Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
398 NORTH SERVICE ROAD
GRIMSBY, ONTARIO

Prepared For: Losani Homes
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Stoney Creek, Ontario
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Attention: Mr. Brandon Almeida

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1.0 INTRODUCTION

Terraprobe Inc. was retained by Losani Homes to carry out a geotechnical investigation at 398 North Service Road in Grimsby, Ontario. The site is located on the north side of North Service Road just east of Casablanca Boulevard, as shown on the Site Location Plan, Figure 1. A proposal and cost estimate to carry out the work were outlined in our letter of April 13, 2018. Authorization to proceed with the investigation was provided by Losani Homes on April 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, 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 irregularly shaped, and occupies an area of approximately 7 hectares. The property is bound by North Service Road on the south side and Lake Ontario on the north side, extending east-west approximately 400 m along North Service Road. The general arrangement of the site is shown on Figure 2.

A large portion of the site had been previously developed which consisted of a single residential dwelling, a commercial building containing a restaurant and gift shop, a commercial gas bar, a car wash building, a truck wash building, and a truck scale. The ground surface of the previously developed portion of the site generally consisted of granular and asphalt pavements. The remainder of the site was overgrown and contained topsoil and/or earth fill at the ground surface. At the time of the investigation, the previous buildings had been demolished. The site topography is relatively flat with generally 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 glaciolacustrine sand and Halton Till.[1] Beneath the overburden deposits is red shale bedrock of the Queenston Formation of Ordovician age.[2] The geological mapping

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[1] Quaternary Geology, Grimsby Area, Southern Ontario; Ontario Division of Mines; Map No. P.993; 1975.

[2] Paleozoic Geology, Grimsby, Southern Ontario; Ontario Division of Mines; Map No. 2343; 1976.

and regional well records indicated that the bedrock beneath the site can be found at an elevation of about 65 to 75 metres, approximately 5 to 10 metres below the existing grade.[3]

2.3 Proposed Development

The proposed development features are shown on Figure 3, as derived from a Site Plan (A001) prepared by Chamberlain Architect Services Ltd. It is understood that the development presently under consideration would include six (6) condominium towers (Buildings ‘A’ through ‘F’), 2.5-storey and 3-storey townhouse units (Buildings ‘G’ through ‘N’), a clubhouse building, an outdoor pool, and new asphalt pavements. The condominium tower buildings ‘A’ and ‘B’ (18 and 22 storeys respectively) will be adjoined with a six (6) storey podium and are expected to have three (3) levels of underground parking. Buildings ‘C’ and ‘D’ will each be 12 storeys with two (2) levels of underground parking. Building ‘E’ will be 10 storeys, and building ‘F’ will be 14 storeys, and each will have two (2) level of underground parking. The townhouse units will have exterior parking.

3.0 PROCEDURE

The field work for this investigation was carried out between May 28 and June 7, 2018, during which time thirty-seven (37) boreholes were drilled to depths of about 5.0 to 10.7 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 in Appendix A.

The boreholes were drilled using a track-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 in accordance with Ontario Regulation 903.

Ground water observations were made in each borehole during and upon completion of drilling and sampling. There was no provision for long term ground water monitoring at the site.

The field work was observed throughout by members 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 boreholes were marked in the field by Terraprobe’s staff in relation to existing features shown on the drawings provided by Losani Homes. Boreholes were surveyed for

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[3] Bedrock Topography Series, Grimsby Area, Southern Ontario; Ministry of Natural Resources; Map No. P.2401; 1981.

coordinates and geodetic elevation with a Trimble R10 Receiver connected to the Global Navigation Satellite System.

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 and three (3) Atterberg limits carried out on selected soil samples are shown in Appendix B as well as on the corresponding borehole logs in Appendix A. Soil quality analyses were not carried out as part of this assignment.

4.0 SUBSURFACE CONDITIONS

The subsurface soil, rock and ground water conditions encountered in the boreholes, and the results of the field and laboratory testing, are shown on the Log of Borehole sheets in Appendix A. A list of abbreviations and symbols are provided to assist in the interpretation of the borehole logs. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. These boundaries generally represent a transition from one stratigraphic unit to another and should not be interpreted to represent exact planes of geological change. The subsurface conditions will also vary between and beyond the borehole locations.

4.1 Soil Conditions

The following discussion has been simplified in terms of the major soil and rock strata for the purposes of geotechnical design. In general, the boreholes drilled at the site penetrated asphalt, topsoil and/or surficial fill overlying fill and strata of clayey silt to silty clay till, silt till, and weathered shale bedrock. Subsurface profile sections (A-A’ to G-G’) are shown on Figure 3 and are presented in Appendix A.

4.1.1 Existing Pavements

Boreholes 1, 2, 3, 9, 10, 16, 26, 33, 36 and 37 penetrated about 25 to 75 mm of existing asphalt pavement at the ground surface. The asphalt was underlain by about 230 to 375 mm of granular fill. Borehole 22 encountered a buried layer of asphalt, approximately 75 mm thick at a depth of about 0.5 m BGS.

4.1.2 Topsoil

Topsoil was encountered at the ground surface of Boreholes 6, 22, 28, 29, 30 and 35. A buried layer of topsoil was encountered in Boreholes 16, 18, 21 and 36 at depths of about 0.3 to 0.9 m BGS. The topsoil found in the boreholes was approximately 100 to 600 mm in thickness.

4.1.3 Fill

Boreholes 4, 5, 7, 8, 11 to 15, 17 to 21, 23 to 25, 27, 31, 32 and 34 encountered fill at the existing ground surface. All of the boreholes with the exception of Boreholes 28, 30, 31 and 37 penetrated fill to depths of 0.1 to 2.1 m BGS, or to about elevations 82.4 to 80.3 m. The fill was somewhat variable and primarily consisted of sand to sand and gravel, and clayey silt with topsoil and gravel.

Standard Penetration Testing carried out within the fill determined N values ranging from 6 to 27 blows per 0.3m, inferring a loose to compact or firm to very stiff state of packing. The in-situ water content of the samples of fill recovered from the boreholes ranged from 2 to 28 percent.

4.1.4 Clayey Silt

A stratum of clayey silt with traces of topsoil, rootlets and gravel was encountered beneath the fill in Boreholes 18, 21, 23, 28, 30 and 31 to depths of about 0.8 to 12 m BGS or to about elevations 81.7 to 80.5 m. N values ranging from 9 to 17 blows per 0.3 m were determined in this stratum of clayey silt with a natural water content ranging from 12 to 22 percent.

4.1.5 Clayey Silt to Silty Clay Till

The boreholes penetrated a stratum of greyish brown clayey silt to silty clay till beneath the surficial soils and fill to depths of about 4.0 to 8.1 m bGS, or to about elevations 78.7 to 74.3 m. Boreholes 11, 12, 17 to 34 and 36 were terminated within the silty clay to clayey silt till at depths of about 5.0 to 8.1 m BGS.

The N values determined in the clayey silt to silty clay till ranged from 8 to greater than 100 blows per 0.3 m with an average N value of about 23 blows per 0.3 m, generally indicating a very stiff consistency. The natural water content of the samples of the clayey silt to silty clay till recovered from the boreholes ranged from about 9 to 26 percent.

The results of two (2) grain size analyses carried out on samples of the clayey silt to silty clay till are presented in Appendix B. The results of corresponding Atterberg Limit determinations on the samples of clayey silt to silty clay till indicated Liquid Limits of 39.63 and 30.93 percent and Plastic Limits of 20.75 and 17.07 percent. The results of the Atterberg Limit testing are also shown in Appendix B.

4.1.6 Clayey Silt to Silt Till

Boreholes 3, 5 to 7, 9, 10, 15, 16, 35 and 37 encountered a stratum of brownish grey clayey silt to silt till beneath the clayey silt to silty clay till and to depths of about 4.1 to 9.1 m BGS, or to about elevations 78.3 to 73.7 m. Borehole 16 was terminated within the silt till at a depth of 8.1 m BGS.

N values ranging from 20 to 61 blows per 0.3 m were determined in the clayey silt to silt till, with an average N value of about 37 blows per 0.3 m. The natural water content of the samples of clayey silt to silt till recovered from the boreholes ranged from about 10 to 12 percent.

The results of a grain size analysis carried out on a sample of the clayey silt to silt till are shown on Figure B1 in Appendix B as well as on the corresponding Log of Borehole Sheet in Appendix A. The results of the corresponding Atterberg Limit determination on the sample of clayey silt to silt till indicated a Liquid Limit of 25.97 percent and a Plastic Limit of 15.62 percent. The results of the Atterberg Limit testing are also shown in Figure B2 Appendix B.

4.1.7 Weathered Shale Bedrock

As best as could be practically determined, weathered shale bedrock was encountered in Boreholes 1 to 10, 12, 13, 15, and 37 at depths of about 4.1 to 9.1 m BGS, or at about elevations 78.3 to 73.7 m. The N values determined in the weathered shale were typically greater than 100 blows per 0.3 m. The natural water content of the samples of weathered shale recovered from the boreholes ranged from about 4 to 10 percent.

Detailed exploration of the bedrock was not carried out as part of this assignment; however the bedrock beneath the site is known to consist of the Queenston Formation which is comprised of predominantly thinly bedded reddish brown shale of Ordovician age. The shale contains interbeds of green calcareous shale, limestone, sandstone and siltstone.

There is typically a horizontal zone of weathering at the contact between the weak 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 reproduced from Skempton, Davis and Chandler, a typical weathering profile of low durability shale, 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

	Zone	Description	Notes
Unweathered (Sound)	I	shale	regular fissuring

The augered borehole method used at this site is conventionally accepted investigative practise, however the interval sampling method does not define the bedrock surface with precision, particularly where the surface of the rock is weathered, weaker and easily penetrated by the auger. The change in resistance to augering in between Zones III and II in the shale profile is not profound. The top of rock as indicated on the Borehole Logs from this investigation is to be consistently interpreted as the surface of Zone II in the profile.

The physical properties of the Queenston Formation were presented in the Ontario Ministry of Transportation and Communication publication RR229 - *Evaluation of Shales for Construction Projects-An Ontario Shale Rating System*, 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

4.2 Ground Water Conditions

There was no provision for long term ground water monitoring at the site as part of this investigation. The ground water conditions were observed in the open boreholes during and upon completion of drilling. Ground water was not observed in any of the boreholes during drilling. These conditions may not necessarily represent stabilized conditions. Fluctuation in the ground water levels will also occur due to seasonal variations and precipitation conditions.

A Phase Two Environmental Site Assessment was previously carried out at the site by Soil-Mat Engineering & Consultants Inc. (Soil Mat) in 2018.[4] The results of five (5) monitoring wells installed at the site indicate that the ground water levels at the site ranged from elevation 77.01 to 81.32 m as measured on February 15, 2018.

The site is located along the southern shores of Lake Ontario. Historic water levels of Lake Ontario indicate that the water level of the lake generally fluctuates between elevations of about 74.5 and 75.5 m (geodetic).

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[4] 'Phase Two Environmental Site Assessment, Fifth Wheel Truck Wash Property, Grimsby, Ontario'; prepared by Soil-Mat Engineering & Consultants Inc. for Losani Homes; File No. SM 188072-E; April 16, 2018

5.0 DISCUSSION

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.

The discussion of the geotechnical aspects of the site development plan presently under consideration is offered for preliminary design consideration. It is noted that only conceptual design information is presently available. Further geotechnical review will be required as the details of the design evolve.

The proposed development features are shown on Figure 3, as derived from a Site Plan (A001) prepared by Chamberlain Architect Services Ltd. It is understood that the development presently under consideration would include six (6) condominium towers (Buildings ‘A’ through ‘F’), 2.5-storey and 3-storey townhouse units (Buildings ‘G’ through ‘N’), a clubhouse building, an outdoor pool, and new asphalt pavements. The condominium tower buildings ‘A’ and ‘B’ (18 and 22 storeys respectively) will be adjoined with a six (6) storey podium and are expected to have three (3) levels of underground parking. Buildings ‘C’ and ‘D’ will each be 12 storeys with two (2) levels of underground parking. Building ‘E’ will be 10 storeys, and building ‘F’ will be 14 storeys, and each will have two (2) level of underground parking. The townhouse units will have exterior parking.

5.1 Site Pre-Grading

Based on the existing site grades and the proposed finished floor elevations of the townhouse units it can be expected that some cutting and/or filling will be required prior to construction. Development of the site will typically consist of the removal of topsoil and existing asphalt pavements, fill, and any highly organic or soft soils, and cutting and filling to achieve the design subgrade elevations.

Engineered fill required to restore grade or to achieve the site grading plan must consist of clean earth materials, free of topsoil, rubble, wood, plant materials etc. and at a suitable placement water content to consistently achieve the compaction requirements outlined below. Selective re-use of excavated soil consisting of the existing near surficial soil or fill and the underlying native soils from the site for engineered fill may be feasible subject to the weather conditions at the time of construction. For this reason, pre-grading activities should not be undertaken during spring or spring-like conditions.

Imported earth for use as engineered fill must meet the corresponding property use standard for the site as established in an Environmental Site Assessment (ESA), as well as the physical requirements outlined above. If no ESA is available, MOECC Table 1 standards should be used as the acceptance criteria.

Alternatively consideration could be given to using OPSS Granular B Type I material from a commercial source.

Engineered fill must be placed and uniformly compacted in 200mm thick lifts to at least 98 percent of standard Proctor maximum dry density. For optimal performance, the placement water content of the fill should be maintained within about 2 percent of the laboratory optimum water content for compaction. The limits of any engineered fill can best be determined by the geotechnical engineer during construction. Engineered fill will need to extend laterally a sufficient distance to develop adequate lateral resistance for foundations and pavements. Engineered fill within the roadway limits should be extended to the design subgrade elevation.

All aspects of engineered fill construction including final excavation, material selection, placement and compaction must be verified by the geotechnical engineer. In-situ density testing is required during construction to confirm that each lift has been compacted to the specified degree and that the placement moisture content is within an acceptable range.

5.2 Foundation Design Parameters

The following table shows the expected finished floor elevation of the lowest level of each building based on the provided site plan along with the stratum or strata encountered at those elevations in the boreholes.

Building(s)	Number of Underground Parking Levels	Expected FFE (m) of Lowest Level	Stratum at Lowest FFE
A & B	3	73.5	Weathered Shale Bedrock
C & D	2	77.0	Clayey Silt / Silt Till
			Weathered Shale
E, F & G	2	76.7	Silty Clay / Clayey Silt Till
H, I & J	0	80.1 to 80.3	Silty Clay / Clayey Silt Till
K, L, M & N	0	79.5 to 79.9	Silty Clay / Clayey Silt Till

The greatest capacity can be achieved using foundations that develop resistance in the Queenston Formation shale bedrock. The lowest underground levels of Buildings A, B, C, and D are expected to be within the weathered shale bedrock. It is feasible to support Buildings A through D on conventional strip and spread foundations in the undisturbed weathered shale. It is possible that the invert elevation of the foundations for Building D may still be within the glacial till overburden. It is expected however that due to the proximity to the underlying shale bedrock at this elevation, the foundations can be lowered accordingly to bear in the bedrock.

The lowest underground levels of Buildings E, F and G are expected to be within the undisturbed silty clay to clayey silt till. Preferential consideration has been given to support these buildings on deep foundations developing resistance in the weathered shale bedrock.

The remaining smaller townhouse unit structures, Buildings H through N, can be supported on conventional spread and/or strip footings constructed within the undisturbed silty clay to clayey silt till.

The following discussion provides an assessment of the foundation alternatives together with design parameters.

5.2.1 Conventional Foundations

Strip and Spread Foundations in Weathered Shale - Buildings A, B, C and D

It is proposed to construct up to three (3) levels of underground parking beneath Buildings A, B, C and D. It is expected that the lowest underground level will have a finished floor elevation of about 73.5 m. Based on the results of the boreholes drilled in the area of Buildings A, B, C and D, the shale was encountered between elevations of about 75.1 to 78.3 m (geodetic). The following table summarizes the elevation of the shale bedrock encountered in the boreholes drilled in the area of Buildings A to D.

Buildings A, B, C and D

Borehole #	Elevation of Shale Bedrock (m) (Geodetic)
1	75.1
2	76.6
3	76.9
4	76.9
5	76.9
6	77.8
7	78.3

Based on the results of the boreholes and the expected finished floor elevation of the lowest underground levels, it is considered feasible to support Buildings A through D (including the club house building) on conventionally designed spread and/or continuous strip footings bearing in the weathered shale bedrock. Excavations for conventional foundations constructed within the shale bedrock must fully penetrate all overburden soils.

Conventional spread and/or strip foundations established to bear in the weathered shale bedrock could 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 1:2.

Strip and Spread Foundations in Undisturbed Glacial Till

Based on the results of the boreholes and the provided finished floor elevations of the lowest levels, it is considered feasible to support Buildings H, I, J, K, L, M, and N on conventionally designed spread and/or continuous strip footings bearing in the undisturbed silty clay to clayey silt till underlies the site. Foundation excavations must fully penetrate all fill and any soft soils. Subject to field verification, during construction, conventional foundations constructed as described above may be designed using a factored bearing resistance at Ultimate Limit States (ULS) of 300 kPa and a bearing reaction at Serviceability Limit States (SLS) of 200 kPa at or below the elevations shown in the following table.

Buildings H, I, J, K, L, M, and N

Borehole #	Elevation of Undisturbed Glacial Till (m) (Geodetic)
21	81.1
22	81.4
23	81.4
24	81.0
25	81.0
26	81.7
27	81.6
28	81.2
29	81.4
30	80.5
31	81.1
32	81.1
33	80.9

Minimum footing widths of 500mm for continuous footings, and 900mm for spread footings are 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 native undisturbed strata 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 any fill or soft surficial 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 1:2.

5.2.2 Helical Piers

Based on the provided Site Plan, Buildings H to N may be within close proximity to adjacent underground parking structures and/or access ramps. Assuming the underground levels will extend deeper than the foundations for Buildings H to N, it may be possible that the walls of the underground structure(s) will be within the zone of influence of the buildings. In general practice, the zone of influence beneath foundations is conservatively bound by a 1 horizontal to 1 vertical influence line projecting down and away from the underside of foundations in all directions. If the walls of the underground structure(s) encroach within the zone of influence beneath the foundations for Buildings H to N, it will be necessary to develop the affected foundations at (a) deeper elevation(s) such that the zone of influence does not intersect the walls of the underground structure. It is feasible to support these buildings on a system of helical piers. Helical Piers are proprietary systems offered by specialized design build contractors.

In this instance, the helical pile sections would be drilled into the competent glacial till stratum which was found beneath the fill, providing sufficient resistance. The sections would be extended as required using extension rods. A pile cap/grade-beam is constructed to transfer the structure’s load onto the underlying competent soils through the helical piers. The actual depths of the helical pier foundations are determined on site during installation based on the field torque readings and load support requirements. The load carrying capacity of the helical piers is confirmed by the design-build company based on a full scale prototype/production pile load test.

It is expected that adequate bearing resistance will be achieved in the undisturbed till that underlies the site. The final depth of the piers will depend upon the type and size of helical pier section and loading considerations. It is recommended that the project geotechnical information be provided to a specialized design/build contractor to confirm the feasibility of this foundation system and to determine helical pier refusal/installation depths. These contractors specialize in helical piers foundation design and installation, and can provide further information on the methodology, detailed design, installation and certification.

The following average soil strength parameters may be considered for the design of the helical piles for the proposed building.

Stratum	*Unit Weight	Internal Friction Angle (ϕ)	Undrained Shear Strength (Cu)
Silty Clay to Clayey Silt Till	20.0 kN/m³	32	100 kPa
Clayey Silt to Silt Till	21.0 kN/m³	34	150 kPa

*Submerged unit weight to be used at depths of 1m below ground surface.

5.2.3 Drilled Piers (Caissons)

Buildings E, F and G

It is proposed to construct two (2) levels of underground parking beneath Buildings E, F and G. It is expected that the lowest underground level will have a finished floor elevation of about 76.7 m. Based on the results of the boreholes drilled in the area of Buildings E, F and G, the shale was encountered as deep as elevation 73.7 m. The elevation of the shale bedrock found in the boreholes in the areas of Buildings E, F and G is summarized in the following table.

Buildings E, F and G

Borehole #	Elevation of Shale Bedrock (m) (Geodetic)
11	n/a
12	75.3
13	75.4
14	n/a
15	73.7
16	n/a
17	n/a
18	n/a
19	n/a
20	n/a

Consideration may be given to the use of end-bearing drilled piers (caissons) for Buildings E, F and G given the depth to suitable founding soils and the expected loading. Drilled piers established to bear in the weathered shale bedrock could 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.

The caissons are to be end bearing units, and will require base inspection and hand cleaning of the base prior to concrete placement. End-bearing caissons should have a minimum diameter of 915 mm regardless of loading considerations to facilitate foundation subgrade inspection and hand cleaning of the base. The current minimum caisson diameter requirements for entry are 760 mm. However, in our experience, deep foundation contractors request a minimum 915 mm caisson diameter to permit entry. Caisson foundations at different elevations must be designed such that the higher caissons are set below a line drawn up at 10 horizontal to 7 vertical from the closest edge of the lower caisson.

It is possible that boulders and cobbles are present within the overburden soils and will be encountered during the construction of drilled piers. There could be delays relating to these obstructions and therefore the contract documents for this work must address the allocation of risk between the owner and contractor for such delays. It is suggested that unit prices for time lost to obstructions be established in conjunction with contract development and Terraprobe can provide an independent assessment of delays, in conjunction with the foundation installation inspection activities.

Excavation and installation of the caissons must conform to all applicable sections of the Occupational Health and Safety Act. The caisson contract must stipulate that the contractor will be responsible for the provision of all necessary equipment (including steel liner of adequate strength) and monitoring devices (as needed) for a safe access of the inspection and base cleaning personnel into the caissons, in accordance with the Occupational Health and Safety Act requirements.

End-Bearing Reduced Capacity Caissons

In the event that the contractor or design team wishes to avoid base inspection of end-bearing caissons, the following construction methodology may be utilized (bearing in mind that reduced bearing capacities apply, see below):

1. All caisson excavations are to be inspected on a full-time basis by Terraprobe as per the OBC;
2. Caissons are to be initially advanced to the top of bearing stratum as identified in the geotechnical boreholes and as confirmed by Terraprobe through observation of the auger cuttings at each location;
3. Visual inspection of the augered hole is to take place to ensure that auger cleaning has been carried out as thoroughly as practically possible;
4. Place 2 cu-m minimum of 25 MPa concrete in the base of the hole to be stirred with the auger without advancing the auger any further; and
5. Complete placing of concrete to cut off elevation.

With the above methodology in place, caissons established to bear in the weathered shale can be designed without base inspection and without hand cleaning using a maximum factored geotechnical resistance at ULS of 6.5 MPa.

5.3 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 meters 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**

It is expected that the foundation will consist of either a raft foundation formed in the undisturbed silty clay to clayey silt till or on a deep foundation system with pile caps and grade beams formed in the undisturbed till or weathered shale bedrock. Based on the above noted information, it is recommended that ‘Site Class C’ be used for seismic analysis, 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 Code provide the applicable acceleration and velocity based site coefficients.

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
C	1.0	1.0	1.0	1.0	1.0
Site Class	Values of F_v				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.20$	$S_a(1.0) = 0.30$	$S_a(1.0) = 0.40$	$S_a(1.0) \geq 0.50$
C	1.0	1.0	1.0	1.0	1.0

It should be noted that the above site designation is estimated on the basis of rational analysis of penetration resistance (N-values) with assumed N-values for the soil stratigraphy beyond the investigation depth. Consideration should be given to conduct a site specific Multichannel Analysis of Surface Waves (MASW) to determine the average shear wave velocity in the top 30 meters of the site stratigraphy. The site specific shear wave analysis may result in an improved seismic site designation which may help reduce the cost implication for the structure designed on the basis of a Class C seismic designation

5.4 Earth Pressure Design Considerations

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 (Rankin)	dimensionless
K_o	at-rest earth pressure coefficient (Rankin)	dimensionless
K_p	passive earth pressure coefficient (Rankin)	dimensionless

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

Stratum/Parameter	ϕ	γ	K_a	K_o	K_p
Fill – common fill	28	19.0	0.36	0.53	2.78
Compact Granular Fill Granular 'B' (OPSS 1010)	32	21.0	0.31	0.47	3.26
Silty Clay to Clayey Silt Till	32	20.0	0.31	0.47	3.26
Clayey Silt to Silt Till	34	21.0	0.28	0.44	3.54
Weathered Shale (Queenston Formation)	28	25	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:

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

where,
P = the horizontal pressure at depth, **h** (m)
K = the earth pressure coefficient (depends on the rigidity of the wall)
h_w = the depth below the ground water level (m)
γ = the bulk unit weight of soil, (kN/m^3)
γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
q = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, acting in conjunction with the earth pressure, (or in this case where the ground water level is below the foundation), this equation can be simplified to:

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

In cases where the structure is perfectly rigid, K_o (at rest conditions) should be used for the earth pressure coefficient. In cases where local yielding occurs, K_a (active case) should be used.

The ground water level was measured in monitoring wells at depths of about 6.3 to 7.8 m BGS or at elevations in the range of about 94.1 and 95.9 m. On this basis, foundation drainage is not a major design constraint. It is considered however that substructure walls should be provided with a conventional perimeter foundation drain should be provided for the new buildings. To assist in maintaining a dry basement from seepage, it is recommended that exterior grades around the building also be sloped away at a minimum 2 percent gradient.

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.

5.5 Slab on Grade Design Parameters

Depending on the final design and site grading, the subgrade at the lowest floor level in the structures could consist of clayey silt till or weathered shale bedrock of the Queenston Formation, all of which are capable of supporting a conventional lightly loaded slab on grade. The moduli of subgrade reaction appropriate for slab on grade design on the aforementioned soils or rock are as follows:

• Clayey Silt Till:	30,000 kPa/m
• Queenston Formation:	80,000 kPa/m

It is recommended that when the grade for the slab areas is cut to the design elevation, that the subgrade be inspected while it is proof rolled with a smooth drum compactor. Any weak areas exposed by this activity can then be remediated by replacement of fill, or recompaction of the existing subgrade prior to placing the underfloor fill materials. Final construction beneath slabs on grade should consist of 200 mm of uniformly compacted Granular A uniformly compacted to 98 percent of standard Proctor maximum dry density.

It is understood that the underground levels will be used primarily for parking, storage and for mechanical/electrical plant. On this basis it is anticipated that moisture sensitive floor coverings are not proposed for this level and it may not be necessary to incorporate a vapour barrier into the design of the floor slabs on grade. If moisture sensitive floor finishes are proposed, a capillary moisture barrier and drainage layer will be required beneath the slab. This can be achieved by providing a minimum 200mm thick layer of clear crushed stone compacted to a dense state.

5.6 Basement Drainage

The ground water levels at the site have been measured at elevations in the range of about 77.0 to 81.3 m based on the results of the previously referenced Phase II Environmental Site Assessment that was carried out at the site. Some seasonal fluctuation in the ground water level is expected and higher ground water levels would be expected under spring or spring-like conditions.

The excavation for the substructures may have to be shored. If shoring is undertaken at the site, the walls of the substructure must be protected from seepage from the shoring walls by providing a drained cavity between the shoring system and the structural basement wall. Prefabricated drain core products are available to form this cavity. The water is collected at the base of the building and conveyed by solid (non-perforated) pipe to the storm sump for discharge. A secondary waterproofing layer between the drain core product and the basement wall as an extra layer of protection is recommended. Typical shored basement drainage details are provided in the schematic in Appendix C.

In addition to the perimeter drainage, a subfloor drainage system is recommended to ensure that the underground levels remain dry in the event of an extreme storm water event. The subfloor drainage system should consist of perforated pipes (minimum 100 mm diameter) wrapped in filter fabric, at a maximum spacing of 8 to 10 metres centre-to-centre. The subfloor drains may be constructed in trenches as shown in the typical detail, or alternatively they can be constructed on flat subgrade subexcavated at least 300 mm below the base of slab. The subdrain system is collected and conveyed by solid (non-perforated) pipe to the storm sump for discharge.

The drainage system is a critical element, since it keeps water pressure from acting on the basement walls and floor slab. This sump system must have an industrial duplexed pump arrangement on emergency power, for 100 percent pumping redundancy. The size of the sump should be adequate to accommodate the water seepage. The expected water seepage from the building drainage system will be limited due to the low permeability of the soil strata and can be controlled with typical, widely available commercial grade sump pumps.

5.7 Site Servicing

5.7.1 Bedding

It is expected that site services may consist of storm sewers and watermains, with relatively shallow inverts (less than 3m). The invert elevations are expected to be within the undisturbed clayey silt to silty clay till, however based on the variable depth of fill on the site it may be possible that some services may have invert elevations within the existing fill. The nature and condition of the fill was somewhat variable and for this reason, measures intended to improve the uniformity of the support beneath the pipe and to enhance the performance of the underground plant are recommended.

The foundation bedding material should consist of OPSS Granular A uniformly compacted to at least 95 percent of SPMDD. The pipe must be designed for a Class B bedding condition with Type 3 soil conditions assumed. The underground plant including the pipe joints should be designed to optimize flexibility. It is noted that flexible rather than rigid pipe is recommended for underground services constructed at the site.

5.7.2 Backfill

Based on the results of the boreholes, it is assumed that the majority of excavated soil at the site from the construction of service trenches will consist of fill. The fill was observed to be variable in nature and depth. Any topsoil and/or soil containing high amounts of topsoil should not be used for service trench backfill.

Service trench backfill should consist of clean earth, free of excessively wet or frozen soil and should be placed in lifts of 300 mm thickness or less and uniformly compacted to at least 95 percent of SPMDD at placement water contents within 2 percent of the corresponding laboratory optimum water content for compaction. The upper 1m of the backfill forming the pavement subgrade, should be uniformly compacted to 98 percent of SPMDD.

It may be difficult to consistently achieve the degree of compaction specified above using existing fills on site or the native excavated soil as trench backfill, particularly in narrow trenches. For this reason consideration could be given to using free draining granular material, such as OPSS 1010 Granular A or Granular B Type I as trench backfill to allow for adequate, uniform compaction.

5.8 Pavement Design

5.8.1 Subgrade Preparation

Areas to be developed as pavements should be prepared as outlined in Section 5.1 of this report. The final subgrade surface beneath all pavements should be shaped and graded to promote drainage. The subgrade should be proof-rolled under the direction of a geotechnical engineer to identify any soft or weak zones requiring remedial work. Local sub-excavation may be required due to disturbed, soft, wet or otherwise incompetent subgrade conditions. Such areas may be restored using suitable surplus excavated soil or Granular B material.

5.8.2 Asphaltic Concrete Pavement Design

Two alternative approaches to pavement design can be considered. A minimal pavement design is provided, which will provide adequate service for 8 to 10 years before significant maintenance and rehabilitation will be required.

Minimal Asphaltic Concrete Pavement Structure

Pavement Layer	Compaction Requirements	Car Parking Minimum Component Thickness	Truck Traffic Minimum Component Thickness
Surface Course Asphaltic Concrete HL3 (OPSS 1150)	92-96.5% MRD	65 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150)	92-96.5% MRD	N/A	60 mm
Base Course: 19mm Crusher Run Limestone *	98% SPMDD (ASTM-D1557)	150 mm	150 mm
Subbase Course: Granular B Type II (OPSS 1010) or 50mm Crusher Run Limestone	98% SPMDD (ASTM-D1557)	300 mm	300 mm

The cost of the minimal design should be compared to a more substantial performance design which could be expected to last about twice as long before significant maintenance and rehabilitation.

Performance Asphaltic Concrete Pavement Structure

Pavement Component	Compaction Requirements	Light Duty	Heavy Duty
Surface Course Asphaltic Concrete HL3F (OPSS 1150)	92-96.5% MRD	40 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150)	92-96.5% MRD	50 mm	80 mm
Granular Base Course: Granular 'A' (OPSS 1010) or 19 mm Crusher Run Limestone	98% SPMDD (ASTM-D1557)	150 mm	150 mm
Granular Subbase Course: Granular B Type II (OPSS 1010) or 50 mm Crusher Run Limestone	98% SPMDD (ASTM-D1557)	400 mm	400 mm

Some adjustment to the thickness of the granular subbase material may be required depending on the condition of the subgrade at the time of the pavement construction. The need for such adjustments can be best assessed by the geotechnical engineer during construction.

It is recommended that the placement of the wearing surface be delayed for at least one year after construction of the binder course to minimize the effects of post construction settlement of underground service backfill and the like. Prior to placing the wearing surface, the binder course should be evaluated and remedial work carried out as required in preparation for final construction.

5.8.3 Drainage

Control of surface water is a significant factor in achieving good pavement life. Grading adjacent to pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. The subgrade must be free of depressions and sloped (preferably at a minimum grade of two percent) to provide effective drainage toward subgrade drains or swales and/or ditches.

Continuous perimeter subdrains should be provided in paved areas and short perforated sub drains should be provided at all catch basins locations. The subdrain invert elevations should be maintained at least 0.3 metres below subgrade level.

It should be noted that in addition to a strict adherence to the above pavement design recommendations, a close control on the pavement construction process will be required in order to obtain the desired pavement life. It is therefore recommended that regular inspection and testing should be conducted during the construction to confirm material quality, thickness, drainage, and to ensure adequate compaction.

6.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

6.1 Excavations

6.1.1 Overburden Soil

Excavations must be carried out in accordance with the *Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 213/91 as amended by Ontario Regulation 142/17 (Part III - Excavations, Section 222 through 242).* These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes, all fill and any soft or loose surficial soil are interpreted as Type 3 soils. The undisturbed glacial till can be considered Type 2 soils.

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

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

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

The need for shoring to support adjacent property will depend on the proximity of the building footprint to the property lines and adjacent structures. For preliminary consideration temporary unsupported excavations should be cut to an overall inclination of 1 horizontal to 1 vertical or flatter and a buffer of 2 to 3m should be provided between the top of the excavation and the property lines. If this minimum geometry cannot be achieved then consideration will need to be given to the use of shoring. The requirement for shoring will need to be examined when the actual building footprints and the number of basement levels have been finalized.

It is possible that large particles (rubble, cobbles and boulders) may be found in the earth fill material. Similarly, larger size particles (cobbles and boulders) that are not specifically identified in the boreholes may be present in the underlying native soils. The size and distribution of such obstructions cannot be predicted with boreholes, as the sampler size is insufficient to secure representative samples of particles of this size. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

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. No chemical analyses of soil were carried out as part of this assignment. 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 Bedrock

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.

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’.

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.

6.2 Shoring Design Considerations

The site is bound by North Service Road along the south side. Depending on the proximity of the excavation to North Service Road and whether the appropriate slope configuration(s) as outlined in Section 6.1 can be achieved for the applicable soil type(s), there may be a requirement to shore the south limits of the site. Where excavations cannot be sloped, they can be supported using a conventional soldier pile and lagging system. Terraprobe can provide shoring design services for the project if required.

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 sub-level 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.

The 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:

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

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.

6.2.2 Soldier Pile Toe Design

Soldier pile toes will be made in stiff to very stiff silty clay to clayey silt till, the compact to dense clayey silt to silt till, and/or the weathered shale bedrock. The horizontal resistance of the soldier pile toes will be developed by embedment below the base of excavation, where resistance is developed from passive earth pressure.

For the design of soldier pile toes in the hard cohesive silty clay to clayey silt till beneath the excavation base, the commentary on the Ontario Bridge Design Code 3rd edition suggests that passive earth pressure be taken as twice the undrained shear strength at surface increasing to 9 times the undrained shear strength at 3 effective pile diameters depth. This capacity distributed over the effective pile width. The undrained shear strength of the silty clay to clayey silt till is estimated to be a minimum of 220 kPa.

If the soldier piles are subject to vertical loading, then the toes will support the load by bearing on the base of the concrete toe fill and friction on the embedded portion of the soldier pile toe concrete. The unfactored ultimate end bearing capacity in the undisturbed silty clay to clayey silt till is estimated to be about 300 kPa. The developable ultimate adhesion in the undisturbed silty clay to clayey silt till is estimated to be not less than 140 kPa.

Ground water was previously measured between elevations of 77.0 and 81.3 m at the site, or at depths of about 1.0 to 5.5 m below the existing ground surface. For this reason, it may be necessary to advance temporarily cased holes to maintain sidewall support and to prevent the ingress of water during soldier pile installation. Contractors must adjust their means and methods to ensure that the augered borehole base remains stable.

6.2.3 Shoring Support

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

The undisturbed glacial till below about elevation 80.5 m is suitable for the placement of raker foundations. Raker footings established in the undisturbed till at an inclination of 45 degrees can be designed for a maximum factored geotechnical resistance at ULS of 120 kPa.

Post-grouted wash bored anchors can be made. The design adhesion for earth anchors is controlled as much by the installation technique as the soil and therefore a proto-type anchor must be made in each anchor level executed to demonstrate the anchor capacity and validate the design assumptions. It is expected that post-grouted anchors can be made such that an anchor will safely carry about 60 kN/m of adhered anchor length (at a nominal diameter of 150 mm) within the silty clay to clayey silt till stratum.

Higher bond stresses are possible but proof testing of anchorages on a site by site basis is required. Rock anchorages are typically made in the Queenston Formation using a design bond stress of 620 kPa, without proof testing.

6.3 Site Work

The effects of site work can have an adverse impact on soil integrity, particularly in the case of the undisturbed silty clay to clayey silt till deposit which will likely be exposed in the excavation. An adequate layer of granular material or a concrete mud mat will be needed to maintain the integrity of the subgrade soils. Adequate control of ground water seepage in the excavation is also essential to minimize soil disturbance.

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

6.4 Quality Control

6.4.1 Shoring

The Town of Grimsby will require that any shoring installations be monitored during the period of construction to demonstrate that the shoring is performing adequately. Terraprobe has considerable experience in the provision of shoring instrumentation and monitoring services for a number of similar sites.

The provisions of the Ontario Building Code require that the construction of the earth retaining structures be monitored on a continuous basis. The shoring system constitutes an earth retaining structure as provided in Section 4.2.2.3 of the Ontario Building Code 2012. Terraprobe should be retained to provide this review as the shoring installations are made. It is an integral part of the geotechnical design function as it relates to shoring design considerations.

Assuming soil anchors will be used to support the shoring system on this site, a minimum of one anchor as each target anchorage level must be performance tested to verify the design adhesion used for the anchorages. This performance test anchor shall be consistent dimension in anchor and free stressing zones with the proposed production anchors and be provided with adequate tendon steel capacity to test the anchor to twice the design working load. The performance tests shall be monitored and evaluated by the geotechnical engineer. Production anchorages should not be installed until the performance test at each level has adequately demonstrated the design adhesion value. All production anchorages shall be monitored during stressing and evaluated by a geotechnical engineer.

6.4.2 Foundations

The proposed structures will be founded on conventional spread and strip footings, caissons (drilled piers), and/or helical piers. All foundation installations must be reviewed in the field by Terraprobe, the geotechnical engineer, as they are constructed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical engineering design function and is required by Section 4.2.2.2 of the Ontario Building Code 2012. If Terraprobe is not retained to carry out foundation engineering field review during construction, then Terraprobe accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice contained in this report.

6.4.3 Slabs on Grade

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.

6.4.4 General

The requirements for fill placement on this project have been stipulated relative to standard Proctor maximum dry density (SPMDD). In situ determinations of density during fill and asphaltic pavement placement on site are required to demonstrate that the specified placement density is achieved. Terraprobe is a CNSC certified operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary, with our qualified technical staff.

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

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

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 and coring work was carried out by a specialist drilling contractor. The boreholes were made by a continuous flight power auger machine. A Terraprobe technician logged the boreholes and examined the samples recovered from the boreholes and coring. The samples obtained were sealed in clean, air-tight containers and transferred to the Terraprobe laboratory, where they were reviewed for consistency of description by a geotechnical engineer. Ground water observations were made in the borehole as drilling proceeded.

The samples of the strata penetrated were obtained using the Split-Barrel Method technique (ASTM D1586). The samples were taken at regular intervals of depth. The sampling procedure used for this investigation does not recover continuous samples of soil. Consequently there is 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

The subsurface conditions may potentially be altered with passage of time, by natural occurrences, and direct or indirect human intervention at or near the site. 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 Losani Homes, and their retained design consultants and is not intended 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. It is recognized that Town of Grimsby, 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.

LICENSED PROFESSIONAL ENGINEER
July 13/18
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LICENSED PROFESSIONAL ENGINEER
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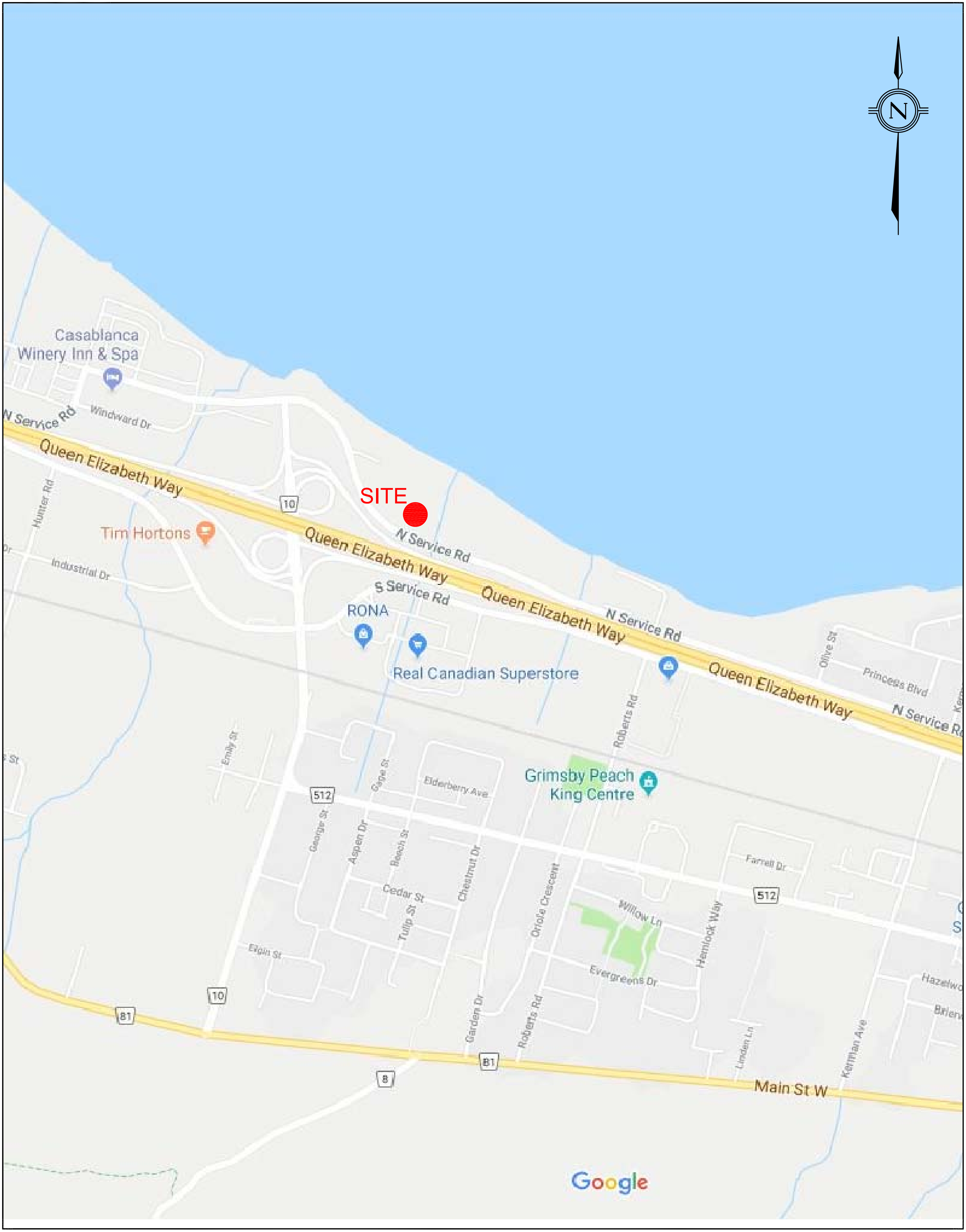
July 13/18
PROVINCE OF ONTARIO

Kyle Byckalo, P. Eng.,
Geotechnical Engineer

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: SITE LOCATION PLAN

File No. 7-18-0055-01

FIGURE : 1

LEGEND

BH1 ⊕ Borehole Location

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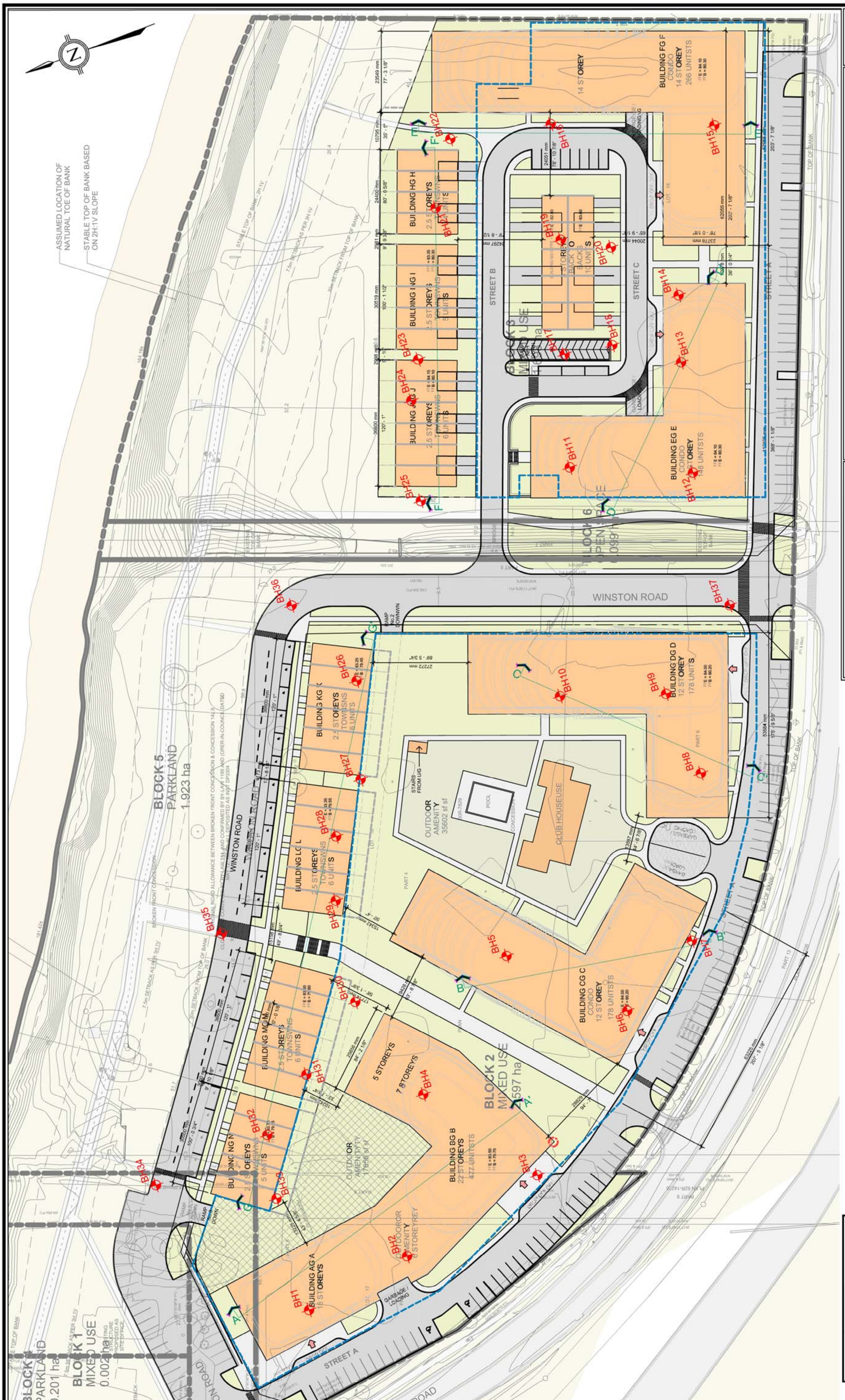
903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title:	BOREHOLE LOCATION PLAN
File No.	7-18-0055-01

FIGURE : 2



To be read with accompanying letter. All borehole locations approximate.

LEGEND

BH1 Borehole Location

A A' Cross Section

Drawing Source:

Chamberlain Architect Services Limited

Terraprobe

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

Title:

PROPOSED SITE DEVELOPMENT PLAN

File No. 7-18-0055-01

FIGURE: 3

LOGS OF BOREHOLES

APPENDIX A

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ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

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

PENETRATION RESISTANCE

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

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

COHESIONLESS SOILS

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

COHESIVE SOILS

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

COMPOSITION

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

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
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.

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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

Terraprobe

LOG OF BOREHOLE 1

Project No. : 7-18-0055-01
Date started : May 28, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614304, N: 4784921 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE – Description
82.4	**GROUND SURFACE**
	25mm **ASPHALTIC CONCRETE**
82.0 0.4	**FILL**, granular base
	FILL, clayey silt, trace sand, trace gravel, stiff, grey / brown
81.5 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to hard, brown (GLACIAL TILL)
75.1 7.3	**WEATHERED SHALE**, reddish brown
74.7 7.7	**END OF BOREHOLE**

Number	Type	SPT 'N' Value	Lab Data and Comments – GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1	SS	15	
2	SS	29	
3	SS	21	
4	SS	25	5 11 34 50
5	SS	24	
6	SS	42	
7	SS	50 / 100mm	

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 2

Project No. : 7-18-0055-01
Date started : May 28, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

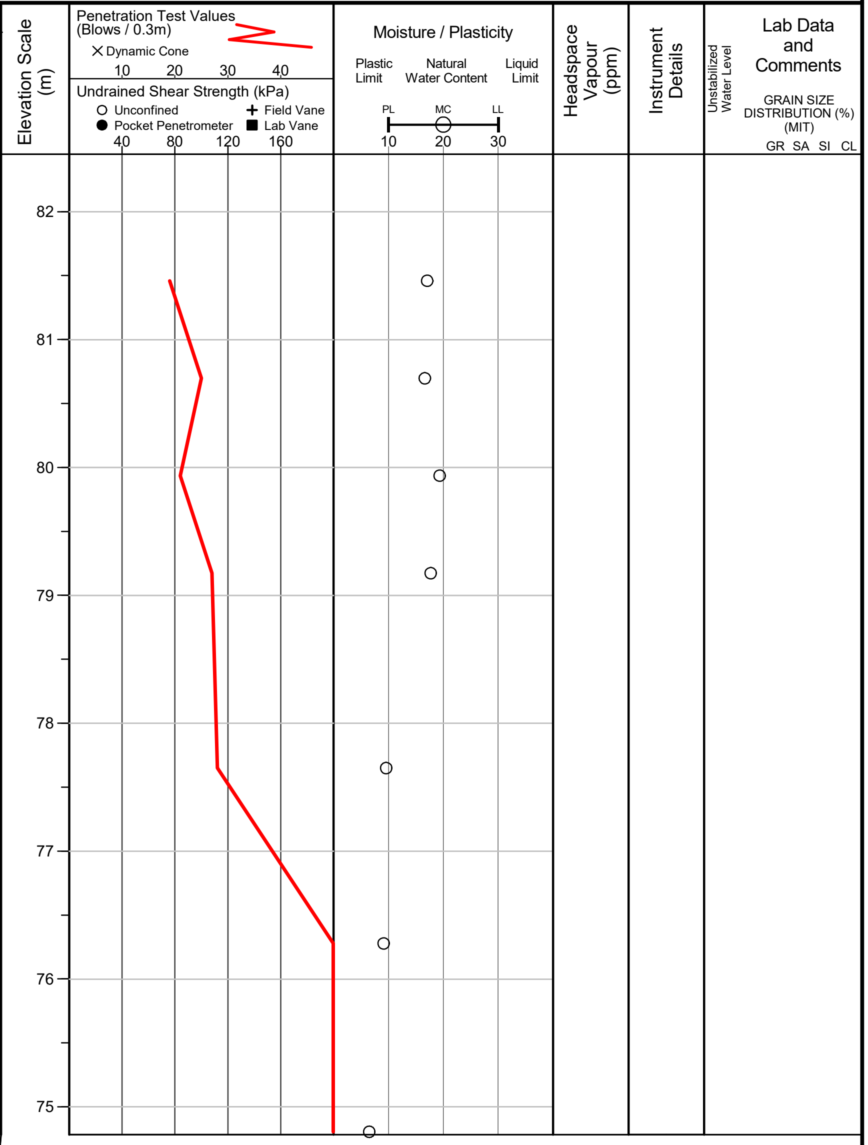
Position : E: 614311, N: 4784888 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE		SAMPLES		
Elev Depth (m)	Description	Number	Type	SPT 'N' Value
82.5	**GROUND SURFACE**			
	30mm **ASPHALTIC CONCRETE**			
82.1 0.4	**FILL**, granular base			
	FILL, clayey silt, trace gravel, stiff, brown			
81.6 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	1	SS	19
		2	SS	25
		3	SS	21
		4	SS	27
		5	SS	28
76.6 5.9	**WEATHERED SHALE**, reddish brown	6	SS	50 / 150mm
74.8 7.7		7	SS	50 / 50mm

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



LOG OF BOREHOLE 3

Project No. : 7-18-0055-01
Date started : May 28, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

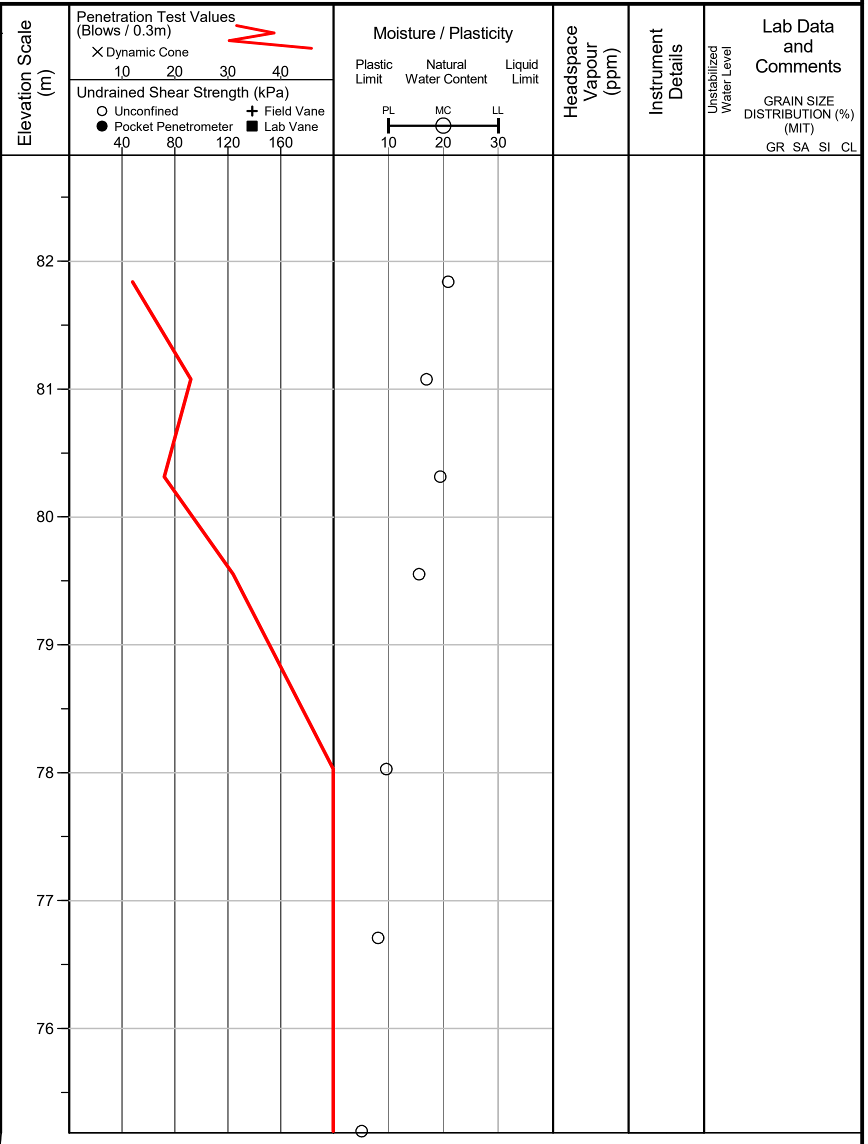
Position : E: 614323, N: 4784847 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value
82.8	**GROUND SURFACE**			
	25mm **ASPHALTIC CONCRETE**			
	FILL, granular base			
82.4 0.4	**FILL**, clayey silt, trace topsoil, trace gravel, trace rootlets, stiff, brown	1	SS	12
81.4 1.4	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)	2	SS	23
		3	SS	18
		4	SS	31
78.2 4.6	**CLAYEY SILT to SILT**, occasional gravel, trace sand, trace clay, very dense, grey / brown (GLACIAL TILL)	5	SS	61
76.9 5.9	**WEATHERED SHALE**, reddish brown	6	SS	50 / 50mm
75.2 7.6		7	SS	50 / 25mm

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



file: 7-18-0055-01 398 nsr grimsby.gpj

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LOG OF BOREHOLE 4

Project No. : 7-18-0055-01	Client : Losani Homes	Originated by : JM
Date started : May 29, 2018	Project : 398 North Service Road	Compiled by : KB
Sheet No. : 1 of 1	Location : Grimsby, Ontario	Checked by : PC

Position : E: 614356, N: 4784872 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

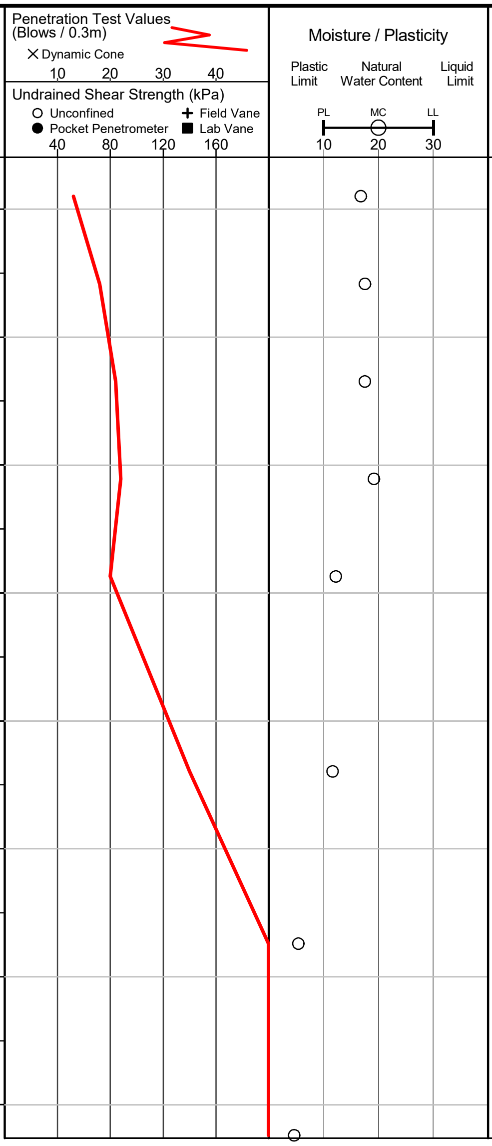
Elev Depth (m)	Description	Sample Number	Type	SPT 'N' Value
82.4	**GROUND SURFACE**			
	FILL, sand and gravel, compact, brown / grey	1	SS	13
81.8 0.6	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, green / brown (GLACIAL TILL)	2	SS	18
		3	SS	21
		4	SS	22
		5	SS	20
		6	SS	35
76.9 5.5	**WEATHERED SHALE**, reddish brown	7	SS	50 / 100mm
74.7 7.7		8	SS	50 / 50mm

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6, 7

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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

file: 7-18-0055-01 398 nsr grimsby.gpj

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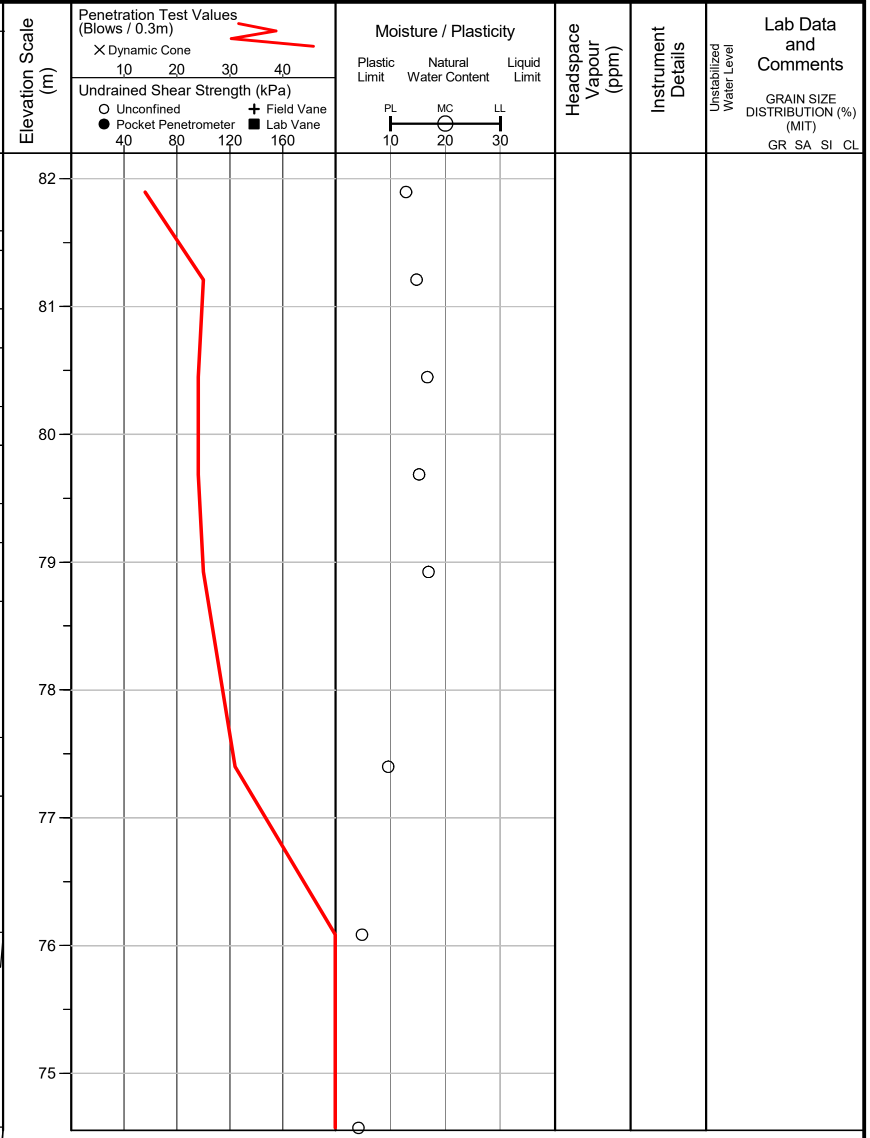
LOG OF BOREHOLE 5

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM
Date started : May 29, 2018
Project : 398 North Service Road
Compiled by : KB
Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

Position : E: 614388, N: 4784838 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
82.2	**GROUND SURFACE**			
	FILL, sand and gravel, trace silt, occasional pieces of coal, compact, brown	1	SS	14
81.9 0.3	**FILL**, clayey silt, trace rootlets, occasional gravel, stiff, grey / brown			
81.3 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	2	SS	25
		3	SS	24
		4	SS	24
		5	SS	25
77.8 4.4	**CLAYEY SILT to SILT**, occasional gravel, dense, grey / brown (GLACIAL TILL)	6	SS	31
76.9 5.3	**WEATHERED SHALE**, reddish brown	7	SS	50 / 40mm
74.6 7.6		8	SS	50 / 15mm



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 6

Project No. : 7-18-0055-01
Date started : May 29, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

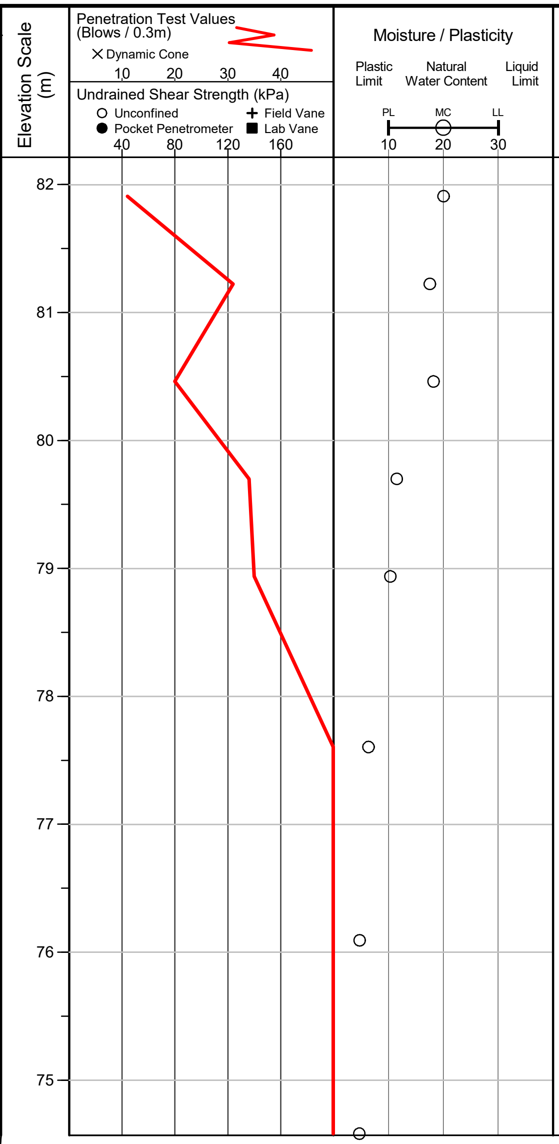
Position : E: 614362, N: 4784809 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.2	**GROUND SURFACE**
82.0 0.2	150mm **TOPSOIL**
	FILL, clayey silt, trace topsoil, occasional gravel, stiff, brown
81.4 0.8	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)
78.8 3.4	**CLAYEY SILT to SILT**, occasional gravel, trace clay, dense, brown / grey (GLACIAL TILL)
77.8 4.4	**WEATHERED SHALE**, reddish brown
74.6 7.6	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	11
2	SS	31
3	SS	20
4	SS	34
5	SS	35
6	SS	50 / 75mm
7	SS	50 / 50mm
8	SS	50 / 25mm



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

Depth Scale (m): 0 1 2 3 4 5 6 7

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 7

Project No. : 7-18-0055-01
Date started : May 29, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

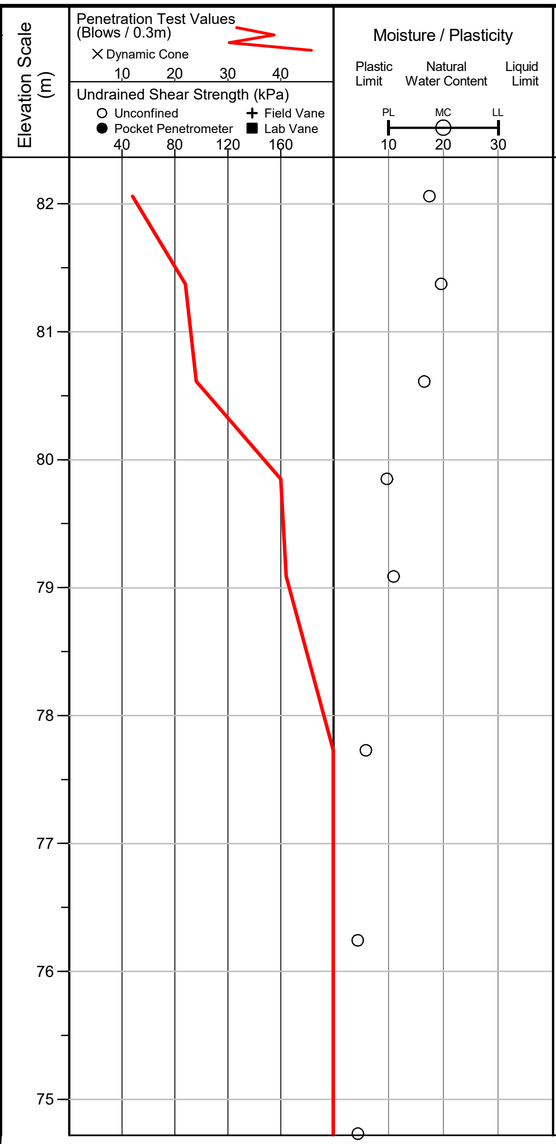
Position : E: 614376, N: 4784785 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value
82.4	**GROUND SURFACE**			
	FILL, sand and gravel, compact, grey / brown	1	SS	12
82.1 0.3	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)	2	SS	22
		3	SS	24
		4	SS	40
79.4 3.0	**CLAYEY SILT to SILT**, occasional gravel, trace clay, dense, grey (GLACIAL TILL)	5	SS	41
78.3 4.1	**WEATHERED SHALE**, reddish brown	6	SS	50 / 125mm
		7	SS	50 / 50mm
74.8 7.6		8	SS	50 / 25mm

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

file: 7-18-0055-01 398 nsr grimsby.gpj

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LOG OF BOREHOLE 8

Project No. : 7-18-0055-01
Date started : May 31, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614422, N: 4784769 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE		SAMPLES		
Elev Depth (m)	Description	Number	Type	SPT 'N' Value
82.3	**GROUND SURFACE**			
	FILL, sand and gravel, grey			
81.8 0.5	**FILL**, clayey silt, trace gravel, stiff, grey / brown	1	SS	10
	CLAYEY SILT to SILTY CLAY, occasional gravel, very stiff to hard, brown (GLACIAL TILL)	2	SS	22
		3	SS	19
		4	SS	19
		5	SS	35
		6	SS	34
76.8 5.5	**WEATHERED SHALE**, reddish brown	7	SS	50 / 100mm
74.7 7.6		8	SS	50 / 50mm

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6, 7

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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

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LOG OF BOREHOLE 9

Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

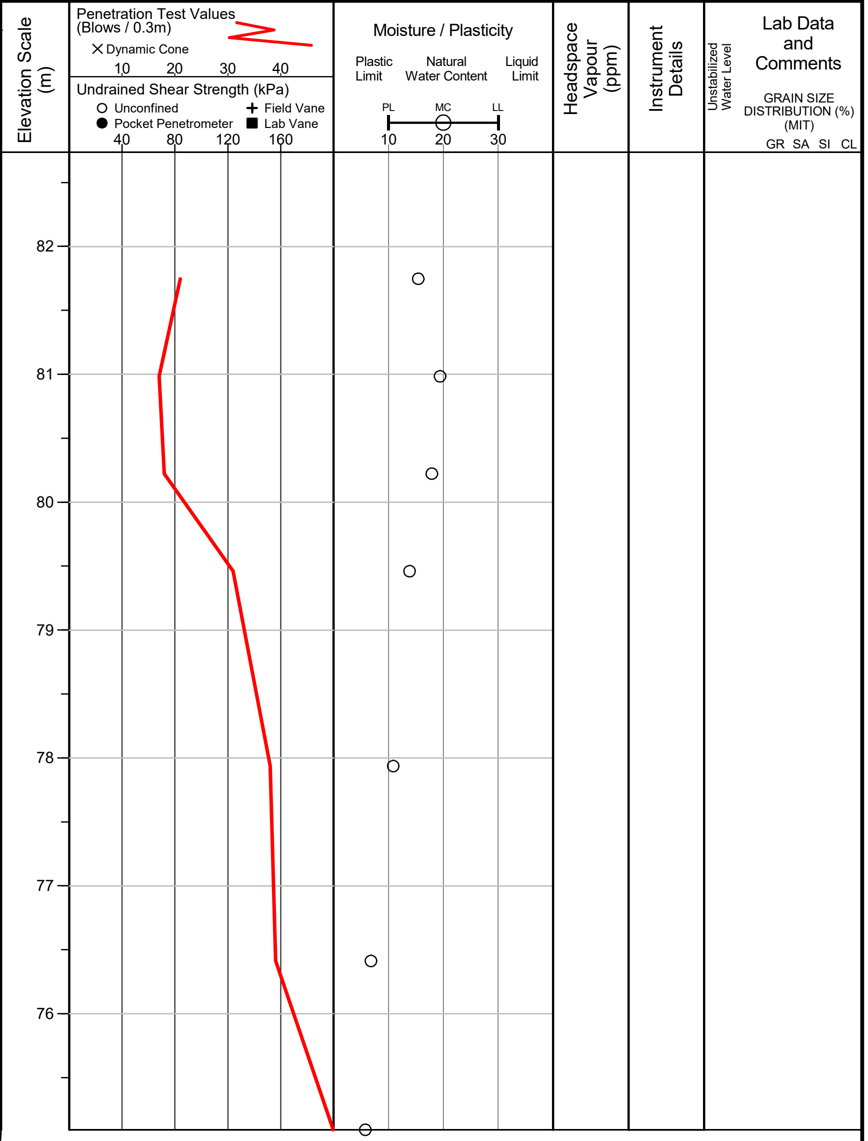
Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614447, N: 4784771 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	Number	Type	SPT 'N' Value
82.7	**GROUND SURFACE**			
82.4 0.3	70mm **ASPHALTIC CONCRETE** **FILL**, granular base **FILL**, clayey silt, trace gravel, occasional shale fragments, occasional rootlets, stiff, grey / brown	1	SS	21
81.5 1.2	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	2 3 4	SS SS SS	17 18 31
78.4 4.3	**CLAYEY SILT to SILT**, trace clay, occasional gravel, dense, grey / brown (GLACIAL TILL)	5	SS	38
77.5 5.2	**WEATHERED SHALE**, reddish brown	6 7	SS SS	39 50 / 50mm
75.1 7.6				

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



file: 7-18-0055-01 398 nsr grimsby.gpj

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LOG OF BOREHOLE 10

Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

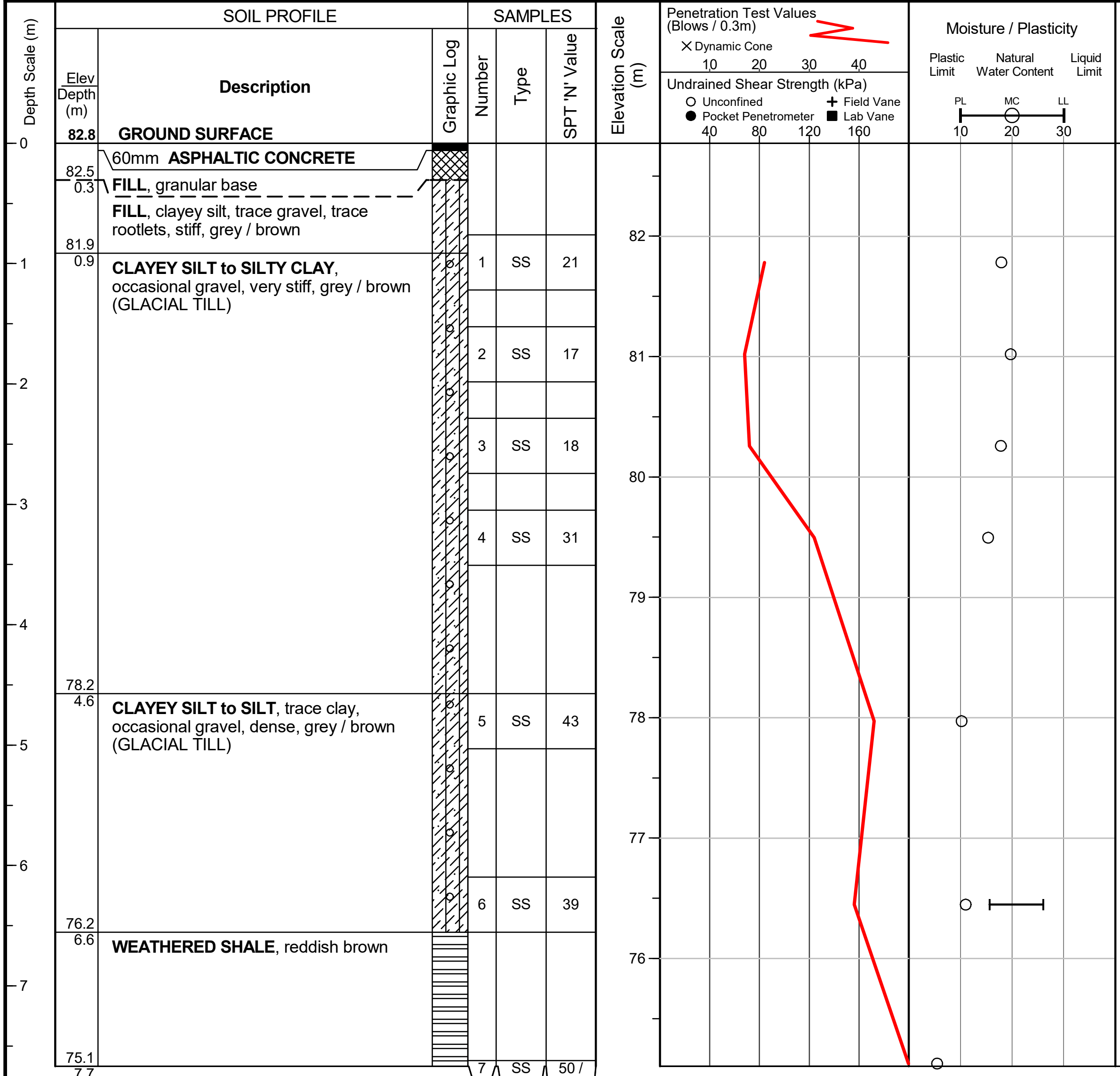
Position : E: 614455, N: 4784801 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
82.8	**GROUND SURFACE**				
	60mm **ASPHALTIC CONCRETE**				
82.5 0.3	**FILL**, granular base				
	FILL, clayey silt, trace gravel, trace rootlets, stiff, grey / brown				
81.9 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, grey / brown (GLACIAL TILL)	1	SS	21	
		2	SS	17	
		3	SS	18	
		4	SS	31	
78.2 4.6	**CLAYEY SILT to SILT**, trace clay, occasional gravel, dense, grey / brown (GLACIAL TILL)	5	SS	43	
		6	SS	39	8 22 41 29
76.2 6.6	**WEATHERED SHALE**, reddish brown				
75.1 7.7		7	SS	50 / 50mm	

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



Terraprobe

LOG OF BOREHOLE 11

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM
Date started : May 31, 2018
Project : 398 North Service Road
Compiled by : KB
Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

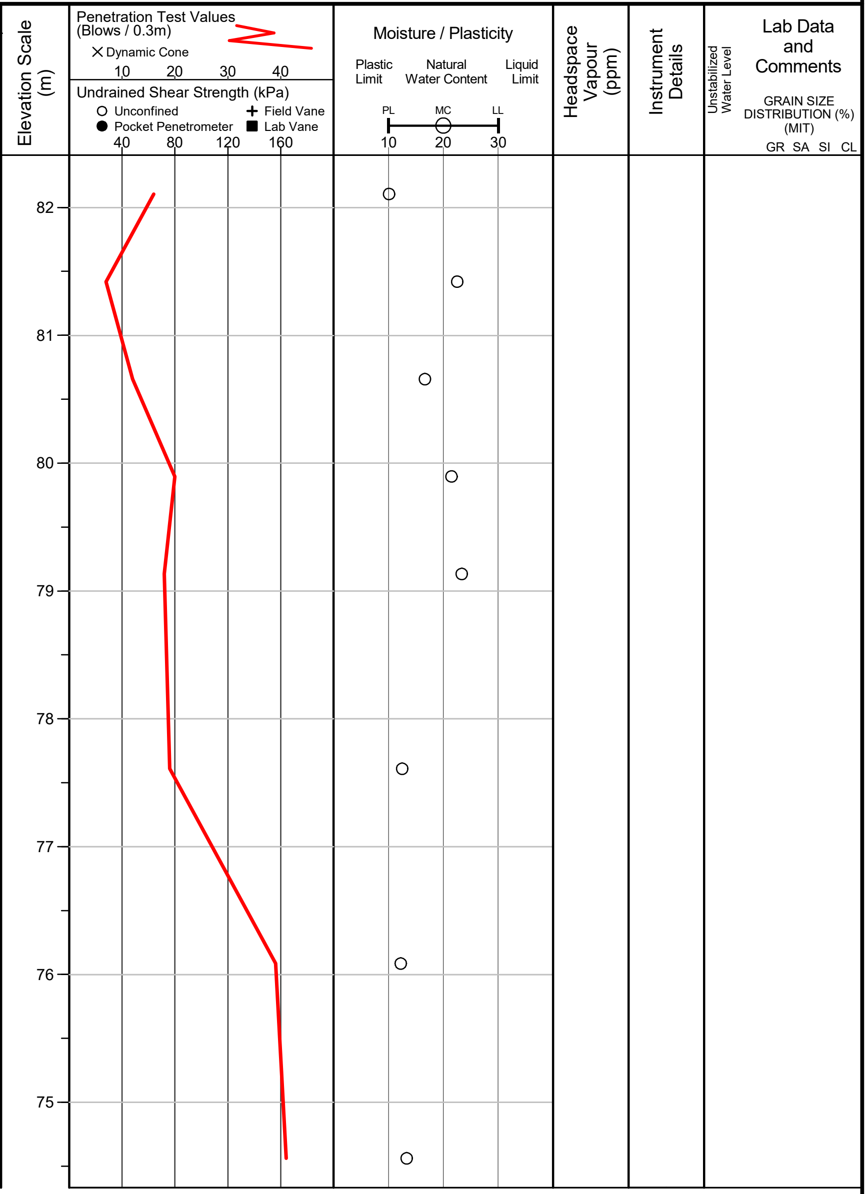
Position : E: 614518, N: 4784780 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.4	**GROUND SURFACE**
	FILL, silt, trace sand, trace shale fragments, occasional gravel, compact, reddish brown
81.9 0.5	50mm **ASPHALTIC CONCRETE**
81.8 0.6	**FILL**, silty clay, trace gravel, firm, brown
80.9 1.5	**FILL**, sand and gravel, with slag, compact, grey
80.3 2.1	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)
74.3 8.1	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	16
2	SS	7
3	SS	12
4	SS	20
5	SS	18
6	SS	19
7	SS	39
8	SS	41



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 12

Project No. : 7-18-0055-01
Date started : May 31, 2018
Sheet No. : 1 of 1

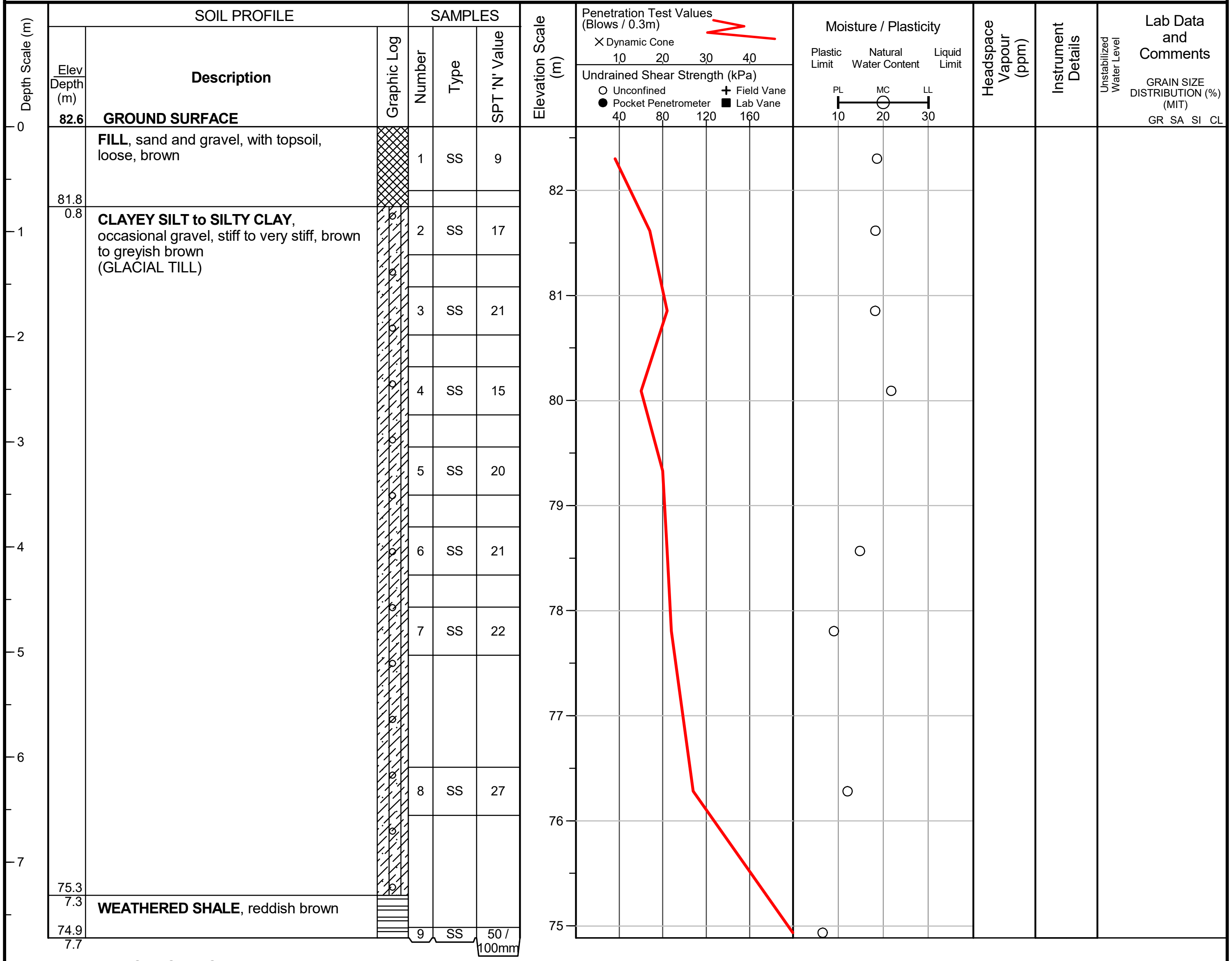
Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614506, N: 4784744 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value
82.6	**GROUND SURFACE**			
	FILL, sand and gravel, with topsoil, loose, brown	1	SS	9
81.8 0.8	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to very stiff, brown to greyish brown (GLACIAL TILL)	2	SS	17
		3	SS	21
		4	SS	15
		5	SS	20
		6	SS	21
		7	SS	22
		8	SS	27
75.3 7.3	**WEATHERED SHALE**, reddish brown	9	SS	50 / 100mm
74.9 7.7	**END OF BOREHOLE**			

Borehole was dry and open upon completion of drilling.



Terraprobe

LOG OF BOREHOLE 13

Project No.	: 7-18-0055-01	Client	: Losani Homes	Originated by	: JM
Date started	: May 31, 2018	Project	: 398 North Service Road	Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario	Checked by	: PC

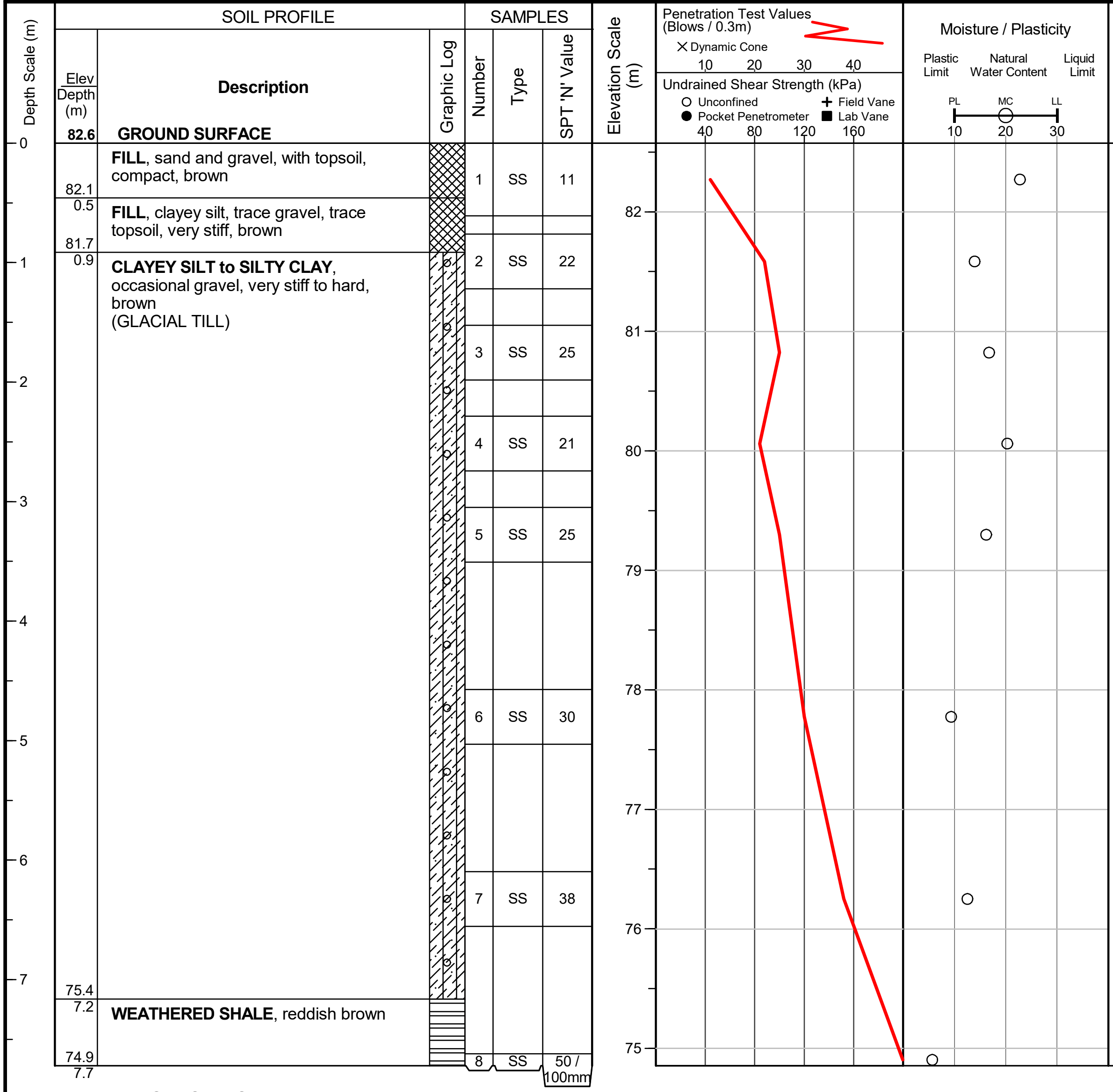
Position : E: 614539, N: 4784740 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.6	**GROUND SURFACE**
82.1 0.5	**FILL**, sand and gravel, with topsoil, compact, brown
81.7 0.9	**FILL**, clayey silt, trace gravel, trace topsoil, very stiff, brown
75.4 7.2	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)
74.9 7.7	**WEATHERED SHALE**, reddish brown

SAMPLES

Number	Type	SPT 'N' Value
1	SS	11
2	SS	22
3	SS	25
4	SS	21
5	SS	25
6	SS	30
7	SS	38
8	SS	50 / 100mm



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 14

Project No.	: 7-18-0055-01	Client	: Losani Homes	Originated by	: JM
Date started	: May 31, 2018	Project	: 398 North Service Road	Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario	Checked by	: PC

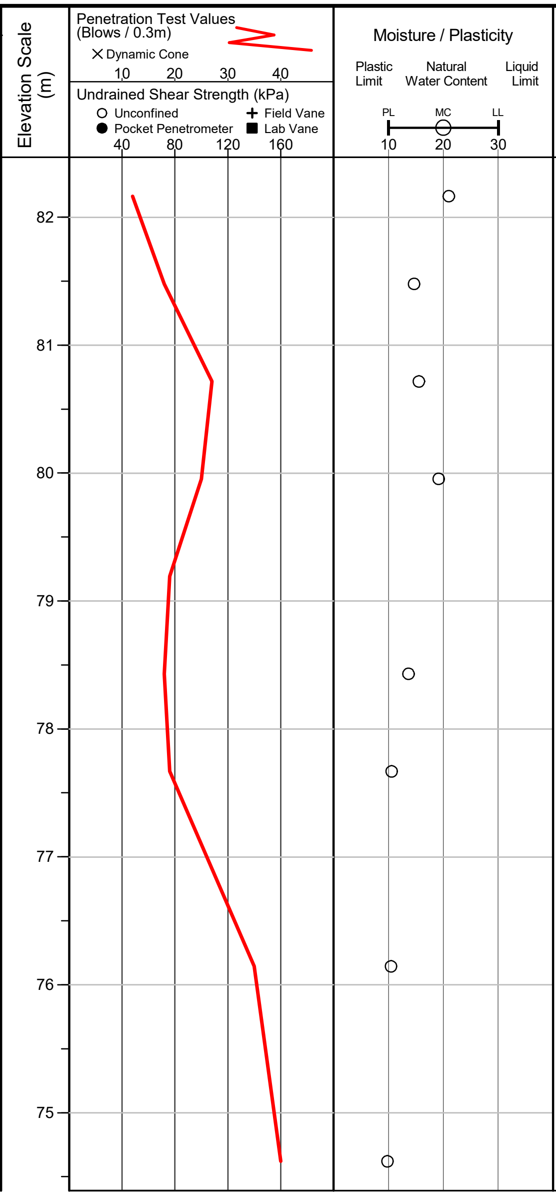
Position	: E: 614558, N: 4784734 (UTM 17T)	Elevation Datum	: Geodetic
Rig type	: CME 55, track-mounted	Drilling Method	: Solid stem augers

SOIL PROFILE

Depth Scale (m)	Elev Depth (m)	Description
0	82.5	**GROUND SURFACE**
		FILL, sand, with topsoil, compact, brown
	82.0 0.5	**FILL**, clayey silt, trace topsoil, very stiff, brown
1	81.6 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff to hard, brown (GLACIAL TILL)
8	74.4 8.1	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	12
2	SS	18
3	SS	27
4	SS	25
5	SS	19
6	SS	18
7	SS	19
8	SS	35
9	SS	40



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

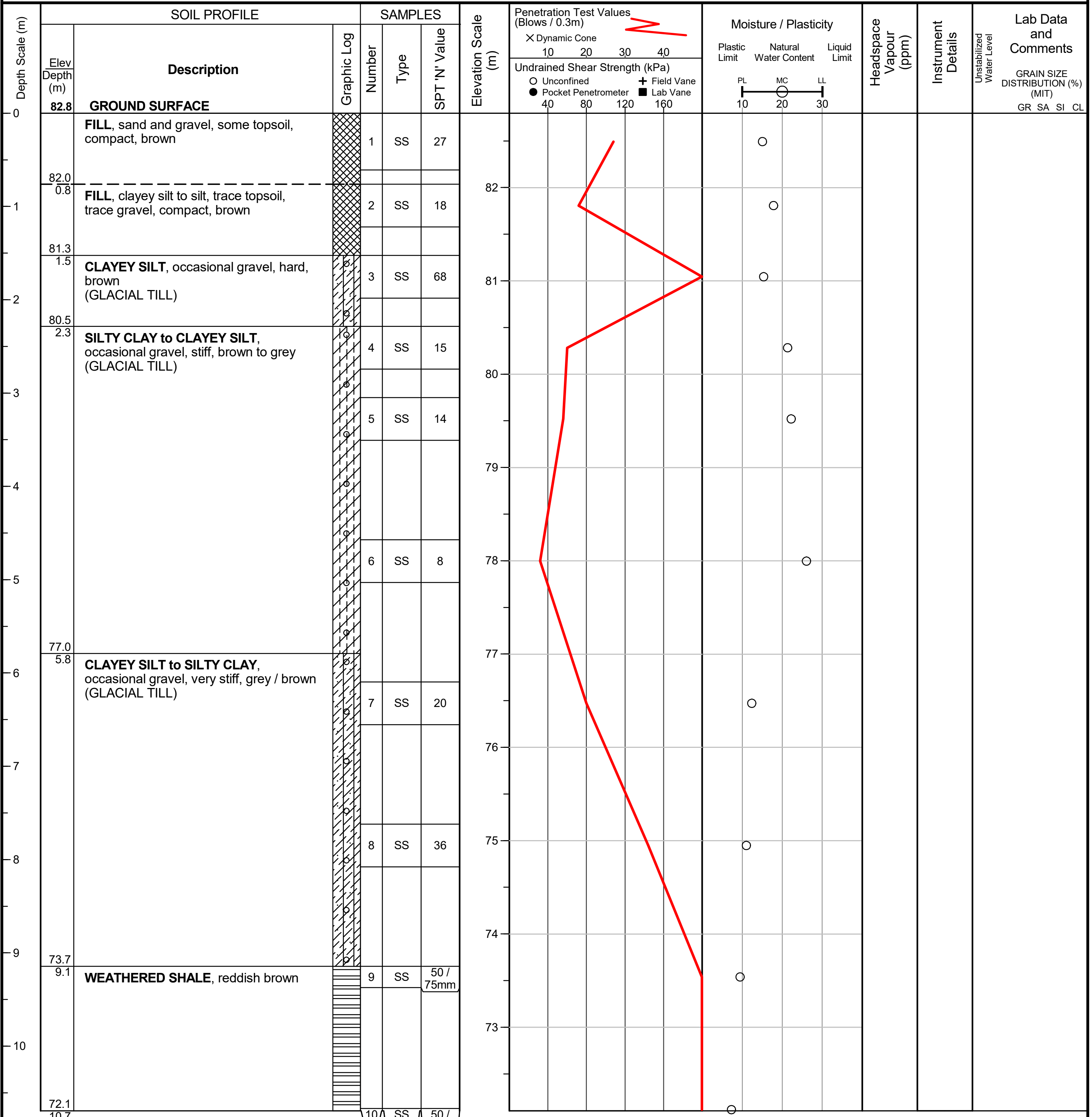
Terraprobe

LOG OF BOREHOLE 15

Project No. : 7-18-0055-01	Client : Losani Homes	Originated by : JM
Date started : June 1, 2018	Project : 398 North Service Road	Compiled by : KB
Sheet No. : 1 of 1	Location : Grimsby, Ontario	Checked by : PC

Position : E: 614602, N: 4784712 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
82.8	**GROUND SURFACE**			
	FILL, sand and gravel, some topsoil, compact, brown	1	SS	27
82.0 0.8	**FILL**, clayey silt to silt, trace topsoil, trace gravel, compact, brown	2	SS	18
81.3 1.5	**CLAYEY SILT**, occasional gravel, hard, brown (GLACIAL TILL)	3	SS	68
80.5 2.3	**SILTY CLAY to CLAYEY SILT**, occasional gravel, stiff, brown to grey (GLACIAL TILL)	4 5 6	SS SS SS	15 14 8
77.0 5.8	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, grey / brown (GLACIAL TILL)	7 8	SS SS	20 36
73.7 9.1	**WEATHERED SHALE**, reddish brown	9	SS	50 / 75mm
72.1 10.7		10	SS	50 / 25mm



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 16

Project No. : 7-18-0055-01
Date started : June 1, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

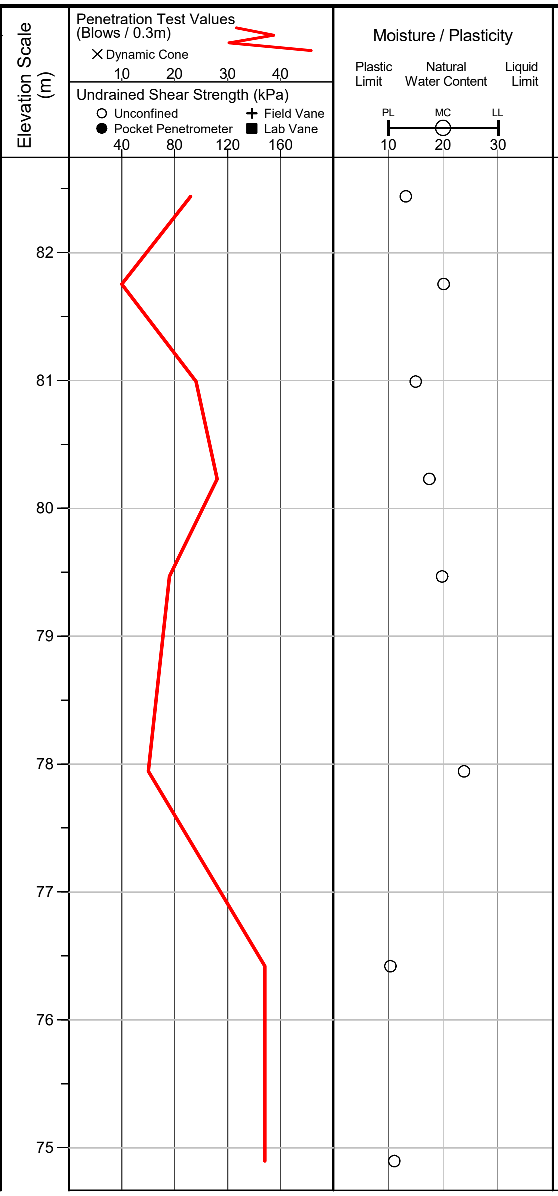
Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614616, N: 4784757 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
82.7	**GROUND SURFACE**			
	50mm **ASPHALTIC CONCRETE**			
	FILL, clayey silt, trace sand, occasional gravel, brown	1	SS	23
81.8 0.9	100mm **TOPSOIL**	2	SS	10
81.7 1.0	**CLAYEY SILT**, occasional gravel, very stiff, brown (GLACIAL TILL)	3	SS	24
		4	SS	28
		5	SS	19
		6	SS	15
77.1 5.6	**CLAYEY SILT to SILT**, occasional gravel, trace sand, trace clay, dense, brown / grey (GLACIAL TILL)	7	SS	37
		8	SS	37
74.6 8.1	**END OF BOREHOLE**			

Borehole was dry and open upon completion of drilling.



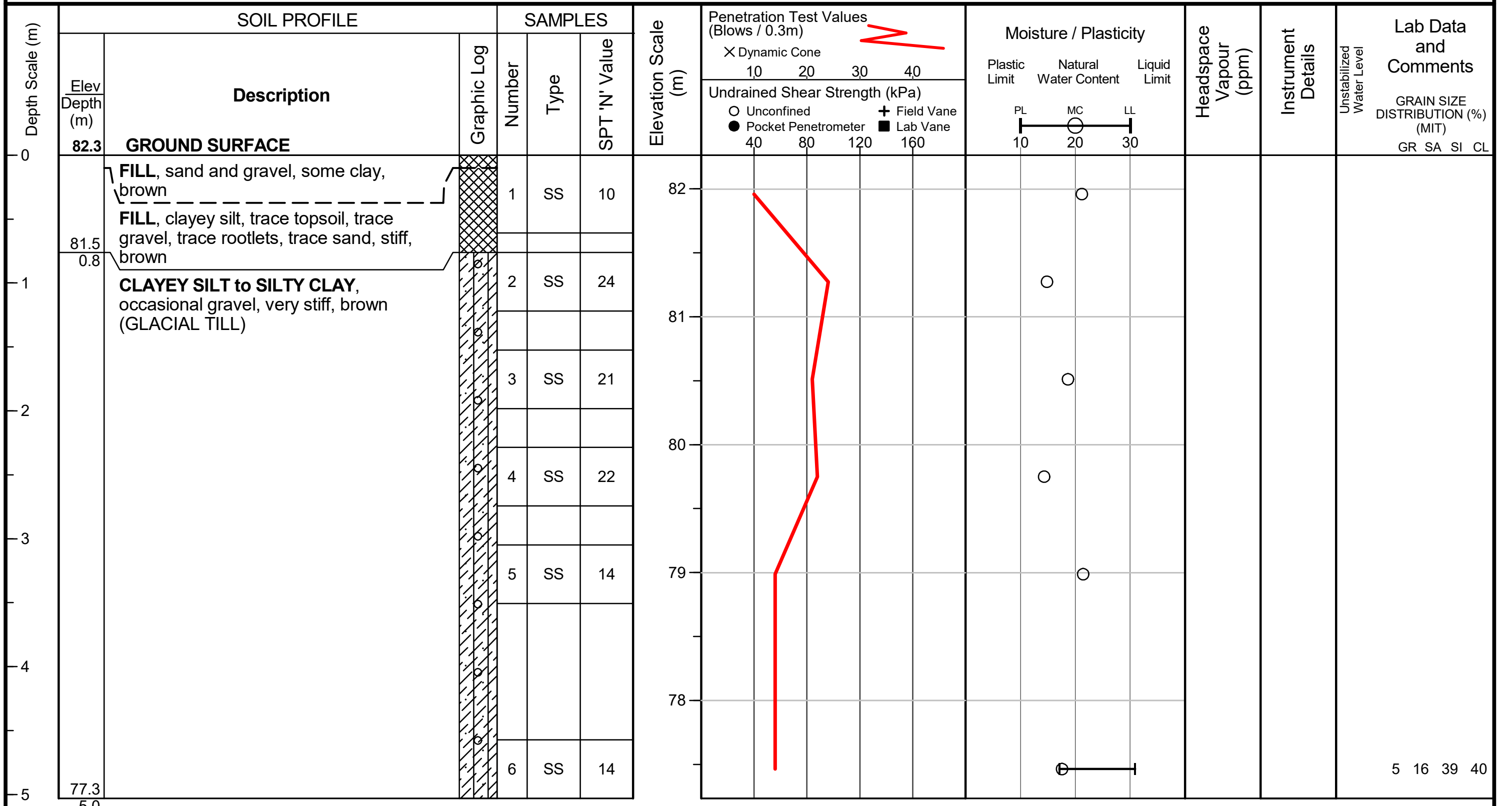
Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Terraprobe

LOG OF BOREHOLE 17

Project No.	: 7-18-0055-01	Client	: Losani Homes	Originated by	: JM
Date started	: June 7, 2018	Project	: 398 North Service Road	Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario	Checked by	: PC

Position : E: 614551, N: 4784772 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers



Elev Depth (m)	Description
82.3	**GROUND SURFACE**
	FILL, sand and gravel, some clay, brown
81.5 0.8	**FILL**, clayey silt, trace topsoil, trace gravel, trace rootlets, trace sand, stiff, brown
	CLAYEY SILT to SILTY CLAY, occasional gravel, very stiff, brown (GLACIAL TILL)
77.3 5.0	

Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1	SS	10	
2	SS	24	
3	SS	21	
4	SS	22	
5	SS	14	
6	SS	14	5 16 39 40

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpi

LOG OF BOREHOLE 18

Project No. : 7-18-0055-01
Date started : June 7, 2018
Sheet No. : 1 of 1

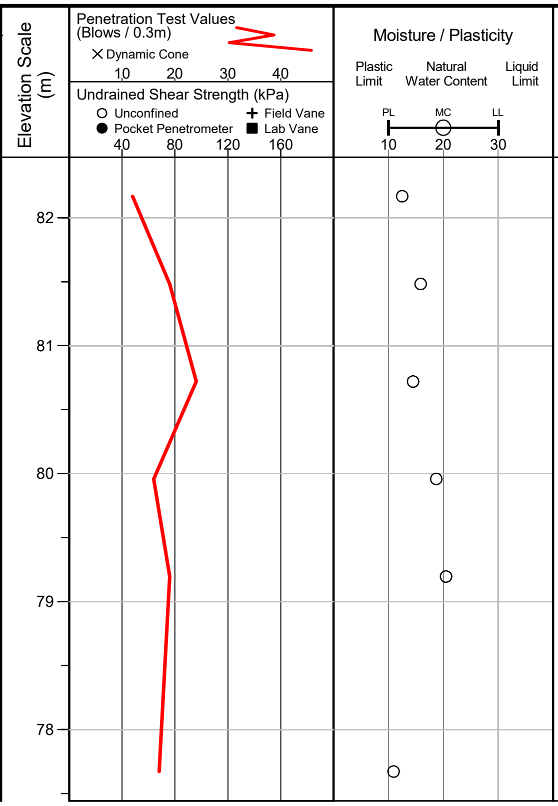
Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614550, N: 4784758 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	**82.5**	**GROUND SURFACE**			
		FILL, sand and gravel, trace clay, brown			
	82.1 0.4	150mm **TOPSOIL**	1	SS	12
	81.7 0.8	**CLAYEY SILT**, trace rootlets, occasional gravel, stiff, brown			
1		**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	2	SS	19
2			3	SS	24
			4	SS	16
3			5	SS	19
4					
5	77.5 5.0		6	SS	17



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 19

Project No. : 7-18-0055-01
Date started : June 1, 2018
Sheet No. : 1 of 1

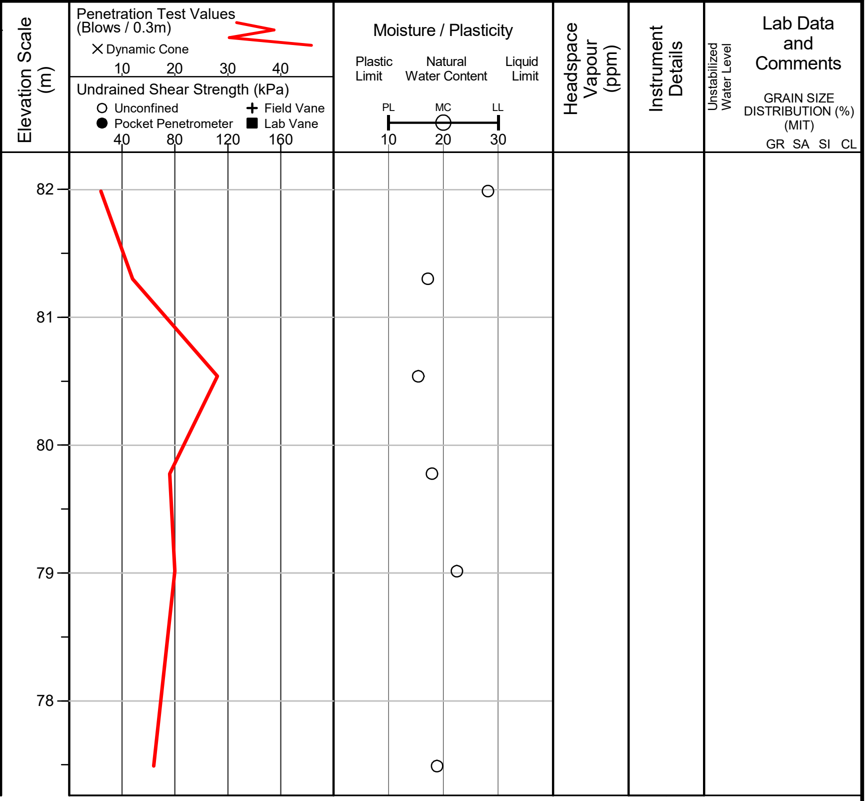
Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614584, N: 4784763 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
	82.3	**GROUND SURFACE**				
0		**FILL**, sand and gravel, loose, brown				
		FILL, silty clay to clayey silt, trace topsoil, occasional gravel, firm to stiff, brown		1	SS	6
1				2	SS	12
	80.8 1.5	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)		3	SS	28
2				4	SS	19
3				5	SS	20
4						
5	77.3 5.0			6	SS	16



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 20

Project No.	: 7-18-0055-01	Client : Losani Homes	Originated by : JM
Date started	: June 7, 2018	Project : 398 North Service Road	Compiled by : KB
Sheet No.	: 1 of 1	Location : Grimsby, Ontario	Checked by : PC

Position : E: 614577, N: 4784750 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

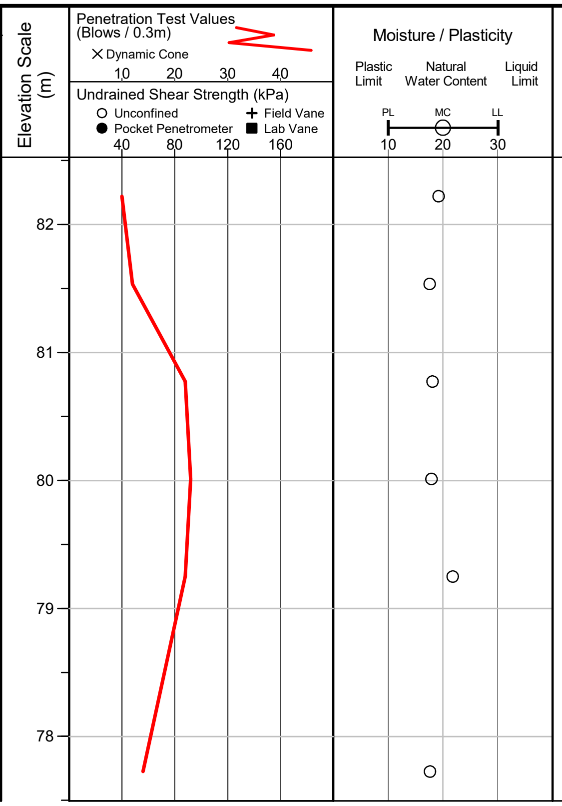
Drilling Method : Solid stem augers

SOIL PROFILE

Depth Scale (m)	Elev Depth (m)	Description
0	82.5	**GROUND SURFACE**
		FILL, sand and gravel, brown
	82.0 0.5	**FILL**, clayey silt, trace topsoil, trace rootlets, trace gravel, stiff, brown
		CLAYEY SILT to SILTY CLAY, occasional gravel, very stiff, brown (GLACIAL TILL)
5	77.5 5.0	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	10
2	SS	12
3	SS	22
4	SS	23
5	SS	22
6	SS	14



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 21

Project No. : 7-18-0055-01
Date started : June 7, 2018
Sheet No. : 1 of 1

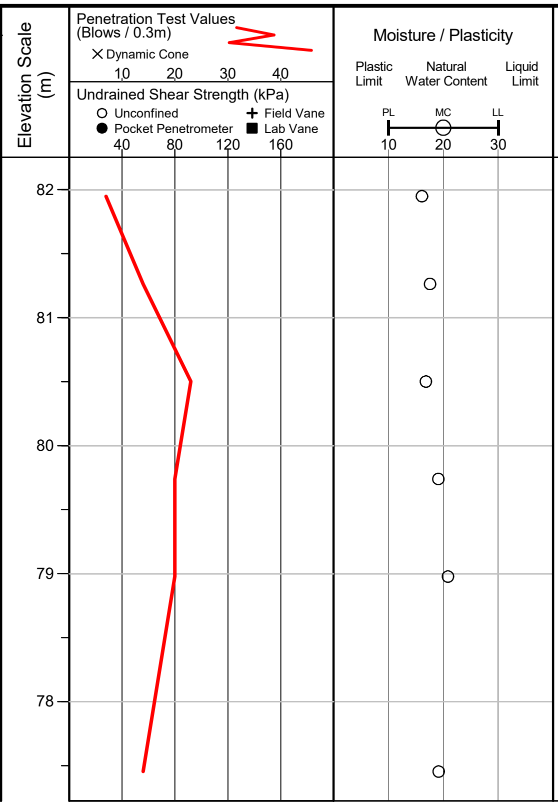
Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614603, N: 4784796 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	82.3	**GROUND SURFACE**			
		FILL, sand and gravel, loose, brown			
	81.8 0.5	**FILL**, silty clay to clayey silt, firm, dark brown	1	SS	7
	81.7 0.6	150mm **TOPSOIL**			
1	81.1 1.2	**CLAYEY SILT**, trace topsoil, occasional gravel, stiff, brown	2	SS	14
2		**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	3	SS	23
3			4	SS	20
4			5	SS	20
5	77.3 5.0		6	SS	14



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 22

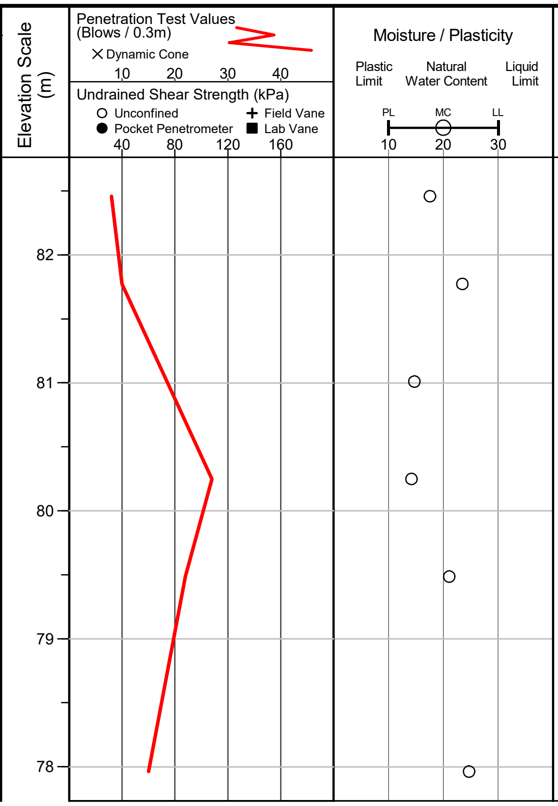
Project No. : 7-18-0055-01
Date started : June 1, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614621, N: 4784785 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
82.8	**GROUND SURFACE**			
	SANDY TOPSOIL, brown			
	FILL, clayey silt, trace topsoil, trace gravel, brown	1	SS	8
82.3 0.5	75mm **ASPHALTIC CONCRETE**			
82.2 0.6	**FILL**, clayey silt, trace topsoil, trace gravel, stiff, brown	2	SS	10
81.4 1.4	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	3	SS	
		4	SS	27
		5	SS	22
		6	SS	15
77.8 5.0				



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

Depth Scale (m): 0, 1, 2, 3, 4, 5

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 23

Terraprobe

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM

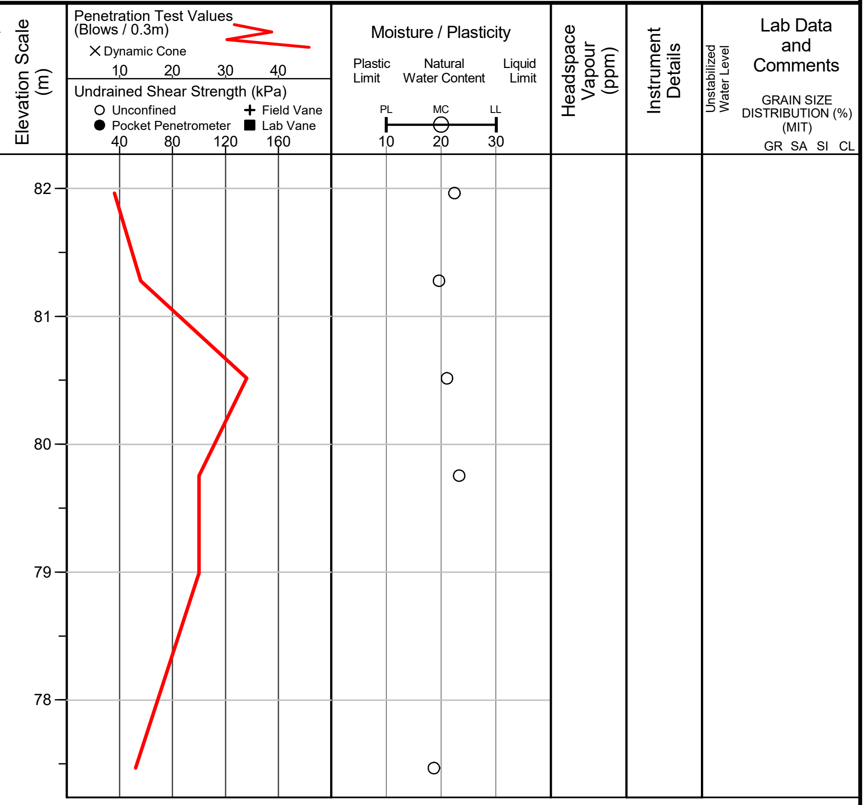
Date started : June 7, 2018
Project : 398 North Service Road
Compiled by : KB

Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

Position : E: 614561, N: 4784814 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	82.3	**GROUND SURFACE**				
		FILL, sand and gravel, some clay, brown		1	SS	9
		SILTY CLAY, trace topsoil, trace rootlets, trace gravel, stiff, brown				
1	81.4 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to hard, grey / brown (GLACIAL TILL)		2	SS	14
				3	SS	34
2						
				4	SS	25
3				5	SS	25
4						
				6	SS	13
5	77.3 5.0					



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 24

Project No. : 7-18-0055-01
Date started : June 7, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

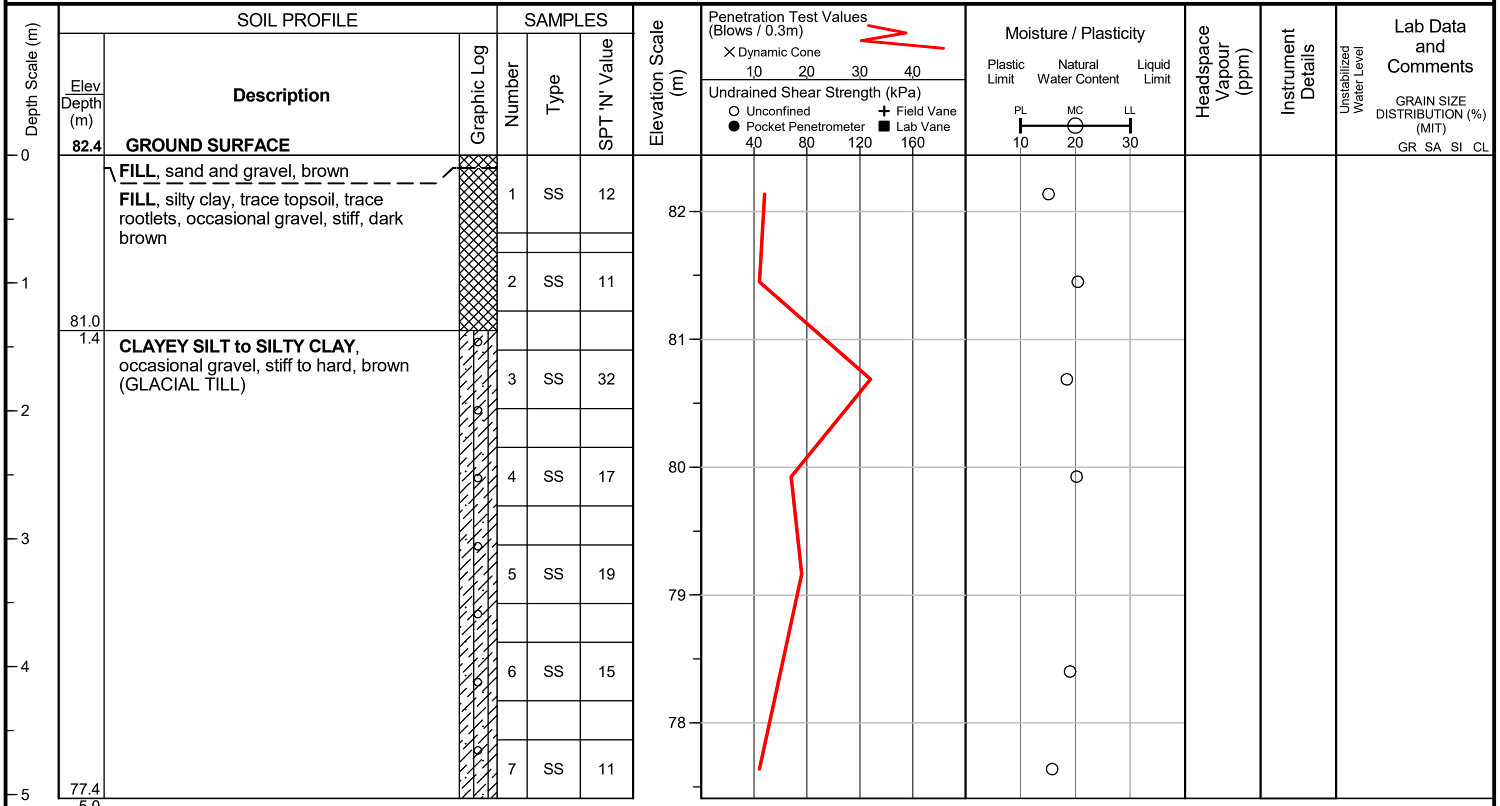
Position : E: 614551, N: 4784818 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.4	**GROUND SURFACE**
	FILL, sand and gravel, brown
	FILL, silty clay, trace topsoil, trace rootlets, occasional gravel, stiff, dark brown
81.0 1.4	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to hard, brown (GLACIAL TILL)
77.4 5.0	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	12
2	SS	11
3	SS	32
4	SS	17
5	SS	19
6	SS	15
7	SS	11



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 25

Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

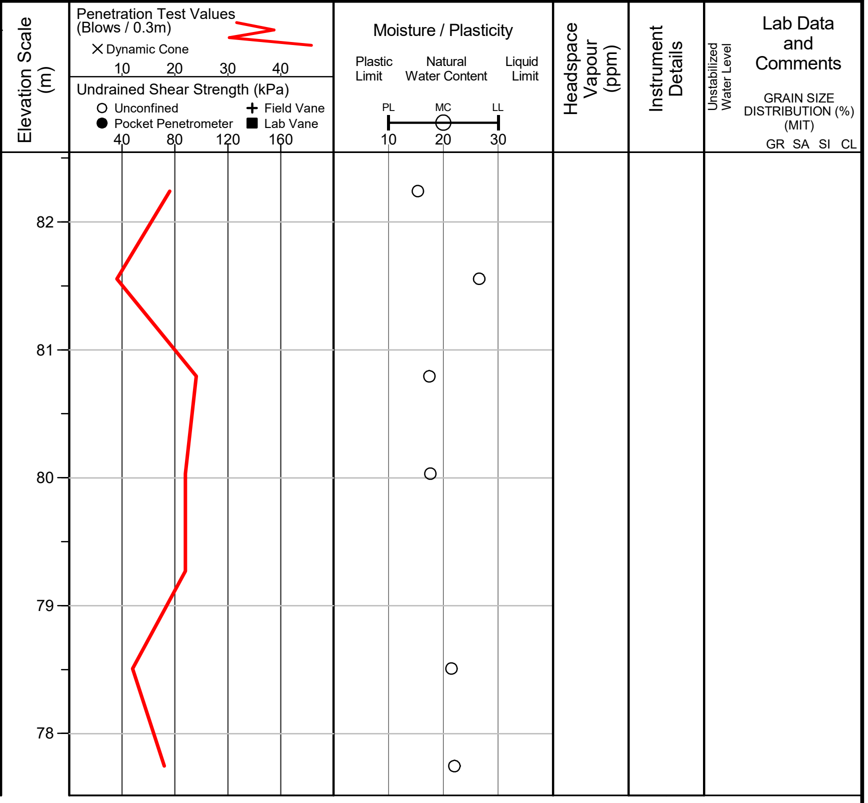
Position : E: 614522, N: 4784824 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
	82.5	**GROUND SURFACE**			
0	82.3 0.2	**FILL**, clayey silt and gravel, brown			
		FILL, silty clay, trace to some topsoil, dark brown	1	SS	19
1			2	SS	9
	81.0 1.5	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	3	SS	24
2			4	SS	22
3			5	SS	22
4			6	SS	12
5	77.5 5.0		7	SS	18

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 26

Terraprobe

Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

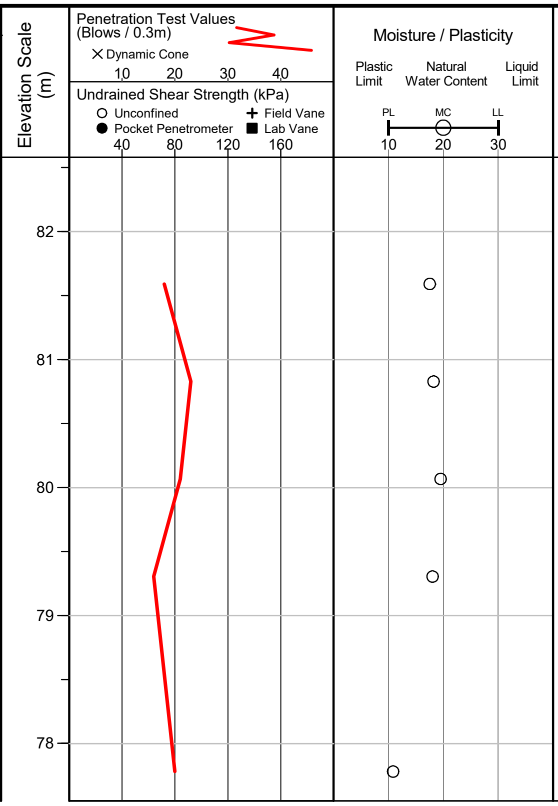
Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614476, N: 4784857 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Sample Number	Type	SPT 'N' Value
	82.6	**GROUND SURFACE**			
0		50mm **ASPHALTIC CONCRETE**			
		FILL, granular base			
	82.3 0.3	**FILL**, clayey silt, trace rootlets, occasional gravel, very stiff, brown			
	81.7 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	1	SS	18
			2	SS	23
			3	SS	21
			4	SS	16
			5	SS	20
5	77.6 5.0	**END OF BOREHOLE**			

Borehole was dry and open upon completion of drilling.



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 27

Terraprobe

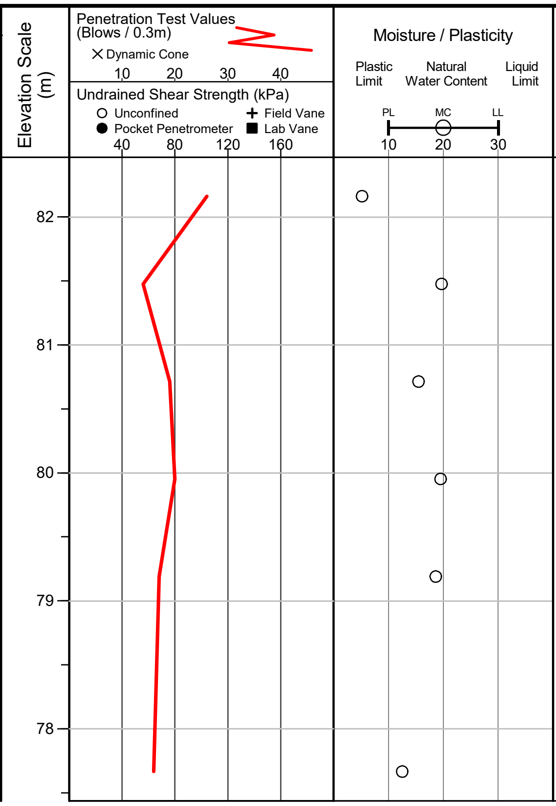
Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614448, N: 4784863 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	SOIL PROFILE Elev Depth (m)	Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
	82.5	**GROUND SURFACE**				
0		**FILL**, sand and gravel, grey	▩	1	SS	26
	81.9 0.6	**FILL**, clayey silt, occasional gravel, stiff, brown	▩			
1	81.6 0.9	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)	▨	2	SS	14
2			▨	3	SS	19
			▨	4	SS	20
3			▨	5	SS	17
4			▨			
5			▨	6	SS	16
	77.5 5.0					



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 28

Project No. : 7-18-0055-01
Date started : May 30, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

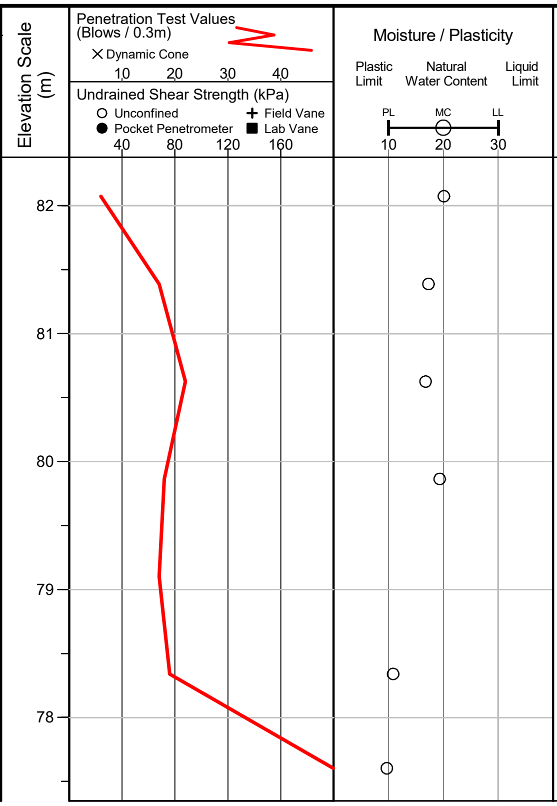
Position : E: 614434, N: 4784874 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Depth Scale (m)	Elev Depth (m)	Description
0	82.4	**GROUND SURFACE**
		TOPSOIL, trace sand, loose, brown
	81.8 0.6	**CLAYEY SILT**, trace rootlets, very stiff, brown
1	81.2 1.2	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)
2		
3		
4		
5	77.4 5.0	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	6
2	SS	17
3	SS	22
4	SS	18
5	SS	17
6	SS	19
7	SS	22 / 250mm



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 29

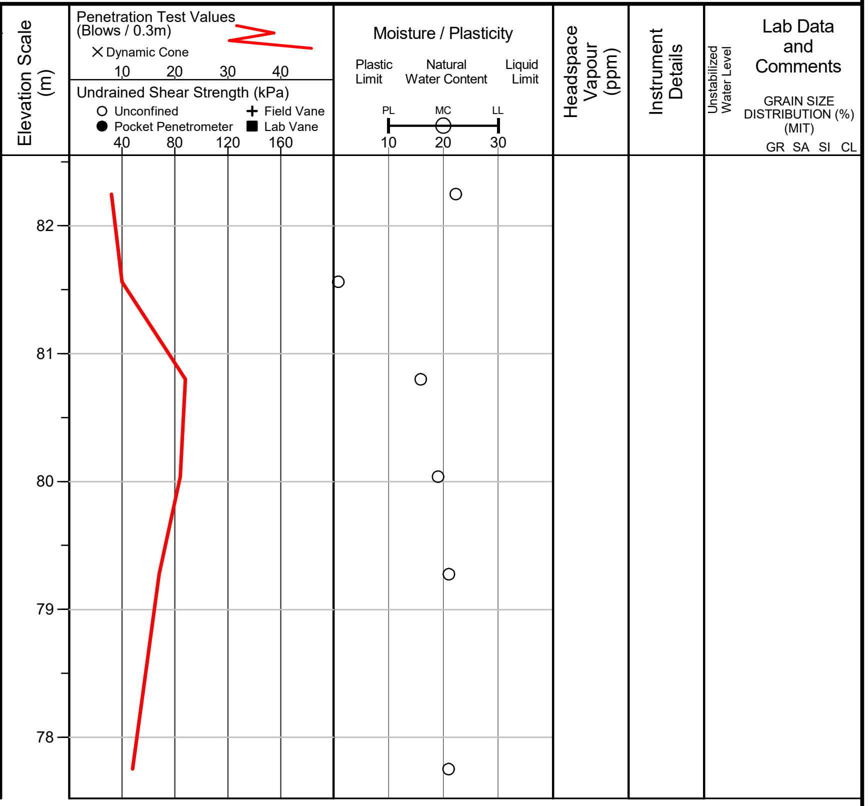
Project No. : 7-18-0055-01
Date started : May 29, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614416, N: 4784880 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	**82.6**	**GROUND SURFACE**			
	82.0 0.6	**SILTY TOPSOIL**, trace sand, loose, dark brown	1	SS	8
1	81.4 1.2	**FILL**, clayey silt, trace gravel, trace rootlets, stiff, brown	2	SS	10
2		**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to very stiff, brown (GLACIAL TILL)	3	SS	22
3			4	SS	21
4			5	SS	17
5	77.6 5.0		6	SS	12



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

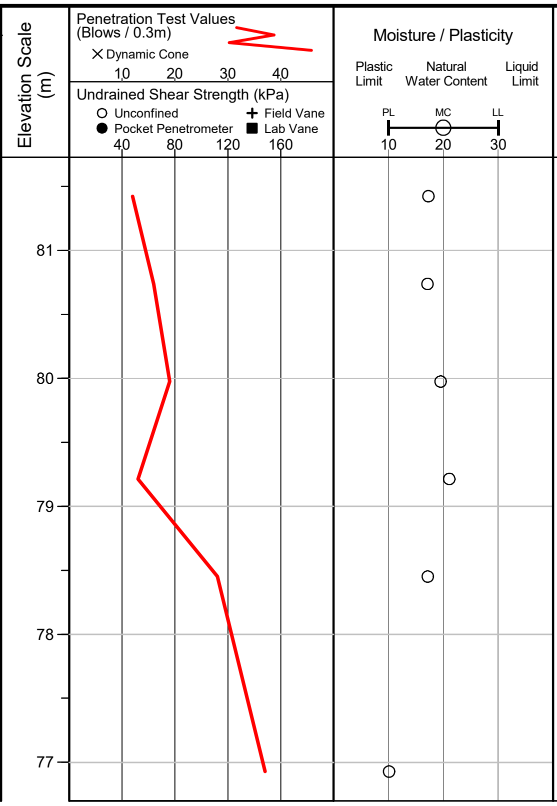
LOG OF BOREHOLE 30

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM
Date started : May 29, 2018
Project : 398 North Service Road
Compiled by : KB
Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

Position : E: 614386, N: 4784882 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE		SAMPLES		
Elev Depth (m)	Description	Number	Type	SPT 'N' Value
81.7	**GROUND SURFACE**			
81.5 0.2	150mm **TOPSOIL**			
	CLAYEY SILT, trace rootlets, occasional gravel, stiff, brown	1	SS	12
		2	SS	16
80.5 1.2	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to very stiff, brown (GLACIAL TILL)	3	SS	19
		4	SS	13
		5	SS	28
		6	SS	37
76.7 5.0				

Depth Scale (m): 0, 1, 2, 3, 4, 5



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 31

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM

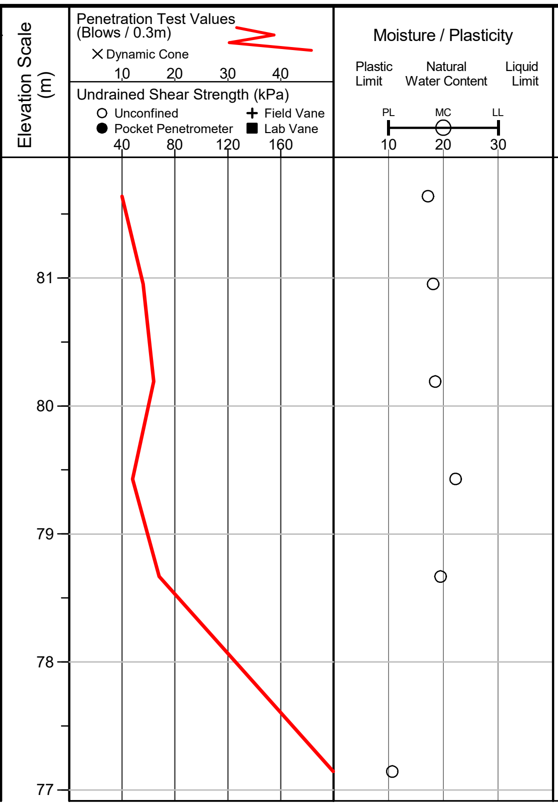
Date started : May 29, 2018
Project : 398 North Service Road
Compiled by : KB

Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

Position : E: 614370, N: 4784903 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	SOIL PROFILE Elev Depth (m)	Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	81.9	**GROUND SURFACE**				
		FILL, sand and gravel, brown				
		CLAYEY SILT, trace rootlets, occasional gravel, stiff, grey		1	SS	10
1	81.1 0.8	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to very stiff, brown (GLACIAL TILL)		2	SS	14
2				3	SS	16
				4	SS	12
3				5	SS	17
4						
5	76.9 5.0			6	SS	52



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 32

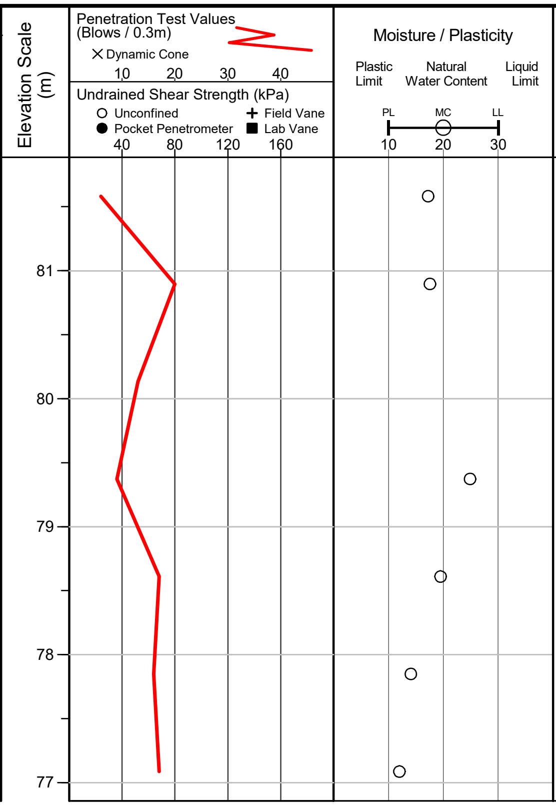
Project No. : 7-18-0055-01
Date started : May 28, 2018
Sheet No. : 1 of 1

Client : Losani Homes
Project : 398 North Service Road
Location : Grimsby, Ontario

Originated by : JM
Compiled by : KB
Checked by : PC

Position : E: 614356, N: 4784918 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	81.9	**GROUND SURFACE**				
		FILL, sand and gravel, brown				
	81.6 0.3	**FILL**, clayey silt, trace sand, trace gravel, firm, brown		1	SS	6
	81.1 0.8	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to very stiff, brown (GLACIAL TILL)		2	SS	20
1						
2				3	SS	13
				4	SS	9
3				5	SS	17
4				6	SS	16
				7	SS	17
5	76.9 5.0					



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 33

Project No. : 7-18-0055-01	Client : Losani Homes	Originated by : JM
Date started : May 28, 2018	Project : 398 North Service Road	Compiled by : KB
Sheet No. : 1 of 1	Location : Grimsby, Ontario	Checked by : PC

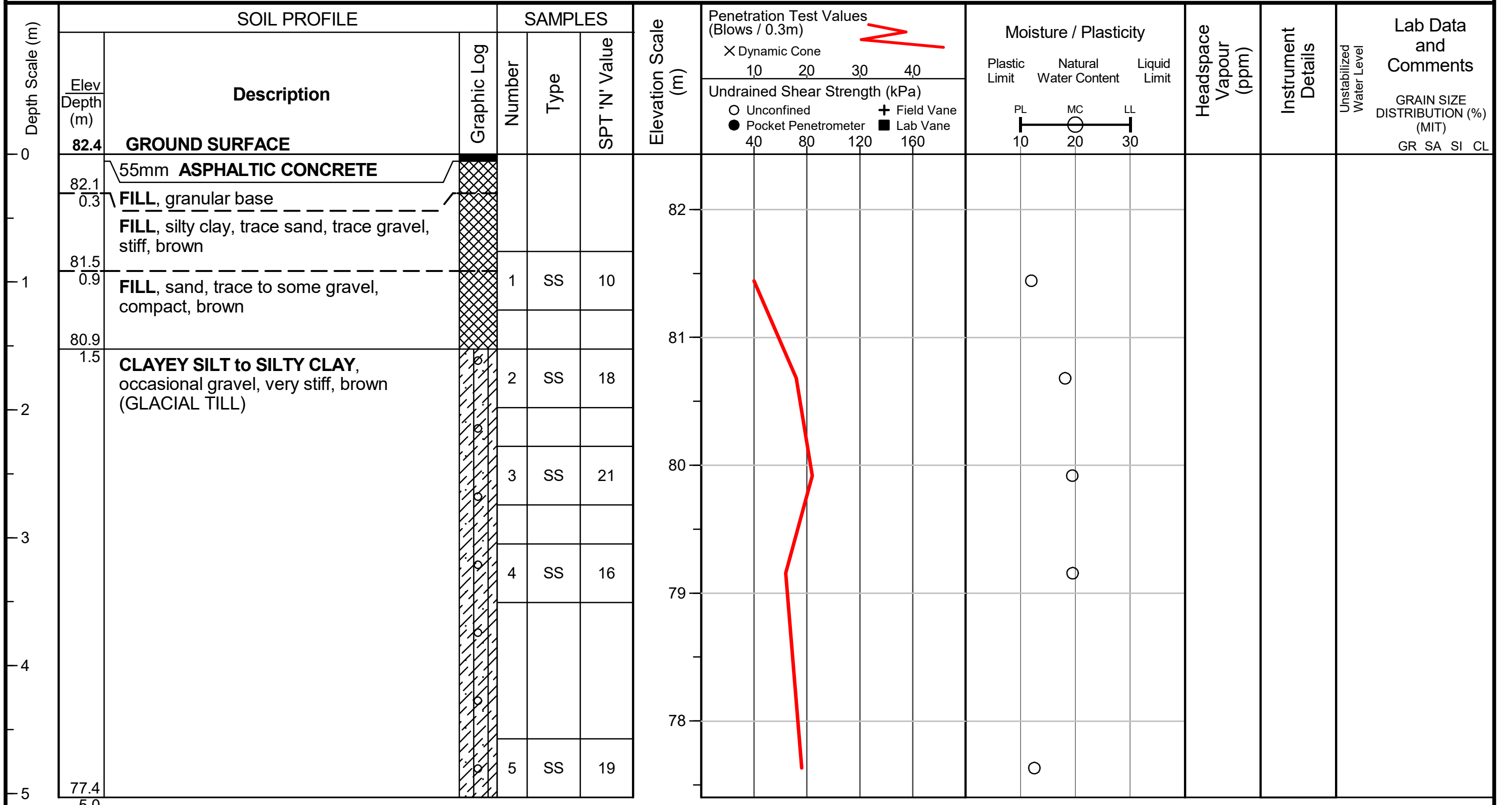
Position : E: 614338, N: 4784920 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

SOIL PROFILE			SAMPLES		
Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
82.4	**GROUND SURFACE**				
	55mm **ASPHALTIC CONCRETE**				
82.1 0.3	**FILL**, granular base				
	FILL, silty clay, trace sand, trace gravel, stiff, brown				
81.5 0.9	**FILL**, sand, trace to some gravel, compact, brown		1	SS	10
80.9 1.5	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown (GLACIAL TILL)		2	SS	18
			3	SS	21
			4	SS	16
			5	SS	19
77.4 5.0					



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

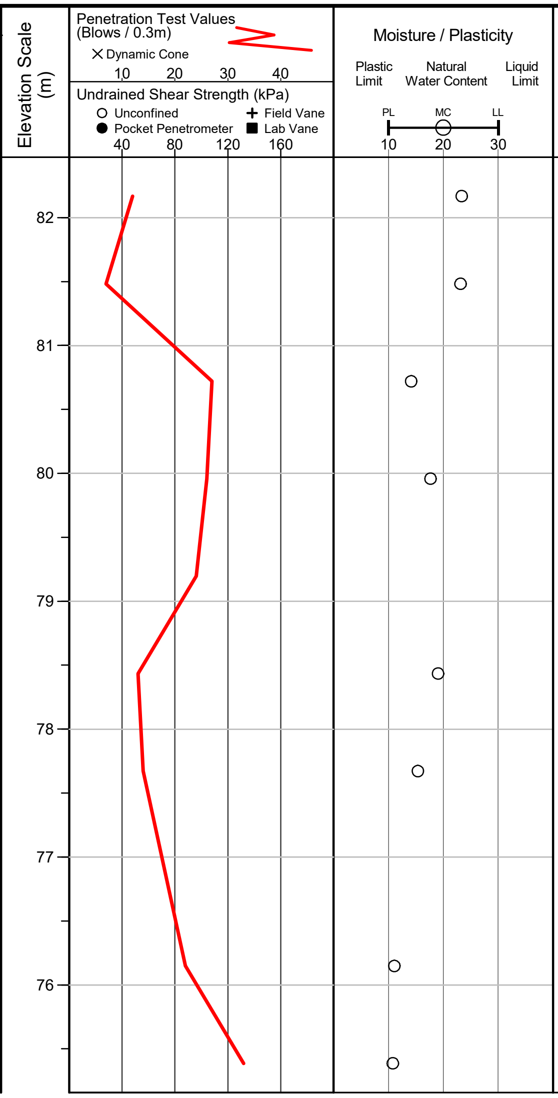
Terraprobe

LOG OF BOREHOLE 34

Project No.	: 7-18-0055-01	Client	: Losani Homes	Originated by	: JM
Date started	: May 28, 2018	Project	: 398 North Service Road	Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario	Checked by	: PC

Position : E: 614352, N: 4784953 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Number	Type	SPT 'N' Value
0	82.5	**GROUND SURFACE**			
	82.3 0.2	**FILL**, sand and gravel, brown			
		FILL, silty clay and topsoil, dark brown	1	SS	12
1			2	SS	7
	81.0 1.5	**CLAYEY SILT to SILTY CLAY**, occasional gravel, stiff to hard, brown (GLACIAL TILL)	3	SS	27
2			4	SS	26
3			5	SS	24
4			6	SS	13
5			7	SS	14
6			8	SS	22
7	75.2 7.3		9	SS	33



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 35

Project No.	: 7-18-0055-01	Client	: Losani Homes	Originated by	: JM
Date started	: May 30, 2018	Project	: 398 North Service Road	Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario	Checked by	: PC

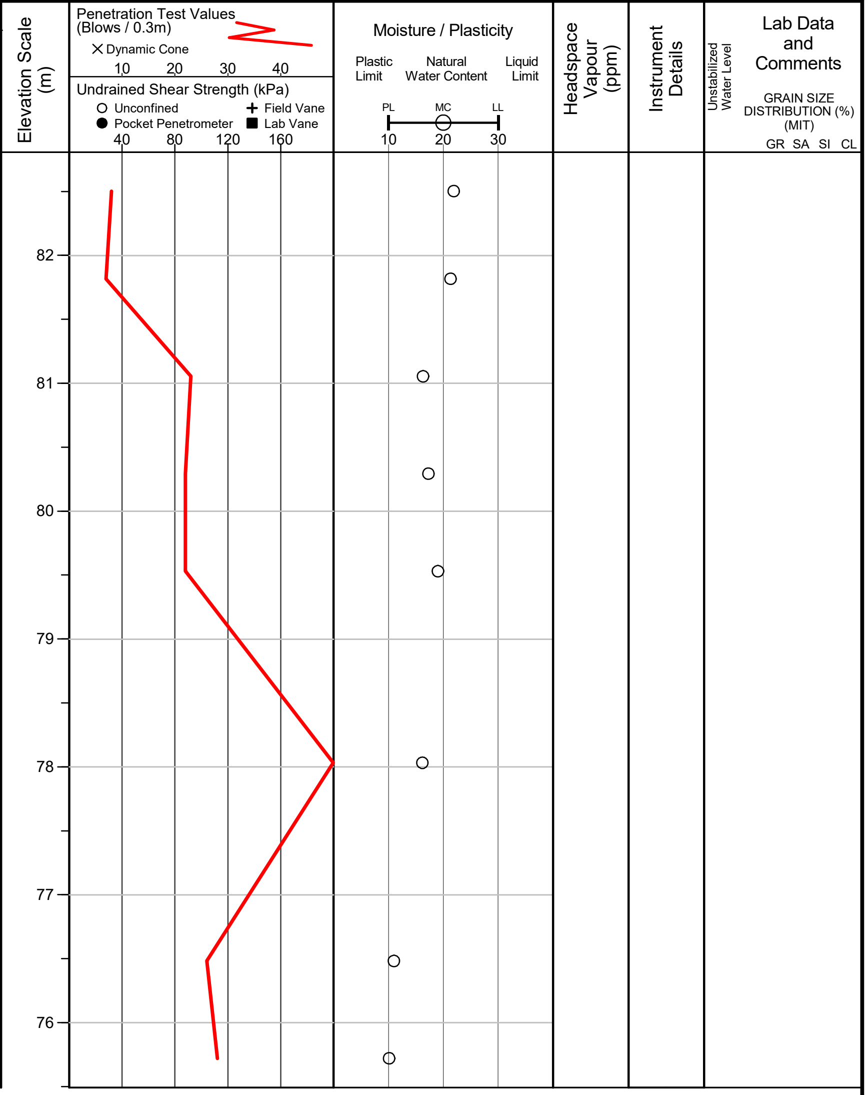
Position : E: 614417, N: 4784914 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.8	**GROUND SURFACE**
	600mm **TOPSOIL**
82.2 0.6	**FILL**, silty clay, trace sand, trace gravel, trace topsoil, firm, brown
81.3 1.5	**CLAYEY SILT to SILTY CLAY**, occasional gravel, very stiff, brown / grey (GLACIAL TILL)
78.5 4.3	**CLAYEY SILT to SILT**, occasional gravel, very stiff, grey / brown (GLACIAL TILL)
75.5 7.3	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value
1	SS	8
2	SS	7
3	SS	23
4	SS	22
5	SS	22
6	SS	18 / 250mm
7	SS	26
8	SS	28



Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

Terraprobe

LOG OF BOREHOLE 36

Project No. : 7-18-0055-01
Client : Losani Homes
Originated by : JM
Date started : May 30, 2018
Project : 398 North Service Road
Compiled by : KB
Sheet No. : 1 of 1
Location : Grimsby, Ontario
Checked by : PC

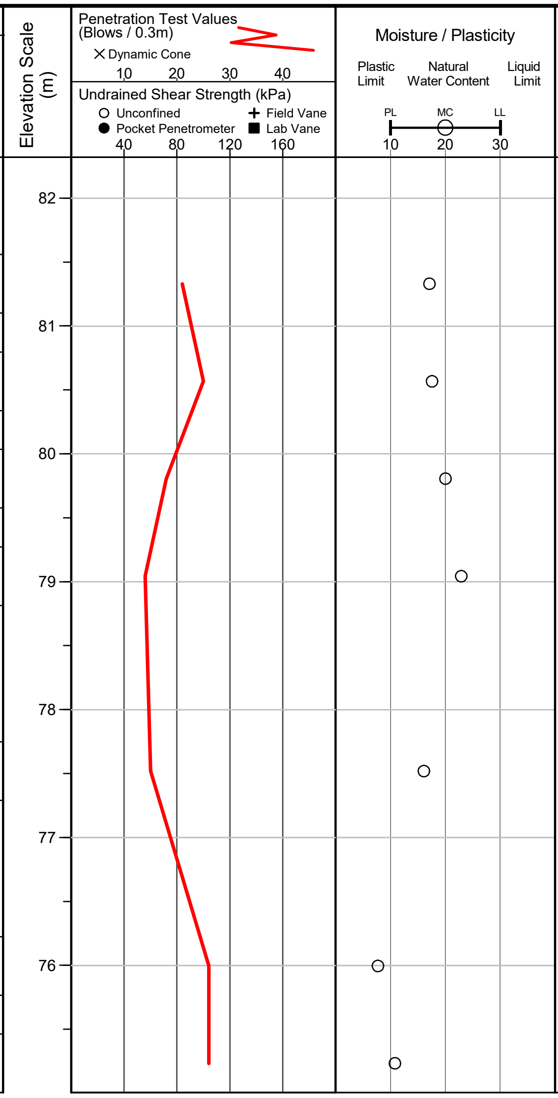
Position : E: 614502, N: 4784869 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
82.3	**GROUND SURFACE**
82.0 0.3	45mm **ASPHALTIC CONCRETE**
	FILL, granular base
81.7 0.6	350mm **TOPSOIL**
81.4 0.9	**FILL**, clayey silt, trace topsoil, trace gravel, trace sand, very stiff, grey / brown
	CLAYEY SILT to SILTY CLAY, stiff to very stiff, brown to greyish brown (GLACIAL TILL)
75.0 7.3	

SAMPLES

Depth Scale (m)	Number	Type	SPT 'N' Value
1	1	SS	21
1.75	2	SS	25
2.5	3	SS	18
3.3	4	SS	14
4.8	5	SS	15
6.3	6	SS	26
7.0	7	SS	26



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

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-18-0055-01 398 nsr grimsby.gpj

LOG OF BOREHOLE 37

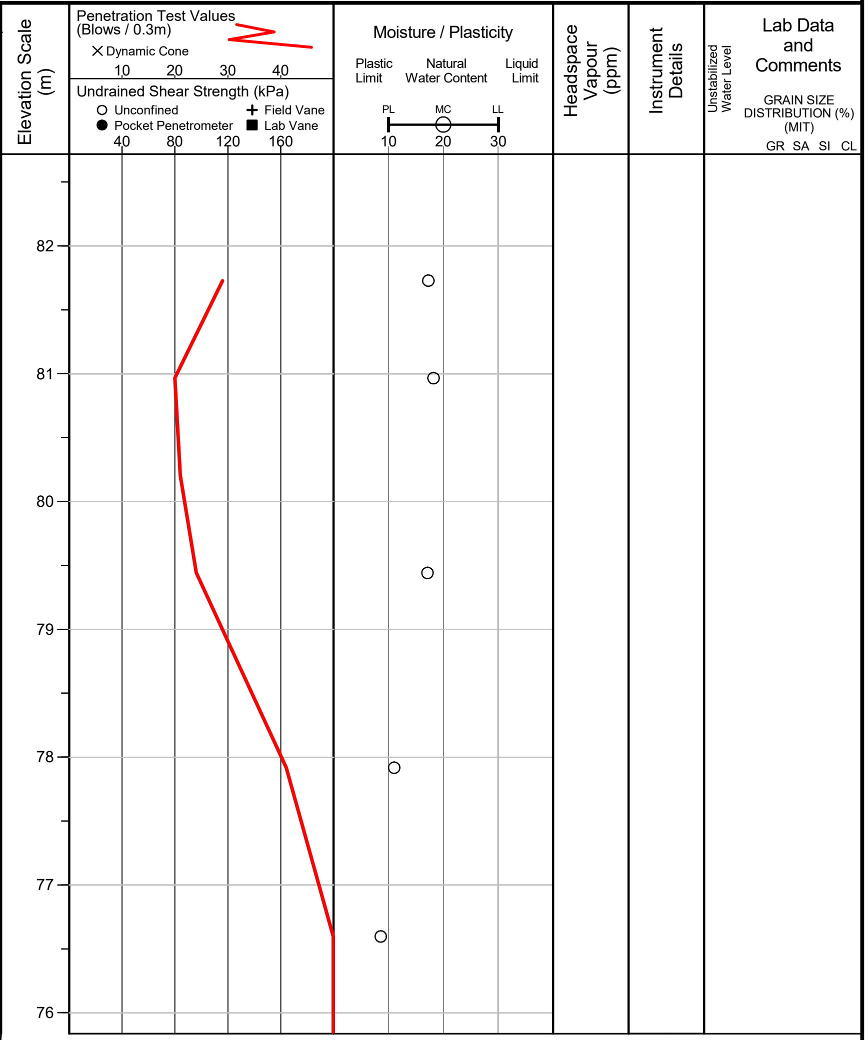
Project No.	: 7-18-0055-01	Client	: Losani Homes			Originated by	: JM
Date started	: May 31, 2018	Project	: 398 North Service Road			Compiled by	: KB
Sheet No.	: 1 of 1	Location	: Grimsby, Ontario			Checked by	: PC

Position : E: 614467, N: 4784746 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

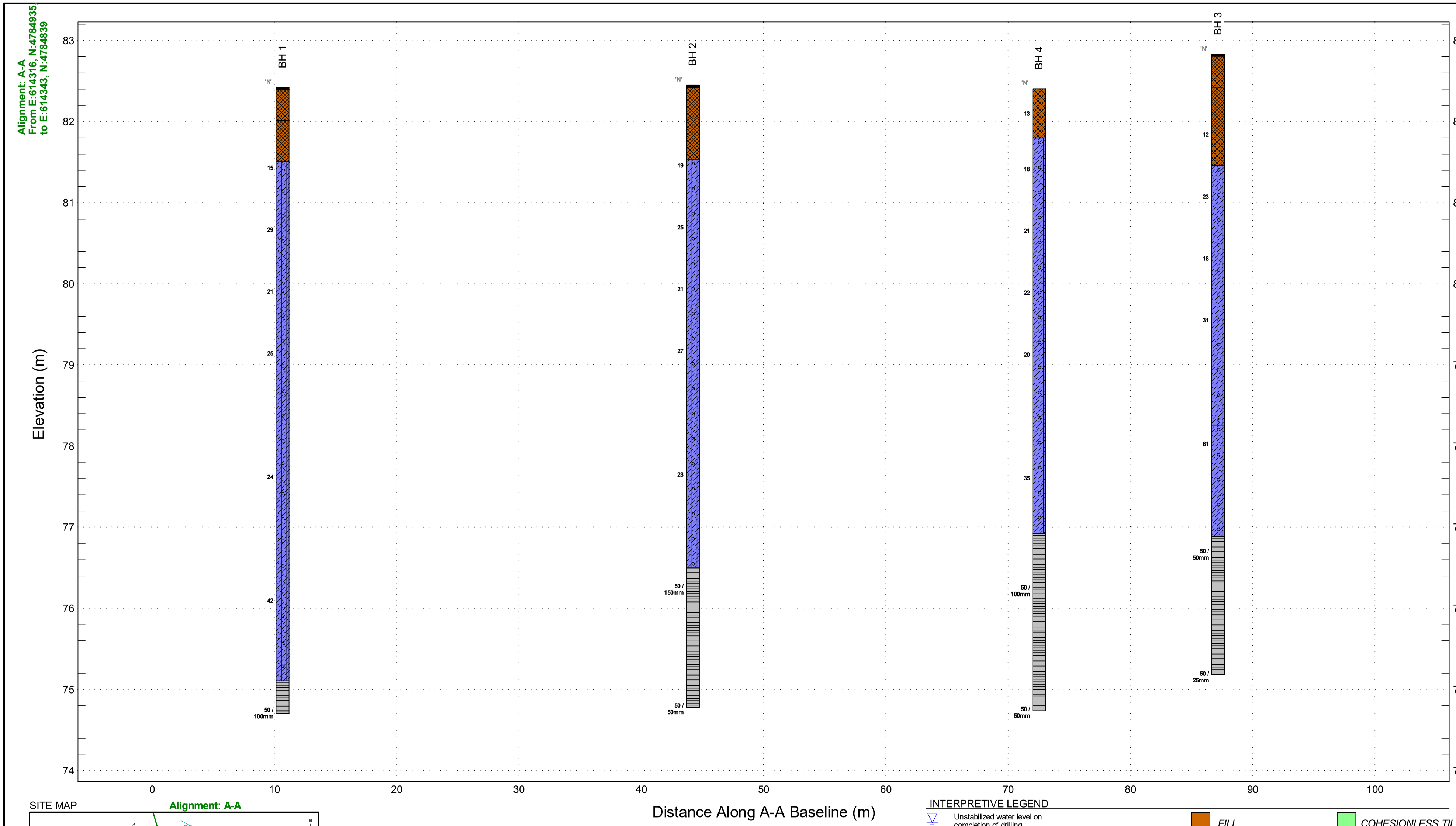
Elev / Depth (m)	SOIL PROFILE – Description	Sample Number	Type	SPT 'N' Value
82.7	**GROUND SURFACE**			
	70mm **ASPHALTIC CONCRETE**			
82.4 0.3	**FILL**, granular base			
	CLAYEY SILT to SILTY CLAY, occasional gravel, very stiff, grey / brown (GLACIAL TILL)	1	SS	29
		2	SS	20
		3	SS	21
		4	SS	24
78.7 4.0	**CLAYEY SILT to SILT**, trace clay, trace gravel, dense, grey / brown (GLACIAL TILL)	5	SS	41
76.9 5.8	**WEATHERED SHALE**, reddish brown	6	SS	50 / 50mm
75.8		7	SS	50 / 25mm

END OF BOREHOLE

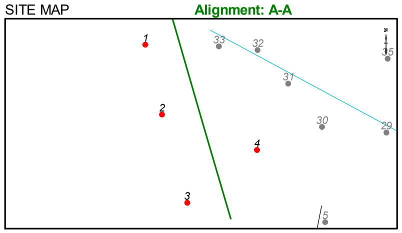
Borehole was dry and open upon completion of drilling.



file: 7-18-0055-01 398 nsr grimsby.gpj



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ■ Asphalt
- ▩ Fill
- ▨ Clayey Silt Till
- ▤ Bedrock (cored)

INTERPRETIVE LEGEND

- ▽ Unstabilized water level on completion of drilling
- ▼ Stabilized water level, most recent
- 30 SPT N-Value

- 🟫 *FILL*
- 🟧 *GRAVELS (gravel to gravelly sand)*
- 🟨 *SILT TO SAND (not till)*
- 🟩 *COHESIONLESS TILLS*
- 🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

Terraprobe

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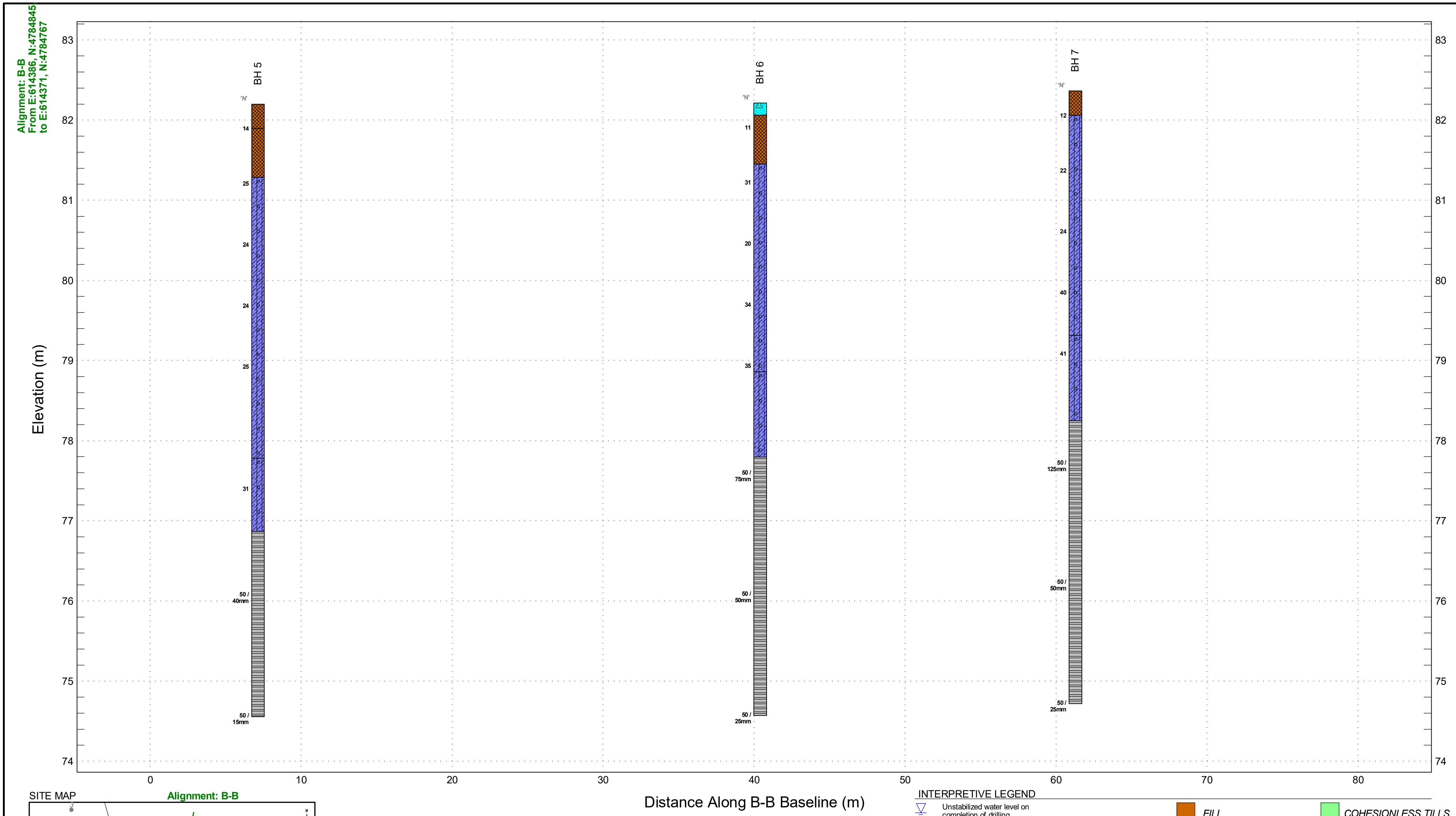
Stoney Creek, Ontario L8E 5P5
(905) 643-7560

Title:

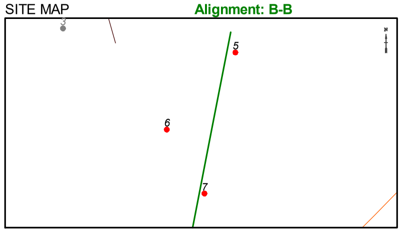
SUBSURFACE PROFILE
SECTION A-A BUILDING A&B

File No.: **7-18-0055-01**

No.: **AA**



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ▨ Fill
- ▨ Clayey Silt Till
- ▤ Bedrock (cored)
- ▨ Topsoil

INTERPRETIVE LEGEND

- ▽ Unstabilized water level on completion of drilling
- ▼ Stabilized water level, most recent
- 30 SPT N-Value

- 🟫 *FILL*
- 🟧 *GRAVELS (gravel to gravelly sand)*
- 🟨 *SILT TO SAND (not till)*
- 🟩 *COHESIONLESS TILLS*
- 🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

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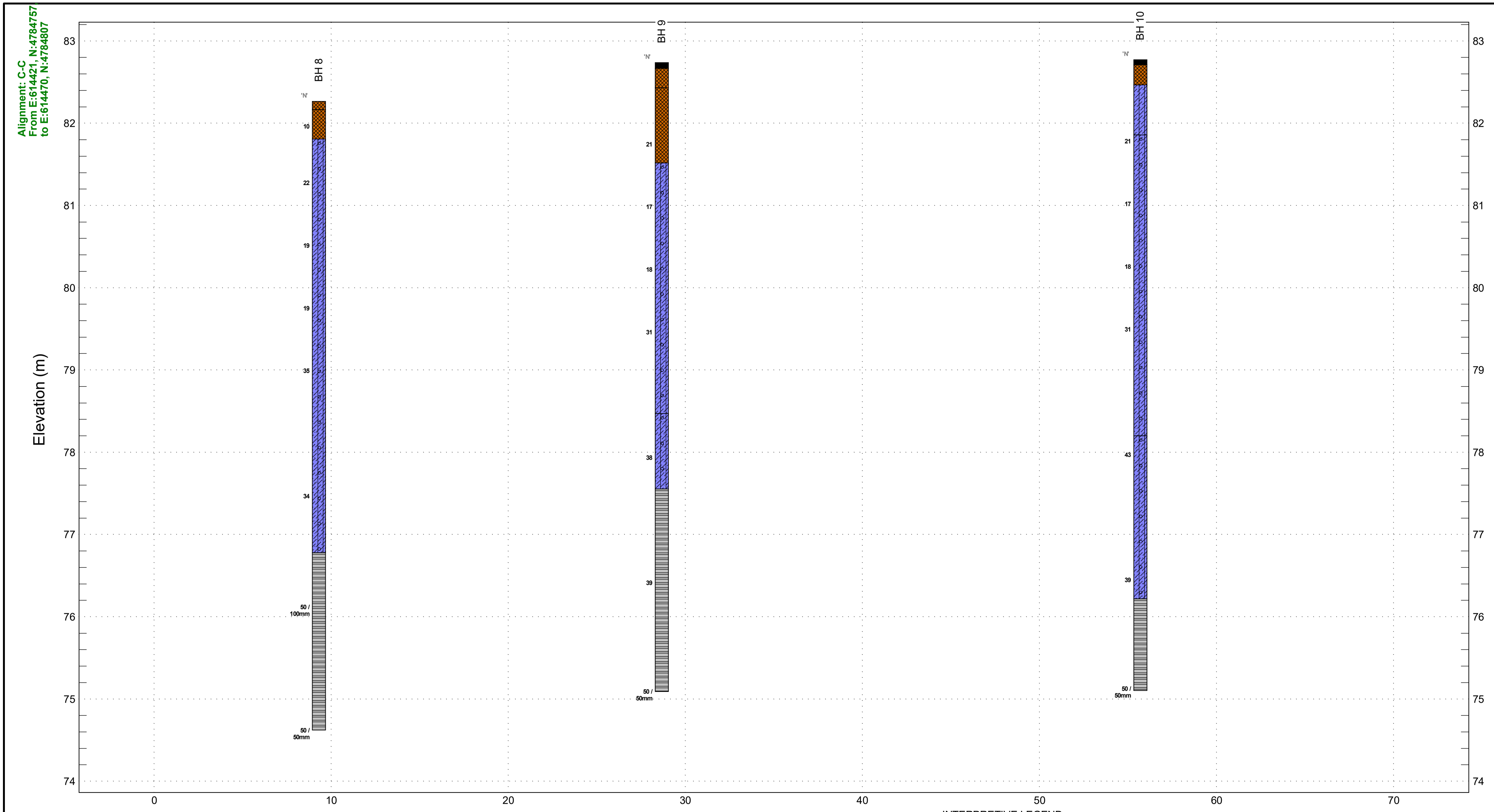
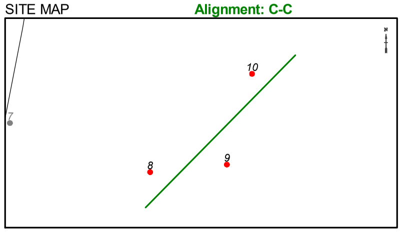
Title:
SUBSURFACE PROFILE
SECTION B-B BUILDING C

File No.: **7-18-0055-01**
No.: **BB**

Report: ISECTION - TABLOID - ELEV



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ▨ Fill
- ▨ Clayey Silt
- ▨ Clayey Silt Till
- ▤ Bedrock (cored)
- ■ Asphalt

INTERPRETIVE LEGEND

- ▽ Unstabilized water level on completion of drilling
- ▼ Stabilized water level, most recent
- 30 SPT N-Value

- 🟧 *FILL*
- 🟧 *GRAVELS (gravel to gravelly sand)*
- 🟨 *SILT TO SAND (not till)*
- 🟩 *COHESIONLESS TILLS*
- 🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

Terraprobe

903 Barton Street, Unit 22
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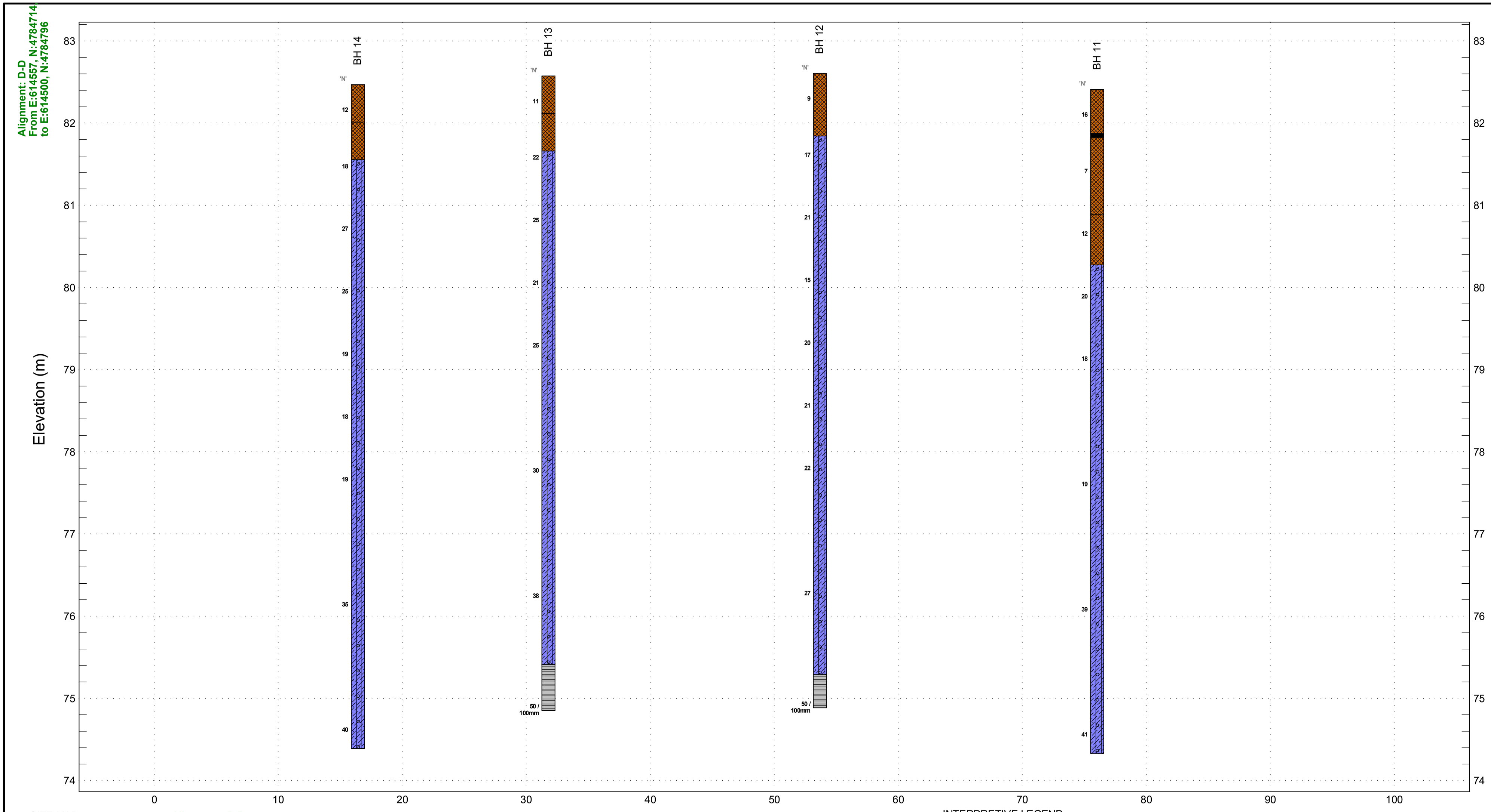
Title:

SUBSURFACE PROFILE
SECTION C-C BUILDING D

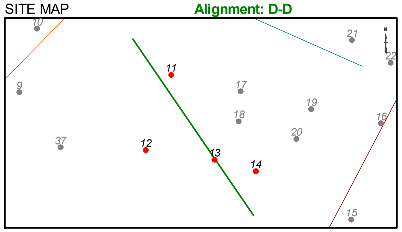
File No.: **7-18-0055-01**

No.: **CC**

Report: ISECTION - TABLOID - ELEV



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ▨ Fill
- ■ Asphalt
- ▨ Clayey Silt Till
- ▤ Bedrock (cored)

INTERPRETIVE LEGEND

- ▽ Unstabilized water level on completion of drilling
- ▼ Stabilized water level, most recent
- 30 SPT N-Value

- 🟫 *FILL*
- 🟧 *GRAVELS (gravel to gravelly sand)*
- 🟨 *SILT TO SAND (not till)*
- 🟩 *COHESIONLESS TILLS*
- 🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

Terraprobe

903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
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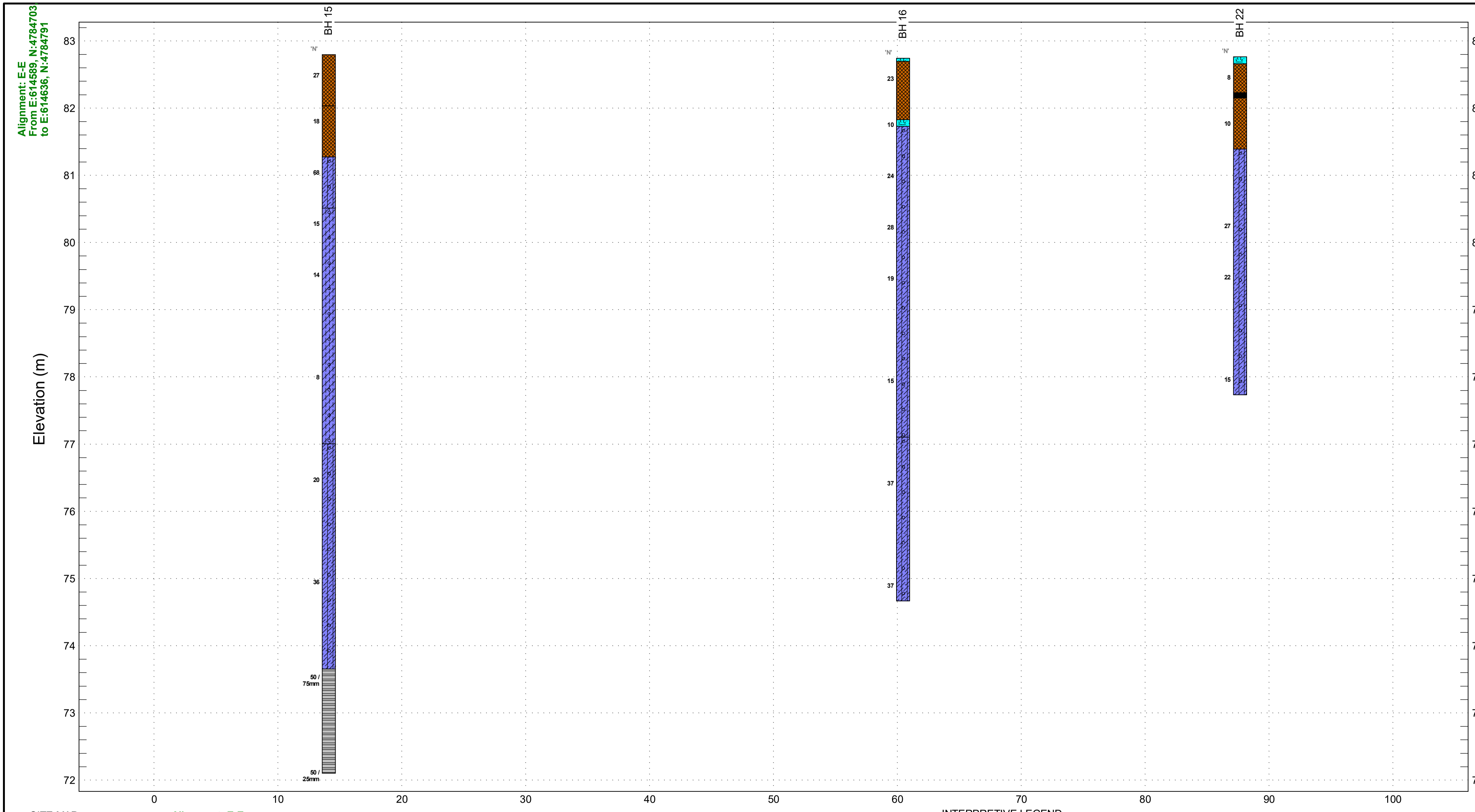
Title:

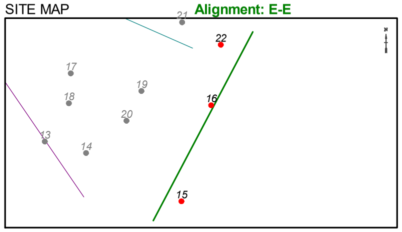
SUBSURFACE PROFILE
SECTION D-D BUILDING E

File No.: **7-18-0055-01**
No.: **DD**

Report: ISECTION - TABLOID - ELEV



SITE MAP



LITHOLOGY GRAPHIC LEGEND

▨ Fill
▨ Topsoil
▨ Clayey Silt Till
■ Asphalt
▨ Silty Clay Till
▤ Bedrock (cored)

INTERPRETIVE LEGEND

▽ Unstabilized water level on completion of drilling
▼ Stabilized water level, most recent
30 SPT N-Value

🟧 *FILL*
🟧 *GRAVELS (gravel to gravelly sand)*
🟨 *SILT TO SAND (not till)*
🟩 *COHESIONLESS TILLS*
🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

Terraprobe

903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
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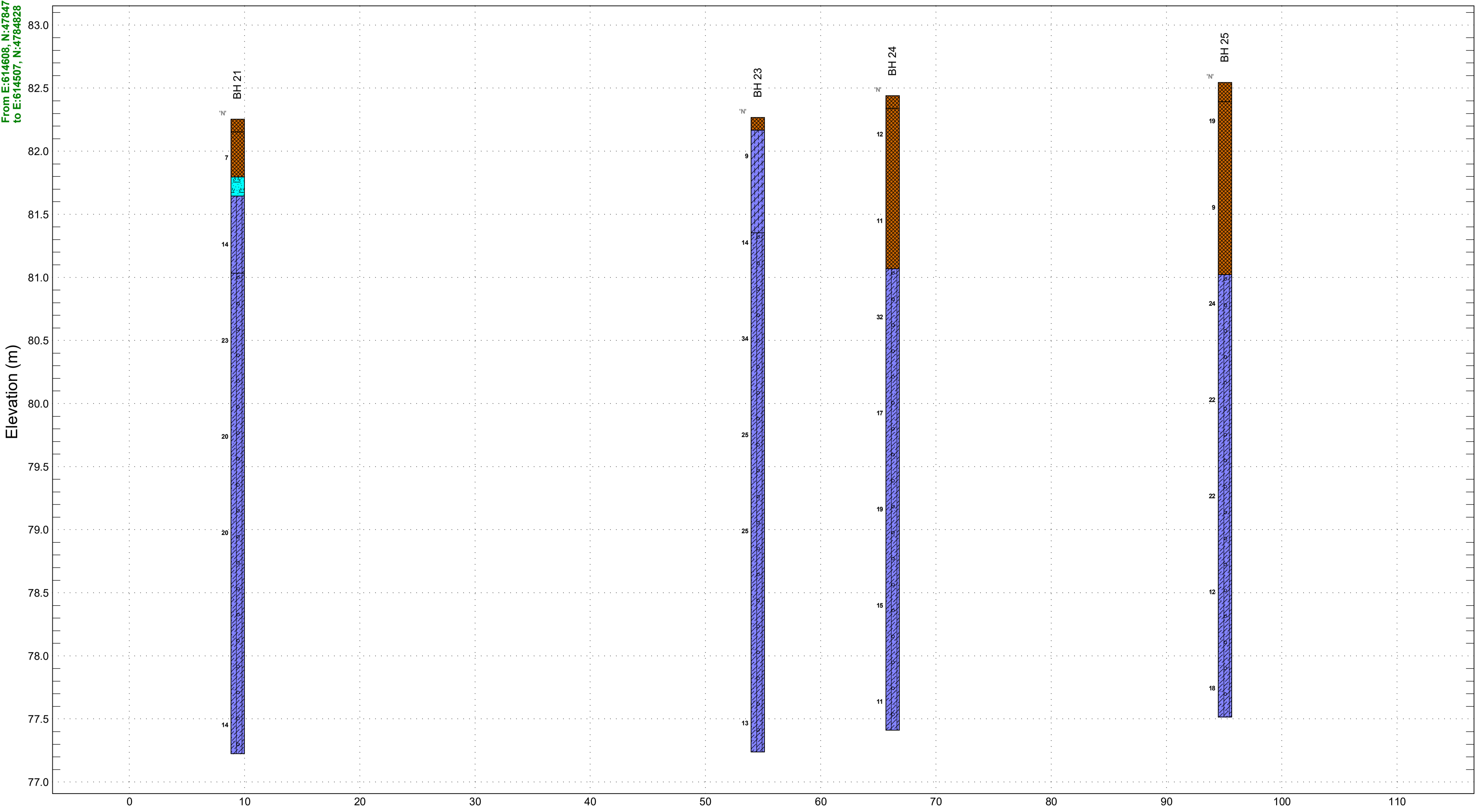
Title:

SUBSURFACE PROFILE
SECTION E-E BUILDING F

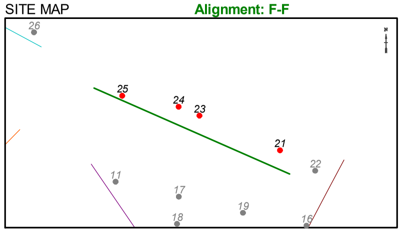
File No.:	7-18-0055-01	No.:	EE

Report: ISECTION - TABLOID - ELEV

Alignment: F-F
From E:614608, N:4784784
to E:614507, N:4784828



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ▨ Fill
- ▨ Silty Clay
- ▨ Topsoil
- ▨ Clayey Silt
- ▨ Clayey Silt Till

INTERPRETIVE LEGEND

- ▽ Unstabilized water level on completion of drilling
- ▼ Stabilized water level, most recent
- 30 SPT N-Value

- 🟫 *FILL*
- 🟧 *GRAVELS (gravel to gravelly sand)*
- 🟨 *SILT TO SAND (not till)*
- 🟩 *COHESIONLESS TILLS*
- 🟦 *COHESIVE SOILS (clayey silt to clay, incl. tills)*

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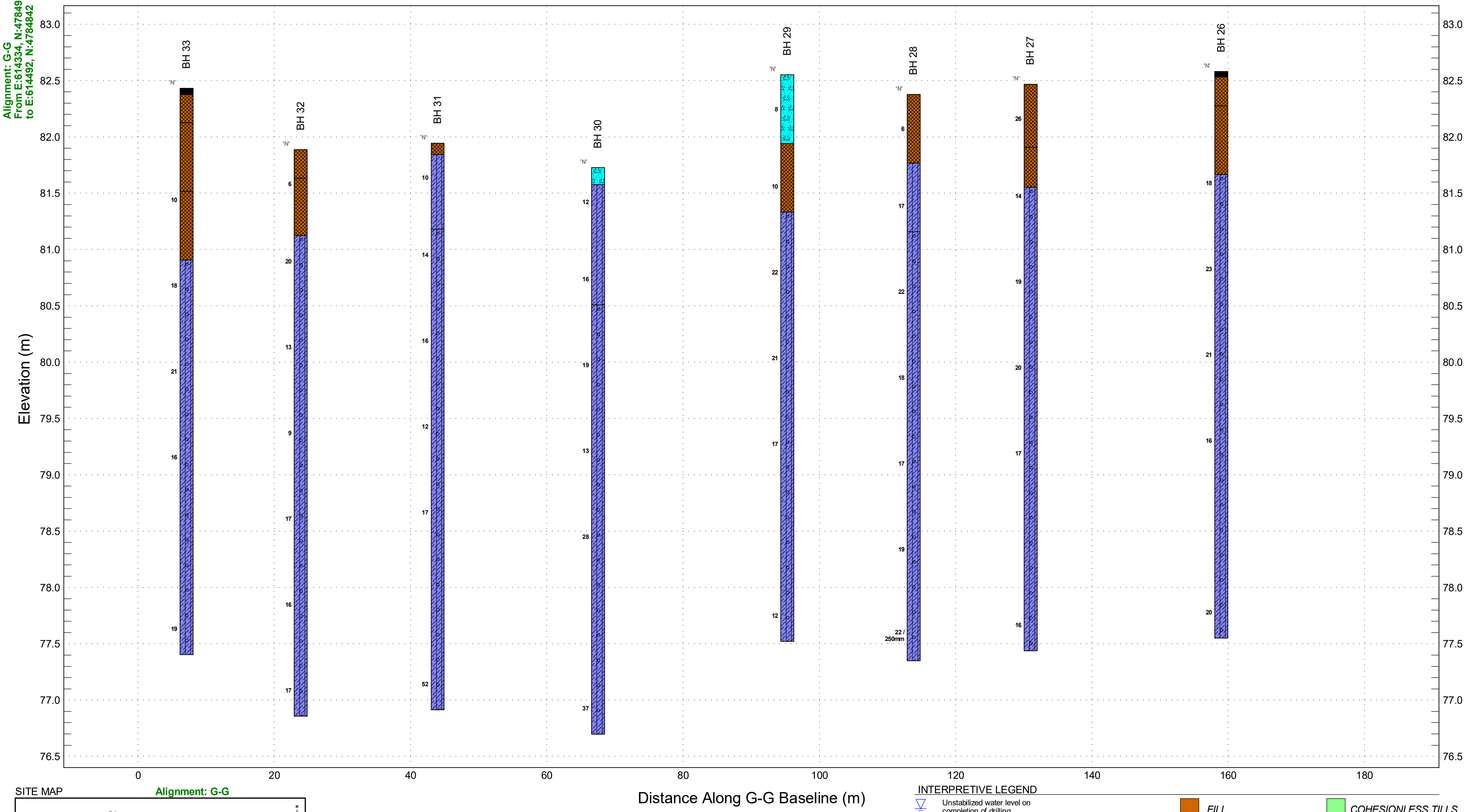
Title:
SUBSURFACE PROFILE
SECTION F-F BUILDINGS H,I,J

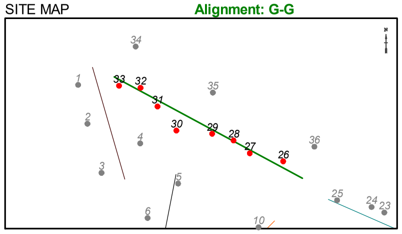
File No.: **7-18-0055-01**
No.: **FF**

Report: ISECTION - TABLOID - ELEV

Alignment: G-G
From E:614334, N:4784928
to E:614492, N:4784842



SITE MAP



LITHOLOGY GRAPHIC LEGEND

■	Asphalt
▨	Topsoil
▨	Fill
▨	Clayey Silt Till
▨	Clayey Silt

INTERPRETIVE LEGEND

▽	Unstabilized water level on completion of drilling
▼	Stabilized water level, most recent
30	SPT N-Value

🟧	*FILL*	🟩	*COHESIONLESS TILLS*
🟧	*GRAVELS (gravel to gravelly sand)*	🟦	*COHESIVE SOILS (clayey silt to clay, incl. tills)*
🟨	*SILT TO SAND (not till)*		

Terraprobe

903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
(905) 643-7560

Title:

SUBSURFACE PROFILE
SECTION G-G BUILDINGS K,L,M,N

File No.: 7-18-0055-01

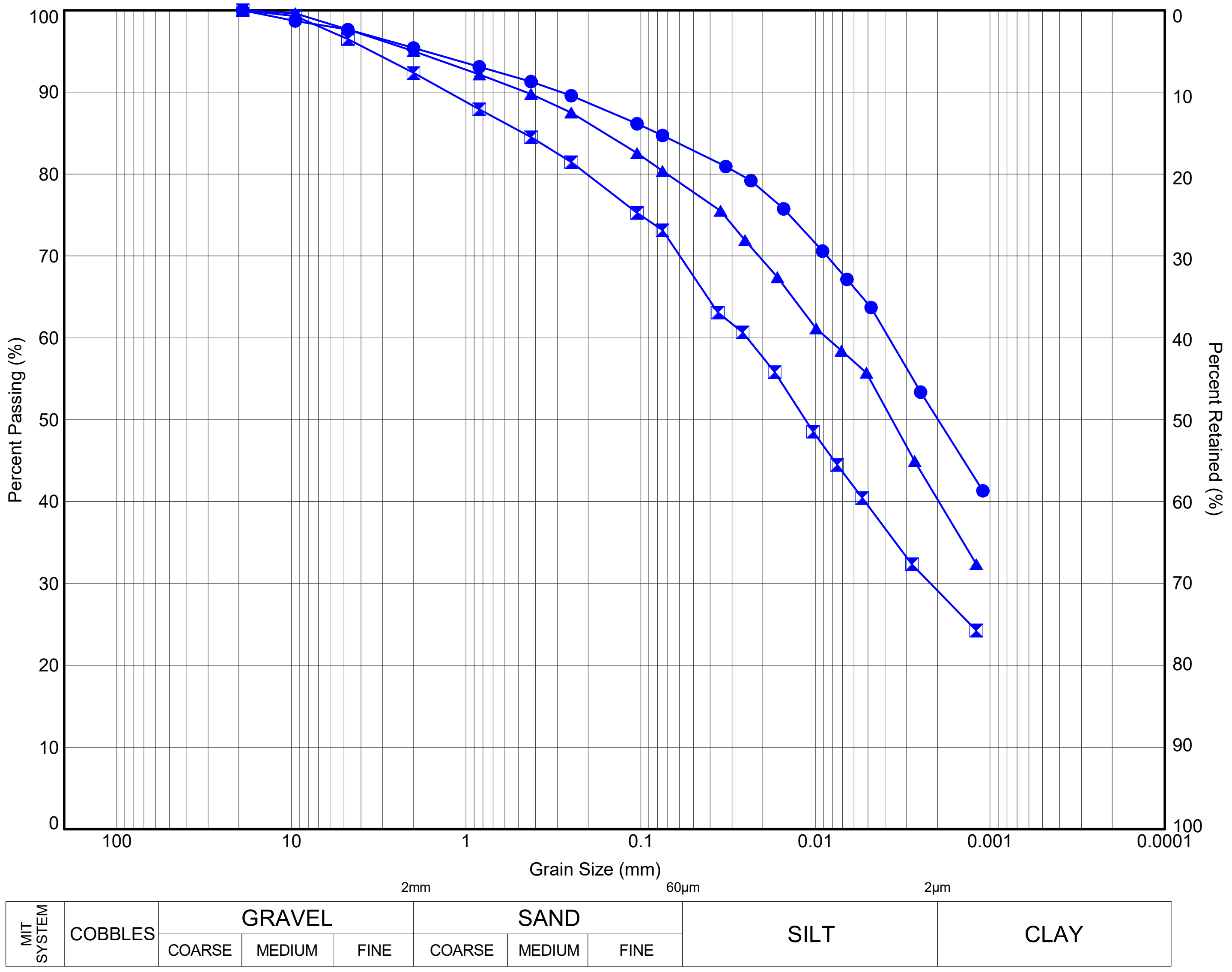
No.: GG

Report: ISECTION - TABLOID - ELEV

GEOTECHNICAL LABORATORY RESULTS

APPENDIX B

Terraprobe Inc.



				MIT SYSTEM				
Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
● **1**	SS4	3.3	79.1	5	11	34	50	
⧗ **10**	SS6	6.3	76.4	8	22	41	29	
▲ **17**	SS6	4.8	77.5	5	16	39	40	

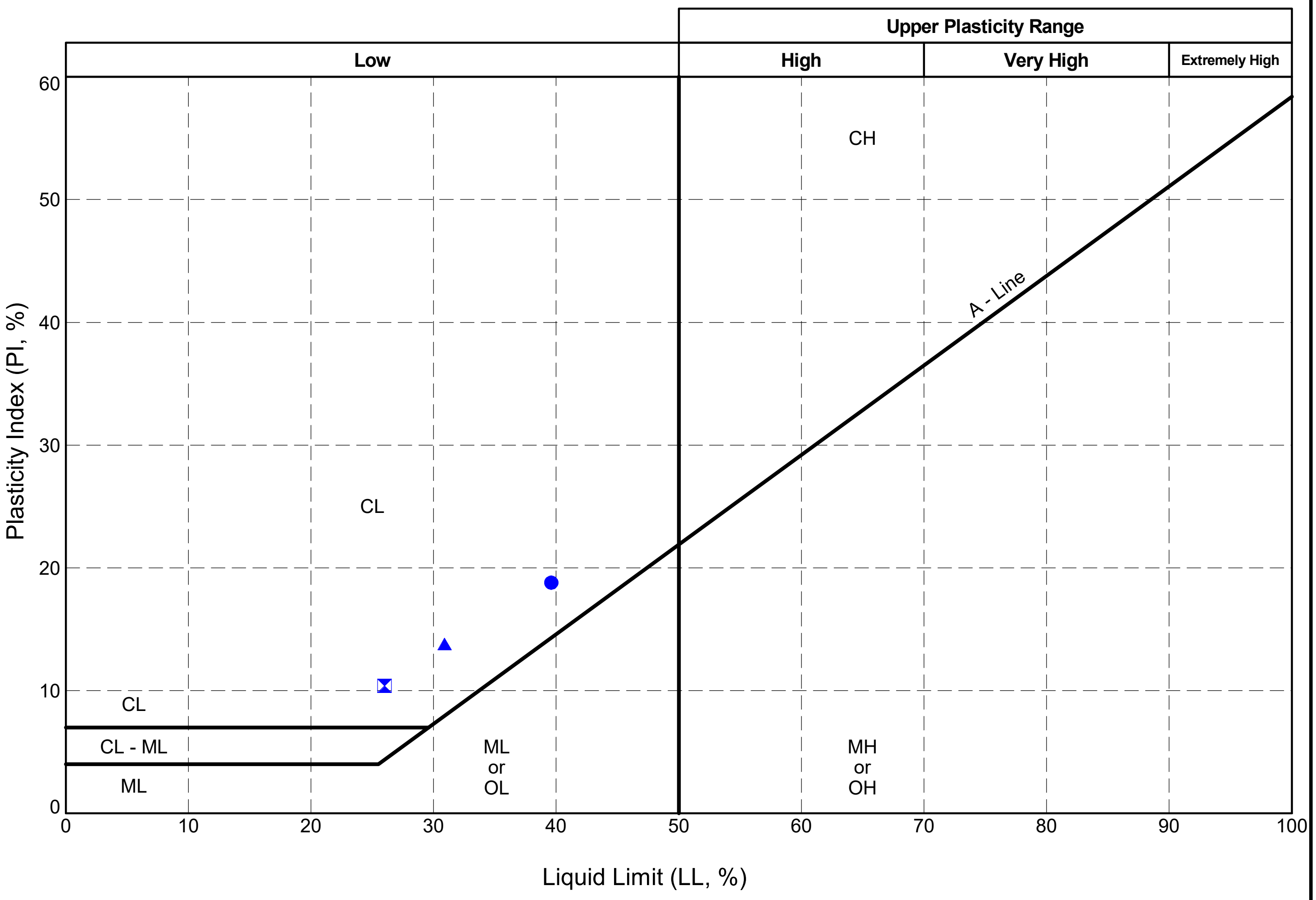
Terraprobe

903 Barton Street, Unit 22, Stoney Creek ON L8E 5P5
(905) 643-7560

Title:

GRAIN SIZE DISTRIBUTION

File No.: **7-18-0055-01**



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
●	1	SS4	3.3	79.1	40	21	19
⧗	10	SS6	6.3	76.4	26	16	10
▲	17	SS6	4.8	77.5	31	17	14

Terraprobe

903 Barton Street, Unit 22, Stoney Creek ON L8E 5P5
(905) 643-7560

Title:

ATTERBERG LIMITS CHART

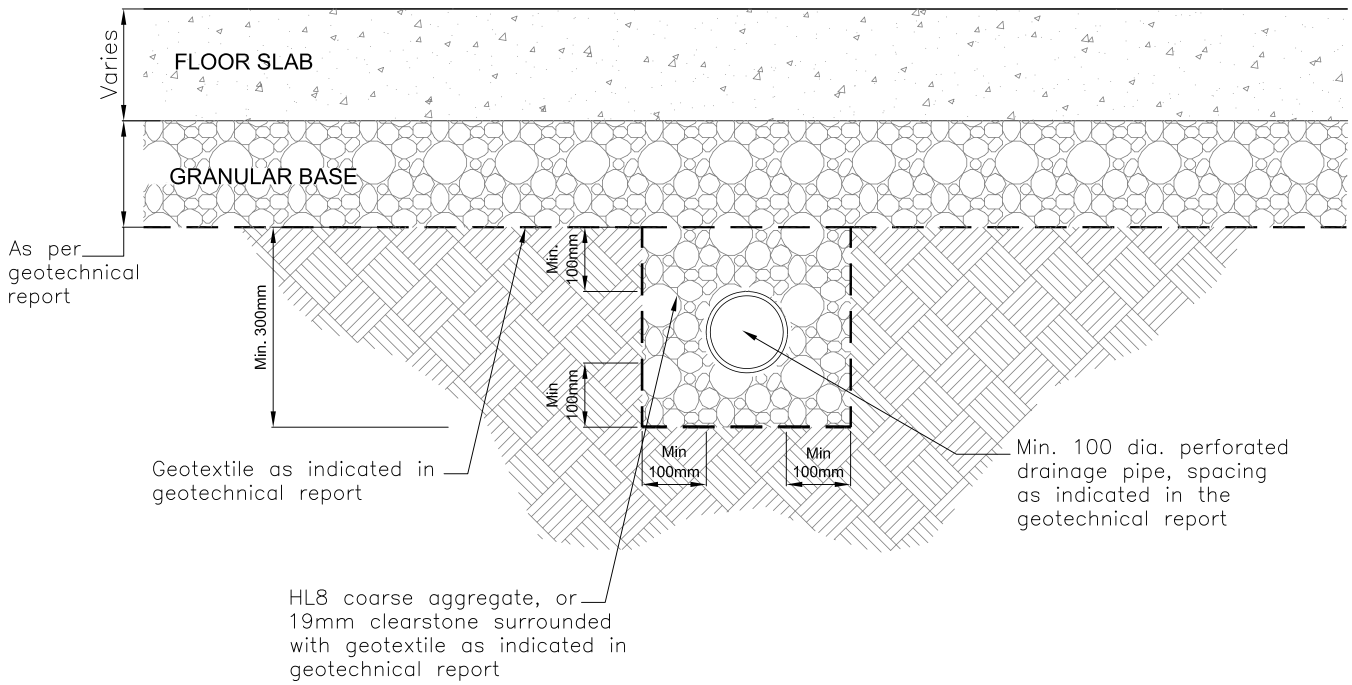
File No.:

7-18-0055-01

BASEMENT DRAINAGE DETAILS

APPENDIX C

Terraprobe Inc.

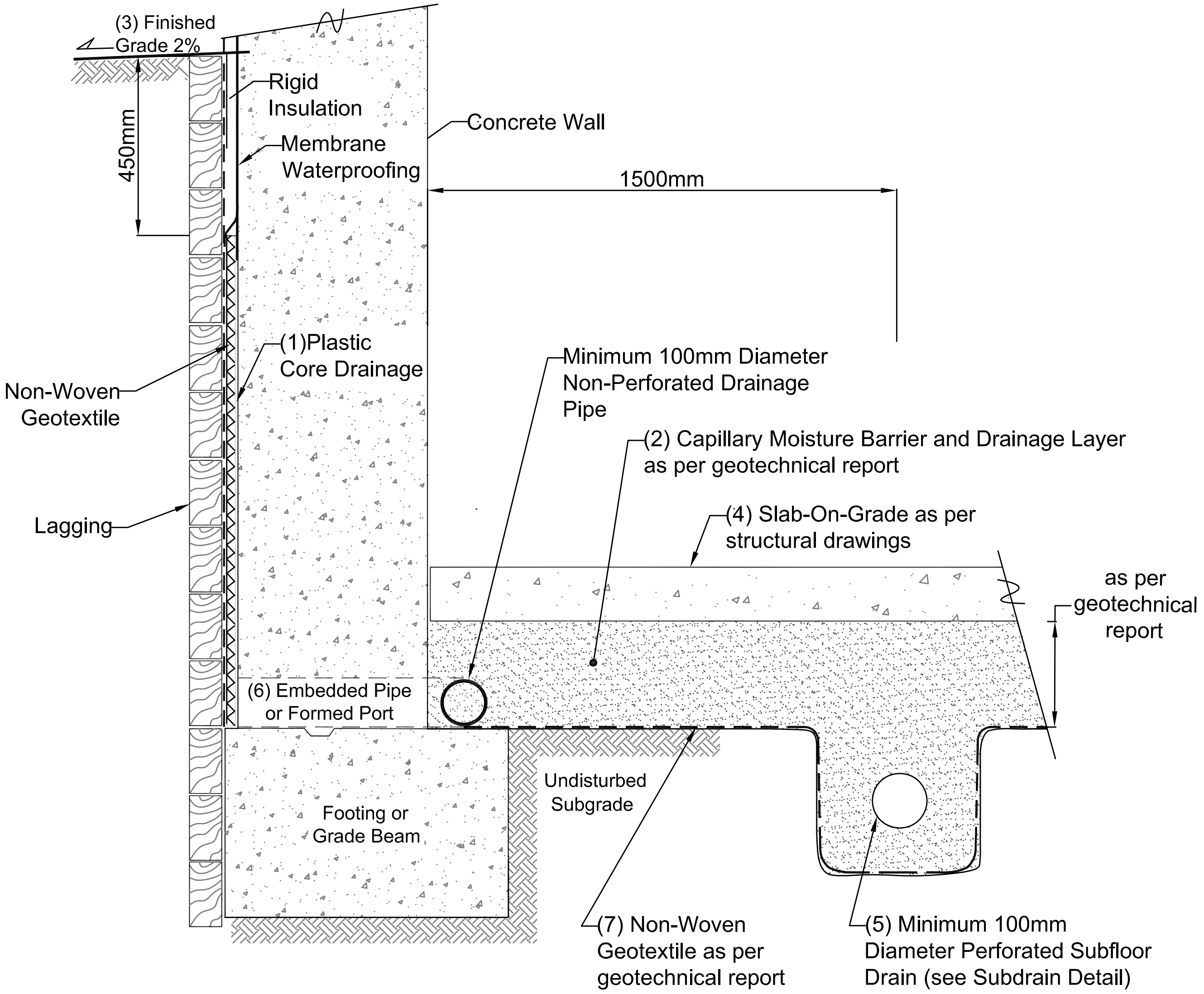


Schematic Only
Not to Scale

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 1500mm^2. Perimeter drainage must be collected and conveyed directly to the building sumps in non-perforated pipe.

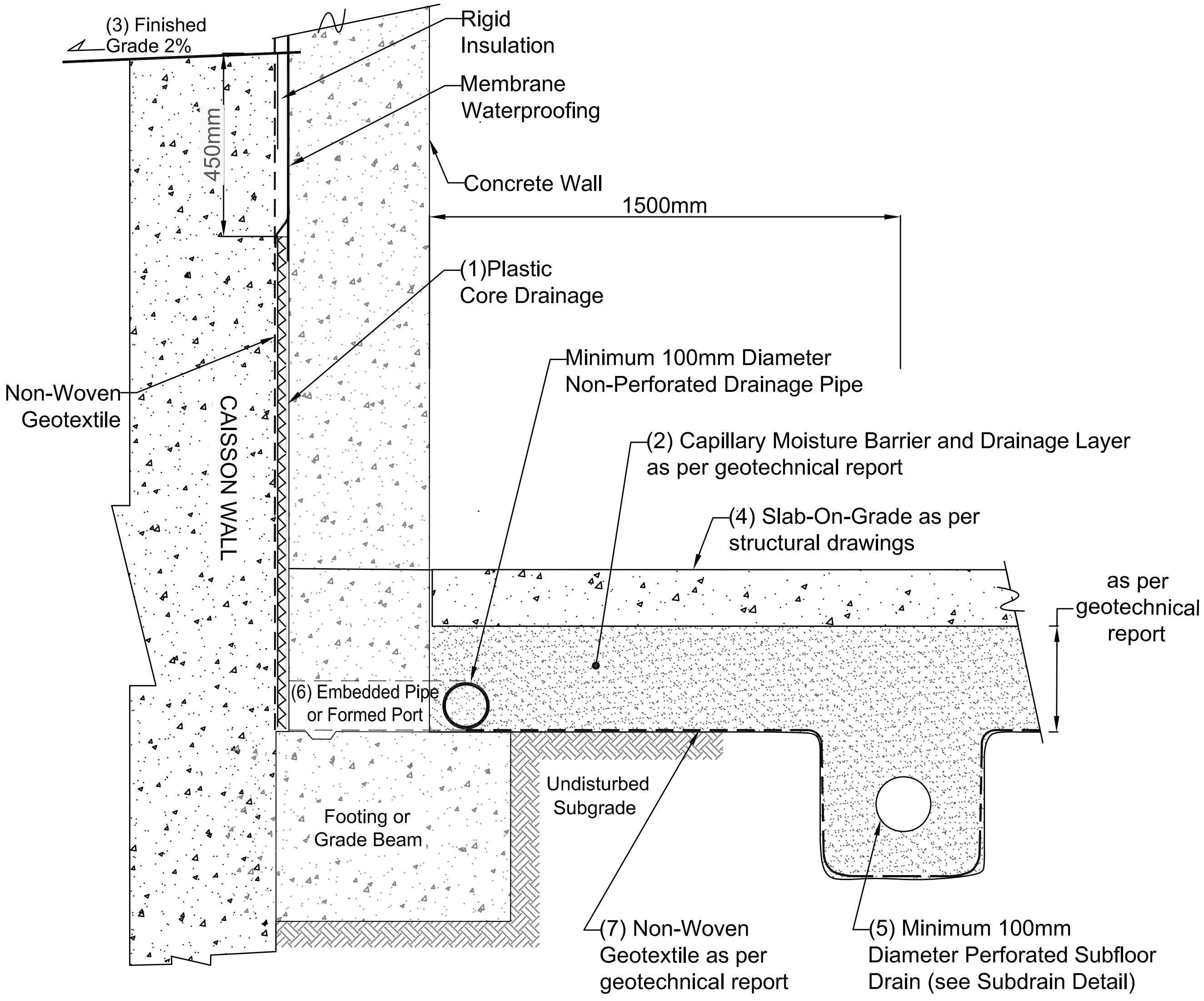
7) When the subgrade consists of a cohesionless soil, the subgrade must be separated from the subfloor drainage layer using a non-woven geotextile (Terrafix 360R or approved equivalent).

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.

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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
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Title:

SCHEMATIC DRAINAGE DETAIL
CAISSON WALL SHORING SYSTEM