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A REPORT TO
BROOKVALLEY DEVELOPMENTS (HWY 10) LTD.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

12760 HURONTARIO STREET

TOWN OF CALEDON

REFERENCE NO. 2310-S042

JANUARY 2024

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1.0 INTRODUCTION

In accordance with the email authorization dated October 2, 2023, from Mr. Frank Filippo of Brookvalley Developments (Hwy 10) Ltd., a geotechnical investigation was carried out for a property located at 12760 Hurontario Street in the Town of Caledon.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of a proposed residential development.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is located on the west side of Hurontario Street, approximately 600 m south of Old School Road, in the Town of Caledon. It is located within a physiographic region known as the South Slope, situated in between the Oak Ridges Moraine and the Peel Plain. The soil stratigraphy in the area is characterized by sand and silt deposits layered in between an upper Halton Till unit and a lower Newmarket Till formation. The sand and silt deposits in the area were identified as part of the Oak Ridges Moraine (ORM) or equivalent unit in the Hydrogeological Assessment for Mayfield West, Phase 2 Stage 3 Lands, prepared by Palmer Environmental Consulting Group Inc. (PECG) in 2018.

The Etobicoke Creek traverses through the eastern half of the site. The land west of the natural system is used for agricultural purposes while the land east of the creek is vacant and open. Historical photos show that previous residential establishments and farm structures fronting Hurontario Street on the property have been demolished, with the exception of an abandoned storage building. Based on the conceptual site plan, the proposed low-density residential development, with a commercial block fronting Hurontario Street, will adjoin with neighbouring developments to form a larger residential community. A bridge crossing will be constructed in the vicinity of Boreholes BC-105 and 106.

3.0 FIELD WORK

The field work, consisting of 7 boreholes extending to a depth ranging from 6.6 to 15.5 m, was carried out between October 13 and 17, 2023. To facilitate the hydrogeological study by PECG, single and nested 50-mm diameter monitoring wells were installed at 2 selected borehole locations. The monitoring wells with a suffix of ‘S’ or ‘D’ represent the shallow and deep well in a well cluster. The depth and details of the monitoring wells are shown on the corresponding Borehole Logs. The locations of the boreholes and monitoring wells are shown on Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a track-mounted machine equipped with solid and hollow stem augers for soil sampling. Split-spoon samples were recovered for soil classification and laboratory testing. Standard Penetration Tests using the procedures described on the enclosed “List of Abbreviations and Terms” were performed at the sampling depths. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the ‘N’ values. The field work was supervised and the findings were recorded by a geotechnical technician.

The ground elevation at each borehole location was determined using a handheld equipment of the Global Navigation Satellite System.

4.0 SUBSURFACE CONDITIONS

Beneath the topsoil veneer and a surficial layer of weathered sandy silt within the farm field, the site is underlain by strata of silty clay till, silty clay and sandy silt till/silty sand till, interstratified with silt deposits in the lower stratigraphy.

Detailed descriptions of the encountered subsurface conditions are presented on the Logs of Borehole, comprising of Figures 1 to 8, inclusive. The stratigraphy is illustrated on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 Topsoil

The revealed topsoil thickness ranges from 18 to 61 cm. Thicker topsoil may be encountered in areas beyond the borehole locations, especially in local low-lying areas.

4.2 Silty Clay Till and Silty Clay

The silty clay till and silty clay were generally encountered in the upper stratigraphy across the site. In deeper boreholes, such as Boreholes BC-104 and BC-105, lower silty clay/silty clay till layers were also contacted. The till consists of a mixture of particle sizes ranging from clay to gravel, with silt and clay being the dominant fraction. The silty clay contains a trace of fine sand and embedded silt layers. Grain size analyses were performed on 2 representative samples of the silty clay till and on a sample of the silty clay, and the results are plotted on Figures 9 and 10, respectively.

The Atterberg Limits of the tested till and clay samples and the natural water content values of all the samples were determined; the results are plotted on the Borehole Logs and summarized below:

	Silty Clay Till	**Silty Clay**
Liquid Limit	24% and 25%	45%
Plastic Limit	15% and 16%	22%
Natural Water Content	10% to 23% (median 12%)	19% to 29% (median 25%)

The results indicate that the clay till is low in plasticity and the clay is medium in plasticity. Sample examination revealed that the till and clay are in moist conditions.

The recorded 'N' values of the clay till range from 6 to over 50 blows, with a median of 30 blows per 30 cm of penetration. This indicates that the clay till is firm to hard, generally being very stiff in consistency. The firm material is restricted to the surficial weathered zone, which extends to depths of 0.8 to 1.4 m below grade. Intermittent hard resistance to augering was encountered in places in the till, indicating the presence of cobbles.

The obtained 'N' values of the clay range from 12 to 32, with a median of 17 blows per 30 cm of penetration. The consistency of the clay is stiff to hard, generally being very stiff.

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

- Moderate to high frost susceptibility and moderate soil adfreezing potential.
- Low water erodibility.
- In excavation, the clays will be stable in relatively steep cuts; however, prolonged exposure may lead to localized sloughing.

4.3 Sandy Silt/Silt

A surficial layer of weathered sandy silt was found at Boreholes BC-101 to 104 drilled at the farm field. A silt deposit, with some sand to being sandy, was found interstratified with the clay and tills in Boreholes BC-104 to BC-107 in the lower stratigraphy. Grain size analyses were performed on 3 representative samples of the silt; the results are plotted on Figure 11.

The obtained natural water content values range from 11% to 24%, with a median of 19%, indicating that the silt is moist to wet, generally in a wet condition.

The recorded ‘N’ values range from 5 to over 50, with a median of 11 blows per 30 cm penetration, indicating that the silt is loose to very dense, generally being compact in relative density.

The engineering properties of the silt are listed below:

- High capillarity and water retention capability.
- Highly frost susceptible, with high soil-adfreezing potential.
- High water erodibility, it will migrate through small openings under seepage pressure.
- The shear strength is mainly derived from internal friction. The wet silt is susceptible to dynamic disturbance, which will induce a build-up of pore water pressure, resulting in soil dilation and a reduction in shear strength.
- In excavation, the silt will remain stable for a short period of time, and will slough and run with seepage. The wet silt will boil under an approximate piezometric head of 0.4 m.

4.4 Sandy Silt Till/Silty Sand Till

Sandy silt till/silty sand till was encountered beneath the clay till or silt deposits in Boreholes BC-105D and 106. The till is cemented with a trace of clay, and is laminated with sand and silt seams and layers. Hard resistance to augering was encountered in the till, indicating the presence of cobbles. Grain size analyses were performed on representative samples of the till; the results are plotted on Figure 12.

The natural water content values of the till range from 10% to 16%, with a median of 11%, indicating that the till is in a moist to wet, generally moist condition.

The obtained ‘N’ values range from 44 to over 50, with a median of 89 blows per 30 cm penetration, indicating that the relative density of the till is dense to very dense, being generally very dense.

The engineering properties of the sandy silt till/silty sand till are listed below:

- Highly frost susceptible and moderately low water erodibility.
- The till will be relatively stable in relatively steep excavation; however, if remained open for an extended period of time, localized sloughing may occur.

4.5 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Silty Clay Till	10 to 23 (median 12)	17	13 to 22
Silty Clay	19 to 29 (median 25)	21 to 22	17 to 25
Sandy Silt Till/ Silty Sand Till	10 to 16 (median 11)	10	6 to 15
Silt	11 to 24 (median 19)	12	8 to 16

The above values show that the tills and clay are generally suitable for structural backfill, and the addition of water may be required prior to structural compaction in the dry and warm seasons and in areas where compaction is best performed on the wet side of the optimum. Portions of the silty clay and sandy silt till/silty sand till may require aeration and the wet silt can be stockpiled to drain the excess water prior to structural compaction.

The weathered soil must be screened and sorted free of topsoil inclusions and deleterious materials, if any, prior to reuse for structural backfill.

The lifts for compaction should be limited to 20 cm, or to a suitable thickness assessed by test strips performed by the compaction equipment. Boulders larger than 15cm in size must be sorted and removed from the backfill.

5.0 GROUNDWATER CONDITION

Groundwater levels were measured in the wet silt deposit, found in Boreholes BC-104 and 106 in the vicinity of the creek. In December 2023, stabilized groundwater levels were recorded from the installed monitoring wells in by PECG; these levels are tabulated in Table 2.

Stabilized water levels were recorded at a depth of 5.27 metres below ground surface (mbgs), or at El. 257.13 m at Borehole BC-101, and at depths of 6.91 to 7.40 mbgs, or El. 253.19 to 252.70 m at the well cluster at Borehole BC-105, suggesting a drainage trend towards the Etobicoke Creek. The groundwater regime is subject to seasonal fluctuations. Detailed groundwater profile and monitoring records should be referred to the hydrogeological study by PECG.

Table 2 - Groundwater Levels

Borehole/ Monitoring Well No.	Ground El. (m)	Well Depth (m)	Measured Groundwater Levels					
			On Completion		Dec. 6, 2023		Dec. 12-13, 2023	
			Depth (m)	El. (m)	Depth (m)	El. (m)	Depth (m)	El. (m)
BC-101	262.4	6.1	Dry	-	5.27	257.13	-	-
BC-102	261.3	-	Dry	-	No Well			
BC-103	261.3	-	Dry	-	No Well			
BC-104	259.5	-	5.9	253.6	No Well			
BC-105D	260.1	15.2	N/A[a]	-	7.35	252.75	7.40	252.70
BC-105S	260.1	7.6	Dry	-	6.91	253.19	6.91	253.19
BC-106	256.6	-	6.7	249.9	No Well			
BC-107	260.6	-	Dry	-	No Well			

[a] Water was used during the drilling operation; measurement of groundwater level was not feasible upon completion of drilling.

6.0 DISCUSSION AND RECOMMENDATIONS

Beneath the topsoil veneer and a surficial layer of weathered sandy silt within the farm field, the site is underlain by strata of generally very stiff silty clay till and silty clay, and very dense sandy silt till/silty sand till, interstratified with generally compact silt deposits in the lower stratigraphy. The surficial weathered zone extends to depths of 0.8 to 1.4 m below grade.

Stabilized water levels were recorded at the monitoring wells at depths ranging from 5.27 to 7.40 mbgs, or from El. 257.13 m at Borehole BC-101 to El. 252.70 m at Borehole BC-105D, suggesting a drainage trend that follows the topography towards the Etobicoke Creek. The groundwater regime is subject to seasonal fluctuations.

Based on the conceptual site plan, the subject site will be developed to a low-density residential subdivision with a commercial block fronting Hurontario Street, and will be provided with municipal services and paved roadways meeting municipal standards. The development will adjoin with neighbouring developments to form a larger residential community. A bridge crossing will be constructed in the area of Boreholes BC-105 and 106.

The following geotechnical considerations warrant special attention:

1. The topsoil must be stripped for development; it can be reused for general landscaping purposes only.
2. The weathered soil should be inspected prior to any placement of earth fill for site grading purpose. Where required, the weathered soil should be subexcavated, sorted free of any organic, topsoil, and/or other deleterious material, before reusing for structural backfill.
3. After removal of the existing building and associated foundation, the debris should be disposed off-site. All loose and disturbed soils should also be removed and the cavities should be backfilled with engineered fill.
4. Where additional fill is required for site grading, the earth fill can be placed in an engineered manner for conventional footing construction, site services support and road construction.
5. The engineered fill and the sound native soils are suitable for supporting structures founded on conventional spread and strip footings.
6. It is recommended that the basement floor be founded at least 1.0 m above the seasonal high groundwater level, particularly in the vicinity of Boreholes BC-104, 105D and 106. Otherwise, underfloor subdrain systems and/or waterproofing of basements should be implemented to relieve any groundwater upfiltration due to seasonal fluctuation of the groundwater.
7. A Class ‘B’ bedding, consisting of compacted 19-mm Crusher-Run Limestone (CRL), is recommended for the construction of underground services. Where services installation extends into the wet silt, or where dewatering is required, a Class ‘A’ concrete bedding should be considered for pipe support.
8. Groundwater seepage from the tills and clay will likely be removable by conventional pumping from sumps during construction. Excavation extending into the saturated soils will require construction dewatering.

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, and the assessment given herein is general in nature based on the borehole findings. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 Site Preparation

The topsoil and vegetation at the ground surface must be removed for development. Where additional fill is required for site grading, the earth fill can be placed in an engineered manner for conventional footing construction, site services support and road construction. The engineering requirements for a certifiable fill are presented below:

1. The subgrade must be inspected and proof-rolled prior to any fill placement. Badly weathered soils should also be subexcavated, sorted free of topsoil inclusions and deleterious materials, if any, aerated and properly compacted in layers.
2. Inorganic soils must be used for the fill, and they must be uniformly compacted in lifts of 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 foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% SPDD.
3. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not begin until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
4. If imported fill is to be used, it should be inorganic soils, free of deleterious or any material with environmental issue or contamination. Any potential imported earth fill from off-site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before being hauled to the site.
5. The fill operation must be inspected on a full-time basis by a technician under direction of a geotechnical engineer.
6. The engineered fill should not be placed during period 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 foundations and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to

ensure that the foundations are 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.

9. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the foundations must be properly reinforced, or be designed by the structural engineer for the project. The total and differential settlements of 25 mm and 20 mm, respectively, should be considered in the design of the foundation founded on engineered fill.
10. 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.

6.2 **Foundation**

Based on the borehole information, the following bearing pressures are recommended for house structures supported on conventional strip and spread footings founded onto engineered fill or sound native soils below the surficial disturbed or weathered soils.

- Maximum Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 250 kPa

The total and differential settlements of footing designed for the recommended bearing pressure at SLS are estimated at 25 mm and 20 mm, respectively.

Higher bearing pressures may be provided depending on location and foundation design depth. This can be confirmed once the design and grading specifications are available for review.

The footing subgrade must be inspected by a geotechnical engineer, or a senior geotechnical technician, under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the design of the foundation.

Footings exposed to weathering, or in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

Where the footing excavation consists of wet sands and/or silts, or the footing subgrade is saturated, a concrete mud-slab of lean mix concrete, 8 to 10 cm in thickness, should be poured immediately after subgrade preparation and inspection to protect the approved subgrade against disturbance by the construction traffic.

The foundation should meet the requirements specified by the latest Ontario Building Code, and the structures can be designed to resist a minimum earthquake force using Site Classification 'D' (stiff soil).

The external grading must be designed to drain surface runoff away from the structures to minimize the frost heave phenomenon generally associated with the disclosed soils.

6.3 Basement Structure

Where house basements are proposed, they should be designed for the lateral earth pressure using the soil parameters provided in Table 6.

In conventional basement design, perimeter walls of the basement structure should be damp-proofed and provided with perimeter subdrains at the wall base. Backfill of the open excavation should consist of free-draining granular material (Drawing No. 3) unless prefabricated drainage board is installed over the entire wall below grade.

As previously noted, wet silt deposits were observed in the eastern half of the site It is recommended that the basement floor be founded at least 1.0 m above the seasonal high groundwater level in the vicinity. Should the basement floor be founded less than 1.0 m above the groundwater table, underfloor subdrains (Drawing No. 4) should be provided to supplement the perimeter subdrain system to relieve any groundwater upfiltration due to seasonal fluctuation. The subdrains, connected to a positive outlet, should be encased in a fabric filter to protect them against blockage by silting. If the basement floor is to be founded less than 0.5 m above the groundwater table, the basement structure should be waterproofed and designed for hydrostatic uplift pressure. Where necessary, additional boreholes can be performed to further delineate the horizontal extent of the wet silt layer during the detail design stage once the site grading plan is available for review.

The subgrade of the basement slab must consist of sound native soil or well compacted inorganic earth fill or engineered fill. The subgrade should be inspected and assessed by proof-rolling prior to slab-on-grade construction. Where loose or soft subgrade is detected, it should be subexcavated and replaced with inorganic material, compacted to at least 98% SPDD.

The concrete slab should be constructed on a minimum 15 cm thick granular base, consisting of 19-mm CRL, or equivalent, compacted to its maximum SPDD. Where underfloor weepers are required, the bedding should be increased to 30 cm in thickness. In addition, a vapor barrier should be placed between the granular bedding and the concrete slab to prevent upfiltration of water vapour.

6.4 **Underground Services**

A Class 'B' bedding is recommended for construction of the underground services. The bedding material should consist of compacted 19-mm CRL, or equivalent, compacted to at least 98% SPDD. In the saturated silt deposits, a Class 'A' bedding should be considered for proper pipe support.

The subgrade for underground services should consist of sound native soils or properly compacted earth fill. Where soft or loose soil is encountered at the invert level, it must be subexcavated and replaced with properly compacted bedding material.

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

Openings to subdrains and catch basins should be shielded by a fabric filter to prevent silting. In order to prevent pipe floatation when the service trench is deluged with water derived from precipitation, a soil cover with a thickness of at least 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 anode weight requirements, the electrical resistivities of the disclosed soils presented in Table 6 can be used. The proposed anode weight must meet the minimum requirements as specified by the Town of Caledon or Region of Peel.

6.5 **Backfilling Trenches and Excavated Areas**

The on-site inorganic soils are suitable for trench backfill. The addition of water may be required for the clay till prior to structural compaction during dry and warm weather and in areas where compaction is best performed on the wet side of the optimum. The wet silt and portions of the silty clay and sandy silt till/silty sand till will require aeration prior to their use as structural backfill. The tills should be sorted free of large cobbles and boulders (over

15 cm in size). The weathered soil must be sorted free of topsoil inclusions and deleterious materials prior to reuse for structural backfill.

The backfill material should be compacted to at least 95% SPDD. In areas below the slab-on-grade and in the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% SPDD with a moisture content 2% to 3% drier than the optimum. This is to provide the required stiffness for floor or pavement construction. The lift of each backfill layer should be limited to a thickness of 20 cm, or the thickness should be determined by test strips at the time of compaction.

In normal construction practice, the problem areas of pavement settlement largely occur adjacent to foundation walls, columns, manholes, catch basins and services crossings. In areas which are inaccessible to a heavy compactor, sand backfill which can be appropriately compacted using a smaller vibratory compactor should be used.

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

- To backfill a deep trench, one must be aware that the future settlement is to be expected, unless the sides is flattened to 1V:2H, 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 98% 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 and the compaction must be carried out diligently, 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.
- In areas where the underground services construction is carried out during the 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 the final surfacing of the new pavement and slab-on-grade construction.
- When construction is carried out in the winter, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in-situ soil 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.

Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as when the trench box is removed. The above will invariably cause backfill settlement that may become evident within several years after construction.

- In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

6.6 Pavement Design

The recommended pavement design for residential local and neighbourhood collector/through roads, satisfying the minimum requirement from the Town of Caledon, is provided in Table 3.

Table 3 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL3
Asphalt Binder		
Local Residential	65	HL8
Collector/Through Road	90	HL8
Granular Base	150	Granular 'A' or equivalent
Granular Sub-base		Granular 'B' or equivalent
Local Residential	300	
Collector/Through Road	450	

In preparation of the pavement subgrade, all topsoil and compressible material should be removed. The subgrade should be proof-rolled and inspected. Any soft spots identified must be subexcavated and replaced with inorganic earth fill. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with a water content at 2% to 3% drier than the optimum. All the granular bases should be compacted to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to infiltrate the mantle. The following measures should be incorporated in the construction procedures and pavement design:

- The pavement subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Lots areas adjacent to the road should be properly graded to prevent ponding of large amounts of water. Otherwise, the water will seep into the subgrade mantle and induce a

regression of the subgrade strength, with costly consequences for the pavement construction.

- In extreme cases during the wet seasons, if soft or weak subgrade is identified, it can be replaced by compacted granular material to compensate for the inadequate strength of the soft or weak subgrade. This can be assessed during construction.
- Fabric filter-encased curb subdrains are required to meet the Town of Caledon requirements.

6.7 Bridge Crossing

A new bridge crossing will be constructed across the natural system in the vicinity of Boreholes BC-105 and 106. At the time of report preparation, design of the bridge crossing is not available for review.

Shallow Foundation

The bridge abutments may be supported on conventional spread footings with restricted bearing capacities, founded onto the stiff to hard silty clay and silty clay till above the wet, loose to compact silt deposit. The recommended bearing pressures at or above an approximate founding depth of El. 255.0 m are restricted as follows:

- Maximum Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Bearing Pressure at Ultimate Limit State (ULS) = 250 kPa

The total and differential settlements of footing designing for SLS are estimated at 25 mm and 20 mm, respectively.

Deep Foundation for the Abutments and Piers

Due to the proximity of the Etobicoke Creek and the underlying wet subsoils with limited bearing capacity, construction of shallow foundations may be difficult. Deep foundation, such as driven H-piles, can be considered for bridge abutments and piers extending past the wet silt deposit and into the very dense sandy silt till or hard silty clay till below El. 246.0 m. The piles must not rest in the loose to dense silt unit which is subject to dilation under vibratory driving forces. It is recommended that the piles be extended at least 3 m into the hard or very dense till with ‘N’ values greater than 50 blows. In view that there is insufficient subsoil data to support this design on the west side of the creek valley (BC-105D), deeper borehole(s) should be carried out in the vicinity of the west abutment once the bridge crossing location and details are confirmed to further elaborate on the subsoil condition below El. 245.0 m.

For preliminary design with typical driven pile sizes of HP310x110 and HP360x174, the recommended geotechnical resistances at SLS and ULS are provided in Table 4.

Table 4 - Pile Capacities for H-Piles

Borehole	Abutment	Pile Size	Pile Capacity (kN) SLS	Pile Capacity (kN) ULS	Depth (m)	El. (m)
BC-105D	West	HP310x110	600	720	Below 14.1	Below 246.0
		HP360x174	790	950		
BC-106	East	HP310x110	780	940	Below 10.6	Below 246.0
		HP360x174	1100	1300		

Other specific sizes and associated resistance capacities can be provided upon request. The actual refusal criteria of pile driving should be established once the chosen pile size and the design loads are known. Cast steel drive shoes, as per OPSD 3000.100, will be required in order to protect the driven pile toe into the till deposit. Full time monitoring of the pile driving operation by a geotechnical technician is necessary in order to assess the pile capacity at refusal. In order to verify the design pile capacity, static load test or Pile Driving Analyzer (PDA) must be performed on selected piles at each abutment and pier. Integral abutments can also be supported on H-piles, with a minimum pile embedment of 0.6 m into the concrete cap.

The settlement of piles designed for the load resistance at SLS are estimated to be less than 25 mm.

Lateral Resistance

Lateral loading can be resisted fully or partially by the use of battered steel H-piles. For vertical piles, the resistance to lateral loading will have to be derived from the soil in front of the pile support. The geotechnical lateral resistance may be calculated using the coefficient of horizontal subgrade reaction (k_s) and the ultimate lateral resistance (p_{ult}):

Cohesive Soil: $k_s = 67\ S_u/D$ and $p_{ult} = 9\ S_u$
Cohesionless Soil: $k_s = n_h\ z/D$ and $p_{ulkt} = 3\ \gamma z\ K_p$

where S_u = undrained shear strength (kPa)
z = depth of pile embedment (m)
n_h = coefficient related to soil relative density (MN/m^3)
D = pile width/diameter (m)

γ = bulk unit weight of soil in overburden [or γ' in submerged condition] (kN/m^3)

K_p = coefficient of passive earth pressure

The soil parameters for the calculation of k_s are summarized in Table 5.

Table 5 - Soil Parameters for Lateral Resistance of Pile

Soil Type	γ (kN/m^3)	n_h (MN/m^3)	S_u (kPa)	K_p
Silty Clay	20.5	-	85	-
Silty Clay Till	22.0	-	175	-
Silt	11.0 (submerged)	1.3	-	2.77
Sandy Silt Till	22.5	11	-	3.39

The computed lateral resistance should be multiplied by a geotechnical resistance factor of 0.5. The design of piles and load capacities should be reviewed by the geotechnical engineer before finalization.

Group Pile Efficiency

Where multiple piles are required to support the structure, it is recommended that the spacing between piles must be at least 3 times the diameter or width of the pile. Pile group action for axial resistance should be considered, and can be evaluated by applying a reduction factor as listed below:

Pile Spacing:	8B	6B	4B	3B
Reduction Factor:	1.0	0.9	0.75	0.7

Pile group action for lateral resistance can also be evaluated as listed below:

Pile Spacing:	8B	6B	4B	3B
Reduction Factor:	1.0	0.7	0.4	0.25

Wing Wall Foundation

Wing walls, constructed with cast-in-place concrete, can be supported on strip footings founded below the frost penetration depth of at least 1.2 m below the proposed grade, onto the sound native soil or engineered fill with the following recommended soil bearing pressures:

- Maximum Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Bearing Pressure at Ultimate Limit State (ULS) = 250 kPa

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

Alternatively, Reinforced Soil Slope (RSS) wall can be used for the wing wall. The RSS wall should be designed in accordance with the MTO Guideline. A 300 mm thick granular bedding, consisting of Granular ‘A’ compacted to 100% SPDD, will be required beneath the wall facing units after the subgrade is inspected.

The footing subgrade must be inspected prior to the construction of the wing walls. Stepped down footings may be specified with a maximum step height of 0.6 m and a minimum step length of 1.2 m, founded on the sound native soil or engineered fill.

Frost and Scour Protection

All pile caps and/or conventional spread and strip footings should be founded below the frost penetration depth, with a soil cover not less than 1.2 m. Where the abutments are constructed in close proximity of the watercourse/tributary, the foundation should extend either below the scouring depth or the frost depth, whichever is greater.

Scouring protection schemes, such as using R10 Rip-Rap, at least 300 mm in thickness, should be provided along the watercourse.

Seismic Consideration

Based on the Canadian Highway Bridge Design Code, the bridge abutments on piles driven into the very dense tills can be designed to resist an earthquake force using Site Classification ‘C’. Conventional shallow bridge foundation and wing wall foundations can be designed using Site Classification ‘D’ (stiff soil).

General Construction

A construction platform and access driveway will be required for the access of machinery and construction equipment near the crossing. Temporary erosion and sediment control plan must be implemented during construction to prevent unnecessary disturbance to the valley system of the Etobicoke Creek. The erosion and sediment control plan should be reviewed and approved by the Toronto and Regional Conservation Authority (TRCA). Where necessary and/or upon request by the conservation, temporary bank protection may also be required to prevent erosion along the creek bank.

For construction of the bridge abutments and piers, the tributary may be temporarily diverted, where necessary. Where excavation extends into the wet silt unit, dewatering will be required to draw down the groundwater to approximately 1 m below the intended bottom of excavation. Dewatering details such as the method, rate and volumes should be verified with the hydrogeologist and the dewatering contractor. Sheeting enclosures may also be required to limit the extent of excavation and disturbance into the natural system. One should be noted that sheeting installed using vibratory method into the wet silt may result in soil dilation and the shear strength of the wet silt will be reduced. It is recommended that the sheeting enclosures be completed using a non-vibratory method unless such disturbance is accounted for when designing the sheeting enclosure, and also in the design of the abutments and footings for the crossing.

Embankment and Wing Wall Backfill

Should embankment heights be raised significantly higher than the original grade, consolidation settlement of the subsoils will occur. Primary consolidation settlement in the fine-grained subsoil can be expected. This should be further assessed once detailed embankment design is available for review.

Prior to the construction of embankment, the ground must be free of compressible topsoil and deleterious material. The subgrade must be proof-rolled and inspected before earth filling. Any soft/weak material as identified must be subexcavated and replaced with properly compacted inorganic earth fill.

The wing walls should be backfilled with free draining, non-frost susceptible granular fill to at least 1.2 m behind the wall structure. This is to prevent the build up of hydrostatic pressure and the development of any frost action against the wall structure. Weep holes and/or subdrains should be specified to dissipate any water collected behind the walls.

The road embankment towards the bridge crossing should be graded with a slope gradient of 1V:3H or gentler. Where steeper gradient is considered, the stability of the embankment slope should be reviewed. Where applicable, flood protection should be considered for any portions of the embankment that will extend below the flood line.

The sloping ground of embankment should be covered with 300-mm thick topsoil layer, sodded or vegetated to prevent surficial erosion. Prior to sodding and growth of vegetation, an erosion control blanket may be utilized.

6.8 Soil Parameters

The recommended soil parameters for the project design are given in Table 6.

Table 6 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Silty Clay Till	22.0	12.0	1.33	1.03
Silty Clay	20.5	10.5	1.30	1.00
Sandy Silt Till/Silty Sand Till	22.5	12.5	1.33	1.05
Silt	21.0	11.0	1.20	1.00
Lateral Earth Pressure Coefficients		**Active K_a**	**At Rest K_o**	**Passive K_p**
Compacted Earth Fill and Silty Clay		0.40	0.55	2.50
Silty Clay Till		0.33	0.50	3.00
Sandy Silt Till/Silty Sand Till		0.29	0.46	3.39
Silt		0.36	0.53	2.77
Estimated Coefficient of Permeability (K) and Percolation Time (T)			**K (cm/sec)**	**T (min/cm)**
Silty Clay Till and Silty Clay			10^{-7}	80+
Sandy Silt Till/Silty Sand Till			10^{-4}	12
Silt			10^{-4} to 10^{-5}	12 to 20
Estimated Electrical Resistivity				**(ohm·cm)**
Silty Clay Till				4000
Silty Clay				3500
Sandy Silt Till/Silty Sand Till				5000
Silt				5500
Coefficients of Friction				
Between Concrete and Granular Base				0.50
Between Concrete and Native Soils or Compacted Earth Fill				0.35

6.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils to be excavated are classified in Table 7.

Table 7 - Classification of Soils for Excavation

Material	Type
Sound Tills and Silty Clay	2
Weathered Soils and Silt (above groundwater)	3
Saturated Soils	4

In excavation, the groundwater seepage from the tills and clay will likely be limited in quantity and can be removed by conventional pumping from sumps. However, excavation extending into the wet silt in around the Etobicoke Creek valley may require more extensive construction dewatering. In order to provide a stable subgrade for the services or foundation construction, the groundwater should be depressed to at least 1.0 m below the intended bottom of excavation. Detailed groundwater profile and dewatering needs should be referred to the hydrogeological report by PEGG.

Excavation into the very stiff to hard and dense to very dense tills containing cobbles and boulders will require extra effort and the use of a heavy-duty, properly equipped backhoe.

Prospective contractors should 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 prior to excavating. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Brookvalley Developments (Hwy 10) Ltd. and for review by its designated consultants, contractors and government agencies. The material in the report reflects the judgement of Hui Wing Yang, P.Eng. 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 use which a Third Party makes of this report, 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.

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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

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 '○'

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 '—●—'

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
>50	very dense

Cohesive Soils:

Undrained Shear Strength (kPa)	'N' (blows/30 cm)	Consistency
<12	<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
>200	>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

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GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-101

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

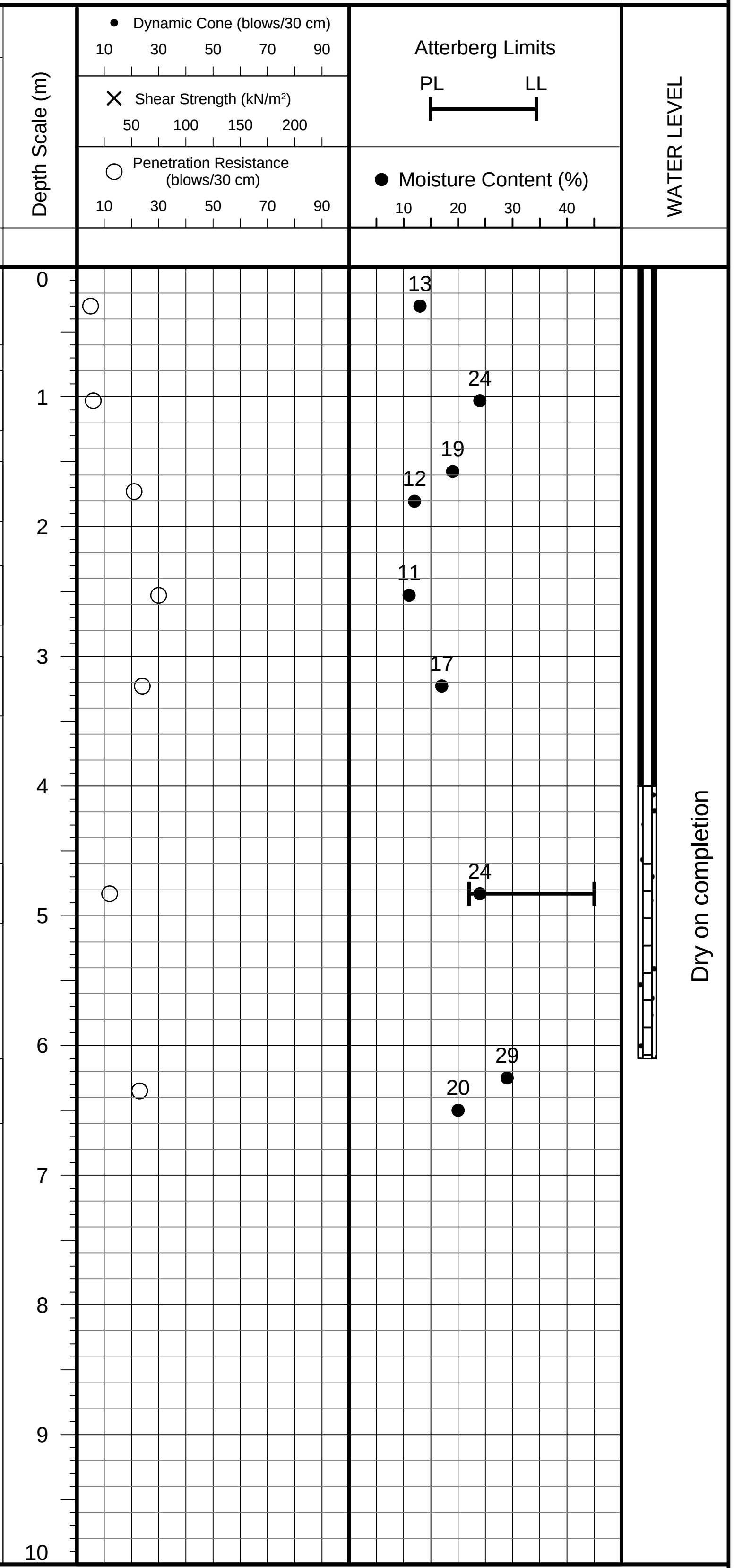
METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 13, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
262.4 0.0	Ground Surface **41 cm TOPSOIL**			
	Brown, loose **SANDY SILT** occ. sand seams and layers — weathered	1	DO	5
		2	DO	6
260.8 1.6	Brown, very stiff **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. sand and silt seams and layers	3A 3B	DO	21
		4	DO	30
		5	DO	24
258.4 4.0	Grey, stiff to very stiff **SILTY CLAY** a trace of sand occ. silt seams and layers	6	DO	12
	— — — — silt	7A 7B	DO	23
255.8 6.6	**END OF BOREHOLE**			

Installed 50-mm Ø PVC monitoring well to 6.1 m, completed with 1.5 m screen
Sand backfill from 4.0 to 6.1 m
Bentonite seal from 0.0 to 4.0 m
Provided with a steel monument casing



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JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-102

FIGURE NO.: 2

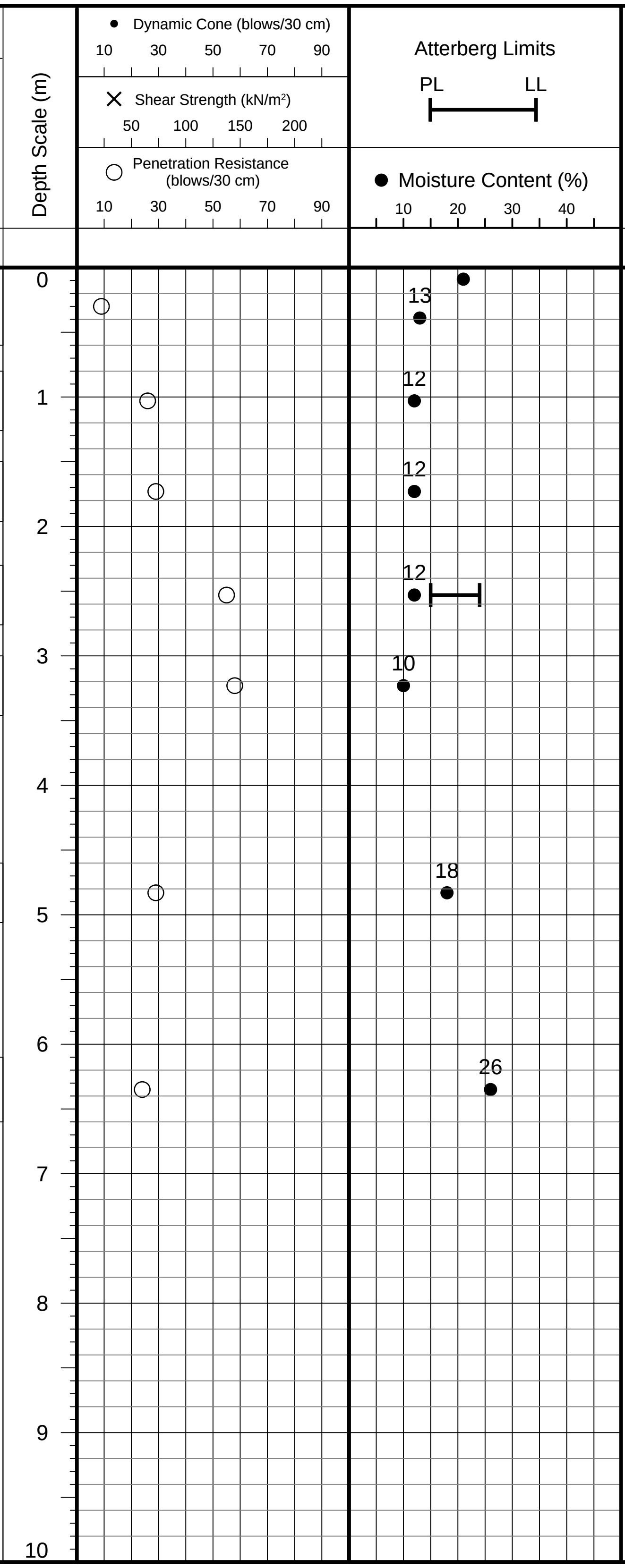
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 16, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
261.3	Ground Surface				Dry on completion
0.0	**18 cm TOPSOIL**	1A	DO	9	
	Brown, loose, weathered **SANDY SILT** occ. sand seams and layers	1B			
260.5 0.8	Very stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. sand and silt seams and layers, cobbles	2	DO	26	
		3	DO	29	
		4	DO	55	
		5	DO	58	
	brown grey				
		6	DO	29	
255.7 5.6	Grey, very stiff **SILTY CLAY** a trace of sand	7	DO	24	
254.7 6.6	**END OF BOREHOLE**				



Soil Engineers Ltd.

JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-103

FIGURE NO.: 3

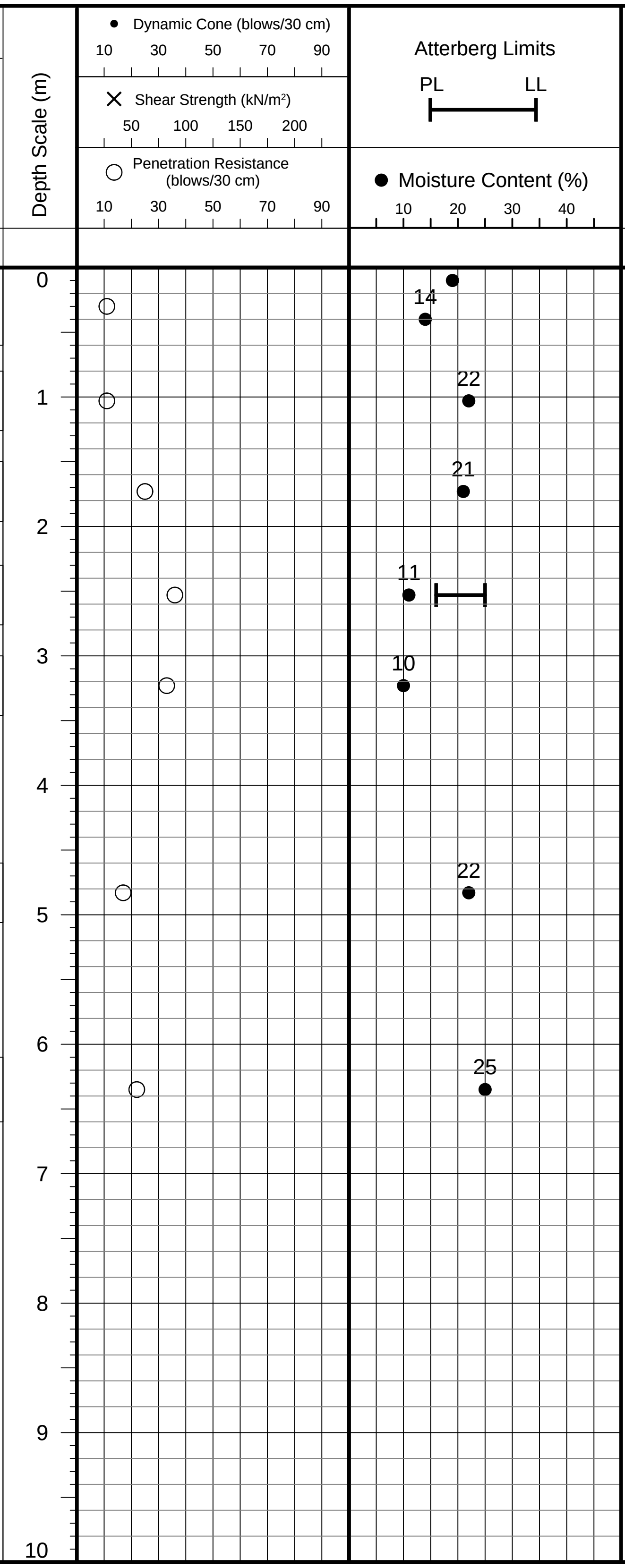
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 16, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
261.3	Ground Surface			
0.0	**20 cm TOPSOIL**	1A	DO	11
	Brown, compact, weathered **SANDY SILT** with organics, occ. silt seams and layers	1B		
		2	DO	11
259.9 1.4	Very stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel — — brown/grey occ. sand and silt seams and layers, cobbles	3	DO	25
		4	DO	36
		5	DO	33
256.7 4.6	Grey, very stiff **SILTY CLAY** a trace of sand, occ. gravel with dilating silt layers	6	DO	17
		7	DO	22
254.7 6.6	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

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Page: 1 of 1

JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-104

FIGURE NO.: 4

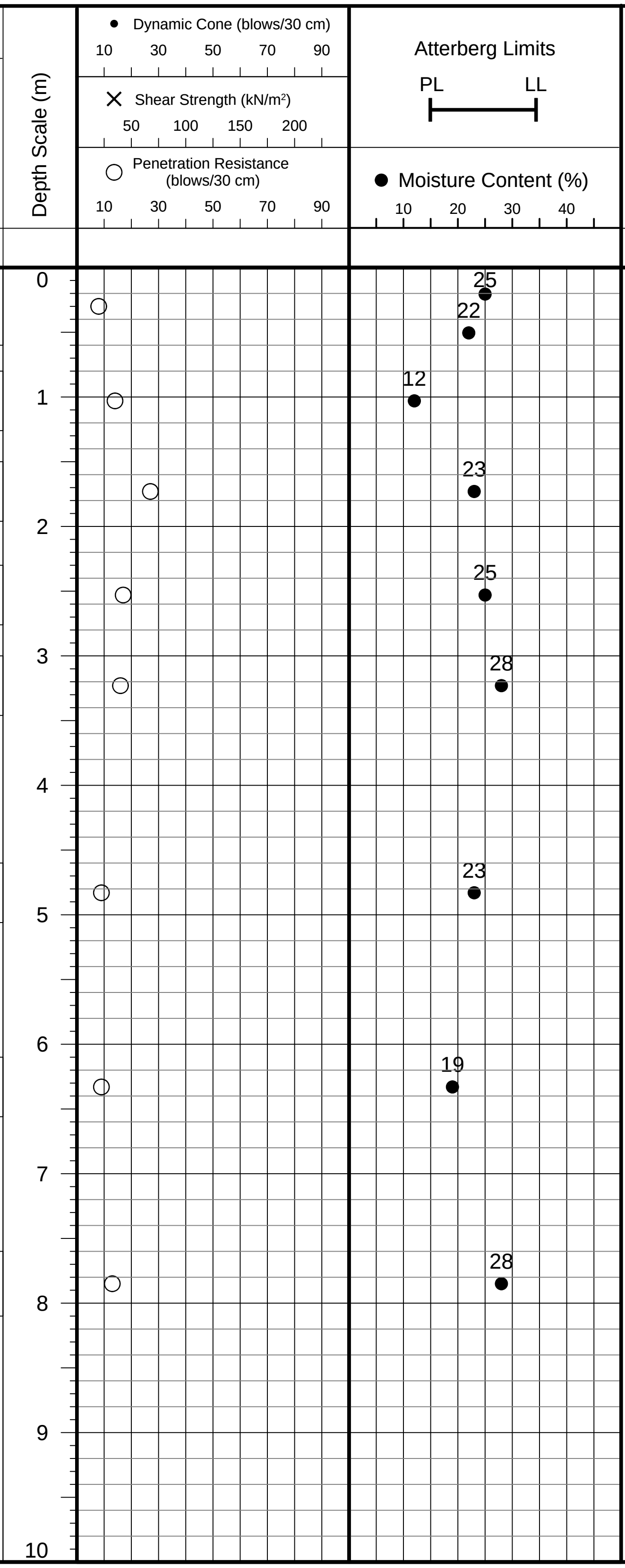
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 16, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
259.5	Ground Surface			
0.0	**41 cm TOPSOIL**	1A	DO	8
	Brown, loose, weathered **SANDY SILT/SILTY FINE SAND**	1B		
258.7 0.8	Brown, stiff to very stiff **SILTY CLAY TILL** some sand, a trace of gravel occ. sand and clay layers	2	DO	14
		3	DO	27
257.2 2.3	Brown, very stiff **SILTY CLAY** a trace of sand, occ. gravel	4	DO	17
		5	DO	16
255.5 4.0	Grey, loose, wet **SILT** some fine sand a trace of clay	6	DO	9
		7	DO	9
252.3 7.2	Grey, stiff **SILTY CLAY** a trace of sand, with varved (silt) layering	8	DO	13
251.4 8.1	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 253.6 m on completion

JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-105D

FIGURE NO.: 5

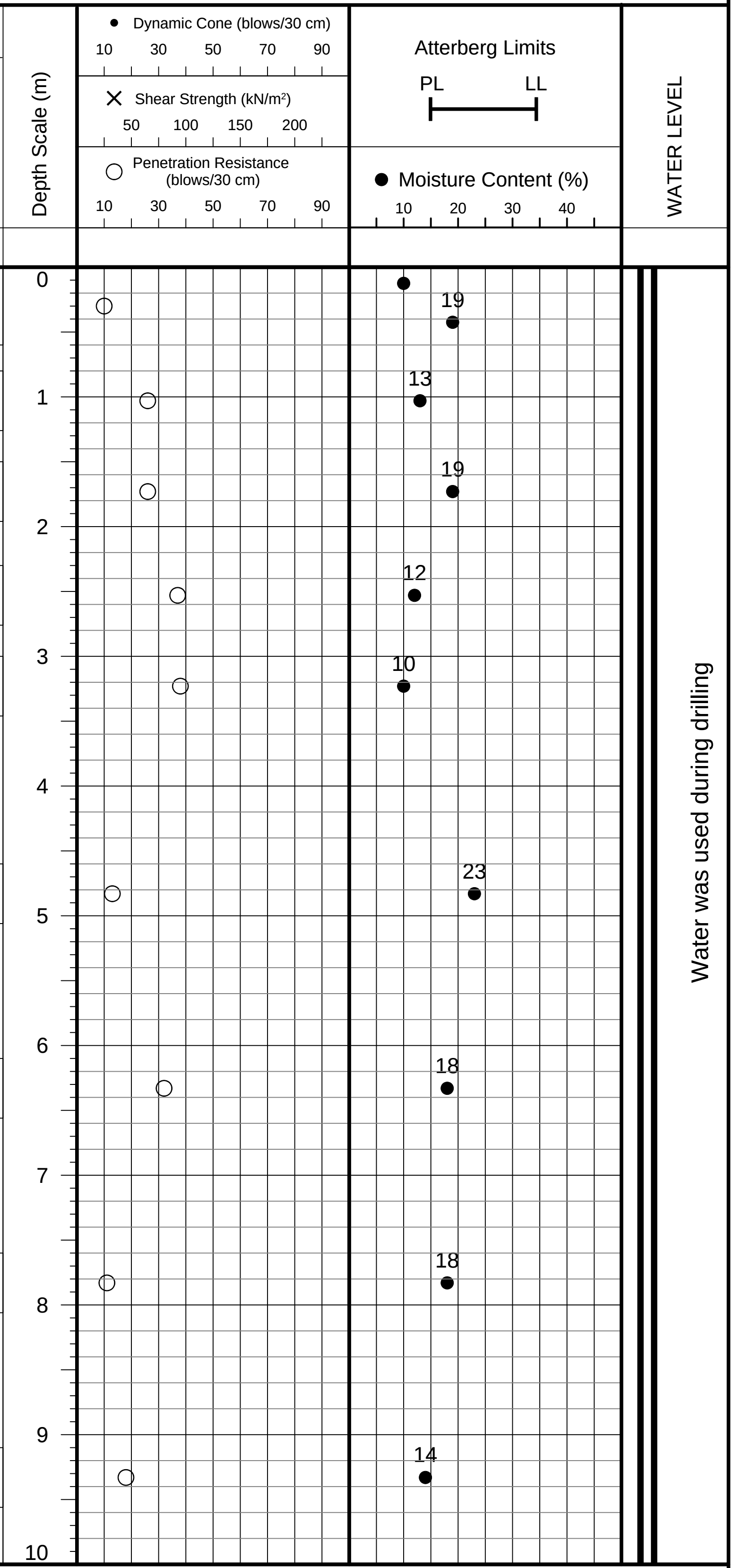
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers and Tricone

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
260.1	Ground Surface			
0.0	**25 cm TOPSOIL**	1A	DO	10
	Brown, stiff to hard	1B		
	SILTY CLAY TILL — weathered	2	DO	26
	some sand to sandy a trace of gravel occ. sand and silt seams and layers, cobbles	3	DO	26
		4	DO	37
		5	DO	38
256.1 4.0	Stiff **SILTY CLAY** a trace of sand, occ. gravel — — brown grey	6	DO	13
254.5 5.6	Grey, compact to dense, wet **SILT** some fine sand a trace of clay	7	DO	32
		8	DO	11
251.4 8.7	Grey, very stiff to hard **SILTY CLAY TILL** sandy, a trace of gravel occ. sand and silt seams and layers	9	DO	18
250.1				



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JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-105D

FIGURE NO.: 5

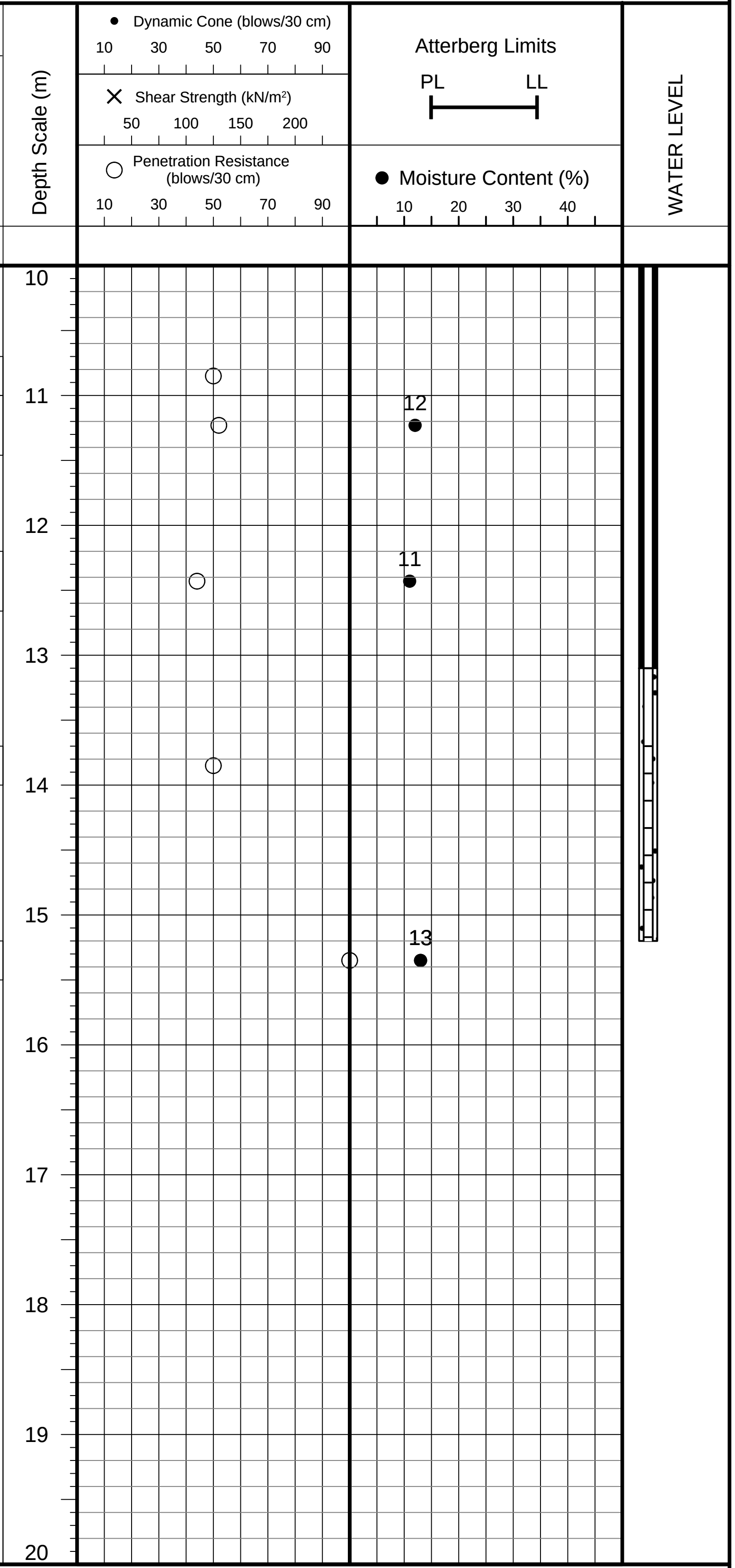
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers and Tricone

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
10.0	Grey, very stiff to hard **SILTY CLAY TILL** sandy, a trace of gravel occ. sand and silt seams and layers	10A	DO	50
		10B	DO	52
248.2 11.9	Grey, dense to very dense **SANDY SILT TILL** traces of clay and gravel occ. cobbles	11	DO	44
		12	DO	50
245.5 14.6	Grey, hard **SILTY CLAY TILL** some sand, with silt layers	13	DO	50/13
244.6 15.5	**END OF BOREHOLE** Installed 50-mm Ø PVC monitoring well to 15.2 m, completed with 1.5 m screen Sand backfill from 13.1 to 15.2 m Bentonite seal from 0.0 to 13.1 m Provided with a steel monument casing			



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JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-105S

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 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
260.1	Ground Surface							
0.0	**NO SAMPLING** **DIRECT AUGER AND INSTALLED NESTED SHALLOW WELL TO 7.6 m**				0 1 2 3 4 5 6 7			Dry on completion
252.5 7.6	**END OF BOREHOLE** Installed 50-mm Ø PVC monitoring well to 7.6 m, completed with 1.5 m screen Sand backfill from 5.5 to 7.6 m Bentonite seal from 0.0 to 5.5 m Provided with a steel monument casing				8 9 10			

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JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-106

FIGURE NO.: 7

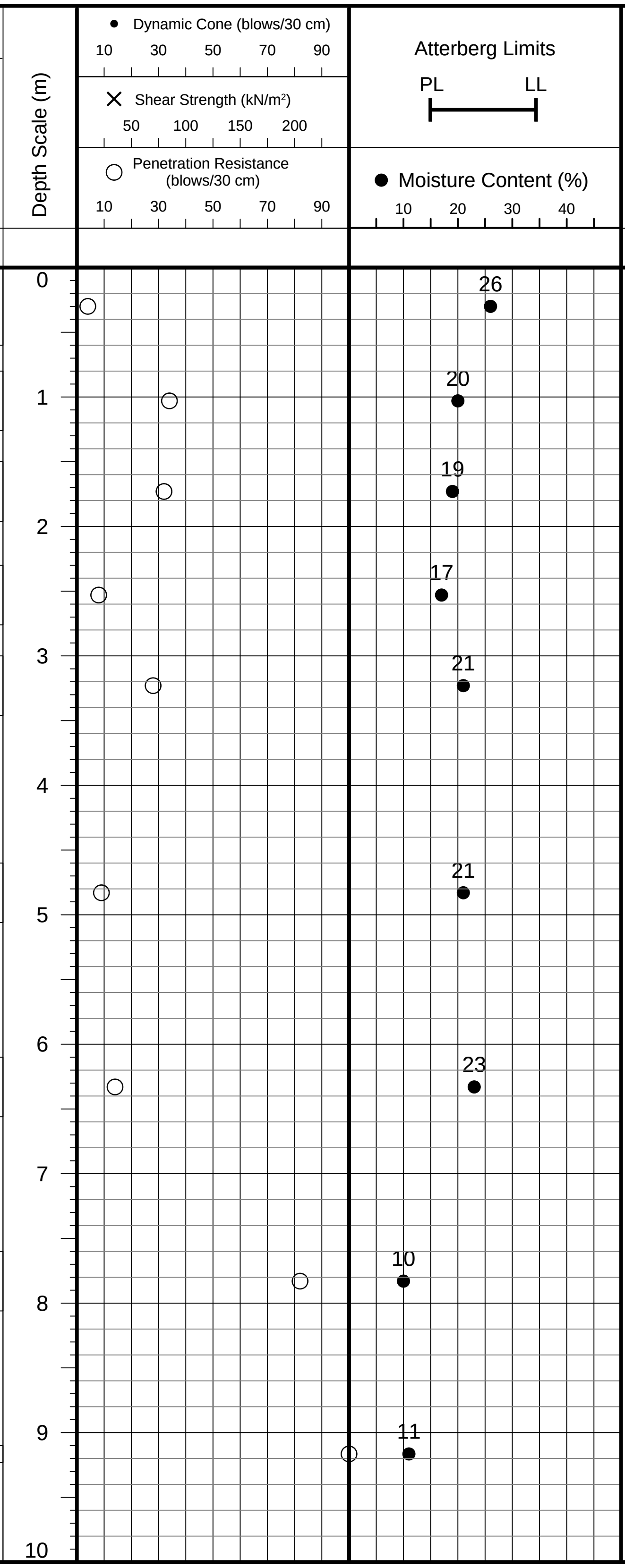
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
256.6	Ground Surface			
0.0	**61 cm TOPSOIL**	1	DO	4
	Brown, hard **SILTY CLAY TILL** some sand, a trace of gravel — weathered	2	DO	34
255.2 1.4	Brown, hard **SILTY CLAY** a trace of sand, occ. gravel	3	DO	32
254.5 2.1	Loose to compact **SILT** some sand, a trace of clay occ. sand seams and clay layers moist, becoming wet below 3.0 m	4	DO	8
		5	DO	28
	— — brown / grey	6	DO	9
		7	DO	14
249.4 7.2	Grey, very dense **SANDY SILT TILL/SILTY SAND TILL** a trace of clay a trace to some gravel occ. silt seams and layers, cobbles and boulders	8	DO	82
		9	DO	50/13
246.6				



WATER LEVEL

W.L. @ El. 249.9 m on completion ▽

Soil Engineers Ltd.

JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-106

FIGURE NO.: 7

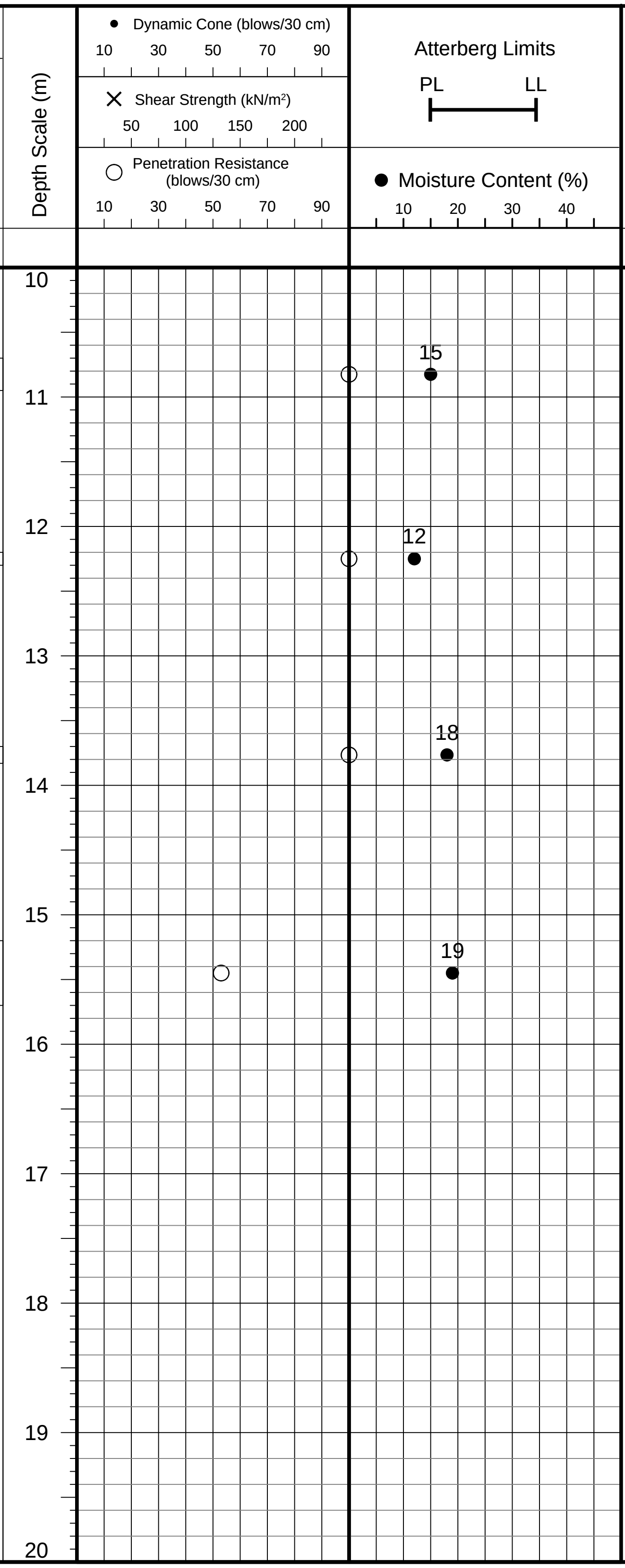
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
10.0	Grey, very dense **SANDY SILT TILL/SILTY SAND TILL** — — — silt a trace of clay a trace to some gravel occ. silt seams and layers, cobbles and boulders	10 11	DO DO	50/10 50/10	
243.3 13.3	Grey, very dense, moist **SILT** some sand and clay occ. clay layers	12 13	DO DO	50/13 53	
240.9 15.7	**END OF BOREHOLE**				



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JOB NO.: 2310-S042

LOG OF BOREHOLE: BC-107

FIGURE NO.: 8

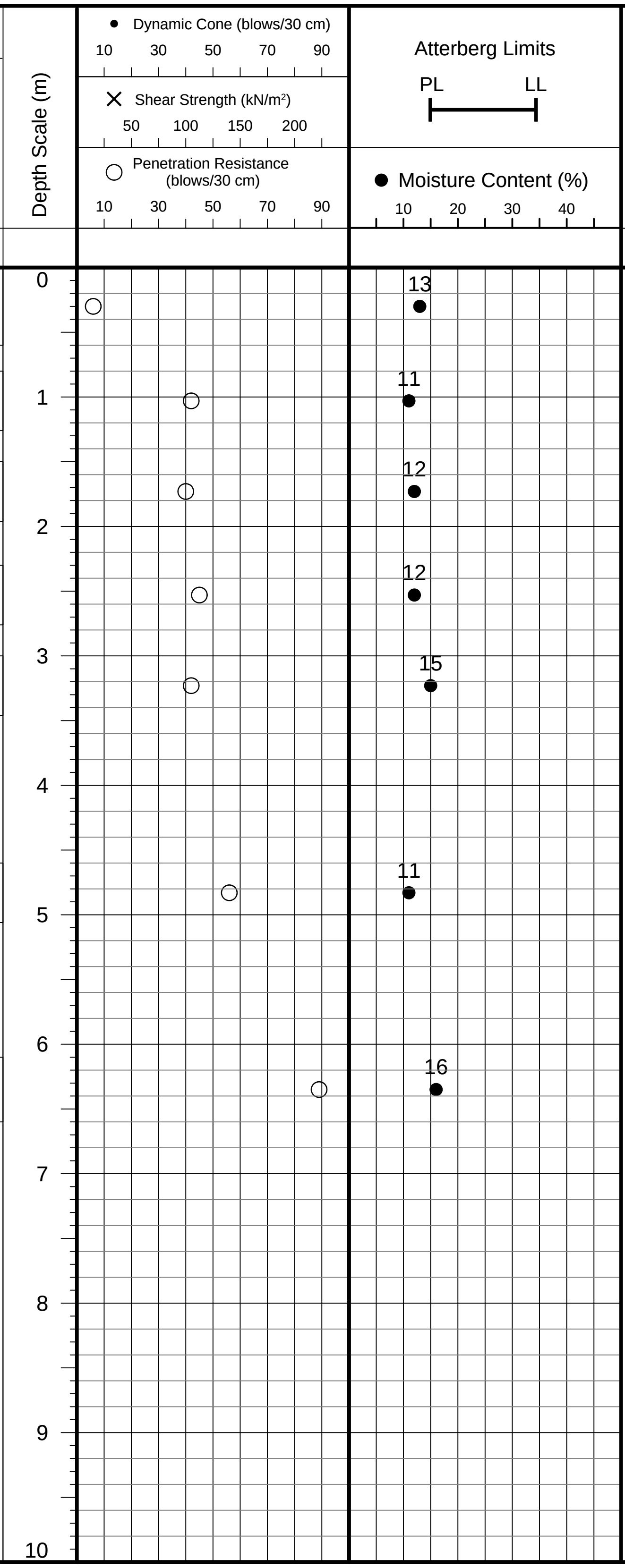
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 12760 Hurontario Street, Town of Caledon

DRILLING DATE: October 17, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
260.6	Ground Surface				
0.0	**25 cm TOPSOIL**				Dry on completion
	Brown, firm to hard weathered	1	DO	6	
	SILTY CLAY TILL	2	DO	42	
	some sand to sandy a trace of gravel occ. sand and silt seams and layers	3	DO	40	
		4	DO	45	
		5	DO	42	
256.6 4.0	Brown, very dense, moist **SANDY SILT**				
	a trace of clay occ. silt lenses	6	DO	56	
255.0 5.6	Brown, very dense **SANDY SILT TILL**				
	traces of clay and gravel occ. sand and silt seams and layers	7	DO	89	
254.0 6.6	**END OF BOREHOLE**				



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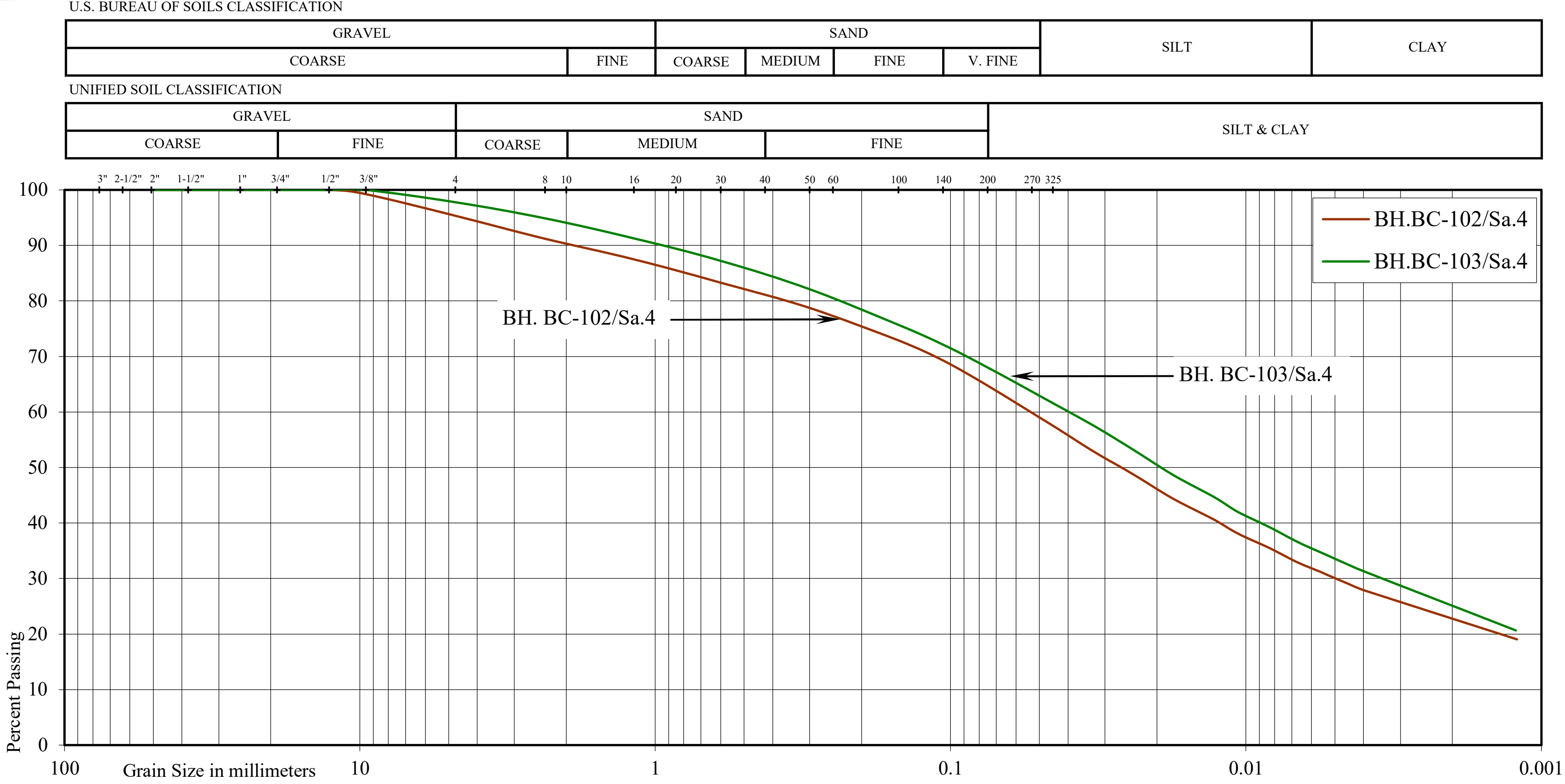
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S042



Project: Proposed Residential Development

Location: 12760 Hurontario Street, Town of Caledon

Borehole No:	BC-102	BC-103
Sample No:	4	4
Depth (m):	2.5	2.5
Elevation (m):	258.8	258.8

	BC-	BC-
BH./Sa.	102/4	103/4
Liquid Limit (%) =	24	25
Plastic Limit (%) =	15	16
Plasticity Index (%) =	9	9
Moisture Content (%) =	12	11
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

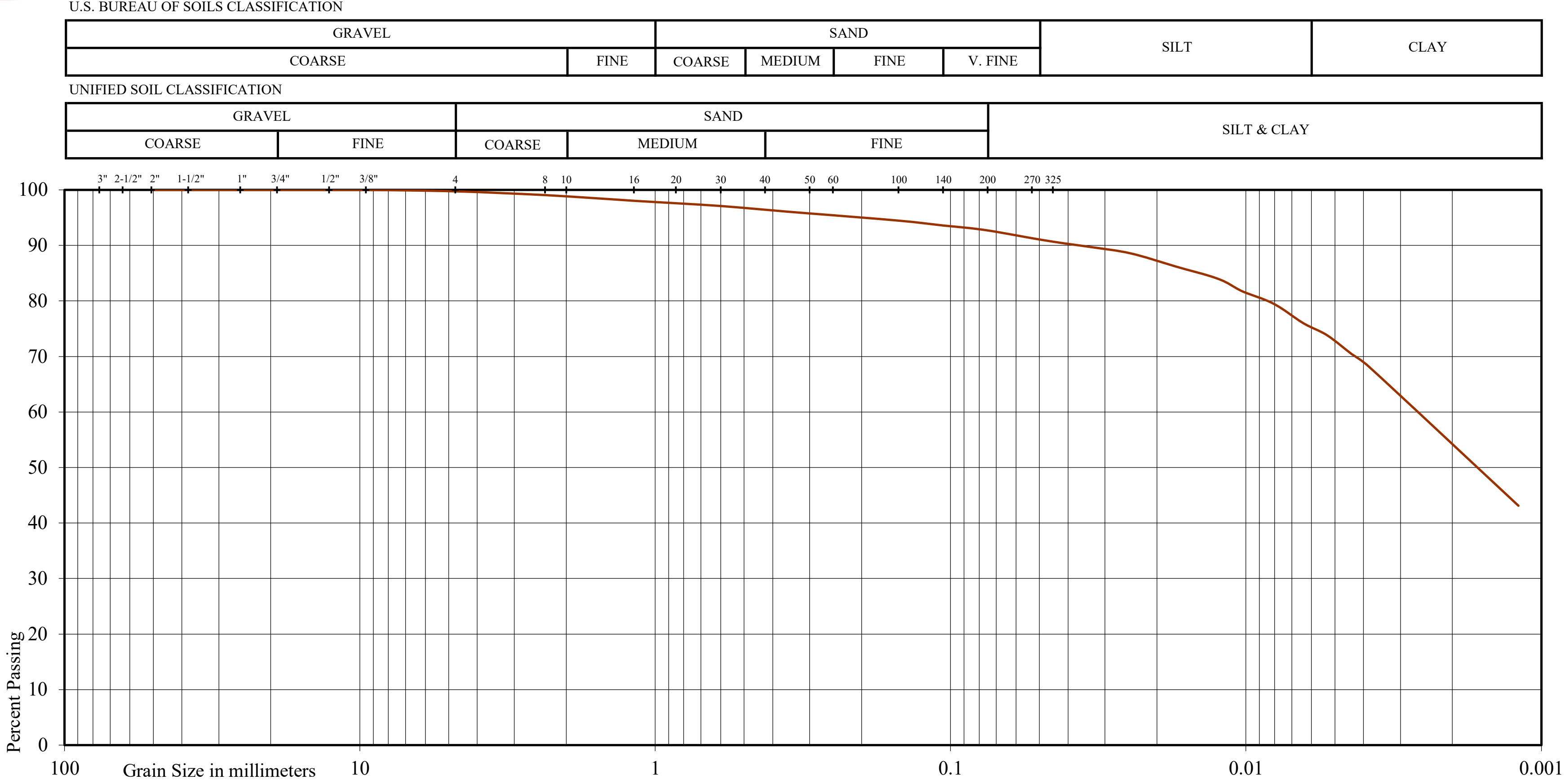
Classification of Sample [& Group Symbol]: SILTY CLAY TILL
sandy, a trace of gravel

Figure: 9

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2310-S042



Project:	Proposed Residential Development		BC-
Location:	12760 Hurontario Street, Town of Caledon		BH./Sa. 101/6
		Liquid Limit (%) =	45
Borehole No:	BC-101	Plastic Limit (%) =	22
Sample No:	6	Plasticity Index (%) =	23
Depth (m):	4.8	Moisture Content (%) =	24
Elevation (m):	257.6	Estimated Permeability (cm./sec.) =	10^{-7}

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

Figure: 10

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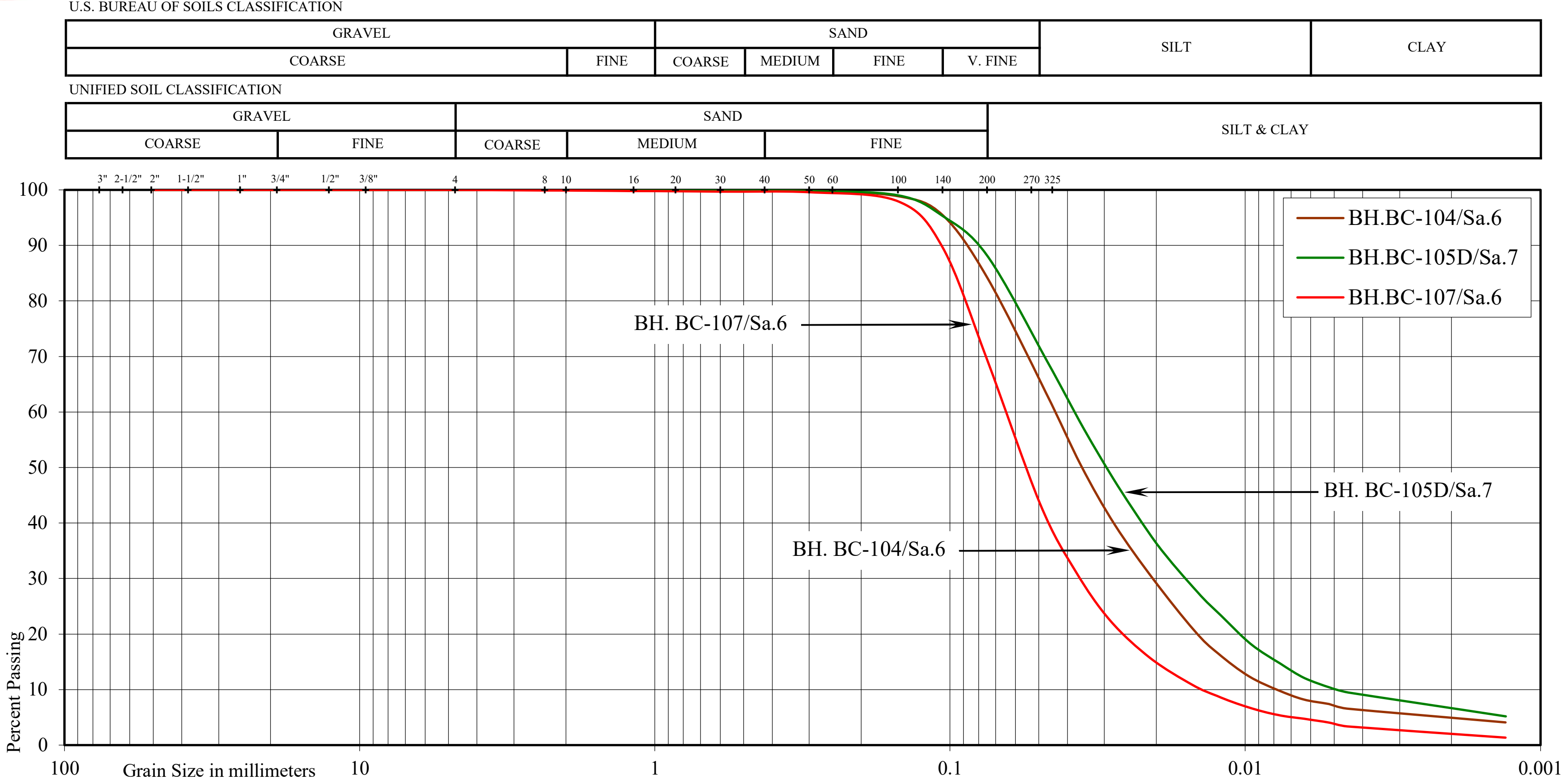
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S042



Project: Proposed Residential Development

Location: 12760 Hurontario Street, Town of Caledon

Borehole No:	BC-104	BC-105D	BC-107
Sample No:	6	7	6
Depth (m):	4.8	6.3	4.8
Elevation (m):	254.7	253.8	255.8

	BC-	BC-	BC-
BH./Sa.	104/6	105/7	107/6
Liquid Limit (%) =	-	-	-
Plastic Limit (%) =	-	-	-
Plasticity Index (%) =	-	-	-
Moisture Content (%) =	23	18	11
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-5}	10^{-4}

Classification of Sample [& Group Symbol]: SILT, some sand to sandy
a trace of clay

Figure: 11

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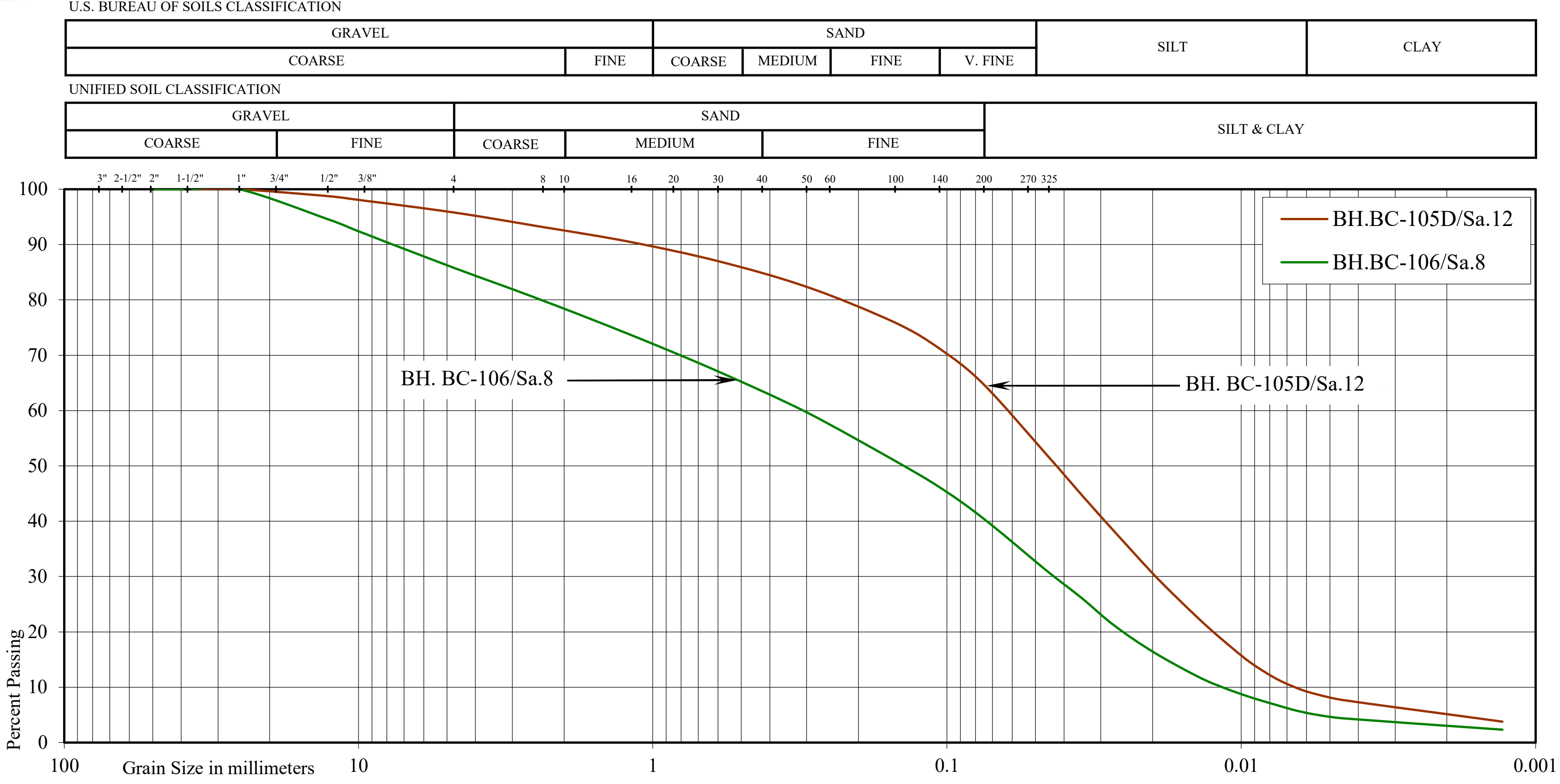
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S042



Project: Proposed Residential Development

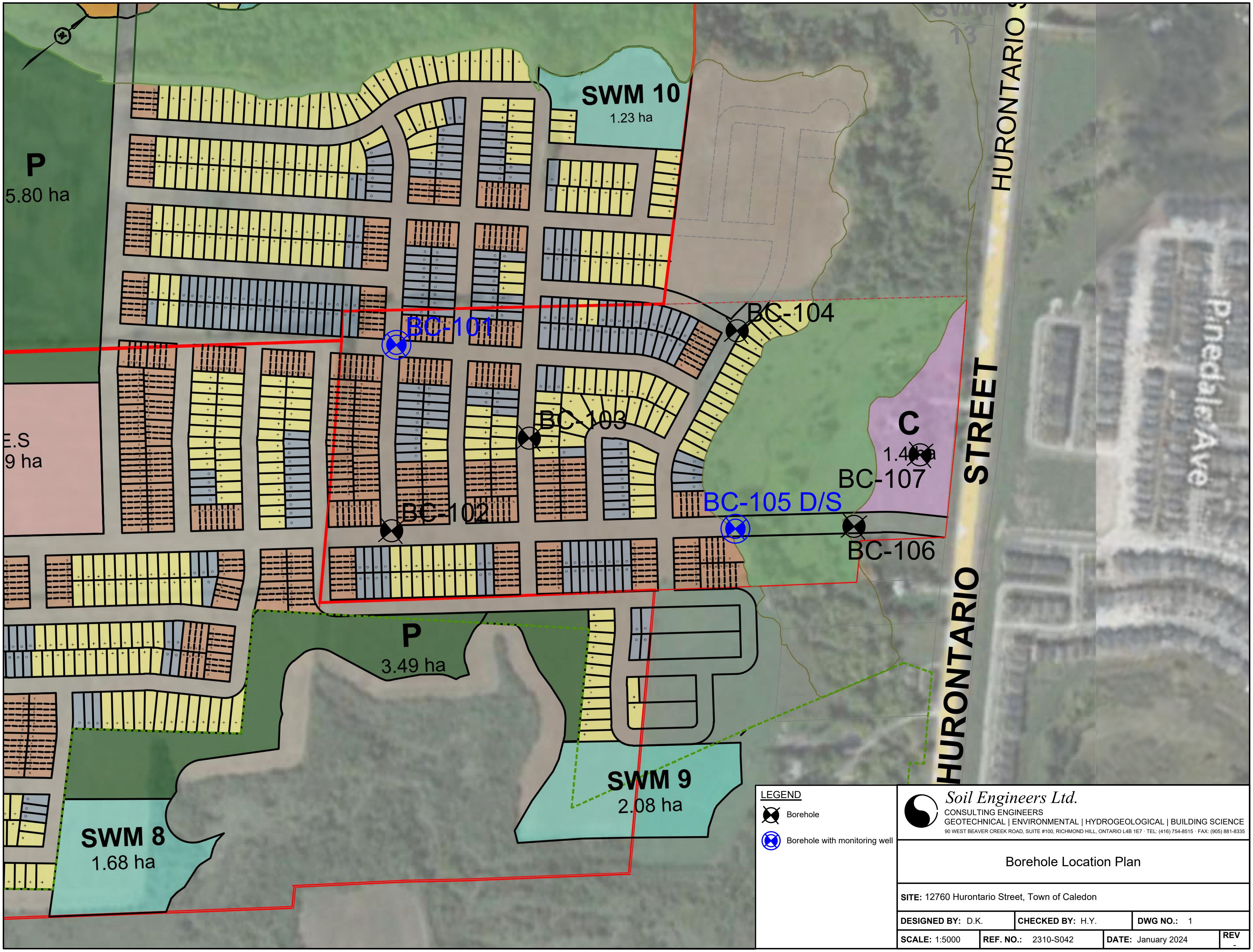
Location: 12760 Hurontario Street, Town of Caledon

Borehole No:	BC-105D	BC-106
Sample No:	12	8
Depth (m):	13.8	7.8
Elevation (m):	246.3	248.8

	BC-	BC-
BH./Sa.	105/12	106/8
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	-	10
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-4}

Classification of Sample [& Group Symbol]: BC-105D/Sa 12 : SANDY SILT TILL BC-106/Sa 8: SILTY SAND TILL
traces of clay and gravel

Figure: 12



LEGEND

⊗	Borehole
⊗	Borehole with monitoring well

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GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

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

Borehole Location Plan

SITE: 12760 Hurontario Street, Town of Caledon

DESIGNED BY: D.K. **CHECKED BY:** H.Y. **DWG NO.:** 1

SCALE: 1:5000 **REF. NO.:** 2310-S042 **DATE:** January 2024 **REV** -

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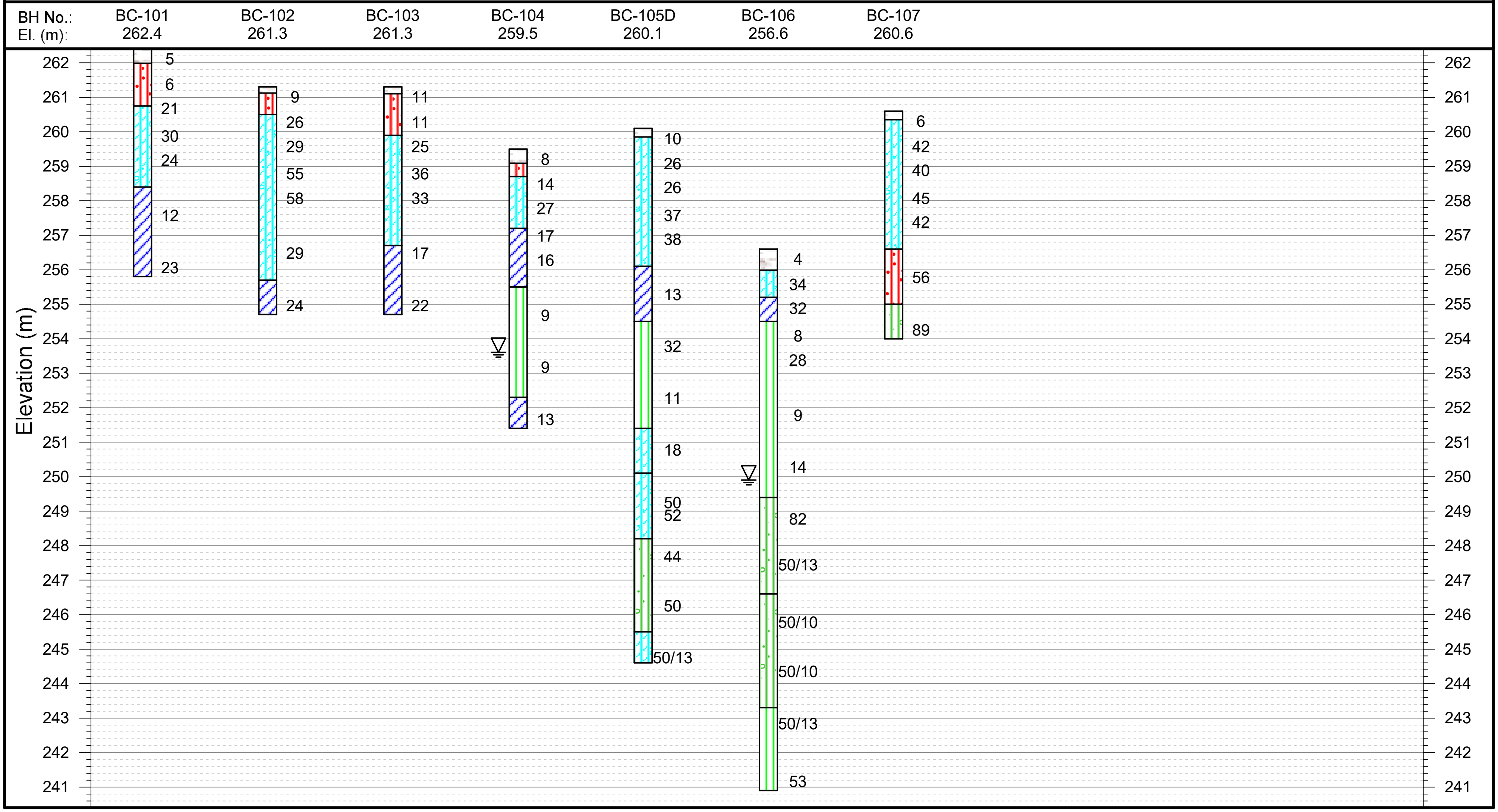
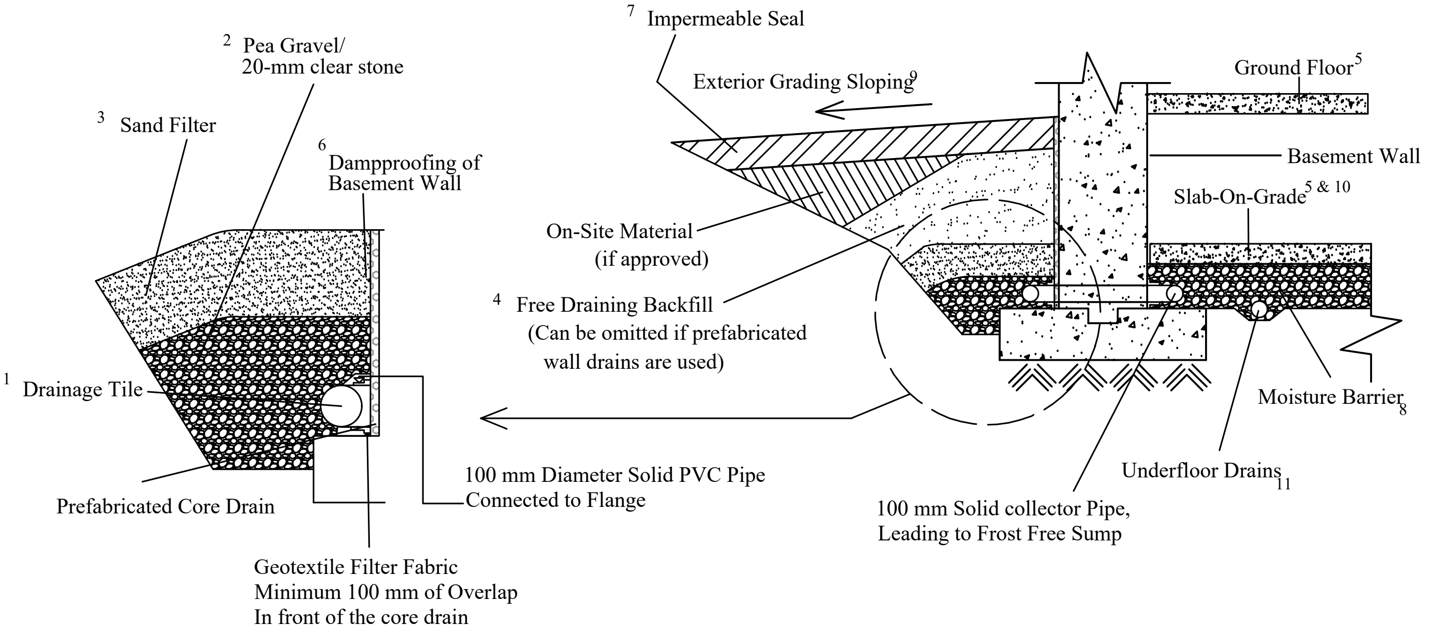
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.:	2310-S042
REPORT DATE:	January 2024
PROJECT DESCRIPTION:	Proposed Residential Development
PROJECT LOCATION:	12760 Hurontario Street, Town of Caledon

LEGEND

- ▨ TOPSOIL
- ▨ SANDY SILT TILL
- ▨ SILTY CLAY
- ▨ SILTY CLAY TILL
- ▨ SANDY SILT
- ▨ SILT
- ▽ 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 compacted OPSS Granular 'A', 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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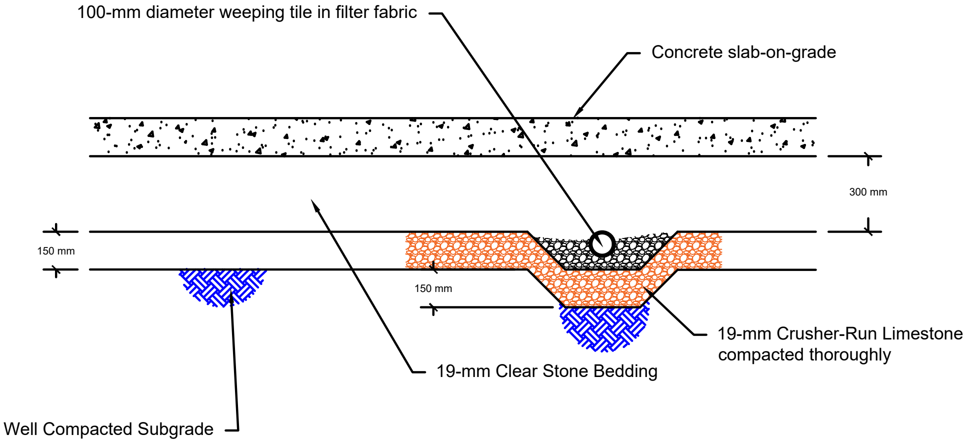
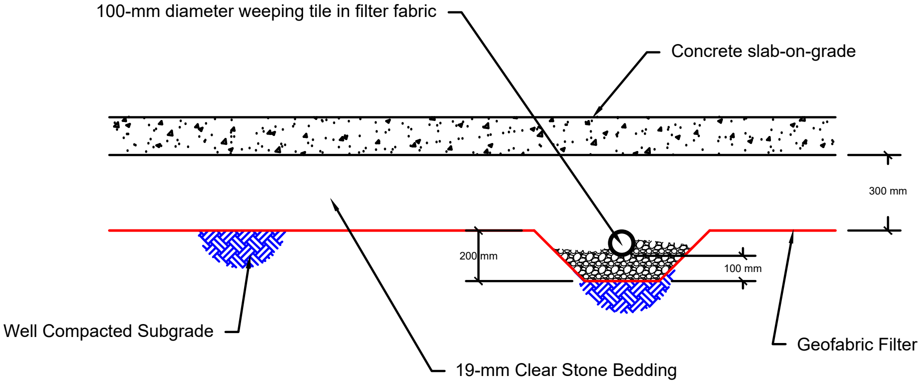
PERMANENT PERIMETER DRAINAGE SYSTEM
(FOR OPEN EXCAVATION)

SITE: 12760 HURONTARIO STREET, TOWN OF CALEDON

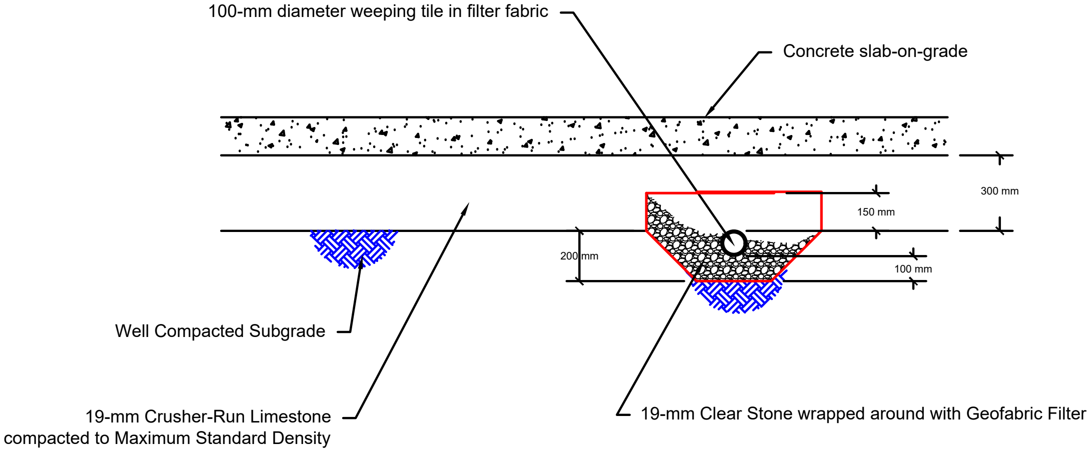
DESIGNED BY: K.L.
CHECKED BY: B.S.
DWG NO.: 3
SCALE: N.T.S.
REF. NO.: 2310-S042
DATE: JANUARY 2024
REV -



Option 'A'



Option 'B'



Option 'C'

Note:

1. Weepers should be placed in 6 m grids, draining in a positive gradient towards an outlet or a sump pit for removal by pumping.
2. A 10-mil polyethylene sheet should be specified between the gravel bedding and concrete slab.

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DETAILS OF UNDERFLOOR WEEPERS

SITE: 12760 HURONTARIO STREET, TOWN OF CALEDON

DESIGNED BY: K.L. **CHECKED BY:** B.S. **DWG NO.:** 4

SCALE: N.T.S. **REF. NO.:** 2310-S042 **DATE:** JANUARY 2024 **REV** -