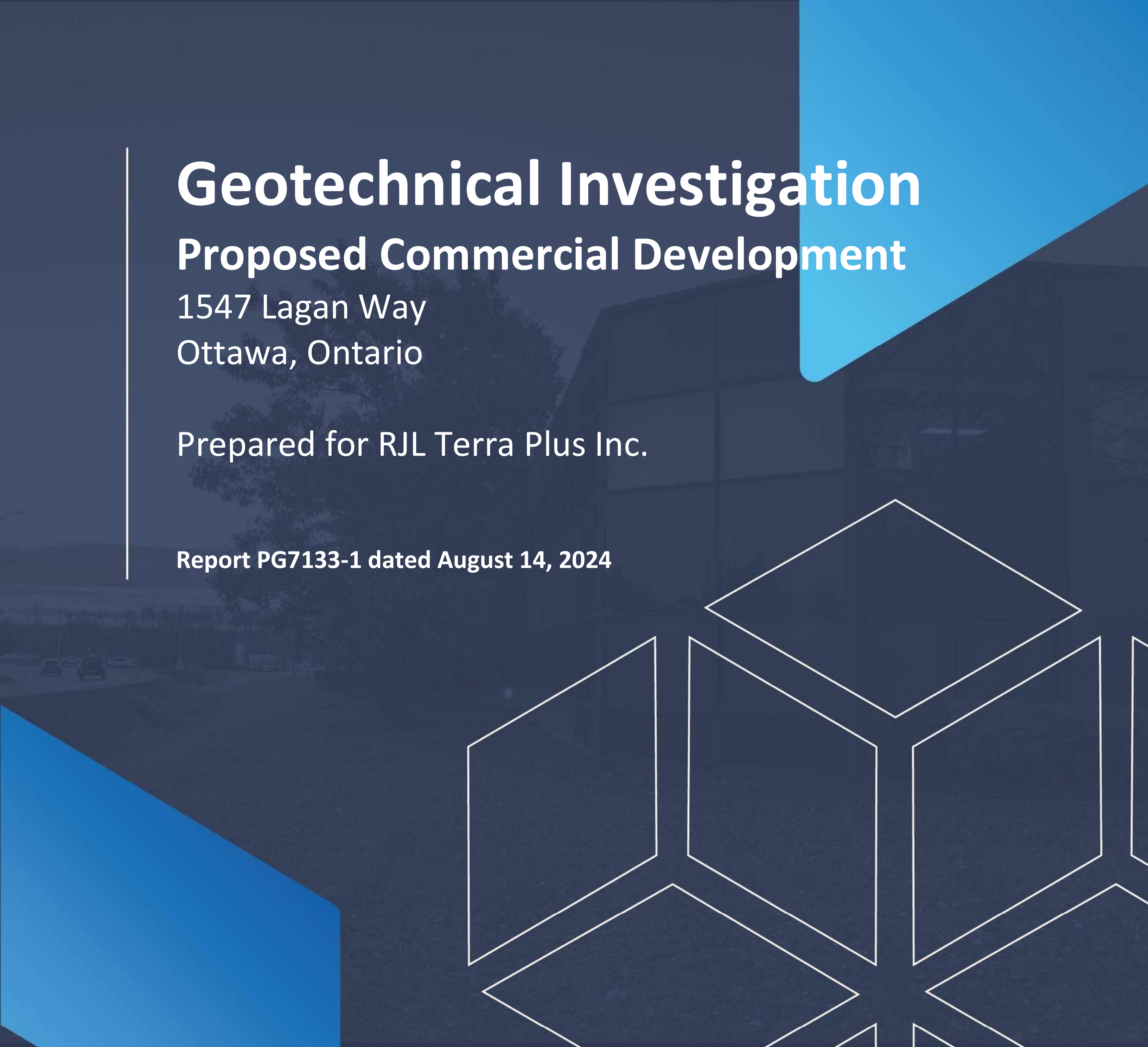

Geotechnical Investigation

Proposed Commercial Development

1547 Lagan Way
Ottawa, Ontario

Prepared for RJL Terra Plus Inc.

Report PG7133-1 dated August 14, 2024

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by RJL Terra Plus Inc. to conduct a geotechnical investigation for the proposed commercial development to be located at 1547 Lagan Way in the City of Ottawa (reference should be made to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were to:

☐ Determine the subsoil and groundwater conditions at this site by means of boreholes.

☐ 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 for the presence or potential presence of contamination on the subject property was not part of the scope of work of the present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

Based on the available conceptual plan, it is understood that the proposed development will consist of a single-storey commercial building with a mezzanine and a basement level (Building C) within the northern portion of the subject site and a single-storey slab-on-grade commercial building (Building B) within the southern portion of the subject site.

It is further anticipated that the existing structure located along the northern property line will be partly demolished and partly renovated to accommodate the construction of the proposed development. Several storage buildings at the rear of the property are also expected to be demolished. Furthermore, it is understood that the remainder of the site will generally be occupied by vehicle parking areas, access roads, loading zones, and landscaped areas. It is also expected that the subject site will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was carried out on June 5 and 6, 2024, and consisted of advancing a total of 13 boreholes to a maximum depth of 3.9 m below the existing ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site, taking into consideration underground utilities and site features. The approximate borehole locations are shown on Drawing PG7133-1 – Test Hole Location Plan included in Appendix 2.

The boreholes were completed using a truck-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. The testing procedure consisted of augering and excavating to the required depth at the selected location and sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split spoon (SS) sampler. All samples were visually inspected and initially classified on site. The auger and split-spoon samples were placed in sealed plastic bags.

All samples were transported to our laboratory for further examination and classification. 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.

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

Groundwater monitoring wells were installed in boreholes BH 1-24, BH 2-24, BH 3-24, and BH 10-24 to permit monitoring of the groundwater levels following the completion of drilling. Additionally, standpipe piezometers were installed in all other boreholes. The groundwater level readings were obtained after a suitable stabilization period subsequent to the completion of the field investigation.

Monitoring Well Installation

Typical monitoring well construction details are described below:

- ☐ Up to 1.5 m of slotted 51 mm diameter PVC screen at base the base of the boreholes.
- ☐ 51 mm diameter PVC riser pipe from the top of the screen to the ground surface.
- ☐ No.3 silica sand backfill within annular space around the screen.
- ☐ 600 mm thick bentonite hole plug directly above the PVC slotted screen.
- ☐ Clean backfill from the top of bentonite plug to the ground surface.

3.2 Field Survey

The borehole locations, and ground surface elevation at each borehole location, were surveyed by Paterson using a high-precision, handheld GPS and referenced to a geodetic datum. The locations of the boreholes, and the ground surface elevations at each borehole location, are presented on Drawing PG7133-1 – Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging.

Sample Storage

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

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

Currently, the subject site has a gravel surface and is used primarily as vehicle and equipment storage, with a 2-storey commercial building located in the northern portion of the site.

The site is bordered by the Lagan Way to the west and industrial properties to the east, north, and south. The ground surface across the subject site slopes downward from south to north from an approximate geodetic elevation of 69.6 m to an approximate geodetic elevation of 69.2 m. The site is approximately at grade with surrounding roadways and developments.

4.2 Subsurface Profile

Generally, the subsoil profile encountered at the borehole locations consists of a fill layer. The fill layer was generally observed to consist of loose to very dense brown silty sand and/or silty clay with sand, gravel, crushed stone, concrete, and trace topsoil. The fill layer was observed to extend to maximum depths of 0.6 to 2.4 m below the existing ground surface.

A deposit of compact brown clayey silt was observed underlying the fill layer at borehole BH 6-24 which was further underlain by a deposit of silty sand and extended to a maximum depth of 2.1 m below the existing ground surface. A deposit of dense to loose, brown to grey clayey silt with sand was observed underlying the fill layer at borehole BH 7-24 and extended to a maximum depth of 2.2 m below the existing ground surface.

At all test hole locations, a glacial till deposit was encountered, consisting of an undisturbed, compact to very dense brown to grey silty sand to sandy silt with gravel, cobbles, and boulders, and extended to a depth between 2.2 to 3.9 m below the existing ground surface.

Practical refusal to augering was encountered at all test hole locations, at approximate depths between 2.2 to 3.9 m below the existing ground surface.

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

Bedrock

Weathered bedrock was encountered at a depth between 2.7 to 2.9 m at borehole BH 10-24 location. The weathered bedrock was observed to consist of shale bedrock.

Further, based on available geological mapping, bedrock in the area of the subject site consists of shale of the Carlsbad Formation. The overburden drift thickness is estimated to be between 3 and 5 m depth.

4.3 Groundwater

Groundwater levels were measured within the installed monitoring wells and the installed piezometers on June 13, 2024. The measured groundwater levels noted at that time are presented in Table 1 below.

Table 1 – Summary of Groundwater Levels

Borehole Number	Ground Surface Elevation (m)	Measured Groundwater Level		Dated Recorded
		Depth (m)	Elevation (m)	
BH 1-24*	68.60	1.21	67.39	June 13, 2024
BH 2-24*	68.28	0.64	67.64	
BH 3-24*	69.05	0.96	68.09	
BH 4-24	68.35	1.12	67.23	
BH 5-24	69.66	0.96	68.70	
BH 6-24	69.54	1.59	67.95	
BH 7-24	69.18	1.45	67.73	
BH 8-24	69.38	1.03	68.35	
BH 9-24	68.26	1.19	67.07	
BH 10-24*	68.40	1.28	67.12	
BH 11-24	68.74	0.82	67.92	
BH 12-24	68.72	0.57	68.15	
BH 13-24	69.51	0.77	68.74	

Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS and referenced to a geodetic datum.
* - Monitoring well has been installed in boreholes

It should be noted that surface water can become trapped within a backfilled borehole that can lead to higher than typical groundwater level observations. It should be noted that groundwater levels are subject to seasonal fluctuations, therefore the groundwater levels could vary at the time of construction.

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 **1.5 to 2.0 m** below the ground surface. The recorded groundwater levels are also provided on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

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 commercial buildings be founded on conventional spread footings bearing on undisturbed, compact to very dense glacial till and/or existing fill layer approved by Paterson Personnel at the time of construction and/or clean surface sounded bedrock.

It is anticipated that some bedrock removal and the removal of large boulders will be required for building construction and servicing installation. Therefore, the contractor should be prepared for bedrock removal and the presence of large boulders within the subject site.

Removal of concrete elements is likely to be encountered due to the demolition of the existing structure on site.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and any fill containing significant amounts of deleterious or organic materials should be stripped from under any buildings and other settlement sensitive structures.

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

The existing fill material, where free of significant amounts of organic material, should be proof rolled by a vibratory roller making several passes under dry and above-freezing conditions, and reviewed and approved by Paterson Group at the time of construction. Provided that minimal flexing is observed the fill layer can be left in place as subgrade for the basement slab and pavement structure and for use as a bearing medium for footings. Care should be taken not to disturb adequate bearing soils below the founding level during site preparation activities. Any poor-performing layers observed during the proof rolling program should be removed and reinstated with an approved engineered fill.

Any soft areas should be removed and backfilled with OPSS Granular B Type II, with a maximum particle size of 50 mm and compacted to 98% of the material's SPMDD.

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.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

If excavated rock is to be used as fill, it should be suitably fragmented to produce a well-graded material with a maximum particle size of 300 mm. Where this fill material is open-graded, a woven geotextile may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements. Site-generated blast rock fill should be compacted using a suitably sized smooth drum vibratory roller when considered for placement. This can be assessed at the time of construction.

Under winter conditions, if snow and ice are present within the blast rock fill below future basement slabs, then settlement of the fill should be expected and support of a future basement slab and/or temporary supports for slab pours will be negatively impacted and could undergo settlement during spring and summer time conditions. The geotechnical consultant should complete periodic inspections during fill placement to ensure that snow and ice quantities are minimized.

Bedrock/Boulder Removal

Bedrock and/or boulder removal may be required at the subject site and can be accomplished by hoe ramming where the bedrock and/or boulders are weathered, and/or where only small quantities need to be removed. Sound bedrock and/or boulders may be removed by line drilling in conjunction with controlled blasting and/or hoe ramming.

Prior to considering blasting operations, the blasting effects on the existing services, buildings, and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in the proximity of the blasting operations should be carried out prior to commencing site activities. The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries or claims related to the blasting operations.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 50 mm/s during the blasting program to reduce the risks of damage to the existing structures. The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Vibration Considerations

Construction operations are also the cause of vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels should be incorporated in the construction operations to maintain, as much as possible, a cooperative environment with the residents.

The following construction equipment could be a source of vibrations: piling rig, hoe ram, compactor, dozer, crane, truck traffic, etc. Vibrations, whether caused by blasting operations or by construction operations, could be the cause of the source of detrimental vibrations on the nearby buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters are used to determine the permissible vibrations, namely, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz).

In addition, it should be noted that the guidelines are for current construction standards. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended to be completed to minimize the risks of claims during or following the construction of the proposed buildings.

5.3 Foundation Design

Bearing Resistance Values

Clean Surface Sounded Bedrock

Footings supported directly on clean, surface-sounded bedrock can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **1,000 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Soil Bearing Surface

Footings placed on an undisturbed, compact to very dense glacial till or approved silty sand fill layer (as per subsection 5.2) can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **300 kPa.**

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 the concrete for the footings. The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

Settlement

Footings bearing on an undisturbed soil or an acceptable weathered bedrock bearing surface or an approved engineered fill and designed for the bearing resistance values at SLS provided herein will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

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 glacial till or a weathered bedrock bearing surface 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 or weathered bedrock or a material of the same or higher capacity as the in situ soil or weathered bedrock.

Adequate lateral support is provided to a sound bedrock bearing medium when a plane extending horizontally and vertically from the footing perimeter at a minimum of 1H:6V (or shallower) passes through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete.

Bedrock/Soil Transition

Where a footing is founded partly on bedrock and partly on soil, it is recommended to decrease the soil bearing resistance value by 25% for the portion placed on a soil bearing medium to reduce the potential long-term total and differential settlements.

Also, at the soil/bedrock transitions, it is recommended that a minimum depth of 500 mm of bedrock be removed from below the founding elevation for a minimum length of 2 m on the bedrock side. This area should be subsequently reinstated with an engineered fill, such as OPSS Granular A or Granular B Type II and compacted to a minimum of 98% of the material SPMDD.

The width of the sub-excavation should be a minimum of 500 mm greater than the width of the footing. Steel reinforcement, extending a minimum of 3 m on both sides of the 2 m long transition, should be placed in the top portions of the footing and foundation walls.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C**. If a higher seismic site class is required (Class A or B) for the proposed commercial buildings, a site-specific shear wave velocity test may be completed to accurately determine the applicable seismic site classification for foundation design of the proposed building, as defined in Table 4.1.8.4.A of the Ontario Building Code (OBC) 2012.

Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest version of the OBC 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab / Slab on Grade Construction

With the removal of all topsoil and fill, containing significant amounts of deleterious or organic materials, the native soil and/or approved fill is considered to be an acceptable subgrade surface on which to commence backfilling for floor slab construction.

For structures with slab-on-grade construction, it is recommended that the upper 200 mm of sub-slab fill consist of OPSS Granular A crushed stone compacted to a minimum of 98% of the materials SPMDD.

For structures with basement slabs, it is recommended that the upper 200 mm of sub-floor fill consists of 19 mm clear crush stone compacted to a minimum of 98% of the material’s SPMDD.

All backfill material within the footprint of the proposed buildings should be placed in a maximum 300 mm thick loose layers and compacted to a minimum of 98% of the material’s SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

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^3. Where undrained conditions are anticipated (i.e., below the groundwater level), the applicable effective (undrained) unit weight of the retained soil can be taken as 13 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)
γ = unit weight of fill of the applicable retained soil (kN/m^3)
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 (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

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

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32 g according to the 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 $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ 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 the OBC 2012.

5.7 Pavement Design

For design purposes, the pavement structures presented in the following tables are recommended for the design of car-only parking areas, access lanes, and heavy truck parking and loading areas.

Table 2 - 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.	

Table 3 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking/Loading Areas

Thickness (mm)	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	**BASE** - OPSS Granular A Crushed Stone
450	**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.	

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 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 vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 100 mm to 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 structure. The pipe should have positive outlet, such as a gravity connection to the storm sewer.

Foundation Backfill

If the proposed buildings include below-grade space, 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 geo-composite board, such as Delta Terraxx, MiraDrain G100N or equivalent, connected to the perimeter foundation drainage system.

If the proposed buildings do not include below-grade space, then backfill against the exterior sides of the foundation wall may consist of on-site excavated fill, provided it is maintained in an unfrozen state and at a suitable moisture content for compaction. 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.

However, foundations which are founded directly on clean, surface-sounded bedrock with no cracks or fissures, and which is approved by Paterson at the time of construction, is not considered frost susceptible and does not require soil cover. Where the bedrock is considered frost susceptible, foundation insulation will need to be provided or the frost susceptible bedrock will need to be removed and replaced with lean concrete (minimum 17 MPa 28-day strength).

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. For the proposed development, it is expected that sufficient room will be available for the greater part of the excavation to be undertake by open-cut methods (i.e. 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.

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

Well fractured bedrock should be acceptable as backfill provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones 300 mm or larger in their longest dimension are removed. Where blast rock is used a blinding layer (OPSS Granular A crushed stone) or a geotextile may be required above the blast rock to reduce the loss of fine particles within the voids of the rockfill.

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. 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.

Groundwater Control for Building Construction

A temporary Ministry of the Environment, Conservation and Parks (MECP) 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, 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 and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16.

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 moderate to aggressive corrosive environment.

6.8 Protection of Potentially Expansive Shale Bedrock

Upon being exposed to air and moisture, the shale bedrock may decompose into thin flakes along the bedding planes. Previous studies have concluded shales containing pyrite are subject to volume changes upon exposure to air. As a result, the formation of jarosite crystals by aerobic bacteria occurs under certain ambient conditions.

It has been determined that the expansion process does not occur or can be retarded when air (i.e. oxygen) is prevented from contact with the shale and/or the ambient temperature is maintained below 20^{o}C, and/or the shale is confined by pressures in excess of 70 kPa. The latter restriction on the heaving process is probably the major reason why damage to structures has, for the greater part, been confined to slabs-on-grade rather than footings.

Based on the test hole logs, expansive shale may be encountered at the subject site. To reduce the long term deterioration of the shale, exposure of the bedrock surface to oxygen should be kept as low as possible.

The weathered bedrock surface within the proposed building footprint should be protected from excessive dewatering and exposure to ambient air. A 50 mm thick concrete mud slab, consisting of minimum 17 MPa lean concrete, should be placed on the exposed bedrock surface within a 48 hour period of being exposed. The excavated sides of the exposed bedrock should be sprayed with shotcrete to seal bedrock from exposure to air and dewatering.

7.0 Recommendations

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

☐ Review of the final design details, 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.

☐ 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 soil 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 RJL Terra Plus Inc., or their agents, is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
August 14, 2024
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Yashar Ziaeimehr, M.A.Sc., EIT

David J. Gibert, P.Eng.

Report Distribution:

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☐ Paterson Group (1 Copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

PATERSON GROUP

9 Auriga Drive
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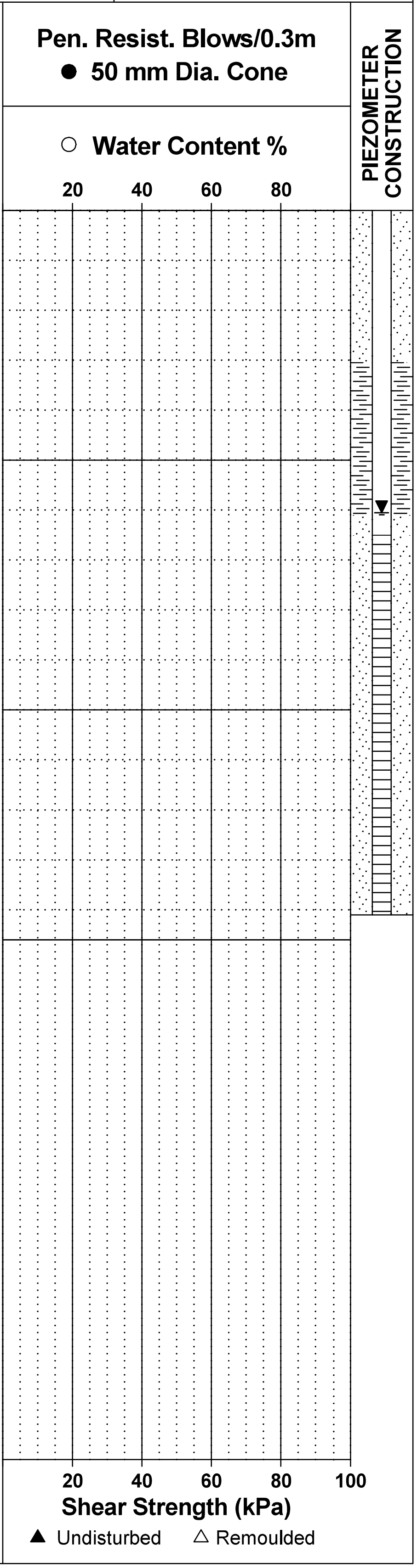
SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373046.654 **NORTHING:** 5030499.942 **ELEVATION:** 68.60
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 5

FILE NO. PG7133
HOLE NO. BH 1-24

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	68.60
FILL: Brown silty sand with gravel and crushed stone - Some clay by 0.3 m depth 0.46		SS	1	75	19		
FILL: Brown silty sand 1.45		SS	2	58	17	1	67.60
FILL: Brown to grey silty clay with sand and gravel, trace topsoil 2.13		SS	3	54	7	2	66.60
GLACIAL TILL: Dense grey silty sand to sandy silt with gravel, cobbles and boulders 2.92		SS	4	84	38		
End of Borehole Practical refusal on inferred bedrock or boulder at 2.92 m depth (GWL at 1.21 m depth - June 13, 2024)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373059.576 **NORTHING:** 5030545.607 **ELEVATION:** 68.28
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 5

FILE NO. PG7133
HOLE NO. BH 2-24

SAMPLE DESCRIPTION

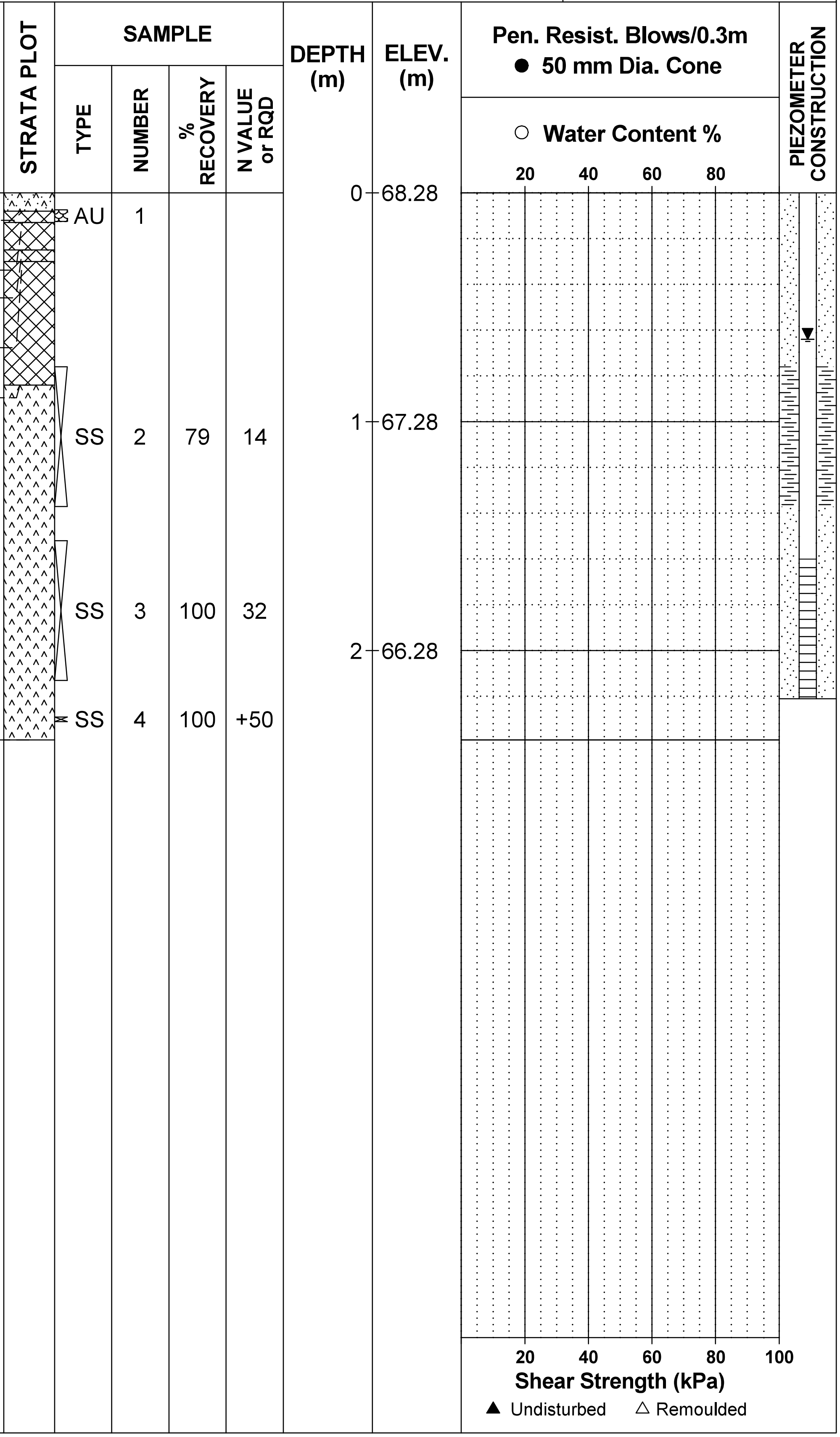
GROUND SURFACE

SAMPLE DESCRIPTION		TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
						0	68.28
ASPHALT	0.08	AU	1				
FILL: Brown silty sand with gravel	0.13 0.25						
FILL: Concrete	0.30						
FILL: Brown silty sand with gravel							
FILL: Brown silty clay with crushed stone	0.84						
GLACIAL TILL: Compact to dense brown silty sand to sandy silt with gravel, cobbles and boulders		SS	2	79	14	1	67.28
		SS	3	100	32	2	66.28
	2.39	SS	4	100	+50		

End of Borehole

Practical refusal on inferred bedrock or boulder at 2.39 m depth

(GWL at 0.64 m depth - June 13, 2024)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed
Commercial Development - 1547 Lagan Way
Ottawa, Ontario

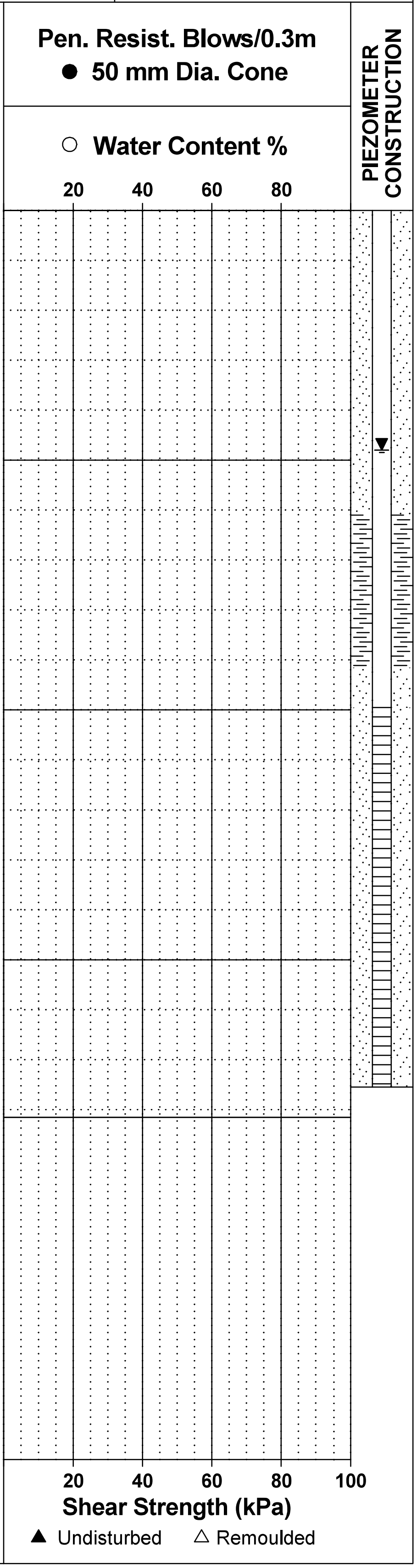
EASTING: 373111.774 **NORTHING:** 5030513.887 **ELEVATION:** 69.05
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 5

FILE NO. PG7133
HOLE NO. BH 3-24

SAMPLE DESCRIPTION	Depth (m)
GROUND SURFACE	
FILL: Brown silty sand with crushed stone and gravel	0.46
FILL: Brown silty sand, some gravel, trace clay and topsoil	0.69
GLACIAL TILL: Dense brown silty sand to sandy silt with gravel, cobbles - Grey by 2.4 m depth - Rock fragments at 2.9 m depth	3.63
End of Borehole Practical refusal on inferred bedrock or boulder @ 3.63 m depth (GWL at 0.96 m depth - June 13, 2024)	

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	24
SS	2	71	35
SS	3	92	+50
SS	4	67	25
SS	5	100	+50

DEPTH (m)	ELEV. (m)
0	69.05
1	68.05
2	67.05
3	66.05



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373025.193 **NORTHING:** 5030561.928 **ELEVATION:** 68.35

DATUM: Geodetic

REMARKS:

BORINGS BY: CME 55 Power Auger

DATE: 2024 June 5

FILE NO. PG7133

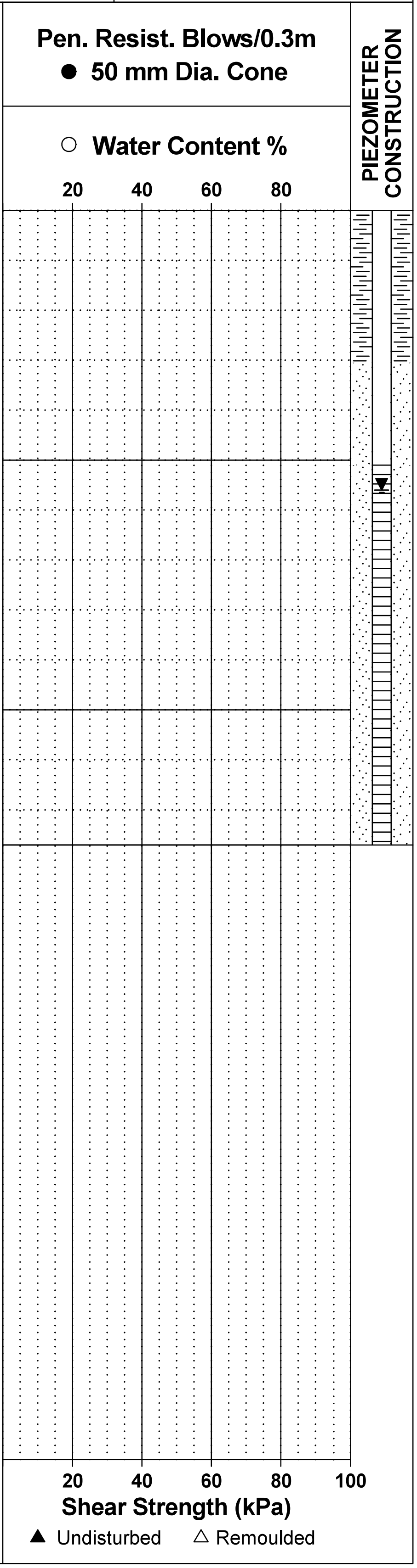
HOLE NO. BH 4-24

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.35
ASPHALT	0.10						
FILL: Brown silty sand with gravel and crushed stone, trace clay		SS	1	29	8		
						1	67.35
	1.07	SS	2	25	6		
FILL: Brown silty clay with sand, trace gravel	1.45						
GLACIAL TILL: Compact to dense brown silty sand to sandy silt with gravel, cobbles and boulders		SS	3	54	13		
						2	66.35
		SS	4	0	+50		
	2.54						

End of Borehole

Practical refusal on inferred bedrock or boulder at 2.54 m depth

(GWL at 1.12 m depth - June 13, 2024)



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SOIL PROFILE AND TEST DATA

**Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario**

EASTING: 373109.492 **NORTHING:** 5030468.295 **ELEVATION:** 69.66

DATUM: Geodetic

REMARKS:

BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 5

FILE NO. PG7133

HOLE NO. BH 5-24

SAMPLE DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	69.66
FILL: Brown silty sand with gravel and crushed stone, trace clay	SS	1	71	19		
0.69						
FILL: Brown silty sand to sandy silt	SS	2	79	13	1	68.66
1.68						
GLACIAL TILL: Compact to dense grey silty sand to sandy silt with gravel, cobbles and boulders	SS	3	8	17	2	67.66
	SS	4	50	28		
	SS	5	67	40	3	66.66
3.73						
End of Borehole Practical refusal on inferred bedrock or boulder at 3.73 m depth (GWL at 0.96 m depth - June 13, 2024)						

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

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

STRATA PLOT

PIEZOMETER CONSTRUCTION

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed
Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373107.832 **NORTHING:** 5030405.825 **ELEVATION:** 69.54
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH 6-24

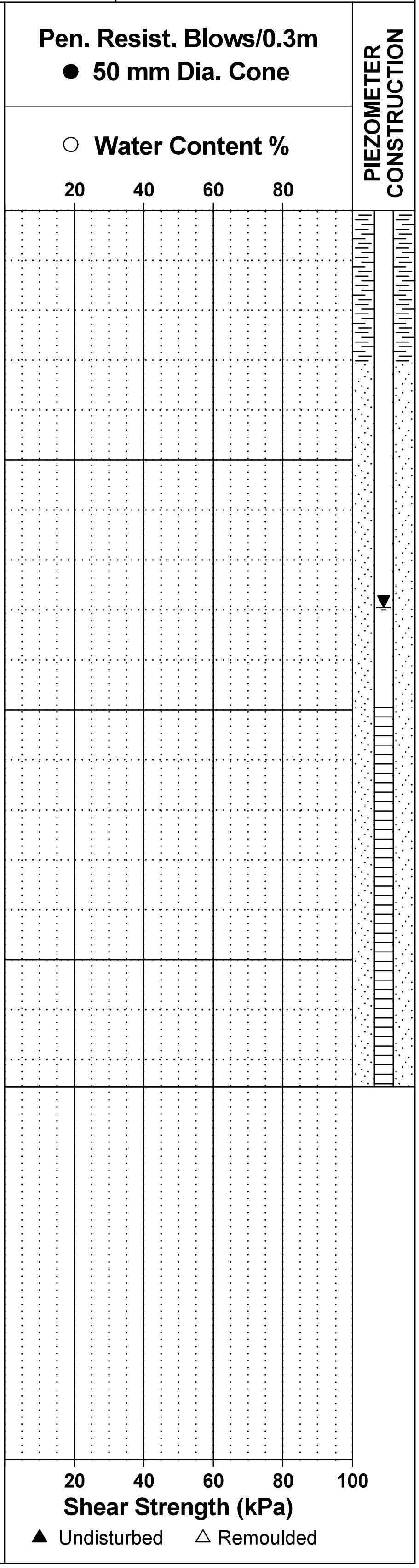
SAMPLE DESCRIPTION	Depth to base (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with crushed stone and gravel	0.69	SS	1	46	50
FILL: Brown clayey silt, trace topsoil and organics	1.07	SS	2	67	16
Compact brown **CLAYEY SILT**	1.45				
Loose to compact brown **SILTY SAND** , trace gravel	2.13	SS	3	38	8
GLACIAL TILL: Dense dark grey to black silty clay, some sand and gravel	3.05	SS	4	46	9
GLACIAL TILL: Compact to dense grey silty sand to sandy silt with gravel, cobbles and boulders	3.51	SS	5	50	+50

DEPTH (m)	ELEV. (m)
0	69.54
1	68.54
2	67.54
3	66.54

End of Borehole

Practical refusal on inferred bedrock or boulder at 3.51 m depth

(GWL at 1.59 m depth - June 13, 2024)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373081.109 **NORTHING:** 5030418.932 **ELEVATION:** 69.18
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH 7-24

SAMPLE DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel and crushed stone — 0.84	SS	1	25	26
FILL: Brown to grey clayey silt, trace topsoil — 1.07				
Dense brown to grey **CLAYEY SILT**, trace sand — 1.45	SS	2	75	12
Loose **CLAYEY SILT** , trace sand — 2.21	SS	3	71	3
GLACIAL TILL: Dense dark grey to black silty clay with sand, some gravel — 2.74	SS	4	33	7
GLACIAL TILL: Compact grey silty sand to sandy silt with gravel, cobbles and boulders — 3.76	SS	5	33	26

DEPTH (m)	ELEV. (m)
0	69.18
1	68.18
2	67.18
3	66.18

End of Borehole

Practical refusal on inferred bedrock or boulder @ 3.76 m depth

(GWL at 1.45 m depth - June 13, 2024)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80
PIEZOMETER CONSTRUCTION

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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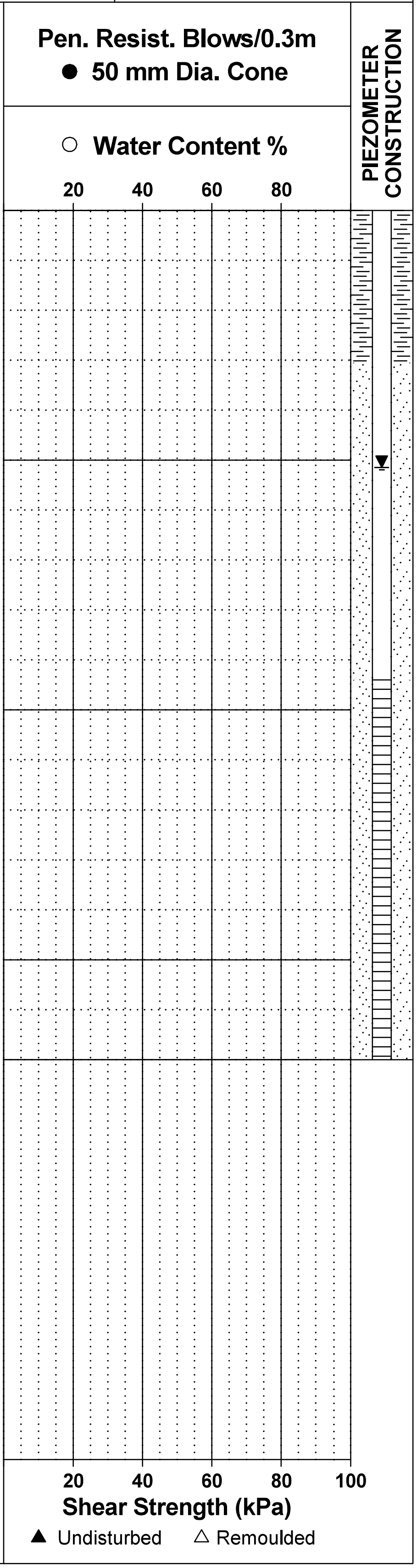
SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373086.406 **NORTHING:** 5030457.24 **ELEVATION:** 69.38
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH 8-24

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	69.38
FILL: Brown silty sand with crushed stone, gravel and bricks	▨	SS	1	67	34		
0.84							
FILL: Brown silty sand to sandy silt, trace gravel	▨	SS	2	79	13	1	68.38
	▨	SS	3	25	45	2	67.38
2.36							
GLACIAL TILL: Dense grey silty sand to sandy silt with gravel, trace clay, cobbles and boulders	^	SS	4	25	22		
	^	SS	5	54	+50	3	66.38
3.40							
End of Borehole Practical refusal on inferred bedrock or boulder at 3.40 m depth (GWL at 1.03 m depth - June 13, 2024)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373049.465 **NORTHING:** 5030525.575 **ELEVATION:** 68.26

DATUM: Geodetic

REMARKS:

BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133

HOLE NO. BH 9-24

SAMPLE DESCRIPTION	Strata bottom depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.26
FILL: Brown silty sand with gravel	0.84	SS	1	25	+50		
FILL: Brown silty sand	1.14	SS	2	75	16	1	67.26
FILL: Brown sandy silt to silty sand, trace topsoil and gravel	1.45						
GLACIAL TILL: Compact to dense brown silty sand to sandy silt with gravel, cobbles and boulders, trace clay - Grey by 1.7 m depth	2.24	SS	3	100	23	2	66.26

End of Borehole

Practical refusal on inferred bedrock or boulder at 2.24 m depth

(GWL at 1.19 m depth - June 13, 2024)

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

○ Water Content %

20 40 60 80

PIEZOMETER CONSTRUCTION

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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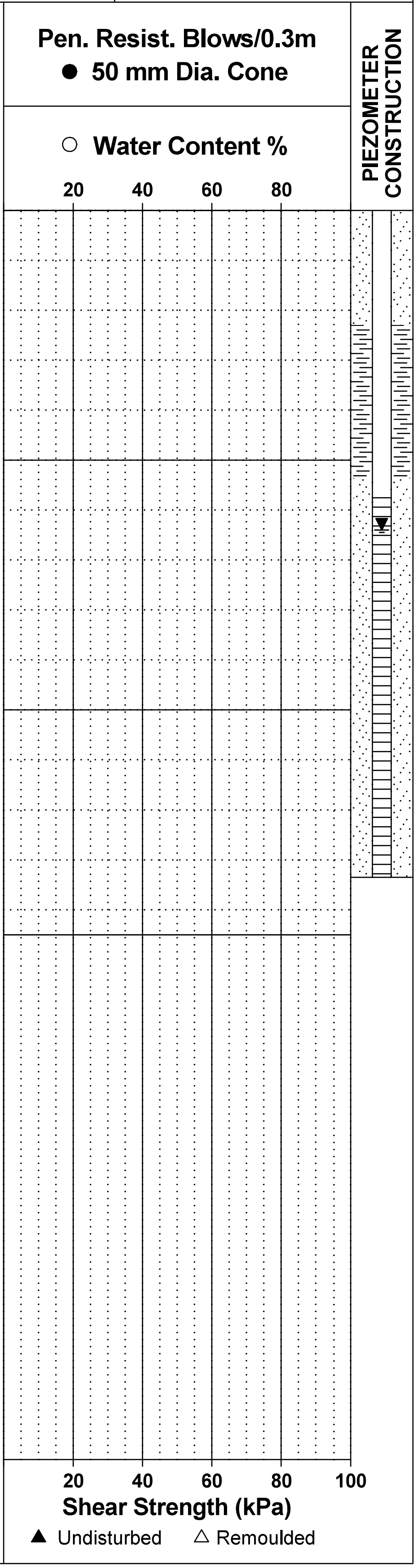
SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373035.565 **NORTHING:** 5030530.524 **ELEVATION:** 68.40
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH10-24

SAMPLE DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.40
ASPHALT	0.08						
FILL: Brown silty sand with gravel and crushed stone		SS	1	42	41		
	1.07					1	67.40
FILL: Brown sandy silt to silty sand with some clay		SS	2	83	9		
	1.45						
FILL: Brown silty sand to sandy silt with topsoil, trace gravel and clay	1.83	SS	3	54	11		
GLACIAL TILL: Compact brown silty sand to sandy silt with gravel, cobbles and boulders - Grey by 2.2 m depth						2	66.40
		SS	4	92	+50		
	2.74						
BEDROCK: Weathered shale	2.90						
End of Borehole (GWL at 1.28 m depth - June 13, 2024)							



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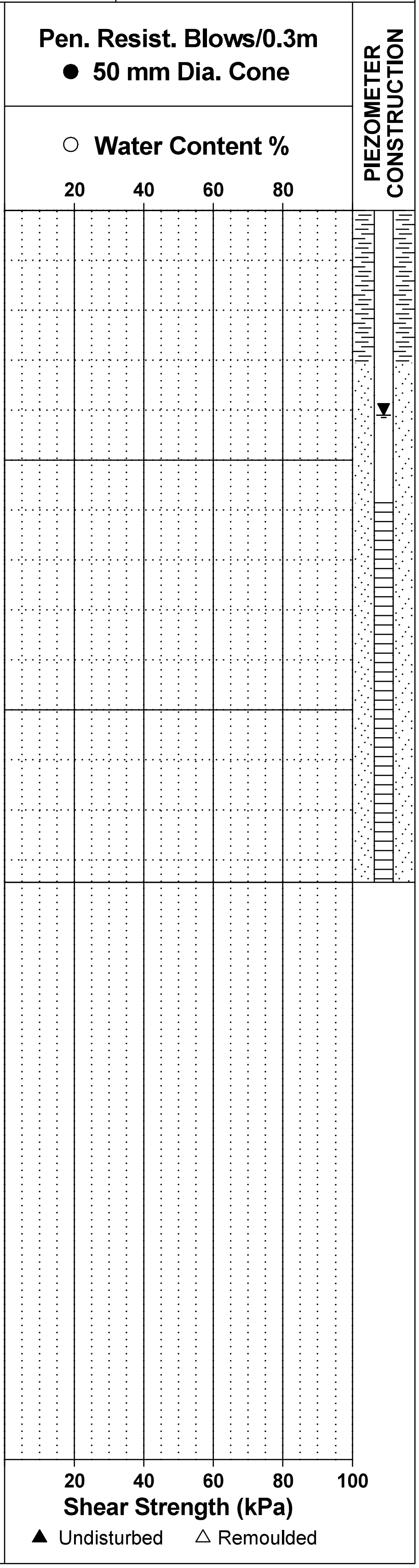
SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373073.38 **NORTHING:** 5030486.243 **ELEVATION:** 68.74
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH11-24

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.74
FILL: Brown silty sand with crushed stone, gravel and concrete	☒	SS	1	33	+50		
0.84							
FILL: Brown silty sand	☒	SS	2	63	21	1	67.74
1.45							
FILL: Dark grey to black silty clay with sand, some gravel and topsoil	☒	SS	3	50	10		
1.88						2	66.74
GLACIAL TILL: Compact to dense grey silty sand to sandy silt with gravel, cobbles and boulders	^	SS	4	21	+50		
2.69							
End of Borehole Practical refusal on inferred bedrock or boulder at 2.69 m depth (GWL at 0.82 m depth - June 13, 2024)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373081.452 **NORTHING:** 5030507.931 **ELEVATION:** 68.72

DATUM: Geodetic

REMARKS:

BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133

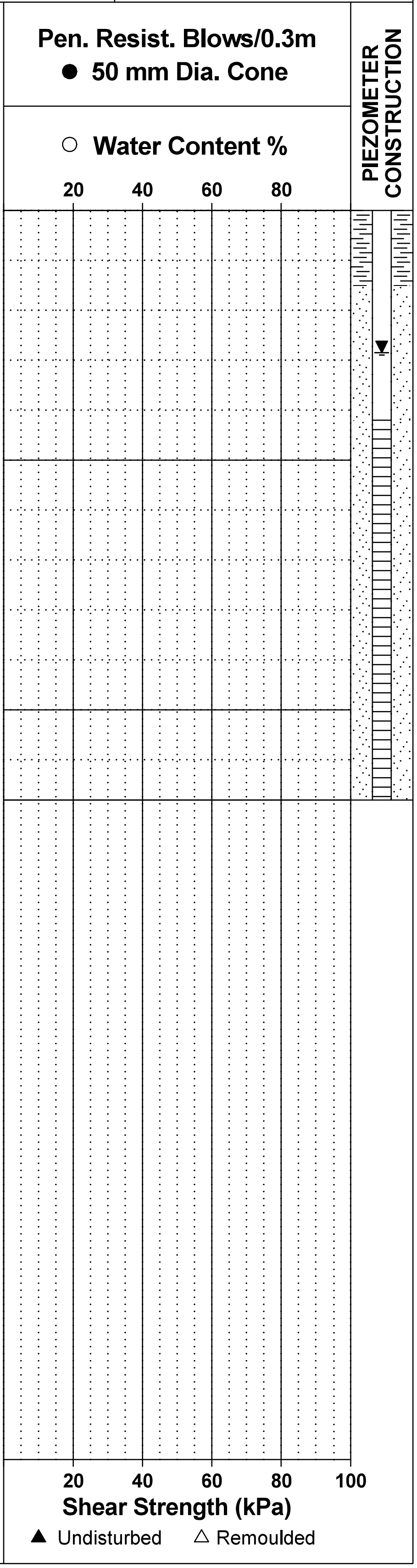
HOLE NO. BH12-24

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.72
FILL: Brown silty sand with crushed stone and gravel		SS	1	33	+50		
0.69							
FILL: Rock fragments, with gravel, some sand		SS	2	29	23	1	67.72
1.22							
GLACIAL TILL: Very dense brown silty sand to sandy silt with gravel, cobbles and boulders		SS	3	100	+50	2	66.72
2.36							

End of Borehole

Practical refusal on inferred bedrock or boulder at 2.36 m depth

(GWL at 0.57 m depth - June 13, 2024)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation - Proposed Commercial Development - 1547 Lagan Way
Ottawa, Ontario

EASTING: 373124.76 **NORTHING:** 5030433.631 **ELEVATION:** 69.51
DATUM: Geodetic
REMARKS:
BORINGS BY: CME 55 Power Auger **DATE:** 2024 June 6

FILE NO. PG7133
HOLE NO. BH13-24

SAMPLE DESCRIPTION	Depth to base (m)
GROUND SURFACE	
ASPHALT	0.05
FILL: Brown silty sand with gravel, crushed stone and bricks	0.84
FILL: Brown silty sand to sandy silt	1.83
FILL: Stiff brown silty clay with gravel, sand and some topsoil	2.13
GLACIAL TILL: Very dense brown silty sand to sandy silt with gravel, cobbles and boulders - Grey by 2.6 m depth	3.89

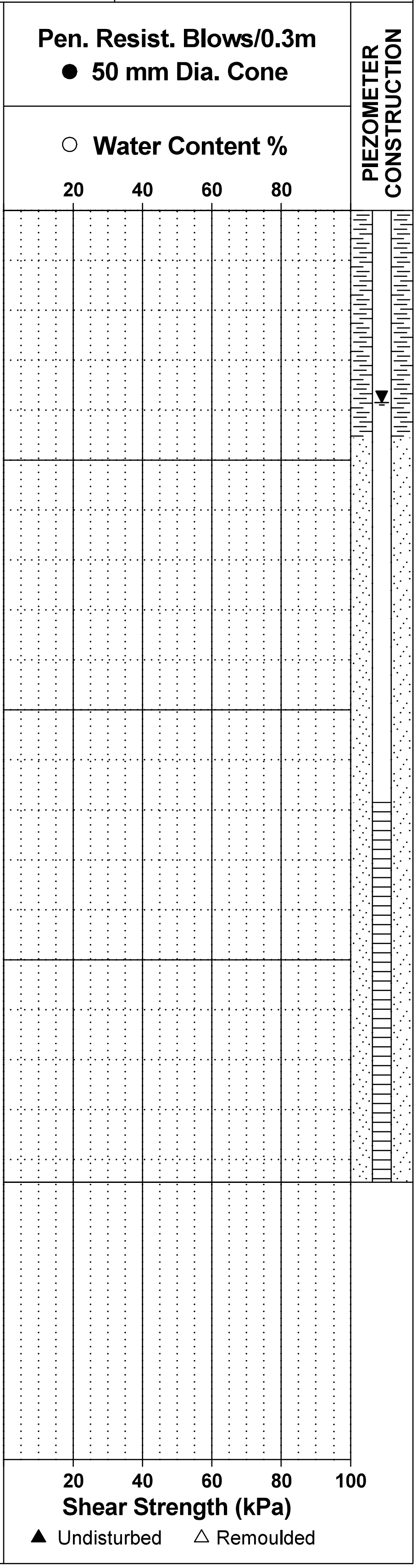
End of Borehole

Practical refusal on inferred bedrock or boulder at 3.89 m depth

(GWL at 0.77 m depth - June 13, 2024)

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	58	33
SS	2	71	14
SS	3	38	7
SS	4	0	35
SS	5	83	29

DEPTH (m)	ELEV. (m)
0	69.51
1	68.51
2	67.51
3	66.51



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 = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = $D60 / D10$

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)

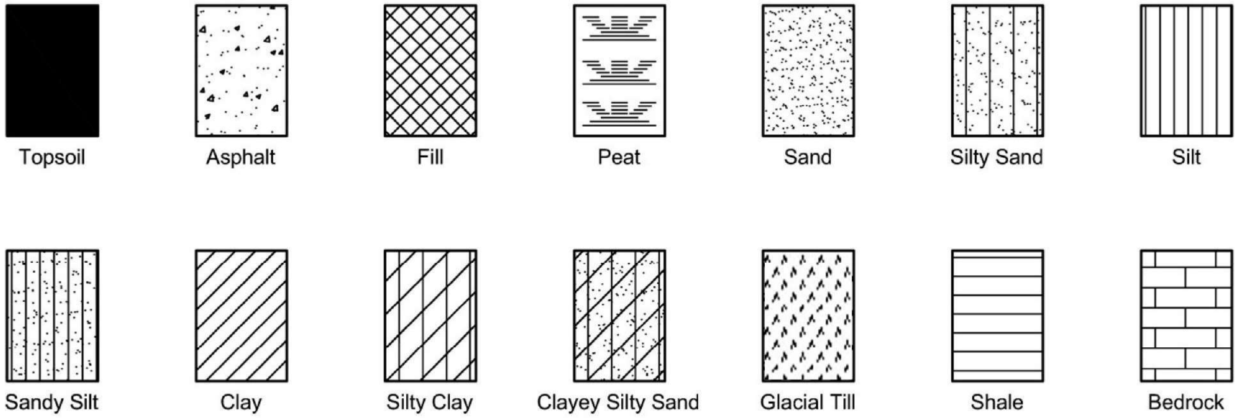
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

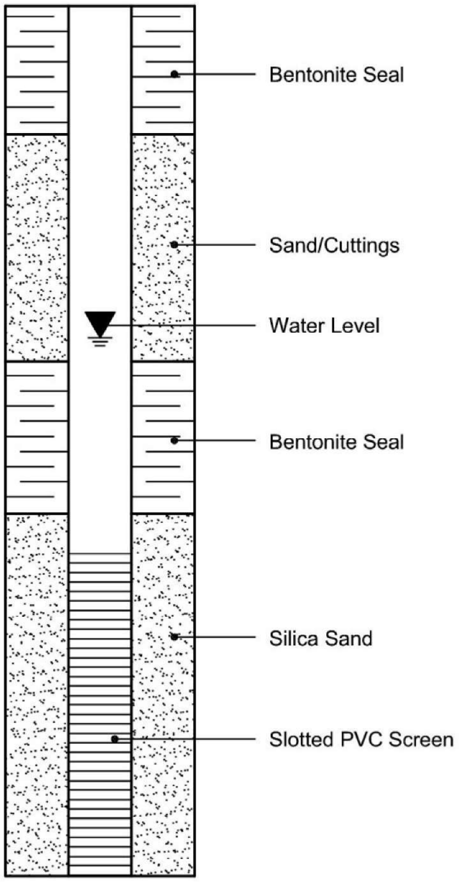
SYMBOLS AND TERMS (continued)

STRATA PLOT

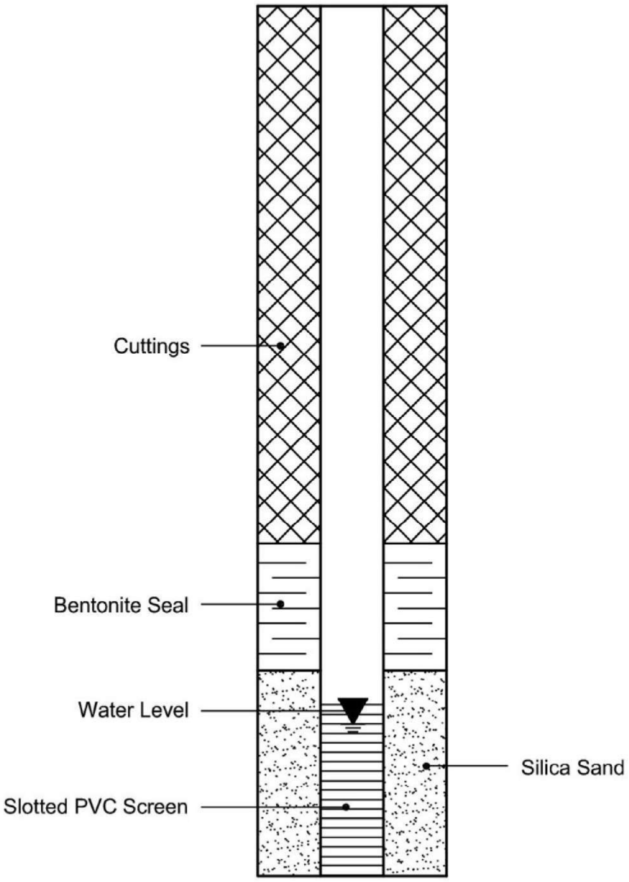


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: **Paterson Group Consulting Engineers (Ottawa)**

Client PO: 60409

Report Date: 17-Jun-2024

Order Date: 11-Jun-2024

Project Description: PG7133

	Client ID:	BH1-24-SS4	-	-	-		
	Sample Date:	05-Jun-24 09:00	-	-	-	-	-
	Sample ID:	2424314-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	93.5	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.18	-	-	-	-	-
Resistivity	0.1 Ohm.m	39.3	-	-	-	-	-
Anions							
Chloride	10 ug/g	10	-	-	-	-	-
Sulphate	10 ug/g	129	-	-	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG7133-1 - TEST HOLE LOCATION PLAN

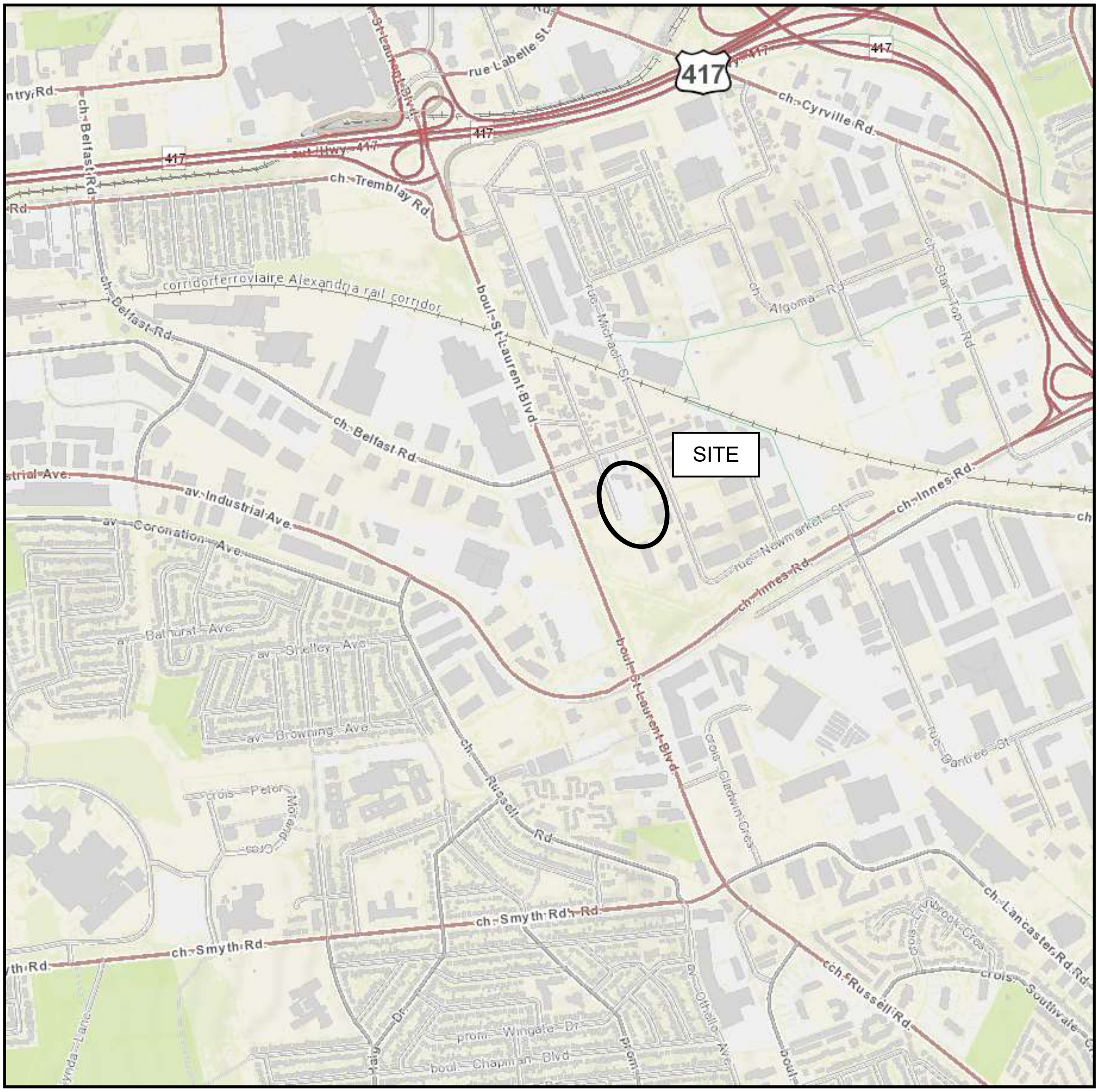
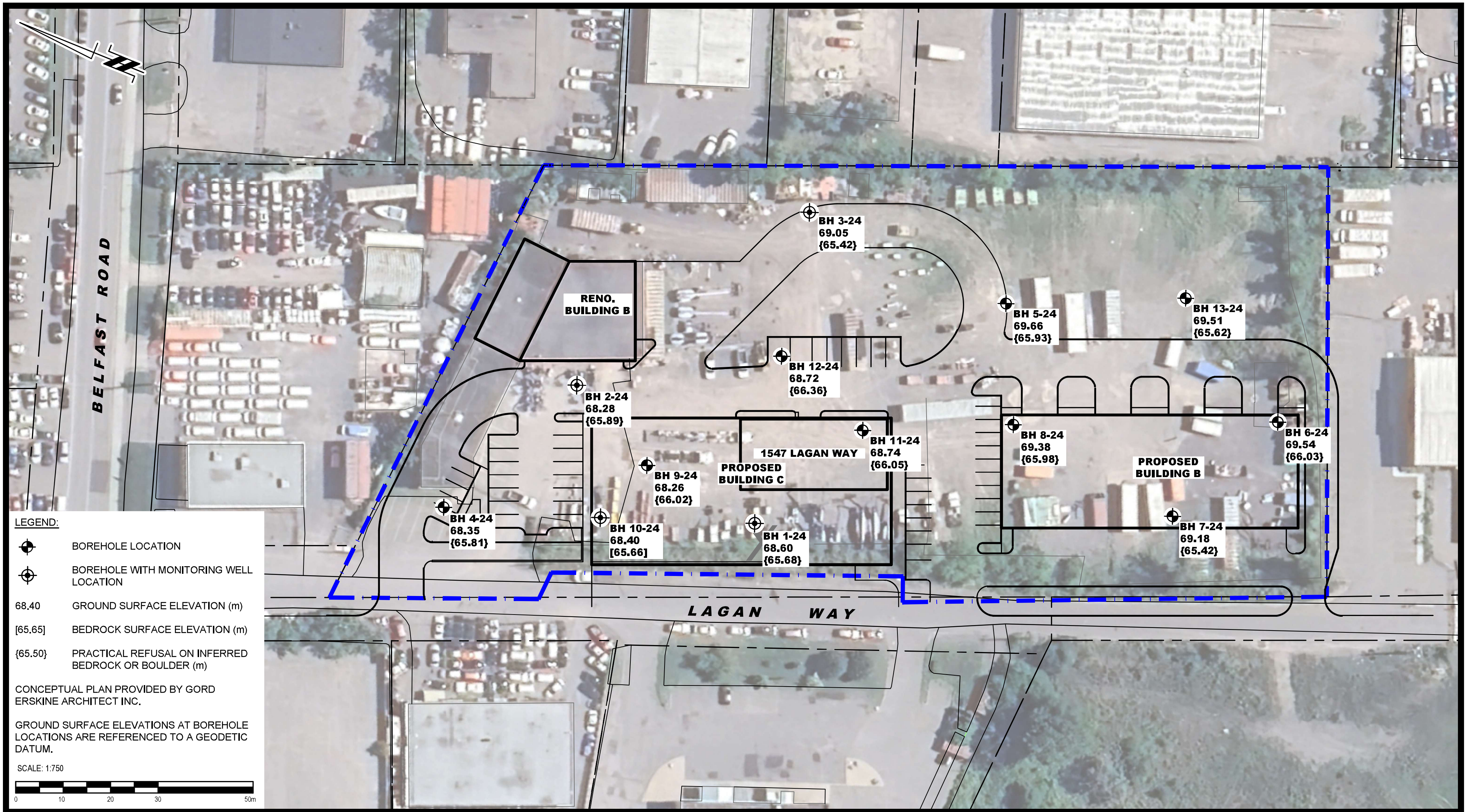


FIGURE 1

KEY PLAN

PATERSON
GROUP



LEGEND:

◉	BOREHOLE LOCATION
⊕	BOREHOLE WITH MONITORING WELL LOCATION
68.40	GROUND SURFACE ELEVATION (m)
[65.65]	BEDROCK SURFACE ELEVATION (m)
{65.50}	PRACTICAL REFUSAL ON INFERRED BEDROCK OR BOULDER (m)

CONCEPTUAL PLAN PROVIDED BY GORD ERSKINE ARCHITECT INC.

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

SCALE: 1:750

0 10 20 30 50m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

RJL TERRA PLUS INC.
GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL DEVELOPMENT
1547 LAGAN WAY

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale:	1:750	Date:	06/2024
Drawn by:	GK	Report No.:	PG7133-1
Checked by:	MA	Dwg. No.:	PG7133-1
Approved by:	YZ	Revision No.:	

11x17

p:\autocad drawings\geotechnical\pg71xx\pg7133\pg7133-1 test hole location plan.dwg