Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
HOLY FAMILY CATHOLIC CEMETERY
(Bronte Road and Lower Base Line West)
MILTON, ONTARIO

2523 LOWER BASE LINE ROAD, MILTON ONTARIO

Prepared for: The Catholic Cemeteries of the Diocese of Hamilton
600 Spring Gardens Road
Burlington, Ontario
L7T 1J1

Attention: Mr. John O'Brien

File No. 11-13-3165
Revised
October 9, 2014
©Terraprobe Inc.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

Distribution:

2 Copies - The Catholic Cemeteries of the Diocese of Hamilton
1 Copy - Terraprobe Inc., Brampton

TABLE OF CONTENTS

1. INTRODUCTION 1

2. SITE AND PROJECT DESCRIPTION 1

3. FIELD PROCEDURE 2

4. SUBSURFACE CONDITIONS 3
- 4.1 Topsoil/Interlocking Pavers 3
- 4.2 Glacial Till 4
- 4.3 Geotechnical Laboratory Test Results 4
- 4.4 Ground Water 6

5. DISCUSSION AND RECOMMENDATIONS 7
- 5.1 Foundations 7
  - 5.1.1 Foundation Installations 9
- 5.2 Slab-On-Grade 9
- 5.3 Storm Water Management Pond 10
  - 5.3.1 Earth Berm and Pond Slope Surface Treatment 11
  - 5.3.2 Operational Considerations 13
- 5.4 Excavations and Groundwater Control 14
- 5.5 Earth Pressure Design Parameters 16
- 5.6 Backfill 18
- 5.7 Pipe Bedding 18
- 5.8 Pavement Design 19
- 5.9 Earthquake Design Parameters 19

6.0 LIMITATIONS AND USE OF REPORT 21

APPENDIX
- Abbreviations and Terminology
- Borehole Logs
- Sieve and Hydrometer Analysis
- Atterberg Limits Test Results
- Figure 1 - Site Location Plan
- Figure 2 - Borehole Location Plan
- Figure 3 - Conceptual Site Plan

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

1. INTRODUCTION

Terraprobe Inc. (Terraprobe) was retained by The Catholic Cemeteries of the Diocese of Hamilton to conduct a geotechnical investigation for a vacant parcel of land situated at the west corner of Bronte Road and Lower Base Line West in the Town of Milton, Ontario. The property is proposed to be developed as a cemetery site with internal roads, as well as open space and stormwater management pond blocks.

The initial first phase of development comprised the southern portion of the site, including four buildings, serviced privately, storm water management ponds and internal paved roads. This geotechnical report was prepared for the initial first phase. Subsequently, the first phase was changed to comprise a smaller land area including one building(cemetery office) and internal paved roads.

This report encompasses the geotechnical investigation conducted for the property to assess its geotechnical suitability for the intended development. The field investigation consisted of advancing a total of twenty (20) exploratory boreholes across the site. The objective of the geotechnical investigation was to determine the prevailing subsurface soil and groundwater conditions, in order to provide geotechnical engineering recommendations for the design of proposed building foundations, earthworks, earth pressure design parameters, pipe bedding, underground utilities and pavement structure component design. In addition, comments are also included on the pertinent project construction aspects including excavation, backfill and ground water control.

2. SITE AND PROJECT DESCRIPTION

The first phase of the development consists of the southern portion of the site located southwest of Bronte Road and northwest of Lower Base Line West, as shown on Figure 1.

The property is currently vacant and/or is under agricultural use. The surrounding lands are generally rural or rural-residential in nature. The majority of the site is characterized by generally flat to gently rolling topography, which typically slopes from northwest to southeast.

It is proposed to develop the site as a cemetery use comprising buildings, as well as park/open space and future storm water management pond blocks. The property would be serviced privately with internal paved roads.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

3. FIELD PROCEDURE

The field investigation for the site was conducted on October 4, 7 and 8, 2013 and consisted of advancing a total of twenty (20) exploratory boreholes extending to depths of about 3.3 to 5 m below existing ground surface, as follows:

- four (4) boreholes (Boreholes 9, 14, 19 and 20) were advanced within the proposed storm water management ponds, extending to a depth of about 5 m below existing grade;
- two (2) boreholes (Boreholes 12 and 13) were advanced within the proposed office, extending to a depth of about 5 m below the existing grade;
- two (2) boreholes (Boreholes 16 and 17) were advanced within the proposed mausoleum, extending to a depth of about 5 m below the existing grade;
- two (2) boreholes (Boreholes 2 and 3) were advanced within the proposed maintenance facility/service centre, extending to a depth of about 5 m below the existing grade;
- two (2) boreholes (Boreholes 6 and 10) were advanced within the proposed crematory, extending to a depth of about 5 m below the existing grade; and
- eight (8) boreholes (Boreholes 1, 4, 5, 7, 8, 11, 15 and 18) were advanced along the proposed road alignment, extending to about 3 m depth.

The boreholes were staked in the field by Terraprobe and the ground surface elevations at these borehole locations were provided by the client. The approximate locations of the boreholes are presented on Figures 2 and 3.

Various utility locate agencies were contacted by Terraprobe to clear the borehole locations prior to the commencement of the field investigation.

The borings were drilled by a specialist drilling contractor using a track mounted drill rig power auger. The borings were advanced using continuous flight solid stem augers, and were sampled at regular intervals with a conventional 50 mm diameter split barrel samplers when the Standard Penetration Test (SPT) was carried out (ASTM D 1586). The field work (drilling, sampling and testing) was observed full time and recorded by a Terraprobe technician, who logged the boring and examined the samples as they were obtained.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

All samples obtained during the investigation were sealed into plastic jars and transported to our geotechnical laboratory for detailed inspection and testing. The borehole samples were examined (tactile) in detail by a geotechnical engineer, and classified according to visual and index properties. Geotechnical laboratory testing consisted of water content determination on all samples, as well as a sieve and hydrometer analysis and Atterberg Limits test on nine (9) selected native soil samples (Borehole 1, Sample 2; Borehole 8, Sample 2; Borehole 9, Sample 6; Borehole 10, Sample 4; Borehole 13, Sample 5; Borehole 14, Sample 5; Borehole 17, Sample 4; Borehole 19, Sample 3; Borehole 20, Sample 6). The measured natural water contents for individual samples and the results of the sieve and hydrometer analyses as well as Atterberg Limits tests are plotted on the enclosed borehole logs at respective sampling depths. The results of sieve and hydrometer analyses and Atterberg Limits tests are also summarized in Section 4.3, and are appended.

Ground water levels were observed in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes 3, 6, 9, 12, 14, 16 and 20 to facilitate shallow ground water monitoring. The results of the ground water monitoring are summarized in Section 4.4 of this report.

4. SUBSURFACE CONDITIONS

The results of the individual boreholes are summarized below and recorded on the accompanying Borehole Logs. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions at the site.

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

In summary, the subsurface soil conditions encountered in the boreholes advanced across the site were fairly consistent. The boreholes encountered a topsoil layer/interlocking pavers at the ground surface underlain by a weathered/disturbed soil zone, which was in turn underlain by undisturbed native till soil deposit extending to the full depth of investigation at each borehole location.

4.1 Topsoil/Interlocking Pavers

A layer of topsoil/organic mixed materials was encountered at the ground surface in all boreholes except Borehole 13, varying in thickness from about 200 to 600 mm. The topsoil predominantly consisted of clayey silt matrix. A layer of 70 mm thick interlocking pavers underlain by 390 mm aggregate was encountered at the ground surface at Borehole 13.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

The above information (topsoil thicknesses) is approximate and may vary between and beyond the borehole locations. The ground surface at the property appeared to have been ploughed/disturbed, therefore, the topsoil thickness data measured at borehole locations are approximate. This information is not considered sufficient for estimating material quantities/or associated costs. We recommend that a shallow test pit investigation should be carried out across the site to determine accurate topsoil/interlocking pavers thickness for material estimation purposes.

4.2 Glacial Till

Undisturbed native glacial till deposit was encountered in all boreholes beneath the topsoil layer/interlocking paver structure. The upper zone of native till soils underlying the surficial topsoil layer and extending to a depth of about 0.8 m below grade was noted to be weathered/disturbed. The composition of the weathered/disturbed soils was generally similar to that of the underlying undisturbed native soils, and included trace amounts of organics/rootlets. The glacial till deposit predominantly consisted of a clayey silt matrix, with some sand to sandy, and trace amounts of embedded gravel. Cobble/boulder inclusions were encountered in Boreholes 4, 7, 15, 16, 17 and 20. The till deposit extended to the full depth of investigation (up to 5.0 m below grade).

The Standard Penetration Test results ('N' Values) obtained from till deposit varied from 16 to 61 blows per 300 mm of penetration, 50 blows per 100 mm of penetration and 75 blows per 275 mm of penetration, indicating stiff to hard consistency. Atterberg Limits test results carried out on the till soil samples indicate that the till deposit is generally slightly to medium plastic.

Measured moisture contents of the glacial till soil samples ranged from 10 to 20 percent by weight, indicating a typically moist condition.

It should be noted that the native till deposit may contain larger size particles (cobbles and boulders) that are not specifically identified in the boreholes. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples for the particles of this size.

4.3 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of water content determination on all samples, and a sieve and hydrometer analysis, and Atterberg Limits tests on selected native soil samples.

A summary of the Sieve and Hydrometer (grain size) analysis results is presented below:

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

Borehole No. Sample No.	Sampling Depth below Grade	Percentage				Description (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 1 Sample 2	1.0 m	1	18	51	30	CLAYEY SILT, some sand, trace gravel
Borehole 8 Sample 2	1.0 m	2	32	45	21	CLAYEY SILT, some sand, trace gravel
Borehole 9 Sample 6	4.8 m	5	22	48	25	CLAYEY SILT, trace gravel
Borehole 10 Sample 4	2.5 m	5	19	50	26	CLAYEY SILT, some sand, trace gravel
Borehole 13 Sample 5	3.3 m	1	11	39	49	CLAYEY SILT, some sand, trace gravel
Borehole 14 Sample 5	3.3 m	4	21	46	29	CLAYEY SILT, trace gravel
Borehole 17 Sample 4	2.5 m	2	13	49	36	CLAYEY SILT, some sand, trace gravel
Borehole 19 Sample 3	1.8 m	2	17	50	31	CLAYEY SILT, some sand, trace gravel
Borehole 20 Sample 6	4.8 m	6	22	50	22	CLAYEY SILT, trace gravel

The results of Atterberg Limits tests were plotted on A-Line Graph (refer to enclosed figures, Atterberg Limits Test Results). The results of Atterberg Limits Tests are summarized below:

Borehole No. Sample No.	Sampling Depth below Grade	Liquid Limit (WL)	Plastic Limit (WP)	Plasticity Index (IP)	Natural Water Content (WN)	Plasticity
Borehole 1 Sample 2	1.0 m	31	18	13	14	Slightly Plastic
Borehole 8 Sample 2	1.0 m	25	15	10	13	Slightly Plastic
Borehole 9 Sample 6	4.8 m	25	16	9	12	Slightly Plastic
Borehole 10 Sample 4	2.5 m	29	17	12	12	Slightly Plastic
Borehole 13 Sample 5	3.3 m	37	18	19	18	Medium Plastic

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

Borehole No. Sample No.	Sampling Depth below Grade	Liquid Limit (WL)	Plastic Limit (WP)	Plasticity Index (IP)	Natural Water Content (WN)	Plasticity
Borehole 14 Sample 5	3.3 m	31	18	13	13	Slightly Plastic
Borehole 17 Sample 4	2.5 m	34	19	15	15	Slightly Plastic
Borehole 19 Sample 3	1.8 m	33	18	15	14	Slightly Plastic
Borehole 20 Sample 6	4.8 m	23	15	8	11	Slightly Plastic

4.4 Ground Water

Observations pertaining to the depth of water level and borehole caving were made in the open boreholes immediately after the completion of drilling, and are noted on the enclosed borehole logs. Standpipe piezometer were installed in Boreholes 3, 6, 9,12, 14, 16 and 20, and the ground water levels measurement was taken on October 24 and November 12, 2013, approximately three to five weeks following the installation. A summary of these observations is provided below:

Borehole No.	Depth of Boring	Depth to Cave	Water level at the time of drilling	Water level in piezometer on Oct. 24, 2013	Water level in piezometer on Nov. 12, 2013
3	5.0 m BG	open	dry	3.6 m BG	2.4 m BG
6	5.0 m BG	open	dry	2.4 m BG	1.1 m BG
9	5.0 m BG	open	dry	4.3 m BG	3.8 m BG
12	5.0 m BG	open	dry	4.2 m BG	3.8 m BG
14	5.0 m BG	open	dry	4.3 m BG	3.9 m BG
16	5.0 m BG	open	dry	0.3 m BG	0.3 m BG
20	5.0 m BG	open	dry	4.2 m BG	3.7 m BG

BG = Below Grade
NP = No Piezometer

The remaining boreholes without being installed piezometers were dry and open upon the completion of the drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

It should be noted that the ground water levels may fluctuate seasonally depending on the amount of precipitation and surface runoff.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

5. DISCUSSION AND RECOMMENDATIONS

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

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

5.1 Foundation

At the time of preparation of this report, there was no detailed information available regarding the proposed structures. It is understood that the only building in the new first phase will be the cemetery office to be converted from the existing house where Terraprobe's Boreholes 12 and 13 are located. However it is assumed that the proposed buildings including cemetery office, maintenance/service centre, crematory and mausoleum complex would consist of slab-on-grade structures (no basement) supported on conventional shallow spread footing foundations. A total of eight (8) boreholes (Boreholes 12 and 13 within the proposed office, Boreholes 2 and 3 within the proposed maintenance/service centre, Boreholes 6 and 10 within the proposed crematory and Boreholes 16 and 17 within the proposed mausoleum) were advanced within the footprints of the proposed buildings. The boreholes encountered a topsoil or interlocking paver structure at the ground surface underlain by a layer of weathered/disturbed soils at all borehole locations. The weathered/disturbed soils extended to a depth of about 0.8 m below existing grade. The weathered/disturbed soils were underlain by undisturbed native glacial till deposit extending to the full depth of investigation (up to at least 5.0 m below grade).

The existing topsoil/aggregate and weathered/disturbed soils are unsuitable for the support of the proposed building foundations. All foundations must be supported on the underlying competent undisturbed native till soils.

A net geotechnical reaction of 250 kPa at Serviceability Limit States (SLS) and a factored geotechnical resistance of 375 kPa at Ultimate Limit States (ULS) are recommended for the design of conventional spread footings foundations supported on the underlying stiff to hard undisturbed native glacial till soils at minimum depths noted in the following table. This table summarizes the recommended geotechnical resistance

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

available at varying depths at the borehole locations, advanced within the proposed building footprints (Boreholes 2, 3, 6, 10, 12, 13, 16 and 17).

Borehole No.	Minimum Founding Depth Below Existing Grade	Highest Founding Elevation	Net Geotechnical Reaction at S.L.S.	Factored Geotechnical Resistance at U.L.S.	Bearing Stratum
2	1.2 m	179.8 m	250 kPa	375 kPa	Clayey Silt Till
3	1.2 m	179.9 m	250 kPa	375 kPa	Clayey Silt Till
6	1.2 m	179.9 m	250 kPa	375 kPa	Clayey Silt Till
10	1.2 m	177.2 m	250 kPa	375 kPa	Clayey Silt Till
12	1.2 m	178.1 m	250 kPa	375 kPa	Clayey Silt Till
13	1.2 m	179.1 m	250 kPa	375 kPa	Clayey Silt Till
16	1.2 m	178.4 m	250 kPa	375 kPa	Clayey Silt Till
17	1.2 m	177.9 m	250 kPa	375 kPa	Clayey Silt Till

Higher bearing pressures are available and can be analyzed based on the development specific details, if required.

The underside of footing elevations must be designed to provide a minimum of 1.2 m of soil cover or equivalent insulation for the foundation subgrade for frost protection consideration in unheated areas. All footings must be designed to bear at least 0.3 m into the undisturbed native soil stratum. The minimum foundations depths provided in the above table include the recommended 0.3 m depth of embedment.

The minimum width of continuous strip footings must be 500 mm if supported on native till soil (600mm if supported on engineered fill) and the minimum size of isolated footings must be 800 mm x 800 mm if supported on native till soils (1000 mm x 1000 mm if supported on engineered fill) regardless of loading considerations, in conjunction with the above recommended geotechnical resistance. The geotechnical resistance(s) as recommended allow for up to 25 mm of total settlement. This settlement will occur as load is applied and is linear elastic and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

5.1.1 Foundation Installation

It is recommended that all excavated footing bases must be evaluated by a qualified geotechnical engineer to ensure that the founding soils exposed at the excavation base are consistent with the design bearing pressure intended by the geotechnical engineer.

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

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

5.2 Slab-on-Grade

Conventional lightly loaded concrete floor slab should be placed on at least 150 mm of granular base (OPSS 1010 Granular "A" or 19 mm crusher run limestone) compacted to a minimum of 98 percent SPMDD. The existing weathered/disturbed materials may remain to support the slab-on-grade provided they are assessed and approved by a geotechnical engineer at the time of construction. Any subgrade area containing excessive amount of deleterious materials must be subexcavated. The subgrade must be assessed by a geotechnical engineer prior to the placement of granular base. Any soft or wet subgrade areas identified, should be locally subexcavated and backfilled with clean earth fill compacted to a minimum of 95 percent SPMDD. Based on the borehole information, selection and sorting of the earth fill materials will be required. Above granular base thickness is considered adequate for a slab loading up to 12 kPa (about 250 psf). Recommendations for heavier slab loads can be provided if required.

The following subgrade parameters are recommended for the design of slab-on-grade supported on the undisturbed native till soil subgrade:

$Ks = 30{,}000$ kPa/m
$\phi = 32°$

If the slab is supported on earth fill subgrade, constructed by approved earth fill placed in maximum 150 mm thick lifts and compacted to a minimum of 95 percent SPMDD, the modulus of subgrade reaction may be

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

assumed as 10,000 kPa/m. A modulus of subgrade reaction of 18,000 kPa/m may be used for slab design for subgrade comprising engineered fill compacted to 98 percent SPMDD.
Provided the finish floor level of the slab-on-grade buildings is at least 200 mm above the outside design grade, and the site is graded to promote drainage away from the building; subfloor drainage provisions are not required.

Regardless of the approach to slab construction, the floor slabs that are to have bonded floor finishes (such as tiles with adhesives) should be provided with a capillary moisture/vapour barrier. The floor manufacturers have specific requirements for moisture/vapour barrier, therefore, the floor designer/architect must ensure that a provision of appropriate moisture/vapour barrier conforming to specific floor finish product requirements is incorporated in the project specifications. Adequate testing must be carried out to ensure acceptable levels of moisture/relative humidity in the concrete slab prior to the installation of floor finish. Studies indicate that a provision of 200 mm thick 19 mm clearstone base (OPSS 1004) under the slab helps provide a good capillary moisture break, provided the granular base is positively drained. However, this provision does not replace the floor manufacturers' specific requirement(s) for a moisture/vapour barrier.

5.3 Storm Water Management Pond

Based on the project design concept, the proposed Storm Water Management (SWM) Ponds would be located in the southwest portion of the site. Boreholes 9, 14, 19 and 20 were advanced within the general footprint of the proposed SWM ponds. These boreholes were advanced to a depth of about 5.0 m below existing grade. The boreholes encountered a layer of topsoil at the ground surface underlain by a zone of weathered/disturbed soils (extending up to a depth of about 0.8 m below grade) which was in turn underlain by undisturbed native glacial till deposit extending to the full depth of investigation. The native till soils encountered in these boreholes predominantly consisted of clayey silt matrix with embedded gravel particle.

Sieve and hydrometer (grain size) analyses of the selected native till soil samples (Borehole 9, Sample 6; Borehole 14, Sample 5; Borehole 19, Sample 3 and Borehole 20, Sample 6) were carried out. The results of the grain size analyses indicated that the native till soils consists of 46 to 50 percent silt and 22 to 31 percent clay by weight. The estimated permeability of the native till soils, based on the soil sample analyzed, is on the order of 10^{-7} cm/sec. These boreholes remained open and dry upon completion of drilling. The water level in the piezometers, in Boreholes 9, 14 and 20 on October 24, 2013, varied from about 4.2 to 4.3 m below grade, and on November 12, varied from about 3.7 to 3.9 m below grade. It is noted that the undisturbed native soils at the SWM pond locations consist of low permeability clayey silt till deposit which precludes significant amounts of free flow/seepage of the ground water. Therefore, it appears that the ground water levels in the piezometers are likely due to the perched water typically present within the earth

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

fill/weathered/disturbed soils and in the relatively permeable sand/silt lenses typically found embedded in the glacial till deposit due to its mode of deposition.

Based on the site design details, the pond base and side slopes are expected to consist of undisturbed native clayey silt till soils of relatively low permeability (on the order of 10^{-7} cm/sec). The relatively low permeability of the native till soils should preclude significant seepage or percolation into and from the pond, and therefore, a pond liner may not be required. As noted before, the measured water levels in the piezometer appear to be likely related to perched ground water condition rather than a static ground water table. The glacial till deposit typically contains intermittent relatively permeable silt/sand zones, with perched water, due to its mode of deposition.

The pond slopes and base must be inspected by a geotechnical engineer to assess the exposed soil conditions, and to identify presence of any relatively permeable silt or sand layers/pockets typically found within the till deposit, in order to provide recommendations for possible modification to the geotechnical design of the pond. These modifications may include local subexcavation of the relatively permeable soil zone(s) and backfilling with low permeable clay/silty clay soils.

Based on the subsurface soils conditions encountered in the boreholes, the recommended stable slope inclination for the pond side slope is 4 horiz. to 1 vert. above water level and 5 horiz. to 1 vert. below the pond water lever. It must be noted that regulatory agencies may also have specific requirements with respect to pond design (including side slopes) in addition to the slope considerations noted above.

5.3.1 Earth Berm and Pond Slope Surface Treatment

The final pond design grades may require an earth-berm. The earth fill materials used for the berm construction must include a minimum of 15 percent clay (finer than 0.002 mm) and 35 percent silt sized (finer than 0.08 mm, i.e., passing No. 200 sieve) particles. This material must not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.8 mm size (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots, stumps and topsoil. The earth fill materials should be placed in lifts not exceeding 150 mm and be compacted to a minimum of 95 percent of the SPMDD. The materials shall be placed and compacted at a water content of between 2 percent dry and 3 percent wet of the optimum moisture content. In order to achieve required compaction of the berm fill soils at the pond slope surface, consideration should be given to over-build the berm (minimum 1.5 m beyond the design slope surface) and cut neatly to the final design slope configuration.

The subgrade area beneath berm fill and pond base should be stripped to remove all organics, topsoil and vegetation. The exposed subgrade should be proof-rolled and inspected by a qualified geotechnical engineer

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

to confirm the founding soil conditions. Any loose, soft or otherwise deleterious materials must be removed to their full extent and replaced with compacted earth fill (as specified) under the direction of a qualified geotechnical engineer. Similarly, pockets/areas of sand/silt soils must be identified, subexcavated and replaced with compacted and approved low permeability earth fill soils. The subgrade should be compacted to at least 95 percent SPMDD prior to the berm fill placement.

The recommended stable slope inclination for the outside slope of any fill berm should be 3 horiz. to 1 vert. or flatter. The final slope surface and all bare or exposed areas (where applicable) should be provided with suitable ground cover or erosion protection. The slope surface should be provided with a thin layer of topsoil (minimum 100 mm thick) and should be hydro-seeded with a grass mixture and mulch. If seeded, during the first 2 to 3 years, the surface cover of topsoil and seeding may require periodic maintenance until the vegetation becomes well established. It is recommended that erosion netting be staked on the outside slope (where applicable) for erosion protection (and inside slope which is above the water level).

It is understood that the inside slopes of the SWM pond(s) will likely be vegetated with aquatic vegetation species. It should be noted that periodic fluctuations in the pond water level will make inside slopes susceptible to minor sheet and rill erosion over extended periods of exposure if these slopes remain bare and without vegetation. Occasional maintenance and repair of the inside bare pond slopes (and removal of accumulated sediment in the base) will be required. A lining of the pond inside slopes would reduce the amount of maintenance. The lining may consist of rip-rap or local field stones.

The emergency spillway must be provided with a significant erosion resistant lining consisting of either rip-rap, gabion mattresses, buried and staked Geoweb or Duramat Concrete Units (or equivalent). The lining should extend from the design high water level to over the berm and down to the berm/pond slope toe. It is recommended that any piping or trenching in the area of the pond should be provided with seepage cut-off collars (clay plugs, concrete plugs, or other barriers) to protect against water seepage through the pipe bedding and backfill.

In case the relatively permeable zones (sand/silt) are encountered in the pond slope and base, these zones should be subexcavated and replaced with approved low permeability soils. The backfill soil should consist of a natural soil material (such as clay or clayey silt). Primary considerations for the design of the clay backfill will be low permeability, protection from frost damage, desiccation, and burrowing animals. The clay backfill should be a minimum of 1.0 m thick. The backfill soils must consist of low permeability materials (clayey silt or clay) in order to perform adequately and to provide a barrier to potential seepage. As noted before, the backfill material must include a minimum of 15 percent clay (finer than 0.002 mm) and 35 percent silt sized (finer than 0.08 mm, i.e., passing No. 200 sieve) particles. The backfill material must

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.8 mm size (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots, stumps and topsoil.

It is required to ensure that the berm soils and backfill materials for the permeable zones (if encountered in the base and sides of the pond) are compacted to a homogenous mass, and does not remain as distinct "clods" or "clumps". The backfill should be constructed in thin lifts (not exceeding 150 mm thick) and heavily compacted to a minimum of 95 percent SPMDD. The soil should not contain any frozen material should the construction proceeds under winter conditions (ideally not recommended). Also, adequate protection against frost penetration must be provided as required (eg. straw bales, tarping, heating).

The delineation of the permeable soil zones, subexcavation and replacement must be conducted under the full time supervision of a qualified geotechnical engineer.

It is recognized that a broad range of soil materials may be suitable for the berm/backfill material (i.e., will meet the specifications noted above). It is recommended that contractors bidding on the project provide the results of testing, to indicate the following:

- The location (source) of the clay material.
- Verification of the uniformity of the material.
- Demonstration that sufficient material is available for the project.
- Laboratory testing to demonstrate that the material meets the minimum specifications noted above.

The berm/liner construction must be conducted under the full time supervision of a qualified geotechnical engineer. Periodic on-site samples should be collected and tested to ensure that the material placed conforms to the project specification.

5.3.2 Operational Considerations

The following general considerations are recommended with respect to the long-term operation and maintenance of the pond(s):

- A minimum operating freeboard of 0.3 m should be maintained between the high water level and the pond rim/berm. Overtopping of the pond, as a result of overfilling or flooding, would result in severe damage and possible breaching or failure of the earth berm and the

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

downstream slope. A provision of an overflow conveyance route/spillway is recommended to prevent pond overtopping.

- The flat surface (maintenance/access road) at the top of the pond/berm must be a minimum of 3.0 m wide to facilitate adequate compaction and to accommodate service vehicles for maintenance.

- The pond should be carefully inspected each season for including but not limited to the following:

  (i) General condition of various pond components to identify areas of erosion, settlement, slump or deterioration.

  (ii) Inspection of pond base and slope surface for discontinuities or holes as a result of burrowing animals, vandalism, settlement or the like.

  (iii) Removal of unwanted vegetation (tree, seedlings and the like) from within the footprint of the pond area.

Any damaged or deteriorated areas must be repaired regularly.

It must be noted that regulatory agencies stipulate maximum pond slope inclinations and other requirements for stormwater management pond design. These specifications may have requirements above and beyond the geotechnical recommendations provided in this report.

5.4 Excavations and Groundwater Control

The borehole data indicate that the topsoil, weathered/disturbed soils and undisturbed native glacial till soils would be encountered in the excavations. Excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. These regulations designate four broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TYPE 2 SOIL

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

TYPE 3 SOIL

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

TYPE 4 SOIL

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

The weathered/disturbed soils encountered in the boreholes is classified as Type 3 Soil above and Type 4 Soil below the prevailing water table, respectively. The undisturbed native glacial till is classified as Type 2 Soil, under these regulations.

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

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

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

As noted before, glacial till deposit may contain larger particles (cobbles and boulders) that are not specifically identified in the boreholes. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples for particles

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

of this size. Provision should be made in excavation contract to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

All of the boreholes remained dry upon completion of drilling. The ground water level measured in the standpipe piezometers on October 24, 2013 varied from about 0.3 m (Borehole 16) to 4.3 m (Boreholes 9 and 14) below grade, and on November 12, 2013 varied from about 0.3 m (Borehole 16) to 3.9 m (Borehole 14). The ground water levels may fluctuate seasonally depending upon the precipitation and surface runoff.

The glacial till deposit underlying the site is expected to have a relatively low permeability and should preclude significant free-flowing ground water seepage into the excavation in the short-term. There may be perched ground water present within weathered/disturbed soils as well as in sand/silt lenses and seams typically found within the glacial till deposit due to its mode of deposition. This perched ground water seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of excavation. For excavations extending to depths greater than 0.3 m below the water table, it will be necessary to lower the ground water level below the excavation base prior to and during the subsurface construction, and therefore rigorous positive dewatering will likely be required. Dewatering of more than 50,000 litres/day will require a permit from the Ministry of Environment.

The flow of surface water at this site will likely have to be diverted away from the work area so that construction can proceed in sufficiently dry conditions. Depending on the flow conditions, it may be possible to accomplish this by containing the flow and diverting it via a solid pipe. An interceptor perimeter trench may also be required. The design of the dewatering system will be the responsibility of the Contractor.

5.5 Earth Pressure Design Parameters

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

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

where:

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

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

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

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

Resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction (**R**) depends on the normal load on the soil contact (**N**) and the frictional resistance of the soil (**tan** ϕ) expressed as $\mathbf{R = N \tan \phi}$. This is an ultimate resistance value and does not contain a factor of safety.

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

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

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

Stratum/Parameter	ϕ	γ	K_a	K_o	K_p
Glacial Till	30	21	0.35	0.5	3
Weathered/Disturbed Soils	30	19	0.35	0.5	3
Compact Granular Fill	32	21	0.3	0.47	3.25

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

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

5.6 Backfill

The topsoil and weathered/disturbed materials containing excessive amounts of organics should not be reused as backfill in settlement sensitive areas, such as beneath floor slabs, trench backfill and pavement areas. However, these materials may be stockpiled and reused for landscaping purpose.

The native soils are generally considered suitable for reuse as backfill provided these soils are not too wet to achieve specified compaction. It should be noted that there may be some relatively wet zones within subsurface soils. Any soil materials with in-situ moisture content of more than 3 percent above the optimum moisture content could be put aside to dry, or could be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and replaced with imported material which can be readily compacted. It should be noted that the soils encountered on the site are not free draining, therefore, earthworks will be difficult to carry out in wet seasons such as spring and fall and may incur extra cost.

In settlement sensitive areas such as beneath floor slabs and pavements, the backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less, and heavily compacted to a minimum of 95 percent SPMDD at a water content close to optimum (within 3 percent of optimum). The soils encountered on the site will be best compacted with a heavy sheepsfoot type roller.

5.7 Pipe Bedding

The engineered fill and undisturbed native materials will be suitable for support of buried services on conventional well graded granular base material. The utility subgrade may require stabilization as deemed necessary based on the subgrade assessment. Where disturbance of the trench base has occurred, such as due to groundwater seepage, or construction traffic, the disturbed soils should be subexcavated and replaced with suitably compacted granular fill.

Granular bedding material should consist of a well graded, free draining soil, such as OPSS Granular "A" or 19 mm Crusher Run Limestone or its equivalent as per the pertinent Town/Region specifications. The bedding material should be placed in 150 mm lifts and compacted to a minimum of 95 percent SPMDD or vibrated/tamped to a dense state in case of a clear stone material.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

A clear stone type bedding may be considered, however, such bedding should only be used in conjunction with a suitable geotextile filter (Terrafix 270R or equivalent) where sand/silt subgrade is encountered. Otherwise, without proper filtering, there may be entry of fines from the native soils into the bedding. This loss of ground could result in loss of support to the pipes and possible future settlements. Where subgrade consists of clayey soils, a geotextile filter is not required.

If the invert of the trench is below the water table and local drawdown of the groundwater level cannot be tolerated for environmental reasons then clay plugs should be installed within the granular bedding and the granular zones of backfill material to help prevent migration of the ground water along the relatively free draining bedding material and/or backfill material due to the "French Drain" effect.

Clay plugs should be placed in the trenches at 50 m intervals (or less) along the full length of the trench, where the invert of the trench is below the water table. The plug should be at least 1.0 m thick measured along the pipe, and should completely replace the granular bedding and relatively pervious (sand, granular) backfill. The clay plugs must be compacted to a minimum of 95 percent SPMDD. The clay plug material should have a coefficient of permeability less than 10^{-6} cm/s and must include a minimum of 15 percent clay (finer than 0.002 mm) and 30 percent silt sized (finer than 0.08 mm, i.e., passing No. 200 sieve) particles. The backfill material must not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.8 mm size (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots or topsoil.

Alternatively, concrete cut-off collars can be installed around the pipe barrel to achieve the same effect. Collars should not be placed closer than 1.0 m to a pipe joint and precautions should be taken to ensure that a minimum of 95 percent compaction is achieved around the collars. Watertight connections are required between the collar and the pipe wall. The trench backfilling operations should be carried out with materials that are similar to the materials that have been excavated. In particular, the sand zones must not be truncated by backfilling of the trench using lower permeability materials.

5.8 Pavement Design

Based on the existing and proposed site grades, it is understood that both cut and fill may be required for grading design, therefore, the pavement subgrade may consist of undisturbed native soil or compacted earth fill. The pavement subgrade should be proof-rolled with a heavy rubber tire vehicle (such as a grader) and any loose, soft, wet or unstable areas should be sub-excavated, and backfilled with clean earth fill material placed in 150 mm thick lifts and compacted to a minimum of 98 percent SPMDD. Local subexcavation in some areas may be required due to loose/soft, wet and incompetent subgrade conditions or excessive topsoil/organic presence as identified during the proof-roll.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

The existing weathered/disturbed soils encountered on the site may be utilized for subgrade preparation provided they do not contain excessive amounts of organics and deleterious materials, as well as their in-situ moisture content is within 3 percent of the optimum moisture content. The selection and sorting of these soils for reuse, should be conducted under the supervision of a geotechnical engineer. Pavement subgrade upfill material should be compacted to a minimum of 95 percent SPMDD, while the upper zone (within 1.2m of the design subgrade) should be compacted to a minimum of 98 percent SPMDD.

The following flexible pavement designs are recommended for the proposed development. These minimum depths are in accordance with the Town of Milton's current minimum standards (2010):

Material	Compaction Requirement	Minimum Component Thickness	
		Minor Local/Laneway (16 m ROW)	Local, Minor Collector (20 m ROW)
Surface Course Asphaltic Concrete: HL3 (OPSS 1150 and pertinent Town specifications)	as per OPSS 310	40 mm	40 mm
Binder Course Asphaltic Concrete: HL8 (OPSS 1150 and pertinent City specifications)	as per OPSS 310	50 mm	80 mm
Base Course: 19 mm Limestone (OPSS 1010 and pertinent Town specifications)	100 % Standard Proctor Maximum Dry Density	150 mm	150 mm
Sub Base Course: Granular B, Type II (OPSS 1010 and pertinent Town specifications)	98 % Standard Proctor Maximum Dry Density	300 mm	375 mm

The granular materials should be placed in lifts 150 mm thick or less and be compacted to a minimum of 100 percent and 98 percent SPMDD for granular base and granular sub-base, respectively. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS Forms 310, 501, 1010 and 1150 and pertinent Town/Region specifications. It is recommended that Town/Region and other pertinent specifications should be referred for use of higher grade of asphalt cement for asphaltic concrete where applicable.

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum grade of two percent) to provide effective drainage towards subgrade drains. Grading adjacent to the pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement. Continuous pavement subdrains should be provided along both sides of the roads and drained into respective catchbasins to facilitate drainage of the subgrade and

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

granular materials. The subdrain invert should be maintained at least 0.3 m below subgrade level (refer to Figure 5).

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.

The above pavement design thicknesses are considered adequate for the design traffic. However, if the pavement construction occurs in wet, winter or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular sub-base, base or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of the granular materials.

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

5.9 Earthquake Design Parameters

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

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

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

The site is underlain by glacial soil deposit (clayey silt till) which extended to at least 5.0 m below grade.

Based on the above, for seismic design purposes, the weighted Average Standard Penetration Resistance can be taken as between 15 and 50 blows per 300 mm of penetration. On this basis, the site designation for seismic analysis is Class D, according to Table 4.1.8.4.A. of the Ontario Building Code (2012). According to Tables 4.1.8.4.B. and 4.1.8.4.C. of the same code the applicable acceleration and velocity based site coefficients are tabulated below:

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
D	1.3	1.2	1.1	1.1	1.0

Site Class	Values of F_v				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.2$	$S_a(1.0) = 0.3$	$S_a(1.0) = 0.4$	$S_a(1.0) \geq 0.5$
D	1.4	1.3	1.2	1.1	1.1

It should be noted that the above site seismic designation is estimated on the basis of rational analysis of penetration resistance (N-Values) with assumed N-Values for the soil stratigraphy beneath the investigation depth. Alternatively, a site specific Multichannel Analysis of Surface Waves (MASW) may be conducted to determine the average shear wave velocity in the top 30 metres of the site stratigraphy to establish the site designation for seismic analysis.

6.0 LIMITATIONS AND USE OF REPORT

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

assumed for the purposes of providing advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions.

The discussion and recommendations are based on the factual data obtained from the investigation and are intended for use by the owner and its retained designers in the design phase of the project. Since the project is still in the design stage, all aspects of the project relative to the subsurface conditions cannot be anticipated. Terraprobe should review the design drawings and specifications prior to the construction. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant to the revised project. Terraprobe should be retained to review the implications of changes with respect to the contents of this report.

The investigation at this site was conceived and executed to provide information for project design. It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could have an effect on construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on this project should therefore, in this light, be directed to decide on their own investigations, as well as their own interpretations of the factual investigation results. They should be cognizant of the risks implicit in subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was prepared for the express use of The Catholic Cemeteries of the Diocese of Hamilton and its retained design consultants. It is not for use by others. This report is copyright of Terraprobe Inc. and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc. and The Catholic Cemeteries of the Diocese of Hamilton, who are the authorized users.

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

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

Yours truly,

Terraprobe Inc.

W. Lei, P. Eng.
Project Engineer

Michael Tanos, P. Eng.
Principal

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

APPENDIX

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TERRAPROBE INC.

Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

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

PENETRATION RESISTANCE

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

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

COHESIONLESS SOILS

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

COHESIVE SOILS

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

COMPOSITION

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

TESTS AND SYMBOLS

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

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

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

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

BOREHOLE LOGS

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TERRAPROBE INC.

Terraprobe

BOREHOLE LOG 1

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

Position : E: 595985, N: 4812866 (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	Sample Number	Sample Type	SPT 'N' Value
0	180.9	**GROUND SURFACE**				
	180.7	200mm **TOPSOIL**				
	0.2	Trace organics (WEATHERED/DISTURBED)		1	SS	8
	180.1					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	26
				3	SS	31
2				4	SS	54
3				5	SS	52
	177.4					
	3.5	**END OF BOREHOLE**				

Elevation Scale (m): 180, 179, 178

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
1	18	51	30

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 2

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

Position : E: 596008, N: 4812884 (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	Sample Number	Sample Type	SPT 'N' Value
	181.0	**GROUND SURFACE**				
0	180.7	300mm **TOPSOIL**		1	SS	8
	0.3	Trace organics (WEATHERED/DISTURBED)				
	180.2					
	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	32
1				3	SS	36
2				4	SS	44
3				5	SS	48
4		...reddish brown		6	SS	27
5	176.0					
	5.0	**END OF BOREHOLE**				

Elevation Scale (m): 181, 180, 179, 178, 177, 176

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

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

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 3

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

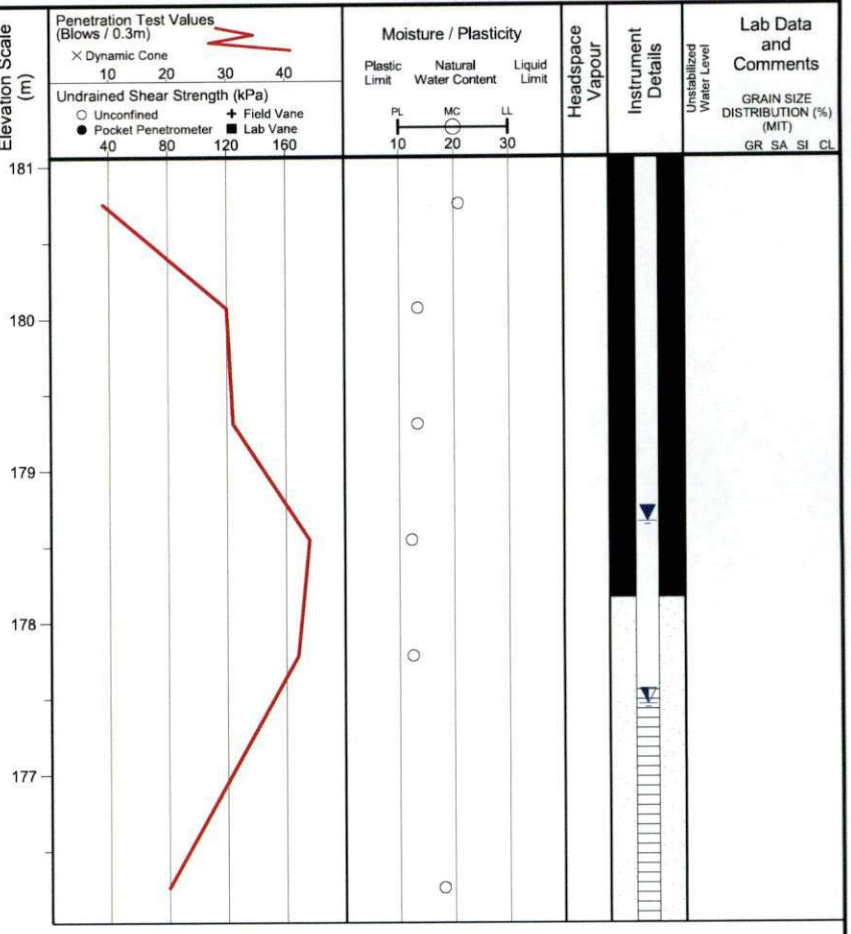
Position : E: 596029, N: 4812913 (UTM 17T)

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	181.1	**GROUND SURFACE**				
	180.8	280mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	9
	180.3					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	30
				3	SS	31
2						
				4	SS	44
3						
				5	SS	42
4						
		...reddish brown		6	SS	20
5	176.1					
	5.0	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	3.6	177.5
Nov 12, 2013	2.4	178.7

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 4

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

Position : E: 595992, N: 4812994 (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	Elevation Scale (m)
	180.3	**GROUND SURFACE**					
0	180.0	280mm **TOPSOIL**					180
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	5	
	179.5						
	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	24	179
1							
				3	SS	36	
2		...cobble/boulder inclusions, reddish brown		4	SS	49	178
3				5	SS	53	177
	176.8						
	3.5	**END OF BOREHOLE**					

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

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

auger grinding

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

Terraprobe

BOREHOLE LOG 5

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

Position : E: 595865, N: 4813157 (UTM 17T)

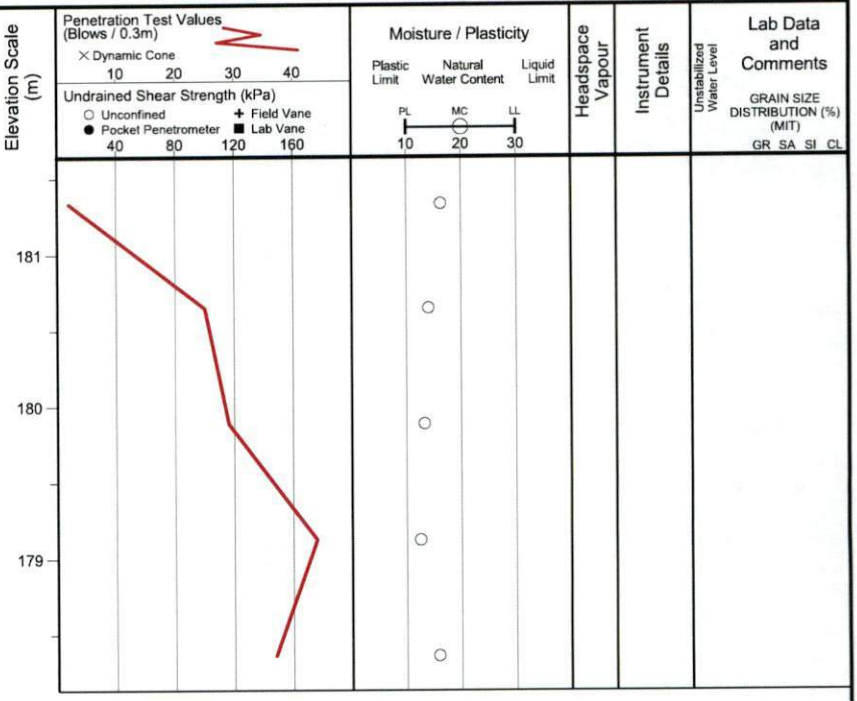
Elevation Datum : Geodetic

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	181.6	**GROUND SURFACE**				
	181.3	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	2
	180.8					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	25
				3	SS	29
2				4	SS	44
3				5	SS	37
	178.1					
	3.5	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 6

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

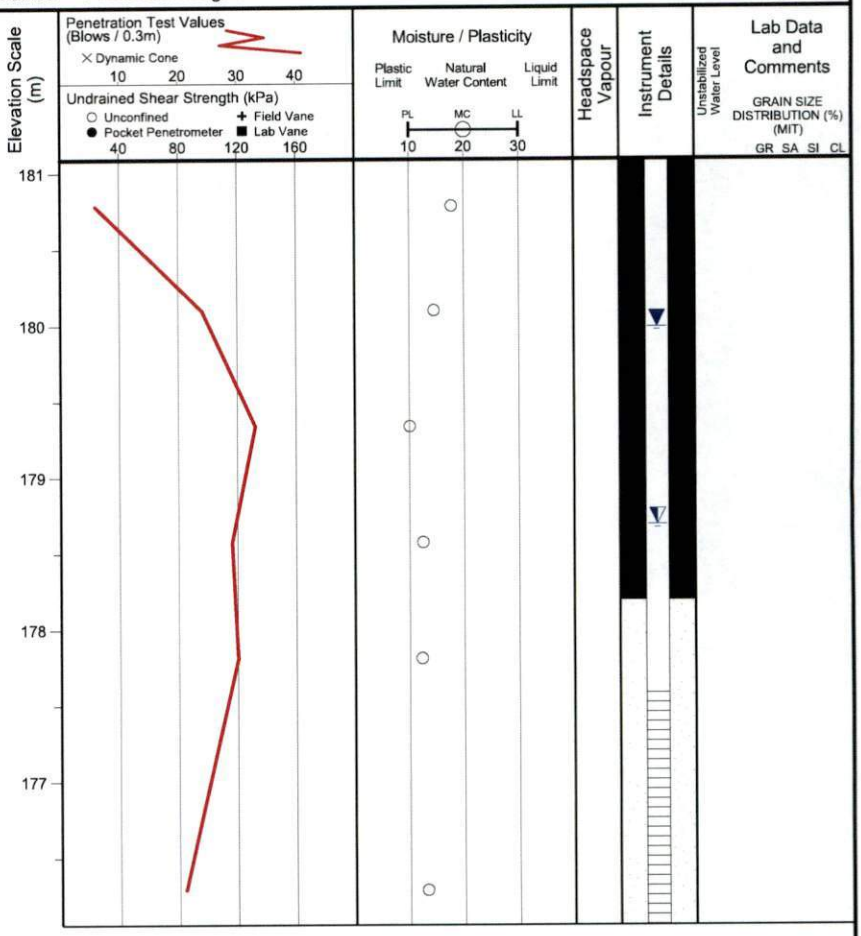
Position : E: 595815, N: 4813226 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	181.1	**GROUND SURFACE**				
	180.8	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	6
	180.3					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	24
				3	SS	33
2				4	SS	29
3				5	SS	30
4		...reddish brown		6	SS	21
5	176.1					
	5.0	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	2.4	178.7
Nov 12, 2013	1.1	180.0

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 7

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

Position : E: 595884, N: 4813274 (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
	180.2	**GROUND SURFACE**				
0		600mm **TOPSOIL**		1	SS	3
	179.6					
	0.6 179.4	Trace organics (WEATHERED/DISTURBED)				
	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	26
1				3	SS	38
2		...cobble/boulder inclusions, reddish brown		4	SS	30
3				5	SS	50 / 100mm
	176.9 3.3					

Elevation Scale (m): 180, 179, 178, 177

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

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

auger grinding

spoon bouncing

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 8

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

Position : E: 595936, N: 4813286 (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	Sample Number	Sample Type	SPT 'N' Value
0	180.0	**GROUND SURFACE**				
	179.6	350mm **TOPSOIL**		1	SS	3
	0.4	Trace organics (WEATHERED/DISTURBED)				
	179.2			2	SS	16
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)				
				3	SS	37
2						
				4	SS	35
3						
	176.5			5	SS	33
	3.5	**END OF BOREHOLE**				

Elevation Scale (m): 180, 179, 178, 177

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
2 32 45 21

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.gtb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 9

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

Position : E: 596073, N: 4813274 (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
	178.7	**GROUND SURFACE**				
0	178.3	400mm **TOPSOIL**		1	SS	6
	0.4	Trace organics (WEATHERED/DISTURBED)				
	177.9					
	0.8	**CLAYEY SILT**, trace gravel, very stiff to hard, brown / grey, moist (GLACIAL TILL)		2	SS	29
1						
				3	SS	27
2						
				4	SS	48
3						
				5	SS	27
4		...clayey sandy silt, reddish brown				
				6	SS	17
5	173.7					
	5.0	**END OF BOREHOLE**				

Elevation Scale (m): 178, 177, 176, 175, 174

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
5 22 48 25

Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	4.3	174.4
Nov 12, 2013	3.8	174.9

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 10

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

Position : E: 596287, N: 4813343 (UTM 17T)

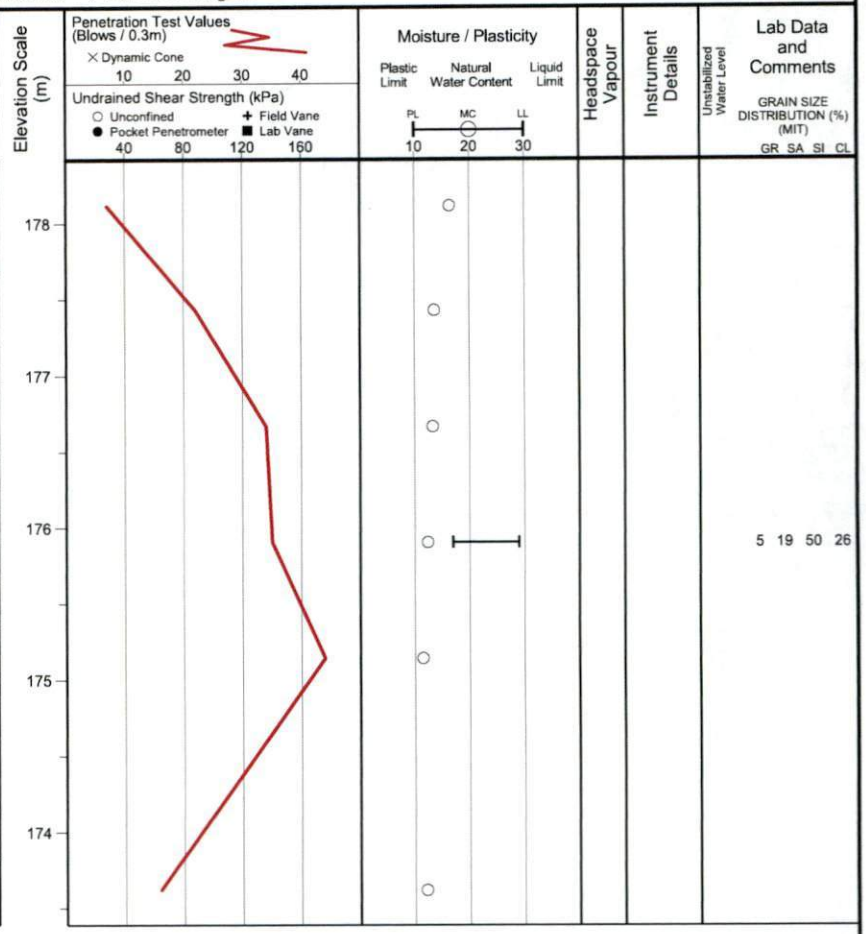
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	178.4	**GROUND SURFACE**				
	178.1	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	7
	177.6					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	22
				3	SS	34
2				4	SS	35
3				5	SS	44
4		...reddish brown		6	SS	16
5	173.4					
	5.0	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 11

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

Position : E: 596147, N: 4813241 (UTM 17T)

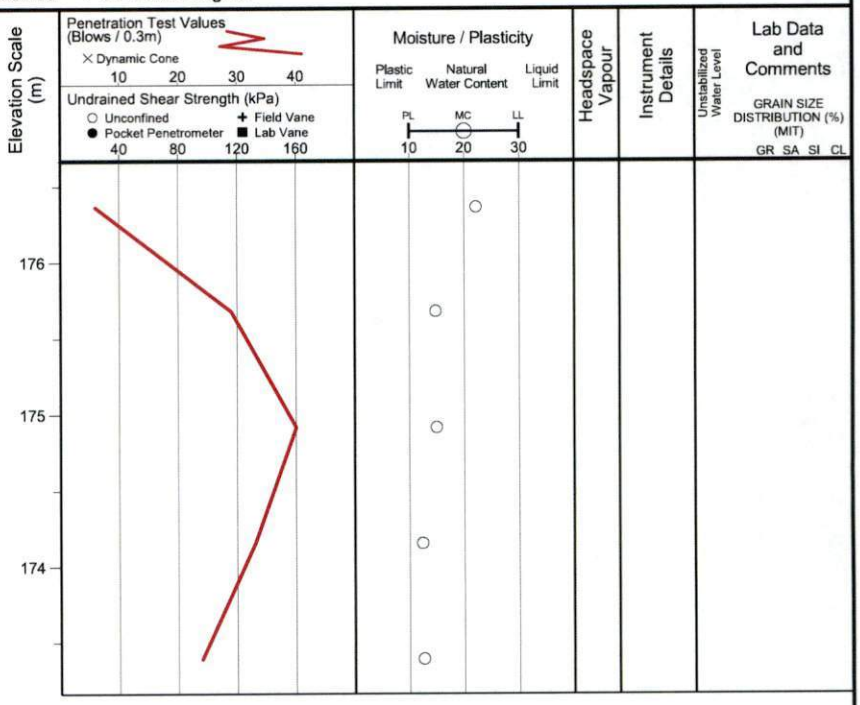
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
	176.7	**GROUND SURFACE**				
0	176.4	300mm **TOPSOIL**		1	SS	6
	0.3	Trace organics (WEATHERED/DISTURBED)				
	175.9			2	SS	29
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)				
				3	SS	40
2						
				4	SS	33
3		...reddish brown		5	SS	24
	173.2					
	3.5	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 12

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

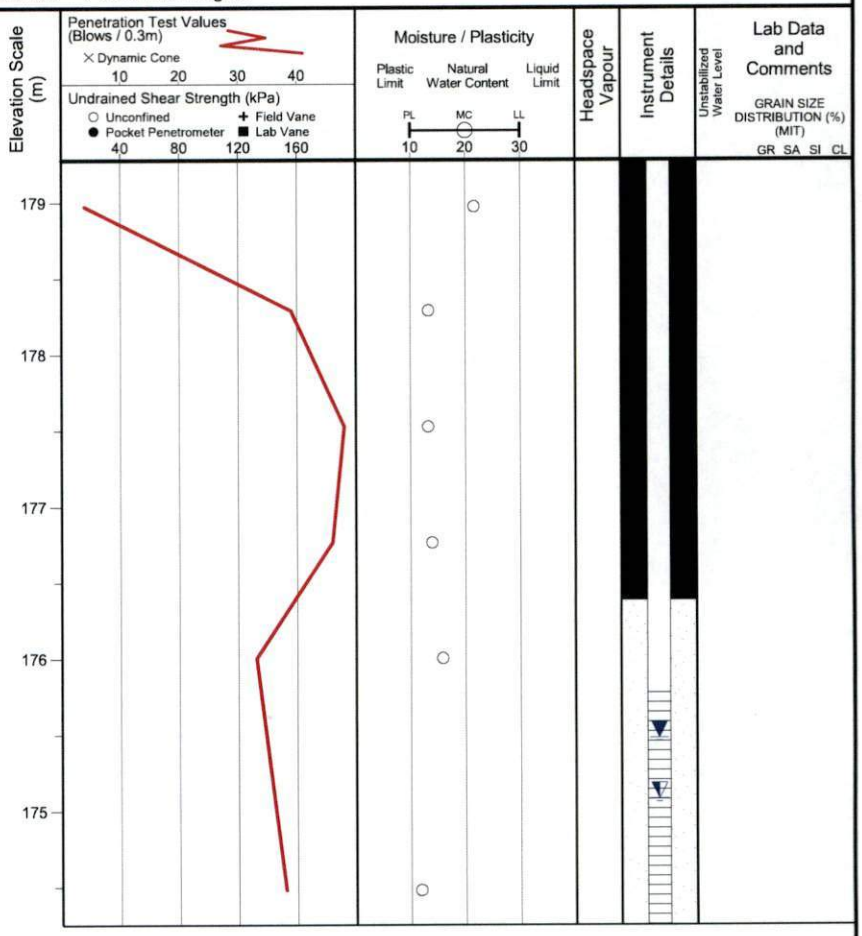
Position : E: 596138, N: 4813080 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	179.3	**GROUND SURFACE**				
	179.0	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	4
	178.5					
	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, hard, brown, moist (GLACIAL TILL)		2	SS	39
1				3	SS	48
2				4	SS	46
3				5	SS	33
4		...reddish brown		6	SS	38
5	174.3					
	5.0	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	4.2	175.1
Nov 12, 2013	3.8	175.5

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 13

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

Position : E: 596139, N: 4813043 (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	Sample Number	Sample Type	SPT 'N' Value
0	180.3	**GROUND SURFACE**				
		70mm **INTERLOCKING PAVERS**				
		390mm **AGGREGATE**		1	SS	10
	179.8					
	0.5	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown / grey, moist (GLACIAL TILL)		2	SS	20
1						
				3	SS	32
2						
				4	SS	34
3		...clay and silt		5	SS	32
4						
				6	SS	31
5	175.3					
	5.0	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 180, 179, 178, 177, 176

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
1	11	39	49

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 14

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

Position : E: 595980, N: 4813088 (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	Sample Number	Sample Type	SPT 'N' Value
0	181.0	**GROUND SURFACE**				
	180.7	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	10
	180.2					
1	0.8	**CLAYEY SILT**, trace gravel, very stiff to hard, brown / grey, moist (GLACIAL TILL)		2	SS	45
				3	SS	34
2				4	SS	45
3		...clayey sandy silt		5	SS	53
4		...reddish brown		6	SS	17
5	176.0					
	5.0	**END OF BOREHOLE**				

Elevation Scale (m): 180, 179, 178, 177, 176

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
4 21 46 29

Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	4.3	176.7
Nov 12, 2013	3.9	177.1

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 15

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 4, 2013

Sheet No. : 1 of 1

Position : E: 596000, N: 4813159 (UTM 17T)

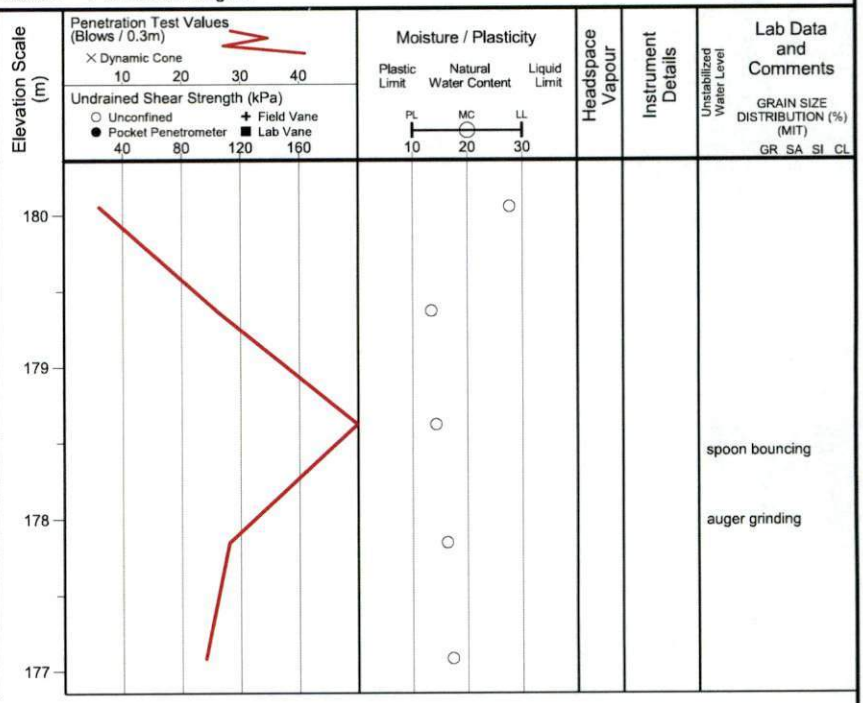
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	180.4	**GROUND SURFACE**				
	180.1	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	6
	179.6					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel (cobble/boulder inclusions), very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	26
				3	SS	75 / 275mm
2				4	SS	28
3				5	SS	24
	176.9					
	3.5	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.gtb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 16

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

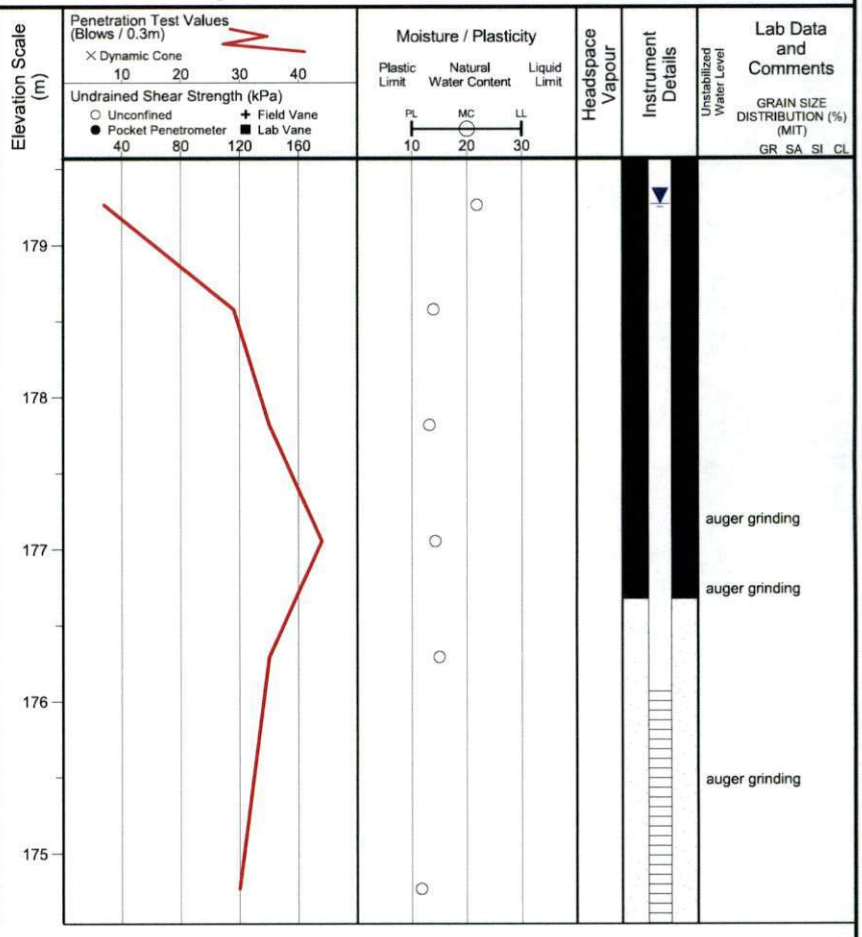
Position : E: 595959, N: 4813276 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	179.6	**GROUND SURFACE**				
	179.2	350mm **TOPSOIL**		1	SS	7
	0.4	Trace organics (WEATHERED/DISTURBED)				
	178.8					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel (cobble/boulder inclusions), very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	29
				3	SS	35
2				4	SS	44
3				5	SS	35
4						
5	174.6			6	SS	30
	5.0	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	0.3	179.3
Nov 12, 2013	0.3	179.3

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 17

Client : Ken Dakin Land Use Planning Consultant
Project : Holy Family Catholic Cemetery
Location : Milton, Ontario

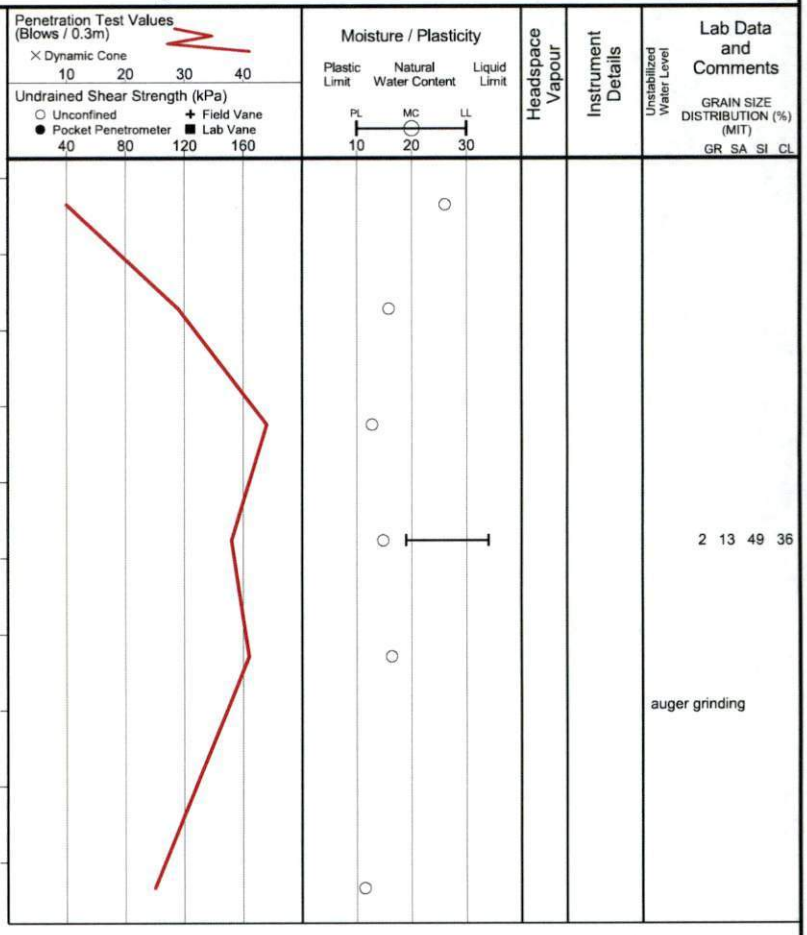
Project No.: 11-13-3165
Date started : October 8, 2013
Sheet No. : 1 of 1

Position : E: 596045, N: 4813240 (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
	179.1	**GROUND SURFACE**				
0		400mm **TOPSOIL**				
	178.7			1	SS	10
	0.4	Trace organics (WEATHERED/DISTURBED)				
	178.3					
	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	29
1						
				3	SS	44
2						
		...silt and clay		4	SS	38
3		...cobble/boulder inclusions		5	SS	41
4						
		...reddish brown		6	SS	25
	174.1					
5	5.0					

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 18

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 8, 2013

Sheet No. : 1 of 1

Position : E: 596080, N: 4813252 (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	Sample Number	Sample Type	SPT 'N' Value
0	178.8	**GROUND SURFACE**				
	178.4	400mm **TOPSOIL**		1	SS	3
	0.4	Trace organics (WEATHERED/DISTURBED)				
	178.0					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	30
				3	SS	27
2				4	SS	44
3				5	SS	61
	175.3					
	3.5	**END OF BOREHOLE**				

Elevation Scale (m): 178, 177, 176

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

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

Borehole was dry and open upon completion of drilling.

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.gtb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 19

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

Position : E: 596087, N: 4813206 (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	Sample Number	Sample Type	SPT 'N' Value
0	178.8	**GROUND SURFACE**				
	178.6	200mm **TOPSOIL**				
	0.2	Trace organics (WEATHERED/DISTURBED)		1	SS	10
	178.0					
1	0.8	**CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	26
				3	SS	31
2				4	SS	44
3				5	SS	32
4		...reddish brown		6	SS	36
5	173.8					
	5.0	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 178, 177, 176, 175, 174

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

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

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
2 17 50 31

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

Terraprobe

BOREHOLE LOG 20

Client : Ken Dakin Land Use Planning Consultant

Project : Holy Family Catholic Cemetery

Location : Milton, Ontario

Project No.: 11-13-3165

Date started : October 7, 2013

Sheet No. : 1 of 1

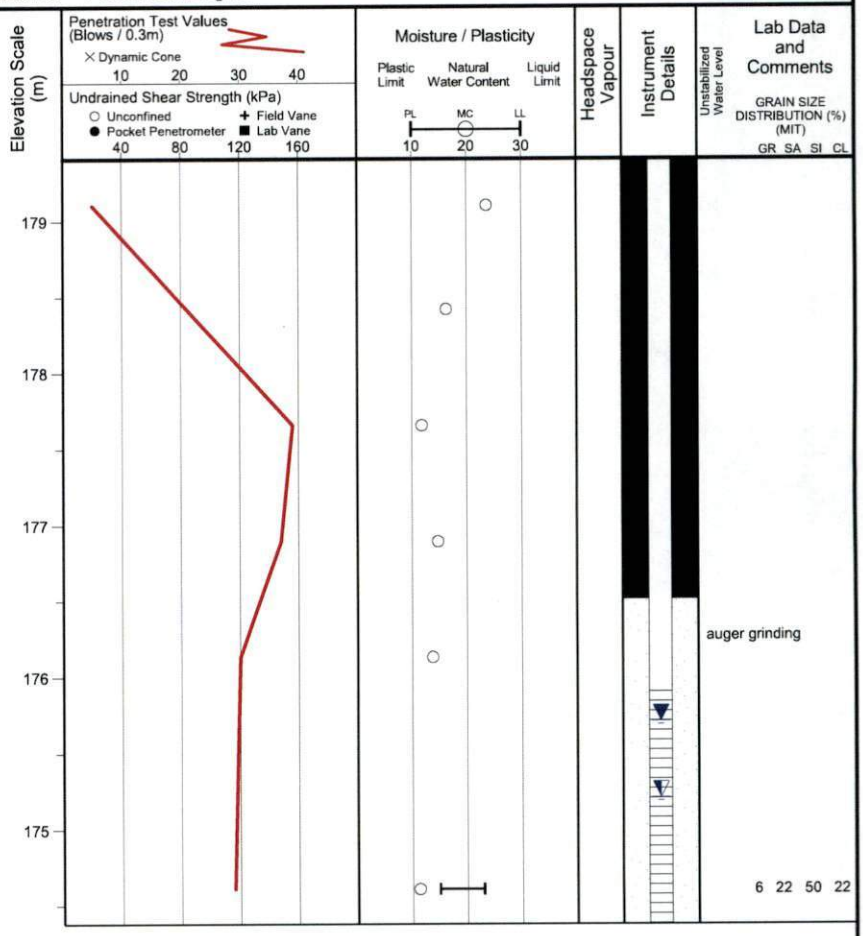
Position : E: 596069, N: 4813177 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	179.4	**GROUND SURFACE**				
	179.1	300mm **TOPSOIL**				
	0.3	Trace organics (WEATHERED/DISTURBED)		1	SS	5
	178.6					
1	0.8	**CLAYEY SILT**, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	21
				3	SS	39
2				4	SS	37
3		...cobble/boulder inclusions		5	SS	30
4						
		...clayey sandy silt, reddish brown		6	SS	29
5	174.4					
	5.0	**END OF BOREHOLE**				



Borehole was dry and open upon completion of drilling.

19 mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 24, 2013	4.2	175.2
Nov 12, 2013	3.7	175.7

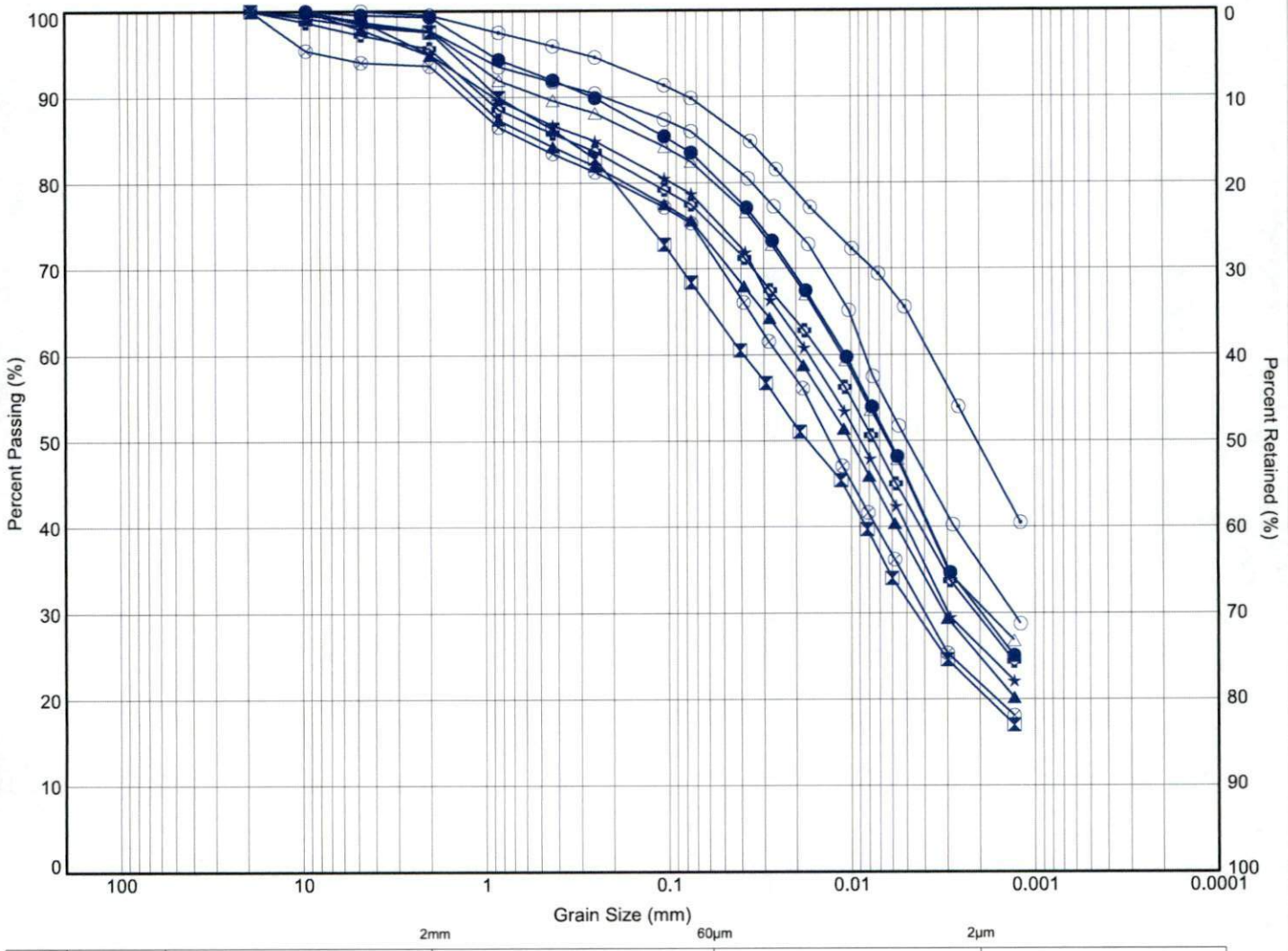
RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

library: library - terraprobe gint.glb report: terraprobe soil log file: 11-13-3165 bh logs.gpj

SIEVE AND HYDROMETER ANALYSIS

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TERRAPROBE INC.



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

MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**1**	SS2	1.0	179.9	1	18	51	30	
⧓	**8**	SS2	1.0	179.0	2	32	45	21	
▲	**9**	SS6	4.8	173.9	5	22	48	25	
★	**10**	SS4	2.5	175.9	5	19	50	26	
⊙	**13**	SS5	3.3	177.0	1	11	39	49	
✿	**14**	SS5	3.3	177.7	4	21	46	29	
○	**17**	SS4	2.5	176.6	2	13	49	36	
△	**19**	SS3	1.8	177.1	2	17	50	31	
⊗	**20**	SS6	4.8	174.6	6	22	50	22	

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

Title: **GRAIN SIZE DISTRIBUTION**
CLAYEY SILT TO SILT AND CLAY TILL

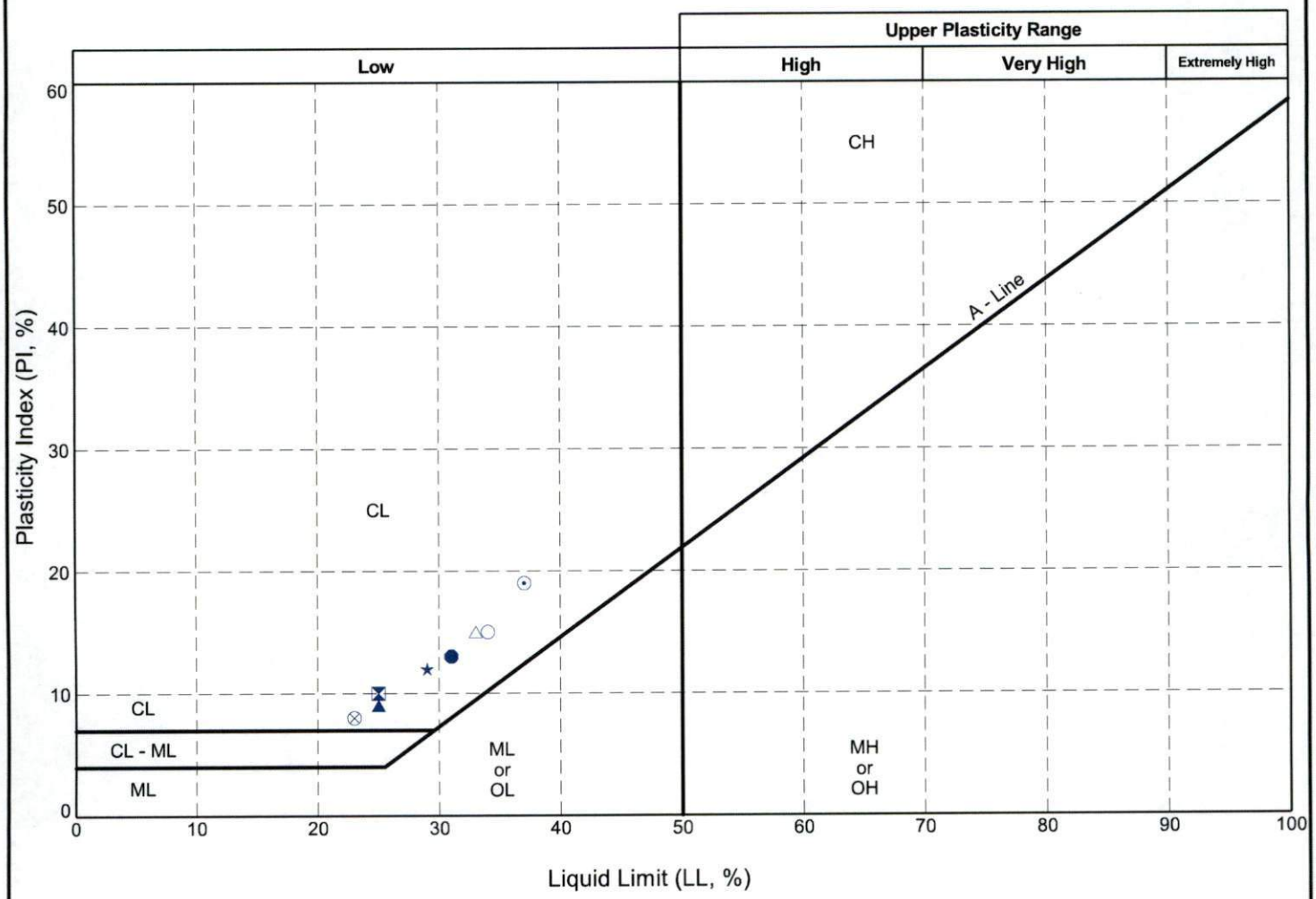
File No.: **11-13-3165**

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

ATTERBERG LIMITS TEST RESULTS

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TERRAPROBE INC.



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)	Description
●	1	SS2	1.0	179.9	31	18	13	SLIGHTLY PLASTIC
⧓	8	SS2	1.0	179.0	25	15	10	SLIGHTLY PLASTIC
▲	9	SS6	4.8	173.9	25	16	9	SLIGHTLY PLASTIC
★	10	SS4	2.5	175.9	29	17	12	SLIGHTLY PLASTIC
⊙	13	SS5	3.3	177.0	37	18	19	MEDIUM PLASTIC
✿	14	SS5	3.3	177.7	31	18	13	SLIGHTLY PLASTIC
○	17	SS4	2.5	176.6	34	19	15	SLIGHTLY PLASTIC
△	19	SS3	1.8	177.1	33	18	15	SLIGHTLY PLASTIC
⊗	20	SS6	4.8	174.6	23	15	8	SLIGHTLY PLASTIC

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

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

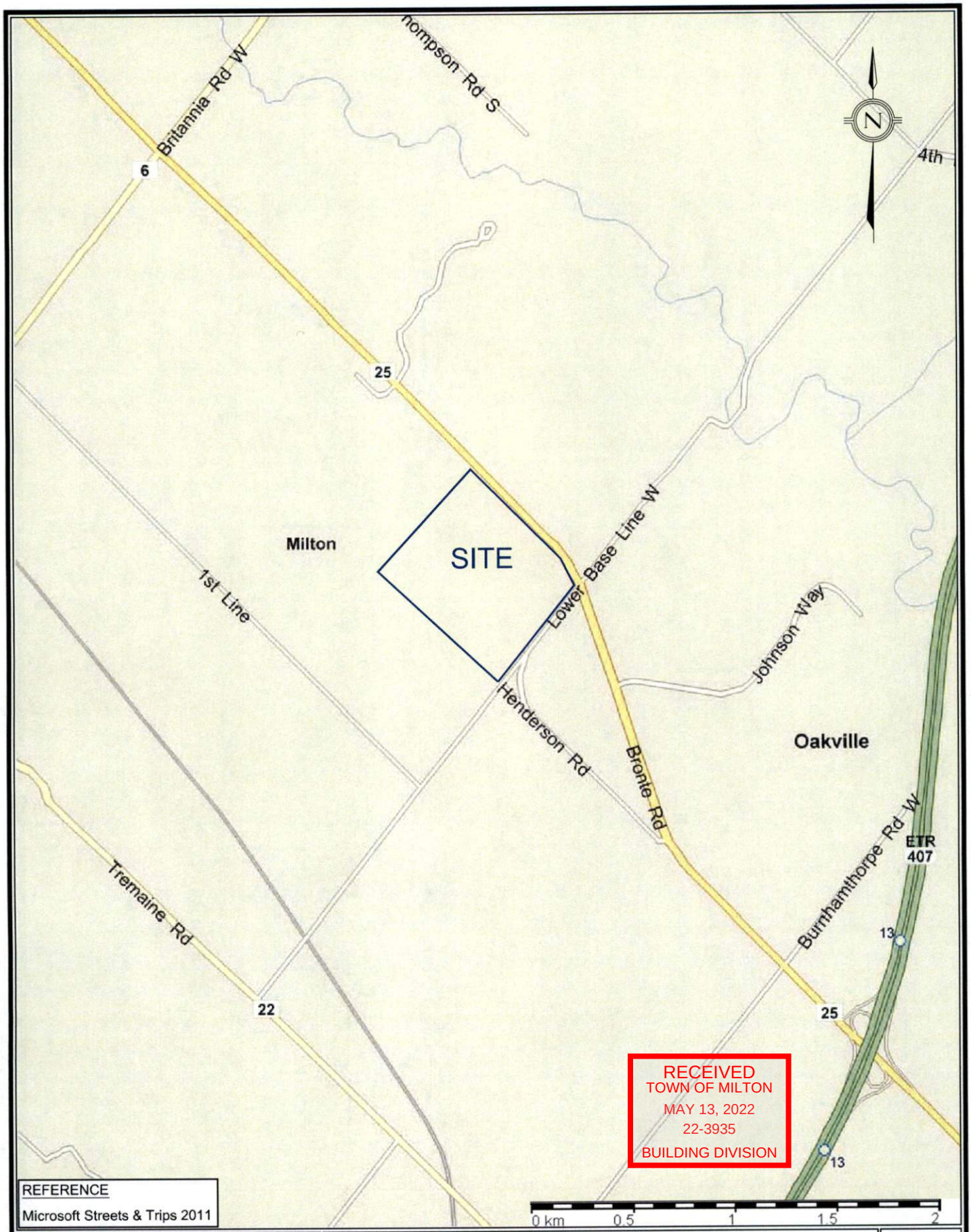
Title: **ATTERBERG LIMITS CHART**

File No.: **11-13-3165**

FIGURES

RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

TERRAPROBE INC.

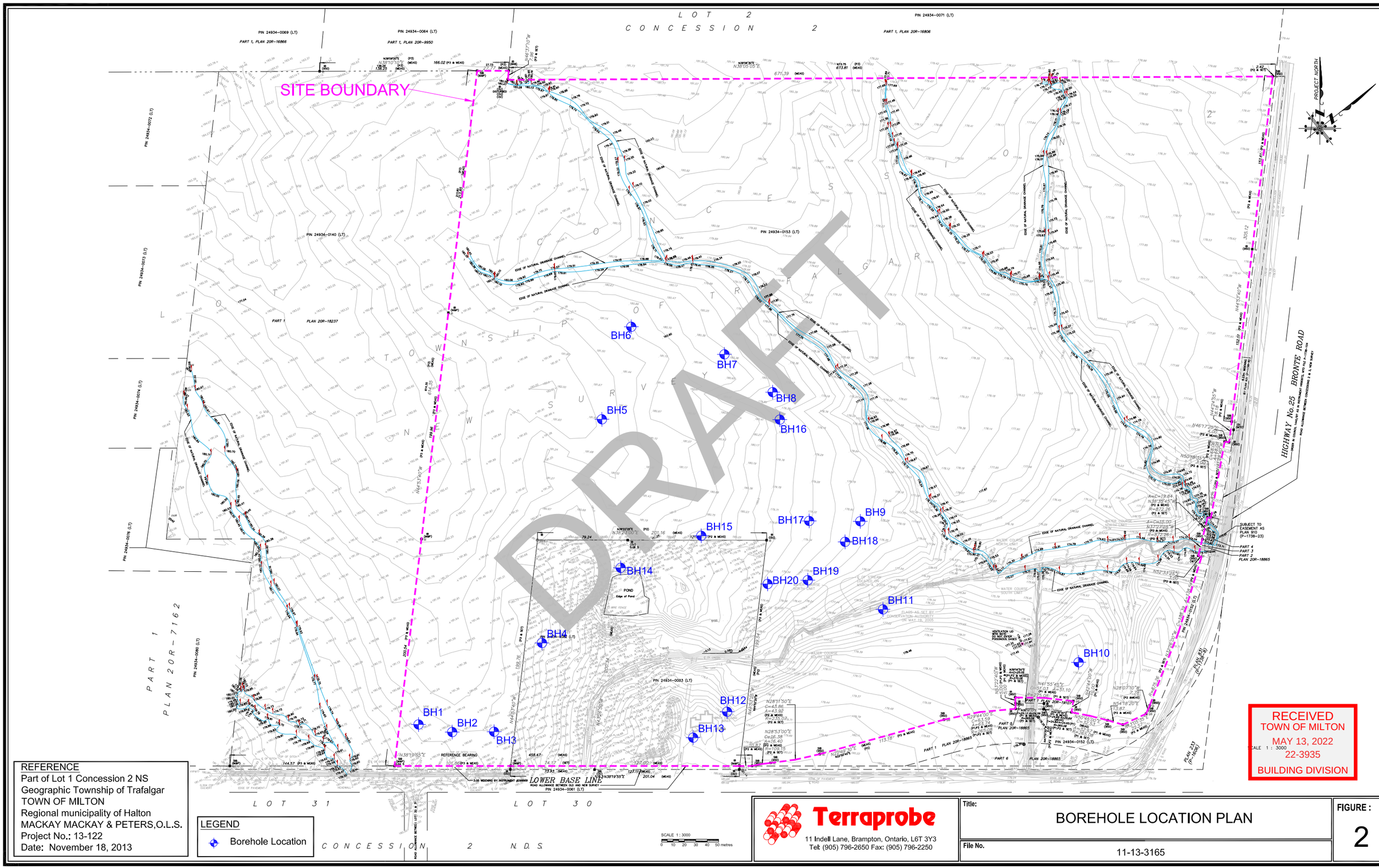


RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

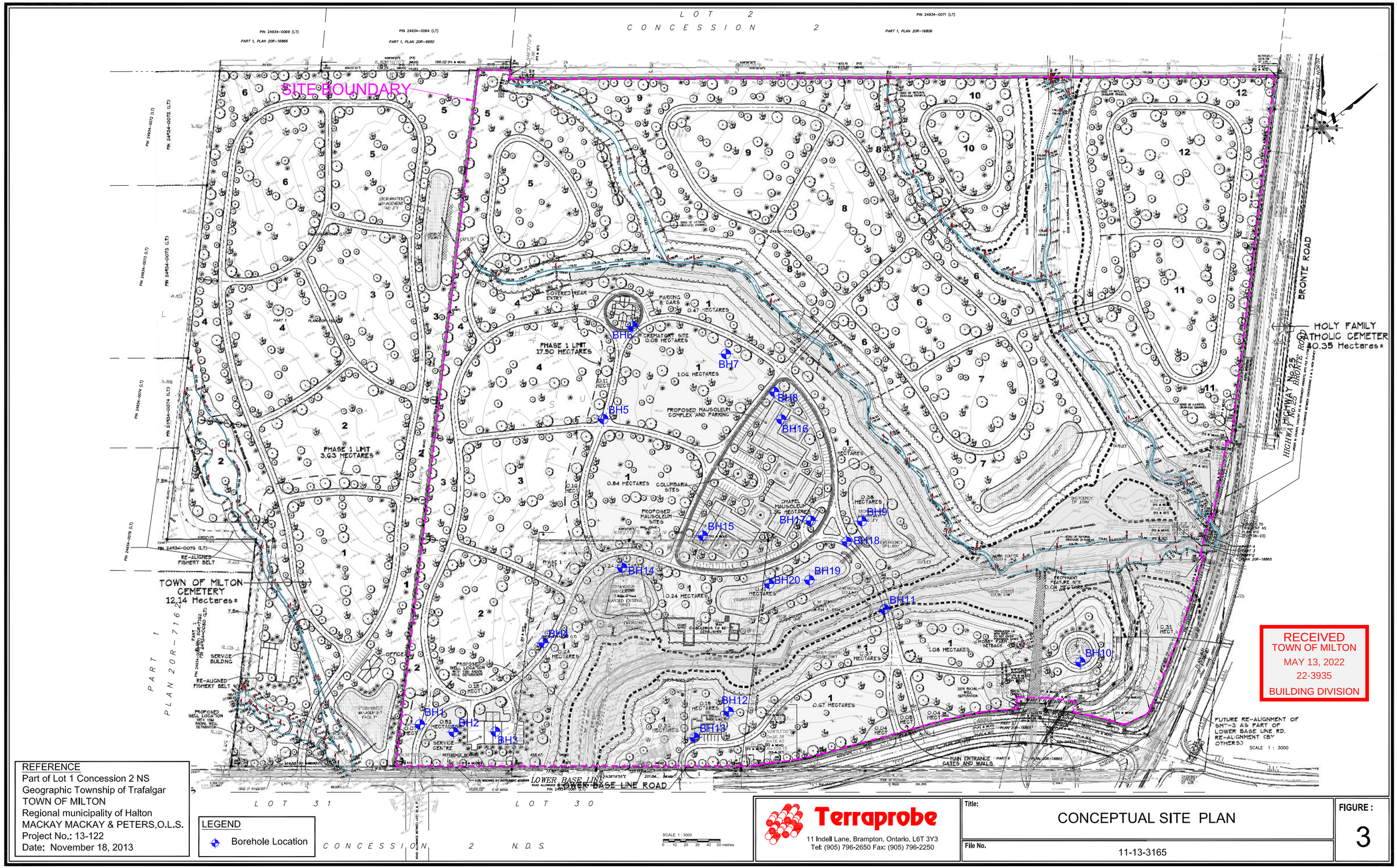
REFERENCE
Microsoft Streets & Trips 2011

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

Title:	FIGURE :
SITE LOCATION PLAN	1
File No. 11-13-3165	



\\PDC\Server1\Project Files\11-Geo\2013\11-13-3165\A_Dwgs, Logs\AutoCAD\11-13-3165 Figs- (Revised).dwg, Kamal



RECEIVED
TOWN OF MILTON
MAY 13, 2022
22-3935
BUILDING DIVISION

REFERENCE
Part of Lot 1 Concession 2 NS
Geographic Township of Trafalgar
TOWN OF MILTON
Regional municipality of Halton
MACKAY MACKAY & PETERS,O.L.S.
Project No.: 13-122
Date: November 18, 2013

LEGEND
Borehole Location

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

Title: CONCEPTUAL SITE PLAN

File No. 11-13-3165

FIGURE : 3

\\PDC\Server\1-Project Files\11-Geo\2013\11-13-3165\A. Dwgs, Logs\AutoCAD\11-13-3165 Figs- (Revised).dwg, Kamal