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January 26, 2016

Reference No. 1512-S086
Related Reference No. 0210-S44

2512461 Ontario Limited
3751 Victoria Park Avenue
Toronto, Ontario
M1W 3Z4

Attention: Mr. Shaun Joffe

Re: Soil Investigation and Slope Stability Study Report Update
Proposed Residential Development
6611 Harmony Hill
City of Mississauga

Dear Sir:

In accordance with your email authorization dated December 14, 2015, we have completed a supplementary slope stability study and updated the soil investigation report for the captioned property. We herein present our findings and recommendations.

The subject property is located within the residential community northwest of Highway 401 and Mavis Road, on the west side of Harmony Hill and extending to 2nd Line West. At the time of investigation, the site consisted of a 1-storey residence accessed via a driveway from 2nd Line West, with open spaces at the front and a gravel parking at the rear of the house. The site is bordered by a drainage ditch valley and open space to the immediate north, and existing residential units to the south. To the west of 2nd Line West lies Fletcher's Creek meandering towards the Credit River. The grade descends gradually toward the west from Harmony Hill, with a total elevation difference of 10± m between property limits.

FINDINGS

In 2002, a soil investigation consisting of 5 boreholes was carried out on the site. It is understood that the site and its physiographic properties have remained largely unaltered throughout the years. This was confined by a recent site inspection conducted on January 8, 2016

Beneath a layer of topsoil fill, 10 to 15± cm thick, and/or a layer of silty clay fill or granular fill, the site is underlain by a layer of firm to hard, generally very stiff silty clay till. The surficial weathered zone generally extends to 1.0± m. Hard resistance to augering was encountered in places, indicating that cobbles and boulders are embedded in the till.

The silty clay fill, containing occasional topsoil inclusions and organics, was found extending to depths ranging from 0.6 to 4.0± m beneath the prevailing ground surface. The deep earth fill is delineated in the western half of the site. The borehole logs and grain size distribution graphs are attached in the Appendix.

The Atterberg Limits of 3 representative clay till samples and the natural water content of all the samples were determined and summarized below:

Liquid Limit	24%, 26% and 27%
Plastic Limit	14% and 16%
Natural Water Content	9% to 22% (mean 13%)

The above results show that the till is a cohesive material with low plasticity. The natural water content lies close to its plastic limit, confirming the very stiff consistency of the till determined by the ‘N’ values.

Based on the above findings, the following engineering properties of the silty clay till are deduced:

- Moderately frost susceptibility and low water erodibility.
- Low soil-adfreezing potential.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive soil, its shear strength is primarily derived from consistency which is inversely related to its moisture content.
- In excavation, the stiff to hard clay till will be stable in a relatively steep cut for a short duration; however, as water seepage saturates the soil fissures and the sand and silt layers, the sides will slough, and sheet collapse may occur without warning.
- A very poor material to support flexible pavement, with an estimated California Bearing Ratio (CBR) value of 3% or less.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm·cm.

COMPACTION

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 the following table:

Soil Type	**Determined Natural Water Content (%)**	**Water Content (%) for Standard Proctor Compaction**	
		100% (optimum)	**Range for 95% or +**
Earth Fill	8 to 26 (mean 14)	16	13 to 20
Silty Clay Till	9 to 22 (mean 13)	15	12 to 19

According to the above, the revealed soils are generally suitable for 95% or + Standard Proctor compaction, while the weathered silty clay till and some of the earth fill and reworked till are wet and will require prior aeration or mixing with drier soils for use as structural fill and backfill. Aeration of the weathered till should be carried out during the dry, warm weather by spreading it thinly on the ground. The soils having a low water content can be mixed with wetter soils or wetted prior to or during structural compaction.

The till should be compacted using a heavy-weight, kneading-type roller. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

When compacting the very stiff to hard clay till on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts of this soil must be limited to 20 cm or less (before compaction). It is difficult to monitor the lifts of backfill placed in deep trenches by a soil technician due to safety concerns in deep excavation; therefore, it is preferable that the compaction of backfill at depths over 1.0 m below the road subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness.

If the compaction of the soils is carried out with the water content within the range for 95% Standard Proctor dry density but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is an unsuitable condition for road construction since each component of the pavement structure is placed under a dynamic compactive load and the subsequent rolling action will cause structural failure of the new pavement. The foundations or bedding of the underground services will be placed on a subgrade which will not be subjected to impact loads. Therefore, structural compaction on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.

The presence of boulders will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in size is mixed with the material, it must either be sorted or must not be used for construction of engineered fill and/or structural backfill.

GROUNDWATER

All boreholes remained dry upon completion of field work. The brown, oxidized soil changes from to grey at depths ranging from 3.4± to 6.2± m. Due to the low permeability of the clay till, the yield of groundwater, if encountered, is expected to be small and limited in quality. During the wet seasons, infiltrated precipitation may be trapped in the soil fissures in places, rendering the occurrence of perched groundwater at shallower depths. Its yield generally is small and may dissipate during the ensuing dry seasons.

DISCUSSION AND RECOMMENDATIONS

Based on the above findings, the geotechnical considerations pertaining to the construction for the project are presented herein.

- The revealed topsoil and topsoil fill must be stripped for the project construction. They are considered void of engineering value, but can be used for general landscaping purposes. They should not be buried within any building envelopes or deeper than 1.2 m below the exterior finished grade.
- The surficial soils are generally weathered in the zone extending to a depth of 1.0± m. The weathered soils are weak in shear strength and are not suitable for supporting foundations.
- The earth fill containing organics, and which is non-uniformly compacted, is considered unsuitable for supporting infrastructure in its present state. In using the fill for structural backfill, it should be subexcavated, inspected, sorted free of any topsoil inclusions and any deleterious materials, proof-rolled and properly compacted. If it is impractical to sort the topsoil and deleterious materials from the fill, then it must be wasted and replaced with properly compacted inorganic earth fill.
- The sound natural soils are suitable for normal spread and strip footing construction.
- The presence of firm reworked silty clay till at Borehole 4 at a depth of 4.5± m, or El. 169.0± m, warrants caution in the construction of the building foundations (depending on proposed grading) and/or the installation of underground services.
- Extensive cut and fill will likely be required for the site grading and it is generally more economical to place engineered fill for normal footing, sewer and road construction.

- The spoil of demolition of the existing dwelling should be properly disposed off site and the resulting cavities should be properly backfilled with engineered fill, and documented.
- Perimeter subdrains and dampproofing of the foundation walls will be required for foundation wall construction. The subdrains should be shielded by a fabric filter to prevent blockage by silting.
- A Class ‘B’ bedding, consisting of compacted 20-mm Crusher-Run (graded) Limestone, is recommended for the construction of underground services.
- The sound till contains occasional boulders. Extra effort and a properly equipped backhoe will be required for excavation. Boulders larger than 15 cm in size are not suitable for structural backfill and/or the construction of engineered fill.
- Due to the presence of topsoil, topsoil fill, weathered soils and earth fill, the soundness of the subgrade must be assessed by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the subgrade conditions are compatible with the designs of the foundations.

Foundations

Based on the borehole information, the footings must be placed below the topsoil, topsoil fill, weathered soils and earth fill, onto the sound natural soils or engineered fill. As a general guide, Maximum Allowable Soil Pressure (SLS) of 150 kPa Factored Ultimate Soil Bearing Pressure (ULS) of 250 kPa can be used for the design of the normal strip and spread footings founded onto sound natural soils. The recommended pressures and corresponding founding levels are presented in the following table.

BH No.	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level 150 kPa (SLS) 250 kPa (ULS) Depth (m)	El. (m)
1	3.0 or +	166.7 or -
2	4.2 or +	167.6 or -
3	1.5 or +	174.8 or -
4	1.2 or +*	172.2 or -*
5	1.2 or +	174.7 or -

* Due to the decrease in 'N' values with depth, the SLS of 150 kPa must be linearly reduced to 100 kPa from a depth of 3.5 to 4.6 m. The width of the spread and strip footings must be limited to 2 m and 1.8 m, respectively.

One must be aware the recommended Maximum Allowable Soil Pressures (SLS) and corresponding founding depths are given as a guide for foundation design and must be confirmed by subgrade inspection performed by a geotechnical engineer at each of the building locations, or by further investigation once building layouts are available.

The recommended soil pressures (SLS) incorporate a safety factor of 3. The total and differential settlements are estimated to be 25 mm and 15 mm, respectively.

The footings should meet the requirements specified by the latest Ontario Building Code, and, based on available borehole information, the structures should be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

Foundations exposed to weathering, and in unheated areas, should have at least 1.2 m of earth cover for protection against frost action, or must be properly insulated.

Perimeter subdrains and dampproofing of the foundation walls will be required for basement construction. All the subdrains must be encased in a fabric filter to protect them against blockage by silting.

Due to the presence of topsoil, topsoil fill, weathered soils and earth fill, the footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of geotechnical engineer; this is to ensure that the subgrade conditions are compatible with the foundation design requirements.

Engineered Fill

The existing earth fill can be upgraded to and/or replaced with engineered fill; where earth fill is required to raise the site, or extended footings are required, it is generally economical to place engineered fill for normal footing, sewer and road construction. The on-site cut native material is suitable for use as fill material. The engineering requirements for a certifiable fill for road construction, municipal services and footings designed with a Maximum Allowable Soil Pressure (SLS) of 150 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 250 kPa are presented below:

1. All of the topsoil must be removed. The subgrade must be inspected, and the weathered soils should be proof-rolled and surface compacted. Any soft spots should be rectified prior to any fill placement.
2. Inorganic soils must be used, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of their maximum Standard Proctor dry density up to the proposed finished grade. The soil moisture must be properly controlled on the wet side of 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% of the maximum Standard Proctor compaction.

3. If imported fill is to be used, the hauler is responsible for its environmental quality and must provide a document to certify that the material is free of hazardous contaminants.
4. 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.
5. The engineered fill should extend over the entire graded area. The fill envelope must be clearly and accurately defined in the field and precisely documented by qualified surveyors. Foundations partially on engineered fill must be properly reinforced by two 15-mm steel reinforcing bars in the footings and upper section of the foundation walls, or must be designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15 mm) between the natural soil and engineered fill.
6. The engineered fill must not be placed during the period from late November to early April when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
7. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground.
8. Where the fill is to be placed on a bank steeper than 1 vertical:3 horizontal, the face of the bank must be flattened to 3+ so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
10. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations are placed within the engineered fill envelope, and that the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.

11. Any excavation carried out in the certified engineered fill must be reported to the geotechnical consultant who inspected the fill placement in order to document the locations of the excavation and/or to inspect the reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
12. Despite stringent control in the placement of engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the strip footings and the upper section of the foundation walls constructed on the engineered fill may require continuous reinforcement with steel bars, depending on the uniformity of the soils in the engineered fill and the thickness of the engineered fill underlying the foundations. Should the footings and/or walls require reinforcement, the required number and size of reinforcing bars must be assessed with consideration to the uniformity as well as the thickness of the engineered fill beneath the foundations. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

Underground Services

The subgrade for the underground services should consist of natural soils and/or properly compacted organic-free earth fill. Where topsoil, organic material or badly weathered soil is encountered, the material must be subexcavated and replaced with properly compacted bedding material.

A Class ‘B’ bedding is recommended for construction of the underground services. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent, to be approved by a geotechnical engineer.

Where a subgrade consisting of soft to firm silty clay till is encountered, the bedding should be thickened or stone immersion techniques should be employed to stabilize the base for sewer construction. Immediate placement of the bedding material should be implemented after a careful subgrade excavation. This procedure will minimize the disturbance of the subgrade and costly rectification will be avoided. It is advisable that the contractor be requested to record the occurrence of loose or soft soils during trenching. This information can be used to forewarn the builders to exercise caution in footing construction.

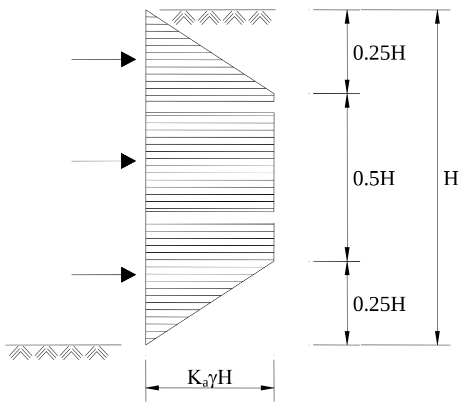
In order to prevent pipe floatation should the trench become deluged with water, a soil cover with a minimum thickness equal to the pipe diameter should be placed at all times after completion of the pipe installation.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting. The pipe joints should be leak-proof or they should be provided with a waterproof membrane. This is to prevent migration of fines due to leaks from inadvertent faulty joints.

Since the in situ clay till material has moderately high corrosivity to buried metal, the pipes may require protection against corrosion. In determining the mode of protection, an electrical resistivity of 3500 ohm·cm should be used. This, however, should be confirmed by testing the soil along the pipe alignment at the time of the underground services construction.

Where a vertical cut is necessary, it can be carried out in a trench box and/or by a sheeting enclosure. In the design of the trench box and/or shoring structure, the recommended lateral earth pressure distribution for the revealed soils is given in the following Diagram.

Lateral Earth Pressure (Sound Tills)



H - Height of Excavation in metres

γ - See Soil Parameters (above groundwater)

K_a - Active Lateral Earth Pressure Coefficient (See Soil Parameters)

h - Height of groundwater level, if any

γ_w - 9.8 kN/m^3

The soils above the trench box must be cut at 1 vertical:1.5 or + horizontal.

In the areas where the new trench infringes upon or is close to existing trench backfill, if any, the side slopes of the new trench must be shored or stabilized by a trench box. Where existing underground services are to remain, they must be properly supported prior to the new trench excavation.

Trench Backfilling

The on-site inorganic soils are suitable for trench backfill. In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% of its maximum Standard Proctor dry density with the moisture content 2% to 3% drier than the optimum. This is to provide the required stiffness for pavement construction. In the lower zone, a 95% or + Standard Proctor compaction is considered to be adequate; however, the material must be compacted on the wet side of the optimum.

In normal sewer construction practice, the problem areas of ground settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, sand backfill should be used. Unless compaction of the backfill is carefully performed, the interface of the native soils and the sand backfill will have to be flooded for a period of at least 1 day.

The narrow trenches should be cut at 1 vertical:2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

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

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, 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 in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement.

- 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 1 vertical: 1.5 + horizontal, 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% of the maximum Standard Proctor dry density, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section. In areas where groundwater movement is expected in the sand fill mantle, seepage collars should be provided.

Garages, Driveways and Landscaping

Due to the high frost susceptibility nature of the underlying soils, heaving of the pavement is expected to occur during the cold weather. The driveways at the entrances to the garages should be backfilled with non-frost-susceptible granular material, with a frost taper at a slope of 1 vertical:1 horizontal.

The garage floor slab and interior garage foundation walls must be insulated with 50-mm Styrofoam, or equivalent.

The slab-on-grade in open areas should be designed to tolerate frost heave, and the grading around the slab-on-grade must be such that it directs runoff away from the structure.

In areas where ground movement due to frost heave cannot be tolerated, the floor slab, sidewalks and interlocking stone pavement must be constructed on a free-draining granular base at least 0.3 to 1.2 m thick, depending on the degree of tolerance to ground movement, with proper drainage which will prevent water from accumulating in the granular base. Alternatively, the slab or pavement should be insulated with 50-mm Styrofoam, or equivalent.

Pavement Design

Based on the borehole findings, the subgrade will consist predominantly of silty clay till, the recommended pavement design for a residential local roadway meeting the standards from the City of Mississauga is provided in the following table.

Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	85	HL-8
Granular Base	200	Granular 'A' or equivalent
Granular Sub-base	235	Granular 'B' or equivalent

In preparation of the subgrade, the topsoil and topsoil fill must be removed and the surface should be proof-rolled. The badly weathered soils and the organic earth fill should be subexcavated, sorted free of any concentrated topsoil and deleterious materials, if any, and properly compacted. Any soft subgrade should be subexcavated, properly compacted or replaced with uniformly compacted, inorganic earth fill or granular materials.

Earth fill used to raise the grade for pavement construction should consist of organic-free soil uniformly compacted to 98% or + of its maximum Standard Proctor dry density. All the granular bases should be compacted to their maximum Standard Proctor dry density.

In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% of its maximum Standard Proctor dry density, with the water content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered adequate.

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

- If the road construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Lot areas adjacent to the roads should be properly graded to prevent the ponding of large amounts of water during the interim construction period.
- Prior to placement of the granular bases, the subgrade should be proof-rolled and any soft spots should be rectified.

- If the roads are to be constructed during the wet seasons and extensively soft subgrade occurs, the granular sub-base may require thickening. This can be assessed during construction.
- Fabric filter-encased curb subdrains may be required to meet the City of Mississauga requirements.

Slope Stability Study

The slope stability study focuses on the valley slope of a drainage ditch along the northern border of the site. At the time of inspection, the drainage ditch was dry.

Three sections, Cross-Sections A-A to C-C, were selected for the analysis where the slope is the tallest and steepest. The locations of the cross-sections are shown on Drawing No. 1. These sections have an overall slope height of 3.0± to 6.0± m, measured from the tableland to the toe of slope or ditch, with an overall gradient of 1V:1.3± to 1.8± H. The surface profiles of the cross-sections was interpreted from the contours on the topographic plan provided by Bradwill Consultants at the time of the original soil report preparation; the subsurface profiles are interpreted from the borehole logs. Cross-Sections A-A to C-C are shown on Drawing Nos. 2 to 6, inclusive.

The valley feature is well defined in the eastern half and gradually opens up and flattens at its entrance in the western half. Visual inspection revealed that the slope is vegetated with shrubs and some young to tall mature trees, most of which stand erect in a vertical orientation. Occasional garbage and debris such as cinder blocks was noted in the valley. While deep-seated failure and active erosion was not evident along the valley, bare slope surfaces and surface sloughing were observed in oversteepened areas.

The slope stability was analyzed using force-moment-equilibrium criteria of the Bishop Method with the soil strength parameters shown in the table below.

Strength Parameters For Slope Stability Analysis

	γ (kN/m^3)	**c (kPa)**	**ϕ (degrees)**
Earth Fill (silty clay)	21.0	0	26
Granular Fill	20.0	0	28
Silty Clay Till	22.0	5	30

The result from the analysis indicates that the slope at Cross-Sections A-A has a factor of safety (FOS) of 2.01, which satisfies the OMNR guideline requirements for active residential land use (minimum FOS of 1.5). The result of analysis is presented on Drawing No. 2. The slope is therefore considered geotechnically stable at Cross-Section A-A.

For Cross-Sections B-B and C-C, the results show that the existing slope has a FOS of 1.44 and 0.80, respectively, which fails to meet the OMNR requirements. The results of analyses are presented on Drawing Nos. 3 and 4. Therefore, the existing valley slope at these locations is considered to be geotechnically unacceptable for the proposed residential development. A stable gradient of 1V:2.0H and1V:3.0H is recommended for use in sound native soils and earth fill, respectively. The remodelled slopes, yielding a FOS of 1.77 and 1.51, which meets the OMNR requirements, are presented on Drawing Nos. 5 and 6.

In the absence of a watercourse at the bottom of slope, toe erosion allowance is thus not required. The long-term stable slope line (LTSSL), incorporating the geotechnically stable gradients is established on the borehole location plan, Drawing No. 1.

Lastly, a development setback buffer for man-made and environmental degradation of the bank will be required. The distance of the buffer is subject to the discretion and approval of CVC.

In future development, should any alteration be carried out in the slope areas, it should either be restored to its original condition or better than its original condition. In order to prevent the occurrence of localized surface slides in the future and to enhance the stability of the slope, the following geotechnical constraints should be stipulated:

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the rooting system that is reinforcement against soil erosion by weathering. If for any reason the vegetation cover is stripped, it must be reinstated to its original, or better than its original, protective condition. Restoration with selective native plantings including deep rooting systems which would penetrate the original buried topsoil shall be carried out to ensure bank stability.
2. Grading of the land adjacent to the slope must be such that concentrated runoff is not allowed to drain onto the slope face. Landscaping features which may cause runoff to pond at the top of the slope, as well as saturation of the crown of the slope must not be permitted.
3. The leafy topsoil cover on the bank face should not be disturbed, since this provides an insulation and screen against frost wedging and rainwash erosion.
4. Where development is carried out near the top of the slope, there are other factors to be considered related to possible human environmental abuse. Soil saturation from maintenance of landscaping features, stripping of topsoil or vegetation, and dumping of loose fill over the bank must not be allowed.

The above recommendations are subject to the approval of the CVC.

Soil Parameters

The recommended soil parameters are given in the following table:

Unit Weight and Bulk Factor			
	Unit Weight (kN/m^3)	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Silty Clay Till	22.0	1.33	1.03
Earth Fill (Clay)	21.0	1.20	0.98
Lateral Earth Pressure Coefficients			
	Active K_a	**At Rest K_o**	**Passive K_p**
Silty Clay Till	0.33	0.50	3.00
Earth Fill (Clay)	0.39	0.56	2.56
Maximum Allowable Soil Pressure (SLS) For Thrust Block Design			
Sound Natural Soils		75 kPa	
Coefficients of Friction			
Between Concrete and Granular Base		0.60	
Between Concrete and Sound Natural Soils		0.40	

Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91.

For excavation purposes, the types of soils are classified in the following table.

Classification of Soils for Excavation

Material	Type
Sound Till	2
Weathered soils and Earth Fill	3

The overall yield of groundwater from the site is expected to be small to some, and will be controllable by pumping from sumps.

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

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation 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.

It should be noted that no tests have been carried out to determine whether environmental contaminants are present in the soils. Therefore, this report deals only with a study of the geotechnical aspects of the proposed project.

This report was prepared by Soil Engineers Ltd. for the account of 2512461 Ontario Limited, and for review by their designated consultants and government agencies. The material in it reflects the judgement of Hui Wing Yang, B.A.Sc., and Bernard Lee, P.Eng. in light of the information available to it at the time of the preparation. Any use which a Third Party makes of this report, or may 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 on this report.

We trust this letter satisfies your present requirements; however, should any queries arise, please feel free to contact this office.

Yours truly,
SOIL ENGINEERS LTD.

LICENSED PROFESSIONAL ENGINEER
Jan 26, 2016
B. P. Y. LEE
100104568
PROVINCE OF ONTARIO

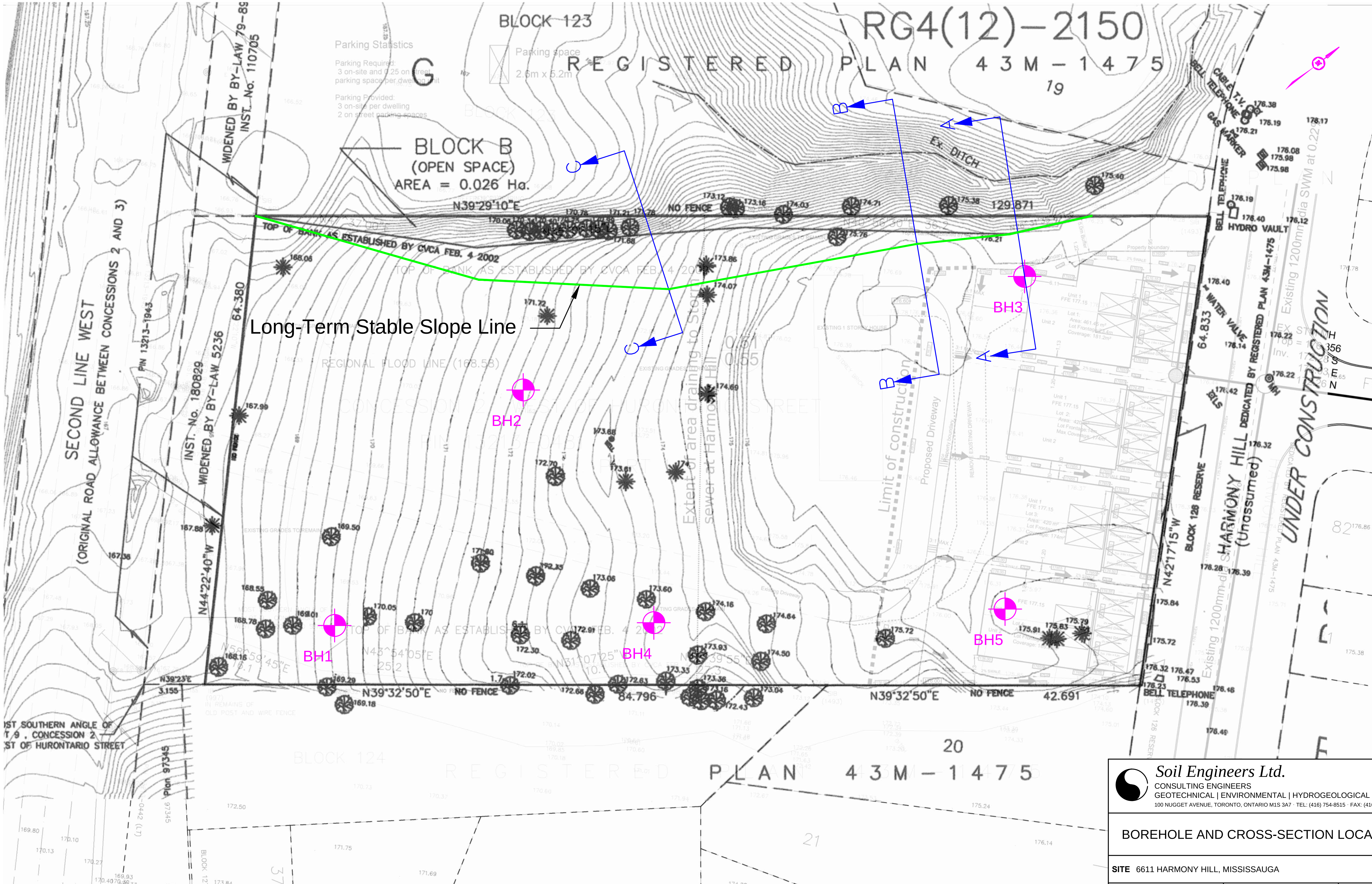
Hui Wing Yang, B.A.Sc.
HWY/BL:dd

Bernard Lee, P.Eng.

ENCLOSURES

Borehole and Cross-Section Location Plan..	Drawing No. 1
Cross-Sections	
Cross-Section A-A (Existing Condition)	Drawing No. 2
Cross-Section B-B (Existing Condition)...	Drawing No. 3
Cross-Section C-C (Existing Condition)...	Drawing No. 4
Cross-Section B-B (Geotechnically Stable Condition)......................	Drawing No. 5
Cross-Section C-C (Geotechnically Stable Condition)......................	Drawing No. 6
Borehole Logs and Grain Size Distribution Graphs...........................	Appendix

c. Soil Engineers Ltd. (Mississauga) Attn: Mr. Benjamin Lee



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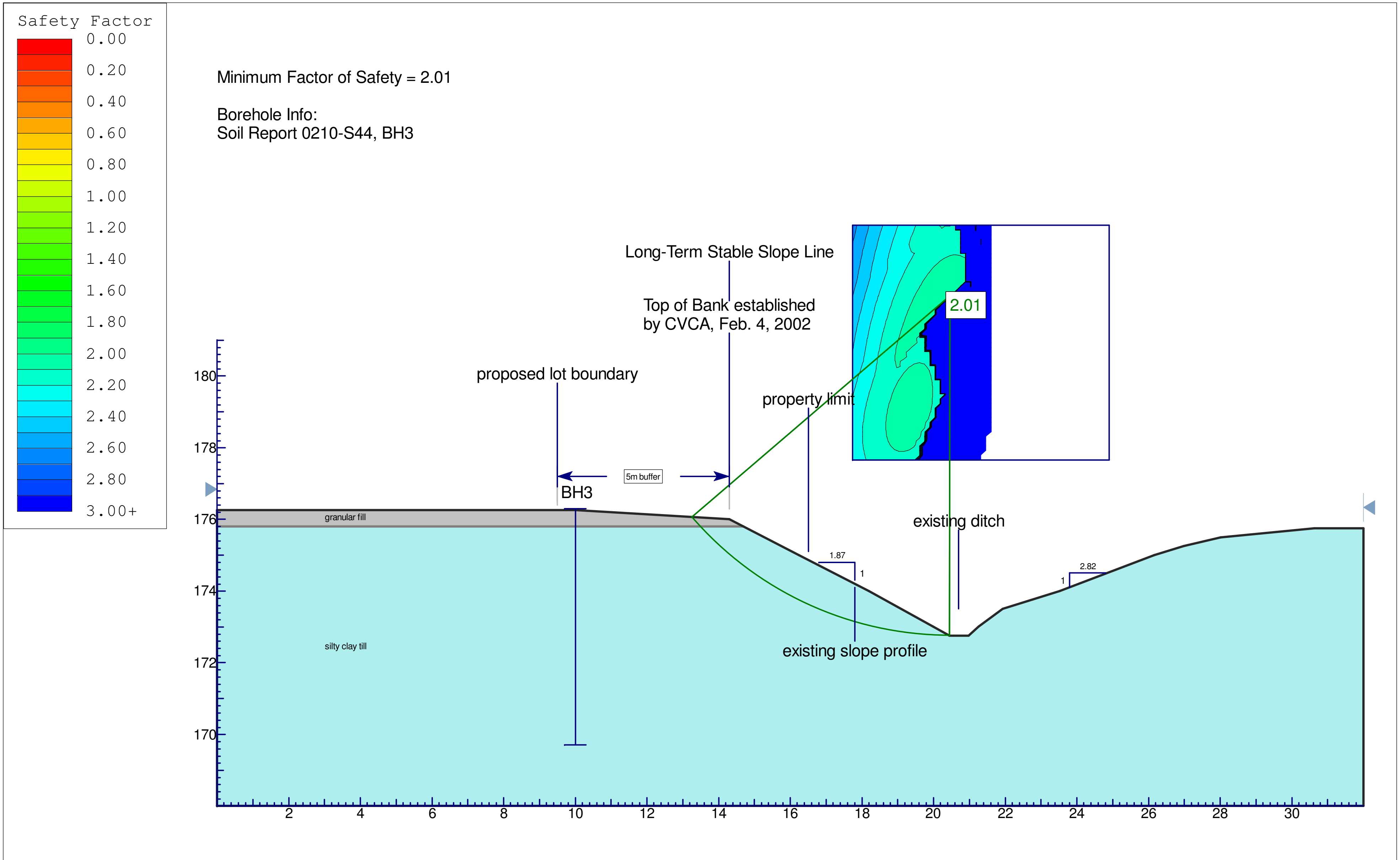
BOREHOLE AND CROSS-SECTION LOCATION PLAN

SITE 6611 HARMONY HILL, MISSISSAUGA			
DESIGNED BY	**CHECKED BY**	**DWG NO.** 1	
SCALE 1:500	**REF. NO.** 1512-S086	**DATE** JANUARY 2016	**REV** -



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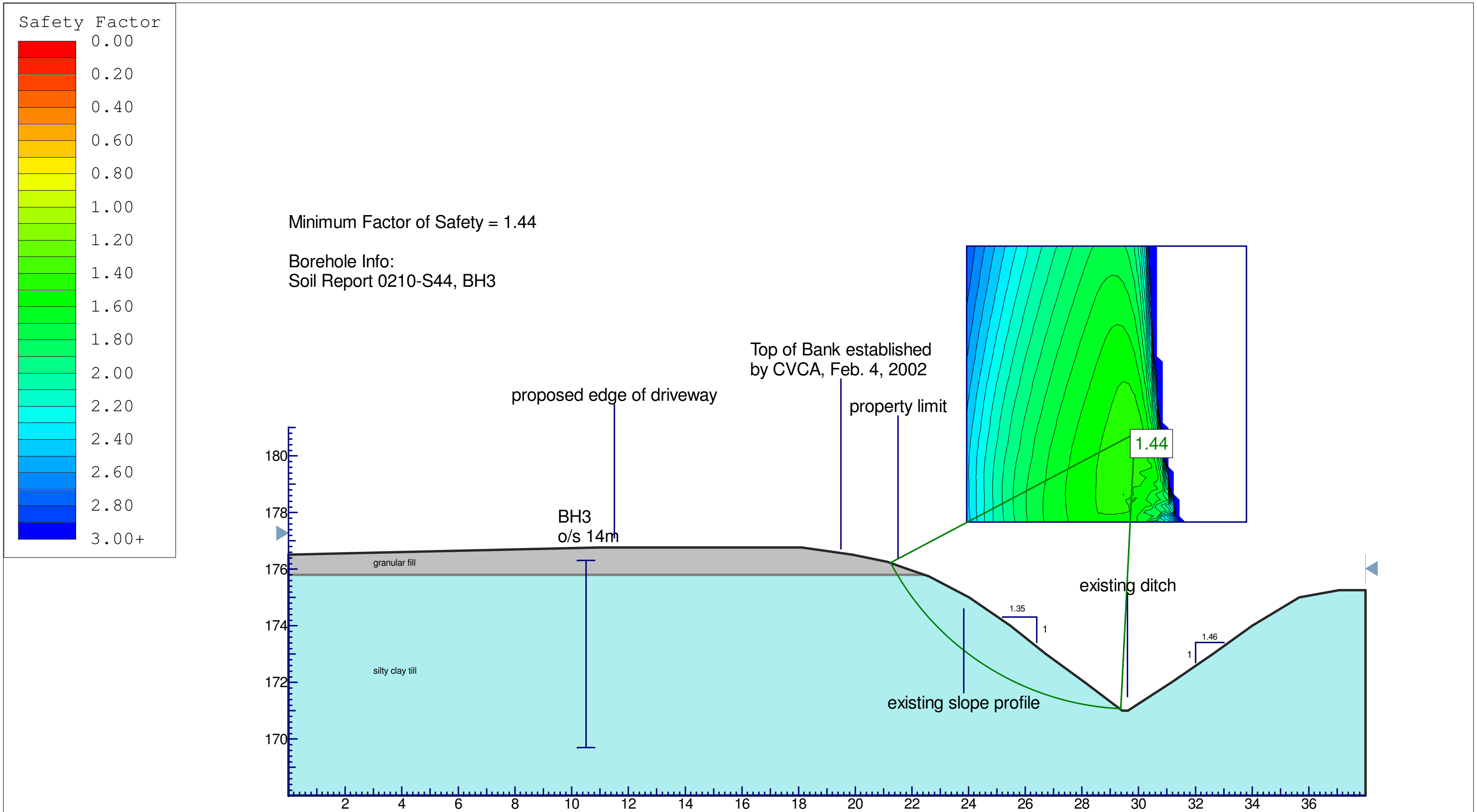
Project Title	Cross-Section A-A - Existing Condition		Load Case -
Location	6611 Harmony Hill, Mississauga		
Drawn By HWY	Checked By BL	Scale 1:150	Revision -
Date January 2016		Reference No. 1512-S086	Drawing No. 2



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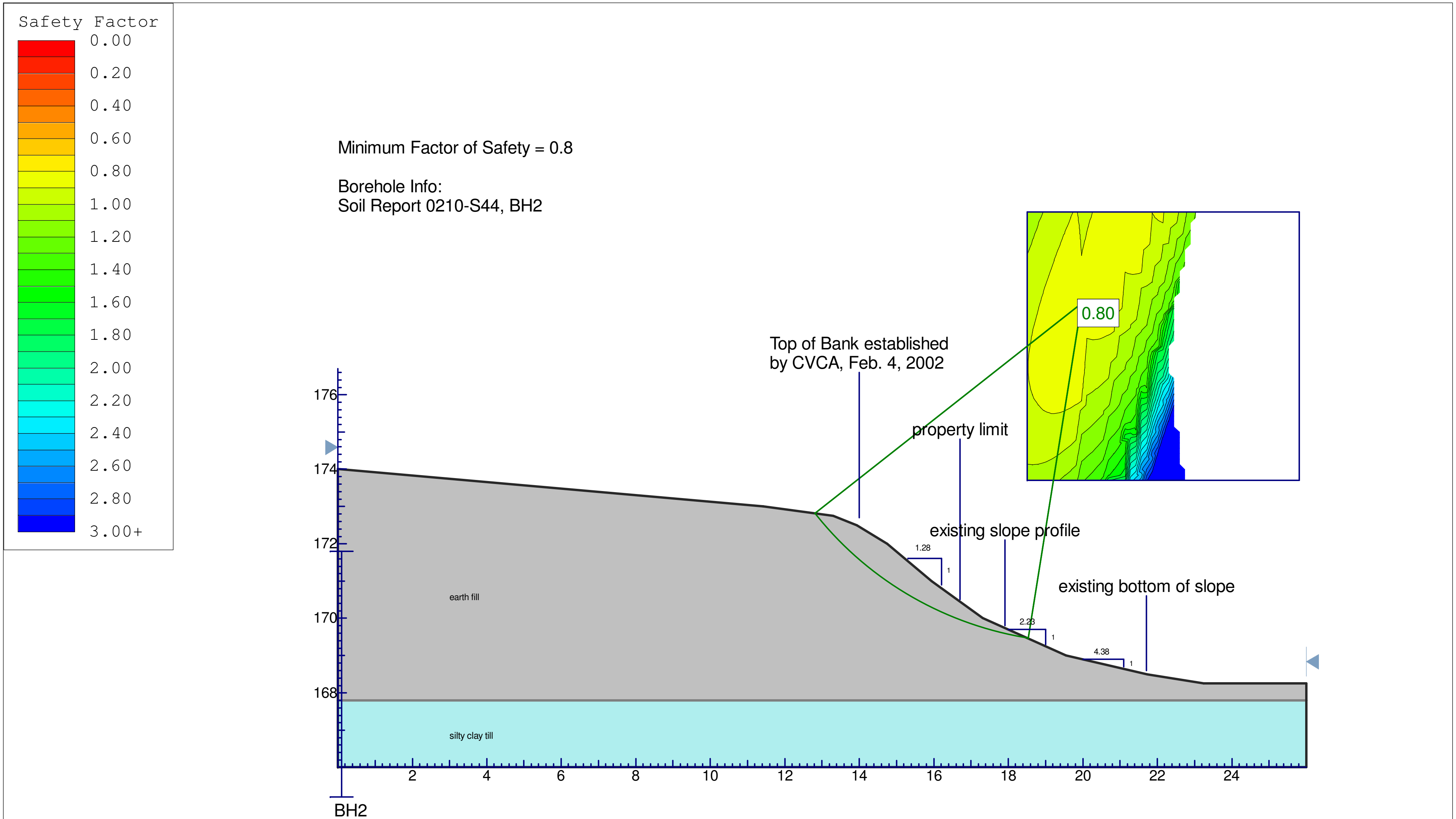
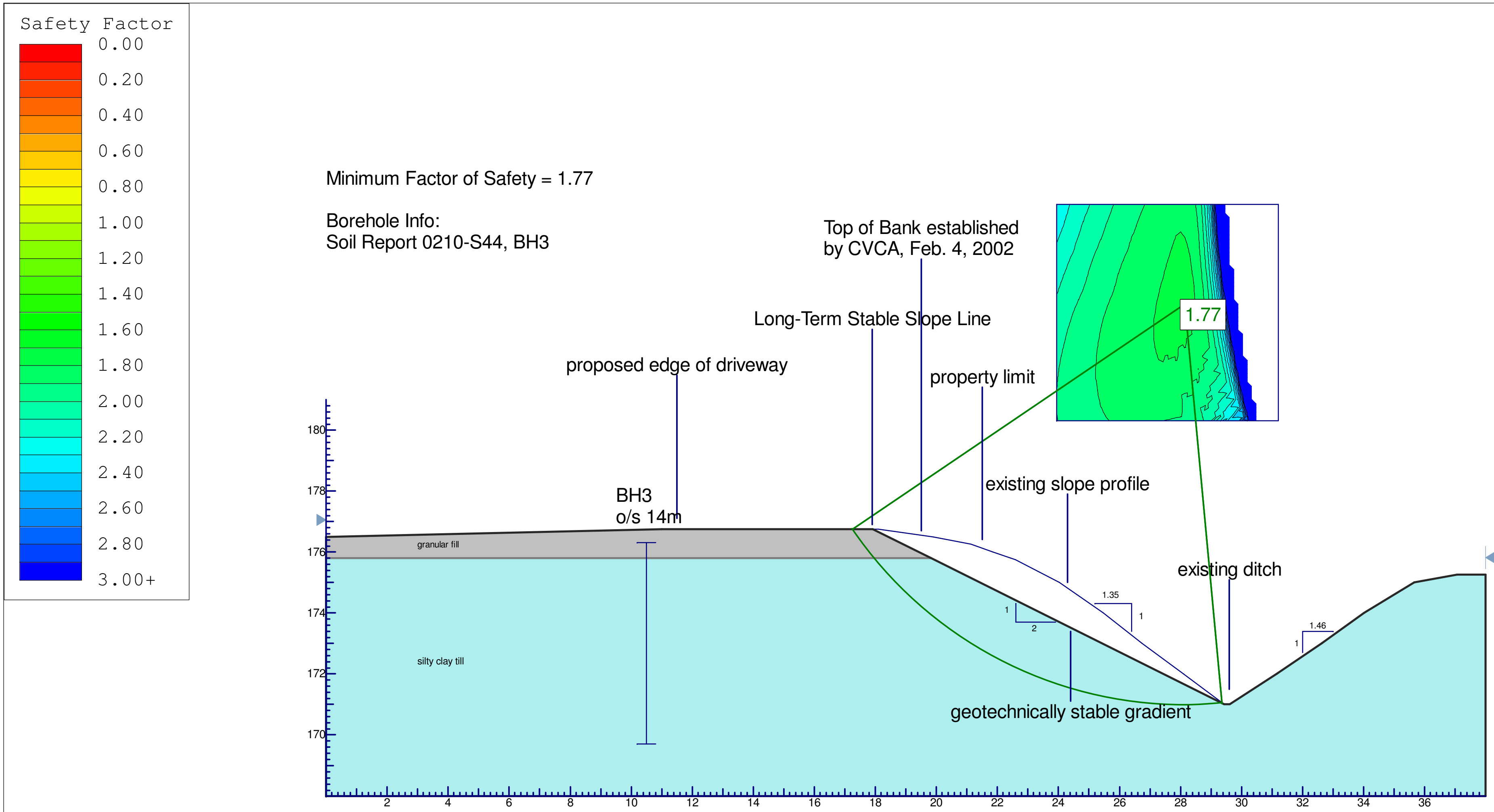
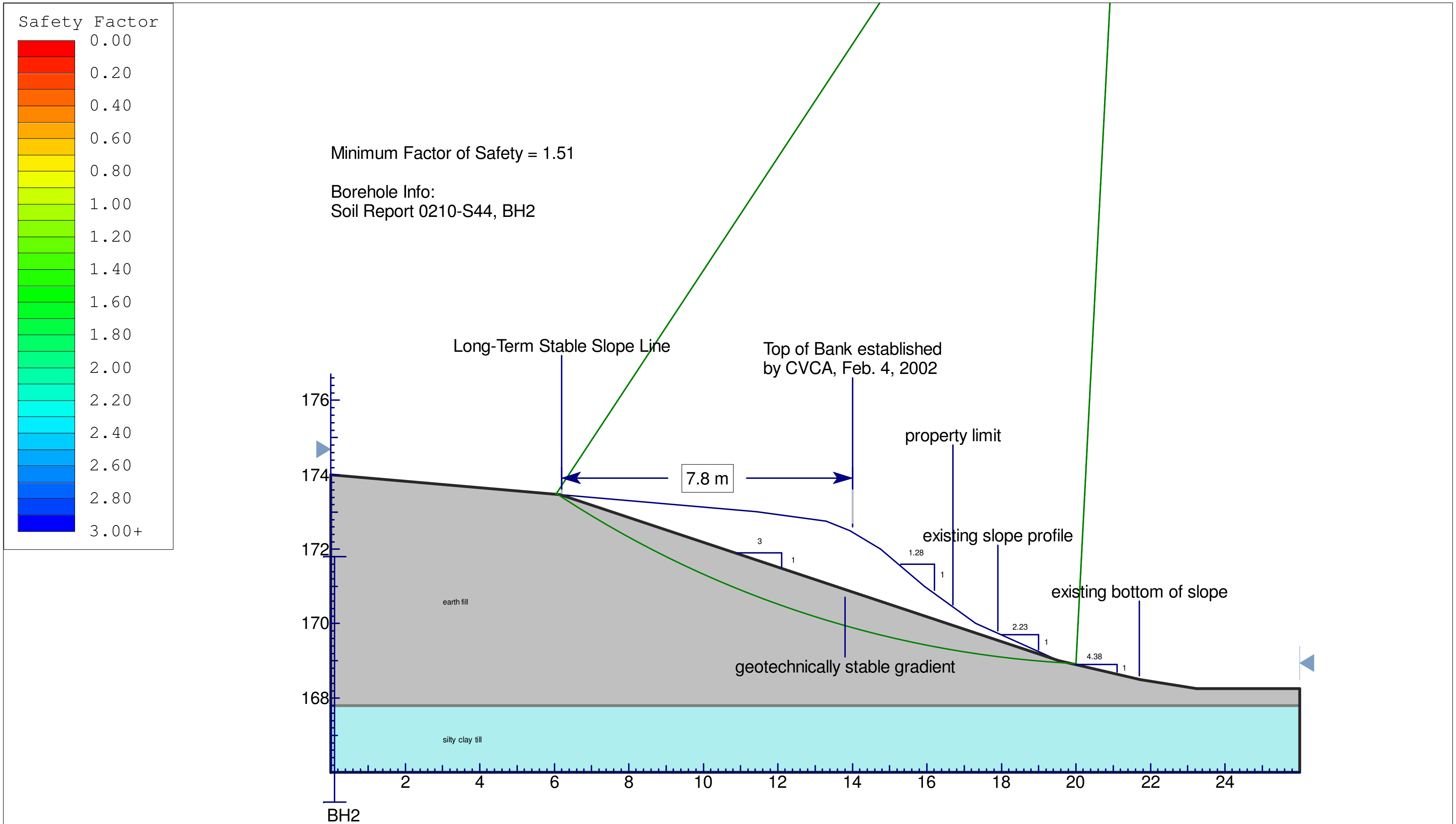
Project Title: Cross-Section B-B - Existing Condition			Load Case: -
Location: 6611 Harmony Hill, Mississauga			
Drawn By: HWY	Checked By: BL	Scale: 1:200	Revision: -
Date: January 2016		Reference No.: 1512-S086	Drawing No.: 3



Soil Engineers Ltd. CONSULTING ENGINEERS GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE 100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 · TEL: (416) 754-8515 · FAX: (416) 754-8516	Project Title: Cross-Section C-C - Existing Condition	Load Case: -
	Location: 6611 Harmony Hill, Mississauga	
	Drawn By: HWY; Checked By: BL; Scale: 1:150	Revision: -
	Date: January 2016; Reference No.: 1512-S086	Drawing No.: 4



Soil Engineers Ltd. CONSULTING ENGINEERS GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE 100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 · TEL: (416) 754-8515 · FAX: (416) 754-8516	Project Title: Cross-Section B-B - Geotechnically Stable Condition		Load Case: -
	Location: 6611 Harmony Hill, Mississauga		
	Drawn By: HWY	Checked By: BL	Scale: 1:200	Revision: -
	Date: January 2016		Reference No.: 1512-S086	Drawing No.: 5



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	Location: 6611 Harmony Hill, Mississauga			
	Drawn By: HWY	Checked By: BL	Scale: 1:150	Revision: -
	Date: January 2016		Reference No.: 1512-S086	Drawing No.: 6

APPENDIX

BOREHOLE LOGS AND GRAIN SIZE DISTRIBUTION GRAPHS FROM REPORT REFERENCE NO. 0210-S44

REFERENCE NO. 1512-S086

LIST OF ABBREVIATIONS & 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:

1. SAMPLE TYPES

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

2. PENETRATION RESISTANCE/'N'

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2" diameter 90° point cone driven by a 140-pound hammer falling 30 inches.
Plotted as _________

Standard Penetration Resistance or 'N' value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil. Plotted as 'O'.

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

3. SOIL DESCRIPTION

a) Cohesionless Soils:

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

b) Cohesive Soils:

Undrained Shear Strength (ksf)	Consistency
Less than 0.25	very soft
0.25 to 0.50	soft
0.50 to 1.0	firm
1.0 to 2.0	stiff
2.0 to 4.0	very stiff
over 4.0	hard

c) 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

□ - Compression test in laboratory.

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength.

METRIC CONVERSION FACTORS

1 ft. = 0.3048 metres	1 inch = 25.4 mm
1 lb. = 0.453 kg	1 ksf = 47.88 kN/m^2

JOB NO.: 0210-S44

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

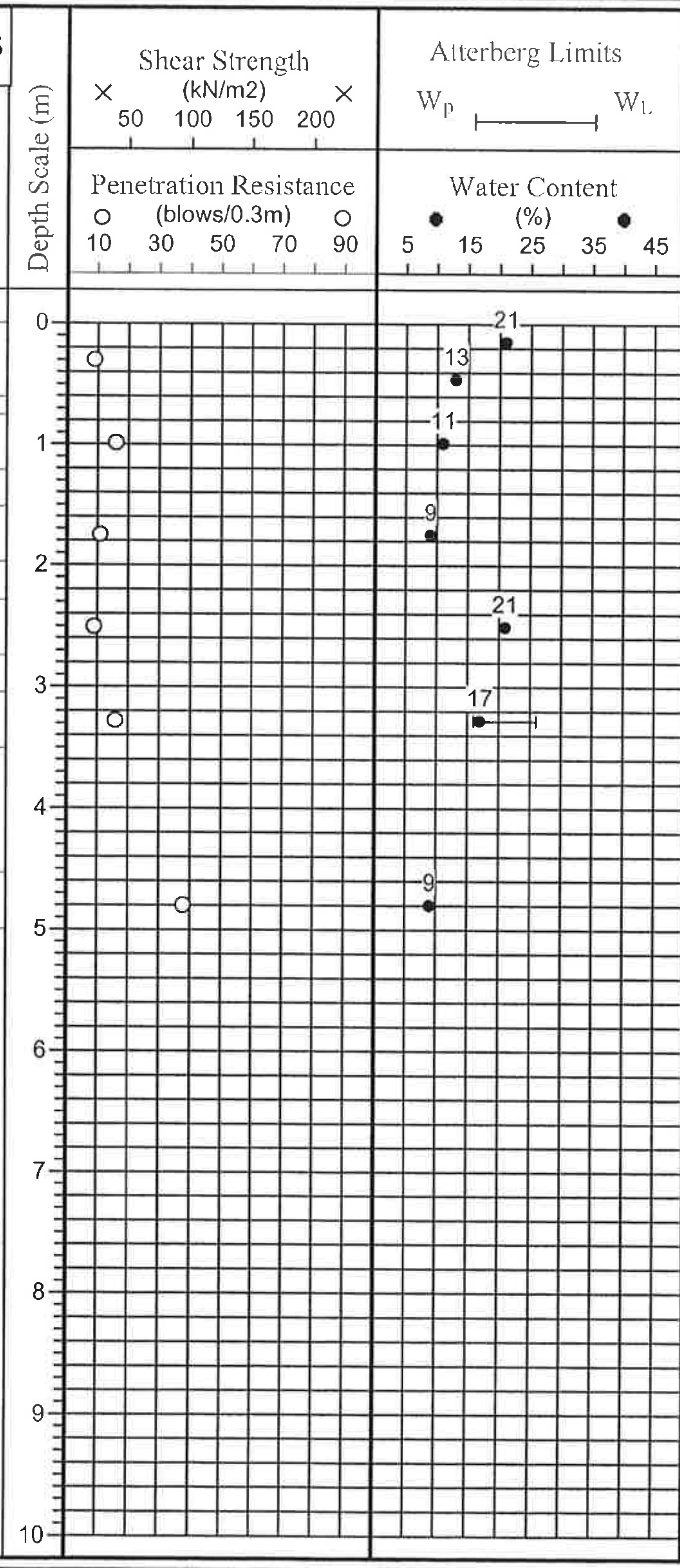
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: 6611 Second Line West, City of Mississauga

METHOD OF BORING: Flight-Auger

DATE: November 6, 2002

Elev. / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Water Content (%)	WATER LEVEL
169.7	Ground Surface					Dry on completion
0.0	**13cm TOPSOIL, Fill**					
	Brown	1	DO	9	21, 13	
	SILTY CLAY, Fill	2	DO	16	11	
	occ. topsoil inclusions	3	DO	11	9	
		4	DO	9	21	
166.8 / 2.9	Very stiff to hard	5	DO	16	17	
	SILTY CLAY, Till brown ---- grey					
	sandy, a tr. of gravel occ. cobbles, boulders and wet sand and silt seams and layers	6	DO	38	9	
164.7 / 5.0	**END OF BOREHOLE**					



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JOB NO.: 0210-S44

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

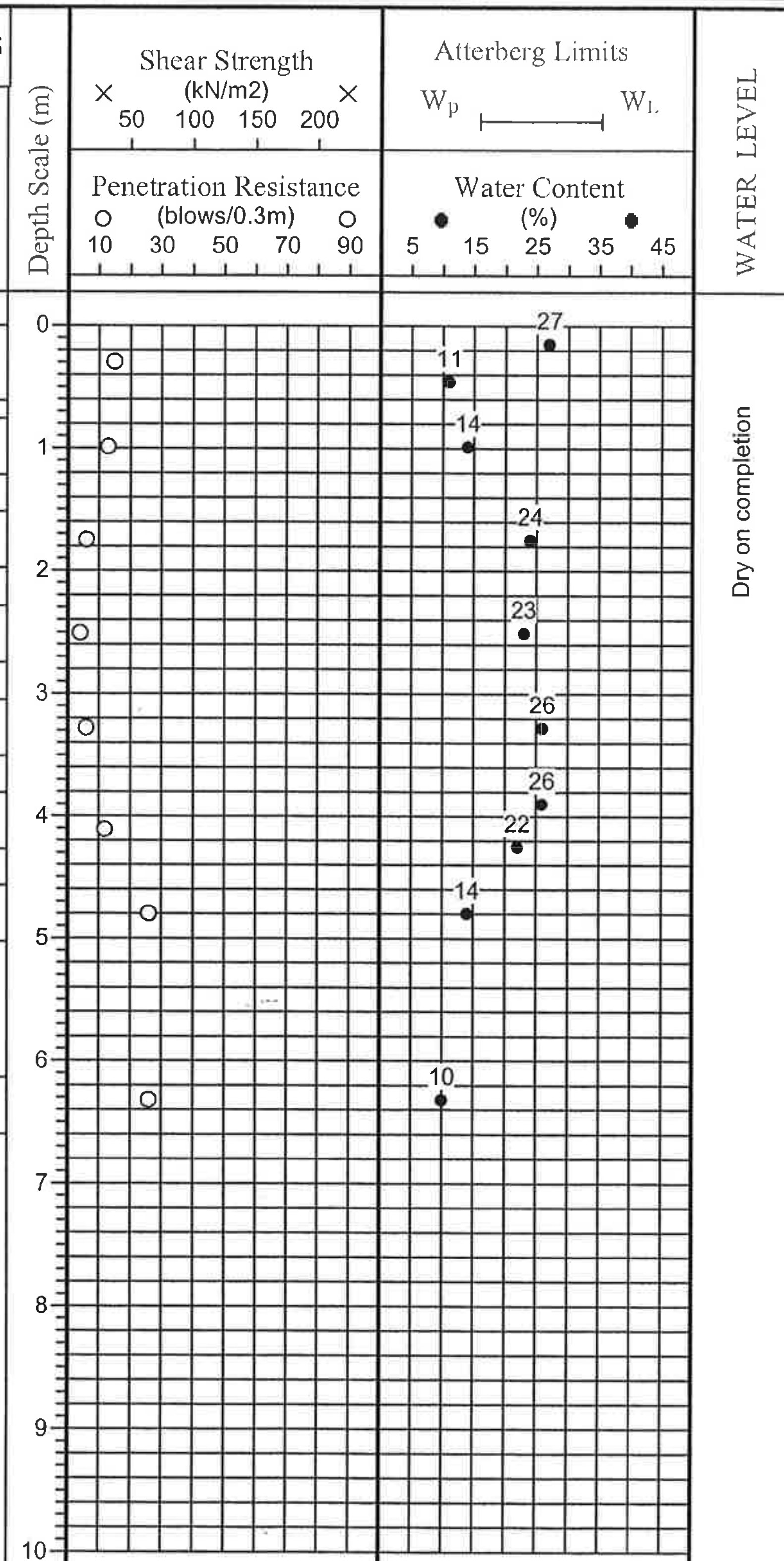
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: 6611 Second Line West, City of Mississauga

METHOD OF BORING: Flight-Auger

DATE: November 6, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
171.8	Ground Surface			
0.0	**10cm TOPSOIL, Fill** Brown/grey	1	DO	15
		2	DO	13
	SILTY CLAY, Fill	3	DO	6
	occ. topsoil and wood inclusions	4	DO	4
		5	DO	6
167.8 / 4.0	Stiff to very stiff	6	DO	12
	SILTY CLAY, Till	7	DO	26
	sandy, a tr. of gravel, occ. cobbles, boulders and wet sand and silt seams and layers; brown / grey	8	DO	26
165.2 / 6.6	**END OF BOREHOLE**			



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JOB NO.: 0210-S44

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

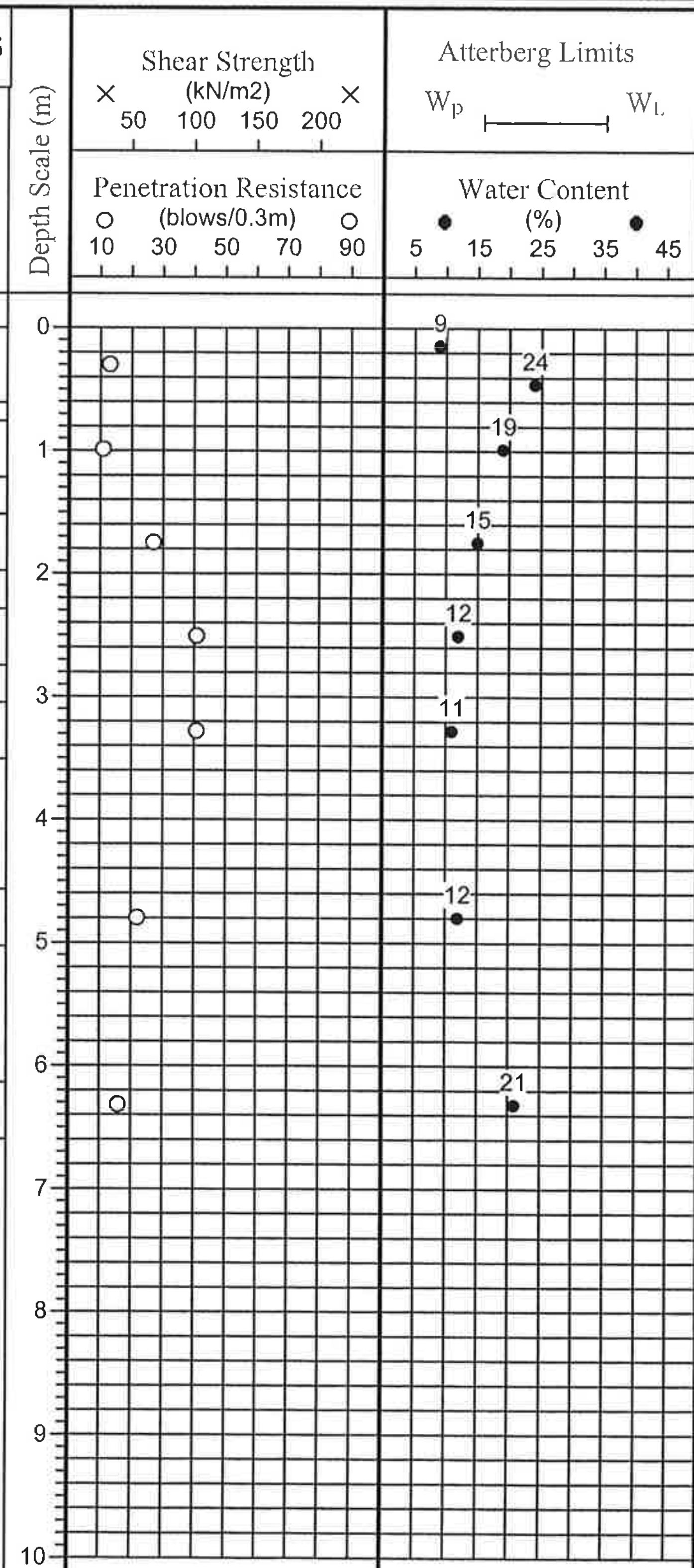
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: 6611 Second Line West, City of Mississauga

METHOD OF BORING: Flight-Auger

DATE: November 6, 2002

Elev. / Depth (m)	SOIL DESCRIPTION	Number	Type	N-Value	Water Content (%)	WATER LEVEL
176.3	Ground Surface					Dry on completion
0.0	**GRANULAR, Fill**	1	DO	13	9; 24	
175.8 / 0.5	**20cm TOPSOIL**					
	SILTY CLAY, Till Stiff to hard weathered sandy, a tr. of gravel occ. cobbles, boulders and wet sand and silt seams and layers	2	DO	11	19	
		3	DO	27	15	
		4	DO	41	12	
		5	DO	41	11	
	brown grey	6	DO	22	12	
		7	DO	16	21	
169.7 / 6.6	**END OF BOREHOLE**					



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JOB NO.: 0210-S44

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

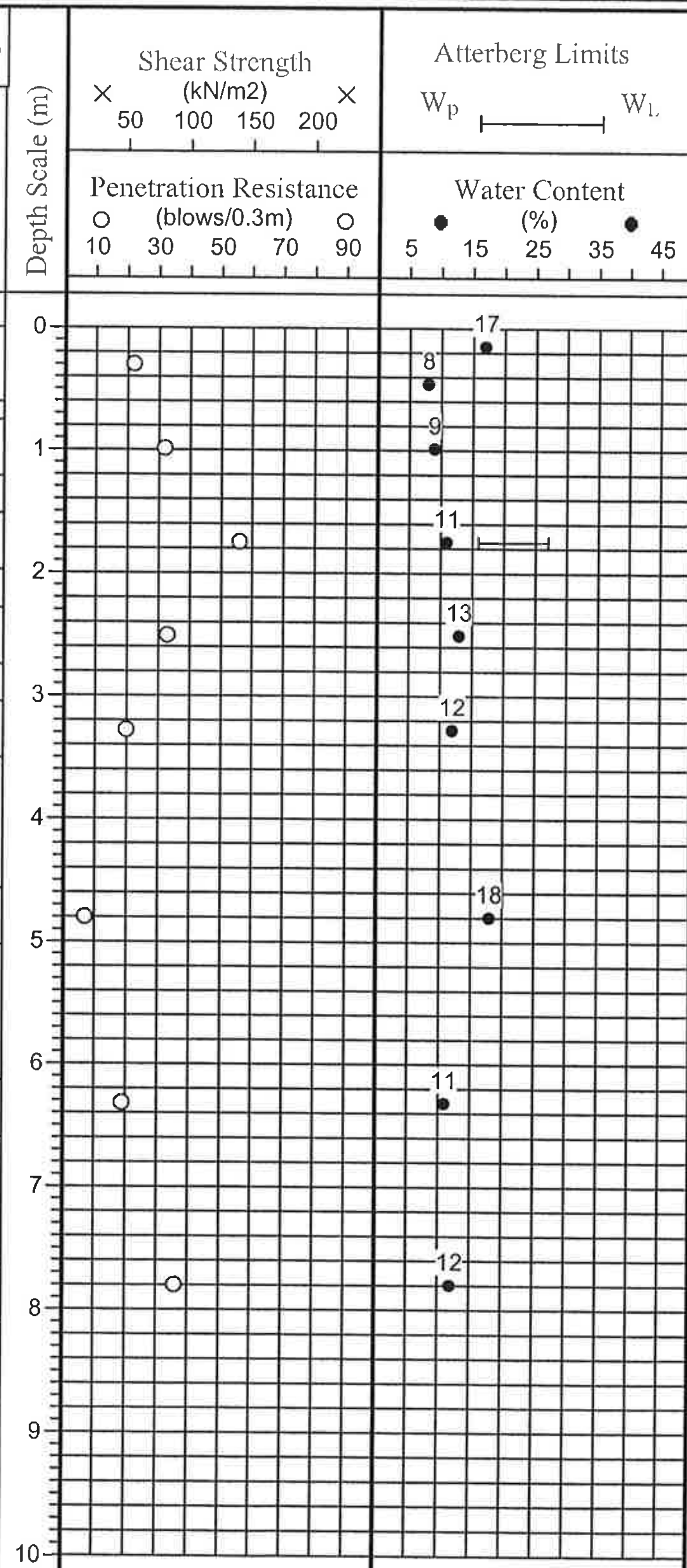
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: 6611 Second Line West, City of Mississauga

METHOD OF BORING: Flight-Auger

DATE: November 6, 2002

Elev. / Depth (m)	Soil Description	Samples: Number	Type	N-Value
173.4 / 0.0	Ground Surface			
	15cm TOPSOIL, Fill; Brown SILTY CLAY, Fill	1	DO	22
172.8 / 0.6	Firm to hard; weathered	2	DO	32
		3	DO	56
		4	DO	33
	SILTY CLAY, Till; brown / grey	5	DO	20
		6	DO	7
	sandy, a tr. of gravel occ. cobbles, boulders and wet sand and silt seams and layers	7	DO	19
165.3 / 8.1		8	DO	36
	END OF BOREHOLE			



WATER LEVEL: Dry on completion

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JOB NO.: 0210-S44

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: 6611 Second Line West, City of Mississauga

METHOD OF BORING: Flight-Auger

DATE: November 6, 2002

Elev. / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Water Content (%)	WATER LEVEL
175.9	Ground Surface					
0.0	Brown **SILTY CLAY, Fill**	1	DO	9	18	Dry on completion
175.3 / 0.6	Very stiff to hard **SILTY CLAY, Till** (weathered)	2	DO	26	12	
		3	DO	31	13	
		4	DO	38	11	
		5	DO	40	11	
	brown / grey; sandy, a tr. of gravel, occ. cobbles, boulders and wet sand and silt seams and layers	6	DO	25	10	
170.9 / 5.0	**END OF BOREHOLE**					

Shear Strength (kN/m2): 50 100 150 200

Penetration Resistance (blows/0.3m): 10 30 50 70 90

Atterberg Limits: W_P — W_L

Water Content (%): 5 15 25 35 45

Depth Scale (m): 0–10

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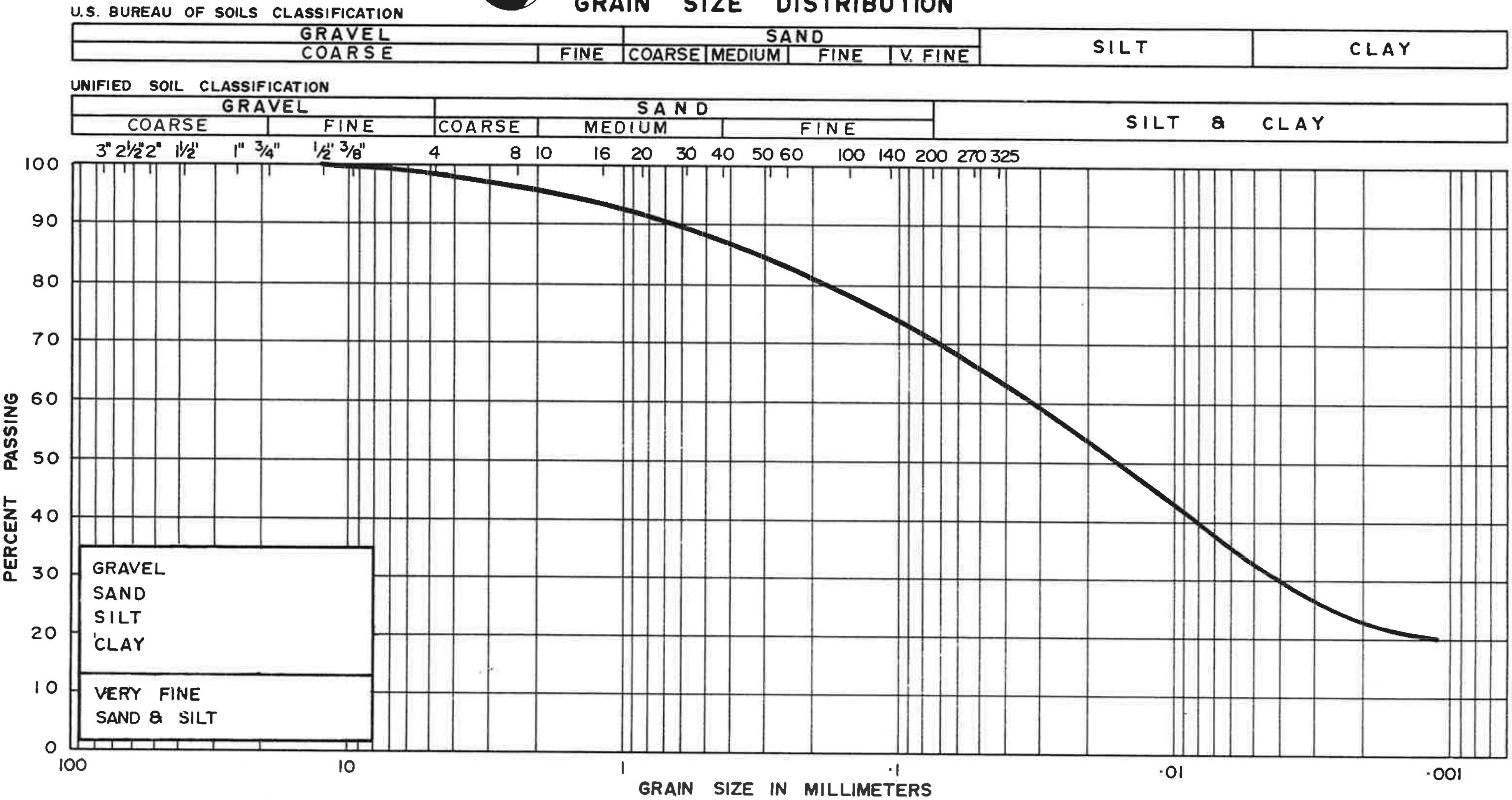
REFERENCE Nº 0210-S44

GRAIN SIZE DISTRIBUTION



PROJECT: Proposed Residential Development

LOCATION: 6611 Second Line West, City of Mississauga

BOREHOLE Nº: 2

SAMPLE Nº: 4

DEPTH: (m) 2.6

ELEVATION: (m) 169.2

Classification of Sample and Group Symbol:

SILTY CLAY, Fill

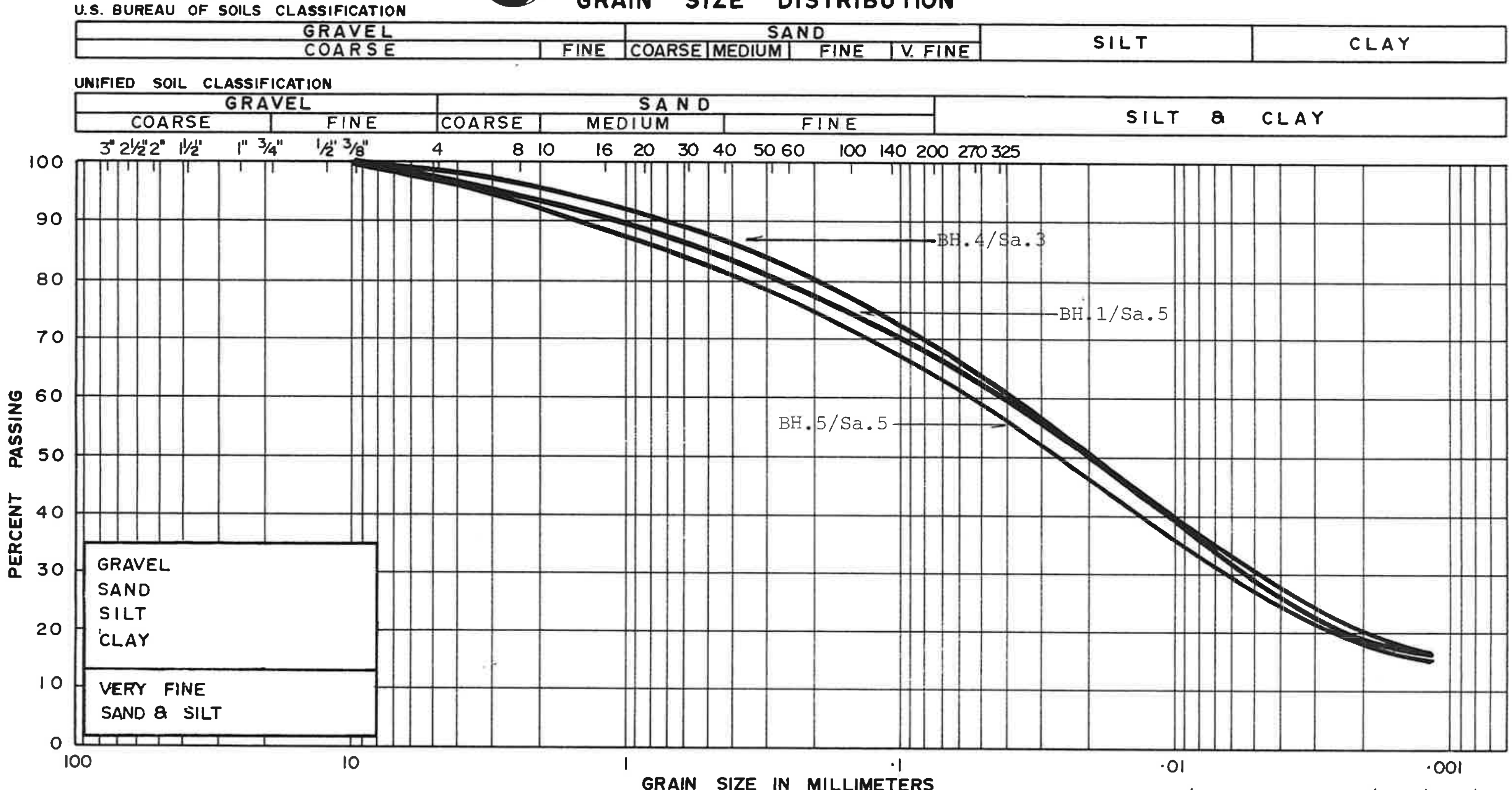
LIQUID LIMIT	%	=
PLASTIC LIMIT	%	=
PLASTICITY INDEX	%	=
MOISTURE CONTENT	%	=
PERMEABILITY	(cm./sec.)	$=10^{-7}$ (Estimated)

FIGURE: 6

Soil-Eng Limited

REFERENCE № 0210-S44

GRAIN SIZE DISTRIBUTION



PROJECT: Proposed Residential Development

LOCATION: 6611 Second Line West, City of Mississauga

BOREHOLE №:	1	4	5
SAMPLE №:	5	3	5
DEPTH: (m)	3.3	1.8	3.3
ELEVATION: (m)	166.4	171.6	172.6

Classification of Sample and Group Symbol:

SILTY CLAY, Till
sandy, a tr. of gravel

BH./Sa.		1/5	4/3	5/5
LIQUID LIMIT	% =	26	27	24
PLASTIC LIMIT	% =	16	16	14
PLASTICITY INDEX	% =	10	11	10
MOISTURE CONTENT	% =	17	11	11
PERMEABILITY (cm./sec.) (Estimated)	=	10^{-7}		

FIGURE: 7