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A REPORT TO
SCHOOL VALLEY SOUTH LTD.

A SUPPLEMENTARY GEOTECHNICAL INVESTIGATION FOR

PROPOSED PUMPING STATION AND STORMWATER MANAGEMENT FACILITIES

SOUTHEAST OF OLD SCHOOL ROAD
AND MCLAUGHLIN ROAD

TOWN OF CALEDON

REFERENCE NO. 2310-S040

JANUARY 2024

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with the email authorization received October 2, 2023, from Mr. Frank Filippo of School Valley South Ltd., a supplementary geotechnical investigation was carried out at the property located southeast of Old School Road and McLaughlin Road in the Town of Caledon.

In 2014, two geotechnical investigations were completed for the captioned property to support the design and construction of a residential subdivision. The findings and recommendations were presented under separate covers, Reference Nos. 1408-S018 and 1408-S019, dated November 2014.

The purpose of the supplementary investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of a pumping station and 3 stormwater management (SWM) ponds within the subdivision. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE DESCRIPTION

The subject site is located approximately 600 m south of Old School Road, between McLaughlin Road and Hurontario Street, in the southern region of 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 were identified as an 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 investigation was carried out in either open grass field or cultivated farm fields. Based on the conceptual site plan, the pumping station will potentially be located close to the McLaughlin Road frontage, and the SWM ponds (SWM 7, 8 and 9) will be constructed at various locations adjacent to the existing natural systems across the southern limit of the property. At the time of report preparation, details of the pumping station and SWM ponds are not available for review.

3.0 FIELD WORK

The field work, consisting of 4 boreholes extending to depths of 6.6 m and 15.3 m, was performed on October 16 to 19, 2023, at the locations shown on the Borehole Location Plan

(Drawing No. 1). The boreholes are labelled in the 100-series in order to differentiate them from the previous borehole investigations carried out for the subdivision.

The boreholes were advanced at intervals to the sampling depths by a track-mounted machine equipped with solid- and hollow-stem augers and split spoon sampler 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.

To facilitate the hydrogeological study by PECG, 50-mm diameter monitoring wells were installed at the borehole locations. The depths and details of the monitoring wells are shown on the corresponding borehole logs.

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

4.0 SUBSURFACE CONDITIONS

The investigation has revealed that beneath the surficial topsoil layer, the investigated areas are underlain by silty clay and silty clay till overlying silty fine sand/sandy silt/silt deposits, which in turn bed onto a sandy silt till deposit in places. Clay-shale reversion and weathered shale bedrock was encountered at the bottom of Borehole 101, at depths below El. 248.0 m.

The tills consist of a random mixture of particle sizes ranging from clay to gravel, with silt and clay being the dominant fractions. The fine-grained silty fine sand, sandy silt and silt samples contain a trace of clay, and are often found to be wet or water-bearing. Sample examination revealed that the soils within the surficial zone, extending to a depth of 1.0± m below grade, is generally weathered. Intermittent hard resistance to augering was encountered in places, indicating the presence of cobbles and boulders in the till mantles.

Detailed descriptions of the encountered subsurface conditions are presented on the borehole logs, comprising of Figures 1 to 4, inclusive. The stratigraphy is illustrated on the Subsurface Profile, Drawing No. 2. Relevant borehole data from previous investigations for each of the SWM ponds is also included in this report, and the associated borehole logs are enclosed in the Appendix for reference. A prefix of 18- and 19- is used to distinguish between the respective 1408-S018 and 1408-S019 investigations.

Grain size analyses were performed on representative samples of the silty clay till, sandy silt till, sandy silt and silty clay; the results are plotted on Figures 5 to 8. In addition, Atterberg limits tests were performed on 3 samples of the clay till and clay and the results are plotted on the respective sample depths on the Borehole Logs. The results show that the clay till is low in plasticity and the clay is medium in plasticity.

The subsurface condition is summarized based on each infrastructure feature in the following sections.

4.1 Pumping Station

The pumping station is proposed on the east side of McLaughlin Road, approximately 1 km south of Old School Road. Borehole 101 was completed within the proposed pumping station, which revealed that beneath a 30-cm thick topsoil layer, the native soil makeup consists of silty clay till and sandy silt till, interstratified with sandy silt and silty clay deposits. Clay-shale reversion was encountered at an approximate depth of 13.7 m or El. 247.9 m and the borehole was terminated in the grey weathered shale bedrock at El. 246.3 m.

The encountered sandy silt deposit is approximately 3 m in thickness at this location. Sample examination revealed that the silt samples are moist to wet, generally becoming wet at depths below 4.5 m. The remaining soils are generally moist.

The obtained 'N' values measured in number of blows per 30 cm of penetration, the resulting relative density/consistency of the soils and water content values are summarized in the table below:

Soil Type	'N' Values	Relative Density/ Consistency	Water Content Values (%)
Silty Clay Till	7 to 78 (median 35)	Firm to hard, generally hard	11 to 18 (median 16)
Silty Clay	20 and over 100 (shale reversion)	Very stiff; reverted clay is hard	15 and 22
Sandy Silt	25	Compact	19 and 20
Shale Bedrock	Over 100	-	14

4.2 SWM 7

SWM 7 is proposed on the opposite side of a natural corridor from the pumping station, adjacent to and west of the Orangeville Brampton railway trail.

Two boreholes, Boreholes 102 and 19-6, were completed within SWM 7. Beneath a topsoil layer measuring 23 and 36 cm thick, the area is generally underlain by silty clay till and silty clay, a silty fine sand/sandy silt deposit at approximate depths of 4.0 to 5.6 m (between El. 256.6 to 255.0 m), which in turn beds onto silty clay or sandy silt till. In Borehole 19-6, a layer of weathered sandy silt is found beneath the topsoil, extending to a depth of 0.7 m below grade. Sample examination revealed that the subsoils are generally moist while the silty fine sand/sandy silt deposit is very moist to wet.

The obtained 'N' values measured in number of blows per 30 cm of penetration, the resulting relative density/consistency of the soils and water content values are summarized in the table below:

Soil Type	'N' Values	Relative Density/ Consistency	Water Content Values (%)
Silty Clay Till	7 to 26 (median 24)	Firm to very stiff, generally very stiff	11 and 13
Silty Clay	22, 35 and 41	Very stiff to hard	16, 18 and 19
Silty Fine Sand/ Sandy Silt	12 and 30	Compact	14, 16 and 20
Sandy Silt Till	20	Compact	12

4.3 SWM 8

SWM 8 is proposed adjacent to and on the west side of the Etobicoke Creek natural valley system located in the southeast corner of the site.

Two boreholes, Boreholes 103 and 18-5, were completed within SWM 8, which revealed that beneath a 15 and 20 cm thick topsoil layer, the area is generally underlain by silty clay till and silty clay deposits. A wet sandy silt deposit was also encountered below a depth of 4.0 m from grade, or below El. 255.0 m, in Borehole 103; this borehole was terminated in the sandy silt deposit.

The obtained 'N' values measured in number of blows per 30 cm of penetration, the resulting relative density/consistency of the soils and water content values are summarized in the table below:

Soil Type	'N' Values	Relative Density/ Consistency	Water Content Values (%)
Silty Clay Till	12 to 47 (median 31)	Stiff to hard, generally hard	8 to 17 (median 11)
Silty Clay	13, 17 and 20	Stiff to very stiff	15, 16 and 28
Sandy Silt	8 and 20	Loose to compact	17 and 20

4.4 SWM 9

SWM 9 is proposed in the southeast corner of the property, adjacent to and on the east side of the Etobicoke Creek natural valley system.

Two boreholes, Boreholes 104 and 18-12, were completed within SWM 9. Beneath the topsoil layer, 10 and 15 cm thick, the area is underlain by silty clay till and silty clay, overlying a silt deposit at approximate depths below 5.6 m, or below El. 252.4 m. Both boreholes were terminated in the silt deposit. Sample examination revealed that the till and clay are generally moist, and the silt is very moist.

The obtained 'N' values measured in number of blows per 30 cm of penetration, the resulting relative density/consistency of the soils and water content values are summarized in the table below:

Soil Type	'N' Values	Relative Density/ Consistency	Water Content Values (%)
Silty Clay Till	22 to 52 (median 25)	Compact to very dense, generally compact	10 to 13 (median 12)
Silty Clay	9 to 46 (median 17)	Stiff to hard, generally very stiff	17 to 33 (median 20)
Silt	25 and 37	Compact to dense	18 and 19

5.0 GROUNDWATER CONDITION

Groundwater levels were recorded in Boreholes 101, 103 and 19-6 at depths ranging from 5.3 to 14.9 m, or from El. 246.7 to 253.7 m while other boreholes remained dry upon completion of drilling. Artesian uplift was not evident from the wet silt and sand units during drilling.

Groundwater readings recorded by PECG from the installed monitoring wells in December 2023 range from depths of 3.57 to 4.40 m, or from El. 258.03 to 254.60 m. The records on completion are plotted on the borehole logs and the December 2023 monitoring well measurements are summarized in Table 1.

Table 1 - Monitored Groundwater Level

Monitoring Well No.	Ground Elevation (m)	Well Depth (m)	Measured Groundwater Level			
			December 6, 2023		December 12-13, 2023	
			Depth (m)	El. (m)	Depth (m)	El. (m)
Pumping Station - 101	261.60	15.2	3.59	258.01	3.57	258.03
SWM 7 - 102	260.56	6.1	4.27	256.29	4.20	256.36
SWM 8 - 103	259.00	6.1	4.40	254.60	N/A	-
SWM 9 - 104	258.98	6.1	Dry	-	N/A	-

The groundwater records are generally consistent with or near the observed wet silty fine sand/silts at the boreholes, and suggest a drainage pattern towards the Etobicoke Creek. The groundwater regime is subject to seasonal fluctuations. Detailed groundwater profile and monitoring records can be referred to the hydrogeological study by PECG.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has revealed that beneath the surficial topsoil veneer, the pumping station and SWM pond sites are predominantly underlain by an upper silty clay/silty clay till deposit, overlying a silty fine sand/sandy silt or silt unit and a lower sandy silt till deposit. Clay-shale reversion and weathered shale bedrock was encountered at the bottom of Borehole 101, at depths below El. 248.0 m. The thickness of the overburden above the more pervious sand/silt unit appears to increase towards the east, with Boreholes 103, 18-12 and 104 terminated within the silt deposit.

Sample examination revealed that the sand/silt unit is moist to wet; artesian uplift was not evident from this unit during drilling. Groundwater readings recorded by PECG from the installed monitoring wells (Boreholes 101 to 103) in December 2023 range from depths of 3.57 to 4.40 m below grade, or from El. 258.03 to 254.60 m. Borehole 104 was dry during the recording event.

At the time of investigation, detailed design of the proposed sanitary pumping station and SWM ponds are not available for review. It is understood that in lieu of a traditional pumping station with wet well, an inverted syphon system is also being explored. The geotechnical findings which warrant special consideration are presented below:

1. Open excavation must be carried out in accordance with Ontario Regulation 213/91. Where vertical cut is necessary, such as in the case of a wet well, the excavation must be properly shored. In addition, any excavation extending into the saturated sand/silt will require construction dewatering.
2. For any proposed structures, they can be supported using conventional spread and strip footings founded onto the native soils.
3. A Class 'B' bedding, consisting of compacted 19-mm Crusher-Run Limestone (CRL), is recommended for the construction of underground services. Where the pipes are founded within the water-bearing sand/silt unit, a Class 'A' (concrete) bedding should be used instead.

6.1 **Pumping Station**

Foundations

Where in-ground structures (such as wet well) or buildings are proposed in the construction of the pumping station, the proposed structures can be supported on conventional footings founded on sound native soils below the weathered soil. The recommended design bearing pressures are presented below:

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

Should the structures extend into the very dense sandy silt till below El. 254.0 m, the design bearing pressures at SLS and ULS can be increased to 500 kPa and 800 kPa, respectively.

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

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

The foundation should meet the requirements specified by the latest Ontario Building Code, and the structures should be designed to resist a minimum earthquake force using Site Classification ‘C’ (very dense soil and soft rock).

The underground structures should be designed to sustain a lateral earth pressure calculated using the soil parameters presented in Table 3, with consideration of applicable surcharge loads, hydrostatic pressure and potential uplift forces. Where the in-ground structures are located within the zone of influence of nearby shallow building foundation, the design of the in-ground structures must also incorporate the added foundation loads.

Hydrostatic uplift pressure is not anticipated for foundations founded into the clay and sandy silt till beneath the wet sand/silt unit below El. 255.0 m. Should the foundation be constructed above El. 255.0 m, this should be further assessed once the detailed design and updated groundwater monitoring levels are available for review.

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

Where the footing excavation consists of wet sand/silt, or the footing subgrade is wet, 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.

Slab-On-Grade Construction

For slab-on-grade construction, the subgrade must consist of sound native soils, or properly compacted inorganic soils. The subgrade should be inspected by a geotechnical technician and assessed by proof-rolling prior to placement of granular bedding. Badly weathered and any soft areas detected should be subexcavated and replaced with inorganic material compacted to at least 98% Standard Proctor Dry Density (SPDD).

The concrete slab should be constructed on a granular base, not less than 20 cm thick, consisting of 19-mm CRL, or equivalent, compacted to 100% SPDD. A Modulus of Subgrade Reaction of 25 MPa/m can be used for the design of slab-on-grade.

6.2 Pipe Bedding

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 should be subexcavated and replaced with bedding material, compacted to at least 98% SPDD.

A Class ‘B’ bedding is recommended for construction of the underground services across the subdivision as well as within the pump station and SWM pond blocks. The bedding material should consist of compacted 19-mm CRL, or equivalent. In water-bearing sand/silt deposits, a Class ‘A’ bedding should be used instead to prevent fines from migrating into a gravel bedding.

The pipe joints connected into manholes, catch basins and into the pumping station must be connected by leak-proof joints to prevent fines migration through the joints. Opening to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

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

6.3 Backfilling Trenches and Excavated Areas

The on-site inorganic soils are generally suitable for trench backfill. Any saturated soils should be properly stockpiled to drain the excess water or aerated prior to being used for structural backfill. Any boulder larger than 15 cm in size are not suitable for structural backfill.

The backfill should be compacted to 95% SPDD in lifts of not more than 20 cm thick. In the zone within 1.0 m below the slab-on-grade, the backfill should be compacted to at least 98% SPDD, with the moisture content at 2% to 3% drier than the optimum. This is to provide the required stiffness for floor construction.

In confined areas which are inaccessible to a heavy compactor, such as around manholes, catch basins and service crossings, sand backfill should be used and compacted using a smaller vibratory compactor. Otherwise in (lower) zones where proper compaction cannot be achieved, the backfill should consist of lean-mix concrete or unshrinkable fill.

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

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

6.4 Stormwater Management Ponds

Three SWM ponds (SWM 7, 8 and 9) are proposed in the southern region of the subdivision, adjacent to natural corridors. Detailed designs of the ponds were not available for review at the time of report preparation.

Based on the borehole findings, the SWM areas are generally underlain by very stiff to hard silty clay till and silty clay, interstratified with or overlying a moist to wet, loose to very dense silty fine sand/sandy silt/silt deposit in the lower stratigraphy. Compact sandy silt till was also encountered at the bottom of Borehole 102 (SWM7) beneath the sandy silt.

A review of the subsoil profile and water level records suggests that the groundwater regime generally lies within the wet sand/silt units, at depths of 4.0+ m below grade. The water levels will fluctuate with seasons.

The need of a clay liner is not anticipated should the pond design remain within the silty clay till and silty clay deposits, with sufficient thickness of the low-permeable overburden above the underlying sand/silt units. However, should the ponds extend close to or into the sandy/silty deposits, an earthen clay liner (with an estimated permeability of 10^{-7} cm/sec or less) or a geosynthetic clay liner (GCL) with soil ballast will be required. The appropriate thickness of the clay liner or ballast to counteract hydrostatic uplift concerns, if any, and the extent of the liner can be established once the pond elevations are available for review.

The side slopes of the ponds should be graded at 1V:3H or flatter for stability above the wet perimeter, and 1V:4H or flatter below the wet perimeter. All exposed side slopes must be vegetated and/or sodded to prevent surface erosion.

Any proposed earth embankments should be constructed using selected on-site inorganic clay or clay till material, compacted to at least 98% SPDD in lifts of no more than 20 cm in thickness. The subgrade must be inspected and proof-rolled prior to any fill placement. The construction of the berms must be supervised and certified by the site geotechnical engineer. The pond side slopes should be surface compacted.

The following bearing pressures can be used for the design of control structures supported on conventional footings founded on sound native soils or on engineered fill:

- Soil Bearing Pressure at SLS: 150 kPa
- Factored Ultimate Soil Bearing Pressure at ULS: 250 kPa

The footings must be placed below the scouring depth and be provided with a minimum earth cover of 1.2 m to protect them from frost damage.

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

One should be aware that minor maintenance may be required after rapid drawdown as the water recedes from a flood level to normal level. Routine visual inspection and maintenance will be required to rectify any observed deficiency.

6.5 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 2.

Table 2 - Classification of Soils for Excavation

Material	Type
Sound Tills and Clay	2
Drained Silt	3
Saturated Soils	4

The yield of groundwater from the clay and tills will likely be limited in quantity and can be controllable by pumping from sumps. Continuous groundwater yield can be expected from the wet sand/silt deposit. Detailed groundwater profile and dewatering needs can be referred to the hydrogeological study by PECG.

In open excavation, the tills and clay will be stable in relatively steep excavation; however, prolonged exposure of the excavated face may lead to localized sloughing. The wet silty fine sand/sandy silt and silt, on the other hand, will slump readily, leading to sloughing and migrate/run with seepage and boil under an approximate piezometric head of 0.4 m.

Where safe sloped excavation is not feasible or where vertical cut is necessary, temporary shoring will be required. For excavation of deep in-ground structures at the pumping station, watertight shoring structures such as caisson wall or secant wall, or sheet piling can be used, extending into the lower till stratum. Where construction dewatering is carried out, a pile and lagging system can also be employed. The shoring structure must be properly designed by a structural engineer experienced in this type of construction or shoring specialist.

The overburden and the surcharge from any adjacent structures, if any, should be considered in the design of the shoring. In calculating the lateral earth pressure for the shoring structure, the soil parameters provided in Table 3.

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

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)
K_p = Passive resistance in subsoil for pile support
L = Embedment depth of the pile (m)
γ = Unit weight of subsoil below bottom of excavation (kN/m^3)

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

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 for pile support = 150 kPa

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

6.6 Soil Parameters

The recommended soil parameters for the project design are given in Table 3.

Table 3 - 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
Sandy Silt Till	22.5	12.5	1.33	1.05
Silty Clay	20.5	10.5	1.30	1.00
Silty Fine Sand/Sandy Silt/Silt	20.5	10.5	1.20	1.00

Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Silty Clay Till	0.33	0.50	3.00
Sandy Silt Till	0.32	0.48	3.12
Silty Clay	0.39	0.56	2.56
Silty Fine Sand/Sandy Silt/Silt	0.33	0.50	3.00

Table 3 - Soil Parameters (Cont'd)

Estimated Coefficient of Permeability (K) and Percolation Time (T)	**K (cm/sec)**	**T (min/cm)**
Silty Clay and Silty Clay till	10^{-7}	80+
Sandy Silt Till	10^{-6}	50
Silty Fine Sand/Sandy Silt/Silt	10^{-4}	12
Coefficients of Friction		
Between Concrete and Granular Base		0.50
Between Concrete and Native Soils or Compacted Earth Fill		0.35

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of School Valley South Ltd., and for review by its designated consultants, contractors and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement.

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. 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.

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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

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.: 2310-S040

LOG OF BOREHOLE: SVS-101

FIGURE NO.: 1

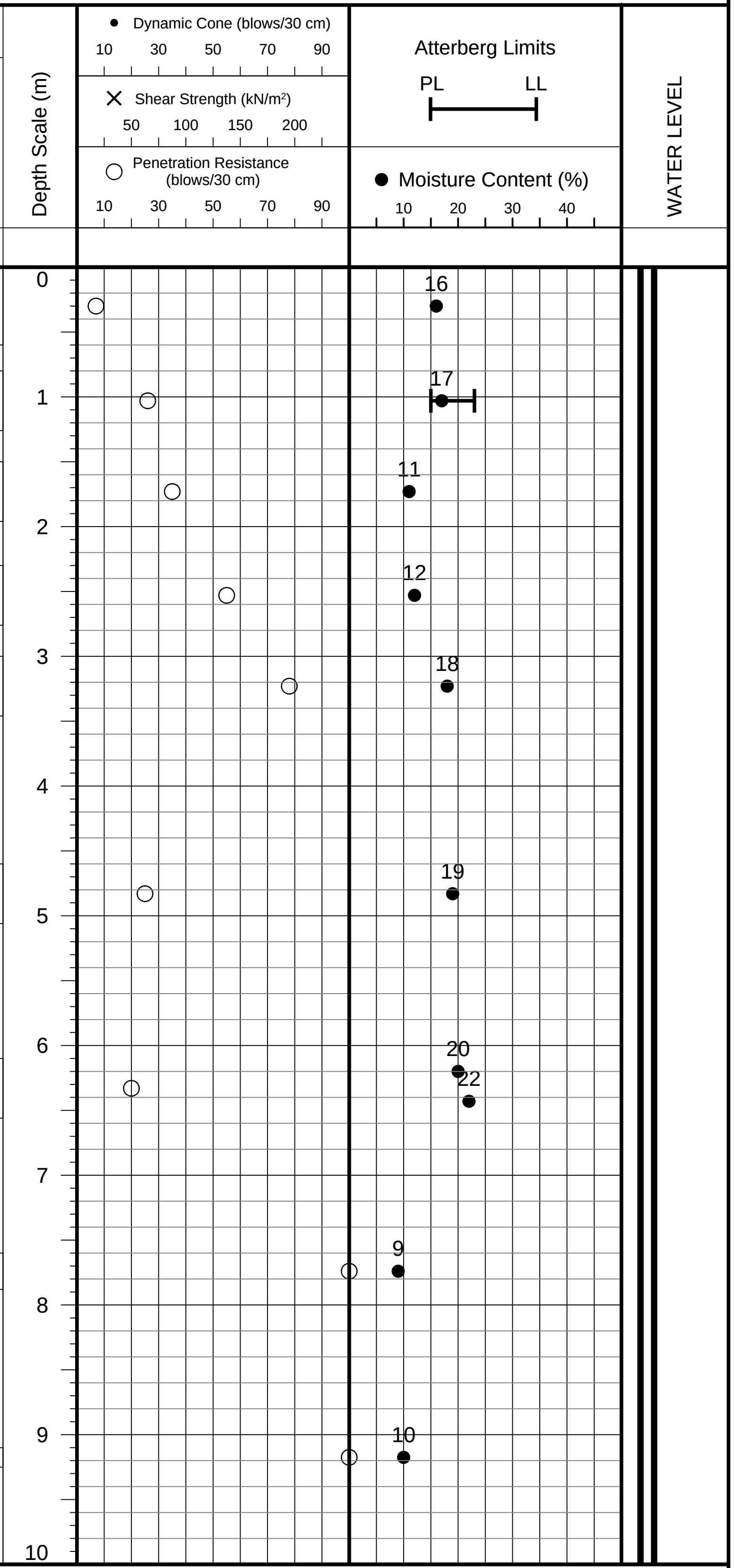
PROJECT DESCRIPTION: Proposed Pumping Station and
Stormwater Management Facilities

METHOD OF BORING: Hollow Stem Augers

PROJECT LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

DRILLING DATE: October 18, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
261.6	Ground Surface			
0.0	**30 cm TOPSOIL**	1	DO	7
	Brown, firm to hard **SILTY CLAY TILL** — weathered some sand to sandy a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	2	DO	26
		3	DO	35
		4	DO	55
		5	DO	78
258.3 3.3	Compact, moist to wet — moist **SANDY SILT** — brown / grey a trace of clay occ. silt layers	6	DO	25
255.3 6.3	Grey, very stiff **SILTY CLAY** a trace of sand	7A 7B	DO	20
254.4 7.2	Reddish-brown, very dense **SANDY SILT TILL** some clay, a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	8	DO	50/13
		9	DO	55/15
251.6				



Soil Engineers Ltd.

JOB NO.: 2310-S040

LOG OF BOREHOLE: SVS-101

FIGURE NO.: 1

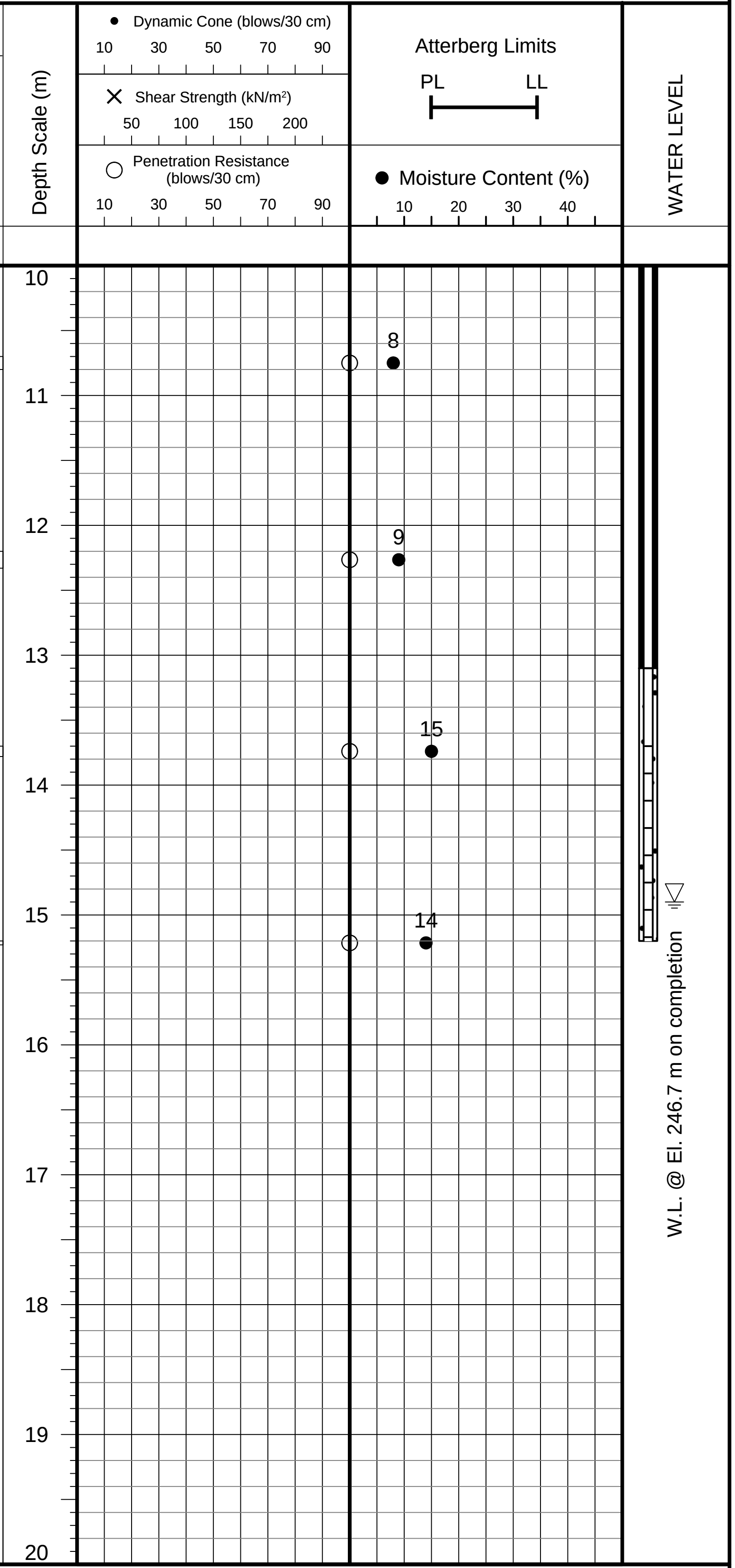
PROJECT DESCRIPTION: Proposed Pumping Station and
Stormwater Management Facilities

METHOD OF BORING: Hollow Stem Augers

PROJECT LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

DRILLING DATE: October 18, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
10.0	Reddish-brown, very dense **SANDY SILT TILL** some clay, a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	10 11	DO DO	50/10 50/13
247.9 13.7	Reddish-brown, hard, very moist **SILTY CLAY** clay shale reversion; with shale fragments	12	DO	50/8
247.0 14.6	Grey, weathered **SHALE BEDROCK** with reddish-brown clay	13	DO	50/3
246.3 15.3	**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			



JOB NO.: 2310-S040

LOG OF BOREHOLE: SVS-102

FIGURE NO.: 2

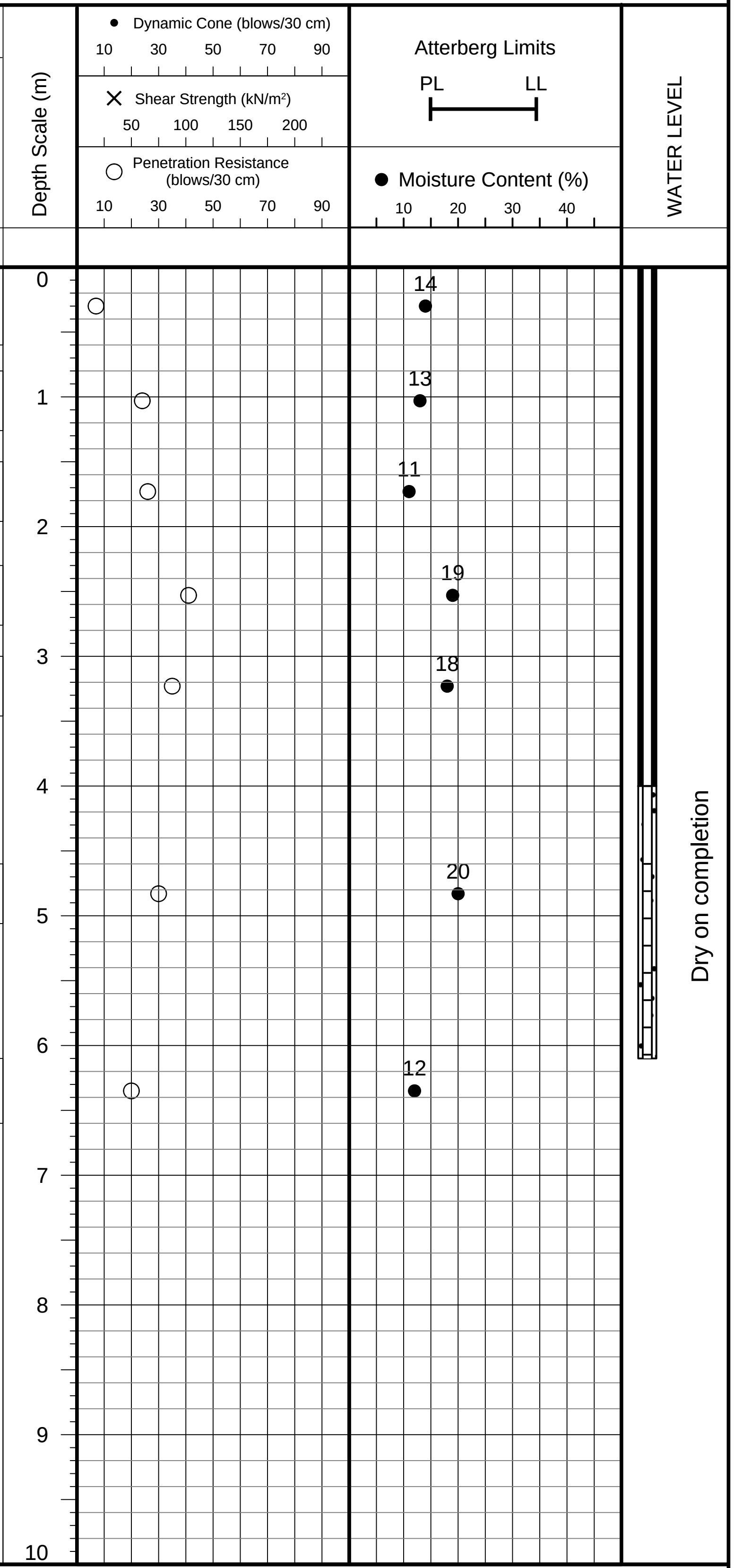
PROJECT DESCRIPTION: Proposed Pumping Station and
Stormwater Management Facilities

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

DRILLING DATE: October 19, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
260.6	Ground Surface			
0.0	**36 cm TOPSOIL**	1	DO	7
	Brown, firm to very stiff **SILTY CLAY TILL** — weathered	2	DO	24
	sandy a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	3	DO	26
258.1 2.5	Grey, hard **SILTY CLAY**	4	DO	41
	a trace to some sand occ. gravel	5	DO	35
256.6 4.0	Grey, compact, wet **SANDY SILT** a trace of clay	6	DO	30
255.0 5.6	Grey, compact, very moist **SANDY SILT TILL** traces of clay and gravel	7	DO	20
254.0 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-S040

LOG OF BOREHOLE: SVS-103

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Pumping Station and
Stormwater Management Facilities

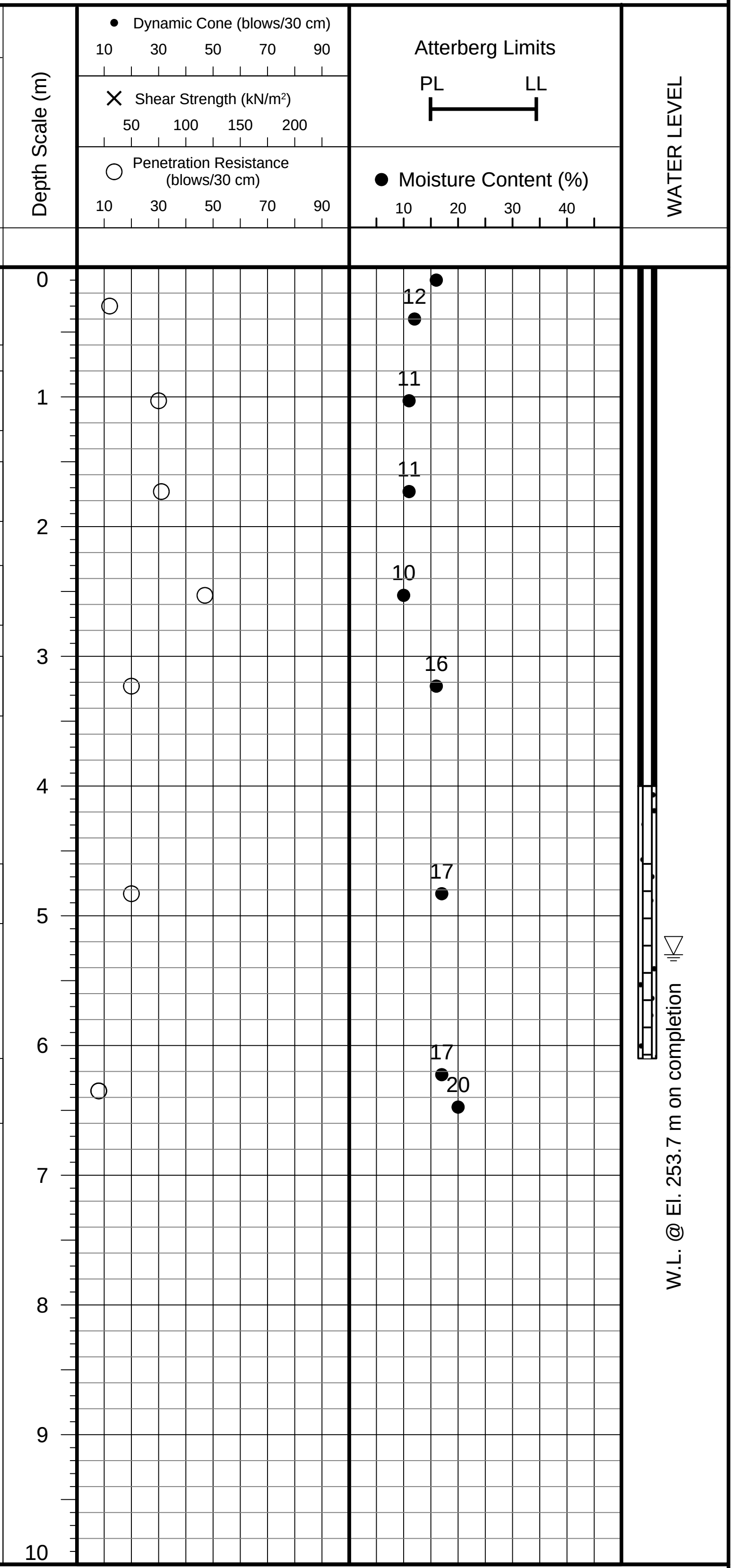
METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

DRILLING DATE: October 18, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
259.0	Ground Surface			
0.0	**20 cm TOPSOIL**	1A 1B	DO	12
	Brown, stiff to hard **SILTY CLAY TILL** weathered	2	DO	30
	sandy, a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	3	DO	31
		4	DO	47
256.1 2.9	Very stiff brown grey **SILTY CLAY** some sand, occ. gravel	5	DO	20
255.0 4.0	Grey, loose to compact, wet **SANDY SILT** a trace of clay	6	DO	20
	clay layer	7A 7B	DO	8
252.4 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



W.L. @ El. 253.7 m on completion

JOB NO.: 2310-S040

LOG OF BOREHOLE: SVS-104

FIGURE NO.: 4

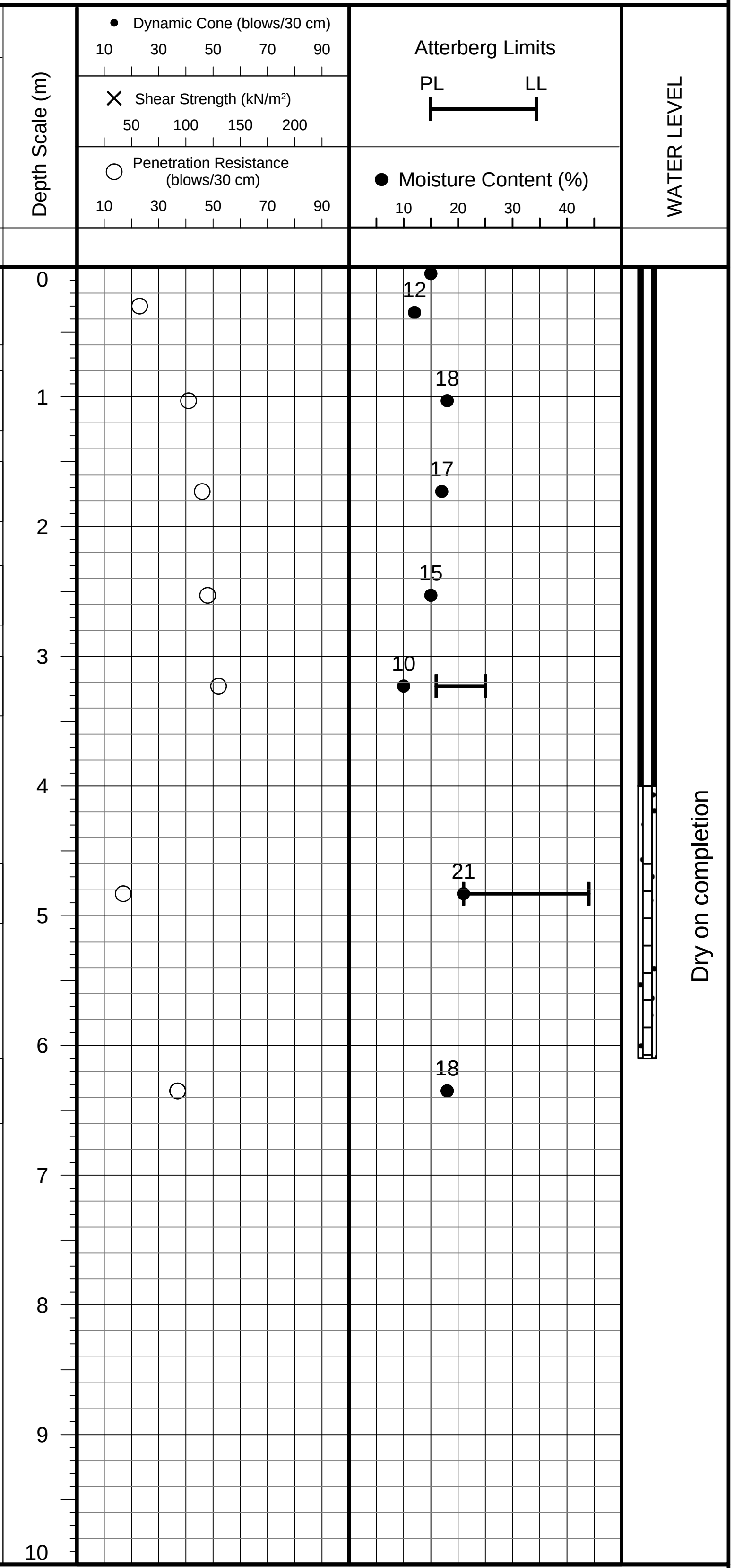
PROJECT DESCRIPTION: Proposed Pumping Station and Stormwater Management Facilities

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

DRILLING DATE: October 16, 2023

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
258.0	Ground Surface			
0.0	**10 cm TOPSOIL**	1A		
	Brown, very stiff **SILTY CLAY TILL** sandy, a trace of gravel	1B	DO	23
257.1 0.9	Brown, hard **SILTY CLAY** a trace to some sand, occ. gravel	2 3	DO DO	41 46
255.6 2.4	Brown, hard **SILTY CLAY TILL** sandy, a trace of gravel occ. sand and silt seams and layers	4 5	DO DO	48 52
254.0 4.0	Grey, very stiff **SILTY CLAY** a trace of sand occ. silt layers	6	DO	17
252.4 5.6	Grey, dense, very moist **SILT** a trace of sand, with clay layers	7	DO	37
251.4 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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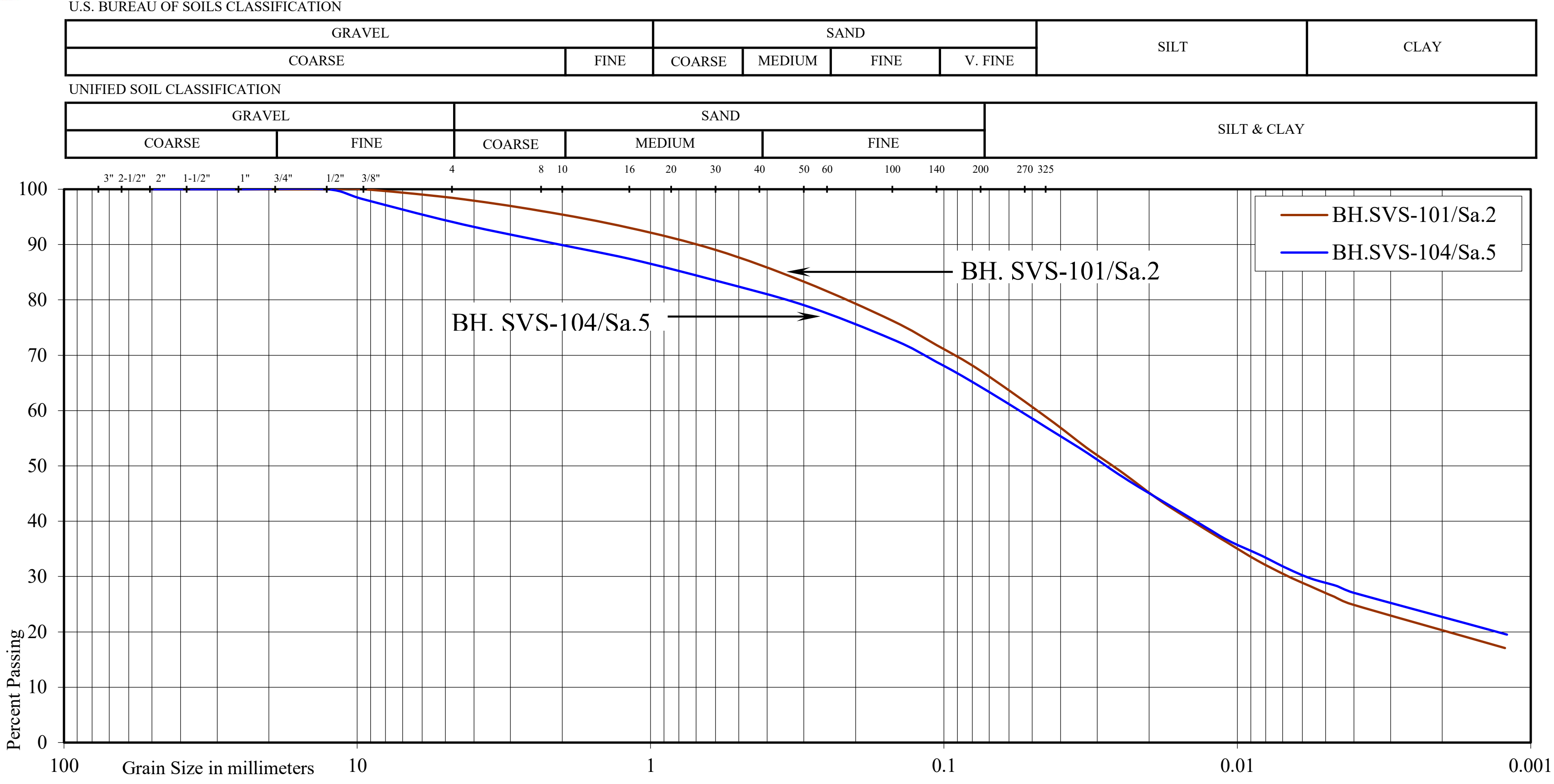
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S040



Project: Proposed Pumping Station and Stormwater Management Facilities

Location: Southeast of Old School Road and McLaughlin Road, Town of Caledon

Borehole No:	SVS-101	SVS-104
Sample No:	2	5
Depth (m):	1.0	3.2
Elevation (m):	260.6	254.8

BH./Sa.	SVS- 101/2	SVS- 104/5
Liquid Limit (%) =	23	25
Plastic Limit (%) =	15	16
Plasticity Index (%) =	8	9
Moisture Content (%) =	17	10
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY TILL

sandy, a trace of gravel

Figure: 5

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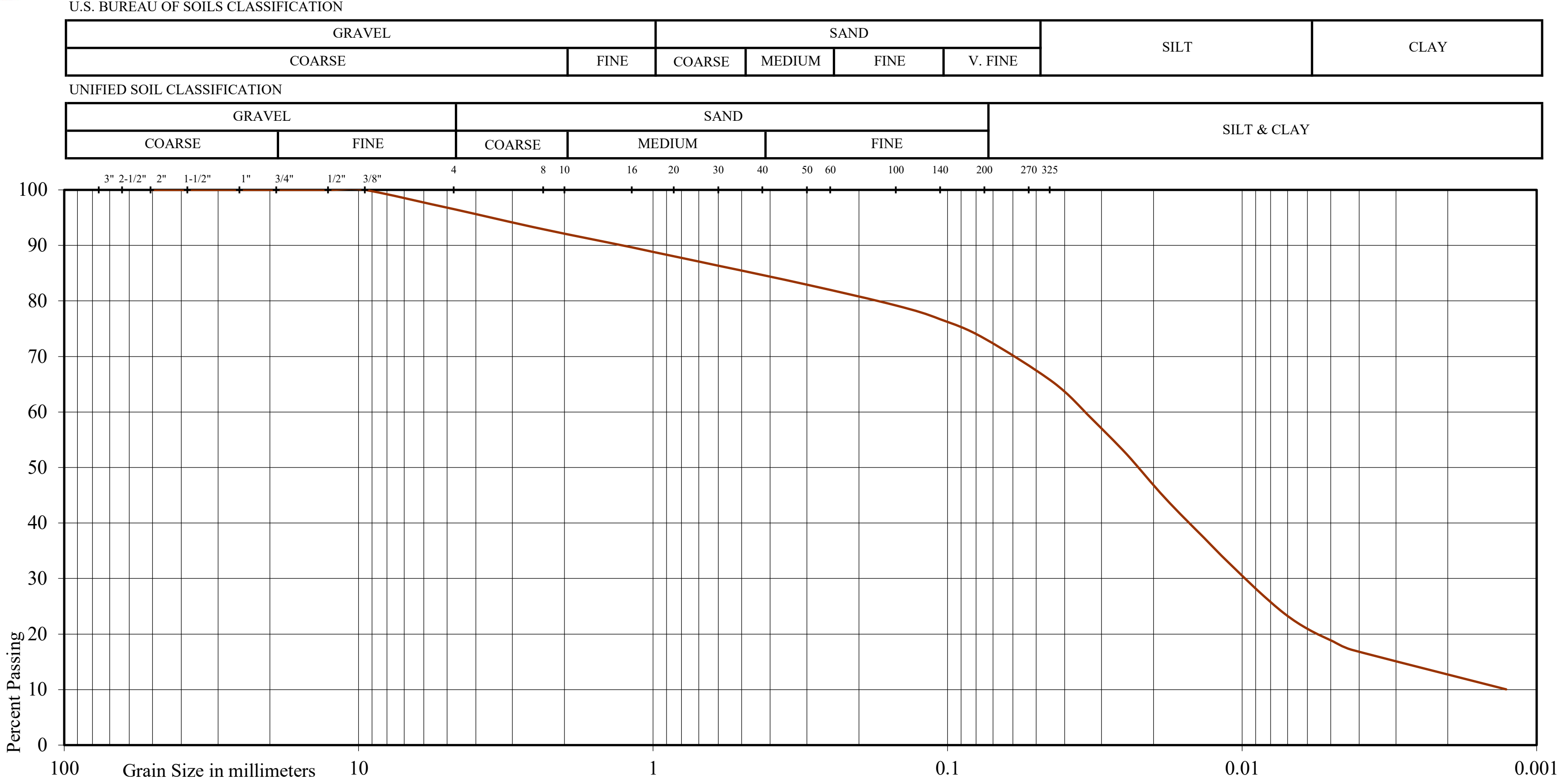
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S040



Project: Proposed Pumping Station and Stormwater Management Facilities

SVS-

Location: Southeast of Old School Road and McLaughlin Road, Town of Caledon

BH./Sa. 101/11

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 9

Estimated Permeability (cm./sec.) = 10^{-6}

Borehole No: SVS-101

Sample No: 11

Depth (m): 12.3

Elevation (m): 249.3

Classification of Sample [& Group Symbol]: SANDY SILT, TILL

some clay, a trace of gravel

Figure: 6

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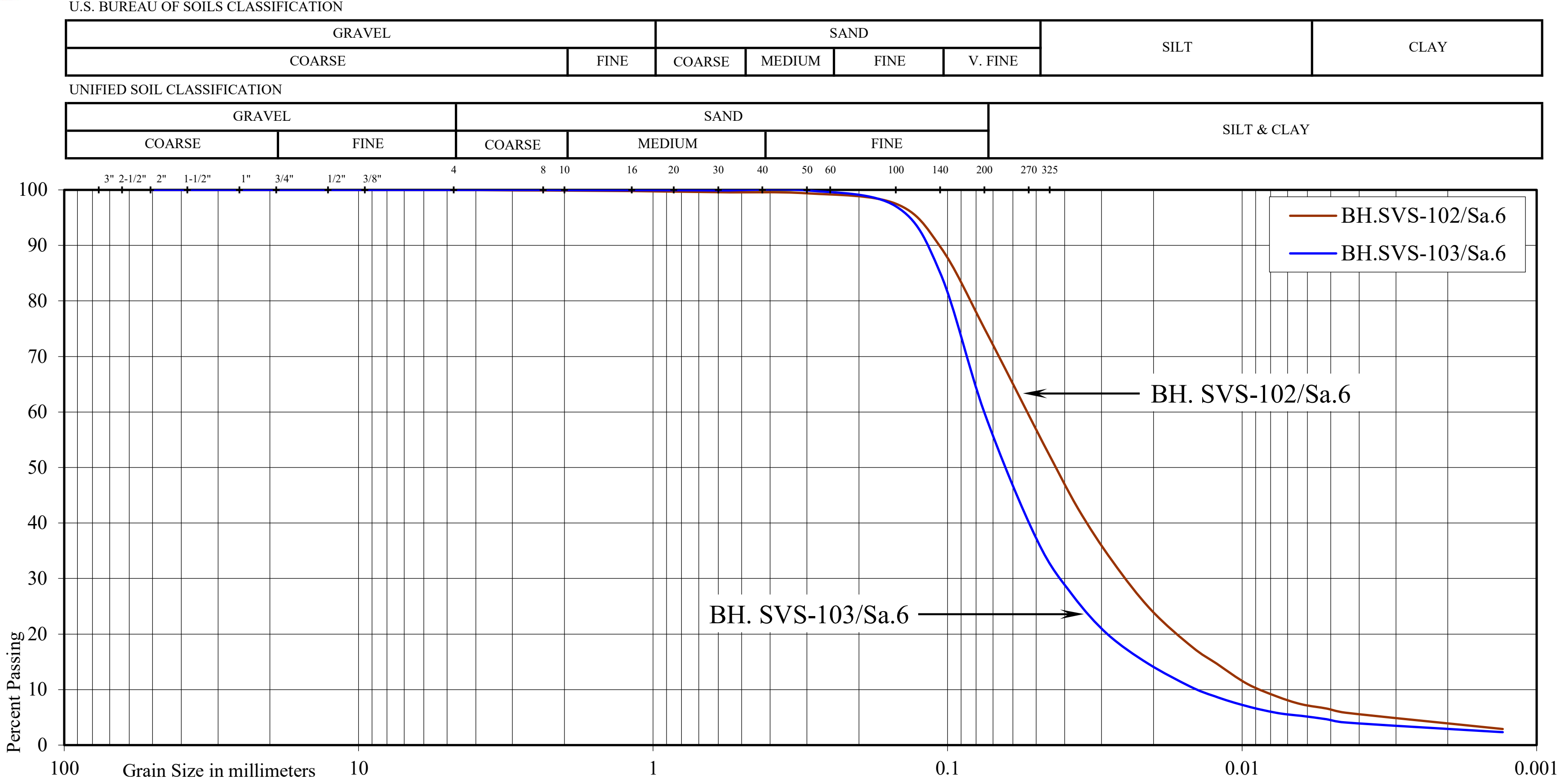
GRAIN SIZE DISTRIBUTION

Reference No: 2310-S040



Project: Proposed Pumping Station and Stormwater Management Facilities

Location: Southeast of Old School Road and McLaughlin Road, Town of Caledon

Borehole No: SVS-102 SVS-103

Sample No: 6 6

Depth (m): 4.8 4.8

Elevation (m): 255.8 254.2

	SVS-	SVS-
BH./Sa.	102/6	103/6
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	20	17
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-4}

Classification of Sample [& Group Symbol]: SANDY SILT

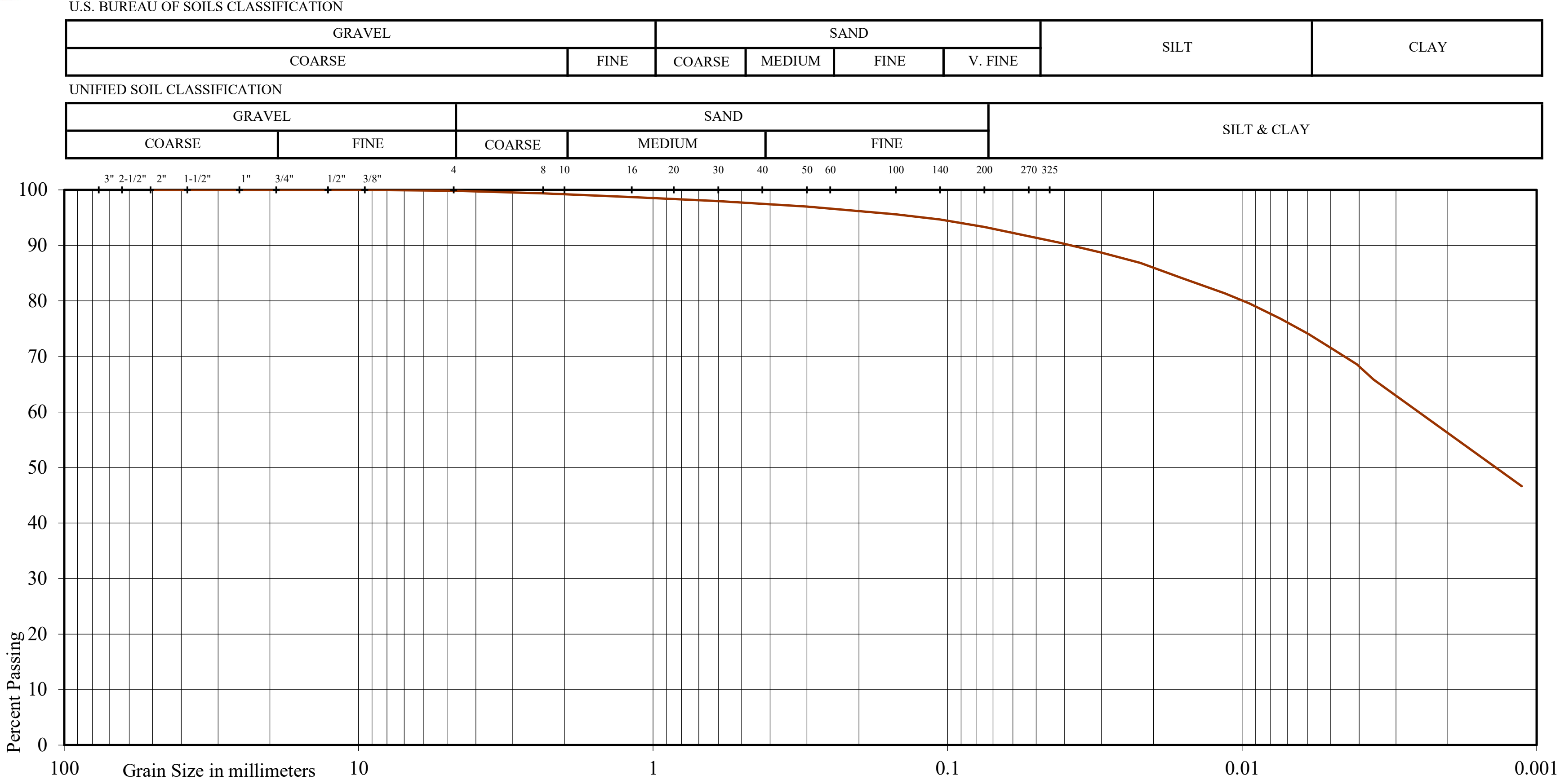
a trace of clay

Figure: 7

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2310-S040



Project: Proposed Pumping Station and Stormwater Management Facilities

SVS-

Location: Southeast of Old School Road and McLaughlin Road, Town of Caledon

BH./Sa. 104/6

Liquid Limit (%) = 44

Borehole No: SVS-104

Plastic Limit (%) = 21

Sample No: 6

Plasticity Index (%) = 23

Depth (m): 4.8

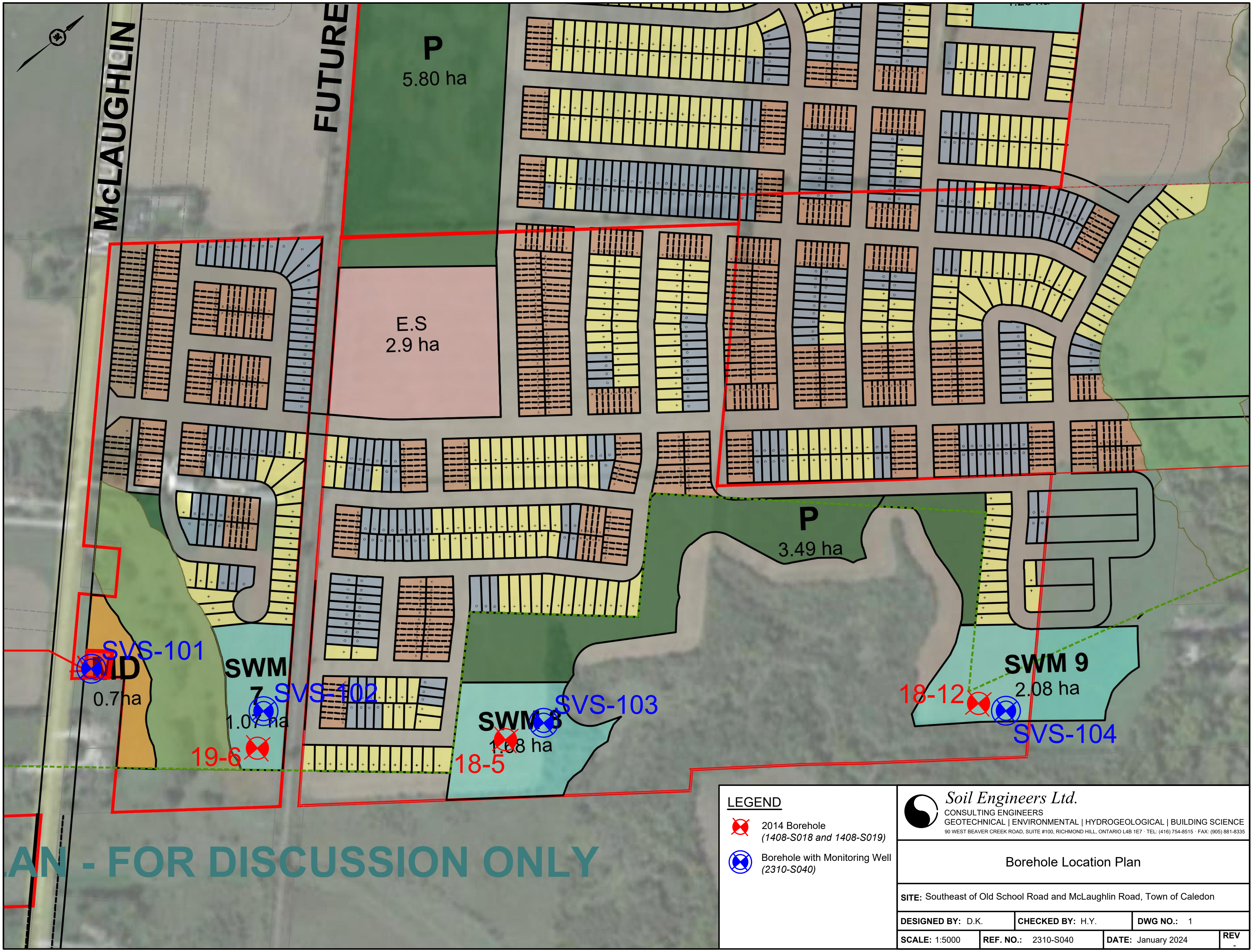
Moisture Content (%) = 21

Elevation (m): 253.2

Estimated Permeability (cm./sec.) = 10^{-7}

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

Figure: 8



LEGEND

- ⊗ 2014 Borehole *(1408-S018 and 1408-S019)*
- ⊗ Borehole with Monitoring Well *(2310-S040)*

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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 Location Plan

SITE: Southeast of Old School Road and McLaughlin Road, Town of Caledon

DESIGNED BY: D.K.	**CHECKED BY:** H.Y.	**DWG NO.:** 1
SCALE: 1:5000	**REF. NO.:** 2310-S040	**DATE:** January 2024

REV -

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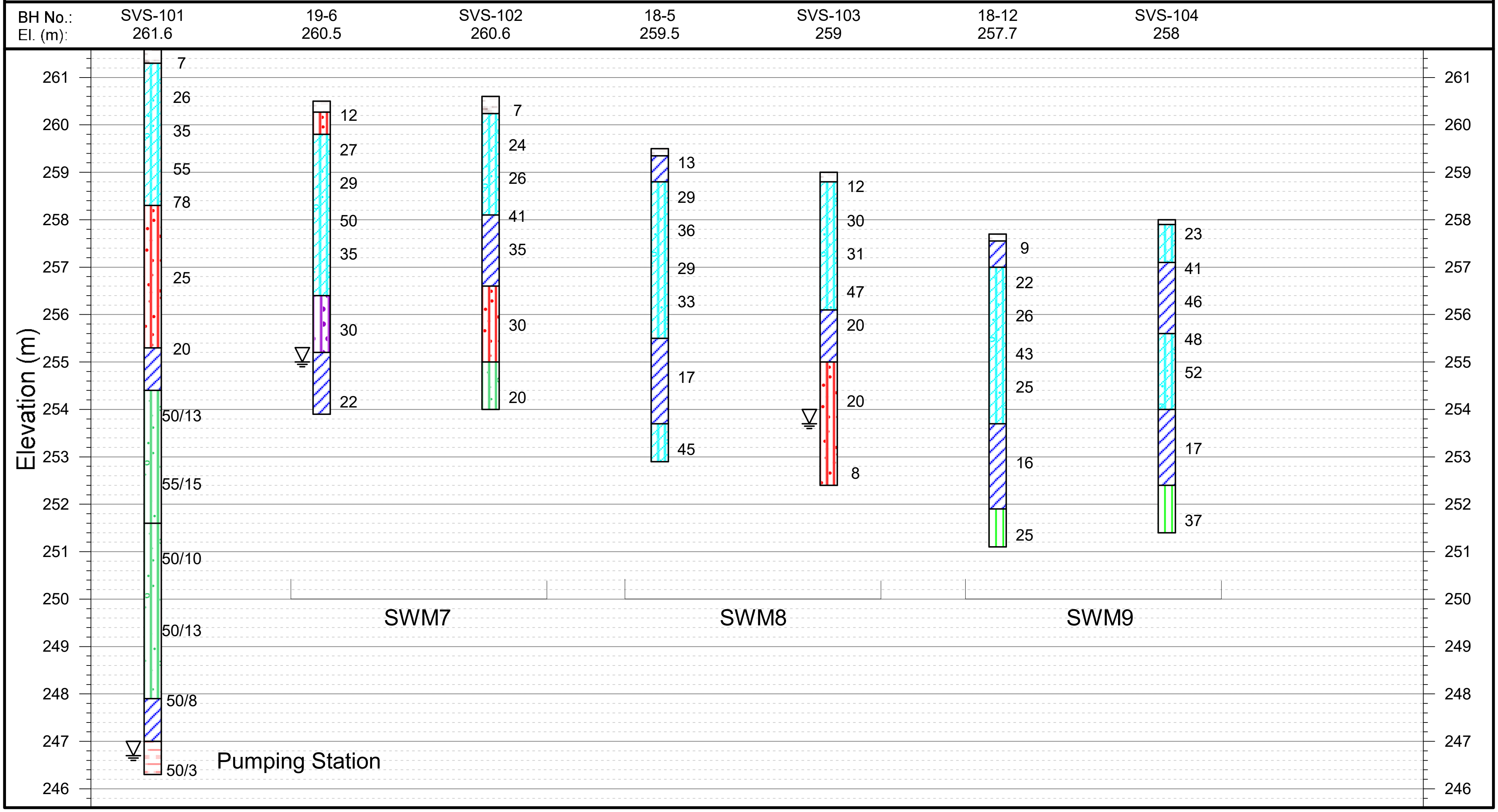
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.:	2310-S040
REPORT DATE:	January 2024
PROJECT DESCRIPTION:	Proposed Pumping Station and Stormwater Management Facilities
PROJECT LOCATION:	Southeast of Old School Road and McLaughlin Road Town of Caledon

LEGEND

- ▨ SANDY SILT
- ▨ SANDY SILT TILL
- ▨ SHALE
- ▨ SILT
- ▨ SILTY CLAY
- ▨ SILTY CLAY TILL
- ▨ SILTY SAND
- ▨ TOPSOIL
- ▽ WATER LEVEL (END OF DRILLING)



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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

BOREHOLE LOGS FROM 2014 GEOTECHNICAL INVESTIGATIONS (1408-S018 AND 1408-S019)

REFERENCE NO. 2310-S040

JOB NO: 1408-S018

LOG OF BOREHOLE NO: 5

FIGURE NO: 5

JOB DESCRIPTION: Proposed Residential Development

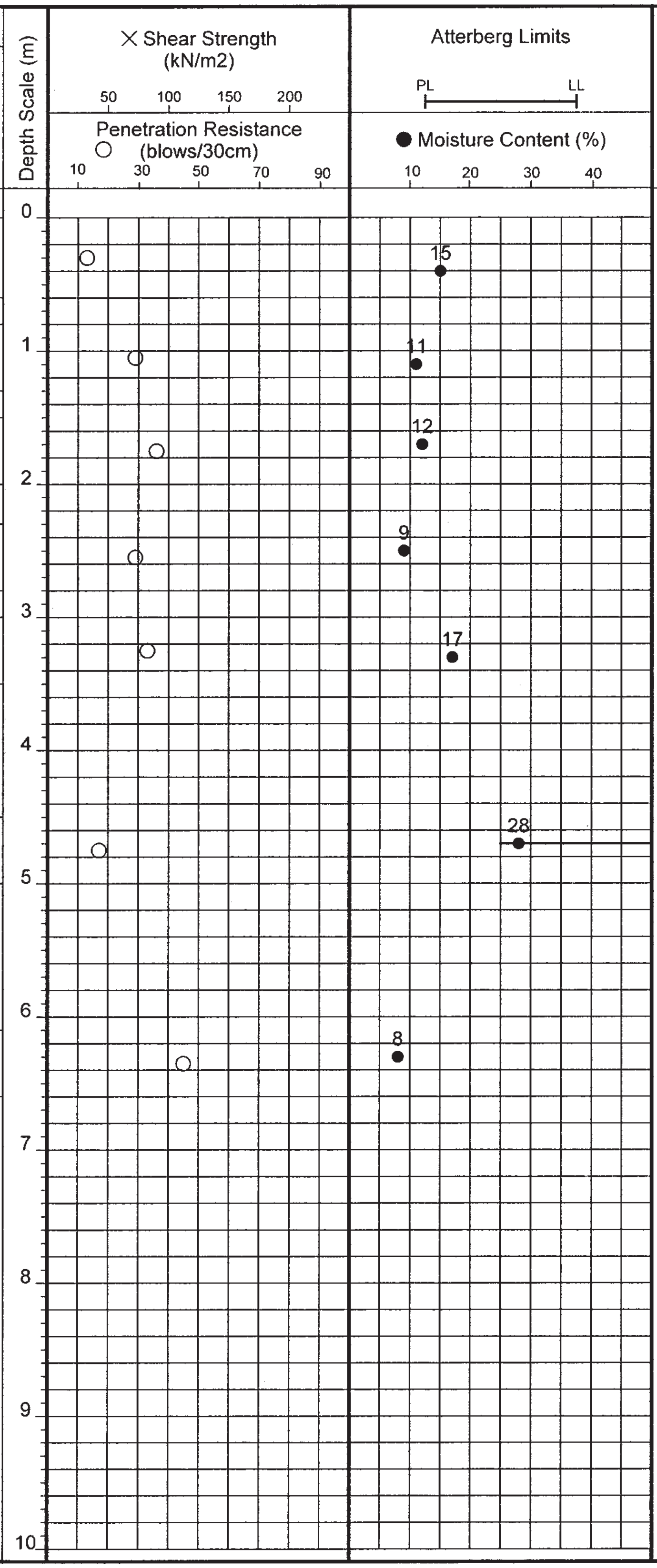
JOB LOCATION: Old School Road and Hurontario Street
Town of Caledon

METHOD OF BORING: Flight-Auger

DATE: August 26, 2014

Depth Elev. (m)	SOIL DESCRIPTION
0.0	Ground Surface
259.5	**15 cm TOPSOIL** Brown, stiff, weathered **SILTY CLAY** occ. wet sand and silt seams and layers
0.7 258.8	Brown, very stiff to hard **SILTY CLAY, Till** occ. wet sand and silt seams and layers, cobbles and boulders
4.0 255.5	Grey, very stiff **SILTY CLAY** occ. wet sand and silt seams and layers
5.8 253.7	Grey, hard **SILTY CLAY, Till** occ. wet sand and silt seams and layers, cobbles and boulders
6.6 252.9	**END OF BOREHOLE**

SAMPLES		
Number	Type	N-Value
1	DO	13
2	DO	29
3	DO	36
4	DO	29
5	DO	33
6	DO	17
7	DO	45



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1408-S018

LOG OF BOREHOLE NO: 12

FIGURE NO: 12

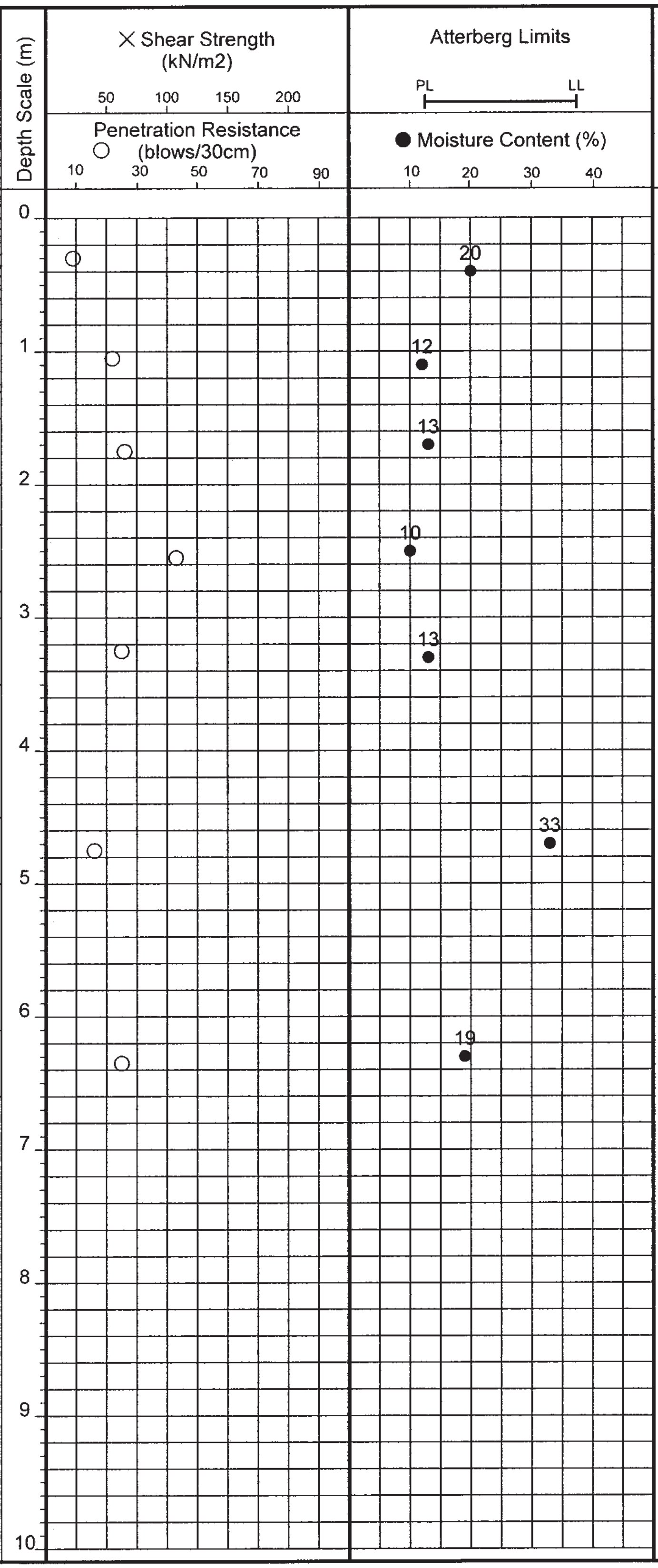
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Old School Road and Hurontario Street
Town of Caledon

METHOD OF BORING: Flight-Auger

DATE: August 26, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
0.0 257.7	Ground Surface **15 cm TOPSOIL** Brown, stiff, weathered **SILTY CLAY** occ. wet sand and silt seams and layers	1	DO	9
0.7 257.0	Brown, very stiff to hard **SILTY CLAY, Till** occ. wet sand and silt seams and layers, cobbles and boulders	2	DO	22
		3	DO	26
		4	DO	43
		5	DO	25
4.0 253.7	Grey, stiff **SILTY CLAY** occ. wet sand and silt seams and layers	6	DO	16
5.8 251.9	Grey, compact **SILT**	7	DO	25
6.6 251.1	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1408-S019

LOG OF BOREHOLE NO: 6

FIGURE NO: 6

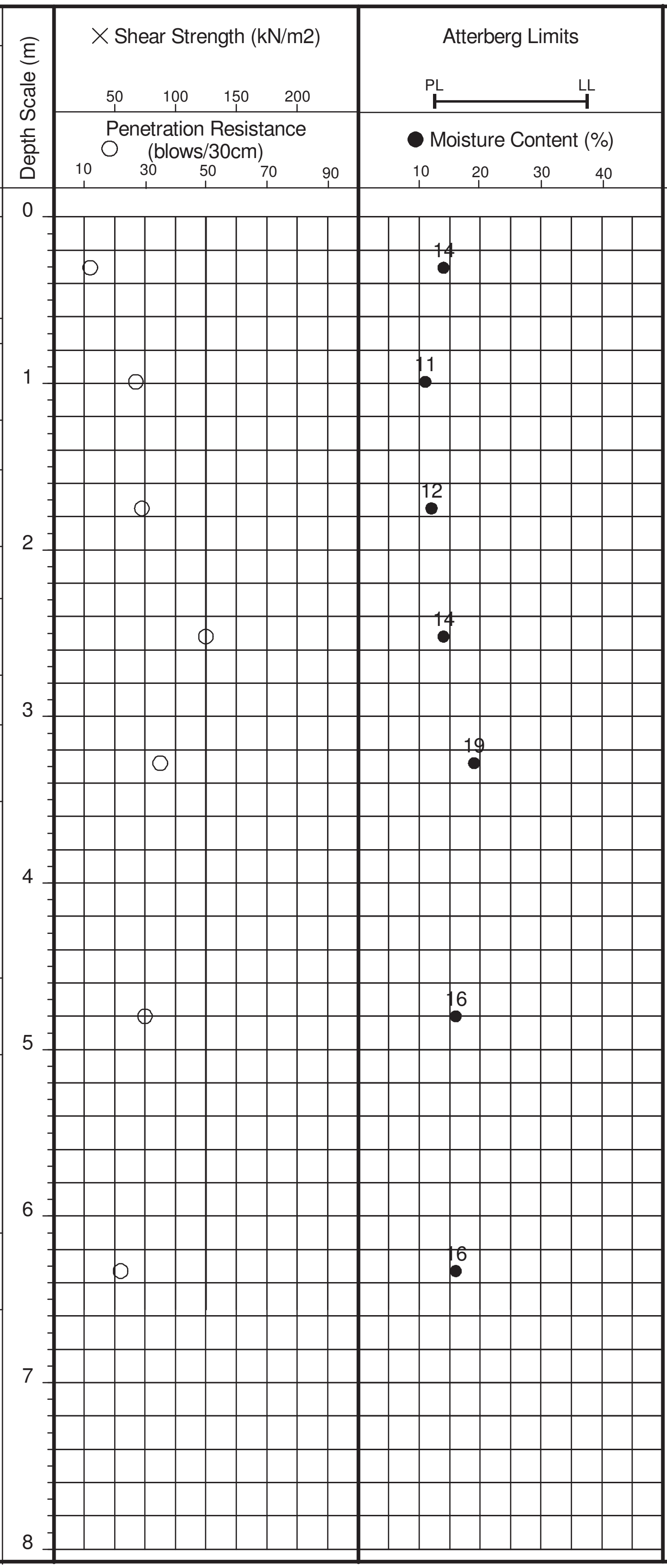
JOB DESCRIPTION: Due Diligence for Proposed Land Acquisition

JOB LOCATION: Southeast of Old School Road and McLaughlin Road
Town of Caledon

METHOD OF BORING: Flight-Auger

DATE: August 21, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
260.5	**23 cm TOPSOIL**			
	Brown, compact **SANDY SILT** weathered, a trace of rootlets a trace of clay	1	DO	12
0.7 259.8	Very stiff to hard **SILTY CLAY, Till** some sand to sandy a trace of gravel occ. rock fragments contains sand seams weathered	2	DO	27
		3	DO	29
		4	DO	50
	brown grey	5	DO	35
4.1 256.4	Grey, compact **SILTY FINE SAND** a trace of clay	6	DO	30
5.3 255.2	Grey, very stiff **SILTY CLAY**	7	DO	22
6.6 253.9	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 255.0 m upon completion

Cave-in @ El. 254.7 m upon completion

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