428 LITTLE INC.

428 LITTLE AVENUE, BARRIE, ONTARIO

GEOTECHNICAL INVESTIGATION

DECEMBER 10, 2019

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428 LITTLE INC.

PROJECT NO.: 181-02959-00
DATE: DECEMBER 10, 2019

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December 10, 2019

428 Little Inc.
10 Wanless Avenue, Suite 201
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Attention: Mr. Aaron Gold

Dear Mr. Gold,

Subject: Geotechnical Investigation - 428 Little Avenue, Barrie, Ontario

WSP Canada Inc. was retained to complete a geotechnical investigation at the above noted site. The purpose of the geotechnical investigation is to identify the subsurface conditions at select test hole locations and to provide design recommendations toward the design of the proposed development, as well as identify any potential constraints which may be encountered during construction.

Kind regards,

Nick La Posta, P. Eng.
Team Lead - Environment

Kent Malcolm, P. Eng.
Senior Geotechnical Engineer

NLP/ham

WSP ref.: 181-02959-00

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by Plazacomm Investments Limited (PIL) to undertake a geotechnical investigation at 428 Little Avenue, in the City of Barrie, Ontario. The location of the site is shown on the attached ***Site Location Plan - Figure 1.***

The scope of this geotechnical investigation was to obtain information about the subsurface conditions through the advancement of seven (7) boreholes and based upon the findings of the boreholes ultimately provide recommendations herein pertaining to the following:

- Site preparation and grading;
- Appropriate foundation type, geotechnical resistances (ULS and SLS) and founding depth;
- Floor slab design and construction;
- General excavation, backfill and bedding requirements, and groundwater control;
- Preliminary infiltration rates;
- Slope stability assessment; and,
- A preliminary pavement design.

This report deals with geotechnical issues only.

This report is provided based on the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The site investigation and recommendations follow generally accepted practice for Geotechnical Consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for PIL. Third party use of this report without WSP consent is prohibited.

2 SITE BACKGROUND AND PROJECT DESCRIPTION

Based on the concept plan provided to our office by PIL (dated May 2017), the proposed development is comprised of:

- Six (6) blocks of townhomes, each three (3) storeys in height;
- A Storm Water Management (SWM) Pond; and,
- Associated driveway/parking areas to the north of the proposed structures.

The site is forested and is rectangular in shape. A slope exists at the northern boundary at the site; based on the topographic elevations indicated on the plan, the existing slope appears to have a maximum height of about 6 m and has an approximate slope angle of 1.1 Horizontal to 1 Vertical (1.1H:1V). A railway line is located at the base of the slope and runs parallel to the slope.

3 INVESTIGATION METHODOLOGY

The field investigation consisted of drilling seven (7) boreholes (BH18-01 to BH18-07) at the site on March 26 and 27, 2018. Boreholes BH18-02 and BH18-03 were advanced at the top of the slope to provide input toward the stability of the slope; Borehole BH18-07 was advanced in the footprint of the proposed Storm Water Management (SWM) Pond. The boreholes were advanced to depths ranging between 5.0 meters below existing ground surface (mbgs) and 8.1 mbgs. The boreholes were drilled with hollow stem continuous flight auger equipment.

Drilling equipment was supplied and operated by a drilling sub-contractor under the direction and supervision of WSP personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler a 0.3 m depth into the undisturbed soil (SPT ‘N’ values) gives an indication of the compactness condition or consistency of the sampled soil material. The SPT ‘N’ values are indicated on the ***Borehole Logs - Enclosures 1-7***.

Soil samples were visually classified in the field and re-evaluated by a senior engineer in our laboratory. All soil samples were tested for moisture contents. Laboratory Grain Size Analyses were carried out on representative samples and the results are provided in ***Enclosures 8-10***.

Water level observations were made during the drilling and in the open boreholes upon the completion of drilling operations. Three (3) standpipes were installed at the site; WSP returned to the site on April 5, 2018 to obtain groundwater levels at the site.

4 SITE AND SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered are presented on the Borehole Logs and summarized in the following sections. It is noted that subsurface conditions can change between boreholes and the details provided below refer to soil conditions that were encountered at the borehole locations only.

4.1 GENERAL SUBSURFACE CONDITIONS

Based on the results of the field investigation, the subsurface conditions at the borehole locations generally comprised topsoil overlying fill / reworked materials. These materials are generally underlain by non-cohesive till; granular layers were observed interlayered with the till.

4.1.1 TOPSOIL

Topsoil was encountered in each of the boreholes. The topsoil ranged between 30 cm to 50 cm in thickness at the borehole locations. It should be noted that topsoil quantities should not be calculated from the borehole information, as large variations in depth may exist between boreholes. A detailed topsoil layer thickness survey is required to determine an accurate evaluation of quantity.

4.1.2 FILL / REWORKED MATERALS

Fill and/or reworked materials were encountered in each of the boreholes underlying the topsoil. A summary of the fill encountered at the site is provided below.

BOREHOLE	DEPTH OF TOP OF FILL (MBGS)	DEPTH OF BOTTOM OF FILL (MBGS)	FILL THICKNESS (m)	TYPE OF SOIL
18-01	0.3	1.4	1.1	Sand and Silt to Clayey Silt
18-02	0.4	0.7	0.3	Sand and Silt
18-03	0.4	0.7	0.3	Sand and Silt
18-04	0.4	1.4	1.0	Clayey Silt / Sandy Silt
18-05	0.4	0.7	0.3	Sandy Silt
18-06	0.3	0.7	0.4	Sandy Silt
18-07	0.5	1.4	0.9	Sand and Silt

As noted above the fill / reworked material ranged from sand and silt fill to clayey silt fill. The fill / reworked material was brown, and observed to be moist to wet. Several samples of the fill / reworked material contained organic materials.

The natural moisture content of these fill / reworked material samples ranged between 8% and 23%.

4.1.3 GLACIAL TILL

A non-cohesive till deposit was encountered in each of the boreholes underlying the fill / reworked material. The till ranged from silty sand to silt till. The till was brown and contains trace to some gravel and trace to some clay; however increased clay and gravel contents were noted in two (2) of the till samples. At the time of the investigation, the till was observed to be moist to wet.

Based upon resistance to augering boulders and cobbles are inferred to be present within the till deposit.

The measured SPT ‘N’ values in the non-cohesive till deposit ranged from 7 blows per 0.3 m of penetration to greater than 50 blows per 0.3 m of penetration, indicating that the non-cohesive till varied from loose to very dense, but generally compact. The SPT ‘N’ values generally increase with depth.

The natural moisture content of till soils ranged between 6% and 22%.

Grain size analyses of two (2) samples of the till deposit were completed and the gradation curves are presented in ***Enclosure 8 and 9***. A review of the grain size analyses indicates the following ranges of clay, silt, sand and gravel percentages:

- Gravel: 1% to 5%
- Sand: 30% to 57%
- Silt: 25% to 42%
- Clay: 13% to 27%

4.1.4 NATIVE SAND DEPOSITS

Native sand deposits were encountered interlayered with the till deposit in two (2) of the boreholes. The sand was brown, moist, and contained trace to some silt and trace gravel.

The measured SPT ‘N’ values in the sand deposits were all greater than 50 blows per 0.3 m, indicating that the native sand deposits were very dense.

The natural moisture content of the native sand deposits ranged between 2% and 3%.

A grain size analysis of one (1) sample of the native sand deposits was completed and the gradation curve is presented in ***Enclosure 10***. A review of the grain size analysis indicates the following ranges of fines (clay and silt), sand and gravel percentages:

- Gravel: 0%
- Sand: 92%
- Fines (Silt and Clay): 8%

4.2 GROUNDWATER

Groundwater was not encountered in any of the boreholes on completion of drilling. WSP visited the site throughout 2018; specifically, twice in April, twice in May, June, August, September, and October 2018. Each of the monitoring wells was dry during these visits.

5 DISCUSSIONS/RECOMMENDATIONS

5.1 GENERAL

The following recommendations for the proposed site development are based on the information obtained from the borehole investigation and laboratory testing, which we believe fairly represents the subsurface conditions of the site. These recommendations are intended for the guidance of the design engineer to establish constructability and should not be construed as instructions to contractors. If significant differences in the subsurface conditions described above are found, we request to be contacted immediately to review and revise our findings and recommendations, if necessary.

The construction methods described in this report must not be considered as being specifications or recommendations to the prospective contractors, or as being the only suitable methods. Prospective contractors should evaluate all the information, obtain additional subsurface information as they might deem necessary and should select their construction methods, sequencing and equipment based on their own experience in similar ground conditions. The readers of this report are also reminded that the conditions are known only at the borehole locations and in view of the generally wide spacing of the boreholes, conditions may vary significantly between boreholes.

It is noted that, as no detailed design information was available at the time of this investigation, the information and recommendations provided below should be considered preliminary in nature only.

5.2 SITE BACKGROUND

Based on the concept plan provided to our office the proposed development is comprised of:

- Six (6) blocks of townhomes, each three (3) storeys in height;
- A Storm Water Management (SWM) Pond in the southern portion of the site; and,
- Associated driveway/parking areas to the north of the proposed structures.

A slope exists at the northern boundary at the site; the slope inclination is as steep as 1H:1V based on the topographic information provided to our office. A railway line is located at the base of the slope and runs parallel to the slope.

The results of the geotechnical investigation indicate that the subsurface conditions at the site comprise topsoil overlying shallow fill / reworked soils; these are underlain by a non-cohesive, loose to very dense but generally compact glacial till. Very dense sand deposits were encountered interlayered within the till deposit. Groundwater was not encountered during the drilling operations; after the drilling operations, groundwater was not observed in any of the monitoring wells installed at the site.

5.3 SITE PREPARATION AND GRADING

Removal of all topsoil / fill / reworked soils will be required to facilitate the proposed development on the site. It is recommended that a topsoil test pit program be completed at the site by WSP prior to construction to refine the topsoil thicknesses. Regarding the reuse of the site topsoil, the topsoil may be reused in landscaping applications or other non-structural fill applications. WSP should be contacted to review all proposed topsoil reuse on site.

Subsequent to the completion of the required stripping and removal of unsuitable materials, the sub-grade should be proof-rolled and inspected by experienced WSP geotechnical engineering personnel. The proof-rolling and compaction of the exposed sub-grade is recommended to be conducted using a vibratory compactor with a minimum static weight of ten (10) tonnes. The proof-rolling program should consist of a minimum of six (6) passes per unit area and be tested to assure that the sub-grade is compacted to a minimum of 100% of the exposed material's Standard Proctor Maximum Dry Density (SPMDD). Any loose/soft or wet areas identified at the time of proof-rolling that cannot be uniformly compacted are recommended to be sub-excavated and backfilled with approved engineered fill consistent with the recommendations provided in ***Engineered Fill - Appendix A.***

Where engineered fill is required to develop the design grades and elevations or for use in backfilling excavations created through the removal of unsuitable materials or soils as described above, the excavated on-site materials may be re-used, subject that these are free of organic and other unsuitable materials and have appropriate moisture content. Boulders or cobbles greater than 200 mm in size should be removed from the fill.

Alternatively, Ontario Provincial Standard Specification (OPSS) Granular B – Type I, OPSS Select Subgrade Material (SSM) or approved equal may be used.

All fill materials imported to the site must meet all applicable municipal, provincial and federal guidelines and requirements associated with environmental characterization of the materials.

Engineered fill is to be placed in maximum 200 mm thick loose lifts under full time supervision of qualified geotechnical personnel. Each lift is to be uniformly compacted to achieve a minimum of 100% of the material's SPMDD. Additional information related to the placement and compaction of engineered fill can be found in ***Engineered Fill - Appendix A***.

5.4 PRELIMINARY FOUNDATION RECOMMENDATIONS

Details of the proposed residential development such as underside of footing elevations were not available at the time when this report was prepared. When this information is available, the recommendations provided below should be reviewed by WSP to confirm that the recommendations are still valid based on the design information.

Based on the soil conditions encountered in the boreholes and provided that the site is prepared in accordance with the recommendations presented in this report, footings that are founded at a minimum depth of 1.5 mbgs on the compact to very dense till or very dense sand soils may be designed based on a preliminary factored ultimate geotechnical resistance at Ultimate Limit States (ULS) of 150 kPa. A preliminary serviceability geotechnical resistance at Serviceability Limit States (SLS) of 100 kPa may be used in the design of the foundations.

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

5.4.1 GENERAL FOUNDATION COMMENTS

All footings exposed to seasonal freezing conditions should be provided with at least 1.5 m of earth cover or equivalent thermal insulation against frost. It is recommended to keep footings as high as possible to avoid or minimize penetration below groundwater levels while considering the minimum frost cover requirement.

Variations in the soil conditions are expected in between the borehole locations, and during construction, the geotechnical resistances should be confirmed by experienced WSP site personnel.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper foundations.

The silty/sandy soils at the base of footings can be easily disturbed by construction machinery and foot traffic or lose their strength in contact with surface water. We recommend that an allowance be made for placing a 50 mm thick skim coat of low-strength concrete on the founding subgrade immediately after its approval, to prevent its disturbance by construction activities and from ground or surface water, where necessary.

During winter construction, foundations and slab on grades must not be poured on frozen soil. Foundations must be adequately protected at all times from cold weather and freezing conditions.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged.

It should be noted that the recommended geotechnical resistances have been calculated by WSP from the borehole information for the preliminary design stage only. Additional input may be required as new design information becomes available and is refined. For example, more specific information is available with respect to conditions between boreholes when construction is underway. In this regard, the interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by WSP to validate the information for use during the construction stage.

5.5 FLOOR SLAB CONSTRUCTION AND DRAINAGE

The basement floor slabs can be placed on undisturbed native soils or on engineered fill. For bedding and moisture barrier purposes, a 200-mm thick layer of 19 mm clear crushed stone must be provided under the concrete basement floor slab. Where localized wet and/or fine-grained soil conditions exist, the moisture barrier should be separated from the subgrade by a geotextile fabric to avoid loss of soil/fines and settlement problems.

5.6 LATERAL EARTH PRESSURES

The lateral earth pressure for the design of retaining walls, foundation walls, shoring, or trench boxes can be estimated from the following expressions:

Above groundwater table: $p = K (\gamma z + q)$

Below groundwater table: $p = K \{\gamma h_1 + \gamma_1(z - h_1) + q\} + p_w$

Where:

p = Lateral earth and water pressure in kPa acting at depth z;

z = Depth below ground surface, in meters;

K = Active earth pressure coefficient, (K_a);

γ = Unit weight of soil above groundwater table, in kN/m^3;

γ_1 = Submerged unit weight of soil below water table;

h = Thickness of soil above groundwater table, in meters;

q = Value of Surcharge (kPa);

p_w = Hydrostatic water pressure

The suggested soil parameters (unfactored) for the retaining wall design and/or ground support systems are summarized below.

SOIL TYPE	UNIT WEIGHT γ(KN/M^3)	EFFECTIVE ANGLE OF INTERNAL FRICTION (Φ')	COEFFICIENT OF EARTH PRESSURE		
			ACTIVE K_A	AT REST K_O	PASSIVE K_P
Granular A	22	35	0.27	0.43	3.69
Granular B	21	32	0.31	0.47	3.25
Engineered Fill / Compact Till	20	32	0.31	0.47	3.25
Very Dense Sand Deposits	19	35	0.27	0.43	3.69

Backfilling of the footing wall excavations is recommended to be placed in 200 mm thick lifts, uniformly compacted to 100% SPMDD to proposed sub-grade elevations.

5.7 TEMPORARY EXCAVATIONS AND GROUNDWATER CONTROL

The details for the proposed services installations are not available at the time of preparing this report. The recommendations provided below assume that conventional depths for services will be carried out (approximately 3 mbgs to 5 mbgs).

Based upon the subsurface conditions at the borehole locations, excavations can be carried out with heavy hydraulic back-hoes. It is recommended that provision be carried in the contract for the excavation and disposal of obstructions on site, including cobbles and boulders.

All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). In accordance with OHSA, the non-cohesive deposits would be classified as a Type 3 soil. If space limitations exist due to adjacent structures or facilities, consideration could be given to the construction of a temporary support system to provide protection to the structures and/or facilities. All excavated spoil should be placed at least the depth of the trench away from the edge of the trench for safety reasons.

As noted above, each of the boreholes drilled at the site were dry on completion; groundwater was not observed in the monitoring wells installed at the site. In this regard, significant groundwater is not anticipated to be encountered and any localized dewatering can be completed with conventional sump pumps.

5.8 PIPE BEDDING AND COVER

The soils above the groundwater level, or properly dewatered if localized groundwater is encountered, will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, must be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of wet, dilatant silt. The bedding material should consist of well graded granular material such as Granular ‘A’ or equivalent. After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local authority or municipality, should be placed.

In the unlikely event that localized wet trench conditions are encountered, a uniformly graded clear stone may be used provided a suitable, approved filter fabric (geotextile) is placed in conjunction with the clear stone. The geotextile must extend underneath the clear stone, along the sides of the trench, and wrapped on top of the clear stone such that **the clear stone is fully wrapped by the geotextile.** A minimum geotextile overlap of 1 m is required; alternatively stitching of the geotextile could be considered.

5.9 TRENCH BACKFILL

The excavated native soils can be used as construction backfill provided their moisture content at the time of placement is within 2% of the optimum moisture content. Boulders or cobbles greater than 200 mm in size should be removed from the trench backfill. Portions of the fill / reworked soils contained organic materials; any soils with organics should not be used as trench backfill.

For the non-cohesive soils, smooth drum type vibratory rollers are recommended. Cohesive soils, if encountered or imported to the site for engineered fill, should be compacted with sheepsfoot type vibratory compactors. The trench backfill should be placed in maximum 0.3 m lift thickness and compacted to at least 98 percent of its SPMDD. Trench backfilling operations should be avoided during freezing weather.

It is preferable that the native soils be re-used from approximately the position at which they are excavated so that frost response characteristics of the soils after construction remain essentially similar. If required, consideration may also be given to backfilling trenches with a well graded, compacted granular soil such as Granular ‘B’ material.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for the compaction requirements noted above. Stockpiles should therefore be covered with tarpaulins to help minimize moisture increases.

5.10 PRELIMINARY PAVEMENT DESIGN

The investigation has shown that the predominant subgrade soils encountered at the site, after stripping any topsoil / fill / reworked soils, will be non-cohesive till, and possibly engineered fill.

Prior to the placement of granular materials as part of the pavement structure, the subgrade should be prepared and heavily proof-rolled under the supervision of WSP. Any poorly performing areas should be sub-excavated and replaced with either granular earth fill approved by WSP or imported Granular B, Type I material conforming to the requirements of OPSS.

Based on the above and assuming that traffic usage will be residential minor local or local, the following minimum pavement thickness is recommended:

PAVEMENT LAYER	COMPACTION REQUIREMENTS	URBAN LOCAL ROAD
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density (MRD)	40 mm HL 3
		70 mm HL 4 / HL 8
OPSS Granular A Base	100% SPMDD	150 mm
OPSS Granular B	100% SPMDD	350 mm

We note that the pavement design noted above should be considered preliminary only. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

5.11 INFILTRATION CHARACTERISTICS

Graphical depictions of the laboratory grain size analyses performed on samples recovered from the boreholes are enclosed. Based on the gradation results, the materials encountered are tabulated below.

MATERIAL	BOREHOLE SAMPLE	PERCOLATION TIME PERMEABILTY (MIN/CM)
Silty Sand to Sandy Silt Till	BH18-02, Sample 4	20 to 30
Sand	BH18-03, Sample 7	8 to 15
Sandy Silt Till	BH18-06, Sample 4	30 to 50

We note that the Percolation Time (“T” time) or Permeability of the subsoil sampled was estimated. The materials, as defined in the Ministry of the Environment Manual of Policy, Procedures and Guidelines for Onsite Sewage Systems, in the appendices 6.3.1 and 6.3.2, mostly resembles the soil with medium to low permeability (T-time

8-20 min / cm range for the sand soils and T-time 20-50 min / cm for the till soils). We must state that this value is strictly for an unsaturated sample.

The value is solely based on the grain size distribution analysis shown in appendices 6.3.1 and 6.3.2 in the Ministry of the Environment Manual of Policy, Procedures and Guidelines for Onsite Sewage Systems. Furthermore, the estimates provided is indicative of the sample in a disturbed state only. We must emphasize that factors between boreholes such as, but not limited to, structure, consistency, density, organic content and degree of saturation influence the estimates.

An accurate analysis of soil infiltration characteristic is best determined with on-site permeameter testing at the location and level of the proposed infiltration condition.

5.12 STORM WATER MANAGEMENT (SWM) POND

In discussion with the design team, a SWM Pond is proposed as part of this design at the southern portion of the site. At the time of this report, design details were not available for the SWM Pond (i.e. design grades, normal water level, side slopes, etc.). In this regard the recommendations below should be considered preliminary in nature.

Borehole BH18-07 was advanced within the footprint of the proposed SWM Pond location. The subsurface conditions at this borehole location comprise surficial topsoil overlying sand and silt fill to a depth of 1.4 mbgs; the fill was underlain by loose to very dense non-cohesive till to the termination depth of about 5.0 mbgs. Groundwater was not observed in the borehole on completion of drilling; groundwater was also not observed in the monitoring well installed in this borehole on April 5, 2018, and April 23, 2018. It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

For preliminary design purposes, the SWM Pond side slopes be no steeper than 3 Horizontal to 1 Vertical (3H:1V).

Given that the side slopes of the pond will likely comprise granular till soils, an impermeable liner should be installed along the bottom and sides of the SWM Pond. The liner may consist of a natural imported soil material (such as silty clay) or a synthetic membrane liner (such as a High-Density Polyethylene, Geo-synthetic Clay Liner, or PVC).

Regarding the clay liner, the clay soils must cover the bottom and sides of the pond. It is recommended that the minimum liner thickness for clay soils be 0.6 m, and that the liner be inspected on an annual basis. The clay liner should not be left to dry out, as shrinkage will occur and the liner may crack, thus inducing excessive seepage. The liner must be covered with a minimum of 300 mm of sand and gravel or other suitable material.

The liner must be constructed of low permeability materials (clayey silt or clay) in order to perform adequately and to provide a liner bulk permeability on the order of 1x10-7 cm/s. The liner material must consist of inorganic soil. The grain size distribution of the liner material must conform to the following:

- no particle greater than 100 mm dimension
- not greater than 15 percent of the material larger than 4.8 mm (No. 4 sieve)
- minimum 20 percent finer than 0.002 mm (clay size)
- plasticity index of minimum 6.0

A strict control and monitoring of the liner material must be maintained to collect samples to verify its composition based on laboratory test results and to identify any variation in the material. The liner material must be placed at water contents 2 to 4 percent wet of the optimum moisture content. This is required to ensure that the material is compacted to a homogenous mass, and does not remain as distinct "clods" or "clumps". The liner should be constructed in thin lifts (not exceeding 150 mm thick) and be heavily compacted to a minimum of 98 percent SPMDD. Liner materials should not contain any frozen soil and in this regard, liner construction in the winter is not recommended.

The liner construction must be conducted under the full-time supervision of qualified WSP geotechnical personnel.

Alternatively, a synthetic liner (such as HDPE, Geosynthetic Clay Liner or PVC) may be used. Manufacturer’s specifications and recommendations must be referred to for the design and construction of a synthetic liner.

Once design details for the SWM Pond are available, the design details should be reviewed by WSP. Also, it is recommended that a slope stability analysis be carried out on the proposed side slopes of the SWM Pond once the design details of the SWM Pond are finalized.

5.13 SLOPE STABILITY ASSESSMENT

A requested site-specific slope stability assessment was carried out for the slope within the proposed development area. The slope stability assessment was completed based on information obtained from the boreholes as well as a visual inspection of the slope within the study area. Existing slope conditions with respect to any obvious signs of instability were noted and a slope stability analysis of representative critical slope sections was performed.

5.13.1 SLOPE DESCRIPTION

A visual inspection of the subject site and slope was conducted by WSP during the drilling investigation. General information pertaining to existing slope features such as slope profile, slope drainage, vegetation cover, structures in the vicinity of the slope, as well as erosion and slope slide features was obtained during the inspection.

As noted above, the subject lot does not include any structures. The slope was vegetated with trees and forest floor cover while the valley was heavily naturalized. The old growth trees on the slope generally had straight trunks. The presence of old straight trees would suggest that the integrity of the overall slope has not been compromised over the lifetime of the trees. There was no visible evidence of groundwater seepage from the slope surface. We note that a railway exists near the base of the slope and as such no watercourses are present near the toe of the slope.

5.13.2 SLOPE GEOMETRY

Two (2) slope areas were analyzed as part of this project; the slope near Borehole BH18-02 (Slope A) and the slope near Borehole BH18-03 (Slope B). Details regarding the existing slope geometry are shown below; we note that the referenced datum elevations of the Top and Bottom of the Slope within the subject property have been taken from the OLS Topographic Plan provided to WSP.

The cross sections (Sections A and B) were created from the topographic information provided to assess the inclination of the slope and determine the slope stability analysis parameters. The cross-section location was selected because of the slope height and inclination to represent the overall and critical slope condition present within the study area. The cross-section locations can be found on the ***Borehole Location Drawing – Figure 2***.

Cross Section	**Top of Slope Elevation (m)**	**Toe of Slope Elevation (m)**	**Height (m)**	**Inclination of Slope**		
				Horizontal	**Vertical**	**Slope**
A	246.0	240.0	6.0	9.0	6.0	1.5H:1V
B	246.2	239.6	6.6	8.5	6.7	1.3H:1V

5.13.3 SLOPE STABILITY ASSESSMENT

The results of the geotechnical investigation indicate that the subsurface conditions at the site comprise topsoil overlying shallow fill / reworked soils; these are underlain by a non-cohesive, loose to very dense but generally compact glacial till. Very dense sand deposits were encountered interlayered with the till deposit. Groundwater was not encountered during the drilling operations; subsequent to the drilling operations, groundwater was not observed in any of the piezometers installed at the site.

Slope stability analyses at Slope A and B were carried out using SLIDE Version 7.0. The subsurface conditions from Boreholes BH18-02 and BH18-03 were used to assess the relevant soil parameters in proximity to these slopes. Soil parameters were estimated from our experience, the results of in situ Standard Penetration Tests (SPT), our visual classification / analysis and the results of laboratory testing on select samples of the soils.

As per Table 4.3 in the Ministry of Natural Resources Technical Guide – River and Stream Systems: Erosion Hazard Limit (Technical Guide), a Factor of Safety of 1.3 was deemed appropriate when compared to the proposed development.

A review of the analyses completed at Slope A and Slope B indicate stable slope lines of about 1.5H:1V in the overburden soils ***(Slope Stability Results - Appendix B)*** for a Factor of Safety of 1.3. As the current slope inclination is steeper than the stable slope line inclination, the top of the stable slope line is located behind the crest of the slope.

5.13.4 TOE EROSION

A body of water is not present at the toe of the slope to weaken the slope and cause slumping. As such, an allowance for toe erosion is not required.

5.13.5 EROSION ACCESS ALLOWANCE

As no active erosion was observed at the base of the slopes, the Technical Guideline requires a six (6) meter allowance for Emergency Access from the top of the stable slope line.

5.13.6 CONCLUSIONS

Based on the subsurface conditions encountered in the boreholes and the existing slope inclination, as well as the analysis completed, an allowance for the top of the stable slope line (1.5H:1V) from the toe of the slope and the erosion access allowance (6 m) is required at the site. Additional comments regarding the slope are as follows.

- Site development and construction activities should be conducted in a manner which does not result in surface erosion of the slope. In particular, site grading and drainage should be designed to prevent direct concentrated or channelized surface runoff from flowing directly over the slope. Water drainage from downspouts and the like should not be permitted to flow over the slope, but a minor sheet flow may be acceptable.
- The existing slope vegetation should be maintained and/or promoted. Any slope areas disturbed by construction should be restored with suitable native vegetation.
- The configuration of the slope should not be altered without prior consultation.
- A sediment control fence must be erected and maintained during construction to isolate work area from the adjoining slope.

5.14 DESIGN REVIEW, TESTING AND INSPECTIONS

WSP requests to be afforded the opportunity to complete a final review of the proposed development discussed in this report to verify that geotechnical recommendations are appropriate. If not given this opportunity, we cannot assume liability for omissions, misinterpretations or deficiencies in our recommendations.

WSP should be contacted to provide geotechnical testing and inspections during construction operations. Exposed subgrade soils for all structures are to be inspected to confirm the material is stable and competent. Inspections of seepage and groundwater conditions during construction are also required, as discussed in this report. Testing and inspections for general QA/QC are to include sampling and laboratory testing of fill materials and asphalt, compaction testing for the placement of fill materials and asphalt, and field and laboratory testing of concrete (including mix design reviews).

APPENDIX

A

ENGINEERED FILL

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows, however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and WSP Canada Inc. Without this confirmation no responsibility for the performance of the structure can be accepted by WSP Canada Inc. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a WSP Canada Inc. engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by WSP Canada Inc. during placement of engineered fill is required. Work cannot commence or continue without the presence of the WSP Canada Inc. representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

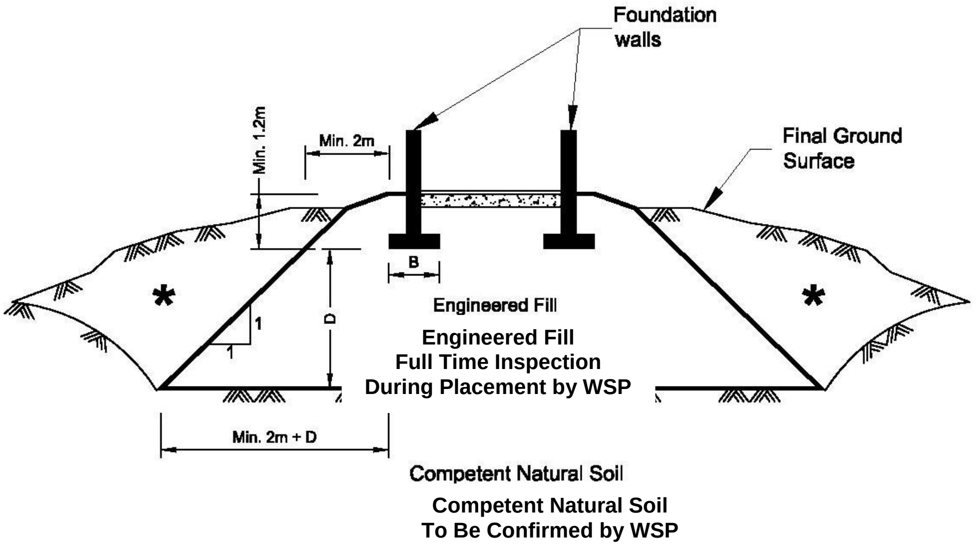
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from WSP Canada Inc. prior to footing concrete placements. All excavations must be backfilled under full time supervision by WSP Canada Inc. to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of WSP Canada Inc.

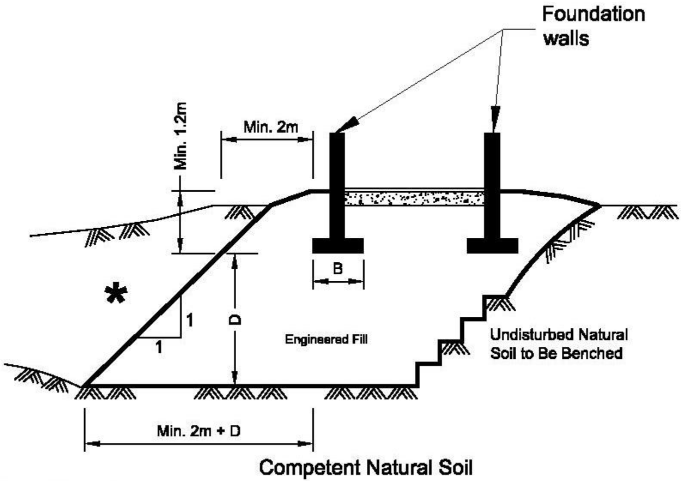
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.

14. These guidelines are to be read in conjunction with WSP Canada Inc. report attached.



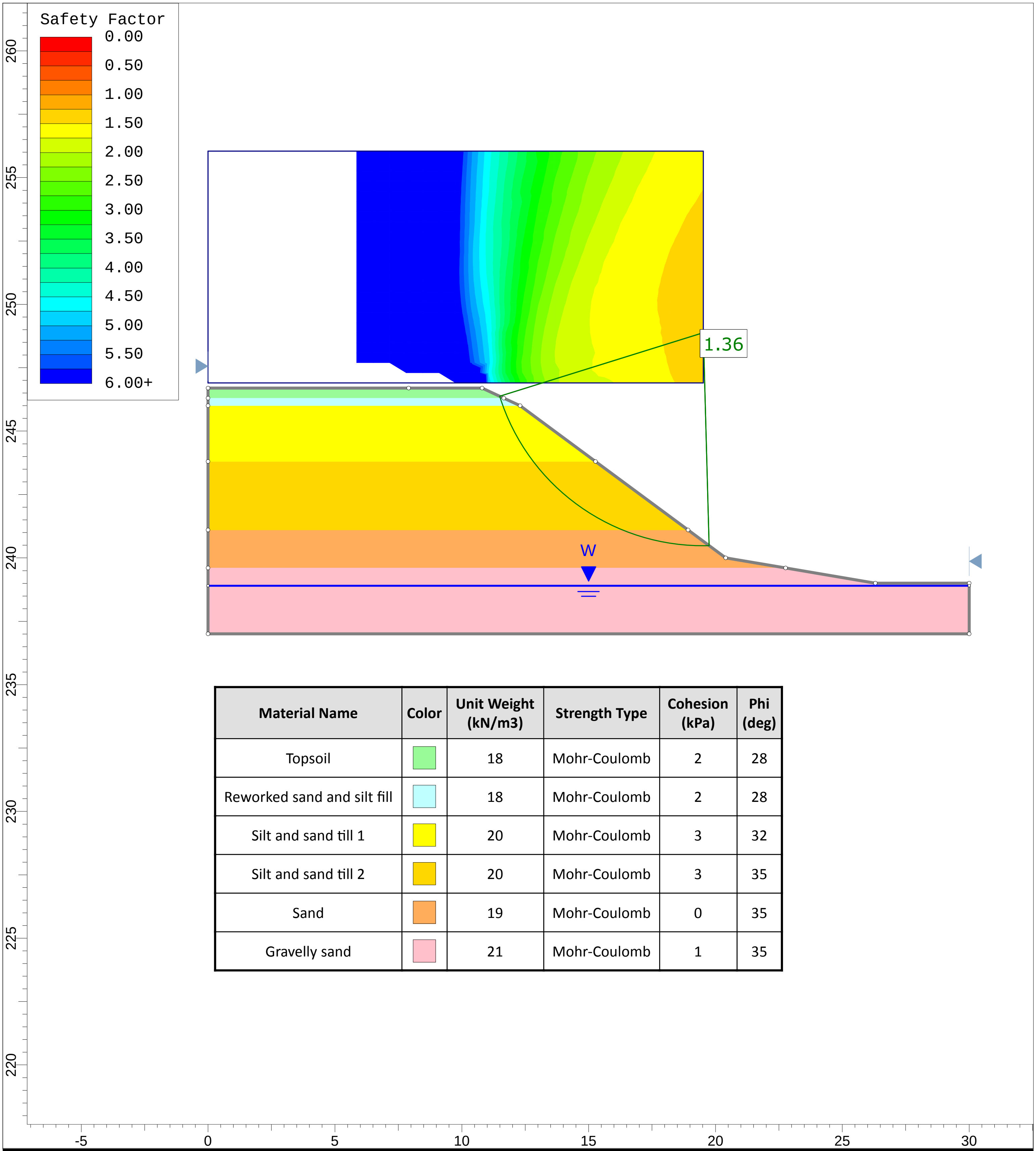


*** Backfill in this area to be as per WSP report.**

APPENDIX

B

SLOPE STABILITY RESULTS



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Topsoil	🟩	18	Mohr-Coulomb	2	28
Reworked sand and silt fill	🟦	18	Mohr-Coulomb	2	28
Silt and sand till 1	🟨	20	Mohr-Coulomb	3	32
Silt and sand till 2	🟨	20	Mohr-Coulomb	3	35
Sand	🟧	19	Mohr-Coulomb	0	35
Gravelly sand	🟥	21	Mohr-Coulomb	1	35

wsp

SLIDEINTERPRET 7.018

Project 428 Little Ave., Barrie

Analysis Description Slope Analysis

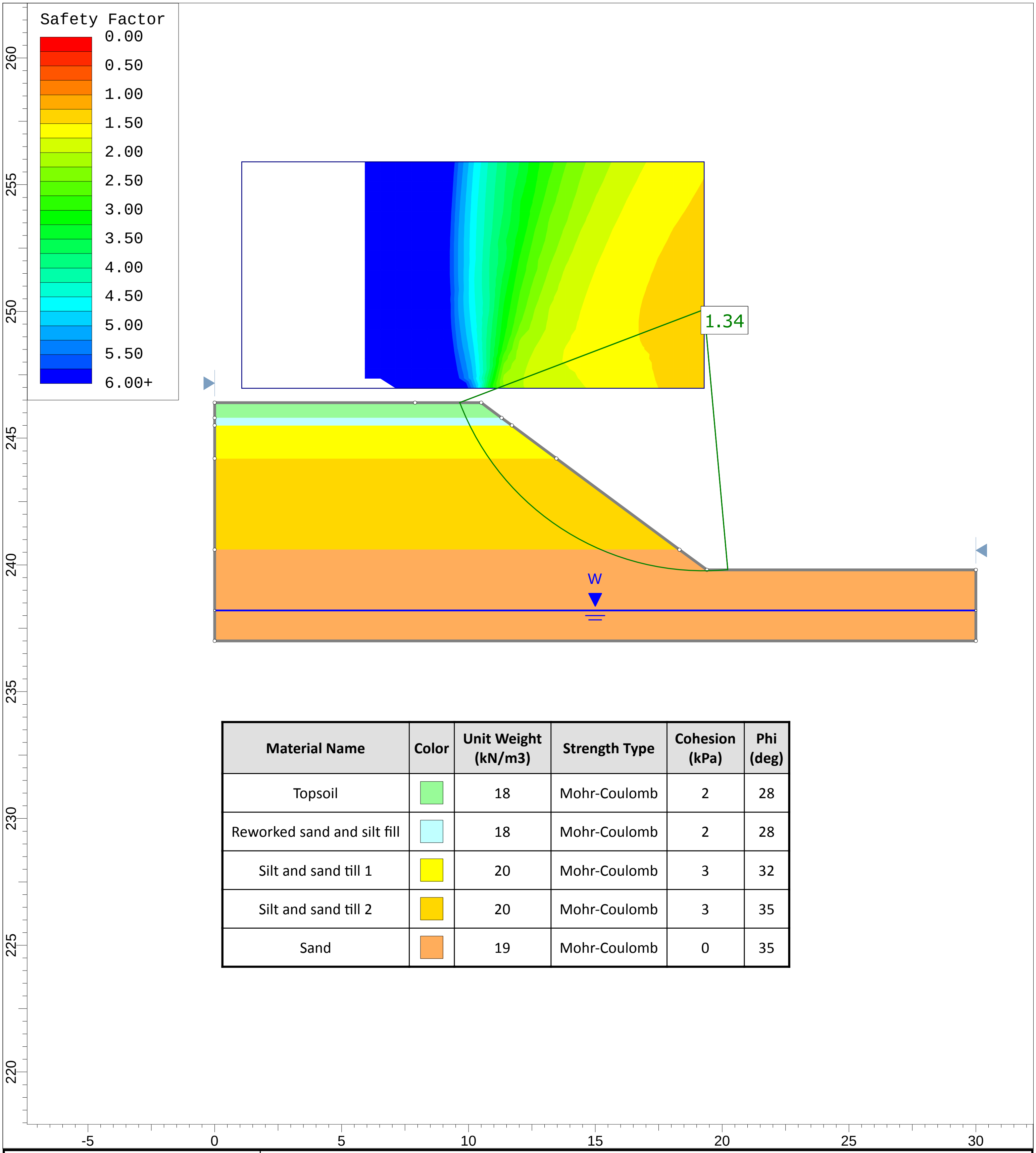
Drawn By MW

Scale 1:200

Company WSP Canada Inc.

5/9/2018

File Name Section A - BH18-2_c3.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Topsoil	🟩	18	Mohr-Coulomb	2	28
Reworked sand and silt fill	🟦	18	Mohr-Coulomb	2	28
Silt and sand till 1	🟨	20	Mohr-Coulomb	3	32
Silt and sand till 2	🟨	20	Mohr-Coulomb	3	35
Sand	🟧	19	Mohr-Coulomb	0	35

wsp

SLIDEINTERPRET 7.018

Project
428 Little Ave., Barrie

Analysis Description
Slope Analysis

Drawn By MW

Scale 1:200

Company WSP Canada Inc.

5/9/2018

File Name Section B - BH18-3_c3.slim

FIGURES

NOTE: BASE PLAN OBTAINED FROM COUNTY OF SIMCOE MAPS, 2017.

561 BRYNE DRIVE, UNITS C & D
BARRIE, ONTARIO CANADA L4N 9Y3
TEL.: 705-735-9771 | FAX: 705-735-6450 | WWW.WSP.COM

PROJECT:
GEOTECHNICAL INVESTIGATION, 428 LITTLE AVENUE, BARRIE, ONTARIO

CLIENT:
428 LITTLE INC.

TITLE:
SITE LOCATION PLAN

SCALE:
1:2000

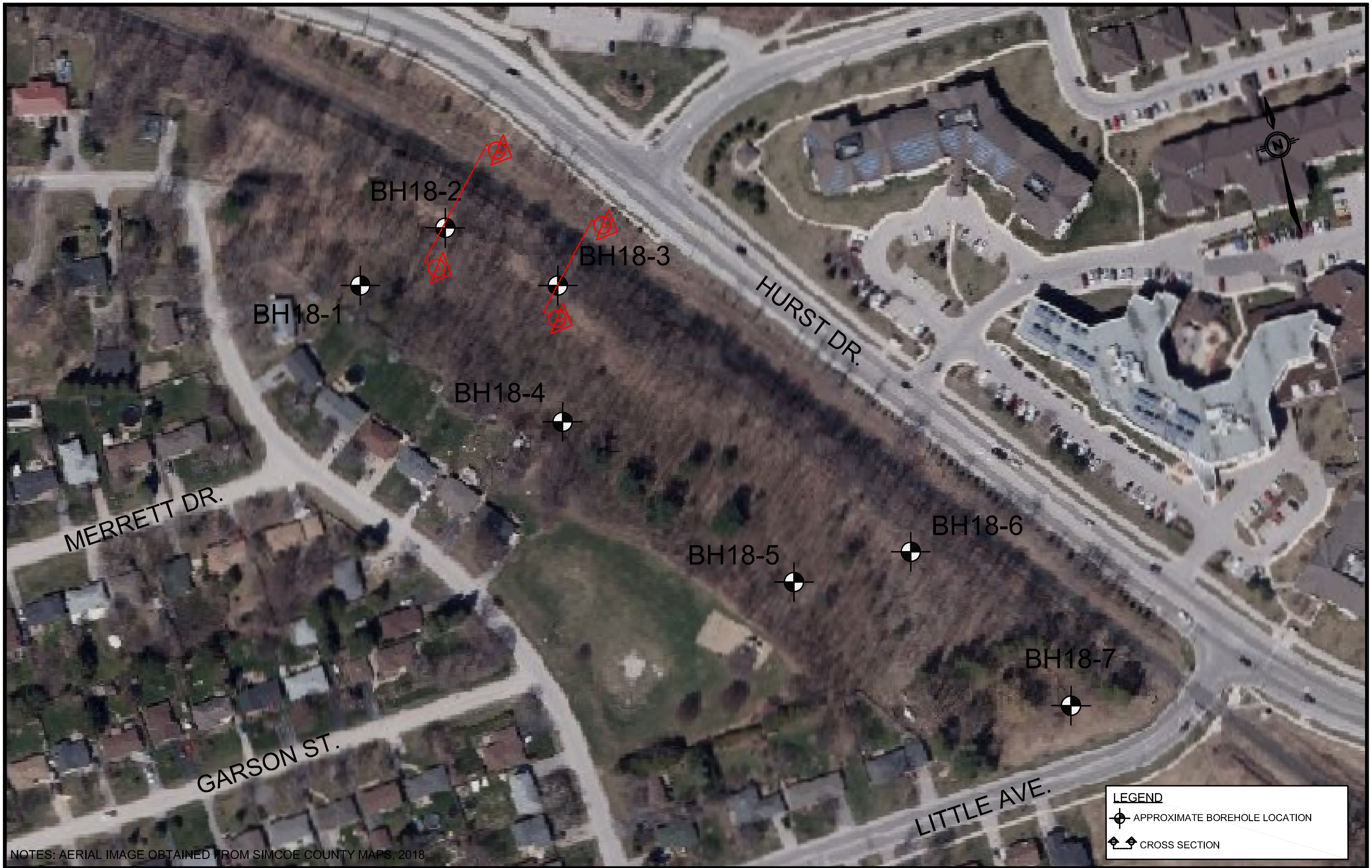
DATE:
MAY / 2018

PROJECT NO:
181-02959-00

FIGURE NO:
1

REV. #

K:\PROJECTS\181-02959-00 428 Little\SITE LOCATION PLAN_181-02959-00.dwg May 10, 2018-7:25am BY:(kaurel.tamasauskas)



NOTES: AERIAL IMAGE OBTAINED FROM SIMCOE COUNTY MAPS, 2018

561 BRYNE DRIVE, UNITS C & D
BARRIE, ONTARIO CANADA L4N 9Y3
TEL.: 705-735-9771 | FAX: 705-735-6450 | WWW.WSP.COM

PROJECT:	GEOTECHNICAL INVESTIGATION, 428 LITTLE AVENUE, BARRIE, ON
CLIENT:	428 LITTLE INC.
TITLE:	BOREHOLE LOCATION PLAN

SCALE: 1:2000

DATE: MAY / 2018

PROJECT NO: 181-02959-00

FIGURE NO: 2

REV. #

K:\PROJECTS\181-02959-00 428 Little\BH PLAN_181-02959-00.dwg May 10, 2018-7:25am BY:(kaurel.tamasauskas)

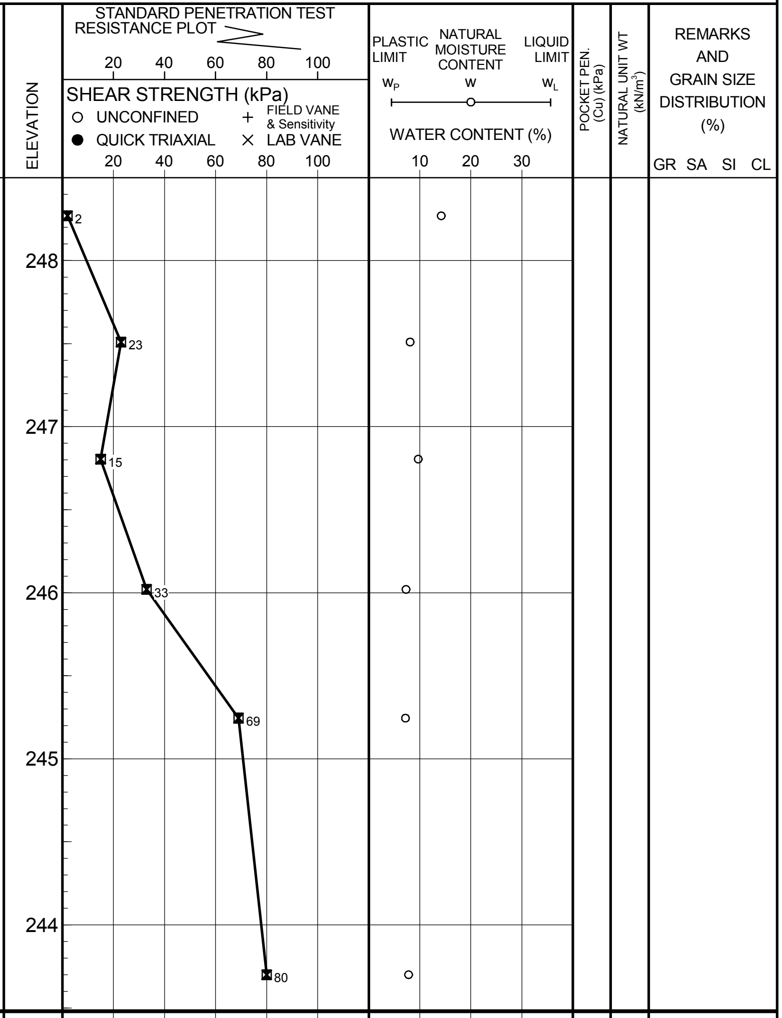
ENCLOSURES

ENCLOSURES 1 – 7: BOREHOLE LOGS
ENCLOSURES 8 – 10: LABORATORY ANALYSES

LOG OF BOREHOLE 18-1

PROJECT: Geotechnical Investigation
REF. NO.: 181-02959-00/100
CLIENT: 428 Little Inc.
Method: Solid Stem Auger
ENCL NO.: 1
PROJECT LOCATION: 428 Little Avenue, Barrie
Diameter: 175 mm
DATUM: NAD 83
Date: Mar/27/2018
BH LOCATION: UTM Zone 17T N 4913802 E 606754

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	
248.5	Ground Surface				
0.0	**TOPSOIL** *sandy silt, some clay, trace gravel* dark brown, wet	1	SS	2	
248.2 0.3	**REWORKED SAND & SILT FILL** *trace clay, trace organics* brown, wet, very loose				
247.8 0.7	**REWORKED CLAYEY SILT FILL** *some sand, trace gravel* brown, wet, very stiff	2	SS	23	
247.1 1.4	**SILT & SAND TILL** *some gravel, trace clay* brown, moist to wet, compact to very dense.	3	SS	15	
		4	SS	33	
		5	SS	69	
		6	SS	80	
243.5 5.0	**END OF BOREHOLE** Borehole was open and dry to 5 mbgs upon completion of drilling.				



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

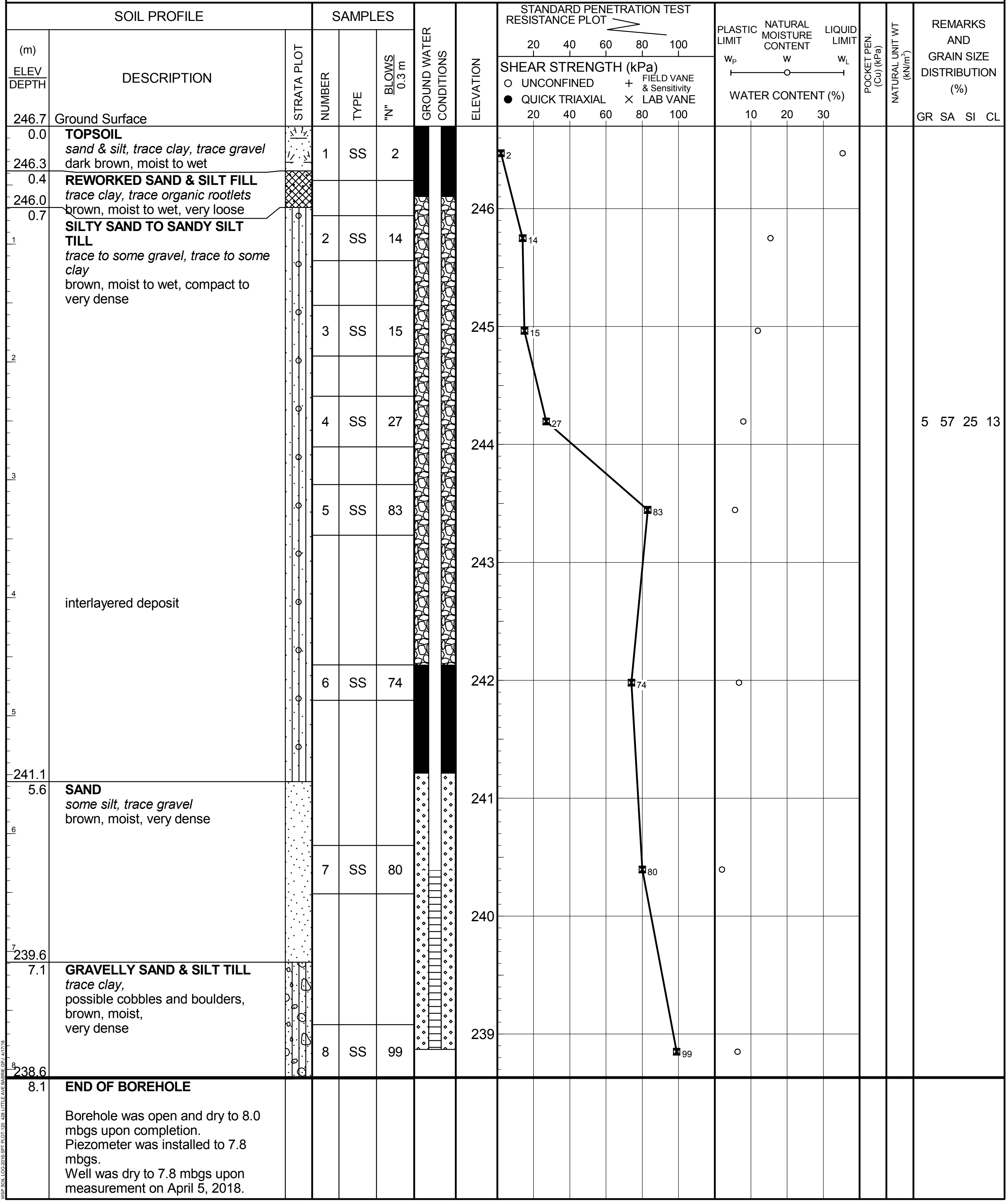
LOG OF BOREHOLE 18-2

1 OF 1

PROJECT: Geotechnical Investigation
CLIENT: 428 Little Inc.
PROJECT LOCATION: 428 Little Avenue, Barrie
DATUM: NAD 83
BH LOCATION: UTM Zone 17T N 4913823 E 606790

REF. NO.: 181-02959-00/100
ENCL NO.: 2

Method: Solid Stem Auger
Diameter: 175 mm
Date: Mar/27/2018



(m) ELEV DEPTH	DESCRIPTION
246.7	Ground Surface
0.0	**TOPSOIL** *sand & silt, trace clay, trace gravel* dark brown, moist to wet
246.3 0.4	**REWORKED SAND & SILT FILL** *trace clay, trace organic rootlets* brown, moist to wet, very loose
246.0 0.7	**SILTY SAND TO SANDY SILT TILL** *trace to some gravel, trace to some clay* brown, moist to wet, compact to very dense interlayered deposit
241.1 5.6	**SAND** *some silt, trace gravel* brown, moist, very dense
239.6 7.1	**GRAVELLY SAND & SILT TILL** *trace clay,* possible cobbles and boulders, brown, moist, very dense
238.6 8.1	**END OF BOREHOLE** Borehole was open and dry to 8.0 mbgs upon completion. Piezometer was installed to 7.8 mbgs. Well was dry to 7.8 mbgs upon measurement on April 5, 2018.

NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	2	
2	SS	14	
3	SS	15	
4	SS	27	5 57 25 13
5	SS	83	
6	SS	74	
7	SS	80	
8	SS	99	

WSP-SOIL-ROCK-MAY-29-2017.GLB
WSP SOIL LOG-2016-SPT PLOT-120 428 LITTLE AVE BARRIE.GPJ 4/17/18

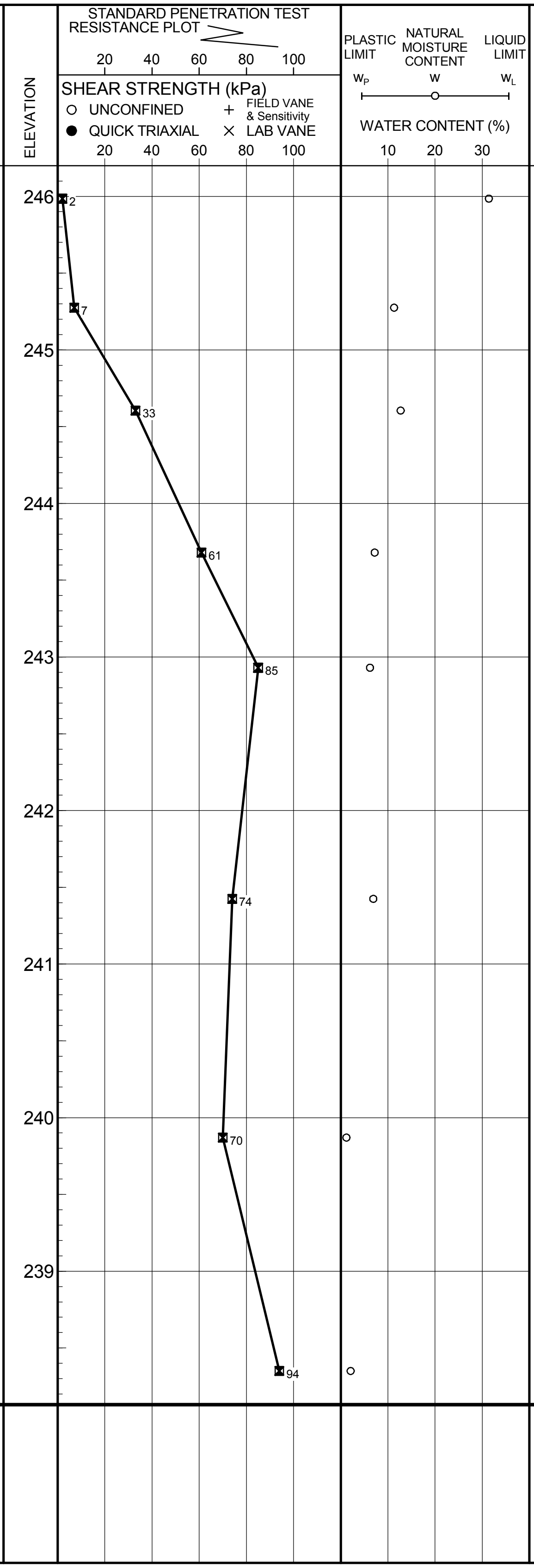
GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 18-3

PROJECT: Geotechnical Investigation
REF. NO.: 181-02959-00/100
CLIENT: 428 Little Inc.
Method: Solid Stem Auger
ENCL NO.: 3
PROJECT LOCATION: 428 Little Avenue, Barrie
Diameter: 175 mm
DATUM: NAD 83
Date: Mar/26/2018
BH LOCATION: UTM Zone 17T N 4913796 E 606837

SOIL PROFILE			SAMPLES						REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	GR	SA	SI	CL
246.2	Ground Surface											
0.0	**TOPSOIL** *sand & silt,* dark brown, moist		1	SS	2							
245.8 0.4	**REWORKED SAND & SILT FILL** *trace organics* Orangey brown, moist, loose											
245.5 0.7	**SILT & SAND TILL** *trace to some gravel, trace clay* brown, moist, dense to very dense		2	SS	7							
			3	SS	33							
	Trace organic rootlets from 0.76 mbgs to 1.22 mbgs		4	SS	61							
			5	SS	85							
			6	SS	74							
240.6 5.6	**SAND, trace silt** brown, moist, very dense		7	SS	70				0	92	(8)	
			8	SS	94							
238.1 8.1	**END OF BOREHOLE** Borehole was open and dry to 8 mbgs upon completion of drilling.											



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

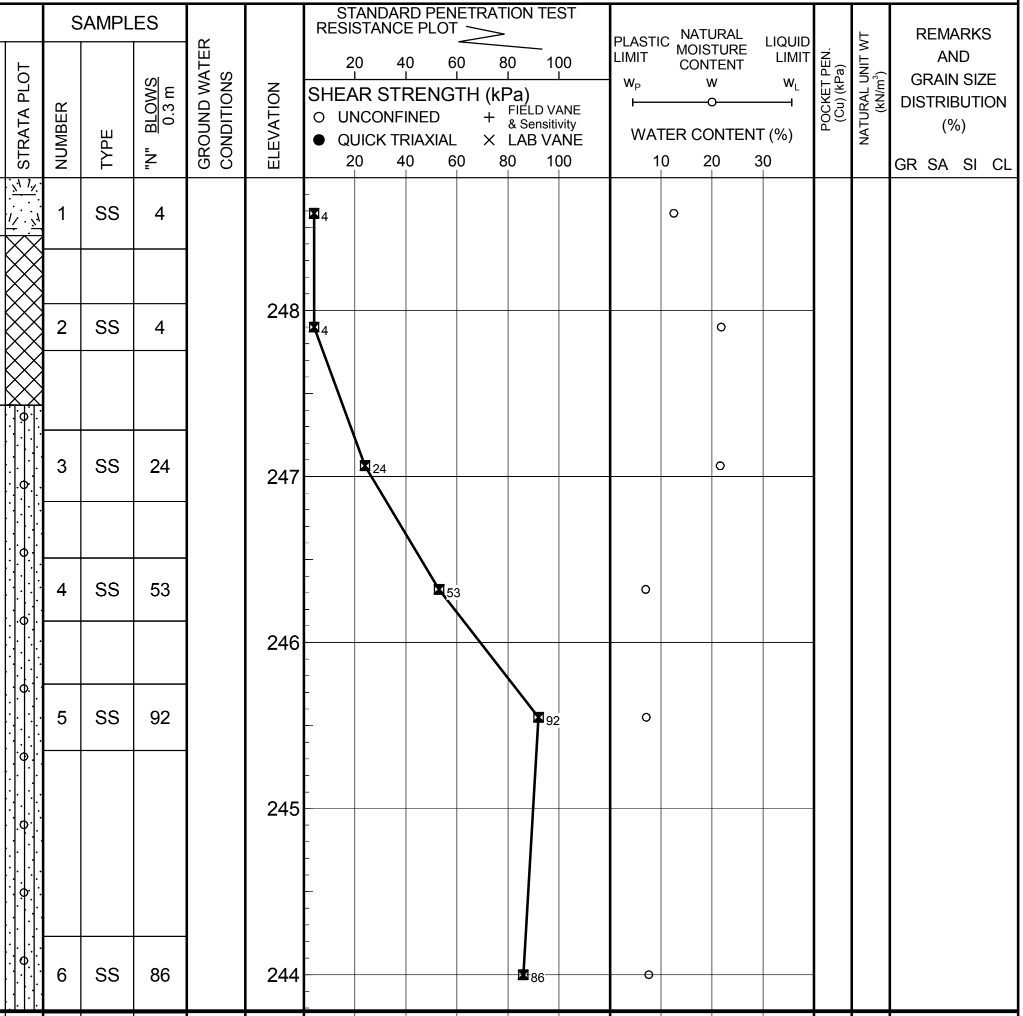
wsp

LOG OF BOREHOLE 18-4

PROJECT: Geotechnical Investigation
REF. NO.: 181-02959-00/100
CLIENT: 428 Little Inc.
Method: Solid Stem Auger
ENCL NO.: 4
PROJECT LOCATION: 428 Little Avenue, Barrie
Diameter: 175 mm
DATUM: NAD 83
Date: Mar/26/2018
BH LOCATION: UTM Zone 17T N 4913747 E 606830

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION
248.8	Ground Surface
0.0	**TOPSOIL** *sandy & silt, trace gravel* dark brown, moist to wet
248.5 0.4	**REWORKED CLAYEY SILT & SANDY SILT FILL** *trace gravel, trace organic rootlets* orangy brown to brown, moist, loose Trace organic pockets, some red oxidation.
247.4 1.4	**SILT & SAND TILL** *some gravel, trace clay* brown to brownish gray, moist, compact to very dense
243.8 5.0	**END OF BOREHOLE** Borehole was open and dry to 5 mbgs upon completion of drilling.

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m
1	SS	4
2	SS	4
3	SS	24
4	SS	53
5	SS	92
6	SS	86



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE 18-5

PROJECT: Geotechnical Investigation
CLIENT: 428 Little Inc.
PROJECT LOCATION: 428 Little Avenue, Barrie
DATUM: NAD 83
BH LOCATION: UTM Zone 17T N 4913688 E 606913

Method: Solid Stem Auger
Diameter: 175 mm
Date: Mar/26/2018

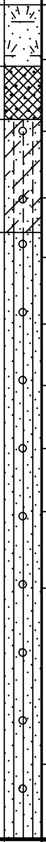
REF. NO.: 181-02959-00/100
ENCL NO.: 5

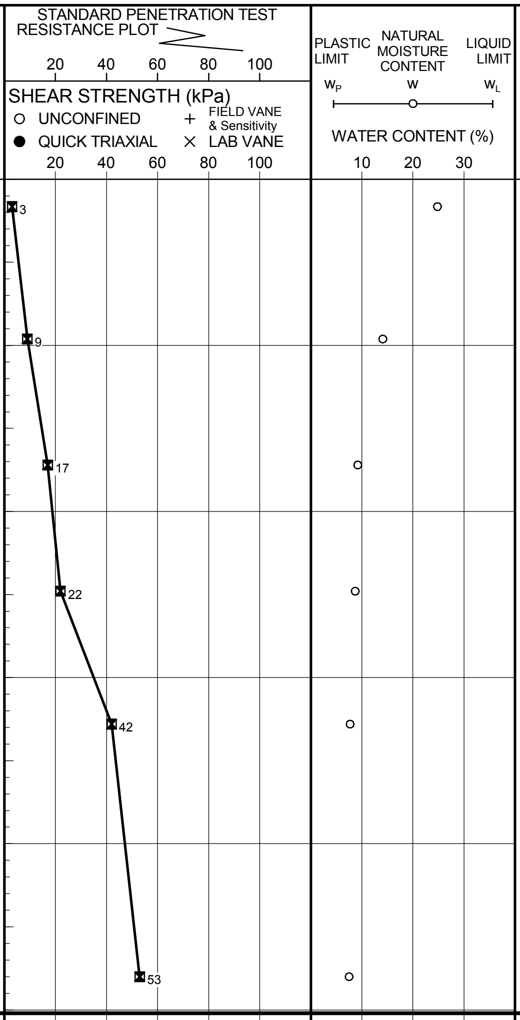
SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
247.0	Ground Surface
0.0	**TOPSOIL** *sand & silt, trace clay* dark brown, moist to wet
246.6 0.4	**REWORKED SANDY SILT FILL** *some clay, trace organics* brown, moist, loose
246.3 0.7	**CLAYEY SILT & SAND TILL** *trace gravel* brown, moist, loose
245.6 1.4	**SILT & SAND TILL** *some clay, trace gravel* brown to brownish gray, moist, compact to very dense
242.0 5.0	**END OF BOREHOLE** Borehole was open and dry to 5 mbgs upon completion of drilling.

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m
1	SS	3
2	SS	9
3	SS	17
4	SS	22
5	SS	42
6	SS	53





POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

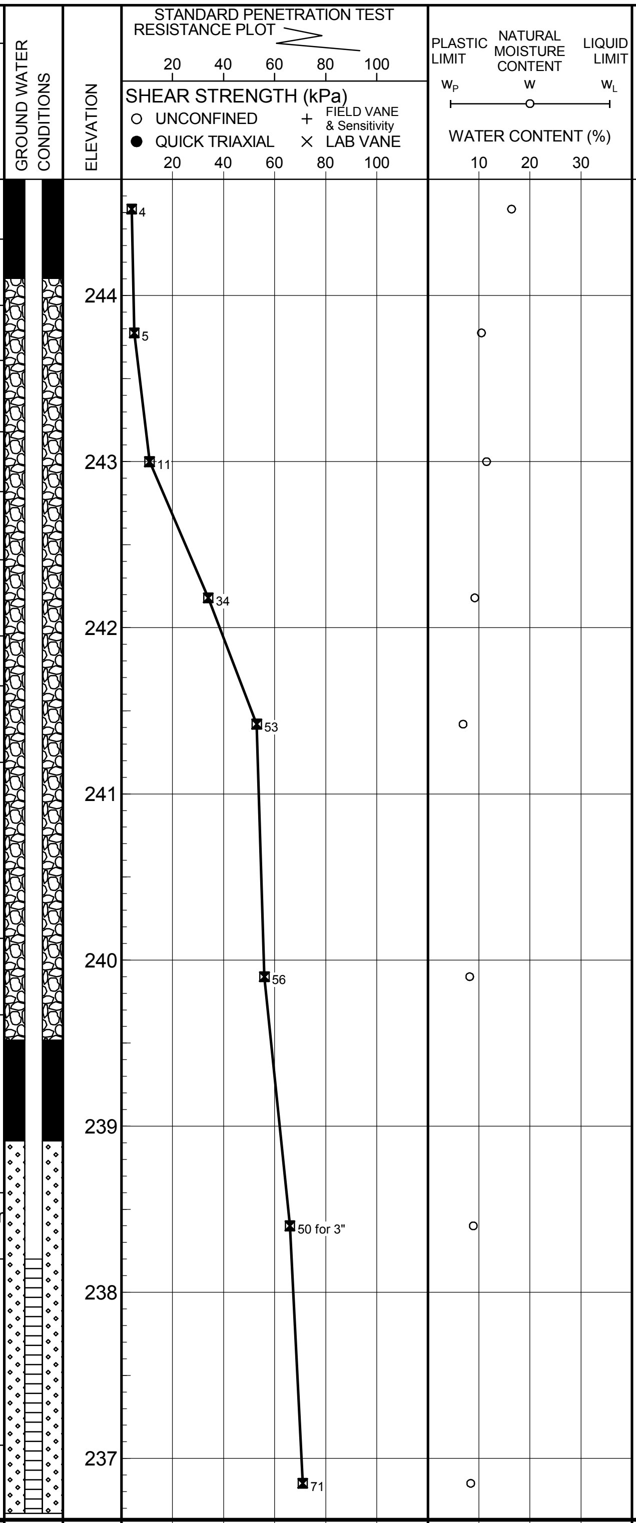
○ ε=3% Strain at Failure

LOG OF BOREHOLE 18-6

PROJECT: Geotechnical Investigation
REF. NO.: 181-02959-00/100
CLIENT: 428 Little Inc.
Method: Solid Stem Auger
ENCL NO.: 6
PROJECT LOCATION: 428 Little Avenue, Barrie
Diameter: 175 mm
DATUM: NAD 83
Date: Mar/26/2018
BH LOCATION: UTM Zone 17T N 4913699 E 606950

ELEV (m) / DEPTH	DESCRIPTION
244.7	Ground Surface
0.0	**TOPSOIL** *sandy silt, trace clay,* dark brown, wet
244.4 0.3	**REWORKED SANDY SILT FILL** *trace clay, trace organics, trace gravel,* brown, wet, loose
244.0 0.7	**SILTY SAND TILL to SANDY SILT TILL** *some clay to clayey, trace to some gravel* brown, moist, loose to very dense Occasional cobbles & boulders throughout.
236.6 8.1	**END OF BOREHOLE** Borehole was open and dry to 8.0 mbgs upon completion of drilling. Piezometer was installed to 8.0 mbgs. Well was dry to 8 mbgs upon measurement on April 5, 2018.

NUMBER	TYPE	"N" BLOWS / 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	4				
2	SS	5				
3	SS	11				
4	SS	34	1	30	42	27
5	SS	53				
6	SS	56				
7	SS	50 for 3"				
8	SS	71				



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

WSP-SOIL-ROCK-MAY-29-2017.GLB
WSP SOIL LOG-2016-SPT PLOT-120 428 LITTLE AVE BARRIE.GPJ 4/17/18

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

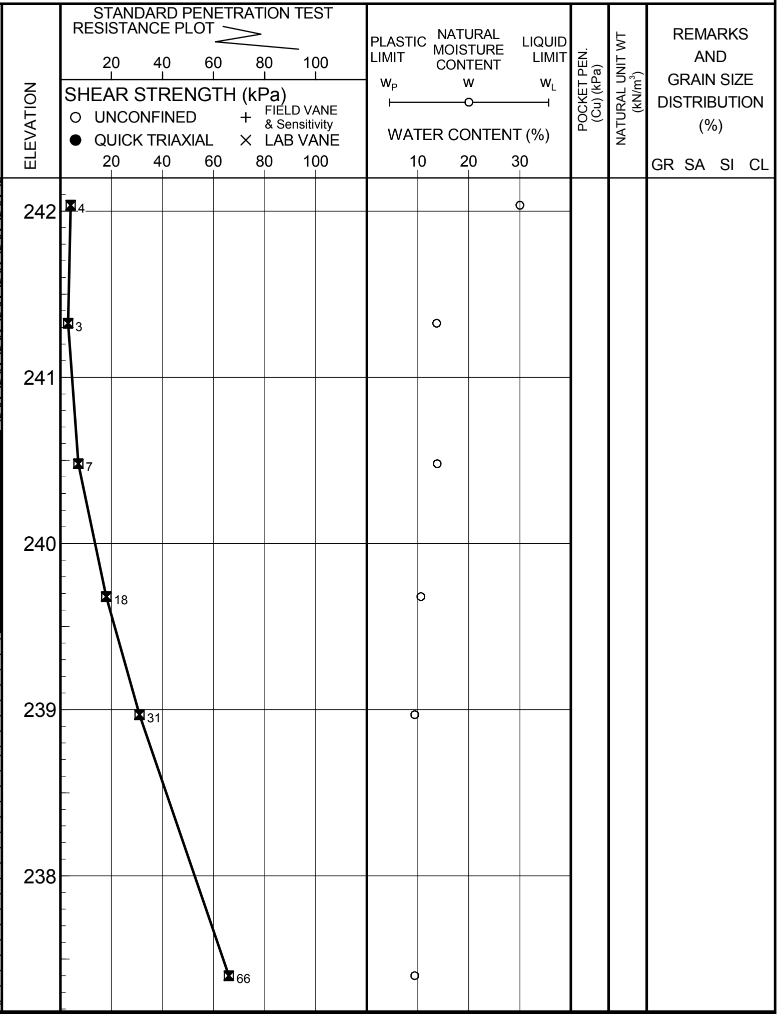
GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 18-7

PROJECT: Geotechnical Investigation
REF. NO.: 181-02959-00/100
CLIENT: 428 Little Inc.
Method: Solid Stem Auger
ENCL NO.: 7
PROJECT LOCATION: 428 Little Avenue, Barrie
Diameter: 175 mm
DATUM: NAD 83
Date: Mar/26/2018
BH LOCATION: UTM Zone 17T N 4913647 E 607016

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION
242.2	Ground Surface
0.0	**TOPSOIL** *sand & silt, trace gravel* dark brown, wet,
241.7 0.5	**SAND & SILT FILL** *some clay, some gravel, trace organics* brown, wet, very loose no bedding, slight red oxidation
240.8 1.4	**SANDY SILT TILL** *some gravel, some clay* brown, moist, loose to compact some layering
239.3 2.9	**CLAYEY SILT TILL TO SILT SOME CLAY TILL** *some sand, trace to some gravel* brown, moist to wet, dense to very dense occasional sand layers
237.2 5.0	**END OF BOREHOLE** Borehole was dry & open to 5 mbgs upon completion of drilling. Piezometer was installed to 5 mbgs. Well was dry to 8 mbgs upon measurement on April 5, 2018.

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m
1	SS	4
2	SS	3
3	SS	7
4	SS	18
5	SS	31
6	SS	66

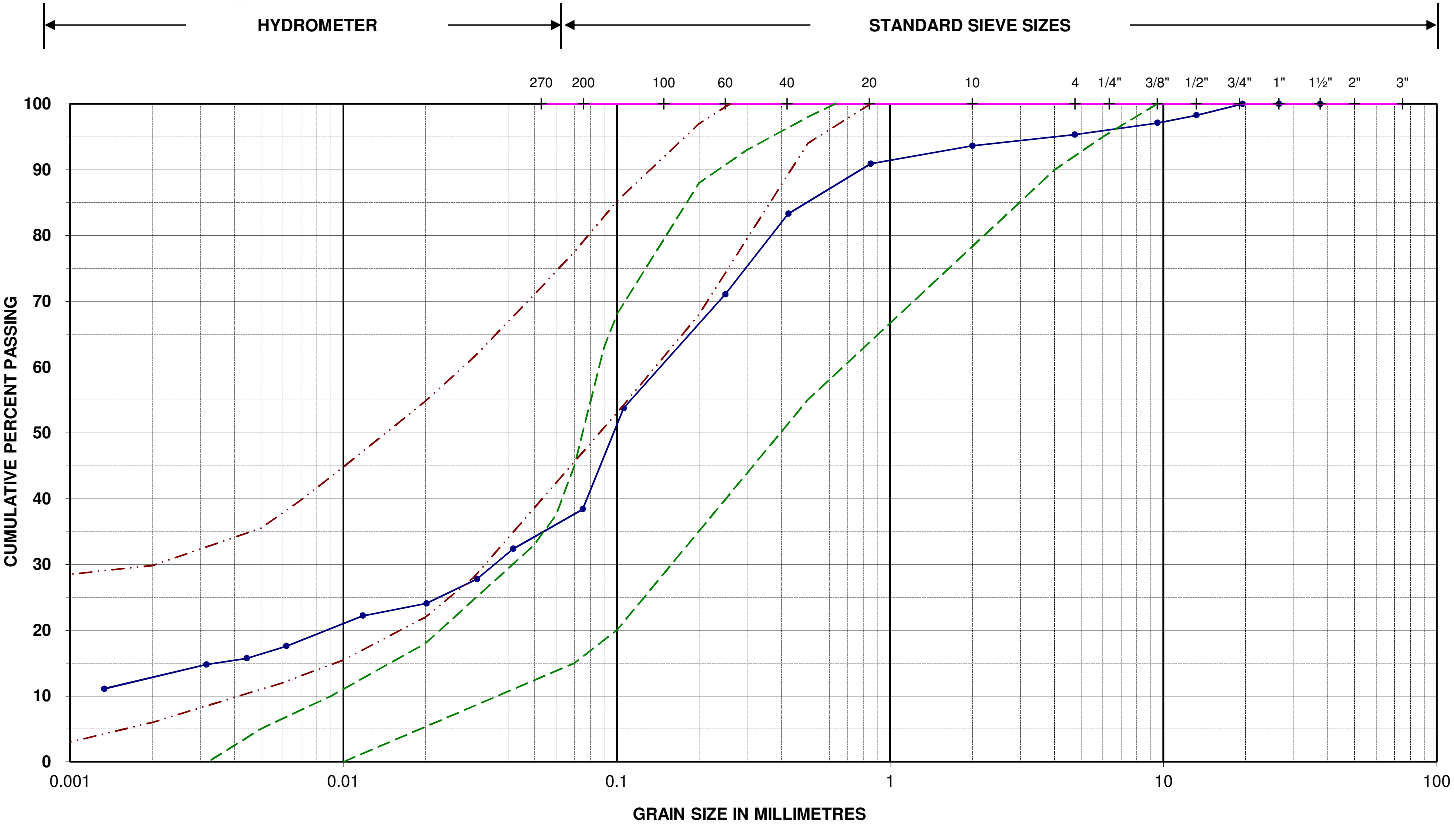


GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

GRAVEL	5	%
SAND	57	%
SILT	26	%
CLAY	12	%

----------------------- sm envelope T = 8 - 20 min/cm

- - - -·- - - -·- - - ml envelope T = 20 - 50 min/cm

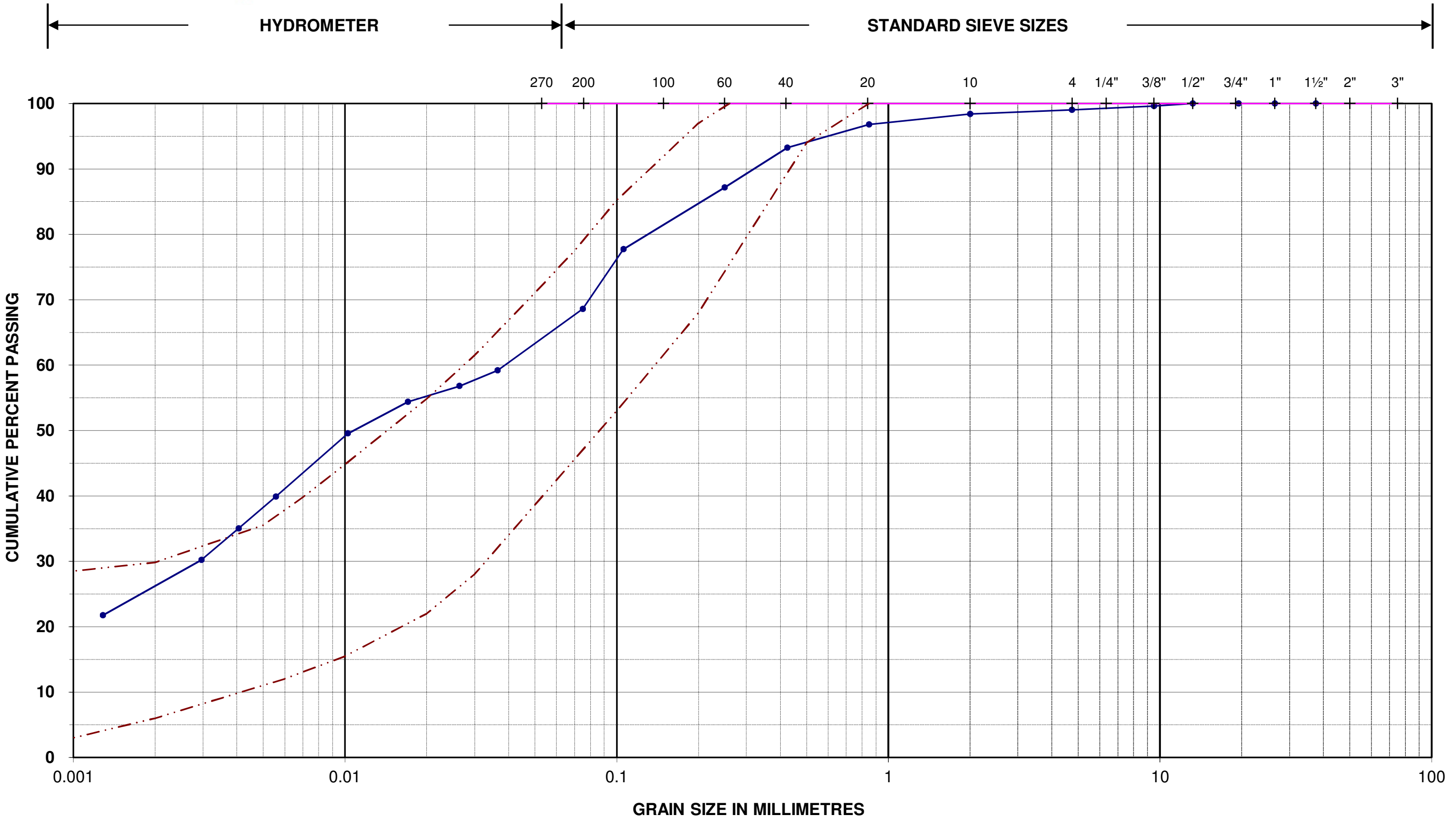
Estimated T = 20 to 30 min/cm

Project Name:	428 Little Avenue	**Project No.:**	181-02959-00
Location ID.:	BH18-2	**Sample No./Depth:**	SS4

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
26.5 mm	100.0	**0.850 mm**	90.9	**0.042**	32.4
13.2 mm	98.3	**0.425 mm**	83.3	**0.020**	24.1
9.50 mm	97.1	**0.250 mm**	71.1	**0.006**	17.6
4.75 mm	95.3	**0.106 mm**	53.7	**0.003**	14.8
2.00 mm	93.6	**0.075 mm**	38.4	**0.001**	11.1

Enclosure No.: 8

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

GRAVEL	1	%
SAND	30	%
SILT	43	%
CLAY	26	%

-·-·—·-·— ml envelope T = 20 - 50 min/cm

Estimated T = 30 to 50 min/cm

Project Name: 428 Little Avenue

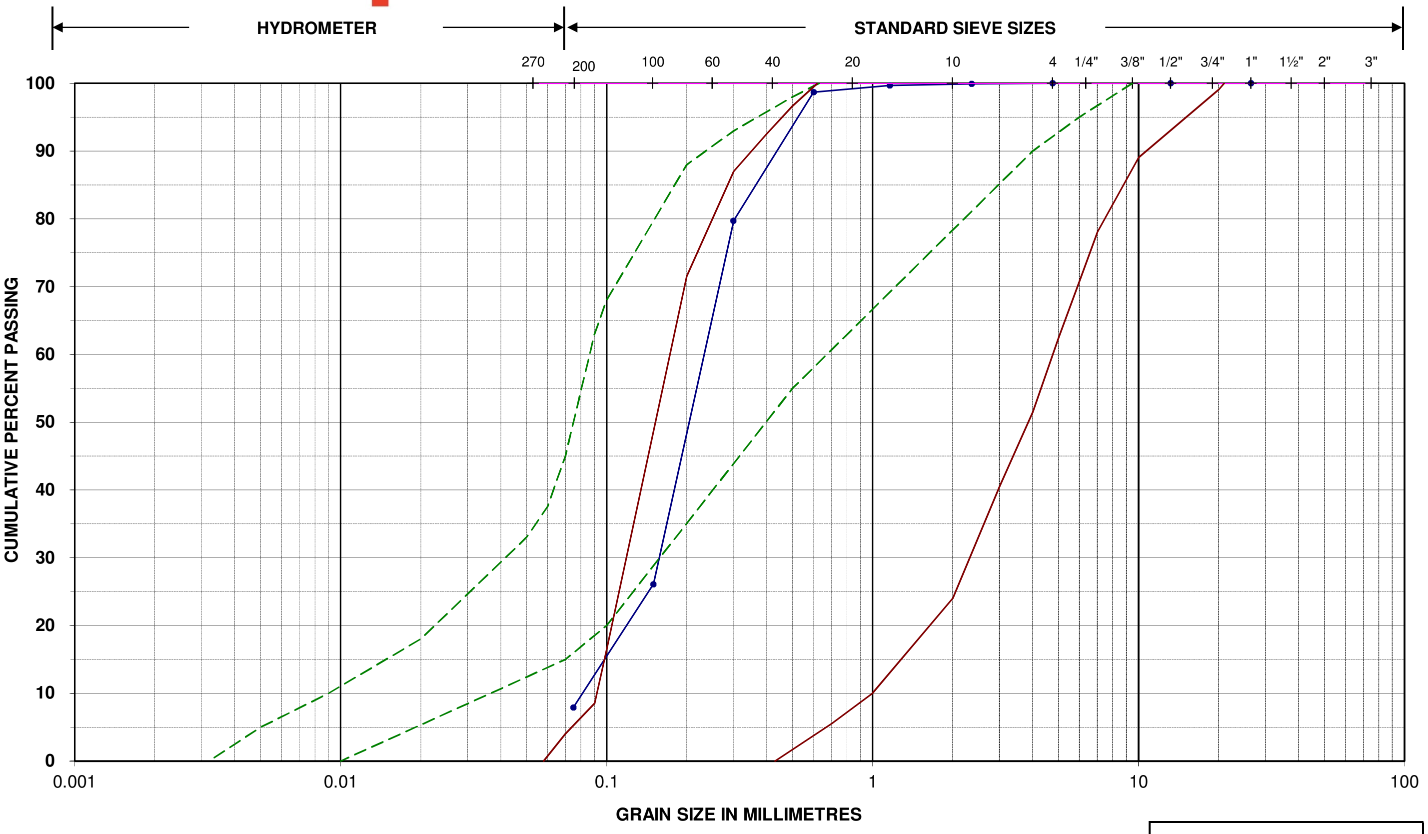
Project No.: 181-02959-00

Location ID.: BH18-6

Sample No./Depth: SS4

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
26.5 mm	100.0	**0.850 mm**	96.8	**0.036**	59.2
13.2 mm	100.0	**0.425 mm**	93.2	**0.017**	54.4
9.50 mm	99.6	**0.250 mm**	87.1	**0.006**	39.9
4.75 mm	99.0	**0.106 mm**	77.7	**0.003**	30.2
2.00 mm	98.4	**0.075 mm**	68.6	**0.001**	21.7

PARTICLE SIZE DISTRIBUTION



Unified Classification System

SILT AND CLAY	**SAND**	**GRAVEL**

GRAVEL	**0**	**%**
SAND	**92**	**%**
SILT & CLAY	**8**	**%**

---------------------- sm envelope T = 8 - 20 min/cm

———————— sp envelope T = 2 - 8 min/cm

Estimated T = 8 to 15 min/cm

Project Name:	428 Little Avenue	**Project No.:**	181-02959-00
Location ID.:	BH18-3	**Sample No./Depth:**	SS7

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	99.7
26.5 mm	100.0	**0.60 mm**	98.7
13.2 mm	100.0	**0.30 mm**	79.7
4.75 mm	100.0	**0.15 mm**	26.1
2.36 mm	99.9	**0.075 mm**	7.9

Enclosure No.: 10