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A REPORT TO
UNITED HOLDINGS INC.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

NORTHWEST OF MOUNT HOPE ROAD AND COLUMBIA WAY

TOWN OF CALEDON

REFERENCE NO. 2309-S138

DECEMBER 2023

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with written authorization dated September 21, 2023, from Mr. Giuseppe Paolicelli of United Holdings Inc., a geotechnical investigation was carried out at a land parcel to the northwest of Mount Hope Road and Columbia Way in the Town of Caledon.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the design and construction of the proposed residential development. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Caledon is situated on Halton Till plain where the drift dominates the soil stratigraphy. In places, lacustrine sand, silt and clay, which has been reworked by the water action of Peel Ponding (glacial lake), have modified the drift stratigraphy.

The subject site, which encompasses a gross developable area of 33.68 hectares, is situated on to the northwest of Mount Hope Road and Columbia Way in the Town of Caledon. At the time of investigation, the site was occupied by farm fields. The existing site gradient is undulating with grade difference of approximately 4 m.

It is understood that the site will be developed into a residential subdivision with mid-rise buildings with 2-levels of underground parking in parts of the site, provided with municipal services and paved roadways meeting the municipality's standards.

3.0 FIELD WORK

The field work, consisting of 13 sampled boreholes extending to depths ranging from 6.6 to 17.2 m below the prevailing ground surface, was performed between September 23 and 26, 2023. Upon completion of borehole drilling and sampling, groundwater monitoring wells were installed in selected boreholes to facilitate groundwater monitoring and hydrogeological assessment. Details of the monitoring wells are shown on the Borehole Logs. The locations of the boreholes and monitoring wells are shown on the Borehole and Monitoring Well Location Plan, Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a track-mounted machine using both solid and hollow stem augers and equipped with split spoon sampler for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed

"List of Abbreviations and Terms", were performed at the sampling depths. The results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

The field work was supervised, and the findings were recorded by the geotechnical technician. The ground elevation at each borehole location was obtained using hand-held Global Navigation Satellite System (GNSS) survey equipment.

4.0 SUBSURFACE CONDITIONS

The boreholes were carried out in the farm field. The investigation revealed that beneath a veneer of topsoil, and a layer of earth fill in places, the site is generally underlain by strata of silty clay and silty clay till.

Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 14, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 Topsoil

A layer of topsoil, approximately 10 to 36 cm in thickness, was contacted at the ground surface in all boreholes. Thicker topsoil layer may be contacted in areas beyond the borehole locations, especially in treed and/or low-lying areas.

4.2 Earth Fill

A layer of earth fill, consisting of silty clay with topsoil and organics inclusion, was contacted beneath the topsoil veneer at Boreholes 5 and 6. The fill extends to depths of 4.7 m and 3.7 m below the ground surface, respectively.

The recorded 'N' values range from 7 to 16 blows per 30 cm of penetration, showing the fill was place with nominal compaction and without quality control. In places, the fill may have self-consolidated over time.
The natural water content values range from 13% to 26%, with a median of 21%, indicating the fill is in moist condition.

One must be aware that the samples retrieved from boreholes may not be truly representative of the geotechnical and environmental quality of the earth fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This can be further assessed by laboratory testing and/or test pits.

4.3 Silty Clay Till and Silty Clay

Native silty clay till and silty clay was generally contacted beneath the topsoil veneer and earth fill. Occasional wet sand and silt layers were also identified within the drift. Grain size analyses were performed on 6 representative samples of silty clay and the results are plotted on Figures 15 and 16.

The recorded 'N' values range from 8 to over 100, with a median of 25 blows per 30 cm of penetration, indicating the silty clay till and silty clay are stiff to hard, being generally very stiff in consistency.

The natural water content values range from 9% to 25%, with a median of 18%, indicating the silty clay till and silty clay are generally in moist conditions.

Atterberg Limits were performed on 3 representative samples of the silty clay. The resulting Liquid Limits of 25% to 40% and the Plastic Limits of 16% to 19% indicate that the silty clay is low to medium in plasticity.

The engineering properties of the silty clay till and silty clay are presented below:

- High frost susceptibility and low water erodibility.
- In excavation, both silty clay till and silty clay will be stable in relatively steep cuts; however, prolonged exposure may be prone to localized sloughing, especially in areas where wet sand/silt layers were contacted.
- The relatively weak clay may undergo long term consolidation settlement under additional surcharge load from the proposed building and site grading.

5.0 GROUNDWATER CONDITION

The groundwater was not recorded in deep boreholes, Boreholes 1, 2 and 4, since water was used for borehole drilling. The remaining boreholes were checked for the presence of groundwater on completion of borehole drilling. The recorded groundwater levels in the boreholes are summarized in Table 1.

Table 1 - Groundwater Levels on Completion of Drilling

Borehole No.	Ground Elevation (m)	Borehole Depth (m)	Recorded Groundwater Level	
			Depth (m)	Elevation (m)
3	260.3	6.6	Dry	Below 253.7
5	259.2	8.1	3.1	256.2
6	258.9	8.1	Dry	Below 250.8
7	259.0	6.6	5.9	253.1
8	262.0	6.6	6.0	256.1
9	260.6	6.6	2.1	258.4
10	263.1	6.6	Dry	Below 256.5
11	260.9	6.6	Dry	Below 254.3
12	263.0	6.6	5.9	257.1
13	262.0	6.6	6.1	255.9

The groundwater levels were recorded at depths between 3.1 m and 6.1 m below grade, or between El. 258.4 m and El. 253.1 m on completion of borehole drilling. Detailed interpretation of the groundwater will be provided in the hydrogeological assessment under separate cover.

6.0 DISCUSSION AND RECOMMENDATIONS

The boreholes were carried out in the farm field. The investigation revealed that beneath a veneer of topsoil, and a layer of earth fill in places, the site is generally underlain by strata of silty clay and silty clay till.

The groundwater levels were recorded at depths between 3.1 m and 6.1 m below grade, or between El. 258.4 m and El. 253.1 m on completion of borehole drilling.

It is understood that the development will consist of a residential subdivision with mid-rise buildings with 2-level of underground parking in parts of the site. The geotechnical findings which warrant special considerations are presented below:

1. The topsoil must be stripped before site grading and construction. It can only be reused for landscaping purpose. Any surplus should be disposed off-site.

2. The existing earth fill and any badly weathered/ploughed soils should be subexcavated, inspected, sorted free of organics and/or deleterious material, before reusing for structural backfill or engineered fill.
3. Where site grading with additional fill is required, the earth fill should be constructed in an engineered manner for building foundation, underground services and road construction.
4. The low-rise residential dwellings with basement can be supported with conventional spread and strip footings founded on engineered fill or sound native soils. In conventional design, the foundation wall must be damp-proofed and provided with a perimeter subdrain at wall base, connected to a positive outlet.
5. Bulk excavation for the mid-rise buildings with 2 levels of underground parking will likely extend to at least 6 to 7 m below grade, in which native silty clay till or silty clay is anticipated, and it is suitable to support the proposed structure on conventional spread and strip footing.
6. The foundation subgrade should be inspected by the geotechnical engineer or the senior geotechnical technician to ensure that the revealed conditions are compatible with the foundation design requirements.
7. A Class 'B' bedding, consisting of compacted 19-mm Crusher-Run Limestone (CRL), is recommended for the construction of underground utilities.
8. Excavation should be carried out in accordance with O. Reg. 213/91. Where safe sloped excavation is not feasible, temporary braced shoring walls will be required for the excavation and construction of the underground parking and foundation.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should any subsurface variance become apparent during construction, the geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 Site Preparation

Where the site needs to be re-graded with additional earth fill, the fill should be constructed in an engineered manner to support building foundation, underground utilities and pavement construction. The engineering requirements for a certifiable fill are presented below:

1. The topsoil must be stripped. It can only be reused for landscaping purposes. Any surplus should be disposed off-site.
2. The existing earth fill must be subexcavated, sorted free of organics, topsoil, and/or other deleterious material, before reusing for engineered fill construction.

3. The exposed subgrade must be inspected and proof-rolled prior to any fill placement. Badly weathered/ploughed soils near the ground surface should also be subexcavated, sorted free of organics and deleterious materials, if any, aerated before reuse for site grading.
4. Inorganic soil must be used for engineered fill construction. It should be uniformly compacted in lifts 20 cm thick to at least 98% Standard Proctor Dry density (SPDD) up to the proposed finished grade. The soil moisture must be properly controlled near the optimum. If the foundation is to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% SPDD.
5. If imported fill is to be used, it should be inorganic soil, free of deleterious material. Any potential imported earth fill must be reviewed for geotechnical and environmental assessment by the appropriate personnel as authorized by the developer or agency, before being hauled to the site.
6. The engineered fill must not be placed when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
7. The engineered fill must extend over the entire graded area; the engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors.
8. The bank of the engineered fill envelope must be maintained at a gradient equal to or flatter than 1 vertical (V):3 horizontal (H) for safe operation of the compactor in order to obtain the required compaction.
9. The fill operation should be inspected and monitored on a full-time basis by the geotechnical engineer or senior geotechnical technician.
10. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundation is placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.
11. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who supervised the fill placement in order to document the locations of the excavation and/or to supervise reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
12. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the foundation constructed

partially or fully on the engineered fill should be reinforced and designed by a structural engineer.

13. In sewer construction, the engineered fill is considered to have the same structural proficiency as a native inorganic soil.

Should additional earth fill is required for site grading, the additional surcharge may cause potential long-term settlement. It is recommended that the site grading plan be reviewed for potential long-term settlement.

6.2 Foundation

Low Rise Residential Dwellings

The proposed low-rise residential dwellings with basement can be supported with conventional spread and strip footings founded on engineered fill or sound native soils. The recommended bearing pressures at the Ultimate Limit State (ULS) and Serviceability Limit State (SLS) for the design of conventional spread and strip footings are provided as follows:

- Maximum Allowable Soil Bearing Pressure at SLS = 150 kPa
- Factored Ultimate Bearing Pressure at ULS = 250 kPa

Mid Rise Developments with 2-level of Underground Parking

While detailed design of the mid-rise developments is not available for review, it is anticipated that the proposed mid-rise buildings with 2 levels of underground parking will be found at least 6 to 7 m below the prevailing ground surface, which consists of native silty clay till or silty clay, and it is suitable to support the proposed structure on conventional spread and strip footing.

The recommended bearing pressures at ULS and SLS for the design of conventional spread and strip footings are provided as follows:

- Maximum Allowable Soil Bearing Pressure at SLS = 200 kPa
- Factored Ultimate Bearing Pressure at ULS = 300 kPa

The total and differential settlements of footings designing for the bearing pressure at SLS are estimated within 25 mm and 20 mm, respectively.

Where the footing size is excessively large, raft foundation may be considered to support the proposed structure. The above soil bearing pressures along with the Modulus of Subgrade Reaction of 25 MPa/m can be used for the design of the raft foundation.

Alternatively, where higher bearing pressures are required, deep foundation, extending to at least El. 246 to 248 m, can be considered. Further investigation with deeper boreholes will be necessary in order to provide a proper design for deep foundation consideration.

One must be noted that the above recommended design bearing pressures are for preliminary design purposes. During construction, the foundation subgrade should be inspected by the geotechnical engineer or senior geotechnical technician to ensure that the revealed conditions are compatible with the foundation design requirements.

Foundations exposed to weathering or in unheated areas should have at least 1.2 m of earth cover for protection against frost action. The frost cover for footings in the underground parking can be reduced if the parking entrances are kept closed most of the time in the winter season. A minimum earth cover of 0.9 m for interior footings and 0.6 m for the perimeter footings are recommended, except those footings in close proximity of the ventilation shafts and entrances.

The design of the foundation should meet the requirements specified in the latest Ontario Building Code. The proposed structure should be designed to resist an earthquake force using Site Classification ‘D’ (stiff soil).

6.3 Basement and Underground Structure Construction

The perimeter walls of the underground structure or basement should be designed to sustain the lateral earth pressure calculated using the soil parameters stated in Section 6.7. Any applicable surcharge loads adjacent to the proposed structure must be considered in the design of the foundation walls.

In conventional design of a typical basement, the perimeter wall should be damp-proofed and provided with subdrain at the wall base. The subdrain should be wrapped with geotextile filter fabric and connected to a positive outlet. Details of the perimeter subdrains for typical basement are illustrated on Drawing No. 3.

Where shoring is required for construction of the underground parking structure for the mid-rise development, prefabricated drainage board, such as Miradrain 6000 or equivalent, must be provided on the perimeter walls, between the shoring wall and the cast-in-place

foundation wall, as shown on Drawing No. 4. The perimeter drains should be installed on a positive gradient, connecting into the frost-free sump-well and discharge into the storm sewers.

The subgrade should consist of sound native soils or properly compacted inorganic soils. In preparation of the subgrade, it should be inspected and assessed by proof-rolling prior to slab-on-grade construction. The concrete slab should be constructed on a minimum 15 cm thick granular bedding, consisting of 19-mm CRL or equivalent, compacted to 100% SPDD.

The exterior grading should be sloped away from the proposed structures to prevent water ponding adjacent to the structures.

6.4 Underground Services

The subgrade for underground service pipes should consist of sound native soils or properly compacted earth fill. In areas where the subgrade consists of loose or soft soils, they should be subexcavated and replaced with the bedding material, properly compacted to 98% SPDD.

A Class 'B' granular bedding, consisting of compacted 19-mm CRL, or equivalent, is recommended for construction of underground services.

The pipe joints connecting into catch basins and manholes should be leak-proof or wrapped with an appropriate waterproof membrane. This is to prevent the migration of fines due to leakage, leading to a loss of subgrade support and subsequent sewer collapse.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover having a thickness equal to the diameter of the pipe should be in place at all times after completion of the pipe installation.

The service pipes and metal fittings should be protected against corrosion. For estimation of the anode weight, the estimated electrical resistivity of the disclosed soils can be used for the design of the anode weight. The proposed anode weight must meet the minimum requirements as specified by the Town's Standard.

6.5 Backfilling in Trenches and Excavated Areas

The on-site inorganic soils are generally suitable for structural backfill. Any wet soil must be aerated by spreading them thinly on ground surface under warm and dry weather. The backfill soils must be sorted free of any organics or other deleterious material, if any, prior to

backfilling. Any oversized cobbles and boulders (over 15 cm in size) should not be used for backfill.

The backfill in-service trenches or beside foundation walls should be compacted to at least 95% SPDD. In the zone within 1.0 m below the pavement subgrade or slab-on-grade, the material should be compacted to 98% SPDD, with the water content at 2% to 3% drier than the optimum. The lift of each backfill layer should be limited to a thickness of 20 cm or the lift thickness should be determined by test strips.

In normal construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns; it is recommended that a sand backfill should be used for compaction in confined spaces with a smaller vibratory compactor.

One must be aware of possible consequences during trench backfilling and exercise caution as described below:

- Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill when construction is carried out in freezing weather condition. Should the in-situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soil due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement. Thus, it is generally not recommended to carry out sewer construction under freezing weather.
- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1V:1.5+H, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% SPDD, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is

necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.

6.6 Pavement Design

The pavement design for local and collector residential roads is provided in Table 2.

Table 2 - Pavement Design (Municipal Roads)

Course	Thickness (mm)		OPS Specifications
	Local	Collector	
Asphalt Surface	40	50	HL-3
Asphalt Binder	75	100	HL-8
Granular Base	150		19-mm CRL or equivalent
Granular Sub-base	300	450	50-mm CRL or equivalent

The pavement design for access road into the mid-rise development is presented in Table 4.

Table 3 - Pavement Design (On-Grade Assess Road for Mid-Rise Developments)

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	75	HL-8
Granular Base	150	19-mm CRL or equivalent
Granular Sub-base	300	50-mm CRL or equivalent

Where the pavement is to be built on a structural slab, such as an underground garage rooftop, a sufficient granular and adequate drainage must be provided to prevent frost damage to the pavement. A waterproof membrane must be placed above the structural slab exposed to weathering to prevent water leakage, as well as to protect the reinforcing steel bars against brine corrosion. The recommended pavement structure to be placed on the roof of the underground structure is presented in Table 4.

Table 4 - Pavement Design (On Structural Slab)

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	75	HL-8
Granular Base	250	19-mm CRL or equivalent
Granular Sub-base	100	50-mm CRL or equivalent

Prior to the placement of granular materials, the subgrade should be inspected and proof-rolled. Any soft or wet subgrade identified should be sub-excavated and replaced by inorganic soils or granular materials, compacted to at least 98% SPDD, with the water content at 2% to 3% drier than the optimum, in lifts no more than 20 cm thick. All granular bases should be compacted to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to infiltrate prior to paving. The following measures should therefore be incorporated into the construction and road design.

- If the pavement construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Areas adjacent to the pavement should be properly graded to prevent the ponding of large amounts of water during the interim construction period.
- If the pavement is to be constructed during the wet seasons and extremely soft subgrade occurs, the granular sub-base may require thickening. This can be further assessed during construction.
- Fabric filter-encased curb subdrains are required to meet the Town's requirements.

6.7 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Existing Earth Fill/Silty Clay	21.0	11.0	1.33	1.03
Silty Clay Till	22.0	12.0	1.33	1.05
Lateral Earth Pressure Coefficients				
	Active, K_a	**At Rest, K_o**	**Passive, K_p**	
Compacted Earth Fill/Silty Clay	0.39	0.56	2.56	
Silty Clay Till	0.33	0.50	3.00	
Estimated Coefficients of Permeability (K) and Percolation Times (T)				
		K (cm/sec)	**T (min/cm)**	
Silty Clay/Silty Clay Till		10^{-7}	Over 50	
Estimated Electrical Resistivities		**ohm.cm**		
Silty Clay/Silty Clay Till		3000 to 3500		
Coefficients of Friction				
Between Concrete and Granular Base		0.50		
Between Concrete and Sound Native Soils		0.35		

6.8 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 6.

Table 6 - Classification of Soils for Excavation

Material	Type
Silty Clay Till and Silty Clay	2
Earth Fill and weathered soils	3

Where safe sloped excavation is not feasible, the excavation for underground parking must be supported by temporary braced shoring. The overburden, surcharge from any adjacent structures and hydrostatic pressure, if any, should be considered in the design of shoring. The design parameters and recommendations for shoring design are attached in Appendix.

Assessment of the adjacent building foundations, if any, should be carried out prior to the shoring design.

In excavation, any water seepage from the glacial till and clay will likely be limited in quantity and can be removed by conventional pumping from sumps.

Where necessary, prospective contractors may be asked to assess the in-situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation to assess the trenching conditions.

6.9 Monitoring of Performance

It is recommended that close monitoring of vertical and lateral movement of the shoring wall should be carried out and frequent site inspections should be conducted to ensure that the excavation does not adversely affect the structural stability of the adjacent buildings and the existing underground utilities. Extra bracing or support may be required if any movement is found excessive. The contractor should maintain the shoring to ensure any movement is within the design limit.

The foundation details of the adjacent structures must be investigated and incorporated into the design and construction of the proposed development. It is recommended that a pre-construction survey and a monitoring program be carried out for all adjacent structures in order to verify any potential future liability claims.

Vibration control and monitoring is strongly recommended for the adjacent properties and structures prior to any excavation activities at the site. Further advice or undertaking of the vibration control and monitoring can be provided as necessary.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of United Holdings Inc., and for review by its designated consultants, contractors, financial institutions, and government agencies. The material in the report reflects the judgment of Poh Fung Kwok, M.Sc. and Kin Fung Li, P.Eng., in light of the information available to it at the time of preparation.

Use of the report is subject to the conditions and limitations of the contractual agreement. Any uses which a Third Party makes of this report, and/or any reliance on decisions to be made based on it are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no

responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

Poh Fung Kwok, M.Sc.

Kin Fung Li, P.Eng.
PK/KL

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows per each 30 cm of penetration of a 51 mm diameter, 90° point cone driven by a 63.5 kg hammer falling from a height of 76 cm.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 63.5 kg hammer falling from a height of 76 cm required to advance a 51 mm outer diameter drive open sampler 30 cm into undisturbed soil, after an initial penetration of 15 cm.

Plotted as '○'

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/30 cm)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (kPa)	'N' (blows/30 cm)	Consistency
less than 12	less than 2	very soft
12 to 25	2 to 4	soft
25 to 50	4 to 8	firm
50 to 100	8 to 15	stiff
100 to 200	15 to 30	very stiff
over 200	over 30	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding
△ Laboratory vane test

METRIC CONVERSION FACTORS

1 ft = 0.3048 m
1 inch = 25.4 mm
1 lb = 0.454 kg
1 ksf = 47.88 kPa

JOB NO.: 2309-S138

LOG OF BOREHOLE: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers with Tricone

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 24, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
262.5	Ground Surface							
0.0	**23 cm TOPSOIL**	1	DO	13	0		20	
	Stiff to hard **SILTY CLAY TILL** traces of sand and gravel	2	DO	22	1			
		3	DO	26	2		17	
		4	DO	34			16	
	brown / grey	5A 5B	DO	25	3		17 18	
		6	DO	24	4		18	
	clay layer	7	DO	12	5			
		8	DO	19	6		25	
		9	DO	17	7		14	
	clay layer	10	DO	24	8		17	
		11	DO	43	9		20	
		12	DO	92/28	10		14	
	sand layer	13A 13B	DO	86/28	11		11	
245.3		14	DO	78	12		13 18	
17.2	**END OF BOREHOLE**				13		15	
	Installed 50 mm Ø PVC monitoring well to 16.8 m with 3.0 m screen Sand backfill from 13.1 to 16.8 m Bentonite seal from 0.0 m to 13.1 m Provided with monument casing				14 15 16 17 18 19 20			W.L. not recorded on completion due to mud rotary drilling

JOB NO.: 2309-S138

LOG OF BOREHOLE: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers with Tricone

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 26, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
262.6	Ground Surface							
0.0	**23 cm TOPSOIL**	1A 1B	DO	10	0		14	
	Brown, stiff to hard **SILTY CLAY** a trace of sand	2	DO	25	1		17	
		3	DO	37	2		17	
		4	DO	39			18	
		5	DO	30	3		19	
	wet silt layer	6	DO	32	4		19	
257.0					5			
5.6	Grey, very stiff to hard **SILTY CLAY TILL** traces of sand and gravel	7	DO	24	6		11	
		8	DO	16	7		20	
		9	DO	24	8		17	
	wet silt layer	10A 10B	DO	52	9		11 23	
		11	DO	63	10		18	
		12	DO	56	11		9	
247.9					12			
14.7	Grey, hard **SILTY CLAY** a trace of sand	13	DO	50/13	13		15	
245.6		14	DO	50/13	14		14	
17.0	**END OF BOREHOLE**				15			
	Installed 50 mm Ø PVC monitoring well to 16.8 m with 1.5 m screen Sand backfill from 14.6 to 16.8 m Bentonite seal from 0.0 m to 14.6 m Provided with monument casing				16			
					17			
					18			
					19			
					20			

W.L. not recorded on completion due to mud rotary drilling

Soil Engineers Ltd.

JOB NO.: 2309-S138

LOG OF BOREHOLE: 2S

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 26, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES: Number	SAMPLES: Type	SAMPLES: N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
262.6	Ground Surface							
0.0	**Straight auger to install well**				0			
					1			
					2			
					3			
					4			
					5			
256.5					6			
6.1	**END OF BOREHOLE**							
	Installed 50 mm Ø PVC monitoring well to 6.1 m with 1.5 m screen Sand backfill from 4 to 6.1 m Bentonite seal from 0.0 m to 4 m Provided with monument casing				7			
					8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			

W.L. not recorded on completion

JOB NO.: 2309-S138

LOG OF BOREHOLE: 3

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 23, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
260.3	Ground Surface							
0.0	**18 cm TOPSOIL**	1A 1B	DO	12	0		17	
	Stiff to hard **SILTY CLAY** a trace of sand	2	DO	20	1		23	
		3	DO	27	2		15	
		4	DO	38			16	
	brown / grey	5	DO	27	3		17	
		6	DO	22	4 5		13	
253.7		7	DO	28	6		17	
6.5	**END OF BOREHOLE**				7 8 9 10 11 12 13 14 15 16 17 18 19 20			Dry on completion

Soil Engineers Ltd.

JOB NO.: 2309-S138

LOG OF BOREHOLE: 4

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers with Tricone

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 25, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
261.0	Ground Surface							
0.0	**36 cm TOPSOIL**	1	DO	10	0		20	
	Brown, stiff to hard **SILTY CLAY TILL** traces of sand and gravel occ. sand seams	2	DO	15	1		18	
		3	DO	28	2		14	
		4	DO	28			12	
		5	DO	37	3			
257.0					4			
4.0	Grey, very stiff **SILTY CLAY** a trace of sand	6	DO	21	5		19	
		7	DO	24	6		18	
		8	DO	22	7		24	
		9	DO	19	8			
		10	DO	18	9		21	
249.4					10			
11.7	Grey, very stiff to hard **SILTY CLAY TILL** traces of sand and gravel occ. sand layers	11	DO	19	11		21	
		12	DO	20	12		13	
		13	DO	66	13			
		14	DO	65	14		16	
243.8					15		10	
17.2	**END OF BOREHOLE**				16			
	Installed 50 mm Ø PVC monitoring well to 16.8 m with 3.0 m screen Sand backfill from 13.1 to 16.8 m Bentonite seal from 0.0 m to 13.1 m Provided with monument casing				17		12	
					18			
					19			
					20			

W.L. not recorded on completion due to mud rotary drilling

JOB NO.: 2309-S138

LOG OF BOREHOLE: 5

FIGURE NO.: 6

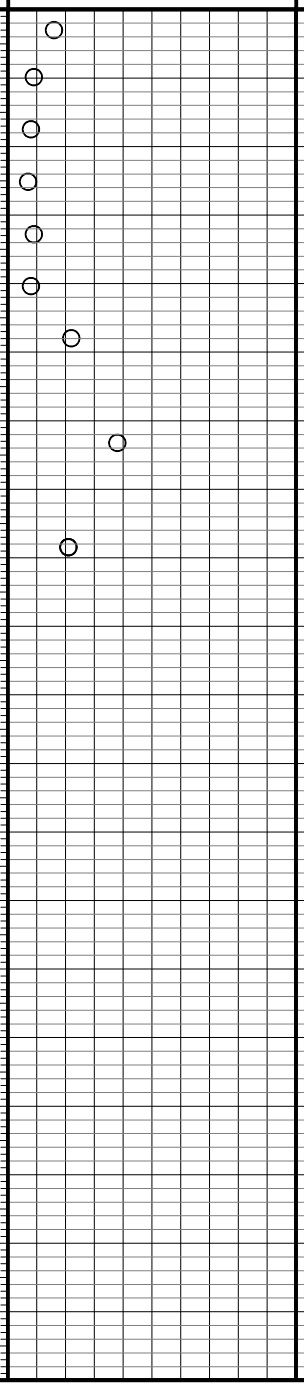
PROJECT DESCRIPTION: Proposed Residential Development

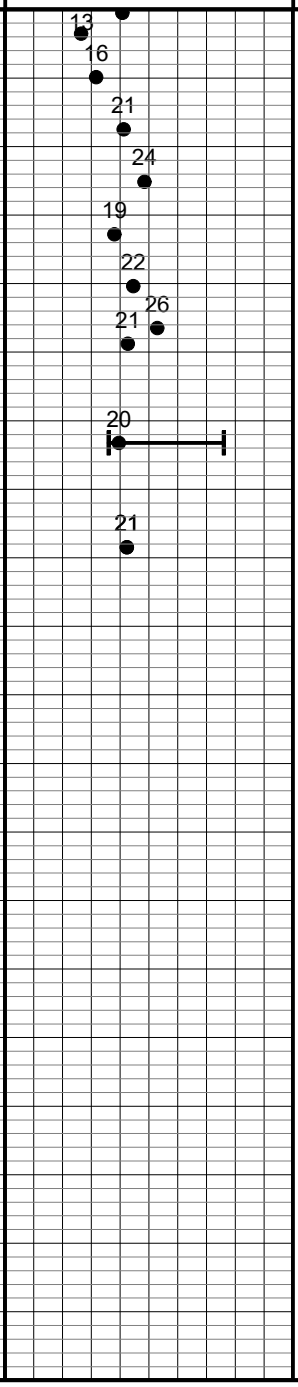
METHOD OF BORING: Solid Stem Augers

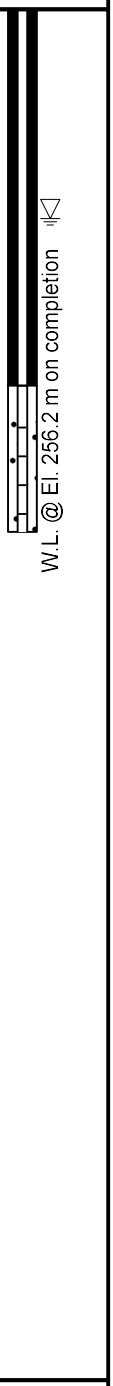
PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 25, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
259.2	Ground Surface				
0.0	**10 cm TOPSOIL**	1A			0
	EARTH FILL Dark brown, silty clay occ. organics inclusion	1B	DO	16	
		2	DO	9	1
		3	DO	8	2
		4	DO	7	
		5	DO	9	3
		6	DO	8	4
254.5		7A			
4.7	Very stiff to hard **SILTY CLAY** a trace of sand	7B	DO	22	5
		8	DO	38	6
	brown / grey				7
251.1		9	DO	21	8
8.1	**END OF BOREHOLE**				9
	Installed 50 mm Ø PVC monitoring well to 7.6 m with 1.5 m screen Sand backfill from 5.5 to 7.6 m Bentonite seal from 0.0 m to 5.5 m Provided with monument casing				10
					11
					12
					13
					14
					15
					16
					17
					18
					19
					20







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JOB NO.: 2309-S138

LOG OF BOREHOLE: 6

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 25, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
258.9	Ground Surface							
0.0	**18 cm TOPSOIL**	1A 1B	DO	11	0		15	
	EARTH FILL Dark brown, silty clay occ. organics inclusion and asphalt debris	2	DO	7	1		24	
		3	DO	8	2		23	
		4	DO	9			25	
		5	DO	10	3		19	
255.3								
3.7	Very stiff to hard **SILTY CLAY** a trace of sand	6	DO	27	4		24	
		7	DO	35	5		15	
	brown / grey	8	DO	30	6		18	
					7			
250.8		9	DO	23	8		17	
8.1	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 7.6 m with 1.5 m screen Sand backfill from 5.5 to 7.6 m Bentonite seal from 0.0 m to 5.5 m Provided with monument casing				9 10 11 12 13 14 15 16 17 18 19 20			Dry on completion

Soil Engineers Ltd.

JOB NO.: 2309-S138

LOG OF BOREHOLE: 7

FIGURE NO.: 8

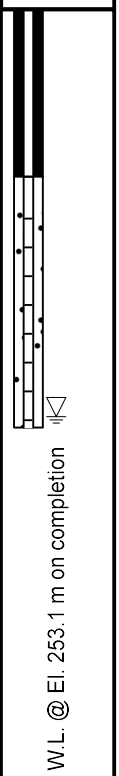
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 23, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
259.0	Ground Surface							
0.0	**18 cm TOPSOIL**	1A			0			
	Stiff to hard **SILTY CLAY** a trace of sand	1B	DO	15				
		2	DO	29	1			
		3	DO	36	2			
		4	DO	35				
	brown / grey	5	DO	32	3			
					4			
	wet sandy silt layer	6A 6B	DO	49	5			
					6			
252.5		7	DO	25				
6.5	**END OF BOREHOLE**				7			
	Installed 50 mm Ø PVC monitoring well to 6.1 m with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with monument casing				8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			



JOB NO.: 2309-S138

LOG OF BOREHOLE: 8

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 23, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
262.0	Ground Surface							
0.0	**20 cm TOPSOIL**	1A 1B	DO	17	0		15	
	Brown, very stiff to hard **SILTY CLAY** a trace of sand	2	DO	32	1		14	
		3	DO	29	2		18	
		4A 4B	DO	40			18 19 17	
	wet sandy silt layer	5A 5B	DO	20	3		19	
257.2					4			
4.8	Grey, very stiff **SILTY CLAY TILL** traces of sand and gravel	6	DO	18	5		19	
255.5		7	DO	21	6		12	W.L. @ El. 256.1 m on completion
6.5	**END OF BOREHOLE**				7			
					8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			

JOB NO.: 2309-S138

LOG OF BOREHOLE: 9

FIGURE NO.: 10

PROJECT DESCRIPTION: Proposed Residential Development

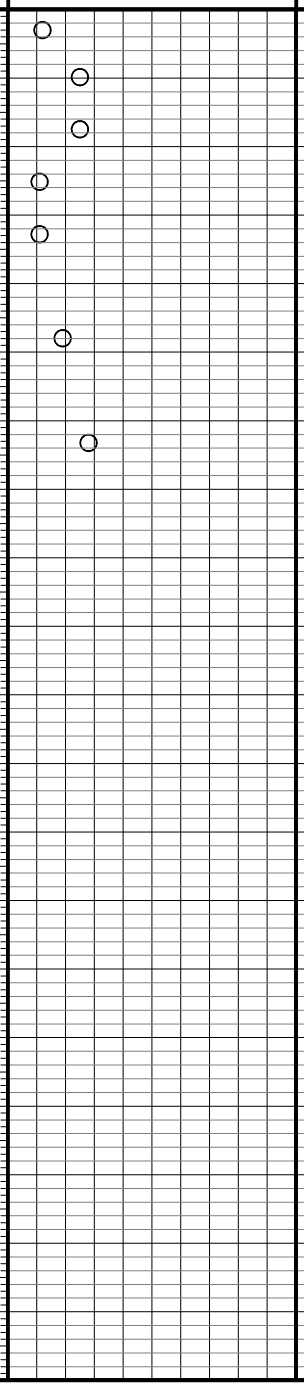
METHOD OF BORING: Solid Stem Augers

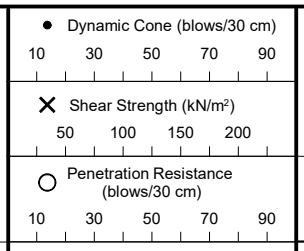
PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

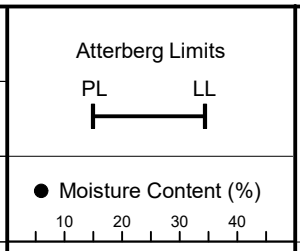
DRILLING DATE: October 24, 2023

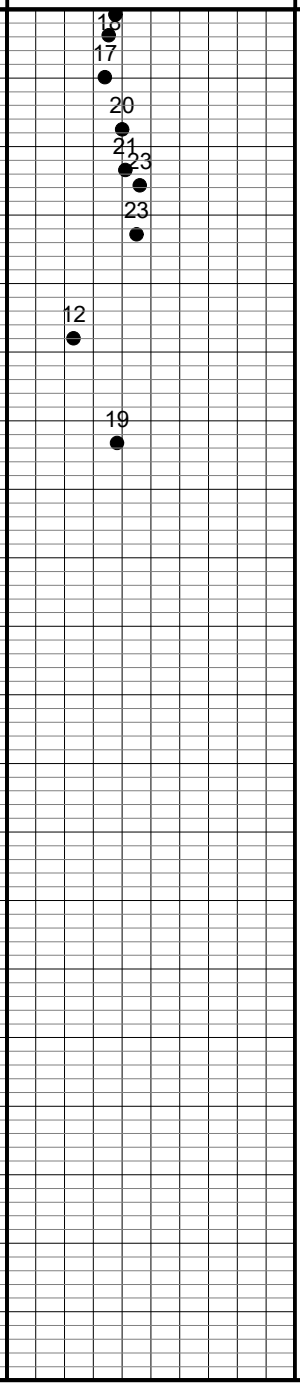
El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
260.6	Ground Surface			
0.0	**15 cm TOPSOIL**	1A		
	Brown, stiff to very stiff **SILTY CLAY** a trace of sand	1B	DO	12
		2	DO	25
		3	DO	25
	wet sandy silt layer	4A		
		4B	DO	11
		5	DO	11
256.5				
4.0	Grey, very stiff **SILTY CLAY TILL** traces of sand and gravel	6	DO	19
254.0		7	DO	28
6.5	**END OF BOREHOLE**			

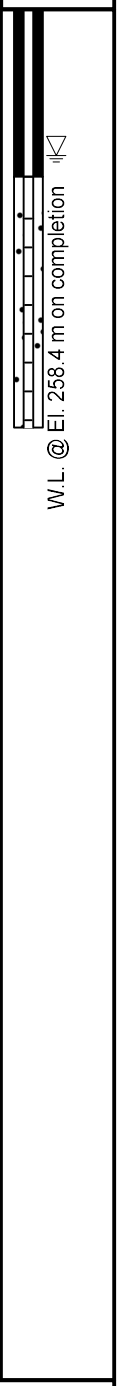
Installed 50 mm Ø PVC monitoring well
to 6.1 m with 3.0 m screen
Sand backfill from 2.4 to 6.1 m
Bentonite seal from 0.0 m to 2.4 m
Provided with monument casing











WATER LEVEL

Soil Engineers Ltd.

JOB NO.: 2309-S138

LOG OF BOREHOLE: 10

FIGURE NO.: 11

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 23, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
263.1	Ground Surface							
0.0	**25 cm TOPSOIL**	1A 1B	DO	13	0		21	
	Stiff to hard **SILTY CLAY** a trace of sand	2	DO	23	1		17	
		3	DO	19	2		19	
		4	DO	36	3		17	
	brown grey	5	DO	48	4		16	
		6	DO	34	5		15	
256.5		7	DO	27	6		17	
6.5	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with monument casing				7 8 9 10 11 12 13 14 15 16 17 18 19 20			Dry on completion

JOB NO.: 2309-S138

LOG OF BOREHOLE: 11

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 24, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
260.9	Ground Surface							
0.0	**13 cm TOPSOIL**	1A			0		18	
	Stiff to hard **SILTY CLAY** a trace of sand	1B	DO	12			18	
		2	DO	18	1		19	
		3	DO	25	2		19	
		4	DO	26			20	
		5	DO	32	3			
	brown grey				4		18	
		6	DO	17	5			
					6		17	
254.3		7	DO	23				
6.5	**END OF BOREHOLE**				7			Dry on completion
					8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			

Soil Engineers Ltd.

JOB NO.: 2309-S138

LOG OF BOREHOLE: 12

FIGURE NO.: 13

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 24, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
263.0	Ground Surface							
0.0	**30 cm TOPSOIL**	1A 1B	DO	8	0		19 19	
	Firm to hard **SILTY CLAY** a trace of sand	2	DO	11	1			
		3	DO	12	2		21	
		4	DO	29			18	
		5	DO	48	3		18	
	brown grey				4			
	wet sandy silt layer	6A 6B	DO	44	5		19 21	
257.4								
5.6	Hard **SILTY CLAY TILL** traces of sand and gravel	7	DO	37	6		10	
256.4					7			
6.5	**END OF BOREHOLE**				8			
	Installed 50 mm Ø PVC monitoring well to 6.1 m with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with monument casing				9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			

W.L. @ El. 257.1 m on completion

JOB NO.: 2309-S138

LOG OF BOREHOLE: 13

FIGURE NO.: 14

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

DRILLING DATE: October 24, 2023

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
262.0	Ground Surface							
0.0	**15 cm TOPSOIL**	1A 1B	DO	9	0		21	
	Stiff to hard **SILTY CLAY** a trace of sand	2	DO	25	1		16	
		3	DO	23	2		16	
		4	DO	33			19	
	brown / grey	5	DO	19	3		20	
					4			
	wet sandy silt layer	6A 6B	DO	25	5		14 16	
255.4		7	DO	28	6		18	
6.5	**END OF BOREHOLE**				7			
	Installed 50 mm Ø PVC monitoring well to 6.1 m with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with monument casing				8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			

W.L. @ El. 255.9 m on completion

Soil Engineers Ltd.

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

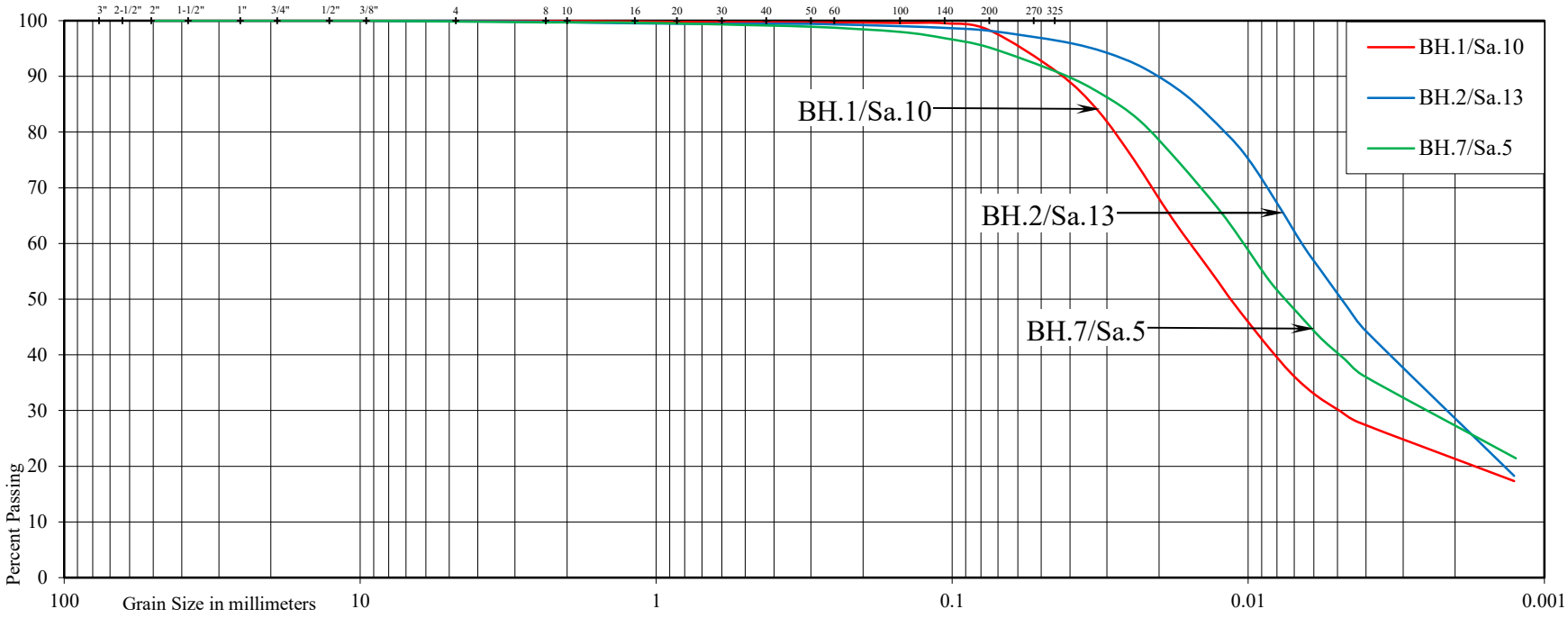
Reference No: 2309-S138

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Residential Development

Location: Northwest of Mount Hope Road and Columbia Way, Town of Caledon

Borehole No:	1	2	7
Sample No:	10	13	5
Depth (m):	10.7	15.2	3.1
Elevation (m):	251.8	247.4	256.0

BH./Sa.	1/10	2/13	7/5
Liquid Limit (%) =	25	-	-
Plastic Limit (%) =	16	-	-
Plasticity Index (%) =	9	-	-
Moisture Content (%) =	20	15	16
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY
a trace of sand

Figure: 15

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

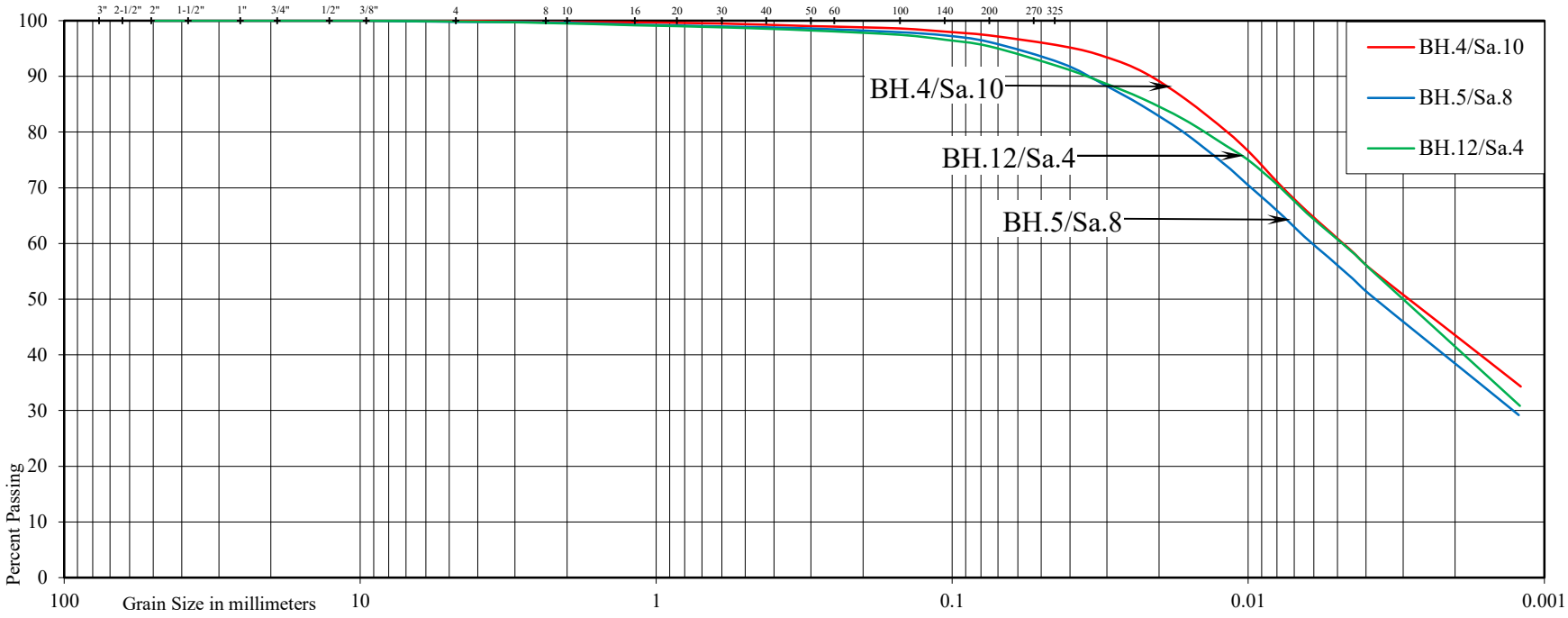
Reference No: 2309-S138

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Residential Development

Location: Northwest of Mount Hope Road and Columbia Way, Town of Caledon

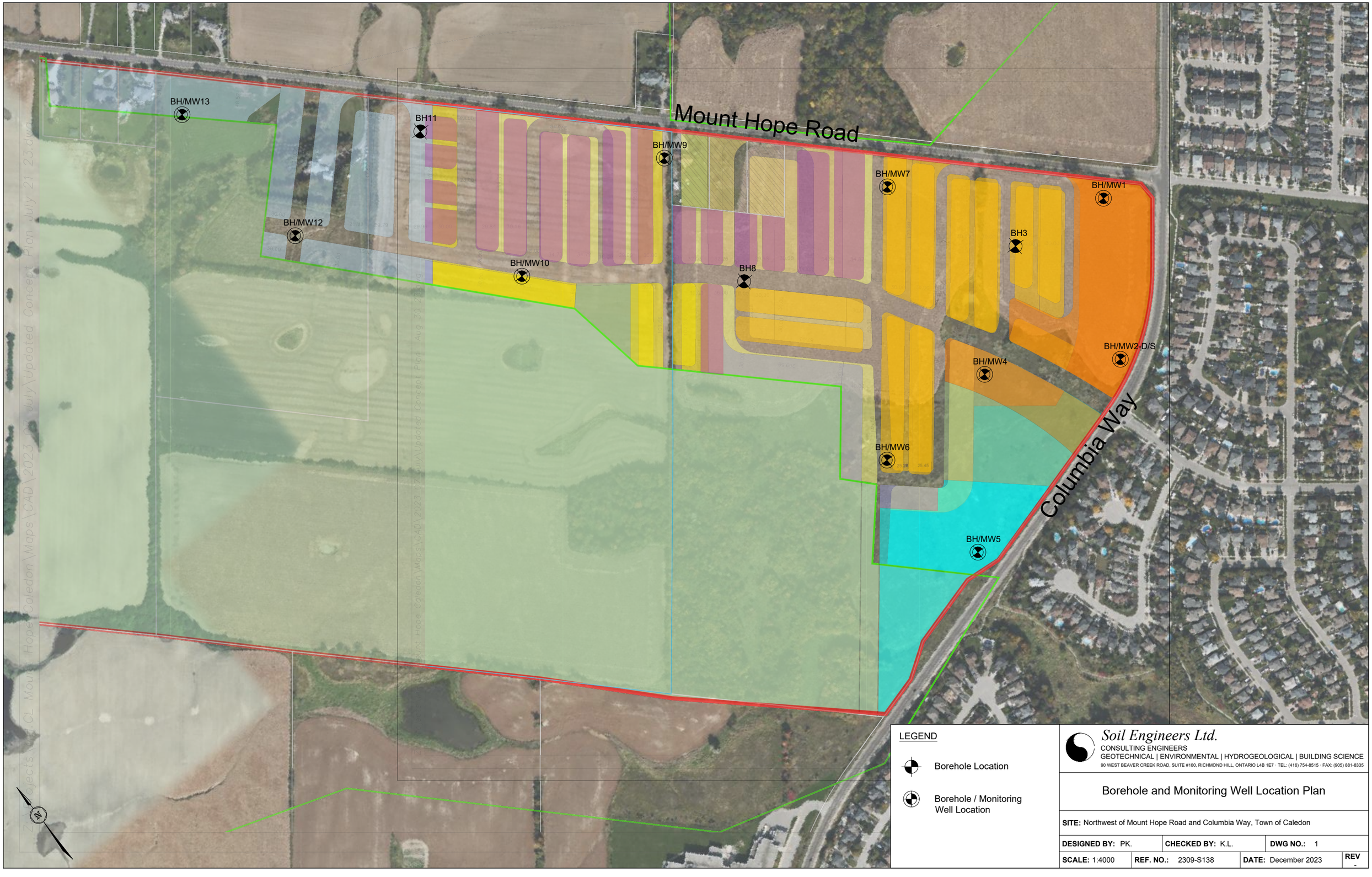
Borehole No:	4	5	12
Sample No:	10	8	4
Depth (m):	10.7	6.1	2.3
Elevation (m):	250.4	253.1	260.7

BH./Sa.	4/10	5/8	12/4
Liquid Limit (%) =	-	38	40
Plastic Limit (%) =	-	18	19
Plasticity Index (%) =	-	20	21
Moisture Content (%) =	21	20	18
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY

a trace of sand

Figure: 16



LEGEND

- Borehole Location
- Borehole / Monitoring Well Location

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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Borehole and Monitoring Well Location Plan

SITE: Northwest of Mount Hope Road and Columbia Way, Town of Caledon

DESIGNED BY: PK.	**CHECKED BY:** K.L.	**DWG NO.:** 1	
SCALE: 1:4000	**REF. NO.:** 2309-S138	**DATE:** December 2023	**REV** -

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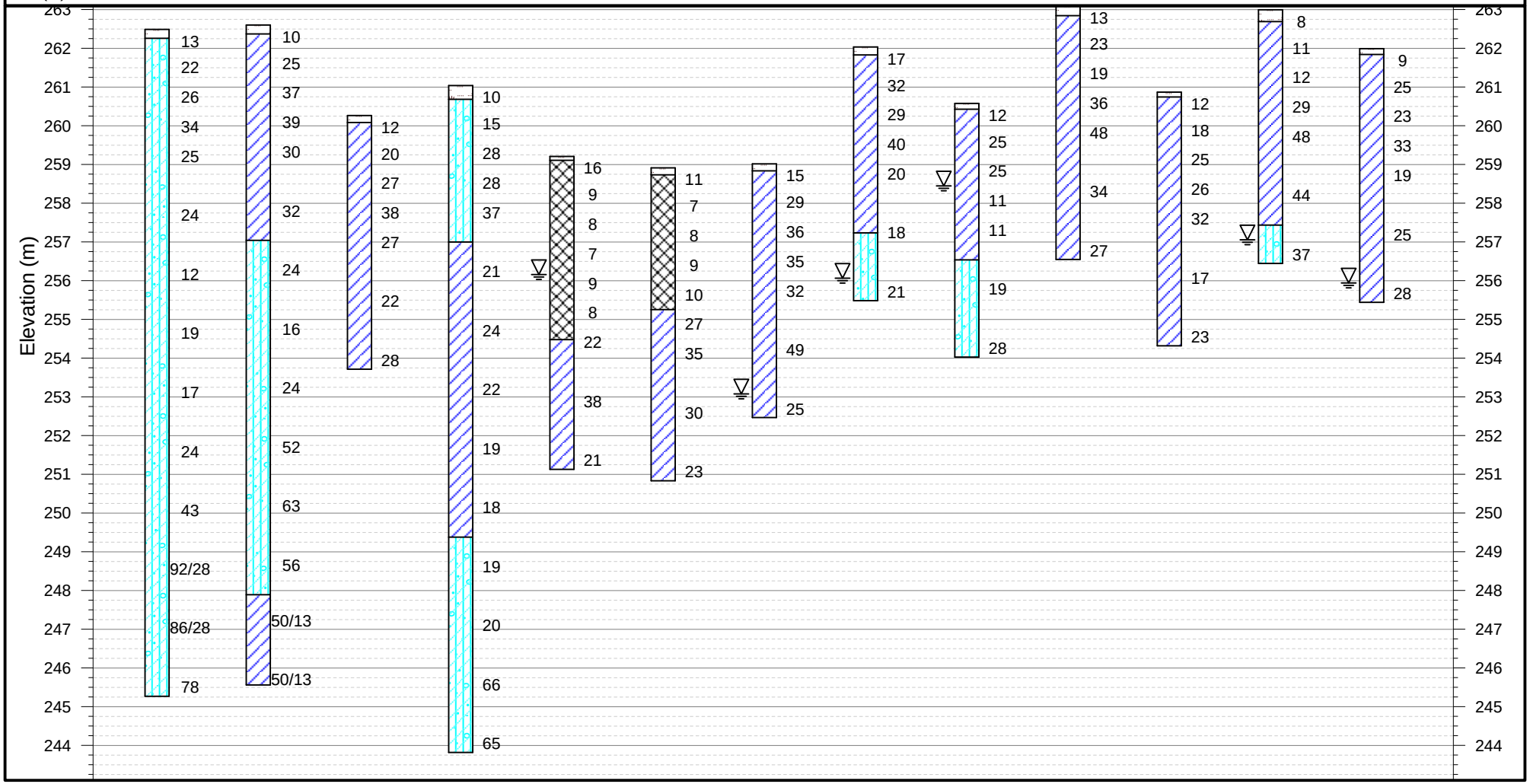
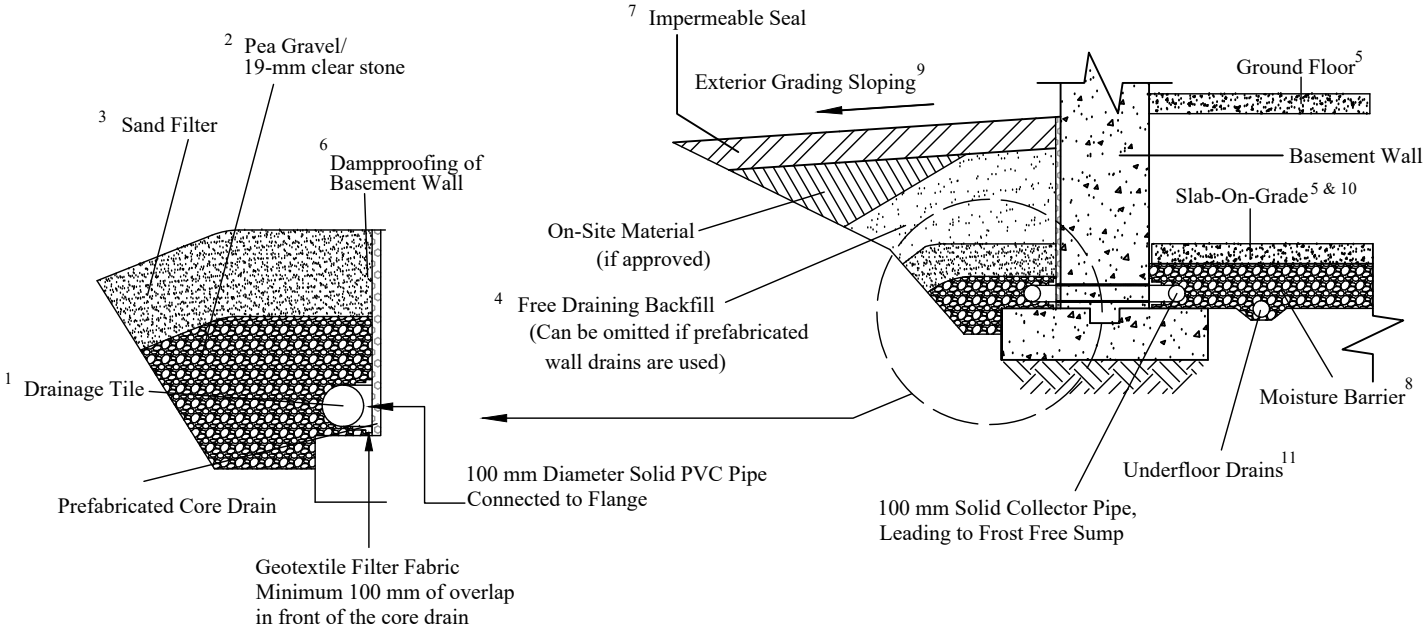
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 2309-S138
REPORT DATE: December 2023
PROJECT DESCRIPTION: Proposed Residential Development

PROJECT LOCATION: Northwest of Mount Hope Road and Columbia Way
Town of Caledon

LEGEND
FILL | SILTY CLAY | SILTY CLAY TILL | TOPSOIL
WATER LEVEL (END OF DRILLING)





NOTES:

1. **Drainage tile**: consists of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be at minimum of 150 mm (6") below underside of basement floor slab.

2. **Pea gravel**: at 150 mm (6") on the top and sides of drain. If drain is not placed on concrete footing, provide 100 mm (4") of pea gravel below drain. The pea gravel may be replaced by 19-mm clear stone provided that the drain is covered by a porous geotextile membrane of Terrafix 270R or equivalent.

3. **Filter material**: consists of C.S.A. fine concrete aggregate. A minimum of 300 mm (12") on the top and sides of gravel. This may be replaced by an approved porous geotextile membrane of Terrafix 270R or equivalent.

4. **Free-draining backfill**: OPSS Granular 'B' or equivalent, compacted to 95% to 98% (maximum) Standard Proctor dry density. Do not compact closer than 1.8 m (6') from wall with heavy equipment. This may be replaced by on-site material if prefabricated wall drains (Miradrain) extending from the finished grade to the bottom of the basement wall are used.

5. **Do not backfill** until the wall is supported by the basement floor slab and ground floor framing, or adequate bracing.

6. **Dampproofing** of the basement wall is required before backfilling

7. **Impermeable backfill seal** of compacted clay, clayey silt or equivalent. If the original soil in the vicinity is a free-draining sand, the seal may be omitted.

8. **Moisture barrier**: 19-mm CRL or equivalent. The thickness of this layer should be 150 mm (6") minimum.

9. **Exterior Grade**: slope away from basement wall on all the sides of the building.

10. **Slab-On-Grade** should not be structurally connected to walls or foundations.

11. **Underfloor drains*** should be placed in parallel rows at 6 to 8 m (20'-25') centre, on 100 mm (4") of pea gravel with 150 mm (6") of pea gravel on top and sides. The spacing should be at least 300 mm (12") between the underside of the floor slab and the top of the pipe. The drains should be connected to positive sumps or outlets. Do not connect the underfloor drains to the perimeter drains.

* Underfloor drains can be deleted where not required.

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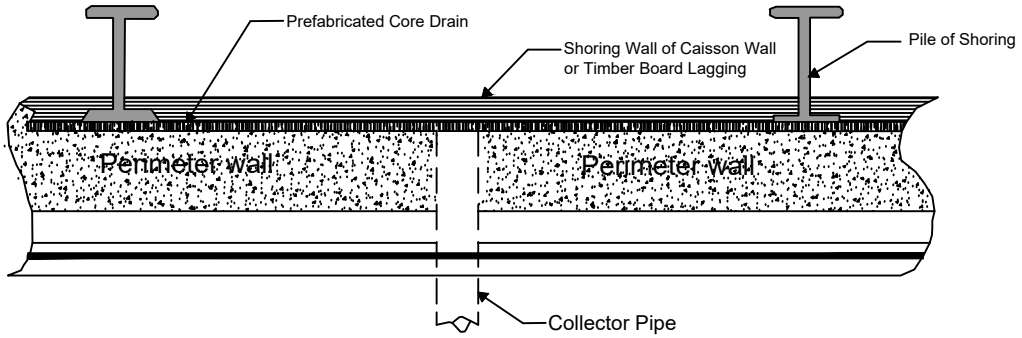
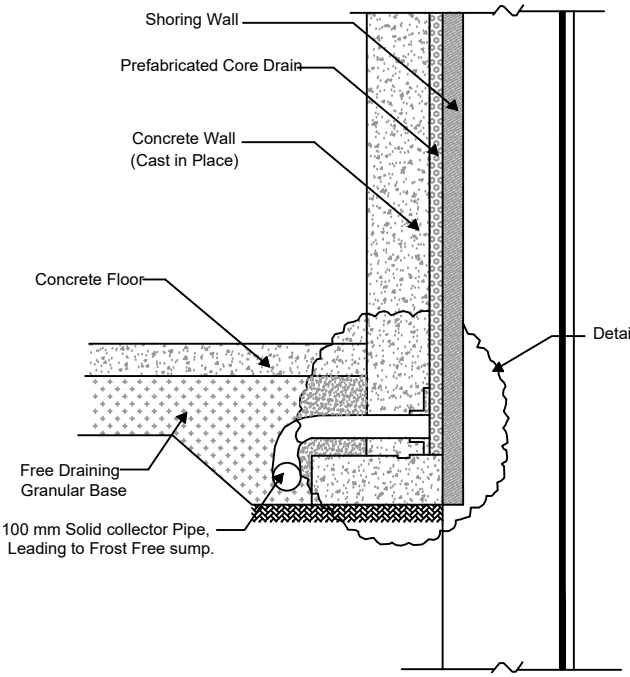
Permanent Perimeter Drainage System
(Sloped Excavation)

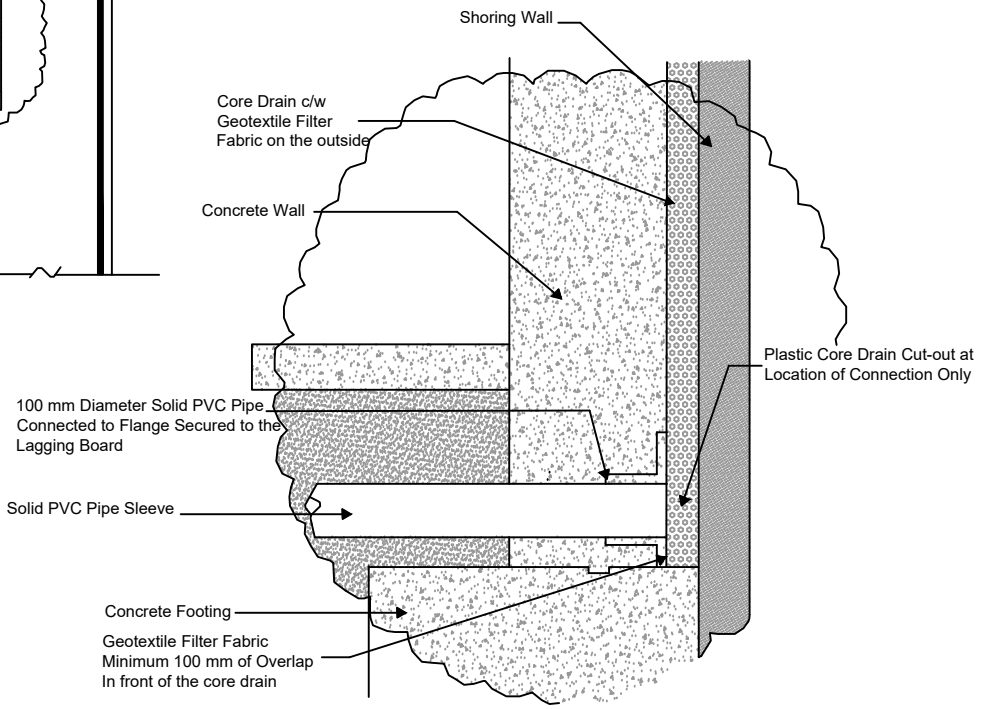
SITE: Northwest of Mount Hope Road and Columbia Way, Town of Caledon			
DESIGNED BY: K.L.	**CHECKED BY:** B.L.	**DWG NO.:** 3	
SCALE: N.T.S.	**REF. NO.:** 2309-S138	**DATE:** December 2023	**REV** -



PLAN



TYPICAL SECTION



DETAIL A

NOTES:

1. A continuous blanket of prefabricated drainage system, Miradrain 6000 or equivalent, should extend continuously from the top of footings to the ground surface.
2. All joints of the Miradrain should be taped. All openings above the concrete footing must be covered with filter fabric to prevent intrusion of fresh concrete into the core of the drain.
3. Backfill behind the lagging board must be free draining. Filter fabric or straw should be used to prevent loss of fines behind the lagging.
4. The perimeter drainage and any subfloor drainage systems must be kept separate.

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Permanent Perimeter Drainage System
(With Shoring)

SITE: Northwest of Mount Hope Road and Columbia Way, Town of Caledon			
DESIGNED BY: K.L.	**CHECKED BY:** B.S.	**DWG NO.:** 4	
SCALE: N.T.S.	**REF. NO.:** 2309-S138	**DATE:** December 2023	**REV** -

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BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	MUSKOKA	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

APPENDIX

SHORING DESIGN

REFERENCE NO. 2309-S138

SHORING SYSTEM

Shoring will be required in an excavation to limit the horizontal and vertical movements of adjacent properties.

A shoring system consisting of soldier piles and lagging boards can be used in an excavation where slight movement in the adjacent properties is tolerable. In an area with close proximity of adjacent structure and the excavation will be extending below the foundation level where any movement in the adjacent properties is a concern, or in an excavation embedding into saturated sand or silt deposit, an interlocking caisson wall is more appropriate.

The design and construction of the shoring system should be carried out by a specialist designer and contractor experienced in this type of construction. All specifications for the design of the shoring system should be in accordance with the latest edition of the Canadian Foundation Engineering Manual (CFEM).

LATERAL EARTH PRESSURE

For single and multiple level supporting systems, the lateral earth pressure distributions on the shoring walls are shown on Drawing A1. The design soil parameters are provided in the geotechnical report.

The lateral earth pressure expressions do not include hydrostatic pressure buildup behind the shoring. If the wall is designed to be watertight or undrained, such as a caisson wall, the anticipated hydrostatic pressure must be included behind the structure.

PILE PENETRATION

The depth of pile support should be calculated from the following expressions:

In Cohesive Soils: $R = 9\ C_u\ D\ (L - 1.5\ D)$

In Cohesionless Soils: $R = 1.5\ D\ K_p\ L^2\ \gamma$

where	R	= Ultimate load to be restrained	kN
	D	= Diameter of concrete filled hole	m
	L	= Embedment depth of the pile	m
	C_u	= Undrained shear strength of subsoil	kPa
	K_p	= Passive resistance in cohesionless soils	-
	γ	= unit weight of the soil	kN/m^3

The shoring system should be designed for a factor of safety of F = 2.

For anchor supported shoring system, the global factor of safety against sliding and overturning of the anchored block of soil must also be considered.

The steel soldier piles in the shoring system must be installed in pre-augured holes. The lower portion will have to be filled with 20 MPa (3000 psi) concrete to the excavation level. The upper portion of the pile within the excavation depth should be filled with lean mix concrete or non-shrinkable cementitious filler (U-fill).

LAGGING

The following thicknesses of lagging boards have been recommended in CFEM:

Thickness of Lagging	Maximum Spacing of Soldier Piles
50 mm (2 in)	1.5 m (5 ft)
75 mm (3 in)	2.5 m (8 ft)
100 mm (4 in)	3.0 m (10 ft)

Local experience has indicated that the lagging board thickness of 75 mm has been adequate for soldier pile spacing of 3 m for soil conditions similar to those encountered at the subject site. However, it is important to consider all local conditions, such as the duration of excavation, the weather likely to be encountered through the construction period, seasonal variations in the ground water and ice lensing causing frost heave and softening of soils in determining the lagging thickness. During winter months, the shoring should be covered with thermal blankets to prevent frost penetration behind the shoring system which may result in unacceptable movements.

During construction of shoring, all the spaces behind the lagging board must be filled with free-draining granular fill. If wet conditions are encountered, the space between the boards should be packed with a geotextile filter fabric or straw to prevent the loss of fine particles.

TIEBACK ANCHORS

The minimum spacing and the depths of the soil anchors should be as recommended in the CFEM.

All drilled holes for tieback anchors should be temporarily cased or lined to minimize the risk of caving. Systems involving high grout pressures should be avoided if working near other basements or buried services.

The tieback anchor lengths can be estimated using an adhesion value of 50 kPa. Full scale load tests should be carried out on the tieback anchors in each type of soils and at each level of anchor support at the site to confirm the design parameters and the adhesion values. The test anchors should be loaded in a pattern as described in CFEM, to 200% of the design load or until there is a significant increase in the pullout rate. In the latter case, the design load must be limited to 50% of the maximum load at which the pullout increases. Based on the results of the pullout test, it may be necessary to modify the anchor design of the production anchors.

Each tieback anchor must be proof-loaded to 133% of the design load, and the anchor must be capable of sustaining this load for a minimum of 10 minutes without creep. The load may then be relaxed to 100% of the design and locked in. The higher the lock-in loads, the less will be the outward movement on the shoring wall after excavation.

RAKERS

An alternative to tieback anchor support of the shoring is to use raker footings. Rakers inclining at an angle of 45º, founded in the native soil deposit below the bottom of excavation should be designed for the allowable bearing pressure of 100 kPa.

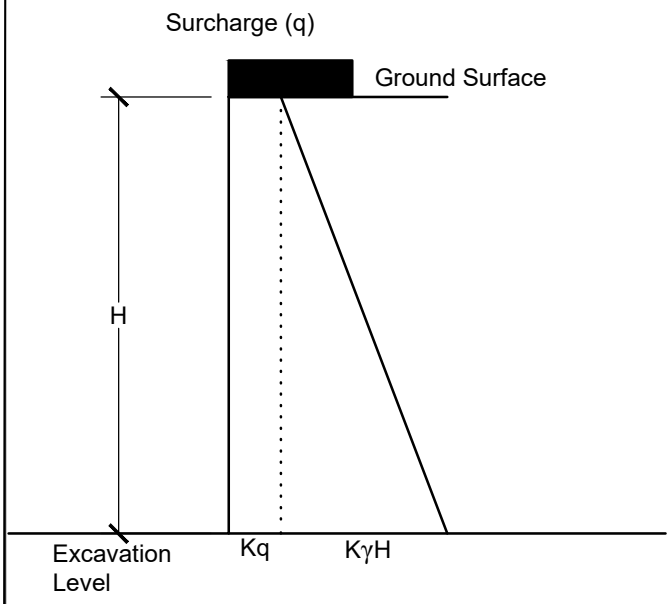
The raker footings should be located outside the zone of influence of the buried portion of the soldier piles at a distance of not less than 1.5 of the length of embedment of the soldier pile.

To prevent undermining of the raker footing, no excavation should be made within two times the width of raker footing on the opposite side of the raker.

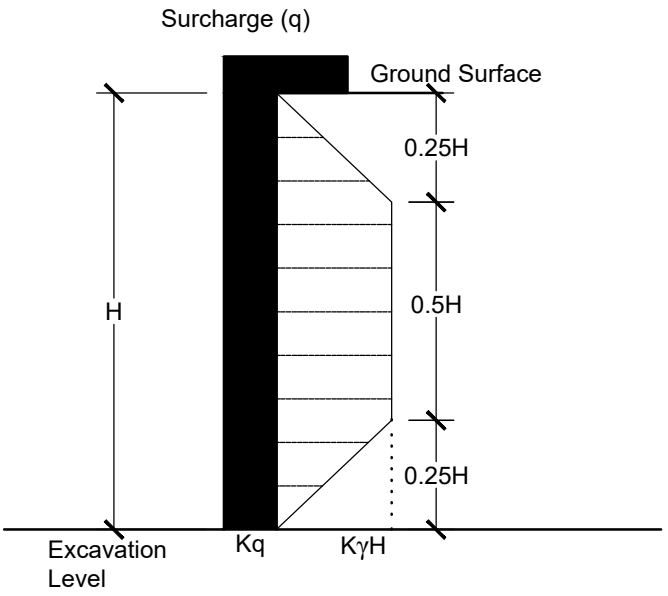
MONITORING OF PERFORMANCE

Close monitoring of the vertical and lateral movement of the shoring system, by inclinometers or by survey on targets, should be carried out at the site. Extra bracing or support may be required if any movement is found excessive. The contractor should maintain the shoring to ensure any movement is within the design limit.

TEMPORARY SHORING
Lateral Earth Pressures



Single Support System



Multiple Support System

Lateral Pressure $P = K(\gamma H + q)$

Where

H = Height of Shoring	m
γ = Unit Weight of Retained Soil	21 kN/m^3
q = Surcharge	kPa
K = Earth Pressure Coefficient	

- If moderate ground and shoring movements are permissible then:
  $K = K_a$ = Active Earth Pressure Coefficient

- if there are building foundations within a distance of 0.5 H behind the shoring then:
  $K = K_o$ = Earth Pressure at rest

- If there are building foundations within a distance of between 0.5 H and H behind the shoring then:
  $K = 0.5 (K_a + K_o)$

Note:
1. The lateral pressure expression assumes effective drainage from behind the temporary shoring.
2. The earth pressure coefficients are specified in the geotechnical report.

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Lateral Earth Pressure and Temporary Shoring

SITE: Northwest of Mount Hope Road and Columbia Way, Town of Caledon			
DESIGNED BY: P.K.	**CHECKED BY:** K.L.	**DWG NO.:** A1	
SCALE: N.T.S.	**REF. NO.:** 2309-S138	**DATE:** December 2023	**REV** -