Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

**Materials Testing** 

**Building Science** 

Archaeological Services

# **Geotechnical Investigation**

Proposed Multi-Storey Building Complex 1009 Trim Road Ottawa, Ontario

#### **Prepared For**

Starwood Group Inc.

#### Paterson Group Inc.

Consulting Engineers 154 Colonnade Road South Ottawa (Nepean), Ontario Canada K2E 7J5

Tel: (613) 226-7381 Fax: (613) 226-6344 www.patersongroup.ca

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# **1.0 Introduction**

Paterson Group (Paterson) was commissioned by Starwood Group Inc. (Starwood) to carry out a geotechnical investigation for the proposed multi-storey building complex to be located at 1009 Trim Road, in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the current this geotechnical investigation was to:

- Determine the subsoil and groundwater conditions at this site by means of test holes.
- Provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation.

# 2.0 Proposed Development

Based on available drawings, the proposed complex will consist of four high rise residential buildings. It is understood that all the towers will be constructed over a common podium consisting of an underground parking structure extending 2 levels under finished grade along Trim Road. The development will also include associated asphalt covered parking areas, access lanes and landscaped areas. It is further anticipated that the site will be municipally serviced.

# 3.0 Method of Investigation

#### **Field Program**

A previous field program was carried out by others in 2016. At that time a total of 6 boreholes and 4 test pits were advanced to a maximum depth of 47.9 m below the existing grade. These locations of these test holes are illustrated on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

The field program for the current investigation was carried out on June 29 to July 2, 2020 and consisted of a total of 4 boreholes drilled and sampled to a maximum depth of 15.9 m below the existing grade. A dynamic cone penetration test (DCPT) was carried out at two boreholes (BH 3 and BH 4) to determine inferred bedrock depth which ranged from 34.0 to 41.8 m below the existing grade. The borehole locations for the current investigation were determined in the field by Paterson personnel taking into consideration existing borehole coverage and existing site features. The locations of the boreholes are illustrated on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer. The testing procedure for boreholes consisted of augering to the required depths and at the selected locations and sampling the overburden.

#### Sampling and In Situ Testing

Borehole samples were recovered from a 50 mm diameter split-spoon (SS) or the auger flights (AU). All soil samples were visually inspected and initially classified on site. The split-spoon and auger samples were placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the split-spoon and auger samples were recovered from the test holes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The thickness of the overburden was evaluated during the course of the investigation by a dynamic cone penetration test (DCPT) at all borehole locations. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils. This testing was done in general accordance with ASTM D2573-08 - Standard Test Method for Field Vane Shear Test in Cohesive Soil. Reference should be made to the Soil Profile and Test Data Sheets provided in Appendix 1.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

#### Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless otherwise directed.

### 3.2 Field Survey

The test hole locations were determined by Paterson field personnel. The test hole locations and ground surface elevations at the test hole locations reference a geodetic datum. The test holes by others also reference a geodetic datum. The location of the test holes and the ground surface elevation at each test hole location, if available, are presented on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

# 3.3 Laboratory Testing

Soil samples recovered from the subject site were visually examined in our laboratory to review the field logs. All samples will be stored in the laboratory for a period of one month after the issuance of this report. They will then be discarded unless we are otherwise directed.

# 3.4 Analytical Testing

One soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. If available, the results are presented in Appendix 1 and are discussed further in Subsection 6.7.

# 4.0 Observations

# 4.1 Surface Conditions

The majority of the subject site is gravel covered with large boulders. Small to medium sized trees are present on the property boundaries of the subject site that border Trim Road and Inlet Private. The southern portion of the site is relatively flat and slightly above grade from Inlet Private. The site slopes towards the Ottawa river to the north, following Trim Road. An approximately 2 m high pile of boulders was observed at the northwestern portion of the site. The ground surface within the subject site slopes down gradually towards the northern portion of the site. The northern portion of the site is wet land from the Ottawa River. The site is bordered to the north by the Ottawa River, to the east by vacant treed land, to the west by Tweddle Road, and to the south by Trim Road.

# 4.2 Subsurface Profile

#### Overburden

Generally, the subsurface profile at the test hole locations consists of topsoil underlain by a fill consisting of silty sand mixed with clay and/or gravel. Fill consisting of boulders and blast rock were also noted on site. A very stiff brown silty clay deposit was encountered under the fill layer. The brown silty clay was underlain by a stiff grey silty clay layer. Practical refusal to DCPT was encountered in BH3 and BH4 between 34.0 and 41.8 m below existing grade. Specific details of the soil profile at each test hole location are presented Appendix 1.

#### Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River formation. The overburden drift thickness is estimated to be between 20 to 35 m.

#### 4.3 Groundwater

The groundwater level readings are presented in Table 1. It is important to note that groundwater level readings from piezometers and monitoring wells could be influenced by surface water infiltrating the backfilled boreholes within low permeability soils, such as at the subject site. Groundwater conditions can also be estimated based on the observed colour, moisture levels and consistency of the recovered soil samples. Based on Paterson's review of the recovered soil samples, the long-term groundwater level is expected to be at a depth ranging between 4 to 5 m below existing ground surface.

Table 1 - Summary of Groundwater Levels									
Borehole	Borehole Ground Measured Groundwater Level								
Number	Surface Elev. (m)	Depth (m)	Elevation (m)	Recording Date					
BH1-20	46.87	4.72	42.15	July 17, 2020					
BH2-20	47.73	4.51	43.22	July 17, 2020					
BH3-20	49.31	4.93	44.38	July 17, 2020					
MW16-1	47.30	3.29 1.5	44.01 45.80	July 17, 2020 April 7, 2016					
MW16-2	47.20	2.83 5.50	44.37 41.70	July 17, 2020 April 7, 2016					
MW16-3	48.80	4.10 5.02	44.70 43.78	July 17, 2020 April 7, 2016					
MW16-4	47.10	2.83 2.0	44.27 45.1	July 17, 2020 April 7, 2016					
MW16-5	43.6	4.80	38.80	April 7, 2016					
MW16-6	43.00	1.10 0.7	41.90 42.30	July 17, 2020 April 7, 2016					
Note: Ground	surface elevations a	t the test hole locat	ions are referenced to	o a geodetic datum.					

# 5.0 Discussion

### 5.1 Geotechnical Assessment

#### Foundation Design Considerations

From a geotechnical perspective, the subject site is suitable for the proposed high-rise buildings. It is expected that the proposed high-rise buildings will be founded on end bearing piled foundations extending to the bedrock surface. It is also expected that the underground parking structure beyond the towers' extent will be founded on conventional spread footings placed on an undisturbed, very stiff to stiff silty clay bearing surface.

A control joint between the piled foundation and the underground parking foundation can be considered to avoid differential settlement. The structural design will dictate if this is required.

#### Permissible Grade Raise

Due to the presence of a silty clay layer, the subject site is subjected to a permissible grade restriction. Our permissible grade raise recommendations are discussed in Subsection 5.3.

# 5.2 Site Grading and Preparation

#### **Stripping Depth**

Topsoil and fill, such as those containing organic or deleterious materials, should be stripped from under any buildings and other settlement sensitive structures.

#### **Fill Placement**

Fill placed for grading beneath the building area should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill material should be tested and approved prior to delivery to the site. The fill should be placed in maximum 300 mm thick lifts and compacted to 98% of the material's standard Proctor maximum dry density (SPMDD).

Site-excavated soil can be placed as general landscaping fill where settlement is a minor concern of the ground surface. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be placed to increase the subgrade level for areas to be paved, the fill should be compacted in maximum 300 mm thick lifts and to a minimum density of 95% of the respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls due to the frost heave potential of the site excavated soils below settlement sensitive areas, such as concrete sidewalks and exterior concrete entrance areas.

Fill used for grading beneath the base and subbase layers of paved areas should consist, unless otherwise specified, of clean imported granular fill, such as OPSS Granular A, Granular B Type II or select subgrade material. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the paved areas should be compacted to at least 95% of its SPMDD.

# 5.3 Foundation Design

#### **Conventional Shallow Footings**

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, very stiff brown silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **200 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **300 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, stiff grey silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed prior to the placement of concrete for footings.

For the parking garage, the bearing resistance value given for footings at SLS will be subjected to potential post construction total and differential settlements of 20 and 10 mm, respectively.

#### Footings on Lean Concrete

Where the underside of footings is located within the existing fill layer, consideration should be given to lower the footings to a native bearing surface.

Alternatively, footings can be placed over lean concrete in-filled trenches extending from design underside of footing level to the native bearing surface. The bearing surface surface should be reviewed and approved by the geotechnical consultant at the time of excavation. The near vertical, zero entry trench should extend at least 300 mm beyond the outside face of the footing and be in-filled with minimum 15 MPa lean concrete. It should be noted that the zero-entry trenches would be excavated through silty sand and therefore, the sidewalls could become unstable. Precautions should be taken during construction to ensure personnel and equipment are kept away from the top of the trenches (see Subsection 6.3).

#### Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided to a stiff silty clay when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:1V passes only through in situ soil or engineered fill.

#### **Piled Foundation**

It is expected that the buildings will be constructed over concrete filled steel pipe piles driven to refusal on the bedrock surface.

For deep foundations, concrete-filled steel pipe piles are generally utilized in the Ottawa area. Applicable pile resistance at SLS values and factored pile resistance at ULS values are given in Table 1. A resistance factor of 0.4 has been incorporated into the factored ULS values. Note that these are all geotechnical axial resistance values.

The geotechnical pile resistance values were estimated using the Hiley dynamic formula, to be confirmed during pile installation with a program of dynamic monitoring. For this project, the dynamic monitoring of two (2) to four (4) piles would be recommended. This is considered to be the minimum monitoring program, as the piles under shear walls may be required to be driven using the maximum recommended driving energy to achieve the greatest factored resistance at ULS values. Re-striking of all piles at least once will also be required after at least 48 hours have elapsed since initial driving.

Table 2 - Pile Foundation Design Data										
Pile Outside	Pile Wall	Geotechn Resis	Final Set	Transferred Hammer						
Diameter (mm)	Thickness (mm)	SLS (kN)	Factored at ULS (kN)	(blows/ 12 mm)	Energy (kJ)					
245	9	925	1110	6	27					
245	11	1050	1260	6	31					
245	13	1200	1440	6	35					

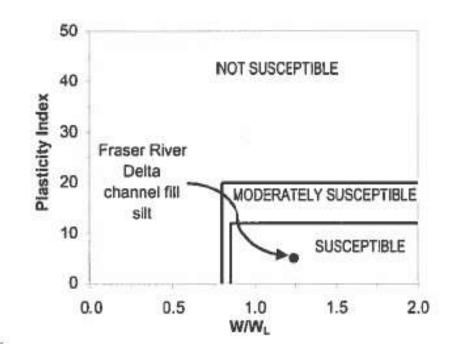
### Permissible Grade Raise Recommendations

The grade raise restriction for the subject site was determined to be **2 m** above original ground surface.

# 5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Site Class D** for the proposed foundations considered at this site, as per Table 4.1.8.4.A of the OBC 2012.

Further to the above, it should be noted that liquefaction potential is assessed as part of the seismic design considerations. The silty clay deposit encountered at the subject site has been encountered during numerous geotechnical investigations completed by Paterson across the greater Ottawa area. Based on our experience, and supported by multiple laboratory testing results, this material would typically be considered highly plastic with a plasticity index (PI) greater than 20. Figure 6.15 of the Canadian Foundation Manual (2006) provides criteria for liquefaction assessment of fine-grained soils from Bray et al. (2004) as shown in Figure 1 below.



#### Figure 1 - Bray et al. (2004) criteria for liquefaction assessment of fine-grained soils

Based on the Atterberg Limits testing results conducted on the representative soils samples at the subject site resulting in Plasticity Index (PI) above 20 in conjunction with the site specific shear wave velocity test results, the underlying soils at the subject site not considered susceptible to liquefaction or subsequent 'earth flows' from a geotechnical perspective.

#### 5.5 Basement Slab

The basement areas for the proposed project will be mostly parking and the recommended pavement structure noted in Subsection 5.7 will be applicable. However, if storage or other uses of the lower level where a concrete floor slab will be constructed, the upper 200 mm of sub-slab fill is recommended to consist of 19 mm clear crushed stone. The upper 200 mm of sub-slab fill is recommended to consist of OPSS Granular A crushed stone for slab on grade construction. All backfill material within the footprint of the proposed building(s) should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. All backfill material within the footprint of the proposed building(s) should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD.

In consideration of the groundwater conditions encountered at the time of the current and previous fieldwork, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone under the lower basement floor (discussed in Subsection 6.1).

### 5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structures. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m<sup>3</sup>. The applicable effective (undrained) unit weight of the retained soil can be taken as  $13 \text{ kN/m}^3$ , where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

#### Lateral Earth Pressures

The static horizontal earth pressure ( $p_o$ ) can be calculated using a triangular earth pressure distribution equal to  $K_o \cdot \gamma \cdot H$  where:

- $K_{o}$  = at-rest earth pressure coefficient of the applicable retained soil, 0.5
- $\gamma$  = unit weight of fill of the applicable retained soil (kN/m<sup>3</sup>)
- H = height of the wall (m)

An additional pressure having a magnitude equal to  $K_o \cdot q$  and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the "at-rest" case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

#### Seismic Earth Pressures

The total seismic force ( $P_{AE}$ ) includes both the earth force component ( $P_o$ ) and the seismic component ( $\Delta P_{AE}$ ). The seismic earth force ( $\Delta P_{AE}$ ) can be calculated using 0.375·a<sub>c</sub>· $\gamma$ ·H<sup>2</sup>/g where:

 $a_c = (1.45 - a_{max}/g)a_{max}$   $\gamma = unit weight of fill of the applicable retained soil (kN/m<sup>3</sup>)$ H = height of the wall (m)g = gravity, 9.81 m/s<sup>2</sup>

The peak ground acceleration,  $(a_{max})$ , for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component (P<sub>o</sub>) under seismic conditions can be calculated using P<sub>o</sub> = 0.5 K<sub>o</sub>  $\gamma$  H<sup>2</sup>, where K<sub>o</sub> = 0.5 for the soil conditions noted above.

The total earth force  $(P_{AE})$  is considered to act at a height, h (m), from the base of the wall, where:

 $h = \{P_{o} \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\} / P_{AE}$ 

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

### 5.7 Pavement Design

Car only parking, access lanes, heavy truck parking areas, local and collector roadways are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 3 - Recommended Pavement Structure - Car Only Parking Areas									
Thickness (mm)	Material Description								
50	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete								
150	BASE - OPSS Granular A Crushed Stone								
300	SUBBASE - OPSS Granular B Type II								
SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill									

Thickness Material Description								
40	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete							
50	Binder Course - HL-8 or Superpave 19.0 Asphaltic Concrete							
150	150 BASE - OPSS Granular A Crushed Stone							
400 SUBBASE - OPSS Granular B Type II								

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable compaction equipment.

#### Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Where silty clay is encountered at subgrade level, consideration should be given to installing subdrains during the pavement construction. These drains should be constructed according to City of Ottawa specifications. The drains should be connected to a positive outlet. The subgrade surface should be crowned to promote water flow to the drainage lines. The subdrains will help drain the pavement structure, especially in early Spring when the subgrade is saturated and weaker and, therefore, more susceptible to permanent deformation.

# 6.0 Design and Construction Precautions

## 6.1 Foundation Drainage and Backfill

#### Foundation Drainage/Flood Proofing

Based on the available information, the lower parking level will be located below the 100 year flood level. To limit long-term groundwater infiltration, it is recommended that a flood proofing system be designed for the proposed building. The system should consist of a water suppression system to lessen the infiltration volumes and manage discharge. Also, a perimeter foundation drainage system will be required as a secondary system to account for any groundwater which breaches the primary groundwater infiltration control system.

The groundwater infiltration control system should extend above the 1:100 year flood level and the following is suggested for preliminary design purposes:

- Pour a concrete mud slab at the base of the excavation to create a horizontal hydraulic barrier. Typically, the minimum thickness of the concrete mud slab is 150 mm.
- Place a composite drainage layer, such as Delta Drain 6000 or equivalent, over the foundation wall(as a secondary system). The composite drainage layer should extend from finished grade to underside of footing level.
- Place a suitable waterproofing membrane on the drainage layer, such as a bentomat liner system or equivalent. The membrane liner should extend down to footing level. The membrane liner should tie into the concrete mud slab.
- Pour foundation wall against the composite drainage system.

It is recommended that the composite drainage system (such as Delta Drain 6000 or equivalent) extend down to the footing level. It is recommended that 150 mm diameter sleeves at 3-6 m centres be cast in the footing or at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area.

It is important to note that the building's sump pit and elevator pit be considered for waterproofing in a similar fashion. A detail can be provided by Paterson once the design drawings are available for the elevator and sump pits.

#### **Underfloor Drainage**

It is anticipated that underfloor drainage will be required to control water infiltration. For design purposes, we recommend that 150 mm diameter perforated pipes be placed at 6 m centres. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

#### Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials compacted in lifts as per Subsection 5.2 for areas where frost susceptible structures, such as the site access lane, are to be located. A frost taper should also be provided at the transition between the building face and the native, silty clay subgrade for the access lane.

The greater part of the site excavated materials will be frost susceptible and, as such, are acceptable for foundation wall backfill within landscaped finished areas only.

# 6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone should be provided in this regard.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

The parking garage may require protection against frost action depending on the founding depth. Unheated structures, such as the access ramp wall footings, may be required to be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided.

# 6.3 Excavation Side Slopes

#### Temporary Side Slopes

The temporary excavation side slopes anticipated should either be excavated to acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain safe working distance from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by "cut and cover" methods and excavations should not remain open for extended periods of time.

#### Temporary Shoring

Temporary shoring may be required for the overburden soil to complete the required excavations where insufficient room is available for open cut methods. The shoring requirements designed by a structural engineer specializing in those works will depend on the depth of the excavation, the proximity of the adjacent structures and the elevation of the adjacent building foundations and underground services. The design and implementation of these temporary systems will be the responsibility of the excavation contractor and their design team. Inspections and approval of the temporary system will also be the responsibility of the designer. Geotechnical information provided below is to assist the designer in completing a suitable and safe shoring system. The designer should take into account the impact of a significant precipitation event and designate design measures to ensure that a precipitation will not negatively impact the shoring system or soils supported by the system. Any changes to the approved shoring design system should be reported immediately to the owner's structural design prior to implementation.

The temporary system could consist of soldier pile and lagging system or interlocking steel sheet piling. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be included to the earth pressures described below. These systems could be cantilevered, anchored or braced. Generally, it is expected that the shoring systems will be provided with tie-back rock anchors to ensure their stability. The shoring system is recommended to be adequately supported to resist toe failure and inspected to ensure that the sheet piles extend well below the excavation base. It should be noted if consideration is being given to utilizing a raker style support for the shoring system that lateral movements can occur and the structural engineer should ensure that the design selected minimizes these movements to tolerable levels.

The earth pressures acting on the shoring system may be calculated with the following parameters.

Table 5 - Soil Parameters							
Parameters	Values						
Active Earth Pressure Coefficient (K <sub>a</sub> )	0.33						
Passive Earth Pressure Coefficient ( $K_p$ )	3						
At-Rest Earth Pressure Coefficient (K <sub>o</sub> )	0.5						
Dry Unit Weight (γ), kN/m³	20						
Effective Unit Weight (γ), kN/m <sup>3</sup>	13						

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible. The dry unit weight should be calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight are calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil/bedrock should be calculated full weight, with no hydrostatic groundwater pressure component. For design purposes, the minimum factor of safety of 1.5 should be calculated.

# 6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa. A minimum of 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 300 mm above the obvert of the pipe should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts and compacted to 95% of the material's SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

To reduce long term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compatible brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at stratigic locations at no more than 60 m intervals in the service trenches.

### 6.5 Groundwater Control

#### **Groundwater Control for Building Construction**

It is anticipated that groundwater infiltration into the excavations should be low through the sides of the excavation and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment, Conservation and Parks (MECP) Catergory 3 permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes, being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

#### Long-term Groundwater Control

The recommendations for the proposed building long-term groundwater control are presented in Subsection 6.1. Any groundwater encountered along the building perimeter or sub-slab drainage system will be directed to the proposed building cistern/sump pit. Provided the proposed groundwater infiltration control system is properly implemented and approved by the geotechnical consultant at the time of construction, the groundwater flow should be low (i.e.- less than 30,000 L/day per building) with peak periods noted after rain events. A more accurate estimate can be provided at the time of construction, once groundwater infiltration levels are observed. The groundwater flow should be controllable using conventional open sumps.

#### Impacts on Neighbouring Structures

Based on observations, the long term groundwater level is anticipated at depths below 4-5 m. A local groundwater lowering is anticipated under short-term conditions due to construction of the proposed building. The extent of any significant groundwater lowering should occur within a limited range of the subject site due to the minimal temporary groundwater lowering.

The neighbouring structures are expected to be founded within the brown silty clay crust bearing surface. No issues are expected, with respect to groundwater lowering, that would cause long term damage to adjacent structures surrounding the proposed building.

### 6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsurface conditions mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions.

# 6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the samples indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of an aggressive to highly aggressive corrosive environment.

#### 7.0 Recommendations

For the foundation design data provided herein to be applicable that a materials testing and observation services program is required to be completed. The following aspects be performed by the geotechnical consultant:

- Review of the site master grading plan, once available.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials.
- Observation of the placement of the foundation insulation, if applicable.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to backfilling and follow-up field density tests to determine the level of compaction achieved.
- Observation and review of placement of waterproofing and groundwater control system.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming the construction has been conducted in general accordance with the recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.



# 8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review the grading plan once available. Also, our recommendations should be reviewed when the project drawings and specifications are complete.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Starwood or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

#### Paterson Group Inc.

Joey R. Villeneuve, M.A.Sc., P.Eng., ing

David J. Gilbert, P.Eng.

#### **Report Distribution**

- Starwood Group Inc.
- Paterson Group



# **APPENDIX 1**

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

**TEST HOLE LOGS BY OTHERS** 

ANALYTICAL TESTING RESULTS

## SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geodetic

**Geotechnical Investigation** Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

FILE NO.

DATUM

										PG533	6
REMARKS									HOL	E NO	
BORINGS BY Track-Mount Power Aug	er	1		D	ATE .	June 29, :	2020	1		BH 1-2	ס
SOIL DESCRIPTION	PLOT		SAN	IPLE		DEPTH	ELEV.			Blows/0.3m Dia. Cone	Mell
	STRATA F	ТҮРЕ	NUMBER	°. © © © © © ©	VALUE r RQD	(m)	(m)		-	Content %	Monitoring Well Construction
GROUND SURFACE	LS I	H	NN	REC	N N N			20	40	60 80	Cor
FILL: Brown silty sand with gravel,		AU	1			0-	-46.87				
crushed stone, trace cobbles, boulders and blast rock <u>1.1</u> ;	2	i ss ∑ss	2	57	50+	1-	-45.87				
<b>FILL:</b> Brown/black silty clay with gravel, trace sand, brick, occasional cobbles and boulders 2.13	3	ss	3	58	11	2-	-44.87				
FILL: Brown/black sand with		ss	4	50	38						
crushed stone, shale fragments, some clay, occasional cobbles and 3.0. boulders	5	ss	5	79	14	3-	-43.87				
FILL: Grey-brown silty clay, some		ss	6	75	17	4-	-42.87				
sand, gravel, trace cobbles, plastic, organics		ss	7	50	Р	5-	-41.87				
<u>6.1</u>		x ss ss	8 9	54 88	Р	6-	-40.87				2 <b>4</b> 9
		x ss	10	92		7-	-39.87				
		x ss	11	83			00.07			· · · · · · · · · · · · · · · · · · ·	
Hard to very stiff, brown <b>SILTY</b> CLAY		∦ ss	12	100		8-	-38.87				
		x ss	12	100		9-	-37.87				
- stiff and grey by 8.3m depth		N 22	13	100		10-	-36.87				
						11-	-35.87				
						12-	-34.87				
								<b>A</b>			
						13-	-33.87				
		ss	14	50	Р	14-	-32.87	4			·····
						15	21.07				
<u>15.5</u>	4					15-	-31.87	Å			
End of Borehole											
(GWL @ 4.72m - July 17, 2020)											
								20 Shea ▲ Undist		60 80 ength (kPa) △ Remoulded	100

## SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geodetic

DATUM

**Geotechnical Investigation** Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

FILE NO.

DATUM Geodelic										PG5336	
REMARKS	~r				ATE	lune 20	2020		HOLE N	<sup>o.</sup> BH 2-20	
BORINGS BY Track-Mount Power Aug			SAN			June 30, :	2020	Pen B	l Resist Bl	lows/0.3m	=
SOIL DESCRIPTION	PLOT				El a	DEPTH (m)	ELEV. (m)		i0 mm Dia		ng We
	STRATA	ТҮРЕ	NUMBER	» Recovery	VALUE r RQD			• <b>v</b>	Vater Co	ntent %	Monitoring Well Construction
GROUND SURFACE	ß		N	RE	N OF	0-	-47.73	20	40	60 80	≥ိပိ
FILL: Brown silty sand with crushed stone, trace organics, occasional boulders and blast rock			1	10	10		-46.73				त्त्रातित्ति विवित्तितिः
		∦ ss √	2	10	13		-40.73				
		X SS	3	42	18	2-	-45.73				
<b>FILL</b> • Prown to grow silty alow some		∦ ss	4	50	7	3-	-44.73				
<b>FILL:</b> Brown to grey silty clay, some sand and crushed stone, occasional boulders		ss X S	5	50	43		/ <b>- -</b> -				
- some wood from 3.8 to 4.1m depth		∦ ss	6	17	18	4-	-43.73				Ţ Ţ Ţ
		ss	7	33	3	5-	-42.73				
6.10		ss	8	17	3	6-	-41.73				
		ss	9	100	9						
		ss	10	75	Р	7-	-40.73				
Hard to very stiff, brown <b>SILTY</b>		ss	11	100	Р	8-	-39.73			1	<b>99</b> ▲
CLAY		ss	12	100	Р	   9-	-38.73				
- stiff and grey by 8.2m depth							00.70	<b>A</b>			
						10-	-37.73				-
						11-	-36.73	<u> </u>			•
						12-	-35.73				•
		ss	13	100	Р		55.75	4			
						13-	-34.73				-
						14-	-33.73			$\mathbf{K}$	-
						15-	-32.73				
15.54						15-	-32.73	<u> </u>			
(GWL @ 4.51m - July 17, 2020)											
(GVVL @ 4.3111 - JUIY 17, 2020)											
								20 Shea	ar Streng	jth (kPa)	00
								▲ Undis		Remoulded	

## SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

REMARKS	

DATUM Geodetic				
REMARKS				
BORINGS BY Track-Mou	unt Power Auge	er		
SOIL DESCRIF		РГОТ		SA
GROUND SURFACE	TION	STRATA P	ТҮРЕ	NUMBER
FILL: Brown silty sand w	vith crushed			1
stone, occasional cobble and blast rock	es, boulders 1.52		≊ SS	2
	1.02_		ss	3
FILL: Brown sity clay, tra	ace sand,	$\boxtimes$	$\nabla \mathbf{c} \mathbf{c}$	4

FILE NO. PG5336

> HOLE NO. BH 3-20

SOIL DESCRIPTION	PLOT		SAN	IPLE		DEPTH ELEV.	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ≥ 5
GROUND SURFACE	STRATA P	ТҮРЕ	NUMBER	» RECOVERY	N VALUE or RQD	(m) (m)	Pen. Resist. Blows/0.3m       ■         ● 50 mm Dia. Cone       A builtonian of the second sec
FILL: Brown silty sand with crushed	$\times\!\!\times\!\!\times$		1			0+49.31	
stone, occasional cobbles, boulders and blast rock		≊ SS	2	33	50+	1-48.31	
<b>FILL</b> Prown city clay, trace cond		ss	3	0	10	2-47.31	
<b>FILL:</b> Brown sity clay, trace sand, gravel and wood		∦ss ∛ss	4 5	58 83	3 18	3-46.31	
<u>3.96</u>		ss	6	75	19	4-45.31	
		ss	7	92	16	5-44.31	
Hard to very stiff, brown <b>SILTY</b>		∦ss ∦ss	8 9	92 92	P P	6-43.31	250 = 184 =
CLAY		ss	10	96	P	7-42.31	
		ss	11	92	Р	8-41.31	
- stiff and grey by 8.4m depth		ss	12	96	Р	9-40.31	
		∦ss	13	100	P	10-39.31	
						11-38.31	
						12-37.31	
						13-36.31	
		ss	14	96	Р	14-35.31	
<u>15.54</u>		_				15-34.31	106
Dynamic Cone Penetration Test commenced at 15.54m depth. Cone pushed to 31.7m depth.						16-33.31	
						17-32.31	20         40         60         80         100           Shear Strength (kPa)           ▲ Undisturbed         △ Remoulded

DATE July 2, 2020 

# SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

DATUM	Geodetic

#### REMARKS

FILE NO. **PG5336** 

#### HOLE NO. BH 3-20

ORINGS BY Track-Mount Power A	uger	er D			ATE .	July 2, 20	20	1	BH 3-20				
SOIL DESCRIPTION	PLOT		SAN	IPLE	1	DEPTH ELEV.			en. Resist. Blows/0.3m • 50 mm Dia. Cone			Monitoring Well Construction	
	STRATA	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	(m)	(m)	0	Nater	Conten	t %	onitoring	
ROUND SURFACE				8	2 '	17-	-32.31	20	40	60	80	Σ	
						18-	-31.31						
						19-	-30.31		· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·		
							-29.31		· · · · · · · · · · · · · · · · · · ·				
						21-	-28.31						
						22-	-27.31				·····		
						23-	-26.31		· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·		
						24-	-25.31				· · · · · · · · · · · · · · · · · · ·		
						25-	-24.31						
						26-	-23.31			······································	· · · · · · · · · · · · · · · · · · ·		
							-22.31					· · ·	
						28-	-21.31				······································		
						29-	-20.31						
						30-	-19.31			······································	······································		
						31-	-18.31						
						32-	17.31						
						33-	-16.31						
						34-	-15.31						
								20 She ▲ Undis		60 ength (l		00	

# SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

DATUM Geodetic									FILE NO	PG5336		
<b>REMARKS</b> BORINGS BY Track-Mount Power Auge	٩r			г	DATE .	July 2, 20	)20		HOLE N	<sup>o.</sup> BH 3-20		
	PLOT		SAN	/IPLE		DEPTH	ELEV.		. Resist. Blows/0.3m 50 mm Dia. Cone			
	STRATA I	ТҮРЕ	NUMBER	% RECOVERY	N VALUE or RQD	(m)	(m)		Vater Co		Monitoring Well Construction	
GROUND SURFACE	ß		Z	RE	z °	- 34-	-15.31	20	40	60 80	≚ပိ	
						35-	-14.31				-	
						00	10.01					
						30-	-13.31				-	
End of Borehole 36.98		Ŧ										
Practical DCPT refusal at 36.98m depth.												
(GWL @ 4.93m - July 17, 2020)												
								20	40	60 80 1	00	
								Shea ▲ Undist	ar Streng	<b>ith (kPa)</b> ⊾ Remoulded		

## SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geodetic

DATUM

**Geotechnical Investigation** Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

FILE NO.

DATUM Geodelic										PG5336	
REMARKS									HOLE N	<sup>IO.</sup> BH 4-20	
BORINGS BY Track-Mount Power Auge					ATE	June 30,	2020				
SOIL DESCRIPTION	PLOT		SAMPLE			DEPTH (m)	ELEV. (m)		lesist. B 50 mm Di	lows/0.3m ia. Cone	Well
	STRATA	ТҮРЕ	NUMBER	« RECOVERY	VALUE r RQD			0 1	Vater Co	ontent %	Monitoring Well
GROUND SURFACE	S.		N	REC	N N N		40.00	20	40	60 80	l₽c
FILL: Brown silty sand, some gravel, trace organics, cobbles and boulders 60		AU	1			0-	-48.90				
FILL: Brown sand with crushed 0.76 stone		ss	2	33	14	1-	47.90				
		ss	3	4	9	2-	-46.90				
FILL: Grey-brown silty clay, trace	$\bigotimes$	∦ ss	4	75	5						
sand, gravel and topsoil		ss	5	29	Р	3-	-45.90				-
		ss	6	92	7	4-	44.90				-
		ss	7	62	4	5-	-43.90				
- trace wood by 5.2m depth 5.69	XX	ss	8	88	6						
		ss	9	100	Р	6-	42.90			2	50
		ss	10	100	Р	7-	41.90			2	50
		1 ss	11	100	P	8-	-40.90	·····			09
Hard to very stiff, brown <b>SILTY CLAY</b>	X		10	100			10.00				
stiff and every by Q. Zee denth		∦ ss ∦ ss	12 13	100 83	P P	9-	-39.90				•
- stiff and grey by 8.7m depth						10-	-38.90				
		ss	14	100	P		00.00	<b>}</b>	· · · · · · · · · · · · · · · · · · ·		
						11-	-37.90		· · · · · · · · · · · · · · · · · · ·		
						12-	-36.90			· · · · · · · · · · · · · · · · · · ·	
						12	30.30	4			
						13-	-35.90				
									· · · · · · · · · · · · · · · · · · ·	$\sum_{i=1}^{n}$	
	X					14-	-34.90			<b>_</b>	
	X										
			45	100		15-	-33.90				
15.85 Dynamic Cone Penetration Test	XX	ss	15	100	P	16-	-32.90		9 - 2 - 1 9 - 2 - 1 9 - 2 - 1 9 - 2 - 1 9 - 2 - 1 1 - 2	· · · · · · · · · · · · · · · · · · ·	
commenced at 15.85m depth. Cone							02.00				
pushed to 41.1m depth.						17-	-31.90				
								20 She ▲ Undis		60 80 1 gth (kPa) △ Remoulded	00

### SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

DATUM Geodetic

#### REMARKS

HOLE NO.	BH	4-20

RINGS BY Track-Mount Power A	uger			D	ATE .	June 30,	2020		HOLE	В	H 4-20	)
SOIL DESCRIPTION	PLOT		SAN			DEPTH (m)	ELEV. (m)	Pen. Re ● 50		Blows Dia. Co		II Mell
	STRATA	ТҮРЕ	NUMBER	% RECOVERY	N VALUE or RQD					Conten		Monitoring Well
ROUND SURFACE				н		17-	-31.90	20	40	60	80	
						18-	-30.90				· · · · · · · · · · · · · · · · · · ·	
						19-	-29.90				· · · · · · · · · · · · · · · · · · ·	· · ·
						20-	-28.90					
						21-	-27.90					
						22-	26.90					
						23-	-25.90		· · · · · · · · · · · · · · · · · · ·			
						24-	-24.90				· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
						25-	-23.90					
							-22.90					· · · · · · · · · · · · · · · · · · ·
												· · · · · · · · · · · · · · · · · · ·
						27-	-21.90					
						28-	-20.90				• • • • • • • • • • • • • • • • • • • •	
						29-	19.90					
						30-	18.90				······································	
						31-	17.90					
						32-	-16.90					
							-15.90					
						34-	-14.90	20 Shoa	40 r Stro	60 ngth (k	80 (Pa)	100

# SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Prop. Multi-Storey Building Complex - 1009 Trim Road Ottawa, Ontario

DATUM	Geodetic

#### REMARKS

FILE NO.	
	PG5336

HOLE NO.	BH 4-20
	DII 4-20

BORINGS BY Track-Mount Power Auger				D	ATE .	June 30,	1	BH 4-20				
SOIL DESCRIPTION	РГОТ		SAN	/IPLE	1	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m 50 mm Dia. Cone				Monitoring Well Construction
GROUND SURFACE	STRATA	ТҮРЕ	NUMBER	% RECOVERY	N VALUE or RQD	(11)		0 W 20	/ater C	Content %	% 80	Monitoring
						34-	-14.90					
						35-	13.90		· · · · · · · · · · · · · · · · · · ·			
						36-	12.90		· · · · · · · · · · · · · · · · · · ·			
						37-	11.90					
						38-	-10.90		· · · · · · · · · · · · · · · · · · ·			
						39-	-9.90					
							-8.90					
									· · · · · · · · · · · · · · · · · · ·			
41.7	78					41-	-7.90				1	01
actical DCPT refusal at 41.78m oth.												

# SYMBOLS AND TERMS

#### SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of "P" denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

### SYMBOLS AND TERMS (continued)

### **SOIL DESCRIPTION (continued)**

Cohesive soils can also be classified according to their "sensitivity". The sensitivity, St, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	St < 2
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	8 < St < 16
Quick Clay:	St > 16

### **ROCK DESCRIPTION**

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called "mechanical breaks") are easily distinguishable from the normal in situ fractures.

### RQD % ROCK QUALITY

90-100 75-90	Excellent, intact, very sound Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

### SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

### SYMBOLS AND TERMS (continued)

### PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic Limit, % (water content above which soil behaves plastically)
PI	-	Plasticity Index, % (difference between LL and PL)
Dxx	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Сс	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10
<b>o</b> 1	<u> </u>	the second data and the second second second

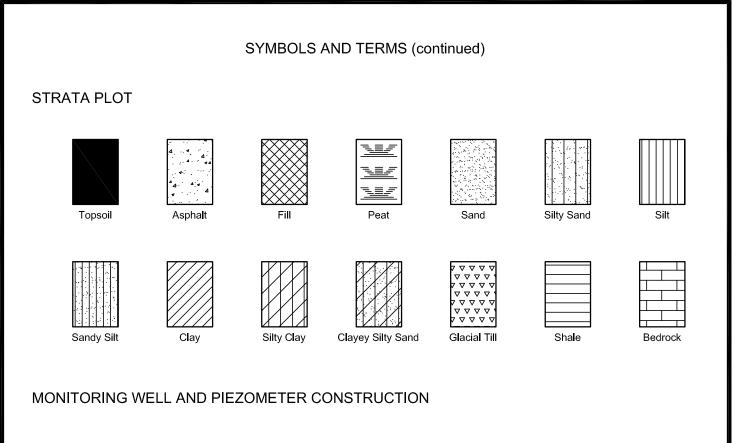
Cc and Cu are used to assess the grading of sands and gravels: Well-graded gravels have: 1 < Cc < 3 and Cu > 4Well-graded sands have: 1 < Cc < 3 and Cu > 6Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded. Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

### **CONSOLIDATION TEST**

p'o	-	Present effective overburden pressure at sample depth
p'c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'c)
Cc	-	Compression index (in effect at pressures above p'c)
OC Ratio	)	Overconsolidaton ratio = $p'_c / p'_o$
Void Rati	io	Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

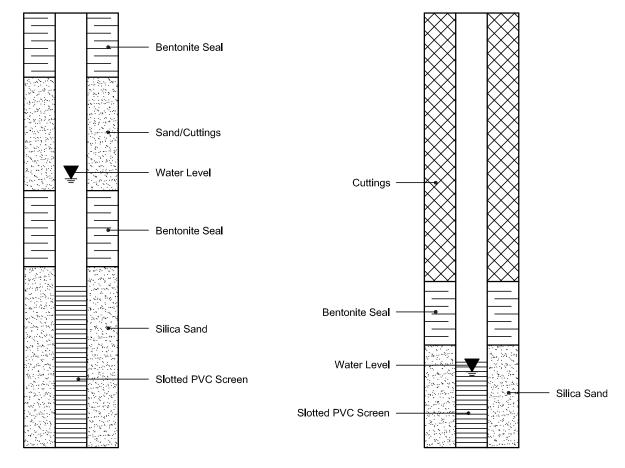
### PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.



MONITORING WELL CONSTRUCTION

PIEZOMETER CONSTRUCTION





Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Project No.: 161-03361-00 Date Started: 3/24/2016

Supervisor:

.... ~ ole location plan. N 5 

Core Diameter: 76 mm

BH LC	ocation: See borehole location plan N 50	1383	1			<u> </u>				one per					F	leview	er:	1		
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(m)		5			ω.	GROUND WATER			1	1		80 100		CON	ITENT W	LIMIT W <sub>L</sub>	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m <sup>3</sup> )		ND N SIZE
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- 3.2	(FILL)	Ŕ	5A	SS	19		g 44-						•				4			
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Ś⊢	grey-brown, wet (FILL)	$\mathbb{X}$	8B				- K	1						Ĩ						
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Shallow/ Single Installation  $\underline{\nabla}$   $\underline{\nabla}$  Deep/Dual Installation  $\underline{\nabla}$   $\underline{\nabla}$ 





	Grandmaître Family							Rig T							F	Project	No ·	161.	03361-00
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	cation: See borehole location plan	N 50383	80 F	46223	7				Diame							Review			
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Sheet No. 2 of 5



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Project No.: 161-03361-00 Date Started: 3/24/2016

Method: Hollow Stem Auger

BH Location: See borehole location plan N 5038380 E 462237

Borehole Diameter: 203 mm Core Diameter: 76 mm

Supervisor: Reviewer:

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nallow/	/ Single Installation 🖳 👤 🛛 Deep/Dual Insta	llation	V	$\mathbf{V}$																



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

GDT SPL.

, ONTARIO.GPJ

OTTAWA.

BH LOGS -

OTTAWA

SOIL LOG

WSP

#### DRILLING DATA

Rig Type:

Project No.: 161-03361-00

Method: Hollow Stem Auger Borehole Diameter: 203 mm Date Started: 3/24/2016

Supervisor:

BH Location: See borehole location plan N 5038380 E 462237 Core Diameter: 76 mm Reviewer DYNAMIC CONE PENETRATION RESISTANCE PLOT SOIL PROFILE SAMPLES PLASTIC LIMIT NOISTURE CONTENT REMARKS LIQUID LIMIT GROUND WATER AND 20 40 60 100 NATURAL UNIT 80 (m) STRATA PLOT GRAIN SIZE CONDITIONS w BLOWS 0.3 m WP WL SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE & Sensitivity O UUICK TRIAXIAL × LAB VANE POCKET (Cu) (kF ELEVATION ELEV DEPTH DISTRIBUTION 0 -1 DESCRIPTION NUMBER (%) WATER CONTENT (%) ТҮРЕ ż 25 50 75 100 125 25 50 75 GR SA SI CL SILTY CLAY grey, wet, 55 stiff(Continued) 17 21 SS 10 H. 0 0 0 32 68 16 15-14 7 22 SS 0 5/5/16 13 12-11 1009 TRIM ROAD, 23 SS 11 0 10 GEOTECHNICAL Slough 9 8 **Continued Next Page** Sheet No. 4 of 5  $+3, \times 3$ : Numbers refer  $\odot$   $^{\pmb{\epsilon}=3\%}$  Strain at Failure <u>GRAPH</u> GROUNDWATER ELEVATIONS NOTES to Sensitivity Shallow/ Single Installation  $\underline{V}$   $\underline{V}$  Deep/Dual Installation  $\underline{V}$   $\underline{V}$ 



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/24/2016

Supervisor:

BHLC	ocation: See borehole location plan N 50	3835	30 E	46223	/	<del></del>			Diame						H	leviewe	er:		
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20 47.9	END OF BOREHOLE																		
	<ol> <li>Borehole terminated at 47.9 m below the existing ground surface.</li> </ol>																		
Ö	<ol><li>2) 31 mm monitoring well installed at</li></ol>																		
VA C	26.8 m below the existing ground surface.																		
AL	3) Date Groundwater Depth																		
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GROUN	NDWATER ELEVATIONS					<u>GRAPH</u> NOTES	+ 3,	$\times^3$ :	Numbers to Sensit	s reter ivity	0	<sup>∎</sup> =3% Stra	iin at Failu	re					0.000110.0 01 0



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

BH Location: See borehole location plan N 462330 E 5038430

#### DRILLING DATA

Rig Type:

Project No.: 161-03361-00

Date Started: 3/22/2016

Supervisor:

Borehole Diameter: 203 mm Core Diameter:

Method: Hollow Stem Auger

Reviewer:

	SOIL PROFILE	2000	í –	SAMPL			1		MIC CO		IETRA <sup>-</sup>	TION		<u> </u>							
						GROUND WATER CONDITIONS								PLAST	C NAT MOIS CON	URAL	LIQUID LIMIT	7	NATURAL UNIT WT (KN/m <sup>3</sup> )	REMA AN	
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DEPTH		STRATA PLOT	NUMBER	Ч		UDO I	ELEVATION		UICK TF		+ ×	& Sensit LAB V	ivity ANE	WA	TER CO	ONTEN	T (%)	P C C	NATI	(%	»)
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0 0 - 20 5		K				602	2														
<u> </u>	SILTY CLAY: grey, wet, stiff	ĥ				602	Y -														
	5 , , ,	K	11	SS	2	665	R									0					
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		KX.	12	SS	1	288	Y.							1		0					
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WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO GPJ SPL GOT 5576 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		K.		VANE			2			+ <sup>10</sup>									L		
-	Continued Next Page					GRAPH	3	×3.	Number			<b>e</b> =3%	Chrote	at Failu						Sheet No.	. 1 of 4
	IDWATER ELEVATIONS					<u>GRAPH</u> NOTES	ı- ,	~ ·	Numbers to Sensi	tivity	0		Juan	ai Fallul	5						
Shallow	/ Single Installation 👤 👤 🛛 Deep/Dual Instal	lation	V	V																	



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Project No.: 161-03361-00 Date Started: 3/22/2016

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Supervisor:

BH Location: See borehole location plan N 462330 E 5038430 Core Diameter: Reviewer DYNAMIC CONE PENETRATION RESISTANCE PLOT SOIL PROFILE SAMPLES PLASTIC NATURAL MOISTURE CONTENT REMARKS LIQUID LIMIT GROUND WATER AND 20 40 100 NATURAL UNIT ( (KN/m<sup>3</sup>) 60 80 (m) STRATA PLOT GRAIN SIZE CONDITIONS w BLOWS 0.3 m WP WL SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE & Sensitivity O UUICK TRIAXIAL × LAB VANE POCKET (Cu) (kF ELEVATION ELEV DEPTH DISTRIBUTION 0 -1 DESCRIPTION NUMBER (%) WATER CONTENT (%) TYPE ż 50 75 100 125 25 50 75 25 GR SA SI CL SILTY CLAY: grey, wet, 20 7 37 stiff(Continued) VANE Slough Ý, WН 13 SS 0 48 52 H. 0 0 Ŧ 36 +<sup>10</sup> VANE +8 VANE 35 SS WΗ 0 14 +<sup>10</sup> VANE 34 VANE + 33 5/5/16 +10 VANE GDT. +11 VANE 32.3 SPL SILTY CLAY(Inferred based on \_14.9 K DCPT results) , ONTARIO.GPJ 32 OTTAWA, 31 - 1009 TRIM ROAD, 30 BH LOGS -GEOTECHNICAL 29 OTTAWA 28 SOIL LOG WSP Continued Next Page Sheet No. 2 of 4  $\odot$   $^{\pmb{\epsilon}=3\%}$  Strain at Failure <u>GRAPH</u> NOTES  $+3, \times 3$ : Numbers refer GROUNDWATER ELEVATIONS

Shallow/ Single Installation  $\underline{V}$   $\underline{V}$  Deep/Dual Installation  $\underline{V}$   $\underline{V}$ 

to Sensitivity



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/22/2016

BHLC	ocation: See borehole location plan N 46	52330	-			<b></b>		Core Diame			1			R	eviewe	er:	<b></b>	
	SOIL PROFILE		S	SAMPL	.ES	~		DYNAMIC CO RESISTANCE			N		NATI	URAL	LIQUID LIMIT WL T (%)		5	REMARKS
(m)		<u>+</u>				GROUND WATER CONDITIONS		20 4	0 60	80	100	PLASTI LIMIT	MOIS CON	TURE	LIMIT	EN.	NATURAL UNIT WT (KN/m <sup>3</sup> )	AND
		STRATA PLOT			BLOWS 0.3 m	AW NC	NC	SHEAR STI		H (kPa)		W <sub>P</sub>	\ \	N 	WL	(kPa	AL UI	GRAIN SIZE
ELEV DEPTH	DESCRIPTION	TA	3ER		<u>9LO</u>		ATIC	O UNCONF	INED	+ FIEL & Se	D VANE Insitivity					POCI (Cu)	TUR. (KI	(%)
		TRA	NUMBER	ТҮРЕ	ž.	ONE	ELEVATION			$\times$ LAB	3 VANE						AN	
	CILITY OF AV/Informed Leased and		Ź	Ѓн	4	σŏ	Ш	25 5	0 75	100	125	2	5 5	0 7	75			GR SA SI CL
	SILTY CLAY(Inferred based on DCPT results)(Continued)	K					27-											
		Ŵ	1															
		KX	1															
F		K					-											
F		XX	1															
-		K					00											
		1X	1				26-									1		
		K																
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GROUN	Continued Next Page				ł	<u>GRAPH</u> NOTES	+ 3,	× <sup>3</sup> : Number to Sensi	s refer	° <sup>8</sup> =	<sup>3%</sup> Strain	at Failur	е					Sheet No. 3 of 4
				•7		NOIES		IO SENSI	uvitý									
Snallow	/ Single Installation ַ 👤 🛛 Deep/Dual Instal	lation	<u>v</u> .	<u> </u>														



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

BH Location: See borehole location plan, N 462330 E 5038430

### DRILLING DATA

Rig Type:

Project No.: 161-03361-00

Date Started: 3/22/2016

Supervisor:

Borehole Diameter: 203 mm Core Dia

Method: Hollow Stem Auger

Revie

	ocation: See borehole location plan N 46	52330							Diamete		IFTRA	TION				К	eviewe	۶۲.	<u> </u>	
	SOIL PROFILE		S	AMPL	.ES	с ш		RESI	MIC CON STANCE F	PLOT	$\geq$			PLASTI LIMIT			LIQUID LIMIT		Ł	REMARKS
(m)		DT				A TE			20 40	1		30 10		LIMIT	CON	TENT		POCKET PEN. (Cu) (kPa)	LINC (	AND GRAIN SIZE
ELEV	DESCRIPTION	V PL(	œ		BLOWS 0.3 m	N OI	NOI	SHE	AR STR	ENG	ΓΗ (kf	Pa)	NE	W <sub>P</sub>		N >	WL	(KFT	RAL (KN/m	DISTRIBUTION
DEPTH		STRATA PLOT	NUMBER	щ	BLO	GROUND WATER CONDITIONS	ELEVATION		INCONFIN UICK TRI	IED AXIAI	+ ×	& Sensitiv	/ity NE	WA	TER CO	ONTEN	Г (%)	90 00	NATURAL UNIT WT (KN/m <sup>3</sup> )	(%)
		STF	ΝΩ	ТҮРЕ	ž	GRC			25 50			00 12		2			75		-	GR SA SI CL
-	SILTY CLAY(Inferred based on	K					17-													
-	DCPT results)(Continued)	1																		
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E		X					-													
<u> </u>																				
L							16-													
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<b>—</b>											$\geq$									
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- 13.3		$\Lambda_1$										$\geq$								
33.9																				
/16	1) Augering 14.9 m below the existing ground surface, switch to																			
2/2	DCPT.																			
GDT	2) Borehole dry at completion of augering.																			
SPL	3) DCPT refusal at 33.9 m below the																			
R	<ul><li>existing ground surface.</li><li>4) 31 mm monitoring well installed at</li></ul>																			
0.0	6.1 m below the existing ground																			
TAR	surface. 5) Date Groundwater Depth																			
ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16																				
WA,	4/7/2016 5.5 m																			
TTA																				
Ú.																				
ROA																				
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WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM																				
						<u>GRAPH</u> NOTES	+ 3	× <sup>3.</sup>	Numbers to Sensitiv	refer	0	<b>e</b> =3%	Strain	t Failur	e					Sheet No. 4 of 4
GROU	INDWATER ELEVATIONS					NOTES	· ,	· · ·	to Sensitiv	/itv	0		Juailla	a anur	0					

GROUNDWATER ELEVATIONS Shallow/ Single Installation  $\underline{\nabla}$   $\underline{\nabla}$  Deep/Dual Installation  $\underline{\nabla}$   $\underline{\nabla}$ 



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/22/2016

Supervisor:

SOIL PRO								DIALA				TION		1				<b></b>	<u> </u>		
	OFILE		S	AMPL	ES	~		RESIS	TANCE	NE PEN PLOT		HON				URAL	LIQUID		F	REMA	RKS
(m)		F				GROUND WATER CONDITIONS		2	0 4	0 6	0 8	30	00	PLASTI LIMIT	MOIS CON	TURE	LIMIT	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m <sup>3</sup> )	ANE	
		STRATA PLOT			BLOWS 0.3 m	AW NC	Z	SHE/	AR ST	RENG	TH (k	Pa)	1	W <sub>P</sub>	1	N	WL	(kPa	AL UI	GRAIN DISTRIBL	
DEPTH DESCR	IPTION	VTA	NUMBER		BLO 0.3		ELEVATION	o u	NCONF	INED	+	FIÉLD & & Sensi	/ANE tivity				T (0()	POCI (Cu	ATUR (K	(%)	
		TRA	INI	ТҮРЕ	ż	IONI IONI				RIAXIAL	×	LAB V 00	ANE		TER CC		I (%) 75				
48.8 - 0.0 CRUSHED SAND		s V	z	-	÷	00	ш		.5 0		5 1	1		- 4	.5 0		+			GR SA	SI CL
<ul> <li>trace to some silt,</li> </ul>	trace to some clay,	$\otimes$	_	~~																	
grey, compact to v	very dense (FILL)	$\ge$	1	SS	14									0							
		$\otimes$																			
	¢	$\ge$					48-														
	<pre>c</pre>	$\otimes$		~~																	
	K	$\ge$	2	SS											0						
	¢	$\otimes$					-Bento	nite													
	<	X																			
		$\otimes$	3	SS	6		47-							0							
	<	$\bigotimes$	3	33	0																
		$\otimes$																			
		$\otimes$					-														
E		$\otimes$	4	SS	15									0							
	< compared with the second sec	$\otimes$		00			. 46-							Ľ							
45.7		$\bigotimes$																			
3.1 SILTY CLAY: grey	, moist, firm to	27																			
stiff	-	21	5	SS	9		:  -								0						
		XX	Ŭ	00																	
	-	20					1														
44.8							45-														
- 4.0 SILTY CLAY: grey	y, moist, firm to	ХŻ	6	SS	8										0						
stiff			-		-	10. H-10.	- 1														
		X					Sand														
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						Ľ 🗄	W. L. 4	138m								-					
		XX					Apr 07	, 2016													
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41.5			ľ	VANE			Sloug	h			$+^{4}$										
	DLE					008	<u> </u>						1				1				
1) Borehole termir	nated at 7.62 m					665	r L														
below the existing	ground surface.																				
2) Borehole dry at	the completion of																				
augering. 3) 31 mm monitor	ring well installed at																				
$\frac{1}{2}$ 6.1 m below the e	ring well installed at xisting ground																				
Surface.	Groundwater Depth																				
× · · · · · · · · · · · · · · · · · · ·																					
4/7/2016	5.02 m																				
ō																					
5																					
7.3     END OF BOREHC       1) Borehole termin below the existing 2) Borehole dry at augering.       3) 31 mm monitor       6.1 m below the existing       9       4) Date       4/7/2016																					
GROUNDWATER ELEVATIONS						GRAPH	⊥ 3	√3. I	Number	s refer	~	<b>8</b> =3%	Strain	ot East	~					Sheet No.	1 of 1

Shallow/ Single Installation  $\underline{\nabla}$   $\underline{\nabla}$  Deep/Dual Installation  $\underline{\nabla}$   $\underline{\nabla}$ 

<u>GRAPH</u> NOTES + <sup>3</sup>, × <sup>3</sup>: Numbers refer to Sensitivity

 $\odot$   $^{\pmb{\epsilon}=3\%}$  Strain at Failure



Project: Geotechnical Investigation

Client: Grandmaître Family

#### DRILLING DATA

Rig Type:

Project No.: 161-03361-00

		t Location: Part Lot 30, Concession 1, P	arts	1&2	2, Cum	ıberlar	id, ON				ollow			-							: 3/22	2/2016
		n: Approximate ocation: See borehole location plan N 46	004	4	00040	7					Diame <sup>.</sup> neter:	ter: 2	203	mm					upervi			
Г	BHLC	SOIL PROFILE	2344	<u> </u>	SAMPL			1			ONE P	ENE	TRAT	ION				R	eviewe	er:		
┢		SOLTHORIEL					ff									PLAST LIMIT	IC NAT	URAL	LIQUID LIMIT	-	TWT	REMARKS AND
	(m)		10			<u></u> ଥ-	GROUND WATER CONDITIONS			20	40	60 	8		00	W <sub>P</sub>	CON	TENT N	WL	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m <sup>3</sup> )	GRAIN SIZE
	ELEV	DESCRIPTION	STRATA PLOT	ff		BLOWS 0.3 m		ELEVATION				GIF	+ (к⊦ +	<b>'a)</b> FIELD V. & Sensiti	ANE	<del>-</del>		C	— <sup>–</sup>	OCKE (CU)	URAL (KN/	DISTRIBUTION
ľ			RAT	NUMBER	ТҮРЕ			EVA			TRIAXI	۹L	×	& Sensiti LAB VA	vity ANE	WA	TER CC	DNTEN	Г (%)	A -	NAT	(%)
L	47.1		ST	ź	⊢≿	ŗ.	БS	Ш		25	50	75	10	0 12	25	2	25 5	0 7	5			GR SA SI CL
F	0.0	CRUSHED SAND AND GRAVEL trace to some silt, trace to some clay,	$\bigotimes$					47-														
E		grey, loose to very loose (FILL)	$\bigotimes$	1	SS	6										0						
F			$\bigotimes$					-														
F			$\bigotimes$																			
F	_		$\bigotimes$					10														
F			$\bigotimes$	2	SS	3		46-														
F	45.0		$\bigotimes$					-Bento	nite													
F	45.6 1.5	SILTY CLAY: brown, moist, stiff to	ŔŔ					-														
F		stiff very (WEATHERED CRUST) 1.5 m - 2.1 m : trace to some	KX	3	SS	wн											0					
F	_	organics	X	ľ			¥	W. L. 4	 15.1 n													
F		-						Apr 07														
F			1X																			
F			ĥ	4	SS	7		-									0					
F			K																			
F	-		X					44-														
F																						
F			X	5	SS	15	目目										0					
F			K.					-														
F			KX.					:														
F	-		W.					43-														
φF				6	SS	13		3									0					
5/5/-			X	<u> </u>				Sand														
ъF				-				Scree	n													
٦Ë			X	7	SS	8	E. 🗖	:									0					
AWA, ONTARIO.GPJ SPL.GDT 5/5/16	-		ĥ	ľ	00			42-									Ŭ					
<u>e</u> E		- becoming wet below 5.2 m		┢──				:														
₽E			X																			
Ϋ́				8	SS	5		-										H				
٩Ë			KX.	1																		
	41.0		Ŵ					41-			_											
ЪĿ	6.1	SILTY CLAY: grey, moist, stiff to	KX					¥														
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ËF								N –														
Ē			X		VANE		286				+	10										
60	-		Ŵ					40-														
Ē			KX		VANE						+'											
ğ			W.				602	Sloug	h													
計			KK.				602															
٦F			X	1	T.M		665	Į.														
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하			KK.	┣—	<u> </u>		ASS &				+	 10										
証 는			W.		VANE		R	la l			+											
WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTT	~ ~		K.F		VANE							-) <sup>9</sup>										
A M H	38.2 8.8	END OF BOREHOLE		-				4			-											
D																						
ġ		<ol> <li>Borehole terminated at 8.8 m below the existing ground surface.</li> </ol>						1														
		<ol> <li>Seepage noted upon completion of borehole at 7.8 m below the</li> </ol>						1														
S		existing ground surface.						1														
<b>NSF</b>		3) 31 mm monitoring well installed at																				

Continued Next Page GROUNDWATER ELEVATIONS

Shallow/ Single Installation  $\underline{\nabla}$   $\underline{\nabla}$  Deep/Dual Installation  $\underline{\nabla}$   $\underline{\nabla}$ 

<u>GRAPH</u> NOTES + <sup>3</sup>, × <sup>3</sup>: Numbers refer to Sensitivity  $\bigcirc$   ${}^{\pmb{\epsilon}=3\%}$  Strain at Failure Sheet No. 1 of 2



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/22/2016

BH Lo	ocation: See borehole location plan N 46	2344	1 E 5	03840	7				Diame							R	eviewe	ər:			
	SOIL PROFILE		s	AMPL	.ES			DYNA RESIS	MIC CO TANCE	NE PEN PLOT		TION			- NATI	IRAI			∟	REMAR	(S
		L				GROUND WATER CONDITIONS			0 4			30 1	00	PLASTI LIMIT	C MOIS	TURE	LIQUID LIMIT	ż.	NATURAL UNIT WT (KN/m <sup>3</sup> )	AND	.0
(m)		101			NS u	NS <sup>-</sup> NS	z		R STI			1	Ĩ	w <sub>P</sub>		v	$W_{L}$	POCKET PEN. (Cu) (kPa)	L UN	GRAIN S	
ELEV DEPTH	DESCRIPTION	ΓA Ρ	EB		BLOWS 0.3 m	DN DI	TIO		CONF		+	FIELD V & Sensit	ANE		(	>		(CCK	(KN	DISTRIBU	ΓION
		STRATA PLOT	NUMBER	ТҮРЕ			ELEVATION	• Q	JICK TF	RIAXIAL	×	LAB V	ANE		FER CC				-NA	(%)	
		ſS	ž	Ĥ	ŗ.	ΰŭ	Ш	2	5 5	0 7	5 1	00 1	25	2	5 5	0 7	75 			GR SA S	I CL
	<ol><li>6.1 m below the existing ground surface.</li></ol>																				
	4) Date Groundwater Depth																				
	 4/7/2016 2.0 m																				
	4/7/2010 2.011																				
												1	1					L			



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON Datum: Approximate

### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/22/2016

Supervisor:

BHLa	ocation: See borehole location plan N 46	62379	9 E 5	03845	0			Core				TION				R	leviewe	er:			
	SOIL PROFILE		s	SAMPL	.ES			RESIS	VIC CO TANCE	PLOT		ATION >		DIACT	_ NAT	URAL			⊢	REMA	ARKS
(m)		⊢⊢				GROUND WATER CONDITIONS		2	0 4	0 6	50	80	100	PLASTI LIMIT	MOIS CON	TURE	LIQUID LIMIT	Ľ.	NATURAL UNIT WT (KN/m <sup>3</sup> )	AN	ID
ELEV		STRATA PLOT			SN E	NS NS	Z		R STI	RENG	L TH (ł	(Pa)		W <sub>P</sub>		w	WL	(kPa	AL UN	GRAIN	
DEPTH	DESCRIPTION	TAF	NUMBER		BLOWS 0.3 m	IN E	ELEVATION	o u	NCONF	INED	+	FIÉLD & Sens	VANE			0		CCU C	TUR/	DISTRIE (%	
		TRA	NME	ТҮРЕ	"Z	NG NG					. ×	LAB \	/ANE			ONTEN	. ,	1	NA		
43.6		l io	z	Ĥ		σõ	Ē	2	5 5	0 7	5	100	125	2	25 5	50 7	75			GR SA	SI CL
_ 0.0	SILTY CLAY brown-grey, moist, soft to firm (FILL)	$\bigotimes$					-														
		$\bigotimes$	1	SS	2										0						
E I		$\mathbb{K}$					10														
E I		$\mathbb{X}$					43-											1			
		$ \rangle\rangle$																			
F		$\bigotimes$	2	SS	6		-								0						
F		$\bigotimes$					-Bento	<b> </b> nite													
<u>42.1</u> 1.5	SILTY CLAY some organic	X																			
- 1.5	deposits, brown-grey, moist, stiff	Ŵ					42-														
F	<b>3 3 3</b>	KK	3	SS	5										0						
-		W																			
- 41.3		KK		SS	21										0						
2.4	SILTY SAND grey-brown, moist	[· ·	4A 4B		21									0	-						
<u> </u>	SILTY CLAY: grey brown, wet, stiff	i ki k	4C		21		41-								0						
	to very stiff (WEATHERED CRUST)	12																			
		1X					. –														
E I			5	SS	15	ΙE									0						
F		1X					40-					_	_								
F																					
<b>F</b>		1X			_																
₀ <b>⊢</b>		K.	6	SS	5		. –									0					
		1X					Sand														
<u>- 39.1</u> 4.6	SILTY CLAY: grey, wet, stiff	KK					Scree														
5 4.0	SILTY CLAY: grey, wet, suit	W.																			
		KK	7	SS	2		W. L. : Apr 07	38.9 m 2016								0					
		1/x																			
		KK																			
		XX		00																	
5		K	8	SS	1		38-											1			
		XX	<u> </u>																		
37.5	END OF BOREHOLE	IX:X																			
2																					
	1) Borehole terminated at 6.1 m																				
	below the existing ground surface. 2) 31 mm monitoring well installed at																				
	6.1 m below the existing ground																				
	surface. 3) Date Groundwater Depth																				
	· · · · · · · · · · · · · · · · · · ·																				
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GROUNDWATER ELEVATIONS

<u>GRAPH</u> <u>NOTES</u> + <sup>3</sup>,  $\times$  <sup>3</sup>: Numbers refer to Sensitivity



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

5/5/16

GDT

SPL.

ONTARIO.GPJ

OTTAWA

ROAD.

1009 TRIM

BH LOGS

GEOTECHNICAL

OTTAWA

SOIL LOG

WSP

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/23/2016

Supervisor:

BH Location: See borehole location plan N 462225 E 5038410 Core Diameter: Reviewer DYNAMIC CONE PENETRATION RESISTANCE PLOT SOIL PROFILE SAMPLES PLASTIC NATURAL MOISTURE LIMIT CONTENT REMARKS LIQUI GROUND WATER LIMIT AND 40 NATURAL UNIT ( (KN/m<sup>3</sup>) 20 60 80 100 (m) STRATA PLOT GRAIN SIZE CONDITIONS BLOWS 0.3 m Wp w WL SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE Sensitivity QUICK TRIAXIAL × LAB VANE POCKET (Cu) (kF ELEVATION ELEV DISTRIBUTION 0 -1 DESCRIPTION NUMBER DEPTH (%) WATER CONTENT (%) TYPE ż 100 25 50 25 50 75 125 75 43.0 GR SA SI CL TOPSOIL - 20 mm 40.0 **CRUSHED SAND AND GRAVEL** SS 28 1A С 39 52 (9) trace silt, brown, wet, compact (FILL) 1B 0 42.2 W. L. 42.3 m CLAYEY SILT some sand, trace 0.8 Apr 07, 2016 gravel, trace brick, dark brown, moist, compact (FILL) 2 SS 10 Bentonite 41.4 SS ЗA SANDY SILT trace gravel, dark 1.6 41.1 3B 0 brown, moist, loose (FILL) 1.8 SILTY CLAY: trace to some gravel, ЗC 41 trace to some sand, brown, moist, firm (FILL) SS 0 4A 40 -39.9 SILTY CLAY: grey brown, moist, stiff (WEATHERED CRUST) 3.1 \_\_\_\_ 5 SS 7 0 39.2 3.8 SILTY CLAY: grey, wet, stiff 39 6 SS WΗ -þ 0 26 74 0 Sand. +13 VANE Screen 10 VANE 38 тw А 37 10 VANE + VANE Bentonite 4 36 SS WН 7 0 ⊥<sup>11</sup> VANE 15 VANE 35-В ΤW 34 16 VANE ++12 VANE Continued Next Page Sheet No. 1 of 5  $\odot$   $^{\pmb{\epsilon}=3\%}$  Strain at Failure <u>GRAPH</u>  $+3, \times3$ : Numbers refer **GROUNDWATER ELEVATIONS** 

Shallow/ Single Installation  $\underline{V}$   $\underline{V}$  Deep/Dual Installation  $\underline{V}$   $\underline{V}$ 

NOTES

to Sensitivity



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/23/2016

BHLC	ocation: See borehole location plan N 46	222							Diameter:		TION			R	eview	ər:		
	SOIL PROFILE		5	SAMPL	ES			RESIS	MIC CONE PEN STANCE PLOT		TION	DIACT		URAL			F	REMARKS
(m)		+				GROUND WATER CONDITIONS		2	20 40 6	0 8	30 100	LIMIT	C NATI MOIS CON	TURE	LIQUID LIMIT	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m <sup>3</sup> )	AND
ELEV		STRATA PLOT			BLOWS 0.3 m	AN ONS	z			TH (kl	і і Ра)	W <sub>P</sub>	Ň	N	WL	(KPa	AL UN	GRAIN SIZE
DEPTH	DESCRIPTION	ITA	NUMBER		BLO 0.3		ELEVATION	οU	AR STRENG NCONFINED UICK TRIAXIAL	+	FIÉLD VANE & Sensitivity					POCI CU	TUR,	(%)
		TRA	MIN	ТҮРЕ	ŗ	INOI INOI		• Q	UICK TRIAXIAL 25 50 7	×	LAB VANE 00 125		TER CC 25 5		I (%) 75		Ž	
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<b>—</b>		£ł,	1	VANE			Sloug	1	+	12								
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		X		VANE						+8								
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				VANE			29-			+5								
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	/ Single Installation $\underline{\nabla}$ $\underline{\Psi}$ Deep/Dual Installation	ati -		<b>▼</b> 7		NULES			IO GENSILIVITY									
Shallow	, ongie installation v T Deep/Dual Installa	ation	V	<u>v</u>														



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/23/2016

BH Lo	ocation: See borehole location plan N 46	62225	i			,		Core Diameter:	TRATION			Re	eviewe	er:	<u> </u>	
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(m)						GROUND WATER CONDITIONS		20 40 60	80 100	PLASTI LIMIT	CON	TENT		PEN.	UTV (	
ELEV		PLO			NS E	AN O	NO	SHEAR STRENGTH	H (kPa)	W <sub>P</sub>	\	w 0	WL	KET (	AL U	GRAIN SIZE DISTRIBUTION
DEPTH	DESCRIPTION	STRATA PLOT	NUMBER		BLOWS 0.3 m	IN E	ELEVATION	SHEAR STRENGTH O UNCONFINED QUICK TRIAXIAL	<ul> <li>+ FIÉLD VANE &amp; Sensitivity</li> </ul>			-		DO DO	ATUR (K	(%)
		TRA	UME	ТҮРЕ	"Z	NOI ONI	LEV	QUICK TRIAXIAL     25 50 75	× LAB VANE				(%) E		AN	
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Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON

Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/23/2016

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Continued Next Page       GRAPH       + 3, × 3       Numbers refer       © <sup>€=3%</sup> Strain at Failure       Sheet No. 4 of         GROUNDWATER ELEVATIONS       NOTES       + 3, × 3       Numbers refer       0 <sup>€=3%</sup> Strain at Failure       Sheet No. 4 of	F		KI.	1											1						
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	<u>GROUN</u>						GRAPH	+ 3,	× <sup>3</sup> :	Numbe	rs refer	0	<b>e</b> =3%	Strain	at Failur	е					Sneet No. 4 of 5
			lation		V																



Project: Geotechnical Investigation

Client: Grandmaître Family

Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON Datum: Approximate

#### DRILLING DATA

Rig Type:

Method: Hollow Stem Auger

Borehole Diameter: 203 mm

Project No.: 161-03361-00 Date Started: 3/23/2016

	ocation: See borehole location plan N 46	2225	1						Diame			TION				R	leview	ər:			
	SOIL PROFILE		S	AMPL	.ES	~		RESIS	STANCE	NE PEI PLOT		HON		PI ASTI	C NAT	URAL			Ę.	REMA	RKS
(m) <u>ELEV</u> DEPTH		STRATA PLOT	NUMBER	ТҮРЕ	"N" <u>BLOWS</u> 0.3 m	GROUND WATER CONDITIONS	ELEVATION	SHE/ 0 U • Q	AR ST NCONF UICK TI	I RENG INED RIAXIAL	TH (k + - ×	L FIELD V & Sensi LAB V	00 /ANE tivity ANE 25		TER CO	W O ONTEN	LIQUID LIMIT w <sub>L</sub> T (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m <sup>3</sup> )	ANI GRAIN DISTRIBI (%) GR SA	SIZE UTION )
-	_		-		-							1									
- 2.7		<u>X'X</u>																			
WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16	1) End of augering at 15.2 m below the existing ground surface. Switch to DCPT.         2) Seepage noted at the bottom of borehole upon completion of augering.         3) DCPT refusal at 40.3 m below the existing ground surface.         4) 31 mm monitoring well installed at 6.1 m below the existing ground surface.         5) Date       Groundwater Depth					GRAPH	+ 3,	× <sup>3</sup> :	Number	s s refer		ر ۱۹۹۵ کې د ۲۹۵۵ کې د ۲۹۵۹ کې د ۱۹۹۵ کې د ۲۹۵۹ کې د ۲		at Failur						Sheet No.	5 of 5

TEST PIT NUMBER (ELEVATION)	DEPTH (METRES)		DESCRIPTION	
TP 16-4 (47.3 m)	$0.0 - 1.8 \\ 1.8 - 4.0 \\ 4.0 - 6.4 \\ 6.4 - 7.3 \\ 7.3$	Crushed Sand and Grav Silty Sand and Gravel, s Silty Clay, trace to some Organic Soil mixed with End of Test Pit	some clay to clayey, brow e gravel, trace roots, grey	wn, moist (FILL)
Sample 1	Depth 0 – 0.6 m	<u>% Gravel</u> 84	<u>% Sand</u> 15	<u>% Fines</u> 1

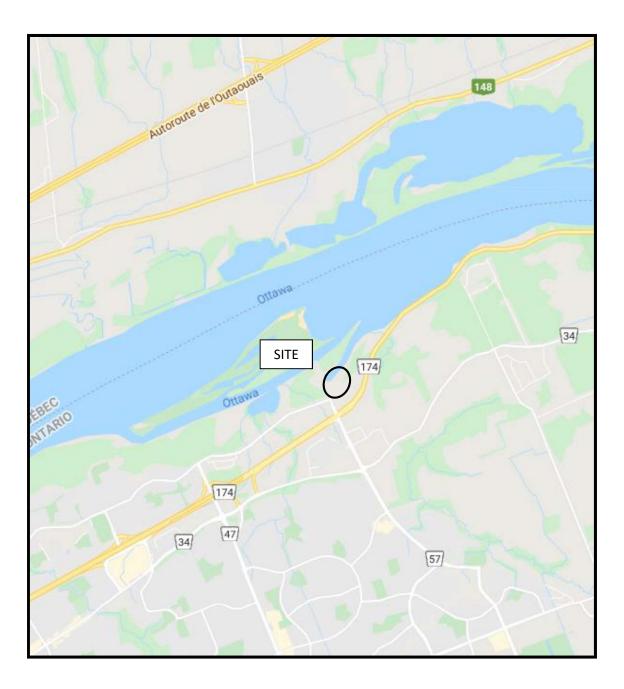
# **APPENDIX 2**

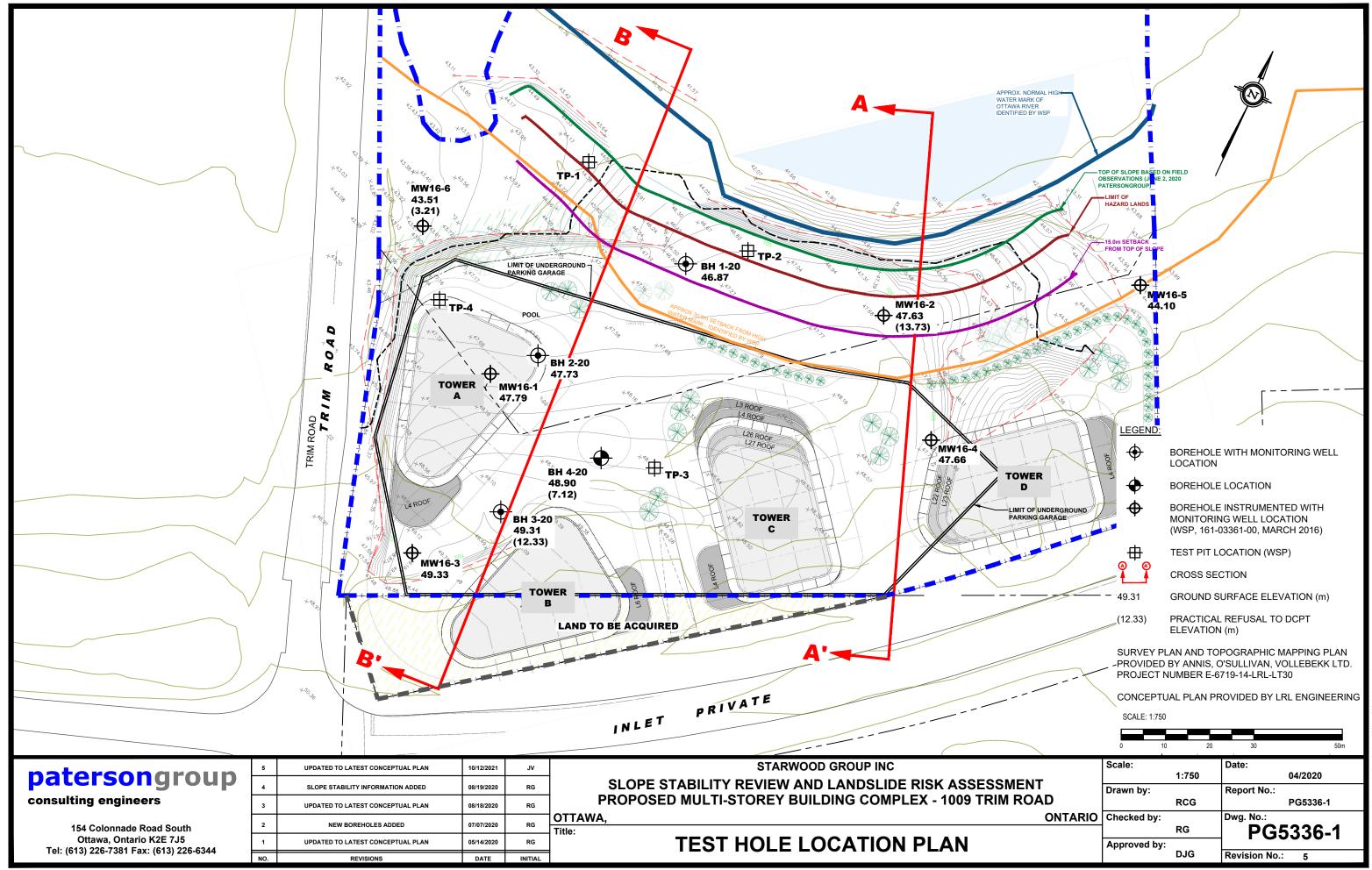
FIGURE 1 - KEY PLAN

DRAWING PG5336-1 - TEST HOLE LOCATION PLAN

# patersongroup

FIGURE 1 KEY PLAN





Autocad drawings/geotechnical/pg53xx/pg5336/pg5336-1 thlp rev