Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION AND ENGINEERING REPORT
PROPOSED MIXED-USE DEVELOPMENT
642 DUNLOP STREET WEST
BARRIE, ONTARIO

Prepared For: **25707517 ONTARIO INC.**
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1.0 THE PROJECT

Terraprobe Inc. (Terraprobe) was retained by 25707517 Ontario Inc. to conduct a subsurface investigation and prepare a geotechnical design report for the re-development of a parcel of land with municipal address 642 Dunlop Street West, in the City of Barrie, Ontario. A site location plan is provided as Figure 1.

This report encompasses the geotechnical investigation conducted for the property to assess its geotechnical suitability for the intended re-development. The field investigation consisted of advancing a total of nine (9) exploratory boreholes (eight (8) boreholes were advanced with regular sampling and one (1) borehole was augered without sampling for installation of a groundwater monitoring well) across the site. The objective of the geotechnical investigation was to determine the prevailing subsurface soil and groundwater conditions, in order to provide geotechnical engineering recommendations for the design of the proposed building foundations, slab-on-grade, earthquake and earth pressure design parameters, pavement design, pipe bedding and installation of underground utilities. In addition, comments are also included on the pertinent project construction aspects including excavation, backfill and groundwater control.

Terraprobe was also retained to conduct a hydrogeological study to assess dewatering requirements for the property. The findings of the hydrogeological study are reported under separate cover.

2.0 SITE AND PROJECT DESCRIPTION

The property is located at the northeast quadrant of Dunlop Street West and Miller Road in Barrie, Ontario, and currently houses two low-rise commercial structures. The municipal addresses are 642 Dunlop Street West, Barrie.

Based on the architectural drawing set (Project: Proposed 5-Storey Condo Building, 642 Dunlop Street W., Barrie, ON; Project Number 15-48) dated Dec. 15, 2015, updated Feb. 4, 2022, prepared by n Architecture Inc., it is proposed to demolish the existing structures and construct a new 5-storey mixed use building with slab-on-grade construction (no basement), commercial use and covered parking/driveway at ground level and residential use above. There will also be at-grade exterior parking and driveway. The ground finished floor elevation was not yet established at the time of this investigation, however it is understood that it may be in the range of Elev. 235.80 m to 236.10 m which would be close to or above current site grades.

As such, the geotechnical investigation was conducted to assess the geotechnical suitability of the property for the intended development. The geotechnical investigation consisted of advancing a total of nine (9) boreholes (eight (8) boreholes were advanced with regular sampling and one (1) borehole was augered without sampling for installation of a groundwater monitoring well) across the site to obtain subsurface soil and groundwater information.

3.0 INVESTRIGATION PROCEDURE

The field investigation was conducted between January 18 and 20, 2021, and consisted of drilling and sampling a total of eight (8) exploratory boreholes (Boreholes 1 to 8) and one borehole (Borehole 9) was augered without sampling for installation of a groundwater monitoring well. The boreholes extended to the depths ranging from about 1.8 to 12.6 m below existing ground surface.

The boreholes were staked out by Terraprobe based on the existing site features. The approximate borehole locations are shown on enclosed Borehole Location Plan (Figure 2A- Existing Condition and Figure 2B – Proposed Condition).

Various utility locate agencies (including a private locate company) were contacted by Terraprobe to clear the borehole locations prior to the commencement of the field investigation.

The ground surface elevations at the borehole locations were surveyed by Terraprobe. Borehole elevations are provided relative to Geodetic Datum (NAD). The horizontal coordinates are reported relative to the Universal Transverse Mercator geographic coordinate system (UTM Zone 17T). It should be noted that the elevations provided on the Borehole Logs are approximate and provided only for the purpose of relating borehole soil stratigraphy and should not be used or relied on for other purposes.

The borings were drilled by a specialist drilling contractor using a track/truck mounted drill rig power auger drilling techniques and sampled at regular intervals with a conventional 50 mm diameter split barrel samplers when the Standard Penetration Test (SPT) was carried out (ASTM D 1586). Additionally, dynamic cone penetration tests were conducted beside Boreholes 2, 3 and 4 and the Penetration Test Values are shown on those borehole logs. The field work (drilling, sampling, and testing) was observed full time and recorded by a Terraprobe filed staff, who logged the boring and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into plastic jars and transported to our geotechnical laboratory for detailed inspection and testing. The borehole samples were examined (tactile) in detail by a geotechnical engineer and classified according to visual and index properties. Geotechnical laboratory testing consisted of water content determination on all samples, while a Sieve and Hydrometer analysis was conducted on four (4) selected soil samples (Borehole 1, Sample 5; Borehole 2, Sample 4; Borehole 3, Sample 7 and Borehole 4, Sample 10). The measured natural water contents of individual samples and the results of the Sieve and Hydrometer analyses tests are plotted on the enclosed borehole logs at respective sampling depths. The results of the Sieve and Hydrometer analyses tests are also summarized in Section 4.5 of this report and appended.

Groundwater levels were observed in the open boreholes upon completion of drilling. Monitoring wells were installed in Boreholes 1 to 5 and 9 to facilitate groundwater monitoring and for hydrogeological purposes. The results of the groundwater monitoring are summarized in Section 4.6 of this report.

4.0 SUBSURFACE CONDITIONS

The specific soil conditions encountered at each borehole location are described in greater detail on the Borehole Logs, with a summary of the general subsurface soil conditions outlined below. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions at the site.

It should be noted that the subsurface conditions are confirmed at the borehole locations only and may vary between and beyond the borehole locations. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

4.1 Surficial Materials

A pavement structure consisting of 130 mm to 230 mm of asphaltic concrete overlying 130 mm to 370 mm of granular fill was encountered at the surface of Boreholes 1, 3, 5 and 6. A 230 mm thick layer of asphaltic concrete was encountered at the surface at Borehole 8, however there was no granular base material observed below the asphaltic concrete at this borehole. Surficial topsoil with thickness raging from about 200 to 450 mm was encountered at the ground surface in Borehole 2. Asphaltic concrete with thickness of about 50 mm and underlain by a 150 mm thick granular base/aggregate layer was encountered at the ground surface in Borehole 3.

Surficial topsoil with thickness raging from about 140 to 150 mm was encountered at the ground surface in Boreholes 2, 4 and 7. The topsoil generally consisted of a silt matrix and was dark brown to black in colour.

The above noted pavement structure and topsoil thicknesses were measured through the collar of the boreholes and are approximate. The pavement structure and topsoil are expected to vary between and beyond the boreholes. We recommend that a shallow test pit investigation be carried out to determine precise pavement structure and topsoil thickness present at the site for quantity estimation and costing purposes (if required).

4.2 Earth Fill

Underlying the surficial topsoil in Boreholes 2, 4 and 7 and the asphaltic concrete in Borehole 8, a layer of earth fill was encountered and extended to a depth of about 0.6 m (Elev. 233.7 m to 234.8 m) below grade. The earth fill material generally consisted of sand or sandy silt with peat and gravel.

Standard Penetration Test results (N-values) obtained from the earth fill zone ranged from 4 to 22 blows per 300 mm of penetration, indicating a loose to compact relative density. The in-situ moisture contents of the earth fill samples ranged from 9 to 27 percent by weight, indicating a generally moist condition. Elevated moisture contents may be attributable to the presence of organic matter in the fill.

4.3 Peat

A layer peat was encountered below the pavement structure in Boreholes 1, 3, 5 and 6, and below the earth fill in Boreholes 2, 4, 7 and 81 and below the organic silt in Borehole 2 and extended to a depth ranging from about 0.8 to 1.5 m (Elev. 232.9 m to 234.5 m) below grade. The peat had inclusions of sand seams.

The Standard Penetration Test results ('N' Values) obtained from the peat deposit ranged from 2 to 14 blows per 300 mm of penetration, indicating a very loose to compact relative density (generally loose). The measured moisture contents of the peat samples ranged from 32 to 132 percent by weight, indicative of the organic nature of the material.

It should be noted that the peat can be a methane generating material. Any such investigation was beyond the scope of this investigation.

4.4 Sand

Sand with trace amount of silt, clay and gravel was encountered below the peat layer in all boreholes and extended to depth of investigation in all boreholes, i.e., depth ranging from 1.8 to 12.6 m below grade. A thin layer of sandy silt was encountered between 4.6 and 5.0 m (Elev. 230.7 m and 230.3 m) in Borehole 3. The sand generally became water bearing below about 1.5 ±m depth below grade.

Standard Penetration Test results (N-values) obtained from the sand deposit ranged from 0 to 46 blows per 300 mm of penetration, indicating a loose to dense relative density (generally very loose to loose or compact to about 9 ±m depth and becoming dense below). However, it should be noted that some of these 'N' values are likely affected by disturbance of the sands from augering.

As noted earlier, dynamic cone penetration tests (DCPT) were conducted beside Boreholes 2, 3 and 4 to get a better appreciation of Penetration values of the sand deposit. At Borehole 2, the DCPT values ranged from 0 to 7 blows per 300 mm of penetration from a depth of 1.2 to 3.5 m below grade; from about 10 to 20 blows per 300 mm penetration from a depth of 3.5 to 7.5 m below grade and generally about greater than 30 blows per 300 mm of penetration from 8 to 12.6 m depth. At Borehole 3, the DCPT values ranged from 0 to 5 blows per 300 mm of penetration from 1.5 to about 5.5 m depth below grade and from about 10 to 22 blows per 300 mm of penetration from about 6.0 to 8.1 m depth. At Borehole 4, the DCPT values ranged from about 4 to 10 blows per 300 mm of penetration between 0.9 and 1.8 m depth below grade, from about 15 to 20 blows per 300 mm of penetration from about 1.8 to 4.0 m depth below grade; 30 to 40 blows per 300 mm of penetration between 4.0 and 8.5 m depth below grade and generally greater than 50 blows per 300 mm penetration or less from 8.5 to 12.6 m depth.

The in-situ moisture contents of the sand samples ranged from 14 to 29 percent by weight, indicating a wet condition.

4.5 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of natural moisture content determination for all samples from the boreholes, while Sieve and Hydrometer analysis tests were conducted on selected soil samples. The test results are plotted on the enclosed Borehole Logs at respective sampling depths.

The results (graphs) of the Sieve and Hydrometer (grain size) analysis are appended, and a summary of these results is presented as follows:

Borehole No. Sample No.	Sampling Depth below Grade (m)	Percentage (by mass)				Descriptions (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 1, Sample 5	3.3	6	89	3	2	SAND, s trace gravel, trace silt, trace clay
Borehole 2, Sample 4	2.5	0	97	2	1	SAND, trace silt, trace clay
Borehole 3, Sample 7	6.3	0	95	3	2	SAND, trace silt, trace clay
Borehole 4, Sample 10	10.9	5	91	2	2	SAND, , trace gravel trace silt, trace clay

4.6 Groundwater

Observations pertaining to the depth of groundwater level and caving were made in the open boreholes immediately after completion of drilling in all boreholes and are noted on the enclosed Borehole Logs. Monitoring wells were installed in all boreholes to facilitate groundwater level monitoring and for the purpose of Terraprobe's geotechnical, environmental, and hydrogeological studies. The groundwater readings taken on February 1, 2022, are noted on the enclosed Borehole Logs. A summary of these observations is provided as follows:

Borehole No.	Ground Surface Elevation (m)	Depth of Boring below Grade (m)	Depth to Cave below Grade (m)	Groundwater Level Depth/Elevation (m)	
				At the Time of Drilling	Monitoring Well February 1, 2022
1	235.5	8.1	Not measured	1.5/234.0	Well Inaccessible

Borehole No.	Ground Surface Elevation (m)	Depth of Boring below Grade (m)	Depth to Cave below Grade (m)	Groundwater Level Depth/Elevation (m)	
				At the Time of Drilling	Monitoring Well February 1, 2022
2	234.5	12.6	Not measured	1.5/233.0	1.7/232.8
3	235.3	8.1	Not measured	2.3/233.0	1.8/233.5
4	235.4	12.6	Not measured	2.3/233.1	1.9/233.5
5	235.2	8.1	Not measured	1.5/233.7	1.5/233.7
6	235.7	1.8	Open	1.5/234.2	Monitoring well not installed
7	234.3	1.8	Open	dry	Monitoring well not installed
8	235.1	1.8	Open	dry	Monitoring well not installed
9	234.4	5.0	Open	1.5/232.9	1.7/232.7

The groundwater levels encountered in the monitoring wells on February 1, 2022 monitoring) indicated a shallow water table with an elevation ranging from about 232.7 m to 233.7 m, i.e., a depth ranging from about 1.5 to 1.9 m below existing grade. Groundwater levels may fluctuate with time, and seasonally, depending on the amount of precipitation and surface runoff.

5.0 GEOTECHNICAL DESIGN

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use by the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards, and guidelines of practice. If there are any changes to the site development features or any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

It is understood that the development concept consists of the demolition of the existing structures and construction of a new 5-storey mixed use building with slab-on-grade construction (no basement), commercial use and covered parking at ground level and residential use above. The ground finished floor elevation was not yet established at the time of this investigation, however it is understood that it may be in the range of Elev. 235.80 m to 236.10 m which would be close to or above current site grades.

5.1 Foundation Design Parameters

Based on the borehole findings, below any surficial materials (topsoil or pavement structure) the subsurface conditions generally consist of loose sand fill with peat organics and or loose an organic peat layer extending to a depth of up to 1.5 m below grade. These materials are underlain by the native sand deposit which is generally very loose to loose with some compact zone to about 6 to 8 m depth and becoming generally dense below about 8± m depth.

Given the prevailing very poor upper subsurface conditions on the site, conventional footings on native soils are not expected to be feasible for this structure. As such considerations should be given to ground improvement or the use of helical piers to support the building.

5.1.1 Ground Improvement Techniques

Consideration may be given to ground improvement techniques, which are used to improve the geotechnical properties of relatively weak and poor earth fill and native soils underlying a site to facilitate the construction of the intended structures using conventional construction techniques and design.

Using ground improvement on this site will allow the use of conventional spread footings. It is estimated that the maximum net geotechnical reaction at SLS is about 150 to 200 kPa, and the maximum factored geotechnical resistance at ULS is about 225 to 300 kPa for preliminary design, to be confirmed by GeoSolv or other design-build firms.

There are various patented ground improvement techniques available. For this site, the Geopier Rammed Aggregate Pier (RAP) system may be considered. Improving the soils using the RAP System will allow for conventional spread footing foundations to support the proposed structure. Rigid inclusions or other ground improvement techniques may be required at this site, however, the design-build firm can make that determination.

5.1.2 Helical Earth Screw Anchors

Helical Screw Anchors (see enclosed information in Appendix C) may also be considered to support the proposed structure and could be drilled through the generally loose upper layer soils (fill, peat, and loose sand zone) and into the underlying compact to dense native sand soils to sufficient depth in order to obtain the adequate resistance for the required support for the foundation. The actual pile design is recommended to be provided by a structural engineer from a specialist contractor who would design, install, and certify the foundations. The screw anchors require little to no excavation to install and are not affected by high groundwater levels.

The helical pile section would be drilled into the competent strata which provides sufficient resistance. The section is extended further as needed with extension rods. A pile cap / grade beam is constructed to transfer the building loads onto the underlying competent soils through the helical piers. The actual depth of the helical screw pile is determined on site during installation based on field torque readings and load support requirements. The load carrying capacity of the helical piers is confirmed by the Proprietary Design-Build company based on a full-scale prototype/production pile test.

There are specific companies (such as EBS Geostructural or other design-build firms) that specialize in the helical screw anchor design and installation, and can provide further information on the methodology, detailed design, installation, and certification. It should be noted that the presence of debris/obstructions within the fill material, if present, could impede the helical pier installation.

The following parameters may be assumed for the underlying dense native soil:

	Sand (Dense)
Soil unit weight (γ_{bulk})	21 kN/m^3
Angle of Internal Friction (φ)	34°
Cohesion (c)	0 kPa

For round shaft helical pier design (RS3500), the following preliminary parameters (Ref: EBS Geostructural Round Shaft Helical Pier Capacity Charts) may be considered below Elevation 226 to 227 m or lower, subject to consultation and confirmation from the design-build contractor:

- Max. Factored Geotechnical Resistance, ULS (kN): 280
- Net Geotechnical Reaction, SLS (kN): 210

The refusal depth of these piers will depend upon the type of helical pier section and loading considerations. It is recommended that the project geotechnical information be provided to a specialized design/build contractor to assess the feasibility of this foundation system and to determine helical pier refusal/installation depths, and any further subsurface investigation, if required.

5.1.3 Placement of Footings

Prior to placing concrete for foundations of the structures, the foundation areas must be cleaned of all deleterious materials such as topsoil, fill, and softened, disturbed, or caved materials, as well as any standing water.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided. Native soils tend to weather rapidly and deteriorate on exposure to the atmosphere and surface water. Hence, foundation bases which remain open for an extended period of time should be protected by a skim coat of lean concrete.

The underside of footing elevations must be designed with a minimum of 1.5 m of soil cover from the proposed site grading elevation or equivalent insulation to the foundation subgrade for frost protection in unheated areas.

Footings stepped from one level to another must be at a slope not exceeding 7 vertical to 10 horizontal.

5.2 Earthquake Design Parameters

The Ontario Building Code stipulates the methodology for earthquake design analysis. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

Under Ontario Regulation 88/19, the ministry amended Ontario's Building Code (O. Reg 332/12) to further harmonize Ontario's Building Code with the 2015 National Codes. These changes will help reduce red tape for businesses and remove barriers to interprovincial trade throughout the country. The amendments are based on code change proposals the ministry consulted in 2016 and 2017. The majority of the amendments came into effect on January 1, 2020, which includes structural sufficiency of buildings to withstand external forces and improve resilience.

Seismic hazard is defined in the Ontario Building Code (OBC) by uniform hazard spectra (UHS) at spectral coordinates of 0.2s, 0.5s, 1.0s and 2.0s and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g., shear wave velocity (vs), Standard Penetration Test (SPT) resistance, and undrained shear strength (s_u) in the top 30 meters of the site stratigraphy below the foundation level, as set out in the Ontario Building Code. There are 6 site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain peak ground acceleration (PGA), peak ground velocity (PGV) site coefficients Fa and Fv, respectively, used to modify the UHS to account for the effects of site-specific soil conditions.

Based on the above noted information, it is recommended that the site designation for seismic analysis be 'Site Class D', as per the Ontario Building Code. Consideration may be given to conducting a site specific Multichannel Analysis of Surface Waves (MASW) at this site to confirm the average shear wave velocity in the top 30 metres of the site stratigraphy.

The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.B. to 4.1.8.4.I. using linear interpolation for intermediate values of PGA.

5.3 Earth Pressure Design Parameters

The parameters used in the determination of earth pressures acting on retaining walls are defined below.

Parameter	Definition	Units
φ	internal angle of friction	degrees
γ	bulk unit weight of soil	kN / m^3
K_a	active earth pressure coefficient (Rankine)	dimensionless
K_o	at-rest earth pressure coefficient (Rankine)	dimensionless
K_p	passive earth pressure coefficient (Rankine)	dimensionless

The appropriate values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

Stratum/Parameter	φ	γ	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS 1010)	32	21.0	0.31	0.47	3.25
Existing Earth Fill	29	19.0	0.35	0.52	2.88
Sand	34	21.0	0.28	0.44	3.54

Walls subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$\boldsymbol{P = K[\gamma(h - h_w) + \gamma' h_w + q] + \gamma_w h_w}$$

where,
- **P** = the horizontal pressure at depth, **h** (m)
- **K** = the earth pressure coefficient
- $\mathbf{h_w}$ = the depth below the groundwater level (m)
- $\boldsymbol{\gamma}$ = the bulk unit weight of soil, (kN/m^3)
- $\boldsymbol{\gamma'}$ = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
- **q** = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall that would otherwise act in conjunction with the earth pressure, this equation can be simplified to:

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

This equation assumes that free-draining granular backfill such as Granular 'B' (OPSS.MUNI 1010) is used and effective drainage is provided. Consideration must also be given to the possible effects of frost on structures retaining earth. Pressures induced by freezing in frost-susceptible soils exert pressures and are effectively irresistible.

The factored geotechnical resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction (**R**) depends on the normal load of the soil contact (**N**) and the frictional resistance of the soil (**tan φ**) expressed as $\boldsymbol{R_f = N\, tan\varphi}$, which is the unfactored resistance. The factored geotechnical resistance at ULS is $\boldsymbol{R_f = 0.8\, N\, tan\varphi}$.

5.4 Slab-on-Grade Design Parameters

The slab on grade should be set at least 0.5 m above the seasonally high groundwater level.

The proposed ground floor slab (understood range: Elev. 235.80 m to 236.10 m) is expected to be close to or above existing grade. As such some grade raise/placement of fill may be required. All non-structural earth fill, peat and other deleterious or unsuitable materials must be removed prior to constructing the slab on grade or placement of new fill for grade raise. These materials do not constitute an adequate subgrade for support of a slab on grade. After any unsuitable materials are removed, the exposed soil which must not be proof rolled as this will disturb the sand subgrade, must be inspected, and approved by Terraprobe at the time of construction. Any structural fill placed to raise grades, must be placed in maximum 150 mm thick lifts, and compacted to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD).

The modulus of subgrade reaction appropriate for slab on grade design on the compacted earth fill or native sand is 18,000 kPa/m.

It is necessary that building floor slabs be provided with a capillary moisture barrier and drainage layer. This is accomplished by placing the 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 the 200 mm drainage layer may be replaced with 50 mm of Granular A (OPSS.MUNI 1010) to provide a trafficable surface.

Perimeter drainage is not needed where the lowest finished floor is at least 300 mm higher than exterior grade. Drainage of the subgrade and frost-resistant backfill is required where doors are flush to grade or in areas where the finished floor is less than 300 mm higher than grade. This is to prevent impaired door function during winter months.

It should be noted that if ground improvement of the site soils is carried out, these soils would also be suitable for supporting the building slab-on-grade.

5.5 Site Servicing

5.5.1 Bedding

In general, the existing native sand soils and new fill compacted to a minimum of 98 percent SPMDD will provide adequate support for buried services on a conventional well graded granular base material. Where disturbance of the trench base has occurred, such as due to groundwater seepage or construction traffic, the disturbed soils should be sub-excavated and replaced with suitably compacted granular fill.

Granular bedding material should consist of a conventional Class 'B' bedding, such as Granular 'A', conforming to OPSS.MUNI 1010 specification. The use of HL 8 coarse aggregate or 19 mm clear stone (OPSS.MUNI 1004) bedding is also acceptable, however only in conjunction with a suitable geotextile filter (Terrafix 360R or equivalent); otherwise without proper filtering, there may be entry of fines from the surrounding soils into the subfloor drainage layer. This loss of ground could result in a loss of support to the pipes and possible future settlements. The bedding material should be compacted to a minimum of 98 percent SPMDD. Clear stone type bedding material should be vibrated to a dense state. The bedding material should conform to the pertinent City and Region Specifications.

5.5.2 Backfill

In general, excavated soils encountered on site may be re-used as backfill, provided the moisture content of these materials is within 2% of optimum to ensure adequate compaction, and the trenches are wide enough to accommodate a large compaction roller, and the soil is free of any deleterious material (e.g., peat, topsoil, debris). Any native material with higher in-situ moisture content could be put aside to dry or be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and replaced with imported material which can be readily compacted.

The backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less and compacted to a minimum of 95 percent SPMDD (in non-settlement sensitive areas) and 98 percent SPMDD (in settlement sensitive areas) at a water content within 2% of optimum. Existing native soils will be difficult to place and compact successfully in narrow trench excavations, where large compaction equipment could not operate. For narrow trench excavations, it is recommended that free draining granular material, such as OPSS.MUNI 1010 Granular 'B' be used in order to allow for adequate compaction using vibratory equipment. The placement and inspection of any earth fill as backfill must be conducted under the full-time observation of the geotechnical engineer.

It should be noted that most of the shallow native soils at the site are not free draining and will be difficult to handle and compact if they become wet as a result of inclement weather or seepage. Hence, it can be expected that earthworks carried out during wet periods (i.e., spring and fall) of the year may result in increased earthwork costs.

6.0 PAVEMENT DESIGN

6.1 Subgrade Preparation

New compacted earth fill, and native soil are considered to be an adequate subgrade for the support of a pavement structure provided the subgrade is approved by Terraprobe at the time of construction, and does not contain excessive amounts of organics, moisture, or deleterious materials. The vertical modulus of subgrade reaction on the compacted earth fill or native sand is 18,000 kPa/m.

The subgrade must be exposed by the removal of any existing deleterious materials or soil with excessive amounts of organics. The pavement subgrade should be proof rolled and inspected by Terraprobe. Any loose, soft, wet, or unstable areas, or areas containing excessive organic materials should be sub-excavated and backfilled with clean earth fill placed in 150 mm thick lifts and compacted to a minimum of 98 percent SPMDD. Some parts of the native soils may require localized sub-excavation and re-compaction to support the pavement structure, as identified by Terraprobe during the subgrade inspection and preparation. These areas must be sub-excavated and backfilled with clean, approved, and compacted earth fill as noted above, and under the supervision of Terraprobe.

The granular materials should be placed in lifts 150 mm thick or less and compacted to a minimum of 100 percent and 98 percent SPMDD for granular base and granular sub-base, respectively. Recommendations are made for flexible asphaltic concrete pavements.

The unheated areas, such as concrete surface sidewalk and entrance slabs (near flush-doors), should be supported on a minimum of 1.5 metres thick non-frost susceptible material (19 mm clear stone separated by a geotextile) provided with a subdrain with positive outlet to help minimize slab heave due to freezing weather conditions.

6.2 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 (preferably at a minimum grade of 2 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 any parking lot/driveway pavement areas along the curb-lines/sidewalk, and at all catchbasins within the 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. Subdrains should consist of a 150 mm diameter perforated pipe with factory installed filter fabric placed in a trench excavated (300 mm by 300 mm size) into the subgrade. The trench should be backfilled with 19 mm clear stone wrapped with geotextile. Pavement drainage details are provided in Appendix D.

6.3 Pavement Structure

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. Traffic data was not provided to Terraprobe for review in preparation of this report. The following pavement thickness design is provided on the above noted considerations and subgrade basis.

Performance Asphaltic Concrete Pavement Structure

Pavement Layer	Compaction Requirements	Light-Duty Minimum Component Thickness	Heavy-Duty Minimum Component Thickness
Surface Course Asphaltic Concrete: HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS 1101)	OPSS 310	40 mm	40 mm
Base Course Asphaltic Concrete: HL8 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS 1101)	OPSS 310	60 mm	80 mm
Base Course: Granular A (OPSS.MUNI 1010) or 19mm Crusher Run Limestone	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular B Type I (OPSS.MUNI 1010) or 50mm Crusher Run Limestone	100% Standard Proctor Maximum Dry Density (ASTM- D698)	250 mm	350 mm

A minimal pavement design is also provided, which will provide an estimated service period of about 8 to 10 years depending on actual traffic volumes. The cost of the minimal pavement design should be compared to the performance design which could be expected to last about twice as long before significant maintenance and rehabilitation.

Minimal Asphaltic Concrete Pavement Structure

Pavement Layer	Compaction Requirements	Light-Duty Minimum Component Thickness	Heavy-Duty Minimum Component Thickness
Surface Course Asphaltic Concrete: HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS 1101)	OPSS 310	65 mm	40 mm
Base Course Asphaltic Concrete: HL8 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS 1101)	OPSS 310	N/A	50 mm

Pavement Layer	Compaction Requirements	Light-Duty Minimum Component Thickness	Heavy-Duty Minimum Component Thickness
Base Course: Granular A (OPSS.MUNI 1010) or 19mm Crusher Run Limestone	100% Standard Proctor Maximum Dry Density (ASTM-D698)	225 mm	325 mm

7.0 DESIGN CONSIDERATION FOR CONSTRUCTABILITY

7.1 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. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety.

For practical purposes, the earth fill, peat, and native sand are Type 3 soil above and Type 4 soil below the prevailing groundwater table.

Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates safe slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes.

The subsurface soils can be removed by conventional excavation equipment. Excavations at this site may encounter construction debris, deleterious materials, and other obstructions in the earth fill. Larger size particles (cobbles and boulders) that are not specifically identified in the boreholes may be present in the native soils. The size and distribution of cobbles/boulders/obstructions cannot be predicted with boreholes, as the sampler size is insufficient to secure representative particles of this size. The risk and responsibility for the removal and disposal of cobbles/boulders/obstructions must be addressed in the contract documents for foundations and excavations contractors.

The measurements of water levels and caving in open boreholes upon completion of drilling was measured and presented in the Borehole Logs. Monitoring wells comprising 50 mm diameter PVC pipes were installed in six selected borehole to facilitate Groundwater monitoring and sampling. The PVC tubing was fitted with a bentonite clay seal as shown on the accompanying Borehole Logs. Water levels in the monitoring wells were measured on February 1, 2022. The results of Groundwater monitoring are presented in Section 4.6 of this report.

Groundwater levels may fluctuate with time, and seasonally, depending on the amount of precipitation and surface runoff.

It is anticipated that excavations for footing foundations and site services may extend below the prevailing groundwater table. The wet native sand materials are considered to be moderate to high permeability soils and free flow of water into the excavations should be expected below the groundwater table. If seepage is encountered, it is expected to be of limited extent and can be controlled using a conventional sump pump system when above the water table. More significant, positive dewatering will be required where excavations are to extend below the encountered groundwater level in sandy soils.

Refer to the hydrogeological report issued under separate cover for comments regarding groundwater volumes for the site.

7.2 Site Work

The soils found at this site will 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 highly 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.

Prior to pouring concrete for the footings, the footing subgrade must be cleaned of deleterious materials, softened, disturbed, or caved materials, and any standing water. The footing excavations must be inspected and approved by Terraprobe to ensure the bearing capacities stated above are applicable. If soft soils are encountered at the proposed bearing depths during footing excavation, sub-excavation to competent soil is required under the direction of the geotechnical engineer. Furthermore, native soils tend to weather and deteriorate on exposure to the atmosphere or to surface water, therefore foundation bases that will remain open and exposed to the atmosphere for an extended period of time shall be protected by applying a skim coat of lean concrete. If construction is to proceed in freezing conditions, temporary frost protection for the footing bases and concrete must be provided.

7.3 Quality Control

The proposed structure will be founded on spread footing foundations. The foundation installations must be field reviewed by the geotechnical engineer as they are constructed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical design function and is required by the current Ontario Building Code. If Terraprobe is not retained to carry out foundation evaluations during construction, then Terraprobe accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice contained in this report.

The long-term performance of the slab on grade is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as practically possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the borings. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by Terraprobe at the time of construction to confirm material quality, thickness and to ensure adequate compaction.

The requirements for fill placement on this project have been stipulated relative to Standard Proctor Maximum Dry Density as determined by ASTM D698. In situ determinations of density during fill and asphaltic placement on site are required to demonstrate that the specified placement density is achieved. Terraprobe is a CNSC certified operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary, with our qualified technical staff.

Concrete will be specified in accordance with the requirements of CAN3 - CSA A23.1. Terraprobe maintains a CSA certified concrete laboratory and can provide concrete sampling and testing services for the project as necessary.

Terraprobe provides quality control services for Building Envelope, Roofing and Structural Steel, as necessary, for the Structural and Architectural quality control requirements of the project. Terraprobe is certified by the Canadian Welding Bureau under W178.1-1996.

8.0 LIMITATIONS AND USE OF REPORT

8.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained from this investigation.

The drilling work was carried out by a drilling contractor and was observed and recorded by Terraprobe on a full-time basis. The boreholes were made by a continuous flight power auger machine using solid and hollow stem augers. A Terraprobe technician logged the boreholes and examined the samples as they were obtained. The samples obtained were sealed in clean, air-tight containers and transferred to the Terraprobe laboratory, where they were reviewed for consistency of description by a geotechnical engineer. Groundwater observations were made in the boreholes as drilling proceeded.

The samples of the strata penetrated were obtained using the technique, Split-Barrel Method, ASTM D1586. The samples were taken at intervals. The conventional interval sampling procedure used for this investigation does not recover continuous samples of soil at any borehole location. There is consequently some interpolation of the borehole layering between samples and indications of changes in stratigraphy as shown on the borehole logs are approximate.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information and geotechnical advice to completely identify all aspects of the site and works that could affect construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on the project must be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, and their approach to the construction works, cognizant of the risks implicit in the subsurface investigation activities.

The subsurface soil and groundwater conditions encountered in the boreholes are presented on the attached Borehole Logs. The stratigraphic boundaries indicated on the Borehole Logs are inferred from non-continuous samples and observations of drilling resistance and typically represent a transition from one soil type to another. These boundaries should not be interpreted to represent exact planes of geological change. The subsurface conditions have been confirmed in a series of widely spaced boreholes and will vary between and beyond the borehole locations. The discussion has been simplified in terms of the major soil strata for the purposes of geotechnical design.

8.2 Changes in Site and Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. In particular, caution should be exercised in the consideration of contractual responsibilities as they relate to control of seepage, disturbance of soils, and frost protection.

The design parameters provided, and the engineering advice offered in this report is based on the factual data obtained from this investigation made at the site by Terraprobe and is intended for use by the owner and its retained design consultants in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters, advice, and comments relating to constructability issues and quality control may not be relevant or complete for the project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

8.3 Use of Report

This report is prepared for the express use of 25707517 Ontario Inc. and their retained design consultants. It is not for use by others. This report is copyright of Terraprobe Inc., and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe, 25707517 Ontario Inc. and their retained design consultants are authorized users.

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 meets with your requirements. Should you have any questions regarding the information presented, please do not hesitate to contact our office.

Sincerely,

Terraprobe Inc.

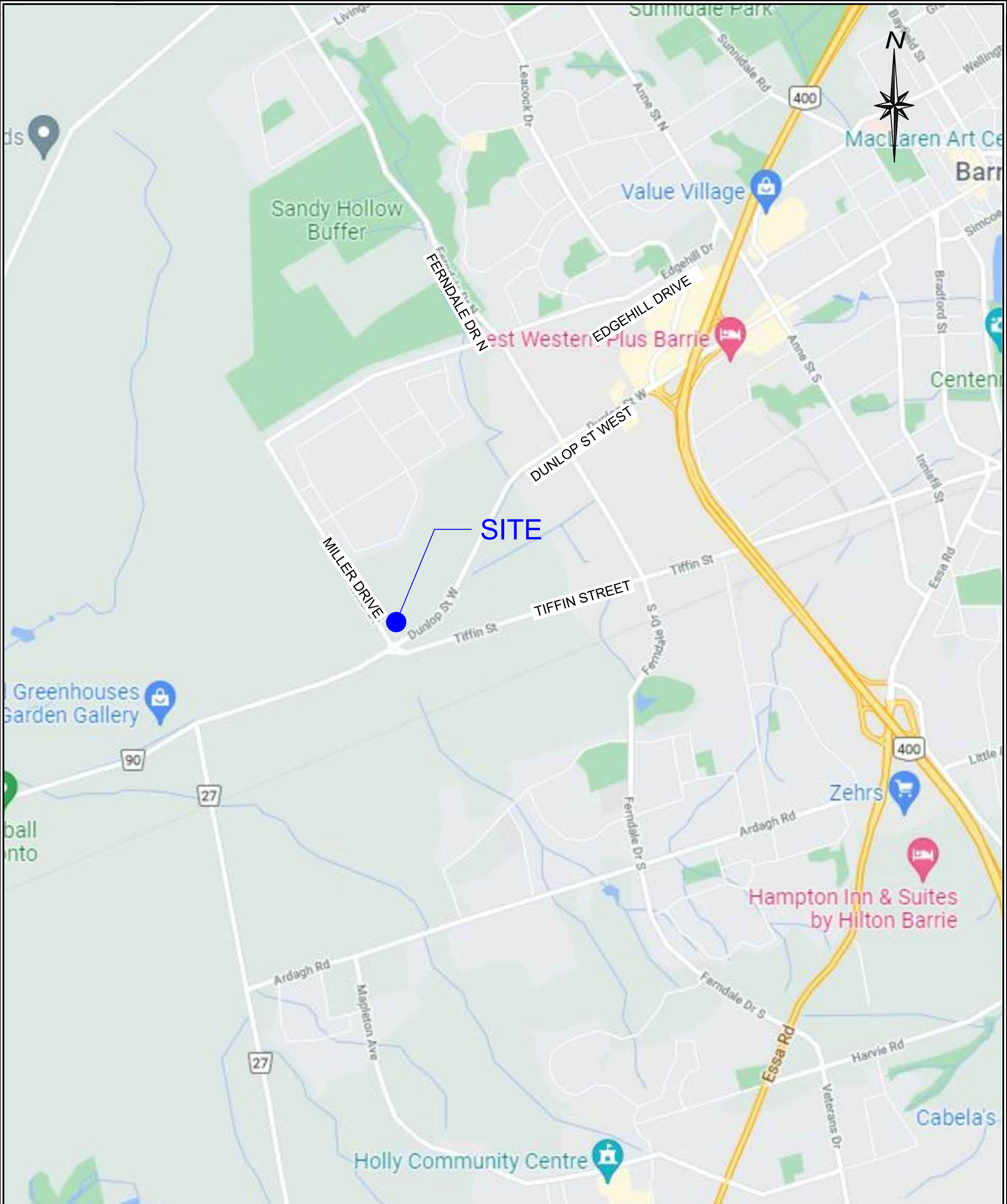
LICENSED PROFESSIONAL ENGINEER
O.B.
O. D. BENJAMIN
90337072
2022-04-06
PROVINCE OF ONTARIO

Mike Tanos, P.Eng.
Review Principal

Osbert (Ozzie) Benjamin, P.Eng.
Senior Project Manager, Geotechnical

FIGURES

TERRAPROBE INC.



REFERENCE
Image ©2022 Google Earth

SCALE 200 0 500m

Terraprobe

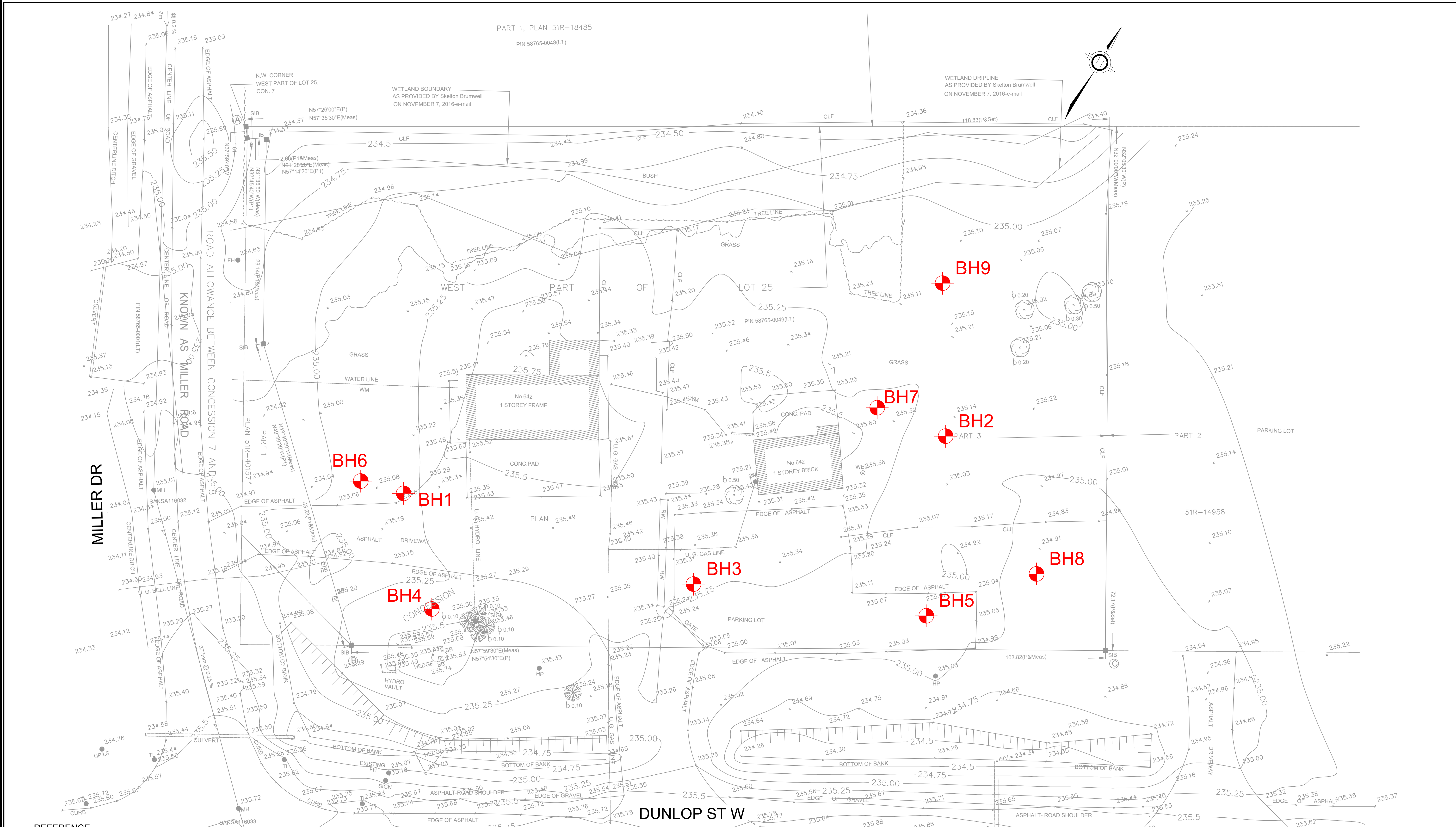
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: **SITE LOCATION PLAN**

File. No.: 3-21-0182-01

FIGURE : 1

Z:\1-Project Files\2021\Branch Folders\3-21-0182 - 642 Dunlop Street West, Barrie\01- Geotechnical Investigation\A. Dwgs, Logs\AutoCAD\3-21-0182-FIG1.dwg, 2/16/2022 3:42:56 PM, DWG To PDF.pc3, 1:25.4



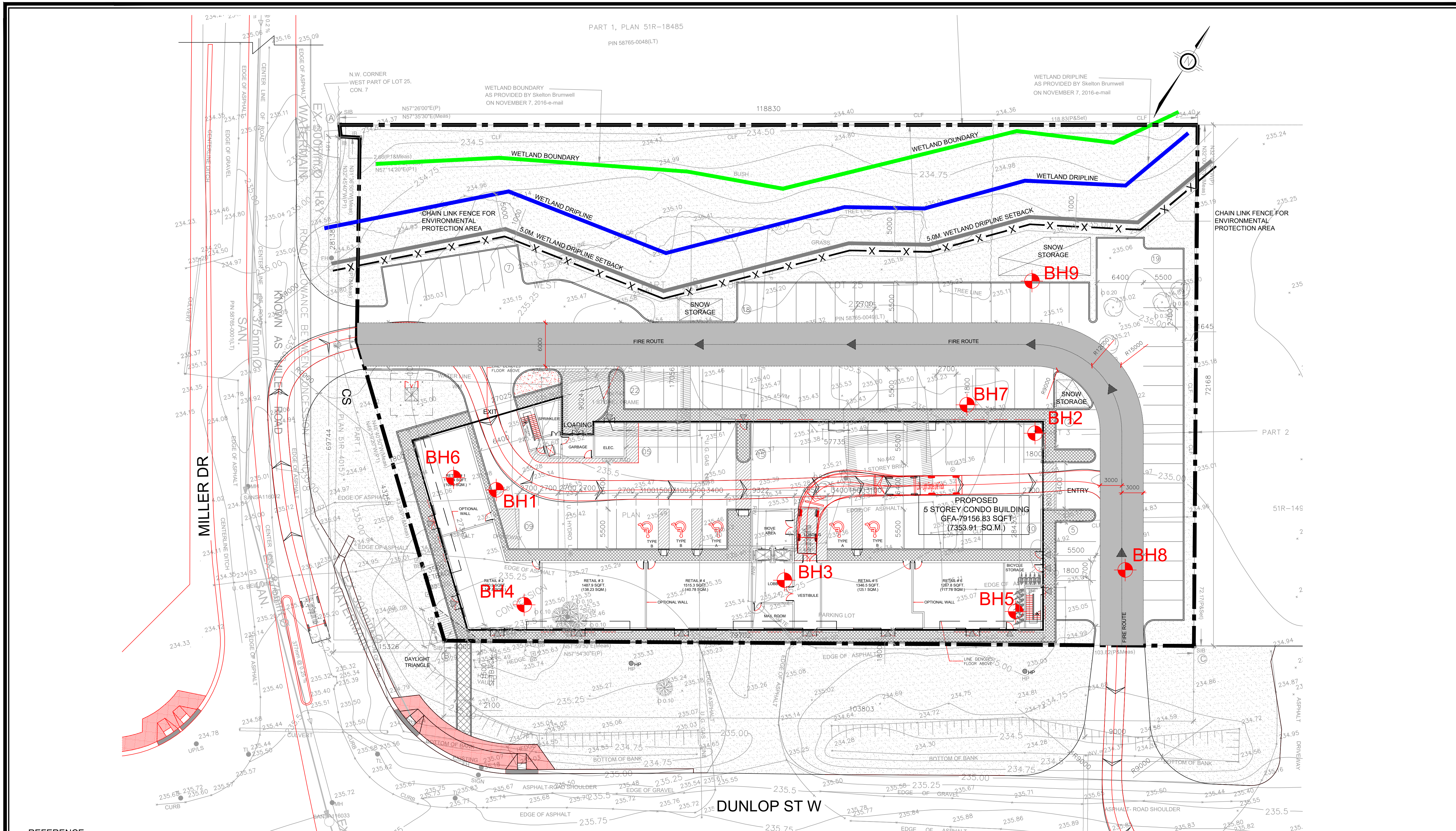
REFERENCE
MAP: PROPOSED 5-STOREY CONDO BUILDING-642 DUNLOP STREET WEST
SITE PLAN
PROJECT NUMBER: 15-48 DRAWING NUMBER: A 1.0
DATE UPDATED: FEB 4, 2022
COMPANY: 'n' ARCHITECTURE INC.
SURVEY INFORMATION: OMARI MWINYI SURVEYING LTD.

LEGEND
Approximate Borehole Location

5 0 10m
SCALE 1:200

Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: BOREHOLE LOCATION PLAN Existing Condition	FIGURE : 2A
File No. 3-21-0182-01	



REFERENCE
MAP: PROPOSED 5-STOREY CONDO BUILDING-642 DUNLOP STREET WEST
SITE PLAN
PROJECT NUMBER: 15-48 DRAWING NUMBER: A 1.0
DATE UPDATED: FEB 4, 2022
COMPANY: 'n' ARCHITECTURE INC.
SURVEY INFORMATION: OMARI MWINYI SURVEYING LTD.

LEGEND
Approximate Borehole Location

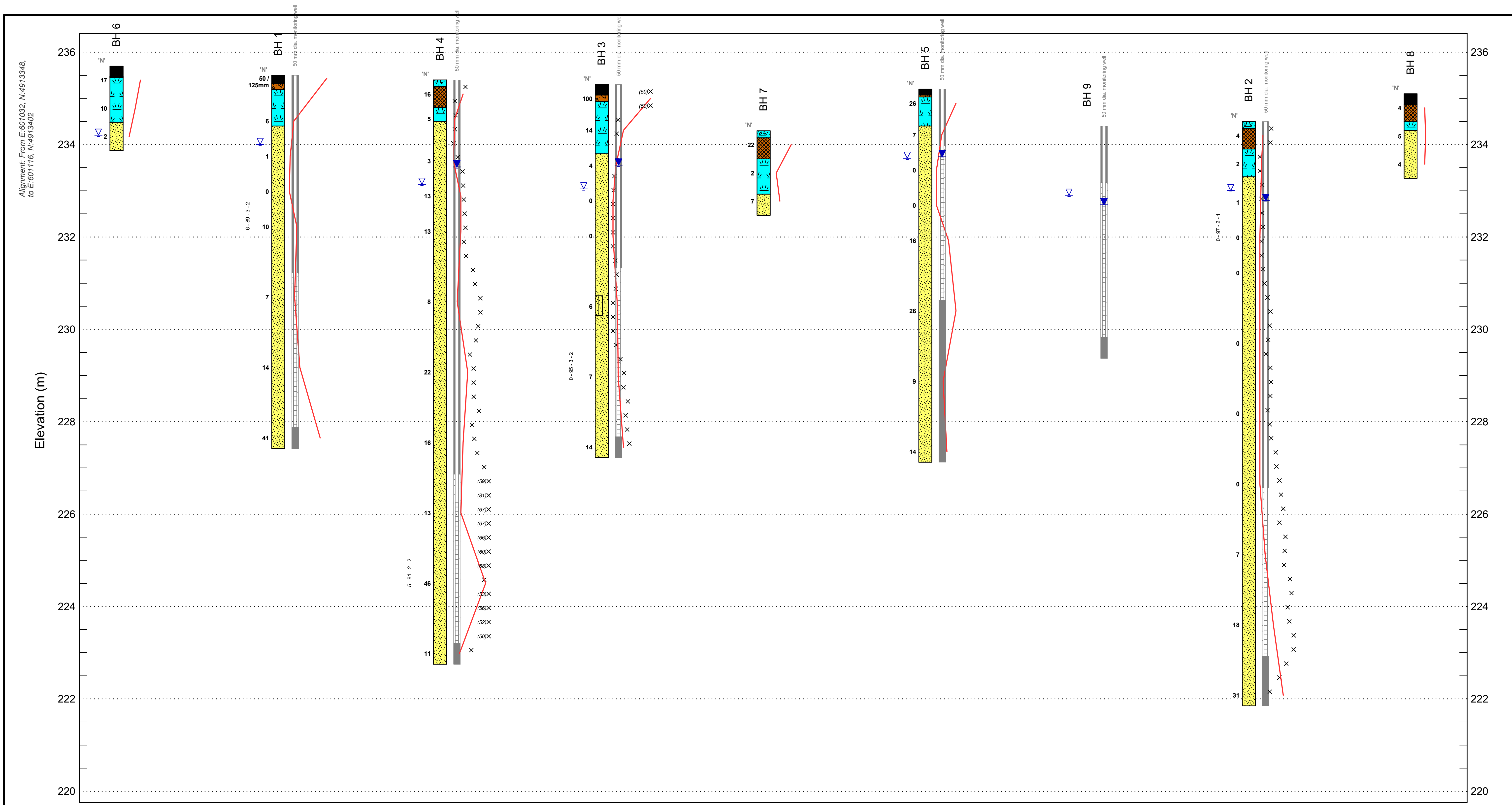
5 0 10m
SCALE 1:200

Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: **BOREHOLE LOCATION PLAN**
Proposed Condition

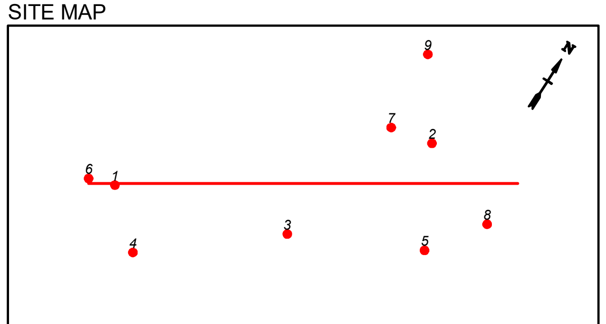
File No. 3-21-0182-01

FIGURE : 2B



Boreholes Equally Spaced

SITE MAP



LITHOLOGY GRAPHIC LEGEND

- Asphalt
- Topsoil
- Aggregate
- Fill
- Peat
- Sandy Silt
- Sand

INTERPRETIVE LEGEND

- WL on completion of drilling
- Stabilized WL, most recent

- *FILL*
- *GRAVELS (gravel to gravelly sand)*
- *SILT TO SAND (not till)*
- *COHESIONLESS TILLS*
- *COHESIVE SOILS (clayey silt to clay, incl. tills)*
- *TOPSOIL/PEAT*

Terraprobe 11 Indell Lane, Brampton Ontario L6T 3Y3 (905) 796-2650	Title: **SUBSURFACE PROFILE**	FIGURE: 3
	File No.: **3-21-0182-01**	

APPENDIX A

TERRAPROBE INC.

LOG OF BOREHOLE 1

Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : SO
Date started : January 19, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : OB

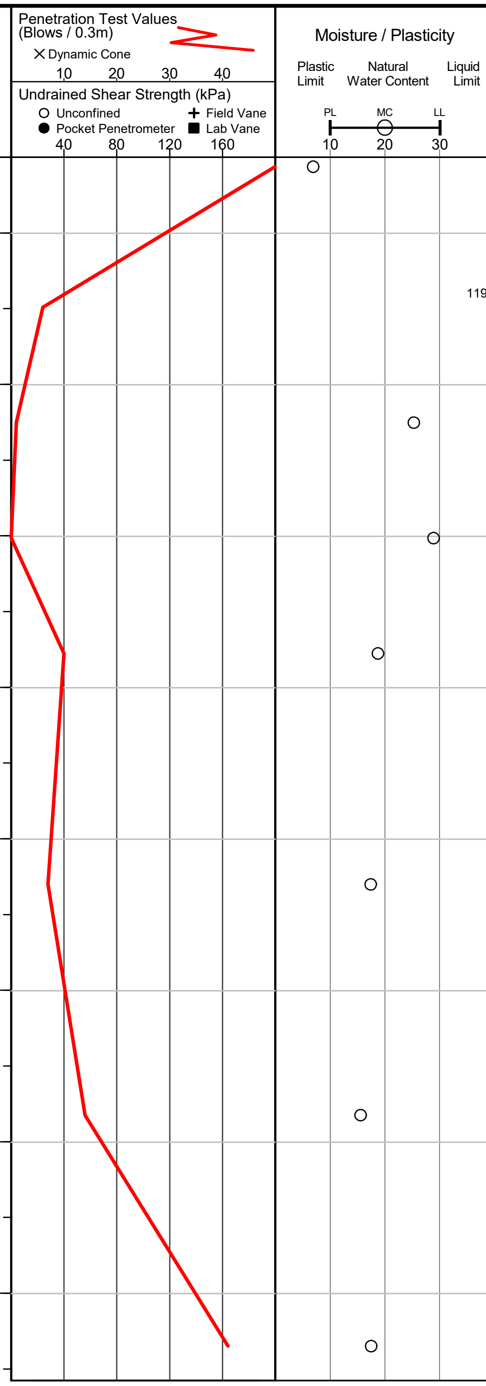
Position : E: 601037, N: 4913351 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Hollow stem augers

SOIL PROFILE

Elev / Depth (m)	Description
235.5	GROUND SURFACE
235.3 / 0.2	180mm **ASPHALT**
235.2 / 0.3	130mm **GRANULAR FILL**
	PEAT, loose, black, moist
234.4 / 1.1	**SAND**, trace silt, trace clay, trace gravel, very loose to loose, brown, moist to wet
	...at 1.5 m, wet below
	...at 3.4 m, compact
	...at 5.0 m, loose
	...at 6.5 m, compact
	...at 7.5 m, dense, trace gravel
227.4 / 8.1	

SAMPLES

Number	Type	SPT 'N' Value	Lab Data and Comments (GR SA SI CL)
1	SS	50 / 125mm	
2	SS	6	
3	SS	1	
4	SS	0	
5	SS	10	6 89 3 2
6	SS	7	
7	SS	14	
8	SS	41	



Elevation Scale (m): 235, 234, 233, 232, 231, 230, 229, 228

Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | GRAIN SIZE DISTRIBUTION (%) (MIT)

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022		n/a

file: 3-21-0182-01 bh logs.gpj

LOG OF BOREHOLE 2

Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : CB
Date started : January 20, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 2	Location : Barrie, Ontario	Checked by : OB

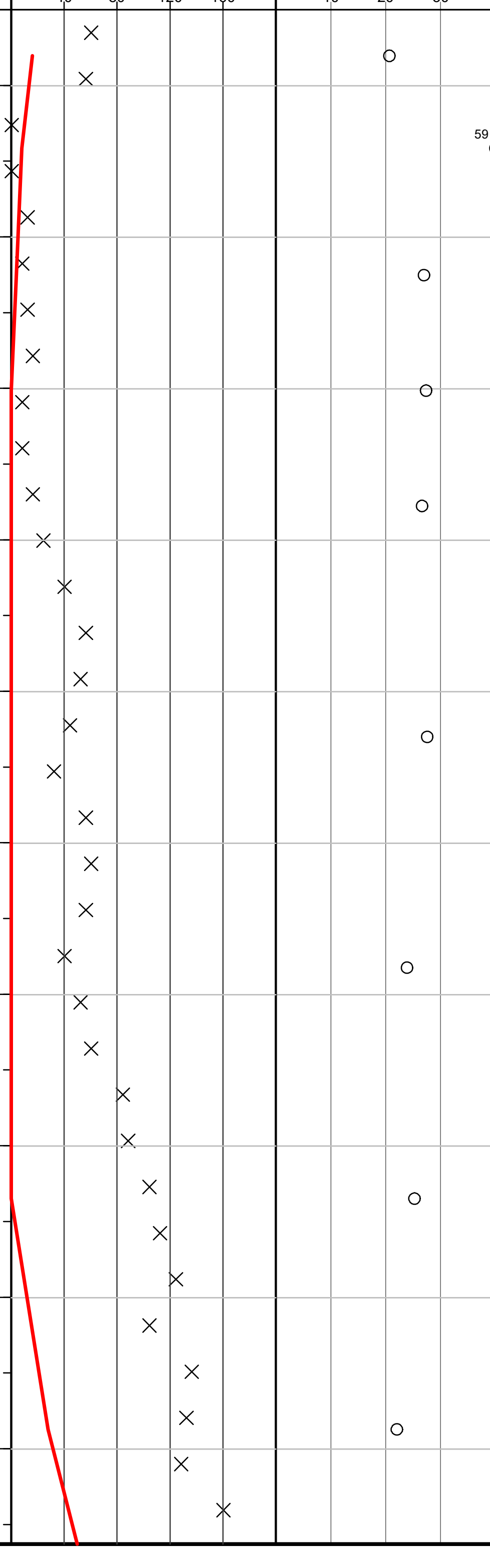
Position : E: 601094, N: 4913399 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Hollow stem augers

Elev Depth (m)	Description (SOIL PROFILE)	Sample Number	Type	SPT 'N' Value
234.5	**GROUND SURFACE**			
234.3 0.2	150mm **TOPSOIL**			
233.9 0.6	**FILL**, sand/peat mix, some gravel, loose, black, moist	1	SS	4
233.3 1.2	**PEAT**, sand seam, very loose, black, moist	2	SS	2
	SAND, trace silt, trace clay, trace gravel, very loose, brown, moist to wet ...at 1.5 m, wet below	3	SS	1
		4	SS	0
		5	SS	0
		6	SS	0
		7	SS	0
		8	SS	0
	...at 9.6 m, loose	9	SS	7

Depth Scale (m): 0 – 10
Elevation Scale (m): 234 – 225

Penetration Test Values (Blows / 0.3m): X Dynamic Cone — 10, 20, 30, 40
Undrained Shear Strength (kPa): O Unconfined, + Field Vane, ● Pocket Penetrometer, ■ Lab Vane — 40, 80, 120, 160

Moisture / Plasticity: Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL) — 10, 20, 30



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT): GR SA SI CL

Sample 4: 0 97 2 1

(continued next page)

file: 3-21-0182-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 2

Project No. : 3-21-0182-01 | Client : 25707517 Ontario Inc. | Originated by : CB

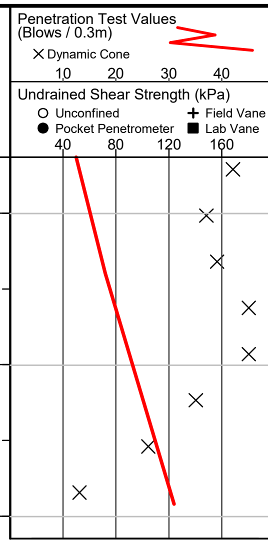
Date started : January 20, 2022 | Project : 642 Dunlop Street West | Compiled by : GO

Sheet No. : 2 of 2 | Location : Barrie, Ontario | Checked by : OB

Position : E: 601094, N: 4913399 (UTM 17T) | Elevation Datum : Geodetic

Rig type : Track-mounted | Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
		(continued) **SAND**, trace silt, trace clay, trace gravel, very loose, brown, moist to wet *(continued)*					224						
11		...at 11.0 m, compact		10	SS	18							
							223						
12				11	SS	31	222						
	221.9 12.6												



Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit; PL, MC, LL; 10 20 30

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022	1.7	232.8

LOG OF BOREHOLE 3

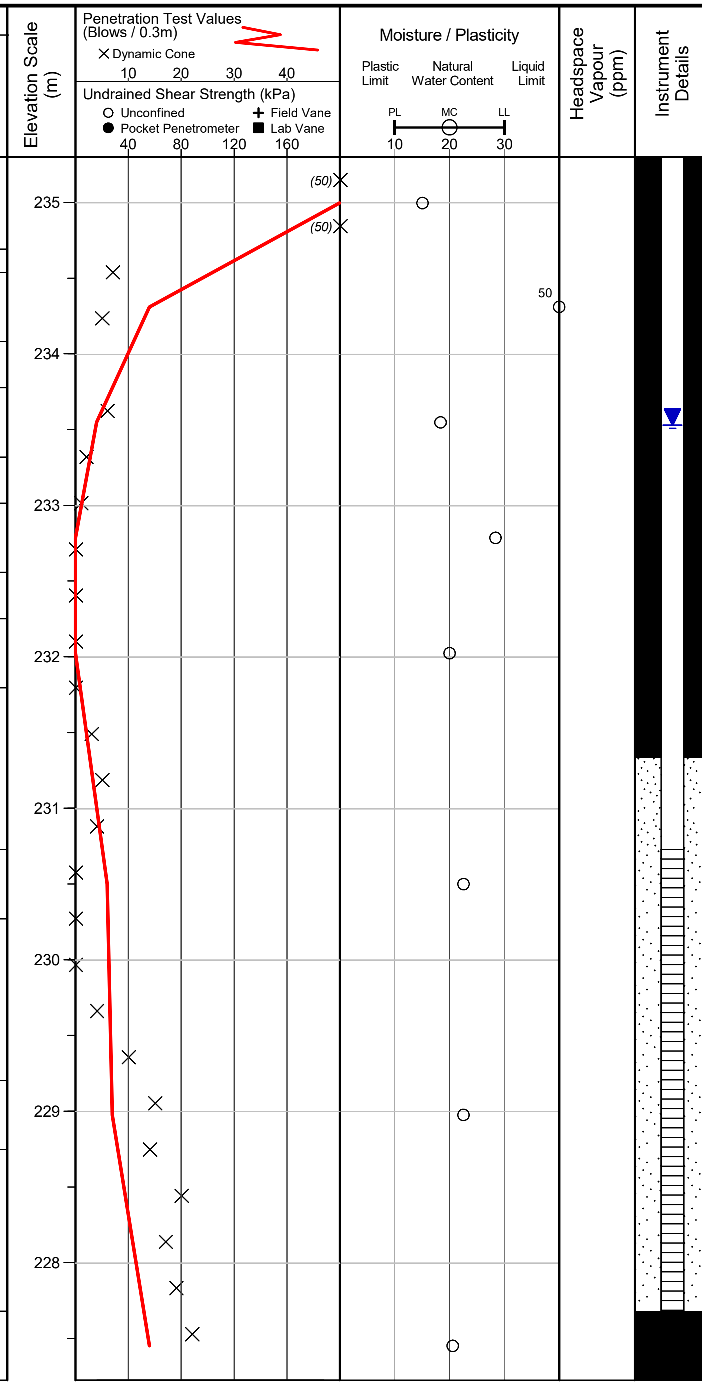
Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : CB
Date started : January 18, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : OB

Position : E: 601077, N: 4913363 (UTM 17T)	Elevation Datum : Geodetic
Rig type : Track-mounted	Drilling Method : Hollow stem augers

SOIL PROFILE / SAMPLES

Elev (m)	Depth (m)	Description	Number	Type	SPT 'N' Value
235.3		**GROUND SURFACE**			
235.1	0.2	230mm **ASPHALT**			
234.9	0.4	370mm **GRANULAR FILL**	1	SS	100
		PEAT, sand seams, compact, black, moist	2	SS	14
233.8	1.5	**SAND**, trace silt, trace clay, trace gravel, very loose to loose, brown, moist to wet	3	SS	4
		...at 2.3 m, wet below	4	SS	0
			5	SS	0
230.7	4.6	**SANDY SILT**, loose, brown, wet	6	SS	6
230.3	5.0	.			
		...at 6.5 m, loose	7	SS	7
		...at 7.8 m, compact	8	SS	14
227.2	8.1				



Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
0	95	3	2

END OF BOREHOLE

Unstabilized water level measured at 2.3 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022	1.8	233.5

file: 3-21-0182-01 bh logs.gpj

LOG OF BOREHOLE 4

Terraprobe

Project No.	: 3-21-0182-01	Client	: 25707517 Ontario Inc.	Originated by	: SO
Date started	: January 19, 2022	Project	: 642 Dunlop Street West	Compiled by	: GO
Sheet No.	: 1 of 2	Location	: Barrie, Ontario	Checked by	: OB

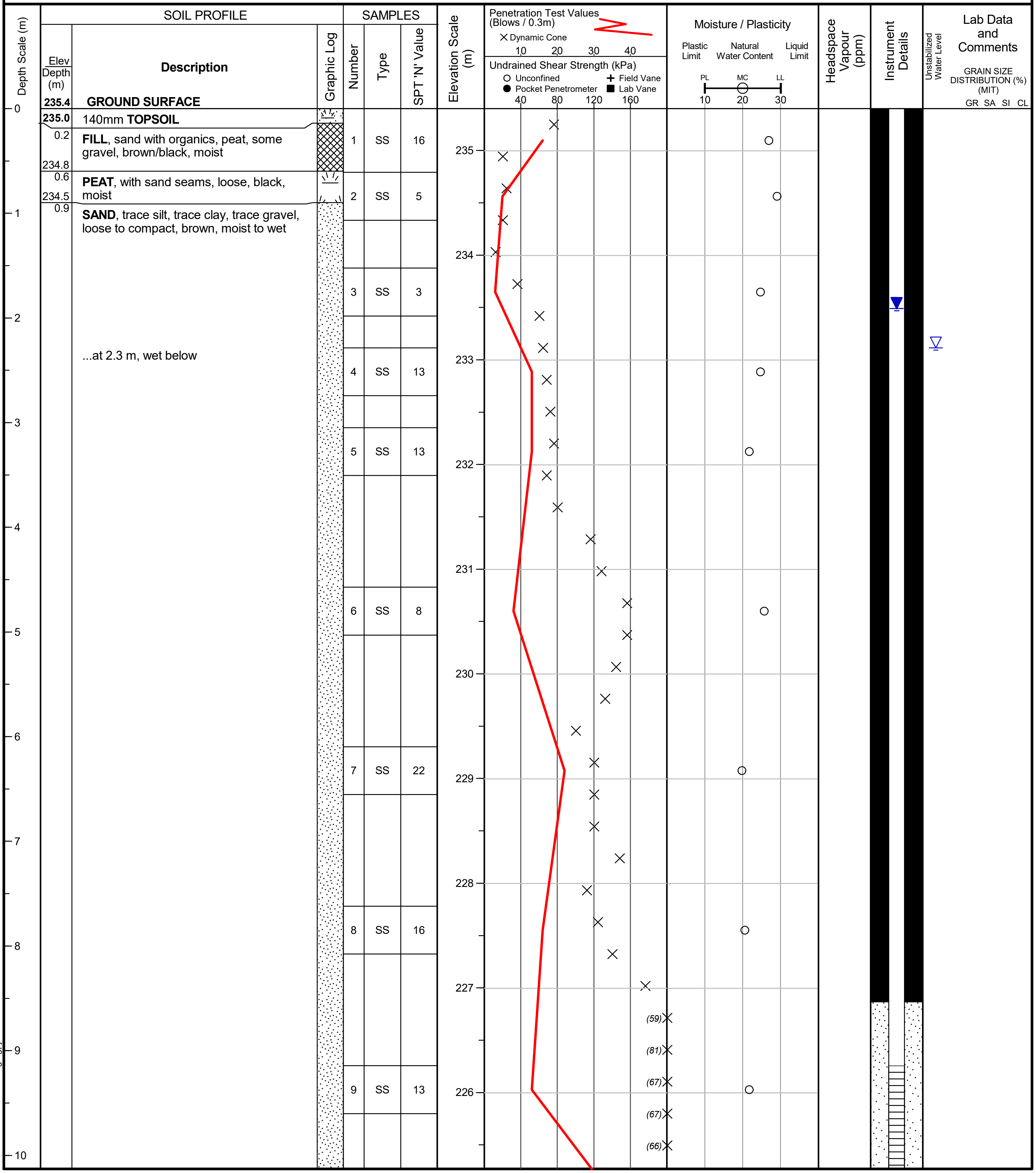
Position	: E: 601049, N: 4913340 (UTM 17T)	Elevation Datum	: Geodetic
Rig type	: Track-mounted	Drilling Method	: Hollow stem augers

SOIL PROFILE

Elev Depth (m)	Description
235.4	**GROUND SURFACE**
235.0	140mm **TOPSOIL**
0.2	**FILL**, sand with organics, peat, some gravel, brown/black, moist
234.8 0.6	**PEAT**, with sand seams, loose, black, moist
234.5 0.9	**SAND**, trace silt, trace clay, trace gravel, loose to compact, brown, moist to wet ...at 2.3 m, wet below

SAMPLES

Number	Type	SPT 'N' Value
1	SS	16
2	SS	5
3	SS	3
4	SS	13
5	SS	13
6	SS	8
7	SS	22
8	SS	16
9	SS	13



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file: 3-21-0182-01 bh logs.gpj

LOG OF BOREHOLE 4

Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.		Originated by : SO
Date started : January 19, 2022	Project : 642 Dunlop Street West		Compiled by : GO
Sheet No. : 2 of 2	Location : Barrie, Ontario		Checked by : OB

Position : E: 601049, N: 4913340 (UTM 17T) Elevation Datum : Geodetic

Rig type : Track-mounted Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	Description *(continued)*	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m)	Moisture / Plasticity	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
		SAND, trace silt, trace clay, trace gravel, loose to compact, brown, moist to wet *(continued)*					225	(60), (68)					
11		...at 10.8 m, dense		10	SS	46		(53), (56), (52), (50)					5 91 2 2
12							224						
	222.8 12.6			11	SS	11	223						disturbed sample

END OF BOREHOLE

Unstabilized water level measured at 2.3 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022	1.9	233.5

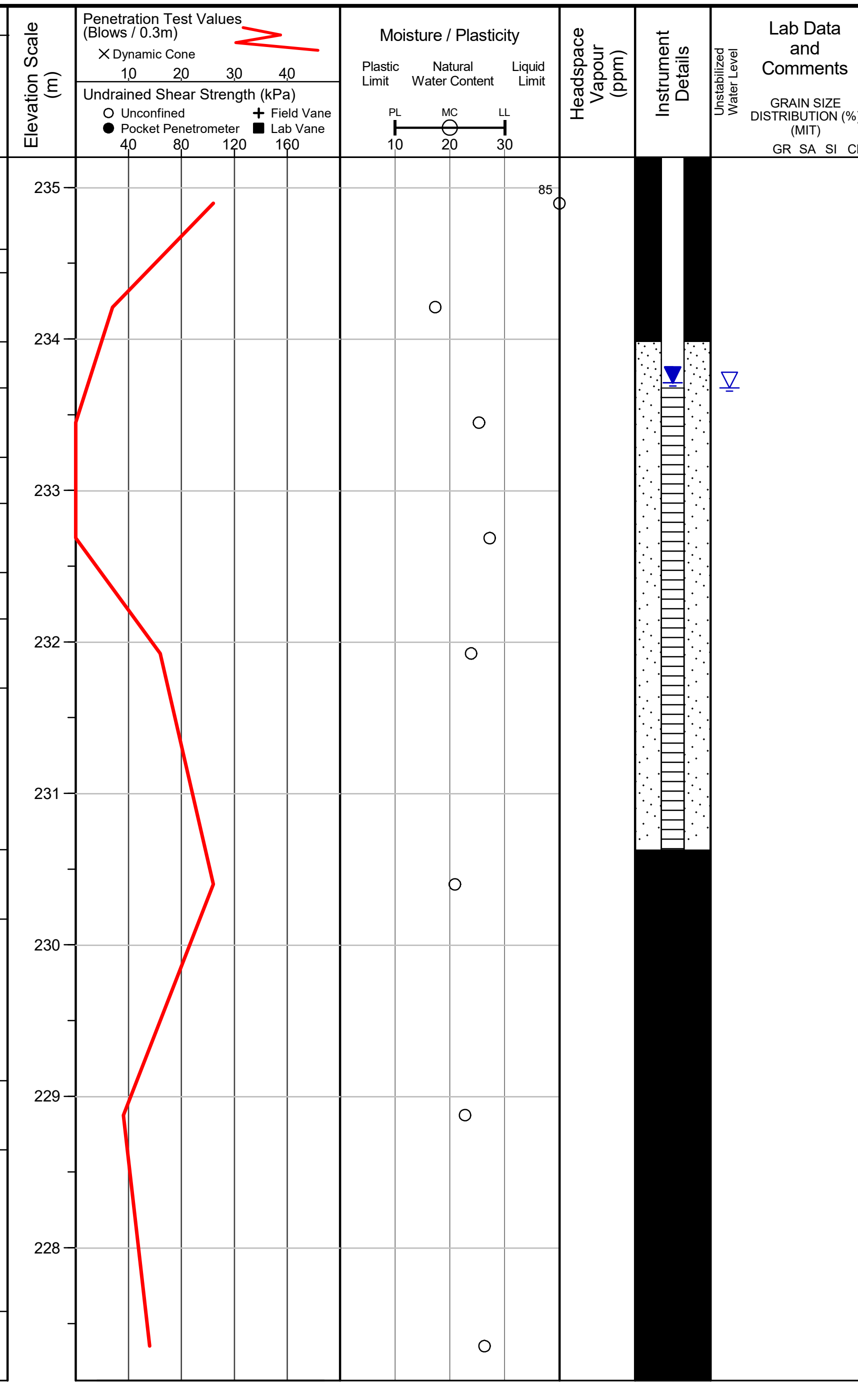
LOG OF BOREHOLE 5

Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : CB
Date started : January 19, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : OB

Position : E: 601106, N: 4913377 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Natural Water Content (%)
235.2	GROUND SURFACE				
235.0 / 0.2	130mm **ASPHALT**				
	170mm **GRANULAR FILL**				
234.4 / 0.8	**PEAT**, with silt, sand seams, loose, black, moist	1	SS	26	85
	SAND, trace silt, trace clay, trace gravel, very loose to compact, brown, moist to wet	2	SS	7	
	...at 1.5 m, wet below	3	SS	0	
		4	SS	0	
		5	SS	16	
		6	SS	26	
		7	SS	9	
227.1 / 8.1		8	SS	14	



END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022	1.5	233.7

file: 3-21-0182-01 bh logs.gpj

LOG OF BOREHOLE 6

Terraprobe

Project No.	: 3-21-0182-01	Client	: 25707517 Ontario Inc.	Originated by	: CB
Date started	: January 18, 2022	Project	: 642 Dunlop Street West	Compiled by	: GO
Sheet No.	: 1 of 1	Location	: Barrie, Ontario	Checked by	: OB

Position : E: 601031, N: 4913349 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Hollow stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Natural Water Content (%)	Unstabilized Water Level
235.7	GROUND SURFACE					
235.5 / 0.2	230mm **ASPHALT**					
235.5 / 0.2	250mm **GRANULAR FILL**					
	PEAT, compact, black, moist	1	SS	17	86	
		2	SS	10	132	
234.5 / 1.2	**SAND**, trace silt, trace clay, trace gravel, trace organics, very loose, brown, moist to wet	3	SS	2		▽
233.9 / 1.8	**END OF BOREHOLE**					

Unstabilized water level measured at 1.5 m below ground surface; borehole was open upon completion of drilling.

Chart headings: Depth Scale (m); Graphic Log; Elevation Scale (m); Penetration Test Values (Blows / 0.3m) — Dynamic Cone 10 20 30 40; Undrained Shear Strength (kPa) — Unconfined, Pocket Penetrometer, Field Vane, Lab Vane 40 80 120 160; Moisture / Plasticity — Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL 10 20 30); Headspace Vapour (ppm); Instrument Details; Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

LOG OF BOREHOLE 7

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : CB
Date started : January 18, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : OB

Position : E: 601084, N: 4913397 (UTM 17T) — Elevation Datum : Geodetic

Rig type : Track-mounted — Drilling Method : Hollow stem augers

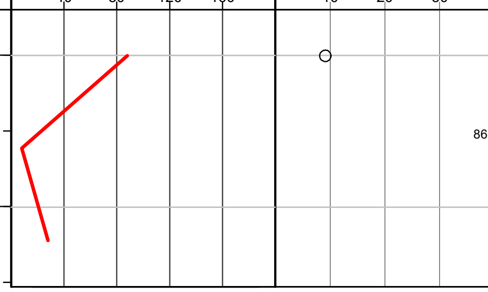
Depth Scale (m)	Elev / Depth (m)	Description (SOIL PROFILE)	Graphic Log	Sample Number	Type	SPT 'N' Value	Elevation Scale (m)
0	234.3	**GROUND SURFACE**					
	234.1 / 0.2	150mm **TOPSOIL**					
		FILL, peat/ sandy silt, some gravel, compact, black, moist		1	SS	22	234
	233.7 / 0.6	**PEAT**, sand seams,, very loose, black, wet		2	SS	2	
1	232.9 / 1.4	**SAND**, trace silt, trace clay, trace gravel, trace organics, loose, brown, moist		3	SS	7	233
	232.5 / 1.8	**END OF BOREHOLE**					

Penetration Test Values (Blows / 0.3m): × Dynamic Cone; 10 20 30 40

Undrained Shear Strength (kPa): ○ Unconfined; + Field Vane; ● Pocket Penetrometer; ■ Lab Vane; 40 80 120 160

Moisture / Plasticity: Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL); 10 20 30

Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT): GR SA SI CL



Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 8

Terraprobe

Project No. : 3-21-0182-01	Client : 25707517 Ontario Inc.	Originated by : CB
Date started : January 18, 2022	Project : 642 Dunlop Street West	Compiled by : GO
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : OB

Position : E: 601115, N: 4913390 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Hollow stem augers

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Natural Water Content (%)	Lab Data and Comments
235.1		GROUND SURFACE					
234.9	0.2	230mm **ASPHALT**					
234.5	0.6	**FILL**, organics/peat, some gravel, sand, loose, black/brown, moist	1	SS	4	~20	
234.3	0.8	**PEAT**, sand seams, loose, black, moist	2	SS	5	56	
233.3	1.8	**SAND**, trace silt, trace clay, trace gravel, some organics, loose, brown, moist	3	SS	4	~22	

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Chart headings: Penetration Test Values (Blows / 0.3m) — Dynamic Cone 10, 20, 30, 40; Undrained Shear Strength (kPa) — Unconfined, Field Vane, Pocket Penetrometer, Lab Vane 40, 80, 120, 160; Moisture / Plasticity — Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL) 10, 20, 30; Headspace Vapour (ppm); Instrument Details; Unstabilized Water Level; GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL. Elevation Scale (m): 235, 234. Depth Scale (m): 0, 1.

file: 3-21-0182-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 9

Project No. : 3-21-0182-01
Client : 25707517 Ontario Inc.
Originated by : CB

Date started : January 18, 2022
Project : 642 Dunlop Street West
Compiled by : GO

Sheet No. : 1 of 1
Location : Barrie, Ontario
Checked by : OB

Position : E: 601082, N: 4913416 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Elevation Scale (m)
0	234.4	GROUND SURFACE					
		Borehole augered to 5m depth without sampling for installation of monitoring well					234
1							233
2							232
3							231
4							230
5	229.4 5.0						

Penetration Test Values (Blows / 0.3m)
X Dynamic Cone
10 20 30 40

Undrained Shear Strength (kPa)
O Unconfined + Field Vane
● Pocket Penetrometer ■ Lab Vane
40 80 120 160

Moisture / Plasticity
Plastic Limit | Natural Water Content | Liquid Limit
PL MC LL
10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

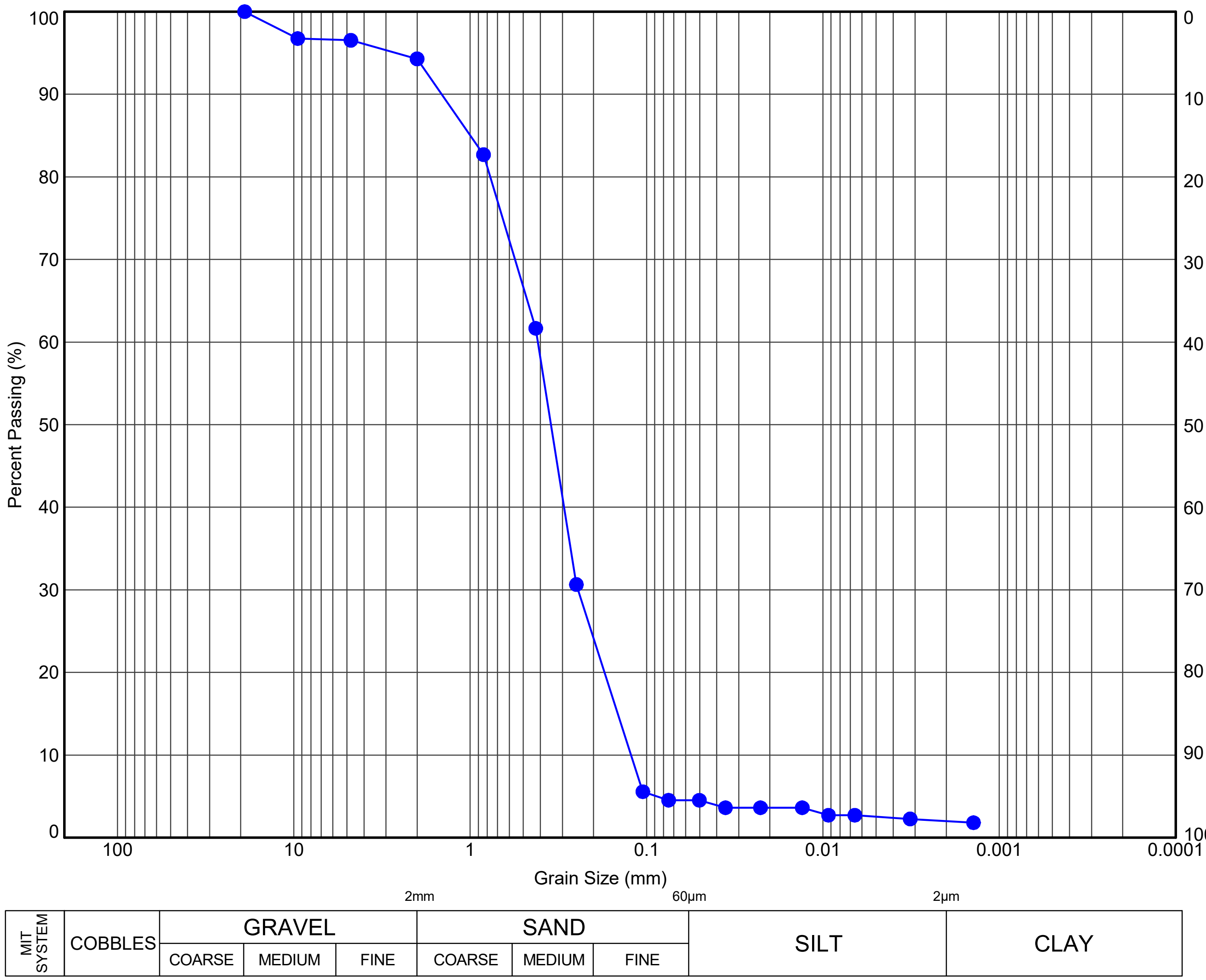
WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 1, 2022	1.7	232.7

file: 3-21-0182-01 bh logs.gpj

APPENDIX B

TERRAPROBE INC.



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**1**	SS5	3.3	232.2	6	89	3	2	

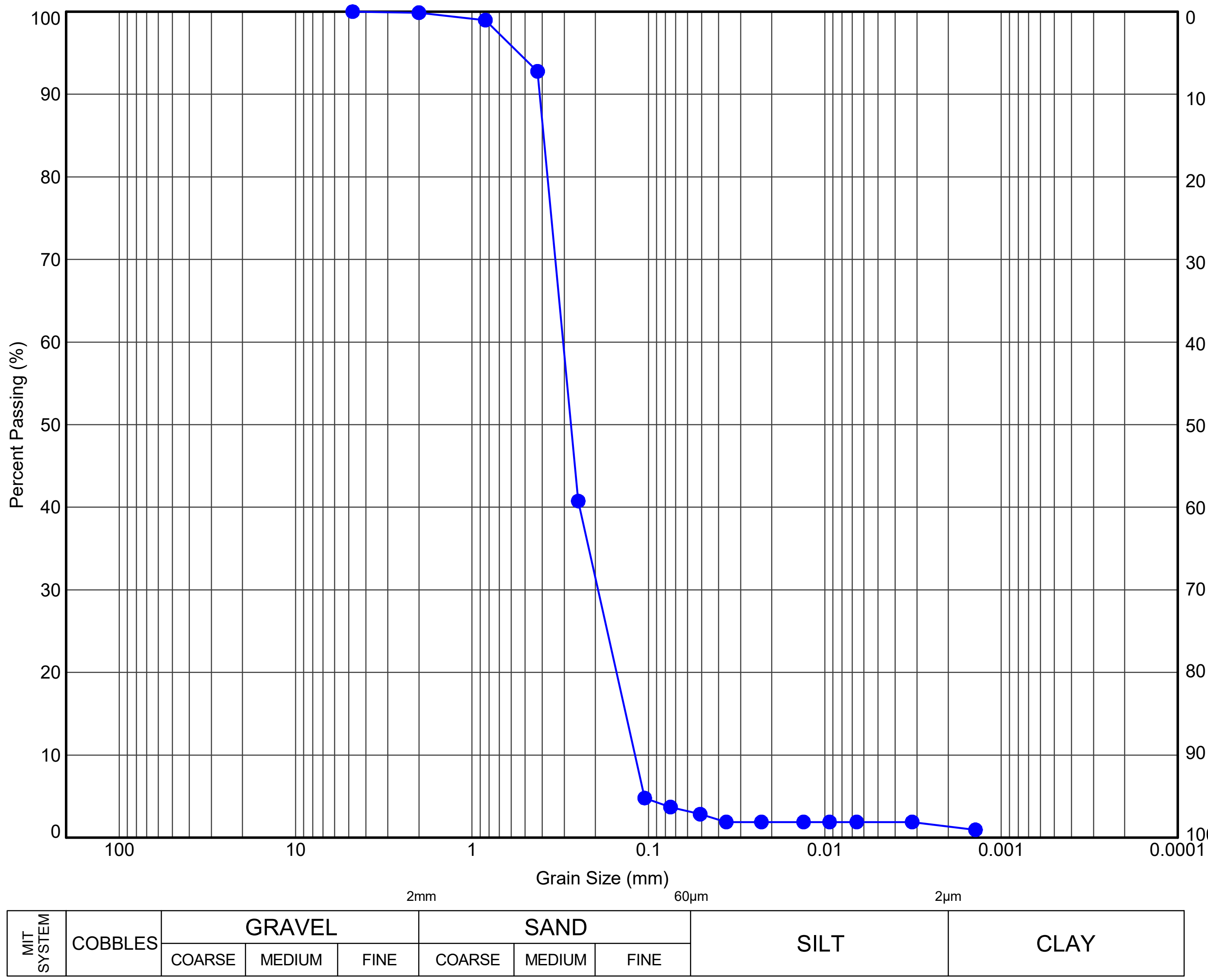
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SAND, TRACE GRAVEL, TRACE SILT, TRACE CLAY

File No.: **3-21-0182-01**



MIT SYSTEM

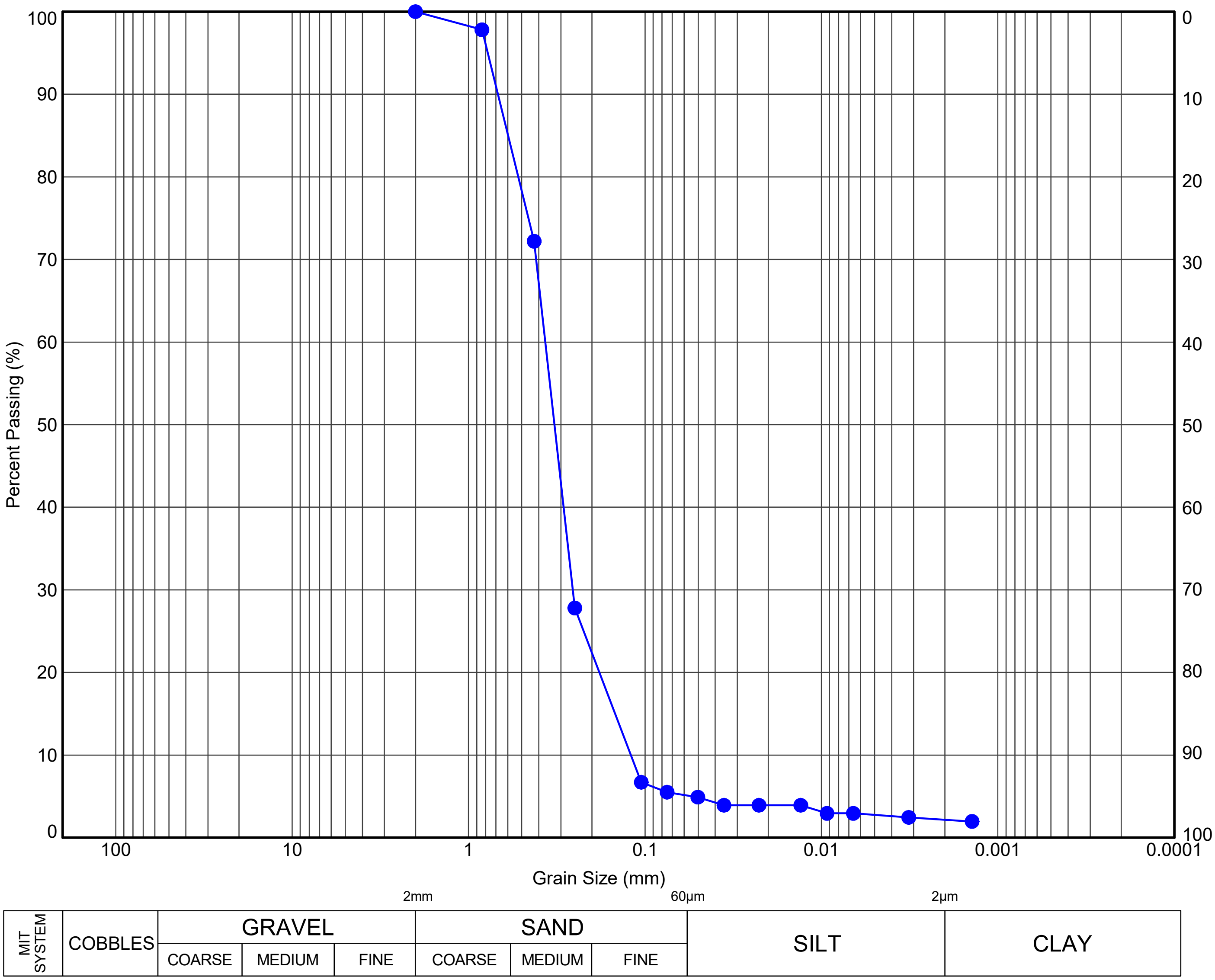
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**2**	SS4	2.5	232.0	0	97	2	1	

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SAND, TRACE SILT, TRACE CLAY

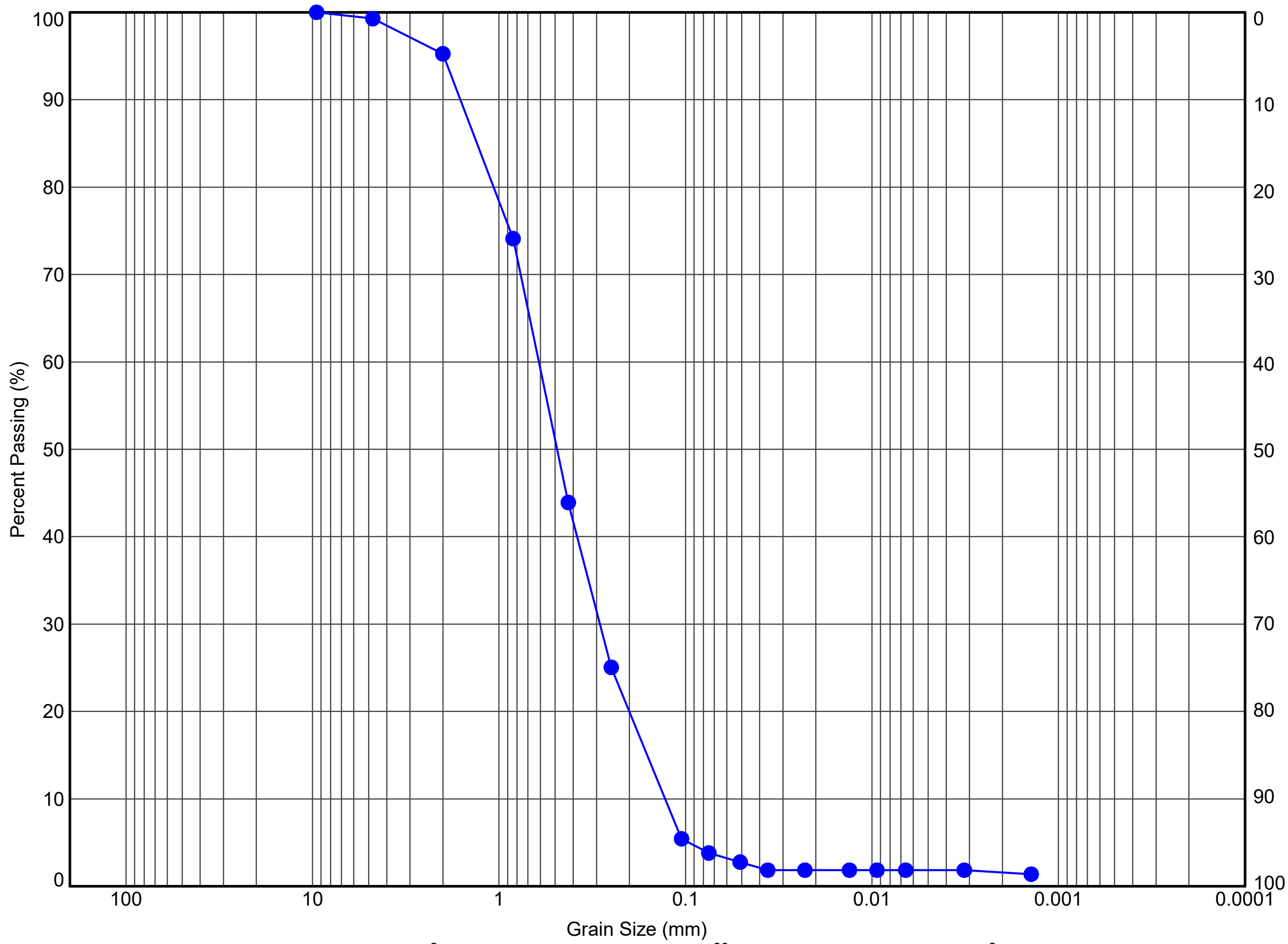
File No.: **3-21-0182-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**3**	SS7	6.3	229.0	0	95	3	2	

Terraprobe 11 Indell Lane, Brampton Ontario L6T 3Y3 (905) 796-2650	Title:	**GRAIN SIZE DISTRIBUTION** **SAND, TRACE SILT, TRACE CLAY**
	File No.:	**3-21-0182-01**



		2mm					60µm	2µm	
MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**4**	SS10	10.9	224.5	5	91	2	2	

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SAND, TRACE GRAVEL, TRACE SILT, TRACE CLAY

File No.: **3-21-0182-01**

APPENDIX C

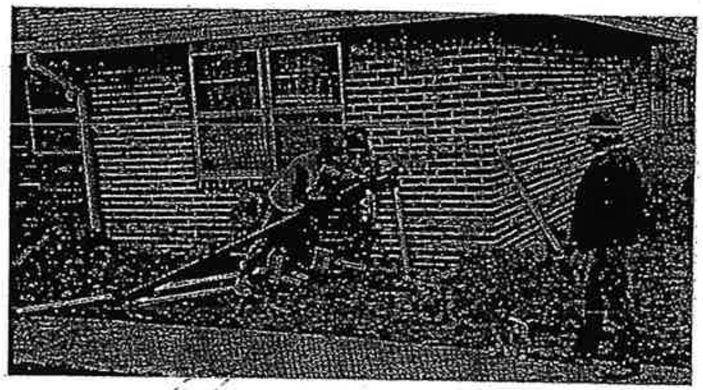
TERRAPROBE INC.

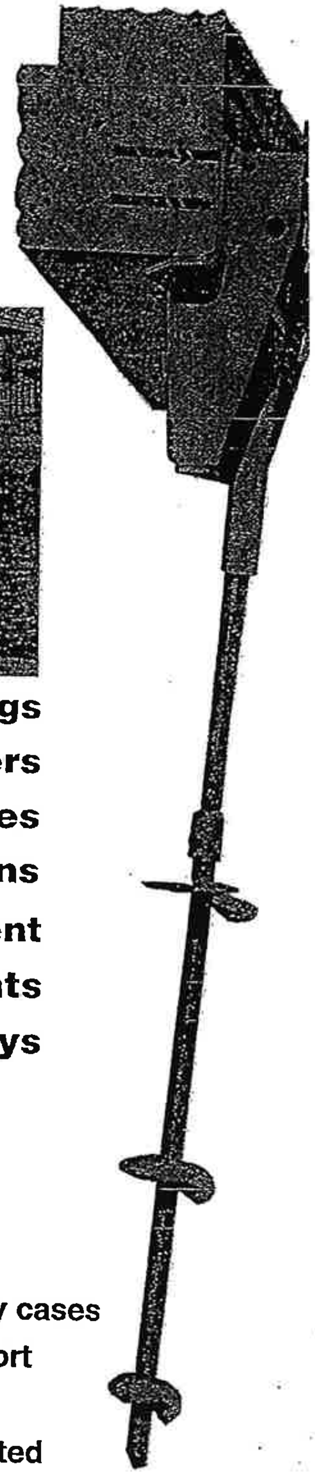
HUBBELL POWER SYSTEMS CHANCE®

A109
02150/CHA
BuyLine 1386

HELICAL-PIER®
FOUNDATION SYSTEM

Saves days and dollars compared to concrete piers, spread footings or other pile methods





•Underpinning buildings
•New-construction piers
•Lifting existing structures
•Seismic applications
•Environment enhancement
•Retaining walls •Revetments
•Dams •Levees •Roadways

Immediate benefits:

- Predictable results
- Lower installed costs
- One-trip convenience: No site preparation or concrete required in many cases
- Holds design loads in specific soils
- Easy to store and transport
- Installs in any weather and in limited-access situations
- Clean – no excavation spoils to remove
- Reusable
- U.S. Patented
- Less equipment needed: No concrete trucks or grout pumps

WORLDWIDE EXPERIENCE IN HELICAL-PIER® SYSTEMS SINCE 1907

Specification References

Details on the Chance Helical Pier® Foundation Support System are available upon request in the three-part section Manu-Spec® format (of the Spec-Data® program copyrighted by The Construction Specifications Insitute). Filed under the identical 02150 designation as Sweet's, highlights include:

Part 1 — General
1.01Section includes: New and remedial building foundation piering and stabilization, retaining walls, tieback systems.
1.02 Related sections: Excavating to working level, load tests, cast-in-place concrete reinforcement.
1.03 References: Fifteen ASTM and one SAE standards specifications.
1.04 Definition of system
1.05 Quality Assurance: Dealer certification, code requirement.

Part 2 — Products
2.01 Manufacturer: Chance Co.
2.02 Manufactured components: Helical plate, pier shaft, bolts, steel bracket.

Part 3 — Execution
3.01 Examination: Verify site conditions under Sect. 01039.
3.02 Preparation: Spare nearby structures; varying elevations.
3.03 Installation: Certified contractor, connect to structure, torque power units, adapters, extensions, torque recording, proper alignment, revolutions per minute, down pressure, coupling bolts, obstructions, minimum depth and torque.
3.04 Field quality control: Inspection, field testing, torque monitoring.
3.05 Project record documents: Submit 8 data records per Sect. 01700.
3.06 Depth and torque tolerances: Maximum torque prior to minimum depth, A/E approval, pier replacement.

Light Duty Bracket

Primarily for correcting sagging lesser loads, affordable "quick fix" outlasts the porches, stairways, decks and patios it repairs.

Standard Duty Bracket

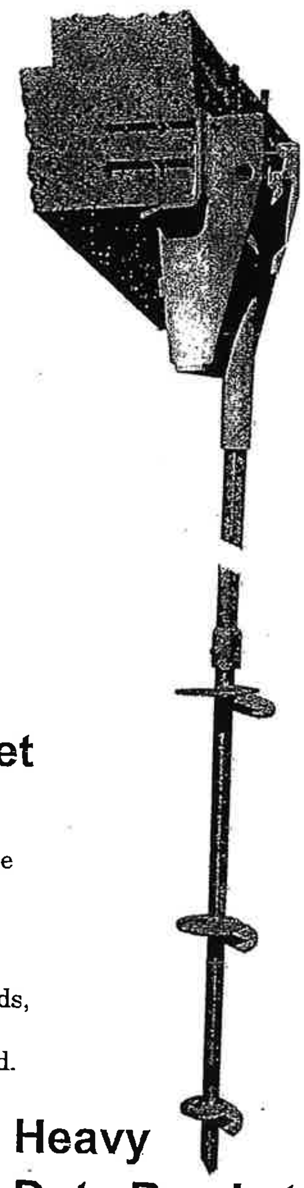
Applied in multiple locations along the foundation to stabilize and correct problems caused by poor soil conditions.

For seismic uplift loads, the Uplift Restraint Bracket may be added.

All components are hot-dip galvanized to increase product life in aggressive soils.

Business Practices

Before each job by contractors certified to install the Chance Helical Pier® Foundation Support System, a quotation is prepared. Customarily, the bid for work is based on the amount to be billed per pier, access and final details required.



Heavy Duty Bracket

For such higher loads as commercial buildings and larger residences. Applied in multiples to stop settled areas, resist new movement.

Lead and extension section lengths

The standard Helical Pier® foundation lead-section lengths are 5, 7, and 10 ft. The standard extension section lengths are 3½, 5, 7, and 10 ft. long. These combinations of leads and extensions provide for a variety of helical foundation lengths for each specific project.

Helix areas

Standard helices manufactured by the Chance Company are:

6 in. diameter = 26.7 sq. in.

8 in. diameter = 48.4 sq. in.

10 in. diameter = 76.4 sq. in.

12 in. diameter = 111.0 sq. in.

14 in. diameter = 151.0 sq. in.

Helix configuration

Standard helices are ⅜ inch thick helically shaped steel plates with outer diameters of 6, 8, 10, 12 and 14 inches. The lead section, or first section installed into the soil, contains the helix plate(s). Multihelix foundations have more than one helix arranged in increasing diameters from the foundation tip to the uppermost helix. If more than one helix is used, the typical spacing between helical plates is three times the diameter of the next lower helix. For example, a helical foundation with an 8-, 10-, and 12- inch helix combination has a 24-inch space between the 8- and 10-inch helix and a 30-inch space between the 10- and 12-inch helix. Helix plates can be added to extension sections if necessary. Extensions with helices should be installed immediately after the lead section.

Capacities listed in the Ratings Table here are system ratings. One must be aware that the actual installed load capacities are dependent on actual soil conditions at each

Minimum pier type required based on mechanical ratings

Design Load, kips	Minimum Pier Type Required
0 to 25	SS5
25 to 35	SS150
35 to 50	SS175 or HS

Note: This chart uses a factor of safety vs. ultimate capacity = 2.

System Ratings Table		Helical Pier® Family			
		*SS5 1½" Square Shaft Column 1	*SS150 1½" Square Shaft Column 2	SS175 1¾" Square Shaft Column 3	HS 3½" OD Pipe Shaft Column 4
Allowable Torque Capacity (ft.-lbs.)	Row A	5,500	7,000	10,000	11,000
Allowable Capacity per Helix (Tension/Compression)	Row B	(1) 20 Kips	20 Kips	25 Kips	25 Kips
Ultimate Capacity per Helix (Tension/Compression)	Row C	(2) 40 Kips	(2) 40 Kips	(2) 50 Kips	(2) 50 Kips
Rated Capacity(4, 5) Underpinning - Retrofit	Row D	20 Kips	25 Kips	40 Kips	_____ (3)
Ultimate Capacity(4, 5) Underpinning - Retrofit	Row E	40 Kips	40 Kips	80 Kips	_____ (3)
Ultimate Capacity(6) for Axially Loaded Foundation (Torque Limited)	Row F	55 Kips	70 Kips	100 Kips	100 Kips

*SS150 shafts have paint stripe at top to distinquish from Type SS5.

(1) For 14"-dia. Helical Pier foundations, reduce allowable capacity by 20% per building code requirements.

(2) For 14"-dia. helices, reduce ultimate capacity by 20%.

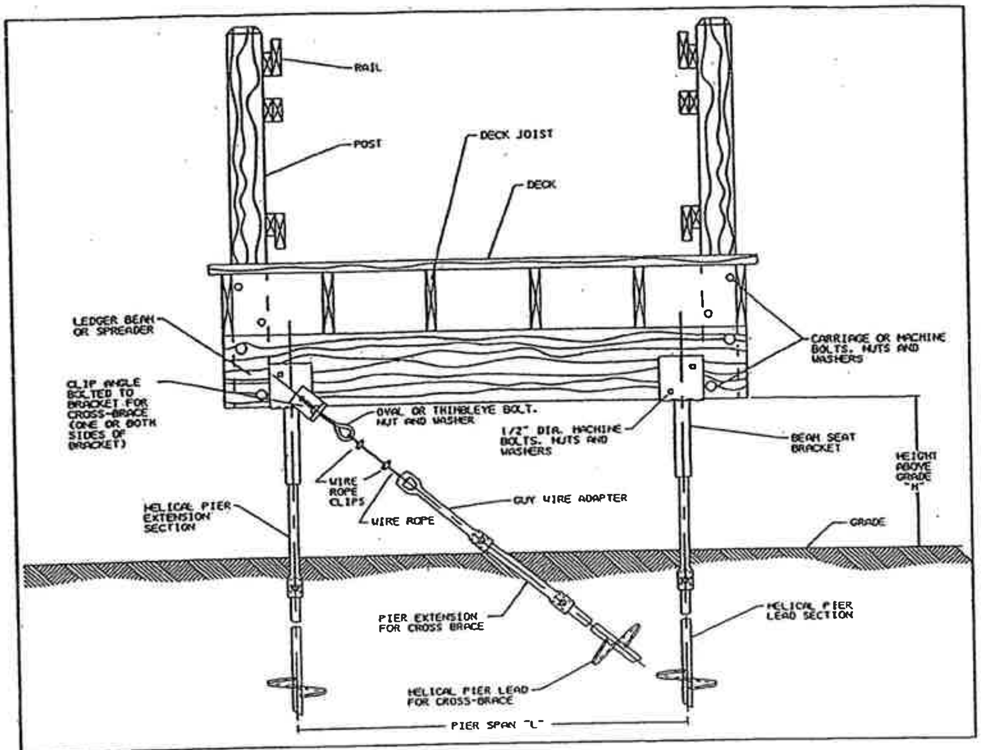
(3) Determined by bracket and haunch design.

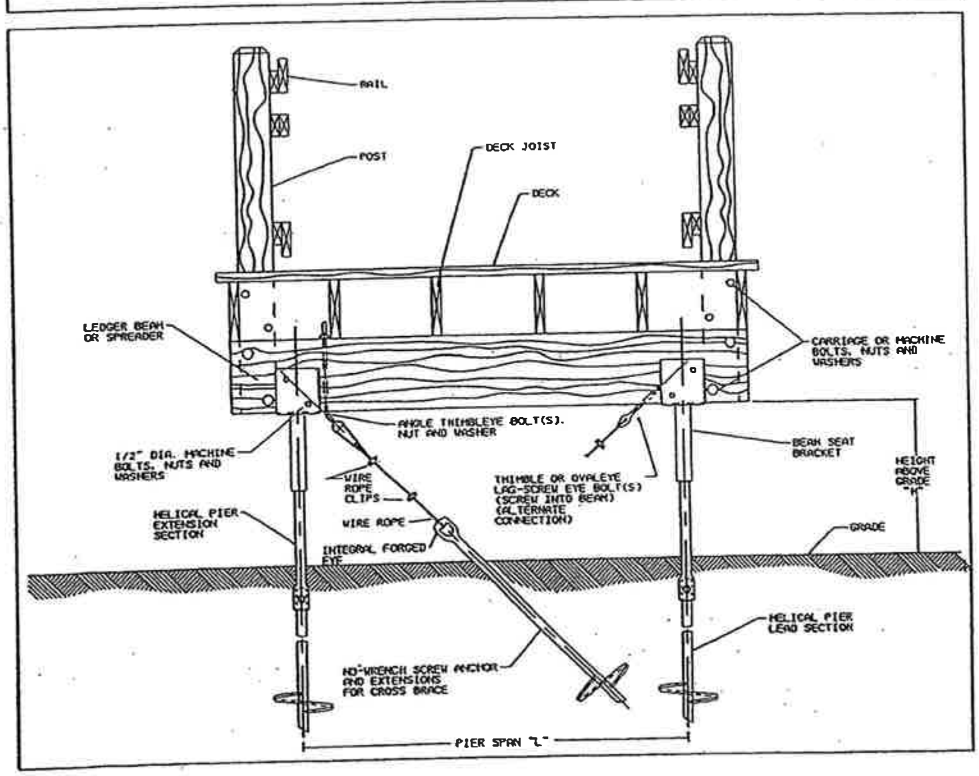
(4) Anchor installed into and supported by soil with SPT blow count (N-value) greater than 4.

(5) Rating with Helical Pier Foundation bracket.

(6) Actual installed capacities are dependent on existing soil conditions.

Typical Walkway Hardware Application





NOTE:

Where applicable, hardware manufactured by A. B. Chance Company is made from steel produced in accordance with ASTM A5 and/or ASTM A576. When galvanized, items are manufactured in accordance with ASTM A153.

Where appropriate, these hardware items comply to the following ANSI specifications:

ANSI

C135.1
C135.2
C135.22
C135.14
C135.17

ON THE COVER: Aerial view of a $1^1/_2$-mile boardwalk constructed at a wetlands site for the Fairfax County, Virginia Park Authority. No wheel or track vehicles were allowed into the wetlands. The Helical Pier® foundation anchors (Type SS5 — $1^1/_2$"-square solid-steel shaft, 10"-dia. helix, hot-dip glavanized) were installed to 7- and 10-ft. depths with average above-grade reveal of 1 to 2 ft. Maximum reveal was $4^1/_2$ ft.

EBS ENGINEERING & CONSTRUCTION LIMITED

Contact Us Home

C3 Environmental	Canadian Construction Controls	EBS Engineering & Constructio
C3 Group Industrial Services	Polymeric Engineering	

Services Case Histories Technical Data

Foundation Stabilization

Structure Repair/ Rennovation

Waterproofing

Injection/ Grouting/ Coatings

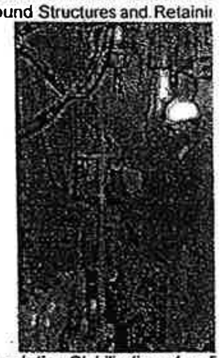
Solves Foundation & Soil Stabilization Problems

EBS Engineering and Construction Limited is the Foundation Division of the C3 Group. EBS delivers a comprehensive service package to both residential and industrial clients. As specialis in foundation restoration and repair, including foundation stabilization, underpinning, floor lowering and waterproofing, EBS is in the business of problem solving. From new construction t industrial retrofits and environmentally sensitive installations, EBS is your comprehensive foundation resource.

Foundation Stabilization

- CHANCE® HELICAL PIER® Foundation System
- CHANCE® Helical Tieback Anchors
- CHANCE® Soil Screw™ Retention Wall System
- CHANCE® Instant Foundation® System for Walkways
- CHANCE® Helical Pulldown™ Micropiles
- Conventional Foundation Underpinning

Installation of Helical Tieback Anc In-Ground Structures and Retaini



Foundation Stabilization of an E Story Structure

Structural Repair/Renovation

- Basement Lowering
- Masonry Repair/Stabilization
- Retaining Walls
- Basement Wall Stabilization and Realignment

Basement Floor Lowering a Underpinning

Water Proofing

- Installation of Interior/Exterior Membranes

- Epoxy and Urethane Resin Injection for Structural Repair and Water Control
- Underfloor Drainage Systems
- Installation and Replacement of Exterior Drainage Systems

Interior Waterproofing Using an A Membrane

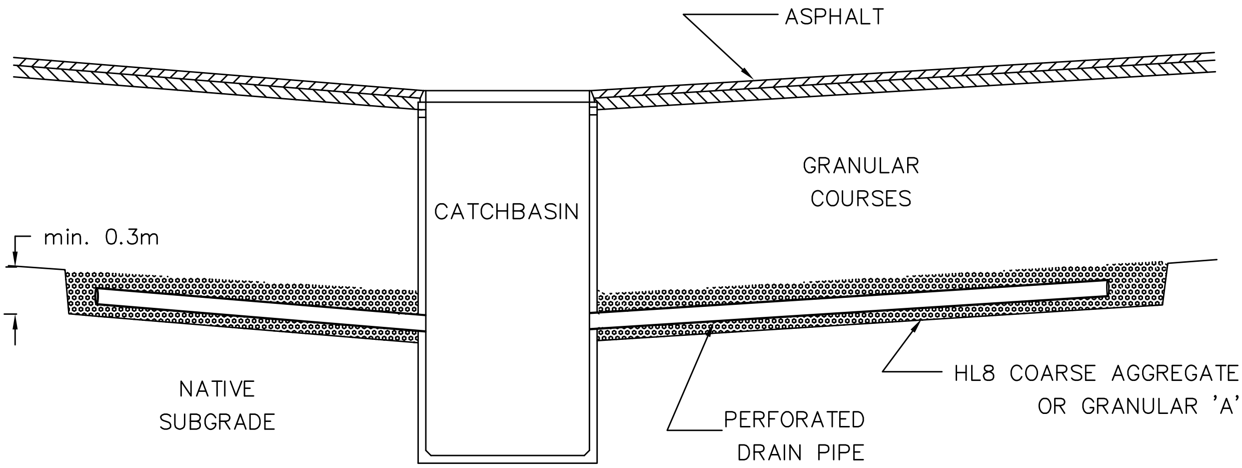
Injection/Grouting/Coatings

- Cementitious and Polymer Grouting for Structural Repair, Water Control and Stabilization
- Slab Jacking
- Concrete Sealers/Epoxy Coatings

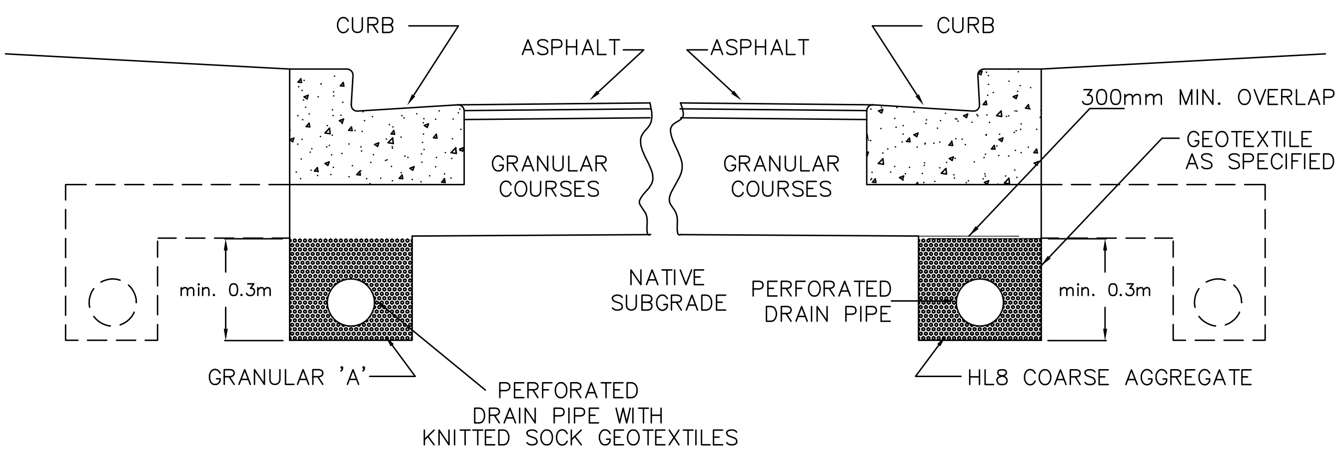
Return to the top

APPENDIX D

TERRAPROBE INC.



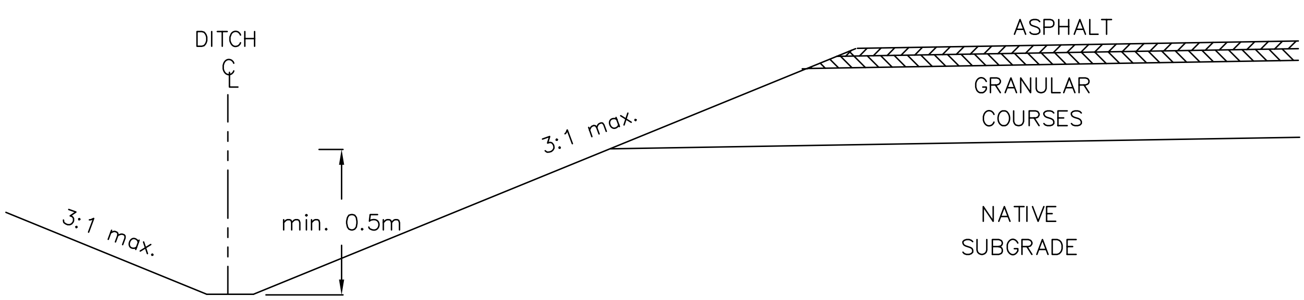
Longitudinal Subdrain Connection to Catchbasin



Unwrapped Trench

Wrapped Trench

Urban Cross Sections



Rural Cross Section

Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

PAVEMENT DRAINAGE ALTERNATIVES