APPENDIX O

Geotechnical Report

REPORT

Geotechnical Factual Report

Southwest Agincourt Transportation Connections Study

Submitted to:

City of Toronto

Submitted by:

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1.0 INTRODUCTION

1.1 Project Information

WSP Canada Inc. (WSP) was retained by the City of Toronto to complete a geotechnical investigation and provide pavement design recommendations for the proposed Southwest Agincourt Connection from Sheppard Avenue East to Village Green Square.

The geotechnical investigation was completed for the purpose of preliminary foundation recommendations for a proposed vehicular underpass and bridge connecting the existing Village Green Square to Sheppard Avenue in Scarborough, Ontario. A Location Map and Borehole Location Plan is provided as Figure 1 in the Figures section of this report. The geotechnical investigation was requested to obtain subsurface information for the purpose of informing the proposed site works relating to the existing geotechnical soil conditions.

Subsequent to the geotechnical investigation, the alignment of the proposed roadway connection was moved West of the West Highland Creek, eliminating the requirement of the bridge connection. The change in alignment did not affect the vehicular underpass at the CP Rail, which is still required to connect the proposed roadway to the existing Village Green Square. The new connection involves extending the existing Gordon Avenue to connect with Village Green Square. The updated alignment is shown in Figure 1 in the Figures section of this report.

This report contains the factual information obtained by WSP from the geotechnical investigation, specifically, subsurface soil information (soil types, compactness etc.) and groundwater conditions. Additionally, this report contains pavement design recommendations based on the previously obtained geotechnical information and related third-party reports. The pavement design covers the reconstruction of the existing Gordon Avenue as well as the new construction of the proposed roadway connection to Village Green Square.

This report has been prepared for the City of Toronto. Third party use of this report without WSP consent is prohibited. The limitation conditions presented in this report form an integral part of the report and they must be considered in conjunction with this report.

1.2 Existing Geotechnical Information

Existing information was provided to WSP prior to commencement of the drilling program, with six (6) geotechnical reports completed by Terraprobe in 2018 available in the area. Relevant to this current investigation is the report “Geotechnical Engineering Report – Cowdray Court Block 4, Toronto, Ontario (Dec 5, 2018)”. This report has been provided in Appendix D for reference.

2.0 SITE DESCRIPTION

2.1 Physiography

The physiography of this local region is generally characterized by young tills, including sandy silt to silty sand-textured tills. Underlying this Till Plain, the bedrock generally consists of the Georgian Bay Formation of the upper Ordovician period which is a grey shale with light grey siltstone and/or limestone interbeds. The bedrock generally slopes south towards Lake Ontario.

3.0 INVESTIGATION PROCEDURES

3.1 Permits, Utility Locates

The borehole locations were predetermined and established in the field by WSP personnel. The borehole locations were selected to avoid conflicts with existing above ground and underground utilities, including water, sewer, gas, hydro, telephone and cable locations that were verified in the field using Ontario One-call and a private utility locater.

A Cut Permit was obtained from the City's park representative (Collingwood Park) after all conditions specific to the project and location. Borehole locations were also cleared with stakeholders in the area prior to drilling and access with the drill rig.

3.2 Field Investigation

3.2.1 Borehole Program and Investigation Procedures

The borehole investigation was conducted in July 2020. A total of eight (8) boreholes were advanced as per the borehole location plan provided in Appendix A. The boreholes were drilled to varying depths below ground surface (bgs). The boreholes were advanced at the locations shown on Figure 1, provided in the Figures section of this report. The borehole program is summarized in Table 3 1.

Table 3-1Borehole Program

LOCATION	EASTING/NORTHING (UTM NAD27)	GROUND SURFACE ELEVATION (m)	DEPTH OF BOREHOLE (m)
BH1	Not Recorded	166.71	7.47
BH2	N 638040.08 E 4849209.99	166.69	12.80
BH3	N 638031.88 E 4849183.03	166.07	20.42
BH4	N 638050.84 E 4849118.75	166.90	7.47
BH5	N 638059.74 E 4849095.53	166.82	7.47
BH6	N 638088.56 E 4848874.41	167.60	5.18
BH7	N 638102.55 E 4848830.09	168.18	12.19
BH8	N 638118.44 E 4848791.48	168.80	7.47

The boreholes were advanced using a track-mounted machine auger. A qualified WSP geotechnical engineering technician performed the drilling, logged and sampled the boreholes in accordance with industry standards. Soil samples were recovered and retained in labeled air-tight containers for subsequent review by the project engineer and laboratory testing, as required. Asphalt/topsoil, granular base, and granular subbase thickness was recorded as each borehole location.

The depth to groundwater and/or borehole "cave-in", if any, was measured upon completion of drilling. The employed drilling method was dominantly solid-stemmed auger, with hollow-stems and wash-boring employed as needed due to changing site conditions. Soil samples were obtained in the boreholes at 0.75 and 1.5 m intervals of depth using a 50 mm outer diameter split spoon sampler in accordance with the Standard Penetration Test

(SPT) procedure (ASTM D1586) driven by an automatic hammer. The in-situ test results presented in the borehole records are uncorrected.

A monitoring well was installed in each borehole and soil cuttings were drummed and removed from site.

All field-work was observed on a full-time basis by a member of WSP's technical staff who located the boreholes in the field, arranged for the clearance of underground utilities, directed the drilling, sampling and monitoring well installation, and logged the boreholes.

The borehole log detailing the individual soil profiles are provided in Appendix B.

3.3 Laboratory Testing Program

3.3.1 Geotechnical Testing

Selected soil samples were submitted to WSP's certified soils laboratory for geotechnical testing in accordance with Table 3 2. Geotechnical laboratory test results are presented on the borehole log in Appendix B and in Section 4 of this report. A copy of the geotechnical laboratory test results is provided in Appendix C.

Table 3-2Geotechnical Laboratory Testing Summary

GEOTECHNICAL TEST	PROCEDURE/METHODOLOGY	NUMBER OF TESTS
Moisture Content	LS-701	All Samples
Atterberg Limits Analysis	LS-602	Seven (7)
Sieve and Hydrometer Analysis	LS-602	Twenty (20)

4.0 INVESTIGATION RESULTS

4.1 Summary of Subsurface Conditions

The advanced boreholes generally encountered very dense native silty sand to sandy silt tills approximately 1.5 m bgs to 2.5 m bgs. Exceptions to this condition were encountered at boreholes BH 2 and BH 3 adjacent to the concrete reinforced creek, where consistent competent material was not encountered (BH2), or encountered deep below the surface (~16.7 mbgs for BH3). The till was bedded with occasional sand with gravel and clay seams. Groundwater elevation was relatively consistent across the site, with groundwater encountered at approximately 6 mbgs to 7 mbgs upon completion of drilling, and rising to approximately 1.5 mbgs to 3 m bgs upon later monitoring.

At the location of the proposed underpass, very dense / hard soils were encountered at approximately 5 mbgs and extended to the end of the advanced boreholes (BH 6 and 7). Geotechnical reports for the planned Cowdray Court development (Appendix D) generally confirm these findings (Specifically, BH 411 and BH 410).

4.1.1 Pavement Structure Thickness

Existing pavement was encountered in two (2) boreholes advanced along the alignment. The following table outlines the pavement structure encountered.

Table 4-1Encountered Pavement Structure Thickness

BOREHOLE ID	ASPHALT THICKNESS (MM)	GRANULAR BASE THICKNESS (MM)	GRANULAR SUBBASE THICKNESS (MM)	TOTAL PAVEMENT STRUCTURE THICKNESS (MM)
BH6 – Cowdray Court Daycare Centre	100	270	1150	1520
BH8 – Village Green Square	90	520	0	610

It is anticipated that these pavement structures will be removed as part of the underpass construction.

4.1.2 Topsoil

Topsoil was encountered on the surface of the remaining boreholes with no surficial pavement structure (BH 1-5 and 7). Topsoil thickness averaged 153 mm, with a minimum encountered thickness of 110 mm and a maximum encountered thickness of 190 mm. It is noted that the topsoil thickness varies based on the general usage of the area, with thinner topsoil encountered in boreholes advanced in boulevards (110 mm and 140 mm), and thicker topsoil encountered in the park area (180 mm, 170 mm, 130 mm, 190 mm). It should be noted that the thickness of the topsoil explored at the borehole locations is not representative for the site and should not be relied on to calculate the quantity of topsoil at the site.

4.1.3 Sand Fill

Sand fill with varying amounts of gravel and trace to some silt was encountered directly beneath the topsoil in Boreholes 1 and 7. This layer was 0.25 to 0.52 meters thick, and had an SPT N-value of 24 to 40 blows per 0.33 m of penetration, indicating dense to very dense compactness. Water content as measured in these samples was 2% to 5%.

4.1.4 Silty Clay Fill

Silty Clay fill was encountered in borehole BH1 at a depth of 0.63 m with a thickness of 870 mm. The layer had an SPT value of 4 blows per 0.33 m of penetration, indicating soft consistency. Moisture content in this layer was measured at 18%.

4.1.5 Sand and Silt to Silty Sand Fill

Sand and Silt to Silty Sand Fill was encountered in boreholes BH2, BH3, BH4, BH5 and BH 7. The fill layer was encountered at depths of 0.13 mbgs to 0.39 mbgs, extending to depths of 0.83 mbgs to 1.52 mbgs. The thickness of this layer ranged from 0.4 m to 1.35 m. SPT N-Values in this layer ranged from 7 to 40 blows per 0.33 m of penetration, indication compact to very dense compactness. The following sieve hydrometer analysis was performed in this fill layer:

Table 4-2Grain Size Distribution - Sand and Silt to Silty Sand Fill

BOREHOLE NO.	SAMPLE I.D.	% GRADATION				SOIL CLASSIFICATION
		GRAVEL	SAND	SILT	CLAY	
BH 2	SS2	3	45	40	12	Sand with Silt some Clay trace Gravel

4.1.6 Sand with Silt to Sandy Silt Till

Sand with silt to sandy silt till with trace to some clay and gravel was encountered all advanced boreholes at depths ranging from 0.61 mbgs to 2.29 mbg, present at end of borehole (7 m – 20 m layer thickness) in boreholes BH1, BH4, BH5, BH6, BH7 and BH8. Deeper layers of the material were found in boreholes BH3 (9.40 to 16.76 mbgs) and BH 7 (6.86 to 12.19 mbgs). SPT N-values in the sand with silt to silt sand layer measured from 4 blows per 0.33 m of penetration to 50 blows per 50 mm of penetration, indicating a variable compactness of loose to very dense. The following Sieve-Hydrometer analyses were performed in this soil unit:

Table 4-3Grain Size Distribution - Sand with Silt to Sand Silt Till

BOREHOLE NO.	SAMPLE I.D.	% GRADATION				SOIL CLASSIFICATION
		GRAVEL	SAND	SILT	CLAY	
BH1	SS2	3	69	22	6	Sand with Silt trace Clay
BH2	AS1	1	64	24	11	Sand with Silt trace Clay
BH3	SS7	7	40	44	9	Silt and sand, trace gravel trace clay
BH3	SS14	0	42	46	2	Silt and sand trace gravel trace clay
BH3	SS16	1	59	38	2	Silty Sand trace gravel trace clay
BH4	SS3	4	43	45	8	Silt and Sand, trace gravel trace clay
BH4	SS7	3	42	46	9	Silt and Sand, trace gravel trace clay
BH5	SS2	2	44	46	8	Silt and Sand, trace gravel, trace clay
BH5	SS6	2	44	45	9	Silt and Sand, trace gravel, trace clay
BH6	SS3	2	44	43	11	Sand and Silt, some clay, trace gravel
BH6	SS7	3	31	56	10	Sandy Silt, some clay trace gravel
BH7	SS15	3	55	36	6	Silty Sand trace clay trace gravel

Atterberg Limits Analysis on samples obtained from this layer are outlined in the table below:

Table 4-4Atterberg Limits Analyses – Sand with Silt to Silty Sand Till

BOREHOLE NO.	SAMPLE NUMBER	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	USCS SOIL CLASSIFICATION
BH 2	SS5	-	-	-	Non-Plastic
BH 2	SS10	-	-	-	Non-Plastic
BH 2	SS15	-	-	-	Non-Plastic
BH 3	SS7	-	-	-	Non-Plastic
BH 3	SS14	-	-	-	Non-Plastic
BH 6	SS3	14	11	3	CL-ML
BH 7	SS10	16	13	3	CL-ML

The results above indicate that the Silty sand to sandy silt till that dominates the subsurface on site is mostly non-plastic, with very limited plastic behaviour (borderline CL-ML) as silt content rises.

4.1.7 Sand, Some Gravel to Sand with Gravel

Seams of Sand some gravel to Sand with Gravel were encountered in boreholes BH2 and BH3 at a depth of 12.19 mbgs (154.40 m Elev.) to end of borehole at 12.80 mbgs (153.79 m Elev.) and 16.76 mbgs (148.31 m Elev.) to 18.29 mbgs (146.78 m Elev.) resulting in seam thicknesses of undefined and 1.53 m. The layers had SPT N-values of 15 and 55 blows per 0.33 m of penetration, indicating compact to very dense compactness. Moisture content in this layer was tested at 5% to 12%.

Table 4-5Grain Size Distribution - Sand some Gravel to Sand with Gravel

BOREHOLE NO.	SAMPLE I.D.	% GRADATION				SOIL CLASSIFICATION
		GRAVEL	SAND	SILT	CLAY	
BH2	SS16	19	59	17	5	Sand with Silt trace Clay

4.1.8 Silt to Silt with Sand

Silt to Silt with sand was encountered in borehole BH7 at depths of 3.81 mbgs to 6.10 mbgs and 6.86 mbgs to 10.67 mbgs. These layers were interbedded within the silty sand to sandy silt layers. SPT N-values in these layers ranged from 177 blows per 0.33 m of penetration to blows per 127 mm of penetration to 50 blows per 50 mm of penetration, indicating very dense consistency. Moisture content in these layers was measured at 11% to 16%.

Table 4-6Grain Size Distribution - Silt to Silt with Sand

BOREHOLE NO.	SAMPLE I.D.	% GRADATION				SOIL CLASSIFICATION
		Gravel	Sand	Silt	Clay	
BH-3A	SS2	3	69	22	6	Sand with Silt trace Clay
BH- 1A	AS1	1	64	24	11	Sand with Silt trace Clay

4.1.9 Clayey Silt to Clay with Silt

Clay with Silt to Clayey Silt was encountered in boreholes BH1, BH3 and BH 7 at depths of 1.52 mbgs to 2.29 mbgs (BH1), 7.62 mbgs to 9.40 mbgs (BH3) and 6.34 mbgs to 6.86 mbgs (BH7). This layer has SPT N-values of 15 blows per 0.33 m to 90 blows per 127 mm of penetration, corresponding to stiff to hard. Moisture content in this layer ranges from 11 to 16%.

4.2 Groundwater Level and Cave-In Conditions

The following Table 4-7 presents the location of Groundwater in the drilled boreholes, in addition to the installed monitoring wells including screen depth and readings.

Table 4-7Groundwater and Monitoring Well

BOREHOLE NO.	WATER LEVEL AT DRILLING TERMINATION (ELEVATION) (DATE)	GROUNDWATER DEPTH (MBGS, DATE)	WATER LEVEL READING (M. ELEVATION) (DATE)	SOIL AT SCREEN DEPTH	CAVE IN DEPTH
BH 1	159.51 m (June 3, 2020)	2.61 m (June 17, 2020)	164.1 m (Jun 17, 2020)	Sand to Clay with Silt	6.05 m
BH 2	159.59 m (June 5, 2020)	3.81 m (June 17, 2020)	162.8 m (Jun 17, 2020)	Sandy Silt to Silty Sand	8.5 m
BH 3	156.6 m, (June 9, 2020)	1.27 m (June 17,2020)	163.8 m (Jun 17, 2020)	Sandy Silt	16.0 m
BH 4	159.58 m, (June 8, 2020)	2.6 m (June 17,2020)	164.3 m (Jun 17, 2020)	Sandy Silt to Sand and Silt	7.0 m
BH 5	159.1 m (June 9, 20020)	1.82 m (June 17,2020)	165.0 m (Jun 17, 2020)	Sandy Silt to Sand and Silt	6.4 m
BH 6	162.88 m (June 8, 2020)	1.6 m (June 17,2020)	166.0 m (Jun 17, 2020)	Sandy Silt	N/A
BH 7	161.18 m (June 4 ,2020)	3.38 m (June 17,2020)	164.8 m (Jun 17, 2020)	Sand with Silt to Sandy Silt	10.3 m
BH 8	Dry upon completion	Dry (Jun 17,2020)	Dry (Jun 17, 2020)	Silt with Sand	6.7 m

It should be noted that groundwater conditions may change seasonally, and water levels should be monitored in order to provide an accurate picture of seasonal groundwater depths for purposes of dewatering and construction considerations.

4.3 Frost Susceptibility of Subgrade Soils

Sieve hydrometer testing of samples taken from the subgrade soils indicate that frost-susceptible silt fractions in the subgrade soils are all less than 30%, which corresponds to low-susceptibility to frost heaving (LSFH). Frost susceptible silt is any fine silt with a particle size in between 5μm and 75μm. Soils with a high concentration of frost susceptible silt tend to develop “frost-lenses” within the frost depth and may heave, causing differential movement in paved surfaces.

4.4 Frost Depth

Following the Frost Penetration Depth of Southern Ontario presented in MTO Pavement Design and Rehabilitation Manual, Second Edition, (MTO, 2013), the frost depth is 1.2 metres.

5.0 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

5.1 General

The following recommendations for the proposed site development are based on the information obtained from the borehole investigation and laboratory testing, which we believe fairly represents the subsurface conditions of the site. These recommendations are intended for the guidance of the design engineer to establish constructability and should not be construed as instructions to contractors. If significant differences in the subsurface conditions described above are found, we request to be contacted immediately to review and revise our findings and recommendations, if necessary.

The construction methods described in this report must not be considered as being specifications or recommendations to the prospective contractors, or as being the only suitable methods. Prospective contractors should evaluate all the information, obtain additional subsurface information as they might deem necessary and should select their construction methods, sequencing and equipment based on their own experience in similar ground conditions. The readers of this report are also reminded that the conditions are known only at the borehole locations and in view of the generally wide spacing of the boreholes, conditions may vary significantly between boreholes.

5.2 Preliminary Foundation Recommendations

As noted above, a CP Underpass structure will be constructed at the southern end of the project. Boreholes BH6 and BH7 were advanced on the north and south sides of the proposed underpass structure. Both boreholes were advanced to spoon refusal.

Footings that are founded on the very dense native silt soils can be designed based on a factored ultimate geotechnical resistance at Ultimate Limit States (ULS) of 350 kPa. A preliminary serviceability geotechnical resistance at Serviceability Limit States (SLS) of 250 kPa for 25 mm of settlement may be used in the design of the foundations.

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

All footings exposed to seasonal freezing conditions should be provided with at least 1.2 m of earth cover or equivalent thermal insulation against frost.

5.3 Excavations

Based upon the subsurface conditions at the boreholes, excavations for the project can be carried out with heavy hydraulic backhoes. It is recommended that provision be carried in the contract for the excavation and disposal of obstructions on site, including cobbles and boulders.

All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). In accordance with OHSA, dense to very dense native silt soils would be classified as Type 3 soils. Fill soils would be classified as Type 4 soils. If space limitations exist due to adjacent structures or facilities, consideration could be given to the construction of a temporary support system to provide protection to the structures and/or facilities. All excavated spoil should be placed at least the depth of the trench away from the edge of the trench for safety reasons.

6.0 PAVEMENT STRUCTURE DESIGN

6.1 New Project Limits

As previously noted, an updated alignment was proposed in January of 2023 of the roadway connection from Sheppard Avenue East to Village Green Square. The new alignment involves extending the existing Gordon Avenue to connect with Village Green Square.

It must be highlighted that the majority of the boreholes completed by WSP are not within the new alignment. Assumptions regarding the existing subgrade have been made for the purpose of this report, based on limited information from the WSP and Terraprobe borehole data taken in the surrounding vicinity of the new alignment.

6.2 Current Pavement Condition – Gordon Avenue

A site visit was completed in February 2023 to assess the existing pavement condition of the ±170 m stretch of Gordon Avenue. The roadway is in a residential area, with houses on the east and west sides and one lane in each direction. The roadway has an urban cross-section, where the pavement surface water generally follows the existing surface grades across the pavement to the curb and gutter. The results of the pavement evaluation are summarized below:

- Moderate severity centerline cracking observed intermittently on the pavement surface;
- High severity joint openings around old patch repairs;
- Moderate severity widespread alligator cracking, mainly in Southbound Lane;
- High severity localized cracking around utilities (catch basins and manholes);
- Slight to moderate severity transverse cracking observed intermittently on the pavement surface;
- Medium sized potholes noted intermittently along roadway.

Overall condition of the roadway is poor to fair, with the South end of the roadway in much better condition than the North end. Photographs illustrating the existing condition of the roadway are attached in Appendix E.

6.2.1 Existing Pavement Structure

At the time of writing, there is no existing pavement structure data available for this section of Gordon Avenue. Recommendations provided in the following sections are based on the visual condition assessment completed and past experience with similar pavements.

An investigation of the pavement structure on Gordon Avenue is strongly recommended, to provide an optimal pavement design recommendation to upgrade the pavement structure, as necessary for the projected traffic.

6.3 Pavement Design Parameters and Analysis

6.3.1 Traffic Data

WSP completed a traffic assessment of the North-South street alignments, titled “Southwest Agincourt Transportation Connections Study Traffic Assessment (Existing and Future Traffic Evaluation)”, dated August 19, 2022. The traffic study can be found in Appendix F of this report. Based on the traffic study, the Annual Average Daily Traffic for alignment C-1 was calculated (Gordon Avenue Connection). The percentage trucks and growth rate were estimated based on previous experience with similar roadways. The traffic data used for the preliminary pavement design analysis for the construction of the Gordon Avenue connection is presented in Table 6-1.

Table 6-1Traffic Data Summary

AADT (YEAR)	PERCENTAGE TRUCKS (%)	GROWTH RATE (%)	ROAD CLASSIFICATION
4198 vpd (2023)	3	1	Urban Collector

Since the Traffic Study did not have a distribution of heavy vehicles, the truck factor was determined in accordance with "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (March 2008)”, Table 3-4 as presented in Table 6-2 below.

Table 6-2Truck Distribution and Truck Factor

VEHICLE CLASS	PERCENT DISTRIBUTION	TRUCK FACTOR	RESULTANT TRUCK FACTOR
2 and 3-axle trucks	90	0.50	0.45
4-axle trucks	2	2.30	0.05
5-axle trucks	5	1.60	0.08
6-axle trucks	3	5.50	0.17
		Total Truck Factor	0.74

6.3.2 Equivalent Single Axle Loads

The equivalent single axle loads (ESALs) for the design lanes were calculated using the traffic data presented above. The input parameters for the design lane ESAL calculation were derived in accordance with the MTO Publication: Procedures for Estimating Traffic Loads for Pavement design with applicable lane and directional distribution factors as outlined in MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, 2008" and the MTO Pavement Design and Rehabilitation Manual.

The estimated design ESALs for Gordon Avenue within the project limits is presented in the table below. The ESAL Calculations are shown in Appendix G of this report.

Table 6-3Design ESALs

ROAD SECTION	LANE DISTRIBUTION FACTOR	DIRECTIONAL DISTRIBUTION FACTOR	20-YEAR DESIGN ESALS
Gordon Avenue (From Sheppard Avenue East to Village Green Square).	1.0	0.5	374,300

6.3.3 Pavement Design Analysis

A pavement design analysis was completed to determine the structural requirements for the proposed roadway connection construction within the project limits. Pavement designs were completed in accordance with the 1993 AASHTO "Guide for the Design of Pavement Structures as modified by the MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, 2008", the MTO Pavement Design and Rehabilitation Manual and the City of Toronto's 2019 Pavement Design and Rehabilitation Guideline.

Based on the limited field investigation results, including Terraprobe's report(s) and WSP's geotechnical investigation for the underpass and roadway connection, the subgrade soils beneath the pavement structure within the project limits mainly consisted of Sandy Silt/Silty Sand to Silt and Sand. For design purposes, a mean subgrade resilient modulus of 25 MPa was selected.

The following input parameters were selected to generate a Structural Number (SNREQ) target for the proposed roadway connection:

Table 6-4AASHTO Pavement Input Design Parameters

DESIGN PARAMETER		VALUE
Design Reliability (%)		90
Standard Deviation		0.49
Serviceability	Initial	4.4
	Terminal	2.2
Subgrade Strength	Subgrade Modulus (MPa)	25
Structural Layer (SN) Coefficients	New Hot-mix Asphalt	0.42
	New Granular Base	0.14
	New Granular Subbase	0.09
Drainage Coefficients	New Hot-mix Asphalt	1.0
	New Granular Base	1.0
	New Granular Subbase	1.0

The required pavement structure thickness for the design lane was determined using the AASHTO design method and the Ministry of Transportation's Pavement Design Manual. Input parameters are shown in Table 5-5, and the design output sheets are presented in Appendix H.

Table 6-5Target Structural Number

ROAD SECTION	REQUIRED STRUCTURAL NUMBER (SNReq) – 20 YEARS
Gordon Avenue (From Sheppard Avenue East to Village Green Square)	95

6.4 Pavement Recommendations

6.4.1 Gordon Avenue connection Reconstruction

Based on a design subgrade modulus of 25 MPa and the traffic information derived from the WSP Traffic Study, a structural number of 95 is required to accommodate the 374,300 ESALs (Year 2042) that the project road is expected to receive over the course of its design life.

Due to the lack of available borehole data for the existing pavement on Gordon Avenue and the overall poor condition of the roadway, a reconstruction design is the only viable option to include within this report. Further investigation of the existing ±170 m stretch of Gordon Avenue would be required to provide a potential rehabilitation/resurfacing recommendation that would increase the structural capability to withstand the projected traffic.

It should be noted that according to the 1993 AAHSTO Guide for Flexible Pavements that flexible pavement designs are usually dependent on the accumulated damaging impact of traffic over a design period of 20 years (in Ontario due to severe weather conditions) and due to unanticipated population increase, traffic volume might exceed the estimated traffic volume.

The preliminary recommendation for the reconstruction of Gordon Avenue is as follows:

40 mm	SuperPave 12.5 Surface Course
70 mm	SuperPave 19.0 Binder Course
150 mm	New Granular 'A'
350 mm	New Granular 'B', Type II
610 mm	Total Thickness

The construction strategy for the above design should be carried out as follows:

6.4.1.1 Gordon Avenue – New Construction/Reconstruction

- Remove the existing topsoil/pavement materials to a depth 610 mm below the finished grade;
- Proof-roll the exposed subgrade, repair soft-spots with Granular 'A' and re-grade as necessary;

- Place 350 mm, or more as required of OPSS 1010 Granular B Type II followed by placing a minimum of 150 mm of OPSS 1010 Granular A. All granular materials should be placed in lift thicknesses of 150 mm or less and compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD);
- Place and compact 70 mm thickness of HL-8 (OPSS 1150) or SP19.0 (OPSS 1151) hot-mix asphalt and compact to minimum 91% Maximum Relative Density (MRD);
- Apply SS-1 Tack Coat on Binder Course; and
- Place and compact one lift of 40 mm thickness of HL-3 (OPSS 1150) or SP12.5 (OPSS 1151) hot-mix asphalt and compact to minimum 92% MRD.

The above pavement structure has an approximate design SN of 99 mm, which is greater than the required SN of 95 mm, and is estimated to have a service life of up to 20 years.

It is recommended that geotechnical testing and inspections be carried out during construction operations to confirm construction is in accordance with the project specifications. Testing and inspections should include road subgrade proof-rolling inspections, compaction testing, monitoring of asphalt placement, etc.

The above pavement strategy assumes that the subgrade has been adequately prepared. It is recommended that qualified geotechnical personnel be retained to complete an inspection of the subgrade and placement of new granular during construction prior to placement of any hot-mix asphalt, or an approved geotextile/geogrid material installed, if required.

6.4.2 Subdrains

Subdrains/stub drains should be installed at the site to facilitate effective subsurface drainage of the pavement structure, in accordance with the overall drainage design (designed by others).

The invert of the subdrains should be established at least 0.3 m below subgrade level. All subdrain construction should be completed in accordance with OPSD 206.050 or the appropriate town’s equivalent. A subdrain system should consist of a 150 mm diameter perforated pipe placed inside a 300 mm x 300 mm trench and backfilled with 19 mm Clear Stone. The excavation should be lined with Class 1 non-woven geotextile (FOS 50-100µm), to surround the Clear Stone backfill before placement of the granular subbase. Subdrains should connect to catch basins and the storm sewer system or, if present, ditches.

6.4.3 Transitions

Smooth transitions are required in all areas where new pavement structures meet existing facilities (i.e., all side roads meeting the project limits of the current assignment).

All longitudinal and transverse joints should meet the requirements of OPSS 313. All longitudinal joints should be staggered between asphalt lifts. Staggering of the longitudinal joints should be constructed by offsetting the paving edge of the surface and binder course by a minimum of 150 mm.

At the limits of paving on the existing pavement surface should be cold planed the depth of the surface course layer, full width, to provide adequate thickness so the new asphalt material can be placed flush to the top of the existing pavement surface. The top surface lift of the new pavement surface on Gordon Avenue should extend or “key into” a minimum of 5 m beyond the bottom lifts into the existing pavement structure. All milled surfaces should be cleaned thoroughly prior placement of a tack coat and new hot mix asphalt.

Transitions in between existing and new granular base and/or subbase where required should be completed at a minimum 10H: 1V taper.

7.0 LIMITATIONS

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

Some of the traffic data, including truck distribution, growth rate, and percentage of commercial traffic were estimated. The estimated values should be confirmed, and designs should be re-evaluated by a qualified Geotechnical Engineer.

Information in this report shall not be used by third parties without WSP’s permission.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact us.

Signature Page

WSP Canada Inc.

SAsghar

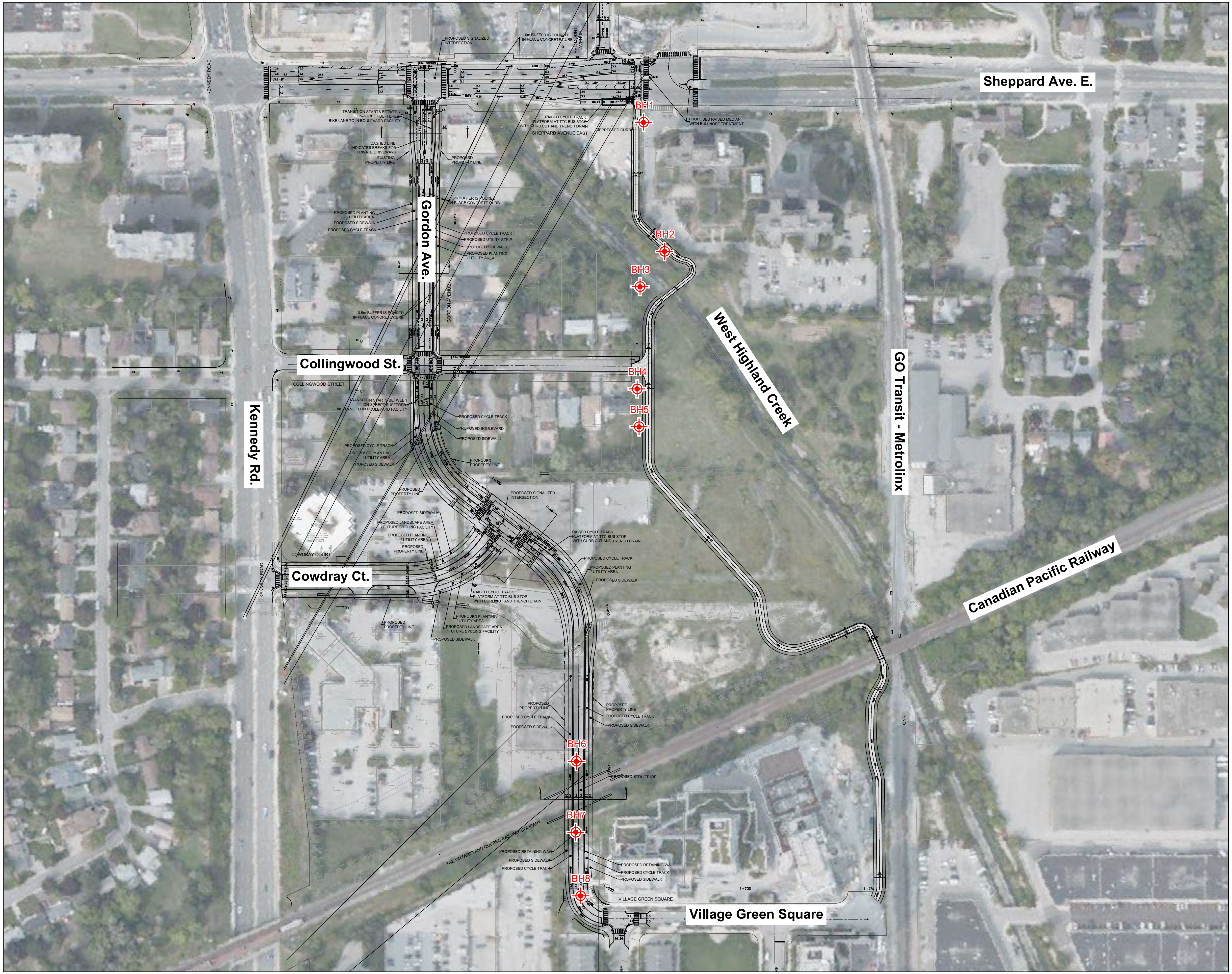
Sunduss Asghar, EIT
Geotechnical, Ground Engineering East

Nick La Posta, P.Eng.
Team Lead, Ground Engineering East

SA/NL/kj

https://wsponline-my.sharepoint.com/personal/karen_jenkins_wsp_com/documents/desktop/19m-01888-00 final report march 2023.docx

FIGURES



Key Plan

N.T.S.

LEGEND:

⌖ MONITORING WELL (WSP 2020)

0 50 100
1:2,500 METRES

BOREHOLE LOCATION PLAN

GEOTECHNICAL INVESTIGATION
for Southwest Agincourt Transportation
Connections Study,
Toronto, Ontario

DATE: MARCH 2023	SCALE: 1:2500
PROJECT: 19M-01888-00	FILE NO.:

FIGURE
1

APPENDIX A

Site Photographs – Geotechnical Investigation

Photo 1: Location of Borehole 8 on Village Green Square looking south.

Photo 2: BH 7, south of CP Rail Tracks looking north.

Photo 3: Location of Borehole 6, in parking lot off of Cowdray Court, looking north.

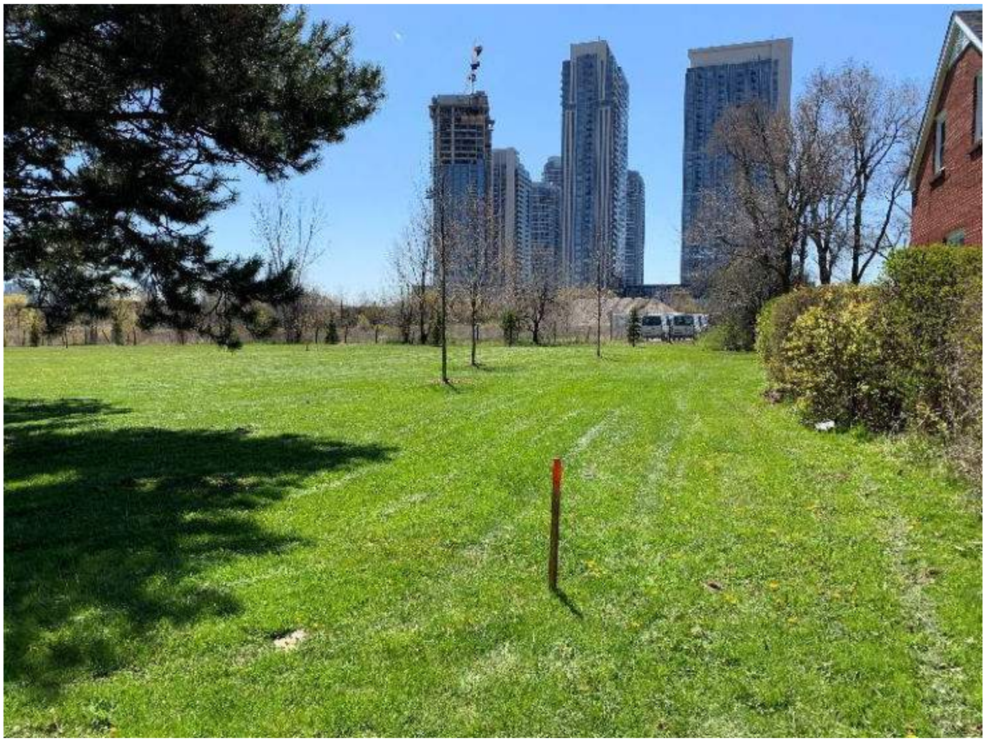


Photo 4: Location of BH 5 in Collingwood Park, looking south.

Photo 5: Location of BH 4, looking Northwest in Collingwood Park.

Photo 6: Location of BH 3, south side of creek, looking north just west of pedestrian bridge

Photo 7: Location of BH 2, north east of creek, looking north.

Photo 8: Location of BH 1, boulevard at condo entrance looking north toward Sheppard.

APPENDIX B

Borehole Logs

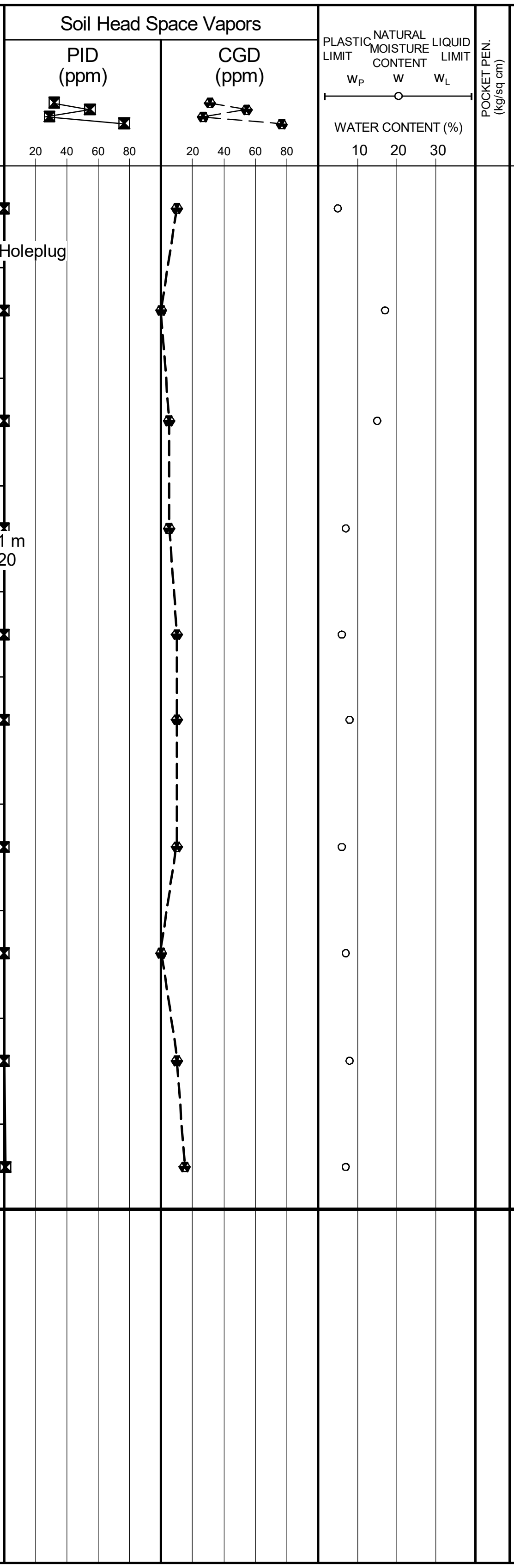
LOG OF BOREHOLE BH1

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638000.73 E 4849286.15

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-03-2020 to Jun-03-2020

REF. NO.: 19M-01888-00
ENCL NO.: 1
ORIGINATED BY MA

SOIL PROFILE		SAMPLES			MONITORING WELL CONSTRUCTION	CHEMICAL ANALYSIS	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m			GR SA SI CL
166.71	Ground Surface						
166.60 0.11	**TOP SOIL (110 mm)** **FILL:** sand and gravel, grey to brown, moist	1	SS	24	Bentonite Holeplug		
166.08 0.63	**FILL:** silty clay, brown to dark brown, moist	2	SS	4	Sand		
165.19 1.52	**CLAY WITH SILT:** some sand, trace gravel, brown to grey	3	SS	15			
164.42 2.29	**SILTY SAND:** trace gravel, mosit, some oxidation, brown to light brown	4	SS	100/ 249mm	W. L. 164.1 m Jun 17, 2020		
163.66 3.05	**SAND AND SILT:** trace gravel, trace clay, some oxidation, grey to brown, moist	5	SS	100/ 254mm	Screen		2 40 49 9
163.05 3.66	**SAND:** some sitl, some gravel, grey, moist	6	SS	100/ 289mm			
162.14 4.57	**SILTY SAND:** some gravel, moist, dark grey	7	SS	97			
	SANDY SILT: Trace gravel, moist, grey to brown	8	SS	60	Caved		
160.61 6.10		9	SS	59			
159.85 6.86	**SILT WITH SAND:** trace gravel, grey, moist	10	SS	60			
159.24 7.47	**END OF BOREHOLE** Notes: 1) Borehole was open and ground water level at 7.2m below ground surface upon completion END OF BOREHOLE AT 7.47 mbgs						



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

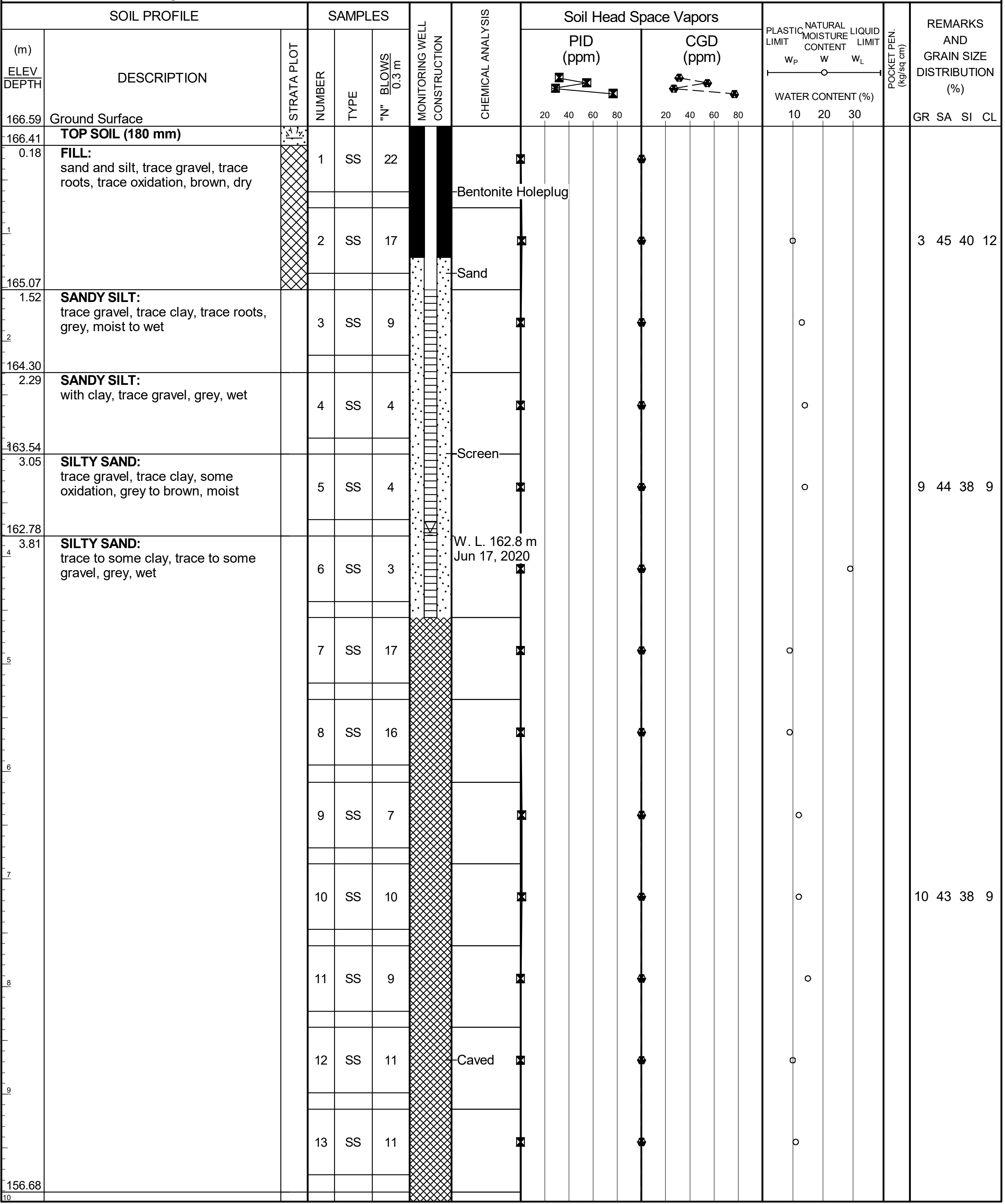
LOG OF BOREHOLE BH2

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638040.08 E 4849209.99

Method: Solid Stem Auger/ Mud Rotary
Diameter: 152.4 mm
Date: Jun-05-2020 to Jun-05-2020

REF. NO.: 19M-01888-00
ENCL NO.: 2
ORIGINATED BY MA

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	GR	SA	SI	CL
166.59	Ground Surface							
	TOP SOIL (180 mm)							
166.41 0.18	**FILL:** sand and silt, trace gravel, trace roots, trace oxidation, brown, dry	1	SS	22				
		2	SS	17	3	45	40	12
165.07 1.52	**SANDY SILT:** trace gravel, trace clay, trace roots, grey, moist to wet	3	SS	9				
164.30 2.29	**SANDY SILT:** with clay, trace gravel, grey, wet	4	SS	4				
163.54 3.05	**SILTY SAND:** trace gravel, trace clay, some oxidation, grey to brown, moist	5	SS	4	9	44	38	9
162.78 3.81	**SILTY SAND:** trace to some clay, trace to some gravel, grey, wet	6	SS	3				
		7	SS	17				
		8	SS	16				
		9	SS	7				
		10	SS	10	10	43	38	9
		11	SS	9				
		12	SS	11				
		13	SS	11				
156.68								



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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

LOG OF BOREHOLE BH2

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638040.08 E 4849209.99

Method: Solid Stem Auger/ Mud Rotary
Diameter: 152.4 mm
Date: Jun-05-2020 to Jun-05-2020

REF. NO.: 19M-01888-00
ENCL NO.: 2
ORIGINATED BY MA

SOIL PROFILE			SAMPLES			MONITORING WELL CONSTRUCTION	CHEMICAL ANALYSIS	Soil Head Space Vapors		PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L	POCKET PEN. (kg/sq cm)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION Continued	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			PID (ppm) 20 40 60 80	CGD (ppm) 20 40 60 80	WATER CONTENT (%) 10 20 30		GR SA SI CL
9.91	**SANDY SILT:** trace gravel, grey, wet(Continued)		14	SS	4	▨		☒	●	○		
155.92 10.67	**SAND WITH SILT:** trace clay, trace gravel, brown, wet		15	SS	10	▨		☒	●	○		1 71 25 2
154.40 12.19	**SAND:** some gravel, some silt, trace clay, brown, wet		16	SS	15	▨		☒	●	○		19 59 17 5
153.79 12.80	**END OF BOREHOLE** Notes: 1) Borehole was caved to 10.3m and ground water level at 7m below ground surface upon completion 2) Swithed to Mud Rotary at depth of 11m below ground sufrace END OF BOREHOLE AT 12.8 mbgs											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

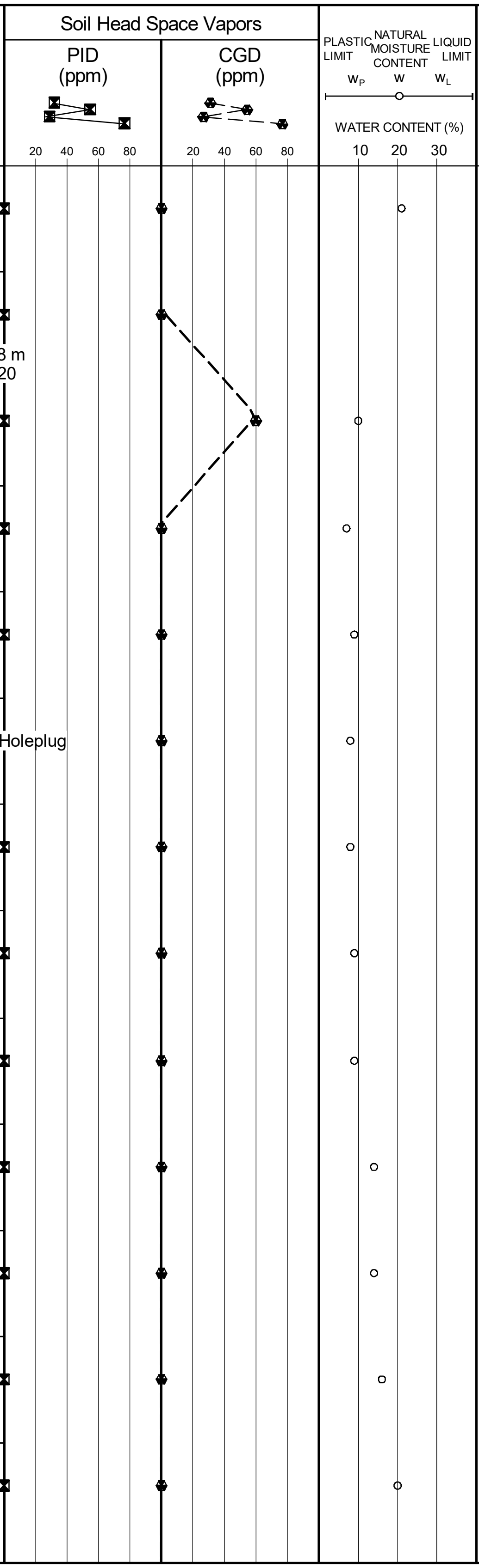
LOG OF BOREHOLE BH3

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638031.88 E 4849183.03

Method: Hollow Stem Auger/ Mud Rotary
Diameter: 152.4 mm
Date: Jun-09-2020 to Jun-10-2020

REF. NO.: 19M-01888-00
ENCL NO.: 3
ORIGINATED BY MA

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	MONITORING WELL CONSTRUCTION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.07	Ground Surface					
164.90	**TOP SOIL (170 mm)**					
164.90 0.17	**FILL:** sand with silt, some gravel, trace roots, brown, somewhat dry	1	SS	7		
164.46 0.61	**FILL:** silty sand, some clay, trace gravel, trace roots, some oxidation, brown to dark brown, moist	2	SS	10	W. L. 163.8 m Jun 17, 2020	
163.55 1.52	**SANDY SILT:** trace gravel, some oxidation, brown to greyish brown, moist	3	SS	25		
162.78 2.29	**SANDY SILT:** trace gravel, trace clay, some oxidation, brown to greyish brown, somewhat dry	4	SS	43		
162.02 3.05	**SANDY SILT:** some gravel, trace clay, grey, moist to somewhat moist	5	SS	42		
		6	SS	80	Bentonite Holeplug	
160.50 4.57	**SAND AND SILT:** trace clay, trace gravel, moist to somewhat moist	7	SS	100/ 279mm		7 40 44 9
159.74 5.33	**SANDY SILT:** some clay, trace gravel, moist to somewhat wet	8	SS	52		
		9	SS	31		
		10	SS	52		
157.45 7.62	**CLAYEY SILT:** with sand, grey, moist to somewhat wet,	11	SS	18		
156.69 8.38	**SANDY SILT:** grey, wet				Sand	
156.46 8.61	**CLAYEY SILT:** with sand, grey, moist	12	SS	34		
		13	SS	21		
155.67 9.40	**SANDY SILT:** grey, wet					



CHEMICAL ANALYSIS

POCKET PEN. (kg/sq cm)

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

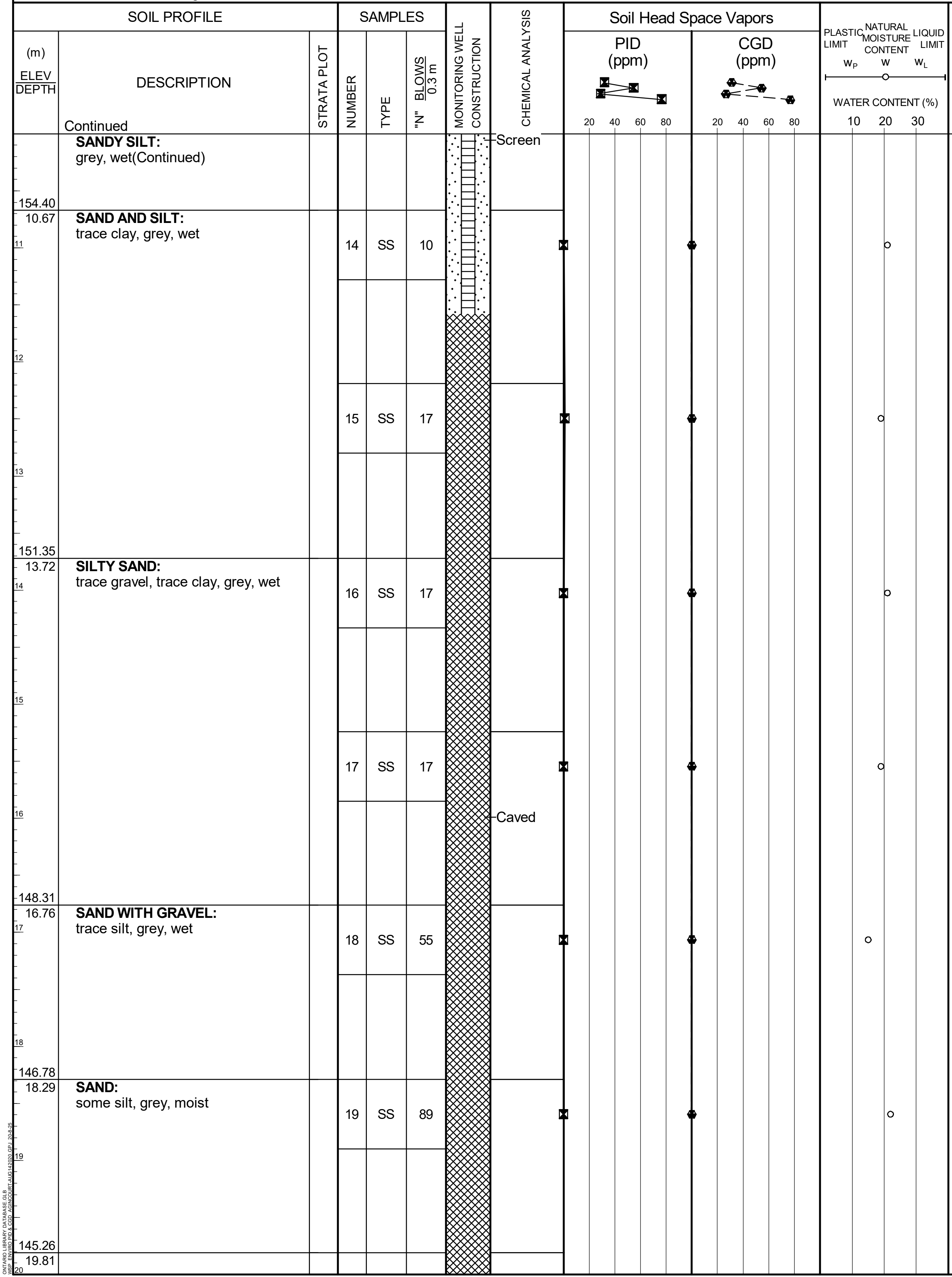
LOG OF BOREHOLE BH3

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638031.88 E 4849183.03

Method: Hollow Stem Auger/ Mud Rotary
Diameter: 152.4 mm
Date: Jun-09-2020 to Jun-10-2020

REF. NO.: 19M-01888-00
ENCL NO.: 3
ORIGINATED BY MA

SOIL PROFILE			SAMPLES			REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION Continued	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GR	SA	SI	CL
	SANDY SILT: grey, wet(Continued)								
154.40 10.67	**SAND AND SILT:** trace clay, grey, wet		14	SS	10	0	42	56	2
			15	SS	17				
151.35 13.72	**SILTY SAND:** trace gravel, trace clay, grey, wet		16	SS	17	1	59	38	2
			17	SS	17				
148.31 16.76	**SAND WITH GRAVEL:** trace silt, grey, wet		18	SS	55				
146.78 18.29	**SAND:** some silt, grey, moist		19	SS	89				
145.26 19.81									



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GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

LOG OF BOREHOLE BH3

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638031.88 E 4849183.03

Method: Hollow Stem Auger/ Mud Rotary
Diameter: 152.4 mm
Date: Jun-09-2020 to Jun-10-2020

REF. NO.: 19M-01888-00
ENCL NO.: 3
ORIGINATED BY MA

SOIL PROFILE			SAMPLES			MONITORING WELL CONSTRUCTION	CHEMICAL ANALYSIS	Soil Head Space Vapors		PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	POCKET PEN. (kg/sq cm)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION Continued	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m			PID (ppm) 20 40 60 80	CGD (ppm) 20 40 60 80	WATER CONTENT (%) 10 20 30		GR SA SI CL
 144.65	**SAND:** trace gravel, brown, moist to somewhat wet(Continued)		20	SS	100/ 279mm	▨				○		
20.42	**END OF BOREHOLE** Notes: 1) Borehole was open and ground water level at 9.1m below ground surface upon completion 2) Swithed to Mud Rotary at depth of 3.05m below ground sufrace END OF BOREHOLE AT 20.4 mbgs											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

LOG OF BOREHOLE BH4

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638050.84 E 4849118.75

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-08-2020 to Jun-08-2020

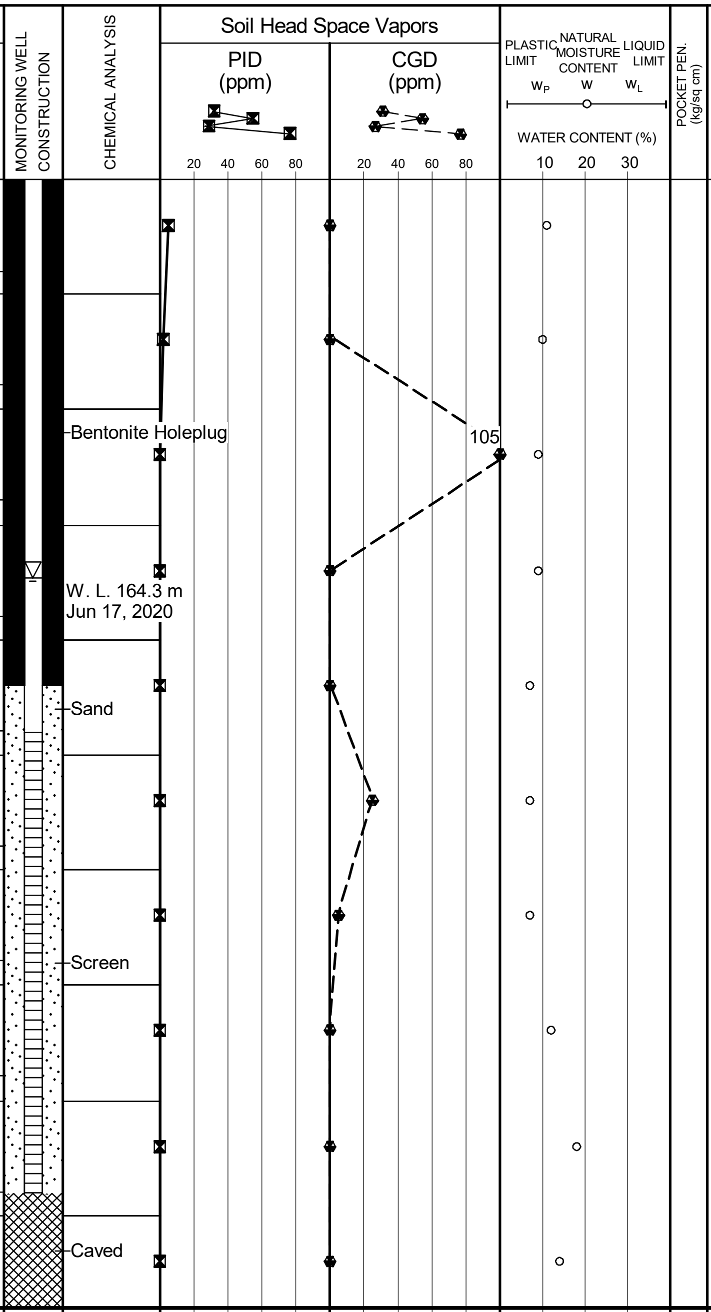
REF. NO.: 19M-01888-00
ENCL NO.: 4
ORIGINATED BY MA

SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
166.90	Ground Surface
166.77	**TOP SOIL (130mm)**
0.13	**FILL:** sand with silt, trace gravel, some oxidation, trace roots, brown, somewhat dry
166.07 0.83	**SILTY SAND:** some gravel, some oxidation, brown, moist
165.38 1.52	**SAND AND SILT:** trace gravel, trace clay, brown, somewhat moist
165.07 1.83	**SANDY SILT:** trace gravel, some clay, grey, moist
164.61 2.29	**SAND AND SILT:** trace gravel, trace to some clay, grey, wet to moist
161.57 5.33	**SANDY SILT:** with clay, trace gravel, grey, wet
160.80 6.10	**SANDY SILT:** with clay, grey, wet
159.43 7.47	**END OF BOREHOLE** Notes: 1) Borehole was open and ground water level at 7.32m below ground surface upon completion END OF BOREHOLE AT 7.47 mbgs

SAMPLES

NUMBER	TYPE	"N" BLOWS / 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	11				
2	SS	15				
3	SS	23	4	43	45	8
4	SS	22				
5	SS	60				
6	SS	47				
7	SS	61	3	42	46	9
8	SS	45				
9	SS	50				
10	SS	30				



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

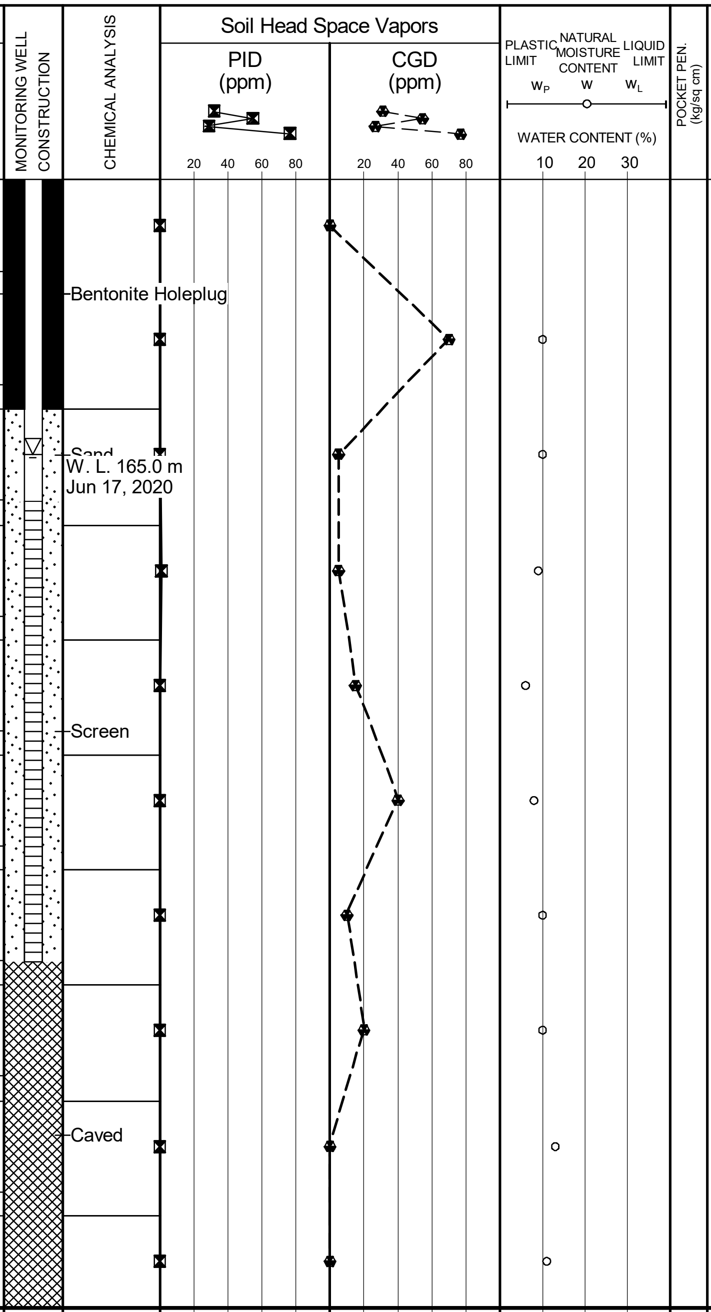
LOG OF BOREHOLE BH5

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638059.74 E 4849095.53

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-09-2020 to Jun-09-2020

REF. NO.: 19M-01888-00
ENCL NO.: 5
ORIGINATED BY MA

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
166.82	Ground Surface				
	TOP SOIL (190 mm)				
166.63 0.19	**FILL:** sand with silt, trace gravel, some oxidation, trace roots, brown, organic odor, somewhat dry	1	SS	7	
166.21 0.61	**SAND AND SILT:** trace gravel, trace clay, some oxidation, brown, moist	2	SS	14	2 44 46 8
165.30 1.52	**SILTY SAND:** trace gravel, brown, somewhat moist	3	SS	24	
164.53 2.29	**SANDY SILT:** trace gravel, grey, wet to moist	4	SS	34	
163.77 3.05	**SANDY SILT:** trace gravel, trace clay, grey, somewhat dry	5	SS	92	
163.01 3.81	**SAND AND SILT:** trace gravel, trace to some clay, grey, wet to moist	6	SS	65	2 44 45 9
162.25 4.57	**SILTY SAND:** trace gravel, some clay, grey, wet to moist	7	SS	74	
		8	SS	39	
		9	SS	42	
159.96 6.86	**SILTY SAND:** with clay, trace gravel, grey, wet	10	SS	29	
159.35 7.47	**END OF BOREHOLE** Notes: 1) Borehole was open and ground water level at 7.39m below ground surface upon completion END OF BOREHOLE AT 7.47 mbgs				



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

LOG OF BOREHOLE BH6

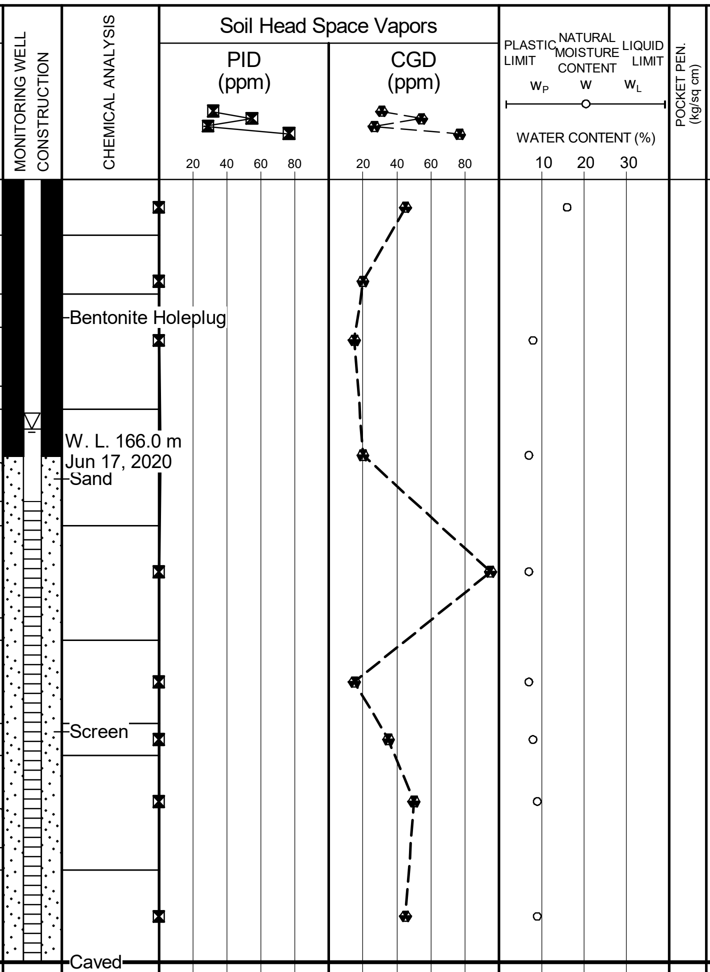
PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638088.56 E 4848874.41

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-08-2020 to Jun-08-2020

REF. NO.: 19M-01888-00
ENCL NO.: 6
ORIGINATED BY MA

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.60	Ground Surface	
167.50 0.10	**ASPHALT (100 mm)**	
167.23 0.37	**GRANULAR BASE (270mm):** gravelly sand with silt, light brown, mostly dry **GRANULAR SUBBASE:** sand with gravel, some oxidation, brown to dark grey, somewhat dry	
166.08 1.52	**SAND AND SILT:** trace gravel, some clay, trace to some oxidation, brown to brownish grey	2 44 43 11
165.31 2.29	**SANDY SILT:** some clay, trace gravel, wet to moist - wet sample from 2.29m to 2.67m	
164.55 3.05	**SANDY SILT:** trace gravel, trace clay, grey, somewhat dry - wet sample from 3.05m to 3.23m	
164.00 3.60	**SAND WITHSILT:** grey, moist to wet -wet sample from 3.76m to 3.81m	
163.79 3.81	**SANDY SILT:** some gravel, trace clay, grey, wet	
163.03 4.57	**SANDY SILT:** trace gravel, some clay, grey, wet to moist -wet sample from 4.57m to 4.62m	3 31 56 10
162.42 5.18	**END OF BOREHOLE** Notes: 1) Borehole was open and ground water level at 4.72m below ground surface upon completion END OF BOREHOLE AT 5.18 mbgs	

SAMPLES: NUMBER	TYPE	"N" BLOWS/0.3 m
1-1	SS	7
1-2	SS	7
2	SS	42
3	SS	100/ 305mm
4	SS	62
5-1	SS	45
5-2	SS	45
6	SS	50/ 127mm
7	SS	90/ 50mm



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

wsp

LOG OF BOREHOLE BH7

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638102.55 E 4848830.09

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-04-2020 to Jun-04-2020

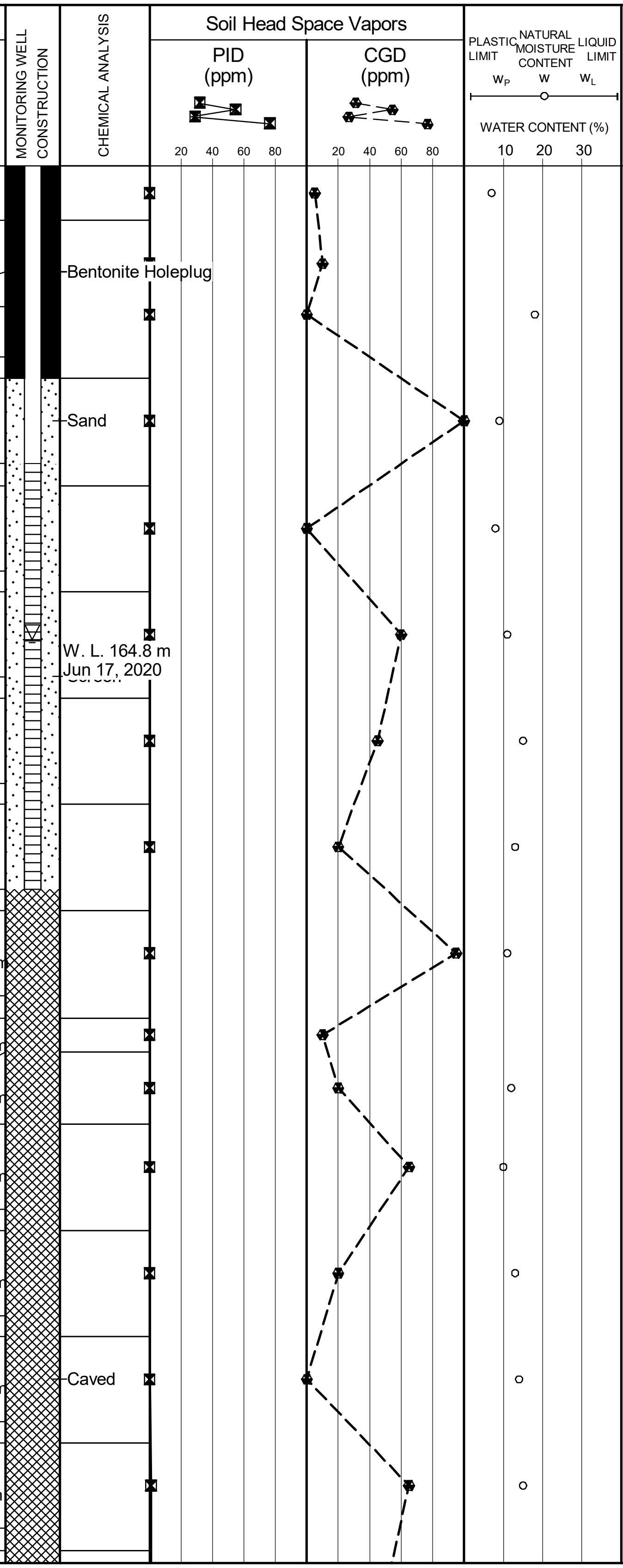
REF. NO.: 19M-01888-00
ENCL NO.: 7
ORIGINATED BY MA

SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
168.18	Ground Surface
168.04 0.14	**TOP SOIL (140 mm)**
167.79 0.39	**FILL:** gravelly sand, some silt, grey, somewhat dry
167.42 0.76	**FILL:** sand and silt, trace clay, trace gravel, brown to grey, moist
	FILL: silty sand, trace gravel, trace roots, trace oxidation, brown, dry
166.66 1.52	**SANDY SILT:** trace gravel, trace clay, trace roots, grey, moist to wet
165.89 2.29	**SANDY SILT:** with clay, trace gravel, grey, wet - moist sample from 2.29 to 2.44
165.13 3.05	**SAND WITH SILT:** trace gravel, some oxidation, grey to brown, moist - wet sample from 3.23m to 3.38m
164.37 3.81	**SILT:** trace sand, trace clay, trace gravel, grey, wet - wet sample from 3.81m to 4.88m - wet sample from 5.33m to 6.1m
162.08 6.10	**SAND:** trace gravel, brown, wet
161.84 6.34	**CLAYEY SILT:** with sand, grey, wet
161.32 6.86	**SILT WITH SAND:** some clay, trace to no gravel, grey, wet
158.27	

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1-1	SS	40				
1-2	SS	40				
2	SS	15				
3	SS	37				
4	SS	52				
5	SS	51				
6	SS	77				
7	SS	86	1	4	88	7
8	SS	100/127mm				
9-1	SS	90/127mm				
9-2	SS	90/127mm				
10	SS	100/102mm	2	29	58	11
11	SS	100/127mm				
12	SS	85/127mm				
13	SS	50/50mm				



Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

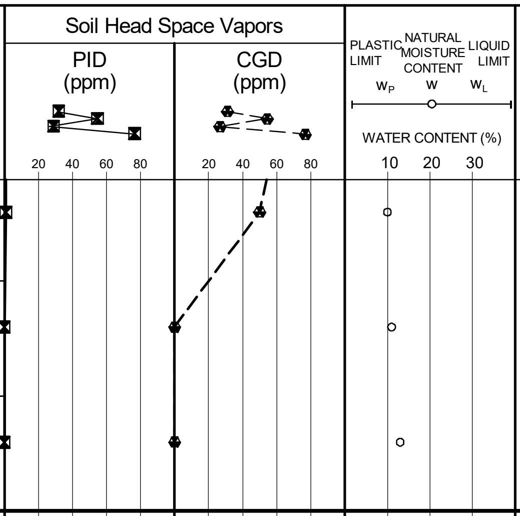
LOG OF BOREHOLE BH7

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638102.55 E 4848830.09

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-04-2020 to Jun-04-2020

REF. NO.: 19M-01888-00
ENCL NO.: 7
ORIGINATED BY MA

SOIL PROFILE			SAMPLES			MONITORING WELL CONSTRUCTION	CHEMICAL ANALYSIS	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION Continued	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m			GR	SA	SI	CL
9.91	**SILT WITH SAND:** trace gravel, trace clay, grey, wet(Continued)		14	SS	50/ 102mm	▩					
157.51 10.67	**SILTY SAND:** trace gravel, trace clay, brown, wet		15	SS	50/ 102mm	▩		3	55	36	6
156.75 11.43	**SANDY SILT:** trace clay, wet		16	SS	50/ 76mm	▩					
155.99 12.19	**END OF BOREHOLE** Notes: 1) Borehole was caved to 10.3m and ground water level at 7m below ground surface upon completion 2) Swithed to Mud Rotary at depth of 11m below ground sufrace END OF BOREHOLE AT 12.19 mbgs										



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

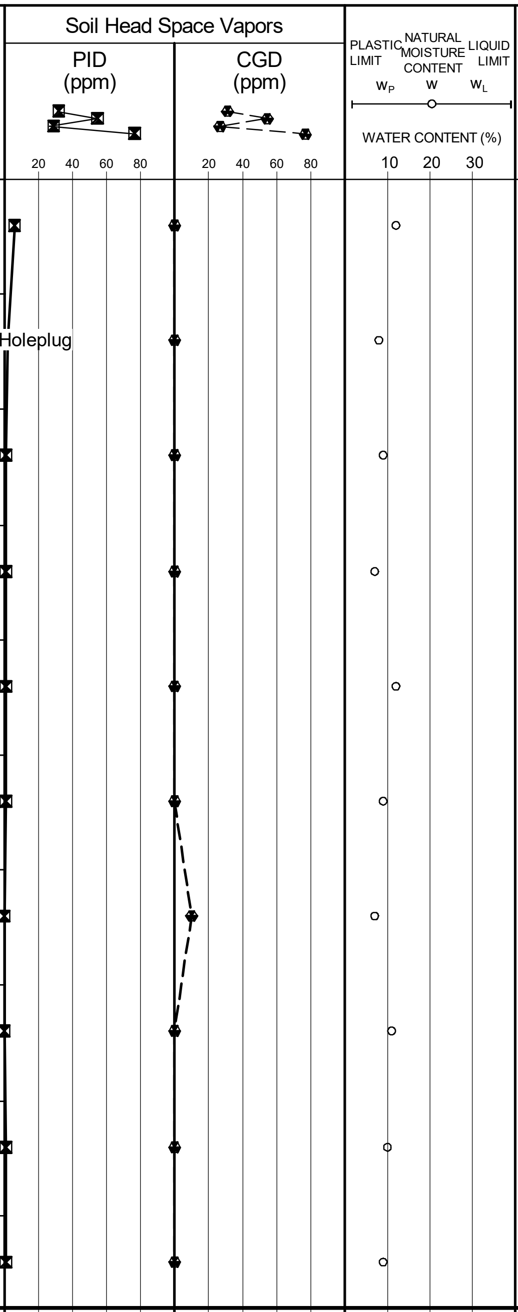
LOG OF BOREHOLE BH8

PROJECT: Agincourt
CLIENT: York Region
PROJECT LOCATION: Scarborough, ON
DATUM: Geodetic
BH LOCATION: Scarborough, ON N 638118.44 E 4848791.48

Method: Solid Stem Auger
Diameter: 152.4 mm
Date: Jun-04-2020 to Jun-04-2020

REF. NO.: 19M-01888-00
ENCL NO.: 8
ORIGINATED BY MA

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	MONITORING WELL CONSTRUCTION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
168.80	Ground Surface								
168.71 0.09	**ASPHALT (90mm)** **GRANULAR BASE (520mm):** gravelly sand, trace silt, brown, dry	1	SS	82/ 102mm					
168.19 0.61	**SANDY SILT:** trace gravel, some clay, brown, dry	2	SS	19	Bentonite Holeplug	6	38	46	10
		3	SS	21					
166.51 2.29	**SAND WITH SILT:** trace gravel, trace oxidation, light brown, dry to moist	4	SS	18	Sand				
165.75 3.05	**SILT WITH SAND:** trace gravel, trace to some clay, grey, moist to wet - wet sample from 3.05m to 3.5m	5	SS	35					
		6	SS	100/ 102mm	Screen	1	23	65	11
		7	SS	100/ 102mm					
		8	SS	100/ 76mm					
	- wet sample from 6.6m to 6.7m	9	SS	100/ 76mm	Caved				
161.94 6.86	**SANDY SILT:** trace clay, grey, moist	10	SS	50/ 127mm					
161.33 7.47	**END OF BOREHOLE** Notes: 1) Borehole was caved to 7.13m below ground surfaceand dry upon completion END OF BOREHOLE AT 7.47 mbgs								



POCKET PEN. (kg/sq cm)

CHEMICAL ANALYSIS

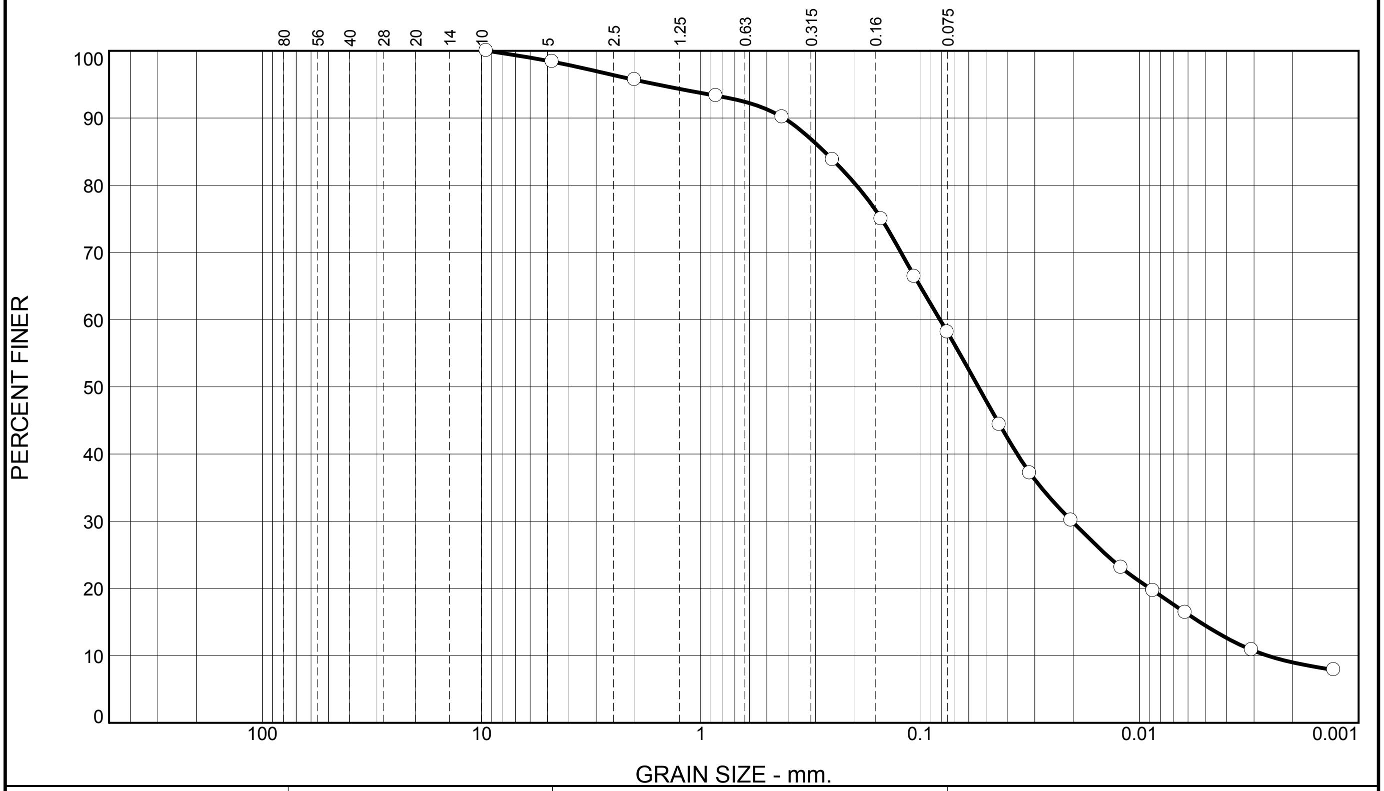
GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

APPENDIX C

Geotechnical Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	2	6	32	49	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	98		
2.00	96		
0.85	93		
0.425	90		
0.250	84		
0.150	75		
0.106	66		
0.075	58		
0.0434 mm.	44		
0.0315 mm.	37		
0.0204 mm.	30		
0.0121 mm.	23		
0.0086 mm.	20		
0.0062 mm.	16		
0.0031 mm.	11		
0.0013 mm.	7.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4199 D_{85}= 0.2733 D_{60}= 0.0812
D_{50}= 0.0543 D_{30}= 0.0203 D_{15}= 0.0053
D_{10}= 0.0026 C_u= 31.12 C_c= 1.94

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH1_SS5

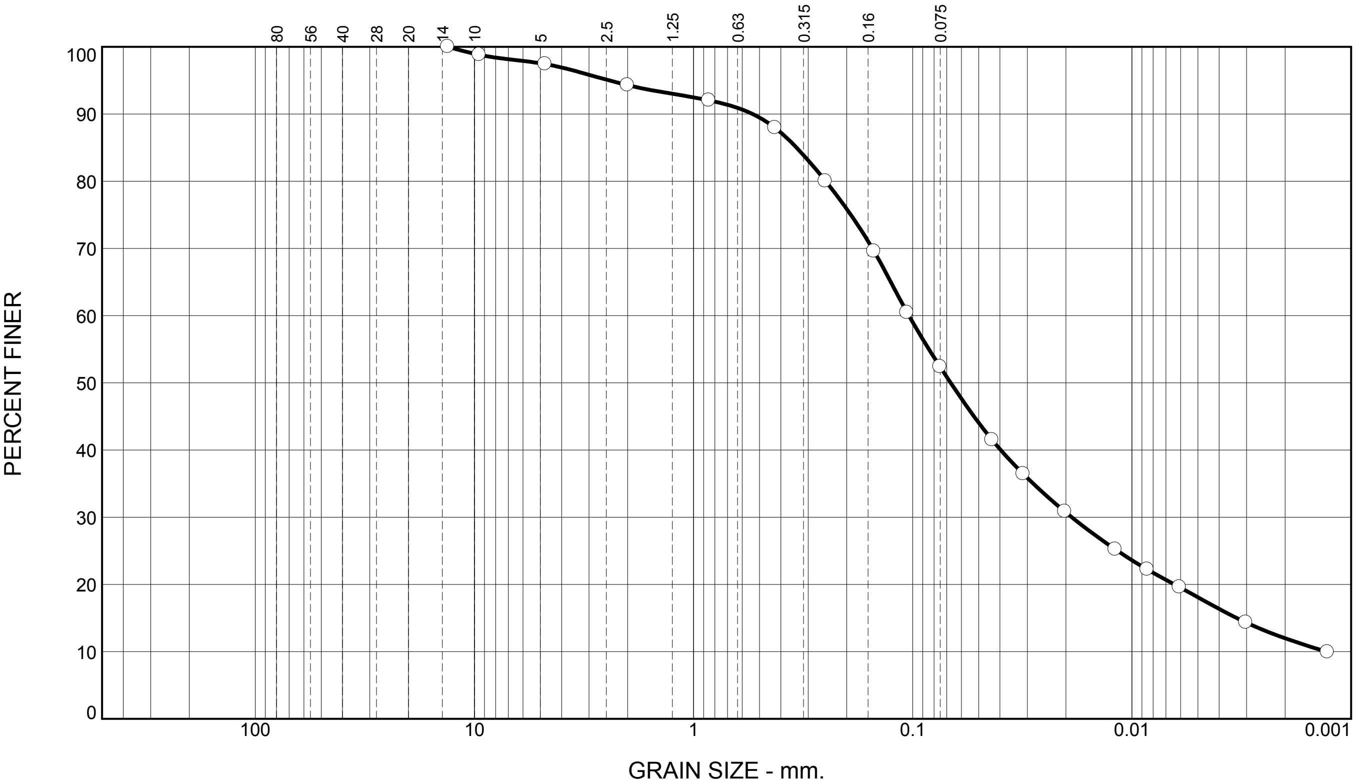
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH1_SS5

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	3	6	36	40	12

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	99		
4.75	97		
2.00	94		
0.85	92		
0.425	88		
0.250	80		
0.150	70		
0.106	60		
0.075	52		
0.0434 mm.	41		
0.0313 mm.	36		
0.0202 mm.	31		
0.0119 mm.	25		
0.0085 mm.	22		
0.0061 mm.	20		
0.0030 mm.	14		
0.0013 mm.	9.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5386 D_{85}= 0.3388 D_{60}= 0.1042
D_{50}= 0.0672 D_{30}= 0.0188 D_{15}= 0.0033
D_{10}= 0.0013 C_u= 79.95 C_c= 2.61

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH2_SS2

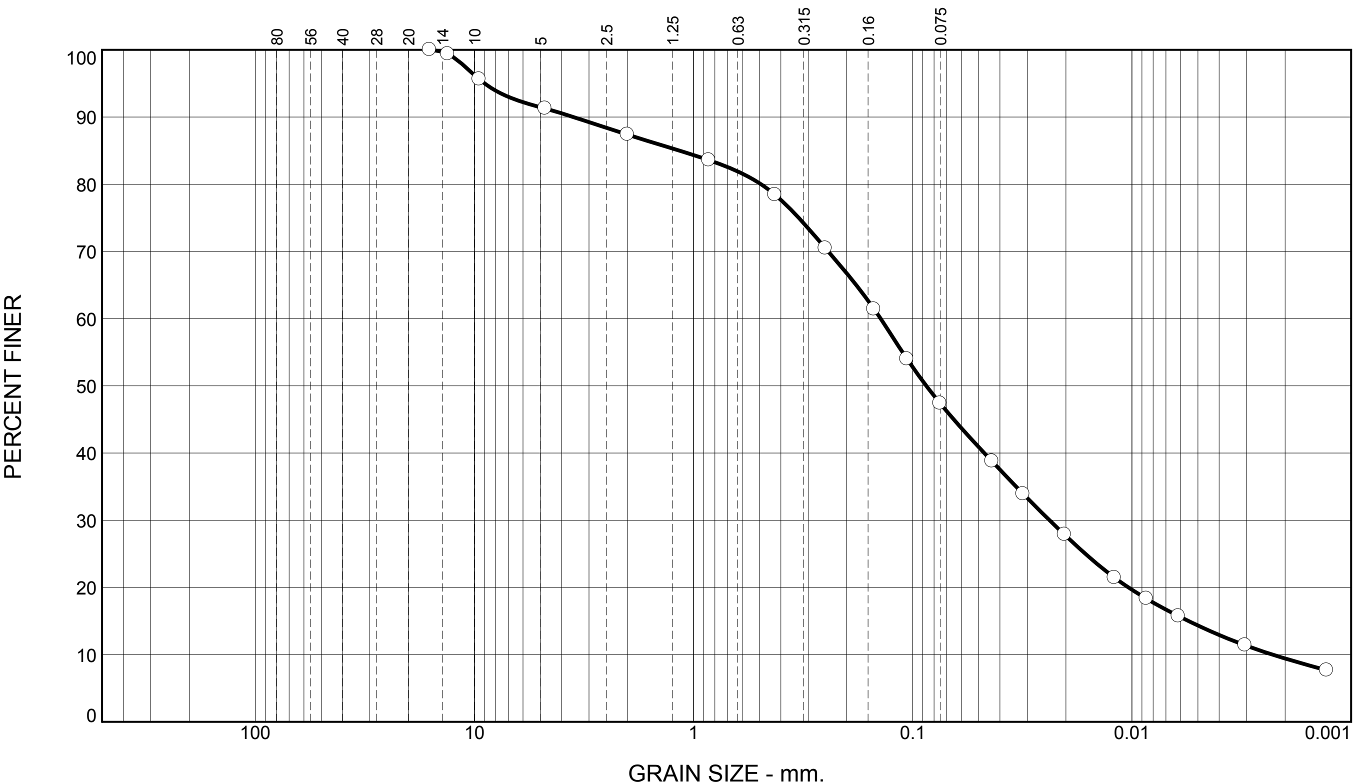
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH2_SS2

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	9	4	9	31	38	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	99		
9.50	96		
4.75	91		
2.00	87		
0.85	84		
0.425	78		
0.250	70		
0.150	61		
0.106	54		
0.075	47		
0.0434 mm.	39		
0.0313 mm.	34		
0.0203 mm.	28		
0.0120 mm.	21		
0.0086 mm.	18		
0.0061 mm.	16		
0.0030 mm.	11		
0.0013 mm.	7.7		

* (no specification provided)

Soil Description

Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 3.5427 D_{85}= 1.1634 D_{60}= 0.1402

D_{50}= 0.0867 D_{30}= 0.0238 D_{15}= 0.0055

D_{10}= 0.0023 C_u= 61.50 C_c= 1.77

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH2_SS5

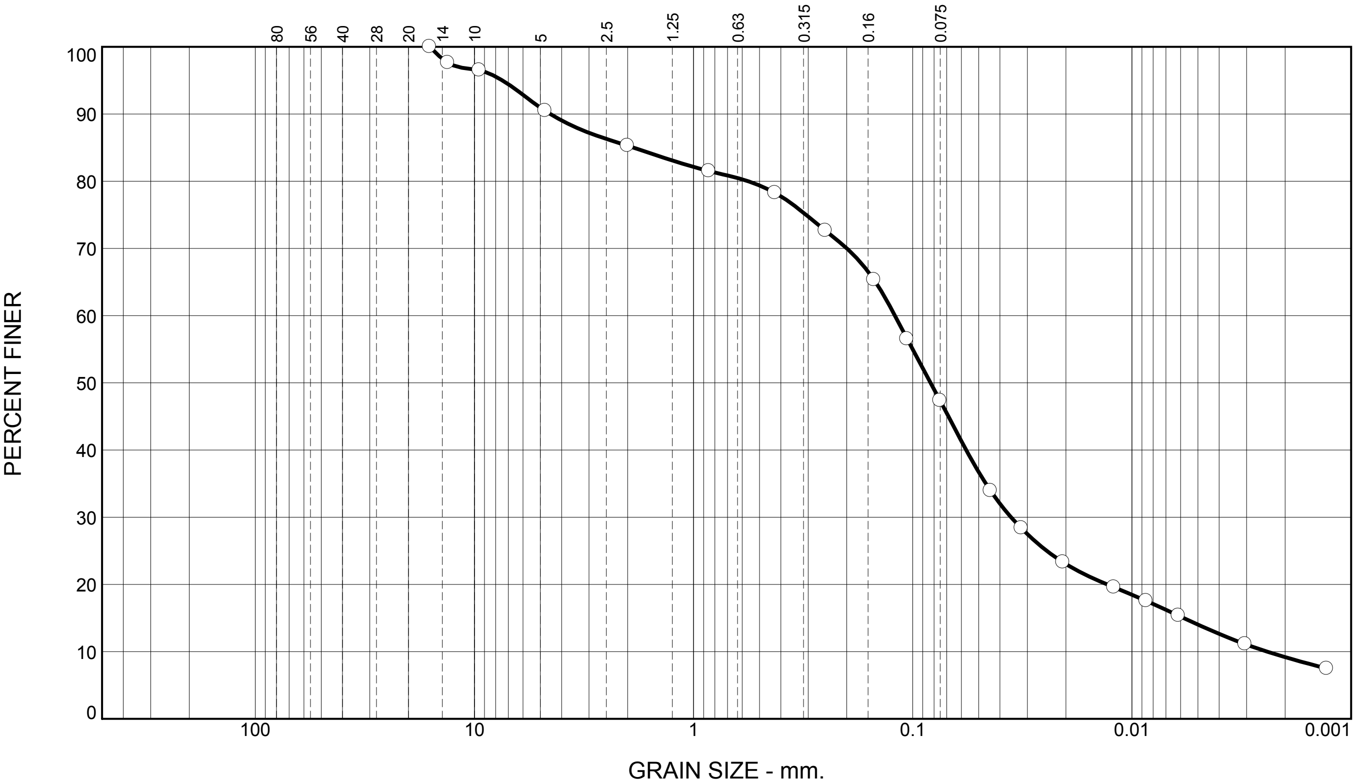
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH2_SS5

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	10	5	7	31	38	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	98		
9.50	97		
4.75	90		
2.00	85		
0.85	81		
0.425	78		
0.250	73		
0.150	65		
0.106	57		
0.075	47		
0.0441 mm.	34		
0.0319 mm.	28		
0.0206 mm.	23		
0.0121 mm.	20		
0.0086 mm.	18		
0.0061 mm.	15		
0.0030 mm.	11		
0.0013 mm.	7.5		

* (no specification provided)

Soil Description

Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 4.5090 D_{85}= 1.8867 D_{60}= 0.1206
D_{50}= 0.0829 D_{30}= 0.0356 D_{15}= 0.0058
D_{10}= 0.0024 C_u= 49.89 C_c= 4.35

Classification

USCS= SM AASHTO= A-4(0)

Remarks

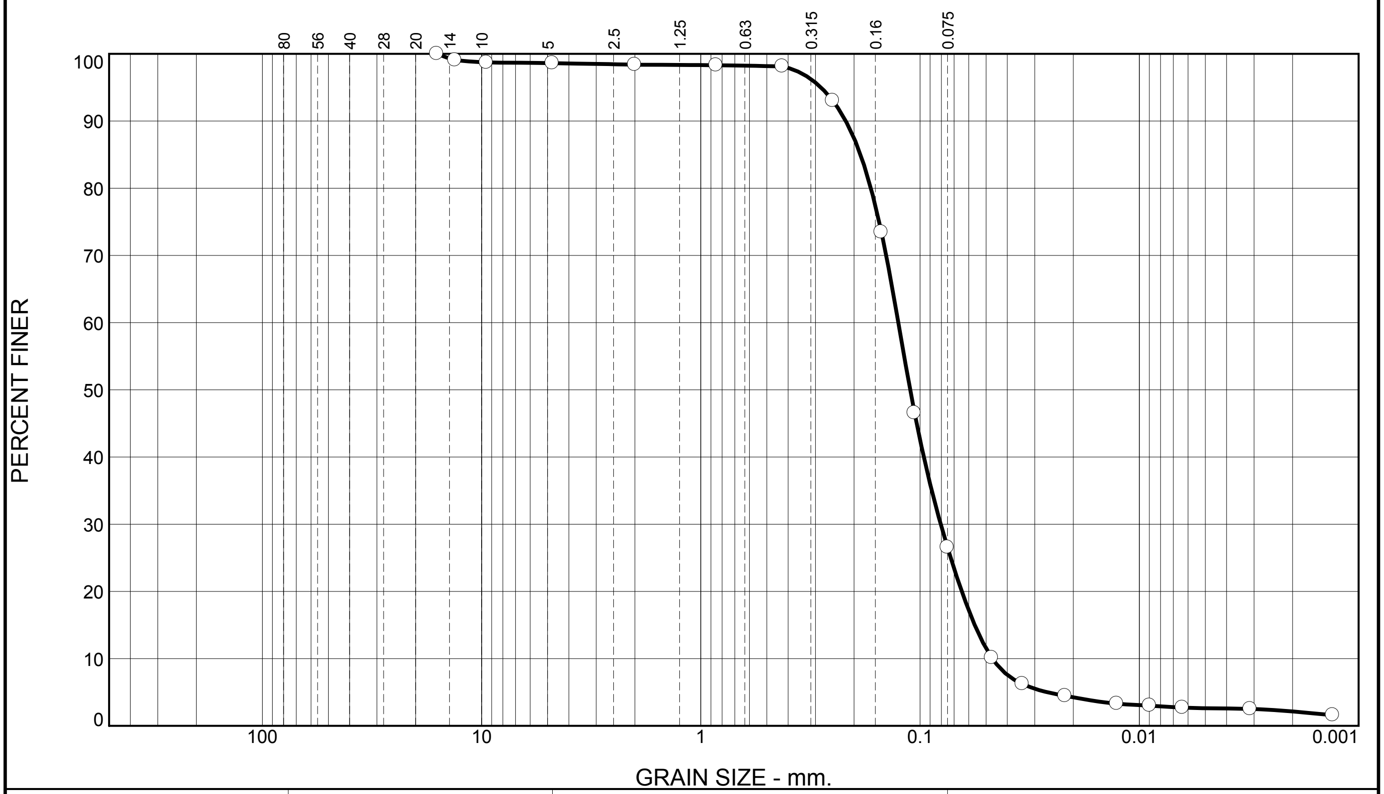
Source of Sample: Site Drilling
Sample Number: BH2_SS10

Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation
Project No: 19M-01888-00 **Figure** BH2_SS10

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	1	0	71	25	2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	99		
9.50	99		
4.75	99		
2.00	98		
0.85	98		
0.425	98		
0.250	93		
0.150	73		
0.106	47		
0.075	27		
0.0470 mm.	10		
0.0341 mm.	6.2		
0.0218 mm.	4.5		
0.0127 mm.	3.3		
0.0090 mm.	3.0		
0.0064 mm.	2.7		
0.0031 mm.	2.5		
0.0013 mm.	1.6		

* (no specification provided)

Soil Description

Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.2181 D_{85}= 0.1870 D_{60}= 0.1257
D_{50}= 0.1110 D_{30}= 0.0805 D_{15}= 0.0564
D_{10}= 0.0468 C_u= 2.69 C_c= 1.10

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH2_SS15

Date: July 16, 2020

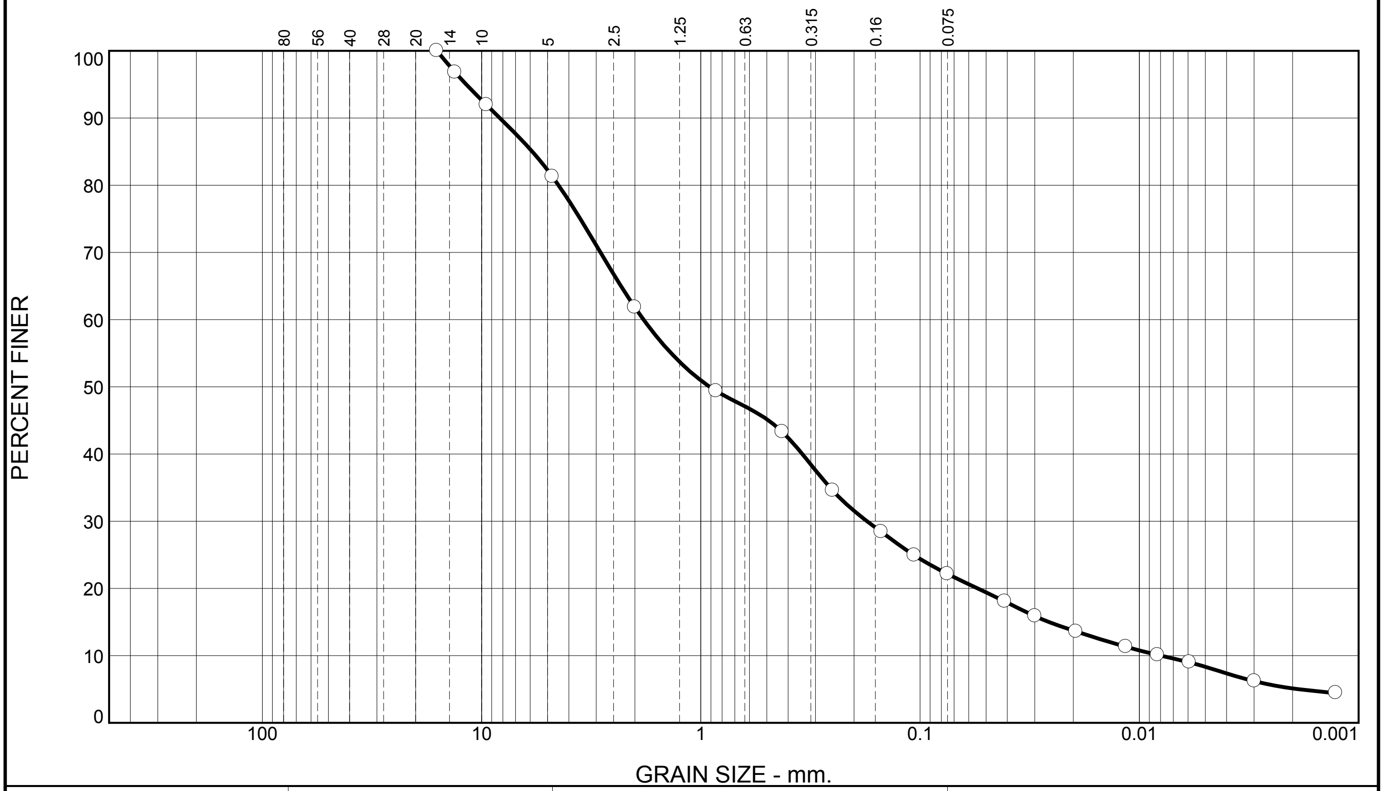
WSP CCIL

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH2_SS15

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	19	19	19	21	17	5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	97		
9.50	92		
4.75	81		
2.00	62		
0.85	49		
0.425	43		
0.250	35		
0.150	28		
0.106	25		
0.075	22		
0.0411 mm.	18		
0.0299 mm.	16		
0.0194 mm.	14		
0.0115 mm.	11		
0.0082 mm.	10		
0.0059 mm.	9.0		
0.0030 mm.	6.2		
0.0013 mm.	4.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.2593	D_{85}= 5.8736	D_{60}= 1.8257
D_{50}= 0.9106	D_{30}= 0.1746	D_{15}= 0.0258
D_{10}= 0.0080	C_u= 227.68	C_c= 2.08

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH2_SS16

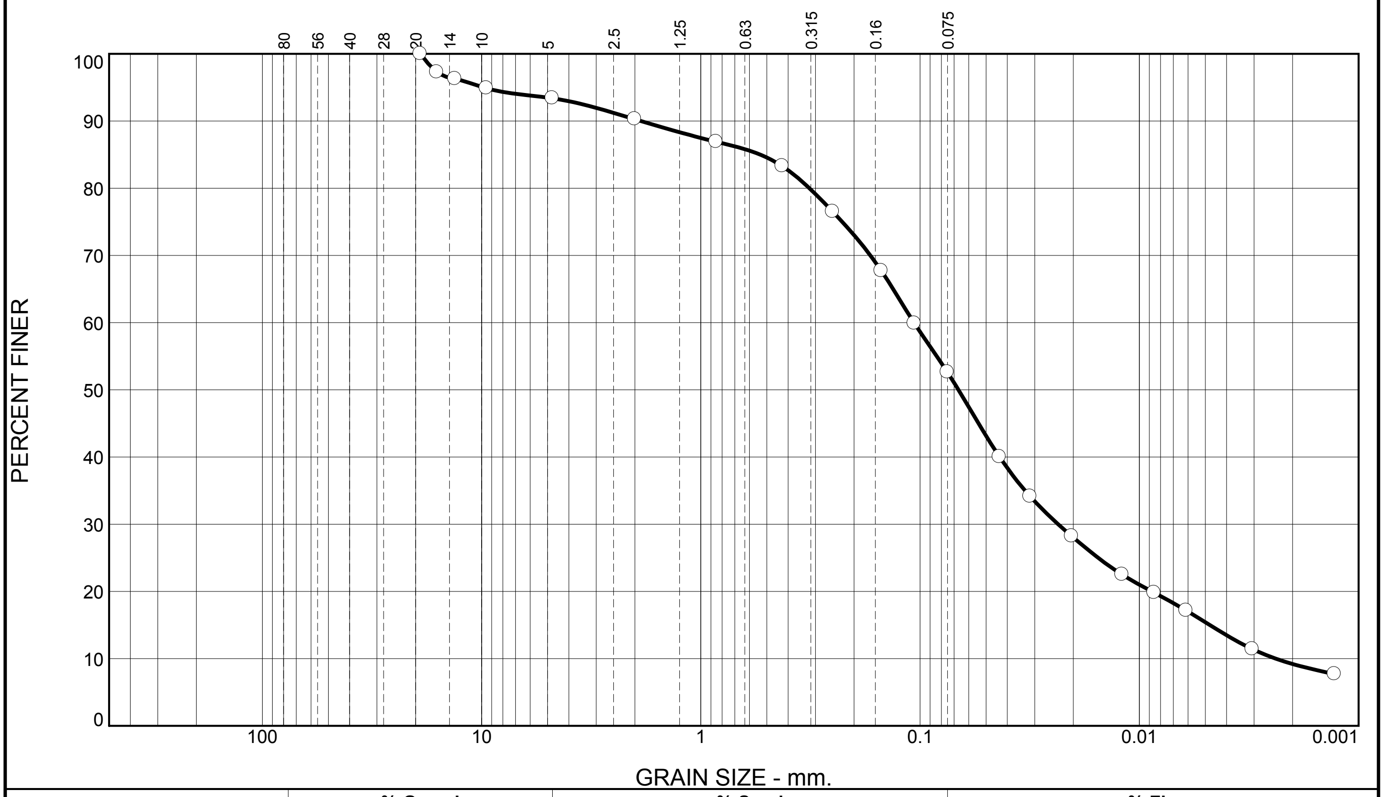
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH2_SS16

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	7	3	7	30	44	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19.00	100		
16.00	97		
13.20	96		
9.50	95		
4.75	93		
2.00	90		
0.85	87		
0.425	83		
0.250	76		
0.150	68		
0.106	60		
0.075	53		
0.0434 mm.	40		
0.0314 mm.	34		
0.0203 mm.	28		
0.0120 mm.	22		
0.0086 mm.	20		
0.0061 mm.	17		
0.0030 mm.	11		
0.0013 mm.	7.7		

* (no specification provided)

Soil Description

Sandy Silt

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 1.8813 D_{85}= 0.5363 D_{60}= 0.1067

D_{50}= 0.0669 D_{30}= 0.0235 D_{15}= 0.0048

D_{10}= 0.0024 C_u= 44.63 C_c= 2.16

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH3_SS7

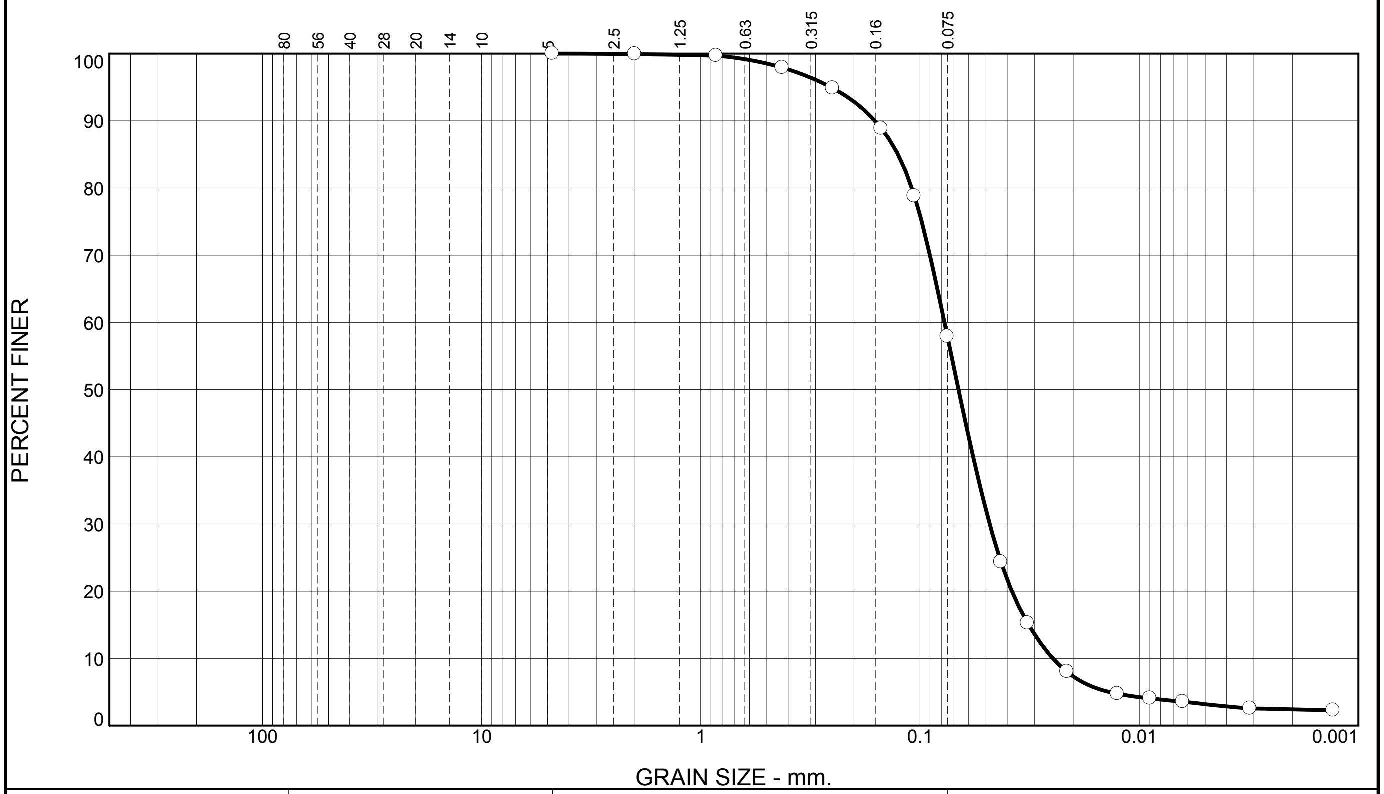
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH3_SS7

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	2	40	56	2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.75	100		
2.00	100		
0.85	100		
0.425	98		
0.250	95		
0.150	89		
0.106	79		
0.075	58		
0.0427 mm.	24		
0.0322 mm.	15		
0.0213 mm.	8.0		
0.0126 mm.	4.7		
0.0089 mm.	4.0		
0.0063 mm.	3.5		
0.0031 mm.	2.6		
0.0013 mm.	2.3		

* (no specification provided)

Soil Description

Sandy Silt

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1609 D_{85}= 0.1261 D_{60}= 0.0774
D_{50}= 0.0667 D_{30}= 0.0481 D_{15}= 0.0319
D_{10}= 0.0248 C_u= 3.12 C_c= 1.21

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH3_SS14

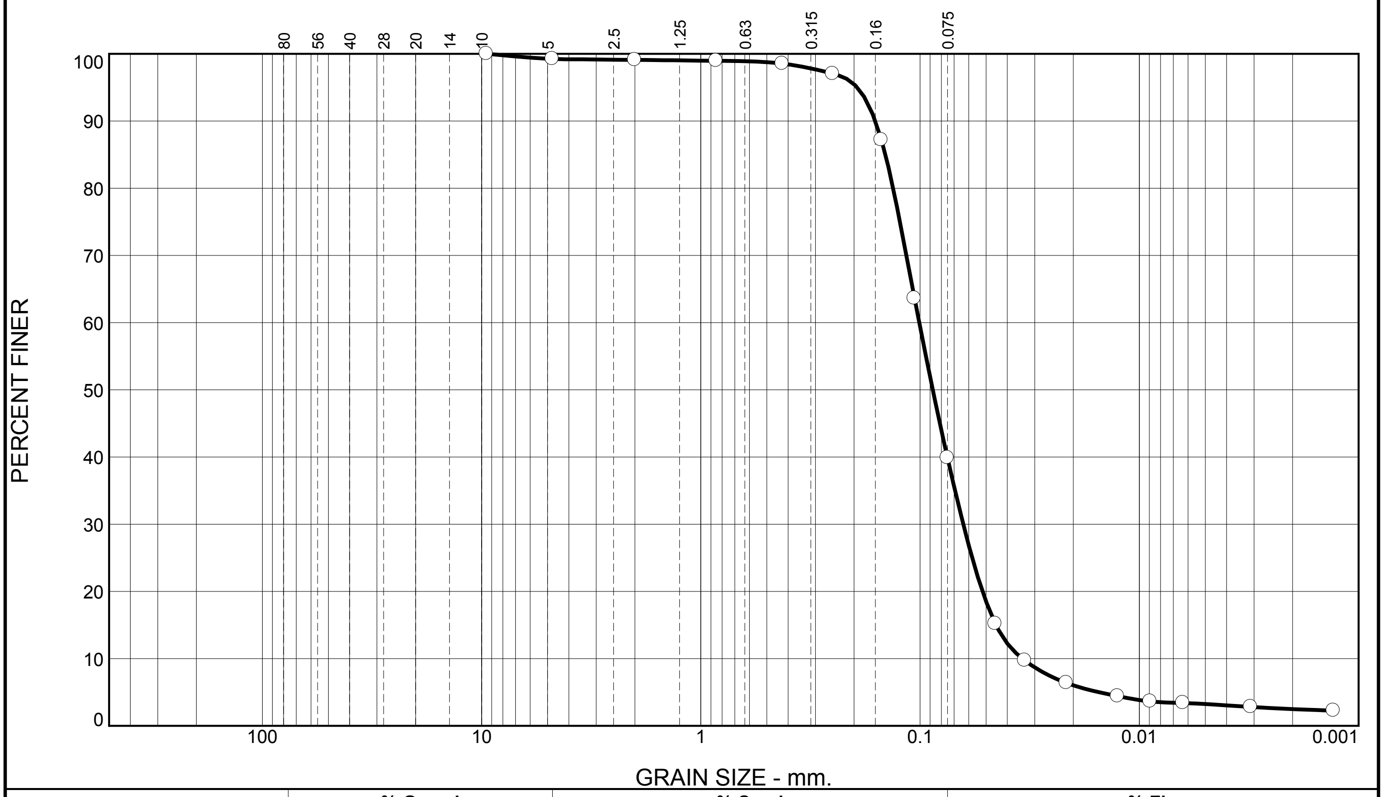
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH3_SS14

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	0	0	59	38	2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	99		
2.00	99		
0.85	99		
0.425	99		
0.250	97		
0.150	87		
0.106	64		
0.075	40		
0.0454 mm.	15		
0.0333 mm.	9.7		
0.0215 mm.	6.4		
0.0125 mm.	4.4		
0.0089 mm.	3.6		
0.0063 mm.	3.4		
0.0031 mm.	2.8		
0.0013 mm.	2.3		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1600 D_{85}= 0.1440 D_{60}= 0.1009
D_{50}= 0.0875 D_{30}= 0.0636 D_{15}= 0.0451
D_{10}= 0.0342 C_u= 2.95 C_c= 1.17

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH3_SS16

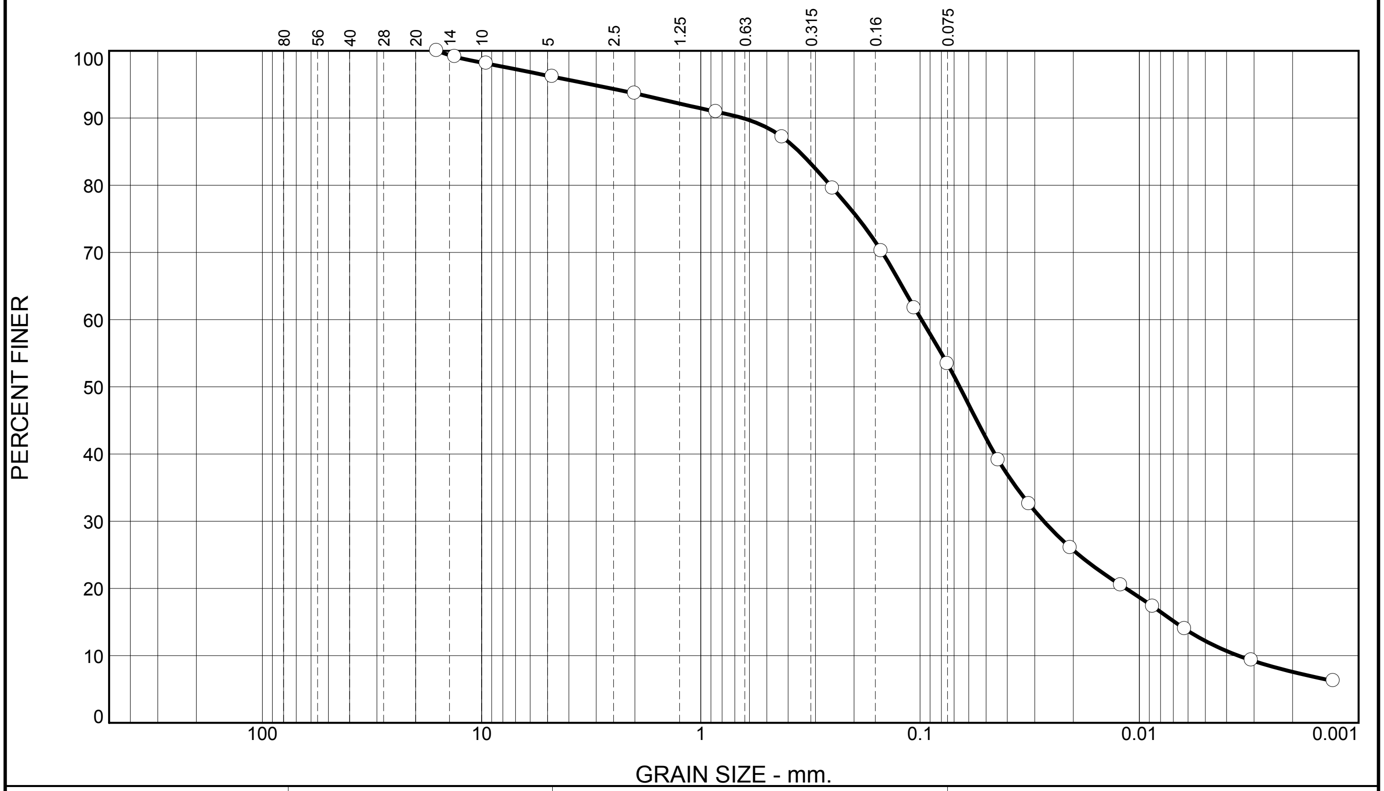
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH3_SS16

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	2	7	34	45	8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	99		
9.50	98		
4.75	96		
2.00	94		
0.85	91		
0.425	87		
0.250	80		
0.150	70		
0.106	62		
0.075	53		
0.0439 mm.	39		
0.0318 mm.	33		
0.0206 mm.	26		
0.0121 mm.	20		
0.0087 mm.	17		
0.0062 mm.	14		
0.0031 mm.	9.3		
0.0013 mm.	6.2		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6469 D_{85}= 0.3562 D_{60}= 0.0987
D_{50}= 0.0660 D_{30}= 0.0273 D_{15}= 0.0069
D_{10}= 0.0035 C_u= 27.86 C_c= 2.13

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH4_SS3

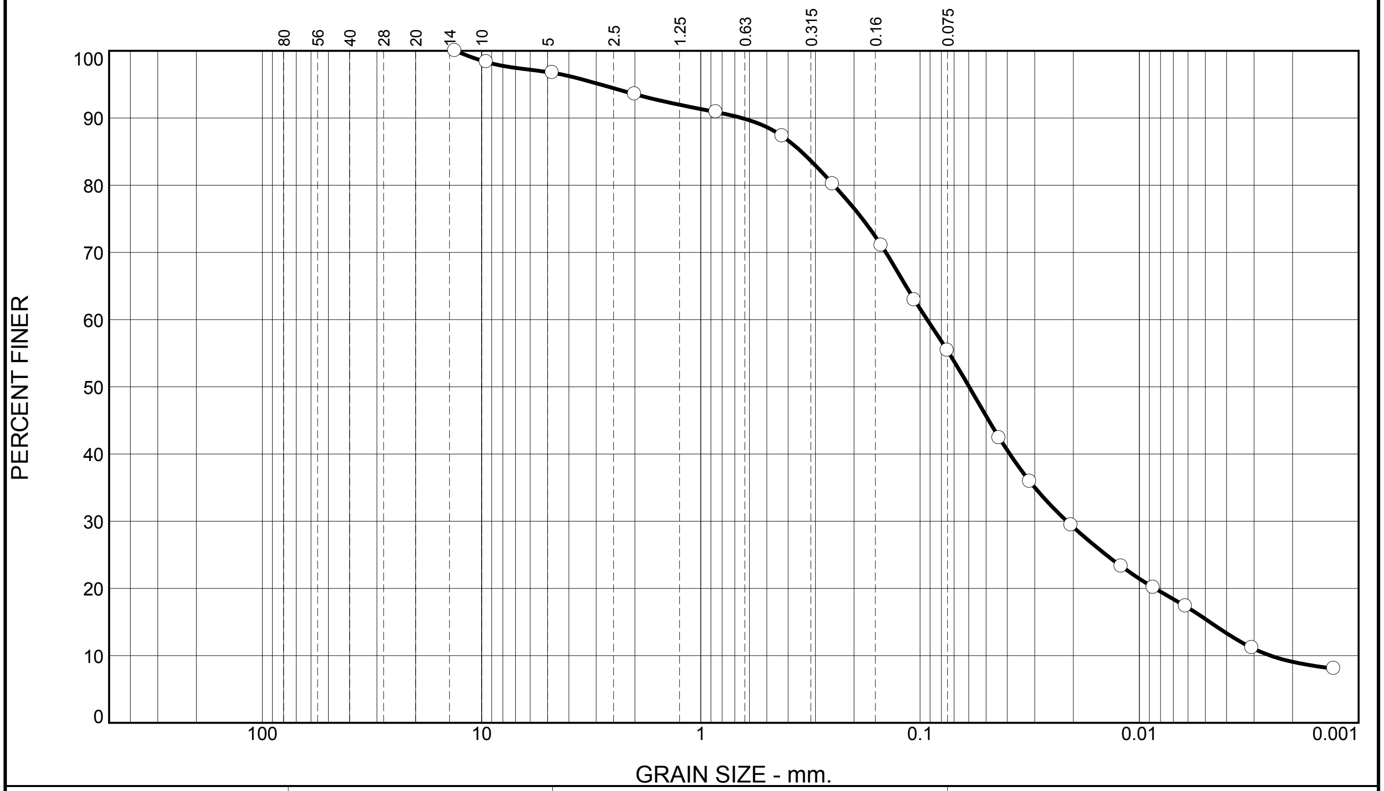
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH4_SS3

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	3	7	32	46	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	98		
4.75	97		
2.00	94		
0.85	91		
0.425	87		
0.250	80		
0.150	71		
0.106	63		
0.075	55		
0.0435 mm.	42		
0.0315 mm.	36		
0.0204 mm.	29		
0.0121 mm.	23		
0.0086 mm.	20		
0.0061 mm.	17		
0.0031 mm.	11		
0.0013 mm.	8.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6499 D_{85}= 0.3482 D_{60}= 0.0929
D_{50}= 0.0598 D_{30}= 0.0214 D_{15}= 0.0048
D_{10}= 0.0025 C_u= 36.79 C_c= 1.95

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH4_SS7

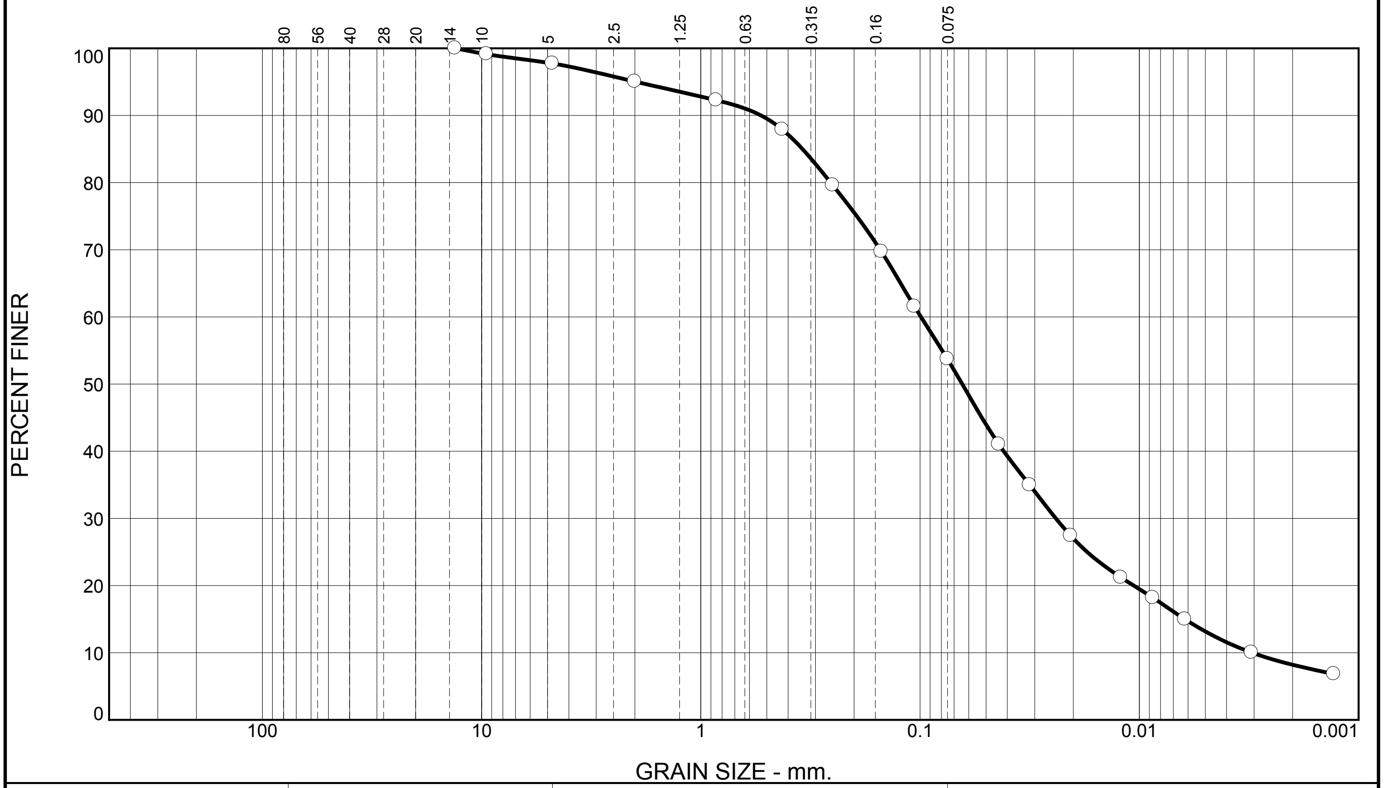
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH4_SS7

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	3	7	34	46	8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	99		
4.75	98		
2.00	95		
0.85	92		
0.425	88		
0.250	80		
0.150	70		
0.106	62		
0.075	54		
0.0437 mm.	41		
0.0316 mm.	35		
0.0205 mm.	27		
0.0121 mm.	21		
0.0087 mm.	18		
0.0062 mm.	15		
0.0031 mm.	10		
0.0013 mm.	6.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5325 D_{85}= 0.3440 D_{60}= 0.0991
D_{50}= 0.0642 D_{30}= 0.0240 D_{15}= 0.0062
D_{10}= 0.0031 C_u= 32.36 C_c= 1.90

Classification

USCS= AASHTO=

Remarks

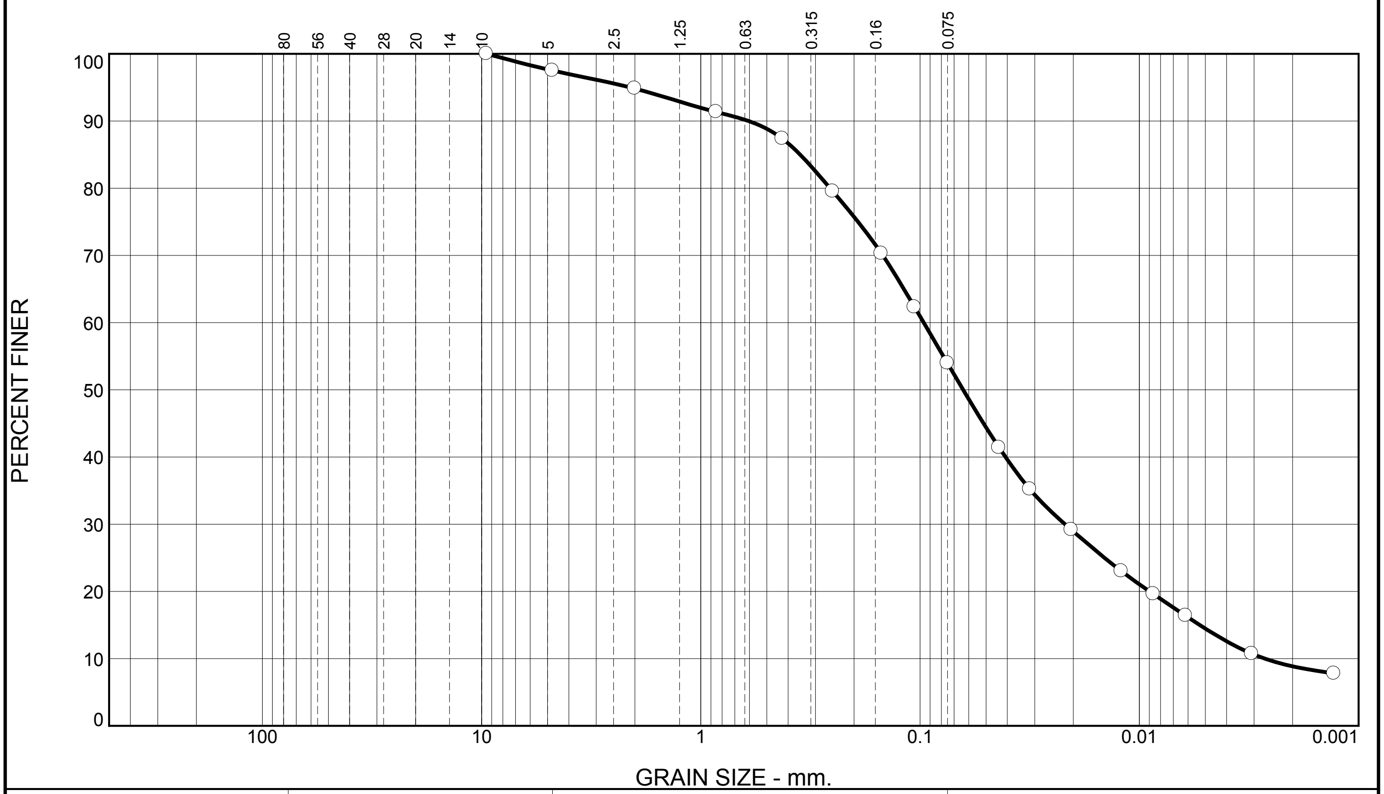
Source of Sample: Site Drilling
Sample Number: BH5_SS2

Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation
Project No: 19M-01888-00 **Figure** BH5_SS2

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	3	8	33	45	9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	98		
2.00	95		
0.85	91		
0.425	87		
0.250	80		
0.150	70		
0.106	62		
0.075	54		
0.0436 mm.	41		
0.0316 mm.	35		
0.0204 mm.	29		
0.0121 mm.	23		
0.0086 mm.	20		
0.0061 mm.	16		
0.0031 mm.	11		
0.0013 mm.	7.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6061	D_{85}= 0.3525	D_{60}= 0.0963
D_{50}= 0.0636	D_{30}= 0.0218	D_{15}= 0.0053
D_{10}= 0.0027	C_u= 35.96	C_c= 1.85

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH5_SS6

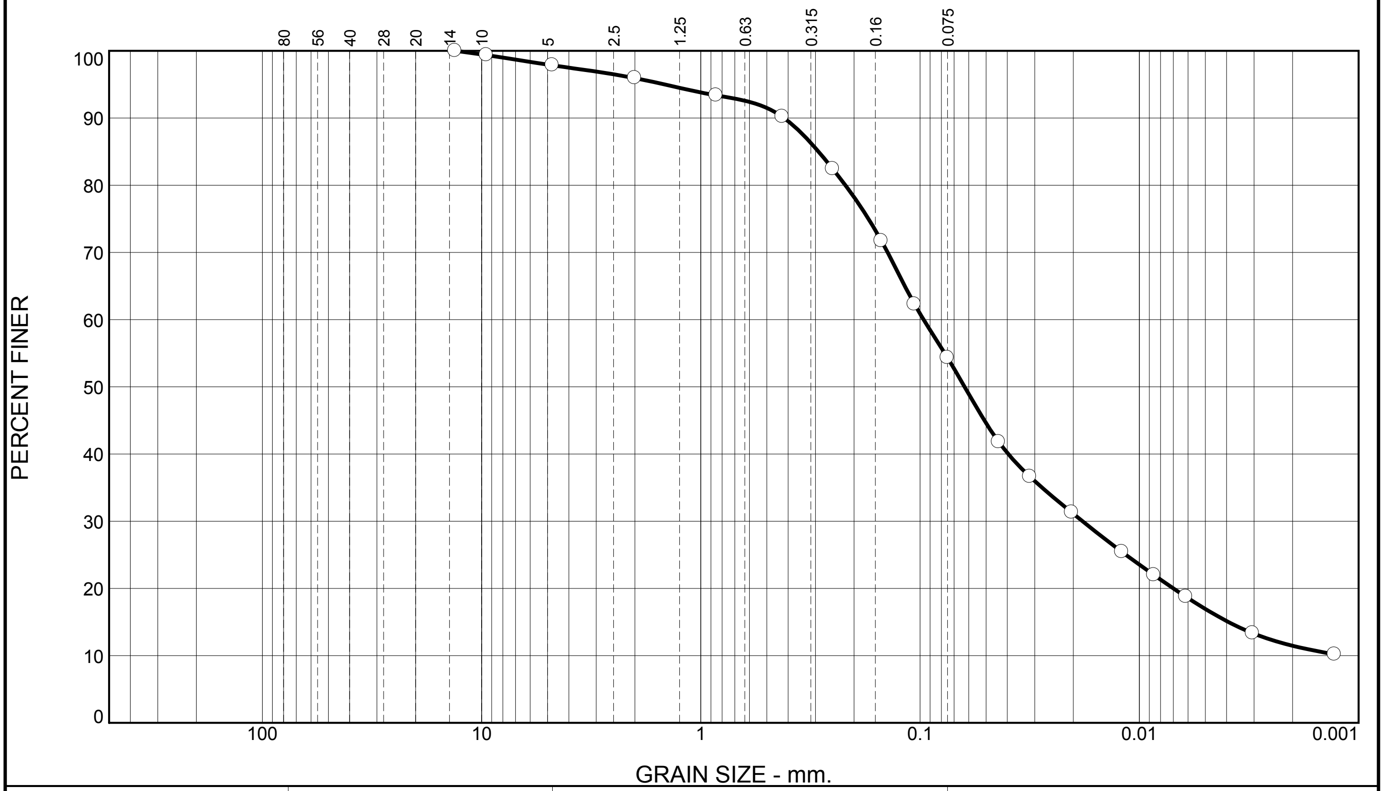
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH5_SS6

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	2	6	36	43	11

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	99		
4.75	98		
2.00	96		
0.85	93		
0.425	90		
0.250	82		
0.150	72		
0.106	62		
0.075	54		
0.0437 mm.	42		
0.0315 mm.	37		
0.0203 mm.	31		
0.0120 mm.	25		
0.0086 mm.	22		
0.0061 mm.	19		
0.0030 mm.	13		
0.0013 mm.	10		

* (no specification provided)

Soil Description

Sandy Silt

Atterberg Limits

PL= 11 LL= 14 PI= 3

Coefficients

D_{90}= 0.4177 D_{85}= 0.2906 D_{60}= 0.0965
D_{50}= 0.0627 D_{30}= 0.0182 D_{15}= 0.0039
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH6_SS3

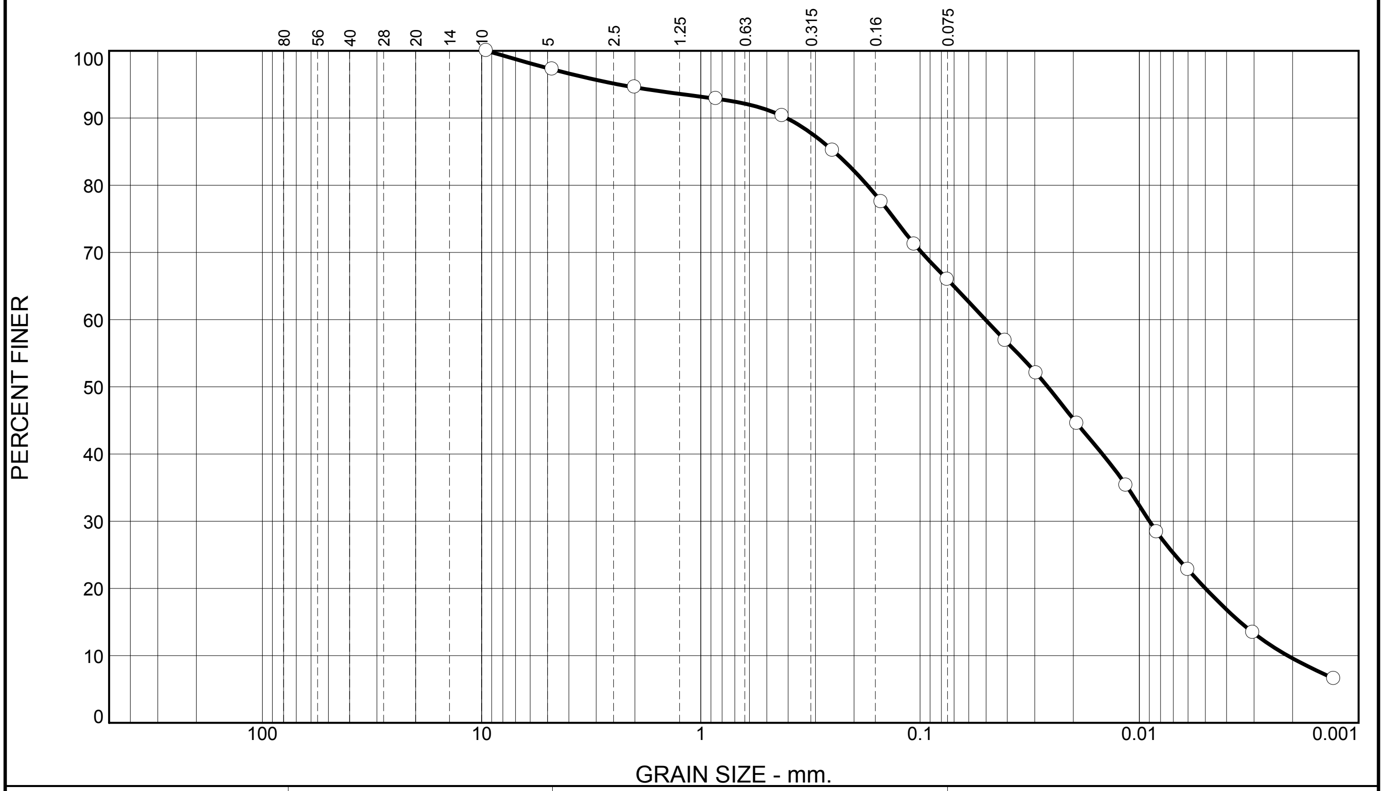
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH6_SS3

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	2	5	24	56	10

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	97		
2.00	95		
0.85	93		
0.425	90		
0.250	85		
0.150	77		
0.106	71		
0.075	66		
0.0408 mm.	57		
0.0295 mm.	52		
0.0192 mm.	45		
0.0115 mm.	35		
0.0083 mm.	28		
0.0060 mm.	23		
0.0030 mm.	13		
0.0013 mm.	6.6		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4071 D_{85}= 0.2469 D_{60}= 0.0504
D_{50}= 0.0262 D_{30}= 0.0090 D_{15}= 0.0035
D_{10}= 0.0021 C_u= 23.91 C_c= 0.76

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH6_SS7

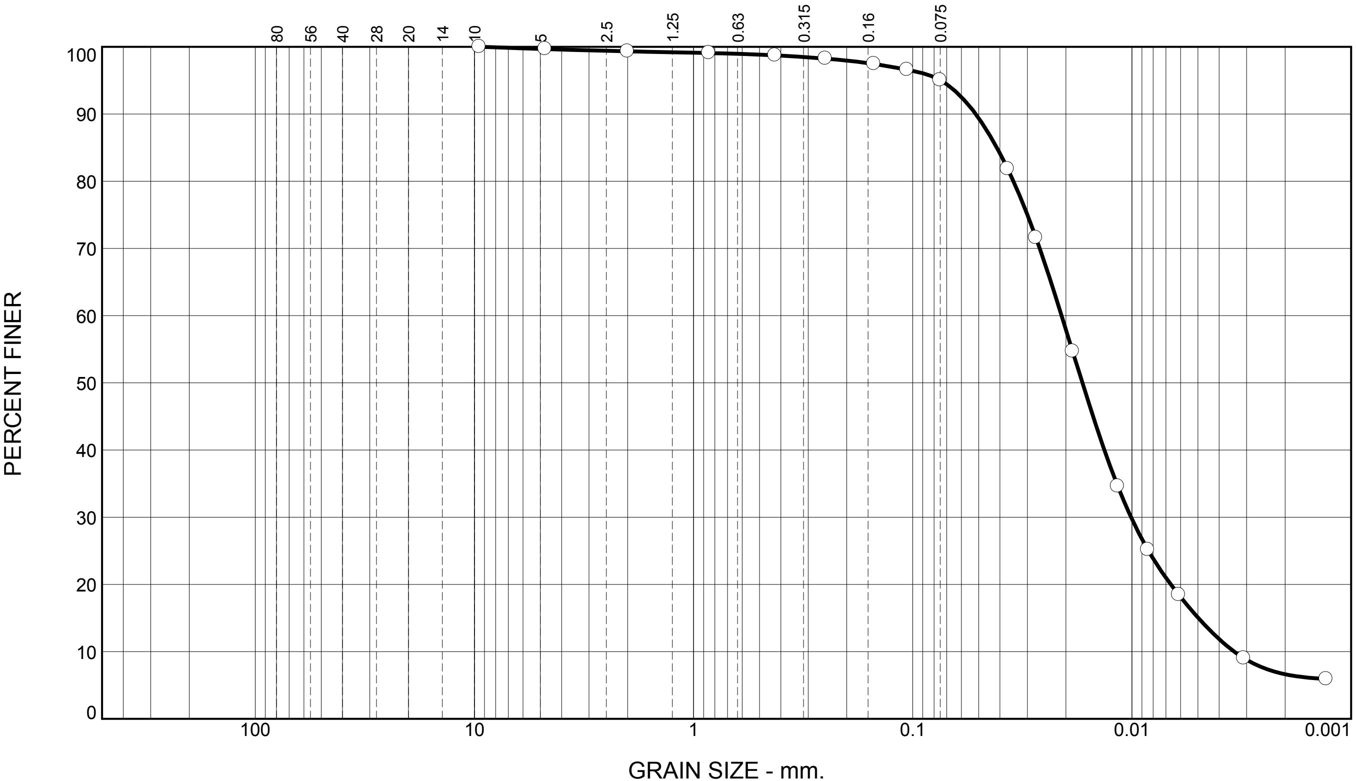
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH6_SS7

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	0	4	88	7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	100		
2.00	99		
0.85	99		
0.425	99		
0.250	98		
0.150	97		
0.106	97		
0.075	95		
0.0369 mm.	82		
0.0274 mm.	72		
0.0186 mm.	55		
0.0116 mm.	35		
0.0085 mm.	25		
0.0061 mm.	18		
0.0031 mm.	9.0		
0.0013 mm.	5.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0516 D_{85}= 0.0414 D_{60}= 0.0209
D_{50}= 0.0168 D_{30}= 0.0101 D_{15}= 0.0050
D_{10}= 0.0034 C_u= 6.14 C_c= 1.42

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH7_SS6

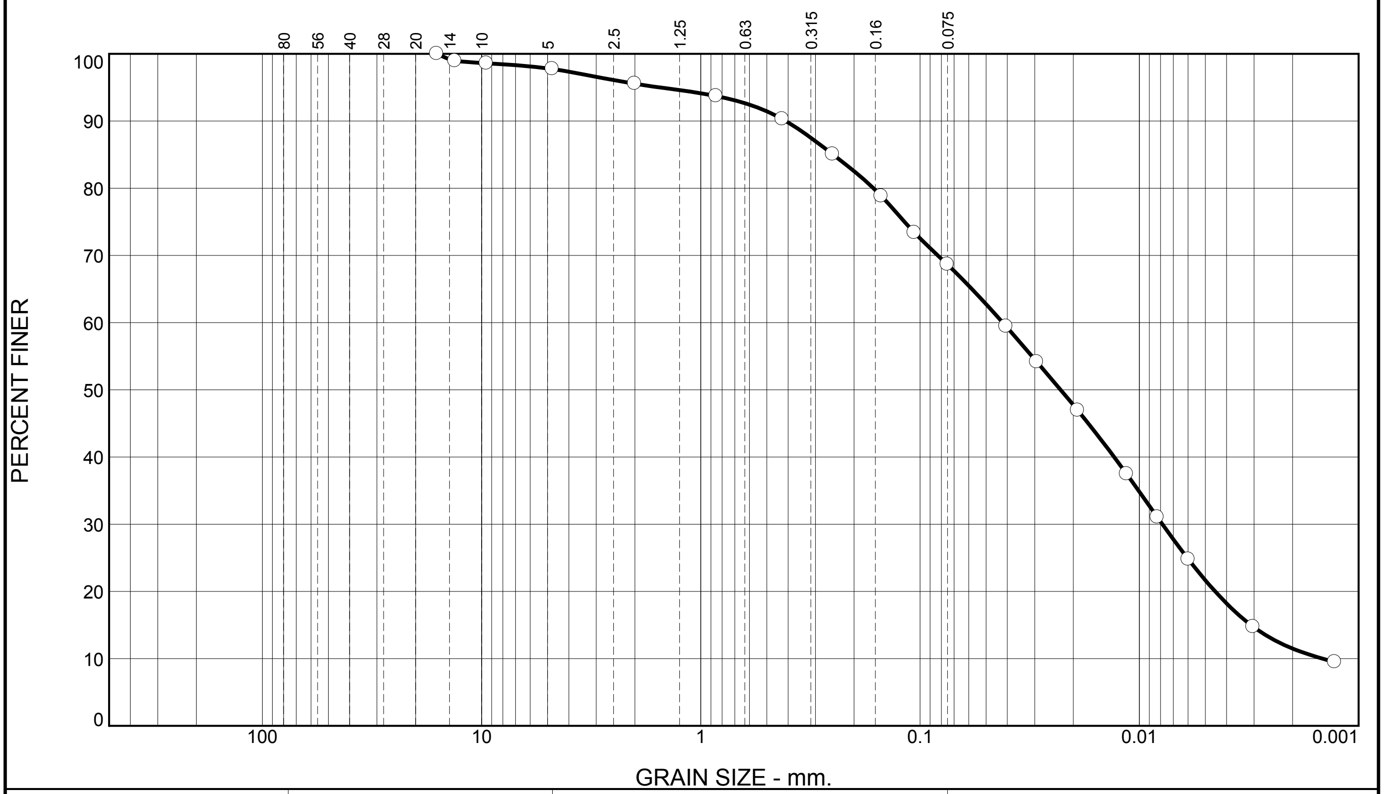
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH7_SS6

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	2	6	21	58	11

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	99		
9.50	99		
4.75	98		
2.00	96		
0.85	94		
0.425	90		
0.250	85		
0.150	79		
0.106	73		
0.075	69		
0.0405 mm.	59		
0.0293 mm.	54		
0.0191 mm.	47		
0.0114 mm.	37		
0.0083 mm.	31		
0.0060 mm.	25		
0.0030 mm.	15		
0.0013 mm.	9.5		

* (no specification provided)

Soil Description

Sandy Silt

Atterberg Limits

PL= 13
LL= 16
PI= 3

Coefficients

D_{90}= 0.4105
D_{85}= 0.2494
D_{60}= 0.0420
D_{50}= 0.0229
D_{30}= 0.0079
D_{15}= 0.0031
D_{10}= 0.0015
C_u= 28.70
C_c= 1.00

Classification

USCS= ML
AASHTO= A-4(0)

Remarks

Source of Sample: Site Drilling
Sample Number: BH7_SS10

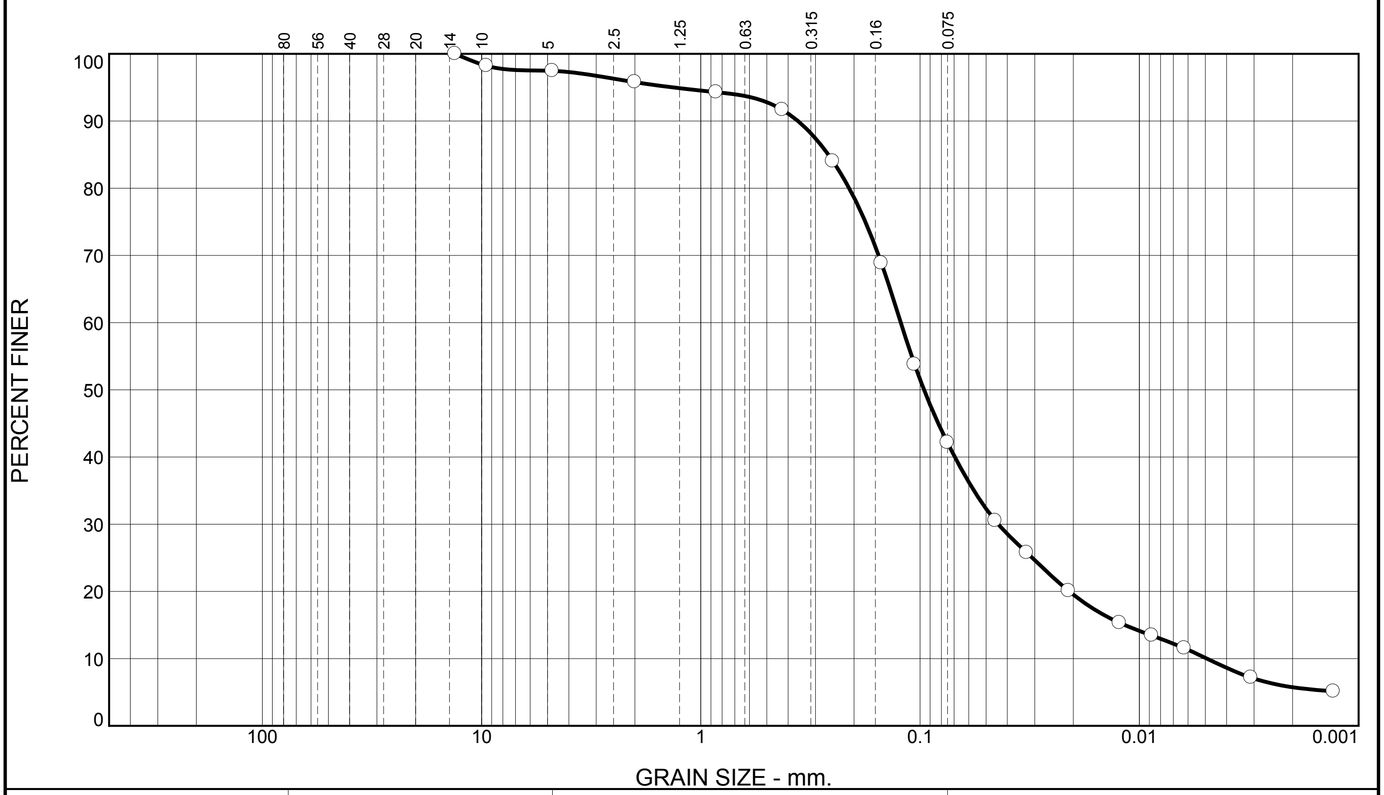
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00
Figure BH7_SS10

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	1	4	50	36	6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	98		
4.75	97		
2.00	96		
0.85	94		
0.425	92		
0.250	84		
0.150	69		
0.106	54		
0.075	42		
0.0454 mm.	31		
0.0326 mm.	26		
0.0210 mm.	20		
0.0123 mm.	15		
0.0088 mm.	13		
0.0062 mm.	12		
0.0031 mm.	7.2		
0.0013 mm.	5.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3609 D_{85}= 0.2624 D_{60}= 0.1225
D_{50}= 0.0960 D_{30}= 0.0440 D_{15}= 0.0117
D_{10}= 0.0049 C_u= 24.88 C_c= 3.21

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH7_SS15

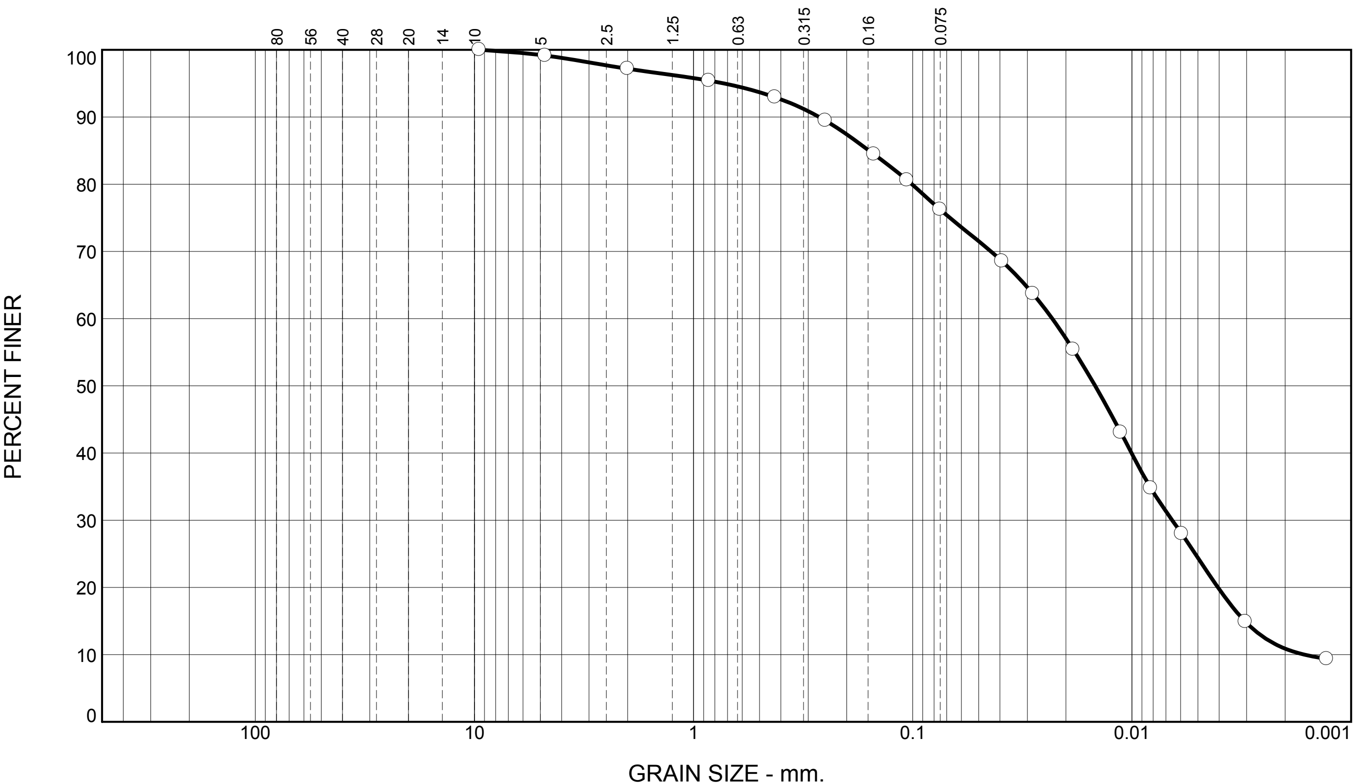
Date: July 16, 2020

Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH7_SS15

Tested By: Bruce Shan & LXQ & S.L

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	2	4	17	65	11

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	99		
2.00	97		
0.85	95		
0.425	93		
0.250	89		
0.150	84		
0.106	81		
0.075	76		
0.0391 mm.	69		
0.0283 mm.	64		
0.0185 mm.	55		
0.0112 mm.	43		
0.0082 mm.	35		
0.0059 mm.	28		
0.0030 mm.	15		
0.0013 mm.	9.3		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2671 D_{85}= 0.1584 D_{60}= 0.0231
D_{50}= 0.0147 D_{30}= 0.0066 D_{15}= 0.0031
D_{10}= 0.0016 C_u= 14.15 C_c= 1.14

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH8_SS6

Date: July 16, 2020

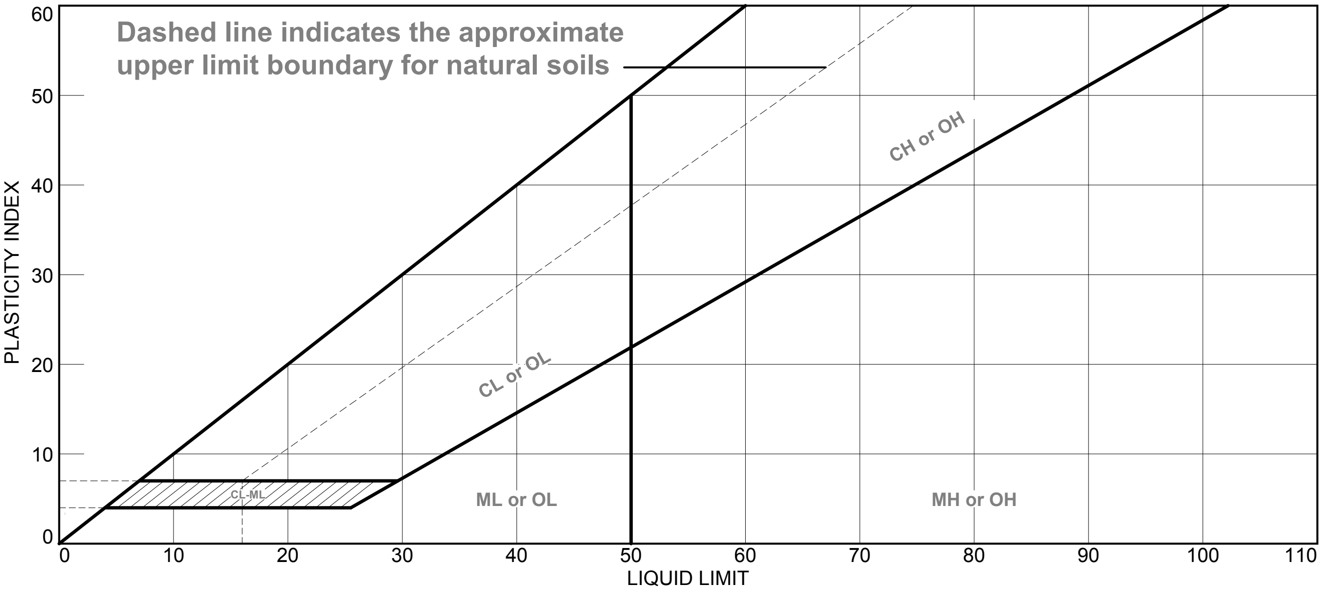
WSP CCIL

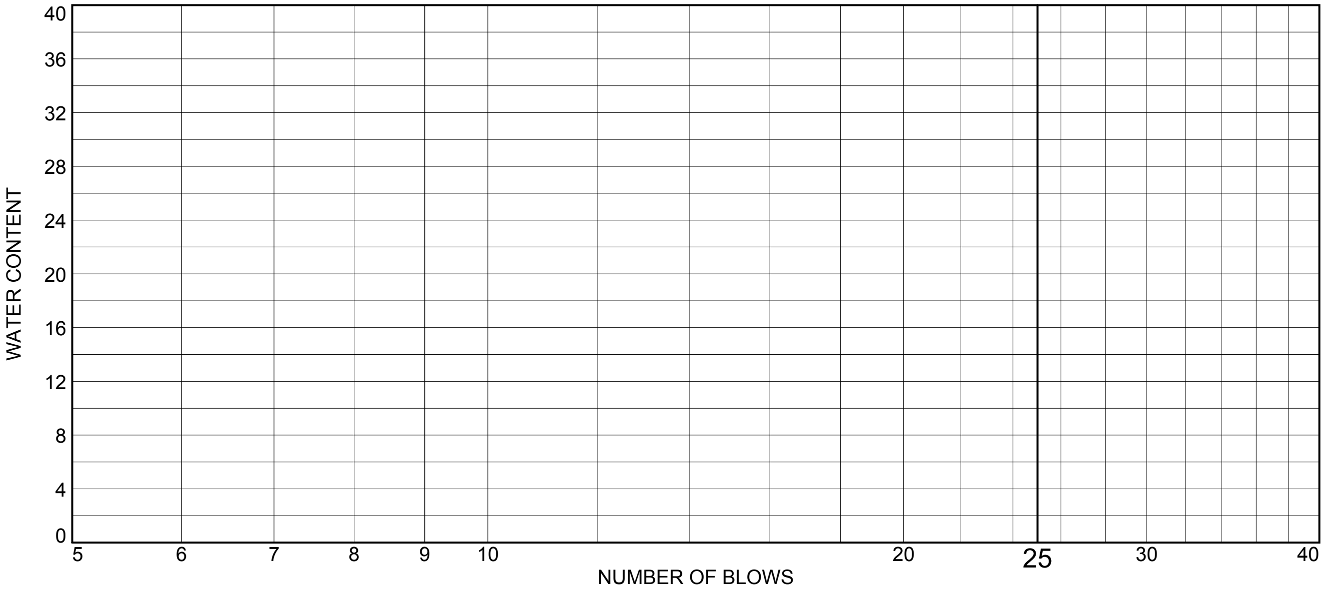
Client: City of Toronto
Project: Agincourt Grade Separation

Project No: 19M-01888-00 **Figure** BH8_SS6

Tested By: Bruce Shan & LXQ & S.L

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty Sand	NV	NP	NP	78	47	SM

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

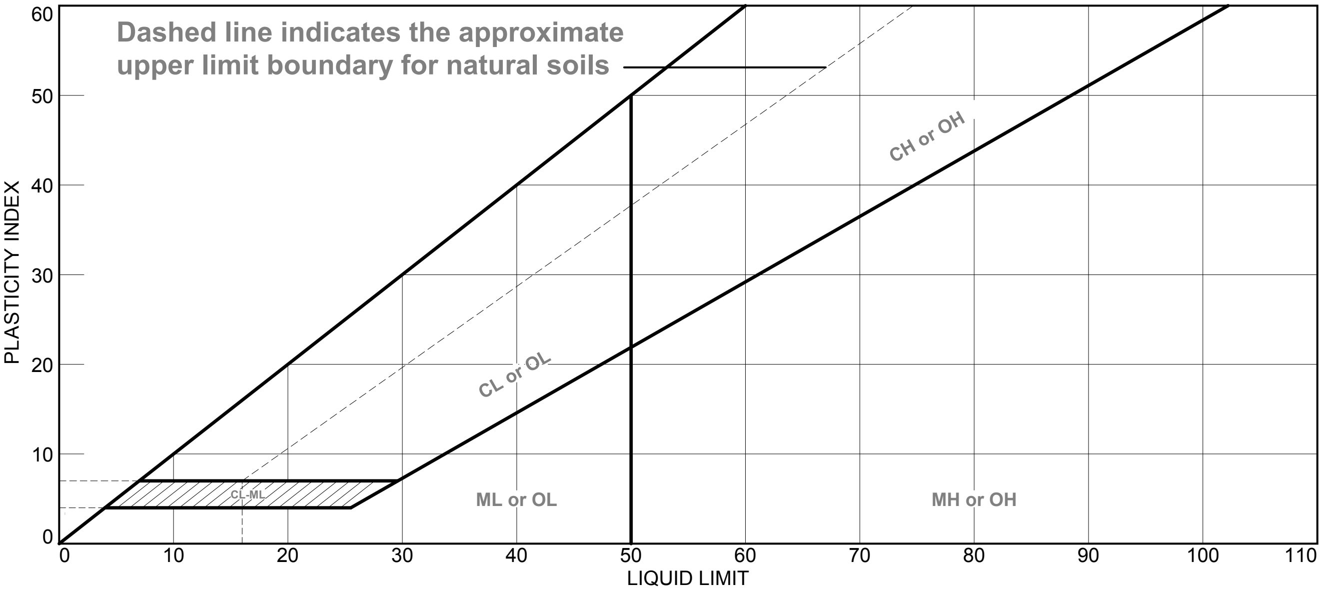
Source of Sample: Site Drilling
Sample Number: BH2_SS5

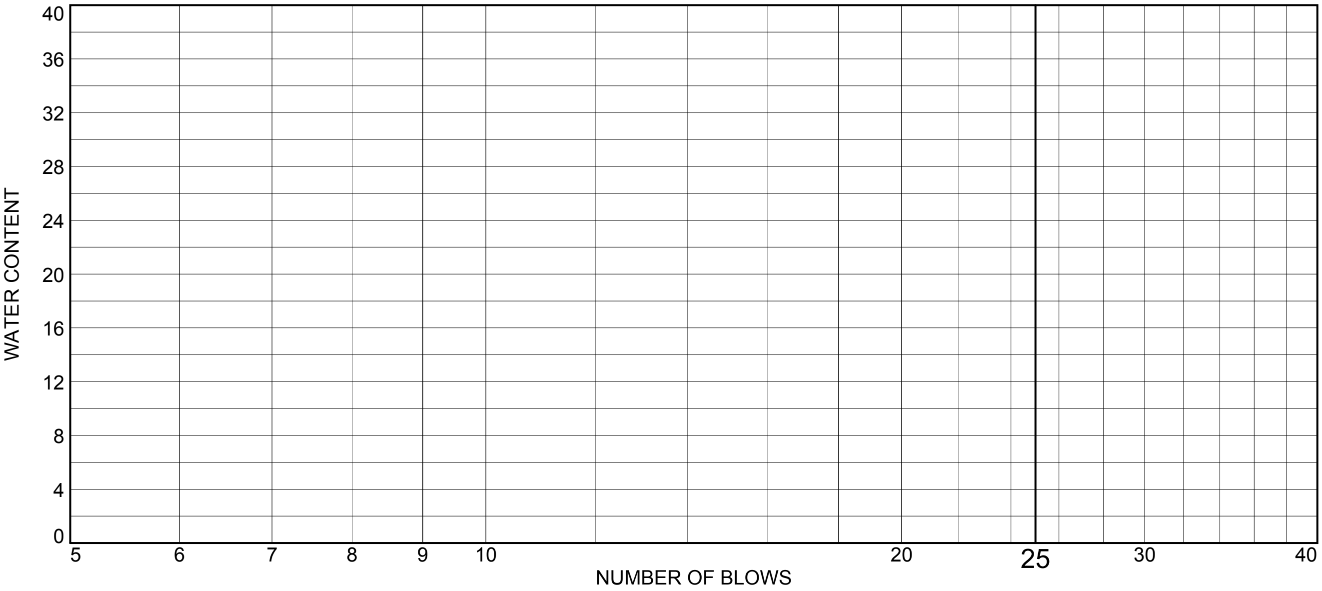
Remarks:

Figure BH2 SS5

Tested By: LXQ

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty Sand	NV	NP	NP	78	47	SM

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

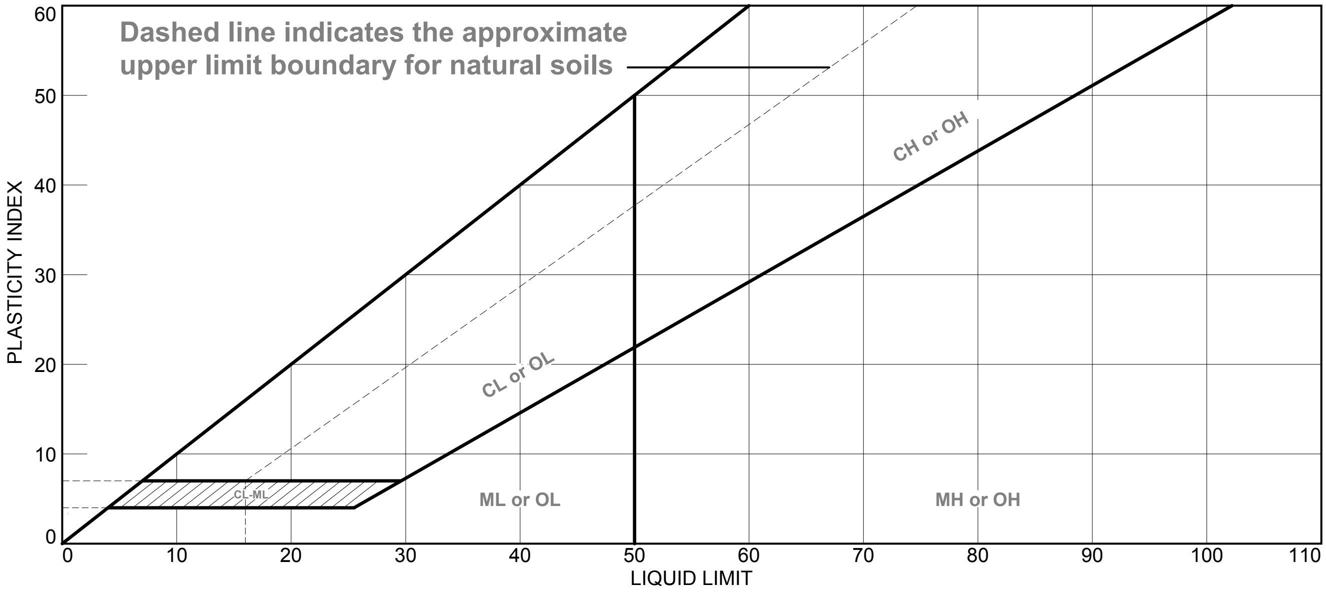
Source of Sample: Site Drilling
Sample Number: BH2_SS10

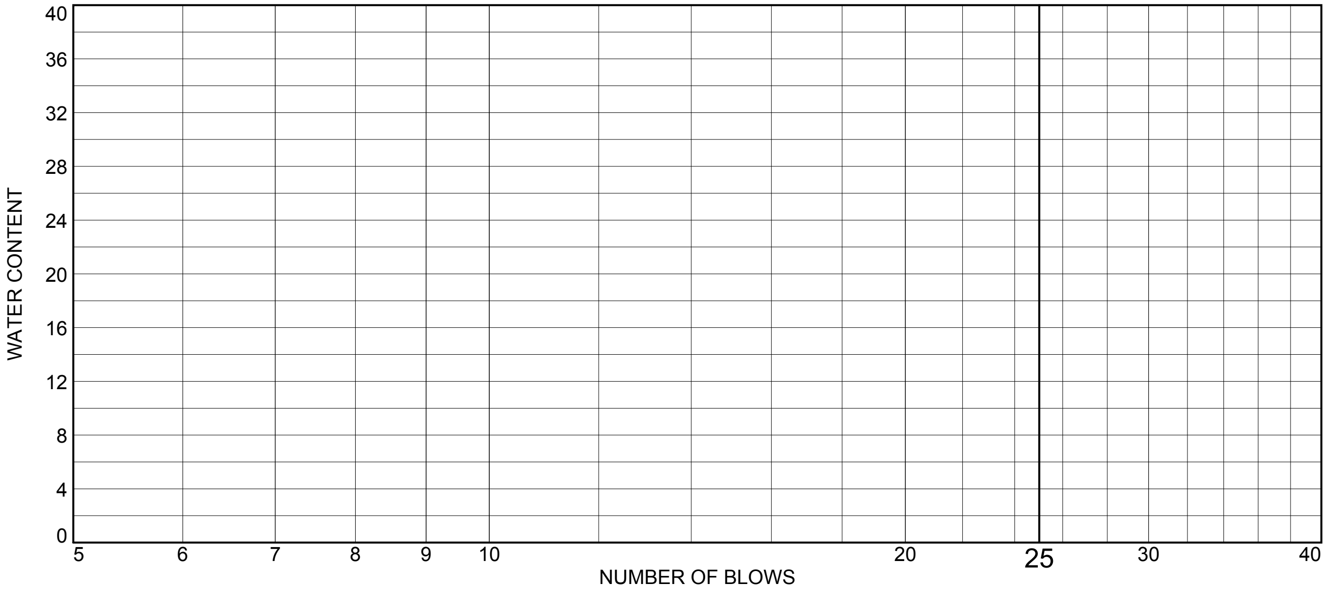
Remarks:

Figure BH2_SS10

Tested By: Bruce

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty Sand	NV	NP	NP	98	27	SM

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

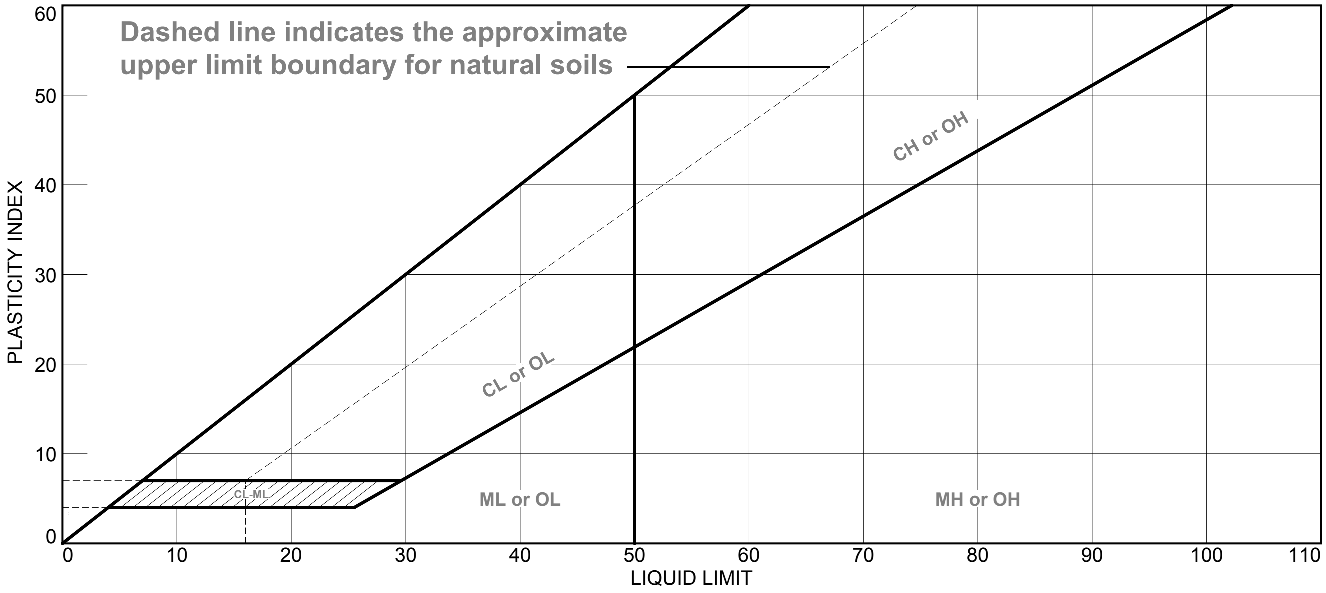
Source of Sample: Site Drilling
Sample Number: BH2_SS15

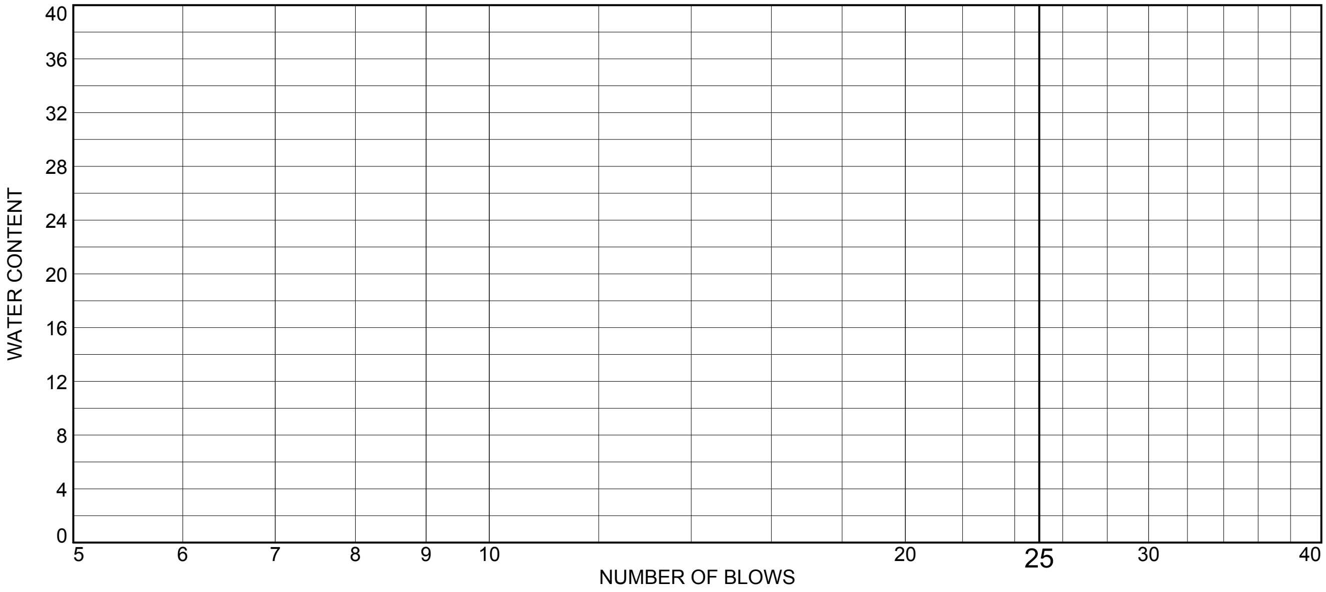
Remarks:

Figure BH2_SS15

Tested By: LXQ

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt	NV	NP	NP	83	53	ML

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

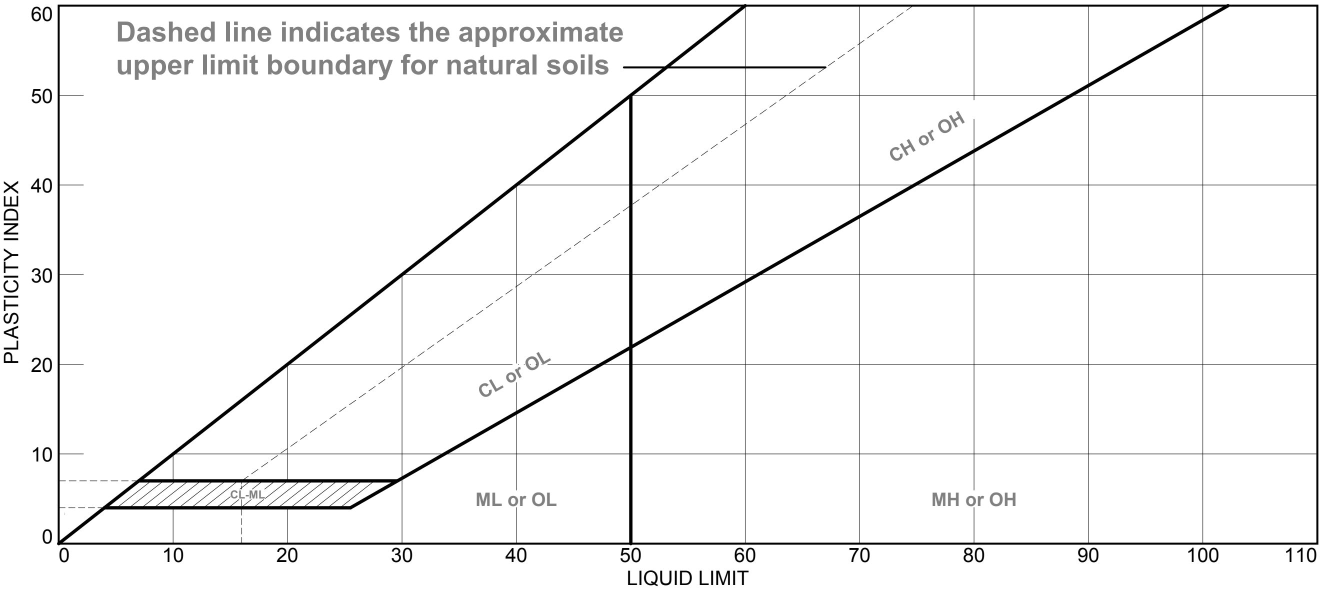
Source of Sample: Site Drilling
Sample Number: BH3_SS7

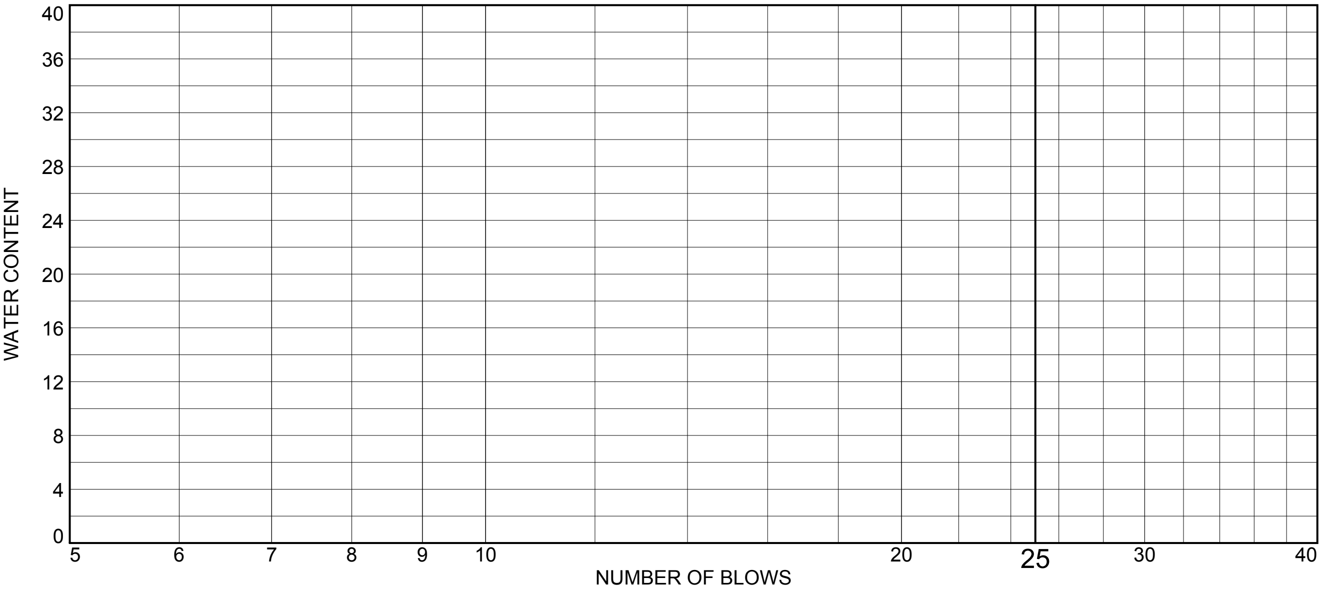
Remarks:

Figure BH3_SS7

Tested By: LXQ

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt	NV	NP	NP	98	58	ML

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

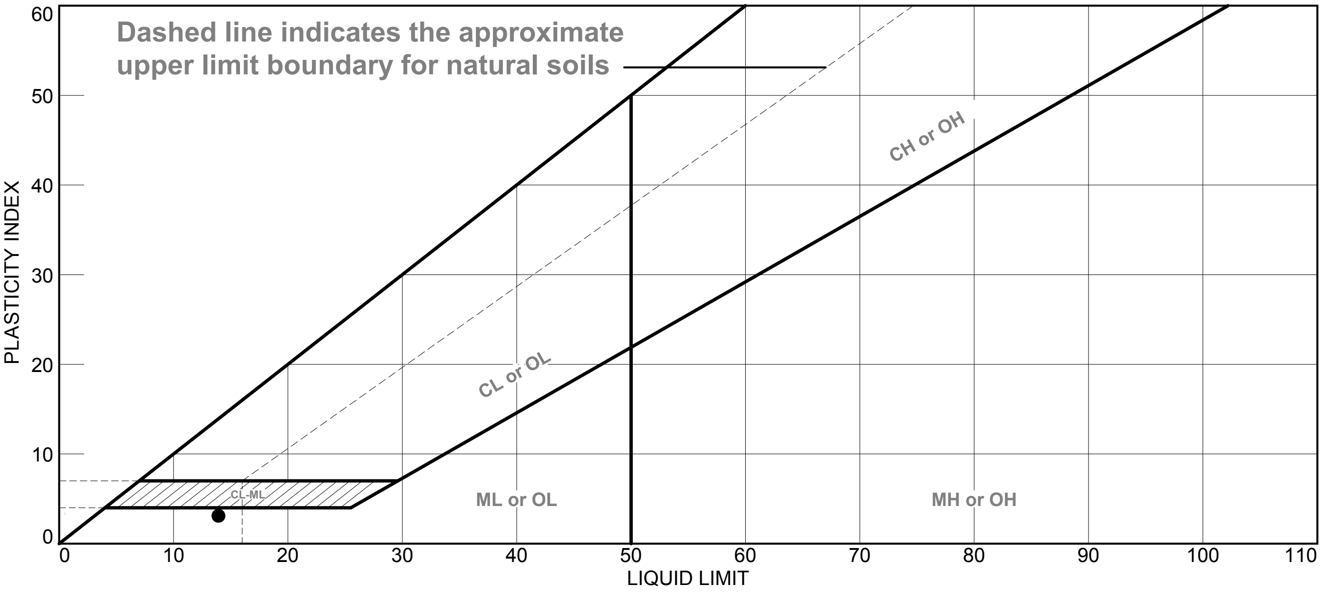
Source of Sample: Site Drilling
Sample Number: BH3_SS14

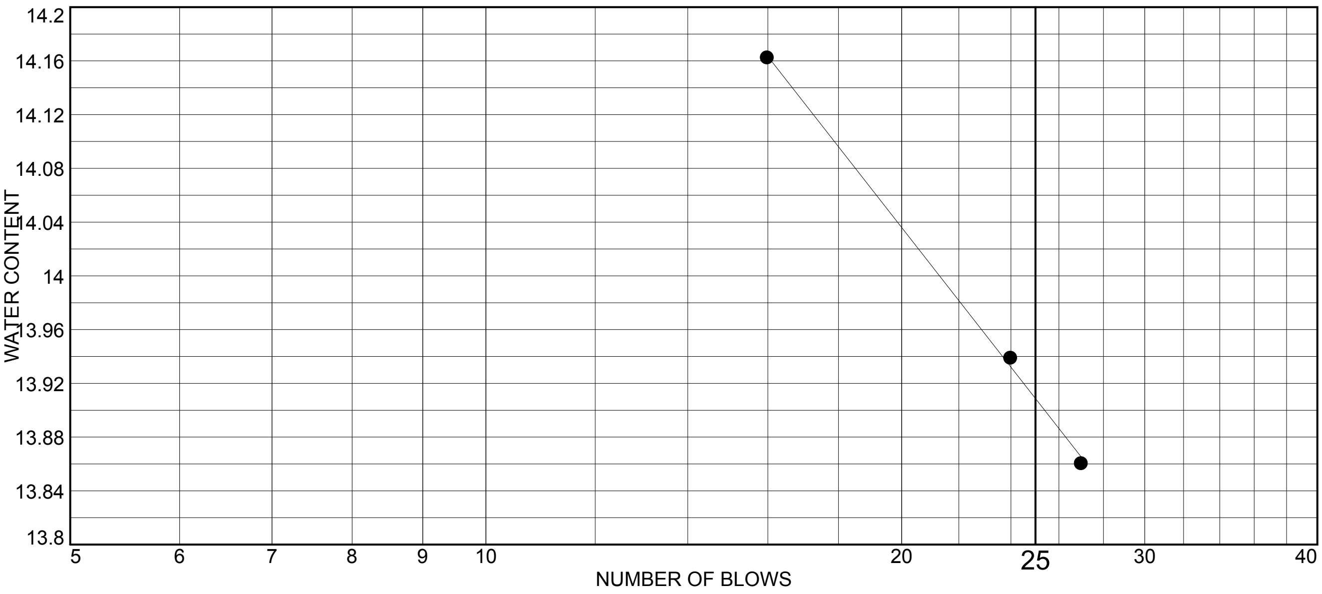
Remarks:

Figure BH3_SS14

Tested By: LXQ

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt	14	11	3	90	54	ML

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

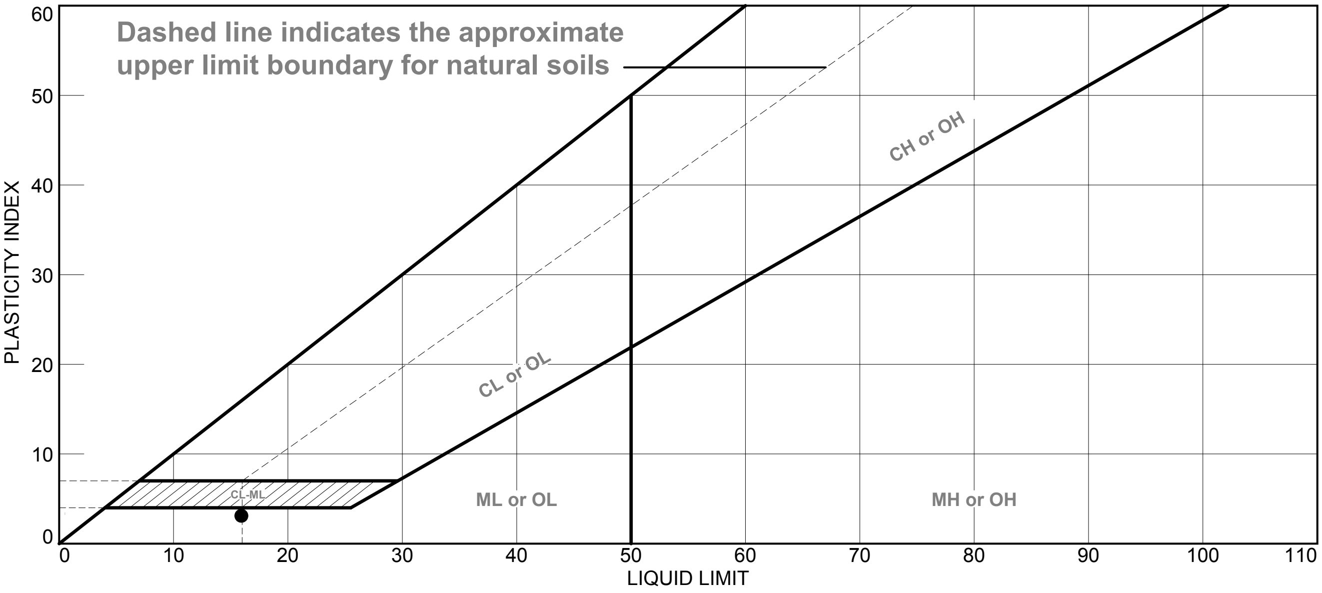
Source of Sample: Site Drilling
Sample Number: BH6_SS3

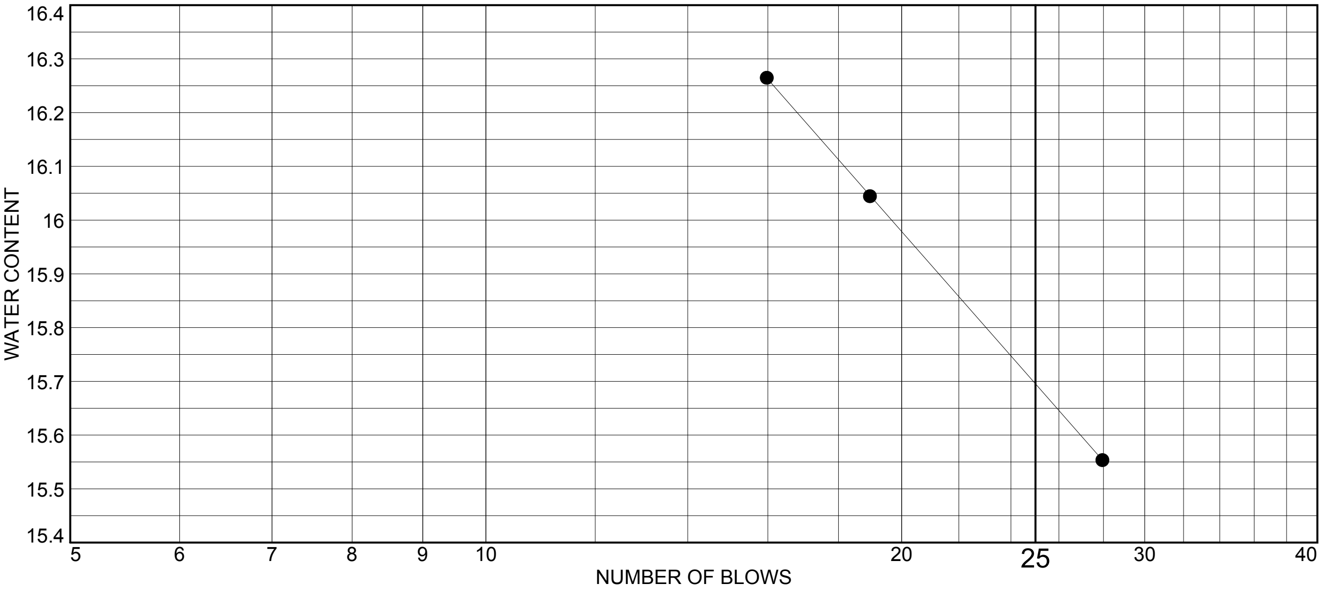
Remarks:

Figure BH6 SS3

Tested By: LXQ

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt	16	13	3	90	69	ML

Project No. 19M-01888- **Client:** City of Toronto

Project: Agincourt Grade Separation

Source of Sample: Site Drilling
Sample Number: BH7_SS10

Remarks:

Figure BH7_SS10

Tested By: LXQ

APPENDIX D

Existing Geotechnical Reports

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL ENGINEERING REPORT
COWDRAY COURT, BLOCK 4
TORONTO, ONTARIO

Prepared For: Gemterra Developments Corp.
200 Consumers Road, Suite 805
Toronto, Ontario
M2J 4R4

Attention: Mr. Maurice Lerman

File No. 1-18-0476-2-B4
December 5, 2018

Distribution of Report:
1 Copy - Gemterra Developments Corp.
1 Copy - Terraprobe Inc.

Terraprobe Inc.

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Brampton, Ontario L6T 3Y3	**Stoney Creek**, ON L8E 5P5	**Barrie**, Ontario L4N 4Y8	**Sudbury**, Ontario P3E 5P4
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FIGURES

APPENDICES

1.0 THE PROJECT

Terraprobe was retained by Gemterra Developments Corp. to conduct a subsurface investigation and provide geotechnical engineering design advice for their proposed development at Cowdray Court, Block 4, in Toronto, Ontario. A site location plan is provided as Figure 1.

The current proposed development scenario of Block 4 includes two (2) high-rise towers (Towers T3 and T4), a 10-12 storey podium, and two underground parking levels below the entire site area. We have been informed by the Architect of the following:

- The P1 level is to be 3.6 m in height and the P2 level is to be 3 m in height.
- For Tower T3 in the southwest portion of the block, the ground floor (lobby) Finished Floor Elevation (FFE) is currently set at 170.1 m. This implies a lowest P2 FFE of 163.5± m.
- For Tower T4 in the northeast portion of the block, the ground floor (lobby) Finished Floor Elevation (FFE) is currently set at 168.5 m. This implies a lowest P2 FFE of 161.9± m.

Boreholes were advanced by Terraprobe for a subsurface investigation of Blocks 2 and 4 (File No. 1-18-0416-02-B2 and -B4), in October 2018. The 400-series boreholes (Boreholes 401 to 411) were advanced in Block 4. Borehole 303 was advanced in Block 2, directly adjacent to the site and about 100 m west of Tower T3. In situ pressuremeter testing (Appendix B) was conducted in Boreholes 303 and 407.

The locations of the boreholes are provided on the Borehole Location Plan as Figure 2. The results of the individual boreholes within Block 2, as well as the relevant boreholes from adjacent Blocks, are recorded on the Borehole Logs in Appendix A. A summary of the geotechnical laboratory tests is provided in Appendix C.

Interpretation, analysis and advice with respect to the geotechnical engineering aspects of the proposed development are provided, based on the information secured from this investigation. Geotechnical design advice pertaining to foundations, seismic site classification, earth pressure design, slab on grade design, basement drainage, and pavement design is provided. The anticipated construction conditions pertaining to excavation, ground water control, and shoring are discussed.

The foundation installations must be reviewed in the field by Terraprobe. The on-site review of the condition of the foundation subgrade as the foundations are constructed is an integral part of the geotechnical engineering design function, and is not to be considered as third-party inspection services. If Terraprobe is not retained to carry out all of the foundation evaluations during construction, then Terraprobe accepts no responsibility for the performance of the foundations.

2.0 SUBSURFACE CONDITIONS

Borehole elevations and coordinates are provided relative to geodetic datum (NAD 83). The horizontal coordinates are reported relative to the Universal Transverse Mercator geographic coordinate system (UTM Zone 17T).

The subsurface soil and ground water conditions encountered in the boreholes are presented on the attached Log of Borehole sheets. The stratigraphic boundaries indicated on the Log of Borehole sheets 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.

Ground surface elevation is at Elev. 167.2 to 170.6 m in the locations of the boreholes in Block 4.

2.1 Stratigraphy

The following stratigraphy is based on the borehole findings, as well as the geotechnical laboratory testing conducted on selected representative soil samples.

2.1.1 Surficial and Earth Fill

Boreholes 401 and 402 encountered topsoil at ground surface, which was 150 mm thick. All other boreholes encountered an asphalt pavement structure comprising 70 to 120 mm thick asphalt overlying aggregate 170 to 440 mm thick.

Earth fill was encountered in all of the 400-series boreholes to depths ranging from 0.6 to 1.5 m below grade (Elev. 166.2 to 170.0 m). The earth fill composition varies widely, but generally consists of sands and silts with trace to some clay and trace gravel. Due to the variation and inconsistent placement of the earth fill material, the relative density of the earth fill varies but is on average loose.

2.1.2 Sandy Silts

Underlying the surficial fills and earth fills at 0.6 to 1.5 m below grade (Elev. 166.2 to 170.0 m), the boreholes encountered undisturbed native cohesionless deposits broadly characterized as “sandy silts unit”. Each individual soil sample was reviewed and grouped based the apparent fines content, per the following convention:

a) Samples labelled as “glacial till” appeared to have a relatively higher fines content. These samples typically maintained their solid “core” shape after sampling.

b) Samples not labelled as "glacial till" appeared to have a relatively lower fines content. These samples generally unravelled in the sample jar and did not maintain a solid core shape.

Based on the grain sizes conducted, the cohesionless "sandy silts" soils have a similar composition overall. Hydraulic conductivity testing in selected wells installed across the site also observe around the same hydraulic conductivity values in the different strata encountered in Block 4 (till and non-till). Those results may be found in Terraprobe's hydrogeological report for the site, under separate cover (File No. 1-18-0476-46-B4).

The sandy silts unit is cohesionless, and generally contain trace to some clay, and trace gravel to gravelly. This unit is generally brown, wet and grey below depths ranging from 4.6 to 13.7 m below grade. There are interbedded sand and gravel layers within the sandy silts unit, encountered in Boreholes 402, 404, and 407 at variable depths and thicknesses.

Standard Penetration Test (SPT) results (N-Values) is the sandy silt unit range from 20 blows to greater than 50 blows per 300 mm of penetration. Below Elev. 166± m, the native soils are consistently dense to very dense (on average, very dense).

All boreholes except Boreholes 408, 410, and 411 reached their target depth in the native sandy silt unit (Elev. 151.4 to 156.7 m).

2.1.3 Lower Sands

Underlying the sandy silt unit in Boreholes 408, 410, and 411 at 9.1 to 14.1 m below grade (Elev. 151.7 to 158.1 m), a lower sand deposit was encountered. This deposit contains some silt and traces of gravel and clay. It is grey and wet. It was observed to contain silt layers in Borehole 411. When mud-rotary drilling techniques maintained the boreholes in their undisturbed state, the SPT N-values are consistently greater than 50 blows per 300 mm of penetration (very dense).

These boreholes were terminated in the lower sands at depths of 13.8 to 15.5 m below grade (Elev. 152.1 to 153.8 m).

2.2 Ground Water

Monitoring wells were installed on completion, as shown on the Borehole Logs. Boreholes were cased and filled with drill fluid on completion, and unstabilized water level and caving notes were not made on this basis. Where nested wells (two wells) were installed in a single borehole, the suffices "S" and "D" are used to denote shallow and deep wells respectively. The ground water measurements are shown on the Borehole Logs and are summarized as follows.

Borehole No.	Depth of well (m)	Strata Screened	Water Level in Well, Depth/Elev. (m)			
			Highest Level	Date	Most Recent Level	Date
401	14.3	Sandy Silts Unit	5.6 / 163.5	12-Nov-2018	5.6 / 163.5	12-Nov-2018
402-D	18.3	Silty Sand	6.7 / 163.1	15-Nov-2018	6.7 / 163.1	8-Nov-2018
402-S	9.8	Sandy Silts Unit	5.7 / 164.1	15-Nov-2018	5.7 / 164.1	15-Nov-2018
403-D	14.2	Silty Sand	4.8 / 165.0	25-Oct-2018	7.8 / 162.0	11-Nov-2018
403-S	7.6	Sandy Silt Till	5.0 / 164.8	12-Oct-2018	5.1 / 164.7	11-Nov-2018
404	13.8	Sandy Silts Unit	4.8 / 165.7	12-Oct-2018	4.9 / 165.7	8-Nov-2018
405	14	Sandy Silts Unit	4.1 / 164.1	11-Nov-2018	4.1 / 164.1	11-Nov-2018
406	13.9	Silty Sand	2.8 / 165.5	10-Oct-2018	3.9 / 164.3	8-Nov-2018
407	13.8	Sandy Silt Till	4.6 / 163.6	10-Oct-2018	4.7 / 163.5	8-Nov-2018
408	15.5	Silty Sand	5.3 / 162.3	12-Nov-2018	5.3 / 162.3	12-Nov-2018
409	14.1	Sandy Silts Unit	4.6 / 163.4	10-Oct-2018	5.0 / 163.0	8-Nov-2018
410	14.1	Silty Sand	4.9 / 163.0	10-Oct-2018	5.0 / 162.8	8-Nov-2018
411-D	13.8	Lower Sand	3.9 / 163.3	10-Oct-2018	4.1 / 163.1	15-Nov-2018
411-S	7.6	Sandy Silts Unit	3.3 / 163.9	15-Nov-2018	3.3 / 163.9	15-Nov-2018

The water levels measured in the wells generally slope down towards the east, ranging from Elev. 165.7 m (Borehole 404) to 162.3 m (Borehole 408). The design ground water table is to be taken as Elev. 166 ±m. This design water level is recommended on the understanding that there are ongoing construction dewatering activities at the construction site south of the tracks, that appears to be influencing the water levels across this site.

Additional water level data should be obtained after local dewatering activities at neighbouring sites have stopped, to confirm the design water table elevation.

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

2.3 Pressuremeter Testing

In situ pressuremeter testing was performed by In Depth Geotechnical Inc. within Boreholes 303 and 407. The full professionally sealed report is provided as Appendix B. The native soils that were tested in Borehole 303 were observed to be similar to the soils in Borehole 407 at the subject site, in terms of both stratigraphy and SPT N-values. The Young’s Modulus results are summarized as follows:

Borehole	Elevation of Test (m)	Stratum Tested	E_{YOUNG} (MPa)
303	163.0	Silt and Sand (Upper Sand unit)	380
303	160.2	Silt and Sand (Upper Sand unit)	351
407	158.3	Sandy Silt Till (Till unit)	335
407	155.3	Sandy Silt Till (Till unit)	500

3.0 GEOTECHNICAL ENGINEERING DESIGN

The following discussion and engineering 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 based 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.

The current proposed development scenario of Block 4 includes two (2) high-rise towers (Towers T3 and T4), a 10-12 storey podium, and two underground parking levels below the entire site area. We have been informed by the Architect of the following:

- The P1 level is to be 3.6 m in height and the P2 level is to be 3 m in height.
- For Tower T3 in the southwest portion of the block, the ground floor (lobby) Finished Floor Elevation (FFE) is currently set at 170.1 m. This implies a lowest P2 FFE of 163.5± m.
- For Tower T4 in the northeast portion of the block, the ground floor (lobby) Finished Floor Elevation (FFE) is currently set at 168.5 m. This implies a lowest P2 FFE of 161.9± m.

3.1 Foundation Design Parameters

Foundations made for two basement levels will be made about 1.5 m below FFE, implying nominal founding elevations of 162 to 160.4± m. At these elevations, conventional spread footings made to bear on undisturbed (dewatered) very dense native soils may be designed using a maximum factored geotechnical resistance at ULS of 1,300 kPa. The maximum net geotechnical reaction at SLS is 1,000 kPa, for an estimated total settlement of 25 mm.

Excavations for typical footings will be nominally 1.5 m below FFE, to as deep as Elev. 159± m for the elevator pits and sumps. The design ground water table is at Elev. 166 ±m. Therefore,

- Foundation excavations will extend up to 7 m below the prevailing ground water table; and
- Foundation excavations will penetrate native soils that will yield free-flowing water.

It will be therefore be necessary to positively depressurized the aquifer the site prior to excavation. The site must be dewatered to a minimum 1.2 m below the deepest proposed excavation elevation prior to excavation, to preserve the in situ integrity of the native soils. If the subsurface is not dewatered prior to excavation, the native soils will become disturbed by the ingress of ground water and the above recommendations for bearing capacity will not be valid.

Footings stepped from one elevation to another should be offset at a slope not steeper than 7 vertical to 10 horizontal.

To achieve the above geotechnical bearing capacities, the minimum size of isolated footings must be 2000 mm, and the minimum depth below FFE must be 1500 mm. This applies regardless of loading considerations, in conjunction with the above recommended geotechnical resistance. The settlement at SLS will occur as load is applied, and is linear and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

It is expected that these bearing capacities will be adequate for support of the proposed tower column loads using conventional spread footings. For the mid-rise portions of the development, if smaller footings are desired, Terraprobe can provide reduced bearing capacities for smaller footings on request.

The design earth cover for frost protection of foundations exposed to ambient environmental temperatures is 1.2 metres in the Greater Toronto Area. Experience suggests that the temperature in “unheated” underground parking levels two or more levels below grade with normal ventilation provisions is not as severe as the ambient open air condition. The earth cover required to prevent frost effects on foundations in the lower parking levels need not be any greater than 1.2 metres, and experience in a number of structures has shown that perimeter foundations provided with 600 mm of cover perform adequately as do interior isolated foundations with 900 mm of cover. At locations adjacent to ventilation shafts, it is normal practise to provide insulation to ensure that foundations are not affected by the cold air flow.

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

3.2 Earthquake Design Parameters

The Ontario Building Code (2012) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2012). The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistance (N-values).

$$\upsilon_{s-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{\upsilon_{si}}} \qquad S_{u-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{s_{ui}}} \qquad N_{avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}}$$

Shear wave velocity **Undrained shear strength** **SPT N-values**

Below the nominal highest founding elevation of 165± metres, there are very dense sands and silts with an average N value of over 50 blows per 300 mm penetration. Based on this information and an analysis of N-values and undrained shear strength, the site designation for seismic analysis is Class C, as per Table 4.1.8.4.A of the Ontario Building Code (2012). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration- and velocity-based site coefficients.

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
C	1.0	1.0	1.0	1.0	1.0

Site Class	Values of F_v				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.2$	$S_a(1.0) = 0.3$	$S_a(1.0) = 0.4$	$S_a(1.0) \geq 0.5$
C	1.0	1.0	1.0	1.0	1.0

3.3 Earth Pressure Design Parameters

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

Stratum/Parameter	γ	φ	K_a	K_o	K_p
Compact Granular Fill Granular ‘B’ (OPSS 1010)	21	32	0.31	0.47	3.26
Existing Earth Fill	19	29	0.35	0.52	2.88
Native Soils, undisturbed, above Elev. 166± m	21	36	0.24	0.38	4.20
Native Soils, undisturbed, below Elev. 166± m	21	40	0.24	0.38	4.20

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

The above earth pressure parameters pertain to a horizontal grade condition behind a retaining structure. Values of earth pressure parameters for an inclined retained grade condition will vary.

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
h_w = the depth below the ground water level (m)
γ = the bulk unit weight of soil, (kN/m^3)
γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
q = the complete surcharge loading (kPa)

The wall backfill must be drained effectively to eliminate hydrostatic pressures on the wall that would otherwise act in conjunction with the earth pressure. In this case, the above equation is simplified to:

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

Where the structure is made directly against a shored excavation, drainage is provided by forming a drained cavity with prefabricated drain core material covering the excavation face and designed to discharge collected water into an underfloor drainage system. This is discussed in Section 3.5.

The factored geotechnical resistance to sliding of foundation elements is developed by friction between the base of the footing and the soil. This friction (**R**) depends on the normal load at 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 $\boldsymbol{R_f = 0.8\ N\ tan\varphi}$.

3.4 Slab on Grade Design Parameters

The slab on grade is to be made to support P2 FFEs ranging from Elev. 163.5 to 161.9 m. At this site, the native soils encountered at these elevations constitute an adequate subgrade for support of a slab on grade. The modulus of subgrade reaction appropriate for design of the slab resting on undisturbed native soils at these elevations is 60,000 kPa/m.

Subgrade preparation involving recompaction or proof rolling will only weaken the subgrade materials. These activities should, therefore, be specifically precluded in the subgrade preparation. It is recommended that the subgrade be neatly cut and inspected prior to construction of the slab on grade. Any disturbed or otherwise unacceptable material should be subexcavated and replaced with Granular B (OPSS 1010) compacted to a minimum of 98% SPMDD.

It is necessary that building floor slabs be provided with a capillary moisture barrier and drainage layer. As the lowest slabs are to be made over cohesionless subgrade, this is accomplished by placing the slab on a minimum 500 mm layer of HL8 coarse aggregate (OPSS 1004) compacted by vibration to a dense state. The drainage layer must be separated from the cohesionless subgrade using a non-woven geotextile (Terrafix 360R or equivalent as approved by Terraprobe). The drainage layer is then placed on top of the geotextile.

3.5 Basement Drainage

To assist in maintaining dry basements and preventing seepage, it is recommended that exterior grades around the buildings be sloped away at a 2 percent gradient or more, for a distance of at least 1.2 m. Foundation walls should be damp-proofed.

For a conventional drained basement approach, perimeter and subfloor drainage is required for all below-grade space. In conjunction with the perimeter foundation drainage, the provision of subfloor drainage (min. 500 mm of HL8 coarse aggregate) is required to collect and remove the water that infiltrates at the building perimeter and under the floor. The subfloor drains should be placed at a maximum 3 m (on-centre) spacing.

The walls of the substructure must be protected from seepage. How this is achieved will depend on whether the basement wall is made on an open cut or shored excavation face. Basement wall drainage provided against a shored excavation is made in the blind by providing a drained cavity between the shoring system and the structural basement wall. Prefabricated drain core products are available to form this cavity. The water is collected at the base of the building and conveyed by solid non-perforated pipe to the sump. A secondary waterproofing layer between the drain core product and the basement wall should be considered as an extra layer of protection.

Basement wall drainage provided in an open cut is made directly against the basement wall from the open cut side. Perimeter foundation drains should comprise perforated pipe (minimum 100 mm diameter) surrounded by a granular filter of OPSS HL-8 Coarse Aggregate (minimum 500 mm thick). Perimeter drainage must be conveyed directly to the sumps in non-perforated pipes.

Typical basement drainage details for both scenarios are provided as Appendix D.

The drainage system is a critical structural element, since it keeps water pressure from acting on the basement walls and floor slab. As such, the sump that ensures the performance of this system must have a duplexed pump arrangement for 100% pumping redundancy and these pumps must be on emergency power. The size of the sump should be adequate to accommodate the water seepage.

Further discussion is provided in Section 5.2.

3.6 Site Servicing

It is anticipated that most of the site services are to be installed within future proposed below grade structures. Where this is not to be the case, the following recommendations apply.

3.6.1 Bedding

In general, the native soils at the site will provide adequate support for buried utilities and piping provided with conventional Class ‘B’ bedding. Bedding materials must be well graded granular fill such as Granular A (OPSS 1010). Clear stone is specifically prohibited for use at this site. All granular bedding must be compacted to a minimum of 98% of Standard Proctor Maximum Dry Density (SPMDD) or compacted by vibration to a dense state in the case of clear stone bedding.

3.6.2 Backfill

Excavated native cohesionless soils may be reused as backfill. Excavated soil can be used as backfill provided that the moisture content of these materials is within optimum or 2 percent greater than optimum to ensure adequate compaction. The utility trench backfill must be compacted to at least 98% of SPMDD.

Excavated existing clean earth fill materials encountered on site may be reused as backfill (in non-settlement sensitive areas) with selection and sorting and after removing any deleterious materials, and may require moisture conditioning.

4.0 PAVEMENT DESIGN

It is expected that some of the pavements will be placed on top of the underground parking structure. All drainage and pavement design considerations for these areas must be designed separately and in conjunction with the civil engineering design of the underground parking structure. The design presented below is only for areas in which the pavements will rest on a soil subgrade.

An asphaltic concrete pavement design is provided. The pavement design recommendations are based on the subgrade support capabilities that will be available from the prepared subgrade compacted to a minimum 98% SPMDD, or the neatly cut undisturbed soil. The typical Performance Graded (PG) asphalt binder recommended in the Greater Toronto Area is PG 58-28.

Prior to the placement of the aggregate pavement components, it is recommended that the cut subgrade be proof-rolled and inspected for obvious loose or disturbed areas as exposed. These areas shall be replaced with Granular B compacted to 98% SPMDD.

The subgrade for all pavement structures shall be frost tapered at a 3H to 1V slope to match with existing pavement structures, to reduce differential settlements due to frost heave. The granular materials should be placed in lifts 150 mm thick or less and compacted to a minimum of 100% and 98% SPMDD for granular base and granular sub-base, respectively. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS Forms 310, 501, 1010, 1101 and 1150 and the pertinent City specifications. It is recommended that City and other applicable specifications should be referred for use of higher grades of asphalt cement (PGAC 64-28) for asphaltic concrete where applicable.

A minimal pavement design is provided, which will provide service for 8 to 10 years before complete reconstruction will be required, depending on actual traffic volumes. The cost of this design should be compared to a more substantial performance design, which could be expected to last about twice as long before significant maintenance and rehabilitation.

Table 4.1 – Minimal Pavement Design

Pavement Layer	**Compaction Requirements**	**Car Parking Minimum Component Thickness**	**Bus/Truck Traffic Minimum Component Thickness**
Surface Course Asphaltic Concrete HL3 (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	65 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	N/A	50 mm
Base Course Granular A (OPSS 1010) or 19mm Crusher Run Limestone	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course Granular B Type II (OPSS 1010) or 50mm Crusher Run Limestone	98% Standard Proctor Maximum Dry Density (ASTM-D698)	200 mm	300 mm

The following pavement design is considered a performance structure which will have a better life cycle cost than a minimal design, but requires a higher initial capital expenditure.

Table 4.2 – Performance Pavement Design

Pavement Layer	**Compaction Requirements**	**Car Parking Minimum Component Thickness**	**Bus/Truck Traffic Minimum Component Thickness**
Surface Course Asphaltic Concrete HL3 (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	40 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	50 mm	80 mm
Base Course Granular A (OPSS 1010) or 19 mm Crusher Run Limestone	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course Granular B Type II (OPSS 1010) or 50 mm Crusher Run Limestone	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	400 mm

Control of surface water is a significant factor in achieving good pavement life. Grading adjacent pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. The existing native soils have a moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly.

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 two percent) to provide effective drainage toward subgrade drains. Subgrade drains are recommended to intercept excess subsurface moisture at the curb lines and catch basins. Typical pavement drainage details are provided as Appendix E.

The above advice pertains to private roads made on soil subgrade. For future public roads, the municipality has its own minimum pavement design requirements which will have to be followed for the making of any of the pavement surfaces that will eventually become a municipal responsibility. Terraprobe is providing a pavement design report for the proposed public roads at this site under separate cover (File No. 1-18-0476-2-R).

5.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

5.1 Excavations

Excavations must be carried out in accordance with the *Occupational Health and Safety Act and Regulations for Construction Projects, November 1993 (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 is a Type 3 soil. The native soils are Type 4 soils, or Type 3 soils if dewatered.

Where workmen must enter a trench or excavation deeper than 1.2 m, the soil must be suitably sloped and/or braced in accordance with the regulation requirements. The regulation stipulates safe excavation slopes 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.

Large size debris (cobbles and boulders) may be found in the earth fill material. Similarly, 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 such obstructions cannot be predicted with boreholes, as the sampler size is insufficient to secure representative samples of particles of this size. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

5.2 Ground Water Control

Two basement levels are proposed, with lowest FFEs ranging from Elev. 163.5 to 161.9 m. The design ground water within the native soils is at Elev. 166± m. Excavations for typical footings will be nominally 1.5± m below FFE. Therefore,

- Foundation excavations may potentially extend up to 7 m below the prevailing ground water table; and
- Foundation excavations will penetrate native soils that will yield free-flowing water.

It will be therefore be necessary to positively depressurized the aquifer the site prior to excavation. The site must be dewatered to a minimum 1.2 m below the deepest proposed founding elevation prior to excavation, to preserve the in situ integrity of the native soils. If the subsurface is not dewatered prior to excavation, the native soils will become disturbed by the ingress of ground water and the above recommendations for bearing capacity will not be valid.

Dewatering will take some time to accomplish prior to the start of excavation. The City of Toronto will require a Discharge Agreement in the short and long terms if any water is to be discharged to the storm or sanitary sewers. It should be noted that securing a Permit To Take Water or a Discharge Agreement on a permanent basis may not be supported by regulatory agencies.

It is recommended that a professional dewatering contractor be consulted to review the subsurface conditions and to design a site-specific dewatering system. It is the dewatering contractor's responsibility to make an assessment of the factual data and to provide recommendations on dewatering system requirements.

Terraprobe has prepared a hydrogeological report for this site under separate cover (File No. 1-18-0476-46-B4).

5.3 Shoring Design

The site is immediately bounded by a CNR rail easement and rail structure to the south, an existing low-rise building to the west, Cowdray Court to the north, and open private lands to the east. No excavation shall extend below the foundations of existing adjacent structures without adequate alternative support being provided. Underpinning guidelines are provided as Appendix F.

CN may have other requirements for excavations at or near their property boundaries.

5.3.1 Lateral Earth Pressure Distribution

If the shoring is supported with a single level of earth anchor or bracing, a triangular earth pressure distribution similar to that used for the basement wall design is appropriate.

Where multiple rows of lateral supports are used to support the shoring walls, research has shown that a distributed pressure diagram more realistically approximates the earth pressure on a shoring system of this type, when restrained by pre-tensioned anchors. A multi-level supported shoring system can be designed based on an earth pressure distribution with a maximum pressure defined by:

$$\boldsymbol{P = 0.65\,K[\gamma H + q] + \gamma_w h_w}$$

where, P = the maximum horizontal pressure (kPa)
K = the earth pressure coefficient (see Section 3.3)
H = the total depth of the excavation (m)
h_w = the depth below the ground water level (m)
γ = the bulk unit weight of soil, (kN/m3)
q = the complete surcharge loading (kPa)

Where walls are drained effectively to eliminate hydrostatic pressures on the wall (e.g. pile and lagging walls), h_w reduces to zero. If rigid impermeable shoring is considered, a ground water table at Elev. 166 m must be accounted for in design.

In cohesionless soils, the pressure distribution is rectangular.

5.3.2 Soldier Pile Toe Embedment

Soldier pile toes will be made in very dense wet sands. The horizontal resistance of the soldier pile toes will be developed by embedment below the base of excavation, where resistance is developed from passive earth pressure.

The soils at this site are cohesionless, permeable and sufficiently wet such that augered holes made into these soils will be unstable. It is necessary to advance temporarily cased holes to prevent excess caving during all augered hole installations. Drill holes for piles, caissons, and/or fillers, utilizing temporary liners, mud/slurry drilling techniques, and/or other methods as deemed necessary by the contractor may be required to prevent issues such as: groundwater inflow or loss of soil into the drill holes, and disturbance to placed concrete. It will also be necessary to control the bases of any augered holes below Elev. 168 m, to protect them against basal disturbance caused by the ingress of ground water and to prevent loss of ground. This may include dewatering to below the shoring toe depths prior to installation, or the use of drilling muds (slurry, polymer, etc.), pre-advancing casing, or other techniques as deemed necessary by the shoring contractor.

5.3.3 Lateral Bracing Elements

If anchor support is necessary and determined to be feasible, the shoring system should be supported by pre-stressed soil anchors extending beneath the adjacent lands. Pre-stressed anchors are installed and stressed in advance of excavation and this limits movement of the shoring system as much as is practically possible. The use of anchors on adjacent properties requires the consent of the adjacent land owners, expressed in encroachment agreements.

In the native soils, it is expected that post-grouted anchors can be made such that an anchor will safely carry about 80 kN/m of adhered anchor length (at a nominal diameter of 150 mm). One or more prototype anchors must be performance-tested to 200% of the design load to demonstrate the anchor capacity and validate design assumptions. Given the potential variability in soil conditions and/or installation quality, all production anchors must also be proof-tested to 133% of the design load.

The very dense native soils below the proposed FFE are suitable for the placement of raker foundations. Raker footings established on undisturbed (dewatered) very dense soils at an inclination of 45 degrees can be designed using a maximum factored geotechnical resistance at ULS of 300 kPa.

5.4 Site Work

The effects of site work can have a profound impact on soil integrity unless care is taken to prevent and reduce this kind of damage. 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. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by site 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 placement of the granular base 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 must be provided. The native soil at this site is susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project.

5.5 Quality Control

The proposed structures will be founded on conventional spread footings. All foundation installations must be reviewed in the field by Terraprobe, 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 engineering 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 engineering field review 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 boreholes. 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 (SPMDD). In situ determinations of density during fill and asphaltic pavement 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 staff can also provide 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.

6.0 LIMITATIONS AND USE OF REPORT

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 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 mud rotary or 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. Ground water observations were made in the boreholes as drilling proceeded.

The samples of the strata penetrated were obtained using the Split-Barrel Method technique (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 advance 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.

6.2 Changes in Site and Scope

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 are based on the factual data obtained from this investigation made at the site by Terraprobe and are 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.

6.3 Use of Report

This report is prepared for the express use of Gemterra Developments Corp. 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.

Gemterra Developments Corp. and their retained design consultants are authorized users.

It is recognized that The City of Toronto, 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 that this report meets your present requirements. Should you have any questions regarding the information presented, please do not hesitate to contact our office.

Terraprobe Inc.

Jory Hunter, B.Sc.(Eng.), EIT
Geotechnical Engineering Division

Michael Diez de Aux, M.A.Sc., P.Eng.
Associate

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M. DIEZ DE AUX
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5/12/2018
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J. J. CROWDER
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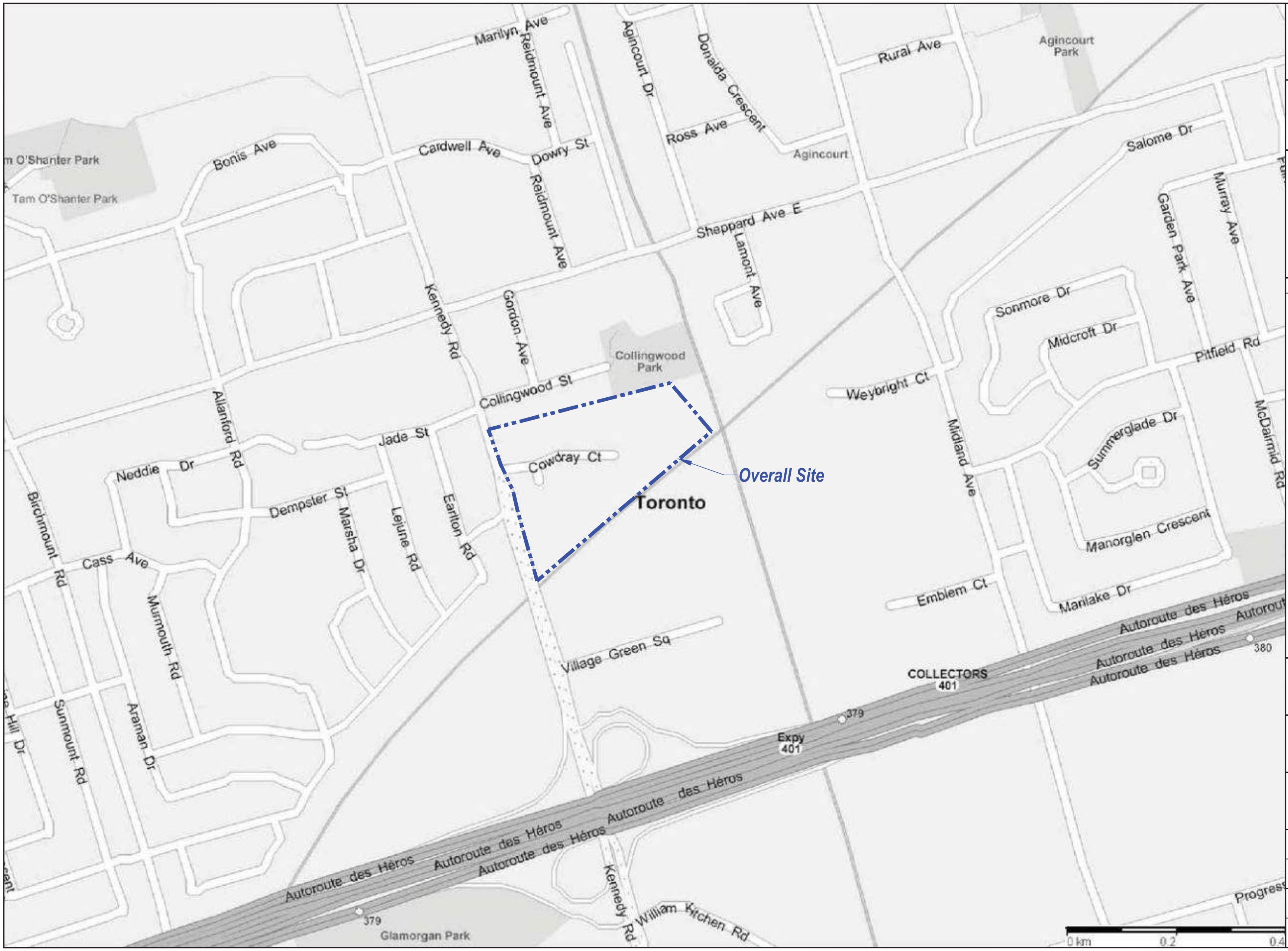
Jason Crowder, Ph.D., P.Eng.
Principal

FIGURES

TERRAPROBE INC.



Terraprobe Inc.

Consulting Geotechnical & Environmental Engineering
Construction Materials, Inspection & Testing

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

Reference: Microsoft Streets & Trips Map

Notes:

Legend:

-·-·-	Site

Project Title: Geological Investigation

Site Location: Cowdray Court, Toronto, Ontario

Figure Title: SITE LOCATION PLAN

Designed By: SM	**File No.:** 1-18-0476-02
Drawn By: MV	**Scale:** As Shown
Reviewed By: MB	
Date: November 2018	**Figure No.:** 1

T:\1-Project Files\2018\1-18-0476 - Cowdray Blocks 1-6, Toronto\02-GEO Report (Blocks 2,4,5,6)\A. Dwgs, Logs\AutoCAD\1-18-0476-02 FIGS.dwg, MV

REFERENCE

Google Earth Image 2018

LEGEND

🟥 Borehole Location (Block 4)

🟦 Borehole Location (Other Blocks)

APPROXIMATE SCALE 1:125

20 16 12 8 4 0 10 20m

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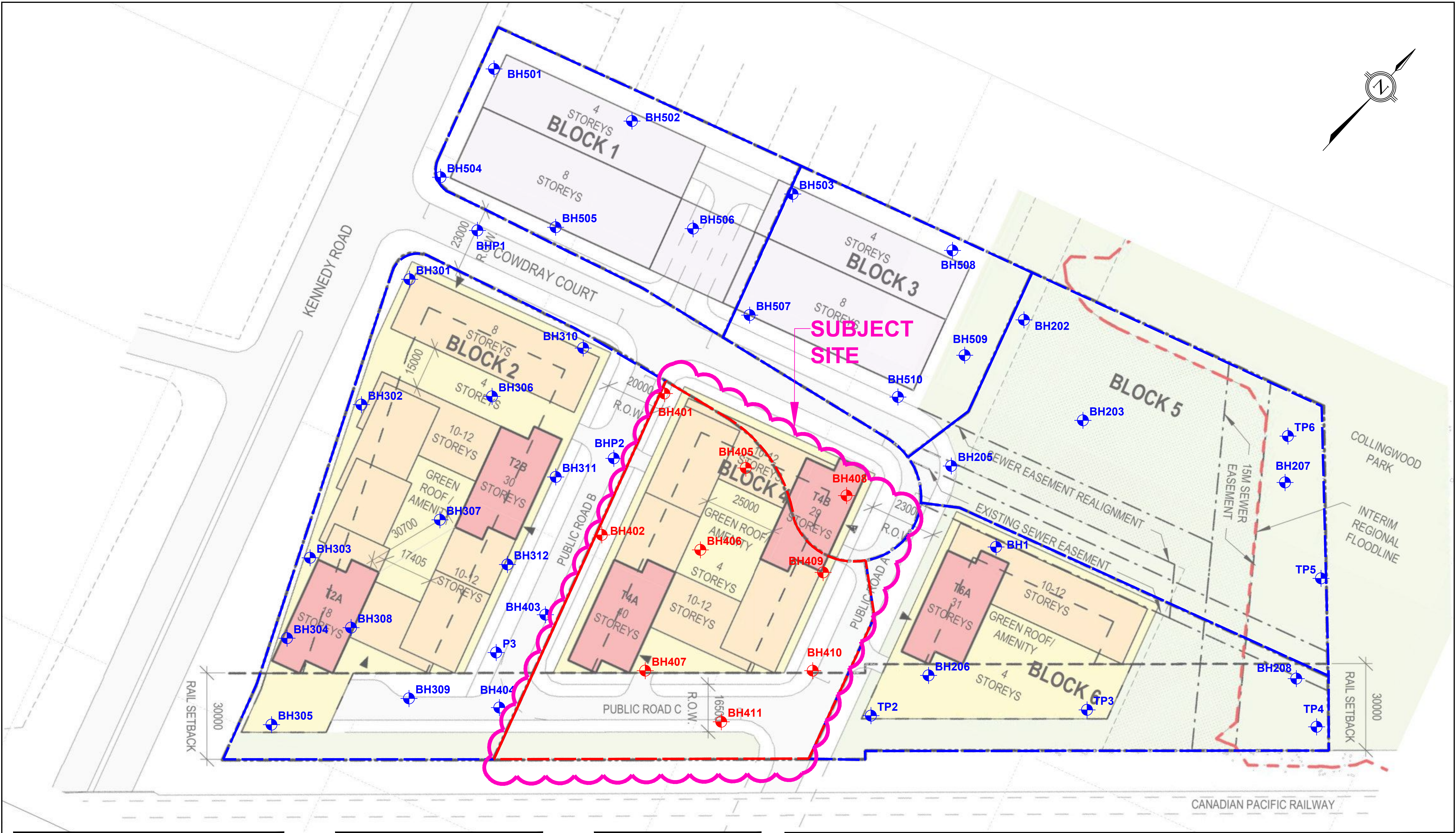
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: BOREHOLE LOCATION PLAN - EXISTING (BLOCK 4)

File No. 1-18-0476-01

FIGURE : 2A

Z:\1-Project Files\2018\1-18-0476 - Cowdray Blocks 1-6, Toronto\01 Subsurface (Blocks 2,4,5,6)\A. Dwgs, Logs\AutoCAD\1-18-0476-01 (2019 01 02) FIG.dwg, Sandy



REFERENCE

GemTerra Cowdray Court, Project No.: 17-118
Dated: MP100 Master Plan, By: Teeple Architects

LEGEND

🔴 Borehole Location (Block 4)
🔵 Borehole Location (Other Blocks)

APPROXIMATE SCALE 1:125
20 16 12 8 4 0 10 20m

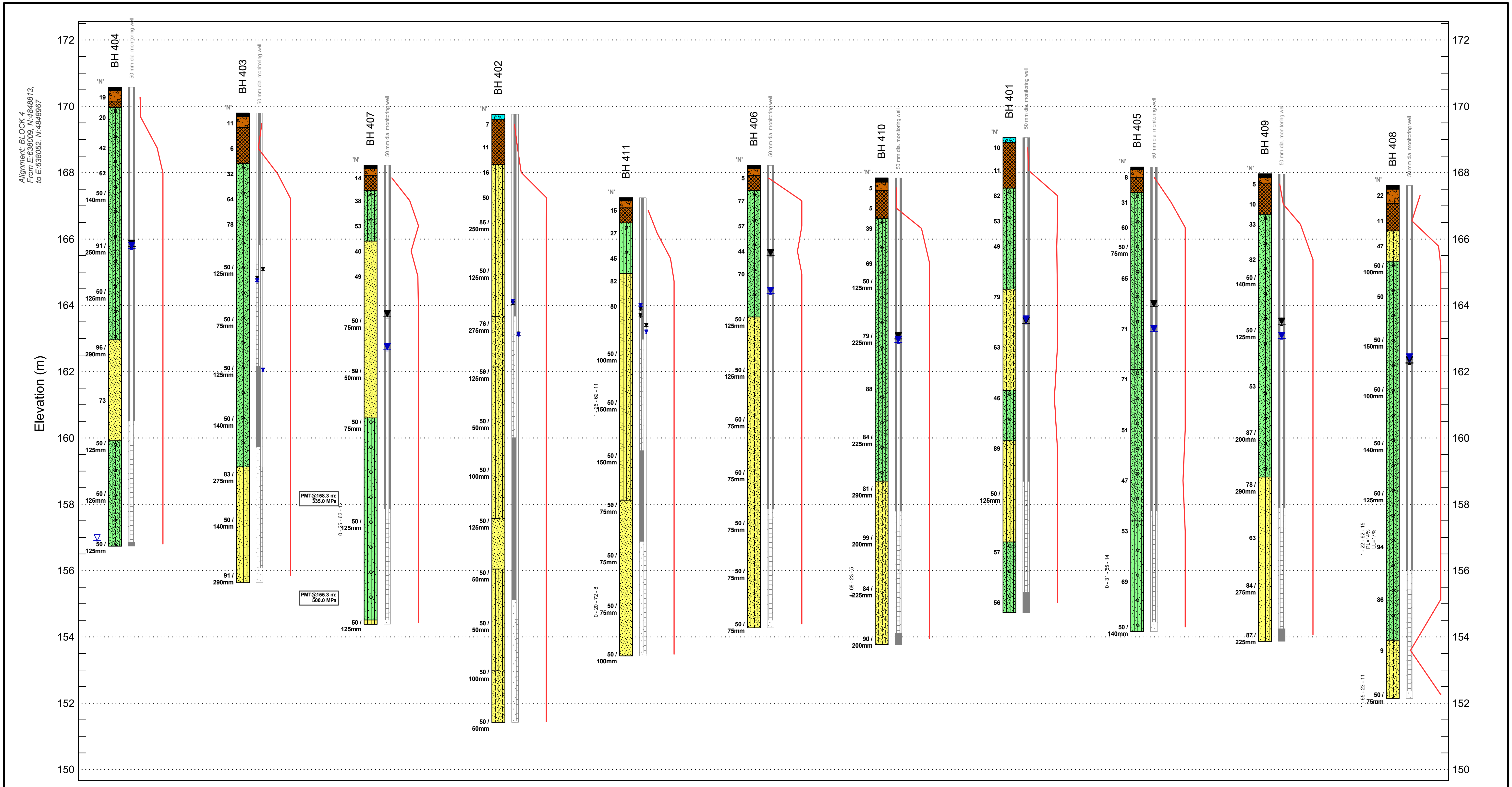
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: BOREHOLE LOCATION PLAN - PROPOSED (BLOCK 4)

FIGURE : 2B

File No. 1-18-0476-01

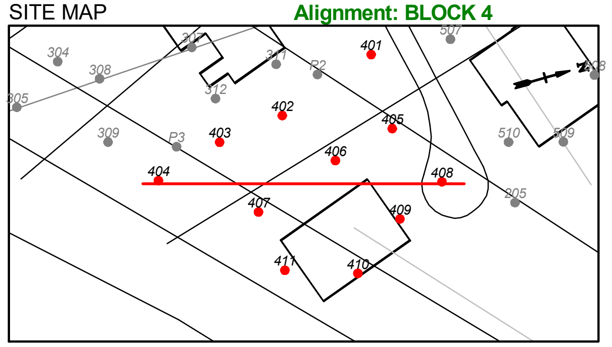
Z:\1-Project Files\2018\1-18-0476 - Cowdray Blocks 1-6, Toronto\01 Subsurface (Blocks 2,4,5,6)\A. Dwgs, Logs\AutoCAD\1-18-0476-01 (2019 01 02) FIG.dwg, Sandy



Boreholes Equally Spaced

SITE MAP

Alignment: BLOCK 4



LITHOLOGY GRAPHIC LEGEND

- Topsoil
- Fill
- Sand and Silt Till
- Silty Sand
- Sand and Silt
- Sand
- Asphalt
- Aggregate
- Silt and Sand Till
- Sandy Silt
- Silty Sand Till
- Sandy Silt Till
- 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)

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(905) 796-2650

Title:
SUBSURFACE PROFILE
BLOCK 4

File No.: **1-18-0476**

FIGURE:
3

APPENDIX A

TERRAPROBE INC.

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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
silty	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
PID	photoionization detector
FID	flame ionization detector

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 plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

Terraprobe

LOG OF BOREHOLE 401

Project No. : 1-18-0476
Date started : 2018 October 1
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : NB
Compiled by : JH
Checked by : JC

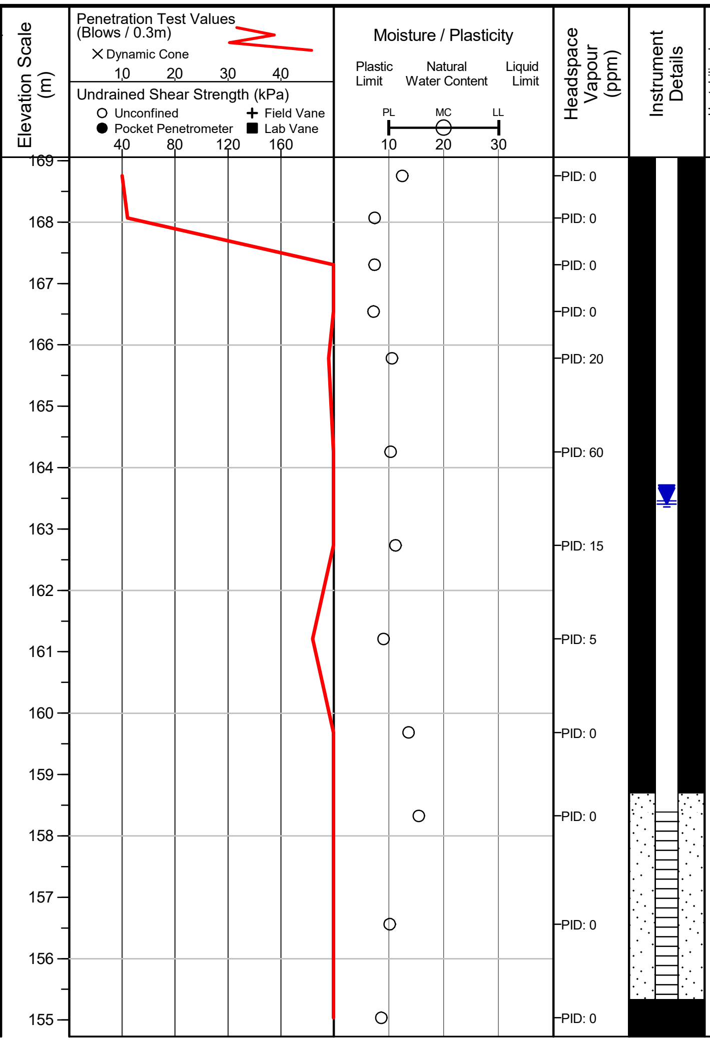
Position : E: 637978, N: 4848940 (UTM 17T)
Rig type : CME 75, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers / mud rotary with casing

SOIL PROFILE

Elev Depth (m)	Description
169.1	**GROUND SURFACE**
	150mm **TOPSOIL**
	FILL, sand and silt, some clay, trace gravel, compact, dark brown to brown, damp
167.6 1.5	**SAND AND SILT**, some clay, trace gravel, very dense, brown with mottled orange, moist (GLACIAL TILL)
164.5 4.6	**SILTY SAND**, trace gravel, trace clay, very dense, grey, wet
161.5 7.6	**SAND AND SILT**, some clay, trace gravel, very dense, grey, moist (GLACIAL TILL)
160.0 9.1	**SAND AND SILT**, trace clay, trace gravel, very dense, grey, moist ...at 10.7 m, sand seams
156.9 12.2	**SAND AND SILT**, trace clay, trace gravel, very dense, grey, wet (GLACIAL TILL)
154.8 14.3	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
1	SS	10	PID: 0
2	SS	11	PID: 0
3	SS	82	PID: 0
4	SS	53	PID: 0
5	SS	49	PID: 20
6	SS	79	PID: 60
7	SS	63	PID: 15
8	SS	46	PID: 5
9	SS	89	PID: 0
10	SS	50 / 125mm	PID: 0
11	SS	57	PID: 0
12	SS	56	PID: 0



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

SS1 Analysis:
M&I, PAH

SS2 Analysis:
VOC, PHC

SS3 Analysis:
PAH
...at 3.0m, awitched to mud rotary

SS6 Analysis:
VOC, PHC

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	5.7	163.4
Oct 10, 2018	5.7	163.4
Oct 25, 2018	5.7	163.4
Nov 8, 2018	5.6	163.5
Nov 12, 2018	5.6	163.5
Nov 15, 2018	5.6	163.5

Terraprobe

LOG OF BOREHOLE 402

Project No. : 1-18-0476
Client : Gemterra Developments Corp.
Originated by : NB

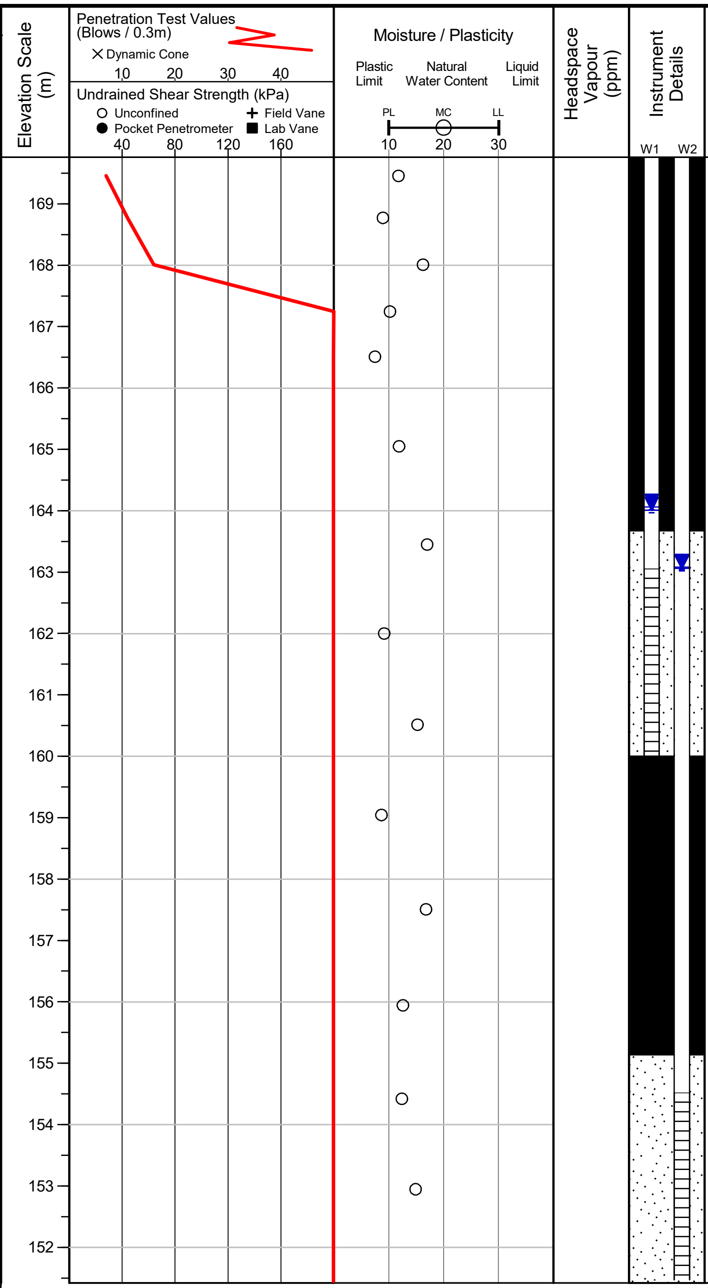
Date started : 2018 October 2
Project : Cowdray Court, Parcels 1- 6
Compiled by : JH

Sheet No. : 1 of 1
Location : Toronto, Ontario
Checked by : JC

Position : E: 637995, N: 4848889 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 75, track-mounted
Drilling Method : Solid stem augers / mud rotary with casing

Elev Depth (m)	SOIL PROFILE Description	Number	Type	SPT 'N' Value
169.8	**GROUND SURFACE**			
	150mm **TOPSOIL**	1	SS	7
168.3 1.5	**FILL**, sand and silt, some clay, trace gravel, loose to compact, dark brown to brown, moist	2	SS	11
	SAND AND SILT, trace gravel, trace clay, compact, orange and grey, moist	3	SS	16
	...at 2.3 m, very dense	4	SS	50
	...at 3.0 m, grey with mottled orange	5	SS	86 / 250mm
163.7 6.1	...at 4.6 m, grey, wet	6	SS	50 / 125mm
162.2 7.6	**SILTY SAND**, trace clay, silt seams, very dense, grey, wet	7	SS	76 / 275mm
	SAND AND SILT, trace gravel, trace clay, very dense, grey, wet	8	SS	50 / 125mm
		9	SS	50 / 50mm
157.6 12.2		10	SS	50 / 100mm
156.1 13.7	**SAND**, some silt, trace gravel, very dense, grey, wet	11	SS	50 / 125mm
	SAND AND SILT, trace gravel, trace clay, trace rock fragments, cobbles (inferred), very dense, grey, wet	12	SS	50 / 50mm
153.0 16.8	...at 15.2 m, trace rock fragments, cobbles (inferred)	13	SS	50 / 50mm
151.5 18.3	**SILTY SAND**, trace clay, very dense, grey, wet	14	SS	50 / 100mm
	...at 18.3 m, trace gravel	15	SS	50 / 50mm



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

...at 3.0m, switched to mud rotary

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

W1: 50 mm dia. monitoring well installed.
W2: 50 mm dia. monitoring well installed.

W1 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	5.8	164.0
Oct 10, 2018	5.8	164.0
Oct 25, 2018	5.8	164.0
Nov 8, 2018	5.8	164.0
Nov 15, 2018	5.7	164.1

W2 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	6.7	163.1
Oct 10, 2018	6.7	163.1
Oct 25, 2018	6.7	163.1
Nov 8, 2018	6.7	163.1
Nov 15, 2018	6.7	163.1

LOG OF BOREHOLE 403

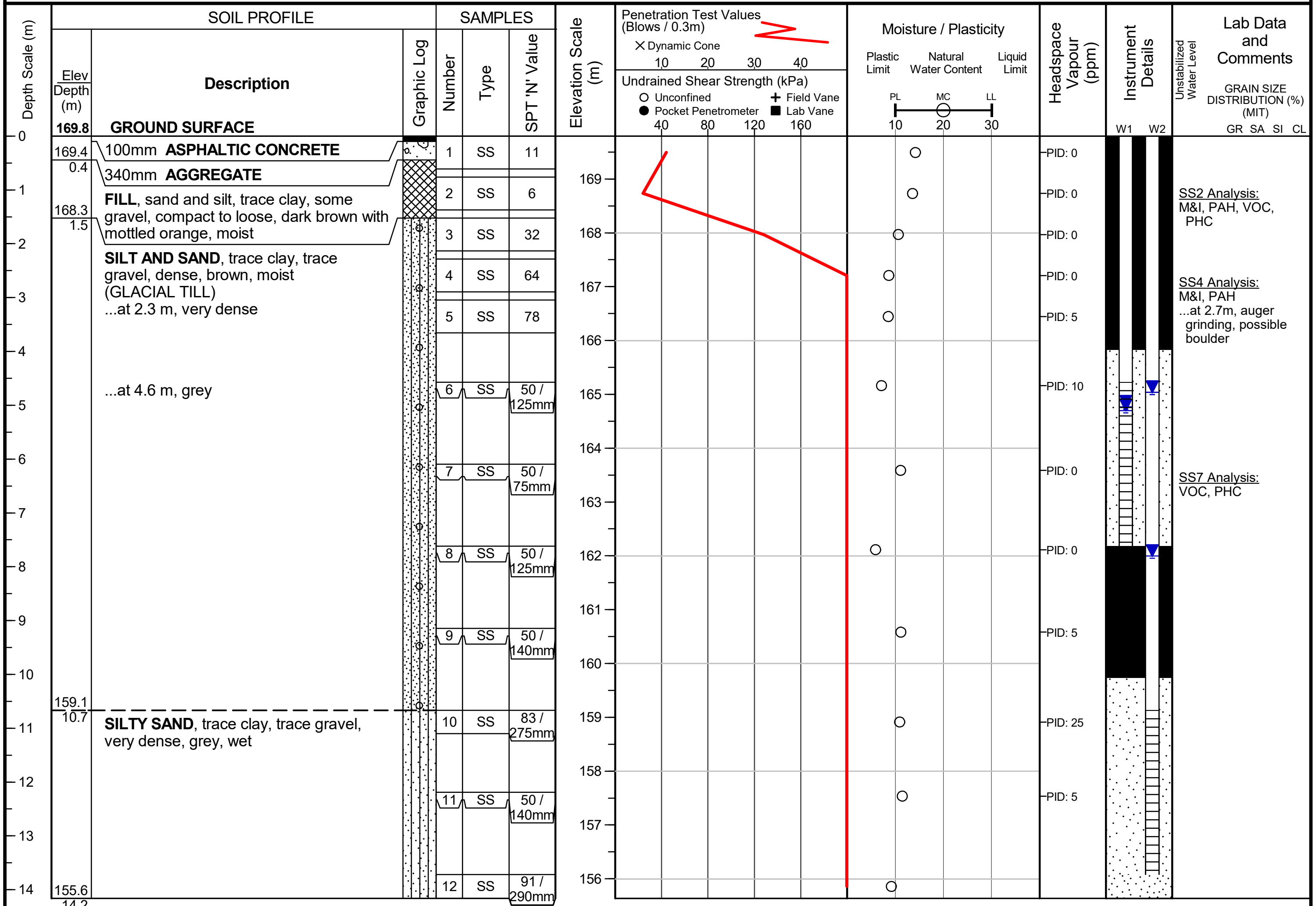
Project No. : 1-18-0476	Client : Gemterra Developments Corp.	Originated by : NB
Date started : 2018 October 4	Project : Cowdray Court, Parcels 1- 6	Compiled by : AJ
Sheet No. : 1 of 1	Location : Toronto, Ontario	Checked by : JC

Position : E: 638000, N: 4848855 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 75

Drilling Method : Hollow stem augers



Elev Depth (m)	Description
169.8	**GROUND SURFACE**
169.4 0.4	100mm **ASPHALTIC CONCRETE**
	340mm **AGGREGATE**
168.3 1.5	**FILL**, sand and silt, trace clay, some gravel, compact to loose, dark brown with mottled orange, moist
	SILT AND SAND, trace clay, trace gravel, dense, brown, moist (GLACIAL TILL) ...at 2.3 m, very dense ...at 4.6 m, grey
159.1 10.7	**SILTY SAND**, trace clay, trace gravel, very dense, grey, wet
155.6 14.2	

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
1	SS	11	PID: 0
2	SS	6	PID: 0
3	SS	32	PID: 0
4	SS	64	PID: 0
5	SS	78	PID: 5
6	SS	50 / 125mm	PID: 10
7	SS	50 / 75mm	PID: 0
8	SS	50 / 125mm	PID: 0
9	SS	50 / 140mm	PID: 5
10	SS	83 / 275mm	PID: 25
11	SS	50 / 140mm	PID: 5
12	SS	91 / 290mm	

Lab Data and Comments:

SS2 Analysis:
M&I, PAH, VOC, PHC

SS4 Analysis:
M&I, PAH
...at 2.7m, auger grinding, possible boulder

SS7 Analysis:
VOC, PHC

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

W1: 50 mm dia. monitoring well installed.
W2: 50 mm dia. monitoring well installed.

W1 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	5.0	164.8
Oct 12, 2018	5.0	164.8
Oct 25, 2018	5.1	164.7
Nov 11, 2018	5.1	164.7

W2 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	4.8	165.0
Oct 12, 2018	4.8	165.0
Oct 25, 2018	4.8	165.0
Nov 11, 2018	7.8	162.0

file: 1-18-0476 bh logs - final.gpj

Terraprobe

LOG OF BOREHOLE 404

Project No. : 1-18-0476
Date started : 2018 October 4
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : NB
Compiled by : JH
Checked by : JC

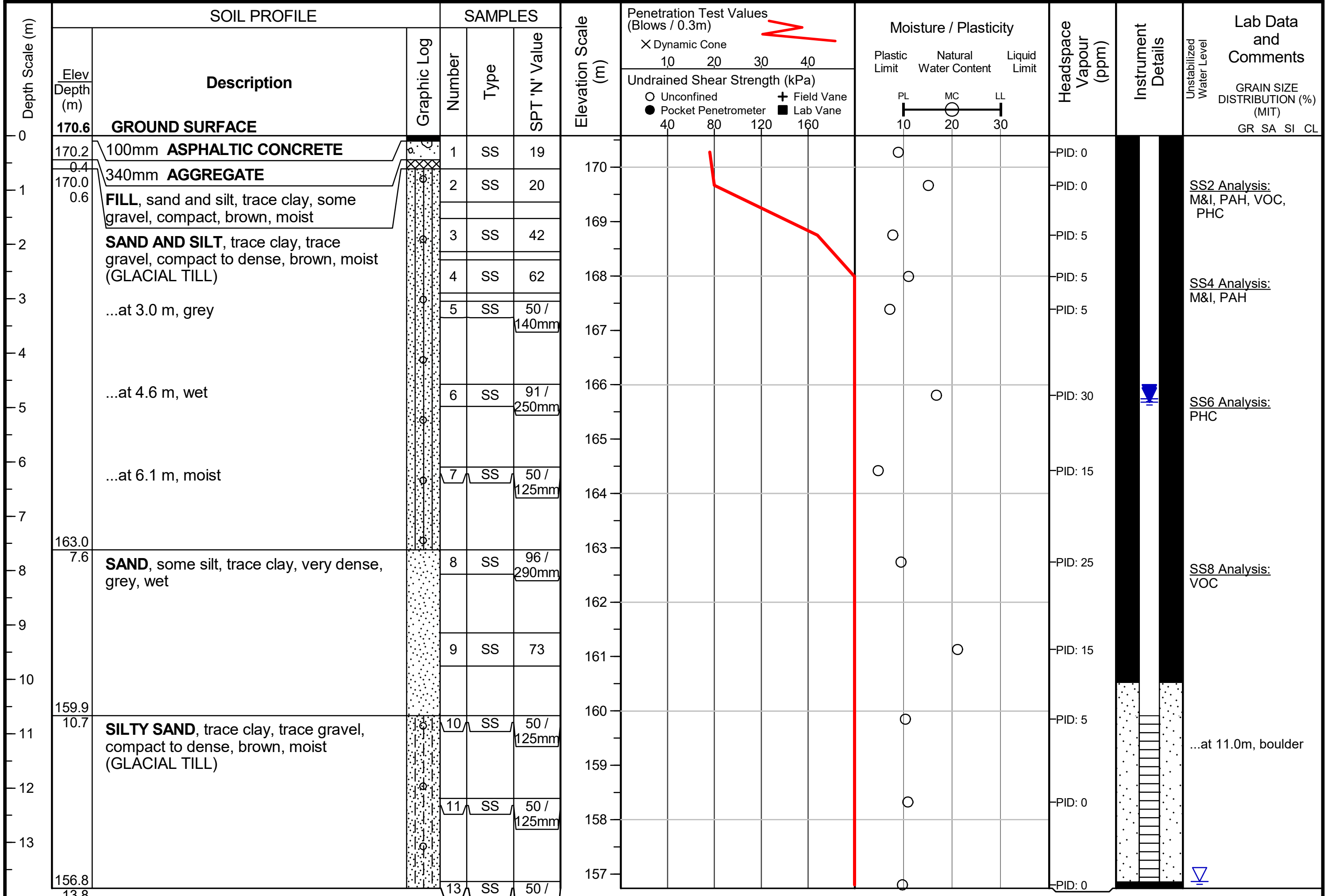
Position : E: 638010, N: 4848821 (UTM 17T)
Rig type : CME 75
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers

SOIL PROFILE

Elev Depth (m)	Description
170.6	**GROUND SURFACE**
170.2	100mm **ASPHALTIC CONCRETE**
0.4	340mm **AGGREGATE**
170.0 0.6	**FILL**, sand and silt, trace clay, some gravel, compact, brown, moist
	SAND AND SILT, trace clay, trace gravel, compact to dense, brown, moist (GLACIAL TILL) ...at 3.0 m, grey ...at 4.6 m, wet ...at 6.1 m, moist
163.0 7.6	**SAND**, some silt, trace clay, very dense, grey, wet
159.9 10.7	**SILTY SAND**, trace clay, trace gravel, compact to dense, brown, moist (GLACIAL TILL)
156.8 13.8	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
1	SS	19	PID: 0
2	SS	20	PID: 0
3	SS	42	PID: 5
4	SS	62	PID: 5
5	SS	50 / 140mm	PID: 5
6	SS	91 / 250mm	PID: 30
7	SS	50 / 125mm	PID: 15
8	SS	96 / 290mm	PID: 25
9	SS	73	PID: 15
10	SS	50 / 125mm	PID: 5
11	SS	50 / 125mm	PID: 0
13	SS	50 / 125mm	PID: 0



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

SS2 Analysis: M&I, PAH, VOC, PHC

SS4 Analysis: M&I, PAH

SS6 Analysis: PHC

SS8 Analysis: VOC

...at 11.0m, boulder

END OF BOREHOLE

Unstabilized water level measured at 13.7 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)
Oct 5, 2018	4.8	165.7
Oct 12, 2018	4.8	165.7
Oct 25, 2018	4.9	165.7
Nov 8, 2018	4.9	165.7

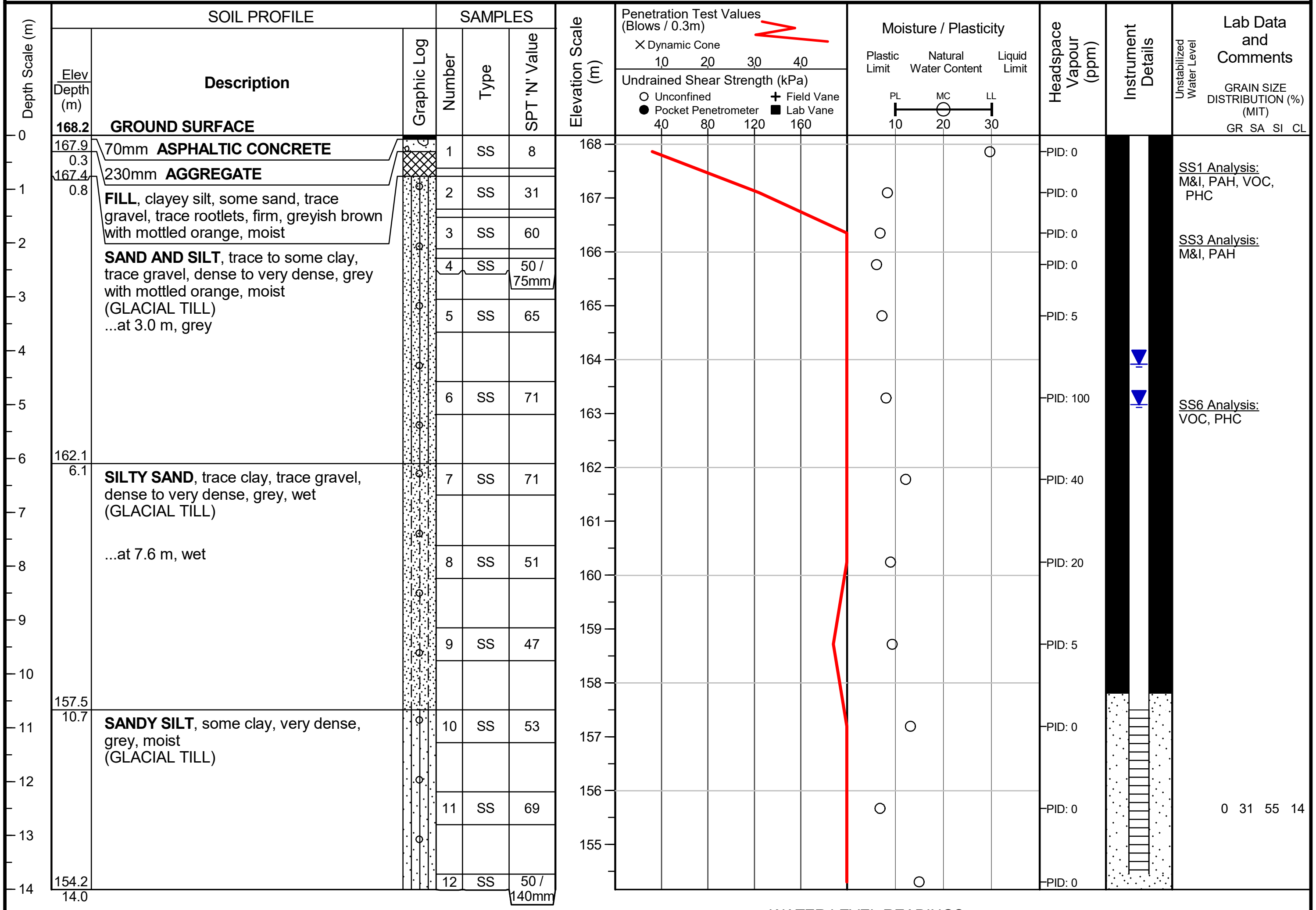
LOG OF BOREHOLE 405

Project No. : 1-18-0476
Date started : 2018 October 3
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : NB
Compiled by : JH
Checked by : JC

Position : E: 638016, N: 4848940 (UTM 17T)
Rig type : CME 75
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers



Elev Depth (m)	Description
168.2	**GROUND SURFACE**
167.9 0.3	70mm **ASPHALTIC CONCRETE**
167.4 0.8	230mm **AGGREGATE**
	FILL, clayey silt, some sand, trace gravel, trace rootlets, firm, greyish brown with mottled orange, moist
	SAND AND SILT, trace to some clay, trace gravel, dense to very dense, grey with mottled orange, moist (GLACIAL TILL) ...at 3.0 m, grey
162.1 6.1	**SILTY SAND**, trace clay, trace gravel, dense to very dense, grey, wet (GLACIAL TILL) ...at 7.6 m, wet
157.5 10.7	**SANDY SILT**, some clay, very dense, grey, moist (GLACIAL TILL)
154.2 14.0	**END OF BOREHOLE**

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments
1	SS	8	PID: 0	SS1 Analysis: M&I, PAH, VOC, PHC
2	SS	31	PID: 0	
3	SS	60	PID: 0	SS3 Analysis: M&I, PAH
4	SS	50 / 75mm	PID: 0	
5	SS	65	PID: 5	
6	SS	71	PID: 100	SS6 Analysis: VOC, PHC
7	SS	71	PID: 40	
8	SS	51	PID: 20	
9	SS	47	PID: 5	
10	SS	53	PID: 0	
11	SS	69	PID: 0	0 31 55 14
12	SS	50 / 140mm	PID: 0	

Borehole was filled with drill water upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	4.3	163.9
Oct 10, 2018	4.3	163.9
Nov 9, 2018	4.1	164.0
Nov 11, 2018	4.1	164.1
Nov 15, 2018	5.0	163.2

file: 1-18-0476 bh logs - final.gpj

Terraprobe

LOG OF BOREHOLE 406

Project No. : 1-18-0476
Date started : 2018 October 3
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : SM
Compiled by : JH
Checked by : JC

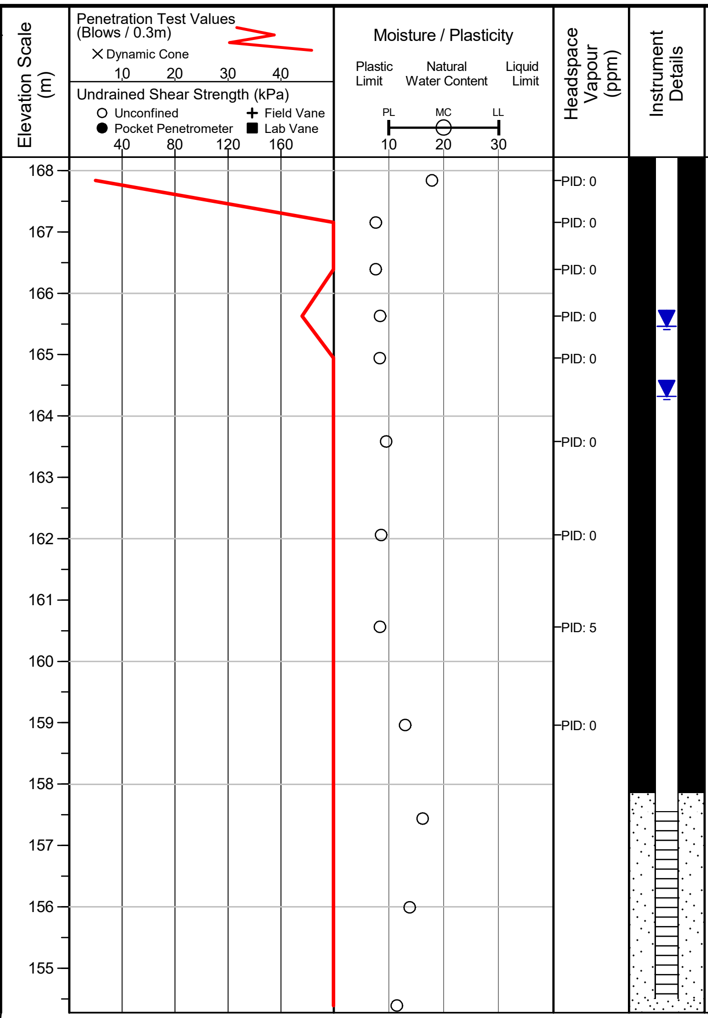
Position : E: 638024, N: 4848908 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers / mud rotary with casing

SOIL PROFILE

Elev Depth (m)	Description
168.2	**GROUND SURFACE**
	90mm **ASPHALTIC CONCRETE**
167.9 0.3	210mm **AGGREGATE**
167.4 0.8	**FILL**, sand and silt, some clay, trace gravel, loose, brown and grey, moist
	SAND AND SILT, trace clay, trace gravel, very dense to dense, brown, moist (GLACIAL TILL) ...at 1.5 m, brown with mottled orange ...at 2.3 m, grey
163.6 4.6	**SILTY SAND**, trace clay, very dense, grey, wet ...at 6.1 m, trace rock fragments ...at 7.6 m, trace rock fragments
154.3 13.9	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments
1	SS	5	PID: 0	SS1 Analysis: M&I, PAH, VOC, PHC
2	SS	77	PID: 0	
3	SS	57	PID: 0	SS2 Analysis: M&I, PAH
4	SS	44	PID: 0	
5	SS	70	PID: 0	...at 3.0m, switched to mud rotary
6	SS	50 / 125mm	PID: 0	
7	SS	50 / 125mm	PID: 0	
8	SS	50 / 75mm	PID: 5	
9	SS	50 / 75mm	PID: 0	
10	SS	50 / 75mm		SS10 Analysis: PHC
11	SS	50 / 75mm		
12	SS	50 / 75mm		SS12 Analysis: VOC



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

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	2.8	165.5
Oct 10, 2018	2.8	165.5
Oct 25, 2018	4.0	164.3
Nov 8, 2018	3.9	164.3
Nov 15, 2018	3.9	164.3

Terraprobe

LOG OF BOREHOLE 407

Project No. : 1-18-0476
Client : Gemterra Developments Corp.
Originated by : SM
Date started : 2018 October 5
Project : Cowdray Court, Parcels 1- 6
Compiled by : JH
Sheet No. : 1 of 1
Location : Toronto, Ontario
Checked by : JC

Position : E: 638038, N: 4848865 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers / mud rotary with casing

SOIL PROFILE

Elev Depth (m)	Description
168.2	**GROUND SURFACE**
167.9 0.3	100mm **ASPHALTIC CONCRETE**
167.4 0.8	200mm **AGGREGATE**
	FILL, sand and silt, trace clay, trace gravel, trace rootlets, compact, brown with mottled orange, moist
165.9 2.3	**SAND AND SILT**, trace clay, trace gravel, dense to very dense, brown with mottled orange, moist (GLACIAL TILL)
	SAND, some silt, trace gravel, dense, brown and grey, wet ...at 3.0 m, grey ...at 4.6 m, trace rock fragments, inferred boulder
160.6 7.6	**SANDY SILT**, some clay, trace gravel, very dense, grey, wet (GLACIAL TILL)
154.5 154.4 13.8	**SILT**, some sand, layered, very dense, grey, moist

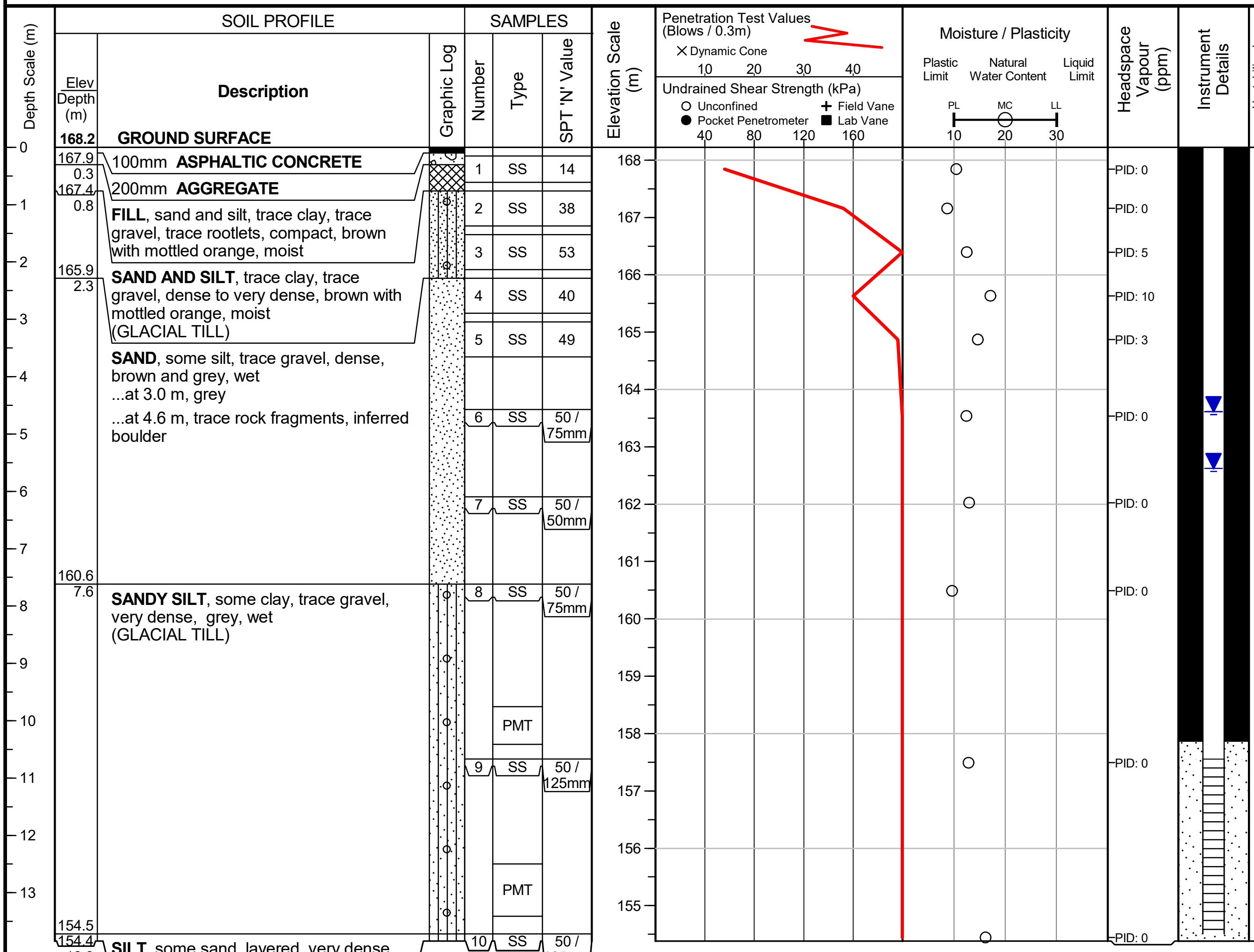
END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

SAMPLES

Number	Type	SPT 'N' Value
1	SS	14
2	SS	38
3	SS	53
4	SS	40
5	SS	49
6	SS	50 / 75mm
7	SS	50 / 50mm
8	SS	50 / 75mm
	PMT	
9	SS	50 / 125mm
	PMT	
10	SS	50 / 125mm



Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
0	25	63	12

SS1 Analysis:
M&I, PAH, VOC, PHC

SS3 Analysis:
M&I, PAH

SS4 Analysis:
PHC

SS5 Analysis:
VOC

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	4.6	163.6
Oct 10, 2018	4.6	163.6
Oct 25, 2018	4.7	163.6
Nov 8, 2018	4.7	163.5
Nov 15, 2018	5.6	162.6

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Terraprobe

LOG OF BOREHOLE 408

Project No. : 1-18-0476
Client : Gemterra Developments Corp.
Originated by : NB
Date started : 2018 October 12
Project : Cowdray Court, Parcels 1- 6
Compiled by : AJ
Sheet No. : 1 of 1
Location : Toronto, Ontario
Checked by : JC

Position : E: 638048, N: 4848957 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 75
Drilling Method : Hollow stem augers

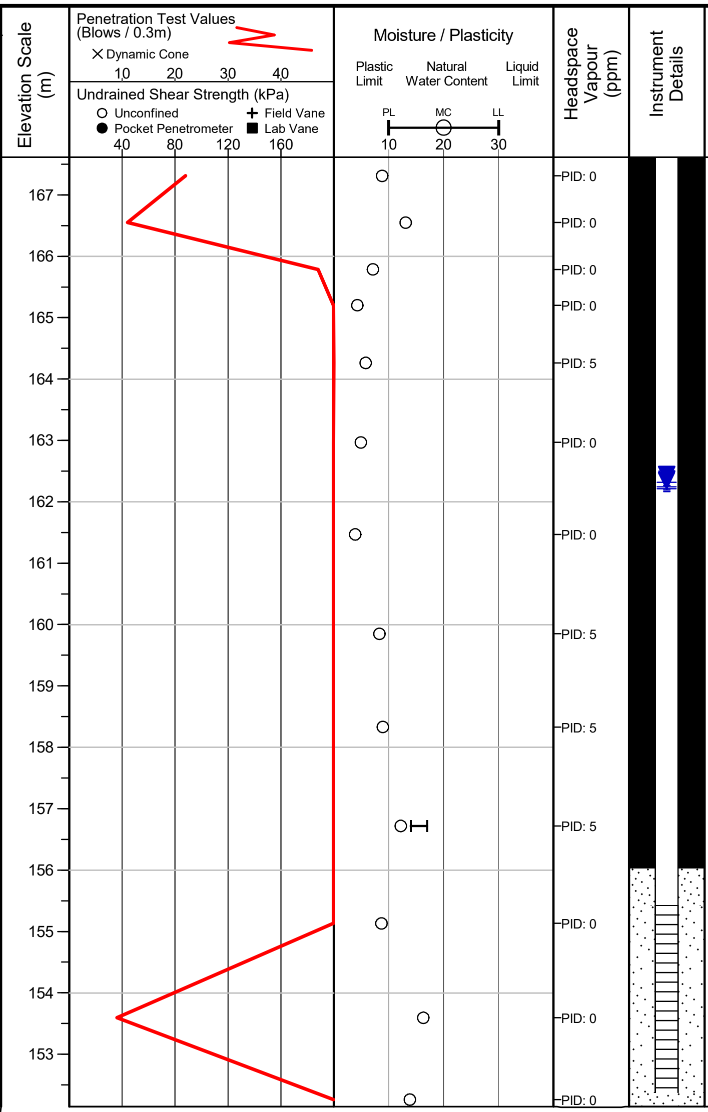
Elev (m)	Depth (m)	Description (SOIL PROFILE)
167.6		**GROUND SURFACE**
167.1	0.5	110mm **ASPHALT**
166.2	1.4	440mm **AGGREGATE**
165.3	2.3	**FILL**, sand and silt, trace clay, some gravel, compact, brown, moist
		SILTY SAND, trace clay, trace gravel, compact to dense, brown, wet
153.9	13.7	**SAND AND SILT**, some clay, trace gravel, very dense, grey, moist (GLACIAL TILL) ...at 10.7 m, sandy
152.1	15.5	**SILTY SAND**, some clay, trace gravel, loose, grey, wet ...at 15.2 m, very dense

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments / GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1	SS	22	PID: 0	
2	SS	11	PID: 0	SS2 Analysis: M&I, PAH, VOC, PHC
3	SS	47	PID: 0	
4	SS	50 / 100mm	PID: 0	SS4 Analysis: M&I, PAH
5	SS	50	PID: 5	
6	SS	50 / 150mm	PID: 0	
7	SS	50 / 100mm	PID: 0	
8	SS	50 / 140mm	PID: 5	SS8 Analysis: VOC, PHC
9	SS	50 / 125mm	PID: 5	
10	SS	94	PID: 5	1 22 62 15
11	SS	86	PID: 0	
12	SS	9	PID: 0	inferred, very dense ...at 13.7m, water added
13	SS	50 / 75mm	PID: 0	1 65 23 11



WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 16, 2018	5.4	162.2
Oct 25, 2018	5.4	162.2
Nov 8, 2018	5.3	162.3
Nov 12, 2018	5.3	162.3
Nov 15, 2018	5.3	162.3

file: 1-18-0476 bh logs - final.gpj

LOG OF BOREHOLE 409

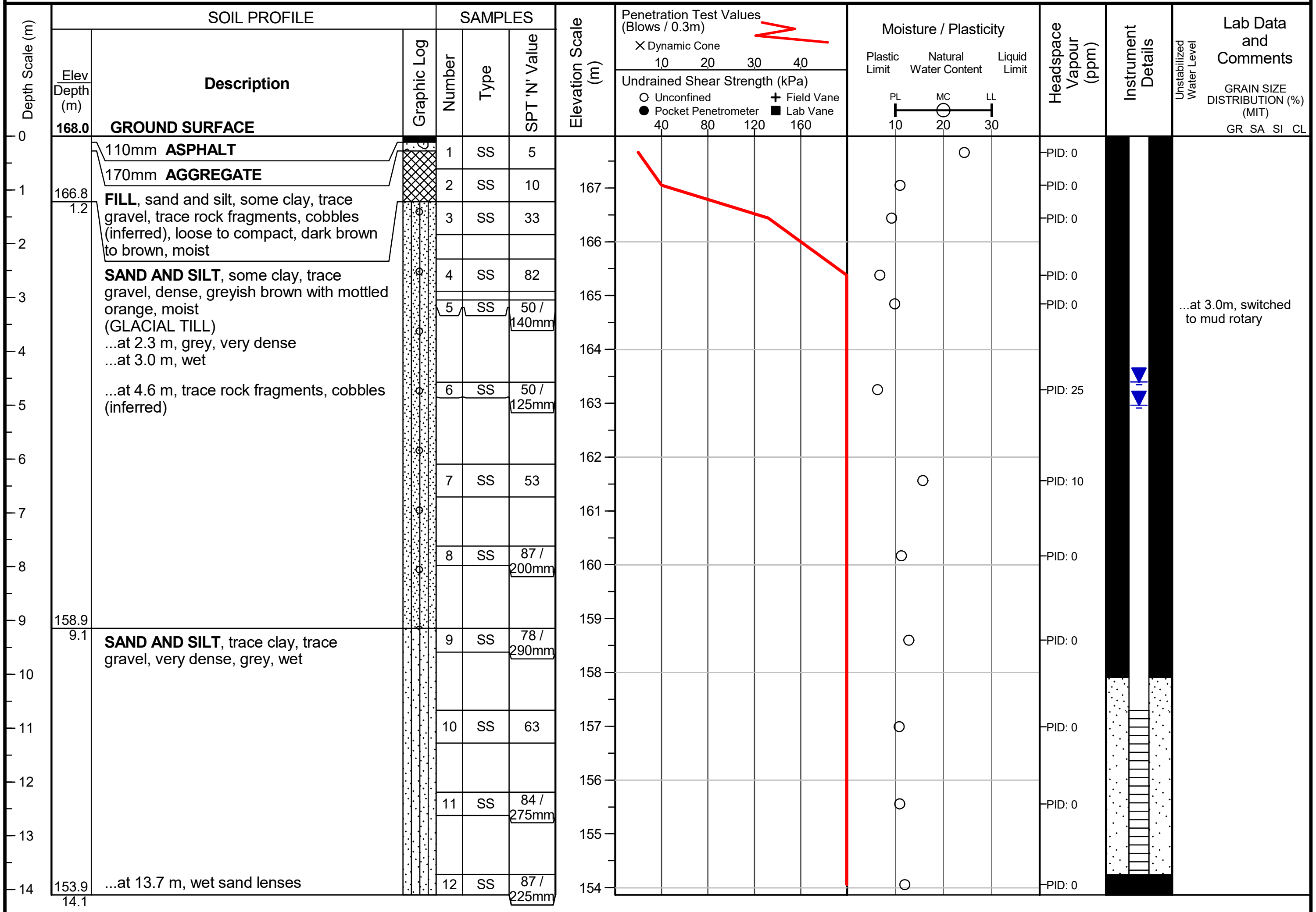
Project No. : 1-18-0476
Client : Gemterra Developments Corp.
Originated by : NB

Date started : 2018 October 1
Project : Cowdray Court, Parcels 1- 6
Compiled by : JH

Sheet No. : 1 of 1
Location : Toronto, Ontario
Checked by : JC

Position : E: 638061, N: 4848931 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 75, track-mounted
Drilling Method : Solid stem augers / mud rotary with casing



Elev Depth (m)	Description
168.0	**GROUND SURFACE**
	110mm **ASPHALT**
	170mm **AGGREGATE**
	FILL, sand and silt, some clay, trace gravel, trace rock fragments, cobbles (inferred), loose to compact, dark brown to brown, moist
166.8 1.2	**SAND AND SILT**, some clay, trace gravel, dense, greyish brown with mottled orange, moist (GLACIAL TILL) ...at 2.3 m, grey, very dense ...at 3.0 m, wet ...at 4.6 m, trace rock fragments, cobbles (inferred)
158.9 9.1	**SAND AND SILT**, trace clay, trace gravel, very dense, grey, wet ...at 13.7 m, wet sand lenses
153.9 14.1	

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
1	SS	5	PID: 0
2	SS	10	PID: 0
3	SS	33	PID: 0
4	SS	82	PID: 0
5	SS	50 / 140mm	PID: 0
6	SS	50 / 125mm	PID: 25
7	SS	53	PID: 10
8	SS	87 / 200mm	PID: 0
9	SS	78 / 290mm	PID: 0
10	SS	63	PID: 0
11	SS	84 / 275mm	PID: 0
12	SS	87 / 225mm	PID: 0

...at 3.0m, switched to mud rotary

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	4.6	163.4
Oct 10, 2018	4.6	163.4
Oct 25, 2018	5.1	162.9
Nov 8, 2018	5.0	163.0
Nov 15, 2018	5.0	163.0

file: 1-18-0476 bh logs - final.gpj

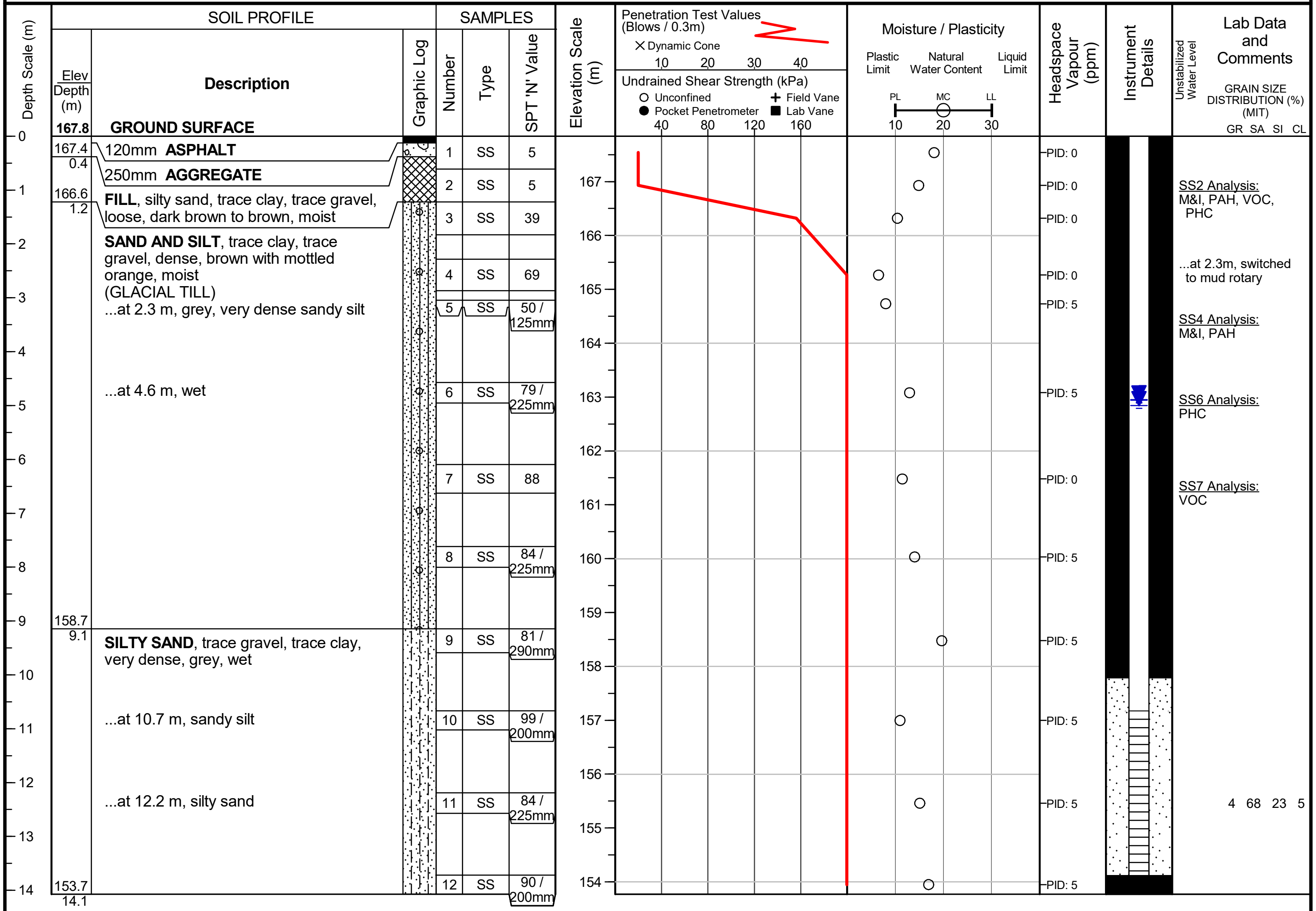
LOG OF BOREHOLE 410

Project No. : 1-18-0476
Date started : 2018 October 2
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : NB
Compiled by : JH
Checked by : JC

Position : E: 638081, N: 4848904 (UTM 17T)
Rig type : CME 75, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers / mud rotary with casing



Elev Depth (m)	Description
167.8	GROUND SURFACE
167.4 0.4	120mm **ASPHALT**
	250mm **AGGREGATE**
166.6 1.2	**FILL**, silty sand, trace clay, trace gravel, loose, dark brown to brown, moist
	SAND AND SILT, trace clay, trace gravel, dense, brown with mottled orange, moist (GLACIAL TILL) ...at 2.3 m, grey, very dense sandy silt ...at 4.6 m, wet
158.7 9.1	**SILTY SAND**, trace gravel, trace clay, very dense, grey, wet ...at 10.7 m, sandy silt ...at 12.2 m, silty sand
153.7 14.1	

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
1	SS	5	PID: 0
2	SS	5	PID: 0
3	SS	39	PID: 0
4	SS	69	PID: 0
5	SS	50 / 125mm	PID: 5
6	SS	79 / 225mm	PID: 5
7	SS	88	PID: 0
8	SS	84 / 225mm	PID: 5
9	SS	81 / 290mm	PID: 5
10	SS	99 / 200mm	PID: 5
11	SS	84 / 225mm	PID: 5
12	SS	90 / 200mm	PID: 5

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
4	68	23	5

SS2 Analysis:
M&I, PAH, VOC, PHC

...at 2.3m, switched to mud rotary

SS4 Analysis:
M&I, PAH

SS6 Analysis:
PHC

SS7 Analysis:
VOC

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	4.9	162.9
Oct 10, 2018	4.9	163.0
Oct 25, 2018	5.0	162.8
Nov 8, 2018	5.0	162.8
Nov 15, 2018	5.0	162.8

Terraprobe

LOG OF BOREHOLE 411

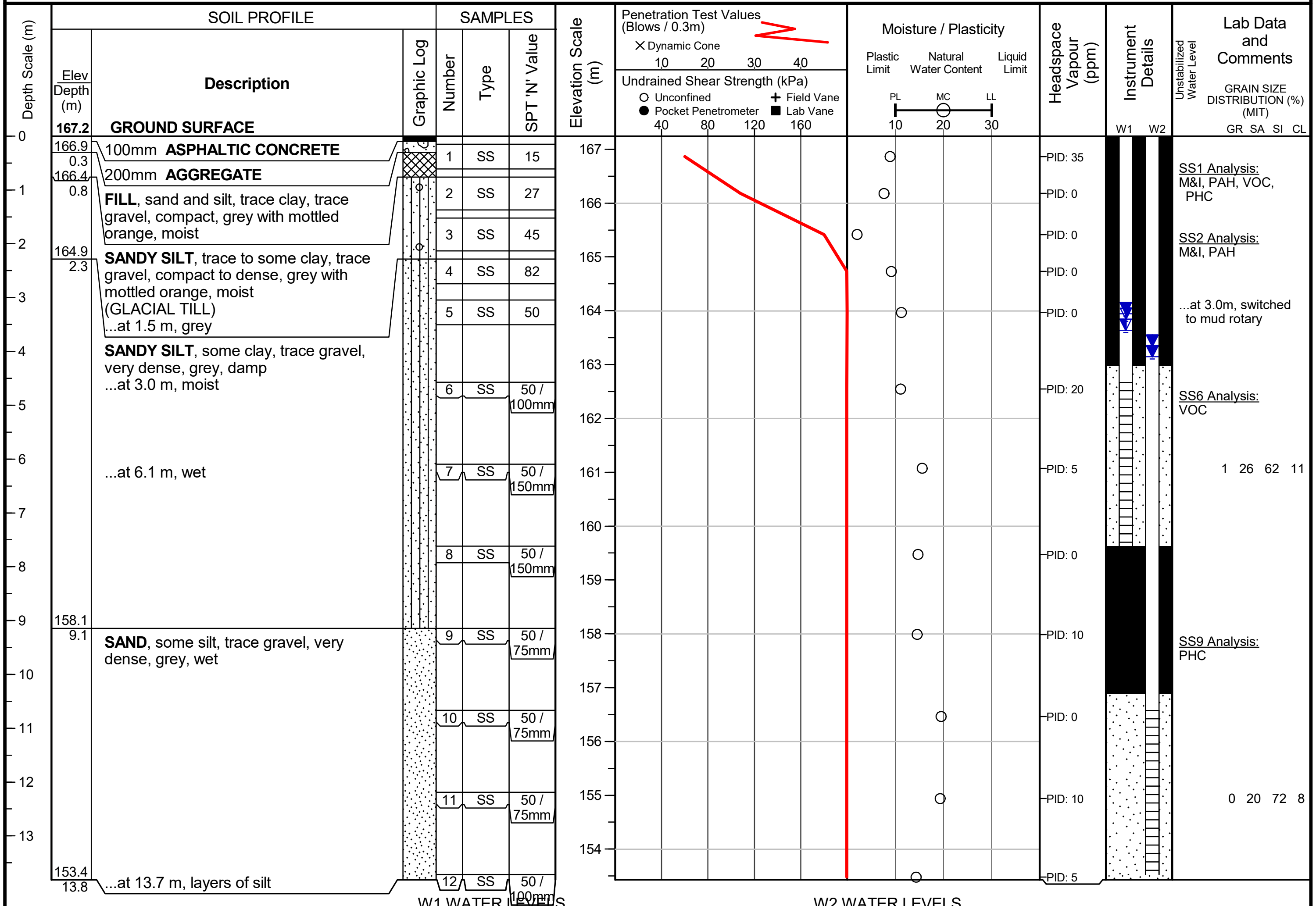
Project No. : 1-18-0476
Date started : 2018 October 4
Sheet No. : 1 of 1

Client : Gemterra Developments Corp.
Project : Cowdray Court, Parcels 1- 6
Location : Toronto, Ontario

Originated by : SM
Compiled by : JH
Checked by : JC

Position : E: 638070, N: 4848869 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers / mud rotary with casing



Elev / Depth (m)	Description
167.2	**GROUND SURFACE**
166.9 0.3	100mm **ASPHALTIC CONCRETE**
166.4 0.8	200mm **AGGREGATE**
	FILL, sand and silt, trace clay, trace gravel, compact, grey with mottled orange, moist
164.9 2.3	**SANDY SILT**, trace to some clay, trace gravel, compact to dense, grey with mottled orange, moist (GLACIAL TILL) ...at 1.5 m, grey
	SANDY SILT, some clay, trace gravel, very dense, grey, damp ...at 3.0 m, moist ...at 6.1 m, wet
158.1 9.1	**SAND**, some silt, trace gravel, very dense, grey, wet ...at 13.7 m, layers of silt
153.4 13.8	

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	GR	SA	SI	CL	Lab Data and Comments
1	SS	15	PID: 35					SS1 Analysis: M&I, PAH, VOC, PHC
2	SS	27	PID: 0					
3	SS	45	PID: 0					SS2 Analysis: M&I, PAH
4	SS	82	PID: 0					
5	SS	50	PID: 0					...at 3.0m, switched to mud rotary
6	SS	50 / 100mm	PID: 20					SS6 Analysis: VOC
7	SS	50 / 150mm	PID: 5	1	26	62	11	
8	SS	50 / 150mm	PID: 0					
9	SS	50 / 75mm	PID: 10					SS9 Analysis: PHC
10	SS	50 / 75mm	PID: 0					
11	SS	50 / 75mm	PID: 10	0	20	72	8	
12	SS	50 / 100mm	PID: 5					

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

W1: 50 mm dia. monitoring well installed.
W2: 50 mm dia. monitoring well installed.

W1 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 25, 2018	3.6	163.6
Nov 8, 2018	3.4	163.8
Nov 9, 2018	3.4	163.9
Nov 15, 2018	3.3	163.9

W2 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2018	3.9	163.3
Oct 10, 2018	3.9	163.3
Oct 25, 2018	4.1	163.1
Nov 8, 2018	4.1	163.1
Nov 9, 2018	4.1	163.2
Nov 15, 2018	4.1	163.1

LOG OF BOREHOLE 303

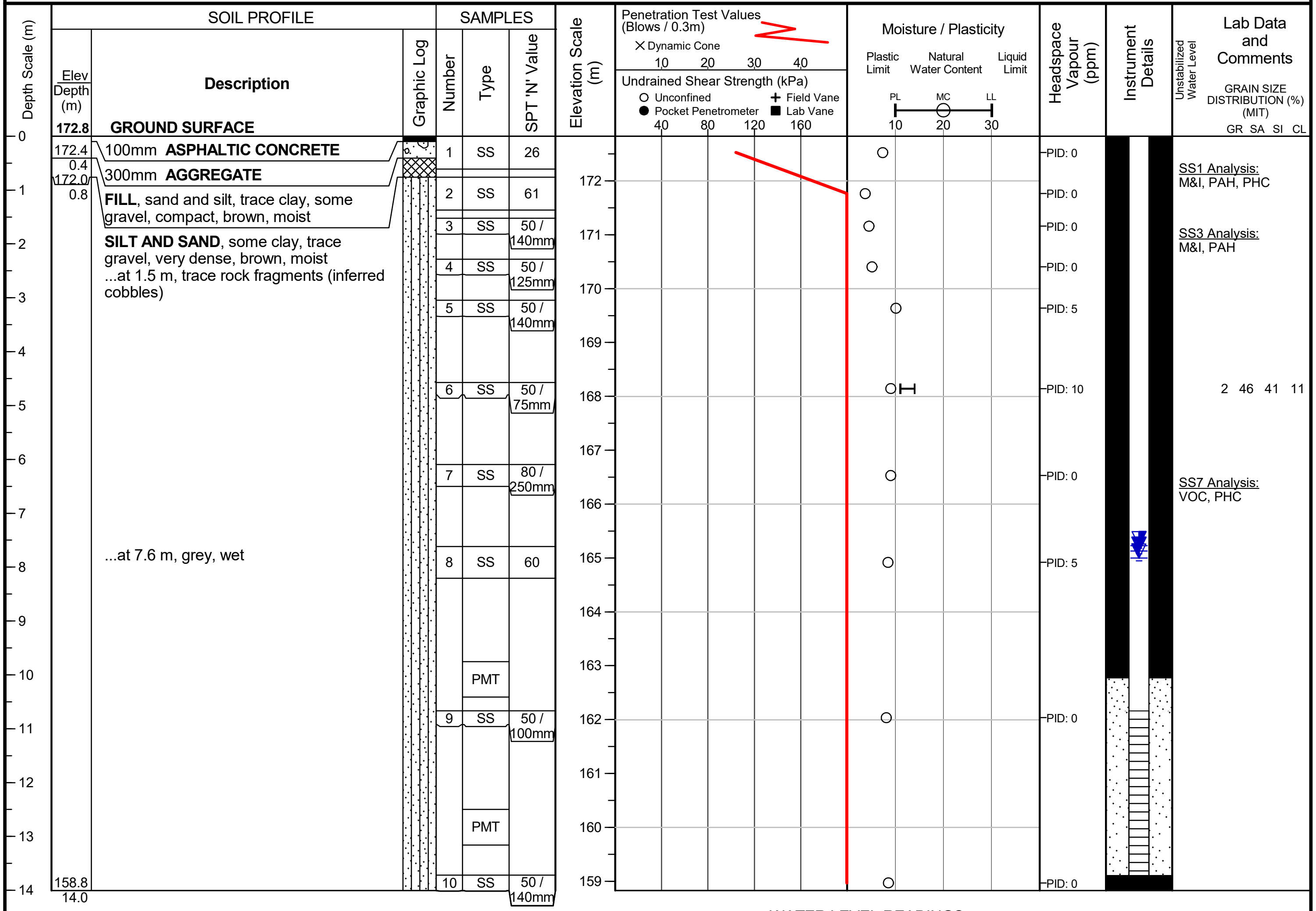
Project No. : 1-18-0476
Client : Gemterra Developments Corp.
Originated by : NB

Date started : 2018 October 11
Project : Cowdray Court, Parcels 1- 6
Compiled by : AJ

Sheet No. : 1 of 1
Location : Toronto, Ontario
Checked by : JC

Position : E: 637926, N: 4848814 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 75
Drilling Method : Hollow stem augers



Elev Depth (m)	Description
172.8	**GROUND SURFACE**
172.4 0.4	100mm **ASPHALTIC CONCRETE**
172.0 0.8	300mm **AGGREGATE**
	FILL, sand and silt, trace clay, some gravel, compact, brown, moist
	SILT AND SAND, some clay, trace gravel, very dense, brown, moist ...at 1.5 m, trace rock fragments (inferred cobbles) ...at 7.6 m, grey, wet
158.8 14.0	

Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments
1	SS	26	PID: 0	SS1 Analysis: M&I, PAH, PHC
2	SS	61	PID: 0	
3	SS	50 / 140mm	PID: 0	SS3 Analysis: M&I, PAH
4	SS	50 / 125mm	PID: 0	
5	SS	50 / 140mm	PID: 5	
6	SS	50 / 75mm	PID: 10	2 46 41 11
7	SS	80 / 250mm	PID: 0	SS7 Analysis: VOC, PHC
8	SS	60	PID: 5	
	PMT			
9	SS	50 / 100mm	PID: 0	
	PMT			
10	SS	50 / 140mm	PID: 0	

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 15, 2018	7.8	165.0
Oct 17, 2018	7.6	165.2
Nov 8, 2018	7.8	165.0
Nov 15, 2018	7.7	165.1

file: 1-18-0476 bh logs - final.gpj

APPENDIX B

TERRAPROBE INC.

In-Depth
Geotechnical Inc.

In-Situ Pressuremeter Testing
Cowdray Court, Scarborough, Ontario

October 21, 2018

Project No. IDG 180469

Prepared for:
Ms. Jory Hunter, EIT
Terraprobe Inc.
11 Indell Lane
Brampton, Ontario
L6T 3Y3

In-Depth Geotechnical Inc.
20 Ravenscliffe Avenue
Hamilton, Ontario
L8P 3M4
Phone: (905) 541 9937
Fax: (877) 624 0140

Table of Contents

1. Introduction

In-Depth Geotechnical Inc. was retained by Terraprobe Inc. to conduct Pressuremeter testing at the Cowdray Court site, in Scarborough, Ontario.

This report presents the results of pressuremeter testing (PMT) carried out at two borehole locations with the purpose of evaluating specific parameters related to a) shear strength; b) deformation properties; and c) in-situ lateral stresses of the encountered soils.

2. Field Testing Procedures

Pressuremeter testing was performed at two borehole locations, as indicated on site by Terraprobe representatives, namely, Boring Nos. 303-PMT and 407-PMT. Boring ground elevations were referenced to a nominal El. 100.00 m. Field work was completed on October 5 (BH 407-PMT), and October 11 (BH 303-PMT), 2018.

Drilling procedures were undertaken by Geo-Environmental Drilling contractor using a rubber track mounted CME 55 drill rig. The boreholes were advanced using rotary mud drilling technique. HW casing was installed to a depth of about 2.5 m below the ground surface to prevent the collapse at the borehole collar.

A total of 2 pressuremeter tests were completed at each boring location. The test sections of the boring were drilled with a tricone bit. The bit was advanced using continuous circulation of drilling mud to flush soil cuttings, producing a controlled diameter hole for the pressuremeter probe. A positive water head was kept inside the surface casing throughout drilling and in-situ testing procedures. In general, the drilling fluid remained at the top of casing.

Pre-boring pressuremeter testing was completed using a TEXAM unit. The testing procedure was in general accordance with Procedure B, volume-controlled loading, as outlined in the ASTM D 4719-00 Standard Test Method for Pre-bored Pressuremeter Testing of Soils. The testing equipment was calibrated for pressure and volume losses as indicated in the above mentioned standard. The control unit was de-aired prior to every test. Also, checks were completed to ensure that the probe, tubing, and control unit assembly were fully saturated, and that the probe membrane was leakage-free at high pressures. Time delays of 15 and 30 seconds were used for recording the pressure at each volume step. One unload-reload cycle has been completed for each PMT test.

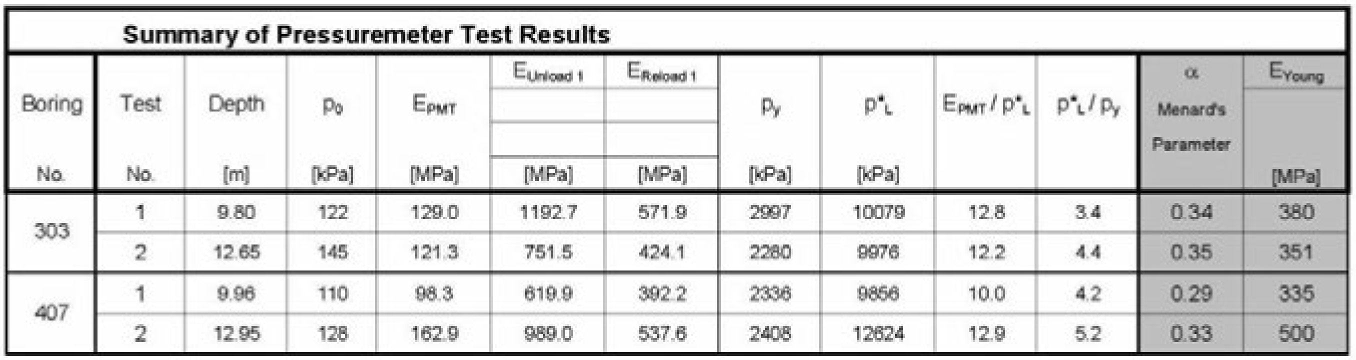
3. Pressuremeter Test Results

The pressuremeter test results are presented in Appendix One. The summary of pressuremeter test results are illustrated in Table No. 1 below.

A general guideline to interpret and infer soil properties based on available PMT test data is attached to Appendix Two. This guideline suggests accepted current procedures to estimate or infer shear strength, contact pressure, and other related soil parameters.

Undrained shear strength values for cohesive soils can be inferred using the method suggested in Appendix Two. Likewise, for cohesionless soils, approximated values of the friction angles can be correlated to the estimated values of the net limit pressure whenever available. See Figure 6-86 in Appendix Two-Page 5. Using the Menard α parameter together with the Pressiorama, we have inferred values of the Young's moduli. These inferred values are shown in the last two columns on the right of Table No. 1 (shaded columns).

TABLE No. 1



Summary of Pressuremeter Test Results

Boring No.	Test No.	Depth [m]	p_0 [kPa]	E_{PMT} [MPa]	$E_{Unload\ 1}$ [MPa]	$E_{Reload\ 1}$ [MPa]	p_y [kPa]	p^*_L [kPa]	E_{PMT} / p^*_L	p^*_L / p_y	α Menard's Parameter	E_{Young} [MPa]
303	1	9.80	122	129.0	1192.7	571.9	2997	10079	12.8	3.4	0.34	380
	2	12.65	145	121.3	751.5	424.1	2280	9976	12.2	4.4	0.35	351
407	1	9.96	110	98.3	619.9	392.2	2336	9856	10.0	4.2	0.29	335
	2	12.95	128	162.9	989.0	537.6	2408	12624	12.9	5.2	0.33	500

4. Closure

The subsoils data presented in this report is based on in-situ PMT testing and interpretation procedures. It should be noted that soil conditions may vary within the site and interpreted data may not be entirely representative of conditions at locations away from the tested borings. Therefore care should be exercised when extrapolating or inferring subsoil conditions away from the borehole location.

We trust that the present report fulfill your requirements. Should you have any question, please feel free to contact the undersigned.

Sincerely,

In-Depth Geotechnical Inc.

LICENSED PROFESSIONAL ENGINEER
G. SEDRAN
October 21, 2018
PROVINCE OF ONTARIO

Gabriel Sedran, P.Eng., Ph.D.
President

Appendix One

Pressuremeter Results - Data

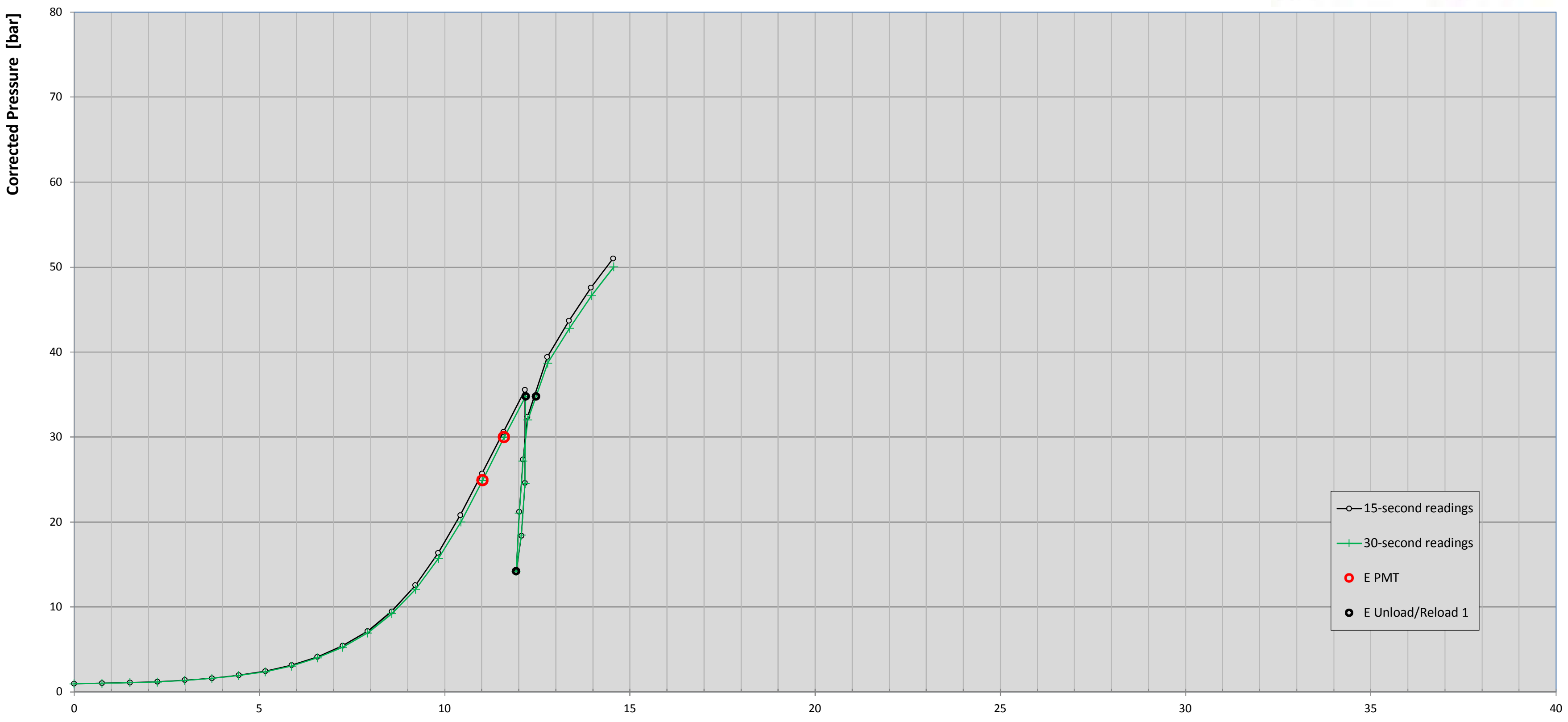
Terraprobe

Field Test Data (uncorrected)		
Volume [cm³]	Pressure [bar] 15 sec	Pressure [bar] 30 sec
2	0.23	0.23
30	0.31	0.31
60	0.40	0.40
90	0.54	0.52
120	0.75	0.74
150	1.00	0.98
180	1.37	1.33
210	1.86	1.81
240	2.58	2.50
270	3.56	3.46
300	4.88	4.73
330	6.62	6.42
360	8.96	8.70
390	12.05	11.59
420	15.85	15.22
450	20.30	19.52
480	25.22	24.42
510	30.14	29.48
540	35.08	34.30
530	24.10	24.05
520	17.88	17.99
510	13.59	13.73
520	20.72	20.59
530	26.87	26.70
540	31.90	31.53
570	38.94	38.25
600	43.21	42.34
630	47.10	46.18
660	50.56	49.56

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
0.98	2	0.00	0.98	2	0.00
1.03	29.7	0.75	1.03	29.7	0.75
1.10	59.6	1.50	1.10	59.6	1.50
1.21	89.5	2.25	1.19	89.5	2.25
1.40	119.3	2.99	1.39	119.3	2.99
1.63	149.1	3.72	1.61	149.1	3.72
1.97	178.8	4.44	1.93	178.8	4.44
2.45	208.3	5.16	2.40	208.4	5.16
3.15	237.7	5.87	3.07	237.7	5.87
4.12	266.8	6.56	4.02	266.9	6.57
5.43	295.6	7.25	5.28	295.7	7.25
7.16	324.0	7.92	6.96	324.2	7.92
9.49	351.9	8.57	9.23	352.1	8.58
12.57	379.1	9.21	12.11	379.5	9.22
16.36	405.6	9.82	15.73	406.2	9.84
20.81	431.6	10.42	20.03	432.3	10.44
25.72	457.1	11.01	24.92	457.8	11.03
30.63	482.6	11.59	29.97	483.2	11.61
35.56	508.2	12.17	34.78	508.9	12.19
24.58	508.1	12.17	24.53	508.2	12.17
18.37	503.8	12.07	18.48	503.7	12.07
14.08	497.7	11.93	14.22	497.5	11.93
21.21	501.2	12.01	21.08	501.3	12.02
27.35	505.6	12.11	27.18	505.8	12.12
32.38	511.1	12.24	32.01	511.4	12.24
39.42	534.7	12.77	38.73	535.3	12.78
43.68	560.8	13.36	42.81	561.6	13.38
47.57	587.3	13.95	46.65	588.1	13.97
51.02	614.1	14.55	50.02	615.0	14.57

Creep	
Volume [cm³]	Δp 30-15 [bar]
2	0.00
29.7	0.00
59.6	0.00
89.5	0.02
119.3	0.01
149.1	0.02
178.8	0.04
208.4	0.05
237.7	0.08
266.9	0.10
295.7	0.15
324.2	0.20
352.1	0.26
379.5	0.46
406.2	0.63
432.3	0.78
457.8	0.80
483.2	0.66
508.9	0.78
535.3	0.69
561.6	0.87
588.1	0.92
615.0	1.00

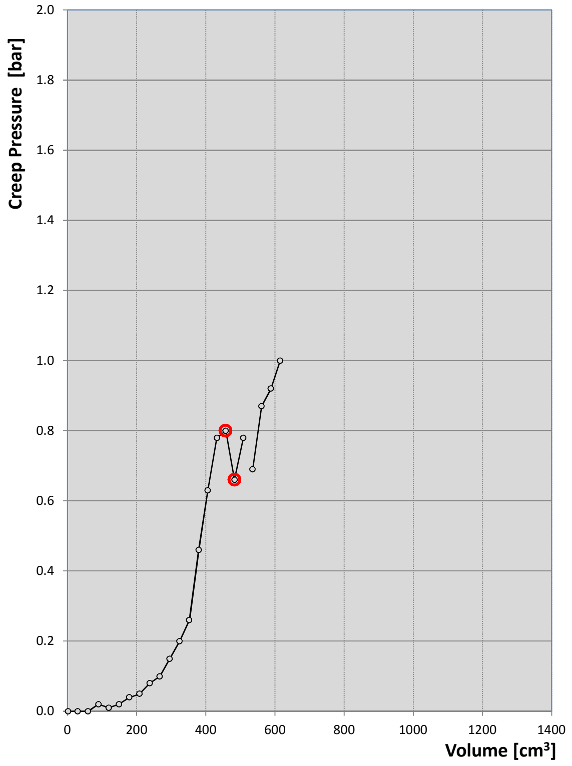
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
0.98	0.55826
1.03	0.03365
1.10	0.01677
1.19	0.01117
1.39	0.00838
1.61	0.00671
1.93	0.00559
2.40	0.00480
3.07	0.00421
4.02	0.00375
5.28	0.00338
6.96	0.00308
9.23	0.00284
12.11	0.00264
15.73	0.00246
20.03	0.00231
24.92	0.00218
29.97	0.00207
34.78	0.00197
24.53	0.00197
18.48	0.00199
14.22	0.00201
21.08	0.00199
27.18	0.00198
32.01	0.00196
38.73	0.00187
42.81	0.00178
46.65	0.00170
50.02	0.00163



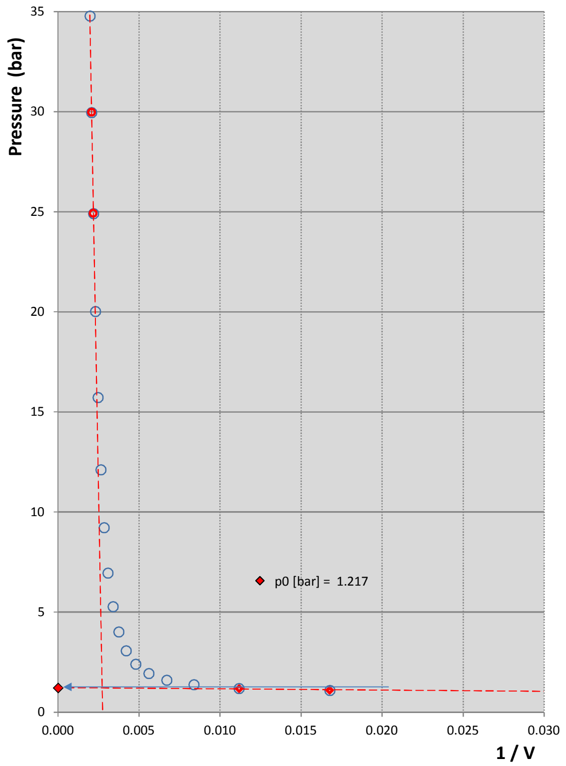
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

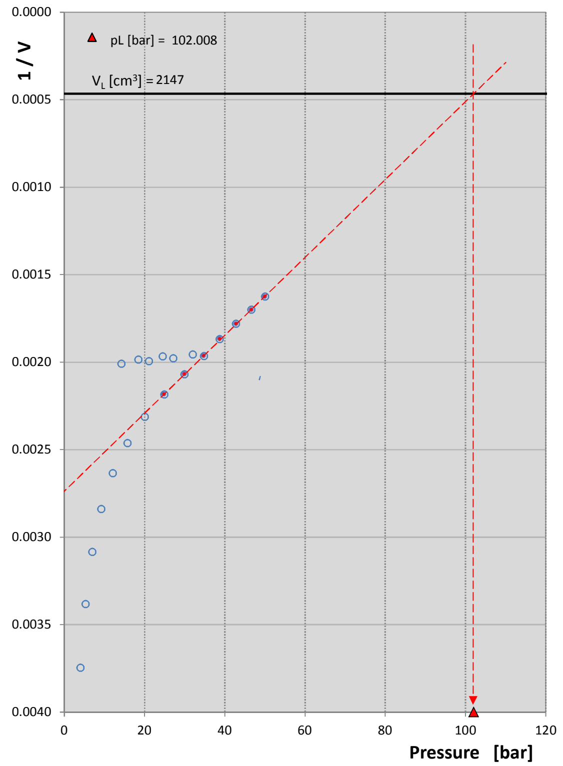
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.22	[bar]	89.5	2.2	
p_L	102.01	[bar]			
p^*_L	100.79	[bar]			
p_Y	29.97	[bar]	483	11.6	
E_{PMT}	1290	[bar]	458	11.0	{11.0 - 11.6 %}
E_{PMT} / p^*_L	12.8				
$E_{Unload\ 1}$	11927	[bar]	498	11.9	
$E_{Reload\ 1}$	5719	[bar]			



Pressure difference from 15 to 30 sec. readings Δp [15-30 sec]



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: B 345
Calibration Record No.: 1
Tubing Length: 160 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: October 11, 2018
Test Depth [m]: 9.80 (center of the probe)
Drilling Company: GeoEnvironmental Drilling

Project: **Cowdray Court, Scarborough, Ontario**
Client: Terraprobe
In-Depth Geotechnical Project No.: IDG 180469

PMT TEST No.: 1
Borehole No.: BH 303-PMT

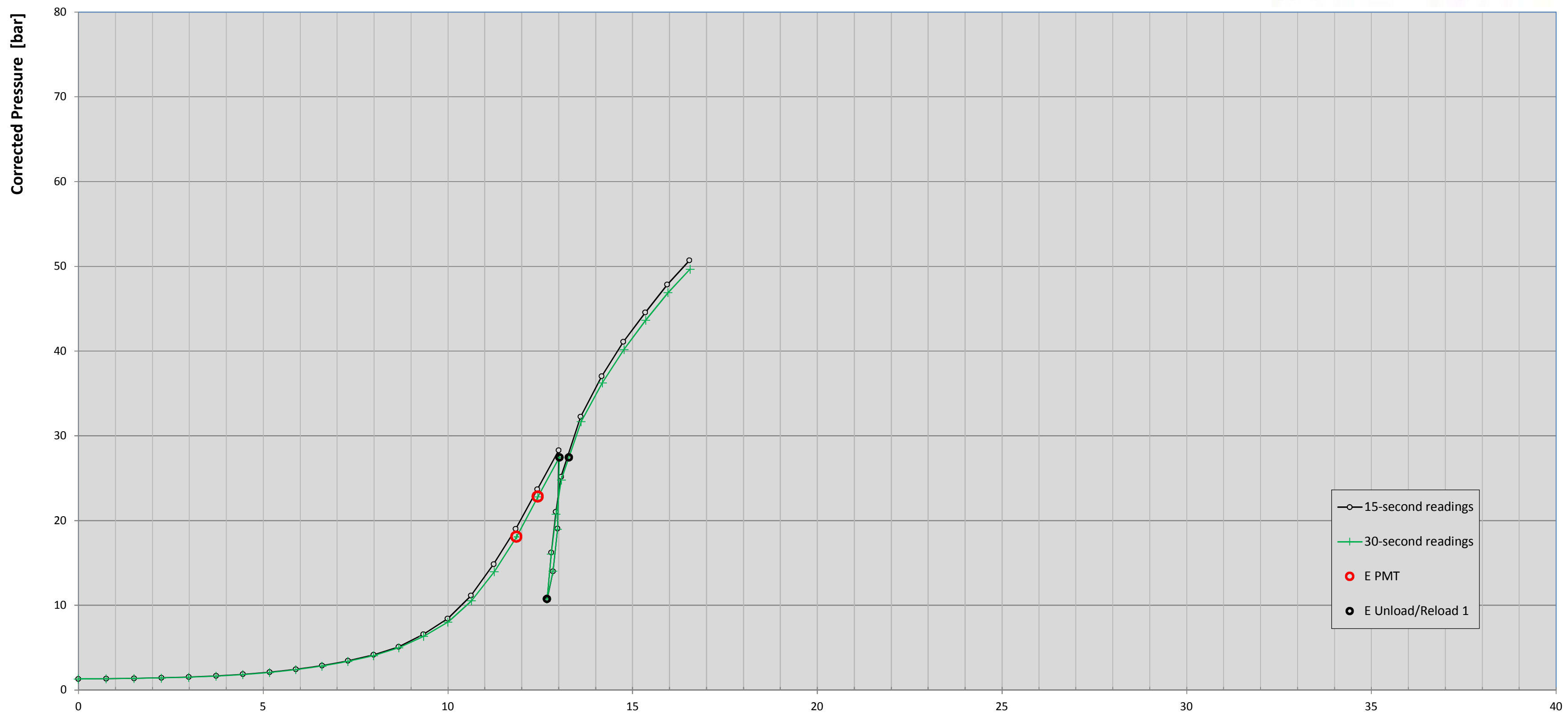
In-Depth
Geotechnical Inc.

Field Test Data (uncorrected)		
Volume [cm³]	Pressure [bar]	
	15 sec	30 sec
2	0.30	0.30
30	0.34	0.34
60	0.41	0.41
90	0.49	0.48
120	0.62	0.60
150	0.77	0.75
180	0.99	0.97
210	1.25	1.21
240	1.59	1.56
270	2.04	1.98
300	2.64	2.57
330	3.34	3.25
360	4.31	4.20
390	5.79	5.54
420	7.63	7.24
450	10.38	9.78
480	14.08	13.21
510	18.25	17.30
540	22.93	22.04
570	27.53	26.70
560	18.28	18.24
550	13.26	13.30
540	9.87	9.98
550	15.48	15.32
560	20.28	20.02
570	24.43	24.06
600	31.50	30.94
630	36.29	35.50
660	40.34	39.44
690	43.82	42.92
720	47.12	46.16
750	49.96	48.94

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	Δr/r₀ [%]	Pressure [bar]	Volume [cm³]	Δr/r₀ [%]
1.33	2	0.00	1.33	2	0.00
1.34	29.7	0.75	1.34	29.7	0.75
1.39	59.6	1.50	1.39	59.6	1.50
1.44	89.6	2.25	1.43	89.6	2.25
1.55	119.4	2.99	1.53	119.5	2.99
1.67	149.3	3.72	1.65	149.3	3.72
1.87	179.1	4.45	1.85	179.1	4.45
2.12	208.9	5.17	2.08	208.9	5.17
2.44	238.6	5.89	2.41	238.6	5.89
2.88	268.1	6.60	2.82	268.2	6.60
3.47	297.6	7.30	3.40	297.7	7.30
4.16	327.0	7.99	4.07	327.1	7.99
5.12	356.1	8.67	5.01	356.2	8.67
6.59	384.7	9.34	6.34	385.0	9.35
8.42	413.1	10.00	8.03	413.4	10.00
11.16	440.6	10.63	10.56	441.1	10.64
14.86	467.2	11.24	13.99	468.0	11.26
19.02	493.4	11.84	18.07	494.3	11.86
23.69	519.2	12.42	22.80	520.0	12.44
28.29	545.0	13.00	27.46	545.8	13.02
19.04	543.4	12.97	19.00	543.4	12.97
14.02	538.0	12.84	14.06	537.9	12.84
10.63	531.0	12.69	10.74	530.9	12.69
16.24	536.0	12.80	16.08	536.1	12.80
21.04	541.6	12.93	20.78	541.8	12.93
25.19	547.8	13.07	24.82	548.2	13.07
32.25	571.4	13.60	31.69	571.9	13.61
37.04	597.1	14.17	36.25	597.8	14.18
41.08	623.4	14.75	40.18	624.2	14.77
44.56	650.2	15.35	43.66	651.0	15.36
47.86	677.2	15.94	46.90	678.1	15.96
50.69	704.7	16.54	49.67	705.6	16.56

Creep	
Volume [cm³]	Δp 30-15 [bar]
2	0.00
29.7	0.00
59.6	0.00
89.6	0.01
119.5	0.02
149.3	0.02
179.1	0.02
208.9	0.04
238.6	0.03
268.2	0.06
297.7	0.07
327.1	0.09
356.2	0.11
385.0	0.25
413.4	0.39
441.1	0.60
468.0	0.87
494.3	0.95
520.0	0.89
545.8	0.83
571.9	0.56
597.8	0.79
624.2	0.90
651.0	0.90
678.1	0.96
705.6	1.02

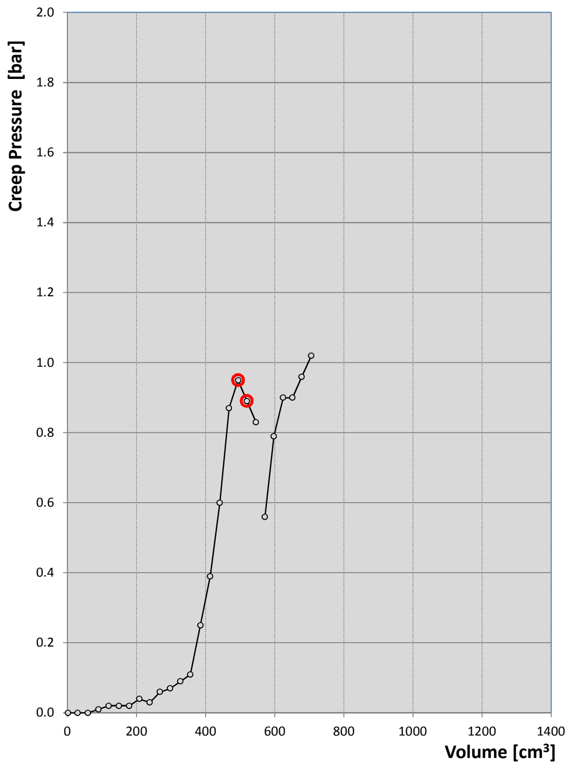
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
1.33	0.57879
1.34	0.03368
1.39	0.01677
1.43	0.01117
1.53	0.00837
1.65	0.00670
1.85	0.00558
2.08	0.00479
2.41	0.00419
2.82	0.00373
3.40	0.00336
4.07	0.00306
5.01	0.00281
6.34	0.00260
8.03	0.00242
10.56	0.00227
13.99	0.00214
18.07	0.00202
22.80	0.00192
27.46	0.00183
19.00	0.00184
14.06	0.00186
10.74	0.00188
16.08	0.00187
20.78	0.00185
24.82	0.00182
31.69	0.00175
36.25	0.00167
40.18	0.00160
43.66	0.00154
46.90	0.00147
49.67	0.00142



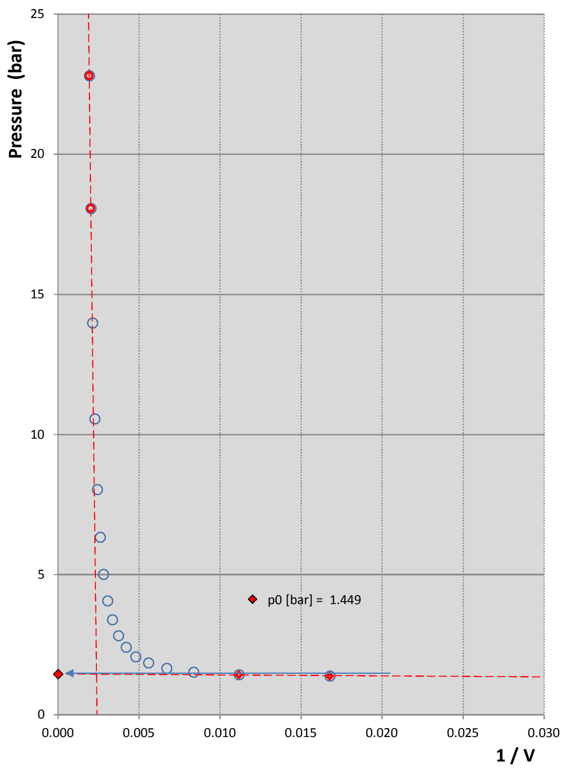
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

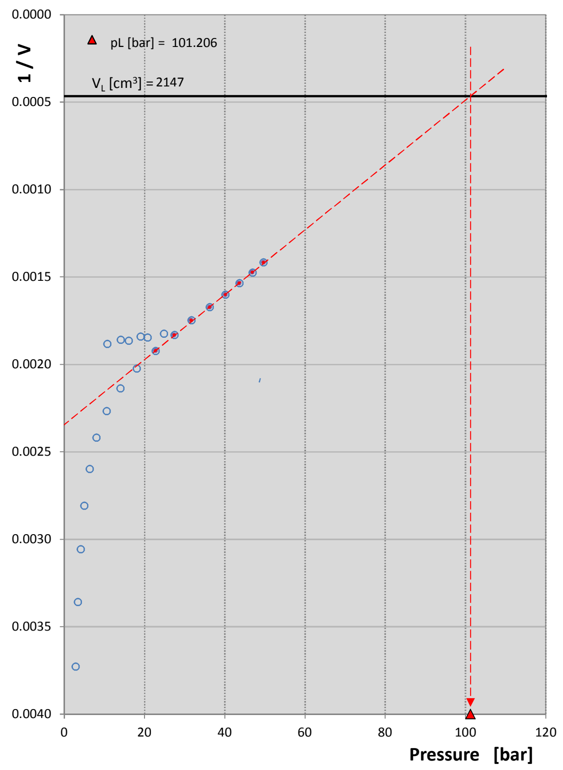
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.45	[bar]	89.6	2.3	
p_L	101.21	[bar]			
p^*_L	99.76	[bar]			
p_Y	22.80	[bar]	520	12.4	
E_{PMT}	1213	[bar]	494	11.9	{11.9 - 12.4 %}
E_{PMT} / p^*_L	12.2				
$E_{Unload\ 1}$	7515	[bar]	531	12.7	
$E_{Reload\ 1}$	4241	[bar]			



Pressure difference from 15 to 30 sec. readings Δp [15-30 sec]



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: B 345
Calibration Record No.: 1
Tubing Length: 160 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: October 11, 2018
Test Depth [m]: 12.65 (center of the probe)
Drilling Company: GeoEnvironmental Drilling

Project: **Cowdray Court, Scarborough, Ontario**
Client: Terraprobe
In-Depth Geotechnical Project No.: IDG 180469

PMT TEST No.: 2
Borehole No.: BH 303-PMT

Field Test Data (uncorrected)

Volume [cm³]	Pressure [bar] 15 sec	Pressure [bar] 30 sec
2	0.17	0.17
30	0.22	0.21
60	0.31	0.30
90	0.39	0.38
120	0.50	0.48
150	0.60	0.60
180	0.76	0.74
210	0.95	0.93
240	1.20	1.17
270	1.50	1.47
300	1.94	1.90
330	2.53	2.48
360	3.38	3.29
390	4.54	4.44
420	6.02	5.86
450	7.76	7.52
480	10.12	9.79
510	12.70	12.36
540	15.96	15.57
570	19.44	19.00
600	23.40	22.87
630	27.14	26.65
620	18.88	18.92
610	14.60	14.67
600	11.62	11.71
610	16.99	16.92
620	21.43	21.27
630	25.15	24.95
660	30.63	30.26
690	34.40	33.94
720	38.15	37.65
750	41.62	41.08
780	44.83	44.30
810	47.96	47.38

Corrected Test data

15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	Δr/r₀ [%]	Pressure [bar]	Volume [cm³]	Δr/r₀ [%]
0.93	2	0.00	0.93	2	0.00
0.96	29.8	0.75	0.95	29.8	0.75
1.02	59.7	1.51	1.01	59.7	1.51
1.07	89.6	2.25	1.06	89.7	2.25
1.16	119.5	2.99	1.14	119.6	2.99
1.24	149.5	3.73	1.24	149.5	3.73
1.38	179.3	4.46	1.36	179.3	4.46
1.55	209.1	5.18	1.53	209.2	5.18
1.79	238.9	5.90	1.76	238.9	5.90
2.08	268.6	6.61	2.05	268.7	6.61
2.51	298.2	7.31	2.47	298.3	7.31
3.09	327.7	8.01	3.04	327.7	8.01
3.93	356.9	8.69	3.84	357.0	8.69
5.08	385.9	9.37	4.98	386.0	9.37
6.55	414.5	10.03	6.39	414.7	10.03
8.28	443.0	10.68	8.04	443.2	10.69
10.63	470.8	11.32	10.30	471.1	11.33
13.20	498.5	11.95	12.86	498.8	11.96
16.46	525.5	12.56	16.07	525.9	12.57
19.93	552.4	13.17	19.49	552.8	13.18
23.89	578.8	13.76	23.36	579.2	13.77
27.62	605.4	14.35	27.13	605.8	14.36
19.36	602.9	14.30	19.40	602.8	14.30
15.08	596.8	14.16	15.15	596.7	14.16
12.11	589.5	14.00	12.20	589.4	14.00
17.47	594.6	14.11	17.40	594.6	14.11
21.91	600.6	14.25	21.75	600.7	14.25
25.63	607.2	14.39	25.43	607.4	14.40
31.11	632.2	14.95	30.74	632.5	14.95
34.88	658.8	15.53	34.42	659.2	15.54
38.62	685.4	16.12	38.12	685.8	16.13
42.09	712.2	16.70	41.55	712.7	16.71
45.30	739.3	17.29	44.77	739.8	17.30
48.43	766.5	17.88	47.85	767.0	17.89

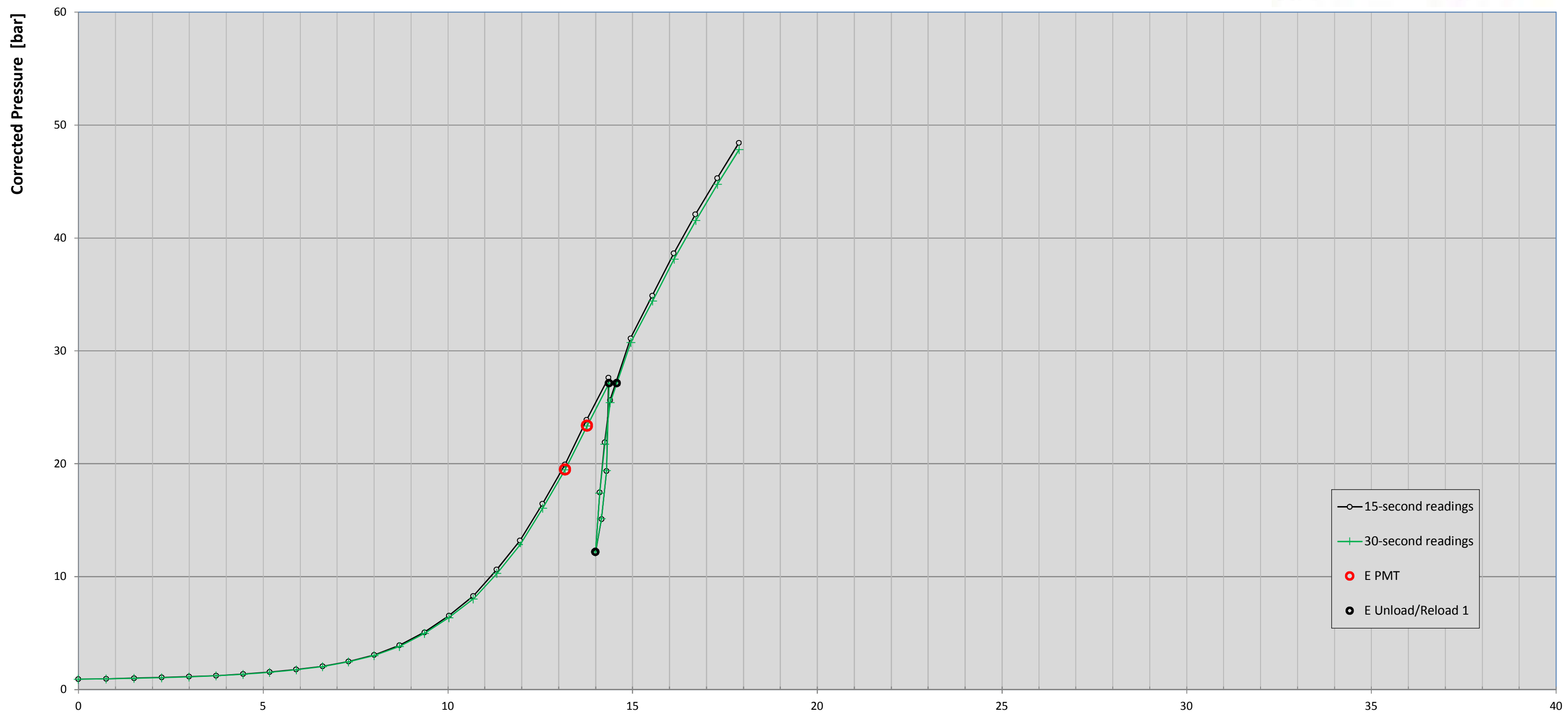
Creep

Volume [cm³]	Δp 30-15 [bar]
2	0.00
29.8	0.01
59.7	0.01
89.7	0.01
119.6	0.02
149.5	0.00
179.3	0.02
209.2	0.02
238.9	0.03
268.7	0.03
298.3	0.04
327.7	0.05
357.0	0.09
386.0	0.10
414.7	0.16
443.2	0.24
471.1	0.33
498.8	0.34
525.9	0.39
552.8	0.44
579.2	0.53
605.8	0.49
632.5	0.37
659.2	0.46
685.8	0.50
712.7	0.54
739.8	0.53
767.0	0.58

Auxiliary Data

30 sec	
Pressure [bar]	1 / V
0.93	0.54179
0.95	0.03355
1.01	0.01674
1.06	0.01115
1.14	0.00836
1.24	0.00669
1.36	0.00558
1.53	0.00478
1.76	0.00419
2.05	0.00372
2.47	0.00335
3.04	0.00305
3.84	0.00280
4.98	0.00259
6.39	0.00241
8.04	0.00226
10.30	0.00212
12.86	0.00200
16.07	0.00190
19.49	0.00181
23.36	0.00173
27.13	0.00165
19.40	0.00166
15.15	0.00168
12.20	0.00170
17.40	0.00168
21.75	0.00166
25.43	0.00165
30.74	0.00158
34.42	0.00152
38.12	0.00146
41.55	0.00140
44.77	0.00135
47.85	0.00130

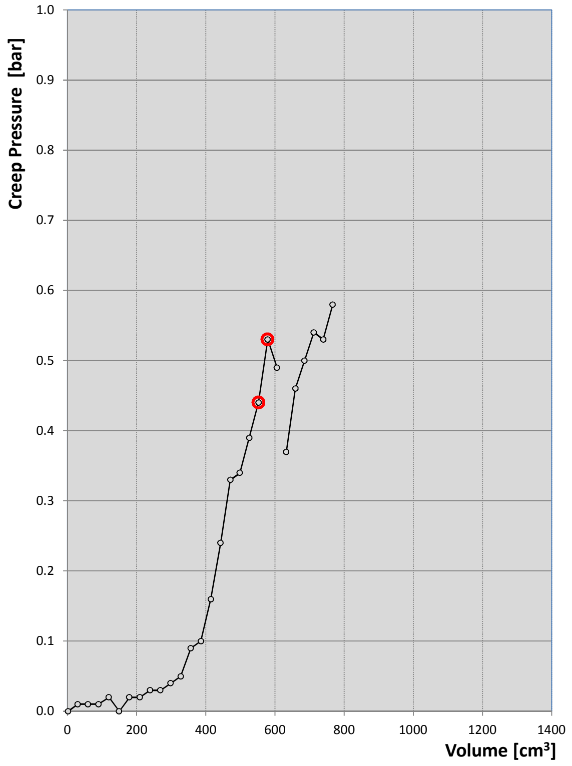
Terraprobe



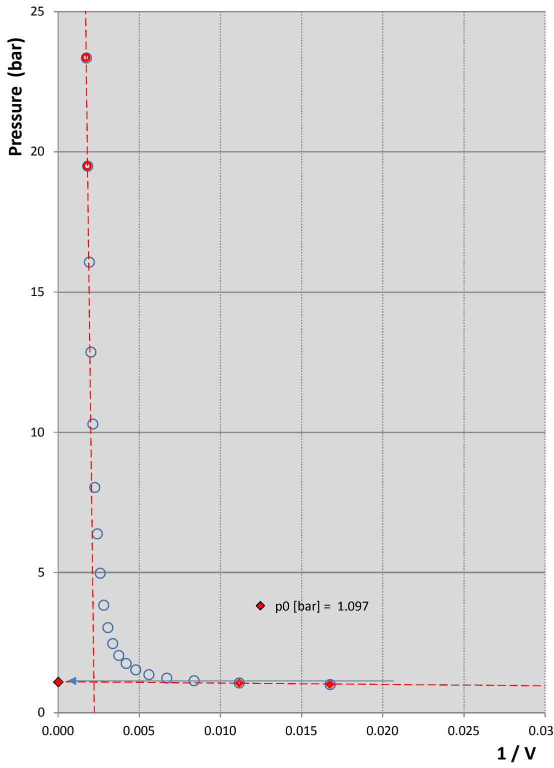
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

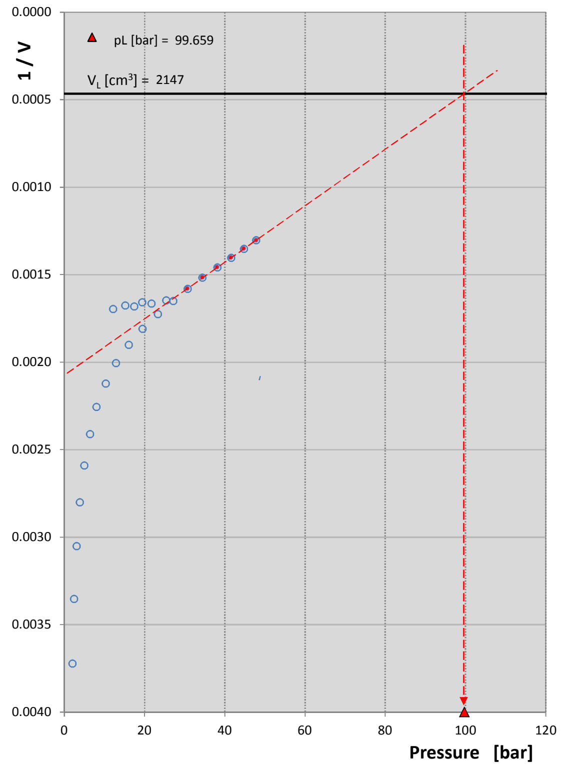
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.10	[bar]	89.7	2.3	
p_L	99.66	[bar]			
p^*_L	98.56	[bar]			
p_Y	23.36	[bar]	579	13.8	
E_{PMT}	983	[bar]	553	13.2	{13.2 - 13.8 %}
E_{PMT} / p^*_L	10.0				
$E_{Unload\ 1}$	6199	[bar]	589	14.0	
$E_{Reload\ 1}$	3922	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: B 345
Calibration Record No.: 1
Tubing Length: 160 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: October 5, 2018
Test Depth [m]: 9.96 (center of the probe)
Drilling Company: GeoEnvironmental Drilling

Project: **Cowdray Court, Scarborough, Ontario**
Client: Terraprobe
In-Depth Geotechnical Project No.: IDG 180469

PMT TEST No.: 1
Borehole No.: BH 407-PMT

In-Depth Geotechnical Inc.

Field Test Data (uncorrected)

Volume [cm³]	Pressure [bar] 15 sec	30 sec
2	0.18	0.18
30	0.21	0.21
60	0.25	0.25
90	0.28	0.28
120	0.32	0.32
150	0.36	0.36
180	0.44	0.43
210	0.54	0.52
240	0.71	0.69
270	0.95	0.93
300	1.34	1.31
330	2.00	1.96
360	3.25	3.16
390	5.16	4.88
420	8.07	7.72
450	12.22	11.83
480	17.62	17.15
510	23.73	23.28
540	29.90	29.40
530	19.95	19.97
520	14.71	14.75
510	11.08	11.11
520	17.05	17.00
530	22.58	22.47
540	27.27	27.10
570	35.23	34.74
600	41.03	40.49
630	46.16	45.59
660	50.85	50.20

Corrected Test data

15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
1.24	2	0.00	1.24	2	0.00
1.24	29.8	0.75	1.24	29.8	0.75
1.26	59.8	1.51	1.26	59.8	1.51
1.26	89.7	2.26	1.26	89.7	2.26
1.28	119.7	3.00	1.28	119.7	3.00
1.29	149.7	3.73	1.29	149.7	3.73
1.35	179.6	4.46	1.34	179.6	4.46
1.44	209.5	5.19	1.42	209.5	5.19
1.59	239.4	5.91	1.57	239.4	5.91
1.82	269.1	6.62	1.80	269.2	6.62
2.20	298.8	7.32	2.17	298.8	7.32
2.85	328.2	8.02	2.81	328.2	8.02
4.09	357.1	8.69	4.00	357.1	8.70
5.99	385.3	9.35	5.71	385.6	9.36
8.89	412.7	9.99	8.54	413.0	9.99
13.03	438.9	10.59	12.64	439.3	10.60
18.43	464.0	11.17	17.96	464.4	11.18
24.53	488.5	11.72	24.08	488.9	11.73
30.69	512.9	12.28	30.19	513.3	12.29
20.74	511.9	12.26	20.76	511.9	12.26
15.51	506.7	12.14	15.55	506.6	12.14
11.88	499.9	11.99	11.91	499.9	11.98
17.85	504.5	12.09	17.80	504.6	12.09
23.37	509.5	12.20	23.26	509.6	12.20
28.06	515.3	12.33	27.89	515.4	12.34
36.02	538.0	12.85	35.53	538.5	12.86
41.81	562.8	13.40	41.27	563.3	13.41
46.94	588.1	13.97	46.37	588.6	13.98
51.62	613.9	14.54	50.97	614.4	14.55

Creep

Volume [cm³]	Δp_{30-15} [bar]
2	0.00
29.8	0.00
59.8	0.00
89.7	0.00
119.7	0.00
149.7	0.00
179.6	0.01
209.5	0.02
239.4	0.02
269.2	0.02
298.8	0.03
328.2	0.04
357.1	0.09
385.6	0.28
413.0	0.35
439.3	0.39
464.4	0.47
488.9	0.45
513.3	0.50
538.5	0.49
563.3	0.54
588.6	0.57
614.4	0.65

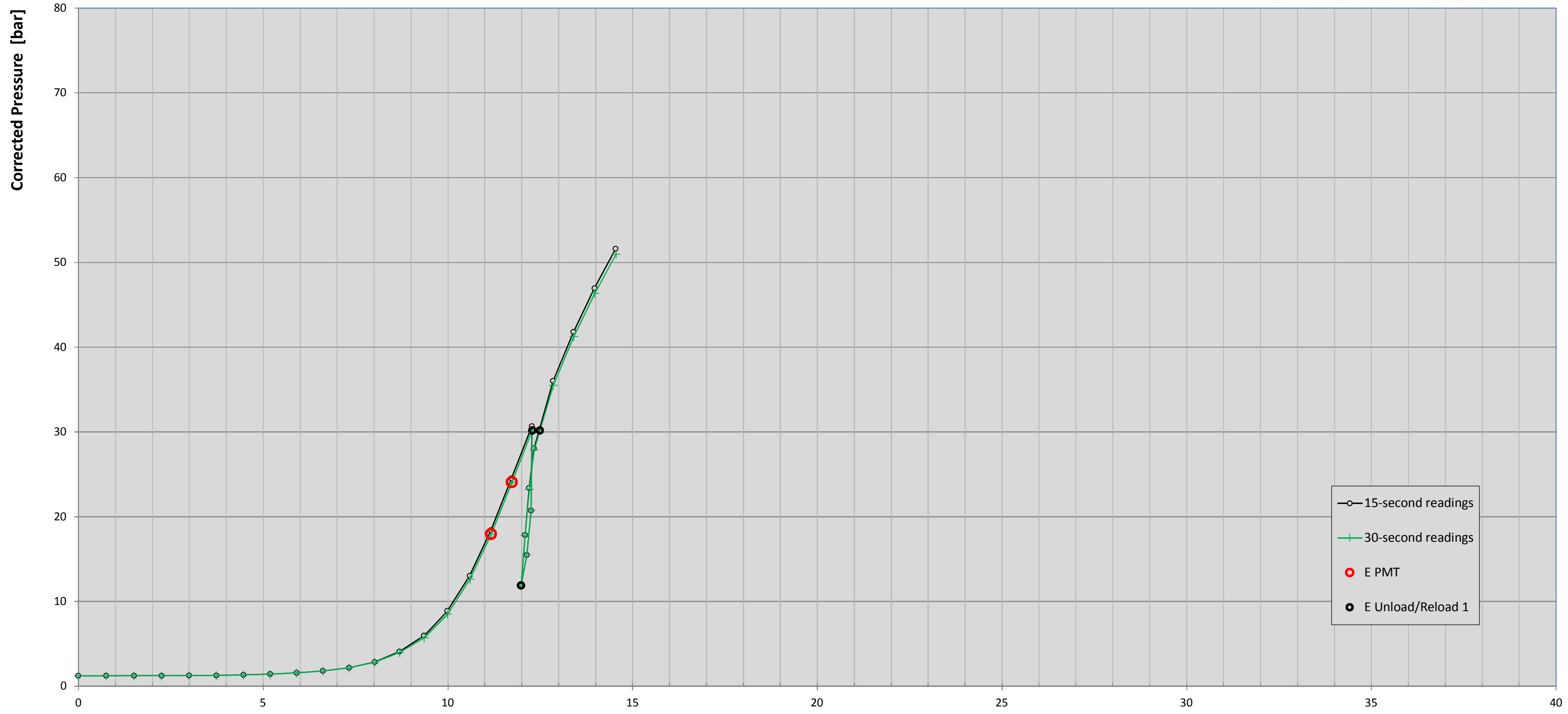
Auxiliary Data

30 sec	
Pressure [bar]	1 / V
1.24	0.54447
1.24	0.03355
1.26	0.01673
1.26	0.01114
1.28	0.00835
1.29	0.00668
1.34	0.00557
1.42	0.00477
1.57	0.00418
1.80	0.00372
2.17	0.00335
2.81	0.00305
4.00	0.00280
5.71	0.00259
8.54	0.00242
12.64	0.00228
17.96	0.00215
24.08	0.00205
30.19	0.00195
20.76	0.00195
15.55	0.00197
11.91	0.00200
17.80	0.00198
23.26	0.00196
27.89	0.00194
35.53	0.00186
41.27	0.00178
46.37	0.00170
50.97	0.00163

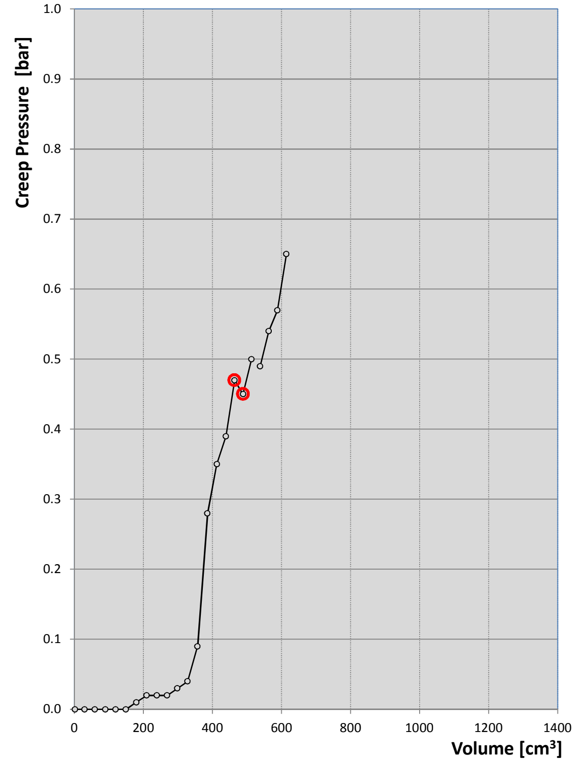
Interpreted PMT Test Results

[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.28	[bar]	149.7	3.7	
p_L	127.52	[bar]			
p^*_L	126.24	[bar]			
p_Y	24.08	[bar]	489	11.7	
E_{PMT}	1629	[bar]	464	11.2	{11.2 - 11.7 %}
E_{PMT} / p^*_L	12.9				
$E_{Unload\ 1}$	8980	[bar]	500	12.0	
$E_{Reload\ 1}$	5376	[bar]			

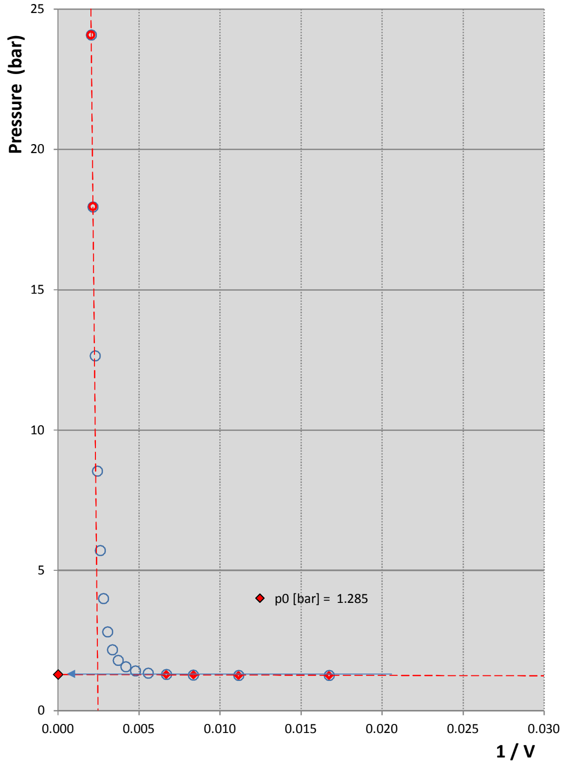
Terraprobe



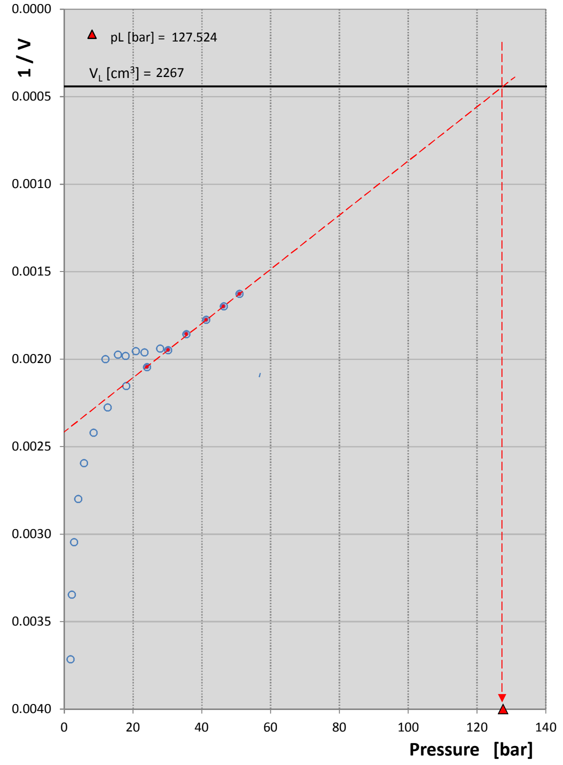
Pressuremeter test results [corrected data] pressure vs radial strain



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15-30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: B 345
Calibration Record No.: 1
Tubing Length: 160 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: October 5, 2018
Test Depth [m]: 12.95 (center of the probe)
Drilling Company: GeoEnvironmental Drilling

Project: **Cowdray Court, Scarborough, Ontario**
Client: Terraprobe
In-Depth Geotechnical Project No.: IDG 180469

PMT TEST No.: 2
Borehole No.: BH 407-PMT

In-Depth
Geotechnical Inc.

Appendix Two

Pressuremeter Data Interpretation

Interpretation of Pressuremeter Test Results

Prebored pressuremeter test results are expressed in terms of applied pressure versus radial strain. Both pressure and strain measurements must be corrected for pressure and volume loses using the corresponding probe and system calibration curves.

The typical pressure versus radial strain curve features up to four distinctive portions which characterize the stress-strain behaviour of the soil, namely:

a) The linear pseudo-elastic stress-strain portion of the deformation curve;
b) The departure from linear elastic conditions starting at the yield pressure p_y;
c) The unload-reload portion of the test (usually two cycles are performed); and
d) The development of soil failure, which is represented by the net limit pressure p^*_L.

Based on these test features the following soil parameters are determined or estimated:

1. **Contact Pressure p_o**:

When using the prebored TEXAM unit, the initial contact pressure is taken as the pressure at the intersection of the two lines representing the pseudo elastic and the initial expansion portions of the pressure vs. 1/V plot, as shown in the PMT data sheets, in Appendix One.

2. **Pressuremeter modulus E_{PMT}**:

The pressuremeter modulus is represented by the slope of the pressure versus radial strain curve along its linear portion, and may be calculated as follows:

$$E_{PMT} = (1+\upsilon)(p_2-p_1)\frac{\left(1+\left(\frac{\Delta R}{R_o}\right)_2\right)^2+\left(1+\left(\frac{\Delta R}{R_o}\right)_1\right)^2}{\left(1+\left(\frac{\Delta R}{R_o}\right)_2\right)^2-\left(1+\left(\frac{\Delta R}{R_o}\right)_1\right)^2}$$

where the sub-indices 1 and 2 indicate the beginning and the end of the linear portion of the curve, respectively. These two points are shown in pressuremeter curves with two red oversized circles. For the self-boring probe, the linear portion of the stress-strain response occurs between the very first data point (zero volume increase) and the subsequent two or three data points.

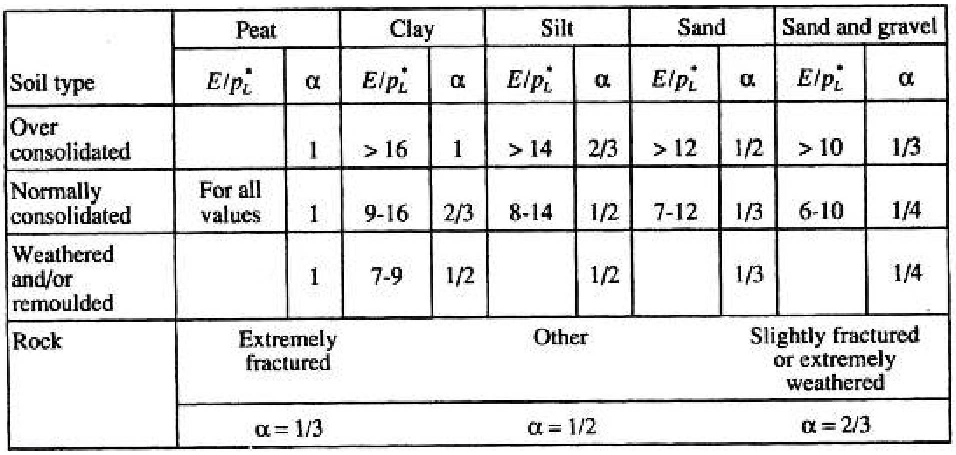
In this determination a value of the Poisson's ratio, typically $\nu = 0.33$ for most soils, must be assumed. For saturated clays a value of $\nu = 0.45$ is suggested.

The Pressuremeter modulus E_{PMT} corresponds to large strains, namely for radial strains in the 2 to 5 % range, and it is therefore considered to be a relatively low value of the elastic modulus.

In practice, the Young's modulus E can be inferred from Pressuremeter testing using the Menard α factor:

$$E = E_{PMT} / \alpha$$

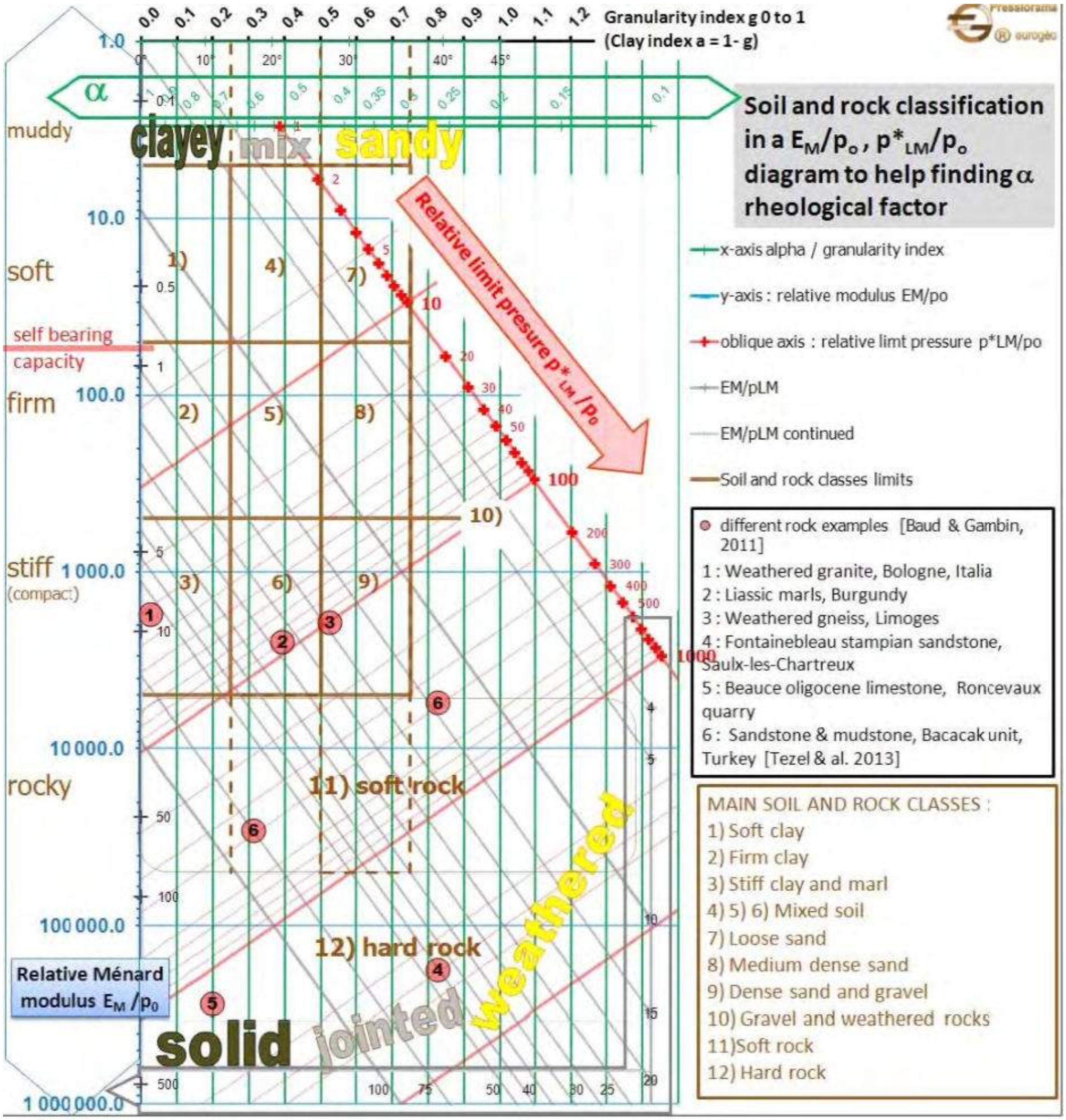
Typical values of the Menard α factor are suggested in the following Table:



Soil type	Peat E/p_L^*	Peat α	Clay E/p_L^*	Clay α	Silt E/p_L^*	Silt α	Sand E/p_L^*	Sand α	Sand and gravel E/p_L^*	Sand and gravel α
Over consolidated		1	> 16	1	> 14	2/3	> 12	1/2	> 10	1/3
Normally consolidated	For all values	1	9-16	2/3	8-14	1/2	7-12	1/3	6-10	1/4
Weathered and/or remoulded		1	7-9	1/2		1/2		1/3		1/4
Rock	Extremely fractured				Other				Slightly fractured or extremely weathered	
	$\alpha = 1/3$				$\alpha = 1/2$				$\alpha = 2/3$	

(from 'The Pressuremeter', J.L. Briaud. Balkema, 1992)

Alternatively, better-defined values of the Menard α parameter can be obtained from the Pressiorama chart introduced by Baud et.al., as illustrated below.



Baud J.P., and Gambin M. 2013. *"Détermination du coefficient rhéologique α de Ménard dans le diagramme Pressiorama".* Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering. Paris, 2013, Parallel Session ISP 6, International Symposium on the Pressuremeter.

3. Yield Pressure p_y:

The yield pressure indicates the end of the linear pseudo-elastic deformations and the onset of plasticity. This yield pressure is useful in indicating beyond which pressure significant creep deformations may occur.

4. Unload-Reload Modulus E_R:

The reload modulus is represented by the slope of the unload-reload loop, and may be used to determine elastic soil deformations upon unloading conditions such as those typically encountered during excavations.

5. Net Limit Pressure p^*_L:

The net limit pressure is a measure of the strength of the soil (either under undrained conditions for cohesive soils, or drained conditions for non-cohesive soils). This parameter is defined as the pressure reached when the soil cavity has been extended to twice its original soil cavity volume V_c (minus the initial total contact pressure p_o).

The limit pressure is not always attained during testing. In such cases, the value of p_L is inferred by plotting pressure versus 1/V for the plastic phase of the deformations. This method of inferring p_L, known as the "upside down curve" method, is described in "*The Pressuremeter and Foundation Engineering*" textbook, by F. Baguelin, J.F.Jezequel, and D.H. Shields, published in 1978 by Trans Tech Publications, Section: Methods of extrapolating pressuremeter curves to p_L. See also ASTM D4719-00, Section 10.6.

It should be noted that radial strains are calculated from the volume of fluid (typically tap water) injected into the probe. In this regard, the radial strains shown in the results are related to the probe expansion, not the cavity's expansion. The cavity initial volume, V_c, is calculate by adding the probe initial volume, V_0, plus the volume of water injected into the probe at the initial contact pressure p_0. For the self-boring PMT probe,

6. Some Additional Parameters

In addition, two useful ratios, (E_{PMT} / p^*_L) and (p^*_L / p_y), may be used as a general guideline for soil identification, as follows:

for sands	$7 < E_{PMT} / p^*_L < 12$
for clays	$12 < E_{PMT} / p^*_L$

Also, as presented in the Canadian Foundation Engineering Manual (4th Edition, 2006)

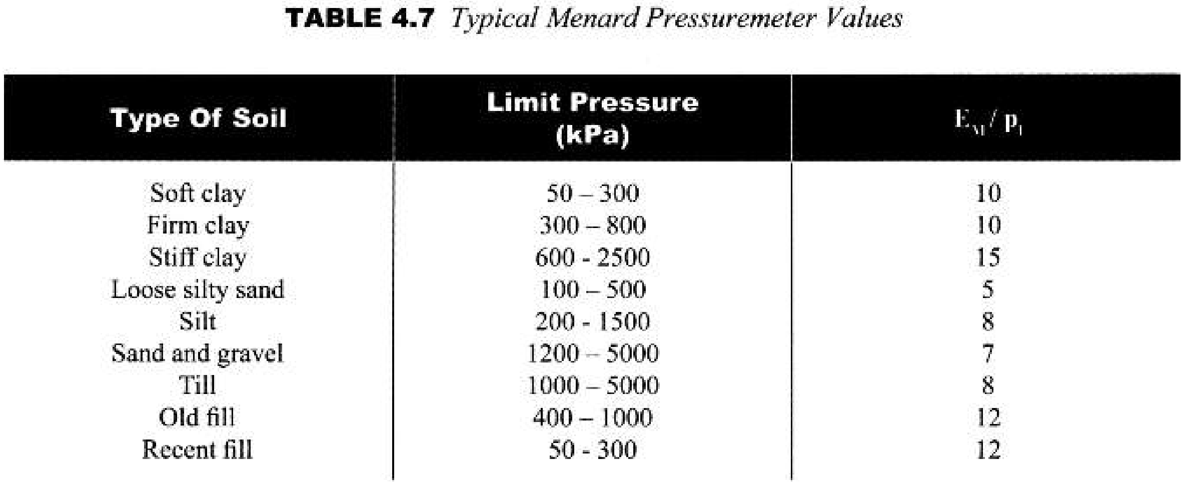


TABLE 4.7 *Typical Menard Pressuremeter Values*

Type Of Soil	Limit Pressure (kPa)	E_M / p_l
Soft clay	50 – 300	10
Firm clay	300 – 800	10
Stiff clay	600 - 2500	15
Loose silty sand	100 – 500	5
Silt	200 - 1500	8
Sand and gravel	1200 – 5000	7
Till	1000 – 5000	8
Old fill	400 – 1000	12
Recent fill	50 - 300	12

For most soil types the ratio between the limit and the yield pressures may be expressed as:

$$1.3 \quad < \quad (p^*_L / p_y) \qquad < \quad 2.0$$

Also as a general guideline, clayey and sandy soils may have the following parameters:

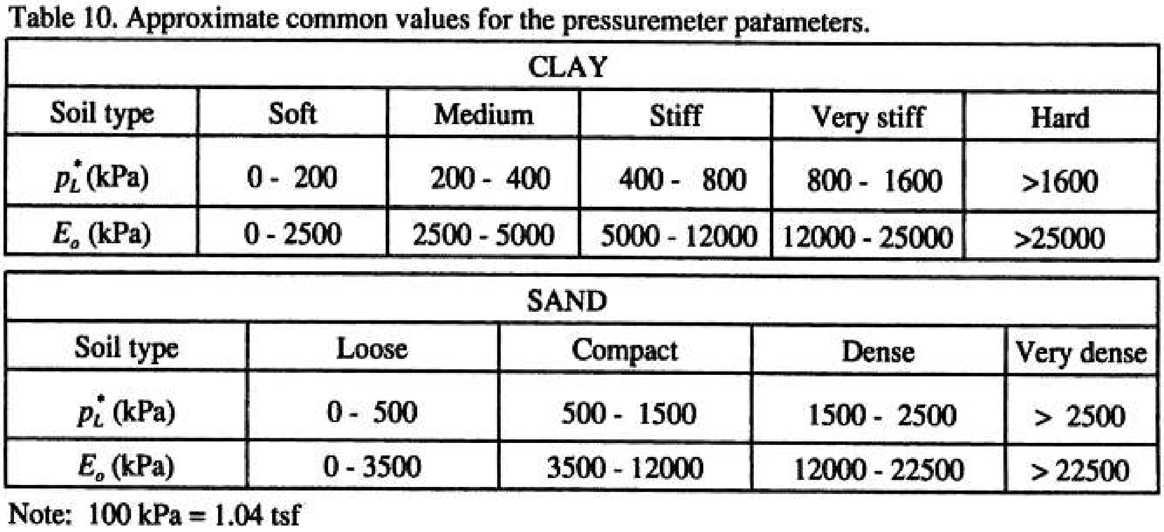


Table 10. Approximate common values for the pressuremeter patameters.

CLAY					
Soil type	Soft	Medium	Stiff	Very stiff	Hard
p^*_L (kPa)	0 - 200	200 - 400	400 - 800	800 - 1600	>1600
E_o (kPa)	0 - 2500	2500 - 5000	5000 - 12000	12000 - 25000	>25000

SAND				
Soil type	Loose	Compact	Dense	Very dense
p^*_L (kPa)	0 - 500	500 - 1500	1500 - 2500	> 2500
E_o (kPa)	0 - 3500	3500 - 12000	12000 - 22500	> 22500

Note: 100 kPa = 1.04 tsf

(from 'The Pressuremeter', J.L. Briaud. Balkema, 1992)

Inferred Shear Strength Parameters

The undrained shear strength of cohesive soils may be estimated as:

$$\frac{S_u}{p_a} = 0.21\left(\frac{p_L^*}{p_a}\right)^{0.75}$$

where p_a represents a reference pressure (i.e., atmospheric pressure = 100 kPa), after J.L. Briaud ('The Pressuremeter', Balkema, 1992).

The drained friction angle of cohesionless soils (c' = 0) may be estimated using the empirical correlations illustrated in the graph shown below. This approach is outlined by Baguelin et.al., in *"The Pressuremeter and Foundation Engineering"* (F. Baguelin; J.F. Jézéquel; and D.H. Shields. TransTech Publications. 1978), and it requires some knowledge on the state or conditions of the cohesionless material. This approach only provides a likely range of friction angles from interpreted limit pressure values.

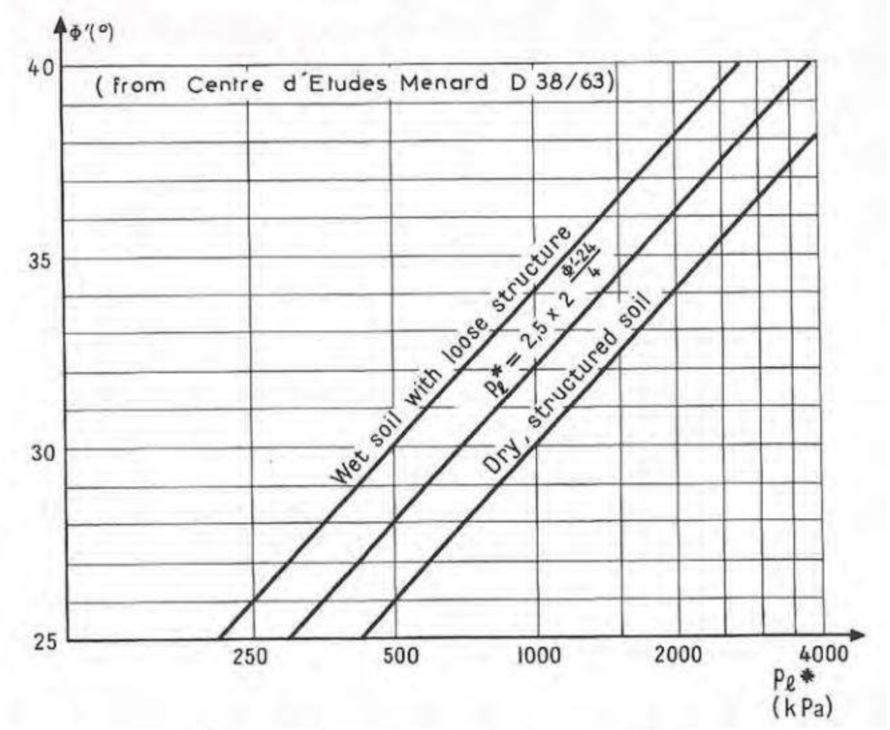


Fig. 6-86: MÉNARD's graph to determine Φ' from p_1^*.

Conservative estimates (lower-bound estimates) of strength parameters can also be inferred from the following table:

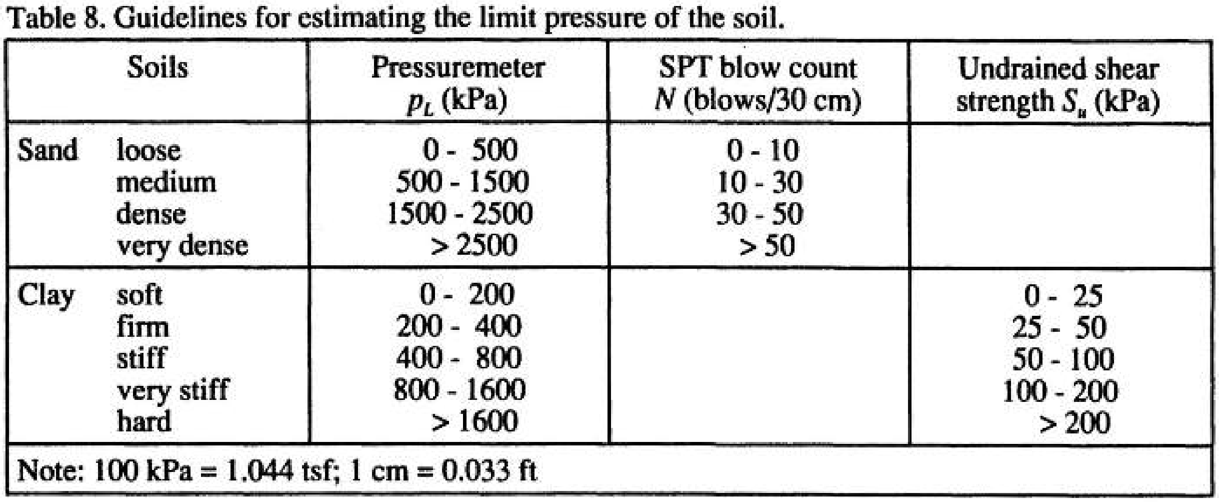


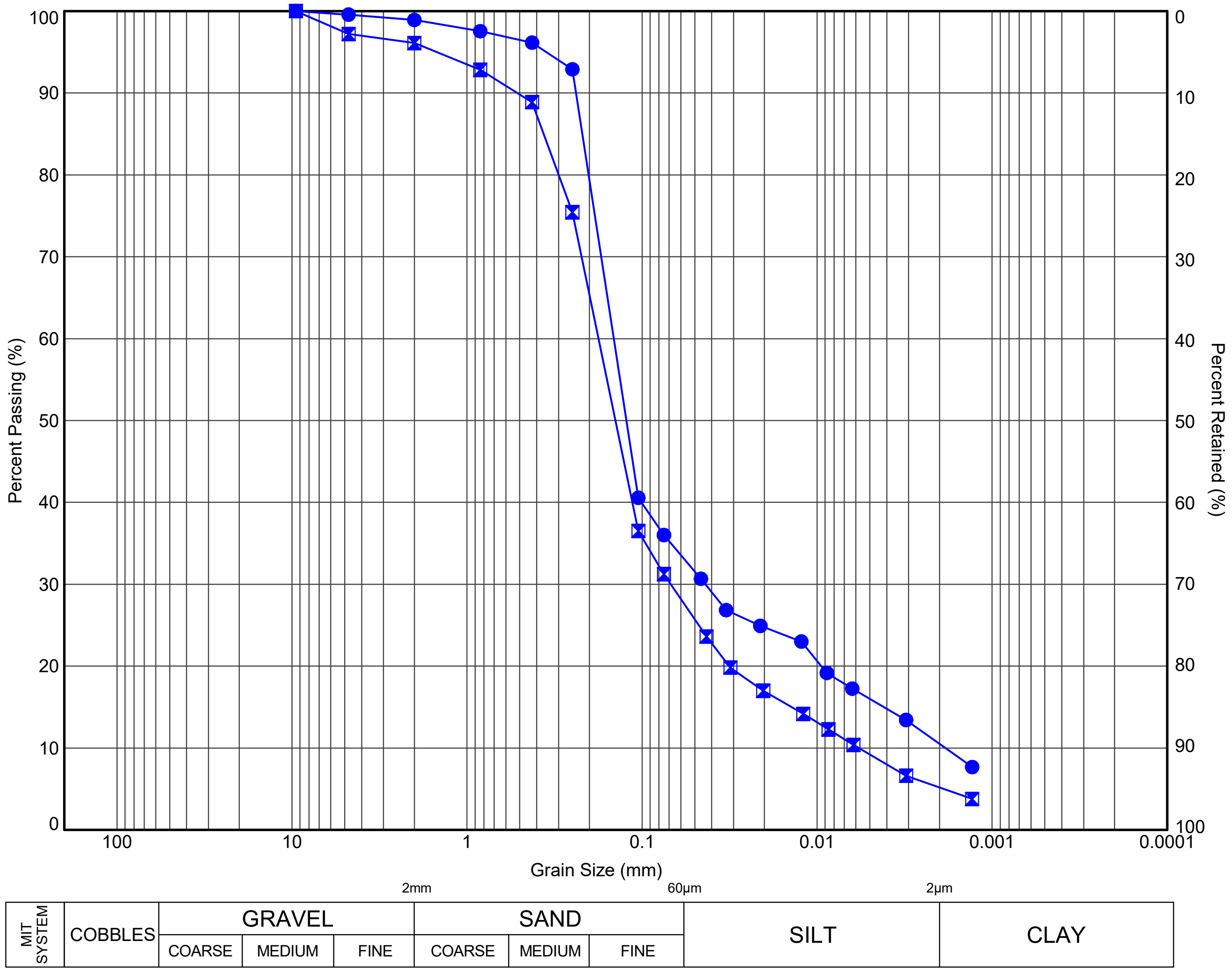
Table 8. Guidelines for estimating the limit pressure of the soil.

Soils		Pressuremeter p_L (kPa)	SPT blow count N (blows/30 cm)	Undrained shear strength S_u (kPa)
Sand	loose	0 - 500	0 - 10	
	medium	500 - 1500	10 - 30	
	dense	1500 - 2500	30 - 50	
	very dense	> 2500	> 50	
Clay	soft	0 - 200		0 - 25
	firm	200 - 400		25 - 50
	stiff	400 - 800		50 - 100
	very stiff	800 - 1600		100 - 200
	hard	> 1600		> 200
Note: 100 kPa = 1.044 tsf; 1 cm = 0.033 ft				

(from 'The Pressuremeter', J.L. Briaud. Balkema, 1992)

APPENDIX C

TERRAPROBE INC.



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**408**	SS13	15.4	152.3	1	65	23	11	
☒	**410**	SS11	12.4	155.5	4	68	23	5	

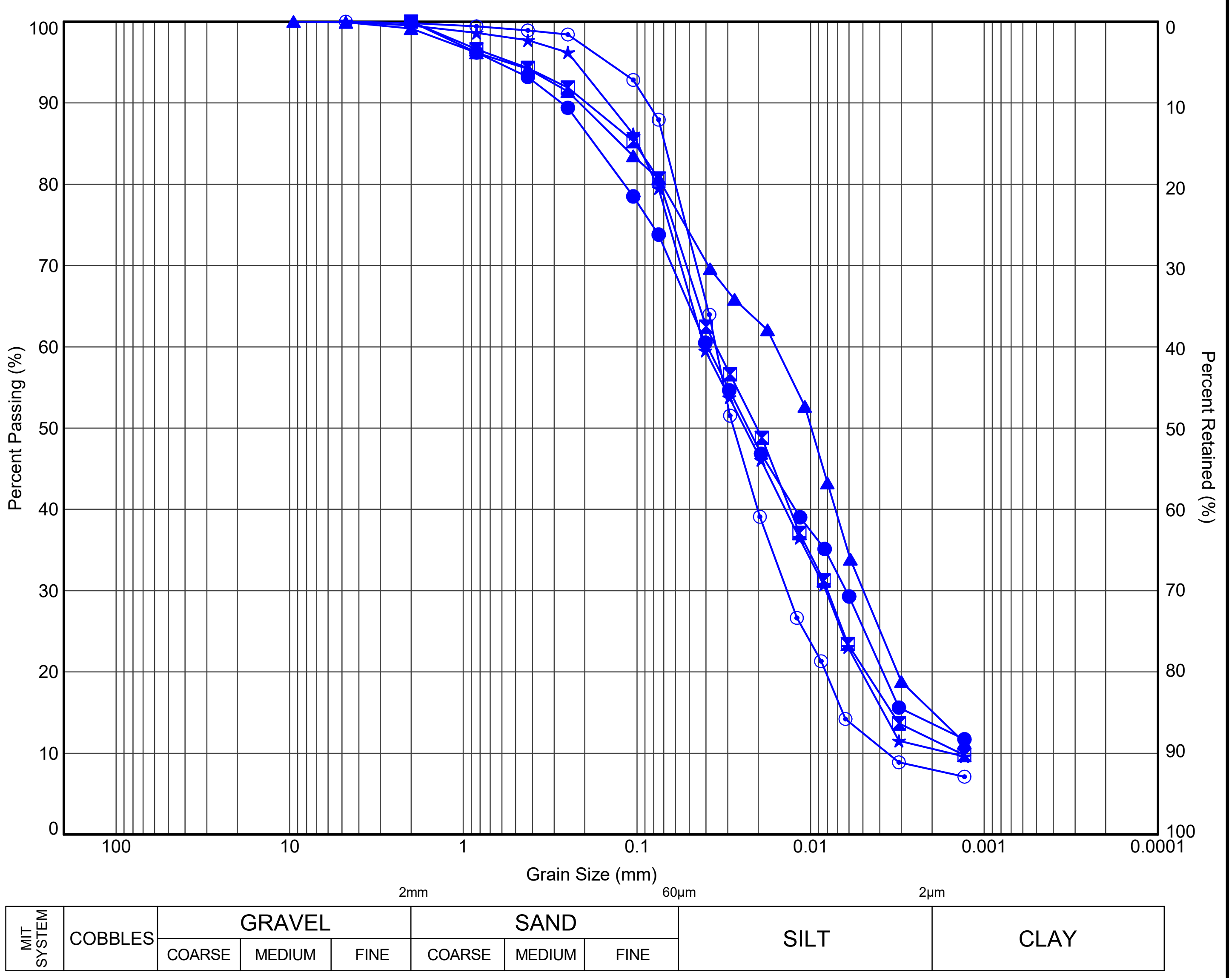
Terraprobe

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

Title:

GRAIN SIZE DISTRIBUTION
SILTY SAND

File No.: **1-18-0476**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**405**	SS11	12.5	155.7	0	31	55	14	
⊠	**407**	SS9	10.7	157.5	0	25	63	12	
▲	**408**	SS10	10.9	156.7	1	22	62	15	
★	**411**	SS7	6.2	161.1	1	26	62	11	
⊙	**411**	SS11	12.3	154.9	0	20	72	8	

Terraprobe

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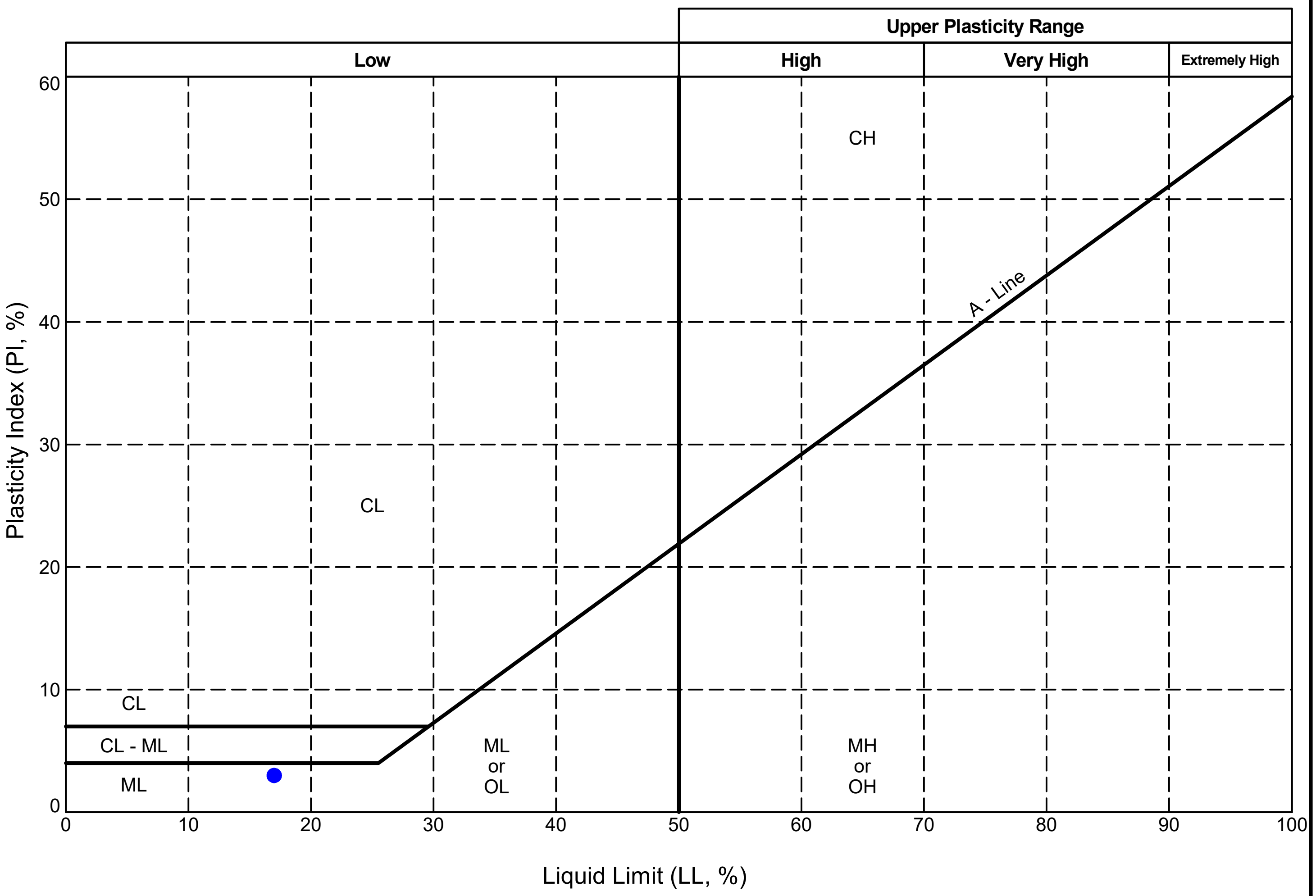
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SANDY SILT

File No.: **1-18-0476**



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
●	408	SS10	10.9	156.7	17	14	3

Terraprobe

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(905) 796-2650

Title:

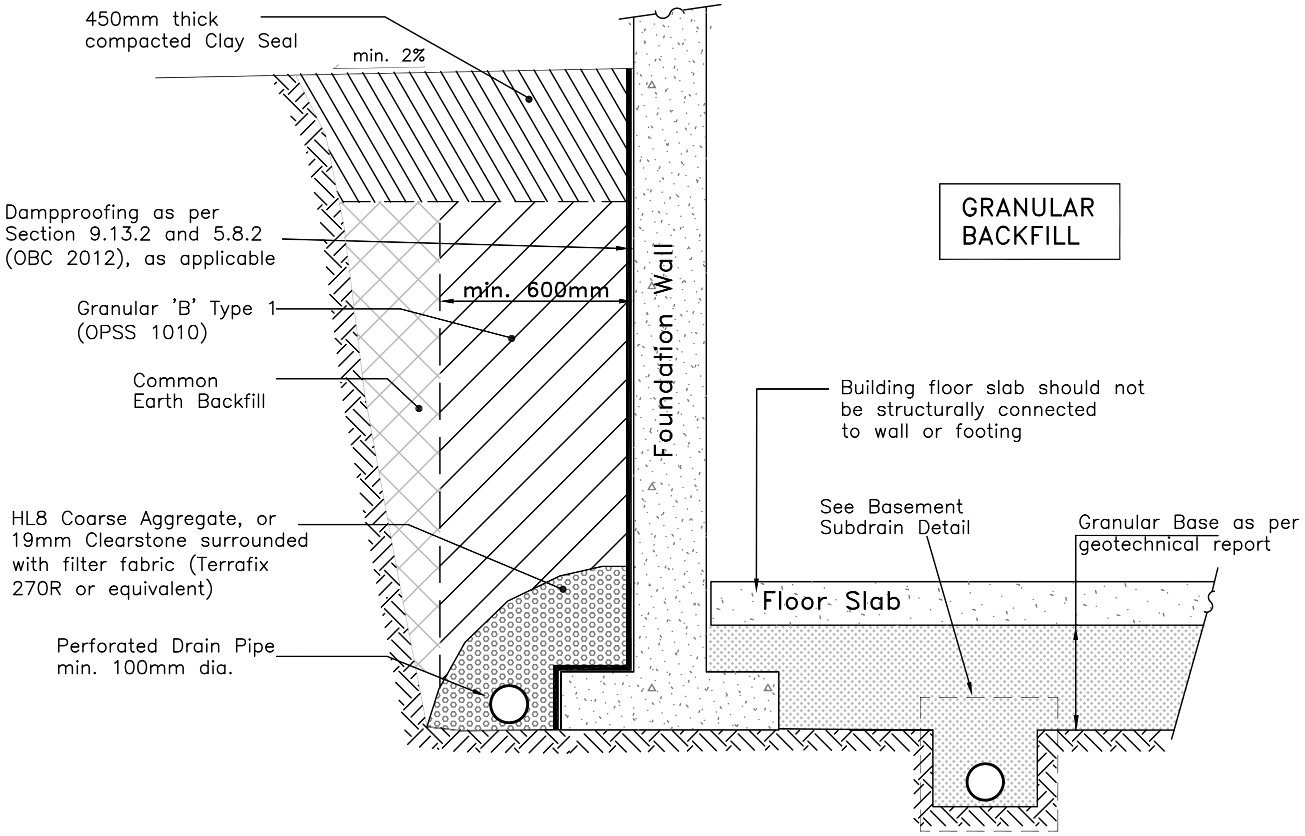
ATTERBERG LIMITS CHART

File No.:

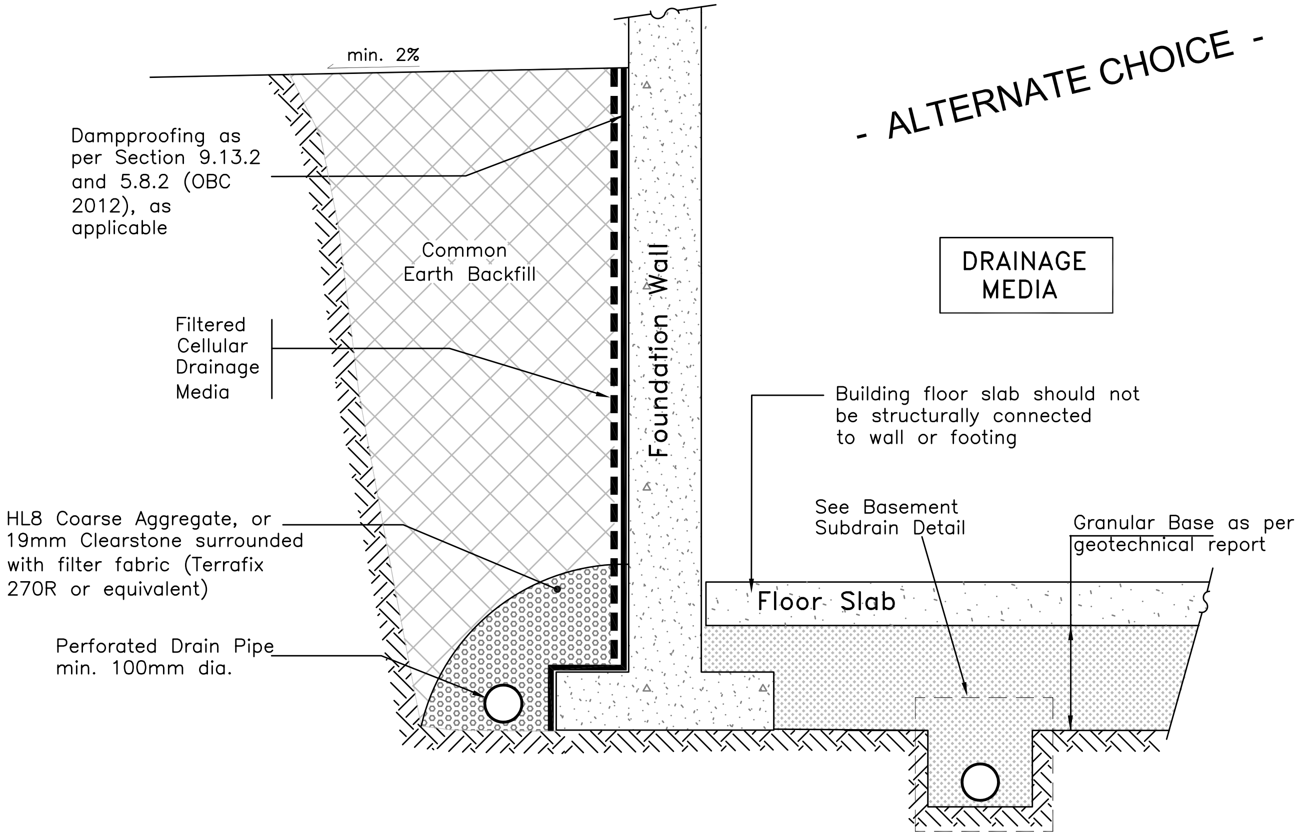
1-18-0476

APPENDIX D

TERRAPROBE INC.



- ALTERNATE CHOICE -

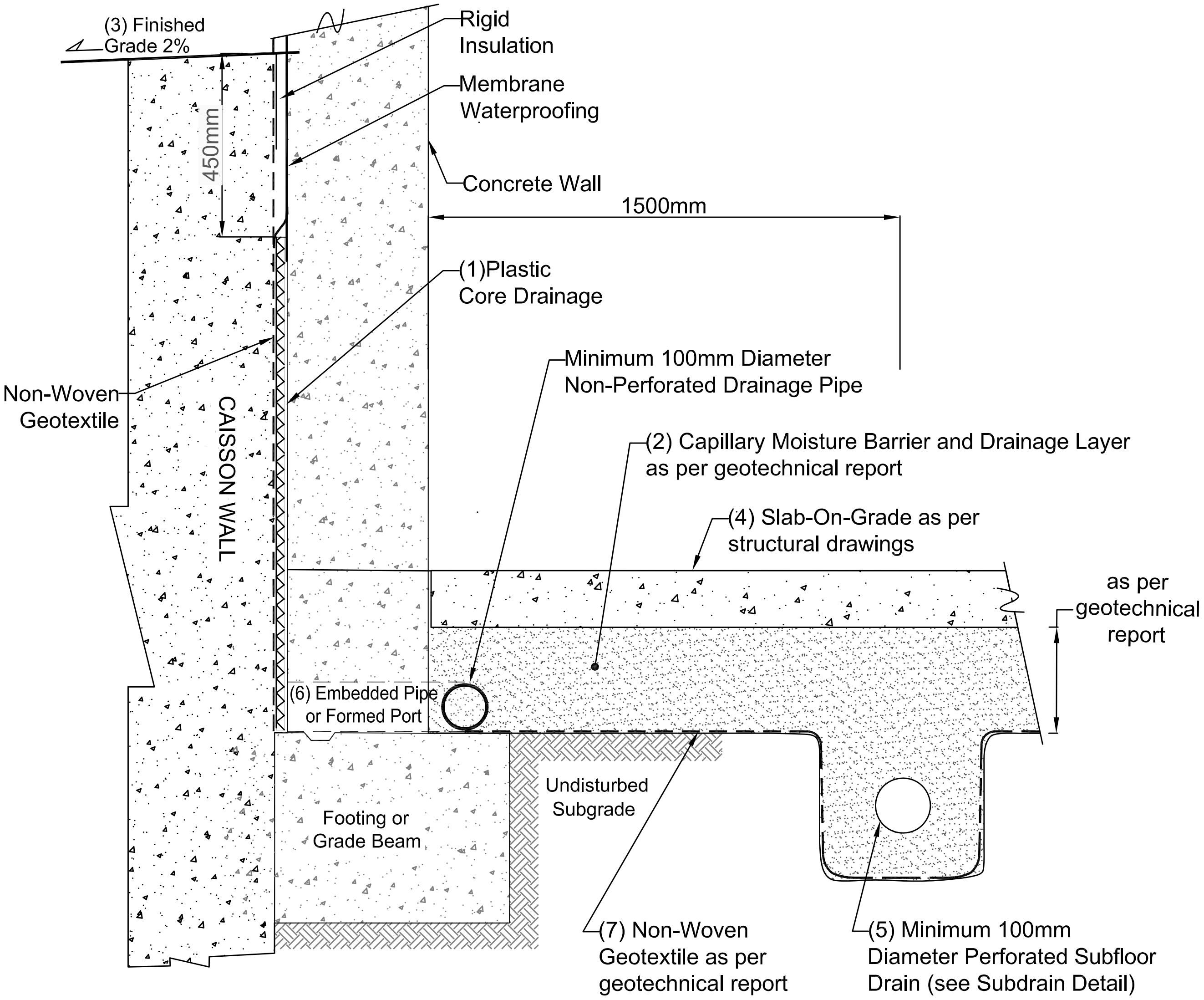


Schematic Only
Not to Scale

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

Title:

BASEMENT DRAINAGE DETAIL



<u>NOTES</u>

1) Prefabricated drainage panels to consist of Terrafix - TERRADRAIN 200, Mirafi - Miradrain 6000, or approved equivalent. Panels should provide continuous cover with a minimum overlap of 300mm.

2) Capillary moisture barrier/drainage layer to consist of a minimum 200mm layer of 19mm clear stone (OPSS 1004), or as indicated in geotechnical report, compacted to a dense state. Upper 50mm can be replaced with Granular “A” (OPSS 1010) compacted to 98% SPMDD where vehicular traffic is required.

3) Exterior finished grade away from wall at a minimum grade of 2% for min. 1.2m.

4) Building floor slab-on-grade shall not be structurally connected to foundation wall or footing.

5) Subfloor drain invert to be a minimum of 300mm below underside of floor slab, to be set in parallel rows, one way, and at the spacing specified in the geotechnical report.

6) Embedded pipes/formed ports to be set a distance of maximum 3m on-centre. Each port to have a minimum cross-sectional area of 1500mm². Perimeter drainage must be collected and conveyed directly to the building sumps in non-perforated pipe.

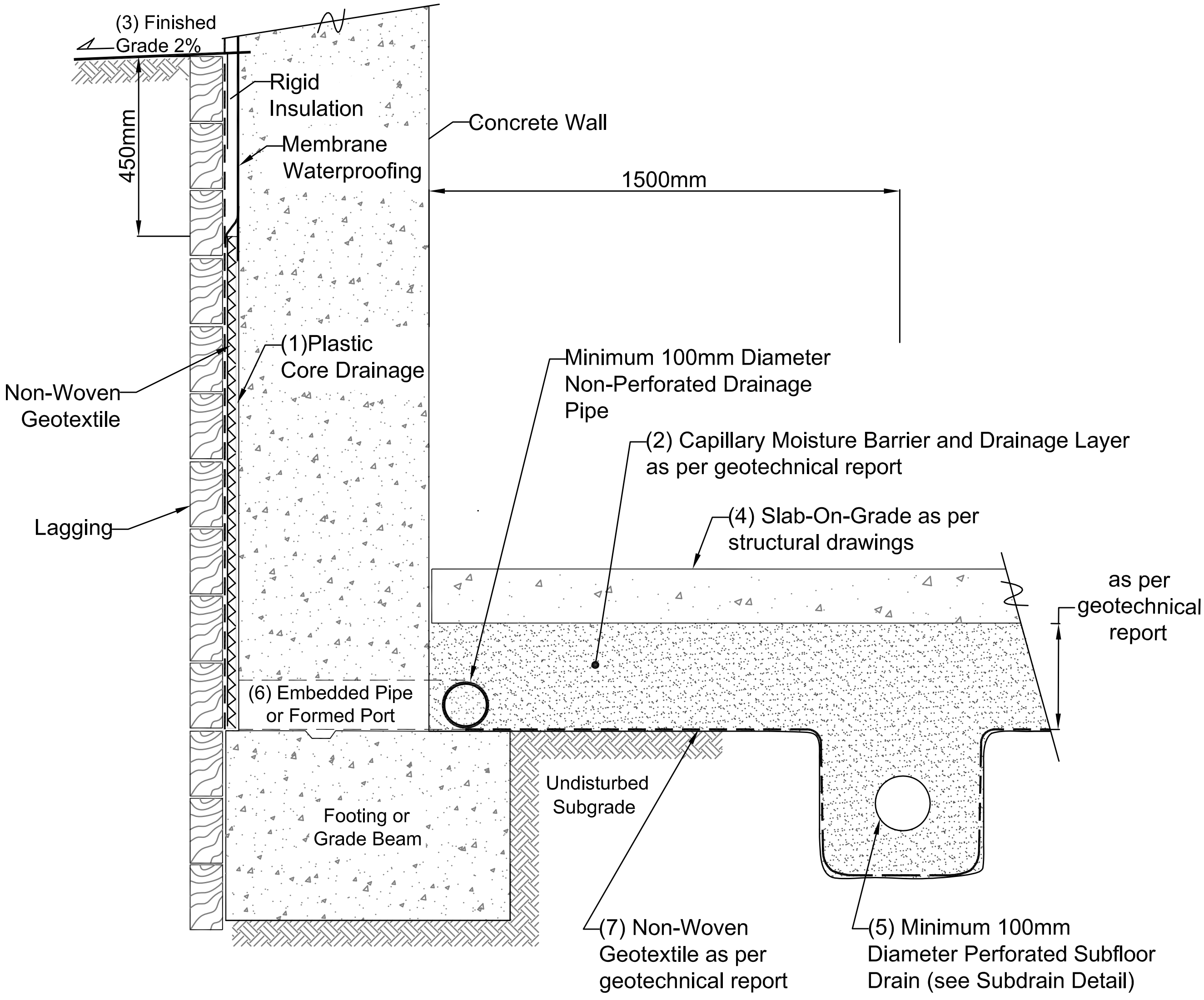
7) When the subgrade consists of a cohesionless soil, the subgrade must be separated from the subfloor drainage layer using a non-woven geotextile (Terrafix 360R or approved equivalent).

N.T.S.

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

Title:

SCHEMATIC DRAINAGE DETAIL
CAISSON WALL SHORING SYSTEM



NOTES

1) Prefabricated drainage panels to consist of Terrafix - TERRADRAIN 200, Mirafi - Miradrain 6000, or approved equivalent. Panels should provide continuous cover with a minimum overlap of 300mm.

2) Capillary moisture barrier/drainage layer to consist of a minimum 200mm layer of 19mm clear stone (OPSS 1004), or as indicated in geotechnical report, compacted to a dense state. Upper 50mm can be replaced with Granular “A” (OPSS 1010) compacted to 98% SPMDD where vehicular traffic is required.

3) Exterior finished grade away from wall at a minimum grade of 2% for min. 1.2m.

4) Building floor slab-on-grade shall not be structurally connected to foundation wall or footing.

5) Subfloor drain invert to be a minimum of 300mm below underside of floor slab, to be set in parallel rows, one way, and at the spacing specified in the geotechnical report.

6) Embedded pipes/formed ports to be set a distance of maximum 3m on-centre. Each port to have a minimum cross-sectional area of 1500mm². Perimeter drainage must be collected and conveyed directly to the building sumps in non-perforated pipe.

7) When the subgrade consists of a cohesionless soil, the subgrade must be separated from the subfloor drainage layer using a non-woven geotextile (Terrafix 360R or approved equivalent).

N.T.S.

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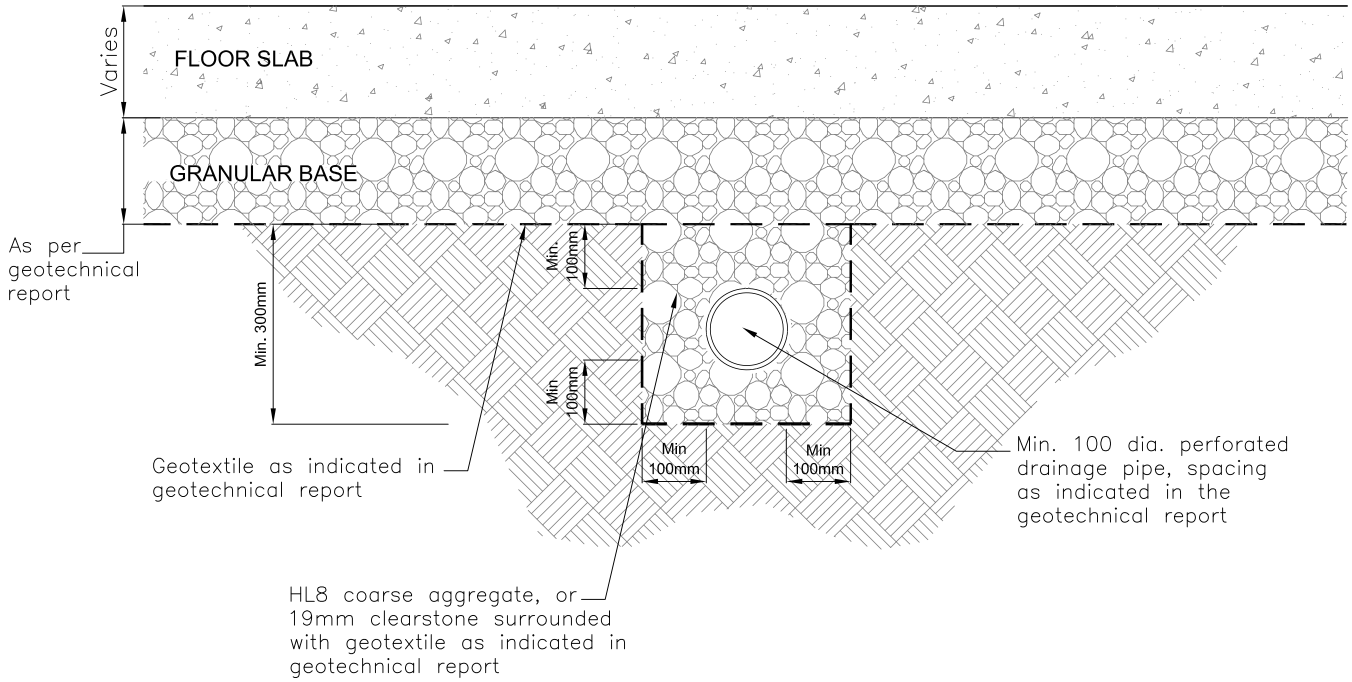
Title:

SCHEMATIC DRAINAGE DETAIL
SOLDIER PILE & LAGGING SHORING SYSTEM



As per geotechnical report

Geotextile as indicated in geotechnical report

HL8 coarse aggregate, or 19mm clearstone surrounded with geotextile as indicated in geotechnical report

Min. 100 dia. perforated drainage pipe, spacing as indicated in the geotechnical report

Schematic Only
Not to Scale

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

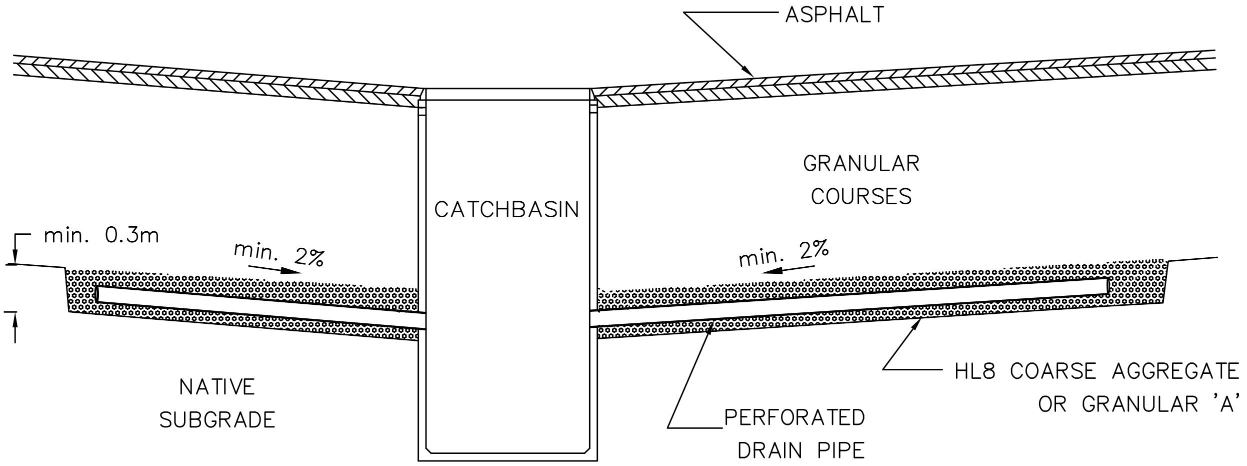
Title:

BASEMENT SUBDRAIN DETAIL

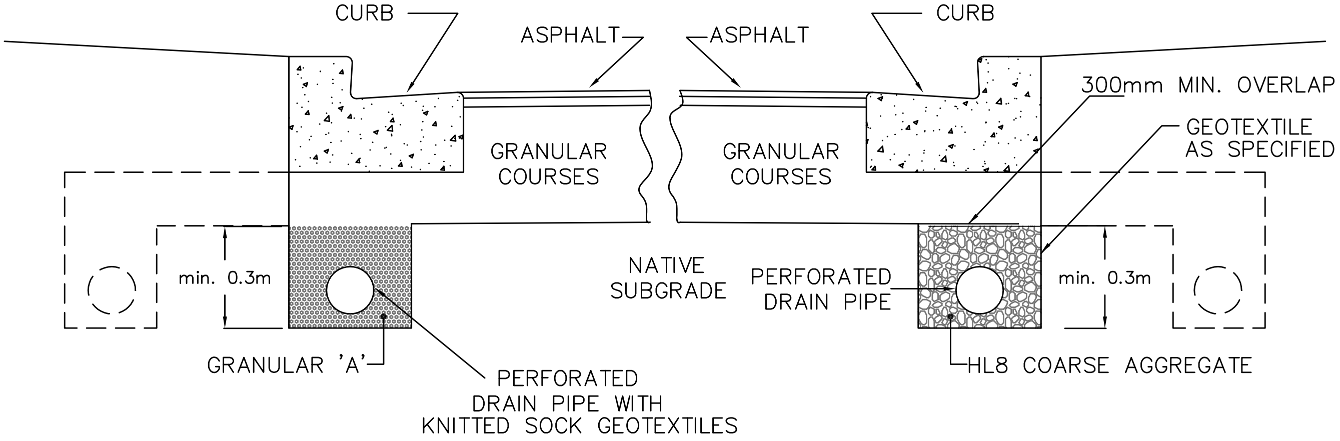
APPENDIX E

TERRAPROBE INC.

Longitudinal Subdrain Connection to Catchbasin



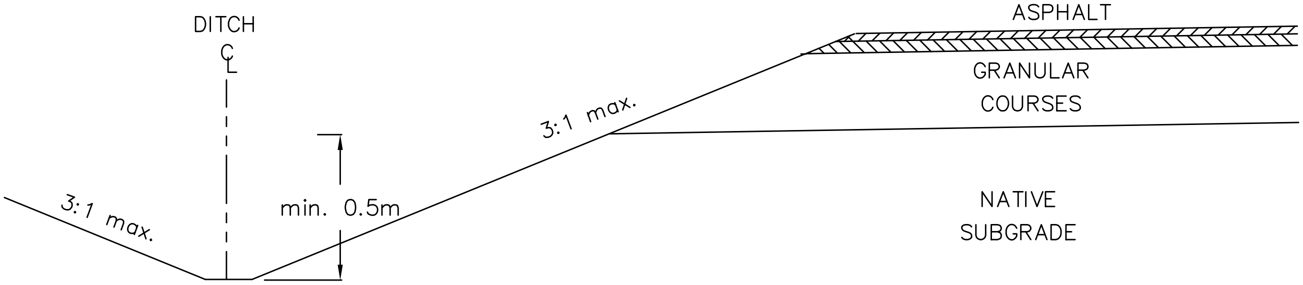
Urban Cross Sections



Unwrapped Trench

Wrapped Trench

Rural Cross Section



Terraprobe

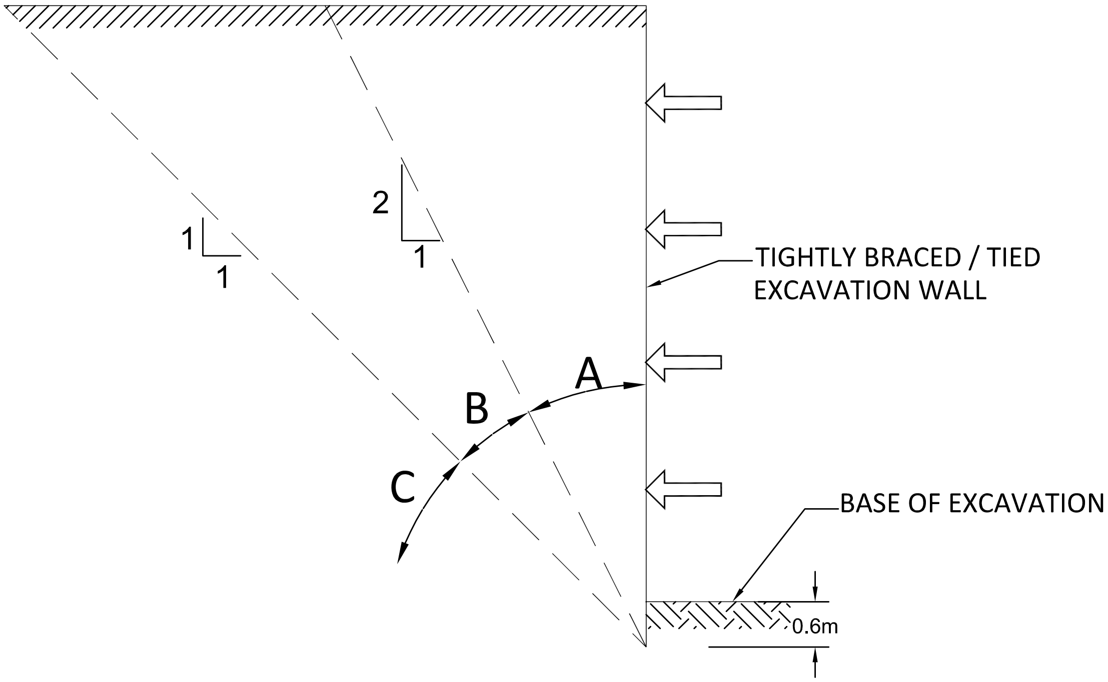
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

PAVEMENT DRAINAGE ALTERNATIVES

APPENDIX F

TERRAPROBE INC.



Zone A: Foundations within this zone often require underpinning. Horizontal and vertical pressures on excavation wall of non-underpinned foundations must be considered.

Zone B: Foundation within this zone often do not require underpinning. Horizontal and vertical pressures on excavation wall of non-underpinned foundations must be considered.

Zone C: Foundations within this zone usually do not require underpinning.

REFERENCE:

User's Guide - NBC 2005 Structural Commentaries
(Part 4 of Division B) - Commentary K

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

Title:

GUIDELINES FOR UNDERPINNING SOILS

APPENDIX E

Site Photos – Pavement Visual Assessment

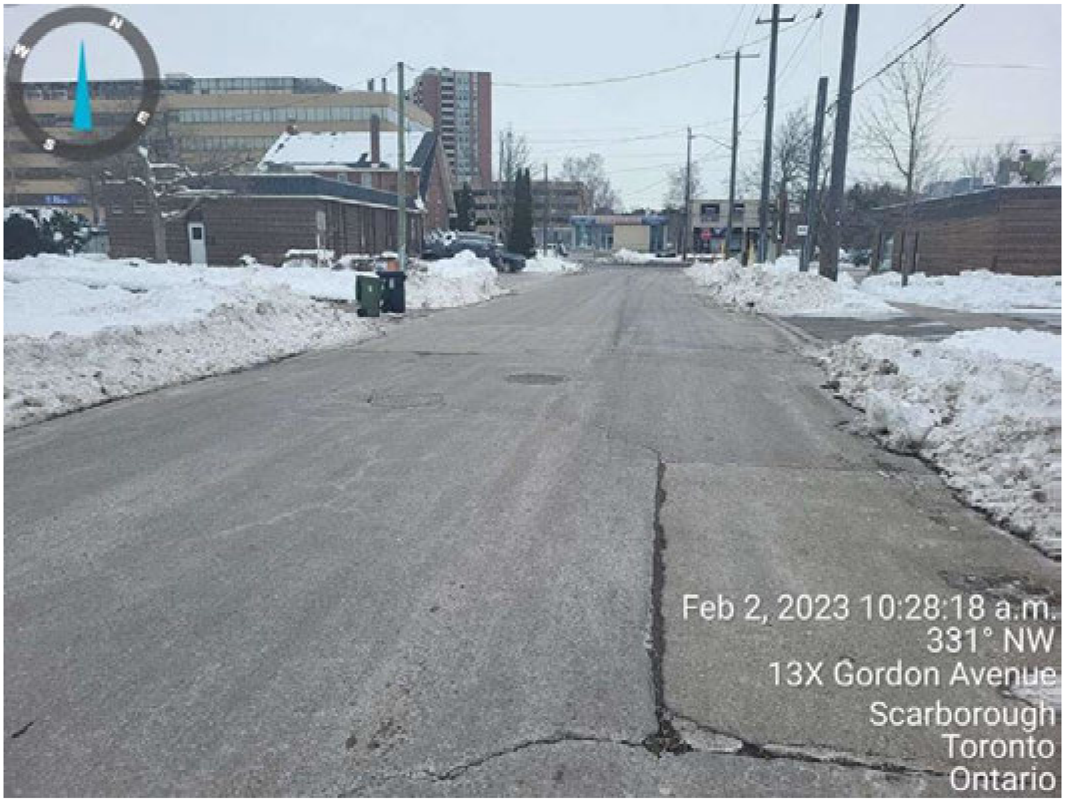
Photograph 1 – Gordon Avenue at Collingwood Street. Pavement in fair condition.

Photograph 2 – Old patch repair and crack sealing, still in fair condition. Some medium severity pavement edge cracking noted.

Photograph 3 – Meandering cracking, stemming from old patch repair. Pavement in overall fair condition.

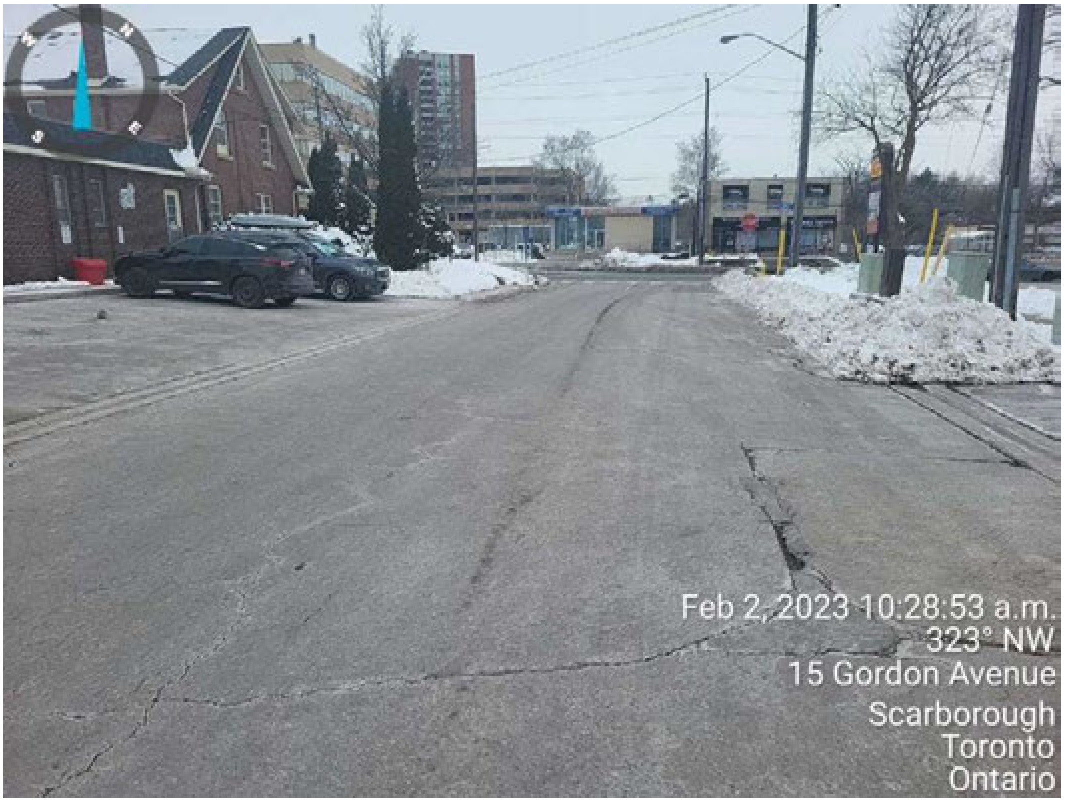
Photograph 4 – Medium severity transverse cracking. Old patch repair with joint openings visible. Pothole in Southbound lane patched.

Photograph 5 – Severe cracking, disintegration and potholes in Northbound Lane.



Photograph 6 – Severe joint opening and localized cracking around old patch repair. Localized cracking around utilities also visible.

Photograph 7 – Moderate severity random/alligator cracking throughout pavement as noted in close up.



Photograph 8 – Severe joint opening and pop-outs around old patch repair. Meandering cracking on pavement surface.

Photograph 9 – Moderate severity meandering cracking.

Photograph 10 – High severity localized alligator cracking around utilities. Intersection with Sheppard Avenue East.

APPENDIX F

WSP Traffic Study

August 19, 2022

Subject: Southwest Agincourt Transportation Connections Study
Traffic Assessment (Existing & Future Traffic Evaluation)

This report presents the traffic assessment supporting the Southwest Agincourt Transportation Connections Municipal Class Environmental Assessment. The purpose of the traffic assessment is to understand the current traffic conditions within the study area and evaluate the future traffic conditions of the four alternative alignments, as shown in **Figure 1**. It is recognized that the current traffic conditions are busy and with the planned growth, the report focuses on how each of the complete street options will handle the future traffic demand.

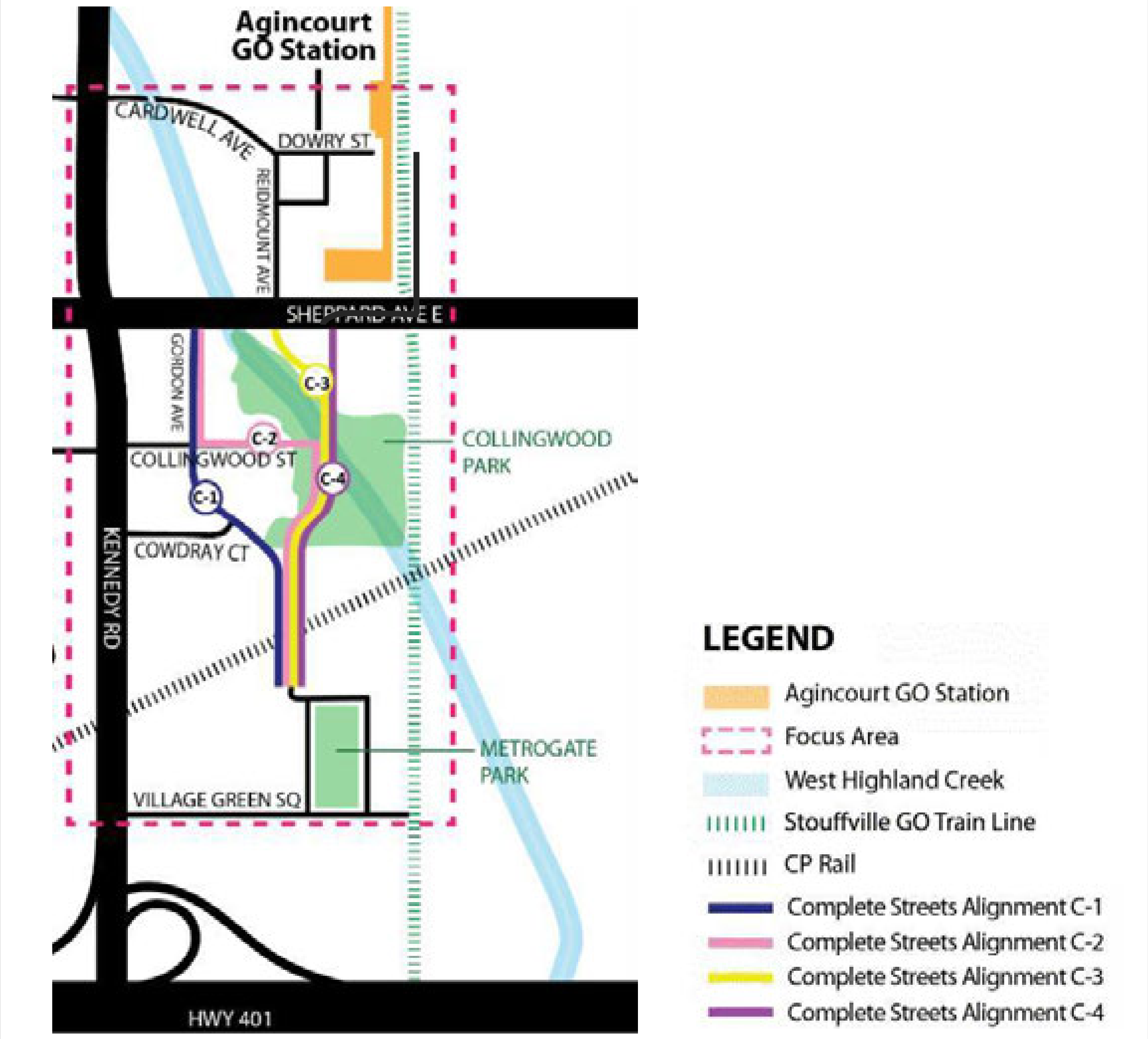


Figure 1 – North-South Street Alternative Alignments

The study area defined for this traffic analysis is illustrated in **Figure 2**, with the signalized study intersections indicated by green squares and the unsignalized intersections by the red circles. The existing lane configurations are also provided in **Figure 3**.

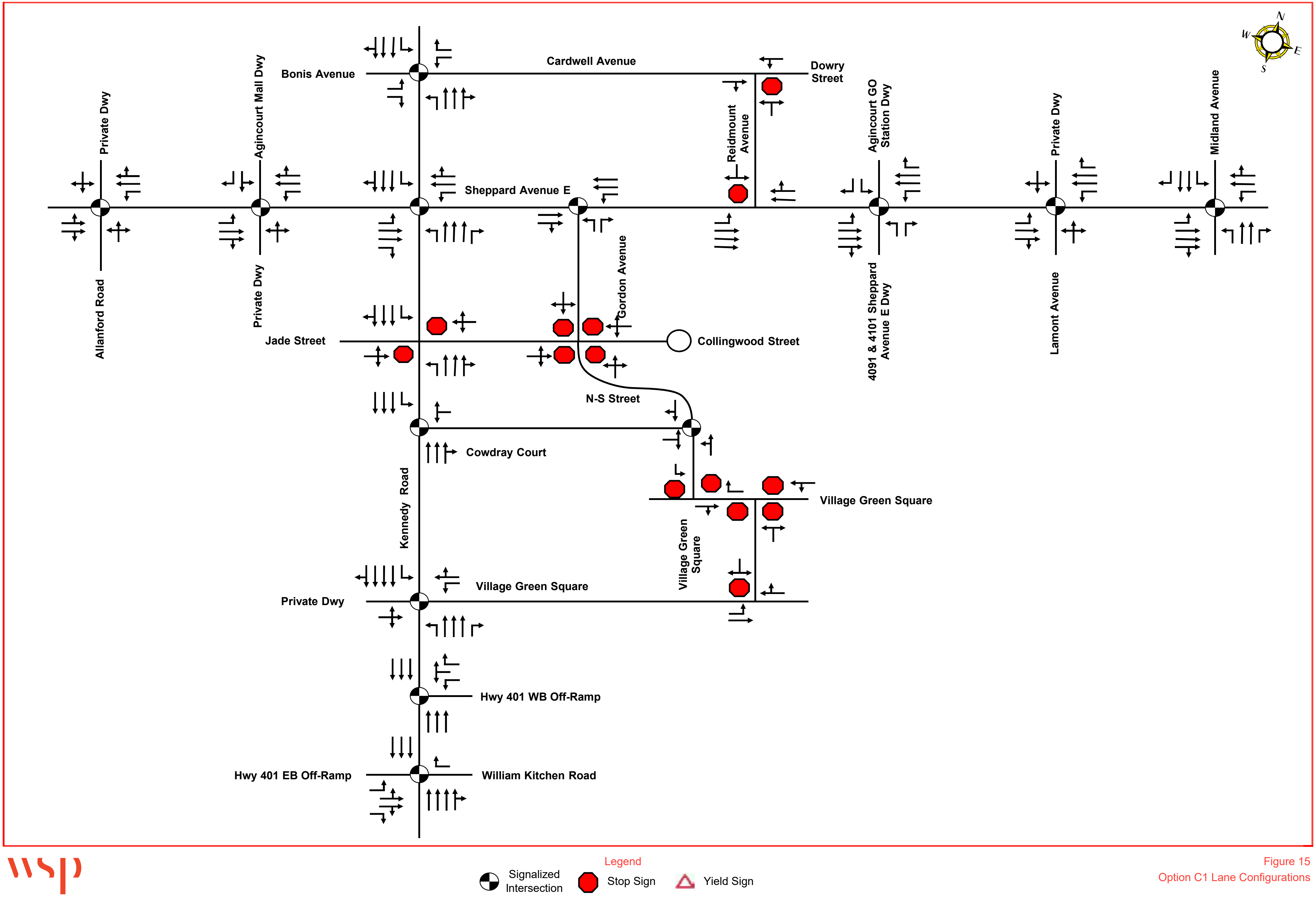
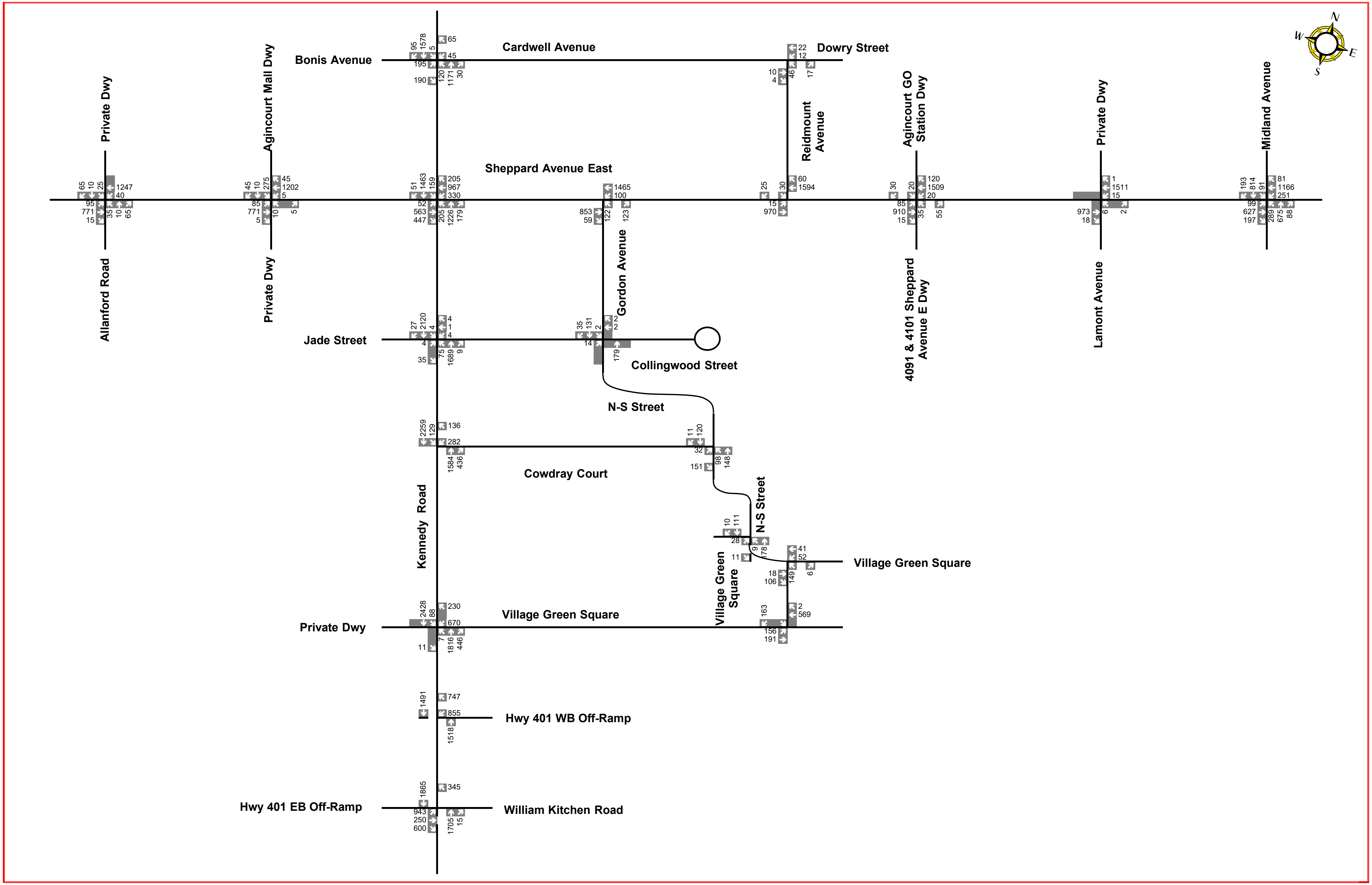


Figure 15

Option C1 Lane Configurations



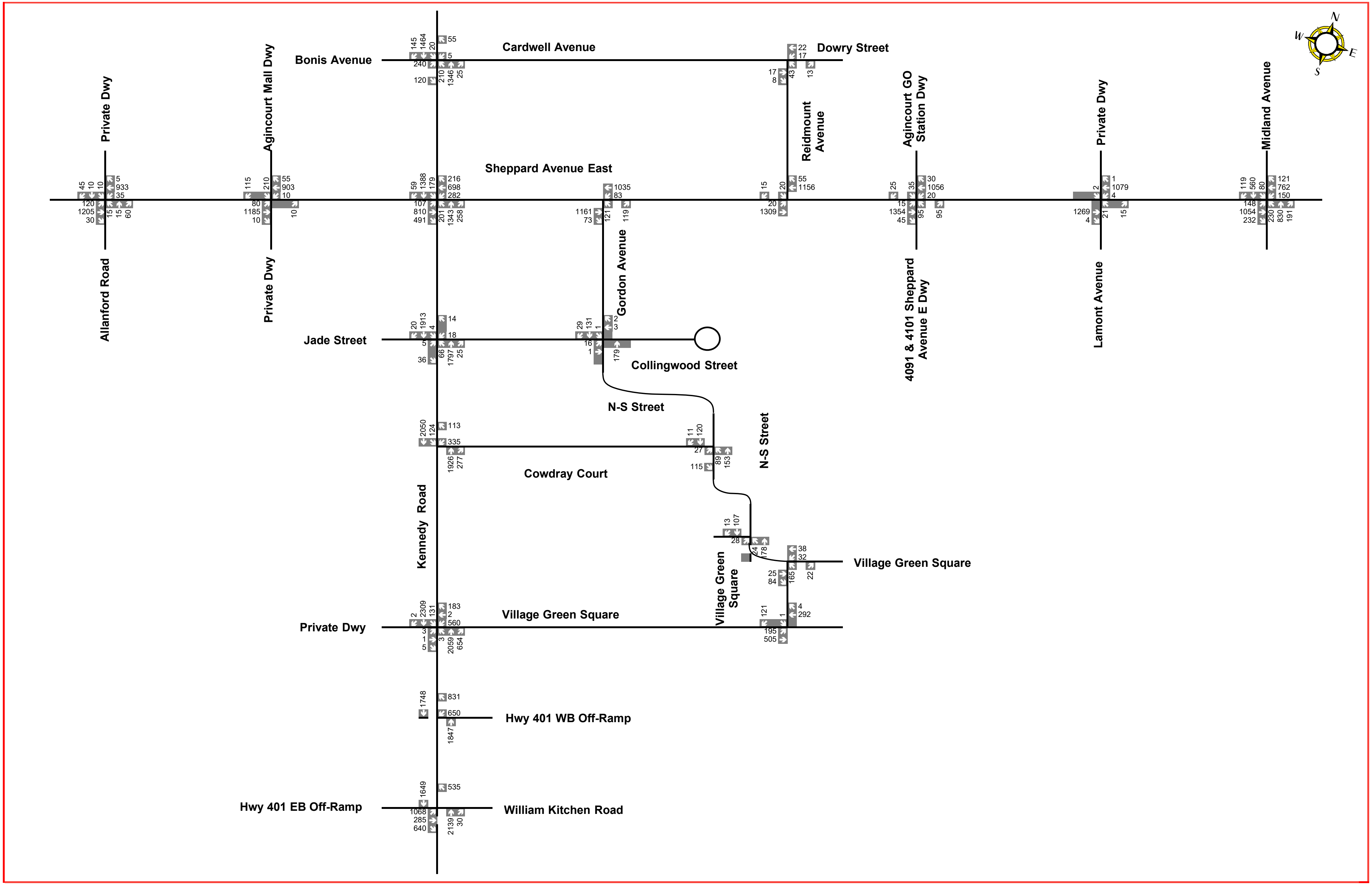
Legend

xx A.M. Peak Hour Traffic Volumes

Figure 16

Future 2035 Traffic Volumes, Weekday A.M. Peak Hour

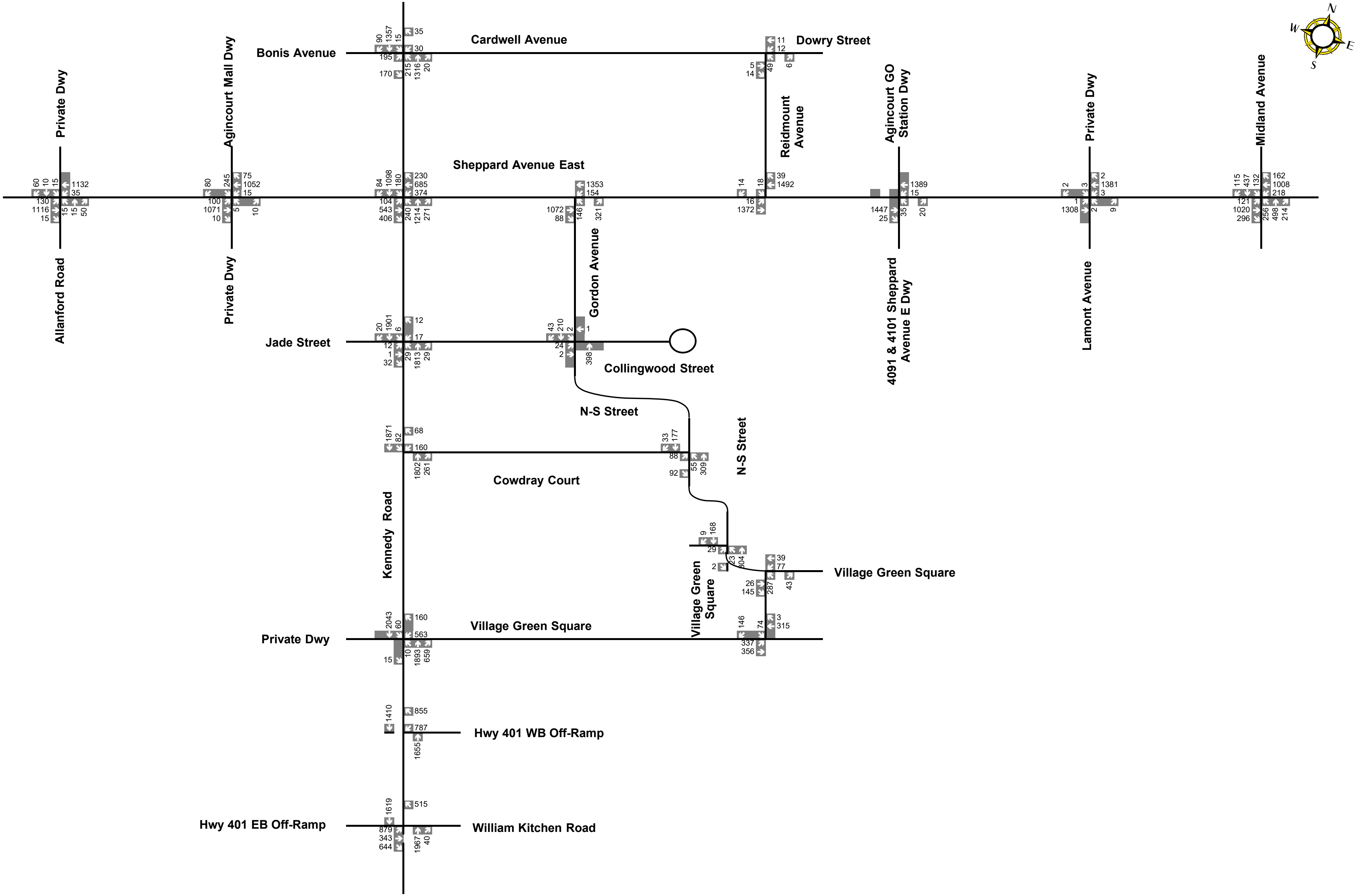
Street Alignment Option C1



Legend

xx P.M. Peak Hour Traffic Volumes

Figure 17
Future 2035 Traffic Volumes, Weekday P.M. Peak Hour
Street Alignment Option C1



Legend

xx SAT Midday Traffic Volumes

Figure 18
Future 2035 Traffic Volumes, Saturday Midday Peak Hour
Street Alignment Option C1

APPENDIX G

ESAL Calculations

TRAFFIC DATA AND ESTIMATED ESALs

Gordon Avenue (From Sheppard Avenue East to Village Green Square)

DESIGN YEAR	YEAR	AVERAGE ANNUAL DAILY TRAFFIC	No. OF LANES	ESTIMATED CUMULATIVE ANNUAL ESALs
1	2023	4,198	2	17,000
2	2024	4,240	2	34,200
3	2025	4,282	2	51,500
4	2026	4,325	2	69,000
5	2027	4,368	2	86,700
6	2028	4,412	2	104,600
7	2029	4,456	2	122,700
8	2030	4,500	2	140,900
9	2031	4,545	2	159,300
10	2032	4,591	2	177,900
11	2033	4,637	2	196,700
12	2034	4,683	2	215,700
13	2035	4,730	2	234,900
14	2036	4,777	2	254,300
15	2037	4,825	2	273,800
16	2038	4,873	2	293,500
17	2039	4,922	2	313,400
18	2040	4,971	2	333,500
19	2041	5,021	2	353,800
20	2042	5,071	2	374,300

Directional Factor (DF) =	0.50
Lane Distribution Factor (LDF) =	1.0
Combined Truck Factor (CTF) =	0.74
Percent Trucks =	3.0%
Traffic Growth Rate =	1.0%
Days Per Year For Truck Traffic =	365
Number of Lanes in one Direction =	1

APPENDIX H

Design Outputs

Table H1
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Gordon Avenue Connection
20 Year Reconstruction Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	374,300
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	95

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	110	110	46
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type II	0.09	1.00	350	350	32
Total	-	-	-	610	610	99

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00		-	2,750,000	29	12
2	New Granular A Base	0.14	1.00	-	-	2,500,000	228	32
3	New Granular B,Type II	0.09	1.00	-	-	210,000	570	51
Total	-	-	-	-	-	-	827	95

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