

# **Geotechnical Investigation**

## **Proposed Multi-Storey Building**

83-91 Sweetland Avenue  
Ottawa, Ontario

Prepared for Upscale Homes

Report PG7100-1 dated May 27, 2024



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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by the Upscale Homes to conduct a geotechnical investigation for the proposed multi-storey building to be located at 83-91 Sweetland Avenue in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 for the general site location).

The objectives of the geotechnical investigation were to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ☐ Provide geotechnical recommendations for the 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.

## 2.0 Proposed Development

Based on the available site plan, it is understood that the proposed development at the subject site will consist of a multi-storey building with 1 basement level and an approximate footprint of 800 m<sup>2</sup>.

Further, an asphalt-paved parking area will be located along the southeast corner of the proposed building, with landscaped areas on the remaining sides.

## **3.0 Method of Investigation**

### **3.1 Field Investigation**

#### **Field Program**

The field program for the current geotechnical investigation was carried out on April 24<sup>th</sup> and 25<sup>th</sup>, 2024. At that time, a total of 3 boreholes (BH 1-24 to BH 3-24) were advanced to a maximum depth of 6.7 m below the existing grade.

The borehole locations were distributed in a manner to provide general coverage of the subject site, taking into consideration underground services and available access. The approximate locations of the boreholes are shown on Drawing PG7100-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a low-clearance track-mounted drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer.

#### **Sampling and In Situ Testing**

Soil samples were collected from the boreholes either by sampling directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. The depths at which the auger and split-spoon samples were recovered from the boreholes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The 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.

Undrained shear strength testing was carried out in cohesive soils using a field vane apparatus.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed at borehole BH 2-24. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the 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.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data Sheets in Appendix 1 of this report.

### **Groundwater**

Flexible polyethylene standpipes were installed in all the boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. The groundwater observations are discussed in Section 4.3, and presented in the Soil Profile and Test Data Sheets in Appendix 1.

### **Sample Storage**

All samples will be stored in the laboratory for a period of 1 month after issuance of this report. They will then be discarded unless we are otherwise directed.

## **3.2 Field Survey**

The borehole locations, and the ground surface elevation at each borehole location, were surveyed by Paterson using a GPS unit with respect to a geodetic datum. The locations of the boreholes, and ground surface elevation at each test hole location, are presented on Drawing PG7100-1 - Test Hole Location Plan in Appendix 2.

## **3.3 Laboratory Review**

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. Moisture content tests were completed on the recovered selected soils samples. The results are presented in the Soil Profile and Test Data Sheets in Appendix 1.

## **3.4 Analytical Testing**

One (1) 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 samples. The results are presented in Appendix 1 and are discussed further in Section 6.7.

## **4.0 Observations**

### **4.1 Surface Conditions**

The subject site consists of 5 contiguous properties which are abutting in a north-south orientation. The site is currently occupied by residential dwellings and associated at-grade parking and landscaped areas. The ground surface across the site slopes downward gently from north to south, from approximate geodetic elevation 63 to 61 m.

This site is bordered by residential dwellings to the north, east and south, and by Sweetland Avenue to the west.

### **4.2 Subsurface Profile**

Generally, the subsurface profile at the subject site consists of topsoil and/or fill, extending to approximate depths ranging from 1 to 2 m below the existing ground surface, overlying a silty clay deposit. The fill was generally observed to consist of loose to dense, brown silty sand to silty clay with varying amounts of gravel and cobbles.

Underlying the fill, the silty clay deposit has a hard to stiff, brown silty clay crust, becoming a very stiff to stiff, grey silty clay below approximate depths of 4.5 to 5.2 m below the existing ground surface.

In borehole BH 1-24, a glacial till deposit was encountered underlying the silty clay at an approximate depth of 5.5 m. The glacial till deposit was observed to consist of a compact to very dense, grey silty sand to sandy silt with gravel, cobbles, and boulders.

Practical refusal of the DCPT was encountered in borehole BH 2-24 at a depth of about 7.87 m below the existing ground surface.

Reference should be made to the Soil Profile and Test Data Sheets in Appendix 1 for details of the soil profile encountered at each test hole location.

#### **Bedrock**

Based on available geological mapping, bedrock in the area of the subject site consists of interbedded limestone and shale of the Verulam Formation, with drift thicknesses ranging from 10 to 15 m.

## 4.3 Groundwater

Groundwater levels were measured in the standpipe piezometers on April 30, 2024. The measured groundwater levels are presented on the Soil Profile and Test Data sheets in Appendix 1, and in Table 1 below.

Table 1 – Summary of Groundwater Level Readings				
Test Hole	Ground Surface Elevation (m)	Measured Groundwater Level (m)		Date Recorded
		Depth (m)	Elevation (m)	
BH 1-24	61.12	2.75	58.38	April 30 ,2024
BH 2-24	62.24	3.53	58.71	
BH 3-24	63.34	3.98	59.36	
<b>Note:</b> - Ground surface elevations at test hole locations were surveyed by Paterson and are referenced to a geodetic datum.				

It should be noted that the groundwater levels could be influenced by surface water infiltrating the backfilled boreholes. Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected at approximately 3 to 4 m below ground surface.

However, it should be noted that groundwater levels are subject to seasonal fluctuations, therefore, the groundwater levels could vary at the time of construction.



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## **5.0 Discussion**

### **5.1 Geotechnical Assessment**

From a geotechnical perspective, the subject site is suitable for the proposed development. It is recommended that the proposed building be founded on conventional spread footings bearing on the undisturbed, hard to stiff silty clay.

Due to the presence of a silty clay deposit at the site, the proposed development will be subjected to permissible grade raise restrictions, which are discussed further in Section 5.3.

Removal of concrete elements is likely due to the existing residential dwelling located at the site.

The above and other considerations are further discussed in the following sections.

### **5.2 Site Grading and Preparation**

#### **Stripping Depth**

Topsoil and fill, such as those containing organic or deleterious materials, should be stripped from under the proposed building footprint or other settlement sensitive structures.

Existing foundation walls, and other construction debris, should be entirely removed from within proposed building additions footprint. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below final grade.

#### **Fill Placement**

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. 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 proposed building areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath exterior parking areas where settlement of the ground surface is of minor concern. In landscaped areas, 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 used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD.

## **5.3 Foundation Design**

### **Bearing Resistance Values**

Conventional spread footings bearing on the undisturbed, hard to stiff silty clay can be designed using a 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 above noted bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Footings designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 mm and 15 mm, respectively.

### **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. Adequate lateral support is provided to an undisturbed, hard to stiff silty clay bearing stratum, above the groundwater table, when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

### **Permissible Grade Raise**

Based on the undrained shear strength values of the silty clay deposit encountered within the vicinity of the subject site, a permissible grade raise restriction of **2 m** is recommended for the site. The final grading plans for the development should be reviewed by Paterson.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

## **5.4 Design for Earthquakes**

The site class for seismic site response can be taken as **Class C** for the foundations considered at this site. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code (OBC) 2012 for a full discussion of the earthquake design requirements.

## **5.5 Basement Floor Slab**

With the removal of all topsoil, debris and deleterious fill within the footprint of the proposed building, the existing fill or undisturbed, hard to stiff silty clay will be considered an acceptable subgrade upon which to commence backfilling for basement slab construction.

Where the existing fill is encountered at the basement slab subgrade, provisions should be made to proof-roll the soil subgrade using heavy vibratory compaction equipment prior to placing any fill. Any soft areas should be removed and backfilled with appropriate backfill material.

It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone. It is further recommended that an underslab drainage system, consisting of lines of perforated drainage pipe sub-drains connected to a positive outlet, should be provided under the basement floor slab. This is discussed further in Section 6.1.

## **5.6 Basement Wall**

There are several combinations of backfill materials and retained soils that could be applicable for the proposed structure's basement walls. 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 dry unit weight of 20 kN/m<sup>3</sup>.

The foundation wall is anticipated to be provided with a perimeter drainage system; therefore, the retained soils should be considered drained.

## 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  $0.375 \cdot a \cdot H^2/g$  where:

$a_c = (1.45 \cdot a_{max}/g) a_{max}$

$\gamma$  = 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 ( $P_o$ ) under seismic conditions can be calculated using  $P_o = 0.5 K_o \cdot \gamma \cdot H^2$ , where  $K = 0.5$  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

The proposed pavement structures for the asphalt-paved access lanes and parking areas at the subject site are presented in Tables 2 and 3 below.

<b>Table 2 – Recommended Pavement Structure – Access Lanes and Heavy Truck Parking Areas</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
40	<b>Wear Course</b> – HL-3 or Superpave 12.5 Asphaltic Concrete
50	<b>Binder Course</b> - HL-8 or Superpave 19.0 Asphaltic Concrete
150	<b>BASE</b> – OPSS Granular A Crushed Stone
400	<b>SUBBASE</b> – OPSS Granular B Type II
<b>Subgrade</b> – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil or fill.	

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

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

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 II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of the material's SPMDD using suitable compaction equipment.

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## **6.0 Design and Construction Precautions**

### **6.1 Foundation Drainage and Backfill**

A perimeter foundation drainage system is recommended to be provided for the portion of the proposed building which will have a basement level. The system should consist of a 100 mm or 150 mm diameter perforated and corrugated plastic pipe, surrounded on all-sides by 150 mm of 19 mm clear crushed stone, which is placed at the footing level around the exterior perimeter of the portion of the structure which has a basement level. The pipe should have a positive outlet, such as a gravity connection to the storm sewer, or sump pit provided below the basement level of the structure.

#### **Underslab Drainage**

Underslab drainage will be required to control water infiltration below the lowest level floor slab. For preliminary design purposes, we recommend that 100 mm or 150 mm diameter perforated pipes be placed at approximate 6 m centres below the basement floor slab. The spacing of the underslab 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. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite board, such as Delta Drain 6000, which is installed over the exterior foundation walls and connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type II granular material, should otherwise be used for this purpose.

### **6.2 Protection of Footings Against Frost Action**

Perimeter footings of heated structures are recommended to be insulated against the deleterious effects of frost action. A minimum 1.5 m thick soil cover, or an equivalent combination of soil cover and foundation insulation, should be provided in this regard.

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

## **6.3 Excavation 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.

### **Unsupported Excavations**

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.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

### **Temporary Shoring System**

Due to the anticipated proximity of the proposed building to the north property boundary, temporary shoring may be required to support the overburden soils of the adjacent property. The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer who is a licensed professional engineer and is hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures.

In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes.

The designer should also 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 designer prior to implementation.

The temporary shoring system may consist of a soldier pile and lagging system or steel sheet piles which could be cantilevered, anchored or braced.

Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be added to the earth pressures described on the following page.

The earth pressures acting on the shoring system may be calculated using the parameters in Table 4 below:

<b>Table 4 – Soil Parameters for Shoring System Design</b>	
<b>Parameters</b>	<b>Values</b>
Active Earth Pressure Coefficient ( $K_a$ )	0.33
Passive Earth Pressure Coefficient ( $K_p$ )	3
At-rest Earth Pressure Coefficient ( $K_o$ )	0.5
Total Unit Weight ( $\gamma$ ), kN/m <sup>3</sup>	210
Submerged Unit Weight ( $\gamma'$ ), 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 is calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil 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 and 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 a 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 98% of the SPMDD.

It should generally be possible to re-use the moist (not wet) site-generated fill above the cover material if the excavation and filling operations are carried out in dry weather conditions.

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 minimize 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 material's SPMDD. All cobbles larger than 200 mm in their longest direction should be segregated from re-use as trench backfill.

## **6.5 Groundwater Control**

It is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. 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.

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

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

For typical ground or surface water volumes being pumped during the construction phase, typically 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.

### **Impacts to Neighbouring Properties**

The proposed building excavation is not expected to extend below the long-term groundwater level, therefore, neighbouring properties will not be impacted by the proposed development at this site.

## 6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site consist of frost susceptible materials. In the 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 use of straw, propane heaters and tarpaulins or other suitable means. In this regard, 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.

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. Additional information could be provided, if required.

## 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 (GU – General Use cement) would be appropriate for this site. The chloride content and pH of the sample indicate that they are not a significant factor in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a severe to aggressive corrosive environment.

## 6.8 Landscaping Considerations

### Tree Planting Restrictions

Based on the stiffness of the clay encountered during the geotechnical investigation, the silty clay deposit at this site is considered to have low to medium sensitivity with regard to tree plantings.

The following tree planting setbacks are therefore recommended for the low to medium sensitivity area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to **4.5 m** for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the conditions noted below are met:

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan.
- ❑ A small tree must be provided with a minimum of 25 m<sup>3</sup> of available soil volume while a medium tree must be provided with a minimum of 30 m<sup>3</sup> of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.
- ❑ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.
- ❑ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).
- ❑ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

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## 7.0 Recommendations

A materials testing and observation services program is also a requirement for the foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- ☐ Review of the final Grading Plan, from a geotechnical perspective.
- ☐ Observation of all bearing surfaces prior to the placement of concrete.
- ☐ Sampling and testing of the concrete and fill materials used.
- ☐ 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 materials.
- ☐ Field density tests to determine the level of compaction achieved.
- ☐ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

All excess soils must be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

## 8.0 Statement of Limitations

The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

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, Paterson requests immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

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 Upscale Homes, or their agents, is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

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**Report Distribution:**

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- ☐ Paterson Group (1 copy)

# APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

# PG7100

**BH 1-24**

**DATE:** April 25, 2024

**BH 1-24**

## Ground Surface

## ASPHALT

**FILL:** Compact crushed stone  
with sand and clay

**FILL:** Compact brown silty clay, some crushed stone, trace concrete

**FILL:** Crushed stone, trace coal and gravel

**FILL:** Loose to compact brown silty clay, trace sand, gravel and brick

Hard to stiff, brown **SILTY CLAY**

Stiff grey **SILTY CLAY** to **CLAYEY SILT**

- Silt content increasing with depth

Very stiff to hard grey **SILTY**  
**CLAY** to **CLAYEY SILT** trace  
gravel

**GLACIAL TILL:** Compact grey silty sand to sandy silt with gravel, trace cobbles and boulders

End of Borehole

(GWL @ 2.75m - April 30, 2024)

## SAMPLE

TYPE

# NUMBER

%

**VALUE**

DEPT  
(m)

**ELEV.**  
**(m)**

**Pen. Resist. Blows/0.3m**  
**● 50 mm Dia. Cone**

- **Water Content %**

20      40      60      80

## PIEZOMETER CONSTRUCTION

250

159

• • • • •

20 40 60 80 100

**Shear Strength (kPa)**

▲ Undisturbed      △ Remoulded

EASTING:

NORTHING:

ELEVATION: 62.236

FILE NO.

PG7100

DATUM: Geodetic

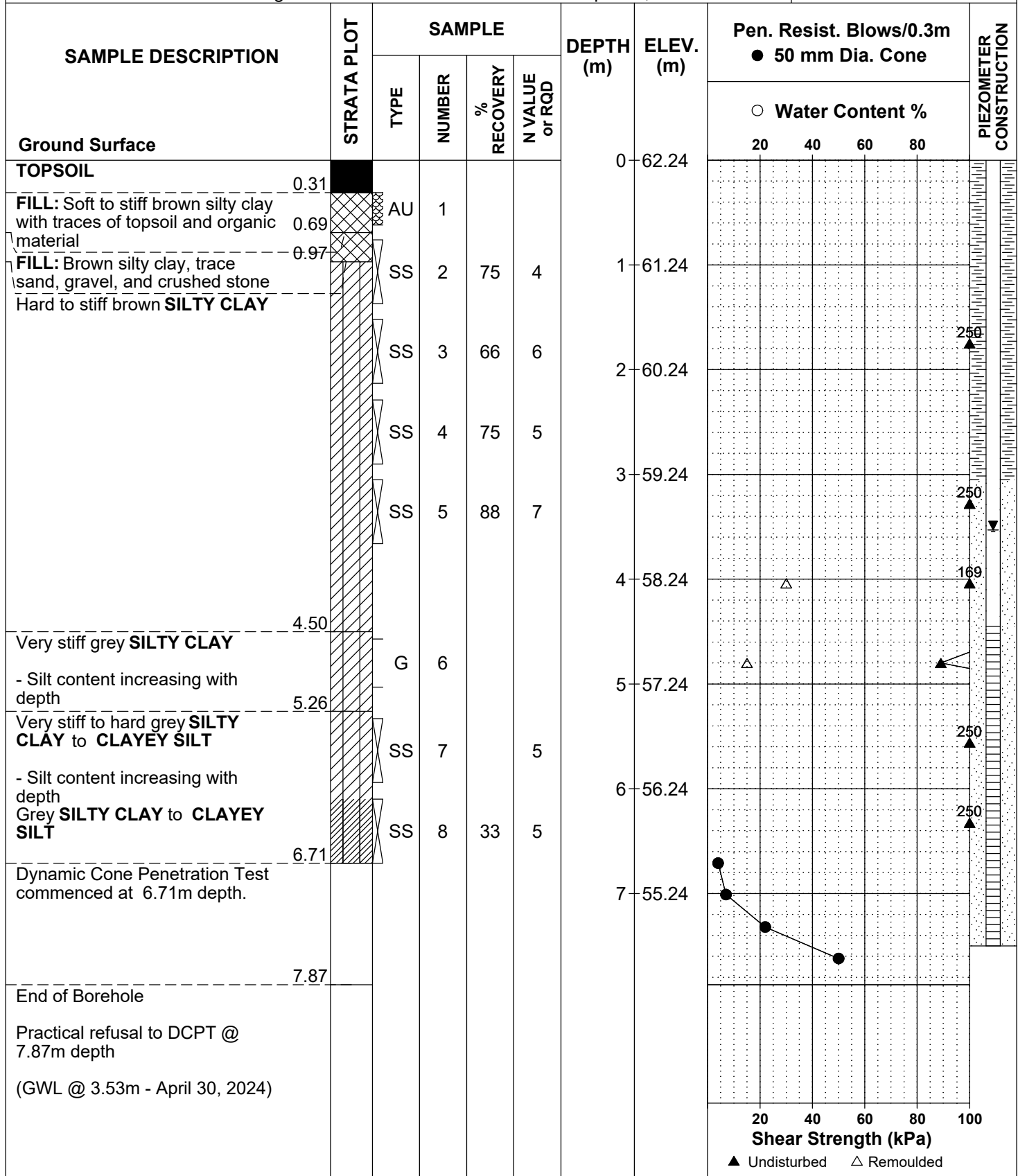
REMARKS:

HOLE NO.

BH 2-24

BORINGS BY: CME 75 Power Auger

DATE: April 24, 2024





EASTING: NORTHING: ELEVATION: 63.34

DATUM: Geodetic

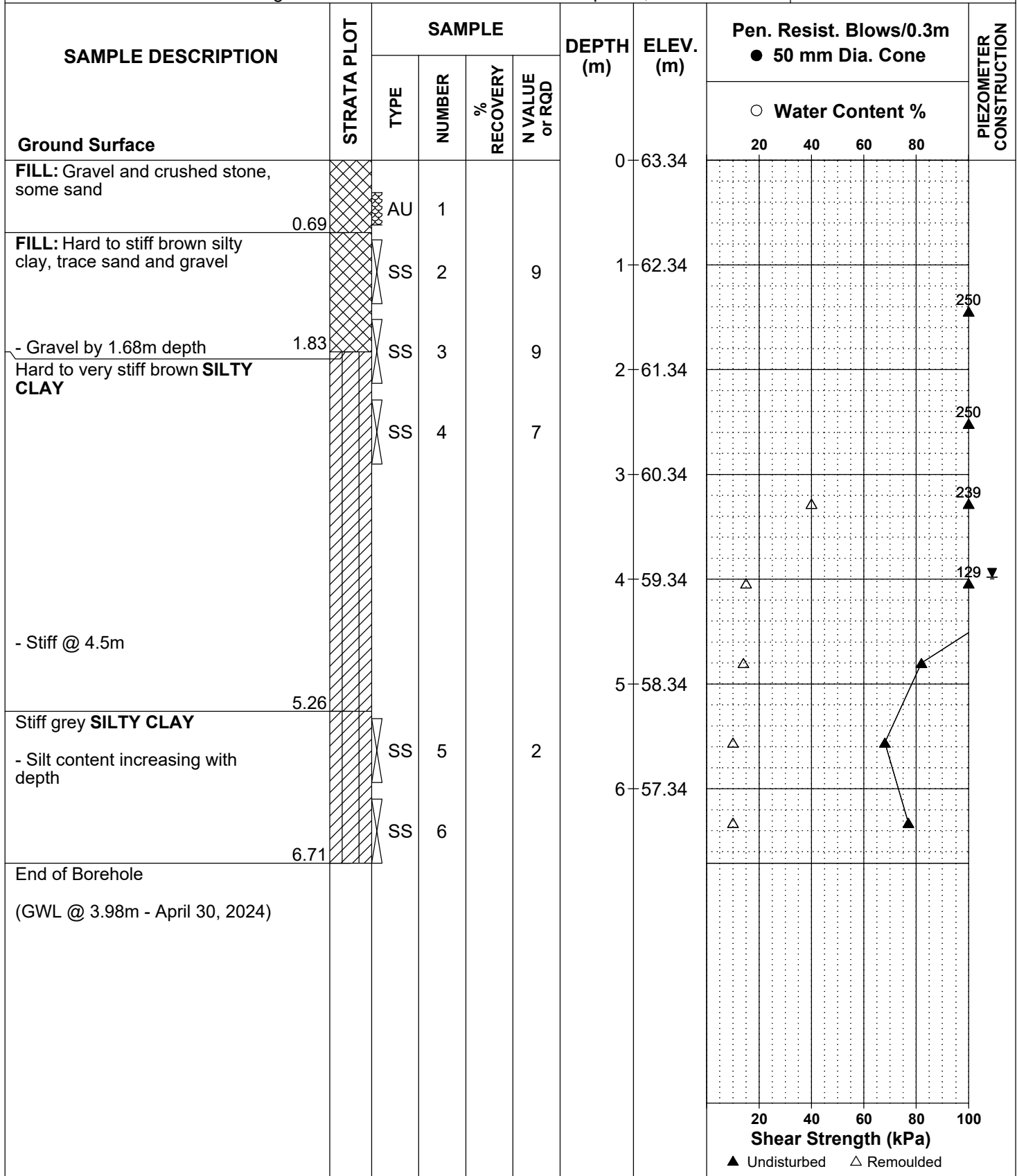
REMARKS:

BORINGS BY: CME 75 Power Auger

DATE: April 25, 2024

FILE NO. **PG7100**

HOLE NO. **BH 3-24**



## 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,  $S_t$ , 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:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

### 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	Excellent, intact, very sound
75-90	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
Cc	-	Concavity coefficient = $(D_{30})^2 / (D_{10} \times D_{60})$
Cu	-	Uniformity coefficient = $D_{60} / D_{10}$

Cc and Cu are used to assess the grading of sands and gravels:

Well-graded gravels have:  $1 < Cc < 3$  and  $Cu > 4$

Well-graded sands have:  $1 < Cc < 3$  and  $Cu > 6$

Sands 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		Overconsolidation ratio = $p'_c / p'_o$
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

### PERMEABILITY TEST

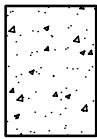
k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during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

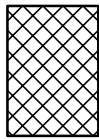
### STRATA PLOT



Topsoil



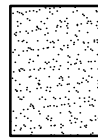
Asphalt



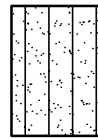
Fill



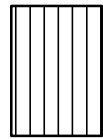
Peat



Sand



Silty Sand



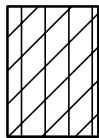
Silt



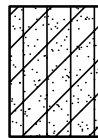
Sandy Silt



Clay



Silty Clay



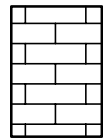
Clayey Silty Sand



Glacial Till



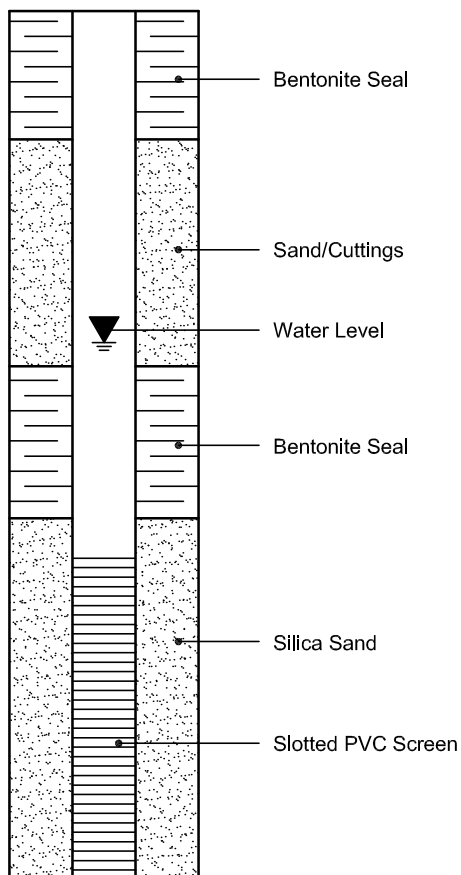
Shale



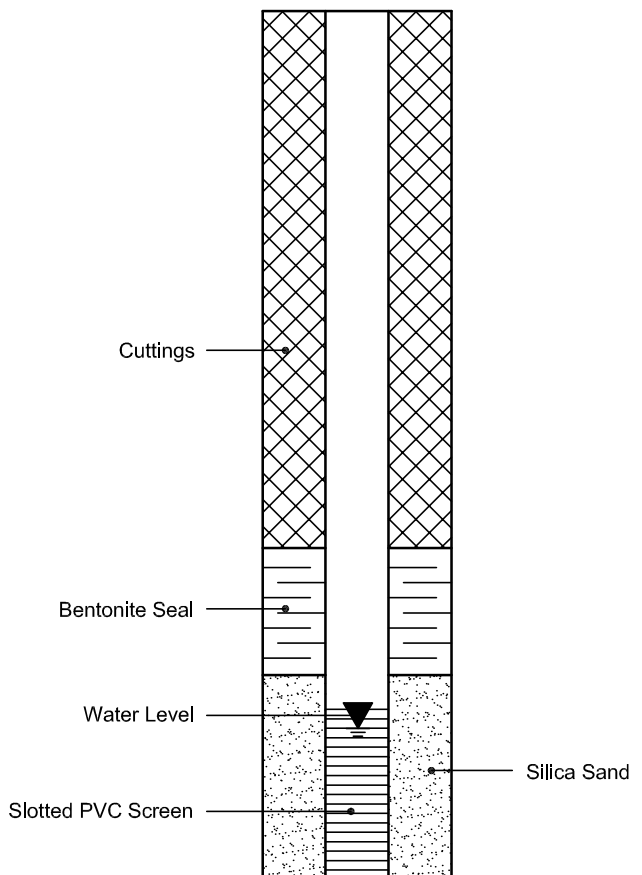
Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION

#### MONITORING WELL CONSTRUCTION



#### PIEZOMETER CONSTRUCTION



Certificate of Analysis  
Client: Paterson Group Consulting Engineers (Ottawa)  
Client PO: 60046

Report Date: 01-May-2024  
Order Date: 25-Apr-2024  
Project Description: PG7100

Client ID:	BH1-24 SS4	-	-	-	
Sample Date:	24-Apr-24 09:00	-	-	-	-
Sample ID:	2417396-01	-	-	-	
Matrix:	Soil	-	-	-	
MDL/Units					

Physical Characteristics

% Solids	0.1 % by Wt.	76.4	-	-	-	-
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General Inorganics

pH	0.05 pH Units	6.82	-	-	-	-
Resistivity	0.1 Ohm.m	73.8	-	-	-	-

Anions

Chloride	10 ug/g	21	-	-	-	-
Sulphate	10 ug/g	32	-	-	-	-

# APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG7100 - 1 - TEST HOLE LOCATION PLAN



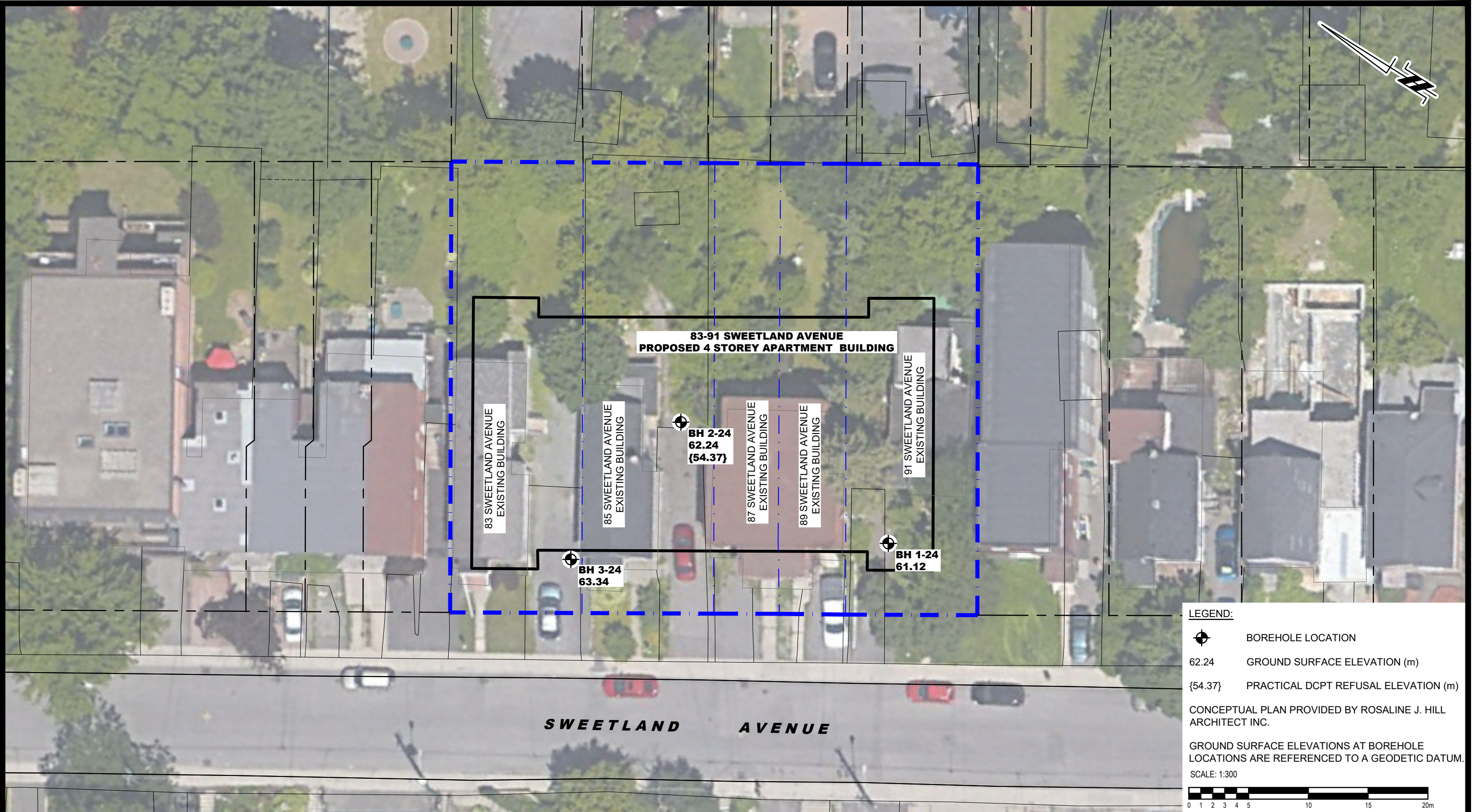
**FIGURE 1**

**KEY PLAN**




**PATERSON  
GROUP**





**LEGEND:**

 BOREHOLE LOCATION


62.24 GROUND SURFACE ELEVATION (m)


{54.37} PRACTICAL DCPT REFUSAL ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY ROSALINE J. HILL ARCHITECT INC.

GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:300



<div><div>9 AURIGA DRIVE OTTAWA, ON K2E 7T9 TEL: (613) 226-7381</div></div>					<div>OTTAWA, Title:</div> <div>UPSCALE HOMES GEOTECHNICAL INVESTIGATION PROPOSED RESIDENTIAL DEVELOPMENT 83-91 SWEETLAND AVENUE ONTARIO</div> <div>TEST HOLE LOCATION PLAN</div>	Scale:	1:300	Date:	05/2024
						Drawn by:	GK	Report No.:	PG7100-1
						Checked by:	DR	Dwg. No.:	PG7100-1
						Approved by:	SD	Revision No.:	
	NO.	REVISIONS	DATE	INITIAL					