



**Final Geotechnical Investigation
West Orillia Neighborhood Plan,
Residential Development**

Orillia, Ontario

July 8, 2020

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Sign-off Sheet

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Introduction
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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by Charter Development LP (Charter) to carry out a geotechnical investigation for the subject lands located east of Line 15 and South of Bass Lake Sideroad (the site) in the City of Orillia, Ontario.

The information provided in this report is specific to the scope of the investigation and the scope of the proposed development as discussed herein and should not be used for any application or purpose other than that stated herein. The scope of this report focuses on the geotechnical aspects of the project and does not include hydrogeological or environmental components. However, a hydrogeological investigation for the overall Site was carried out by Stantec in conjunction with this geotechnical investigation. The results of the hydrogeological investigation are provided under separate cover.

Use of this report is subject to the Statement of General Conditions provided in **Appendix A**.

2.0 SITE DESCRIPTION

2.1 LOCATION AND CURRENT LAND USE

The Site is situated along the west limits of the City of Orillia boundary, east of Line 15 and south of Bass Lake Sideroad. The Site is bounded by residential development lands to the east, Bass Lake Sideroad to the north, Line 15 to the West and vacant wood lots and agricultural fields to the south.

At the time of field investigation, the site consisted of a combination of agricultural fields and wood lots. A Trans Canada Energy (TC Energy) pipeline easement is located in the northern portion of the site and runs in a southwest direction from the northeast corner of the site. A wetland is located in the central portion of the site north of the TransCanada easement and a Storm Water Management Pond associated with the residential development located east of the site, is located south of the TC Energy easement.

The site consists of hills and valleys and the ground surface is undulating and general descends from the southwest and east towards the wetland in the central northern portion of the site. The ground surface elevations vary by approximately 22 m between the highest and lowest borehole locations.

3.0 PROPOSED DEVELOPMENT

3.1 OVERVIEW

Based on the available conceptual drawings, the Site will be developed for construction of low, medium and high-density residential housing, site servicing including sanitary sewers, storm sewers and municipal water supply with associated residential roads.



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As the site consists of hills and valleys it is anticipated that an extensive cut and fill earthworks program will be required to develop the site. Preliminary concept plans provided by the client indicate cuts in the higher ground and fills in the lower areas in the order of 5.0 m will be required.

It is understood that the existing Storm Water Management Pond will be utilized to control storm water flows from the development lands associated with the West Orillia Neighborhood project.

4.0 METHOD OF INVESTIGATION

4.1 FIELD INVESTIGATION

Prior to commencing the field investigation, the various public utility companies were consulted to identify where public utilities crossed the property boundaries. In addition, a private locator was contracted to clear the boreholes of any private on-site services.

The fieldwork for the investigation was carried out between May 14 and May 22, 2019. A total of nineteen (19) boreholes were advanced as part of the geotechnical scope (BH/MW01 to BH/MW18). A total of nine (9) of the nineteen (19) boreholes were advanced as part of the hydrogeological scope (BH/MW2, BH/MW4, BH/MW6, BHMW9, BH/MW10, BH/MW13, BH/MW15, BH/MW16 and BH/MW18). The boreholes were advanced to depths ranging from 6.2 to 9.8 m at the locations shown on the Borehole Location Plan, Drawing 1 in Appendix B.

The boreholes were advanced using a Diedrich B57 track mounted drill rig equipped with hollow and solid stem augers operated by Landshark Drilling Ltd., a specialist drilling subcontractor. Stantec personnel recorded the subsoil and groundwater conditions encountered in the boreholes. The soil samples were recovered at regular 0.76 m and 1.52 m intervals using a 51 mm (outside diameter) split-tube sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM specification D1586. All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed geotechnical classification.

Groundwater monitoring wells were installed in nine (9) boreholes (BH/MW2, BH/MW4, BH/MW6, BHMW9, BH/MW10, BH/MW13, BH/MW15, BH/MW16 and BH/MW18), and the water levels were measured by Stantec personnel between June 4 and July 12, 2019. The monitoring wells consisted of 50 mm inside diameter, Schedule 40 PVC pipe, with a No. 10 slot screen (0.01-inch slot) and a minimum screen length of 3.1 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with well sand to 0.3 m above the top of screen, with the remainder of the annular space being filled with a granular bentonite to prevent a hydraulic connection from occurring between the soil layers along the length of the casing.

The boreholes without monitoring wells were backfilled with a low-permeability mixture of granular bentonite and auger spoils in accordance with the requirements of Ontario Regulation 903 as amended under the Ontario Water Resources Act.

4.2 BOREHOLE ELEVATION SURVEY

The coordinates and elevations were provided by the client and are provided in Table 4.1 below.



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Table 4.1: Borehole Elevations

Borehole Number	Ground Surface Elevation (m)
BH01	282.3
BH/MW02	277.0
BH03	265.8
BH/MW04	267.2
BH05	270.4
BH/MW06	279.7
BH07	270.7
BH08	278.4
BH/MW09	276.8
BH/MW10	262.4
BH11	267.9
BH12	269.5
BH/MW13	273.2
BH/MW14	278.3
BH15	283.3
BH/MW16	284.8
BH17	277.0
BH/MW18	267.8

The borehole locations are shown on the Site Plan Drawing No. 1 in **Appendix B**.

4.3 GEOTECHNICAL LABORATORY TESTING PROGRAM

All samples recovered from the geotechnical investigation were returned to Stantec's geotechnical and materials testing laboratory and were visually examined by a geotechnical specialist.

Laboratory testing of selected samples of the soils obtained during drilling comprised the following:

- A suite of moisture content tests (ASTM D2216-10), the results of which are provided on the borehole logs; and,
- Seven (7) particle size distribution analyses (ASTM D422-63), the results of which are provided on the respective borehole logs, illustrated on Figure Nos. 1 to 2 in **Appendix D**, and discussed in Sections 5.2.2; 5.2.3 and 5.2.4.

Samples remaining after testing will be placed in storage for a period of three months after issue of this geotechnical report. After the storage period, the samples will be discarded.



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5.0 RESULTS OF INVESTIGATION

5.1 SUBSURFACE CONDITIONS

5.1.1 Overview

In general, the soil conditions at the Site consisted of a layer of topsoil overlying strata of silty sand and silty sand till. A layer of sand and gravel was encountered in the lower portion of the stratigraphy in areas throughout the site.

Bedrock was not encountered at the boreholes advances for this investigation. Based on available bedrock mapping and data of the area, bedrock is anticipated at approximate depths of more than 25 to 30 m.

The subsurface conditions observed in the boreholes are presented in detail on the logs provided in **Appendix C**. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

The stratigraphic boundaries shown on the logs are inferred from non-continuous sampling and should be considered approximate only. Variations to the conditions reported and discussed herein must be anticipated.

5.2 SOIL STRATIGRAPHY

The following sections summarize the soil strata encountered in all boreholes completed for the current investigation.

5.2.1 Topsoil

Topsoil was encountered at the ground surface at boreholes BH03, BH/MW04, BH05, BH07, BH08, BH/MW09, BH/MW10, BH14, BH/MW15 and BH/MW16 and extended to depths of 250 mm to 800 mm below the existing ground surface. The topsoil ranged in composition from sandy silt to sand with trace silt and was damp to moist at the time of fieldwork.

5.2.2 Silty Sand (SM)

Silty Sand (SM) was generally contacted underlying the topsoil in lower areas of the site (boreholes BH/MW04, BH05, BH07, BH/MW10 and BH/MW18) and extended onto the silty sand till deposit at depths ranging from 1.0 m to 3.8 m. The silty sand consisted of varying amounts of sand and silt with a trace of clay and gravel. SPT N-values of 2 to 9 blows per 300 mm indicate very loose to loose relative densities.

Based on textural examination of the samples in the field, the silt was described as moist to saturated. Moisture contents obtained from laboratory results ranged from 9% to 32%.

Two (2) particle size distribution analyses were completed on representative samples of the silty sand and the results are summarized in Table 5.1 and illustrated on Figure 1, in **Appendix D**.



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Table 5.1: Grain Size Distribution – Silty Sand (SM)

Borehole	Sample	Median Depth (m)	% Gravel	% Sand	% Silt	% Clay
BH/05	SS5	3.4	7	59	27	7
BH/MW16	SS2	1.0	2	67	25	6

5.2.3 Silty Sand Till (SM)

Silty sand till (SM) dominated the soil stratigraphy and was encountered in all but two boreholes (BH/MW10 and BH/MW18). The silty sand till was encountered below the topsoil or silty sand deposits and extended onto a stratum of poorly graded sand with gravel at depths of 3.8 to 7.2 m and/or to the termination depth of the boreholes at depths ranging from 6.1 m to 9.8 m. The glacial till typically ranged in composition from silty sand with a trace clay and gravel to clayey sand with some silt and a trace of gravel. Frequent cobbles and boulders were inferred to be present in the till due to frequent grinding during augering and refusal to split spoon sampling at the termination depth of boreholes. Previous phases of construction east of the subject site encountered significant amounts of cobbles and boulders therefore it should be anticipated that these glacial till soils will contain similar volumes of cobbles and boulders. SPT N-values of 2 to greater than 100 blows per 300 mm indicate very loose to very dense relative densities, but generally dense to very dense below a depth of 2.0 m.

Based on textural examination of the samples in the field, the glacial till was described as moist to wet. Moisture contents obtained from laboratory results ranged from 6% to 18%, predominantly less than 12%.

Three (3) particle size distribution analysis were completed on representative samples of the silty sand till and the results are summarized in Table 5.2 and illustrated on Figure 1 and 2, in **Appendix D**.

Table 5.2: Grain Size Distribution – Silty Sand Till (SM)

Borehole	Sample	Median Depth (m)	% Gravel	% Sand	% Silt	% Clay
BH/MW02	SS3	1.8	2	54	31	13
BH/MW08	SS7	4.5	5	55	26	14
BH17	SS4	2.5	7	56	29	8

5.2.4 Poorly to Well Graded Sand and Gravel (SP, SW-SM)

Sand and gravel deposits were contacted below the silty sand till deposits in boreholes BH/MW2, BH08, BH/MW09, BH/MW10, BH17 and BH/MW18 and ranged in composition from poorly graded sand with gravel (SP) to well graded sand with silt and gravel (SM-SM,GM). The deposit contained varying amounts of sand and gravel with trace amounts of silt and clay. SPT N-values of 4 to 100+ per 300 mm indicate a loose to very dense relative density. Based on textural examination of the samples in the field, the sand and gravel was described as moist to saturated. Moisture contents obtained from laboratory results ranged from 3% to 17%.

Two (2) particle size distribution analyses were completed on representative samples of the Poorly to Well Graded Sand and Gravel and the results are summarized in Table 5.3 and illustrated on Figure 1 and 2, in **Appendix D**.



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Table 5.3: Grain Size Distribution – Poorly Graded to Well Graded Sand and Gravel (SP, SW-SM)

Borehole	Sample	Median Depth (m)	% Gravel	% Sand	% Silt	% Clay
BH/MW10	SS6	4.0	23	73	2	2
BH/MW18	SS6	4.0	39	52	7	2

5.3 GROUNDWATER CONDITIONS

Groundwater monitoring wells were installed in seven (7) of the boreholes to record the groundwater conditions. The groundwater levels were measured by Stantec personnel between June 4 and July 12, 2019 and the results are summarized in Table 5.4.

Table 5.4: Groundwater Levels – June 4 to July 12, 2019

Borehole	Ground Surface Elevation (m)	Date	Depth to Groundwater Below Ground Surface (mbgs)	Groundwater Elevation (m)
BH/MW02	277.0	June 4, 2019	not measured	not measured
		July 11, 2019	dry	Dry
BH/MW04	267.2	June 4, 2019	2.9	264.3
		July 11, 2019	3.0	264.2
BH/MW06	279.7	June 4, 2019	not measured	not measured
		July 12, 2019	3.8	275.9
BH/MW09	276.8	June 4, 2019	not measured	not measured
		July 11, 2019	3.5	273.3
BH/MW10	262.4	June 4, 2019	1.3	261.1
		July 11, 2019	1.8	260.6
BH/MW13	273.2	June 4, 2019	dry	Dry
		July 11, 2019	not measured	not measured
BH/MW15	283.3	June 4, 2019	dry	Dry
		July 11, 2019	not measured	not measured
BH/MW16	284.8	June 4, 2019	1.1	283.7
		July 11, 2019	2.0	282.8
BH/MW18	267.8	June 4, 2019	not measured	not measured
		July 11, 2019	dry	dry

Fluctuations in the groundwater levels should be anticipated throughout the various seasons. The hydrogeological report issued under separate cover should be referred to for additional groundwater and hydrogeological related information, including more recent groundwater level measurements.



6.0 DESIGN DISCUSSION & RECOMMENDATIONS

It should be noted that only limited design information was available at the time of this report which included conceptual plans. The Site will be developed for construction of low, medium and high-density housing, site servicing including sanitary sewers, storm sewers and municipal water supply with associated residential roads.

Based on the conceptual plans, the higher areas on site, generally above an elevation of 268, m will have grades cut by 1 m to 5 m and areas below this elevation will require fill with depths in the order of 1 m to 5 m.

In general, the subsurface stratigraphy encountered in the boreholes advanced on the subject Site generally consisted of topsoil underlain by silty sand underlain by silty sand till and sand and gravel. Stabilized groundwater was measured at 1.1 m to 3.8 m depths in the monitoring wells installed as part of this investigation, equivalent to Elevations 261.1 m to 283.7 m.

6.1 GEOTECHNICAL CONSIDERATIONS AND CONSTRAINTS

The following general development considerations and constraints are provided with respect to observations made during the current investigation, the subsurface conditions encountered, and the intended scope of development:

- Topsoil was encountered at the ground surface at boreholes BH03, BH/MW04, BH05, BH07, BH08, BH/MW09, BH/Mw10, BH14, BH/MW15 and BH/MW16 and was measured to be 250 to 800 mm in thickness. All topsoil must be stripped from the project area prior to site development;
- Following stripping of topsoil, the exposed native mineral soils on the Site will typically be suitable to support fill to raise grades. The existing silty sand encountered in the boreholes was found to be in a very loose to loose state of compactness which will make grading and placement of fill difficult. Where loose soils are encountered they will need to be sub-excavated to a stable base or alternatively a stabilizing layer of crushed granular fill can be placed to provide a suitable base for fill placement;
- The on-site soils are generally considered suitable for reuse as fill on-site, including engineered fill; however, portions of the silty sand were wet to saturated and will require drying prior to re-use. **It is therefore recommended that area grading operations be completed during the normally drier months of the year;**
- Very dense glacial till soils were encountered in the boreholes and these soils are inferred to contain frequent cobbles and boulders. Additional effort will be required for excavation of these soils; and,
- Upon excavation very dense glacial tills commonly excavate as blocks or solid chunks in the soil media. For re-use these soils must be broken down to sizes less than 150 mm in diameter and must be compacted with large vibratory equipment.

Additional geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of the planned Site development.

6.2 GRADING AND EARTHWORKS

6.2.1 General

Grading operations will be undertaken at the Site, including cutting material from higher areas and placing it as fill in lower lying areas to prepare the lands for the proposed development. Based on the conceptual plans, the majority of fill areas will be adjacent to the wetlands in the central portion of the site and in the valleys between hills. Fill depths are anticipated to range from 1.0 m to 5.0 m.



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The program for grading and earthworks should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction stormwater management control, and associated issues and concerns, and the intended end-use of the subject property as described herein.

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

6.2.2 Erosion & Sediment Control and Regulatory Constraints

An erosion and sediment control plan should be developed and implemented prior to commencement of construction, to direct precipitation and ground surface runoff away from the areas of construction. Identification of an outfall/discharge location will be required for this purpose. All erosion sedimentation control should be conducted in accordance to the approved construction design drawings.

6.2.3 Sub-Excavation and Proof Rolling

All topsoil, organics, and pre-existing fill must be removed (i.e. stripped) from both cut and fill areas prior to grading. Following stripping, the sub-grade in areas of proposed fill should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed. All very loose/soft soils or wet zones identified during site preparation or during general construction activities, are to be removed and replaced with approved Engineered Fill, as referenced below. The existing silty sand encountered in the boreholes was found to be in a very loose to loose state of compactness which will make grading and placement of fill difficult. Where loose soils are encountered they will need to be sub-excavated to stable soils or alternatively a 1.0 m stabilizing layer of crushed granular fill can be placed to provide a suitable base for fill placement.

The exposed sub-grade surface should be proof rolled and compacted across the entire area of the planned development. The proof rolling program should be undertaken using large, non-vibratory compaction equipment having a minimum static weight of 10 tonnes. This will provide a uniform, compact surface that will minimize the potential for infiltration of precipitation and ground surface runoff and promote overland drainage at the ground surface. The proof rolling program should consist of a minimum of five passes per unit area to provide a uniform surface for construction. Vibratory compaction is not recommended for silty soils, due to the potential for subgrade pumping that could occur if perched groundwater is present near the surface.

6.2.4 Engineered Fill Placement

Prior to engineered fill placement under proposed buildings areas, the topsoil and unsuitable native soils must be removed from under the proposed building footprints plus a horizontal distance beyond the periphery sufficient to allow for engineered fill pad construction. The engineered fill pad must extend horizontally 1 m beyond the edge of proposed footings, and then downwards and outwards at a slope of 1 horizontal to 1 vertical to competent soil. Geotechnical comments with respect to excavations are provided in Section 7.3.2.

Engineered fill will need to be benched into any native ground banks steeper than 3 horizontal to 1 vertical. The benching should be excavated with heights matching the engineered fill lift thickness.



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Excavation in the native mineral soils should be straight forward using large tracked excavating equipment, or motor scrapers; however, the presence of frequent cobbles and boulders should be anticipated in the glacial till soils. Further comments with respect to reuse of the on-site soils are provided Section 6.6.

It is anticipated that soils cut from higher areas comprising silty sand and silty sand till will be used as fill in lower areas. The native soils will be suitable for use as engineered fill, but typically have a variable low to high moisture content. Depending on the moisture contents at the time of construction drying of these native soils may be required prior to reuse on-site. If work is carried out in dry weather then water may have to be added to aid in compaction of sandy soils. Cobbles or boulders should be separated from the fill material prior to its use.

Upon excavation very dense glacial tills commonly excavate as blocks or solid chunks in the soil media. For re-use these soils must be broken down to sizes less than 150 mm in diameter and must be compacted with large vibratory equipment.

If additional imported fill materials are required for raising the grade on site, it is recommended that granular materials or materials with characteristics similar to the native soils on site (as described in this report) be imported for this purpose. Additional details with respect to materials recommended for use during periods of poor weather conditions are discussed below. Imported Granular 'B' (recommended) or OPSS SSM are recommended for use as engineered fill below buildings. Other soil types may also be suitable but must be tested and confirmed as acceptable by a geotechnical engineer prior to being imported to site.

All materials placed as engineered fill should be placed in 300 mm thick loose lifts. Each lift should be uniformly compacted to achieve a minimum of 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). The level of compaction should be increased to 100% SPMDD for areas of residential buildings of three or more stories (i.e. mid-rise to or high-rise).

6.2.5 Subgrade Fill Placement

Subgrade fill placement will also be required to raise grades under proposed roads and paved areas. The preparations of the subgrade prior to subgrade fill placement should be the same as for the engineered fill.

Any fill placed in paved areas should be placed in 300 mm thick loose lifts compacted to 98% SPMDD within the upper 1 m of the subgrade immediately below the pavement structure. Subgrade fill placed below 1 m of the pavement structure should be compacted to at least 95% SPMDD. The excavated native mineral soils should be suitable for reuse as subgrade fill placement, but moisture conditioning such as drying may be required for the silty deposits.

6.2.6 Adverse Weather Construction

Additional precautions, effort, and measures may be required, when and where construction is undertaken during late fall, winter, and early spring when the temperature and climatic conditions have an adverse influence on the standard construction practices or during periods of inclement weather.



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With respect to all earthworks activities undertaken during the late fall through to late spring, when less-than-ideal construction conditions may prevail, the following comments are provided:

1. Engineered fill under the buildings should comprise granular materials, such as imported sand or sand and gravel, Granular 'B' or OPSS SSM;
2. The intended area of fill should be clearly identified in the field prior to commencing the work;
3. Temporary ramps or roads for construction access must be constructed outside of the limits of intended fill;
4. Fill placement should be inspected by qualified field personnel on a full-time basis under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are considered to be unfavourable;
5. Imported materials that contain ice, snow, or any frozen material should not be accepted for use;
6. Overnight frost penetration may occur, even in granular fill materials, where precipitation and ground surface runoff pools and accumulates, and freezing temperatures exist. Any frozen materials must be removed prior to placing subsequent lifts of engineered fill. Breaking the frost in-situ is not considered acceptable; and,
7. It may be necessary to stop the placement of engineered fill during periods of cold, where ambient temperatures of -5°C or less, occur.

It should be noted that the placement of engineered fill materials during cold weather conditions requires extra effort beyond that typical when better climatic conditions prevail. At any time where conditions are deemed unfavorable, the engineered fill operation must be suspended. Any frost accumulating in placed fill must be removed prior to re-starting fill operations.

Appropriate scheduling of the work may also require specific consideration and revision from the typical adopted. The scope of work intended may have to be reduced or adjusted, and/or only select construction activities are undertaken during specific climatic conditions. The areas of planned engineered fill may have to be reduced on a daily basis, the extent of excavations may have to be limited, with all excavating and associated backfilling completed without delay.

6.3 SERVICING

6.3.1 General Servicing Overview

Following grading, the subdivision will be serviced to provide water and sewer services to the various lots and blocks. It is anticipated that the sewers will typically be at conventional depths of up to 3 m to 6 m below finished grade throughout the majority of the Site.

The predominant soils expected to be encountered during servicing are silty sand, silty sand till and poorly to well graded sand and gravel. Stabilized groundwater was measured at 1.1 m to 3.8 m depth in the monitoring wells installed as part of this investigation, equivalent to Elevations 261.1 m to 283.7 m.

Based on the soil and groundwater conditions encountered during this investigation, minor to moderate groundwater seepage should be anticipated in the upper silty sand and silty sand till deposits. Excavations that extend into the sand and gravel deposits will encounter significant ground water seepage. Where these conditions exist construction dewatering will likely be required.

It is recommended that Stantec review the proposed servicing plans once available to review the recommendations made as well as requirements for seepage collars.



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6.3.2 Excavations

Temporary excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

The native soils encountered in the boreholes can be classified as a Type 3 soil. The excavation side slopes for a Type 3 soil must be sloped at a maximum inclination of 1:1 (Horizontal: Vertical) from the base of excavation in accordance with the OHSA regulation.

Any excavations that extend into very loose soils or below the groundwater level and exhibit seepage should be classified as Type 4 soil. The maximum excavation side slope for a Type 4 soil is 3:1 (Horizontal: Vertical) in accordance with the OSHA regulation.

The side slopes of the excavations should be protected from exposure to precipitation and associated ground surface runoff, to prevent further softening and loss of strength of native soils and fill materials placed during the area grading activities that could lead to additional sloughing and caving.

Some sloughing and caving must be anticipated for excavations in silty sand, sand and gravel, and silt, particularly where excess moisture (precipitation, ground surface runoff, and/or presence of groundwater table) is present. Where sloughing and cave-in are encountered in the excavation, the slopes should be flattened to achieve a stable configuration.

If space is restricted such that the side slopes cannot be safely cut back in accordance with the OHSA Regulation, temporary shoring must be provided.

The potential for the presence of saturated sandy seams should be expected in the on-site soils. Any localized seepage encountered during the proposed construction should be handled by pumping from sumps using conventional submersible pumps provided the excavations remain open for a short period of time, less than 48 hours.

If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened to a stable configuration.

6.3.3 Bedding

Bedding for services should consist of OPSS Granular 'A' material. In general, a minimum of 150 mm of bedding and 300 mm of cover material is recommended. The portion of bedding below the pipe may comprise clear stone in place of Granular 'A' if needed for groundwater control provided the clear stone is fully wrapped in filter fabric.

The bedding and cover material should be compacted to achieve a minimum of 100% of the material's SPMD.

These recommendations should be confirmed with the pipe manufacturer and care must be taken to avoid incurring damage to the services. Pipe manufacturers may have additional/alternative requirements that should be reviewed by the Designer and Contractor prior to installation of the services.



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6.3.4 Trench Backfill

Backfill for service trenches may consist of the on-site native soils, subject to the constraints and limitations stated with respect to reuse of these soils.

All trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% below 1.5 m of the road subgrade and to 98% SPMDD for the upper 1.0 m of the backfill.

6.3.5 Municipal Infrastructure Backfilling

Where manholes and catch basins are required, these components should be constructed and backfilled in accordance with specifications outlined in OPSS 407: Construction Specification for Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation.

Settlements around manholes are common, and the settlements can be reduced by backfilling immediately around the manhole structure using OPSS Granular 'B' Type I material.

6.3.6 Dewatering

A hydrogeological investigation was completed in conjunction with the geotechnical investigation. Results of the hydrogeological investigation report are provided under separate cover and should be referred to for details related to groundwater at the Site.

The finalized invert elevations for the proposed services, once available, should be reviewed by Stantec to provide additional comments pertaining to dewatering requirements during construction.

6.4 ROAD DESIGN AND CONSTRUCTION

Following area grading as well as installation of site services in accordance with the recommendations provided in the previous sections of this report, the Site will be suitable for construction of municipal roads. The following pavement structures are recommended based on the anticipated subgrade conditions and City of Orillia standards for local and collector roadways.

Table 6.1: Recommended Pavement Structures

Material	Design Pavement Structure Thicknesses (mm)	
	Collector Road	Local Road
HL3 PG 58-28 Top course	40	40
HL4 or HL8 PG 58-28 Base course	100 (two lifts of 50)	60
OPSS 1010 Granular 'A' Base	150	150
OPSS 1010 Granular 'B' Type II Subbase or City of Orillia Crushed Granular B Material	375	300



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These structures should provide a typical pavement service life, provided regular maintenance is carried out during the life cycle of the pavements. The above pavement structure recommendations are based on typical expected use along with anticipated subgrade conditions. It should be noted that no design traffic data was provided to Stantec at the time of this design, and thus a detailed pavement design analysis was not carried out. The pavement design recommendations should be reviewed once the development concept has been finalized to ensure that the provided pavement designs are sufficient for the proposed traffic and encountered subgrade conditions.

The pavement subgrade must be proof rolled under the supervision of geotechnical personnel prior to Granular 'B' placement to identify any soft areas where thickened subbase is warranted.

The base and subbase materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 92% of Maximum Relative Density (MRD). Asphalt compaction must be carried out as specified in OPSS 310.

It is anticipated that the on-site soils will be used for site grading operations and the road subgrade will comprise silty sand soils. The silty soils will require installation of continuous pavement subdrains placed under the curb lines and connected to the catch basins. The subdrains should comprise 100 mm or 150 mm diameter perforated corrugated pipe with filter sock bedded in concrete sand. The top of pipe should be below the lower limit of the granular sub-base, and the subgrade below the sub-base should slope toward the subdrains.

6.5 BUILDING CONSTRUCTION

It is understood that low, medium and high-density housing is being considered for this development. Accordingly, it is anticipated that single detached, semi-detached, townhomes and apartment complexes will likely form the mix for the site. The recommendations provided are considered preliminary and should be reviewed once additional geotechnical data, type of structure including foundation type, as well as site grading plan become available.

Following grading, servicing, and road construction, it is anticipated that residential buildings will be constructed. It is recommended that the engineered fill be allowed to sit for at least 3 months after placement to ensure all consolidation under the fill's own weight is completed prior to building construction. The following provides preliminary input on building design following grading.

Engineered fill placed as outlined in Section 6.2.4 will be suitable to support conventional footings proportioned as per Part 9 of the Ontario Building Code. Alternatively, the geotechnical bearing resistances for factored Ultimate Limit States (ULS) and Serviceability Limit States (SLS) in Table 6.2 can be utilized for sizing conventional shallow footings for residential houses constructed on undisturbed native mineral soils or on approved engineered fill.

Table 6.2: Geotechnical Bearing Resistances

Factored ULS Bearing Resistance (kPa)	SLS Bearing Resistance (kPa)
225	150

The Ultimate Limits States (ULS) values provided above include a resistance factor of 0.5. The Serviceability Limits States (SLS) reaction values have been evaluated to provide a total settlement of 25 mm (or less) and differential settlement of 19 mm.



FINAL GEOTECHNICAL INVESTIGATION WEST ORILLIA NEIGHBORHOOD PLAN, RESIDENTIAL DEVELOPMENT, ORILLIA, ONTARIO

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Geotechnical bearing pressures for residential buildings of three or more stories (i.e. mid-rise to or high-rise) should be determined by site-specific supplemental investigation once the building type and location is determined.

The footings must be provided with a minimum of 1.4 m of soil cover for frost protection. Where construction is undertaken during winter conditions, the footing subgrade must be protected from freezing.

Foundation walls should be backfilled with free-draining granular material such as OPSS Granular 'B' Type I, or a manufactured drainage layer should be provided. The exterior (perimeter) wall backfill should be placed in loose lifts having a maximum thickness of 300 mm. Each lift should be uniformly compacted using suitable compaction equipment for the purpose intended, to achieve a minimum of 95% of the material's SPMD.

The National Building Code specifies that structures should be designed to withstand forces due to earthquake. For the purpose of earthquake design the relevant geotechnical information required based on the conditions at this Site is the "Site Class". For shallow spread or strip footing foundations, we recommend that Site Class D be applied to this site, in accordance with Table 4.1.8.4.A of the National Building Code (2015).

6.6 SITE MATERIALS REUSE

6.6.1 Topsoil

The existing topsoil will need to be stripped from below proposed building, pavement, and site servicing areas. The topsoil can either be removed from site or re-used in landscaped areas. The excavated organic soils are not suitable for reuse as engineered fill, trench backfill, granular base and sub-base materials.

6.6.2 Silty Sand and Sand and Gravel

The silty sand and sand and gravel soils are considered suitable for reuse as subgrade fill, engineered fill, and as backfill in trenches to the finished sub-grade level. Particles larger than 150 mm in size should be separated from these soils prior to reuse on-site.

The material is assessed as having a slight to moderate frost susceptibility in accordance to Section 3.2.5 of the MTO's 2013 Pavement Design and Rehabilitation Manual.

Silty sand and sand and gravel materials excavated from below the groundwater table will require drying and/or blending prior to reuse on-site to allow proper placement and compaction. This material should be placed with moisture contents that are within +/- 2.0% of the optimum moisture content level. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel.

These materials should not be considered as free draining unless additional laboratory testing is carried out at the time of construction to confirm low percentages of fines are present. Therefore, this soil should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, service pipe bedding, or sub-base and base layers in pavements.

6.6.3 Silty Sand Till

These soils may be considered for reuse as subgrade fill, engineered fill, and as backfill in trenches to the finished sub-grade level. Particles larger than 150 mm in size should be separated from these soils prior to reuse on-site.



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The silty sand till are assessed as having a moderate frost susceptibility in accordance to Section 3.2.5 of the MTO's 2013 Pavement Design and Rehabilitation Manual.

The high in-situ moisture content, possible perched groundwater conditions at shallow depth, very dense and blocky structure and high percentage of silt will make these soils difficult to handle, place, and compact, in any "less-than-ideal" weather conditions. Disturbance and loss of strength in the presence of excess moisture and/or construction traffic is a concern. It is recommended that reuse of this soil be limited to prevailing "dry" conditions and during favorable seasons.

This material should be placed with moisture contents that are within +/- 2.0% of the optimum moisture content level. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel. Blending and/or drying of the silty soils may be required depending on the moisture contents at the time of construction.

This material should not be considered as free draining. Therefore, this soil should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, foundation wall backfill, service pipe bedding, or sub-base and base layers in pavements.

6.7 SURFACE WATER MANAGEMENT

It is anticipated that Low Impact Development (LID) technologies will be considered for the development to promote infiltration of storm water. The infiltration potential will depend on the materials cut and placed during the area grading activities. At source infiltration of the predominant native silty sand, silt, and glacial till may be considered; however, lower infiltration rates should be expected and will depend on the gradation of the soils.

Table 6.3 below provides preliminary ranges of coefficients of permeability based on soil types observed in the current borehole program as per guidelines presented in the Supplementary Standard SB-6 of the Ontario Building Code. It is recommended that additional laboratory testing of representative soils is completed once site grades are established to confirm the soil type and composition as well as available infiltration potential of the on-site soils. Alternatively, field testing of the soil permeability at the infiltration feature subgrade with double ring permeameter equipment may be considered. It is noted that the distance to the groundwater table will affect the coefficient of permeability.

Table 6.3: Preliminary Ranges of Coefficients of Permeability

Soil Type	Coefficient of Permeability, K (cm/sec)
SM (Silty sands, sand-silt mixtures)	10-3 to 10-5
SM-SW (Well graded sand, gravelly sands, little or no fines)	10-1 to 10-4
SP (Poorly Graded Sands and Gravels)	10-2 to 10-4

We refer to the hydrogeological investigation report, being prepared by Stantec under separate cover, for additional commentary on infiltration rates.



FINAL GEOTECHNICAL INVESTIGATION WEST ORILLIA NEIGHBORHOOD PLAN, RESIDENTIAL DEVELOPMENT, ORILLIA, ONTARIO

Closure

July 8, 2020

7.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Charter Development LP. (Charter) who are identified as “the Clients” within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report;
- Basis of the report;
- Standard of care;
- Interpretation of site conditions;
- Varying or unexpected site conditions; and,
- Planning, design or construction.

This report has been prepared by Peter Healy and reviewed by Ron Howieson.

Respectfully Submitted,

STANTEC CONSULTING LTD.



APPENDICES

Appendix A
July 8, 2020

APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS



STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

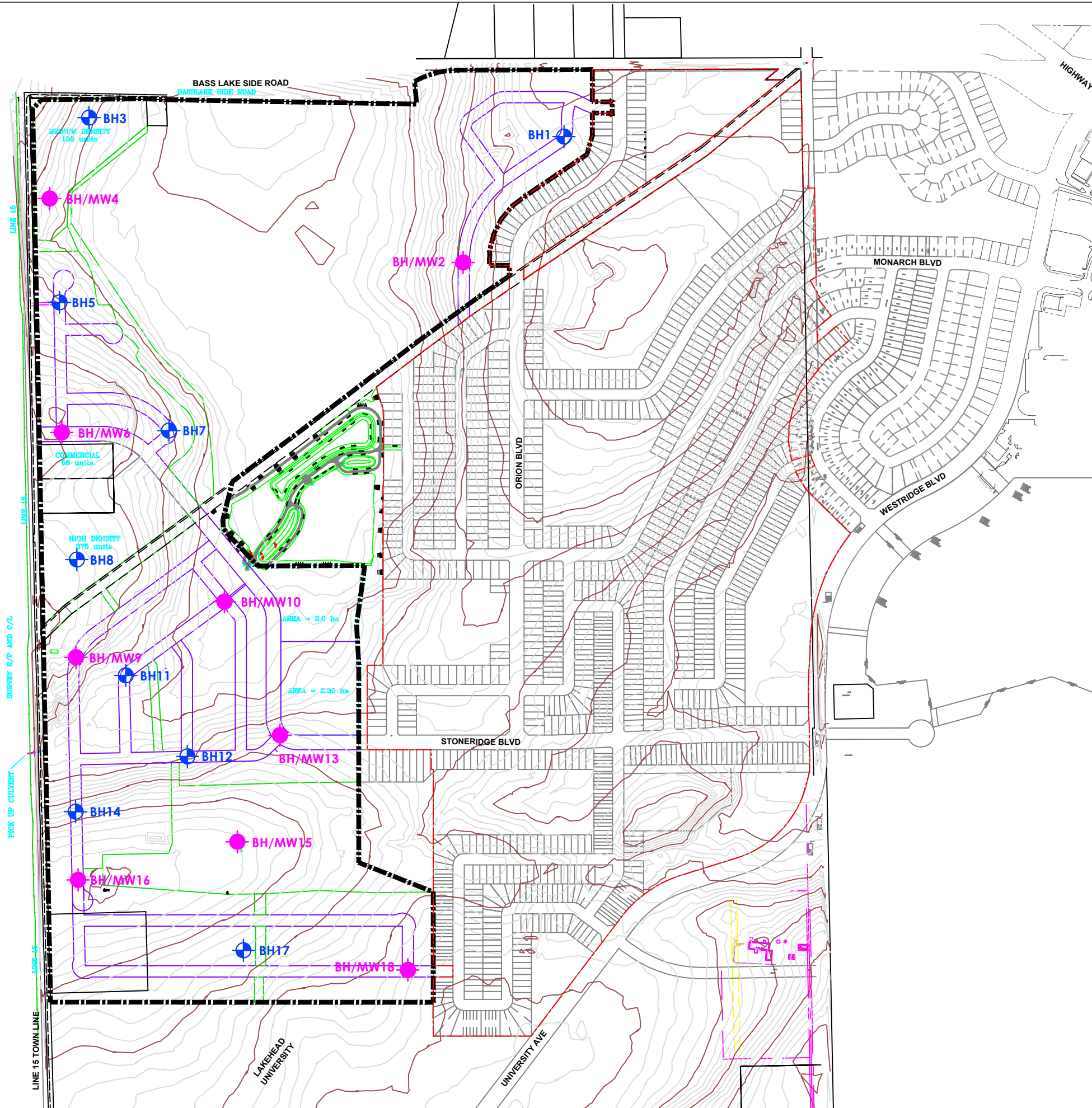
FINAL GEOTECHNICAL INVESTIGATION WEST ORILLIA NEIGHBORHOOD PLAN, RESIDENTIAL DEVELOPMENT, ORILLIA, ONTARIO

Appendix B
July 8, 2020

APPENDIX B




B.1 DRAWINGS

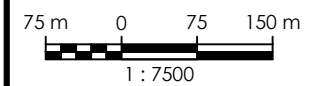
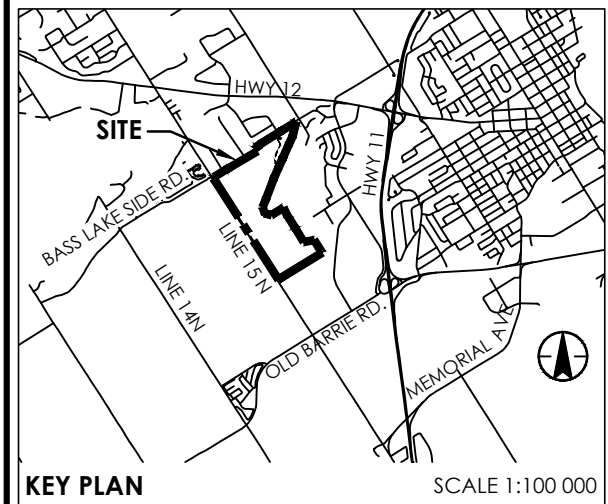




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LEGEND

-  BOREHOLE
-  BOREHOLE WITH MONITORING WELL
-  WORK SITE BOUNDARY



JULY 2020
 Project No. 121622652

Client/Project
 CHARTER DEVELOPMENT LP.
 WEST ORILLIA NEIGHBOURHOOD PLAN
 ORILLIA, ONTARIO

Drawing No.
1

Title
BOREHOLE LOCATION PLAN

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 2020/07/08 1:13 PM By: Briones, Gliceria

Appendix C
July 8, 2020

APPENDIX C

C.1 SYMBOLS & TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	Very Poor Quality
25-50	Poor Quality
50-75	Fair Quality
75-90	Good Quality
90-100	Excellent Quality

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

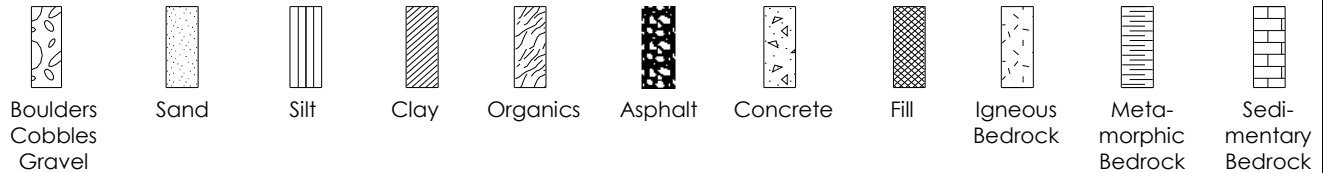
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

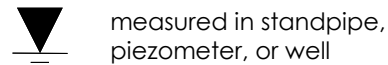
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
y	Unit weight
G _s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q _u	Unconfined compression
I _p	Point Load Index (I _p on Borehole Record equals I _p (50) in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

CLIENT Charter Constrution PROJECT No. 121622652
 LOCATION Orillia DATUM Geodetic
 DATES: BORING 17/05/2019 WATER LEVEL _____ TPC ELEVATION 269.5m

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL									
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS																			
										<div style="display: flex; justify-content: space-between; width: 100%;"> 50 100 150 200 </div>																			
										<div style="display: flex; justify-content: space-between; width: 100%;"> 10 20 30 40 50 60 70 80 90 100 </div>																			
										<div style="display: flex; justify-content: space-between; width: 100%;"> W_p W W_L </div>																			
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ●																			
0	269.5	Very Loose, Brown, Moist Silty SAND (SM) Till trace Organics -Wet, no Organics -Compact -Moist -Very Dense			0	SS	1	300 / 610	2	●																			
1					1	SS	2	360 / 610	2	●																			
2					2	SS	3	230 / 610	11	●																			
3					3	SS	4	530 / 610	22	●											>>▲								
4					4	SS	5	580 / 610	75	●											>>▲								
5					5	SS	6	150 / 610	50 / 150	●											>>▲								
6					6	SS	7	580 / 610	60	●																			
6	263.2				-Brown to Grey, Moist			20	SS	8	200 / 230	50 / 76	●											>>▲					
7		-End of Borehole at 6.35m			21																								
8					22																								
9					23																								
10					24																								
					25																								
					26																								
					27																								
					28																								
					29																								
					30																								
					31																								
					32																								

- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

CLIENT Charter Constrution

PROJECT No. 121622652

LOCATION Orillia

DATUM Geodetic

DATES: BORING 17/05/2019

WATER LEVEL _____

TPC ELEVATION 278.3m

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS										
										50 100 150 200 W _p W W _L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ●										
										10	20	30	40	50	60	70	80	90	100	
0	278.3	Very Loose, Brown, Moist Sandy TOPSOIL			0	SS	1	150 / 610	4	●										
1	277.5	Very Loose, Brown, Moist Silty SAND (SM) Till			2	SS	2	410 / 610	3	●										
2	276.8	Compact, Brown, Moist Clayey SAND (SC) Till			3															
2	276.0	Very Dense, Brown, Moist Silty SAND (SM) Till & Gravel			4	SS	3	330 / 610	22	●										
3		-Dense, Brown & Grey			5															
4		-Very Dense, Moist, No Gravel			6	SS	4	300 / 610	82	●										
4					7															
5		-Trace Gravel			8	SS	5	580 / 610	30	●										
5					9															
5					10	SS	6	230 / 610	50 / 150	●										
5					11															
5					12	SS	7	580 / 610	50	●										
5					13															
6	272.2	-Very Dense, Brown, Very Wet Well Graded SAND with SILT and Gravel			14	SS	8	76 / 76	50 / 76	●										
7		-End of Borehole at 6.17m -Augur Refusal on Boulder			15															
7					16															
8					17															
8					18															
9					19															
9					20															
10					21															
10					22															
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10					30															
10					31															
10					32															

- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

CLIENT Charter Construction

 PROJECT No. 121622652

 LOCATION Orillia

 DATUM Geodetic

 DATES: BORING 21/05/2019

 WATER LEVEL 04/06/2019

 TPC ELEVATION 283.3m

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)				REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m					
0	283.3				0										
	283.0	Very Loose, Brown, Moist TOPSOIL			1	SS	1	300 / 610	1						
1		Very Loose, Dark Brown, Moist Silty SAND (SM) Till -Compact, Organics			2										
					3	SS	2	520 / 610	19						
					4										
	281.6	-Trace Gravel			5										
2		Compact, Light Grey, Dry Broken pieces of ROCK			6	SS	3	430 / 610	29						
	281.0				7										
3		Very Dense, Light Brown, Moist Silty SAND (SM) Till some Gravel -Compact, Light Grey to Grey, Damp			8	SS	4	280 / 610	50 / 130						
					9										
					10	SS	5	610 / 610	23						
					11										
4		-Very Dense, Trace Gravel			12										
					13	SS	6	610 / 610	55						
					14										
5					15	SS	7	580 / 610	59						
					16										
					17										
6		-Light Brown, Damp			18										
					19										
					20										
7					21	SS	8	430 / 610	50 / 130						
					22										
					23										
					24										
8		-Brown, No Gravel -Very Dense, Light Brown			25										
					26	SS	9	410 / 610	50 / 100						
					27										
					28										
					29										
9					30	SS	10	230 / 610	50 / 76						
	273.9	-Light Grey, Moist			31			230 / 230							
		-End of Borehole at 9.37m			32										
10															

Continued Next Page

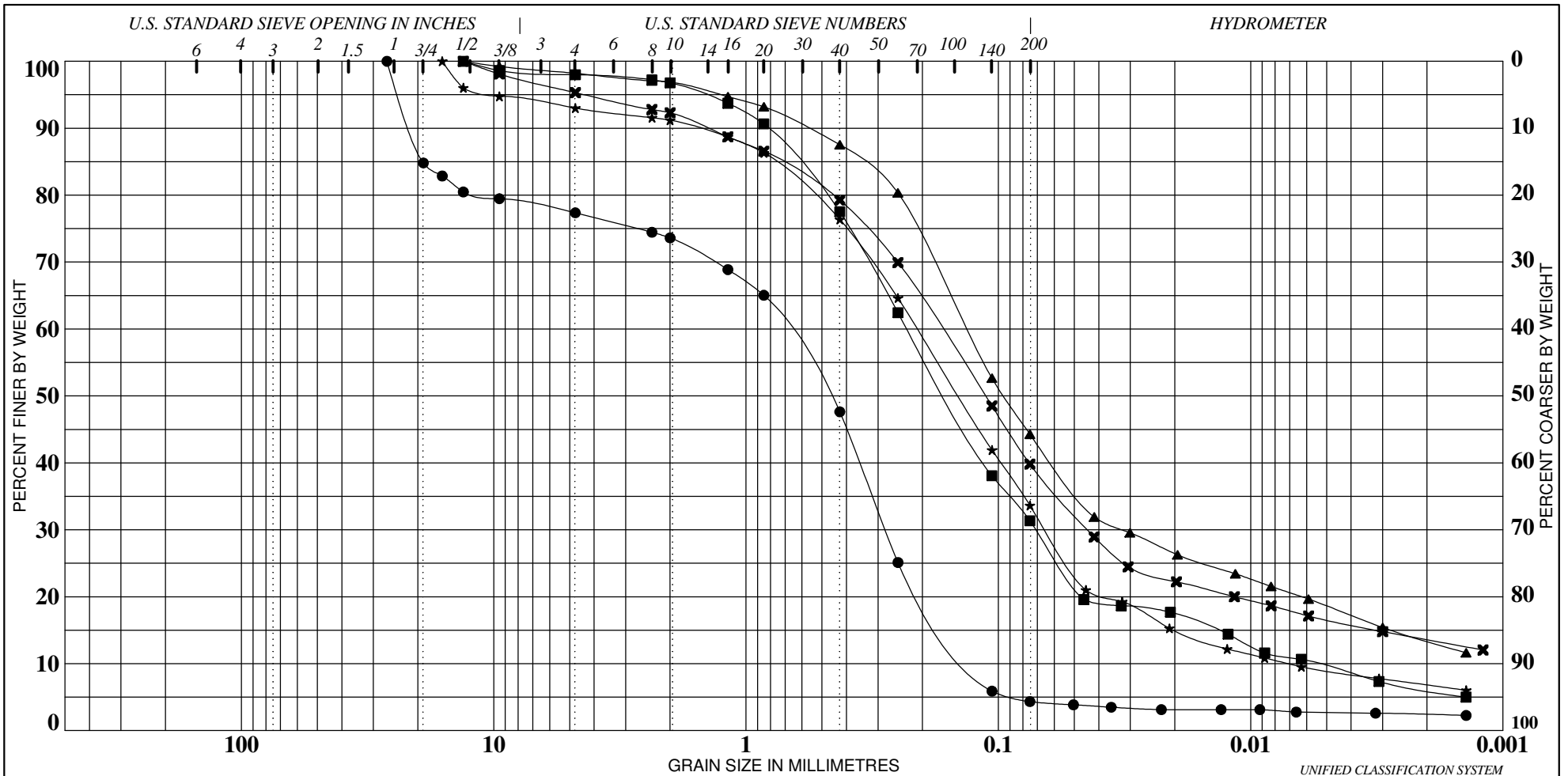
- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

Appendix D
July 8, 2020

APPENDIX D

D.1 LABORATORY TEST RESULTS

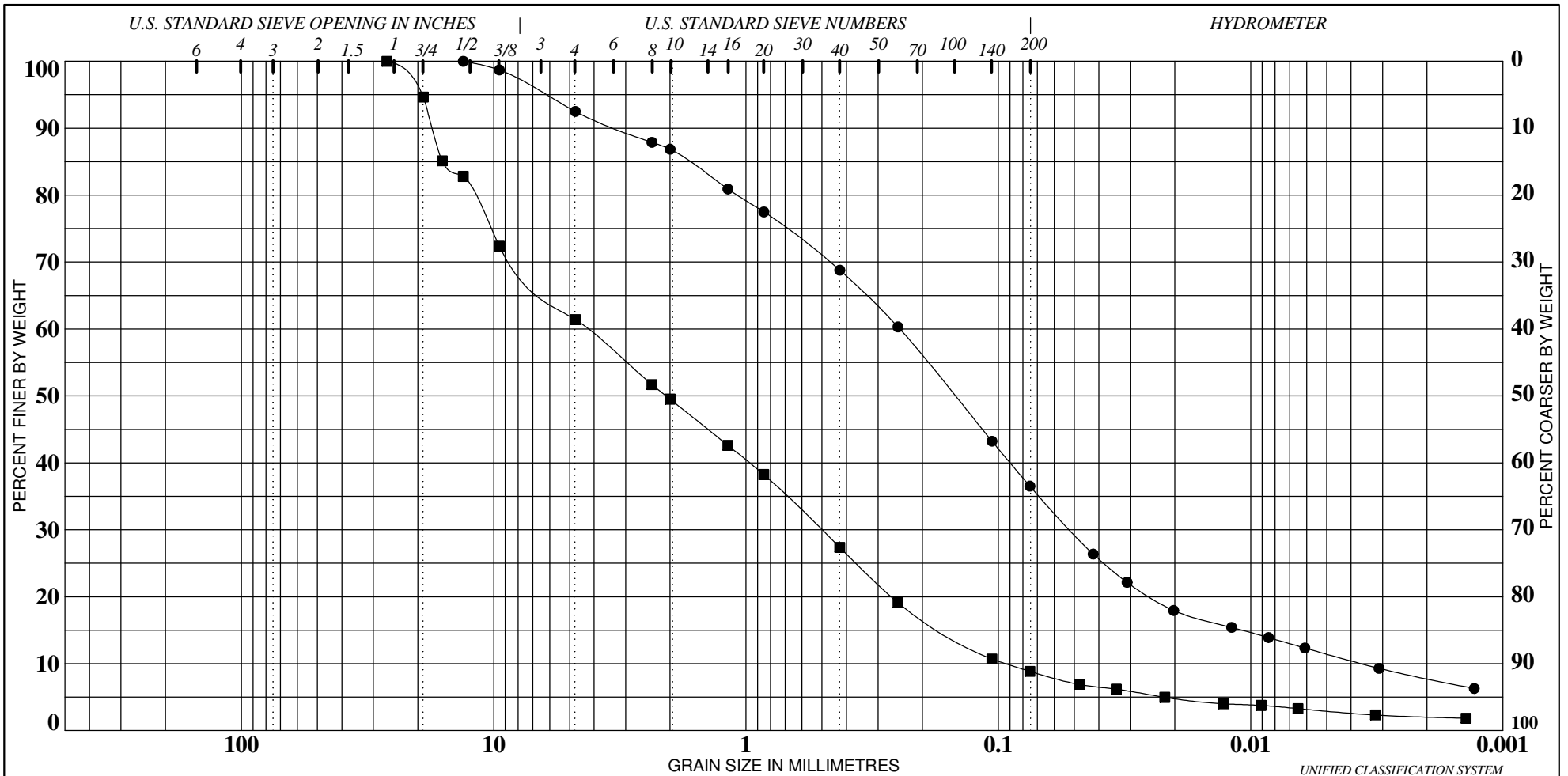




BLDs	COBBLES	GRAVEL		SAND			SILT & CLAY	
		coarse	fine	coarse	medium	fine	SILT	CLAY

Specimen	Depth (m)	Description	W%	%Gravel	%Sand	%Silt	%Clay	>75µ
● BH10	4.0	POORLY GRADED SAND with GRAVEL(SP)	12	23	73	2	2	96
■ BH16	1.0	SILTY SAND (SM)		2	67	25	6	69
▲ BH2	1.8	CLAYEY SAND(SC)	11	2	54	31	13	56
★ BH5	3.4	SILTY SAND(SM)	13	7	59	27	7	66
✕ BH8	4.5	SILTY SAND(SM)		5	55	26	14	60

	Project: West Orillia Neighborhood Plan Location: Project No.: 121622652	GRADATION CURVE (ASTM D422) Figure: 1 Remarks:
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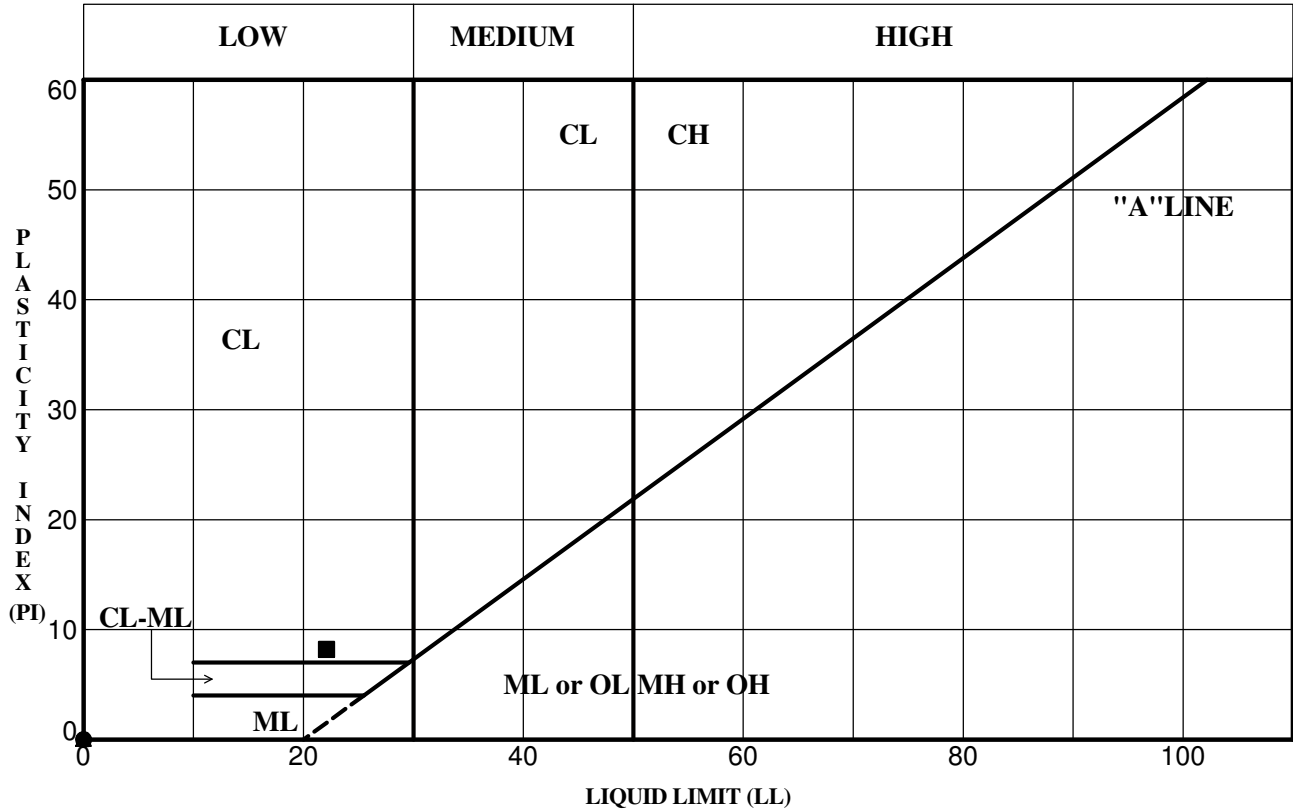


BLDs	COBBLES	GRAVEL		SAND			SILT & CLAY	
		coarse	fine	coarse	medium	fine	SILT	CLAY

Specimen	Depth (m)	Description	W%	%Gravel	%Sand	%Silt	%Clay	>75µ
● BH17	2.5	SILTY SAND(SM)	3	7	56	29	8	63
■ BH18	4.0	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	3	39	52	7	2	91

	Project: West Orillia Neighborhood Plan Location: Project No.: 121622652	GRADATION CURVE (ASTM D422) Figure: 2 Remarks:
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PLASTICITY CHART



Specimen	Depth (m)	LL	PL	PI	Fines	W%	Classification
● BH17	2.5	NP	NP	NP	37		SILTY SAND(SM)
■ BH2	1.8	22	14	8	44	11	CLAYEY SAND(SC)
▲ BH5	3.4	NP	NP	NP	34	13	SILTY SAND(SM)
★ BH8	4.5	NP	NP	NP	40		SILTY SAND(SM)

STN13-ATTERBERG_121622652.GPJ STANTEC MARKHAM DATA TEMPLATE_2015-05-20.GDT 7/4/19



Project: West Orillia Neighborhood Plan
Location:
Project No.: 121622652

ATTERBERG LIMITS
 (ASTM D4318)

Figure: 3
Remarks:

PROJECT:
West Orillia Neighborhood Plan
MOISTURE CONTENT

BH	DEPTH (ft)	SAMPLE	Moisture Content %
BH2	1	1	10.0
BH2	3.5	2	8.1
BH2	6	3	10.7
BH2	8.5	4	5.7
BH2	11	5	8.5
BH2	13.5	6	6.7
BH2	16	7	8.4
BH2	21	8	4.0
BH2	26	9	5.5
BH5	1	1	15.2
BH5	3.5	2	18.6
BH5	6	3	10.6
BH5	8.5	4	13.7
BH5	11	5	12.6
BH5	13.5	6	11.8
BH5	16	7	14.0
BH5	21	8	11.8
BH10	1	1	25.4
BH10	3.5	2	27.0
BH10	6	3	31.9
BH10	8.5	4	9.1
BH10	11	5	9.1
BH10	13.1	6	11.8
BH10	16	7	17.1
BH13	1	1	16.8
BH13	3.5	2	10.0
BH13	6	3	8.9
BH13	8.5	4	8.9
BH13	11	5	7.2
BH13	13.5	6	8.3
BH13	16	7	7.4
BH13	21	8	8.5

PROJECT:**West Orillia Neighborhood Plan****MOISTURE CONTENT**

BH	DEPTH (ft)	SAMPLE	Moisture Content %
BH18	1	1	16.0
BH18	3.5	2	8.6
BH18	6	3	9.6
BH18	8.5	4	6.3
BH18	11	5	3.7
BH18	14.7	6	2.5
BH18	16	7	2.5
BH18	21	8	2.6