GEI Consultants

Consulting
Engineers and
Scientists

Geotechnical Investigation

Proposed Residential Apartment Building Development

427 to 437 Yonge Street, Barrie, Ontario

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1. Introduction

GEI Consultants (GEI) was retained by Barrie Yonge Developments GP Inc. to complete a geotechnical investigation for the proposed 7 storey residential apartment building to be located between 427 to 437 Yonge Street, in Barrie, Ontario. A site location plan is provided as Figure 1. This revision of the report is being provided to reflect the most recent plans provided to GEI.

The existing site is rectangular in shape, and measures approximately 110 metres long and 60 meters wide with an area of approximately 6,600 m^2 (0.66 hectares). The site is currently developed with five residential dwellings (vacant at the time of the field work) and the site is bounded by Yonge Street to the west, Maclaren Avenue to the south, and residential properties to the north and east. The site is relatively flat, ranging from Elev. 254 to 255 metres. An aerial image of the site is shown on Figure 2A.

GEI was provided with the following drawing for review in preparation of this report:

- *"Underground Parking Servicing Plan, Proposed Apartment and Retail Development, 427-437 Yonge Street, City of Barrie," dated May 2024 by Pinestone Engineering Limited.*
- *"Site Grading Plan, Proposed Apartment and Retail Development, 427-437 Yonge Street, City of Barrie," dated April 2024 by Pinestone Engineering Limited.*
- *"Site Servicing Plan, Proposed Apartment and Retail Development, 427-437 Yonge Street, City of Barrie," dated April 2024 by Pinestone Engineering Limited.*
- *"427-437 Yonge Street – City of Barrie, Apartment and Retail Development, Functional Servicing & Stormwater Management Report," dated May 9, 2024 by Pinestone Engineering Limited.*

Currently, it is proposed to construct a 7 storey apartment building in the southern half of the site and on-grade parking and roadways in the northern half of the site. Approximately half of the site will contain 1 level of underground parking (under the apartment building footprint) with additional at-surface parking. A site plan is provided as Figure 2B. The development will be municipally serviced.

The geotechnical investigation was required to provide engineering design parameters for design and construction of the proposed residential apartment building. This includes design recommendations for foundations, slabs-on-grade, earth pressures, temporary shoring, site servicing, basement drainage and pavements, as well as considerations for constructability such as soil excavation, compaction, and temporary groundwater control. GEI was retained to complete a hydrogeological study at the site, under a separate cover.

2. Procedures and Methodology

The fieldwork for the drilling program was carried out on February 1 and 2, 2022, to assess the soil conditions present at the site. A total of five (5) boreholes (Boreholes 101 through 105) were advanced throughout the site to depths from 10.4 to 11.1 metres below existing grade (Elev. 243.0 to 244.4 metres). The boreholes were distributed evenly across the property to assess the composition of the subsurface soils throughout the property.

The borehole locations were laid out in the field by GEI field staff prior to commencement of drilling operations. Ground surface elevations of the boreholes were surveyed by GEI relative to the top of fire hydrant 1079 and was assigned a local elevation of 100.00 metres. Borehole position and coordinates (referencing NAD 83 geodetic datum) were provided by a handheld Garmin eTrex 10 GPS receiver. This reference point was later surveyed to provide a geodetic elevation of 255.79 m. The borehole coordinates, and elevations are provided on the borehole logs in Appendix A. Borehole locations are shown on Figure 2A (aerial image of the site) and 2B (proposed site plan).

Drilling and sampling of the boreholes was completed using a rubber-tire mounted drill rig operated by a drilling subcontractor retained and supervised by GEI. The boreholes were advanced to predetermined depths through the use of solid stem augers, and sampling was conducted using 51 mm O.D. split spoon (SS) samplers. Standard Penetration Test (SPT) “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. Soil sampling was conducted at 0.75 metre intervals for the upper 3.0 metres of each borehole and at 1.5 metre intervals thereafter.

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

Three (3) monitoring wells were installed in Boreholes 102, 103, and 104 to determine the static groundwater elevation at the site, subsequent monitoring or testing purposes, and for use by GEI during the hydrogeological investigation. All borehole backfilling/capping activities and monitoring well installations were performed in accordance with Ontario Regulation (O.Reg.) 903.

In the laboratory, the samples were classified as to their visual and textural characteristics and geotechnical laboratory testing for grain size was carried out with the results provided in Appendix B. Each of the boreholes were backfilled upon completion.

3. Subsurface Conditions

3.1 General Overview

The soil conditions at the site generally consisted of topsoil overlying silty sand to sand and silt glacial till. These soils were encountered throughout each of the boreholes to their respective termination depths. Bedrock was not encountered in the boreholes.

The borehole locations are shown on Figures 2A and 2B. Detailed soil profiles encountered in the GEI boreholes are indicated on the attached borehole logs in Appendix A, with the results of geotechnical laboratory testing included in Appendix B. A subsurface profile beneath the site is included as Figure 3 and the profile alignment is shown in plan view on Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs and subsurface profile 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 and subsurface profile 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, Pavement Structure and Earth Fill

Boreholes 101, 102, 103, and 105 encountered topsoil at ground surface. The surficial topsoil was noted as moist at the time of investigation, generally dark brown to black in colour, and was sandy in composition. The encountered topsoil varied in thickness from 20 to 450 mm.

Borehole 104 encountered a pavement structure at the ground surface. The surficial asphalt was 50 mm in thickness and was underlain by 100 mm of granular material.

An upper zone of cohesionless earth fill consisting of silt and sand with trace organics was encountered immediately beneath the topsoil layer in Borehole 102. The earth fill extended to a depth of 1.8 metres below existing grade (Elev. 253.4 metres) in the borehole. The earth fill was noted as dark brown in colour and moist at the time of the investigation. The SPT “N”

Values measured in the earth fill were 5 and 20 blows indicating a loose to compact relative density.

3.2.2 Glacial Till

Underlying the topsoil in Boreholes 101, 103, and 105, the pavement structure in Borehole 104, and the earth fill in Borehole 102, a native glacial till deposit was encountered with a cohesionless matrix consisting of silty sand to sand and silt, with trace to some clay and trace to some gravel. The upper 0.5 to 0.9 metres of the glacial till was weathered in Boreholes 101, 04 and 105. Occasional cobbles and boulders are likely embedded within the glacial till deposit based on auger grinding and drilling observations. The glacial till extended beyond the borehole termination depths between 10.4 to 11.1 metres below existing grade (Elev. 244.4 to 243.0). The glacial till was moist and brown, turning grey at depths of 4.5 to 7.5 metres below grade.

SPT “N” Values measured in the deposits ranged from 6 to greater than 100 blows per 305 mm of penetration, indicating a loose to very dense relative density. In general, the glacial till was compact to dense to a depth of 4.5 metres below grade, after which the deposit was uniformly very dense.

3.3 Groundwater

Unstabilized groundwater level measurements and borehole sloughing (caving) measurements were taken upon completion of drilling of each borehole. These measurements provide an estimate of possible excavation and temporary groundwater control issues that may arise during construction. The boreholes encountered unstabilized water levels at depths of 3.7 to 6.1 metres below grade, and cave was measured at depths of 6.7 to 8.2 metres below grade.

Three boreholes were outfitted as monitoring wells with 50 mm diameter PVC standpipes and 3-metre-long screens. Monitoring well configurations and groundwater observations are summarized on the borehole logs in Appendix A and are presented in the table below.

Borehole	Well Screen Location		Strata Screened	Depth / Elev. (m) of Groundwater Table on Feb 18, 2022
	Depth (m)	Geodetic Elev. (m)		
BH 102	7.6 to 10.6	247.5 to 244.5	Silty Sand to Sand & Silt Glacial Till	2.3 / 252.8
BH 103	7.6 to 10.6	246.3 to 243.3		1.8 / 252.2
BH 104	7.6 to 10.6	246.9 to 243.9		1.8 / 252.7

Based on the stabilized groundwater measurements in the monitoring wells, the groundwater table appears to be at a depth on the order of 1.7 to 2.3 metres below existing grade (Elev. 252.2 to 252.8 metres) for the proposed development area.

The cohesionless silty sand to sand and silt glacial till soils at the site contain 34 to 51% fines and are moderately permeable but will generally resist the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. Additional considerations are provided in GEI's hydrogeological report under a separate cover.

4. Engineering Design Parameters & Analysis

Currently, it is proposed to construct a 7 storey apartment building in the southern half of the site and on-grade parking and roadways in the northern half of the site. The majority of the site will contain 1 level of underground parking (under both the apartment building and on-grade parking areas). A preliminary site plan is provided as Figure 2B.

Detailed civil engineering drawings (e.g. grading or site servicing plans) or other detailed design information were not available at the time of preparing this report.

4.1 Site Grading

The site grading plan provided indicates that minimal change in the grading is anticipated to complete this development. The site is relatively flat and level, however some site grading may be required to accommodate the parking lot and land development. The earth fill and native glacial till at the site are competent to support moderate grade raises throughout the site.

The existing topsoil, pavement structures, organic rich soils, deleterious soils, and vegetation must be stripped from any location where grades will be raised, prior to placing any new fill. Exposed soil subgrade must be proof-rolled and inspected by the geotechnical engineer in advance of placing fill. Any soil subgrade areas observed containing excessive organics, soft or weak areas, or deleterious material should be further sub-excavated to a competent subgrade under the direction of the geotechnical engineer.

Once the subgrade is approved, all new material placed to raise the grades shall be inorganic soil sourced from the site or suitable imported fill compacted to a minimum of 98% SPMDD. The purpose of this compaction specification is to provide uniform support and to mitigate the potential of significant differential settlements. Additional soil compaction recommendations are provided in Section 5.3 of this report.

4.2 Frost Penetration Depth

Based on review of Ontario Provincial Standard Drawing (OPSD) 3090.101, the frost penetration depth beneath the site is estimated to be 1.5 metres.

4.3 Foundation Design Parameters

The boreholes were evenly distributed throughout the site in support of the proposed residential development. The surficial topsoil, pavement structures, earth fill, any weathered or disturbed soils, or zones with organic content are not suitable for the support of new foundations. The undisturbed silty sand to sand and silt glacial till is suitable for the support or conventional spread and strip footing foundations. In general, the glacial till was compact to dense to a depth of 4.5 metres below grade, after which the deposit was uniformly very dense.

For one basement level, foundations are expected to be made about 3 metres below existing grade (Elev. 252.1 to 250.3 metres). Spread and strip footing foundations made to bear on the undisturbed and dense glacial till at or below a depth of 3 metres below existing grade can be designed using a geotechnical reaction at SLS of 250 kPa, for an estimated settlement of 25 mm or less. The maximum factored geotechnical resistance at ULS is 350 kPa.

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 7 vertical to 10 horizontal. This concept should also be applied to excavations for new foundations in relation to existing footings or underground services unless rigid shoring is provided. All footings exposed to ambient air temperature throughout the year must be provided with a minimum of 1.5 metres of earth cover or equivalent insulation for frost protection. If the proposed structures contain a continuously heated basement, the required earth cover may be reduced to 1.2 metres for footings exposed to ambient air temperatures.

The foundation design parameters provided above are predicated on the assumption that the foundation subgrade surface is undisturbed, and that all 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. Temporary groundwater control during construction is discussed in Section 5.2.

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

4.4 Earth Pressure Design Parameters

The structures 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 structures 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
Earth Fill and Loose Glacial Till	19.0	30	0.33	0.50	3.00
Compact to Dense Glacial Till	20.0	34	0.28	0.44	3.54
Very Dense Glacial Till	21.0	38	0.24	0.38	4.20

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.

4.5 Slab on Grade Design

The topsoil and any earth fill or native soil containing excessive organics are not suitable for the support of a slab on grade. For one basement level, it is expected the slab will be made on compact to very dense silty sand to sand and silt glacial till. Proof-rolled glacial till is suitable for the support of a lightly supported unreinforced concrete slab-on-grade.

The subgrade for the slab on grade must be assessed by the geotechnical engineer, prior to the placement of an aggregate base. 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% of 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. To prevent the migration of fines into the clear stone, filter fabric such as Terrafix 270R or approved equivalent should be placed between the clear stone and the cohesionless soil subgrade.

4.6 Basement Drainage

Based on the monitoring well measurements, the groundwater table appears to be at a depth on the order of 1.7 to 2.3 metres below existing grade (Elev. 252.2 to 252.8 metres) for the proposed development area. One basement level is proposed and will extend into the groundwater table.

For new structures that will be slab on grade with no basement levels, perimeter drainage at the foundation level is not required, provided that the underside of 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 could comprise relatively impervious compacted soil material.

Where basements are constructed, all basement foundation walls must be designed as fully waterproofed structures as per the City of Barrie's requirements:

> *"Permanent dewatering is prohibited in accordance with the City of Barrie's Drinking Water Protection Policy… Site design shall consider that permanent dewatering is prohibited. This includes the application of sump pumps to dewater basements. Alternative design options (i.e., slab on grade construction or full foundation water proofing) are to be explored and implemented."*

The structures must be designed to resist hydrostatic pressures (including uplift). Construction dewatering would be required until sufficient dead weight is available to resist the uplift pressures. Buoyancy calculations can be completed by GEI if requested. Basement and perimeter drainage is not required and there would be no permanent discharge of groundwater.

4.7 Site Servicing

It is understood that the servicing for this project will likely entail watermain and sanitary or storm sewer construction for the proposed development. Detailed civil engineering drawings or other detailed design information were not available at the time of preparing this report. It is expected that the services could be installed between 1.5 to 3 metres below grade.

Based on the monitoring well measurements, the groundwater table appears to be at a depth on the order of 1.7 to 2.3 metres below existing grade (Elev. 252.2 to 252.8 metres) for the proposed development area. The soil encountered in the trenches will consist primarily of cohesionless glacial till, or potentially silt and sand earth fill.

4.7.1 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 802.013 or applicable municipal standards. Pipe bedding for rigid pipes should follow the requirements in Ontario Provincial Standard Drawings 802.030 to 802.033 or applicable municipal standards.

Where disturbance of the trench base has occurred from groundwater seepage, construction traffic, etc., the disturbed soils should be sub-excavated and replaced with suitably compacted granular fill. 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 98% SPMDD. Clear stone or high-performance bedding is permitted at this site provided it is fully wrapped in a non-woven filter fabric to prevent the migration of fines and loss of pipe support.

4.7.2 Backfill

Excavated soils may be used as backfill in trenches provided they are moisture conditioned so that the moisture content is within 2% of optimum. The backfill should be compacted to a minimum of 98% 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 the parking lot, backfill within the frost penetration depth of 1.5 metres 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. 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.

4.8 Pavement Design

The pavement design provided below assumes that the parking lot shown in the eastern half of the site will be on-grade (made on soil) and will not be underlain by an underground parking structure.

4.8.1 Subgrade Preparation

Surficial topsoil and organic rich soils are not a suitable subgrade and must be removed. The pavement subgrade throughout the site will likely consist of loose earth fill, compacted trench backfill, or compact to dense glacial till. These types of soils be considered adequate subgrade for the support of a pavement structure, provided the subgrade is proof-rolled and approved by the geotechnical engineer at the time of construction and does not contain excessive amounts of organics, moisture or deleterious materials. Zones with high moisture, deleterious materials, or excessive organics must be sub-excavated and replaced with clean earth fill, placed and compacted following the specifications in Section 5.3 to a minimum of 98% SPMDD.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.

4.8.2 Frost Susceptibility

The frost susceptibility of soils is correlated to the percentage of particles within a grain size range of 5-75 µm (silt and very fine sand) and divided into three categories summarized below from the Pavement Design and Rehabilitation Manual (2nd Edition, MTO, 2013):

Percentage of Particles Between 5-75 μm by Mass	Susceptibility to Frost Heaving
0 to <40%	Low Susceptibility to Frost Heaving (LSFH)
40% to 55%	Moderate Susceptibility to Frost Heaving (MSFH)
>55 to 100%	High Susceptibility to Frost Heaving (HSFH)

Based on grain size analysis of the glacial till soil samples, the site soils appear to have a low susceptibility to frost heaving with contents of particles between 5-75 μm ranging from 10 to 15%.

4.8.3 Drainage

Control of surface water is an important factor in long lasting pavements and the need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade of 2 percent) to provide positive drainage to the edges of the roadway platform. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement.

Parking lot drainage can be managed by conventional catch basins and storm sewers, or ditches / swales around the outside of the parking lot. To minimize movement between the pavement and any manhole or catch basin structures due to frost action, the backfill around the structures should consist of free draining granular materials. Typical pavement drainage details are provided in Appendix C.

4.8.4 Pavement Structure

The projected traffic volumes for the proposed development were unknown at the time of writing of this report. There are two different types of pavements that need to be designed for:

- Light duty: Includes driveways and parking lots which will not see frequent heavy traffic loads such as buses, delivery or fire trucks, etc., and will mostly service small vehicles such as cars or pickup trucks.
- Heavy Duty: Includes driveways and parking lots which are designated fire truck routes, or will see frequent heavy traffic loads such as buses, delivery or garbage trucks, etc.

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions depending on actual traffic volumes. The following pavement thickness designs are provided on the above noted considerations and subgrade basis for an asphaltic concrete pavement structure.

Pavement Layer	Compaction Requirements	Light Duty Minimum Thickness	Heavy Duty Minimum Thickness
Surface Course Asphaltic Concrete: HL-3 (OPSS.MUNI 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm	40 mm
Binder Course Asphaltic Concrete: HL-4 (OPSS.MUNI 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)		50 mm	70 mm
Base Course: Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular B Type I or Type II (OPSS.MUNI 1010)		300 mm	450 mm

The granular materials should be placed in lifts 200 mm thick or less and be compacted to a minimum of 100% SPMDD for both granular base and subbase. Asphalt materials should be rolled and compacted as per OPSS.MUNI 310. The granular and asphalt pavement materials and their placement should conform to OPSS.MUNI 310, 501, 1010 and 1150.

Smooth transitions are required in all areas where the new pavement meets the existing asphalt surface. All longitudinal and transverse joints should meet the requirements of OPSS.MUNI 310. All longitudinal joints should be staggered between the asphalt lifts. The staggering of the longitudinal joints should be accomplished by offsetting the paving edge in the upper asphalt course by a minimum of 150 mm.

If the pavement construction occurs in wet, winter, or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular subbase, base, or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials.

It should be noted that in addition to adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

4.9 Shoring Design

Based on the building footprint in the conceptual site plan, it appears the building will be located close to the north, south, and western property lines. The sidewalks and public lands associated with Yonge Street and Maclaren Avenue are near the property lines, and a neighbouring residential property is located to the north. Open cut excavations may not be feasible, depending on the final location of the building and depth of basement levels. A shoring system such as soldier piles and lagging or a continuous caisson wall may be required to support parts of the basement excavation.

No excavation shall extend below the foundations of existing adjacent structures without adequate alternative support being provided. The shoring designer should review the subsurface and proposed site conditions to select the appropriate shoring system.

For one basement level, a cantilevered shoring system may be feasible. The shoring system could also be supported by pre-stressed soil anchors extending beneath the adjacent lands. Pre-stressed anchors are installed and stressed in advance of excavation and this limits movement of the shoring system as much as is practically possible. The use of anchors on adjacent properties requires the consent of the adjacent landowners, expressed in encroachment agreements. The City Transportation and Works Department negotiates permits for the encroachment in City lands, which are generally allowed. Where a cantilevered system or tiebacks cannot be constructed, the use of rakers can be used which provide support to the shoring wall internally.

4.9.1 Earth Pressures

If a single level of support (e.g. anchors, tie-backs, or bracing) are used to support the excavation, the pressure distribution on the wall is triangular and can be calculated as discussed in Section 4.4.

If multiple supports are required to support the excavation, a distributed pressure diagram more realistically approximates the earth pressure on a shoring system of this type, when restrained by pre-tensioned anchors. The multi-level supported shoring can be designed based on an earth pressure distribution consisting of a rectangular pressure distribution for the cohesionless soils with a maximum pressure defined by:

$$\boldsymbol{P = 0.65 * K[\gamma h + q]}$$

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)

For groundwater pressure distribution along the shoring wall in conjunction with the above soil pressures, the groundwater level for design should be taken at 1.7 metres below existing grades. The groundwater pressure distribution is only applicable where an impermeable boundary condition is created along the perimeter of the excavation, as is the case with an interlocking caisson wall. If the site is continuously dewatered for the duration of construction, hydrostatic pressures will not be applied on the system.

4.9.2 Soldier Pile Toe Design

The lateral resistance for the toe of the shoring piles will be developed by passive earth pressure in the dense to very dense glacial till below the base of the excavation. The factored vertical axial resistance at ULS is 350 kPa, where the pile toes are installed deeper than 3 metres below existing grade. The factored vertical axial resistance at ULS is 500 kPa, where the pile toes are installed deeper than 6 metres below existing grade. It needs to be noted that the glacial till beneath the site is cohesionless and wet such that augered borings for soldier piles made into the sand may become unstable. Augered borings that extend below the groundwater table at 1.7 to 2.3 metres below existing grade may become disturbed by the ingress of water. It may be necessary to advance temporarily cased holes to prevent excess caving during the soldier pile installations. The base of the boring can be protected from groundwater ingress by drilling with mud or temporarily dewatering the site. The design and installation methods will be determined by the shoring designer and contractor. It must also be noted that cobbles and boulders could be embedded within the glacial till.

4.9.3 Shoring Support

The design adhesion for earth anchors is controlled as much by the installation technique as the soil and therefore a proto-type anchor must be made in each anchor level executed to demonstrate the anchor capacity and validate the design assumptions to 200% of the ULS design load (performance test). All production anchors must be proof-tested to 133% of the ULS design load, to validate the design assumptions.

Conventional earth anchors made in the glacial till can be designed using a maximum factored geotechnical resistance (ULS) of 35 kPa for design. It is expected that post-grouted anchors (typically 150 mm diameter) can be made such that an anchor will safely carry about 75 kN/m of adhered anchor length. Where anchors cannot be used, internal bracing or rakers would be necessary. The footings for the rakers would be made on dense to very dense glacial till where they could be designed using a factored geotechnical resistance at ULS of 150 kPa when inclined at 45 degrees.

4.9.4 General Considerations

The strata in the anchor zones will be cohesionless and potentially wet. The shoring designer and contractor must decide if the borings made for anchorages will be completely cased as the holes are advanced and that there is no excess removal of soil beyond the volume of the boring made.

Once the shoring system is configured for immediate support and anchorage it is imperative that a global stability assessment be made of the soil and excavation to ensure that there is not a potential failure condition that is beyond the shoring anchor zone.

It is recommended that the contract have a performance specification limiting movement. A maximum of 13 mm is generally acceptable for a street where movement sensitive utilities are not nearby. Otherwise, the engineering departments of the utility companies must be contacted to assess what movement is acceptable. Anchor spacing and elevation, and the timing of the excavation and anchoring operations are critical in determining the movements.

The shoring designer should be retained to monitor installation and testing of the system, and to monitor the shoring during all phases of the excavation. Inclinometers should be installed at locations where sensitive buildings or services lie close to the excavation. Careful monitoring is needed in any shored excavation, especially when buildings are located in close proximity. This is necessary not only to anticipate when and if additional support is needed, but also to provide data to meet claims from adjacent property owners. In this regard, it is essential that detailed precondition surveys be made on adjacent buildings.

5. Constructability Considerations

5.1 Excavations

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. The regulation stipulates safe slopes of excavation as follows based on the soils encountered at this site:

- *Type 3 Soils – All soils on site above the groundwater table or when dewatered:* Trench sidewalls to be constructed no steeper than 1 horizontal to 1 vertical from the base of the excavation.
- *Type 4 Soils – All soils on site within the groundwater table:* Trench sidewalls to be constructed no steeper than 3 horizontal to 1 vertical from the base of the excavation.

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. For the purposes of design, excavations should be conducted assuming a Type 3 soil (assuming the excavation will be dewatered) unless otherwise directed by a geotechnical engineer on site.

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

Based on the stabilized and unstabilized groundwater measurements and the moisture contents of the soil within the boreholes, the prevailing groundwater table appears to be at a depth on the order of 1.7 to 2.3 metres below existing grade (Elev. 252.2 to 252.8 metres) across the site.

The cohesionless native sand and silt to silty sand glacial till soils at the site are moderately permeable but are expected to generally resist the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

It is important to control the groundwater adequately. If the groundwater table is not controlled during construction, the base for the servicing, foundations or basement slabs may become unstable. It is typical to lower the groundwater table about 1 metre below the base of the excavation. If the basement excavations will be supported by a shoring wall, dewatering may also be required in advance of shoring wall construction (e.g. to facilitate the installation of wooden lagging in dry conditions), to be determined by the shoring designer and contractor.

The following conditions are assumed for the site:

- Site services could extend 1.5 to 3 metres below grade, or up to about 1.3 metres into the groundwater table.
- For one basement level, the slab subgrade could extend about 1.3 metres into the groundwater table, with footings extending an additional 0.5 to 1 metre deeper. Total drawdown could be approximately 3.3 metres to maintain dry working conditions and prevent disturbance to the foundation subgrade soil.

For excavations kept above the prevailing groundwater table, any seepage from precipitation or minor perched water zones can be controlled using a conventional sump pump system. It is expected that sump pumps can also be used to control seepage into the servicing trenches.

For the basement excavations, well points or deep wells may be required to lower the groundwater table. 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, footings or basement slabs. 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 with determining the most appropriate dewatering methods based on their own means and methods.

The hydrogeological study being completed for the site concurrently by GEI should be referenced for additional dewatering and hydrogeological considerations.

5.3 Compaction Specifications

Standard Proctor Maximum Dry Density (SPMDD) is the level to which a 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. Based on our review of the soil types encountered in the boreholes with associated moisture contents, the soils at this site are as follows:

- About half of the glacial till is at or near optimum moisture content.
- About a quarter of the glacial till is above optimum moisture content.
- About a quarter of the glacial till is below optimum moisture content.

Moisture can be increased by adding water and mixing the soil prior to re-use, 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.

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 or unstable areas should be sub-excavated, and backfilled with clean earth fill or Granular ‘B’ (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. This recommendation applies to site servicing, slab, and pavement subgrades.

5.4 Quality Verification Services

On-site quality verification services are an integral part of the geotechnical design function, and for foundations and retaining walls, are required under the Ontario Building Code (OBC). 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 the shallow foundations must be field reviewed by the geotechnical engineer.
- The installation of any shoring wall systems must be field reviewed by the shoring design engineer.
- 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:
    - Slabs-on-grade;
    - Pavement structure (granular layers 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.

5.5 Site Work

The soils found at this site may become weakened when subjected to traffic, particularly when wet. If there is site work carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of granular fill material for site restoration or underfloor fill that is not intrinsic to the project requirements.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during paving and other work may be required, especially if construction is carried out during unfavourable weather.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade and concrete must be provided. The soil at this site is susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this project development.

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 prepared by GEI for the account of Barrie Yonge Developments GP Inc. 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

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May 30, 2024
PROVINCE OF ONTARIO

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May 30, 2024
PROVINCE OF ONTARIO

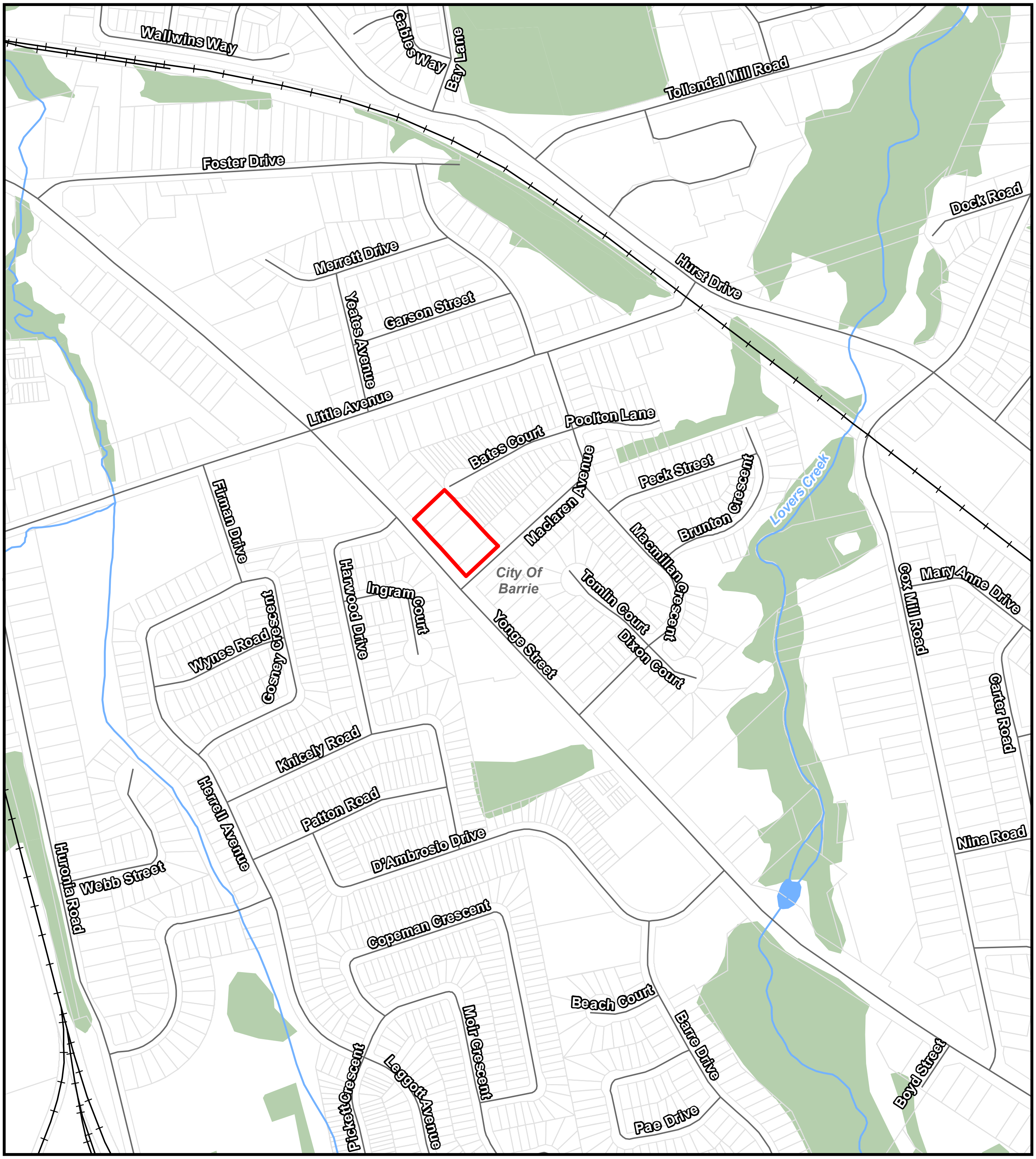
Alexander Winkelmann, P.Eng.
Geotechnical and Earth Sciences Manager

Figures

Site Location Plan

Borehole Location Plans

Geological Cross-Section A-A’



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.
3. Parcels from 'Tax Parcels', City of Barrie, AGOL. Accessed March 2022.

Legend

🟥 Site Location
— Road
+—+ Railway
— Watercourse
🟦 Waterbody
🟩 Wooded Area
☐ Parcels

N

0 80 160
m
1:8,000

427-437 Yonge Street
Barrie, Ontario

Innovative Planning Solutions

GEI Consultants

SITE LOCATION PLAN

Project 2200334

March 2022

Fig. 1

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.
3. Orthoimagery © First Base Solutions, 2022. Imagery taken in 2020.

Legend

- 🟥 Site Limit
- ⊕ Approximate Borehole/Monitoring Well Location
- ◕ Approximate Borehole Location

N

0 7 14 m
1:700

427-437 Yonge Street
Barrie, Ontario

Innovative Planning Solutions

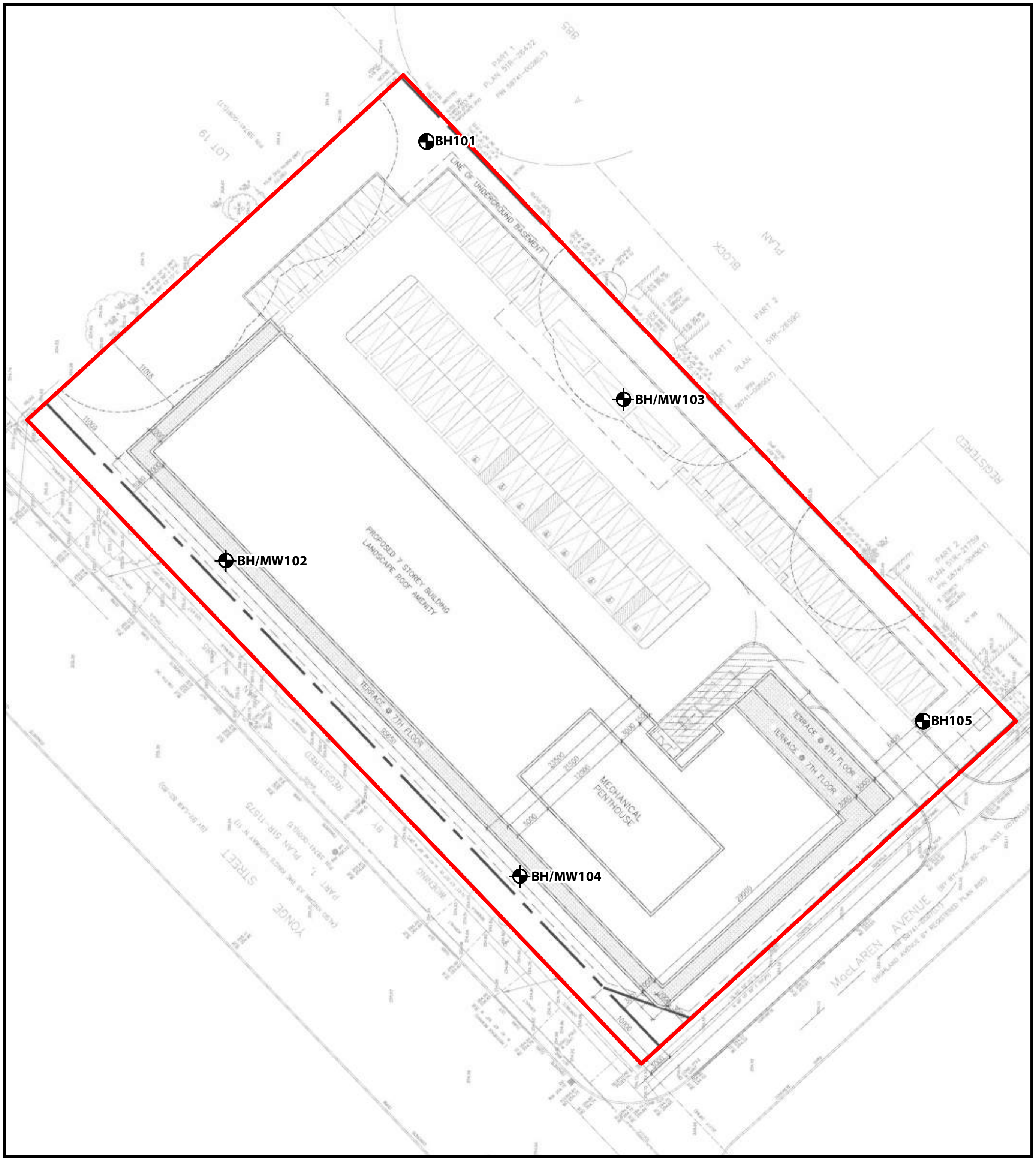
GEI Consultants

BOREHOLE LOCATION PLAN (AERIAL)

Project 2200334

March 2022

Fig. 2A



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.

Legend

🟥 Site Location

⊕ Approximate Borehole/Monitoring Well Location

◐ Approximate Borehole Location

N

0 7 14 m

1:700

427-437 Yonge Street
Barrie, Ontario

Innovative Planning Solutions

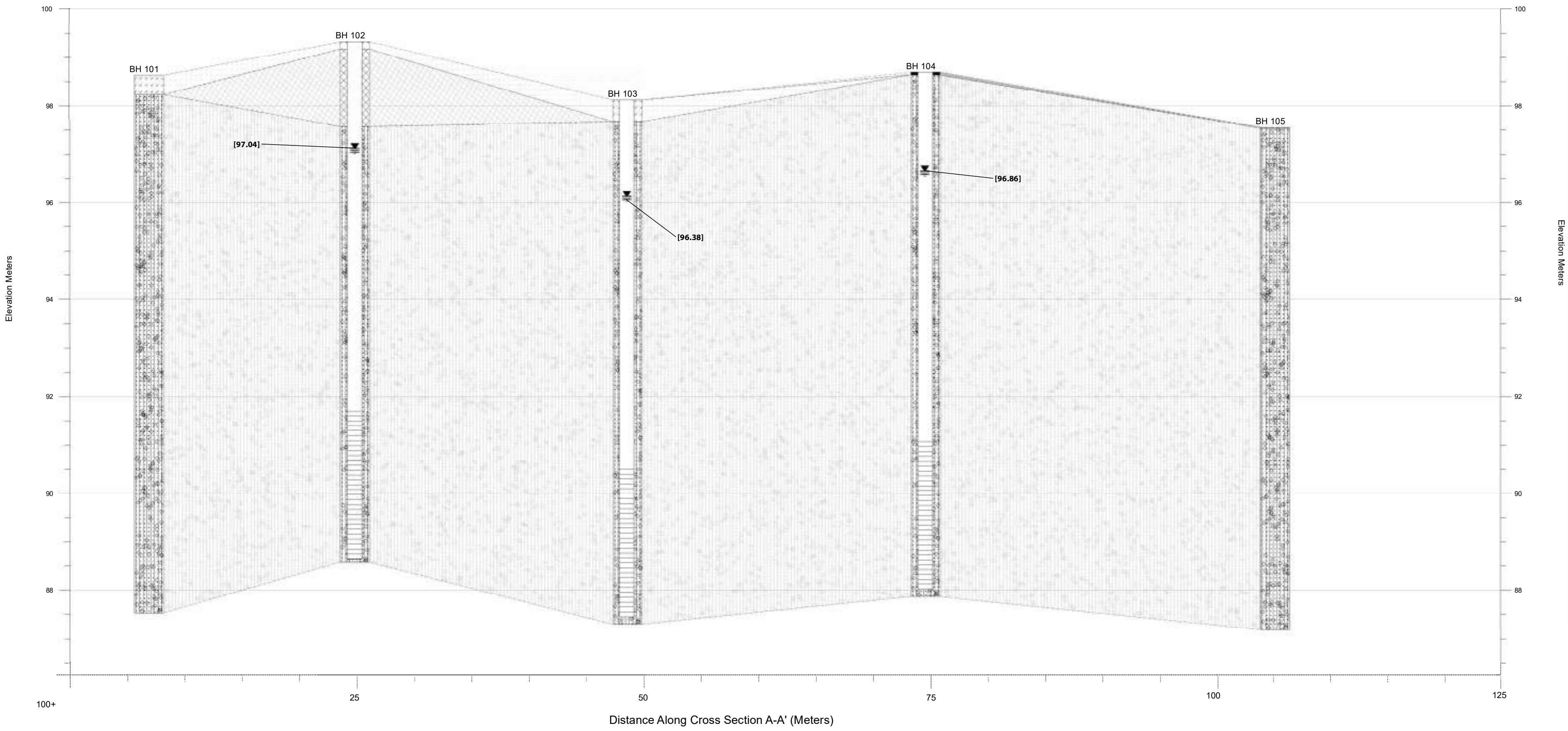
GEI Consultants

Project 2200334

BOREHOLE LOCATION PLAN
(PROPOSED SITE PLAN)

September 2022

Fig. 2B



Legend

⩸ Water Level In Monitoring Well

▨ Topsoil

▨ Earth Fill

▨ Silty Sand to Sand and Silt Glacial Till

[ ] Groundwater level (m bgs), measured February 18, 2022

Strata

■ Asphalt

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

427-437 Yonge Street
Barrie, Ontario

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GEOLOGICAL CROSS SECTION A-A'

Project 2200334

March 2022

Fig. 3

Appendix A

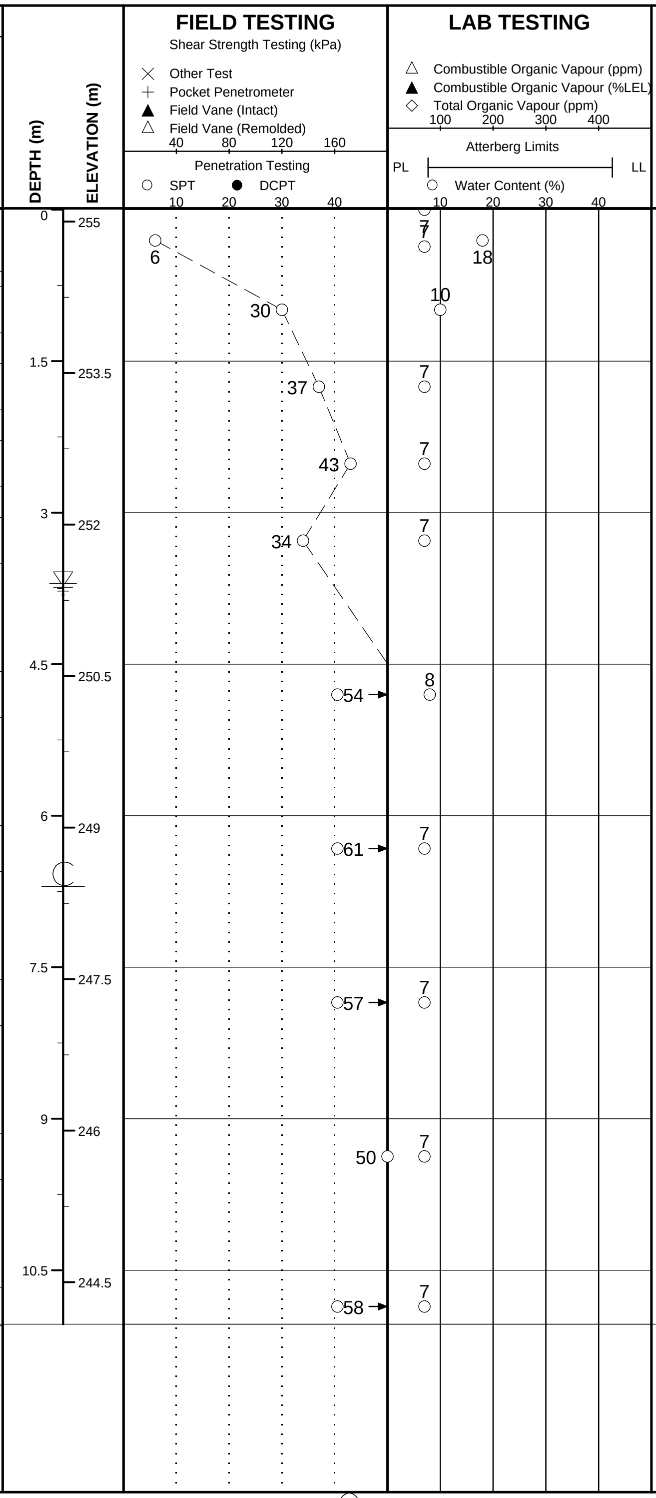
Borehole Logs

RECORD OF BOREHOLE No. 101

Project Number: **2200334**
Project Client: **Barrie Yonge Development GP Inc.**
Project Name: **427 - 437 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **CME 85, Buggy**
Logged By: **SP**
Reviewed By: **AB**
Northing: **4913372**
Easting: **606733**
Date Started: **Feb 1/22**
Date Completed: **Feb 1/22**

Depth (m)	Elevation (m) Geodetic	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
0.0	255.1	TOPSOIL: 400 mm	SS	1	75	6	7 7 18				
0.4	254.8	WEATHERED: Trace organics, dark brown, loose									
0.8	254.4	SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some gravel, trace to some clay, brown, moist, dense	SS	2	65	30	10				
			SS	3	95	37	7	4	62	28	6
			SS	4	90	43	7				
			SS	5	100	34	7				
		- - - Very dense - - -	SS	6	100	54	8				
		- - - Grey - - -	SS	7	90	61	7				
			SS	8	90	57	7				
			SS	9	100	50	7				
11.0	244.1		SS	10	100	58	7				
		Borehole Terminated at 11.0 m									



Groundwater depth encountered on completion of drilling: 3.7 m.
Cave depth after auger removal: 6.7 m.
Groundwater depth observed on:
Groundwater Elevation:

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Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

Page: **1 of 1**

RECORD OF BOREHOLE No. 102

GEI Consultants

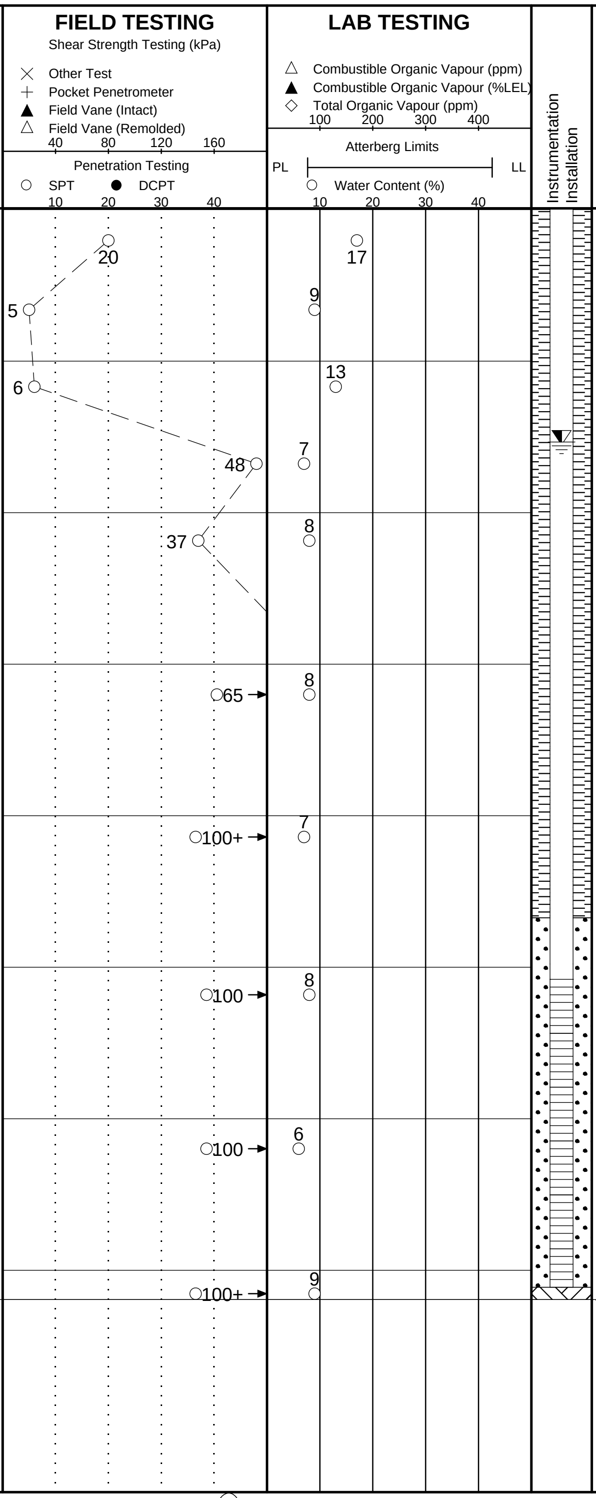
Project Number: **2200334**
Project Client: **Barrie Yonge Development GP Inc.**
Project Name: **427 - 437 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **CME 85, Buggy**
Logged By: **SP**
Reviewed By: **AB**
Northing: **4913329**
Easting: **606712**
Date Started: **Feb 1/22**
Date Completed: **Feb 1/22**

LITHOLOGY PROFILE / SOIL SAMPLING

Depth (m)	Geodetic Elevation (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL	COMMENTS
0.0	255.1											
0.2	255.0	TOPSOIL: 150 mm										
		EARTH FILL: Silt & sand, trace organics, dark brown, moist, compact	SS	1	100	20	17					
		- - - Trace gravel, loose - - -	SS	2	100	5	9					
1.7	253.4	SILTY SAND to SAND & SILT GIACIAL TILL: Trace to some gravel, trace to some clay, brown, moist to wet, loose	SS	3	75	6	13					
		- - - Moist, dense - - -	SS	4	100	48	7					
			SS	5	100	37	8					
		- - - Very dense - - -	SS	6	100	65	8					
			SS	7	100	100+	7					
		- - - Grey - - -	SS	8	100	100	8					
			SS	9	100	100	6	6	47	37	10	
10.8	244.3		SS	10	65	100+	9					Spoon bouncing
		Borehole Terminated at 10.8 m										

FIELD TESTING / LAB TESTING



Groundwater depth encountered on completion of drilling:

Groundwater depth observed on: Feb 18/22 at depth of: 2.3 m. Groundwater Elevation: 252.8 m

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Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

RECORD OF BOREHOLE No. 103

GEI Consultants

Project Number: **2200334**

Project Client: **Barrie Yonge Development GP Inc.**

Project Name: **427 - 437 Yonge Street**

Project Location: **Barrie, Ontario**

Drilling Location: **See Borehole Location Plan**

Local Benchmark:

Drilling Method: **Solid Stem Augers**

Drilling Machine: **CME 85, Buggy**

Logged By: **SP**

Reviewed By: **AB**

Northing: **4913343**

Easting: **606762**

Date Started: **Feb 1/22**

Date Completed: **Feb 1/22**

LITHOLOGY PROFILE — DESCRIPTION — Geodetic 0.0 / 253.9

Depth (m)	Elevation (m)	Description
0.0	253.9	TOPSOIL: 450 mm
0.5	253.4	SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some gravel, trace to some clay, brown, moist, compact - - - Occasional cobble - - - - - - Dense - - - - - - Very dense - - - - - - Grey - - -
10.8	243.1	Borehole Terminated at 10.8 m

SOIL SAMPLING / FIELD TESTING / LAB TESTING / COMMENTS & GRAIN SIZE DISTRIBUTION (%)

FIELD TESTING legend: 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 legend: △ 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

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	Comments	GR	SA	SI	CL
SS	1	100	3	26					
SS	2	100	22	8					
SS	3	65	26	8					
SS	4	90	24	10	Auger grinding to 3.1 m				
SS	5	100	42	7		3	56	33	8
SS	6	100	53	7					
SS	7	100	100	9					
SS	8	100	86	7					
SS	9	100	100	10					
SS	10	85	100	8					

DEPTH (m): 0, 1.5, 3, 4.5, 6, 7.5, 9, 10.5

ELEVATION (m): 253.5, 252, 250.5, 249, 247.5, 246, 244.5

Instrumentation Installation

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Groundwater depth encountered on completion of drilling: C

Groundwater depth observed on: Feb 18/22 at depth of: 1.6 m. Groundwater Elevation: 252.3 m

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

RECORD OF BOREHOLE No. 104

Project Number: **2200334**
Project Client: **Barrie Yonge Development GP Inc.**
Project Name: **427 - 437 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **CME 85, Buggy**
Logged By: **SP**
Northing: **4913289**
Date Started: **Feb 2/22**
Reviewed By: **AB**
Easting: **606746**
Date Completed: **Feb 2/22**

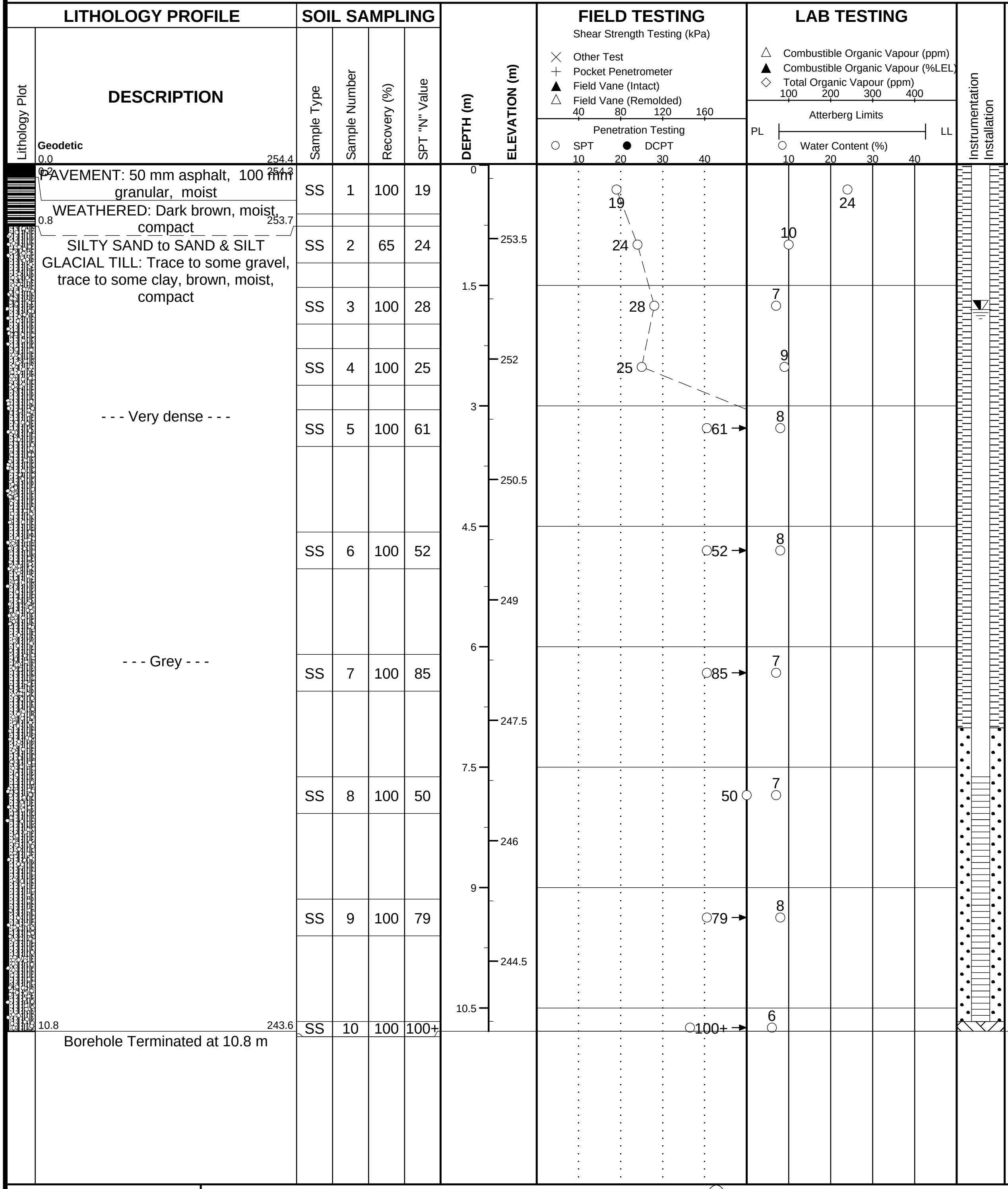
LITHOLOGY PROFILE

Geodetic

Depth (m)	Elevation (m)	Description
0.0	254.4	
0.2	254.3	PAVEMENT: 50 mm asphalt, 100 mm granular, moist
0.8	253.7	WEATHERED: Dark brown, moist, compact
		SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some gravel, trace to some clay, brown, moist, compact
		- - - Very dense - - -
		- - - Grey - - -
10.8	243.6	Borehole Terminated at 10.8 m

SOIL SAMPLING / FIELD TESTING / LAB TESTING

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
SS	1	100	19	24				
SS	2	65	24	10				
SS	3	100	28	7				
SS	4	100	25	9				
SS	5	100	61	8				
SS	6	100	52	8				
SS	7	100	85	7				
SS	8	100	50	7	7	53	31	9
SS	9	100	79	8				
SS	10	100	100+	6				



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

Groundwater depth encountered on completion of drilling: C

Groundwater depth observed on: Feb 18/22 at depth of: 1.8 m. Groundwater Elevation: 252.6 m

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Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

RECORD OF BOREHOLE No. 105

GEI Consultants

Project Number: **2200334**

Project Client: **Barrie Yonge Development GP Inc.**

Project Name: **427 - 437 Yonge Street**

Project Location: **Barrie, Ontario**

Drilling Location: **See Borehole Location Plan**

Local Benchmark:

Drilling Method: **Solid Stem Augers**

Drilling Machine: **CME 85, Buggy**

Logged By: **SP**

Reviewed By: **AB**

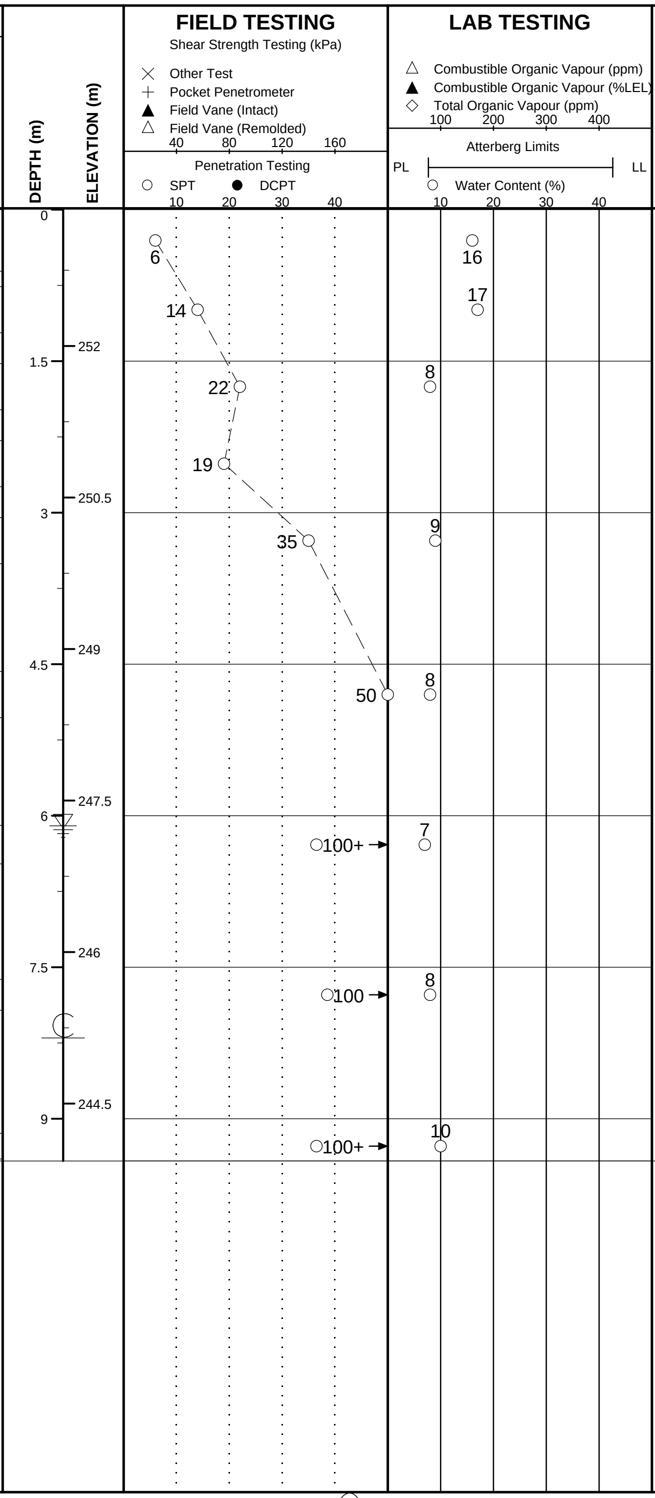
Northing: **4913308**

Easting: **606785**

Date Started: **Feb 2/22**

Date Completed: **Feb 2/22**

LITHOLOGY PROFILE DESCRIPTION Geodetic 0.0 / 253.4	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	GR	SA	SI	CL
TOPSOIL: 20 mm WEATHERED: Trace rootlets, brown, moist, loose	SS	1	100	6				
0.9 / 252.4 SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some gravel, trace to some clay, brown, moist, compact	SS	2	100	14				
	SS	3	100	22				
	SS	4	100	19				
- - - Dense - - -	SS	5	100	35				
- - - Grey, very dense - - -	SS	6	100	50	4	45	40	11
	SS	7	100	100+				
	SS	8	85	100				
9.4 / 243.9	SS	9	100	100+				
Borehole Terminated at 9.4 m Upon Auger Refusal								



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Groundwater depth encountered on completion of drilling: 6.1 m.

Cave depth after auger removal: 8.2 m.

Groundwater depth observed on:

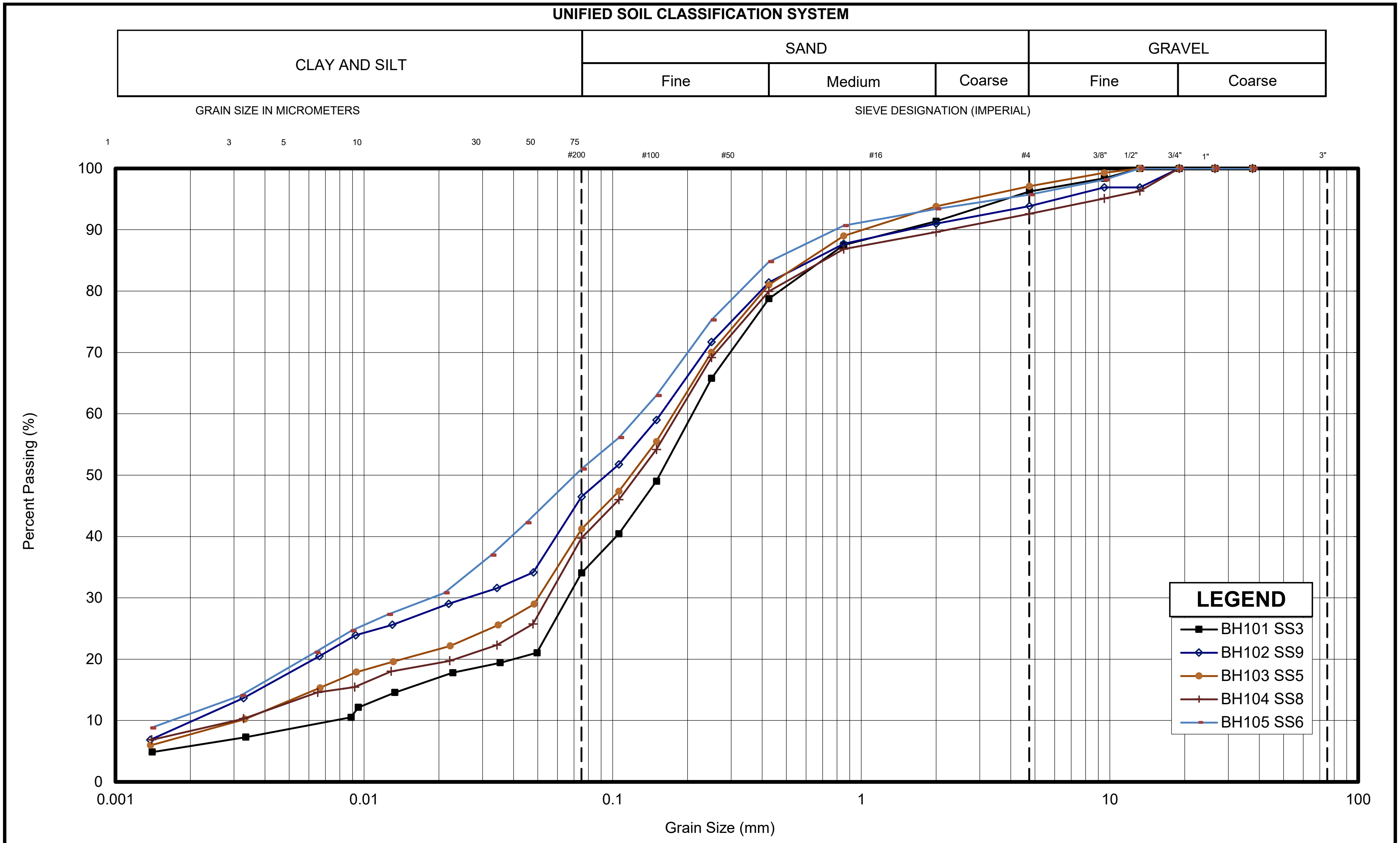
Groundwater Elevation:

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

Appendix B

Geotechnical Laboratory Testing



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH101 SS3	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel	4	62	28	6	0.008	0.066	0.210	26.3	2.6
BH102 SS9	SAND AND SILT GLACIAL TILL, Some Clay, Trace Gravel	6	47	37	10	0.002	0.026	0.156	78.0	2.2
BH103 SS5	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel	3	56	33	8	0.003	0.050	0.176	58.7	4.7
BH104 SS8	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel	7	53	31	9	0.003	0.055	0.183	61.0	5.5
BH105 SS6	SAND AND SILT GLACIAL TILL, Some Clay, Trace Gravel	4	45	40	11	0.002	0.019	0.129	64.5	1.4

GEI Consultants

GRAIN SIZE DISTRIBUTION - 427 to 437 Yonge Street, Barrie

Silty Sand to Sand and Silt Glacial Till

FIGURE No. BH 101-105 Graph
REF. No. 2200334
DATE April 2022