Consulting
Engineers and
Scientists

Preliminary Geotechnical Investigation

Proposed Residential and Commercial Development

664, 674 & 692 Essa Road & 320 Mapleview Drive West,
Barrie, Ontario

Submitted to:
Pearl Builders

Submitted by:
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Executive Summary

GEI Consultants Ltd. (GEI) was retained by Pearl Builders to complete a geotechnical investigation and report for the proposed residential and commercial development at 664, 674 & 692 Essa Road and 320 Mapleview Drive West, in Barrie, Ontario.

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

- "*Mapleview, Barrie*", Dwg. 01, by IBI Group, dated Oct. 20, 2022.
- "*Preliminary Grading Plan, Mapleview Essa Development, City of Barrie*", File No. 422433, Dwg. GP-1, dated October 2020, by Tatham Engineering.

Based on both GEI's review of these drawings and our correspondence, it is understood that the development is conceptualized to include:

- Townhouse blocks within the northern half of the combined properties and will be interconnected by internal roadways. Over half of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 0 to 2 metres of grade raise will be required in this area.
- The drainage channel will be re-aligned as an up to 50-metre-wide drainage easement that will run from east to west near the centre of the site.
- The southern quarter of the combined properties will contain 4 mid-rise apartment buildings ranging in height between 6 to 12 stories. The majority of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 2 to 3 metres of grade raise will be required in this area.

Key recommendations and conclusion are discussed below. The executive summary must not be relied upon for design parameters and recommendations. The full report must be reviewed for design purposes. If there is a discrepancy between the executive summary and the full report, the full report must be followed. At the time of the original subsurface investigation, only one (1) shallow underground parking level was proposed for the buildings at the site and GEI advanced boreholes across the site accordingly. As this is no longer the case, additional deeper boreholes must be advanced by GEI under a separate scope of work to confirm the preliminary engineering recommendations for the deeper underground levels that are provided in this report.

- Fifteen (15) boreholes were advanced across the site and typically encountered 0.8 to 2.3 metres of earth fill overlying silty sand to sandy silt glacial till. Cohesionless deposits of sands and silts were typically encountered underlying the glacial till. The native soils were mostly dense to very dense below depths of 1.5 to 4.0 metres below grade.
- GEI used eleven (11) existing monitoring wells on site installed previously by a different consultant to determine that the high groundwater table measured on April 1, 2020 was located at Elev. 304.4 to 304.9 metres (about 0.7 to 3.9 metres below existing grade).
- Foundations for all proposed structures (townhouses, mid-rise residential buildings, commercial buildings, etc.) are recommended to be supported by conventional spread footing foundations. Deep foundations are not expected to be required.
  - Spread footings made at depths of approximately 0.8 to 1.5 metres below grade can be designed using 100 kPa at SLS and 150 kPa at ULS. If the spread footings extend to depths of

    approximately 1.5 to 4.0 metres below grade, they can be designed using 225 kPa at SLS and 325 kPa at ULS.
    - For preliminary design purposes, it is expected that spread footings made at depths of 6 metres or more below grade for deeper levels of underground parking can be designed using 300 kPa at SLS and 450 kPa at ULS. Final design recommendations can only be provided once deeper boreholes are advanced across the site.
    - The foundation excavation must be done in such a way that groundwater is controlled to prevent any disturbance to the foundation base.
- The Site Classification for Seismic Site Response is “D” for this site.
- The modulus of subgrade reaction appropriate for design of a slab-on-grade on the compacted earth fill or undisturbed compact native soils is 30,000 kPa/m. For deeper underground parking levels, the slab will likely be made on generally dense to very dense or hard native soils, and the modulus of subgrade reaction is 50,000 kPa/m. This must be confirmed by advancing deeper boreholes on site.
- Perimeter and subfloor drainage will be required for all buildings with underground parking or basement levels. Permanent dewatering will be required, or the structures could be designed to be fully waterproofed (full waterproofing is likely required based on more recent requirements from the City of Barrie).
- The site soils will provide adequate support for pipes and bedding of new services. Trench plugs may be required every 50 metres along the length of the pipes if the invert of the trench is below the groundwater table.
- A light duty pavement structure is provided for private roads and parking lots that will primarily service small vehicle traffic. A heavy-duty pavement structure is also provided for designated fire routes, roads and parking lots that will service trucks and buses, or roadways that will be assumed by the City of Barrie.
- For excavations, the soils on site are Type 3 Soils above the groundwater table or when dewatered and are Type 4 Soils within the groundwater table.
- Excavations for deeper levels of underground parking will extend below the groundwater table. The earth fill, glacial till and other cohesionless soil deposits are relatively permeable such that they will allow for the free flow of water when wet. Additional details pertaining to basement drainage and groundwater control are provided in the hydrogeological study by GEI under a separate cover.
- 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.

1 Introduction

GEI Consultants Ltd. (GEI) was retained by Pearl Builders to complete a preliminary geotechnical investigation and report for the proposed residential and commercial development at 664, 674 & 692 Essa Road and 320 Mapleview Drive West, in Barrie, Ontario. A site location plan is provided as Figure 1. The site is irregular in shape and consists of the four parcels of land with a total area of approximately 10.2 hectares. The overall length is about 315 metres in length (north to south) and 240 to 425 metres in width (east to west). The site is currently vegetated with low-lying grasses, farmland and a few trees, and is developed with a gravel parking area and two residential dwellings with driveways, sheds, and garages. The site is relatively flat with minor changes in topographic relief, but the northern half of the site is generally 1 to 2 metres higher in elevation (near Elev. 308 metres) than the southern half of the site (near Elev. 306 metres). A constructed drainage channel (Bear Creek) runs from east to west through the site, about 90 metres north of Mapleview Drive West. An aerial image of the site from 2018 is provided as Figure 2A.

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

- "*Mapleview, Barrie*", Dwg. 01, by IBI Group, dated Oct. 20, 2022.
- "*Preliminary Grading Plan, Mapleview Essa Development, City of Barrie*", File No. 422433, Dwg. GP-1, dated October 2020, by Tatham Engineering.

Based on both GEI's review of these drawings and our correspondence, it is understood that the development is conceptualized to include:

- Townhouse blocks within the northern half of the combined properties and will be interconnected by internal roadways. Over half of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 0 to 2 metres of grade raise will be required in this area.
- The drainage channel will be re-aligned as an up to 50-metre-wide drainage easement that will run from east to west near the centre of the site.
- The southern quarter of the combined properties will contain 4 mid-rise apartment buildings ranging in height between 6 to 12 stories. The majority of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 2 to 3 metres of grade raise will be required in this area.

The purpose of the geotechnical investigation was to assess the subsurface conditions at the site by advancing twelve (12) exploratory boreholes to provide geotechnical engineering recommendations in support of the proposed development. There were eleven (11) existing monitoring wells located on the site by other consultants that were incorporated into the investigation and report. This report summarizes the borehole findings, provides design recommendations for foundations, slabs on grade, earth pressures, site servicing, and pavements, and provides considerations for constructability such as soil excavation, compaction, and temporary groundwater control. GEI has also been retained to complete a hydrogeological study for the site, which is provided under a separate cover.

At the time of the original subsurface investigation, only one (1) shallow underground parking level was proposed for the buildings at the site and GEI advanced boreholes across the site accordingly. As this is no longer the case, additional deeper boreholes must be advanced by GEI under a separate scope of work to confirm the preliminary engineering recommendations for the deeper underground levels that are provided in this report.

2 Procedures and Methodology

Prior to the commencement of drilling activities, the locations of underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies. The fieldwork for the drilling program was carried out on March 3 to 5, 2020. A total of fifteen boreholes (Borehole 1 to 15) were advanced on site by Drilltech Drilling using a track-mounted drill rig. To advance the boreholes, continuous flight solid stem augers and standard soil sampling equipment was utilized. All samples were collected as per ASTM D1586 to assess the strength characteristics of the substrate.

The GEI boreholes were advanced to depths of 6.2 to 6.6 metres below existing grade. The horizontal locations were laid out in the field by GEI prior to the drilling operations and the locations are shown on Figure 2. Ground surface elevations of the boreholes were measured using survey equipment in reference to a geodetic benchmark (a fire hydrant and a monitoring well casing) with known geodetic elevations. GPS measurements measured with a handheld GPS unit and referenced to the NAD 83 geodetic datum.

The 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 construction, and processed the recovered samples. Soil sampling was conducted at regular intervals for the full depth of the borehole. The boreholes were backfilled upon completion. All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their visual and textural characteristics and geotechnical laboratory testing was carried out with the results included in Appendix B.

There are eleven (11) existing monitoring wells (shown on Figure 2) installed previously at the site by other consultants. It is unknown who installed the wells, when they were installed, or for what purpose. Borehole logs, monitoring well information or previous reports for the site are not available from the client. GEI reviewed the MECP Well Records database but no detailed information about wells were available. GEI measured the diameter, stick-up, depth of well, and depth of water for each well during the geotechnical investigation to ascertain the approximate well construction and water levels. The GEI boreholes were generally advanced in close proximity to the existing wells such that the screened strata can be inferred. The screen lengths are inferred to be 1.5 metres.

GEI did not observe the installation of the monitoring wells, but it is expected that they were installed by a licenced well driller and therefore were installed following typical drilling practices for the method of drilling, sand pack, bentonite seal, etc. Less stringent controls are needed for geotechnical studies compared to environmental studies, so using the existing wells is suitable to determine water table measurements for this geotechnical report.

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 C. The borehole locations are shown on Figure

2 and detailed subsurface profiles for the northern, eastern, southern and western areas of the site are provided as Figures 3A to 3D.

It should be noted that the conditions indicated on the borehole logs and subsurface profiles are for specific locations only and can vary between and beyond the borehole 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.

As discussed in Section 2.0, GEI measured the diameter, stick-up, depth of well, and depth of water in each existing well on site during the geotechnical investigation to ascertain the approximate well construction and water levels. The GEI boreholes were generally advanced in close proximity to the existing wells such that the screened strata can be inferred, and the wells are shown on the nearest GEI borehole log for illustrative context.

3.2 Stratigraphy

3.2.1 Topsoil and Earth Fill

Boreholes 1 to 11 and 13 to 15 encountered a topsoil layer at the ground surface that ranged in thickness from 180 to 610 mm (280 mm on average).

Earth fill was encountered underlying the topsoil layer in Boreholes 1 to 7, 9 to 11, and 13 to 15, and at the ground surface in Borehole 12. The earth fill extended to depths of 0.8 to 2.3 metres below grade (Elev. 307.1 to 303.3 metres) and was generally brown to dark brown and moist. The earth fill ranged in consistency from silty sand, to sandy silt, to sand and silt with variable amounts of clay and gravel. Trace rootlets were also encountered within the earth fill in some boreholes. The Standard Penetration Test (SPT) results (“N” Values) measured in the earth fill ranged from 2 to 14 blows per 300 mm of penetration, indicating a very loose to compact (but generally loose) relative density.

3.2.2 Native Soils

Native soils were encountered underlying the earth fill in Boreholes 1 to 7 and 9 to 15 and underlying the topsoil in Borehole 8. The native soils were encountered at depths of 0.6 to 2.3 metres below grade (Elev. 307.1 to 303.3 metres and extended beyond the vertical depth of investigation at depths of 6.2 to 6.6 metres below grade (Elev. 301.9 to 298.5 metres). In general, the native soil below the site consists of glacial till underlain by cohesionless deposits with some interbedded layers of clay and silt. The glacial till was also interbedded with sands and silts in some boreholes.

The glacial till has a cohesionless matrix consisting of silty sand, to sandy silt, to sand and silt, with trace to some clay and trace gravel. The glacial till is brown and moist, becoming wet with depth. The till deposit is generally thicker in the northern part of the site compared to the southern part of site. The other cohesionless deposits typically encountered underlying the upper glacial till ranged in consistency from silty sand, to sandy silt, to sand and silt, to sand, to gravelly sand. These cohesionless deposits are generally brown and wet, turning grey with depth. Some deposits of grey and moist silt and clay to clayey silt with trace sand and frequent silt partings were encountered interbedded in Boreholes 3 to 6, 9 and 10.

The Standard Penetration Test (SPT) results ("N" Values) measured in the glacial till and cohesionless deposits ranged from 4 to greater than 50 blows per 300 mm of penetration, indicating a loose to very dense relative density. At or below a depth of approximately 1.5 to 4.0 metres below existing grade, these deposits are generally uniformly compact to dense. The SPT "N" Values measured in the clay and silt to clayey silt deposits were greater than 30 blows per 300 mm of penetration, indicating a hard consistency.

3.3 Groundwater

Unstabilized groundwater level measurements and cave measurements were taken upon completion of drilling of each borehole. These measurements provide a rough estimate of the possible excavation and temporary ground water control constructability considerations that may arise. Unstabilized water levels were measured at depths of 1.8 to 5.5 metres below grade, and the boreholes remained open or caved to a depth of 2.1 metres below grade.

There are eleven (11) existing monitoring wells installed previously at the site by other consultants as shown on Figure 2. It is unknown who installed the wells, when they were installed, or for what purpose. Borehole logs, monitoring well information or previous reports for the site are not available from the client. GEI measured the diameter, stick-up, depth of well, and depth of water for each existing well during the geotechnical investigation to ascertain the approximate well construction and water levels. Existing monitoring wells 1 to 4 and 7 were 32 mm in diameter and wells 5, 6, and 8 to 11 were 50 mm in diameter. The screen lengths are inferred to be 1.5 metres.

GEI advanced boreholes in proximity to the existing monitoring wells on site so that the existing monitoring wells could be transposed onto the GEI borehole logs as shown in Appendix A. To summarize the approach taken:

- The top of pipe of the existing monitoring wells were surveyed to centimeter accuracy relative to a geodetic elevation. Therefore, all measurements of the groundwater elevations taken in those wells are also accurate to centimeter accuracy.
- The ground surface elevation at the existing monitoring wells were not surveyed. The rationale behind this was that the elevation of the groundwater table is primarily what matters, not depth below grade, especially when no stratigraphic information is available.
- To provide context to the depth of the water level relative to existing grade, the elevation of the water level in the monitoring wells was projected onto the nearest GEI borehole advanced and shown on the borehole log to provide visual context and give a sense of the general depth that groundwater exists below grade. The purpose of showing the wells on the boreholes was also important to understand what stratigraphic unit the existing well screen was likely located in.

The groundwater measurements are summarized in the table below and were measured over a 4-month period during Spring of 2020 to determine the seasonally high level. The following assumptions were made when transposing the existing monitoring well information onto the GEI logs:

- The geodetic elevations for groundwater, screen depth and base of well are based off the measurements at the existing monitoring well locations.
- The depth below grade shown is based off the projection of the elevations at the monitoring well location to the closest borehole location. The depth measurements are not reflective of the actual monitoring well

locations, but are used to provide context to the general depth below grade and what stratigraphic unit the wells were screened in.

Monitoring Well and Nearby GEI Borehole	Inferred Well Screen Location		Inferred Strata Screened	Depth / Elevation (m) of Groundwater Table			
	Depth (m)	Elevation (m)		March 5, 2020	April 1, 2020	May 5, 2020	June 4, 2020
MW1 (BH2)	5.7 to 7.2	302.2 to 300.7	Silty Sand	3.89 / 303.92	**3.11 / 304.70**	3.55 / 304.26	3.68 / 304.13
MW2 (BH3)	5.7 to 7.2	302.2 to 300.7	Silty Sand to Sandy Silt	3.84 / 304.04	**3.21 / 304.67**	3.49 / 304.39	3.66 / 304.22
MW3 (BH1)	5.8 to 7.3	301.5 to 300.0	Silty Sand	3.48 / 303.79	**2.61 / 304.66**	3.11 / 304.16	3.22 / 304.05
MW4 (BH7)	4.6 to 6.1	300.0 to 301.5	Silty Sand Glacial Till	3.57 / 303.99	**2.67 / 304.89**	3.24 / 304.32	3.37 / 304.19
MW5 (BH5)	9.4 to 10.9	298.4 to 296.9	Unknown*	3.82 / 304.01	**3.03 / 304.80**	3.48 / 304.35	3.62 / 304.21
MW6 (BH4)	9.4 to 10.9	299.1 to 297.6	Unknown*	4.72 / 303.73	**3.85 / 304.60**	4.38 / 304.07	4.46 / 303.99
MW7 (BH6)	7.8 to 9.3	298.2 to 296.7	Unknown*	2.33 / 303.67	**1.44 / 304.56**	2.00 / 304.00	2.05 / 303.95
MW8 (BH11)	5.7 to 7.2	299.6 to 298.1	Sand, Some Silt to Silty	1.47 / 303.84	**0.68 / 304.63**	1.18 / 304.13	1.26 / 304.05
MW9 (BH13)	8.1 to 9.6	297.9 to 296.4	Unknown*	2.15 / 303.76	**1.38 / 304.53**	1.78 / 304.13	1.88 / 304.03
MW10 (BH15)	7.4 to 8.9	298.3 to 296.8	Unknown*	1.57 / 304.06	**0.91 / 304.72**	1.35 / 304.28	1.36 / 304.27
MW11 (BH9)	6.7 to 8.2	298.7 to 297.2	Unknown*	1.79 / 303.60	**1.01 / 304.38**	1.45 / 303.94	1.53 / 303.86

*Screened strata is unknown because the well screen extends below the vertical extent of the nearby GEI borehole.

Note: The seasonally high groundwater level measured in each monitoring well is in **bold**. The highest levels were measured in April 1, 2020 within each well.

Based on the results of the water levels, the seasonally high groundwater table was measured on April 1, 2020 and was located between Elev. 304.4 to 304.9 metres across the site (ranging from about 0.7 to 3.9 metres below grade). The groundwater table gently slopes down to the southwest but overall is relatively flat across the site. Based on the groundwater levels and depth of the drainage channel through the site (Bear Creek), groundwater flows into Bear Creek as baseflow (i.e. it is a “gaining” watercourse). The earth fill, glacial till and other cohesionless soil deposits are relatively permeable such that they will allow for the free flow of water when wet.

Additional details pertaining to groundwater at the site including the seasonally high groundwater level measurements are provided in the revised hydrogeological study under a separate cover.

4 Engineering Design Parameters & Analysis

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

- “*Mapleview, Barrie*”, Dwg. 01, by IBI Group, dated Oct. 20, 2022.
- “*Preliminary Grading Plan, Mapleview Essa Development, City of Barrie*”, File No. 422433, Dwg. GP-1, dated October 2020, by Tatham Engineering.

Based on both GEI's review of these drawings and our correspondence, it is understood that the development is conceptualized to include:

- Townhouse blocks within the northern half of the combined properties and will be interconnected by internal roadways. Over half of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 0 to 2 metres of grade raise will be required in this area.
- The drainage channel will be re-aligned as an up to 50-metre-wide drainage easement that will run from east to west near the centre of the site.
- The southern quarter of the combined properties will contain 4 mid-rise apartment buildings ranging in height between 6 to 12 stories. The majority of this area will be underlain by a single level of underground parking situated at approximately 8 metres below proposed grade. 2 to 3 metres of grade raise will be required in this area.

GEI originally advanced boreholes on site to depths of 6.6 metres below grade to provide recommendations for one shallow level of underground parking that was previously proposed for the site. Additional deeper boreholes will be required to be advanced by GEI under a separate scope of work to confirm the preliminary engineering recommendations for the deeper underground levels that are provided in this report that may extend of up to 8 metres below grade. Reference should be made to the sections of the Ontario Building Code which stipulate the geotechnical design and construction requirements for the type of structures being proposed at this site.

4.1 Foundation Design

The topsoil and surficial zone of earth fill encountered beneath the site are not suitable for the support of new foundations. Foundations at this site may be constructed as conventional spread and strip footing foundations that extend down to bear on the undisturbed native soil typically consisting of glacial till or cohesionless deposits of sands and silts. The native soils were encountered at depths of 0.6 to 2.3 metres below grade (Elev. 307.1 to 303.3 metres). These foundation recommendations are applicable for all residential and commercial building types being proposed for the site.

Foundations set on undisturbed native soil may be designed using the geotechnical reactions at SLS for an estimated settlement of 25 mm or less and the maximum factored geotechnical resistances at ULS as shown in the table below. These bearing capacities and elevations are applicable for detailed design and for up to one (1) level of underground parking.

Location on Site	**Depth / Elevation (m) for the Geotechnical Reactions at SLS and Geotechnical Resistances at ULS**	
	100 kPa at SLS, 150 kPa at ULS	**225 kPa at SLS, 325 kPa at ULS**
Borehole 1	n/a	1.5 / 305.8
Borehole 2	0.8* / 307.1	1.5 / 306.3
Borehole 3	n/a	1.5 / 306.4
Borehole 4	1.5 / 306.9	2.3 / 306.2
Borehole 5	1.5 / 306.3	2.3 / 305.5
Borehole 6	n/a	2.3 / 303.7
Borehole 7	0.8* / 306.8	1.5 / 206.1

Location on Site	Depth / Elevation (m) for the Geotechnical Reactions at SLS and Geotechnical Resistances at ULS	
	100 kPa at SLS, 150 kPa at ULS	225 kPa at SLS, 325 kPa at ULS
Borehole 8	0.6* / 305.1	1.5 / 304.1
Borehole 9	0.8* / 304.6	4.0 / 301.4
Borehole 10	1.5 / 303.5	2.3 / 302.8
Borehole 11	0.8* / 304.6	1.5 / 303.8
Borehole 12	0.8* / 305.1	2.3 / 303.6
Borehole 13	0.8* / 305.2	1.5 / 304.4
Borehole 14	0.8* / 305.2	3.0 / 303.0
Borehole 15	n/a	2.3 / 303.3

*Foundations must have a minimum of 1.2 metres of soil cover or equivalent insulation to protect against frost effects.

For preliminary design purposes to accommodate deeper underground parking levels, conventional spread and strip footing foundations made at or below a depth of 6 metres below existing grade can be designed using a geotechnical reaction at SLS of 300 kPa, for an estimated settlement of 25 mm or less. The maximum factored geotechnical resistance at ULS is 450 kPa. These bearing capacities are preliminary only and are based on the assumption that conditions encountered at the bottom of the boreholes remain consistent or improve with depth. It is expected that shallow foundations will be suitable for the support of all proposed structures at the site and deep foundations are likely not required. Final design recommendations can only be provided once deeper boreholes are advanced across the site. Depending on the deeper borehole findings, certain borehole locations may require a reduction in bearing capacity or may have an increased bearing capacity available.

It is important to note that these bearing capacities are applicable for foundations set onto undisturbed native soils, which were encountered up to 2.3 metres below current grades in the general locations of proposed structures. If the grade is raised prior to foundation construction, the foundations must be extended through any new grade raise in addition to the required depth to reach the competent bearing elevation.

The minimum strip and spread footing widths to be used for the townhouses shall be dictated as per the Ontario Building Code, and shall be 0.6 metres for strip footings and 1 by 1 metres for spread footings for the apartment buildings, 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 1.2 metres of earth cover or equivalent insulation for frost protection.

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 is discussed in Section 5.2.

The foundation subgrade must be reviewed prior to concrete placement to ensure the below foundation design parameters 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 (after inspection by the geotechnical engineer), to ensure that no deterioration will occur due to weather effects.

4.2 Seismic Site Classification

Section 4.1.8.4 of the Ontario Building Code provides values of the acceleration and velocity-based site coefficients (F_a and F_v) for various time periods, associated with specific Site Classes. These Site Classes are based on the energy-corrected Average Standard Penetration Resistance values and undrained shear strength within the upper 30 metres of soil underlying the grade beams or foundations of the proposed structure. As the boreholes were advanced less than this depth at the site, the site classification recommendation provided below assumes that the soil conditions are similar below the drilled depth.

Underneath the proposed foundations, the subsoil will consist of generally compact to dense glacial till and cohesionless soils. Based on this, the Site Classification for Seismic Site Response is “D” for this site. An improved Site Classification (e.g. “C”) may be obtained for buildings with deeper underground parking levels since the foundations will bear on soil deposits that are typically dense to very dense with depth, but this must be confirmed by advancing deeper boreholes on site.

4.3 Earth Pressures

Underground levels, basements, retaining walls, cantilevered shoring walls and shoring walls with a single level of earth anchors all 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 1010)	21.0	32	0.31	0.47	3.25
Earth Fill	19.0	30	0.33	0.50	3.00

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**
Loose Native Soils					
Compact to Dense Native Soils	20.0	36	0.26	0.41	3.85
Very Dense Native Soils	21.0	40	0.22	0.36	4.60

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 must be increased 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 Slab-on-Grade Design

The topsoil and any existing earth fill containing excessive deleterious materials and organics are not suitable for the support of a slab on grade. Undisturbed native soils or proof-rolled and approved earth fill are 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. The modulus of subgrade reaction appropriate for design of a slab-on-grade on the compacted earth fill or undisturbed compact native soils is 30,000 kPa/m. For deeper underground parking levels, the slab will likely be made on generally dense to very dense or hard native soils, and the modulus of subgrade reaction is 50,000 kPa/m. This must be confirmed by advancing deeper boreholes on site.

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 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.

4.5 Basement Drainage Design

For 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 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 compacted relatively impervious soil material (such as the clayey silt till or clay and silt from the site).

Where basements are constructed, 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 1 (OPSS 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.

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 the underfloor drainage layer with water. The basement slab should also be provided with subfloor 100 mm diameter perforated pipes, trenched 0.3 metres below the slab granular base material and covered with 19 mm clear stone. One run of subfloor pipe is recommended for the townhouse units and runs with 6 metre on-centre spacing is recommended for larger buildings. 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.

In conditions where there is a high groundwater level and relatively permeable soils coupled with a basement level as part of the proposed building design, it is common practice to set the basement level a minimum of 0.5 metres above the seasonally high groundwater level. If the basement level is set near or within the prevailing groundwater level, it is possible that perimeter drainage issues may occur in the future (e.g. sump pump failure, blockage of drainage pipes, etc.), which would lead to potential foundation cracking and basement flooding. Basements can be set below the groundwater table provided these risks are fully acknowledged and all obligations set by the governing bodies in the jurisdiction are met which stipulate minimum clearance distances between basement slab elevation and seasonal high groundwater table.

Alternatively, basement levels made below the groundwater table could be fully waterproofed and designed to resist hydrostatic pressure, in which case permanent dewatering would not be required. It is noted that in recent years, the City of Barrie typically does not allow permanent dewatering and a fully waterproofed system will likely be required for any underground levels within the groundwater table.

Additional groundwater considerations are provided in the revised hydrogeological study and the seasonally high groundwater levels determined through the monthly monitoring are also included in the revised hydrogeological study.

4.6 Site Servicing

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 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.

A subgrade consisting of earth fill or the native soils 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., the disturbed soils 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.

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 only if it is fully wrapped in a non-woven filter fabric to prevent the migration of fines and loss of pipe support.

4.6.2 Backfill

Excavated native soils and earth fill may be used as backfill in trenches provided the moisture content is within 2% of optimum. 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 roadway, backfill within the frost penetration depth of 1.2 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 fill was used to backfill the trenches which is less susceptible to frost compared to most of the existing soils at the site with higher silt content. Alternatively, if different soil is used as the backfill due to issues with achieving compaction, a frost taper of 3H:1V can be implemented to help mitigate the potential for differential settlement and frost heave.

4.6.3 Trench Plugs

It is expected that sections of the site servicing will be installed within the prevailing groundwater table, especially in the southern portion of the site. Trench plugs are typically incorporated into trenches for the following reasons:

- To prevent the “French Drain” effect of the granular bedding and backfill material lowering the surrounding groundwater table (either due to a high groundwater gradient or if the trench would connect into a positive drainage outlet which would drain water quickly).

- To prevent erosion/movement of soil within a steep trench or high groundwater flows which can cause piping erosion and potential loss in support of pipes.
- To mitigate the movement of contaminants through a preferential drainage path

If the invert of the trench is below the water table and some or all of the reasons provided apply, then trench plugs can be installed within the granular bedding and the granular zones of backfill material.

Trench plugs are recommended every 50 metres along the length of the pipes. Clay plug seals should be a minimum of 1 metre thick parallel to the pipe direction. The clay plugs should be keyed into the surrounding native soil and should extend across the full width and height the of pipe bedding and cover material. Material used for the clay plugs should contain not less than 15% particles finer than 2 microns and should have a coefficient of permeability less than 10^{-9} m/s. Alternatively, lean-mix concrete or unshrinkable fill can be used to form an anti-seepage collar. Pipe joints must not be located within 1 metre of the trench plug material.

4.6.4 Horizontal Directional Drilling

It is understood that horizontal directional drilling (HDD) may be required for a sanitary sewer forcemain crossing under the drainage channel easement. The sewer invert elevation is unknown but may be installed at a depth of about 2.5 metres below the bottom of the channel. Boreholes 8 and 11 were advanced near the possible HDD area. Borehole 8 encountered silty sand glacial till from Elev. 305.1 to 304.1, underlain by wet and dense silty sand to sand with some gravel that extended beyond the vertical extent of investigation. Borehole 11 encountered silty sand glacial till from Elev. 304.6 to 302.8 metres, underlain by wet and dense gravelly sand to sand that extended beyond the vertical extent of investigation. Cobbles and boulders may be encountered within the glacial till deposit during directional drilling. The groundwater table is near Elev. 304.6 metres in the proposed area of the HDD.

The typical HDD process involves excavating shallow trenches at the proposed entry and exit points for the sewer. A directional drilling rig creates a pilot bore using a rotating and steerable drill bit along the desired bore path while continuously pumping a specific bentonite or polymer slurry through the boring to stabilize the hole, reduce friction, and carry soil cuttings to the ground surface for processing. Following completion of the pilot bore, the bore is typically backreamed using tooling with a diameter that is typically 50% larger than the outside diameter of the pipes to be installed. After reaming is completed, the full length of the pipes to be pulled through the bore are typically jointed as one length (space permitting) and then are pulled through the reamed bore without interruption. Upon completion, the borehole diameter will exceed the diameter of the installed pipe. This annular space must either be grouted, or the drilling fluid is designed to solidify and develop enough strength such that the annular gap is stabilized thereby mitigating the potential for surface settlement.

This report is not considered to be a complete baseline study for subsurface conditions in respect to HDD construction. The soils at the site do vary significantly both laterally and vertically. In the location of the existing drainage channel, there is the possibility of coarser grained soils (sands and gravels) that were not identified as part of the boreholes advanced on site, which may lead to increased hydraulic pressures. Some of the strata encountered consists of glacial till, where the possibility of cobbles and boulders exist which may impede or deflect the initial pilot hole. This must be considered during HDD construction, including the potential for re-boring of pilot holes, re-alignment or change in drilling technique.

Careful monitoring of drilling pressures during construction is required to mitigate the potential for fracking, especially at the base of the drainage channel. Since the potential for fracking cannot be fully eliminated, the contractor should prepare a detailed plan to minimize the potential for fracking and what measures are available to mitigate, contain and clean-up affected areas if it does occur. Most drilling fluids use bentonite and/or polymer additives which are not generally considered to be hazardous, however local regulations should be followed regarding disposal.

The HDD specialized contractor is responsible for carrying out the design and construction with reference to the subsurface information available within this report. Reference should also be made to OPSS 450 *“Construction Specification for Pipeline and Utility Installation in Soil by Horizontal Directional Drilling”* and their own experience and expertise when determining the appropriate HDD technique and design for this site.

4.7 Pavement Design

4.7.1 Subgrade Preparation

New roadways and parking areas will be constructed as part of the proposed residential and commercial development. It is expected that subgrade soils below a pavement structure at the site will consist of earth fill, loose to compact glacial till, or compact cohesionless deposits. These soils will be an adequate subgrade for the support of a pavement structure, provided the subgrade is proof-rolled and approved by a geotechnical engineer at the time of construction and does not contain excessive amounts of organics or deleterious materials. The topsoil is not suitable and must be removed. The pavement subgrade fill or native soil surface should be compacted to a minimum of 98% SPMDD. It is anticipated that the subgrade bearing modulus will be 25,000 kPa/m.

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.

4.7.2 Drainage

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade of 3 percent) to provide effective drainage toward subgrade drains. 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.

Continuous pavement subdrains should be provided along both sides of the roadways and parking areas and drained into respective catchbasins to facilitate drainage of the subgrade and the granular materials. The subdrain invert should be maintained at least 0.3 metres below subgrade level. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free-draining granulars. Typical pavement drainage details are included in Appendix C.

4.7.3 Pavement Structure

There are two different types of pavements that need to be designed for:

- Light Duty: Includes private roads, driveways and parking lots which will not see frequent heavy traffic loads such as buses, trucks, etc., and will be predominantly servicing small vehicles such as cars.

- Heavy Duty: Private roads which are designated fire routes, or will see frequent heavy traffic loads such as buses, trucks, etc. This pavement structure also includes all roadways which will be assumed by the City of Barrie.

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.

Pavement Layer	**Compaction Requirements**	**Minimum Component Thickness**	
		Light Duty	**Heavy Duty** **(as well as all roads to be assumed by the City)**
Surface Course Asphaltic Concrete: HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)	OPSS 310	40 mm	40 mm
Binder Course Asphaltic Concrete: HL8 (OPSS 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 II (OPSS.MUNI 1010)		300 mm	450 mm

The above heavy-duty pavement structure meets the recommended pavement minimums for a private road per the City of Barrie document, "*Transportation Design Manual, Engineering Department,"* (dated October 27, 2017). The minimum pavement design for a private road in the manual is considered adequate for this site. It is expected that most of the new roadways to be constructed at the site will be assumed by the City.

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

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.

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.

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. In order 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 assumed that open cut excavations will be made due to the space available at the site.

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 widely spaced 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 Groundwater Control

Excavations for servicing and foundations may extend below the prevailing groundwater table that was encountered at Elev. 304.4 to 304.9 metres across the site (ranging from about 0.7 to 4 metres below grade). Excavations for deeper levels of underground parking will extend below the groundwater table. The earth fill, glacial till and other cohesionless soil deposits are relatively permeable such that they will allow for the free flow of water when wet.

For excavations that extend into the prevailing groundwater table, the cohesionless soils will allow for the free flow of water when wet. Local sumps placed at the base of the excavation can typically control groundwater seepage where excavations are between 0 to no more than 0.5 metres into the prevailing groundwater table in cohesionless deposits. Sumps created with a corrugated steel pipe filled with gravel which allows the water to enter the sumps and continuously pumping the sumps until all the water stored within the cohesionless soils are drained can typically control groundwater seepage where excavations are between 0.5 to no more than 1.0 metres into the prevailing groundwater table in cohesionless deposits.

Positive methods for control of groundwater seepages may be required for deeper excavations that extend into the prevailing groundwater table in cohesionless deposits. These methods may include, although may not necessarily be limited to, lowering the groundwater table a minimum of 0.5 metres below the pipe invert or footing level prior to construction using a system such as well-points.

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.

Additional details on temporary groundwater control are provided in the hydrogeological study by GEI provided under a separate cover.

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.

All soil below the water table at this site is significantly wet of optimum and will likely not be able to be re-used as fill at the site in non-landscaped areas. Based on our review of the soil types encountered in the boreholes with associated moisture contents, the soils at this site (above the groundwater table) are considered as follows:

- Half of in-situ soil above the groundwater table: At or near optimum moisture content.
- A quarter of in-situ soil above the groundwater table: Above optimum moisture content.
- A quarter of in-situ soil above the groundwater table: Below optimum moisture content.

The zones with higher moisture content will require moisture conditioning prior to re-use in areas that require compaction. Moisture could be reduced by tilling the soil, spreading the soil out, or blending it with drier material. Soil that is dry of optimum could be blended with wetter soil or have water added prior to re-use. It must be also noted that the above percentages can change based on the time of year in which construction occurs, as the prevailing weather can have a significant effect on the moisture content of stockpiled and in-situ soil.

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 of Granular ‘B’ (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. This recommendation applies to site servicing 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. 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 townhouse foundations may be field reviewed by the geotechnical engineer as required by the municipal regulating authority.
- The subgrade for shallow commercial and apartment building foundations must be field reviewed by the geotechnical engineer as required in the OBC.
- Installation of retaining structures over 1.0 metres high and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required in the OBC.
- Part-time monitoring of the subgrade support capabilities (i.e. proof-roll), 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 (granulars 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 particular project development.

6 Limitations and Conclusion

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 Pearl Builders. 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 Consultants Ltd. 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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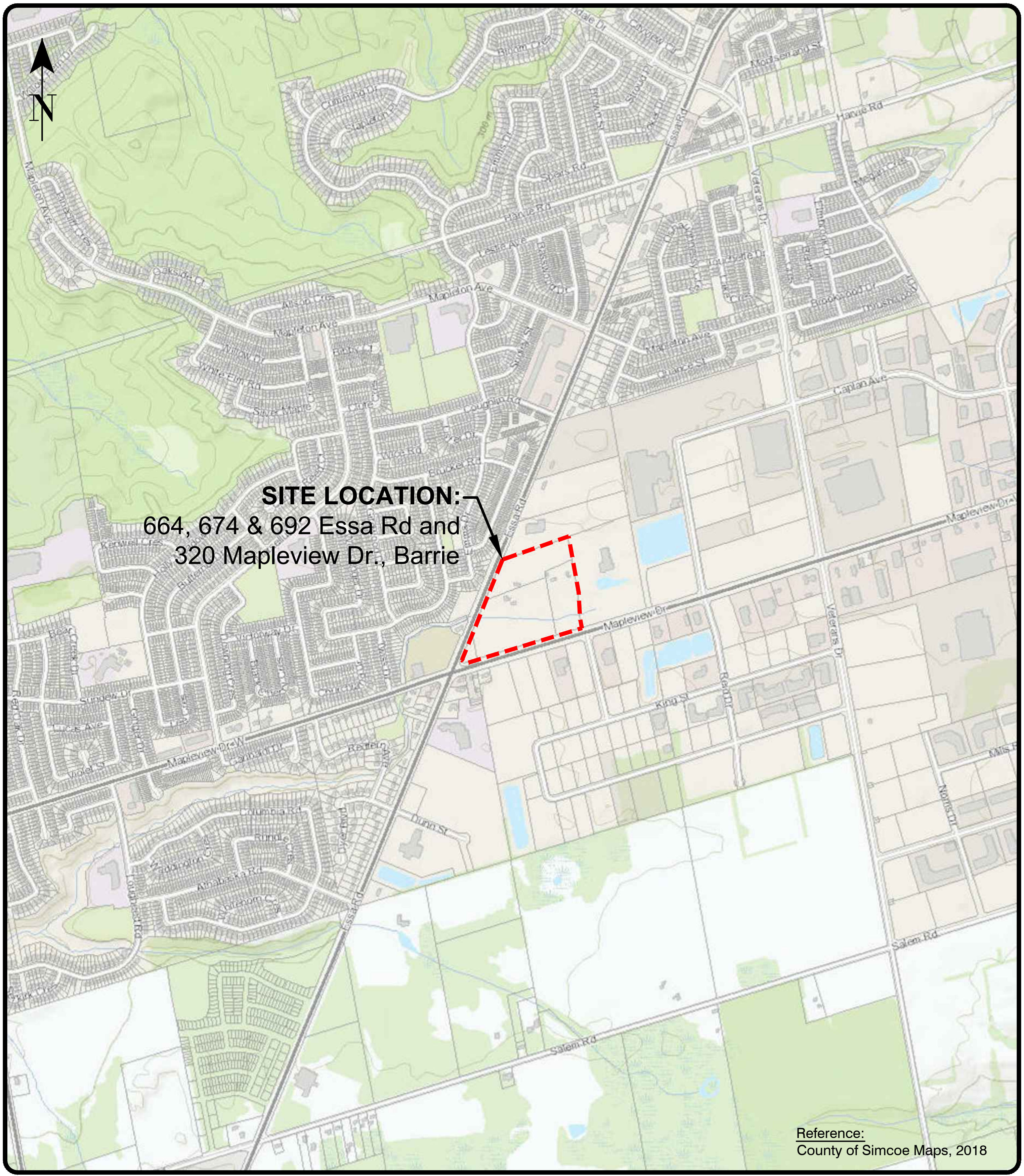
Figures –

SITE LOCATION PLAN

BOREHOLE LOCATION PLAN

SUBSURFACE PROFILES



SITE LOCATION:
664, 674 & 692 Essa Rd and
320 Mapleview Dr., Barrie

Reference:
County of Simcoe Maps, 2018

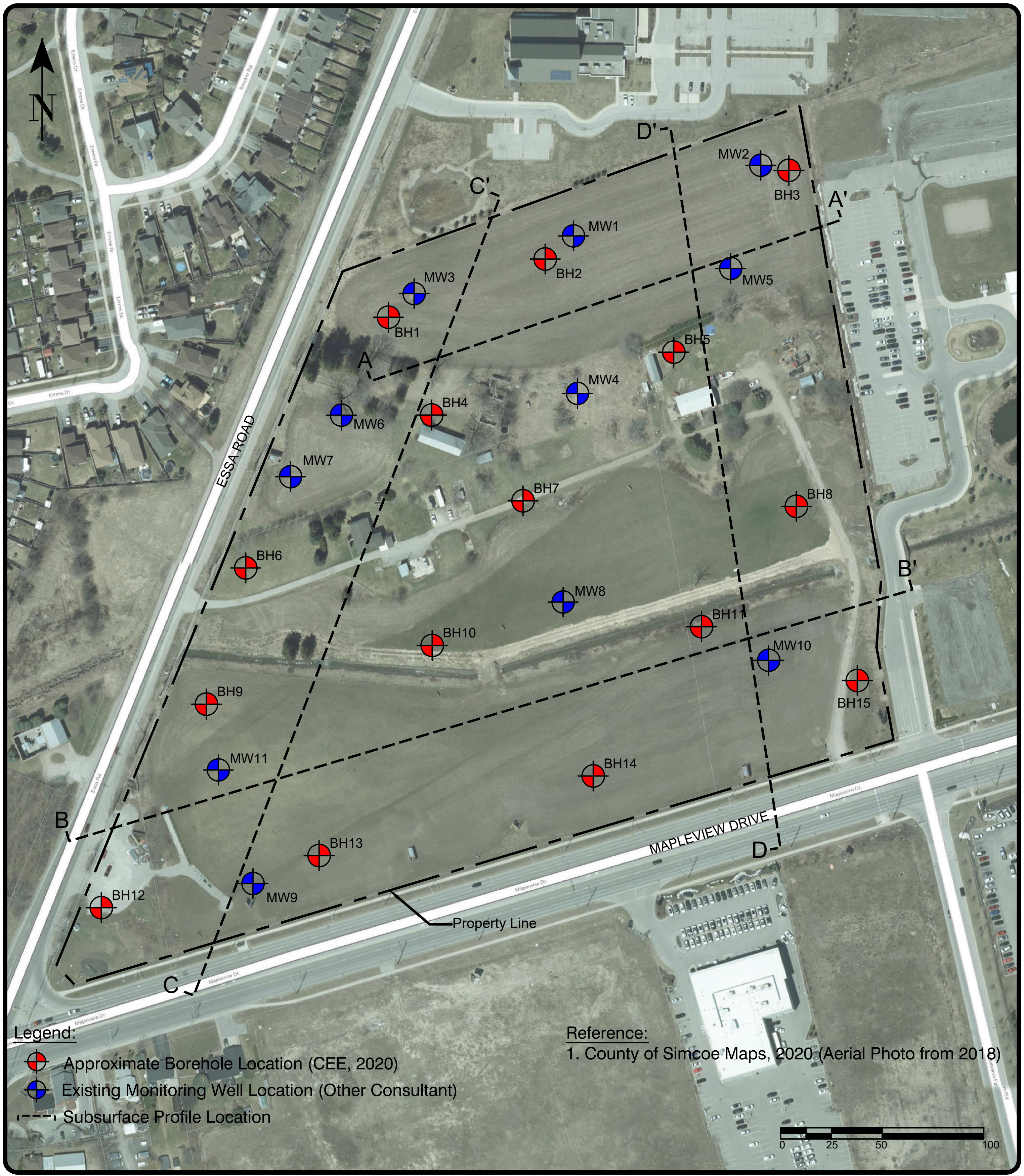
GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7
P: (705) 719-7994

Project: 664, 647 & 692 Essa Rd. & 320 Mapleview Dr., Barrie

Title: SITE LOCATION PLAN

Approved by:	A.W.	Date:	March 2020	Project No.:	20-1014A
Drawn by:	B.H.	Scale:	N.T.S.	Figure No.:	1



Legend:

🟥 Approximate Borehole Location (CEE, 2020)

🟦 Existing Monitoring Well Location (Other Consultant)

- - - Subsurface Profile Location

Reference:

1. County of Simcoe Maps, 2020 (Aerial Photo from 2018)

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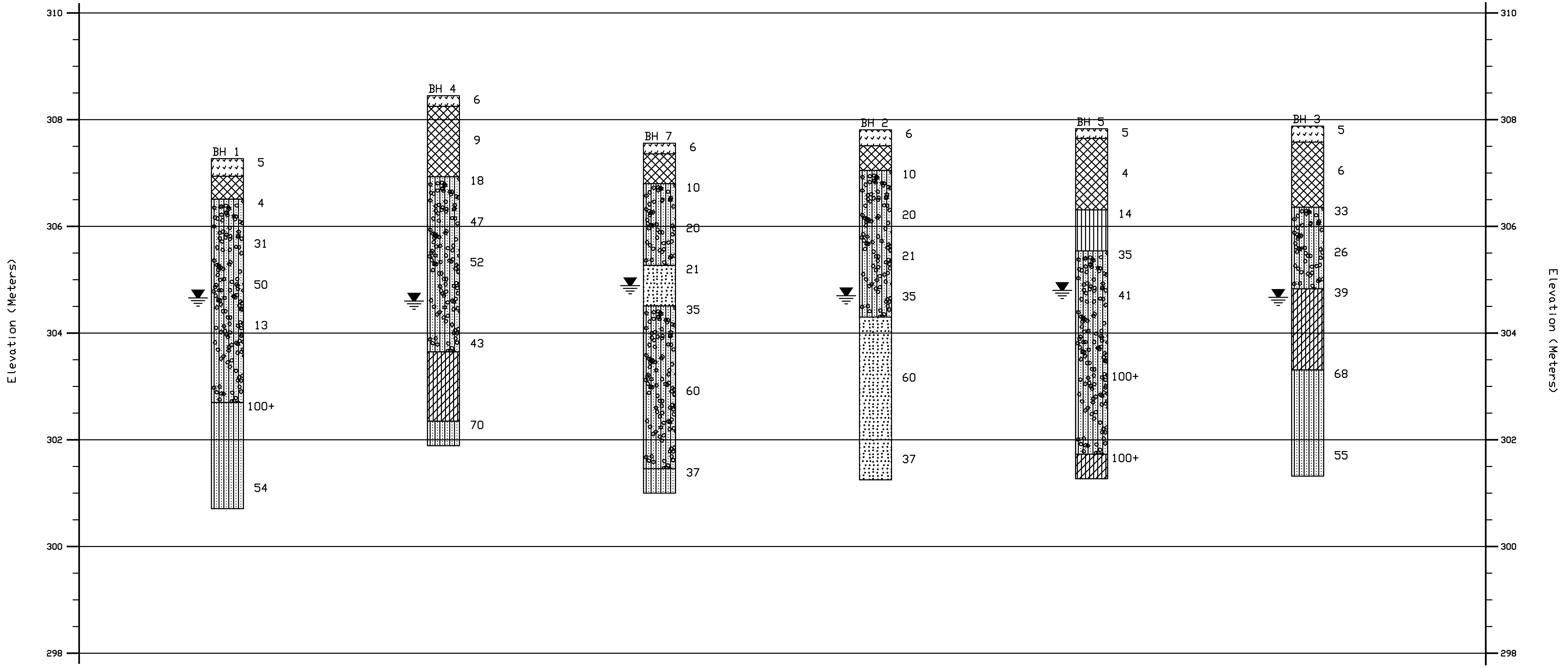
Project: 664, 647 & 692 Essa Rd. & 320 Mapleview Dr., Barrie

Title: BOREHOLE LOCATION PLAN

Approved by:	A.W.	Date:	March 2020	Project No.:	20-1014A
Drawn by:	B.H.	Scale:	1 : 2,500	Figure No.:	2



Legend:

- ▼ Water Level in Monitoring Well
- ▨ Topsoil
- ▨ Earth Fill
- ▨ Silty Sand to Sandy Silt to Silt & Sand Glacial Till
- ▨ Sandy Silt to Silty Sand to Sand & Silt
- ▨ Silt
- ▨ Sand
- ▨ Gravelly Sand
- ▨ Clayey Silt to Clay & Silt

Notes:

1. Numbers shown next to boreholes are SPT "N" Values.
2. Subsurface conditions known only at borehole locations.
3. Horizontal distance between boreholes is not to scale.
4. Water levels measured on April 1, 2020.

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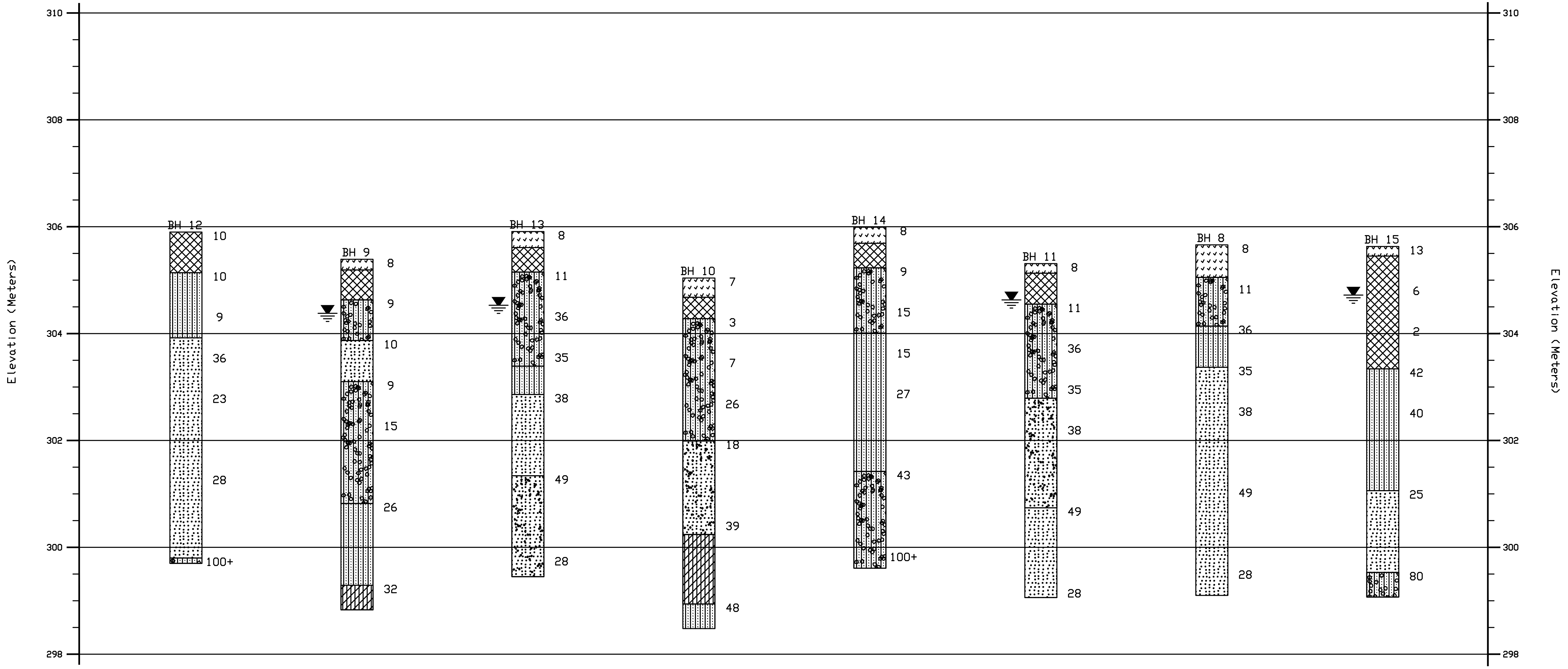
Project: 6275 & 6299 County Road 90, Essa, ON

Title: SUBSURFACE PROFILE A-A'

Approved by: A.W.
Date: March 2020
Project No.: 20-1007A
Drawn by: R.W.
Scale: Vertical: 1:75 Horizontal: N.T.S.
Figure No.: 3A



Legend:

- ▼ Water Level in Monitoring Well
- ▨ Topsoil
- ▨ Earth Fill
- ▨ Silty Sand to Sandy Silt to Silt & Sand Glacial Till
- ▨ Sandy Silt to Silty Sand to Sand & Silt
- ▨ Silt
- ▨ Sand
- ▨ Gravelly Sand
- ▨ Clayey Silt to Clay & Silt

Notes:

1. Numbers shown next to boreholes are SPT "N" Values.
2. Subsurface conditions known only at borehole locations.
3. Horizontal distance between boreholes is not to scale.
4. Water levels measured on April 1, 2020.

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647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7
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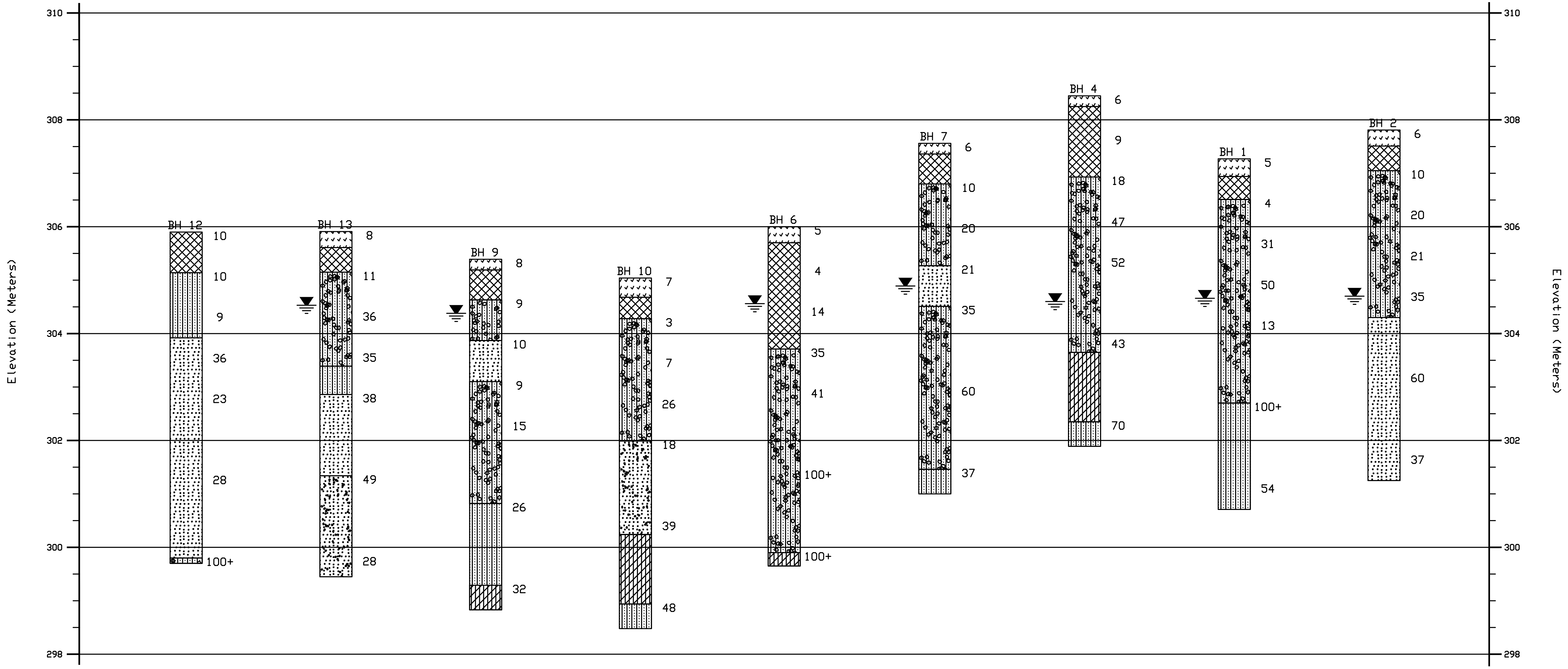
Project: 6275 & 6299 County Road 90, Essa, ON

Title: SUBSURFACE PROFILE B-B'

Approved by: A.W.
Date: March 2020
Project No.: 20-1007A

Drawn by: R.W.
Scale: Vertical: 1:75 Horizontal: N.T.S.
Figure No.: 3B



Legend:

- ▼ Water Level in Monitoring Well
- ▨ Topsoil
- ▨ Earth Fill
- ▨ Silty Sand to Sandy Silt to Silt & Sand Glacial Till
- ▥ Sandy Silt to Silty Sand to Sand & Silt
- ▥ Silt
- ▨ Sand
- ▨ Gravelly Sand
- ▨ Clayey Silt to Clay & Silt

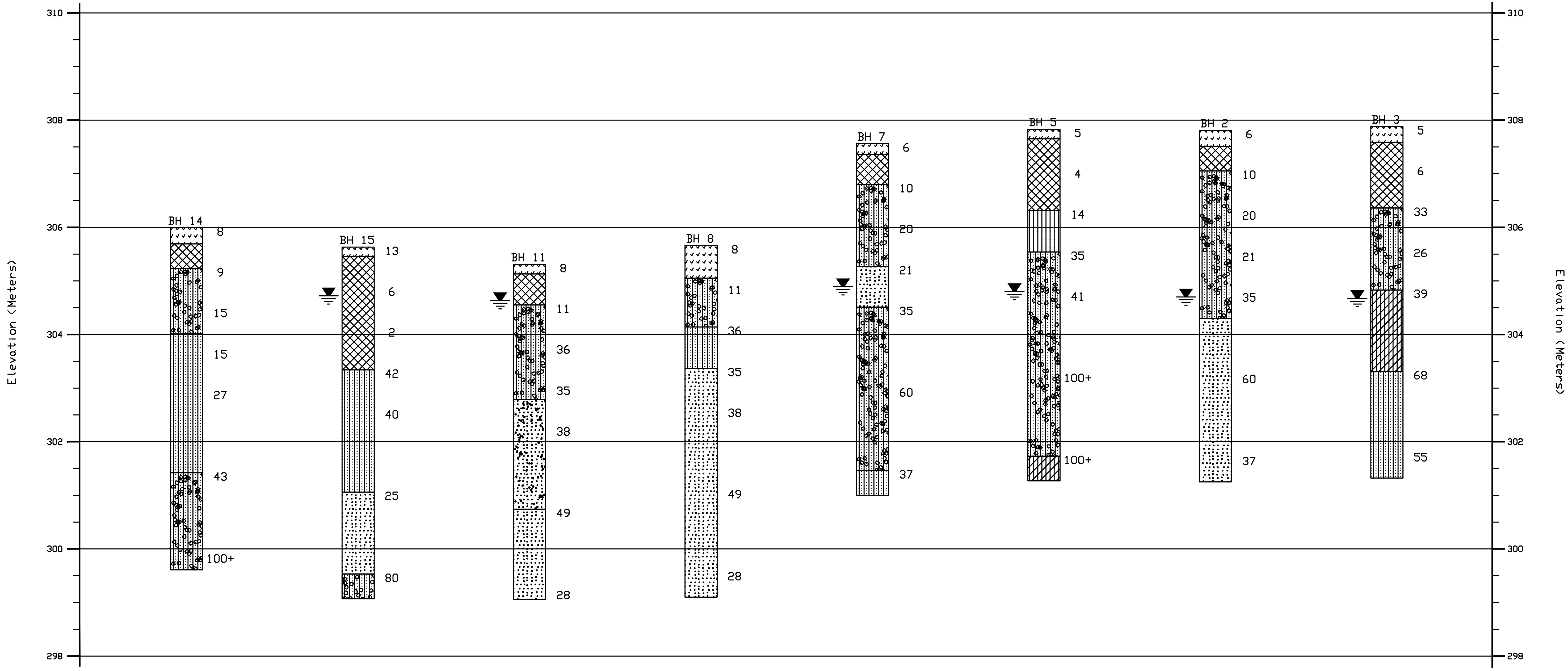
Notes:

1. Numbers shown next to boreholes are SPT "N" Values.
2. Subsurface conditions known only at borehole locations.
3. Horizontal distance between boreholes is not to scale.
4. Water levels measured on April 1, 2020.

GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7
P: (705) 719-7994

Project:	6275 & 6299 County Road 90, Essa, ON				
Title:	SUBSURFACE PROFILE C-C'				
Approved by:	A.W.	Date:	March 2020	Project No.:	20-1007A
Drawn by:	R.W.	Scale:	Vertical: 1:75 Horizontal: N.T.S.	Figure No.:	3C



Legend:

- ▼ Water Level in Monitoring Well
- ▦ Topsoil
- ▩ Earth Fill
- ▦ Silty Sand to Sandy Silt to Silt & Sand Glacial Till
- ▥ Sandy Silt to Silty Sand to Sand & Silt
- ▥ Silt
- ▦ Sand
- ▦ Gravelly Sand
- ▨ Clayey Silt to Clay & Silt

Notes:

1. Numbers shown next to boreholes are SPT "N" Values.
2. Subsurface conditions known only at borehole locations.
3. Horizontal distance between boreholes is not to scale.
4. Water levels measured on April 1, 2020.

GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7
P: (705) 719-7994

Project: 6275 & 6299 County Road 90, Essa, ON

Title: SUBSURFACE PROFILE D-D'

Approved by:	A.W.	Date:	March 2020	Project No.:	20-1007A
Drawn by:	R.W.	Scale:	Vertical: 1:75 Horizontal: N.T.S.	Figure No.:	3D

Appendix A –

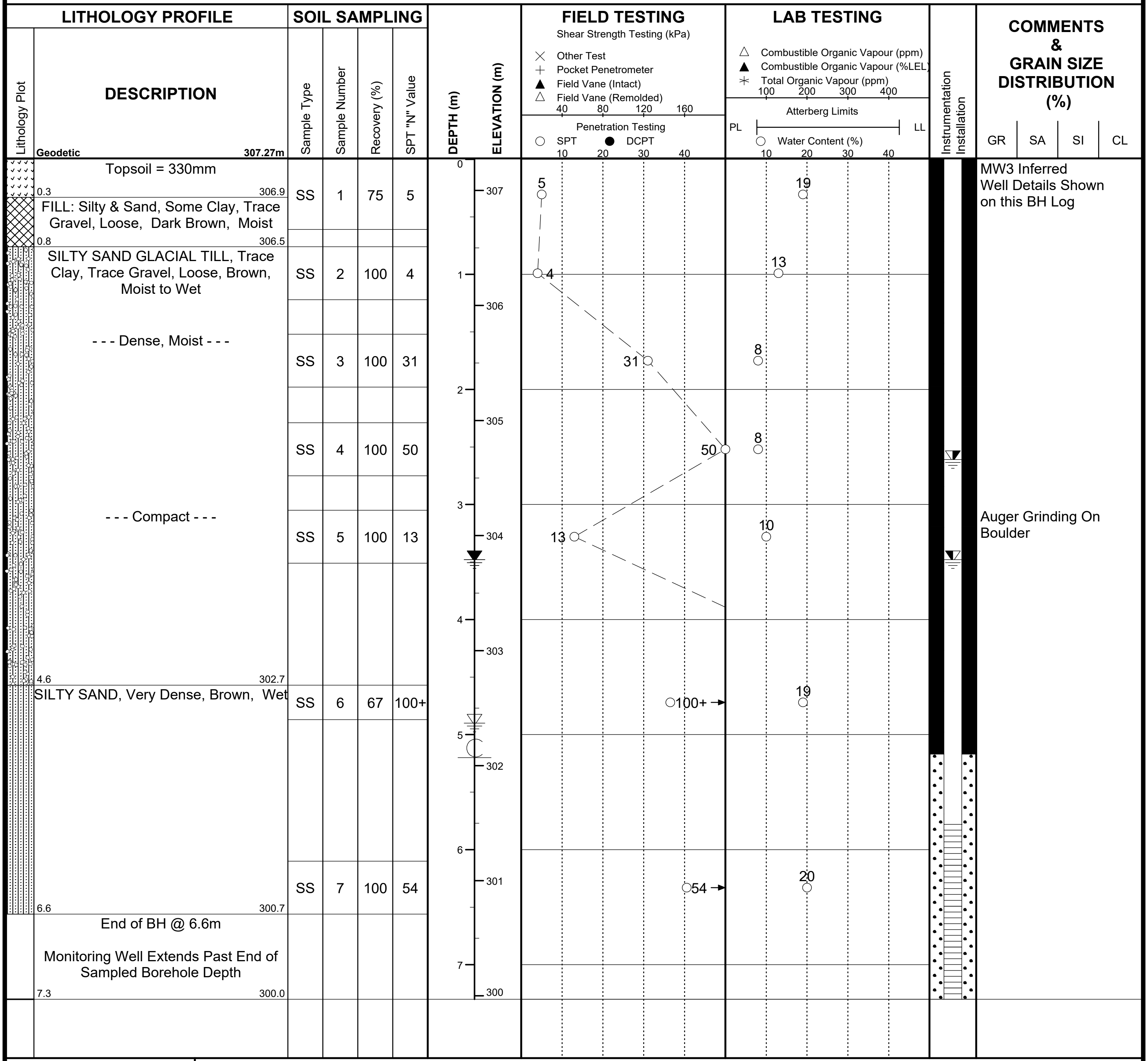
BOREHOLE LOGS

RECORD OF BOREHOLE No. 1

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909557**
Easting: **602654**
Date Started: **2020-03-03**
Date Completed: **2020-03-03**

Depth (m) / Elevation (m)	DESCRIPTION (Geodetic 307.27m)	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
0.3 / 306.9	Topsoil = 330mm						MW3 Inferred Well Details Shown on this BH Log
0.8 / 306.5	FILL: Silty & Sand, Some Clay, Trace Gravel, Loose, Dark Brown, Moist	SS	1	75	5	19	
	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel, Loose, Brown, Moist to Wet	SS	2	100	4	13	
	- - - Dense, Moist - - -	SS	3	100	31	8	
		SS	4	100	50	8	
4.6 / 302.7	- - - Compact - - -	SS	5	100	13	10	Auger Grinding On Boulder
	SILTY SAND, Very Dense, Brown, Wet	SS	6	67	100+	19	
6.6 / 300.7		SS	7	100	54	20	
7.3 / 300.0	End of BH @ 6.6m Monitoring Well Extends Past End of Sampled Borehole Depth						



CENTRAL EARTH ENGINEERING

647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **4.9m**

Cave depth after auger removal: **5.2m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **3.48m**

Observed on **Apr. 1/20** at a depth of: **2.61m**

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 :50**

RECORD OF BOREHOLE No. 2

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909588**
Date Started: **2020-03-03**
Reviewed By: **AW**
Easting: **602742**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE

Geodetic 307.81m

Depth (m)	DESCRIPTION	Elevation (m)
0.3	Topsoil = 300mm	307.5
0.8	FILL: Silty Sand, Trace Rootlets, Loose, Brown, Moist	307.1
3.5	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Compact, Brown, Moist - - - Dense, Moist to Wet - - -	304.3
6.6	SAND, Some Silt, Very Dense, Brown, Wet - - - Silty - - -	301.3
7.2	End of BH @ 6.6m Monitoring Well Extends Past End of Sampled Borehole Depth	300.7

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)
SS	1	100	6	8
SS	2	100	10	11
SS	3	100	20	9
SS	4	100	21	8
SS	5	100	35	10
SS	6	100	60	19
SS	7	100	37	25

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

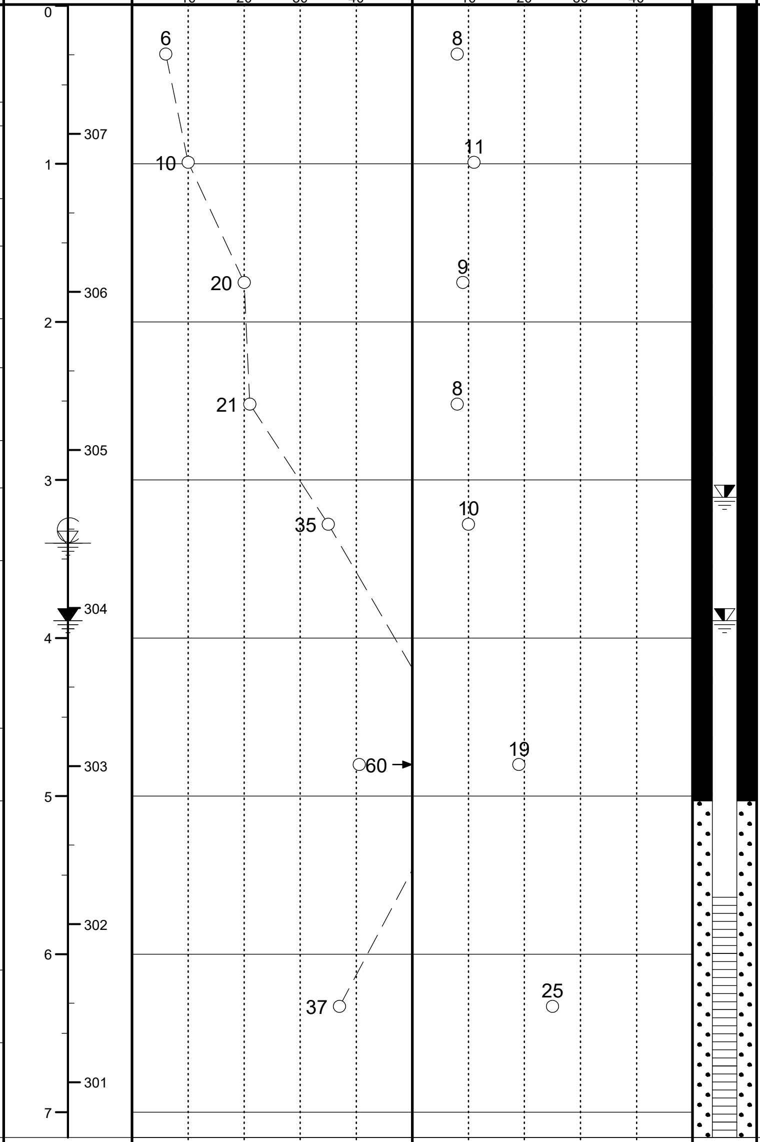
- △ Combustible Organic Vapour (ppm)
- ▲ Combustible Organic Vapour (%LEL)
- ✳ Total Organic Vapour (ppm)

100 200 300 400

Atterberg Limits: PL — LL

○ Water Content (%)

10 20 30 40



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL

MW1 Inferred Well Details Shown on this BH Log

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Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **3.4m**

Cave depth after auger removal: **3.4m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **3.89m**

Observed on **Apr. 1/20** at a depth of: **3.11m**

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 :50**

Page: **1 of 1**

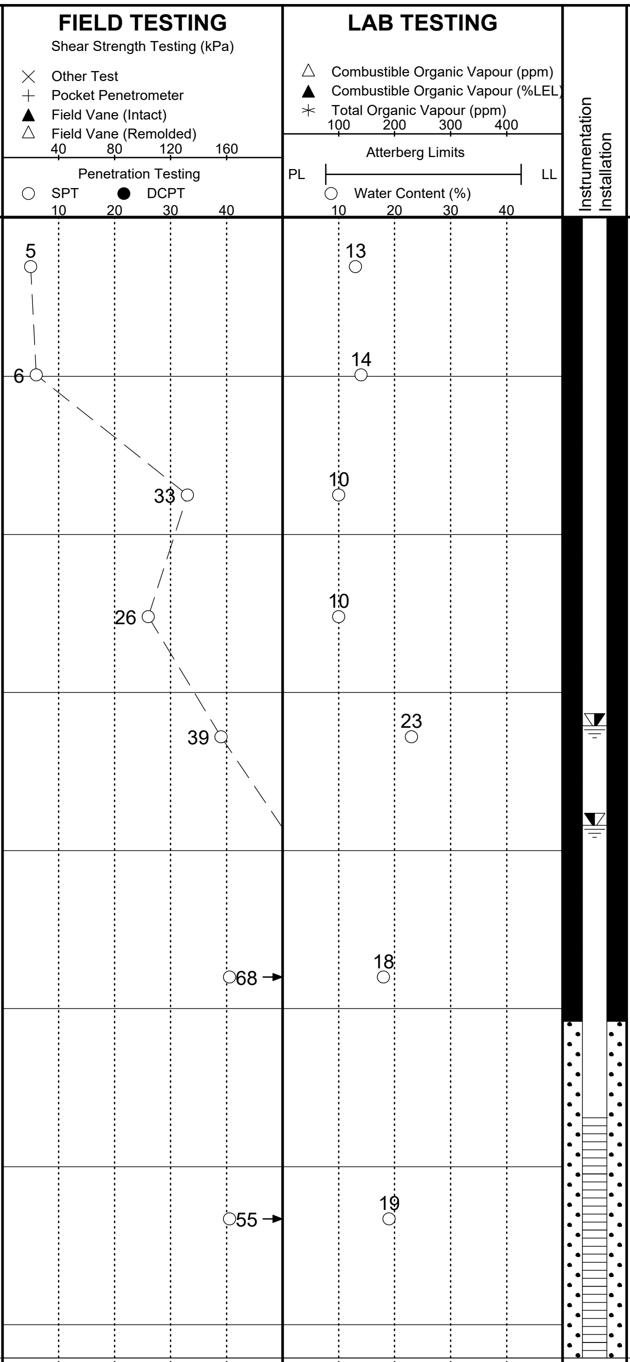
RECORD OF BOREHOLE No. 3

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909634**
Easting: **602853**
Date Started: **2020-03-03**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE		SOIL SAMPLING						LAB TESTING	COMMENTS & GRAIN SIZE DISTRIBUTION (%)				
DESCRIPTION	Depth / Elevation	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	Water Content (%)	GR	SA	SI	CL	
Geodetic	307.88m					0							MW2 Inferred Well Details Shown on this BH Log
Topsoil = 300mm	0.3 / 307.6												
FILL: Sand & Silt, Trace Clay, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist		SS	1	100	5			13					
	1.5 / 306.4	SS	2	100	6	1	307	14					
SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Dense, Brown, Moist		SS	3	100	33	2	306	10					
- - - Compact - - -	3.1 / 304.8	SS	4	100	26			10					
SILT & CLAY, Trace Sand, Frequent Silt Partings, Hard, Brown, Moist	4.6 / 303.3	SS	5	100	39	3	305	23					
SILTY SAND, Very Dense, Brown, Wet	6.1 / 301.8	SS	6	100	68	4 5	304 303	18					
SANDY SILT, Trace Clay, Very Dense, Brown, Moist to Wet	6.6 / 301.3	SS	7	100	55	6	302	19	0	23	70	7	
End of BH @ 6.6m Monitoring Well Extends Past End of Sampled Borehole Depth	7.2 / 300.7					7	301						



CENTRAL EARTH ENGINEERING

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Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **4.9m**
Cave depth after auger removal: **4.9m**
Groundwater depth observed on **Mar. 5/20** at a depth of: **3.84m**
Observed on **Apr. 1/20** at a depth of: **3.21m**

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 :50**
Page: **1 of 1**

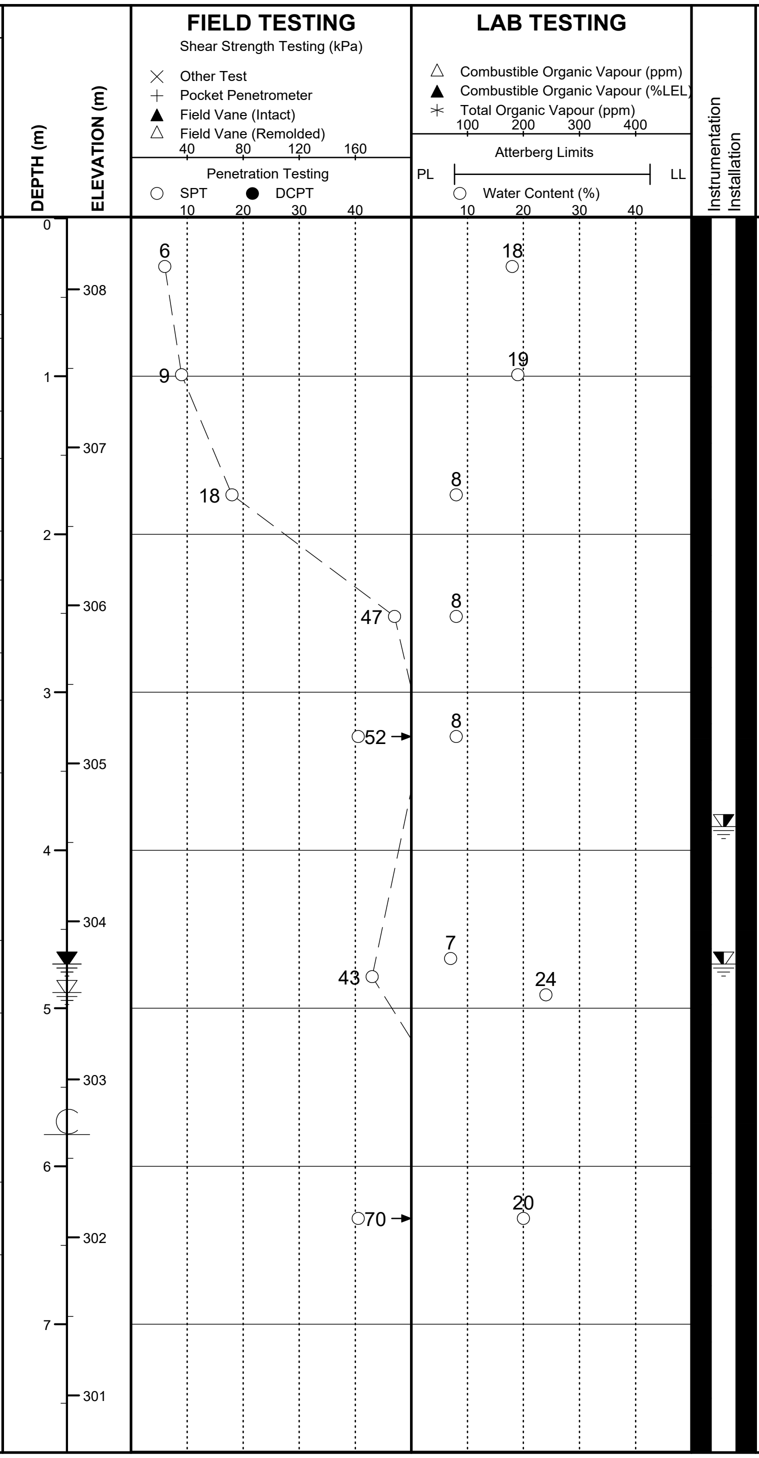
RECORD OF BOREHOLE No. 4

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909497**
Date Started: **2020-03-03**
Reviewed By: **AW**
Easting: **602680**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE	SOIL SAMPLING			
DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value
Geodetic 308.45m				
Topsoil = 200mm 0.2 308.3				
FILL: Sand & Silt, Trace Clay, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist	SS	1	100	6
	SS	2	100	9
1.5 306.9				
SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Compact, Brown, Moist	SS	3	100	18
- - - Dense - - -	SS	4	100	47
	SS	5	100	52
4.8 303.7				
SILT & CLAY, Trace Sand, Frequent Silt Partings, Hard, Brown, Moist	SS	6A 6B	100	43
6.1 302.4				
SILTY SAND, Very Dense, Brown, Wet	SS	7	100	70
6.6 301.9				
End of BH @ 6.6m Monitoring Well Extends Past End of Sampled Borehole Depth				



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

MW6 Inferred Well Details Shown on this BH Log

GR	SA	SI	CL
5	57	25	13

CENTRAL EARTH ENGINEERING

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Groundwater depth encountered on completion of drilling: **4.9m**

Cave depth after auger removal: **5.8m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **4.72m**

Observed on **Apr. 1/20** at a depth of: **3.85m**

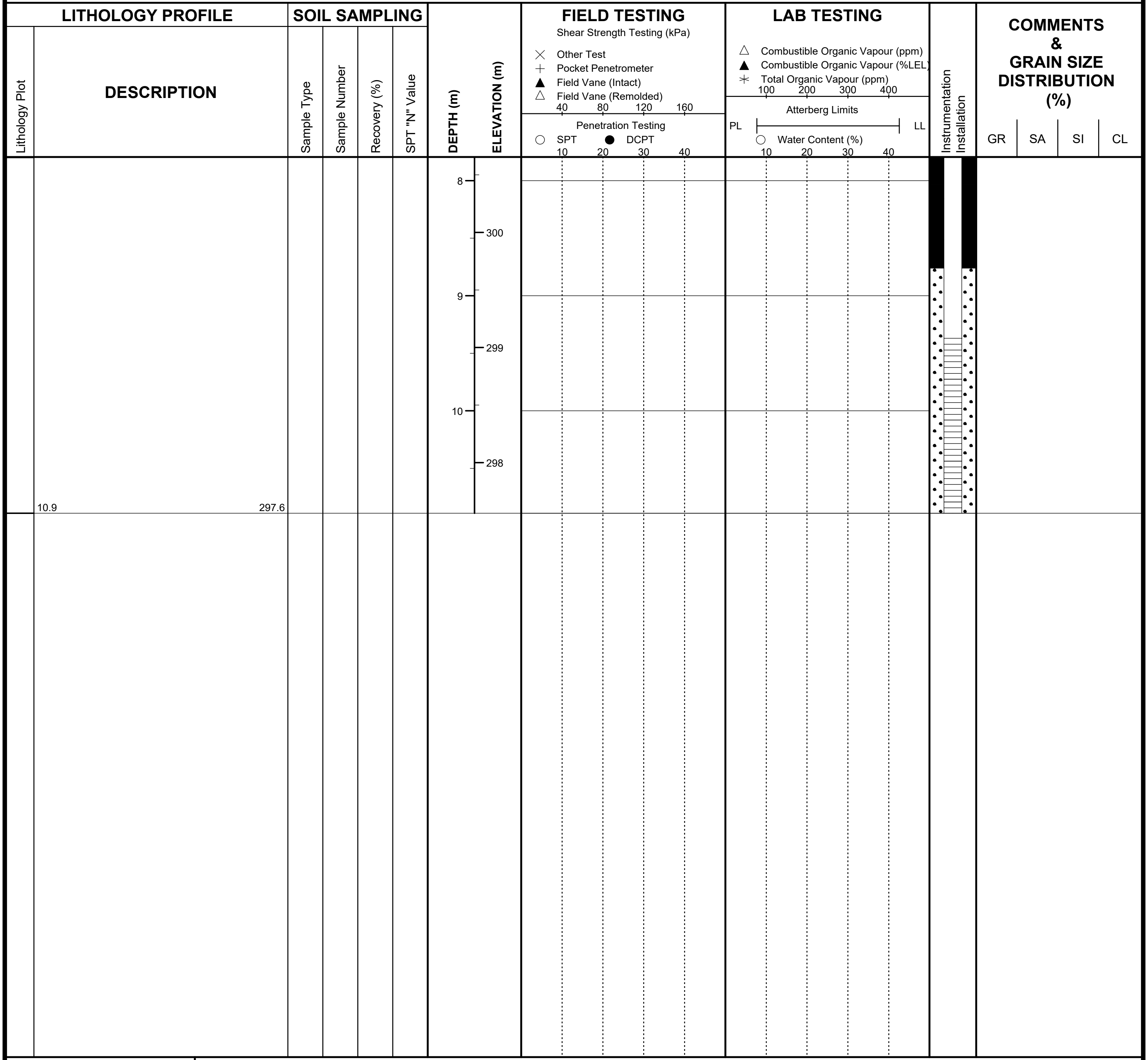
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and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

Scale: **1 :50**

RECORD OF BOREHOLE No. 4

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909497**
Easting: **602680**
Date Started: **2020-03-03**
Date Completed: **2020-03-03**



CENTRAL EARTH ENGINEERING

647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **4.9m**

Cave depth after auger removal: **5.8m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **4.72m**

Observed on **Apr. 1/20** at a depth of: **3.85m**

Scale: **1 :50**

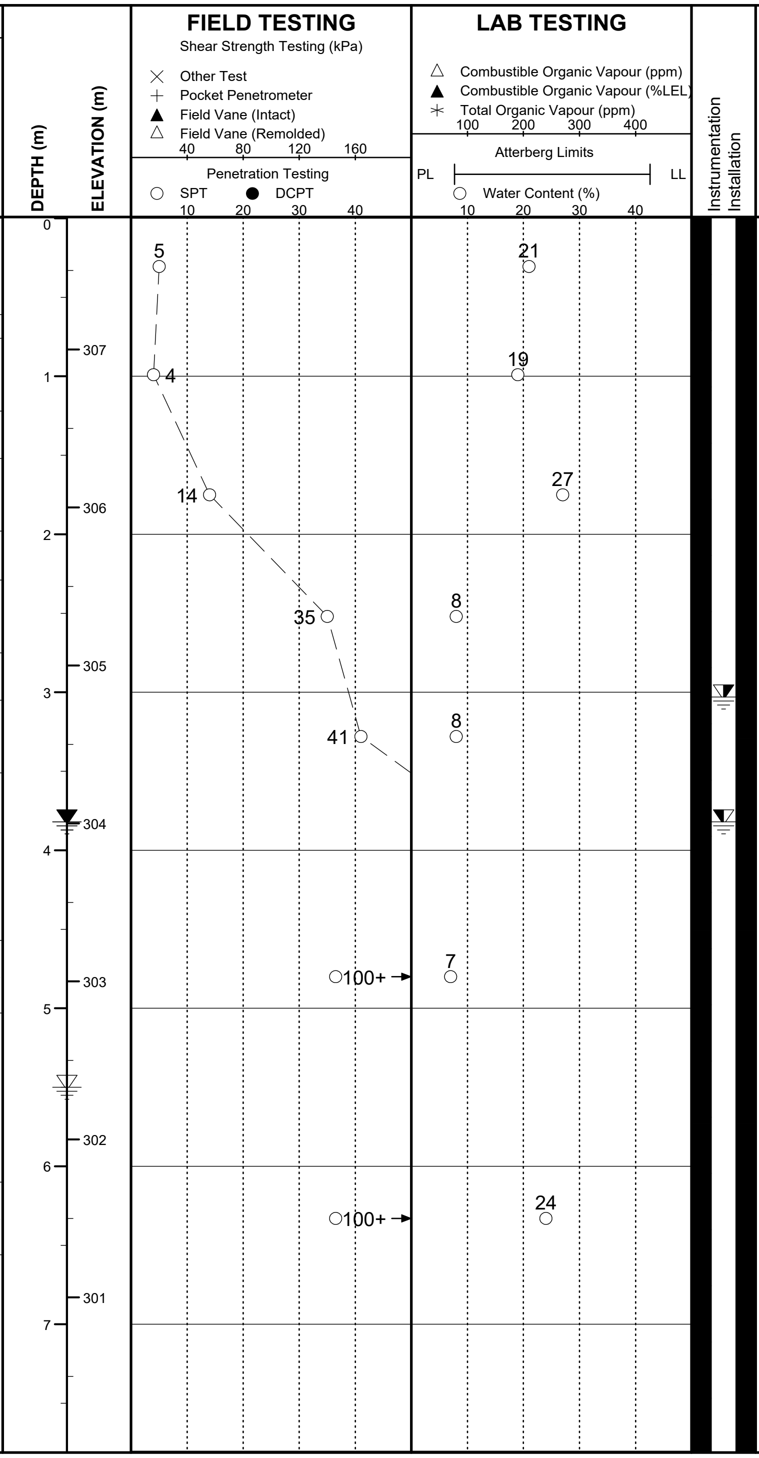
RECORD OF BOREHOLE No. 5

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909539**
Easting: **602808**
Date Started: **2020-03-03**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE / SOIL SAMPLING

Depth (m)	Elevation (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	COMMENTS
	307.83m	Geodetic						
0.2	307.7	Topsoil = 180mm						MW5 Inferred Well Details Shown on this BH Log
		FILL: Sand & Silt, Trace Clay, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist	SS	1	100	5	21	
		- - - Brown - - -	SS	2	100	4	19	
1.5	306.3	SILT, Some Sand, Trace Clay, Compact, Brown, Moist	SS	3	100	14	27	
2.3	305.5	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Dense, Brown, Moist	SS	4	100	35	8	
			SS	5	100	41	8	
		- - - Very Dense - - -	SS	6	56	100+	7	
6.1	301.7	CLAYEY SILT, Trace Sand, Frequent Silt Partings, Hard, Brown, Moist	SS	7	56	100+	24	
6.6	301.3	End of BH @ 6.6m Monitoring Well Extends Past End of Sampled Borehole Depth						



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

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647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
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W: centralearth.com

Groundwater depth encountered on completion of drilling: **5.5m**

Cave depth after auger removal: **Open**

Groundwater depth observed on **Mar. 5/20** at a depth of: **3.82m**

Observed on **Apr. 1/20** at a depth of: **3.03m**

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 :50**

RECORD OF BOREHOLE No. 5

Project Number:	**20-1014A**				
Project Client:	**PetromaxX Construction**				
Project Name:	**664, 674 & 692 Essa Rd and 320 Mapleview**	Drilling Method:	**Solid Stem**	Drilling Machine:	**Track Mount**
Project Location:	**Barrie, Ontario**	Logged By:	**BH**	Northing:	**4909539**	Date Started:	**2020-03-03**
Drilling Location:	**See Attached Drawing**	Reviewed By:	**AW**	Easting:	**602808**	Date Completed:	**2020-03-03**

LITHOLOGY PROFILE: Lithology Plot, **DESCRIPTION**

SOIL SAMPLING: Sample Type, Sample Number, Recovery (%), SPT "N" Value

DEPTH (m), **ELEVATION (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

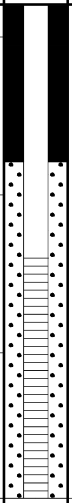
LAB TESTING
△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
✳ Total Organic Vapour (ppm)
100 200 300 400
Atterberg Limits
PL ├──┤ LL
○ Water Content (%)
10 20 30 40

Instrumentation Installation

COMMENTS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Depth (m)	Elevation (m)
	300
8	
	299
9	
	298
10	
	297

10.9 296.9



CENTRAL EARTH ENGINEERING
647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **5.5m**

Cave depth after auger removal: **Open**

Groundwater depth observed on **Mar. 5/20** at a depth of: **3.82m**

Observed on **Apr. 1/20** at a depth of: **3.03m**

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'.

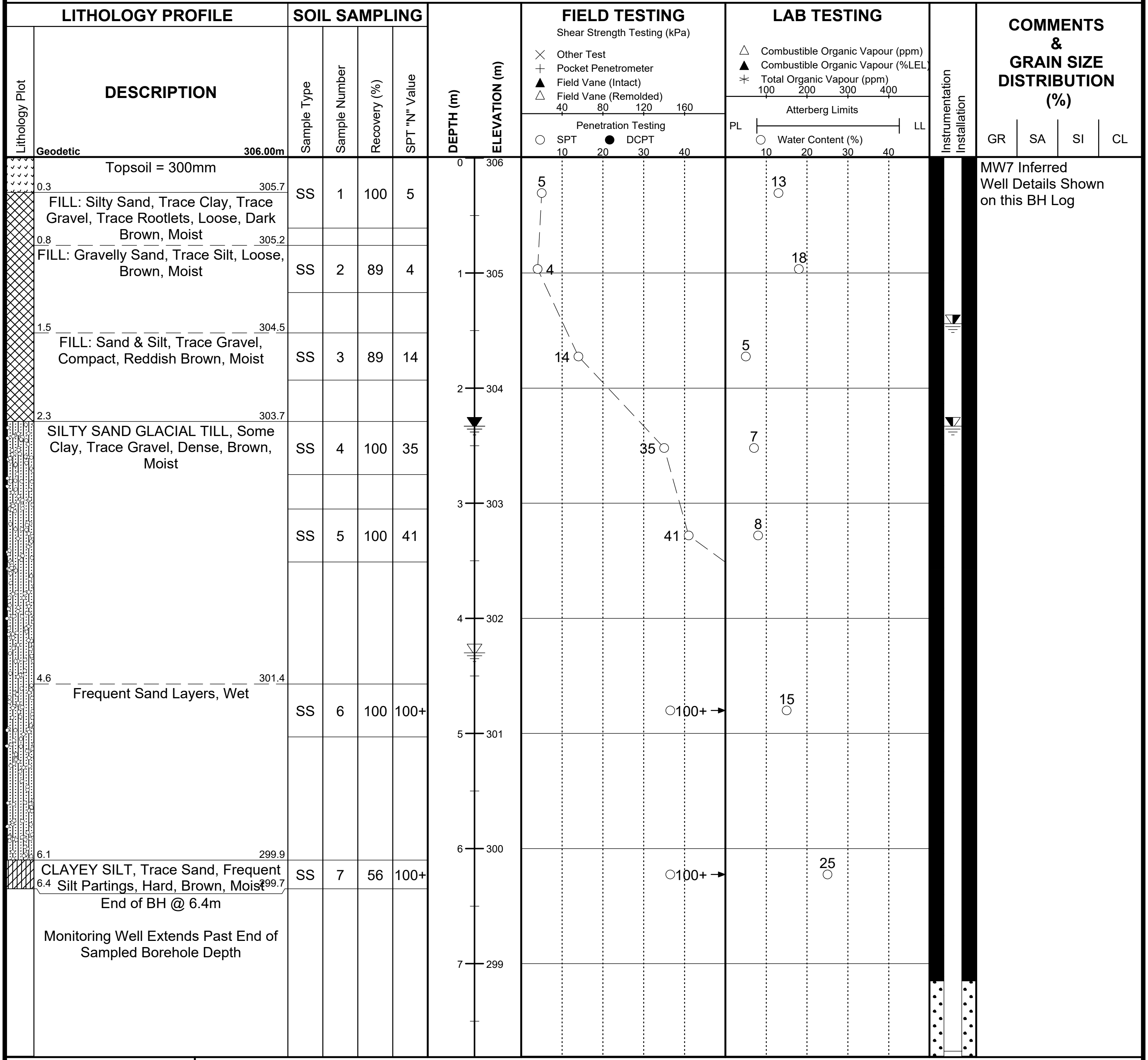
Scale: **1 :50**

RECORD OF BOREHOLE No. 6

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909434**
Date Started: **2020-03-03**
Reviewed By: **AW**
Easting: **602602**
Date Completed: **2020-03-03**



Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)
0	306	Topsoil = 300mm					
0.3	305.7	FILL: Silty Sand, Trace Clay, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist	SS	1	100	5	13
0.8	305.2	FILL: Gravelly Sand, Trace Silt, Loose, Brown, Moist	SS	2	89	4	18
1.5	304.5	FILL: Sand & Silt, Trace Gravel, Compact, Reddish Brown, Moist	SS	3	89	14	5
2.3	303.7	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Dense, Brown, Moist	SS	4	100	35	7
			SS	5	100	41	8
4.6	301.4	Frequent Sand Layers, Wet	SS	6	100	100+	15
6.1	299.9	CLAYEY SILT, Trace Sand, Frequent Silt Partings, Hard, Brown, Moist	SS	7	56	100+	25
6.4	299.7	End of BH @ 6.4m					

Monitoring Well Extends Past End of Sampled Borehole Depth

MW7 Inferred
Well Details Shown on this BH Log

CENTRAL EARTH ENGINEERING
647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **4.3m**
Cave depth after auger removal: **Open**
Groundwater depth observed on **Mar. 5/20** at a depth of: **2.33m**
Observed on **Apr. 1/20** at a depth of: **1.44m**

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 :50**
Page: **1 of 2**

RECORD OF BOREHOLE No. 6

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909434**
Date Started: **2020-03-03**
Reviewed By: **AW**
Easting: **602602**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE | **SOIL SAMPLING** | **FIELD TESTING** | **LAB TESTING** | **COMMENTS & GRAIN SIZE DISTRIBUTION (%)**

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	Instrumentation Installation	GR	SA	SI	CL
						8	298					
						9	297					
	9.3 296.7											

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

CENTRAL EARTH ENGINEERING
647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **4.3m**
Cave depth after auger removal: **Open**
Groundwater depth observed on **Mar. 5/20** at a depth of: **2.33m**
Observed on **Apr. 1/20** at a depth of: **1.44m**

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 :50**

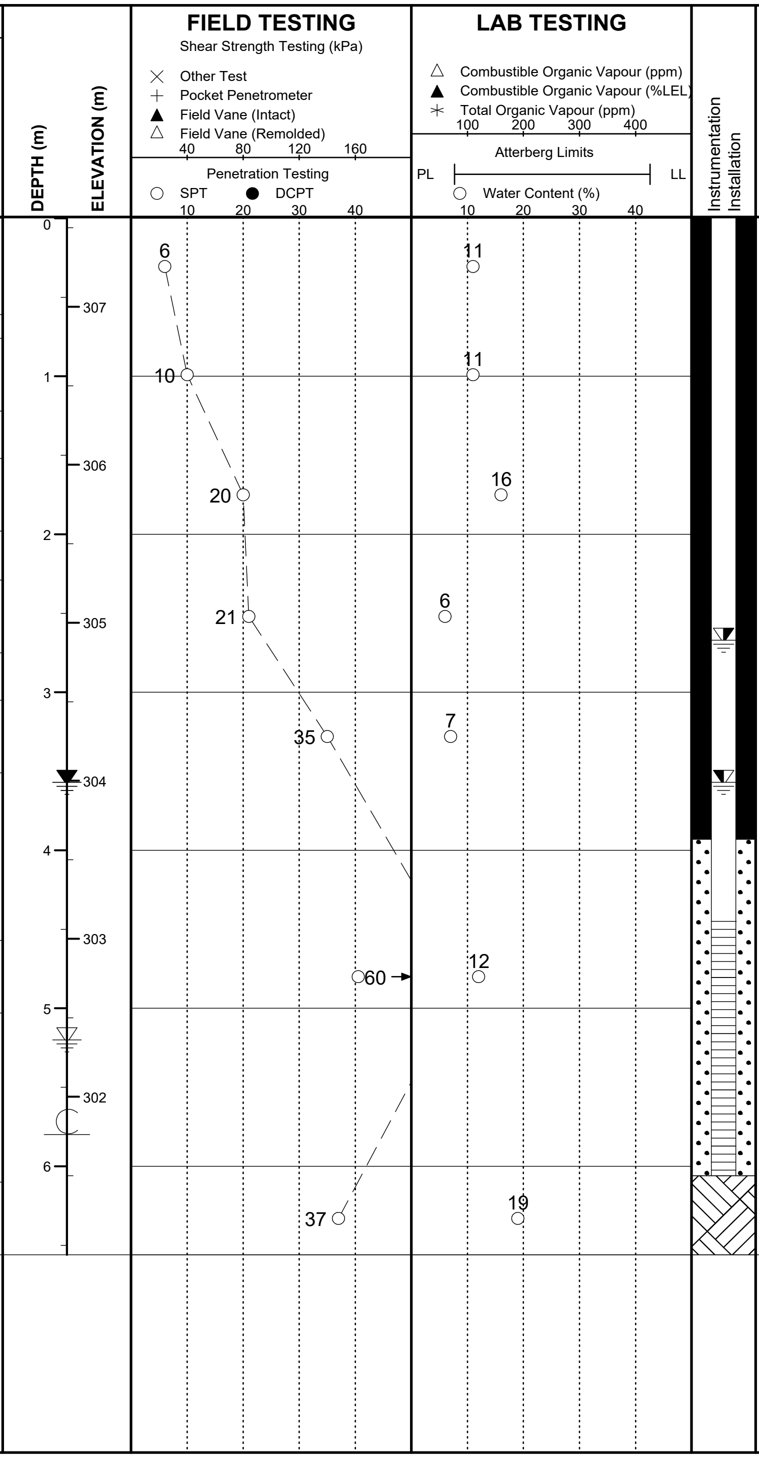
RECORD OF BOREHOLE No. 7

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909472**
Easting: **602753**
Date Started: **2020-03-03**
Date Completed: **2020-03-03**

LITHOLOGY PROFILE		SOIL SAMPLING			
Depth / Elevation (Geodetic 307.56m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value
0.2 / 307.4	Topsoil = 200mm				
0.8 / 306.8	FILL: Silty Sand, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist	SS	1	100	6
2.3 / 305.3	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Comapct, Brown, Moist - - - Occasional Sand Pockets - - -	SS SS	2 3	100 100	10 20
3.1 / 304.5	FINE SAND, Some Silt, Compact, Light Brown, Damp to Moist	SS	4	100	21
6.1 / 301.5	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Dense, Brown, Moist	SS SS	5 6	100 100	35 60
6.6 / 301.0	SILTY FINE SAND, Dense, Brown, Wet	SS	7	100	37
	End of BH @ 6.6m				



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL

MW4 Inferred
Well Details Shown on this BH Log

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Groundwater depth encountered on completion of drilling: **5.2m**

Cave depth after auger removal: **5.8m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **3.57m**

Observed on **Apr. 1/20** at a depth of: **2.67m**

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 :50**
Page: **1 of 1**

RECORD OF BOREHOLE No. 8

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909467**
Easting: **602868**
Date Started: **2020-03-04**
Date Completed: **2020-03-04**

LITHOLOGY PROFILE

Geodetic 305.66m

Depth (m)	Elevation (m)	DESCRIPTION
0.6	305.1	Topsoil = 610mm
1.5	304.1	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Compact, Brown, Moist
2.3	303.4	SILTY SAND, Trace Clay, Dense, Brown, Wet
6.6	299.1	SAND, Some Gravel, Trace Silt, Dense, Brown, Wet - - - Trace to Some Silt, Trace Gravel, Greyish Brown - - - - - - Grey - - -
		End of BH @ 6.6m

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
SS	1	100	8	35				
SS	2	100	11	24				
SS	3	100	36	20				
SS	4	100	35	19	11	82	(7)	
SS	5	100	38	20				
SS	6	100	49	18				
SS	7	100	28	21				

FIELD TESTING

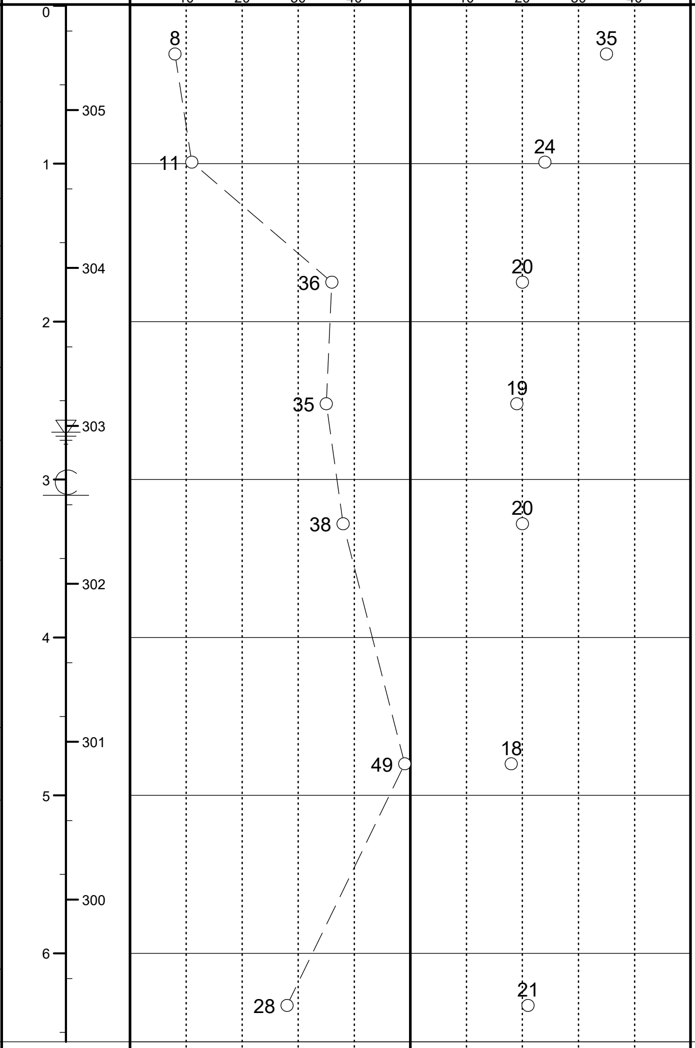
Shear Strength Testing (kPa)
× Other Test
+ Pocket Penetrometer
▲ Field Vane (Intact)
△ Field Vane (Remolded)
40 80 120 160
Penetration Testing
○ SPT ● DCPT
10 20 30 40

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

COMMENTS & GRAIN SIZE DISTRIBUTION (%)



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Groundwater depth encountered on completion of drilling: **2.7m**

Cave depth after auger removal: **3.1m**

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 :50**

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RECORD OF BOREHOLE No. 9

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909361**
Easting: **602576**
Date Started: **2020-03-05**
Date Completed: **2020-03-05**

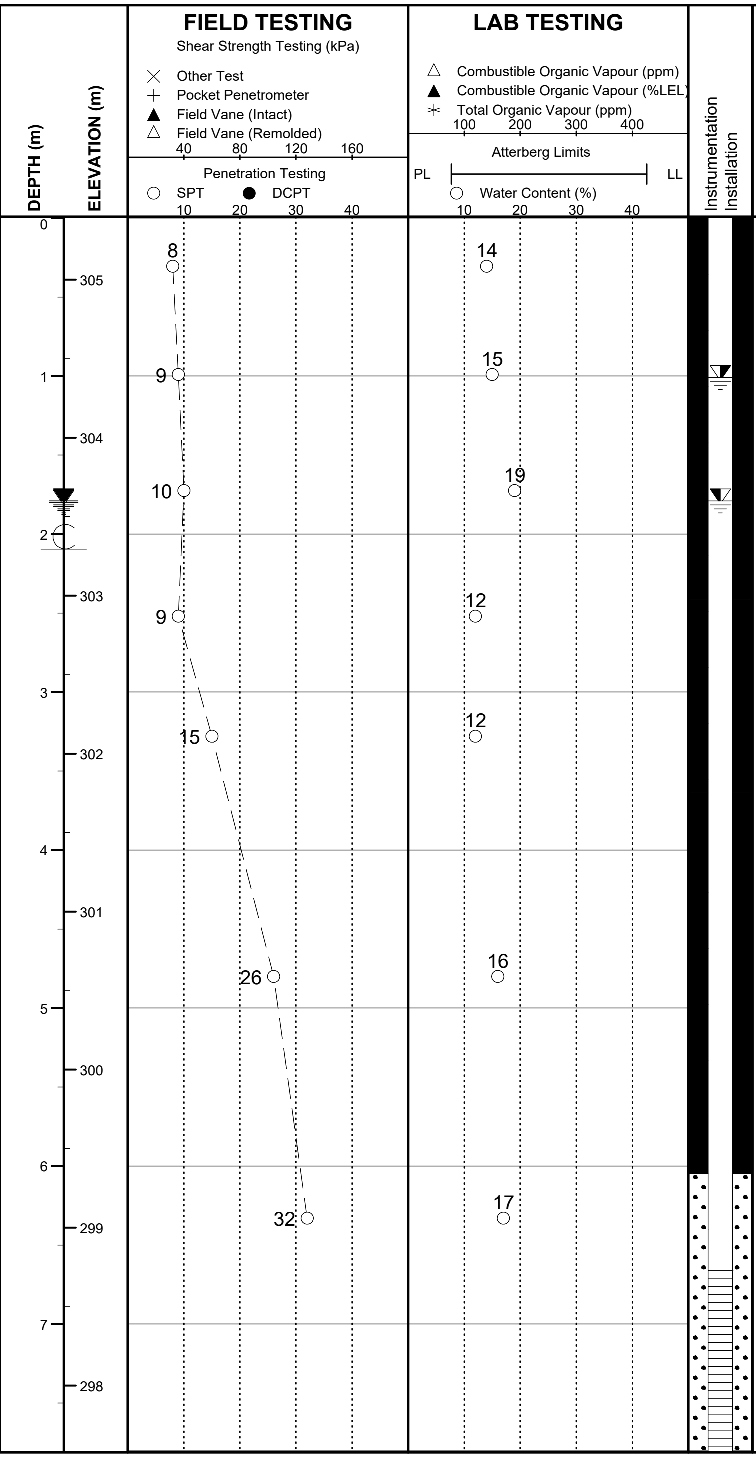
LITHOLOGY PROFILE / SOIL SAMPLING

Geodetic 305.39m

Depth (m)	Elevation (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL	COMMENTS
0.2	305.2	Topsoil = 200mm										MW11 Inferred Well Details Shown on this BH Log
0.8	304.6	FILL: Silty Sand, Trace Gravel, Trace Rootlets, Loose, Dark Brown, Moist	SS	1	100	8	14					
1.5	303.9	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Loose, Brown, Moist	SS	2	100	9	15					
2.3	303.1	SAND, Some Silt, Compact, Brown, Wet	SS	3	89	10	19					
4.6	300.8	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Loose, Brown, Moist to Wet	SS	4	100	9	12					
		- - - Compact, Wet - - -	SS	5	100	15	12					
6.1	299.3	FINE SAND & SILT, Compact, Grey, Wet	SS	6	100	26	16					
6.6	298.8	SILT & CLAY, Trace Sand, Frequent Silt Partings, Hard, Grey, Moist	SS	7	100	32	17	0	6	52	42	

End of BH @ 6.6m

Monitoring Well Extends Past End of Sampled Borehole Depth



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Groundwater depth encountered on completion of drilling: **1.8m**

Cave depth after auger removal: **2.1m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **1.79m**

Observed on **Apr. 1/20** at a depth of: **1.01m**

Scale: **1 :50**

RECORD OF BOREHOLE No. 9

Project Number:	**20-1014A**				
Project Client:	**PetromaxX Construction**				
Project Name:	**664, 674 & 692 Essa Rd and 320 Mapleview**	Drilling Method:	**Solid Stem**	Drilling Machine:	**Track Mount**
Project Location:	**Barrie, Ontario**	Logged By:	**BH**	Northing: **4909361**	Date Started: **2020-03-05**
Drilling Location:	**See Attached Drawing**	Reviewed By:	**AW**	Easting: **602576**	Date Completed: **2020-03-05**

LITHOLOGY PROFILE | **SOIL SAMPLING** | **FIELD TESTING** | **LAB TESTING** | **COMMENTS & GRAIN SIZE DISTRIBUTION (%)**

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

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	Field Testing	Lab Testing	Instrumentation Installation	GR	SA	SI	CL
	8.2 297.2					8								

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Groundwater depth encountered on completion of drilling: **1.8m**

Cave depth after auger removal: **2.1m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **1.79m**

Observed on **Apr. 1/20** at a depth of: **1.01m**

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 :50**

RECORD OF BOREHOLE No. 10

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

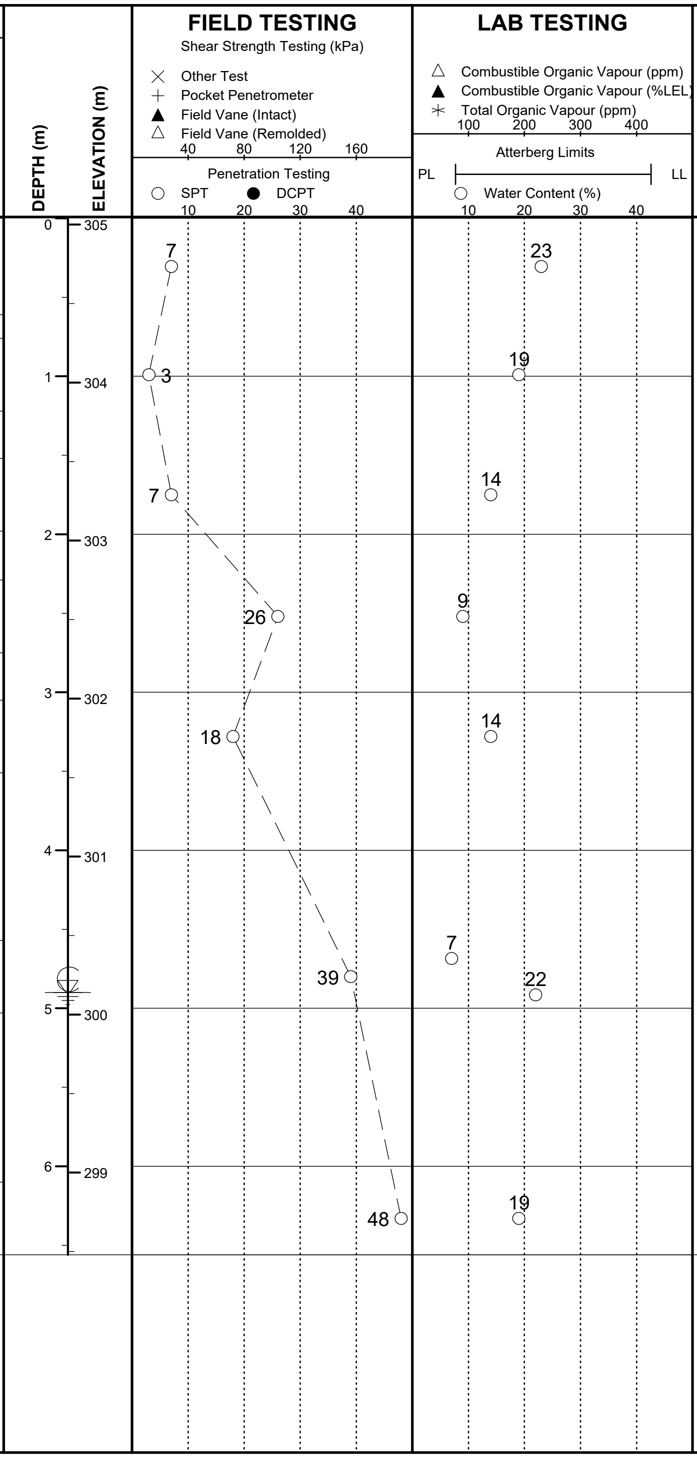
Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909395**
Easting: **602683**
Date Started: **2020-03-04**
Date Completed: **2020-03-04**

LITHOLOGY PROFILE

Depth (m)	Elevation (m)	DESCRIPTION
Geodetic	305.04m	
0.4	304.7	Topsoil = 360mm
0.8	304.3	FILL: Silty Sand, Trace Clay, Trace Gravel, Loose, Brown, Moist
2.3	302.8	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Very Loose, Brown, Moist - - - Loose, Moist to Wet - - -
3.1	302.0	SILT & SAND GLACIAL TILL, Some Clay, Trace Gravel, Compact, Grey, Moist
4.8	300.2	GRAVELLY SAND, Some Silt, Compact, Brownish Grey, Wet - - - Grey - - -
6.1	298.9	SILT & CLAY, Trace Sand, Frequeny Silt Partings, Hard, Grey, Moist
6.6	298.5	SILTY SAND, Dense, Grey, Wet
		End of BH @ 6.6m

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)
SS	1	100	7	23
SS	2	100	3	19
SS	3	100	7	14
SS	4	100	26	9
SS	5	100	18	14
SS	6A 6B	100	39	7 22
SS	7	100	48	19



Instrumentation Installation

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL

Groundwater depth encountered on completion of drilling: **4.9m**

Cave depth after auger removal: **4.9m**

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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 :50**

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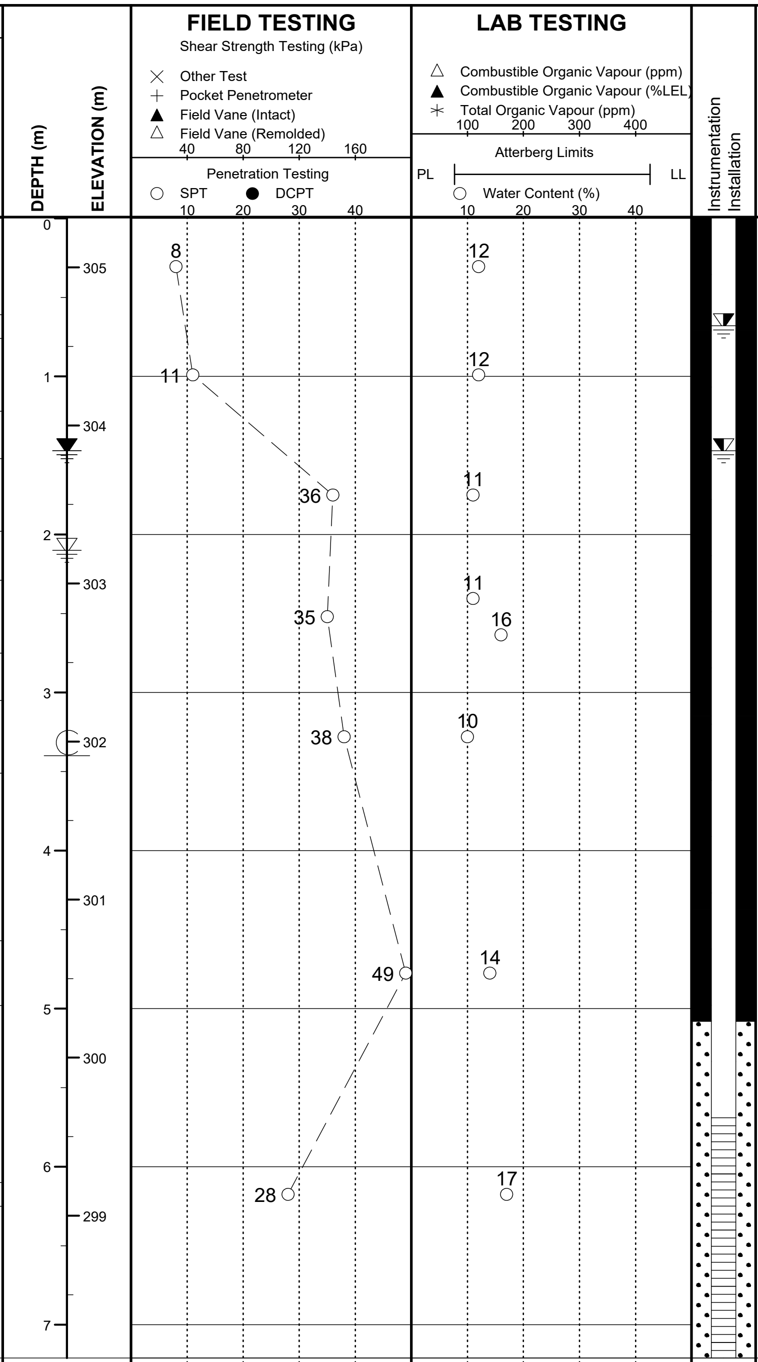
RECORD OF BOREHOLE No. 11

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909403**
Date Started: **2020-03-04**
Reviewed By: **AW**
Easting: **602804**
Date Completed: **2020-03-04**

LITHOLOGY PROFILE		SOIL SAMPLING			
Lithology Plot	DESCRIPTION Geodetic 305.31m	Sample Type	Sample Number	Recovery (%)	SPT "N" Value
	0.2 Topsoil = 180mm 305.1				
	FILL: Sandy Silt, Some Clay to Clayey, Trace Gravel, Trace Silty Sand Nodules, Loose, Brown, Moist	SS	1	100	8
	0.8 304.6				
	SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Compact, Brown, Moist to Wet	SS	2	100	11
	- - - Dense - - -	SS	3	100	36
	2.0 303.3				
	SAND & SILT GLACIAL TILL, Some Clay, Trace Gravel, Hard, Brownish Grey, Moist to Wet	SS	4A	100	35
	2.5 302.8		4B		
	GRAVELLY SAND, Some Silt to Silty, Dense, Brownish Grey, Wet				
	- - - Grey - - -	SS	5	100	38
	4.6 300.7				
	SAND, Trace Silt, Trace Gravel, Dense to Compact, Brownish Grey, Wet	SS	6	89	49
	6.3 - - - Some Silt to Silty - - - 299.1	SS	7	33	28
	End of BH @ 6.3m Monitoring Well Extends Past End of Sampled Borehole Depth				
	7.2 298.1				



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL

MW8 Inferred Well Details Shown on this BH Log

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Groundwater depth encountered on completion of drilling: **2.1m**

Cave depth after auger removal: **3.4m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **1.47m**

Observed on **Apr. 1/20** at a depth of: **0.68m**

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 :50**

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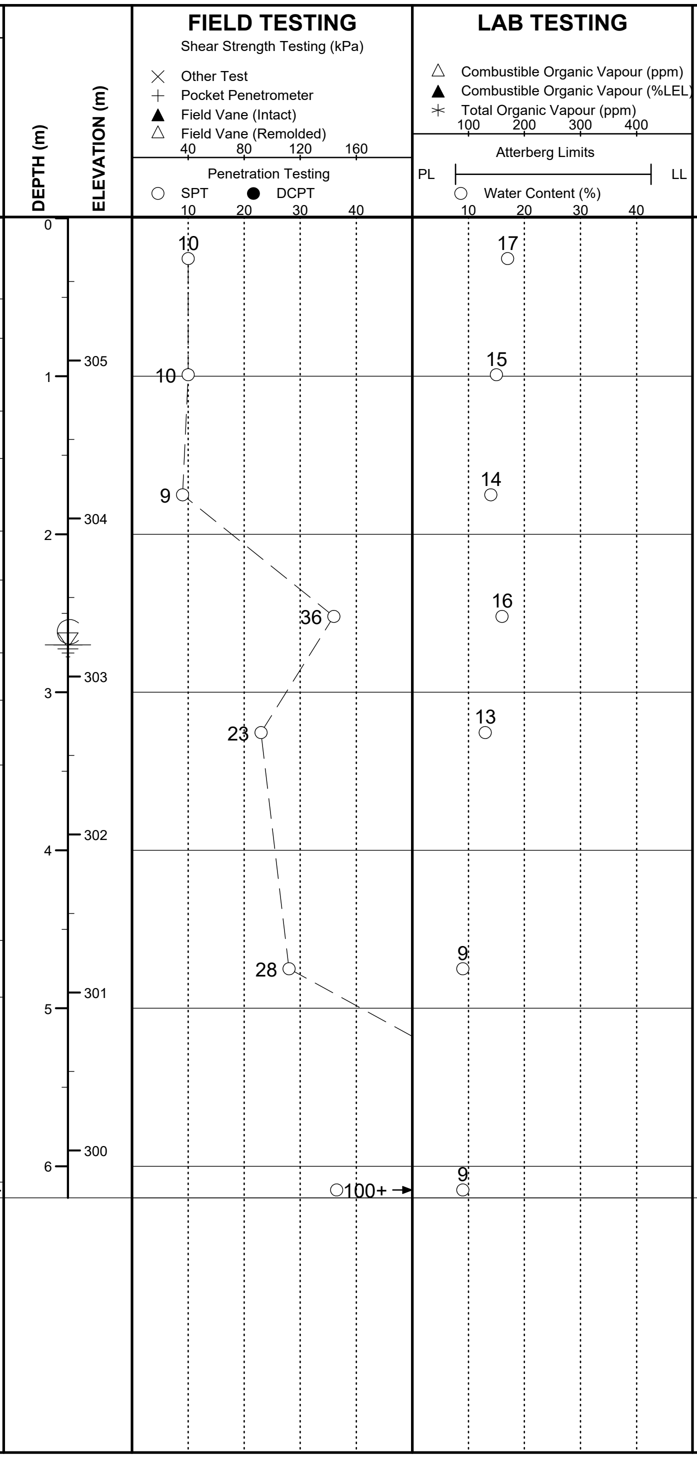
RECORD OF BOREHOLE No. 12

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909261**
Easting: **602533**
Date Started: **2020-03-05**
Date Completed: **2020-03-05**

LITHOLOGY PROFILE		SOIL SAMPLING				LAB TESTING	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
Geodetic 305.90m										
	FILL: Gravelly Sand, Trace Silt, Compact, Brown, Damp to Moist	SS	1	83	10	17				
0.8 305.1	SAND & SILT, Trace Clay, Loose, Mottled Brown, Moist	SS	2	100	10	15				
	- - - Silty, Moist to Wet - - -	SS	3	100	9	14				
2.0 303.9	SAND, Some Silt, Trace Gravel, Dense, Brown, Wet	SS	4	100	36	16				
	- - - Trace Silt - - -	SS	5	89	23	13	20	76	(4)	
	- - - Some Gravel - - -	SS	6	78	28	9				
6.1 299.8 6.2 299.7	SAND & SILT GLACIAL TILL, Some Clay, Trace Gravel, Hard, Grey, Moist to Wet	SS	7	22	100+	9				
	End of BH @ 6.2m									



Instrumentation Installation

CENTRAL EARTH ENGINEERING
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Groundwater depth encountered on completion of drilling: **2.7m**

Cave depth after auger removal: **2.7m**

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 :50**

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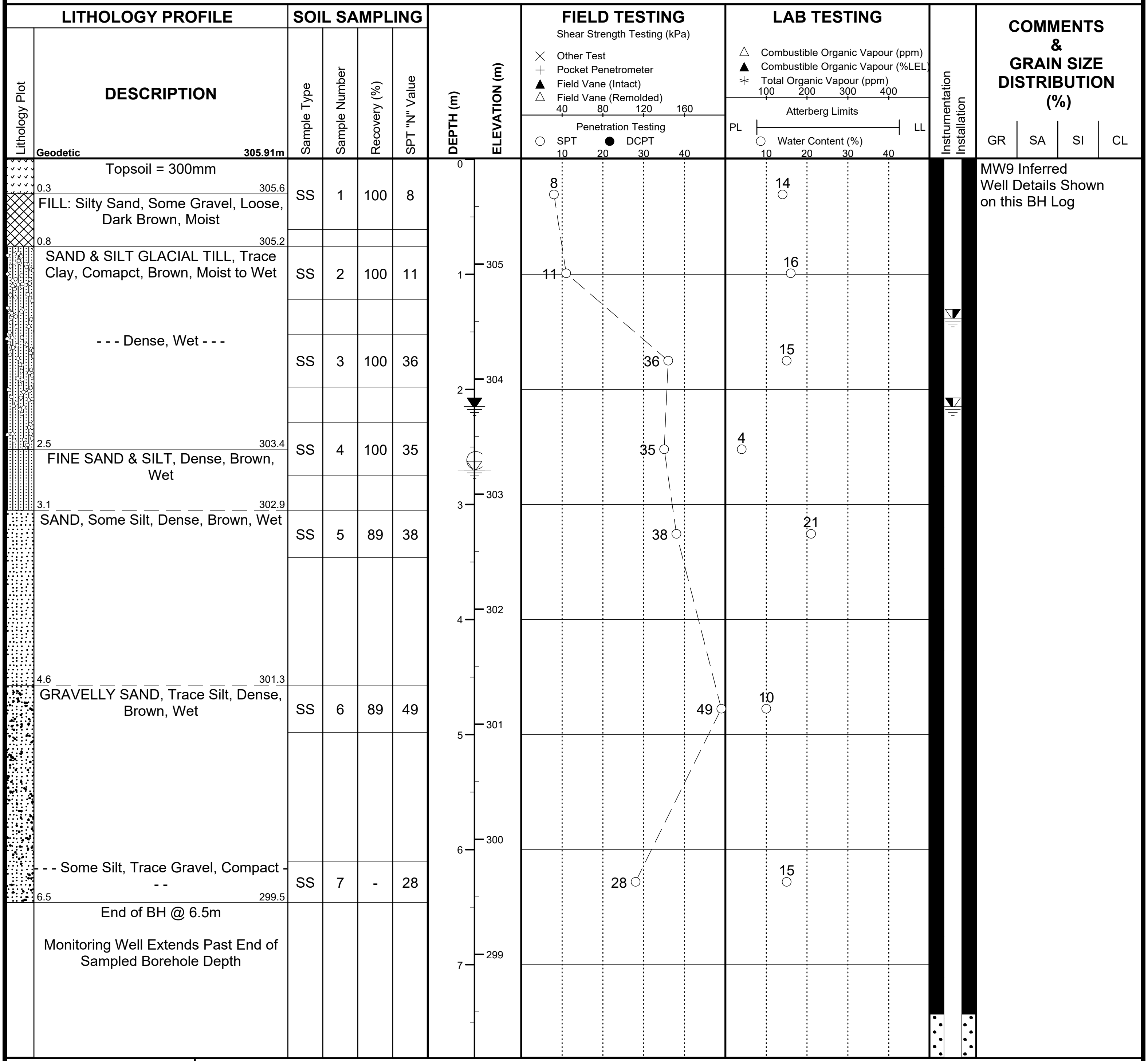
RECORD OF BOREHOLE No. 13

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909296**
Easting: **602655**
Date Started: **2020-03-05**
Date Completed: **2020-03-05**



Depth (m)	Elevation (m)	DESCRIPTION
0	305.91	Topsoil = 300mm
0.3	305.6	FILL: Silty Sand, Some Gravel, Loose, Dark Brown, Moist
0.8	305.2	SAND & SILT GLACIAL TILL, Trace Clay, Comapct, Brown, Moist to Wet - - - Dense, Wet - - -
2.5	303.4	FINE SAND & SILT, Dense, Brown, Wet
3.1	302.9	SAND, Some Silt, Dense, Brown, Wet
4.6	301.3	GRAVELLY SAND, Trace Silt, Dense, Brown, Wet - - Some Silt, Trace Gravel, Compact - - -
6.5	299.5	End of BH @ 6.5m Monitoring Well Extends Past End of Sampled Borehole Depth

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)
SS	1	100	8	14
SS	2	100	11	16
SS	3	100	36	15
SS	4	100	35	4
SS	5	89	38	21
SS	6	89	49	10
SS	7	-	28	15

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL

MW9 Inferred Well Details Shown on this BH Log

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Groundwater depth encountered on completion of drilling: **2.7m**

Cave depth after auger removal: **2.7m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **2.15m**

Observed on **Apr. 1/20** at a depth of: **1.38m**

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 :50**

RECORD OF BOREHOLE No. 13

GEI Consultants

Project Number:	**20-1014A**				
Project Client:	**PetromaxX Construction**				
Project Name:	**664, 674 & 692 Essa Rd and 320 Mapleview**	Drilling Method:	**Solid Stem**	Drilling Machine:	**Track Mount**
Project Location:	**Barrie, Ontario**	Logged By: **BH**	Northing: **4909296**	Date Started:	**2020-03-05**
Drilling Location:	**See Attached Drawing**	Reviewed By: **AW**	Easting: **602655**	Date Completed:	**2020-03-05**

LITHOLOGY PROFILE: Lithology Plot; DESCRIPTION

SOIL SAMPLING: Sample Type; Sample Number; Recovery (%); SPT "N" Value

DEPTH (m); **ELEVATION (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

COMMENTS & GRAIN SIZE DISTRIBUTION (%): GR; SA; SI; CL

Depth (m)	Elevation (m)
	298
8	
	297
9	

Description depth	Elevation
9.6	296.4

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Groundwater depth encountered on completion of drilling: **2.7m**

Cave depth after auger removal: **2.7m**

Groundwater depth observed on **Mar. 5/20** at a depth of: **2.15m**

Observed on **Apr. 1/20** at a depth of: **1.38m**

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 :50**

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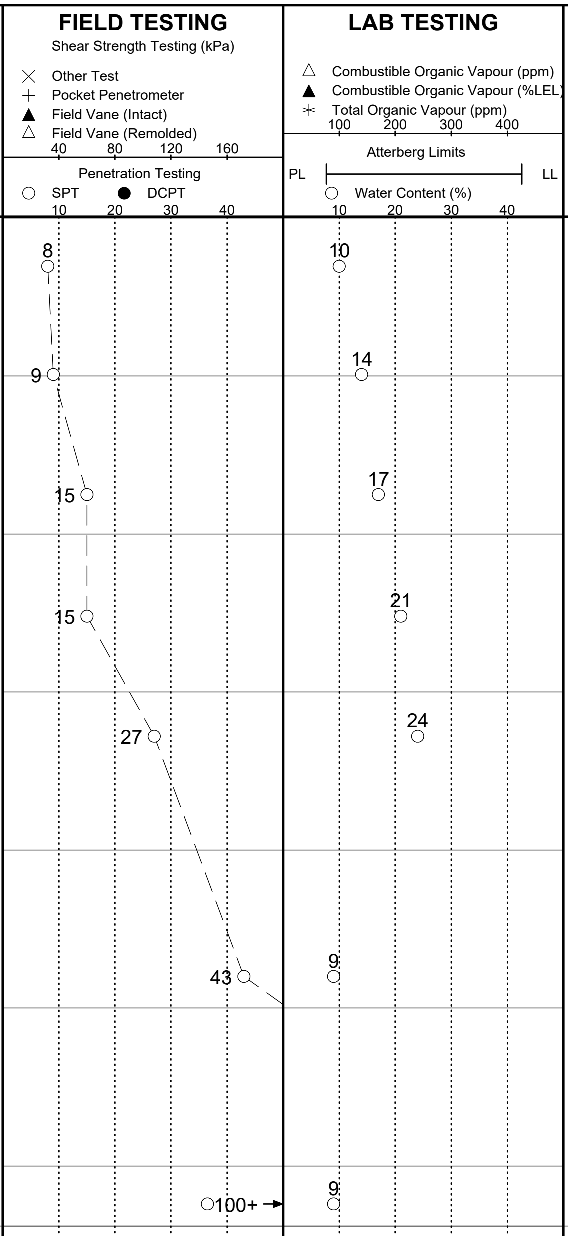
RECORD OF BOREHOLE No. 14

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**
Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4909333**
Easting: **602771**
Date Started: **2020-03-05**
Date Completed: **2020-03-05**

LITHOLOGY PROFILE		SOIL SAMPLING						COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Depth / Elevation	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	GR	SA	SI	CL
	Geodetic 305.99m					0					
0.3 305.7	Topsoil = 300mm										
0.8 305.2	FILL: Sand & Silt, Some Gravel, Trace to Some Clay, Loose, Dark Brown, Moist	SS	1	100	8						
	SAND & SILT to SILTY SAND GLACIAL TILL, Trace Clay, Loose, Brown, Moist to Wet	SS	2	100	9	1	305				
2.0 304.0	- - - Compact, Wet - - -	SS	3	100	15						
	SILTY SAND, Trace Clay, Compact, Greyish Brown, Wet					2	304				
		SS	4	100	15			0	69	27	4
						3	303				
	- - - Some Gravel, Compact, Wet - - -	SS	5	100	27						
4.6 301.4						4	302				
	SAND & SILT GLACIAL TILL, Some Clay, Trace Gravel, Hard, Grey, Moist	SS	6	100	43						
						5	301				
						6	300				
6.4 299.6	- - - Moist to Wet - - -	SS	7	61	100+						
	End of BH @ 6.4m										



Instrumentation Installation

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Groundwater depth encountered on completion of drilling: **2.4m**

Cave depth after auger removal: **2.4m**

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 :50**

Page: **1 of 1**

RECORD OF BOREHOLE No. 15

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909368**
Date Started: **2020-03-04**
Reviewed By: **AW**
Easting: **602891**
Date Completed: **2020-03-04**

LITHOLOGY PROFILE / SOIL SAMPLING

Lithology Plot	DESCRIPTION Geodetic 305.63m	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	0.2 Topsoil = 180mm 305.5					MW10 Inferred Well Details Shown on this BH Log
	FILL: Silty Sand, Compact, Dark Brown, Moist	SS	1	100	13	
	0.8 FILL: Sandy Silt, Some Clay to Clayey, Loose, Greyish Brown, Moist to Wet 304.9	SS	2	100	6	
	- - - Very Loose, Wet - - -	SS	3	100	2	
	2.3 FINE SAND & SILT, Trace Clay, Dense, Brown, Wet 303.3	SS	4	100	42	
		SS	5	100	40	
	4.6 SAND, Some Silt to Silty, Trace Gravel, Compact, Greyish Brown, Wet 301.1	SS	6	100	25	
	6.1 SAND & SILT GLACIAL TILL, Some Clay, Trace Gravel, Hard, Grey, Moist 299.5	SS	7	100	80	
	6.6 End of BH @ 6.6m 299.1 Monitoring Well Extends Past End of Sampled Borehole Depth					

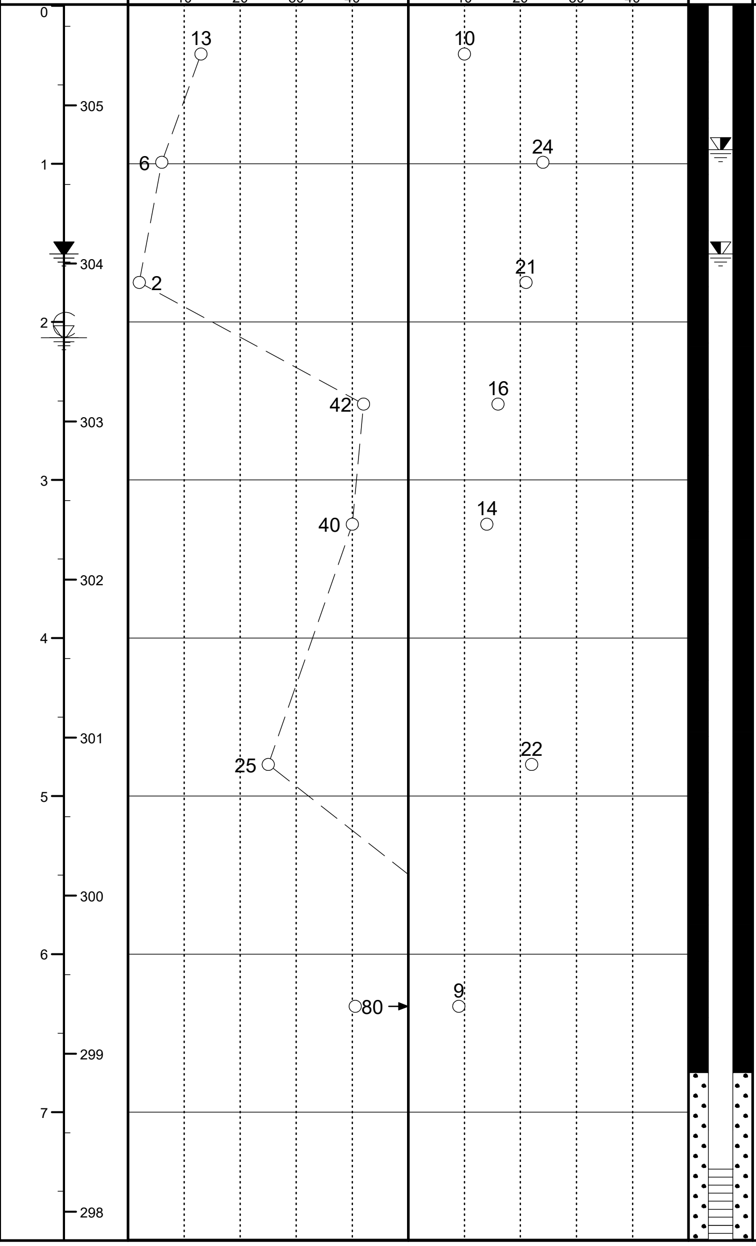
FIELD TESTING

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



CENTRAL EARTH ENGINEERING

647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
E: info.com
W: centralearth.com

Groundwater depth encountered on completion of drilling: **2.1m**
Cave depth after auger removal: **2.1m**
Groundwater depth observed on **Mar. 5/20** at a depth of: **1.57m**
Observed on **Apr. 1/20** at a depth of: **0.91m**

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 :50**

RECORD OF BOREHOLE No. 15

GEI Consultants

Project Number: **20-1014A**
Project Client: **PetromaxX Construction**
Project Name: **664, 674 & 692 Essa Rd and 320 Mapleview**
Project Location: **Barrie, Ontario**
Drilling Location: **See Attached Drawing**

Drilling Method: **Solid Stem**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4909368**
Date Started: **2020-03-04**
Reviewed By: **AW**
Easting: **602891**
Date Completed: **2020-03-04**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	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	△ 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	GR	SA	SI	CL
	8.9 296.8					8	297							

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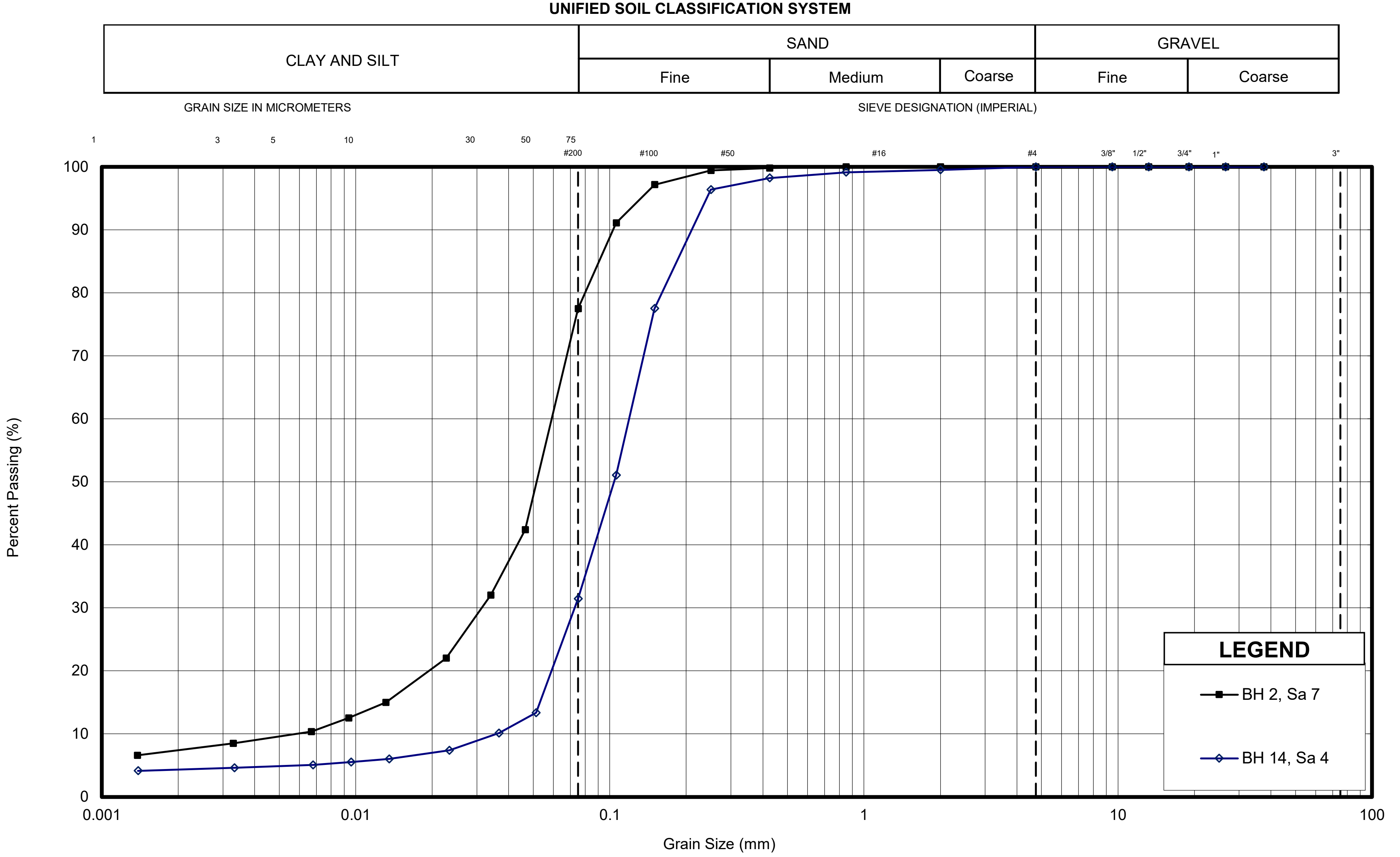
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and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

Scale: **1 :50**

Appendix B –

GEOTECHNICAL LABORATORY DATA



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 3, Sa 7	SANDY SILT, trace clay	0	23	70	7	0.006	0.032	0.059	10.11	2.9
BH 14, Sa 4	SILTY SAND, trace clay	0	69	27	4	0.036	0.073	0.119	3.3	1.12

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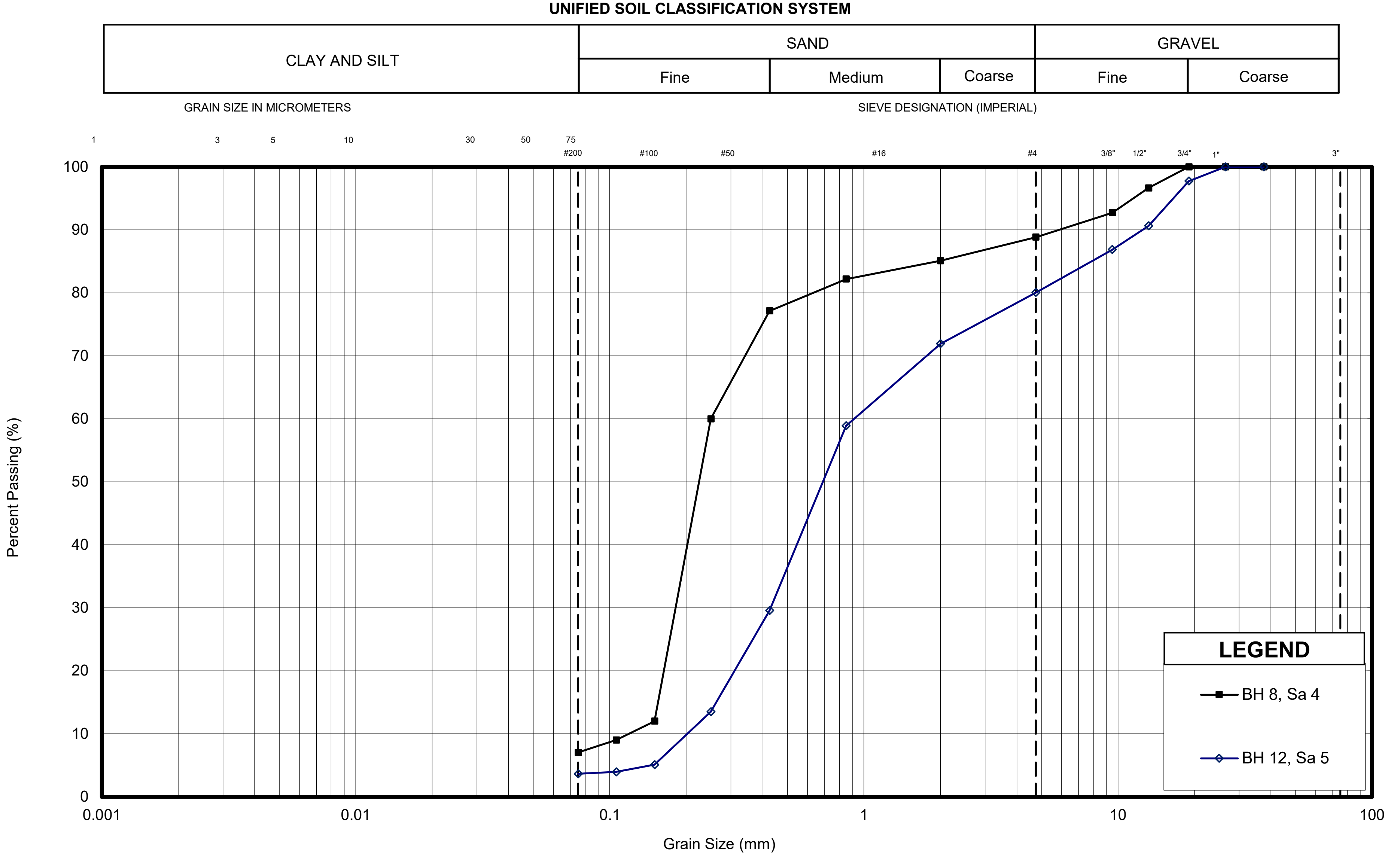
GRAIN SIZE DISTRIBUTION

SANDY SILT TO SILTY SAND

FIGURE No. B1

REF. No. 20-1014A

DATE April 2020



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 8, Sa 4	SAND, some gravel, trace fines	11	82	7		0.12	0.18	0.25	2.1	1.1
BH 12, Sa 5	GRAVELLY SAND, trace fines	20	76	4		0.20	0.429	0.914	4.5	1.0

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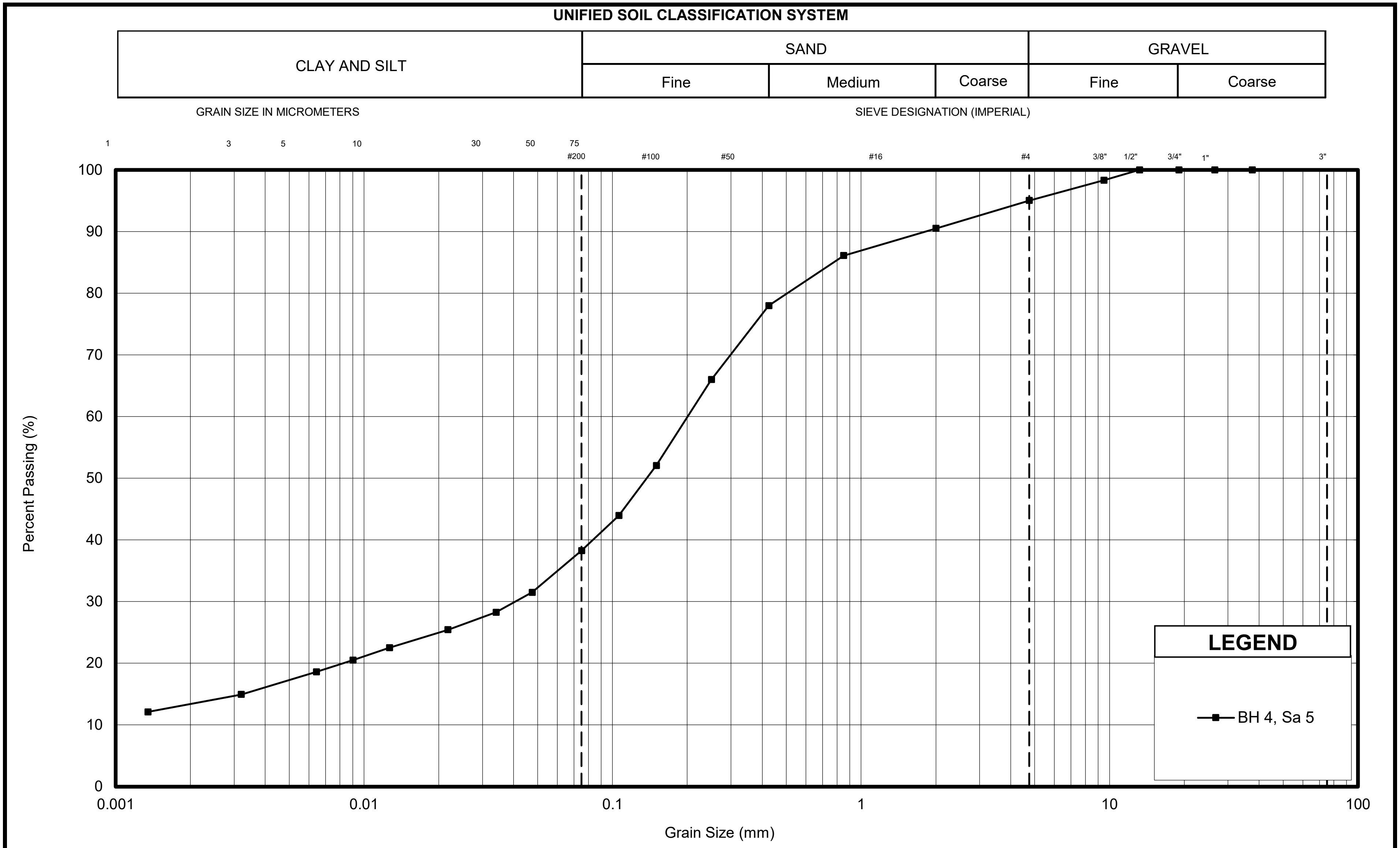
GRAIN SIZE DISTRIBUTION

SAND TO GRAVELLY SAND

FIGURE No.	B2
REF. No.	20-1014A
DATE	April 2020

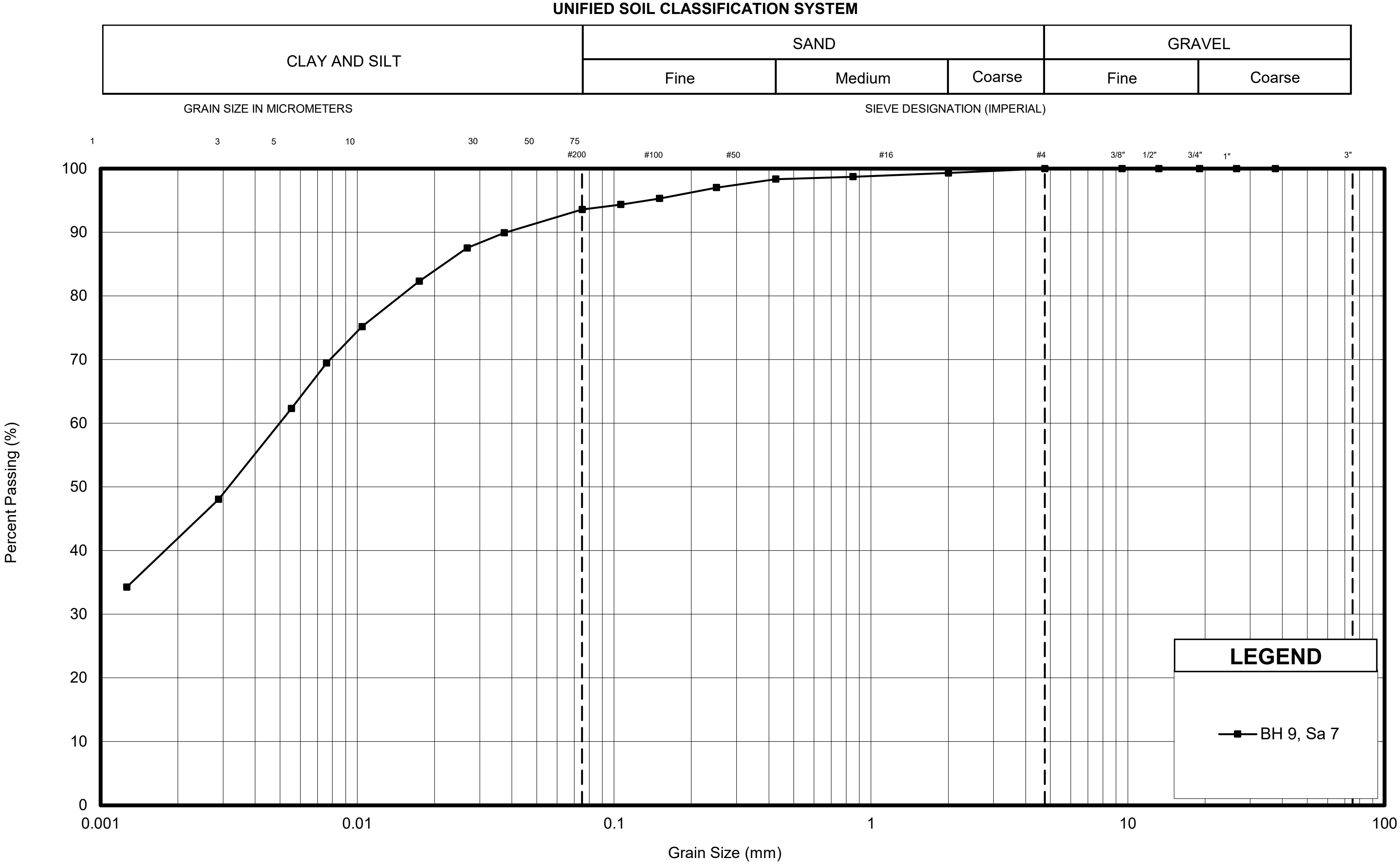


Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 4, Sa 5	SILTY SAND GLACIAL TILL, some clay, trace gravel	5	57	25	13	-	0.041	0.20	-	-

GRAIN SIZE DISTRIBUTION

SILTY SAND GLACIAL TILL

FIGURE No. B3
REF. No. 20-1014A
DATE April 2020



Sample	**Description**	**Gr.**	**Sa.**	**Si.**	**Cl.**	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 9, Sa 7	SILT AND CLAY, trace sand	0	6	52	42	-	-	0.005	-	-

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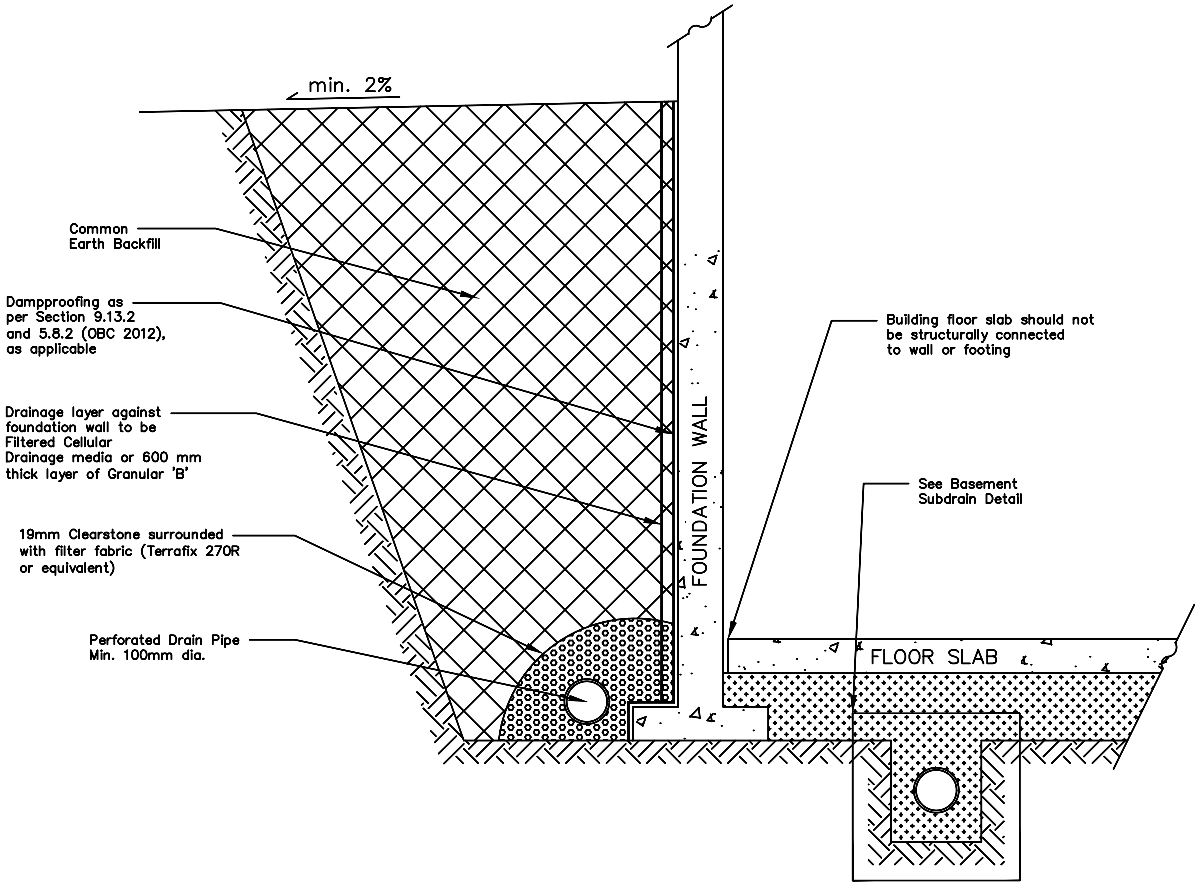
GRAIN SIZE DISTRIBUTION

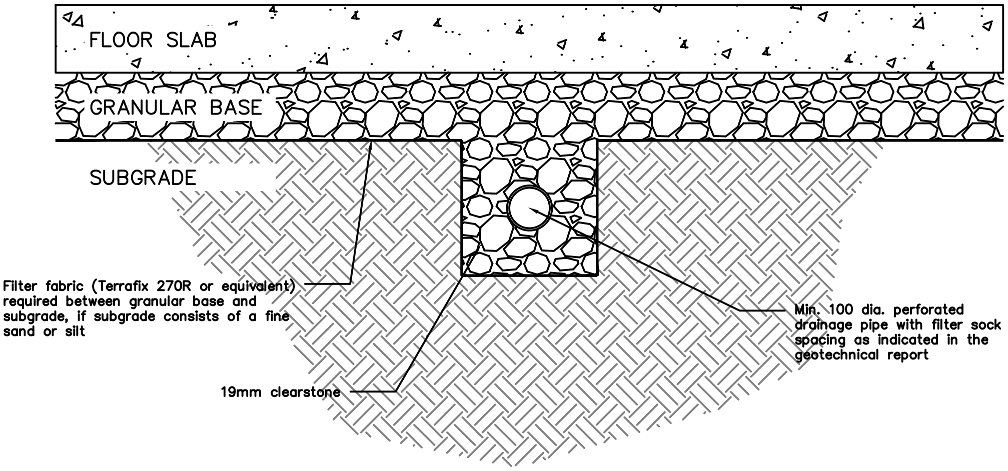
SILT & CLAY

FIGURE No. B4
REF. No. 20-1014A
DATE April 2020

Appendix C –

TYPICAL DETAILS





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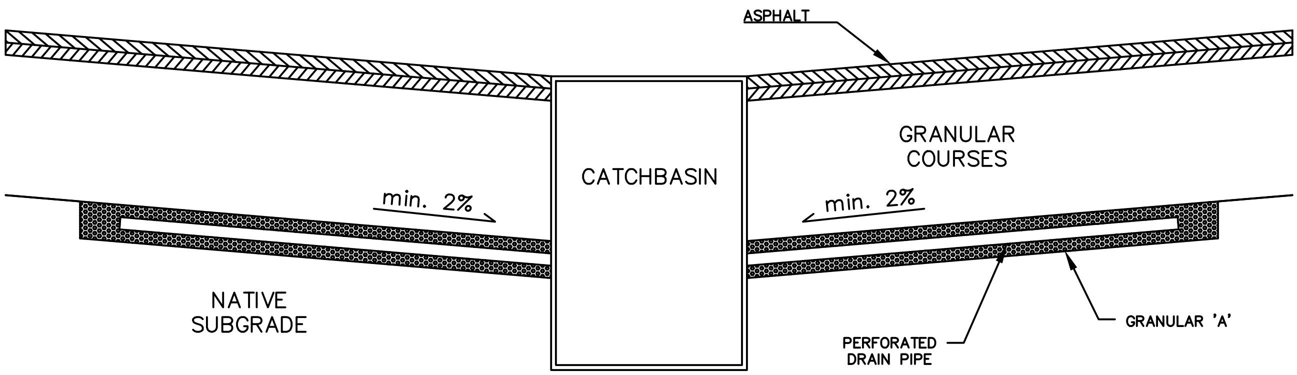
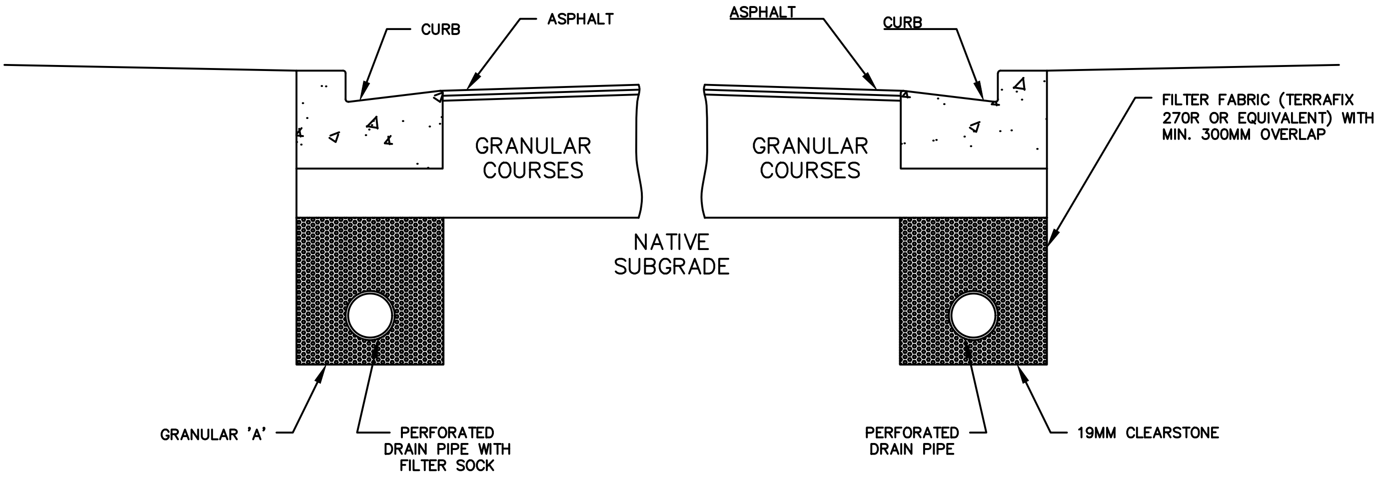
BASEMENT FOUNDATION WALL & SUBFLOOR DRAINAGE TYPICAL DETAIL

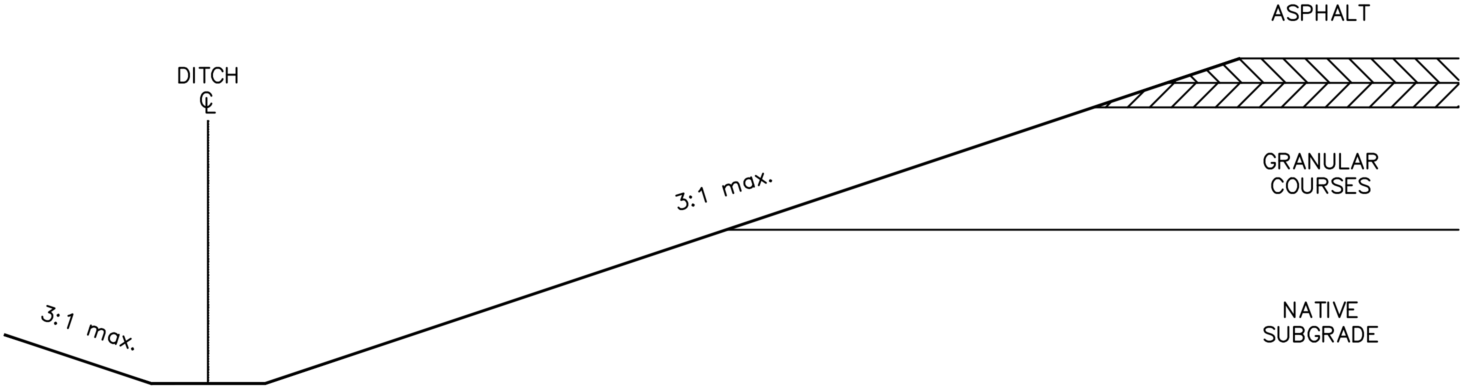




Unwrapped Trench

Wrapped Trench

Urban Cross Sections



Rural Cross Section

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PAVEMENT DRAINAGE ALTERNATIVES TYPICAL DETAILS