Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
11 MAIN STREET
PUSLINCH, ONTARIO

Prepared for: Mr. Varun Gupta
2060 Lakeshore Road, Unit 301
Burlington, ON
N0B 2C0

Attention: Ms. Mina Rahimi

©Terraprobe Inc.

File No. 1-22-0482-01
Issued: October 3, 2022

Distribution

1 Electronic Copy	-	Mr. Varun Gupta
1 Copy	-	Terraprobe Inc., Brampton

Terraprobe Inc.

Greater Toronto
11 Indell Lane
Brampton, Ontario L6T 3Y3
(905) 796-2650 Fax: 796-2250
brampton@terraprobe.ca

Hamilton – Niagara
903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
(905) 643-7560 Fax: 643-7559
stoneycreek@terraprobe.ca

Central Ontario
220 Bayview Drive, Unit 25
Barrie, Ontario L4N 4Y8
(705) 739-8355 Fax: 739-8369
barrie@terraprobe.ca

Northern Ontario
1012 Kelly Lake Rd., Unit 1
Sudbury, Ontario P3E 5P4
(705) 670-0460 Fax: 670-0558
sudbury@terraprobe.ca

www.terraprobe.ca

TABLE OF CONTENTS

ENCLOSURES

Figures

Appendices

1 INTRODUCTION

Terraprobe Inc. (Terraprobe) was retained by Mr. Varun Gupta to conduct a geotechnical investigation for a proposed residential development at 11 Main Street, in the Town of Puslinch, Ontario. The general location of the site is presented on Figure 1.

This report encompasses the results of the geotechnical investigation conducted for the proposed development site to determine the prevailing subsurface soil and ground water conditions, and on this basis, provides geotechnical engineering design advice and recommendations for the building foundations, earthquake and earth pressure design parameters, basement floor slab and drainage and pavement. In addition, comments are also included on pertinent construction aspects including excavation, backfill and ground water control.

Terraprobe has also conducted hydrogeological studies for this site. The findings of the studies are reported under a separate cover.

2 SITE AND PROJECT DESCRIPTION

The subject site is located in the southeast quadrant of the intersection of Highway 6 and Badenoch Street, in the Town of Puslinch. The legal description of the site is PT LOT 31 CON 8, Township of Puslinch, County of Wellington. The property is an irregular shape parcel of vacant land.

The proposed development would include a residential subdivision, consisting of single detached dwellings and internal roadways. The site is generally undulated and has a significant topographic relief (about 5 m) from west to east at the north portion of the site and a significant topographic relief (about 3 m) from west to east at the south portion of the site. It is understood that the proposed single detached dwelling would include a basement.

Terraprobe was provided with the following site plan for review in preparation of this report,

- *10779 Concept C2_2022-03-16, dated on March 16, 2022, by Western Consulting.*

The above preliminary sit plan does not indicate the finished floor elevation (FFE) for the proposed basement. However, the basement FFE is generally set at about 3 m below grade.

3 INVESTIGATION PROCEDURE

The field investigation was conducted on August 16, 2022 and consisted of drilling and sampling a total of five (5) boreholes within the close proximity of proposed building footprint. Boreholes were advanced between 6.6 m to 8.1 m depth below grade. The approximate locations of the boreholes are shown on the enclosed Borehole Location Plan (Figures 2, 2A and 2B).

All the boreholes were drilled by a specialist drilling contractor using continuous flight solid stem augers and were sampled at 0.75 m (up to 3.0 m depth) and 1.5 m (below 3.0 m depth) intervals with a conventional 50 mm diameter split barrel sampler when the Standard Penetration Test (SPT) was carried out (ASTM D1586). The field work (drilling, sampling and testing) was observed and recorded by a member of our field engineering staff, who logged the borings and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into clean plastic jars, and transported to our geotechnical testing laboratory for detailed inspection and testing. All borehole samples were examined (tactile) in detail by a geotechnical engineer, and classified according to visual and index properties. Laboratory tests consisted of water content determination on all samples; and a Sieve and Hydrometer analysis test on selected native soil samples. The measured natural water contents of individual samples and the results of the Sieve and Hydrometer analysis are plotted on the enclosed Borehole Logs at respective sampling depths. The results of Sieve and Hydrometer analysis tests are also summarized in Section 4.4 of this report and appended.

Water levels were measured in open boreholes upon completion of drilling. Monitoring well comprising 50 mm diameter PVC pipe was installed in four (4) borehole to facilitate ground water monitoring and for the purpose of the Hydrogeological Study. 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 August 24, September 7 and 19, 2022. The results of ground water monitoring are presented in Section 4.5 of this report.

The borehole ground surface elevations were surveyed by Terraprobe using a Trimble R10 GNSS System. The Trimble R10 system uses the Global Navigation Satellite System and the Can-Net reference system to determine target location and elevation. The Trimble R10 system is reported to have an accuracy of up to 10 mm horizontally and up to 30 mm vertically. 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 Log are approximate, for the purpose of relating soil stratigraphy and should not be used or relied on for other purposes.

4 SUBSURFACE CONDITIONS

The specific soil conditions encountered at each borehole locations 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 encountered 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 in 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 Earth Fill

Earth fill materials, consisting of sand, with some gravel and trace amount of rootlets were encountered at the surface layer in each borehole and extended to 0.8 m depth below grade.

Standard Penetration Test results (N-values) obtained from the earth fill zone ranged from 8 to 35 blows per 300 mm of penetration, indicating a loose to dense relative density. The in-situ moisture contents of the fill samples ranged from 2 to 7 percent by mass, indicating a moist condition.

4.2 Silty Sand to Sand and Silt

Silty sand to Sand and Silt deposits, with trace amounts of clay and gravel was encountered beneath the earth fill zone in each borehole and extended to the depths ranging from 6.1 m to the full depth of investigation.

Standard Penetration Test results (N-values) obtained from the silty sand to sand and silt deposits ranged from 8 blows per 300 mm of penetration to 50 blows per 150 mm of penetration, indicating loose to very dense relative density. The in-situ moisture contents of the silt soil samples ranged from 0 to 22 percent by mass, indicating a moist to wet condition.

4.3 Clayey Silt

Clayey Silt deposits, with trace amount of sand was encountered beneath the silty sand to sand and silt deposits in Borehole 1 and extended to the depth of 6.6 m below the grade.

Standard Penetration Test result (N-values) obtained from the clayey silt deposit was 27 blows per 300 mm of penetration, indicating a very stiff consistency. The in-situ moisture content of the clayey silt sample was 15 percent by weight, indicating a moist condition.

4.4 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of natural water content determination for all samples, while a Sieve and Hydrometer analysis 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 are 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 7	6.3	0	3	72	25	CLAYEY SILT trace sand
Borehole 3, Sample 7	6.3	0	36	59	5	SILT AND SAND trace clay
Borehole 5, Sample 3	1.8	0	73	26	1	SILTY SAND trace clay

4.5 Ground Water

Observations pertaining to the depth of water level and caving were made in all boreholes immediately after completion of drilling and are noted on the enclosed Borehole Logs. Monitoring wells were installed in four (4) boreholes to facilitate ground water level monitoring and for the purpose of the hydrogeological study. The ground water level measurements in the monitoring wells were taken on August 24, September 7 and 19, 2022 and are noted on the enclosed Borehole Logs. A summary of these observations is provided as follows:

Borehole No.	Depth of Borehole (m)	Upon Completion of Drilling		Water Level Depth/Elevation in Monitoring Wells		
		Depth to Cave (m)	Unstabilized Water Level (m)	Aug 24, 2022	Sep 7, 2022	Sep 19, 2022
BH 1	6.6	open	dry	dry	dry	dry
BH 2	4.8	open	dry	6.6/311.6	6.7/311.5	6.8/311.4
BH 3	9.4	7.2	dry	5.2/311.9	5.3/311.8	5.4/311.7
BH 5	9.4	6.1	dry	5.1/311.7	5.2/311.6	5.2/311.6

Construction dewatering at adjacent sites, existing building drains or dewatering systems, and seasonal fluctuations may cause significant changes to the depth of the ground water table over time. Additional information pertaining to ground water at the site is discussed in the hydrogeological report by Terraprobe provided under a separate cover (File No. 1-22-0482-46).

5 DISCUSSIONS AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for the use of 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 there is 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.

5.1 Foundations

The proposed development would include a residential subdivision, consisting of single detached dwellings and internal roadways. The site is generally undulated and has a significant topographic relief (about 5 m) from west to east at the north portion of the site and a significant topographic relief (about 3 m) from west to east at the south portion of the site. It is understood that the proposed single detached dwelling would include a basement. The preliminary sit plan does not indicate the finished floor elevation (FFE) for the proposed basement.

The earth fill soils are unsuitable for the support of proposed building foundations. All foundations must be supported on the underlying competent undisturbed native soils and engineered fill.

5.1.1 Foundation on Native Soils

The undisturbed silty sand to silt and sand deposits were encountered at 0.8 m depth below grade (Elev. 312.2 to 319.1 m). This undisturbed native deposit is considered suitable to support the proposed building foundations. A net geotechnical reaction of 300 kPa (Serviceability Limit States, SLS) and factored geotechnical resistance of 450 kPa (Ultimate Limit States, ULS) will be used for the design of conventional spread footing foundations (for vertical and concentric loads) supported on the underlying competent native silty sand to silt and sand deposits of compact to dense relatively density. The geotechnical reaction(s) as recommended allow for up to 25 mm of total settlement. This settlement will occur as load is applied and is linear elastic and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

The final grading plan and design drawings must be reviewed by Terraprobe to better assess the design foundation elevations and to provide updated foundation bearing pressure (geotechnical reaction and resistance) recommendations prior to the individual development.

The minimum width of the continuous strip footings must be 450 mm and the minimum size of isolated footings must be 900 mm×900 mm regardless of loading considerations, in conjunction with the above recommended geotechnical resistance. Footing sizes for houses and small buildings are provided in Division B, Part 9 of Ontario Building Code and must be followed regardless of footing sizes provided above. The geotechnical reaction (s) as recommended allow for up to 25 mm of total settlement. This settlement will occur as load is applied and is linear elastic and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

5.1.2 Foundation on Engineered Fill

Where site grades are required to be raised, consideration should be given to the construction of engineered fill which may also support house foundations at normal depths, if needed.

The engineered fill refers to earth fill designed and constructed with a full-time inspection and testing to support the building foundations without excessive settlement. Construction of engineered fill should only be conducted under the full-time engineering guidance and supervision.

Prior to the placement of the engineered fill, it is recommended that the topsoil, weathered /disturbed native soils be stripped from beneath and beyond the proposed building footprints (a minimum of 2 m beyond), and that the subgrade be proof rolled. Any soft or wet areas that deflect excessively during the proof roll should be sub-excavated and replaced with suitably compacted clean earth fill placed in maximum 150 mm thick lifts. It should be noted that localized subgrade stabilization measures may be required, based on proof roll assessment. The selection and sorting of the existing earth fill or weathered/disturbed native soil materials present on the site should be conducted under the supervision of a geotechnical engineer. These materials may be utilized as engineered fill, provided these soils are not too wet to achieve specified compaction and do not contain excessive organic inclusion. The moisture content of the engineered fill material must be within 2 percent of its optimum moisture content

The engineered fill should consist of clean earth fill or imported granular materials (OPSS.MUNI 1010), and should be placed in maximum 150 mm thick lifts, and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). The engineered fill should extend for a distance of at least 2 m beyond the building footprint as measured at the founding level and should extend downwards from this point at a 1 to 1 (horizontal to vertical) slope, to the approved subgrade. In addition, the engineered fill should extend at least 0.6 m above the proposed foundation elevation. This is to ensure that the foundations are placed on the engineered fill both in plan and elevation. The engineered fill must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate frost protection.

The placement and inspection of the engineered fill must be conducted under the full-time supervision of a qualified geotechnical engineer. Provided the engineered fill is placed and compacted as indicated above, a maximum net allowable geotechnical reaction of 150 kPa at SLS and factored geotechnical resistance of 225 kPa at ULS may be utilized for the design of conventional spread footing foundations supported on engineered fill. Site grading plan should be reviewed by Terraprobe to better assess the suitability and requirements for engineered fill.

In case of footings supported on engineered fill, the minimum width for the conventional spread strip footing must be 600 mm, and the minimum size of the individual column footing must be 1,000 mm×1,000 mm, regardless of loading considerations.

It should be noted that for buildings placed on engineered fill, nominal reinforcing steel is recommended in the foundation walls. The reinforcing steel should consist of two (2) continuous 15 M bars at the top of the foundation wall and two (2) continuous 15 M bars at the bottom (Figure 3). A draft copy of "Engineered Fill Earthworks Specifications" is enclosed in the appendix section of this report for reference.

5.1.3 Foundation Installation

Prior to pouring concrete for the footings, the footing subgrade must be cleaned of all deleterious materials such as 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. As per the Ontario Building Code (2012), the foundation excavations must be inspected and approved (by Terraprobe) to ensure the bearing capacities stated below are applicable. If incompetent soils are encountered at the proposed bearing depths during foundation excavation or due to inadequate dewatering, sub-excavation to competent soil subgrade is required under the direction of the geotechnical engineer.

All exterior foundations and foundations in unheated areas must be provided with a minimum soil cover of 1.2 m or equivalent insulation for frost protection. All footings must be designed and constructed to bear at least 0.3 m into the undisturbed native soil/engineered fill stratum.

Prior to pouring foundation concrete, the foundation subgrade should be cleaned of all deleterious materials such as topsoil, fill, softened, disturbed or caved materials, as well as any standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the foundation subgrade and concrete must be provided.

It is noted that the native soils tend to weather rapidly and deteriorate on exposure to the atmosphere or surface water. Hence, foundation bases which remain open for an extended period of time should be protected by a skim coat of lean concrete. Provisions should be made to minimize disturbance to the exposed foundation subgrade.

5.2 Earth Pressure Design Parameters

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

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

Where:

- **P** = the horizontal pressure (kPa)
- **K** = the earth pressure coefficient
- **h** = the depth below the ground surface (m)
- h_w = the depth below the ground water level (m)
- γ = the bulk unit weight of soil (kN/m^3)
- γ_w = the bulk unit weight of water (9.8 kN/m^3)
- γ' = the submerged unit weight of the exterior soil, (γ_{sat} - γ_w)
- **q** = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, this equation can be simplified to:

$$P = K[\gamma h + q]$$

This equation assumes that free-draining granular backfill is used and positive drainage is provided to ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure.

Resistance to sliding of retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact (**N**) and the frictional resistance of the soil (**tan ϕ**) expressed as **R = N tan ϕ**. The factored geotechnical resistance at ULS is **0.8 R**.

Passive earth pressure resistance is generally not considered as a resisting force against sliding for conventional retaining structure design because a structure must deflect significantly to develop the full passive resistance.

The average values for use in the design of walls subjected to unbalanced earth pressures at this site are tabulated as follow:

Parameter	Definition	Units
ϕ	angle of internal 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

Stratum/Parameter	γ	Φ	K_a	K_o	K_p
Engineered Fill	19.0	28	0.36	0.53	2.77
Silty Sand to Silt and Sand	21.0	32	0.31	0.47	3.25
Clayey Silt	21.0	32	0.31	0.47	3.25

The above values of the earth pressure coefficients are for the horizontal backfill grade behind the wall. The earth pressure coefficients for inclined grade will vary based on the inclination of the retained ground surface.

5.3 Earthquake Design Parameters

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 2012 Ontario Building Code (OBC 2012) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 s, 0.5 s, 1.0 s and 2.0 s 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 (v_s), 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 Table 4.1.8.4A of the Ontario Building Code (2012). 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 Table 4.1.8.4.A of the Ontario Building Code (2012). Consideration may be given to conducting a site-specific Multichannel Analysis of Surface Waves (MASW) at this site to determine 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.

5.4 Basement Floor Slab

The excavated surface should be assessed by a qualified geotechnical engineer. The modulus of subgrade reaction appropriate for the slab design constructed on undisturbed silty sand to silt and sand subgrade is 35,000 kPa/m, and the modulus of subgrade reaction appropriate for the slab design constructed on engineered fill subgrade is 20,000 kPa/m.

Prior to the construction of the slab, it is recommended that the subgrade be cut-neat, approved and inspected under the supervision of Terraprobe for obvious loose or disturbed areas as exposed, or for areas containing excessively deleterious materials or moisture. All sub excavated areas shall be replaced with Granular B placed as compacted fill (in lifts 150 mm thick or less and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density, SPMDD).

The basement floor slab should be provided with a capillary moisture barrier and drainage layer. This can be made by placing the slab on a minimum of 300 mm thick 19 mm clear stone layer (OPSS.MUNI 1004) compacted by vibration to a dense state. This material also serves as the drainage media for the subfloor drainage system. Provision of subfloor drainage is required in conjunction with the perimeter drainage of the structure. Suitable geotextile (for instance OPSS.MUNI 1860 Class II non-woven geotextile) needs to be placed to separate granular base course from the subgrade to prevent migration of soil fines.

The subfloor drainage system is an important building element, as such the storm sumps which ensure the performance of this system must have a duplexed pump arrangement for 100 percent pumping redundancy provided with emergency power as needed. Basement and subfloor drainage provisions are further discussed in Section 5.5 of this report.

5.5 Basement Drainage

The ground water level measurements in the monitoring wells were taken on August 24, September 7 and 19, 2022. The measured ground levels in the wells installed in Boreholes 2, 3 and 5 ranged from Elev. 311.4 to 311.9 m while the well installed in Borehole 1 remained dry.

The exterior grade around the buildings should be sloped away at a 2 percent gradient or more for a distance of at least 1.2 m to assist in maintaining basement dry from seepage. The basement wall (for basement) must be provided with damp-proofing provisions in conformance to the Section 9.13.2 of the Ontario Building Code (2012). In case of open excavation, the basement wall backfill for a minimum lateral distance of 0.6 m out from the wall should consist of free-draining granular material (OPSS.MUNI 1010 Granular B), or provided with a prefabricated drain material (for instance, CCW MiraDRAIN 6000 series or Terrafix Terradrain 600), see Figure 3 Typical Basement Drainage Schematic. The perimeter drain installation and outlet provisions must conform to the plumbing code requirements.

The sub-floor drainage system should consist of perforated pipes (minimum 100 mm diameter) located at a spacing of about 5.0 m centre to centre (Refer to Figure 4 Basement Floor Subdrain Detail). The subdrain system should be outlet to a suitable discharge point under gravity flow, or connected to a sump located in the lowest level of the basement. The water from the sump must be pumped out to a suitable discharge point/positive outlet. The installation of the drains as well as the outlet must conform to the applicable plumbing code requirements.

The size of the sump should be adequate to accommodate the anticipated water seepage. An industrial duplex pumping arrangement (main pump with a provision of a backup pump) on emergency backup power is recommended. The pump capacity must be adequate to accommodate peak flow conditions expected during the wet seasons (i.e., spring melt and fall).

The subfloor drainage system is an important building element at this site, as such the storm sump that ensures the performance of this system must have an industrial duplexed pump arrangement on emergency power, as noted above, for 100 percent pumping redundancy.

5.6 Pavement

Design recommendations for the asphalt pavement supported on the soil subgrade are provided in this section.

5.6.1 Pavement Design

The asphalt pavement design is provided in the following table.

Pavement Structural Layers	Light-Duty	Heavy-Duty
HMA Surface Course, OPSS.MUNI 1150 HL 3	40 mm	40 mm
HMA Binder Course, OPSS.MUNI 1150 HL 8	50 mm	100 mm
Base Course, OPSS.MUNI 1010 Granular A	150 mm	150 mm
Subbase Course, OPSS.MUNI 1010 Granular B Type I	300 mm	450 mm
Total Thickness	540 mm	740 mm

It should be noted that in addition to the adherence to 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. It is recommended that regular inspection and testing be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

5.6.2 Drainage

Control of water is an important factor in achieving a good pavement life. Therefore, we recommend that provisions be made to drain the new pavement subgrade and its granular layers. Drainage can be achieved by installing catch basin(s) and a storm sewer system to collect surface runoff and, this system can also be used for subsurface drainage by installing sub drains that are designed to drain into the catch basins. The subgrade must be free of depressions and sloped at a grade of 3 percent to provide positive drainages.

Continuous pavement sub drains (designed to drain into catch basins) should be provided along both sides of the internal route curb lines. Two lengths of sub drain (each minimum 3 m long) should also be installed at each catch basin at the parking lot area. All sub-drain arrangements should comply with OPSD 216.021.

5.6.3 General Pavement Recommendations

HL 3 and HL 8 hot mix asphalt mixes should be designed, produced and placed in conformance with OPSS.MUNI 1150 and OPSS.MUNI 310 requirements and pertinent Town’s standards.

Portland cement concrete should be design, produced and placed in conformation with CAN/CSA A23.1, OPSS.MUNI 1350 and OPSS 350 requirements and relevant Town’s standards.

Granular base and subbase materials should be compacted to 100 percent SPMDD at ±2 percent of the OMC.

PG 58-28, conforming to OPSS.MUNI 1101 is recommended in the HMA surface and binder courses.

Tack coat SS-1 should be applied between hot mix asphalt binder course and surface course.

5.6.4 Subgrade Preparation

All topsoil, organics, soft/loose soils should be stripped from the subgrade areas. The exposed subgrade is expected to consist of earth fill, engineered fill or native soils and these soils will be weakened by construction traffic when wet; especially if site work is carried out during the periods of wet weather. An adequate granular working surface would be likely required in order to minimize subgrade disturbance and protect its integrity in wet periods.

Immediately prior to placing the granular subbase, the exposed subgrade should be proof rolled with a heavy rubber tired vehicle (such as a loaded gravel truck). The subgrade should be inspected for signs of rutting, distress and displacement. Areas displaying signs of rutting, distress and displacement should be re-compacted and re-tested or, these materials should be locally excavated and replaced with well-compacted clean approved fill material.

The fill material may consist of either granular material or local inorganic soils provided that its moisture content is within ±2 percent of OMC. Fill material should be placed and compacted in accordance with OPSS.MUNI 501 and the subgrade should be compacted to 98 percent of SPMDD. The final subgrade surface should be sloped at least 3 percent to provide positive drainage.

5.7 Excavations

The boreholes data indicate that the earth fill materials and undisturbed native soils would be encountered in the excavations. Excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

a. is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b. has a low natural moisture content and a high degree of internal strength;
c. has no signs of water seepage; and
d. can be excavated only by mechanical equipment.

TYPE 2 SOIL

a. is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b. has a low to medium natural moisture content and a medium degree of internal strength; and
c. has a damp appearance after it is excavated.

TYPE 3 SOIL

a. is stiff to firm and compact to loose in consistency or is previously-excavated soil;
b. exhibits signs of surface cracking;
c. exhibits signs of water seepage;
d. if it is dry, may run easily into a well-defined conical pile; and
e. has a low degree of internal strength

TYPE 4 SOIL

a. is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b. runs easily or flows, unless it is completely supported before excavating procedures;
c. has almost no internal strength;
d. is wet or muddy; and
e. exerts substantial fluid pressure on its supporting system.

The earth fill materials encountered in the boreholes are classified as Type 3 Soil, while the undisturbed native soils would be classified as Type 2 Soil above and Type 3 Soil below prevailing ground water level under these regulations.

Where workmen must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates the steepest 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 the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

5.8 Ground Water Control

Terraprobe has completed Hydrogeological Report (File No. 1-22-0482-46) for this site to provide ground water control measures and estimate ground water discharge volume (Refer to this report for detailed information about ground water volumes, quality and control provisions).

The ground water level measurements in the monitoring wells were taken on August 24, September 7 and 19, 2022. The measured ground levels in the wells installed in Boreholes 2, 3 and 5 ranged from Elev. 311.4 to 311.9 m while the well installed in Borehole 1 remained dry. Considering relatively shallow excavation at this project site, significant amount of groundwater will not be encountered during the foundation and trench excavations. However, perched water seepage may be encountered during the excavations primarily emanating from the earth fill zone. The perched ground water seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation. For excavations extending to depths greater than 0.3 m below the prevailing water table, it will be necessary to lower the ground water level below the excavation base, prior to, and maintain during the subsurface construction. A professional dewater contractor should review the subsurface information to provide further comments for the potential requirements for the ground water control.

5.8.1 Regulatory Requirements

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

- Construction Dewatering less than 50,000 L/day: The takings of both ground water and storm water **does not require** a Construction Dewatering Assessment Report (CDAR) and **does not require** a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).

- Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day: The taking of ground water and/or storm water **requires** a Construction Dewatering Assessment Report (CDAR) and **does not** require a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).
- Construction Dewatering greater than 400,000 L/day: The taking of ground water and/or storm water **requires** a Construction Dewatering Assessment Report (CDAR) and **requires** a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).

If it is expected that greater than 50,000 L/day of water will be pumped, a CDAR and/or a PTTW should be obtained as soon as possible in advance of construction to avoid possible delays. Depending on the construction methodology for the site servicing (trench boxes or open cut, and length of trench) and the time of year (high versus low ground water levels), there is the possibility that water taking of greater than 50,000 L/day may occur at this site.

A CDAR takes up to 1 month to complete if monitoring wells are already installed on site. Once the CDAR is completed, it is uploaded to the Environmental Activity and Sector Registry (EASR), which registers the construction dewatering with the MOECC without the need for a permit. If the results of the CDAR indicate that greater than 400,000 L/day will be pumped, a PTTW application must be submitted to the MOECC. A PTTW application can take up to an additional 3 months for the MOECC to process upon completion of the CDAR. Note that Environmental Compliance Assessments, Impact Study Reports and applicable municipal, provincial and conservation authority approvals (completed by others) will be required as part of the CDAR.

5.9 Backfill

The native soils are considered suitable for backfill provided the moisture content of these soils is within 3 percent of the Optimum Moisture Content (OMC). It should be noted that there may be wet zones within the subsurface soils which could be too wet to compact. Any soil material with 3 percent or higher in-situ moisture content than its OMC, 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.

In settlement sensitive areas, the backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less, and heavily compacted to a minimum of 95 percent Standard Proctor Maximum Dry Density (SPMDD) at a water content close to OMC (within 3 percent). The upper 1.2 m of the pavement subgrade must be compacted to a minimum of 98 percent SPMDD.

5.10 Quality Control

Excavations on this site must be shored to preserve the integrity of the surrounding properties and structures. The Ontario Building Code 2012 stipulates that engineering review of the subsurface conditions is required on a continuous basis during the installation of earth retaining structures. Terraprobe should be retained to provide this review, which is an integral part of the geotechnical design function as it relates to the shoring design considerations. Terraprobe can provide detailed shoring design services for the project, if requested.

All foundations must be monitored by the geotechnical engineer on a continuous basis 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 Section 4.2.2.2 of the Ontario Building Code 2012. 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 provided in this report.
Concrete for this structure 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.

The requirements for fill placement on this project should be stipulated relative to SPMDD, as determined by ASTM D698. In-situ determinations of density during fill placement by Procedure Method B of ASTM D2922 are recommended to demonstrate that the contractor is achieving the specified soil density. Terraprobe is a CNSC licensed operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary.

Terraprobe can provide thorough in house resources, quality control services for Building Envelope, Roofing, as well as Structural Steel in accordance with CSA W178, 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.

6 LIMITATIONS AND RISK

6.1 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 by Terraprobe.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even 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. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

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 that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should 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, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

6.2 Changes in Site and Scope

It must also 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. Groundwater levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from this investigation conducted at the site by Terraprobe and are intended for use by the owner and its retained designers 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 and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

This report was prepared for the express use of Mr. Varun Gupta and their retained design consultants and 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 Inc. and Mr. Varun Gupta who are the authorized users.

It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

Yours truly,
Terraprobe Inc.

LICENSED PROFESSIONAL ENGINEER
L. ZHANG
100108585
2023-02-27
PROVINCE OF ONTARIO

Frank Meng, M.Eng., P.Eng.
Geotechnical Engineer

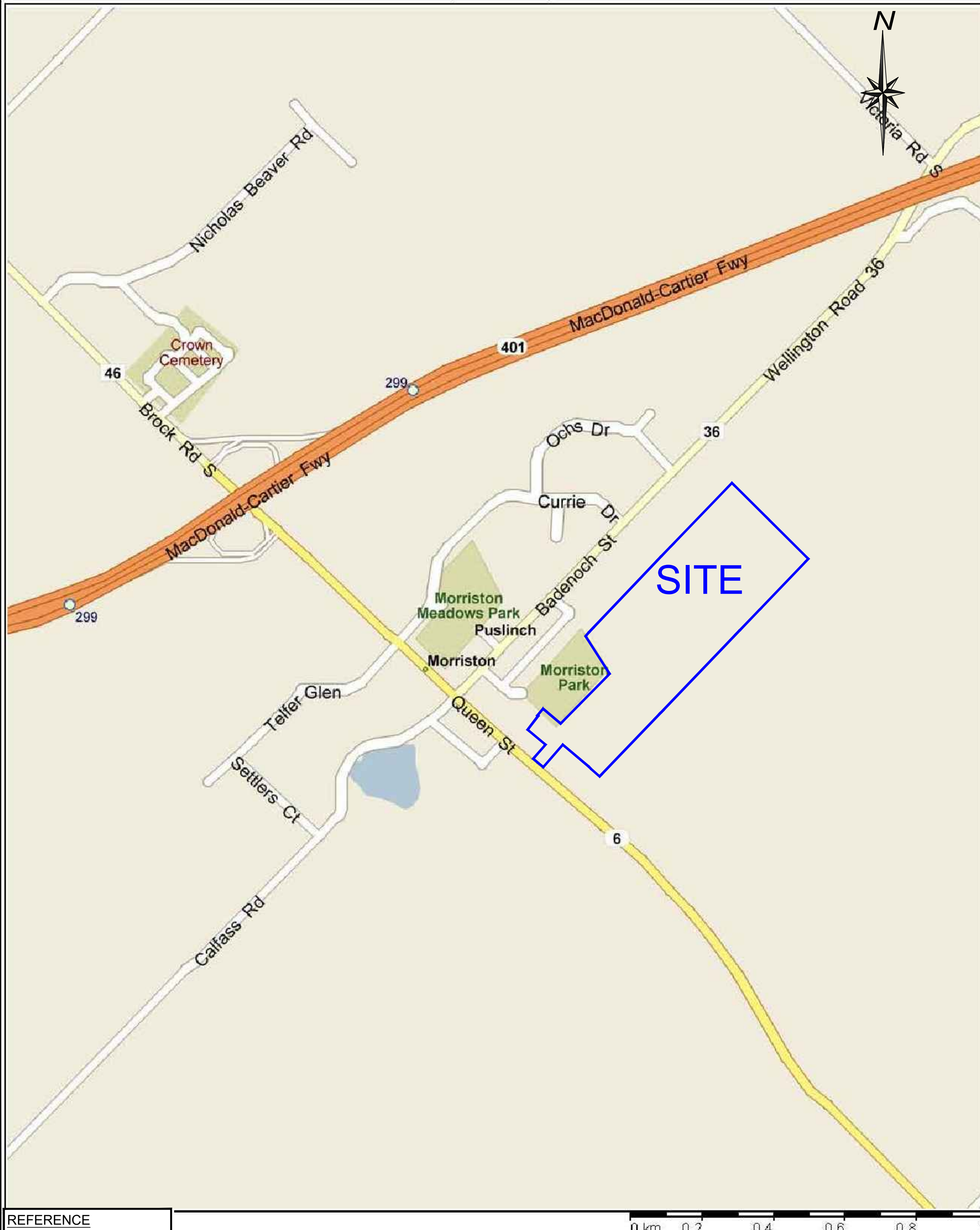
Seth Zhang, M. Eng, M.Sc., P.Eng.
Associate

ENCLOSURES

TERRAPROBE INC.

FIGURES

TERRAPROBE INC.



REFERENCE
Microsoft Streets and Trips

Terraprobe

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

Title:	**SITE LOCATION PLAN**
File. No.:	1-22-0482-01

FIGURE : 1

Y:\Shared\CA\Terraprobe\Brampton\1-Project Files\2022\1-22-0482 - 11 Main Street, Puslinch\01-Geotechnical Investigation\A. Dwgs, Logs\AutoCAD\1-22-0482-01 Figure 1 & 2.dwg,
DWG To PDF.pc3, Kamal, Kamal

REFERENCE
Image © 2022 Google Earth

LEGEND
Approximate Borehole Location

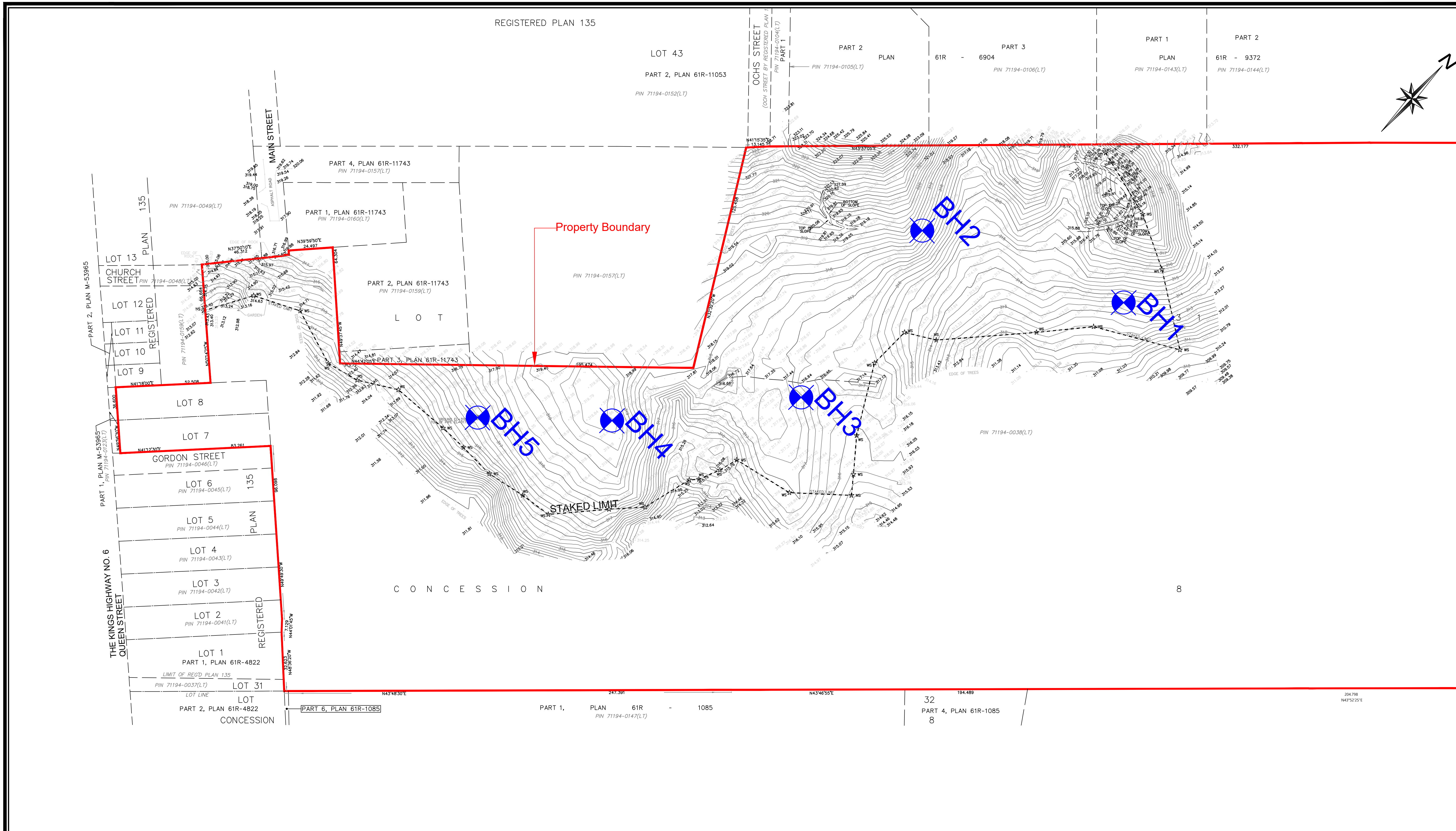
SCALE 16 0 40m

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

Title: **BOREHOLE LOCATION PLAN**
Aerial Photograph

File No. 1-22-0482-01

FIGURE : 2



REFERENCE

Part of Lots 7 & 8 North of Queen Street, Registered Plan 135,
Township of Puslinch, City of Wellington
Reference No.: 22-14-718-00-topo, Date: September 16, 2022
By: J.D.Barnes Limited

LEGEND

Approximate Borehole Location

SCALE 16 0 40m

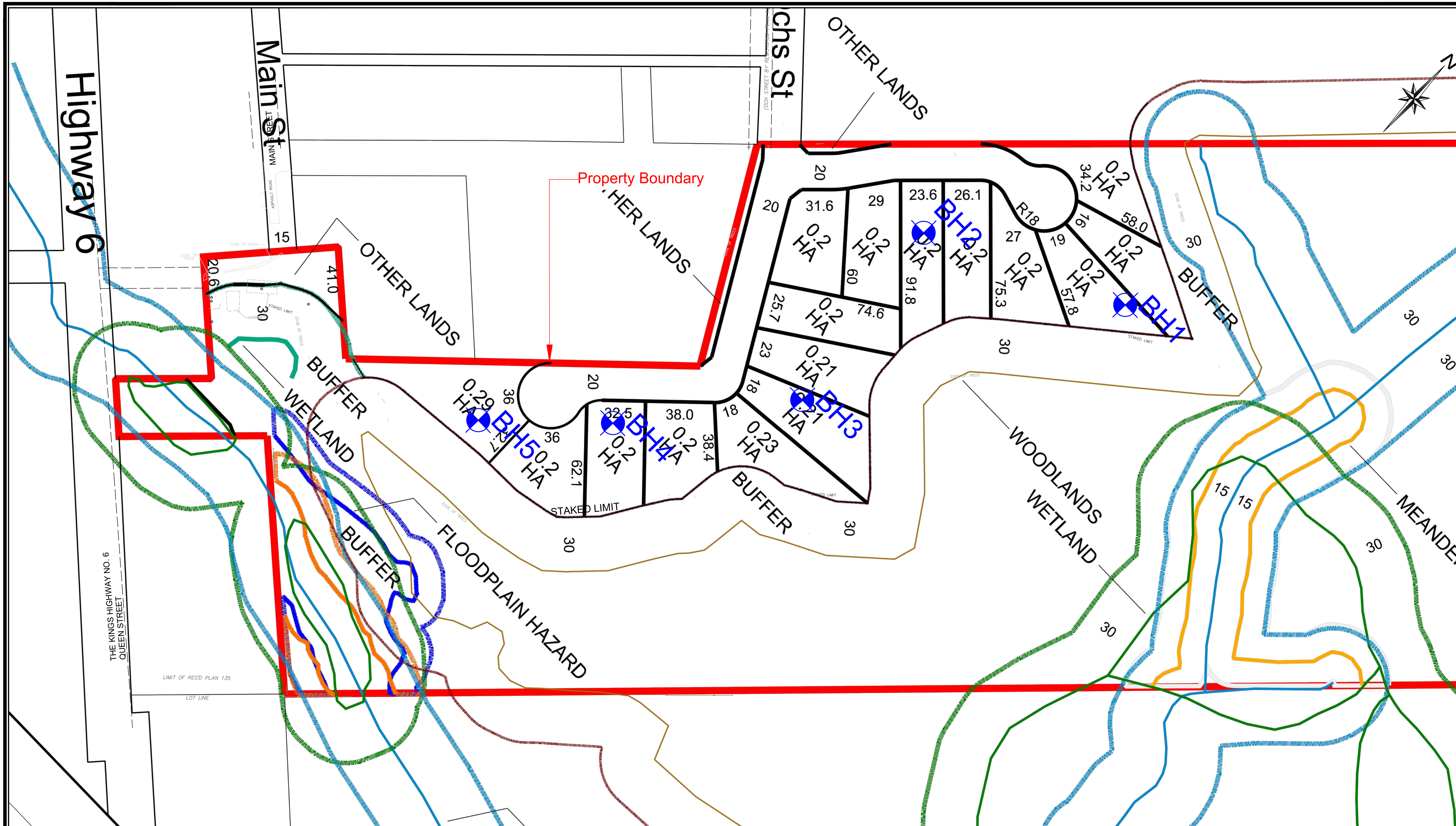
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: **BOREHOLE LOCATION PLAN**
Existing Condition

FIGURE : 2A

File No. 1-22-0482-01

Y:\Shared\CA\Terraprobe\Brampton\1-Project Files\2022\1-22-0482 - 11 Main Street, Puslinch\01-Geotechnical Investigation\A Dwgs, Logs\AutoCAD\1-22-0482-01 Figure 2.dwg,
DWG To PDF.pc3, Kamal, Kamal



REFERENCE
Development Concept
File No.: 10779, Date: 2022-03-16
Drawing No.: C2, By: Weston Consulting

LEGEND
Approximate Borehole Location

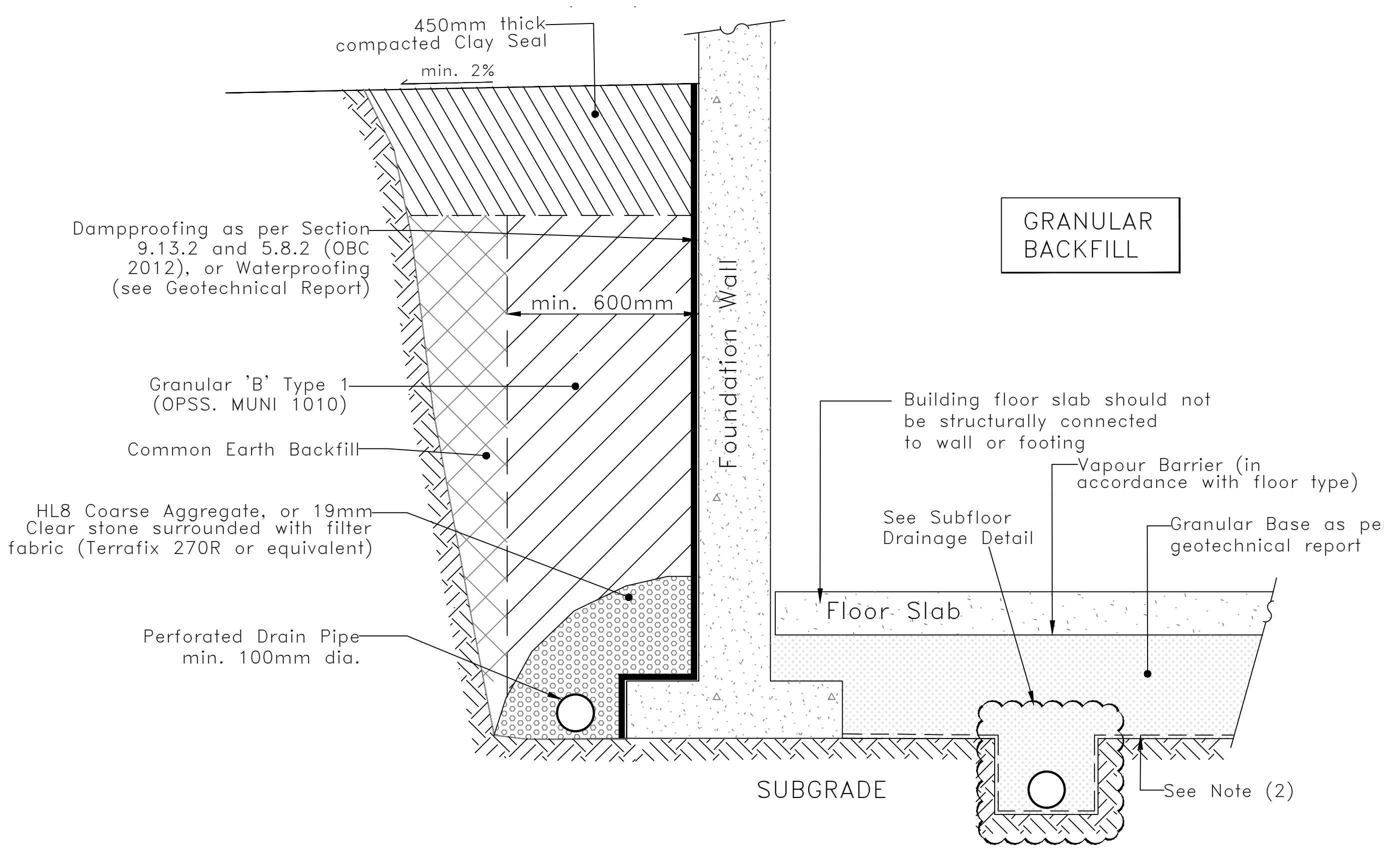
SCALE 16 0 40m

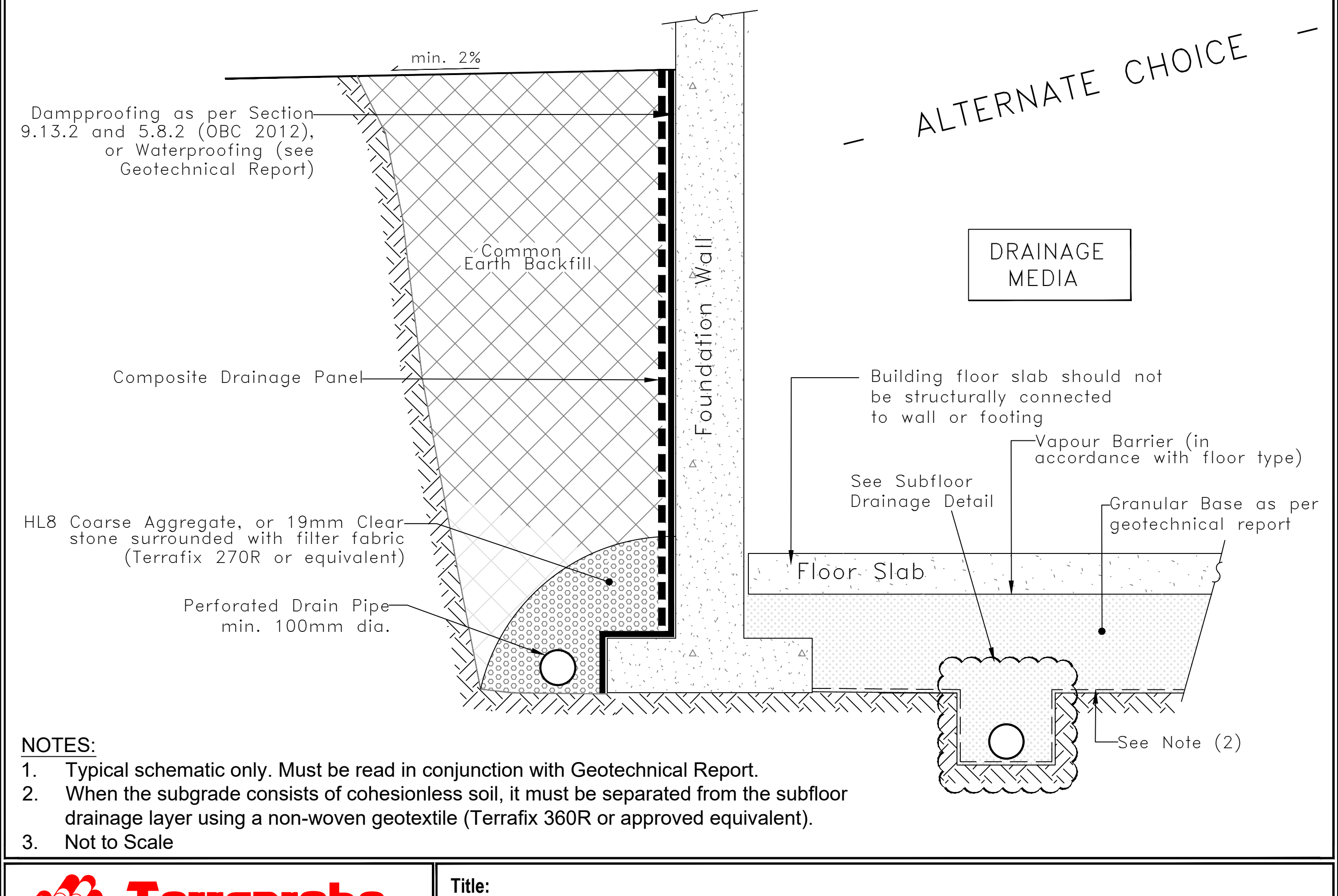
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: **BOREHOLE LOCATION PLAN**
Proposed Condition

File No. 1-22-0482-01

FIGURE : 2B





NOTES:

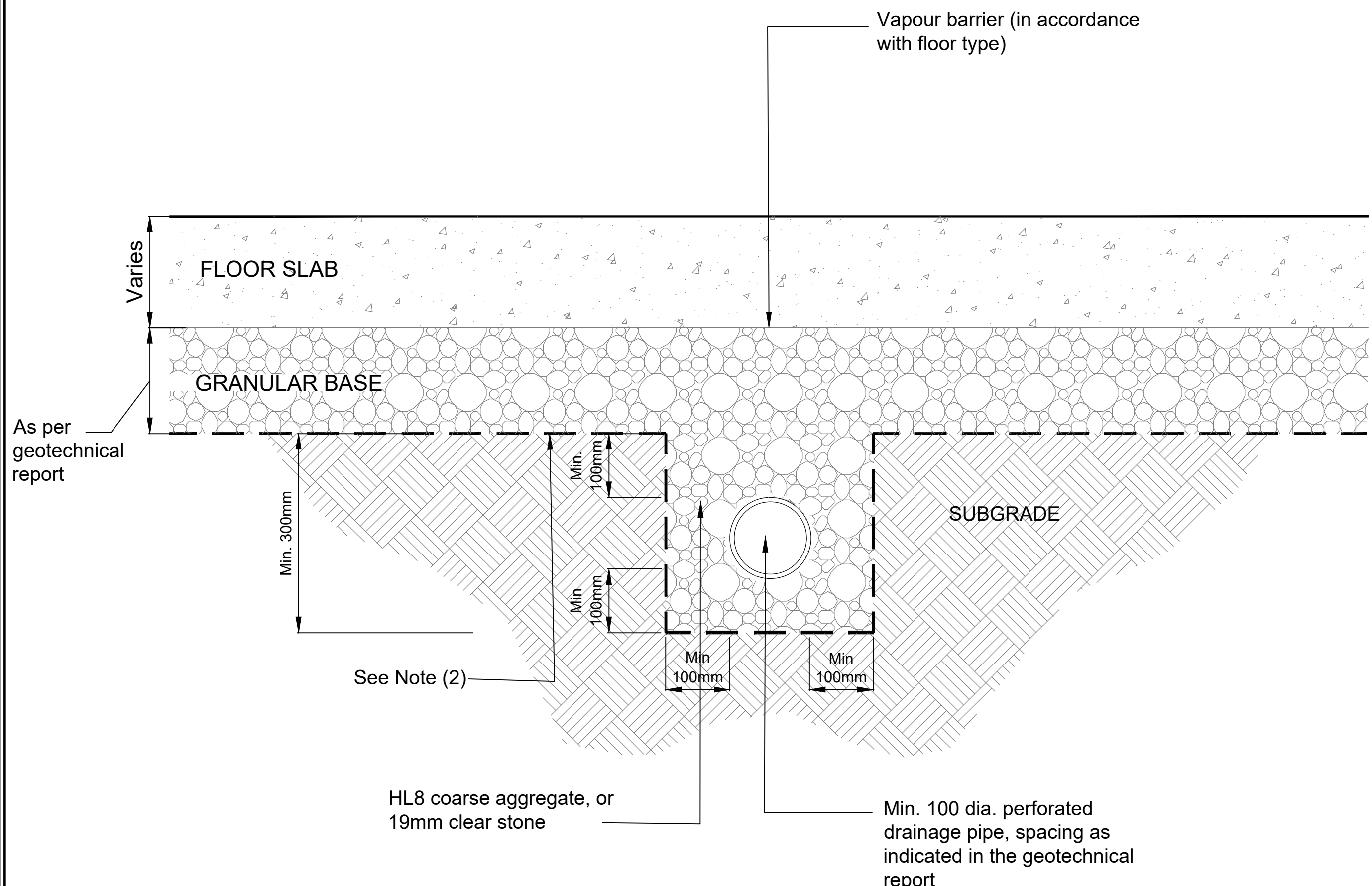
1. Typical schematic only. Must be read in conjunction with Geotechnical Report.
2. When the subgrade consists of cohesionless soil, it must be separated from the subfloor drainage layer using a non-woven geotextile (Terrafix 360R or approved equivalent).
3. Not to Scale

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

Title:

TYPICAL BASEMENT DRAINAGE SCHEMATIC

(OPEN EXCAVATION)



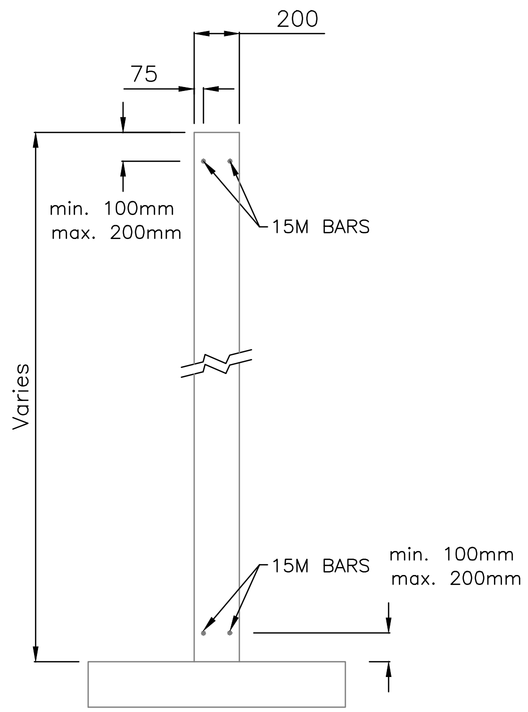
NOTES:

1. Typical schematic only. Must be read in conjunction with Geotechnical Report.
2. When the subgrade consists of cohesionless soil, it must be separated from the subfloor drainage layer using a non-woven geotextile (Terrafix 360R or approved equivalent).
3. Not to Scale

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

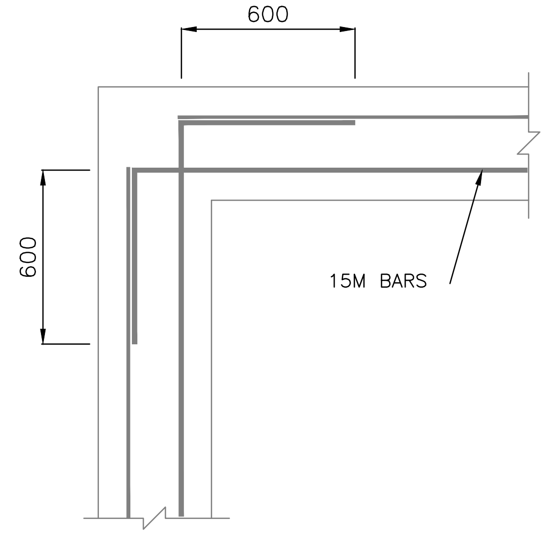
Title:

TYPICAL BASEMENT SUBDRAIN DETAIL



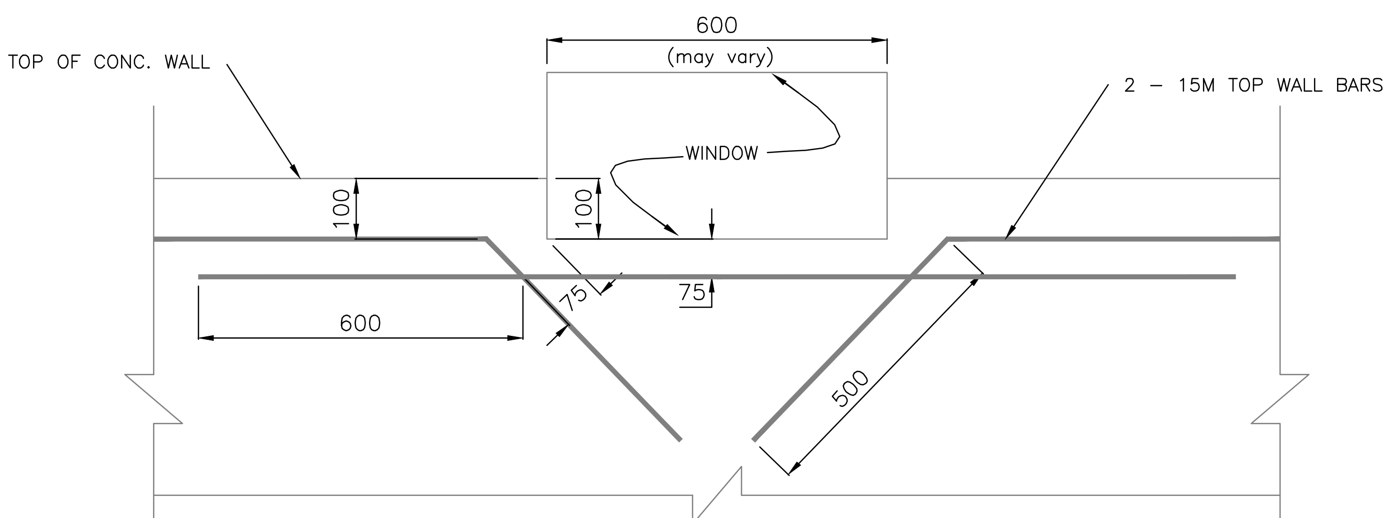
TYPICAL REINFORCED WALL

NOT TO SCALE



TYPICAL SPLICING AT CORNERS

NOT TO SCALE



TYPICAL WINDOW REINFORCING

NOT TO SCALE

NOTES:

1. Reinforcing steel C.S.A. G30.18–09 Grade 400
2. Concrete min. 28 day strength 20MPa (3000psi)
3. Base of all footing excavations to be inspected and approved prior to placing formwork.
4. All dimensions are in mm.

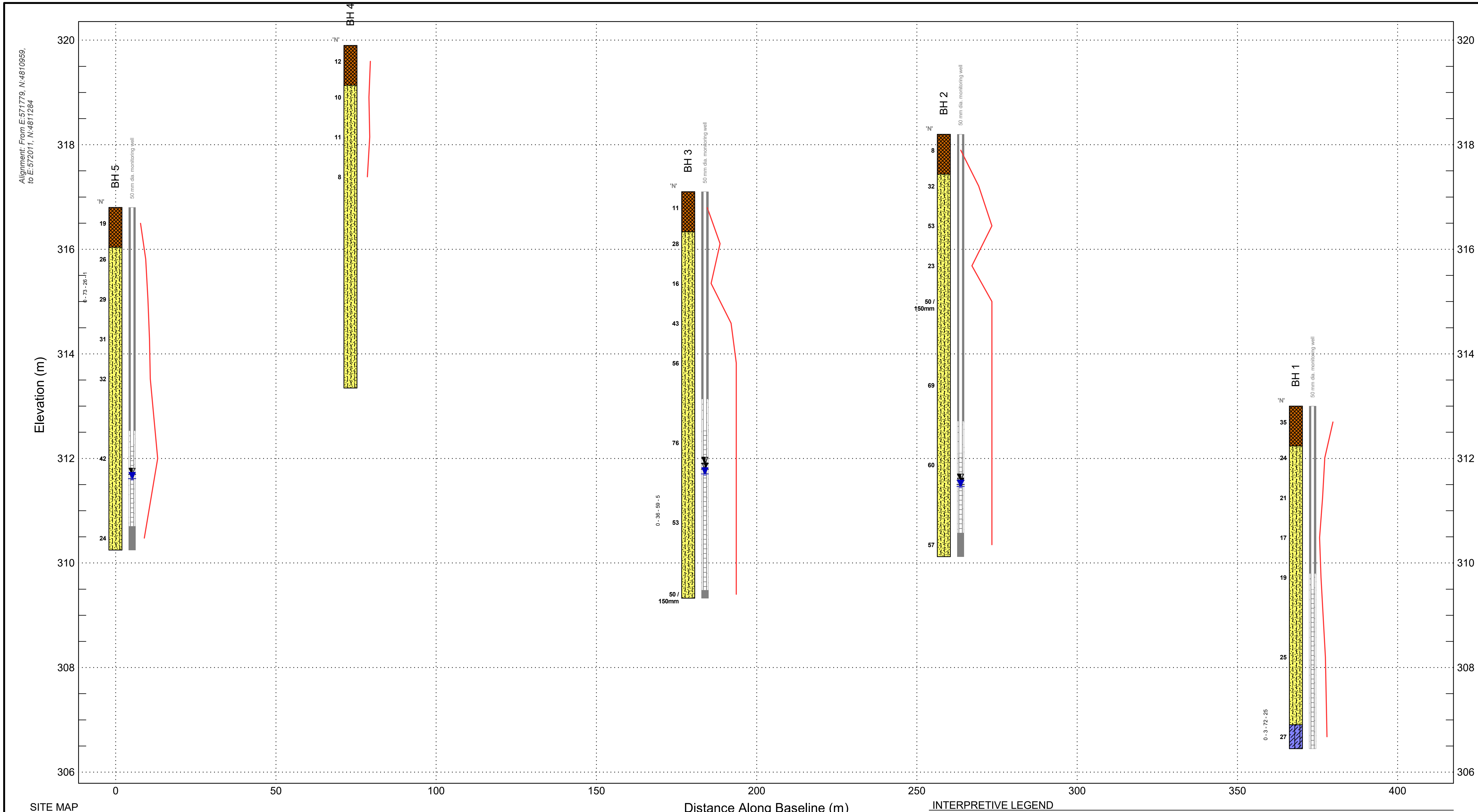
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

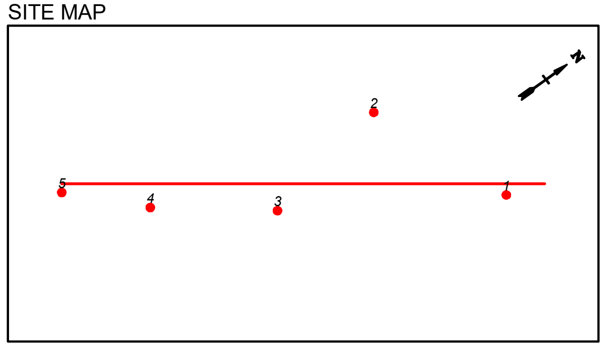
TYPICAL FOUNDATION WALL DETAILS FOR STRUCTURES ON ENGINEERED FILL

APPENDIX A

TERRAPROBE INC.



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- Fill
- Silty Sand
- Clayey Silt

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)*
- *DISTURBED/REWORKED SOILS*

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

Title: **SUBSURFACE PROFILE (INSERT CAPTION)**

File No.: **1-22-0482-01**

FIGURE: **X**

Report: ISECTION - TABLOID - ELEV

Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

AS	auger sample
CORE	cored sample
DP	direct push
FV	field vane
GS	grab sample
SS	split spoon
ST	shelby tube
WS	wash sample

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.)."

COHESIONLESS SOILS

Compactness	'N' value
very loose	< 4
loose	4 – 10
compact	10 – 30
dense	30 – 50
very dense	> 50

COHESIVE SOILS

Consistency	'N' value	Undrained Shear Strength (kPa)
very soft	< 2	< 12
soft	2 – 4	12 – 25
firm	4 – 8	25 – 50
stiff	8 – 15	50 – 100
very stiff	15 – 30	100 – 200
hard	> 30	> 200

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
silt*y*	20 – 35
sand *and* silt	> 35

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
G_s	specific gravity
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index
c_v	coefficient of consolidation
m_v	coefficient of compressibility
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Damp	refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.
Moist	refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at or close to plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

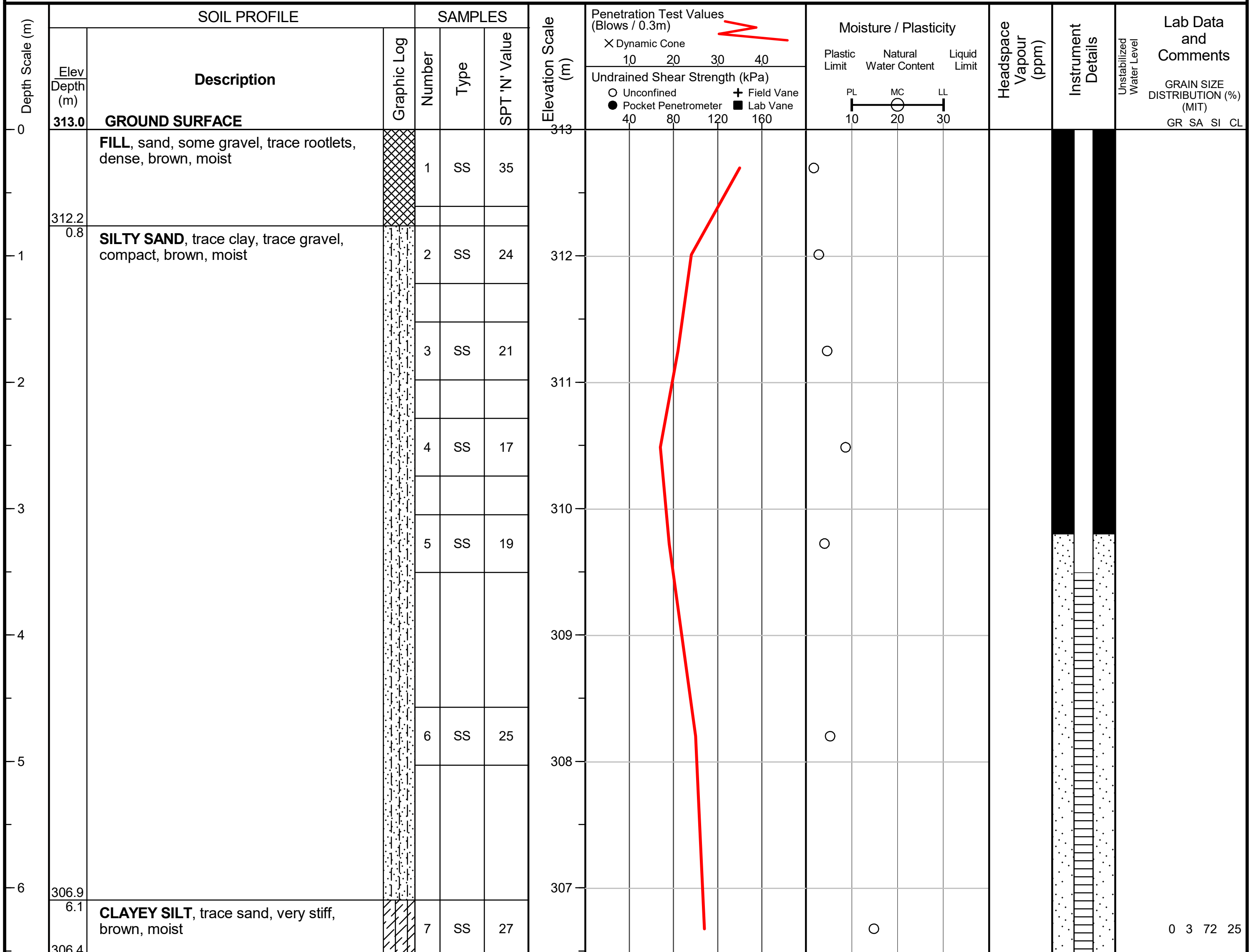
LOG OF BOREHOLE 1

Terraprobe

Project No.	: 1-22-0482-01	Client	: Wdd Main Street	Originated by	: AA
Date started	: August 16, 2022	Project	: 11 Main Street	Compiled by	: FM
Sheet No.	: 1 of 1	Location	: Puslinch, Ontario	Checked by	: SZ

Position : E: 572000, N: 4811253 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Solid stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Lab Data and Comments (GR SA SI CL)
313.0	**GROUND SURFACE**				
	FILL, sand, some gravel, trace rootlets, dense, brown, moist	1	SS	35	
312.2 / 0.8	**SILTY SAND**, trace clay, trace gravel, compact, brown, moist	2	SS	24	
		3	SS	21	
		4	SS	17	
		5	SS	19	
		6	SS	25	
306.9 / 6.1	**CLAYEY SILT**, trace sand, very stiff, brown, moist	7	SS	27	0 3 72 25
306.4 / 6.6	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Aug 24, 2022	dry	n/a
Sep 7, 2022	dry	n/a
Sep 19, 2022	dry	n/a

file: 1-22-0482-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 2

Project No. : 1-22-0482-01	Client : Wdd Main Street	Originated by : AA
Date started : August 16, 2022	Project : 11 Main Street	Compiled by : FM
Sheet No. : 1 of 1	Location : Puslinch, Ontario	Checked by : SZ

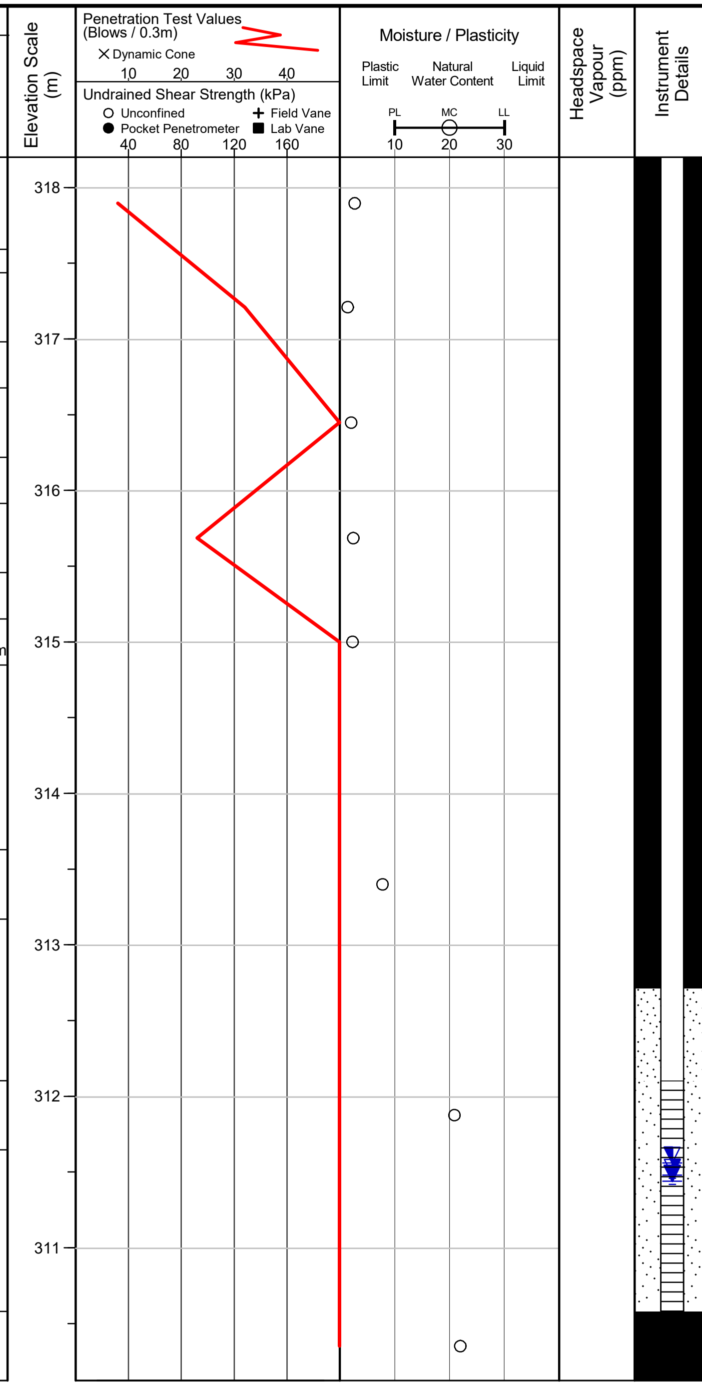
Position : E: 571881, N: 4811204 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
318.2	GROUND SURFACE
	FILL, sand, some gravel, trace rootlets, loose, brown, moist
317.4 / 0.8	**SILTY SAND to SILT AND SAND**, trace clay, trace gravel, compact to very dense, brown, moist
	...wet below
310.1 / 8.1	END OF BOREHOLE

SAMPLES

Number	Type	SPT 'N' Value
1	SS	8
2	SS	32
3	SS	53
4	SS	23
5	SS	50 / 150mm
6	SS	69
7	SS	60
8	SS	57



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Aug 24, 2022	6.6	311.6
Sep 7, 2022	6.7	311.5
Sep 19, 2022	6.8	311.4

LOG OF BOREHOLE 3

Terraprobe

Project No. : 1-22-0482-01 | Client : Wdd Main Street | Originated by : AA

Date started : August 16, 2022 | Project : 11 Main Street | Compiled by : FM

Sheet No. : 1 of 1 | Location : Puslinch, Ontario | Checked by : SZ

Position : E: 571901, N: 4811091 (UTM 17T) | Elevation Datum : Geodetic

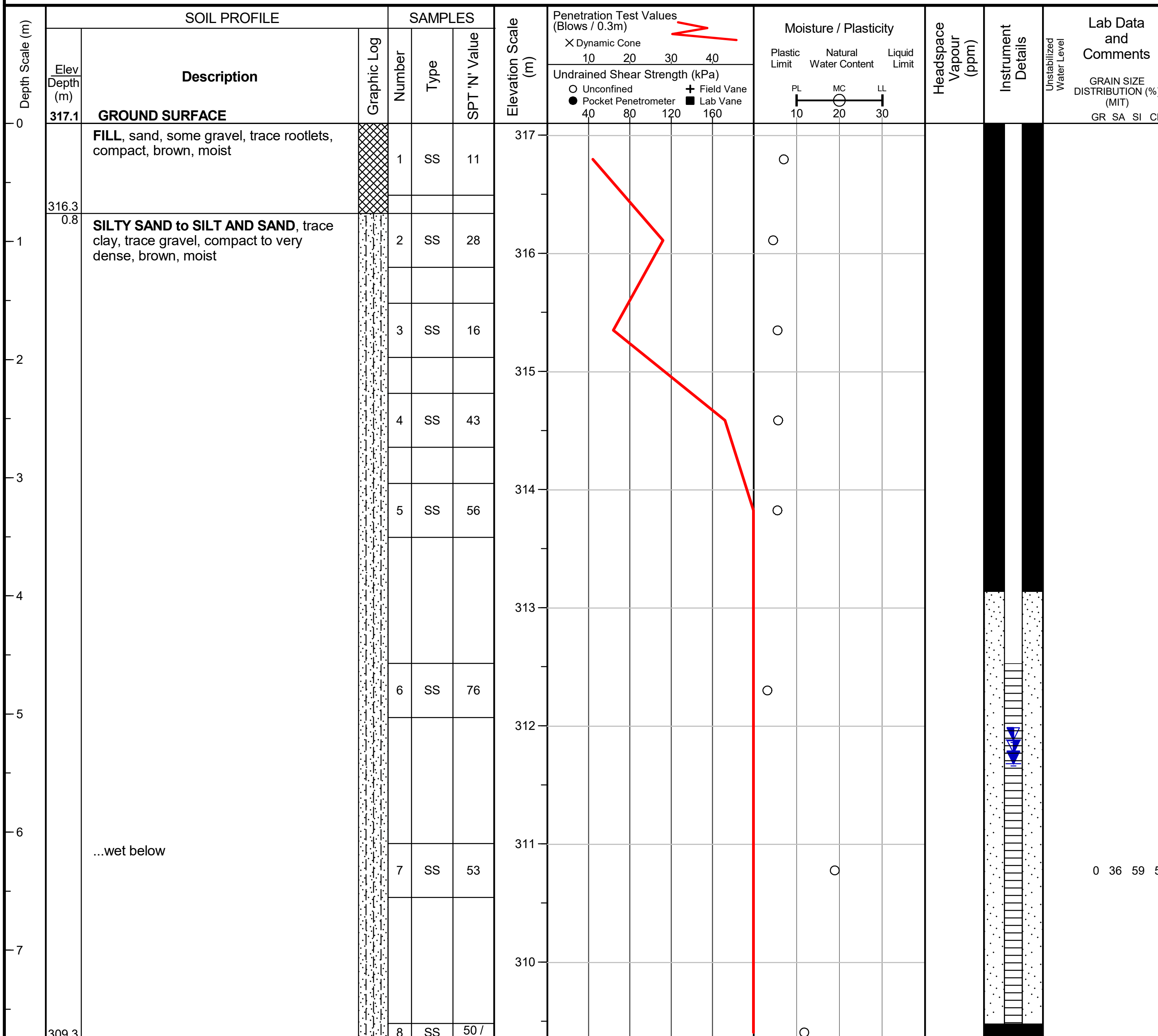
Rig type : Track-mounted | Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
317.1	GROUND SURFACE
316.3 / 0.8	**FILL**, sand, some gravel, trace rootlets, compact, brown, moist
309.3 / 7.8	**SILTY SAND to SILT AND SAND**, trace clay, trace gravel, compact to very dense, brown, moist ...wet below

SAMPLES

Number	Type	SPT 'N' Value	Lab Data and Comments: GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1	SS	11	
2	SS	28	
3	SS	16	
4	SS	43	
5	SS	56	
6	SS	76	
7	SS	53	0 36 59 5
8	SS	50 / 150mm	



END OF BOREHOLE

Borehole was dry and caved to 7.2 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Aug 24, 2022	5.2	311.9
Sep 7, 2022	5.3	311.8
Sep 19, 2022	5.4	311.7

file: 1-22-0482-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 4

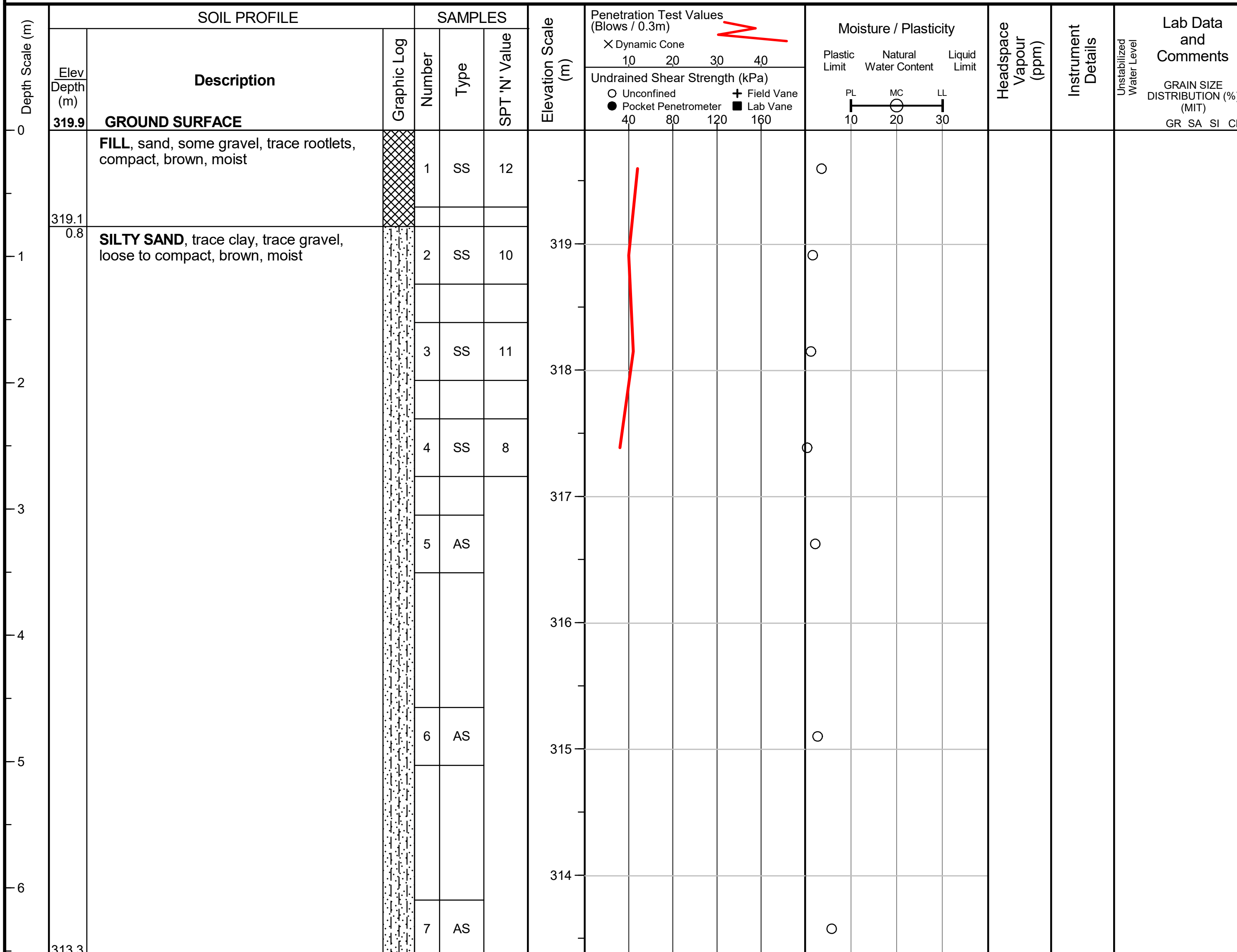
Project No.	: 1-22-0482-01	Client	: Wdd Main Street	Originated by	: AA
Date started	: August 16, 2022	Project	: 11 Main Street	Compiled by	: FM
Sheet No.	: 1 of 1	Location	: Puslinch, Ontario	Checked by	: SZ

Position : E: 571837, N: 4811007 (UTM 17T) Elevation Datum : Geodetic

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

Elev Depth (m)	Description	Graphic Log	Sample Number	Type	SPT 'N' Value
319.9	GROUND SURFACE				
	FILL, sand, some gravel, trace rootlets, compact, brown, moist		1	SS	12
319.1 0.8	**SILTY SAND**, trace clay, trace gravel, loose to compact, brown, moist		2	SS	10
			3	SS	11
			4	SS	8
			5	AS	
			6	AS	
			7	AS	
313.3 6.6	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



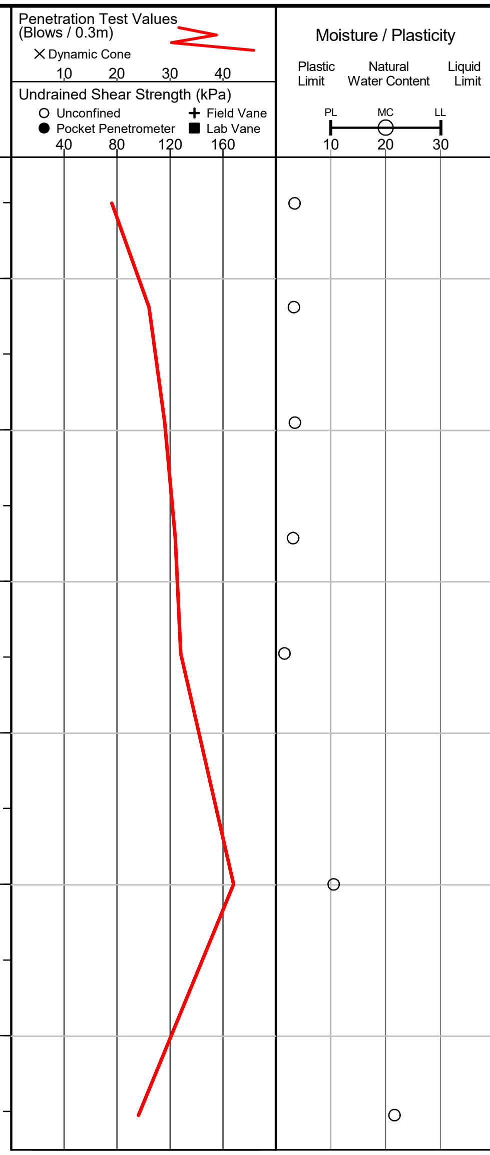
LOG OF BOREHOLE 5

Terraprobe

Project No. : 1-22-0482-01	Client : Wdd Main Street	Originated by : AA
Date started : August 16, 2022	Project : 11 Main Street	Compiled by : FM
Sheet No. : 1 of 1	Location : Puslinch, Ontario	Checked by : SZ

Position : E: 571785, N: 4810955 (UTM 17T)	Elevation Datum : Geodetic
Rig type : Track-mounted	Drilling Method : Solid stem augers

Elev (m) / Depth (m)	Description (SOIL PROFILE)	Sample Number	Type	SPT 'N' Value	Lab Data and Comments (GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL)
316.8 / 0	**GROUND SURFACE**				
	FILL, sand, some gravel, trace rootlets, compact, brown, moist	1	SS	19	
316.0 / 0.8	**SILTY SAND**, trace clay, trace gravel, compact to dense, brown, moist	2	SS	26	
		3	SS	29	0 73 26 1
		4	SS	31	
	...gravelly sand	5	SS	32	
	...wet below	6	SS	42	
310.2 / 6.6		7	SS	24	



Depth Scale (m): 0 – 6; Elevation Scale (m): 316 – 311. Columns: Graphic Log, Headspace Vapour (ppm), Instrument Details, Unstabilized Water Level.

END OF BOREHOLE

Borehole was dry and caved to 6.1 m below ground surface upon completion of drilling.

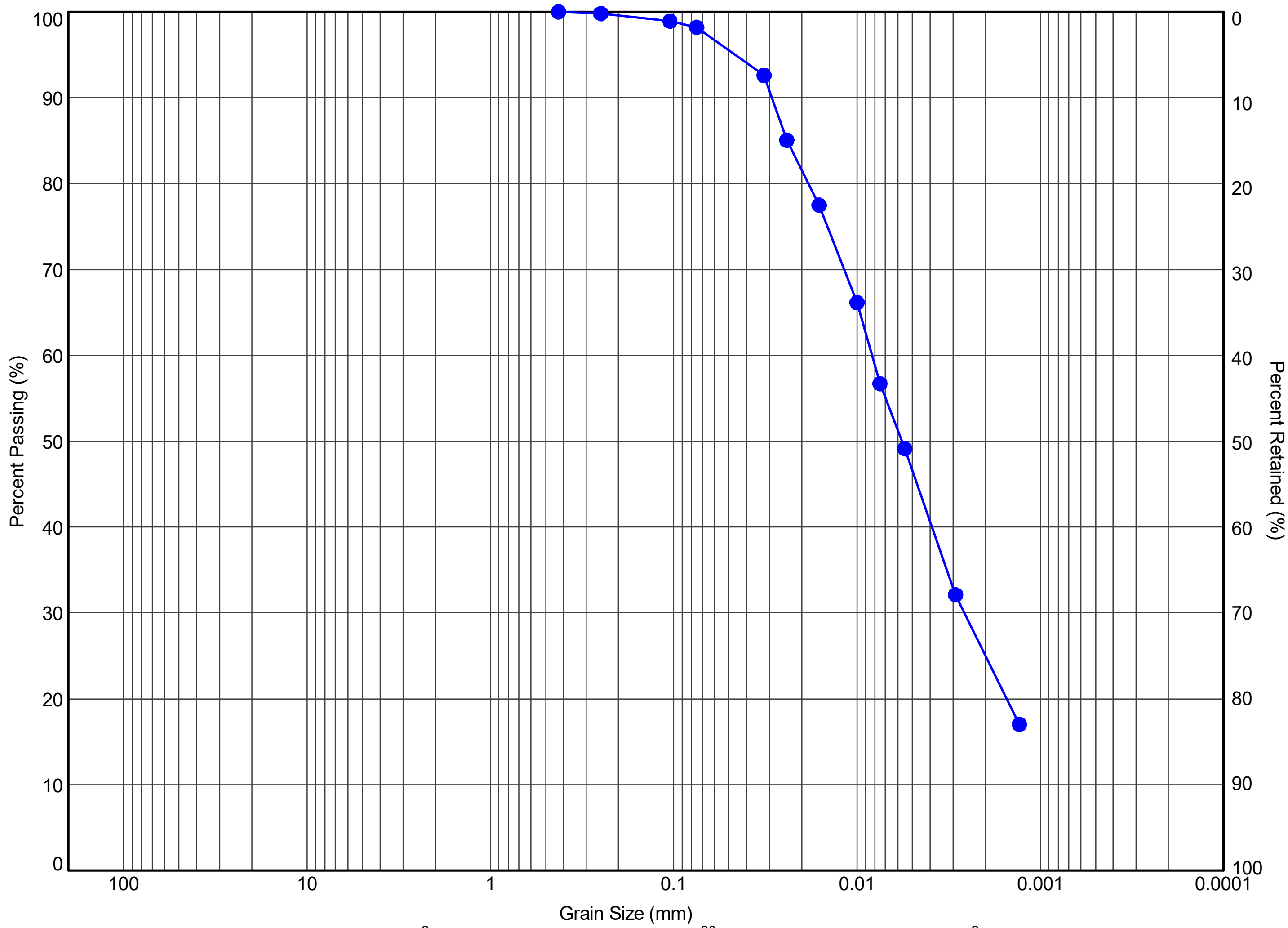
50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Aug 24, 2022	5.1	311.7
Sep 7, 2022	5.2	311.6
Sep 19, 2022	5.2	311.6

APPENDIX B

TERRAPROBE INC.



2mm | 60µm | 2µm

MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

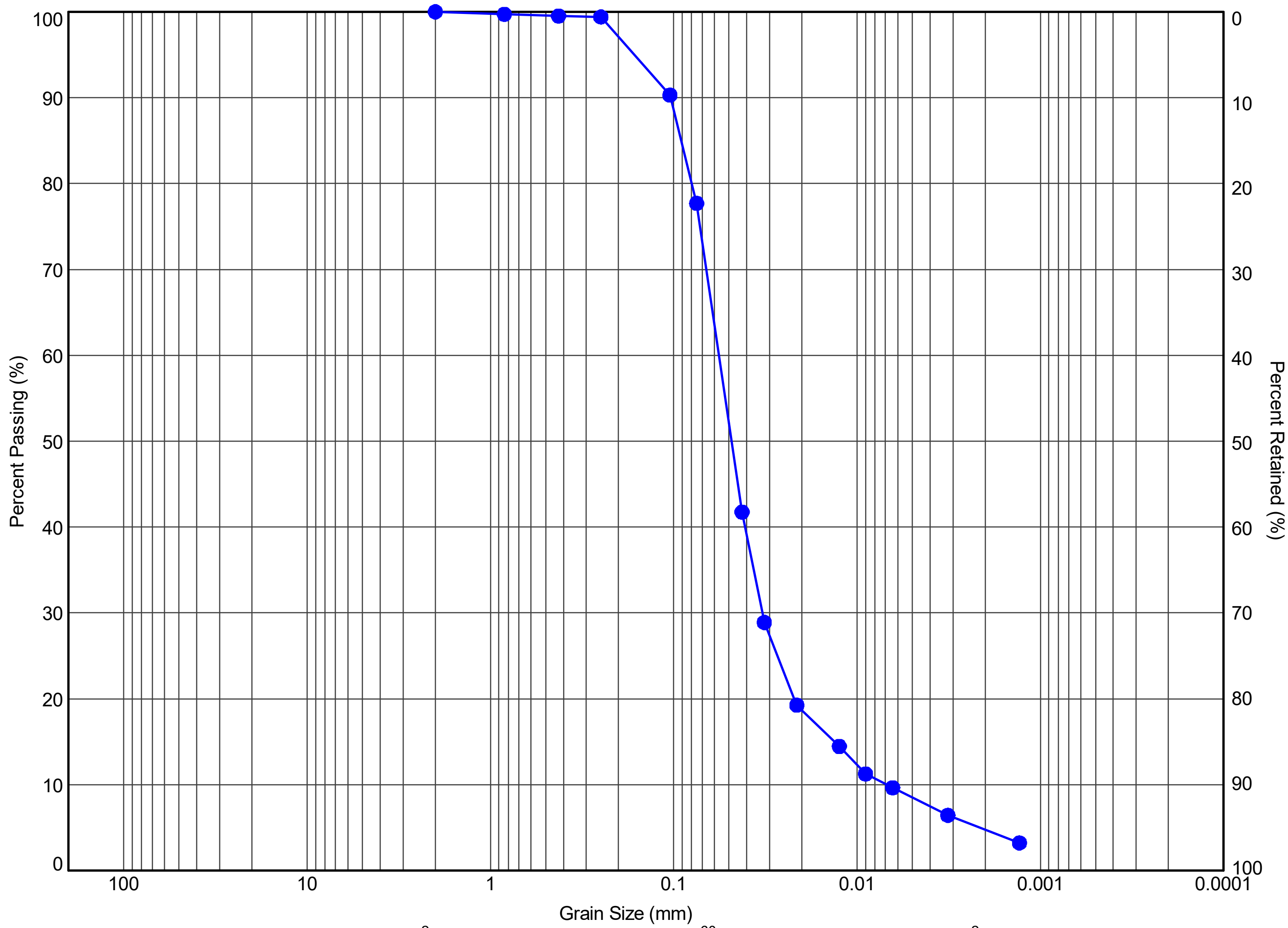
					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**1**	SS7	6.3	306.7	0	3	72	25	

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

Title:

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, TRACE SAND

File No.: **1-22-0482-01**



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

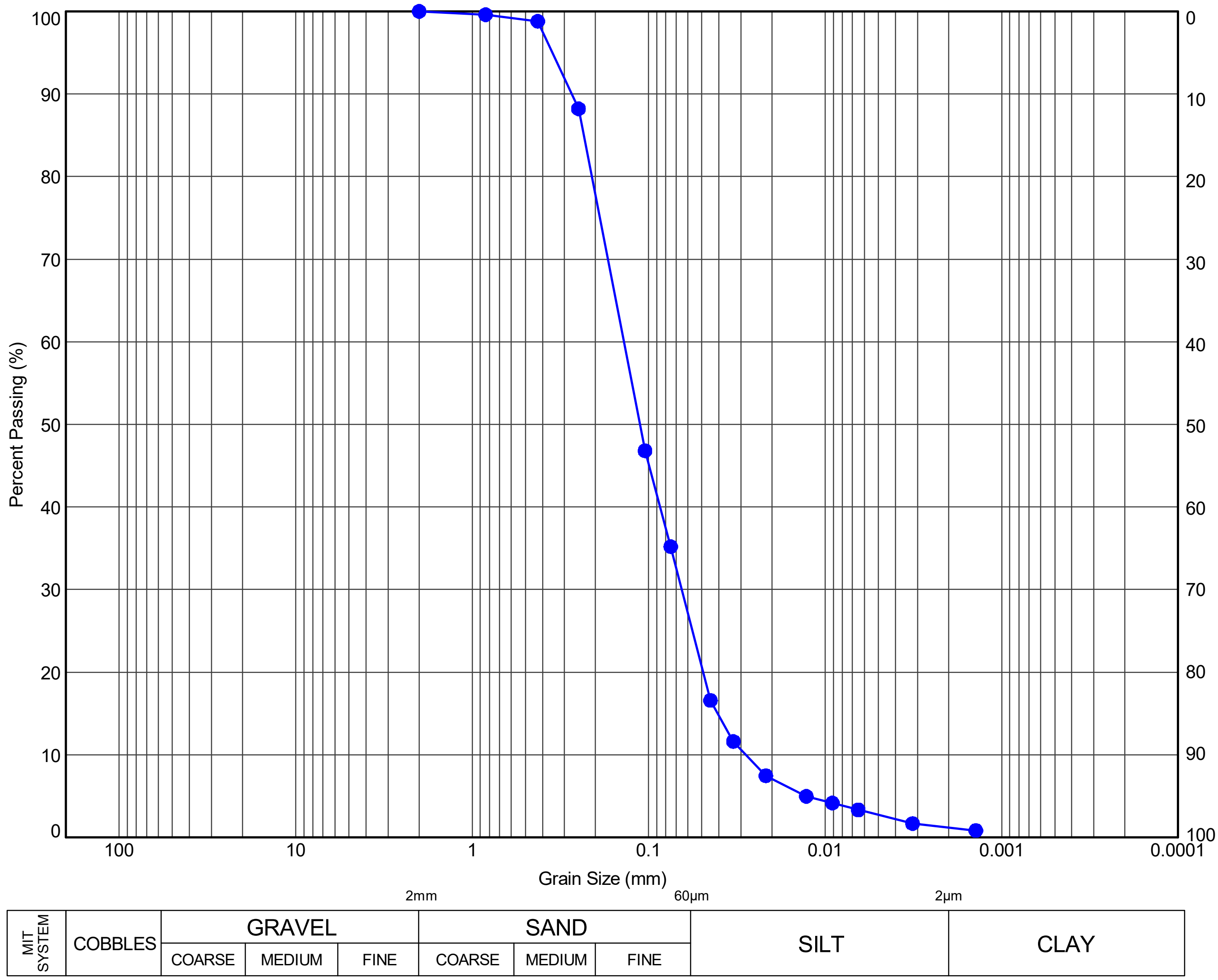
MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**3**	SS7	6.3	310.8	0	36	59	5	

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

Title:
GRAIN SIZE DISTRIBUTION
SILT AND SAND, TRACE CLAY

File No.: **1-22-0482-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**5**	SS3	1.8	315.0	0	73	26	1	

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

Title:

GRAIN SIZE DISTRIBUTION
SILTY SAND, TRACE CLAY

File No.: **1-22-0482-01**

APPENDIX C

TERRAPROBE INC.

PART 1 GENERAL

1.01 Description

Engineered Fill refers to earth fill (earthworks) designed and constructed with engineering inspection and testing, so as to be capable of supporting structure foundations and slabs without excessive settlement. Poured concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

Preparation for Engineered Fill and Engineered Fill operations must only be conducted under full time inspection and testing by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

The work for the construction of Engineered Fill, is shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section includes the following:

a) Stripping of the existing topsoil, fill layer, and weathered/disturbed soil as needed from the ground surface below all areas to be covered with Engineered Fill,

b) Excavation of Test Holes into the subgrade to investigate the suitability of subsurface conditions for support of the Engineered Fill and determine if any prior existing fill materials are present,

c) Proof-rolling or visual inspection (as directed by the geotechnical engineer) of the subgrade below areas to be covered with Engineered Fill, to detect the presence and extent of unstable ground conditions,

d) Excavation and removal of unstable subgrade materials or other approved stabilization measures, if required prior to the placement of Engineered Fill,

e) Surveying of ground elevations prior to placing Engineered Fill,

f) Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,

g) Surveying of ground elevations on completion of Engineered Fill placement,

h) Providing and maintaining survey layout of areas to receive Engineered Fill, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.02 The Project Parties

A) The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of Engineered Fill.

B) The term Geotechnical Engineer shall refer to the individual or firm who will be carrying out the full time inspection and testing of the earthworks related to preparation and construction of Engineered Fill.

C) The term Design Civil Engineer shall refer to the individual or firm who will be carrying out the Site Grading Design (pre-grading), the determination of Design Foundation Grades for the structures on the site, and the choice of lots and site areas to receive Engineered Fill.

PART 2 MATERIALS

2.01 Definitions

A) Topsoil Layer is the surface layer of naturally organic soil typically found at the ground surface and with thickness on the order of 25 to 250 mm thick.

B) Earth fill is soil material which has been placed by man-made effort and has not been deposited by nature over a long period of time.

C) Weathered/disturbed soil is natural or native soil that has been disrupted by weathering processes such as frost damage.

D) Subgrade soil is the “in situ” (in place) natural or native soil beneath any earth fill and/or weathered/disturbed soil and/or topsoil layer(s).

E) Engineered Fill soils must consist of clean earth materials (not excessively wet), free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials, placed in thin lifts not exceeding 150 mm in thickness. Cohesionless soils such as sand or gravel, are the easiest to handle and compact.

F) All values stated in metric units shall be considered as accurate.

PART 3 ENGINEERED FILL DESIGN

3.01 Design Foundation Pressure

A) Engineered Fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered Fill. The time period over which most of this settlement typically occurs, depends on the composition of the Engineered Fill as follows (after initial placement);

a) Sand or gravel soil; several days,

b) Silt soil; several weeks,

c) Clay or clayey soil; several months.

The placement of Engineered Fill might also result in post-construction settlement of the underlying natural soil.

The timing of foundation construction must take into account the post-construction settlement of the Engineered Fill and the foundation soil.

B) Unless otherwise stated, the Engineered Fill is to be placed over the entire lot or site area.

C) The Engineered Fill is to extend up to 1 m above the highest level of required foundation support. Typically this can be within 1 m of the design final grades. Additional common fill can be placed over the Engineered Fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

E) A geotechnical reaction at SLS of 150 kPa for 25 mm of settlement is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.6 m for continuous strip footings, and minimum dimensions of 1 m for column footings.

F) At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.

G) Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.

H) At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,

a) placement of footing concrete, and

b) placement of foundation wall concrete.

PART 4 CONSTRUCTION

4.01 Survey Layout

A) The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.

B) At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed.

C) The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Geotechnical Engineer.

D) The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.

E) On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.02 Topsoil Stripping

A) The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.

B) Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have had the earth fill suitably stripped.

4.03 Test Holes Into Subgrade

A) After the topsoil has been stripped, the exposed subgrade must be investigated for the presence of weak zones or deleterious material, which may be unsuitable for the support of Engineered Fill.

B) Exploratory test holes must be dug using a small backhoe, on a suitable pattern to obtain a representative indication of the entire site area.

C) The Geotechnical Engineer must observe the digging and backfilling of the test holes; must log the test hole stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test hole.

D) If the test holes discover any old buried fill or deleterious materials, it must be excavated and removed from the lot area down to undisturbed, stable native soil.

E) All test holes must be properly backfilled and compacted in loose lifts of maximum 150 mm thickness to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Geotechnical Engineer must observe the backfilling and compaction of the test holes.

4.04 Subgrade Proof-rolling

A) Prior to placing any Engineered Fill, the exposed subgrade must be proof-rolled with a static smooth-drum roller and the Geotechnical Engineer must observe the proof-rolling.

B) Cohesive soil will be disrupted by proof-rolling. Competency must be determined by a geotechnical engineer by cutting and inspecting the soil.

C) If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.05 Engineered Fill Placement

A) Engineered fill must not be placed without the approval of the Geotechnical Engineer. Prior to placing any Engineered Fill, the existing fill must be removed down to native soil subgrade, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.

B) Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability. Some of the existing site fill that is removed prior to placement of Engineered Fill may be sorted and reused as Engineered Fill, but must first be approved by the Geotechnical Engineer. Samples of the proposed fill material must be obtained by the Geotechnical Engineer and tested in the geotechnical laboratory for Standard Proctor Maximum Dry Density, prior to approval of the material for use as Engineered Fill. The Engineered Fill must be free of organics and other deleterious material (wood, building debris, rubble, cobbles, boulders, and the like).

C) The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.

D) Field density tests must be taken by the Geotechnical Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.

E) Engineered fill must not be placed during the period of the year when cold weather occurs, i.e., when there are freezing ambient temperatures during the daytime and overnight.