solids (mg/L)	495	350

Storm Sewer Guidelines

MW1	Found Value	Limit
Total Suspended Solids (mg/L)	495	15
Copper (mg/L)	0.0128	0.01

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

Christine Burke
Lab Manager

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Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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Final Report

C.O.C.: ---

REPORT No. B22-36077 (i)

Rev. 1

Report To:

GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
Attention: Geoff White

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Chromium (VI)	2	Holly Lane	LMG	20-Dec-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	16-Dec-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	NHG	19-Dec-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	ST	20-Dec-22	D-ICPMS-01 (o)	EPA 200.8

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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Final Report

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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

	Client I.D.		MW1	MW1F			PWQO	
	Sample I.D.		B22-36077-1	B22-36077-2			Interim PWQO	PWQO
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
Aluminum	µg/L	10	**7200**	50			75	
Antimony	µg/L	0.1	0.2	0.2			20	
Arsenic	µg/L	0.1	1.2	< 0.1			5	5
Beryllium	µg/L	2	< 2	< 2				11
Boron	µg/L	5	29	17			200	
Cadmium	µg/L	0.015	0.086	< 0.015			0.1	0.2
Chromium	µg/L	1	9	< 1				
Chromium (VI)	µg/L	1	< 1	< 1 [1]				1
Cobalt	µg/L	0.1	**5.5**	0.2			0.9	
Copper	µg/L	0.1	**12.8**	1.0			5	
Iron	µg/L	5	**12700**	< 5				300
Lead	µg/L	0.02	**4.57**	< 0.02			1	5
Mercury	µg/L	0.02	< 0.02	< 0.02				0.2
Molybdenum	µg/L	10	< 10	< 10			40	
Nickel	µg/L	0.2	10.7	2.2				25
Selenium	µg/L	1	< 1	< 1				100
Silver	µg/L	0.1	< 0.1	< 0.1				0.1
Thallium	µg/L	0.05	0.11	< 0.05			0.3	0.3
Tungsten	µg/L	10	< 10	< 10			30	
Uranium	µg/L	0.05	3.75	3.85			5	
Vanadium	µg/L	5	**21**	< 5			6	
Zinc	µg/L	5	**32**	< 5			20	30
Zirconium	µg/L	3	**5**	< 3			4	

1 . Chromium (VI) result is based on total chromium

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

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REPORT No. B22-36077 (i)

Rev. 1

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GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
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Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
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DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

Summary of Exceedances

Interim PWQO

MW1	Found Value	Limit
Zirconium (µg/L)	5	4
Zinc (µg/L)	32	20
Vanadium (µg/L)	21	6
Lead (µg/L)	4.57	1
Copper (µg/L)	12.8	5
Cobalt (µg/L)	5.5	0.9
Aluminum (µg/L)	7200	75

Provincial Water Quality Objectives

MW1	Found Value	Limit
Zinc (µg/L)	32	30
Iron (µg/L)	12700	300

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

Christine Burke
Lab Manager

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

GENERAL SAMPLE SUBMISSION FORM

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured. Proudly Canadian

SAMPLES SUBMITTED TO:

Kingston	
Ottawa	
Richmond Hill	
Barrie	x
London	
Windsor	

TESTING REQUIREMENTS

	O'Reg 153/04		Table (1 - 9)		Record of Site
	O'Reg 406/19		Table (1 - 9.1)		SPLP Table (1 - 9.1)
	RPI		ICC		Agricultural
	Coarse		Medium/Fine		O'Reg 558 TCLP
	MISA	x	PWQO		Landfill Monitoring
	Other:		Barrie Storm Sewer		

REPORT NUMBER (Lab Use)

B22-36077

Are any samples to be submitted intended for Human Consumption under any Drinking Water Regulations? [ ] Yes [x] No (If yes, submit all Drinking Water Samples on a Drinking Water Chain of Custody)

Organization: GEI Consultants	Address: 647 Wellham Road, Barrie	Invoicing Address (if different):
Contact: Geoffrey White		
Tel: 705-350-1852 Fax:		
Email: gwhite@geiconsultants.com	Quote #:	Project Name/#: 2204000
Additional Info (email, cell, etc):	P.O. #:	Additional Info:

ANALYSES REQUESTED

PWQO Metals; PWQO TSS; Barrie Storm Sewer; Suspected Highly Contaminated

TURNAROUND SERVICE REQUESTED (see back page)

*Must be arranged in advance

	Platinum*	200% Surcharge
	Gold*	100% Surcharge
	Silver	50% Surcharge
	Bronze	25% Surcharge
x	Standard	5-7 days
	Specific Date:	

* Sample Matrix Legend: WW=Waste Water, SW=Surface Water, GW=Groundwater, LS=Liquid Sludge, SS=Solid Sludge, S=Soil, Sed=Sediment, PC=Paint Chips, F=Filter, Oil = Oil

Lab No.	Sample Source and/or Sample Identification	S.P.L.	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided	X	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered Y/N
1	MW1		GW	~~22-07-19~~ 22-12-13		X X				6	N
2	MW1 F		GW	~~22-07-19~~ 22-12-13		X X				4	Y
	#1 & 2 gen chem + #2 → K										
	#1 gen chem → O										
	#1 & 2 metals + CrVI + Hg → O										

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	S.Patrick	S.Patrick
Sign:		
	~~21-07-19~~ 22-12-13	~~21-07-19~~ 22-12-13
	Date (yy-mm-dd)/Time:	Date (yy-mm-dd)/Time:

SHIPPING INFORMATION

Courier (Client account)	
Courier (Caduceon account)	
Drop Off	x
Caduceon (Pick-up)	

Invoice

# of Pieces

REPORTING / INVOICING

Report by Fax	
Report by Email	x
Invoice by Email	x
Invoice by Mail	

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)

Received By (print): Autumn Signature: AH

Date Received (yy-mm-dd): 22-12-14 Time Received: 8CW

Laboratory Prepared Bottles: [X] Yes [ ] No

Sample Temperature °C: 7.7 Labeled by: AH

Comments:

Appendix F

Construction Dewatering Calculations

GEI Consultants

Construction Dewatering Rate Estimate

159 Huronia Road, Barrie, Ontario

Temporary Construction Dewatering Rate Estimates - Zone 1: Per Service Lateral

Description	Symbol	Values	Unit	Explanation
Input Data				
Lowest Ground Elevation		240.5	m asl	
Highest Groundwater Elevation		238.2	m asl	Highest groundwater level 2.3 mbgs measured on Dec 6, 2022
Lowest Proposed Excavation		237.0	m asl	3.5 mbgs
Aquifer Bottom		236.5	m asl	Assume at target water level
Hydraulic Conductivity	K	4.00E-05	m/s	Greatest K measures on site
Length of Excavation	x	20	m	Assumed
Width of Excavation	a	3	m	Assumed
Output				
Top of Aquifer		238.2	m asl	Highest groundwater level 2.3 mbgs measured on Dec 6, 2022
Target Water Level		236.5	m asl	Assume 0.5 m below lowest proposed excavation
Water Level above aquifer bottom before dewatering	H	1.7	m	
Target Water Level above above aquifer bottom	h	0.0	m	
Radius of Influence	L (R_0)	32	m	Sichardt Equation
Precipitation		600	L/day	10 mm rain event
Construction Dewatering Flow Rate - Steady State	Q	14	m^3/day	Construction Dewatering Flow - Dupuit Equation
Maximum Construction Flow Rate (safety factor of 2)	2Q	28	m^3/day	

Construction Dewatering Flow Rate - Steady State	Q	**14,200**	L/day
Maximum Construction Flow Rate (safety factor of 2)	2Q	**28,400**	L/day
Maximum Construction Flow Rate (safety factor of 2) with 10 mm rainfall event	2Q	**29,000**	L/day

Appendix G

Groundwater Taking Plan

Construction Dewatering Discharge Rate and Zone of Influence

The Radius of Influence and temporary dewatering discharge rate were estimated in Section 5.1 and the details are summarized below.

Dewatering Zone	Description	ROI (m)
1	General Site Servicing Scenario Per Lateral	32

Potential Settlement and Monitoring

Settlement Estimate

The potential settlement was estimated by a qualified professional engineer as described below.

For the estimated 1.7 m drawdown for dewatering, settlement of the soil within the zone of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. The maximum settlement is estimated to be 5mm or less and will occur adjacent to the dewatering system where the maximum drawdown occurs. Settlement has the potential to damage buried utilities, building foundations, or cause subsidence in adjacent lands. The amount of settlement will decrease exponentially to zero towards the radius of influence limit. Due to the relatively negligible amount of settlement calculated, no structures, infrastructure of buried utilities within near proximity of the proposed temporary construction dewatering will be adversely affected.

Another cause of significant dewatering related settlement is due to pumping of fines through the system. It is imperative that any dewatering systems shall be designed and installed adequately to ensure no soil is conveyed through the system. Sufficient filtering techniques are incorporated at the entry point to avoid migration fines in the pumping/dewatering system. The turbidity of pumped water should be monitored daily to ensure that minimal fines are being conveyed.

Potential Impact on Other Water Users

Since the proposed residential subdivision and the surrounding areas are municipally serviced temporary dewatering activities will not impact any water well users.

Reduction of Ground Water Flow to Waterbodies

Given the short duration of the proposed construction dewatering and that the water removed will ultimately be returned back to the watershed, it is not anticipated that the proposed construction dewatering activity will negatively impact the groundwater flow to Whiskey Creek.

Water Quantity, Quality and Ground Water Level Monitoring Program

If the dewatering discharge water is treated by filtration (a decantation tank and silt bag at a minimum) to remove sediment and fines, the water quality is expected to improve to likely meet the PWQO.

Discharge Options

Based on the groundwater quality analysis to date dewatering discharge can be directed to the surface provided groundwater quality during dewatering activities comply with the applicable PWQO.

If the groundwater quality of the construction dewatering discharge does not meet the applicable standards treatment options should be evaluated and/or the system should be shut down.

Water Quality Monitoring and Potential Treatment Plan

The monitoring plan for discharge to the surface is outlined on Table G-1.

Ground Water Level Monitoring Program

The ground water level monitoring program is outlined on Table G-2.

Discharge Rate Monitoring

In accordance with O.Reg.63/16 daily ground water takings are to be measured and recorded by the dewatering contractor using a flow measuring device.

For each day of water taking a total daily water taking volume must be recorded. All water taking volumes for the duration of the EASR must be submitted annual through the MECP online reporting system.

Summary of Qualifications

Sarah Griffith, G.I.T.

Ms. Sarah Griffith, G.I.T. is a geoscientist-in-training registered with the Professional Geoscientists of Ontario with more than two years of experience of experience specializing in geoenvironmental and hydrogeological investigations.

She has been trained in to complete local scale ground water assessments, well feasibility studies, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, in-situ borehole permeability testing, determination of ground water flow characteristics, surface water sampling, and preparation of hydrogeological reports and compliance monitoring programs in accordance with the applicable MECP requirements.

Geoffrey White, P.Eng.

Mr. Geoffrey White, P.Eng., is a senior geotechnical engineer with twenty-six years of interdisciplinary professional experience specializing in geotechnical and materials engineering, geoenvironmental and hydrogeologic investigations and project management.

His hydrogeological experience includes long-term/short-term groundwater and surface water monitoring, local scale groundwater assessments, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, and determination of groundwater flow characteristics.

Date of Plan Preparation

This plan prepared on the date March 27, 2023.

TABLE G-1

WATER QUALITY MONITORING PLAN FOR DEWATERING DISCHARGE TO SURFACE [1]

Period	Monitoring Location	Parameters[2]	Monitoring Frequency[3]	Trigger For Mitigation	Mitigation Measures / Comments
Trial Dewatering	Dewatering discharge	○ PWQO Metals ○ City of Barrie Storm Sewer Use By-Law Criteria	Once during trial dewatering	Exceeds the PWQO and/or the City of Barrie Storm Sewer Use By-Law Criteria	Modify treatment method and/or shut down.
	Surface Water	○ Water Level ○ Turbidity		Establish background conditions	Not applicable.
During Construction	Dewatering discharge	○ PWQO Metals ○ City of Barrie Storm Sewer Use By-Law Criteria	Weekly then every four weeks after 3 consecutive weekly compliant samples[3]	Exceeds the PWQO and/or the City of Barrie Storm Sewer Use By-Law Criteria	Modify treatment method and/or shut down.
		○ Turbidity	Daily until stable (minimum 5 samples) then weekly[3]	Exceeds 15 NTU.	
	Discharge point (should dewatering discharge be discharged into the creek)	○ Impact Assessment	At each sampling event	Sedimentation, erosion	Reduce pumping and/or improve sediment/erosion control measures
	Surface Water	○ Water Level ○ Turbidity	Daily for first 5 days of dewatering and then weekly for the duration of dewatering.	Visible lowering of surface water levels, and/or turbidity increases by more than 10% when compared to the turbidity measured during the trial dewatering.	

Notes:
(1) It is recommended that discharge be treated by a sediment control items such as a decantation tank and filtration bags.
(2) Parameters may be removed from future testing after three consecutive compliant results and with agreement by QP. If dewatering moves to a different location all initial parameters must be retested.
(3) If dewatering moves to a different location or a non-compliant result is detected, the sampling will return to the initial frequency.

TABLE G-2

SUMMARIZED GROUND WATER LEVEL MONITORING PLAN

Period	Monitoring Location	Method	Monitoring Frequency	Trigger For Mitigation	Mitigation Measures / Comments
During Construction	On-site monitoring well	Water level meter	Every two weeks	Water level more than 1 m lower than proposed depth of excavation	Reduce pumping
Post-Construction	On-site monitoring well	Water level meter	Every two weeks for four weeks, then every four weeks until 90% recovery	Water level recovery less than 90% of baseline level	Continue monitoring

Appendix H

Discharge Plan

Construction Dewatering Discharge Rate and Zone of Influence

The Radius of Influence and temporary dewatering discharge rate were estimated in Section 5.1 and the details are summarized below.

Location and Scenario	Drawdown	ROI	Construction Dewatering Flow Rate Without Safety Factor	Construction Dewatering Flow Rate Including Safety Factor of 2	Construction Dewatering Flow Rate Including Safety Factor of 2 with a 10 mm Rainfall Event
	m		L/day		
1 - General Site Servicing Scenario Per Lateral	1.7	32	14,200	28,400	29,000

Proposed Discharge Method and Location

It is understood that the preferred discharge location would be to the surface. Dewatering discharge will be directed by hose or pipe from the dewatering system to any pre-treatment systems (i.e., silt bag and sediment tank), and then by hose or pipe to the preferred discharge location.

In the event of a significant rainfall event (100-year storm event), on-site excavation will cease until the dewatering system can be re-evaluated and/or storm water flow subsides.

Erosion and Sediment Control Measures

The construction dewatering setup will include sediment and erosion control measures, and sufficient filtration to ensure removal of suspended solids prior to discharge in accordance with typical Best Management Practices.

Statements

If discharge is directed to the surface with adherence to the water quantity and quality monitoring program outlined in the Water Taking Plan in Appendix G, no adverse effect on the environment is expected.

The discharge water temperature was considered in determining the method of transfer and discharge and is not expected to have an adverse impact.

Summary of Qualifications

Sarah Griffith, G.I.T.

Ms. Sarah Griffith is a geoscientist-in-training registered with the Professional Geoscientists of Ontario with more than two years of experience of experience specializing in geoenvironmental and hydrogeological investigations.

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Date of Plan Preparation

This plan prepared on the date March 27, 2023.

Appendix I

Preliminary Water Balance

Water Balance

MONTHLY AND YEARLY WATER BALANCE COMPONENTS														
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Potential Evapotranspiration Calculation	Average Temperature: T (^{o}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	6.9
	Heat Index: $i=(T/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	36.8
	Unadjusted Potential Evapotranspiration: U (mm)	0.0	0.0	0.0	25.2	59.0	88.5	104.1	98.1	74.7	40.6	11.5	0.0	501.7
	Adjusting Factor for U (Latitude 44^{o})	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	-
	Adjusted Potential Evapotranspiration - PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
Pervious Components	Precipitation: P (mm)	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
	Adjusted Potential Evapotranspiration: PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
	P - PET	82.5	61.8	58.1	33.7	7.5	-28.5	-58.1	-27.9	16.3	39.4	79.7	73.6	338.1
	Change in Soil Moisture Storage (mm)	0.0	0.0	0.0	0.0	0.0	-28.5	-58.1	-27.9	16.3	39.4	0.0	0.0	-
	Water Holding Capacity (max. 75 mm)	75.0	75.0	75.0	75.0	75.0	46.5	0.0	0.0	16.3	55.7	75.0	75.0	-
	Water Surplus Available for Infiltration or Runoff	82.5	61.8	58.1	33.7	7.5	0.0	0.0	0.0	0.0	0.0	60.4	73.6	377.6
	Potential Infiltration based on MECP Infiltration Factor (mm)	49.5	37.1	34.9	20.2	4.5	0.0	0.0	0.0	0.0	0.0	36.2	44.2	226.5
	Potential Surface Water Runoff (mm)	33.0	24.7	23.2	13.5	3.0	0.0	0.0	0.0	0.0	0.0	24.2	29.4	151.0
Impervious Components	Precipitation: P (mm)	-												932.9
	Potential Evaporation: PE (mm), Assume 15%	-												139.9
	Potential Surface Water Runoff: P - PE (mm)	-												793.0

PRE- AND POST-DEVELOPMENT WATER BALANCE (NO LOW IMPACT DEVELOPMENT MEASURES IN PLACE)							
		Total Land Area (m^2)	Est. Fraction of Land	Est. Land Area (m^2)	Runoff (m^3/annum)	Infiltration (m^3/annum)	**Runoff Increase Pre to Post**
Existing Land Use (Pre-Development)	Pervious Area	1400	85%	1190	180	270	130%
	Impervious Area (existing structures)		15%	210	167	0	**Infiltration Decrease Pre to Post**
	TOTAL	-	100%	1400	346	270	-59%
Proposed Land Use (Post-Development)	Pervious Area (RM2 Zoning - minimum landscaped open space)	1400	35%	490	74	111	**Infiltration Required to Meet Pre-Development Conditions (m^3)**
	Impervious Area (residential buildings and driveways)		65%	910	722	0	
	TOTAL	-	100%	1400	796	111	159

Notes

1. Both potential infiltration and surface water runoff are independent of temperature
2. Assumption is in January maximum soil moisture storage value is present (75 mm)
3. Water Holding Capacity & Infiltration Factors taken from Table 3.1 of MOE SWMPDM, 2003
4. Average Temp. and Precip. taken from Environment Canada station "Barrie WPCC" between 1981 and 2010
5. Adjusting Factor for U based on Lorente, 1961

Infiltration Criteria	Site Description	Infiltration Factor
Topography	Hilly Land - Average Slope 28 to 47 m/km	0.1
Soils	Open Sandy Loam	0.4
Cover	Cultivated Land	0.1
	Sum of Infiltration Factors	**0.6**

Appendix J

Phosphorous Budget Calculations

Preliminary Phosphorous Budget

Table 1 - Annual Phosphrous Loading

Site Area (ha)	Unit Loading for Site (kg/ha)		Total Annual Loading Rate (kg)
	Barrie Creeks	HID Residential	
0.14	1.32		0.18

Table 2 - Offsetting Compensation Plan without BMPs

Phosphorous Loading (kg)	Unit offsetting Compensation Fee ($/kg)	Total Offsetting Fee with 2.5 Factor ($)	With 15% Administration Fee ($)
0.18	35,770	16,526	19,005