Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
2085 PINE STREET
BURLINGTON, ONTARIO

Prepared For: **Pine Street Burlington Corp.**
1039 Fourth Line
Milton, Ontario
L9T 6P9

Attention: Mr. York Gruehl

File No. 7-18-0123-01
Original Issue: November 9, 2018
Revision 1: November 15, 2018
© Terraprobe Inc.

Distribution of Report:

1 copy (pdf) - York Trafalgar Corp.
1 copy - Terraprobe Inc.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 SITE AND PROJECT DESCRIPTION 1

2.1 Existing Site Conditions 1
2.2 Site Geology 1
2.3 Proposed Development 2

3.0 PROCEDURE 2

4.0 SUBSURFACE CONDITIONS 3

4.1 Stratigraphy 3
4.1.1 Existing Pavements and Topsoil 4
4.1.2 Fill 4
4.1.3 Silty Clay Till 4
4.1.4 Bedrock (Queenston Formation) 4
4.2 Ground Water 6
4.3 Chemical Analyses 7

5.0 GEOTECHNICAL DESIGN 8

5.1 Foundation Design Parameters 8
5.2 Earthquake Design Parameters 9
5.3 Earth Pressure Design Parameters 10
5.3.1 Rock Pressure 11
5.3.2 Sliding Resistance 12
5.4 Slab on Grade Design Parameters 12
5.5 Basement Drainage 13

6.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY 13

6.1 Excavations 13
6.1.1 Overburden Soil 14
6.1.2 Shale Bedrock 14
6.2 Shoring Design 15
6.2.1 Earth Pressure Distribution 16
6.2.2 Soldier Pile Toe Design 16
6.2.3 Shoring Support 16
6.3 Site Work 17
6.4 Quality Control 17

7.0 LIMITATIONS AND USE OF REPORT 18

7.1 Procedures 18
7.2 Changes in Site and Scope 19
7.3 Use of Report 19

FIGURES

FIGURE 1 SITE LOCATION PLAN
FIGURE 2 BOREHOLE LOCATION PLAN
FIGURE 3 PROPOSED SITE PLANS

APPENDICES

APPENDIX A BOREHOLE LOGS
APPENDIX B CERTIFICATES OF ANALYSES AND QUALITY - SOIL
APPENDIX C BASEMENT DRAINAGE DETAILS

1.0 INTRODUCTION

Terraprobe Inc. was retained by Pine Street Burlington Corp. to carry out a geotechnical investigation at 2085 Pine Street in Burlington, Ontario. The location of the site is shown on the Site Location Plan, Figure 1. A proposal and cost estimate to carry out the work were outlined in our letter of September 13, 2018. Authorization to proceed with the investigation was provided by Pine Street Burlington Corp. on September 18, 2018.

The purpose of the work was to investigate and report on the subsurface soil, rock, and ground water conditions in a series of boreholes drilled at the site. Based on this information, advice is provided with respect to the geotechnical aspects of the proposed development. The anticipated construction conditions pertaining to excavation, shoring support, backfill and temporary ground water control are also discussed, but only with regard to how they might influence the proposed design.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Existing Site Conditions

The subject property is rectangular in shape and occupies an area of approximately 0.1 hectares on the north side of Pine Street. The general arrangement of the site is shown on Figure 2. Existing development on the property consists of a single residential dwelling, located at the southeast corner of the property. At the time of the investigation, the dwelling was unoccupied. The site topography is relatively flat with less than 1 metre of grade change across the entire site.

2.2 Site Geology

Based on published geological information for the general area, near surface soil at and in the vicinity of the subject property generally consists of lacustrine and outwash sand, and Halton Till: clay or silt till.[1] Beneath the overburden deposits is red shale bedrock of the Queenston Formation of Ordovician age.[2] The geological mapping and regional well records indicated that the bedrock beneath the site can be found at an elevation of about 80 metres, approximately 3 to 4 metres below the existing grade.[3]

[1] Quaternary Geology, Hamilton Area, Southern Ontario; Ontario Division of Mines and Minerals; Map No. 2509; 1986.

[2] Paleozoic Geology, Hamilton, Southern Ontario; Ontario Division of Mines; Map No. 2336; 1976.

[3] Bedrock Topography of the Hamilton Area, Southern Ontario; Ontario Department of Mines; Map No. 2034; 1981.

2.3 Proposed Development

The proposed development features are shown on Figure 3, as derived from drawings prepared by ATA Architects Inc. It is understood that the development presently under consideration would include a new eleven (11) storey condominium tower with (3) levels of underground parking. The lowest FFE is expected to be about 10 to 11 metres below present grade or at elevations in the range of about 73 to 74 ±m for the lowest (P3) level of underground parking. The excavation will extend to the property limits; as such the soils will have to be supported during the excavation.

It is understood that it is proposed to incorporate the existing dwelling into the building design and that this may be accomplished by temporarily relocating and reinstate the structure during construction.

3.0 PROCEDURE

The field work for this investigation was carried out on September 28, October 22 and 23, 2018, during which time five (5) boreholes were drilled to depths of about 2.7 to 16.6 metres below the existing ground surface (m BGS). The locations of the boreholes are shown on the Borehole Location Plan, Figure 2. The results of the boreholes are shown on the Log of Borehole sheets and the Rock Core Logs presented in Appendix A.

The boreholes were drilled using a truck-mounted power auger drill rig supplied and operated by a specialist drilling contractor. The boreholes were advanced using conventional interval augering and sampling techniques. Soil samples were recovered by split barrel sampling in accordance with ASTM D1586. The boreholes were backfilled with soil cuttings and bentonite sealant. All leftover soil cuttings were stored in large steel drums which were disposed of by a specialist environmental contractor.

The bedrock was explored in Boreholes 2 and 4 by rotary core drilling with HQ sized rock coring equipment in core runs of 1.5 m length to depths of 10.7 and 10.9 m BGS or to about elevations 73.3 and 72.7 m. Our field staff logged and photographed the rock core recovered from the boreholes. The Total Core Recovery (TCR), Solid Core Recovery (SCR) and Rock Quality Designation (RQD) values were recorded in accordance with the conventions used by the International Society for Rock Mechanics (ISRM).

Ground water observations were made in each borehole during and upon completion of drilling and sampling. In addition, a monitoring well was installed and sealed in Borehole 2. The monitoring well was extended to a depth of about 10.7 mBGS and was constructed of 50 mm diameter schedule 40 PVC screen and riser with a silica sand pack, and bentonite seal. The screened section of the well was 3.0 m long. The remainder of the monitoring well sections were sealed with bentonite to the existing ground surface. A conventional 50 mm diameter J-plug was used to seal the top of the well and a flush mount well cap was installed at the ground surface and sealed with concrete. Details of the monitoring well

construction are presented on the attached corresponding borehole log in Appendix A. The water level was measured in the monitoring well on October 30, 2018 by a member of our field staff.

Boreholes that were not equipped with a monitoring well were decommissioned and sealed with bentonite pellets in accordance with Ontario Regulation 903.

The field work was observed throughout by a member of our engineering staff who located the boreholes, arranged for the underground utility clearances at the borehole locations and cared for the samples obtained during the investigation. The borehole locations were located in the field in advance of drilling. The ground surface elevations at the borehole locations were inferred from topographic data provided by York Trafalgar Group. The elevations were understood to have been referred to the geodetic datum.

All of the samples recovered in the course of the investigation were brought to our Stoney Creek laboratory for further examination and laboratory testing. The results of laboratory testing of the recovered samples are shown on the Log of Borehole sheets in Appendix A. The results of three (3) grain size analyses carried out on selected soil samples are shown in Appendix C, as well as on the corresponding borehole logs. Uniaxial compressive strengths were determined on six (6) sections of the cored bedrock, the results of which are shown on the corresponding Rock Core Logs in Appendix A

4.0 SUBSURFACE CONDITIONS

The subsurface soil, bedrock, and ground water conditions encountered in the boreholes are presented on the attached Log of Borehole and Rock Core Log sheets in Appendix A. The stratigraphic boundaries indicated on the borehole and rock core logs are inferred from non-continuous samples and observations of drilling resistance and typically represent a transition from one soil type to another. These boundaries should not be interpreted to represent exact planes of geological change. The subsurface conditions have been confirmed in five (5) generally evenly spaced boreholes, and may 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. For more specific subsurface details, refer to the enclosed Log of Borehole and Rock Core Log sheets in Appendix A.

4.1 Stratigraphy

The following stratigraphy is based on the borehole findings, as well as the geotechnical laboratory testing conducted on selected representative soil samples. In general, earth fill was encountered at the site, underlain by a deposit of glacial till (silty clay till and shaley till) and subsequently shale bedrock of the Queenston Formation.

4.1.1 Existing Pavements and Topsoil

Boreholes 4 and 5 penetrated approximately 25 to 40 mm of asphaltic concrete at the existing ground surface. The pavement surface was underlain by about 160 mm of granular fill in Borehole 4, and immediately by sand fill in Borehole 5.

Boreholes 1, 2 and 3 encountered approximately 200 mm of topsoil at the ground surface underlain by fill.

4.1.2 Fill

Beneath the topsoil and existing pavement structure, the boreholes were advanced through a layer of earth fill that extends to depths of about 0.6 to 1.2 m below the existing ground surface (m BGS) or to about elevations 83.4 to 82.4 m (geodetic). The fill was brown in colour and generally consisted of sand to silty sand, and sandy silt to clayey silt with traces of topsoil, rootlets and gravel. Standard Penetration Testing carried out within the fill determined N values ranging from 5 to 15 blows per 0.3 m, indicating a loose to compact state of compaction. The in-situ water content of the samples of fill recovered from the boreholes ranged from about 5 to 22 percent.

4.1.3 Silty Clay Till

The fill was underlain by a stratum of brownish grey silty clay till extending to depths of about 2.2 to 2.4 m BGS or to about elevations 81.7 to 81.4 m. The N values determined from the Standard Penetration Testing ranged from 18 to 45 blows per 0.3 m, indicating a very stiff to hard consistency. The natural water content of the samples of silty clay till recovered from the boreholes ranged from about 12 to 26 percent. The results of three (3) grain size analyses carried out on samples of the silty clay till are shown on Figure B1 in Appendix A, as well as on the corresponding Log of Borehole Sheets.

4.1.4 Bedrock (Queenston Formation)

The augering and interval sampling method used to explore the overburden at the site is conventionally accepted investigative practice. However, this method does not define the bedrock surface with precision, particularly in this instance where the overlying soil consists of a dense till possibly containing cobbles and boulders, and where the surficial zone of the bedrock is typically highly weathered. The bedrock encountered beneath the site consisted of reddish brown shale of the Queenston Formation.

The bedrock encountered in Borehole 2 was continuously cored between depths of 3.1 and 10.7 m below the existing ground surface, or from about elevation 80.9 to 73.3 m. The bedrock encountered in Borehole 4 was continuously cored between depths of 2.8 and 10.9 m below the existing ground surface, or from about elevation 80.8 to 72.7 m. The remaining boreholes were terminated upon practical refusal to conventionally auger, which was inferred to represent the surface of the bedrock.

A summary of properties with respect to the shale within the Queenston Formation was presented in the Ontario Ministry of Transportation and Communications document RR229, *Evaluation of Shales for Construction Projects* (March 1983), as follows:

	Uniaxial Compressive Strength (MPa)	**Young's Modulus (GPa)**	**Poisson's Ratio**
Average	8.7	1.3	0.32
Range	7.2 to 9.6	0.5 to 2.3	0.28 to 0.35

There is typically a zone of weathering at the contact between the rock of the Queenston Formation and the glacial soil overburden. In the Ontario Ministry of Transportation and Communications document RR229, *Evaluation of Shales for Construction Projects*, there is a *typical weathering profile of a low durability shale*, reproduced from Kempton, Davis and Chandler, that characterizes the shale surface into three grades of weathering and four zones described as follows:

	Zone	**Description**	**Notes**
Fully Weathered	IVb	soil like matrix only	indistinguishable from glacial drift deposits, slightly clayey, may be fissured
Partially Weathered	IVa	soil like matrix with occasional pellets of shale less than 3 mm dia.	little or no trace of rock structure, although matrix may contain relic fissures
	III	soil like matrix with frequent angular shale particles up to 25 mm dia.	moisture content of matrix greater than the shale particles
	II	angular blocks of unweathered shale with virtually no matrix separated by weaker chemically weathered but intact shale	spheroidal chemical weathering of shale pieces emanating from relic joints and fissures, and bedding planes
Unweathered (Sound)	I	shale	regular fissuring

Based on auger grinding, auger resistance, and samples recovered from the split spoon sampler, the bedrock surface was inferred in the boreholes at depths ranging from about 2.2 to 2.3 m BGS (Elev. 81.7 to 81.4 ± m). In Boreholes 2 and 4 where rock core was recovered, the zone of partially weathered (Zone II and III) shale was measured to be approximately 1.2 to 1.3 m thick (described as shaley till and weathered shale on the Log of Borehole sheets), and the transition to sound/unweathered (Zone I) shale was encountered approximately 3.2 to 3.4 m BGS (Elev. 80.2 to 80.4 ± m). A summary of the bedrock elevations is tabulated below:

Borehole	**Ground Surface Elev. (m)**	**Top of Weathered (Zone II / III) Bedrock, Depth / Elev. (m)**	**Top of Sound (Zone I) Bedrock, Depth / Elev. (m)**	**Method of Bedrock Identification**
2	84.0	2.3 / 81.7	3.6 / 80.4	Inferred by split spoon samples, sampler bouncing, auger refusal; Proven by recovered rock core
4	83.6	2.2 / 81.4	3.4 / 80.2	Inferred by split spoon samples, sampler bouncing, auger refusal; Proven by recovered rock core

The TCR (total core recovery), SCR (solid core recovery), and RQD (rock quality designation) values for the core runs of the shale bedrock are summarized in the following table along with the range in uniaxial compressive strengths of samples of the cored rock.

Borehole #	Total Core Recovery (TCR) %	Solid Core Recovery (SCR) %	Rock Quality Designation (RQD) %	Uniaxial Compressive Strength (MPa)
2	94 - 100	28 - 100	0 - 88	18.2 – 34.0
4	85 - 100	20 - 98	20 - 93	15.3 – 50.3

The discontinuities observed in the rock cores were typically horizontal and generally associated with the bedding planes. The joints were generally filled with softening clay deposit and the joint spacing was generally close. Uniaxial compressive strengths ranging from 15.3 to 50.3 MPa were determined on six (6) specimens of the rock core. These parameters indicate that the bedrock can generally be considered to be fairly sound to sound below about elevation 81.0 ± metres.

Since the bedding is horizontal in this formation, and there are many bedding layers within this rock mass, the RQD is typically low and is a function of the regular repeating bedding planes, not of stress induced fractures leading to a weaker rock mass. The results of this investigation in this regard are typical of the deposit.

4.2 Ground Water

Unstabilized ground water level observations were made in the open boreholes during and after drilling, as noted on the borehole logs. A 50 mm diameter monitoring well was installed in Borehole 2 to facilitate long-term ground water monitoring. The water level measured within the well is shown on the corresponding borehole log and is summarized below:

Borehole No.	Elevation of Well Screen (m)	Stratum Captured by Well Screen	Depth / Elevation of Water Level in Well (m)
			October 30, 2018
2	76.3 to 73.3	Queenston Formation – Shale Bedrock	5.1 / 78.9

Based on the above water level readings, the prevailing ground water level at the site is in the bedrock near Elev. 79 ± m. No wells were installed in the overburden soils as part of this investigation. Although the boreholes were observed to be open and dry upon completion of drilling, it is still expected that the overburden may contain perched water depending on precipitation conditions and seasonal affects.

The glacial till contains a high percentage of fines and is of low permeability, precluding the free flow of water. The sound bedrock is considered to be of low permeability.

4.3 Chemical Analyses

Five (5) selected soil samples (BH1 SA2, BH2 SA3, BH3 SA1, BH4 SA3 and BH5 SA2) recovered from the site were submitted for chemical analysis at AGAT Laboratories Limited. In view of the lack of visual and olfactory evidence of contamination, the rational for sample selection was based on general coverage requirements.

The chemical parameter groups selected for analysis were chosen to provide general information regarding the soil quality and to determine the feasibility of removing surplus excavated soil from the site during construction. The Certificate of Analysis for the chemical testing is provided in Appendix B.

The results of the chemical analysis were compared to the Ministry of Environment and Climate Change (MOECC) Standards as found in the '*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act'*, April 15, 2011. The Standards which the results were compared to are as follows:

- Table 1 Full Depth Background Site Condition Standards for Residential/ Parkland/ Institutional/ Industrial/ Commercial/ Community Property Use (Table 1 RPIICC)

- Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial, Commercial and Community Property Use (Table 3 ICC)

The Standards were chosen for the following reasons:

- Table 1 RPIICC – The results were compared to the Table 1 Standards in order to determine if the soil material was suitable as clean fill for reuse by any potential receiving site.

- Table 3 ICC – The results were compared to the Table 3 ICC Standards in order to determine if the soil material should be considered a waste.

In summary, BH4 SA3 had exceeded Table 1 standards for electrical conductivity (EC) and Sodium Adsorption Ratio (SAR). All other samples submitted met the Table 1 RPIICC and Table 3 ICC standards for all parameters tested. The general practice in the construction industry has been that soil that does not meet the Table 3 ICC standards is required to be managed as waste. Based on the above preliminary information, disposal of excess excavated soil from the site is not expected to be problematic. It should be noted however that sites accepting fill usually have aesthetic, or engineering property requirements, as well as chemical requirements for soil acceptance. Such requirements are site specific, so assessment of the appropriateness of the soil from this site for use at other locations was beyond the scope of the investigation.

In all cases, a copy of the analytical data must be provided to the receiver for review. Further analyses of soils to be managed as waste will be required in order to properly classify the soil in accordance with current legislation (this would include a TCLP leachate analysis as set out in Ontario Regulation 558/00 - March 31, 2001) and for acceptance at a disposal site. Further information on soil management practises

is provided in the Ontario Ministry of the Environment (Central Region) publication entitled '*Management of Excess Soil – A Guide for Best Management Practises'*, dated January 2014

5.0 GEOTECHNICAL DESIGN

The following discussion is based on our interpretation of the factual data obtained during this investigation and is intended for the use of the design engineer only. Comments made regarding the construction aspects are provided only in as much as they may impact on design considerations. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

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.

It is understood that the development presently under consideration would include a new eleven (11) storey condominium tower with (3) levels of underground parking. It is proposed to preserve incorporate the existing dwelling into the design of the condominium structure. It is expected that the proposed lowest parking level four (P3) finished floor elevation (FFE) will be at approximately Elev. 73 to 74 ± m within the bedrock. The excavation will extend to the property limits; as such the soils will have to be supported during the excavation.

It should be noted that some of the details regarding the proposed development were of a conceptual nature when this report was prepared. For this reason, the geotechnical aspects of this project should be reviewed by this office at the final design stage.

5.1 Foundation Design Parameters

The top of weathered bedrock was encountered at depths of about 2.2 to 2.3 ± m BGS (Elev. 81.7 to 71.4 ± m). The transition to sound (unweathered) bedrock was identified by the recovered rock core in Boreholes 2 and 4 at depths of about 3.4 to 3.6 m below grade (Elev. 80.4 to 80.2 ± m).

The lowest FFE is expected to be at approximately Elev. 73 to 74 ± m for the lowest (P3) level of underground parking and foundations will extend nominally about 1 m deeper. Based on the factual data from the borehole logs, all foundations will be made as conventional spread and/or strip footings on sound (unweathered) bedrock of the Queenston Formation. Conventional spread and/or strip foundations

established to bear in the sound bedrock as described above may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 8 MPa. In Limit States Design, the factored bearing resistance at ULS will govern the design since bedrock is non-yielding and the loading to produce 25 mm of axial deformation is greater than the factored resistance at ULS.

A minimum footing width of 500mm for continuous footings, and 900mm for spread footings is recommended. All spread footing foundations exposed to freezing temperatures must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

Some variability in the consistency and depth of the shale bedrock is expected. Deeper excavations may be required locally and for this reason, it is important that all of the foundation excavations be inspected by the geotechnical engineer to confirm that all overburden soil has been fully penetrated and to identify any preparatory work required prior to placing the footing concrete. Where deeper excavations are required, the footings should be lowered in a series of steps with maximum vertical increments of 600 mm and with a rise to run ratio of 7:10.

5.2 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**

For spread footings resting uniformly on sound (unweathered) bedrock, it is recommended that 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				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
C	1.0	1.0	1.0	1.0	1.0

It should be noted that the seismic site designation above is estimated on the basis of rational analysis of penetration resistance (N-Values) observed in the boreholes (assuming the consistency for the deeper soil stratigraphy beyond the investigation depth was similar to that of the lowest soil strata penetrated within the investigation depth).

Consideration may be given to conducting a site specific Multichannel Analysis of Surface Waves (MASW) at this site to determine the average shear wave velocity in the top 30 metres of the site stratigraphy. An improved seismic site designation (Site Class B) may be possible.

5.3 Earth Pressure Design Parameters

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

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

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

Stratum/Parameter	φ (deg.)	γ (kN/m^3)	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS 1010)	32	21.0	0.31	0.47	3.25
Existing Earth Fill	29	19.0	0.35	0.52	2.88

Stratum/Parameter	φ (deg.)	γ (kN/m^3)	K_a	K_o	K_p
Glacial Till	32	21.0	0.31	0.47	3.25
Queenston Formation (Bedrock)	28	26.0	n/a	n/a	n/a

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

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

where,
P = the horizontal pressure at depth, **h** (m)
K = the earth pressure coefficient
$\mathbf{h_w}$ = the depth below the groundwater level (m)
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 above equation pertains to a horizontal grade condition behind a retaining structure. Values of earth pressure against retaining structures for an inclined retaining grade condition will vary.

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

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

To ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure, 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 a perimeter/underfloor drainage system. Where the structure is built by open cut excavation methods, this equation assumes that free-draining granular backfill such as Granular 'B' (OPSS 1010) is used and effective drainage is provided.

Consideration must also be given to the possible effects of frost on structures retaining earth. Pressures induced by freezing in frost-susceptible soils are effectively irresistible.

5.3.1 Rock Pressure

Special consideration must be given to structures with sufficient depth that the below grade space would penetrate the bedrock. Excavated bedrock from the Queenston Formation must not be used to backfill structures, firstly because it is unlikely that it can be compacted adequately, and secondly, because there are zones of the Queenston Formation that contain Illite, an expansive clay material. For better grade integrity, the use of imported granular materials is recommended to backfill the structures.

If a structure is made such that it is cast directly into an excavation in the bedrock, the empirical approach for the design of foundation walls below bedrock level has been to use a uniform pressure distribution which is consistent with the maximum earth pressure calculated for the lowest level of soil in the profile. This approach is likely conservative in that the rock is effectively self-supporting, but is recognizes the practical requirement to have a foundation wall of a consistent width through the lower reach of the building.

This approach does not recognize the potential for pressures on the basement walls due to the presence of locked-in horizontal stresses that are relieved when a rock cut is made. It is expected that there would be a sufficient time between the cutting of the rock face and construction of the building structure to allow the rock to de-stress. There is not much documented experience with stress relief and swell in the Queenston Formation. It is know that there are potentially locked in horizontal stresses. Excavations in Toronto in the Georgian Bay Formation, a similar shale deposit, experience stress relief and swell for three to four months when cut. If there is not sufficient time lag between the excavation and the subsequent placing of footings, walls and the suspended slab levels, then special provisions need to be made with respect to time dependent rock stress relief in the design of basement walls of structures.

Where pits are made for sumps and elevators, or other such features which are incorporated within the major excavation, there must also be consideration of the potential for rock squeeze effects if the pits are to be cast directly against the rock face. For such structures, a compressible layer can be placed between the rock and the concrete or alternatively the local structures can be over-excavated and backfilled

5.3.2 Sliding Resistance

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

5.4 Slab on Grade Design Parameters

The P3 level slab is to be made near Elev. 73 to 74 ± m on sound bedrock of the Queenston Formation, which is suitable for the support of slabs on grade. The modulus of subgrade reaction appropriate for design of the slab resting on sound bedrock is 80,000 kPa/m.

It is necessary that building floor slabs be provided with a capillary moisture barrier and drainage layer. This is made by placing the slab on a minimum 300 mm layer of 19 mm clear stone (OPSS 1004) compacted by vibration to a dense state. Basement drainage is required as discussed in Section 5.5.

5.5 Basement Drainage

To assist in maintaining dry basements and preventing seepage, it is recommended that exterior grades around the building be sloped away at a 2 percent gradient or more, for a distance of at least 1.2 m. Provision of nominal subfloor drainage is required in conjunction with the perimeter drainage of the structure, to collect and remove the water that infiltrates at the building perimeter and under the floor. Perimeter and subfloor drainage are required throughout below grade areas.

It is recommended that the subfloor drainage system consists of minimum 100 mm diameter perforated pipes spaced at a maximum of 9 metres on centre. The pipes must be surrounded on all sides by a minimum of 100 mm of 19 mm clear stone, and the pipe inverts should be a minimum 300 mm below the base of the slab. The elevator pits can be drained separately with an independent lower pumping sump or can be designed as water proof structures which are below the drainage level. Terraprobe recommends to cut the rock subgrade neat to 300 mm beneath the floor slab and place subdrains directly on the subgrade. The subfloor drainage layer is then comprised of 300 mm of 19 mm clear stone (OPSS 1004).

Foundation walls must be damp-proofed in conformance to Section 5.8.2 of the Ontario Building Code (2012). Prefabricated drainage composites, such as Miradrain 2000 (Mirafi) or Terradrain 200 (Terrafix), should be incorporated between the shoring wall or rock face and the cast-in-place concrete foundation wall to make a drained cavity. Drainage from the cavity must be collected at the base of the wall in non-perforated pipes and conveyed directly to the sumps. The flow to the building storm water sump from the subsurface drainage will be governed largely by the building perimeter drainage collection during rainfall and runoff events. Typical shored excavation drainage details are provided in Appendix C.

The drainage system is a critical structural element, since it keeps water pressure from acting on the basement floor slab or on the foundation walls. 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 pump should be adequate to accommodate the anticipated ground water and storm event flows. It is expected that the seepage can be controlled with typical widely available, commercial sump pumps.

6.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

6.1 Excavations

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III – Excavations, Sections 222 through 242. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes at this site, the existing fill is considered a Type 3 Soil, provided

that effective ground water control is achieved where required and surface water is directed away from open excavations. The glacial till should be considered a Type 2 Soil.

Where workers must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates maximum slopes of excavation by soil type as follows:

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

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

6.1.1 Overburden Soil

The overburden soils can be removed by conventional excavation equipment. Excavations at this site will likely encounter native cobble/boulder obstructions in the glacial till. Fragments of shale and limestone are also likely to be encountered in the transition zone between the native soil and the bedrock. The size and distribution of cobbles/boulders or bedrock fragments cannot be predicted with boreholes, as the sampler size is insufficient to secure representative particles of this size.

It should be noted that surplus excavated soil resulting from the construction that is to be disposed of off-site, will require chemical analyses to assess the disposal site requirements. Chemical analyses of soil were carried out as part of this assignment and are discussed in Section 4.3. It should be noted however that sites accepting fill usually have aesthetic, or engineering property requirements, as well as chemical requirements for soil acceptance. Such requirements are site specific, so assessment of the appropriateness of the soil from this site for use at other locations was beyond the scope of the investigation.

6.1.2 Shale Bedrock

Queenston Formation bedrock is not considered a “soil” under the act. Excavations into the shale bedrock can be vertical to near-vertical, but not overhanging. The face of the excavation must be scaled of any loose rock to protect the workers working in the excavation. Where this is not possible, protective mesh can be draped over the rock face when work is required in the area immediately beside the cut rock face. The shale (as well as the limestone, sandstone and siltstone interbeds) are transected by sub-vertical fractures, typically oriented at right angles to one another, and these fractures may preferentially cause the

formation of slabs, wedges or blocks of loose unstable rock which will require removal and can often lead to 'over-break' beyond the intended excavation 'cut line'.

Past experience in bedrock belonging to the Queenston Formation indicates that the till-shale transition zone and the underlying rock can be removed without blasting. The upper weathered portion of the shale bedrock can be removed with powerful excavators equipped with rock teeth. The removal of the underlying bedrock and the interbedded limestone and siltstone layers, however, will be more arduous and time consuming, and will require specialized rock buckets, with the assistance of hoe rams and other similar tools. Line drilling may be required, but likely only in sensitive areas such as where excavations are in close proximity to existing structures where it is necessary to limit over-break and vibrations. The relative ease/difficulty in excavation of bedrock will also depend on the size (width) and depth of the excavation. For example, excavation of narrow trenches into the shale will obviously be more difficult than forming large open cuts for structures in which excavators can operate from the base of the cut to 'pry' up hard layers. Some of the thicker "hard" layers may require additional hoe-ramming effort to remove, but this is not considered unusual for rock excavations in this area. The risk and responsibility for these issues must be addressed in the contract documents for foundations, excavation, and shoring contractors.

In the bedrock, ground water seepage is expected to occur continuously through bedding planes, fractures, and along the more pervious sandstone and limestone interbeds. It should be possible to handle the infiltration by means of ditches and filtered sumps, fitted with appropriately sized pumps within the base of the excavation, as the excavation progresses. Be aware that fouling of pumps by powdery shale fines is sometimes a problem as is accumulation of suspended soil and rock fine particles in the ponded seepage water.

During excavation, gas monitoring should be carried out to ensure that any natural gas detected emanating from the bedrock has been adequately vented and dissipated.

6.2 Shoring Design

The depth of the overburden soil at this site varies from about 2.7 to 2.9 metres below existing grade. As such, there is very little soil to be retained at the edges of the proposed excavations. The extent to which the municipality will allow sloping of the soil at the edge of the site will dictate whether any shoring must occur. If a straight edge excavation is required above the top of the shale bedrock, then a system of steel soldier piles and lagging pinned into the top of the rock and anchored would be the appropriate solution. Depending on whether the adjacent buildings on the east and west sides of the site need to be supported, a rigid shoring system to preserve the integrity and support of the soil beneath the existing foundations of the adjacent buildings in a state approximating the at-rest condition may be required. Terraprobe can provide shoring design services for this project if requested.

6.2.1 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 supports are used to support the excavation, 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. For the cohesive glacial till at the site, multi-level supported shoring can be designed based on an earth pressure distribution consisting of a trapezoidal pressure distribution with a maximum pressure defined by:

$$\boldsymbol{P = 0.8\,K[\gamma H + q]}$$

In this distribution, the earth pressure is taken as zero at the grade level, uniformly increasing to a maximum pressure within 1/4H. Similarly, from a depth 3/4H, the maximum design pressure can be decreased to zero pressure at the base of the excavation.

For ground water pressure distribution along the shoring wall in conjunction with the above soil pressures, it should be assumed that the fill is fully saturated with perched water. The ground water pressure distribution is only applicable where an impermeable boundary condition is created along the perimeter of the excavation, as is the case with an interlocking caisson wall. Conventional soldier pile and lagging do not experience ground water pressures, as water is allowed to drain freely through the wall.

6.2.2 Soldier Pile Toe Design

Caisson and soldier pile toes will be made in sound bedrock of the Queenston Formation. The factored vertical bearing capacity for the design of a pile, embedded in the sound bedrock, is 10 MPa. The factored lateral bearing capacity of the sound rock is 1 MPa.

The exposed Queenston Formation deteriorates with time. Exposed excavation faces have been found to flake and recede as much as 300 mm with 12 months exposure. This recession generally takes the form of coin-size shale particles dropping from the face on a constant basis. The deteriorated rock loses internal integrity and bearing capability. Typically, the piles advanced as part of the shoring wall are advanced at least 1 m below the base of the excavation to accommodate this weathering, to ensure the lateral and vertical capacities provided can be utilized.

6.2.3 Shoring Support

Rock anchorages are typically made in the Queenston Formation using a design bond stress of 620 kPa, without proof testing. Higher bond stresses are possible but proof testing of anchorages on a site by site basis is required. The use of soil anchors established in the overburden soil is not recommended because of the overburden character changes in short distances.

6.3 Site Work

The soil at this site is fine-grained and may become weakened or loosened when subjected to construction traffic. If site work is carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. The disturbance caused by the traffic can result in the removal of disturbed soil and use of fill material for site restoration or underfloor fills that is not intrinsic to project requirements.

The timing of the major grading works on the site is critical to the performance of the work. It may not be feasible to carry out fill operations during wet or freezing conditions. The schedule must provide adequate time to complete the work, allowing for delays due to adverse weather.

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

6.4 Quality Control

The proposed structure will be founded on conventional spread footings. The foundation installations must be reviewed in the field by the geotechnical engineer as they are constructed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code 2012. If Terraprobe is not retained to carry out foundation evaluations during construction, then Terraprobe accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice 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 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 A23.1/2-14. 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 W178.1-14.

7.0 LIMITATIONS AND USE OF REPORT

7.1 Procedures

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

The drilling work was carried out by a drilling contractor and was observed and recorded by Terraprobe on a full time basis. The boreholes were made by a continuous flight power auger machine using solid stem augers and HQ rock coring. The Terraprobe technician logged the boreholes and examined the samples as they were obtained. The samples obtained were sealed in clean, air-tight containers or rock core boxes and transferred to the Terraprobe laboratory, where they were reviewed for consistency of description by a geotechnical engineer. Ground water monitoring wells were installed in both boreholes to measure long-term ground water levels.

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 drill a sufficient number of boreholes, or sample and report them in a way that would provide all the subsurface information and geotechnical advice to completely identify all aspects of the site and works that could affect construction costs, techniques, equipment and scheduling. Contractors

bidding on or undertaking work on the project must be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, and their approach to the construction works, cognizant of the risks implicit in the subsurface investigation activities.

7.2 Changes in Site and Scope

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

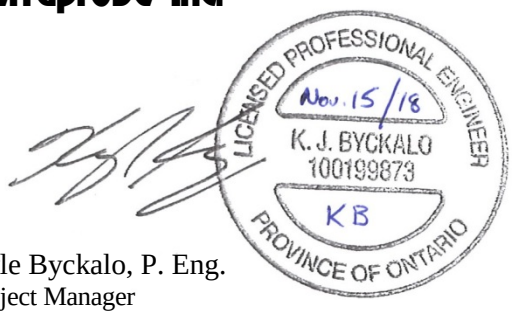
The design parameters provided and the engineering advice offered in this report are based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained design consultants in the design phase of the project. If there are changes 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.

7.3 Use of Report

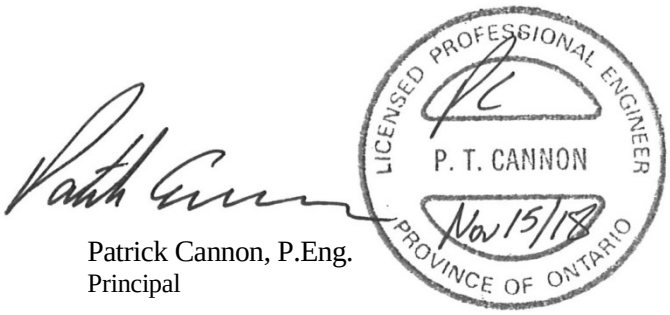
This report is prepared for the express use of York Trafalgar Group, Pine Street Burlington Corp. and their retained design consultants. It is not for use by others. This report is copyright of Terraprobe Inc., and no part of this report may be reproduced by any means, in any form, without the prior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

It is recognized that The City of Burlington, 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.

Terraprobe Inc.



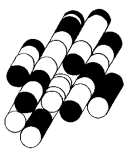
Kyle Byckalo, P. Eng.
Project Manager

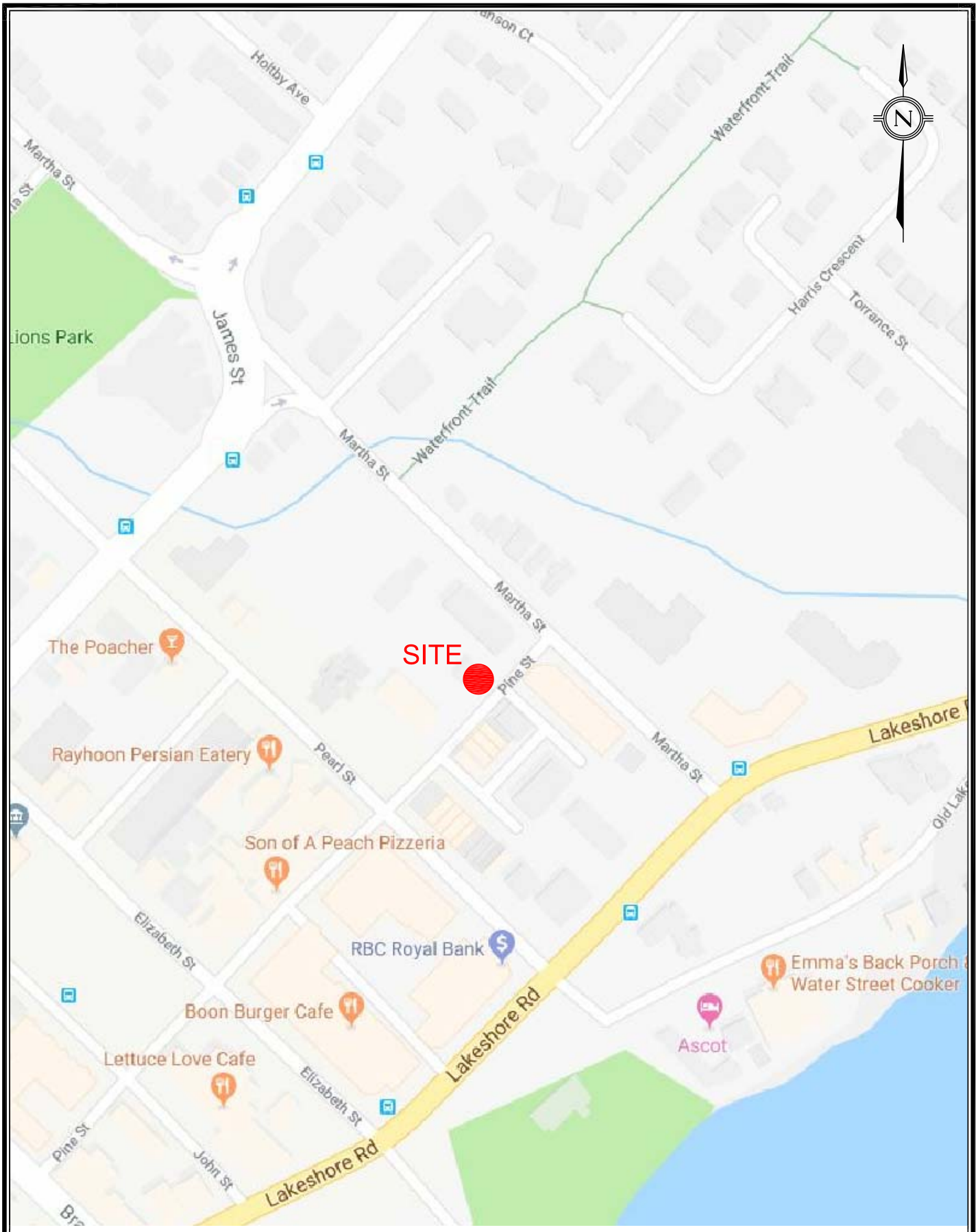


Patrick Cannon, P.Eng.
Principal

FIGURES

Terraprobe Inc.





Terraprobe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title:	FIGURE :
SITE LOCATION PLAN	1
File No. 7-18-0123-01	



LEGEND

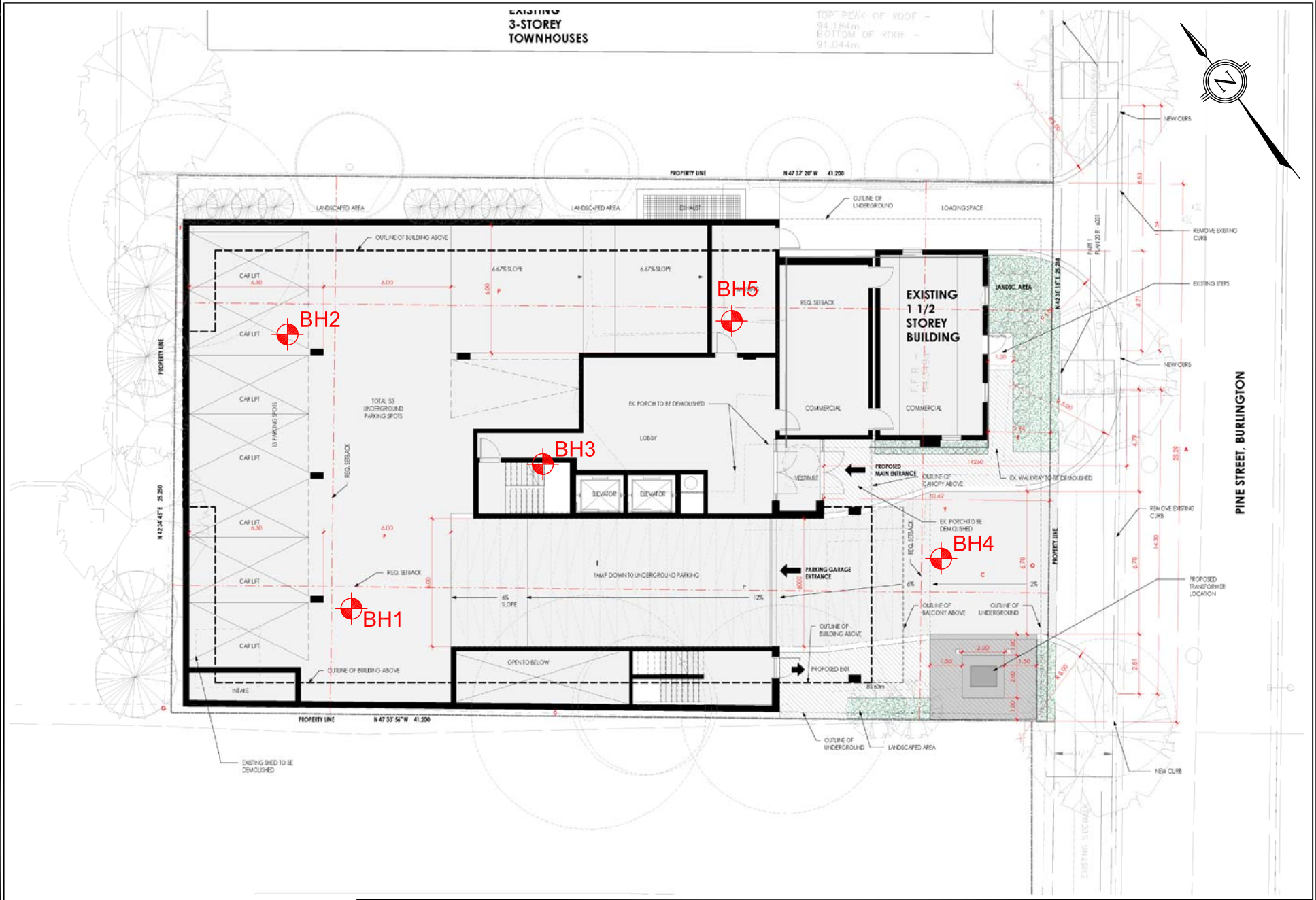
Borehole Location

Terraprobe
903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: BOREHOLE LOCATION PLAN

File No. 7-18-0123-01

FIGURE : 2



LEGEND

BH1 Borehole Location

Terraprobe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: PROPOSED SITE PLAN

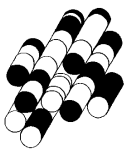
File No. 7-18-0123-01

FIGURE : 3

LOGS OF BOREHOLES

APPENDIX A

Terraprobe Inc.



Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

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

PENETRATION RESISTANCE

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

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

COHESIONLESS SOILS

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

COHESIVE SOILS

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

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
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
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

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

FIELD MOISTURE DESCRIPTIONS

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

Terraprobe Inc.

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

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

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

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

www.terraprobe.ca

RECOVERY

TCR Total Core Recovery is the total length of core pieces, irrespective of their individual lengths obtained in a core run, and expressed as a percentage of the length of that core run.

SCR Solid Core Recovery is the total length of sound full-diameter core pieces obtained in a core run, expressed as a percentage of the length of that core run.

RQD Rock Quality Designation pertains to the sum of those pieces of sound core which are 10 cm or greater in length obtained in a core run, expressed as a percentage of the length of that core run.

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
QUALITY	**very poor**	**poor**	**fair**	**good**	**excellent**

JOINT CHARACTERISTICS

Orientation

horizontal / flat = 0 - 20°
dipping = 20 - 50°
vertical = 50 - 90°

Joint Aperture

Classification	Aperture
closed	< 0.5 mm
gapped	0.5 to 10 mm
open	> 10 mm

Joint Spacing (ISRM, 1981)

Classification	Spacing (m)
extremely close	< 0.02
very close	0.02 to 0.06
close	0.06 to 0.2
moderately close	0.2 to 0.6
wide	0.6 to 2
very wide	2 to 6
extremely wide	> 6

Joint Filling

Description	Approx φ
tight, hard, non-softening	25 - 35
oxidation, surface staining only	25 - 30
slightly altered, clay-free	25 - 30
sandy particles, clay-free	20 - 25
sandy and silty, minor clay	16 - 24
non-softening clays	6 - 12
swelling clay fillings	n/a

Degree of Weathering (after MTO, RR229 Evaluation of Shales for Construction Projects)

Zone	Degree	Description
Z1	unweathered	shale, regular jointing
Z2	partially weathered	angular blocks of unweathered shale, no matrix, with chemically weathered but intact shale
Z3		soil-like matrix with frequent angular shale fragments < 25mm diameter
Z4a		soil-like matrix with occasional shale fragments < 3mm diameter
Z4b	fully weathered	soil-like matrix only

Strength classification (after Marinos and Hoek, 2001)

Grade	Term	UCS (MPa)	Field Estimate (Description)
R6	extremely strong	> 250	can only be chipped by geological hammer
R5	very strong	100 - 250	requires many blows from geological hammer
R4	strong	50 - 100	requires more than one blow from geological hammer
R3	medium strong	25 - 50	can't be scraped, breaks under one blow from geological hammer
R2	weak	5 - 25	can be peeled / scraped with knife with difficulty
R1	very weak	1 - 5	easily scraped / peeled, crumbles under firm blow of geo. hammer
R0	extremely weak	< 1	indented by thumbnail

LOG OF BOREHOLE 1

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : September 28, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597745, N: 4797862 (UTM 17T) Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)
0	**84.0**	**GROUND SURFACE**					
	83.8	200mm **TOPSOIL**					
	0.2	**FILL**, silty fine sand, trace topsoil, trace rootlets, loose to compact, brown		1	SS	7	
1	82.9			2	SS	15	83
	1.1	**SILTY CLAY**, occasional shale fragments, occasional gravel, very stiff to hard, brown / grey (GLACIAL TILL)		3	SS	31	
2	81.6			4	SS	50 / 75mm	82
	2.4	**SHALEY TILL**, reddish brown (GLACIAL TILL)					
	81.1						
3	2.9	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		5	SS	50 / 150mm	81
	80.8						
	3.2	**END OF BOREHOLE**					

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

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
3 10 41 46

Borehole was dry and open upon completion of drilling.

file: 7-18-0123-01 - 2085 pine street.gpj

LOG OF BOREHOLE 2

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : October 22, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597753, N: 4797865 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : **HQ**, OD=96mm, ID=64mm

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value	Elevation Scale (m)
0	**84.0**	**GROUND SURFACE**					
	83.8 / 0.2	200mm **TOPSOIL**					
	83.4 / 0.6	**SILTY FINE SAND**, (possible fill), loose to compact, brown		1	SS	10	
1		**SILTY CLAY**, occasional shale fragments, occasional gravel, trace to some sand, hard, brown / grey (GLACIAL TILL)		2	SS	45	83
2				3	SS	45	
	81.7 / 2.3	**SHALEY TILL**, reddish brown (GLACIAL TILL)		4	SS	50 / 100mm	82
	81.3 / 2.7	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)					
3	80.9 / 3.1	**QUEENSTON FORMATION** (See rock core log for details)		5	SS / RUN	50 / 50mm	81
4					RUN		80
5					RUN		79
6					RUN		78
7					RUN		77
8					RUN		76
9					RUN		75
10					RUN		74
	73.3 / 10.7	**END OF BOREHOLE**					

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

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane; 40 80 120 160

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

4 9 42 45

Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 30, 2018	5.1	78.9

file: 7-18-0123-01 - 2085 pine street.gpj

ROCK CORE LOG 2

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : October 22, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597753, N: 4797865 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : **HQ**, OD=96mm, ID=64mm

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers, HQ rock coring

Rock coring started at 3.1m below grade

QUEENSTON FORMATION

Shale, reddish brown, thinly bedded to medium bedded, weak to strong, grey interbeds, bedding normally 75mm to 200mm with isolated beds up to 300mm.; joints are horizontal

Run	Elev Depth (m)	Recovery
	80.9	
R1	3.1	TCR = **100**% SCR = **28**% RQD = **0**%
R2	3.4	TCR = **100**% SCR = **68**% RQD = **33**%
	79.0	
R3	5.0	TCR = **100**% SCR = **97**% RQD = **87**%
	77.5	
R4	6.5	TCR = **100**% SCR = **100**% RQD = **88**%
R5	7.1	TCR = **94**% SCR = **81**% RQD = **61**%
	76.0	
R6	8.0	TCR = **100**% SCR = **83**% RQD = **70**%
	74.5	
R7	9.5	TCR = **100**% SCR = **98**% RQD = **72**%
	73.3	
	10.7m	

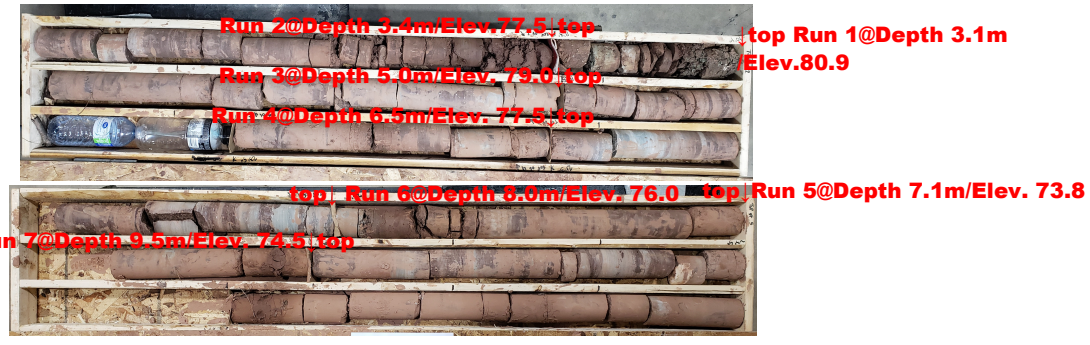
Natural Fractures: Frequency / Spacing

Elevation (m)	Frequency	Spacing
80	7	close
	3	
	3	
	2	
79	4	close
	3	
	3	
	1	
78	1	close
	2	
	3	
77	2	close
	2	
	5	
76	2	close
	2	
	2	
75	2	close
	2	
	2	
74	2	close
	2	
	2	
	3	

Laboratory Testing:
- **4.0m to 4.1m:** UCS = 34 MPa
- **9.6m to 9.8m:** UCS = 18.2 MPa

Comments:
- **3.1-3.7m:** *highly weathered zone (till-like matrix)*
- **7.2-7.3m:** *Celcite deposit*

END OF COREHOLE



file: 7-18-0123-01 - 2085 pine street.gpj

LOG OF BOREHOLE 3

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : September 28, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597754, N: 4797851 (UTM 17T) Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	83.9	**GROUND SURFACE**				
0	83.7	200mm **TOPSOIL**				
	0.2 / 83.3	**FILL**, silty sand, trace topsoil, trace rootlets, loose, brown		1	SS	5
	0.6 / 82.7	**FILL**, sandy silt, compact, brown		2	SS	14
1	1.2 / 81.6	**SILTY CLAY**, occasional shale fragments, occasional gravel, very stiff to hard, brown (GLACIAL TILL)		3	SS	30
2	2.3 / 81.0	**SHALEY TILL**, reddish brown (GLACIAL TILL)		4	SS	50 / 150mm
	2.9 / 80.7	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		5	SS	50 / 150mm
3	3.2	**END OF BOREHOLE**				

Elevation Scale (m): 83, 82, 81

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

Undrained Shear Strength (kPa) — Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40, 80, 120, 160

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) — GR SA SI CL

Borehole was dry and open upon completion of drilling.

file: 7-18-0123-01 - 2085 pine street.gpj

LOG OF BOREHOLE 4

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : October 23, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597772, N: 4797842 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : **HQ**, OD=96mm, ID=64mm

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	**83.6**	**GROUND SURFACE**				
	83.4 / 0.2	40mm **ASPHALTIC CONCRETE**		1	SS	5 / 150mm
	83.1 / 0.5	**FILL**, granular base **FILL**, sand, loose, brown				
1	82.4 / 1.2	**FILL**, silty clay, trace topsoil, trace rootlets, occasional gravel, trace sand, stiff, brown		2	SS	15
2	81.4 / 2.2	**SILTY CLAY**, occasional shale fragments, occasional gravel, very stiff, brown to brownish grey (GLACIAL TILL)		3	SS	18
	80.9 / 2.7	**SHALEY TILL**, reddish brown (GLACIAL TILL)		4	SS	50 / 100mm
3	80.8 / 2.8	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)			RUN	
4		**QUEENSTON FORMATION** (See rock core log for details)			RUN	
5					RUN	
6					RUN	
7					RUN	
8					RUN	
9					RUN	
10	72.7 / 10.9	**END OF BOREHOLE**			RUN	

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73

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

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane — 40 80 120 160

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

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

file: 7-18-0123-01 - 2085 pine street.gpj

ROCK CORE LOG 4

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : October 23, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597772, N: 4797842 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : **HQ**, OD=96mm, ID=64mm

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers, HQ rock coring

GENERAL DESCRIPTION

Rock coring started at 2.8m below grade

QUEENSTON FORMATION

Shale, reddish brown, thinly bedded to medium bedded, weak to strong, grey interbeds, bedding normally 75mm to 200mm with isolated beds up to 300mm.; joints are horizontal

Run	Elev Depth (m)	Recovery
	80.8	
R1	2.8 – 3.3	TCR = **85%** SCR = **20%** RQD = **20%**
R2	3.3 – 78.8	TCR = **97%** SCR = **93%** RQD = **64%**
R3	4.8 – 77.3	TCR = **100%** SCR = **98%** RQD = **75%**
R4	6.3 – 75.7	TCR = **100%** SCR = **92%** RQD = **73%**
R5	7.9 – 74.2	TCR = **100%** SCR = **97%** RQD = **93%**
R6	9.4 – 72.7	TCR = **95%** SCR = **95%** RQD = **90%**
	10.9m	

Shale Weathering Zones: Z1, Z2, Z3, Z4

UCS (MPa): 5, 25, 50, 100, 250

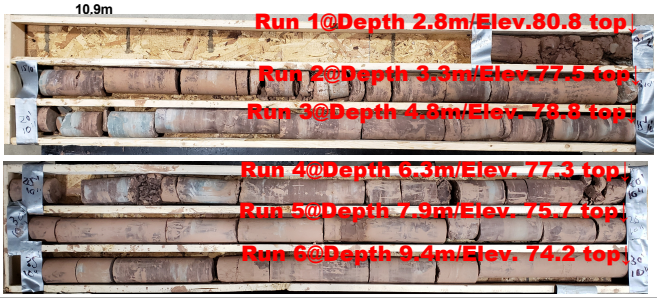
Estimated Strength: R1, R2, R3, R4, R5, R6

Natural Fractures — Frequency: 2, 3, 6, 4, 2, 2, 4, 2, 1, 3, 3, 4, 1, 3, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2 — Spacing: close

Laboratory Testing:
- 5.5m to 5.7m: UCS = 48 MPa
- 7.0m to 7.3m: UCS = 16.3 MPa
- 8.6m to 8.9m: UCS = 50.3 MPa
- 10.1m to 10.3m: UCS = 15.3 MPa

Comments
- **2.8-3.3m:** *highly weathered zone (till-like matrix)*
- **6.4-6.5m:** *Rubbilized zone*
- **7.6-7.7m:** *Rubbilized zone*
- **8.6-8.6m:** *Clay joint*

END OF COREHOLE



file: 7-18-0123-01 - 2085 pine street.gpj

LOG OF BOREHOLE 5

Terraprobe

Project No. : 7-18-0123-01	Client : Pine Street Burlington Corp.	Originated by : JM
Date started : September 28, 2018	Project : 2085 Pine Street	Compiled by : KB
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : KB

Position : E: 597771, N: 4797857 (UTM 17T) Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	83.8	**GROUND SURFACE**				
0		25mm **ASPHALTIC CONCRETE**		1	SS	2 / 150mm
	82.9	**FILL**, silty fine sand, very loose to loose, brown				
1	0.9	**SILTY CLAY**, occasional shale fragments, occasional gravel, very stiff to hard, brown / grey (GLACIAL TILL)		2	SS	10
				3	SS	40
2	81.5					
	2.3	**SHALEY TILL**, reddish brown (GLACIAL TILL)		4	SS	50 / 100mm
	80.9					
3	2.9	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		5	SS	50 / 125mm
	80.6					
	3.2	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 83, 82, 81

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

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane — 40 80 120 160

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

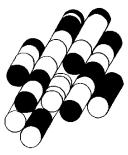
GR	SA	SI	CL
4	10	40	46

file: 7-18-0123-01 - 2085 pine street.gpj

CERTIFICATES OF ANALYSES AND QUALITY ASSURANCE REPORT - SOIL

APPENDIX B

Terraprobe Inc.



O. Reg. 153(511) - Metals & Inorganics (Soil)

AGAT WORK ORDER: 18H400343

PROJECT: 2085 Pine St. 7-18-0123-01

CLIENT NAME: TERRAPROBE INC

DATE RECEIVED: Oct 23, 2018

DATE SAMPLED: Oct 22, 2018

DATE REPORTED: Oct 26, 2018

Sample Description			**BH 1 SA 2**	**BH 2 SA 3**	**BH 3 SA 1**	**BH 4 SA 3**	**BH 5 SA 2**		
Date Sampled			**10/22/2018**	**10/22/2018**	**10/22/2018**	**10/22/2018**	**10/22/2018**	**Table 1***	**Table 3***
Parameter	**Unit**	**RDL**	**9644168**	**9644169**	**9644170**	**9644171**	**9644172**	**R/P/I/I/C/C**	**I/C/C**
Antimony	µg/g	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	1.3	(50) 40
Arsenic	µg/g	1	4	4	4	7	5	18	18
Barium	µg/g	2	43	104	48	162	81	220	670
Beryllium	µg/g	0.5	<0.5	0.6	<0.5	0.8	0.6	2.5	(10) 8
Boron	µg/g	5	<5	11	<5	12	8	36	120
Boron (Hot Water Soluble)	µg/g	0.10	0.17	0.16	0.33	0.31	0.26	N/A	2.0
Cadmium	µg/g	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.2	1.9
Chromium	µg/g	2	16	23	11	32	23	70	160
Cobalt	µg/g	0.5	7.4	13.1	3.9	17.3	10.3	21	(100) 80
Copper	µg/g	1	20	39	13	43	26	92	(300) 230
Lead	µg/g	1	18	11	46	15	11	120	120
Molybdenum	µg/g	0.5	<0.5	<0.5	<0.5	0.6	<0.5	2.0	40.0
Nickel	µg/g	1	14	26	7	37	21	82	(340) 270
Selenium	µg/g	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.5	5.5
Silver	µg/g	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.50	(50) 40
Thallium	µg/g	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.0	3.3
Uranium	µg/g	0.5	<0.5	0.6	<0.5	0.7	0.6	2.5	33.0
Vanadium	µg/g	1	24	30	19	41	34	86	86
Zinc	µg/g	5	42	60	49	78	52	290.0	340.0
Chromium VI	µg/g	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.66	(10) 8
Cyanide	µg/g	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.051	0.051
Mercury	µg/g	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.27	(20) 3.9
Electrical Conductivity	mS/cm	0.005	0.241	0.188	0.148	**0.977**	0.243	0.57	1.4
Sodium Adsorption Ratio	NA	NA	0.847	0.403	0.116	**10.2**	2.12	2.4	12
pH, 2:1 CaCl2 Extraction	pH Units	NA	7.11	7.53	7.15	7.59	7.48	N/V	

Notes:

Analyses by AGAT Laboratories, see Appendix A for Certificates of Analysis.

This table represents Terraprobe's interpretation of the data presented in the Certificate of Analysis for convenience purposes only.

This summary is to be used in conjunction with, not as a replacement of the laboratory certificate of analyses which contains all QA/QC information.

**MOE Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* ; April 15, 2011

Criteria in brackets apply to medium and fine textured soil

Method Detection Limit (M.D.L) ; No Value (NV); Not Applicable (NA)

Table 1 exceedences are in bold type and framed

No Table 3 exceedences

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC
903 Barton Street
Stoney Creek, ON L8E5P5
(905) 643-7560

ATTENTION TO: Patrick Cannon

PROJECT: 2085 Pine St. 7-18-0123-01

AGAT WORK ORDER: 18H400343

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Oct 26, 2018

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18H400343

PROJECT: 2085 Pine St. 7-18-0123-01

CLIENT NAME: TERRAPROBE INC

ATTENTION TO: Patrick Cannon

SAMPLING SITE:Burlington, ON

SAMPLED BY:Jake McGowan

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2018-10-23 **DATE REPORTED: 2018-10-25**

		SAMPLE DESCRIPTION:		BH 1 SA 2	BH 2 SA 3	BH 3 SA 1	BH 4 SA 3	BH 5 SA 2
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2018-10-22	2018-10-22	2018-10-22	2018-10-22	2018-10-22
Parameter	Unit	G / S	RDL	9644168	9644169	9644170	9644171	9644172
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	4	4	4	7	5
Barium	µg/g	220	2	43	104	48	162	81
Beryllium	µg/g	2.5	0.5	<0.5	0.6	<0.5	0.8	0.6
Boron	µg/g	36	5	<5	11	<5	12	8
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.17	0.16	0.33	0.31	0.26
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	16	23	11	32	23
Cobalt	µg/g	21	0.5	7.4	13.1	3.9	17.3	10.3
Copper	µg/g	92	1	20	39	13	43	26
Lead	µg/g	120	1	18	11	46	15	11
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5	0.6	<0.5
Nickel	µg/g	82	1	14	26	7	37	21
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	<0.5	0.6	<0.5	0.7	0.6
Vanadium	µg/g	86	1	24	30	19	41	34
Zinc	µg/g	290	5	42	60	49	78	52
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	0.241	0.188	0.148	**0.977**	0.243
Sodium Adsorption Ratio	NA	2.4	NA	0.847	0.403	0.116	**10.2**	2.12
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.11	7.53	7.15	7.59	7.48

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9644168-9644172 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Divine Basily

Results relate only to the items tested and to all the items tested

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 18H400343

PROJECT: 2085 Pine St. 7-18-0123-01

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC

ATTENTION TO: Patrick Cannon

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9644171	BH 4 SA 3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	0.977
9644171	BH 4 SA 3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	10.2

Results relate only to the items tested and to all the items tested

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: TERRAPROBE INC

AGAT WORK ORDER: 18H400343

PROJECT: 2085 Pine St. 7-18-0123-01

ATTENTION TO: Patrick Cannon

SAMPLING SITE:Burlington, ON

SAMPLED BY:Jake McGowan

Soil Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	9644168	9644168	<0.8	<0.8	NA	< 0.8	95%	70%	130%	81%	80%	120%	81%	70%	130%
Arsenic	9644168	9644168	4	4	NA	< 1	95%	70%	130%	99%	80%	120%	101%	70%	130%
Barium	9644168	9644168	43	43	0.0%	< 2	100%	70%	130%	101%	80%	120%	103%	70%	130%
Beryllium	9644168	9644168	<5	<5	NA	< 0.5	97%	70%	130%	106%	80%	120%	112%	70%	130%
Boron	9644168	9644168	<5	<5	NA	< 5	100%	70%	130%	108%	80%	120%	114%	70%	130%
Boron (Hot Water Soluble)	9644168	9644168	0.17	0.18	NA	< 0.10	117%	60%	140%	99%	70%	130%	98%	60%	140%
Cadmium	9644168	9644168	<0.5	<0.5	NA	< 0.5	96%	70%	130%	115%	80%	120%	117%	70%	130%
Chromium	9644168	9644168	16	16	0.0%	< 2	100%	70%	130%	107%	80%	120%	107%	70%	130%
Cobalt	9644168	9644168	7.4	7.4	0.0%	< 0.5	105%	70%	130%	112%	80%	120%	114%	70%	130%
Copper	9644168	9644168	20	21	4.9%	< 1	105%	70%	130%	116%	80%	120%	119%	70%	130%
Lead	9644168	9644168	18	18	0.0%	< 1	100%	70%	130%	105%	80%	120%	105%	70%	130%
Molybdenum	9644168	9644168	<0.5	<0.5	NA	< 0.5	103%	70%	130%	107%	80%	120%	107%	70%	130%
Nickel	9644168	9644168	14	14	0.0%	< 1	98%	70%	130%	107%	80%	120%	110%	70%	130%
Selenium	9644168	9644168	<0.4	<0.4	NA	< 0.4	94%	70%	130%	100%	80%	120%	105%	70%	130%
Silver	9644168	9644168	<0.2	<0.2	NA	< 0.2	97%	70%	130%	105%	80%	120%	110%	70%	130%
Thallium	9644168	9644168	<0.4	<0.4	NA	< 0.4	98%	70%	130%	101%	80%	120%	100%	70%	130%
Uranium	9644168	9644168	<0.5	<0.5	NA	< 0.5	95%	70%	130%	101%	80%	120%	101%	70%	130%
Vanadium	9644168	9644168	24	25	4.1%	< 1	98%	70%	130%	102%	80%	120%	102%	70%	130%
Zinc	9644168	9644168	42	43	2.4%	< 5	102%	70%	130%	114%	80%	120%	120%	70%	130%
Chromium VI	9642879		<0.2	<0.2	NA	< 0.2	73%	70%	130%	97%	80%	120%	99%	70%	130%
Cyanide	9637862		<0.040	<0.040	NA	< 0.040	93%	70%	130%	101%	80%	120%	86%	70%	130%
Mercury	9644168	9644168	<0.10	<0.10	NA	< 0.10	99%	70%	130%	95%	80%	120%	98%	70%	130%
Electrical Conductivity	9644168	9644168	0.241	0.251	4.1%	< 0.005	96%	90%	110%						
Sodium Adsorption Ratio	9644168	9644168	0.847	0.900	6.1%	NA									
pH, 2:1 CaCl2 Extraction	9642879		7.13	7.17	0.6%	NA	100%	80%	120%						

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

Certified By: Nivine Basily

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: TERRAPROBE INC

AGAT WORK ORDER: 18H400343

PROJECT: 2085 Pine St. 7-18-0123-01

ATTENTION TO: Patrick Cannon

SAMPLING SITE:Burlington, ON

SAMPLED BY:Jake McGowan

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

Results relate only to the items tested and to all the items tested

AGAT Laboratories
5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 18H4700313
Cooler Quantity: 1 BAG
Arrival Temperatures: 5.7 | 5.6 | 5.5
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:
Company: TERRAPROBE INC
Contact: PATRICK CANNON
Address: 903 BARTON ST UNIT 22
STONEY CREEK, ON L8E 5P5
Phone: (905) 643-7560 Fax: (905) 643-7559
Reports to be sent to:
1. Email: pcannon@terraprobe.ca
2. Email: kbyckalo@terraprobe.ca

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)
☑ Regulation 153/04 — Table 1 (Indicate One) ☑ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☑ Fine
☐ Sewer Use — ☐ Sanitary ☐ Storm — Region ____ (Indicate One) ☐ MISA
☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other ____ (Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No
Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply): ____
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 2085 PINE ST. 7-18-0123-01
Site Location: BURLINGTON ON
Sampled By: JAKE McGOWAN
AGAT Quote #: ____ PO: ____
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information: Bill To Same: Yes ☑ No ☐
Company:
Contact:
Address:
Email:

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics	All Metals ☐ 153 Metals (excl. Hydrides)	Hydride Metals ☐ 153 Metals (Incl. Hydrides)	ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr^{6+} ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use
BH 1 SA 2	10/22/18	9:00AM	1	S	1x250mL JAR		✓													
BH 2 SA 3	10/22/18	10:00AM	1	S	" "		✓													
BH 3 SA 1	10/22/18	11:00AM	1	S	" "		✓													
BH 4 SA 3	10/22/18	12:00PM	1	S	" "		✓													
BH 5 SA 2	10/22/18	1:00PM	1	S	" "		✓													

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Kyle Byckalo	Oct. 22/18	12:15 PM	Daniella JAIC	OCT 23/18	12:15pm

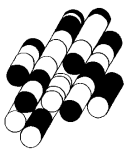
Page 1 of 1
N°: T 061202

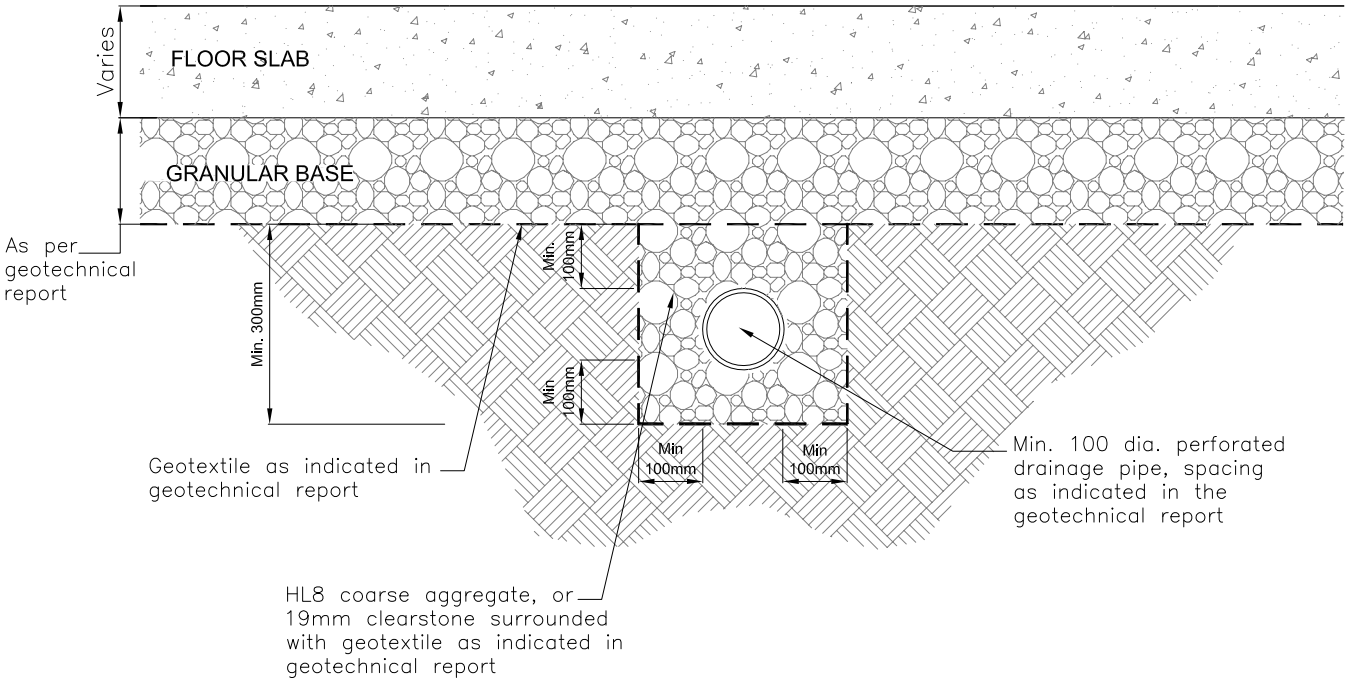
Document ID: DIV 78-1511-014
Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT
Date Issued: February 22, 2017

BASEMENT DRAINAGE DETAILS

APPENDIX C

Terraprobe Inc.



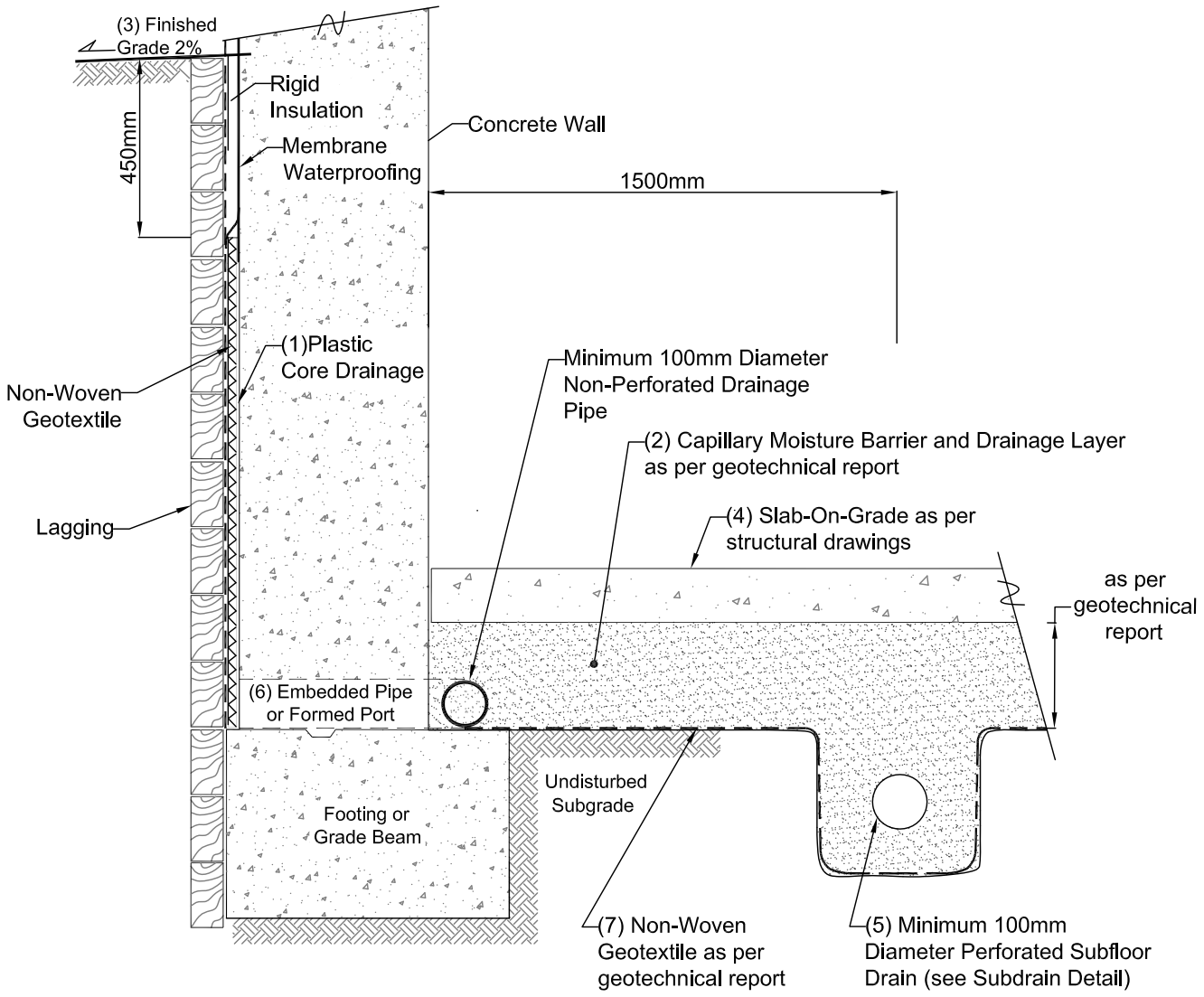


Schematic Only
Not to Scale

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

Title:

BASEMENT SUBDRAIN DETAIL



NOTES

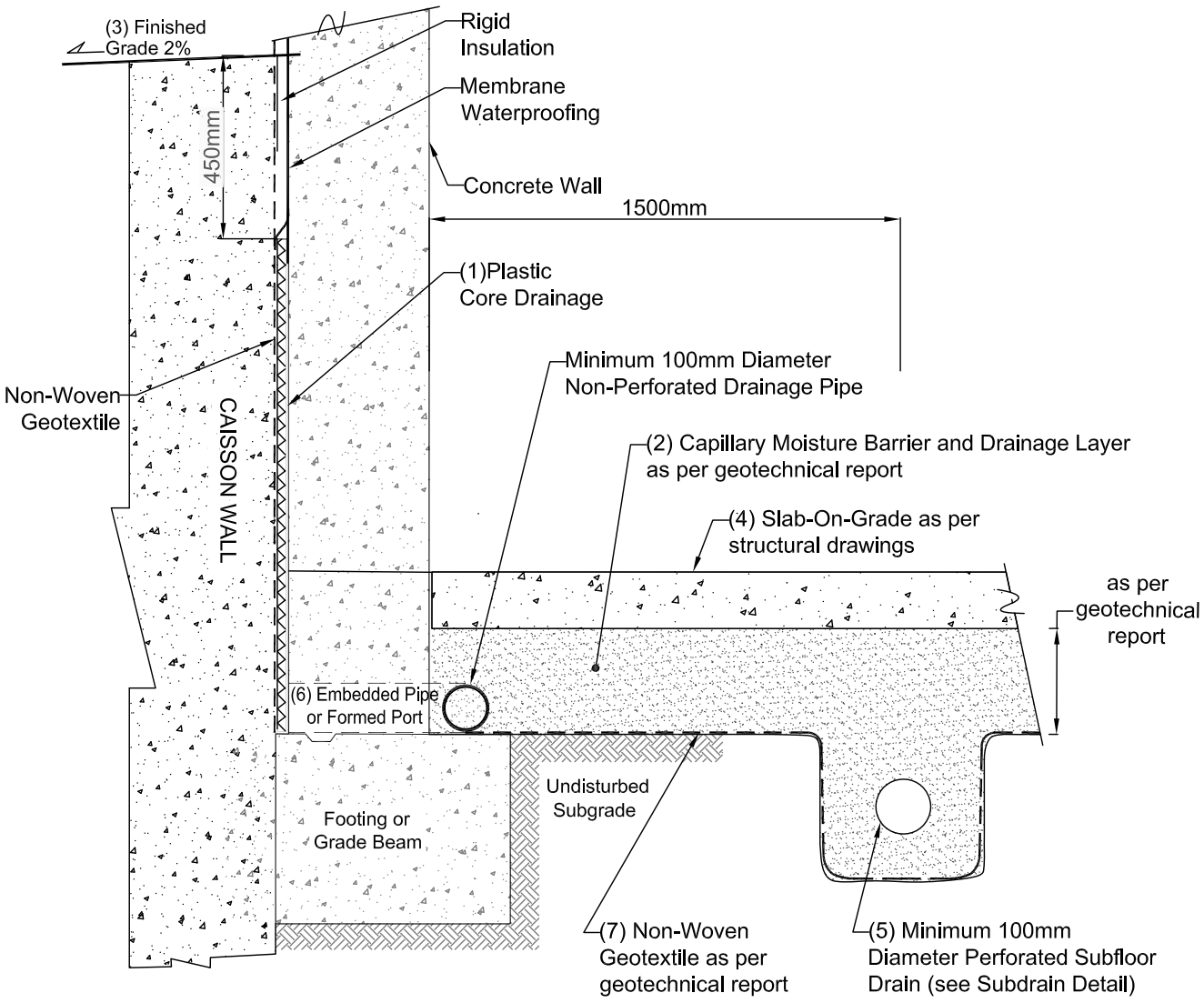
1) Prefabricated drainage panels to consist of Terrafix - TERRADRAIN 200, Mirafi - Miradrain 6000, or approved equivalent. Panels should provide continuous cover with a minimum overlap of 300mm.
2) Capillary moisture barrier/drainage layer to consist of a minimum 200mm layer of 19mm clear stone (OPSS 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.

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

Title:

SCHEMATIC DRAINAGE DETAIL
SOLDIER PILE & LAGGING 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.

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

Title:

SCHEMATIC DRAINAGE DETAIL
CAISSON WALL SHORING SYSTEM