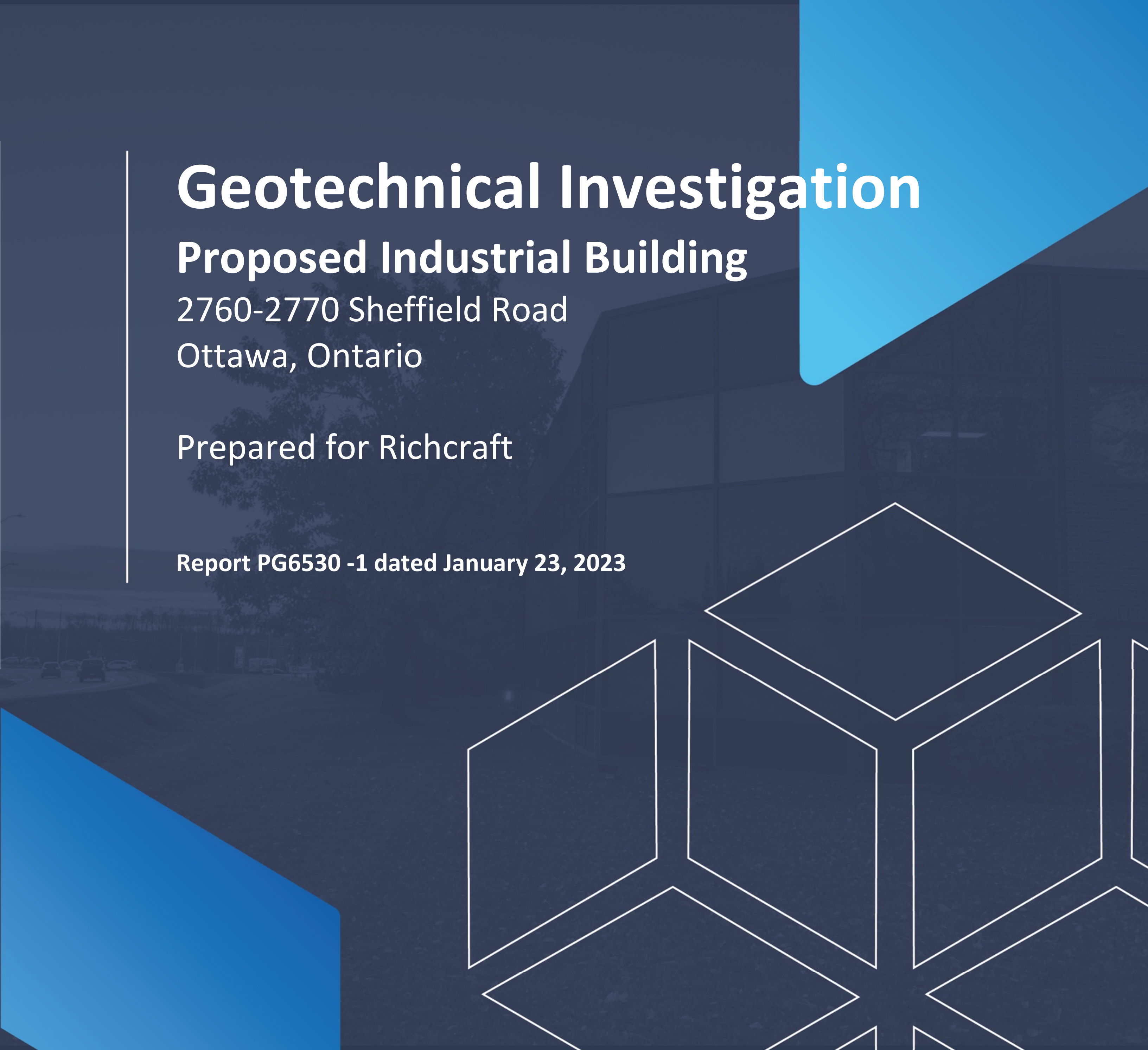

Geotechnical Investigation

Proposed Industrial Building

2760-2770 Sheffield Road
Ottawa, Ontario

Prepared for Richcraft

Report PG6530 -1 dated January 23, 2023

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by the Richcraft to conduct a geotechnical investigation for the proposed industrial building to be located at 2760-2770 Sheffield Road in the City of Ottawa (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 drawings, it is understood that the proposed development will consist of an industrial building with a slab-on-grade and an approximate footprint of 10,000 to 11,000 m^2. It is further understood that associated asphalt-paved access lanes, loading areas, and parking areas will surround the proposed building.

It is also understood that the proposed building will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The current geotechnical investigation was carried out on January 10th and 11th, 2023, and consisted of a total of nine (9) boreholes (BH 1-23 through BH 9-23) advanced to a maximum depth of 7.3 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 PG6530-1 - 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

The soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler or from the drill auger and hand auger flights. The samples were initially classified on site, placed in sealed plastic bags, and transported to our laboratory. The depths at which the drill 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 in Appendix 1.

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

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 boreholes BH 1-23 and BH 4-23. 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

Three (3) monitoring well were installed at boreholes BH 4-23, BH 8-23 and BH 9-23. Flexible polyethylene standpipes were installed in the remaining 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.

3.2 Field Survey

The borehole locations were selected by Paterson to provide general coverage of the proposed development taking into consideration the existing site features and underground utilities.

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 borehole location, are presented on Drawing PG6530-1 - 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. A total of three (3) Atterberg limits tests were completed on selected soil samples obtained from the current geotechnical investigation. All samples from the current investigation will be stored in the laboratory for 1 month after this report is completed. 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

The subject site is currently a vacant grassed area, however, based on reviewing available aerial photos, the site formerly consisted of a right-of-way for several railroads which have since been demolished. The site is bordered by commercial buildings to the east and west, and the former railroad right-of-way to the north and south. The ground surface across the site is relatively level at approximate geodetic elevation 67 to 68.

4.2 Subsurface Profile

Generally, the subsurface profile at the subject site consists of topsoil and/or fill, extending to approximate depths of 0.2 to 1.8 m, overlying a silty clay deposit. The fill was generally observed to consist of silty sand to silty clay with varying amounts of gravel, cobbles, and organics.

The silty clay deposit, encountered underlying the topsoil and/or fill, was observed to have a very stiff to hard, brown silty clay crust, becoming a stiff, grey silty clay below approximate depths of 2.5 to 3.5 m.

A DCPT was conducted at boreholes BH 1-23 and BH 4-23, which encountered practical refusal at approximate depths of 11.9 and 9.6 m, respectively.

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

Bedrock

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

Atterberg Limits Testing

Atterberg limits testing was completed on the recovered silty clay samples at selected locations throughout the subject site during the current and previous investigations. The results of the Atterberg Limits testing are presented in Table 1 on the next page, and on the Atterberg Limits Results sheet in Appendix 1.

Table 1 – Atterberg Limits Results – Current Investigation

Borehole	Sample	Depth (m)	LL (%)	PL (%)	PI (%)	Classification
BH 1-23	SS4	2.3-2.9	63	21	42	CH
BH 3-23	SS4	2.3-2.9	62	22	40	CH
BH 4-23	SS4	2.3-2.9	65	21	44	CH

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plastic Index; CH: Inorganic Clay of High Plasticity. MH: Inorganic Silt of High Plasticity

4.3 Groundwater

Groundwater levels were measured in the monitoring wells and standpipe piezometers on January 17, 2023. The measured groundwater levels are presented on the Soil Profile and Test Data sheets in Appendix 1, and in Table 2 below.

Table 2 – Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Groundwater Level (m)	Groundwater Elevation (m)	Recording Date
BH 1-23	67.57	0.96	66.61	January 17, 2023
BH 2-23	67.11	1.08	66.03	
BH 3-23	67.28	1.32	65.96	
BH 4-23*	67.73	1.04	66.69	
BH 5-23	67.57	0.79	66.78	
BH 6-23	67.73	0.95	66.78	
BH 7-23	67.45	1.66	65.76	
BH 8-23*	66.80	1.20	65.60	
BH 9-23*	66.74	0.48	66.26	

Note:

-*Denotes borehole instrumented with a 51 mm diameter monitoring well.

- Ground surface elevations at borehole locations were surveyed by Paterson and are referenced to a geodetic datum.

It should be noted that surface water can become trapped within a backfilled borehole, which can lead to higher than typical groundwater level observations. Similarly, it is our experience that surface water generated by snowmelt and rainfall events may sheet drain into the borehole column given the relatively impermeable nature of the silty clay soil surface.

The long-term groundwater level can also be estimated based on the observed colour, moisture content, and consistency of the recovered samples. Based on these observations, the long-term groundwater level is expected at approximate depths of 2.5 to 3 m below the existing 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.

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 industrial building be founded on conventional spread footings placed on an undisturbed, very to hard silty clay bearing surface.

Due to the presence of a silty clay deposit, a grade raise restriction will apply to the subject site. Permissible grade raise recommendations are discussed in Section 5.3.

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 any buildings and other settlement sensitive structures. It is anticipated that the existing fill within the future building footprint, free of deleterious material and significant amounts of organics, can be left in place below the proposed building footprints outside of lateral support zones for the footings. However, it is recommended that the existing fill layer be proof-rolled several times under dry conditions and above freezing temperatures and approved by Paterson personnel at the time of construction. Any poor performing areas noted during the proof-rolling operation should be removed and replaced with an approved fill.

Fill Placement

Engineered fill placed for grading beneath the proposed buildings, where required, should consist 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 buildings and paved areas should be compacted to at least 98% of the material’s standard Proctor maximum dry density (SPMDD).

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material's SPMDD.

5.3 Foundation Design

Bearing Resistance Values – Conventional Spread Footings

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed on an undisturbed, very stiff to hard silty clay bearing surface 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 **225 kPa**. A geotechnical resistance factor of 0.5 is applied to the above noted bearing resistance value at ULS.

The above-noted bearing resistance values at SLS for soil bearing surfaces will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

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.

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 a silty clay bearing medium 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 engineered fill of the same or higher capacity as the bearing soil.

Permissible Grade Raise

Due to the presence of the silty clay deposit, a permissible grade raise restriction of **2 m** is recommended. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise calculations.

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 D**. If a higher seismic site class is required (Class C), a site-specific shear wave velocity test may be completed to accurately determine the applicable seismic site classification for foundation design of the proposed buildings, as presented 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 revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of all topsoil and fill, containing significant amounts of deleterious or organic materials, the existing fill subgrade or native soil subgrade approved by the geotechnical consultant at the time of excavation will be considered an acceptable subgrade surface on which to commence backfilling for slab-on-grade construction. Where the subgrade consists of the existing fill, a vibratory drum roller should complete several passes over the subgrade surface as a proof-rolling program. Any poor performing areas should be removed and reinstated with an engineered fill, such as OPSS Granular B Type II.

It is recommended that the upper 200 mm of sub-floor fill consists of OPSS Granular A crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Design

Car only parking, heavy truck parking areas and access lanes are proposed at this site. The proposed pavement structures are presented in Tables 3 and 4 on the next page.

Table 3 – Recommended Pavement Structure – Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
300	**SUBBASE –** OPSS Granular B Type II
Subgrade – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over fill or in-situ soil.	

Table 4 - Recommended Pavement Structure - Access Lanes/Local Roadways, Loading Areas and Heavy Truck Parking

Thickness (mm)	Material Description
40	**Wear Course** - Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - 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 placedover fill or in situ soil.	

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or II material. Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. 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.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity. For areas where silty clay is encountered at subgrade level, it is recommended that subdrains be installed during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free draining non frost susceptible granular materials, such as clean sand or OPSS Granular B Type I granular material. 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.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum 1.5 m thick soil cover, or an equivalent thickness of soil cover and foundation insulation, should be provided for adequate frost protection of heated structures.

Exterior unheated footings, such as those for isolated exterior piers, retaining walls or loading ramps, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover, or an equivalent thickness of soil cover and foundation insulation

Consideration should be given to providing 2.1 m thick soil cover to interior footings within loading bays where significant exposure to freezing conditions during the winter months may occur. Further consideration may be given to installing heated slabs in these areas.

6.3 Excavation Side Slopes

The side slopes of the excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. 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).

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 subsoil at this site is considered to be mainly 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 be kept away 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.

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) and above the cover material 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 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 and the Water Taking and Discharge Plan to be prepared by a Qualified Persons as stipulated under O.Reg. 63/16.

If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

Impacts to Neighboring Properties

As the proposed building will be a slab-on-grade structure, it is not anticipated that it will be founded below the long-term groundwater level. As a result, long-term groundwater lowering is not anticipated, and therefore no adverse effects are expected to neighboring properties.

Further, as the proposed slab-on-grade structures will be setback from the site limits, no impacts to the neighbouring properties are anticipated as a result of excavation at the subject 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 using 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 into 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 (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a moderate to aggressive corrosive environment.

6.8 Landscaping Considerations

Paterson completed a soils review of the site to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) for trees planted within a public right-of-way (ROW).

Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Grain size distribution and hydrometer testing was also completed on selected soil samples. The above-noted test results were completed on samples taken at depths between the anticipated underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 1, 2, and 3 in Section 4.2, and in Appendix 1.

Based on these testing results, the plasticity index was found to be less than or equal to 40%. Therefore, the silty clay encountered throughout the subject site is considered to be a clay of low to medium potential for soil volume change.

The following tree planting setbacks are therefore recommended for the low to medium sensitivity silty clay deposit present throughout the subject site. Large trees (mature height over 14 m) can be planted 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 **7.5 m** for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the condition 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 centre of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.

☐ A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 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 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).

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, they should not be considered in the landscaping design.

7.0 Recommendations

It is a requirement for the foundation data provided herein to be applicable that the following material testing, and observation program be performed by the geotechnical consultant.

- Review of the 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.
- 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.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by Paterson

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 Richcraft, 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.

Puneet Bandi, M.Eng.

Scott Dennis

Scott S. Dennis, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Jan. 23, 2023
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMIT TESTING RESULTS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

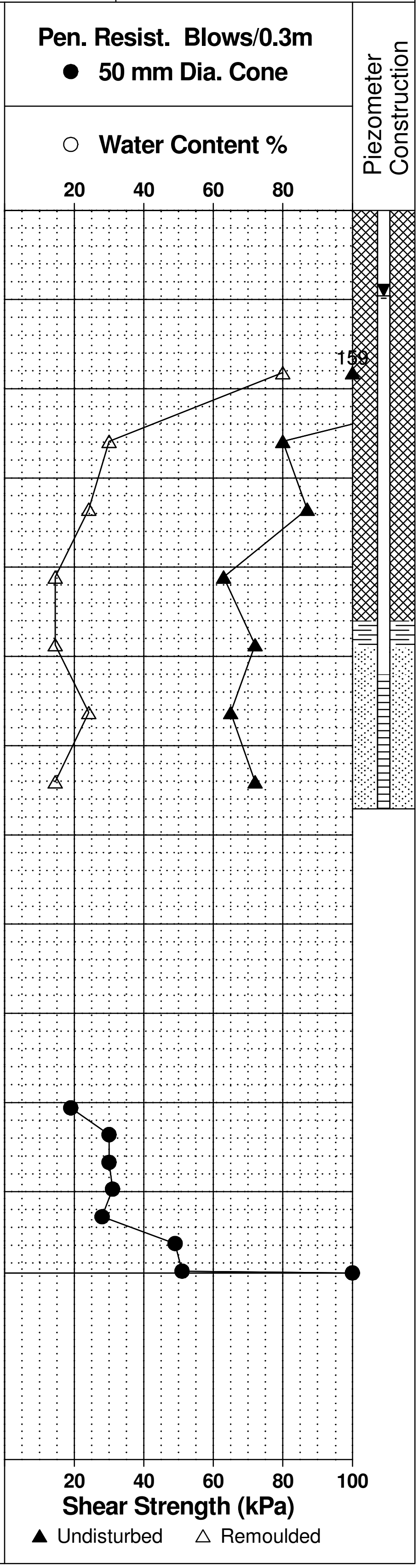
BORINGS BY CME-55 Low Clearance Drill

DATE January 10, 2023

FILE NO. PG6530

HOLE NO. BH 1-23

SOIL DESCRIPTION	STRATA PLOT	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.57
TOPSOIL 0.15		AU	1				
FILL: Peat with brown silty sand, trace gravel 0.41							
		SS	2	75	6	1	66.57
		SS	3	83	P	2	65.57
		SS	4	100	P		
Very stiff to stiff, brown **SILTY CLAY**		SS	5	100	P	3	64.57
- grey by 3.7m depth		SS	6	100	P	4	63.57
		SS	7	100	P	5	62.57
		SS	8	100	P	6	61.57
6.71		SS	9	100	P		
Dyamic Cone Penetration Test commenced at 6.71m depth. Cone pushed to 9.75m depth.						7	60.57
						8	59.57
						9	58.57
						10	57.57
						11	56.57
11.91							
End of Borehole Practical DCPT refusal at 11.91m depth. (GWL @ 0.96m - Jan. 17, 2023)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

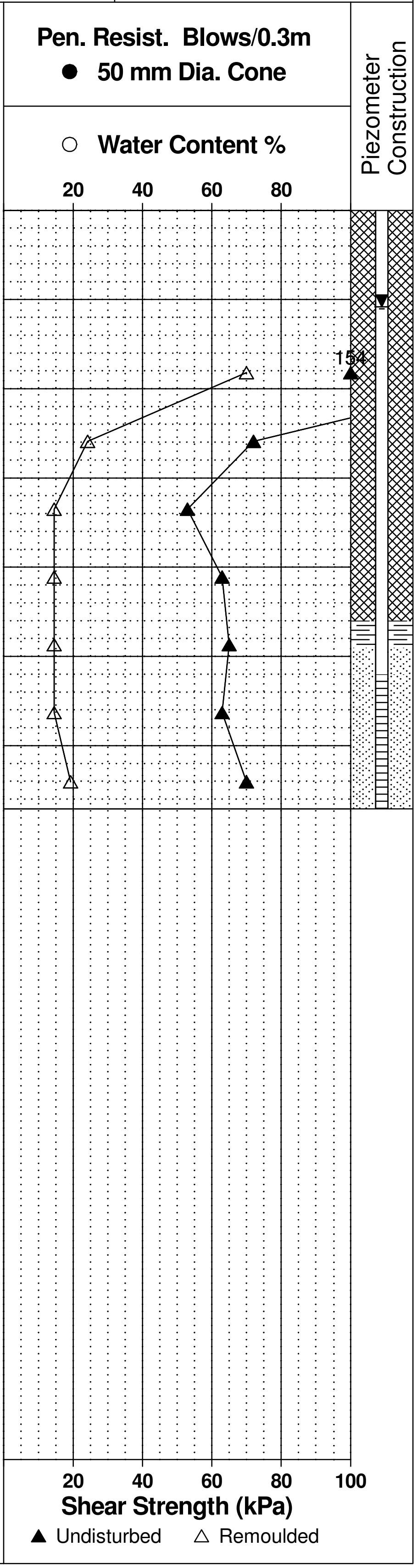
DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE January 10, 2023
FILE NO. **PG6530**
HOLE NO. **BH 2-23**

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.20				
FILL: Brown silty clay with topsoil, some peat and gravel 1.07	AU	1		
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.15m depth	SS	2	42	6
	SS	3	58	P
	SS	4	100	P
	SS	5	100	P
	SS	6	100	P
	SS	7	67	P
	SS	8	100	P
6.71	SS	9	100	P

DEPTH (m)	ELEV. (m)
0	67.11
1	66.11
2	65.11
3	64.11
4	63.11
5	62.11
6	61.11

End of Borehole

(GWL @ 1.08m - Jan. 17, 2023)



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SOIL PROFILE AND TEST DATA

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Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 10, 2023

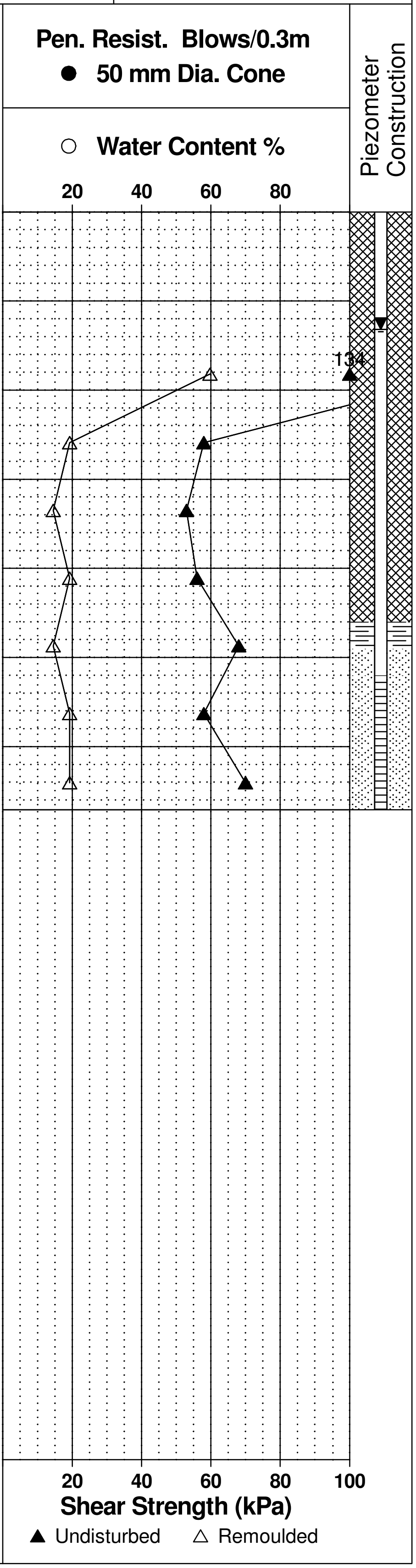
FILE NO. PG6530

HOLE NO. BH 3-23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.28
FILL: Brown silty sand with gravel, occasional cobbles 0.15		AU	1				
0.48							
FILL: Brown silty clay, some gravel, trace topsoil		SS	2	58	7	1	66.28
Very stiff to stiff, brown **SILTY CLAY**		SS	3	67		2	65.28
		SS	4	100			
		SS	5	100		3	64.28
- grey by 3.7m depth		SS	6	100		4	63.28
		SS	7	100		5	62.28
		SS	8	67			
6.71		SS	9	4	P	6	61.28

End of Borehole

(GWL @ 1.32m - Jan. 17, 2023)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

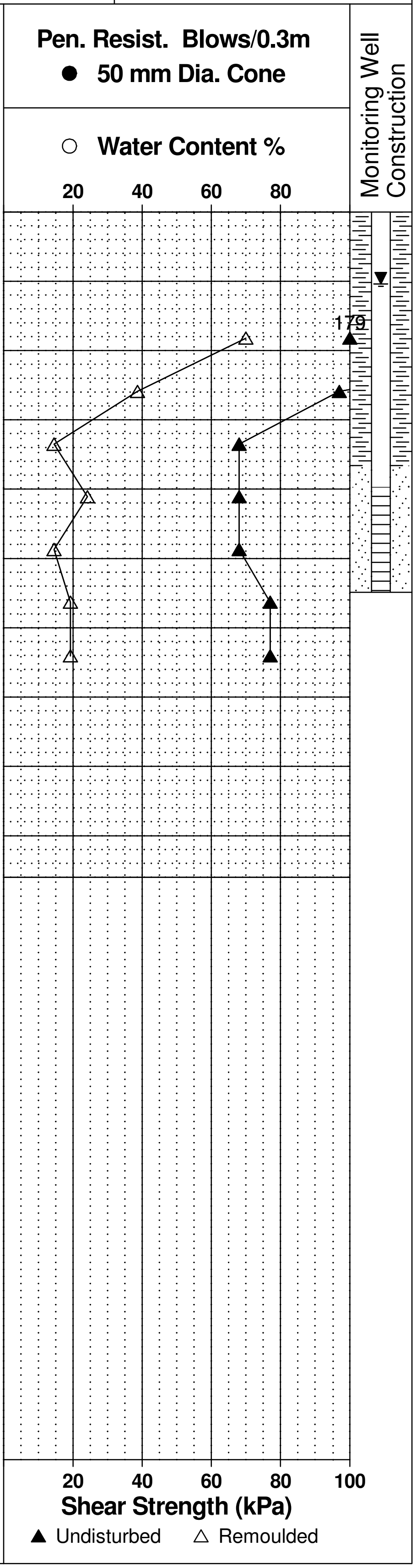
DATE January 10, 2023

FILE NO. PG6530

HOLE NO. BH 4-23

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Dark brown silty sand with gravel, some clay, trace organics — 0.94	AU	1		
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.7m depth	SS	2	62	7
	SS	3	58	P
	SS	4	83	P
	SS	5	83	P
	SS	6	100	P
	SS	7	100	P
	SS	8	100	P
— 6.71	SS	9		P
Dynamic Cone Penetration Test commenced at 6.71m depth. Cone pushed to 9.3m depth. — 9.60				
End of Borehole Practical DCPT refusal at 9.60m depth. (GWL @ 1.04m - Jan. 17, 2023)				

DEPTH (m)	ELEV. (m)
0	67.73
1	66.73
2	65.73
3	64.73
4	63.73
5	62.73
6	61.73
7	60.73
8	59.73
9	58.73



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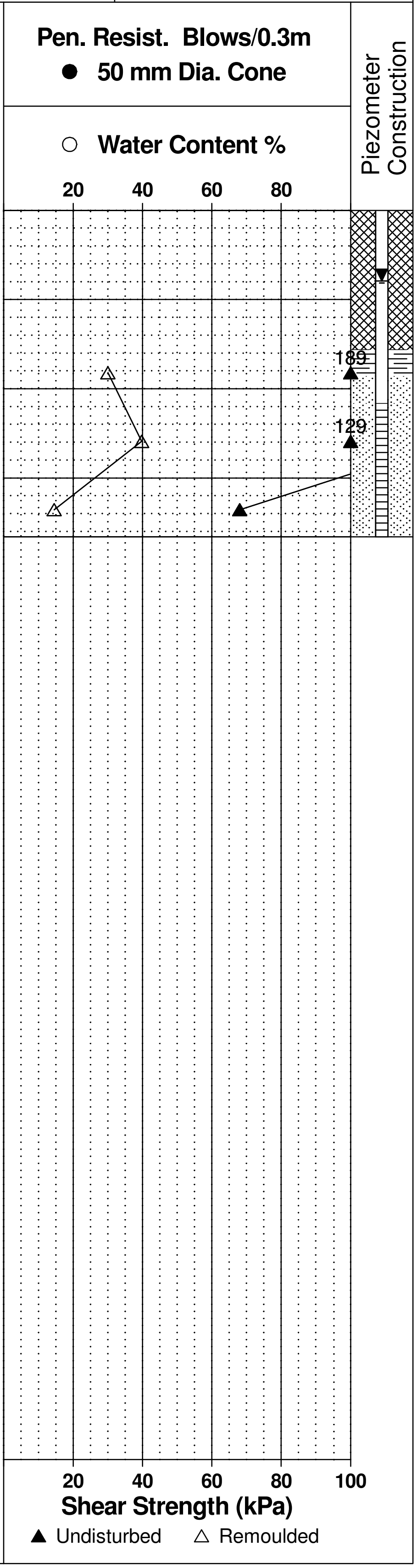
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE January 10, 2023
FILE NO. PG6530
HOLE NO. BH 5-23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.57
FILL: Dark brown silty sand with gravel, trace clay, occasional cobbles 0.69		AU	1				
FILL: Dark brown silty clay, some sand and gravel, trace organics 1.22		SS	2	75	3	1	66.57
Very stiff to stiff, brown **SILTY CLAY**		SS	3	42	P	2	65.57
		SS	4	75	P	3	64.57
3.66		SS	5	83	P		
End of Borehole (GWL @ 0.79m - Jan. 17, 2023)							



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SOIL PROFILE AND TEST DATA

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Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

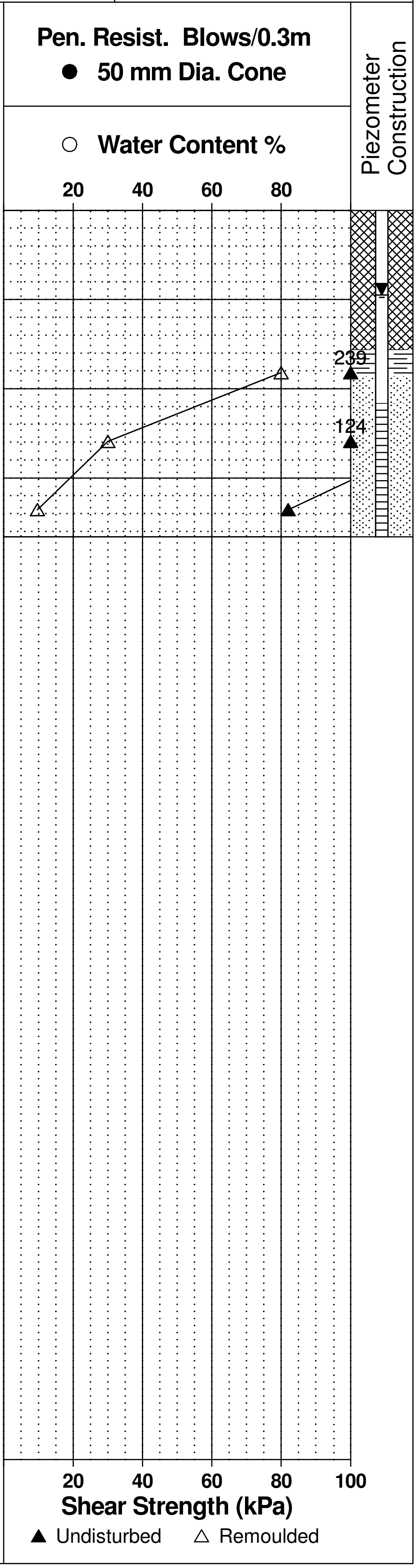
BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2023

FILE NO. PG6530

HOLE NO. BH 6-23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.73
FILL: Dark brown silty clay, some gravel, topsoil and organics		AU	1				
0.91							
Hard to stiff, brown **SILTY CLAY**		SS	2	29	6	1	66.73
		SS	3	58	P	2	65.73
		SS	4	83	P	3	64.73
		SS	5	100	P		
3.66							
End of Borehole							
(GWL @ 0.95m - Jan. 17, 2023)							



SOIL PROFILE AND TEST DATA

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Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2023

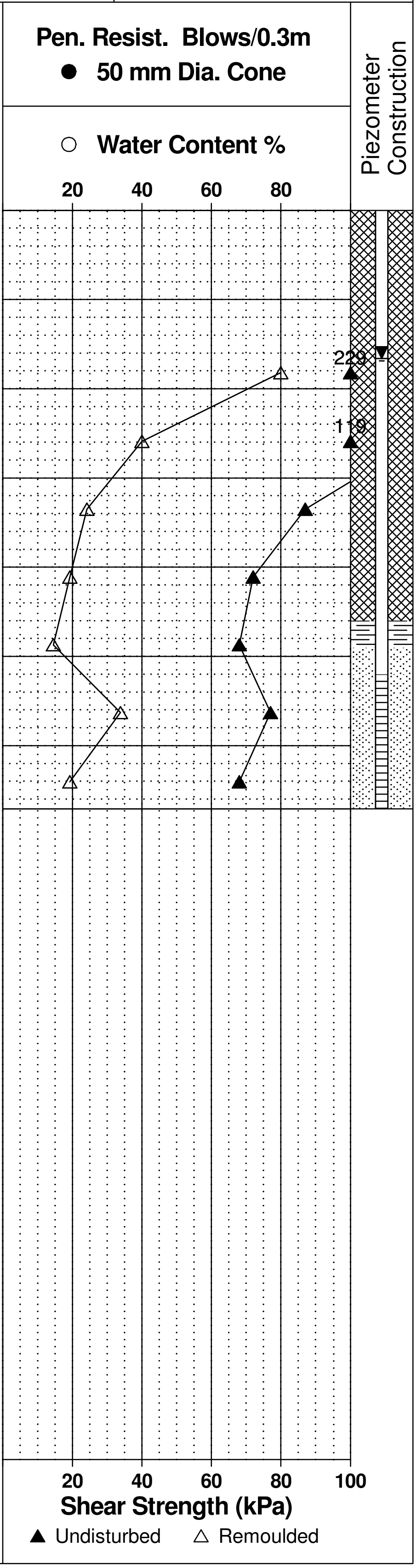
FILE NO. PG6530

HOLE NO. BH 7-23

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown silty sand with gravel, occasional cobbles	0.28
FILL: Dark brown silty clay, some gravel, topsoil, organics	0.91
Hard to stiff, brown **SILTY CLAY** - grey by 3.7m depth	6.71
End of Borehole (GWL @ 1.66m - Jan. 17, 2023)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	6
SS	3	58	P
SS	4	83	P
SS	5	100	P
SS	6	100	P
SS	7	58	P
SS	8	100	P
SS	9	67	P

DEPTH (m)	ELEV. (m)
0	67.45
1	66.45
2	65.45
3	64.45
4	63.45
5	62.45
6	61.45



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

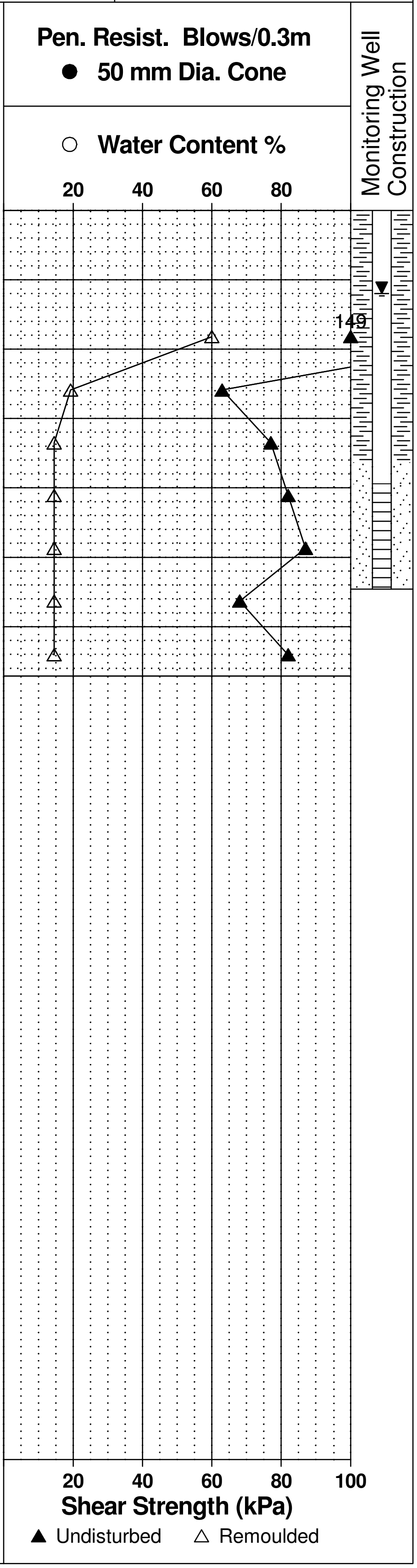
DATE January 11, 2023

FILE NO. PG6530

HOLE NO. BH 8-23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Crushed stone and gravel with sand 0.59		AU	1		
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.4m depth		SS	2	58	8
		SS	3	75	P
		SS	4	75	P
		SS	5	100	P
		SS	6	100	P
		SS	7	100	P
		SS	8	100	P
6.71		SS	9	67	P
End of Borehole (GWL @ 1.20m - Jan. 17, 2023)					

DEPTH (m)	ELEV. (m)
0	66.80
1	65.80
2	64.80
3	63.80
4	62.80
5	61.80
6	60.80



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Industrial Building - 2760-2770 Sheffield Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2023

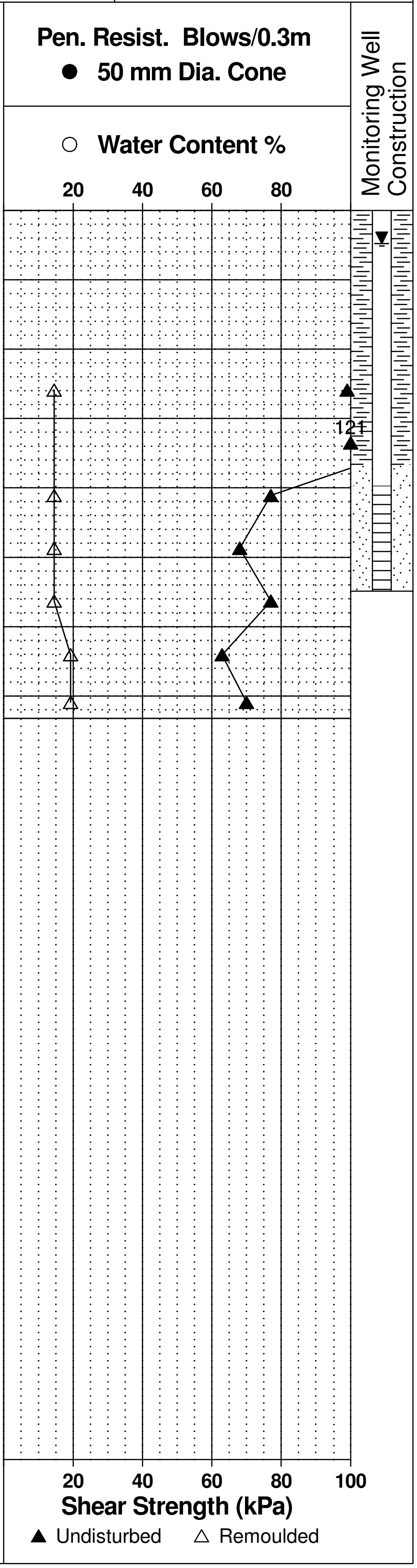
FILE NO. **PG6530**

HOLE NO. **BH 9-23**

SOIL DESCRIPTION					
GROUND SURFACE					
FILL: Crushed stone and gravel with sand	0.56				
FILL: Brown silty clay, some sand - trace gravel by 1.7m depth	1.83				
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.7m depth	7.32				
End of Borehole (GWL @ 0.48m - Jan. 17, 2023)					

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	10
SS	3	75	P
SS	4	92	P
SS	5	58	P
SS	6	100	P
SS	7	100	P
SS	8	100	P
SS	9	100	P

DEPTH (m)	ELEV. (m)
0	66.74
1	65.74
2	64.74
3	63.74
4	62.74
5	61.74
6	60.74
7	59.74



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)

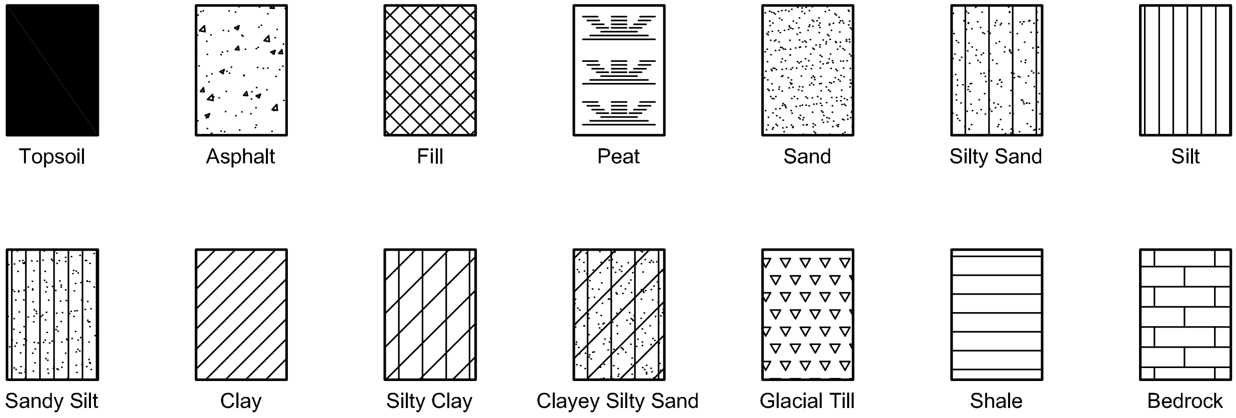
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

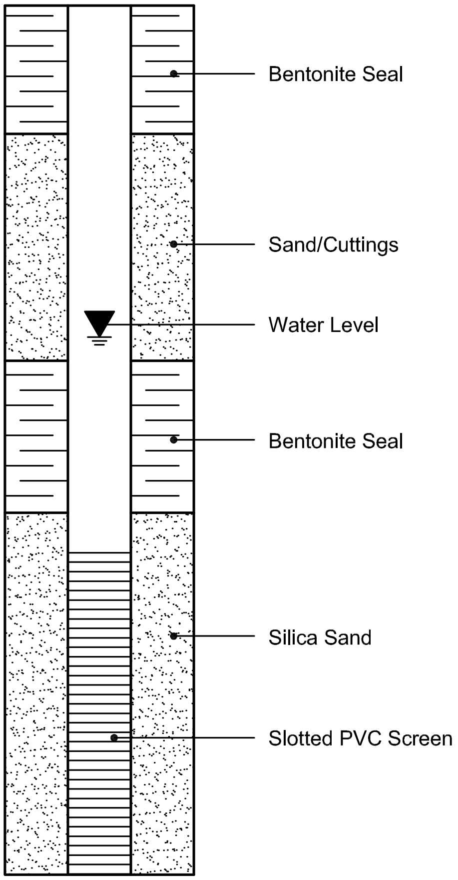
SYMBOLS AND TERMS (continued)

STRATA PLOT

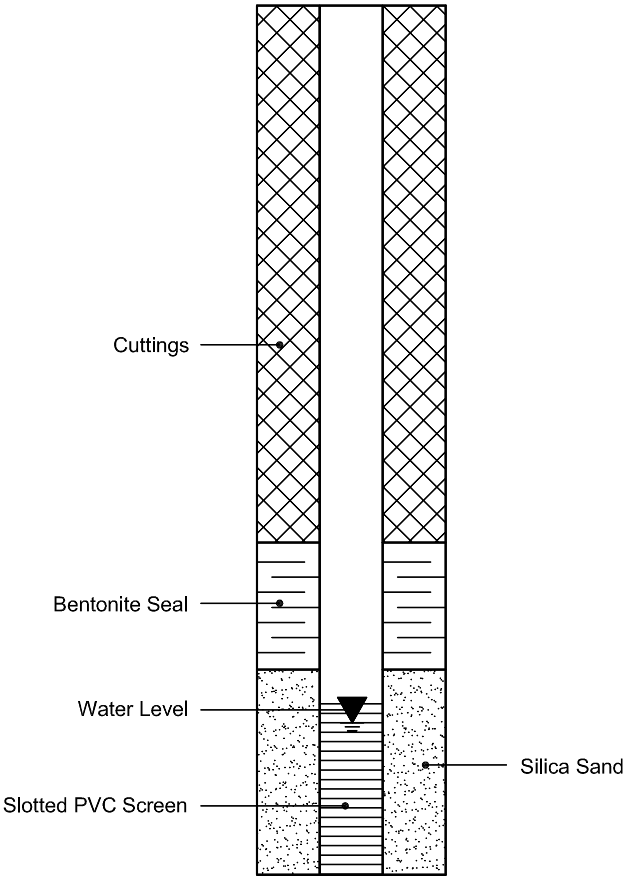


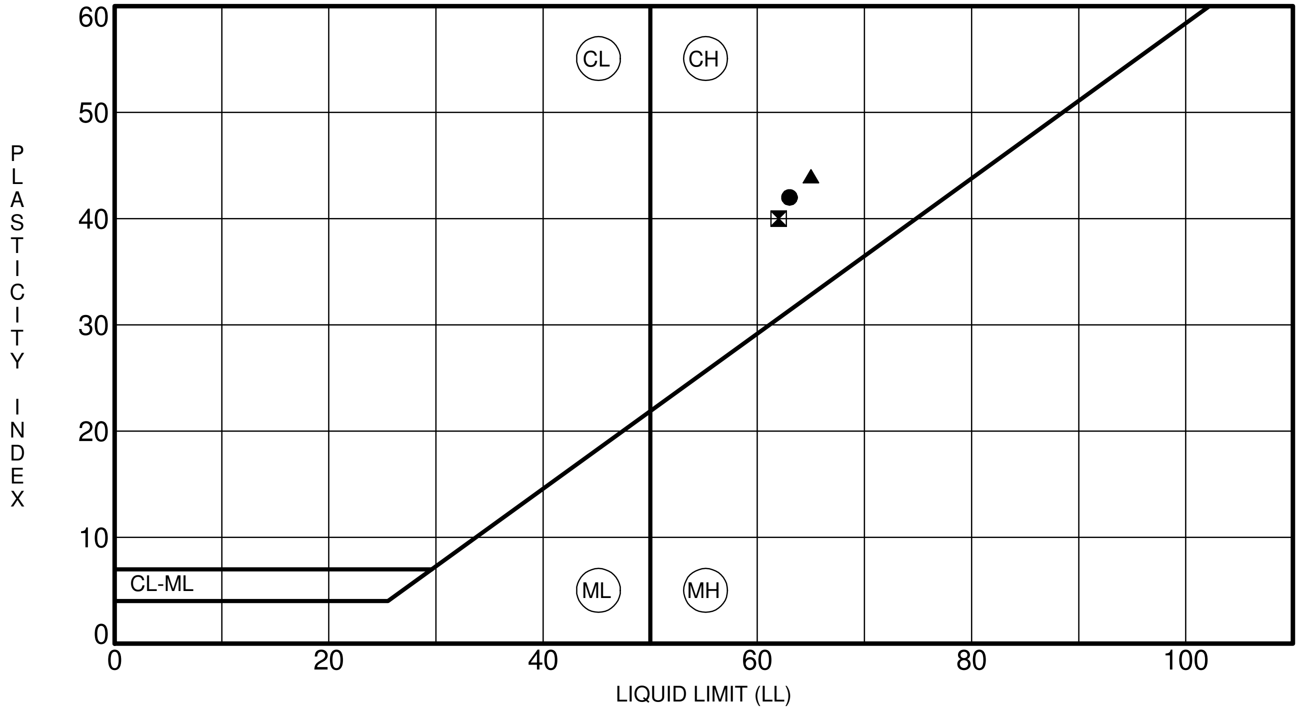
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH 1-23**	**SS4**	**63**	**21**	**42**		**CH - Inorganic clay of high plasticity**
⧗	**BH 3-23**	**SS5**	**62**	**22**	**40**		**CH - Inorganic clay of high plasticity**
▲	**BH 4-23**	**SS4**	**65**	**21**	**44**		**CH - Inorganic clay of high plasticity**

CLIENT **Richcraft Homes**

PROJECT **Geotechnical Investigation - Prop. Industrial Building - 2760-2770 Sheffield Drive**

FILE NO. **PG6530**

DATE **10 Jan 23**

patersongroup **Consulting Engineers**

9 Auriga Drive, Ottawa, Ontario K2E 7T9

ATTERBERG LIMITS' RESULTS

Certificate of Analysis
Client: **Paterson Group Consulting Engineers**
Client PO: 56579

Report Date: 17-Jan-2023
Order Date: 12-Jan-2023
Project Description: PG6530

	Client ID:	BH3-23-SS3	-	-	-
	Sample Date:	10-Jan-23 09:00	-	-	-
	Sample ID:	2302473-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	74.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.37	-	-	-
Resistivity	0.10 Ohm.m	38.1	-	-	-
Anions					
Chloride	10 ug/g dry	73	-	-	-
Sulphate	10 ug/g dry	51	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG6530 - 1 - TEST HOLE LOCATION PLAN

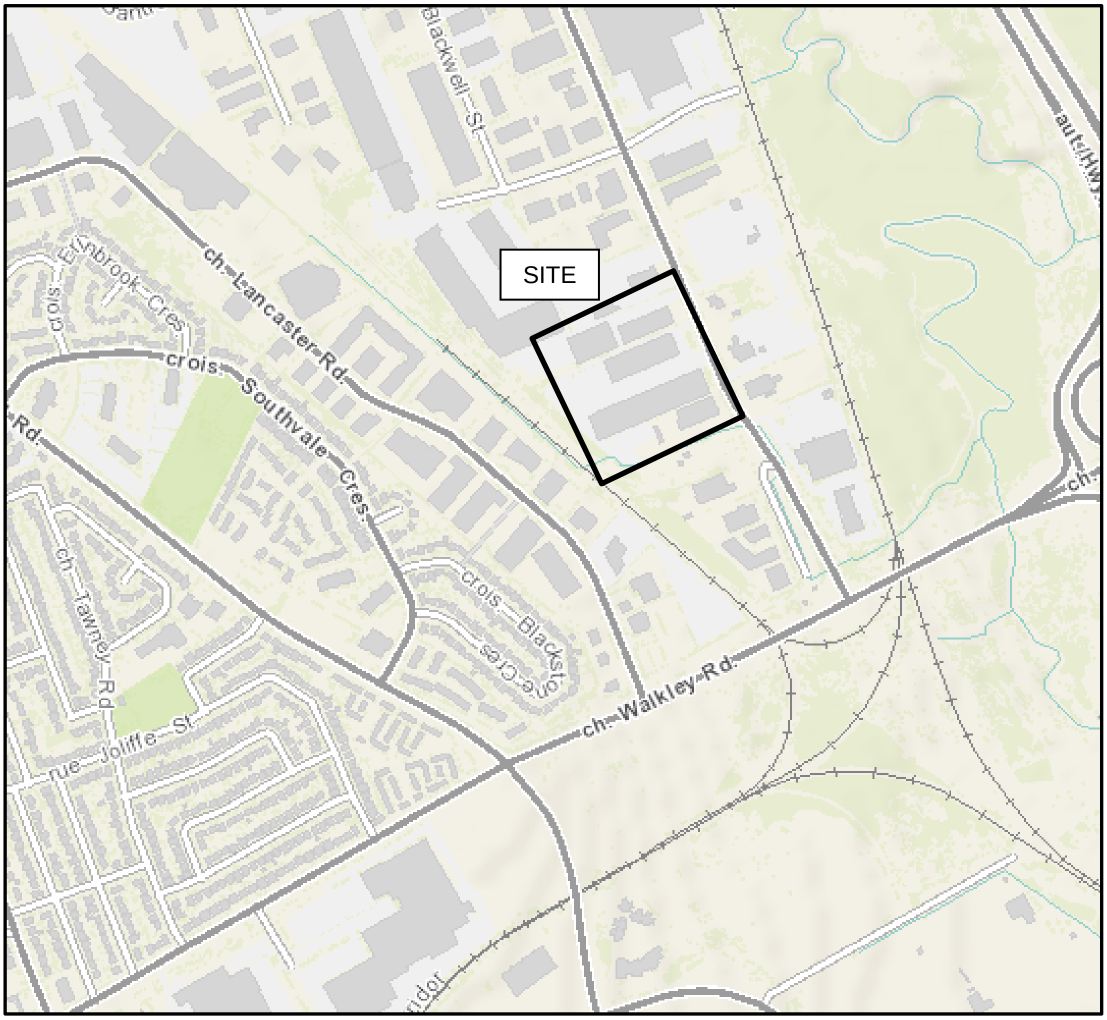
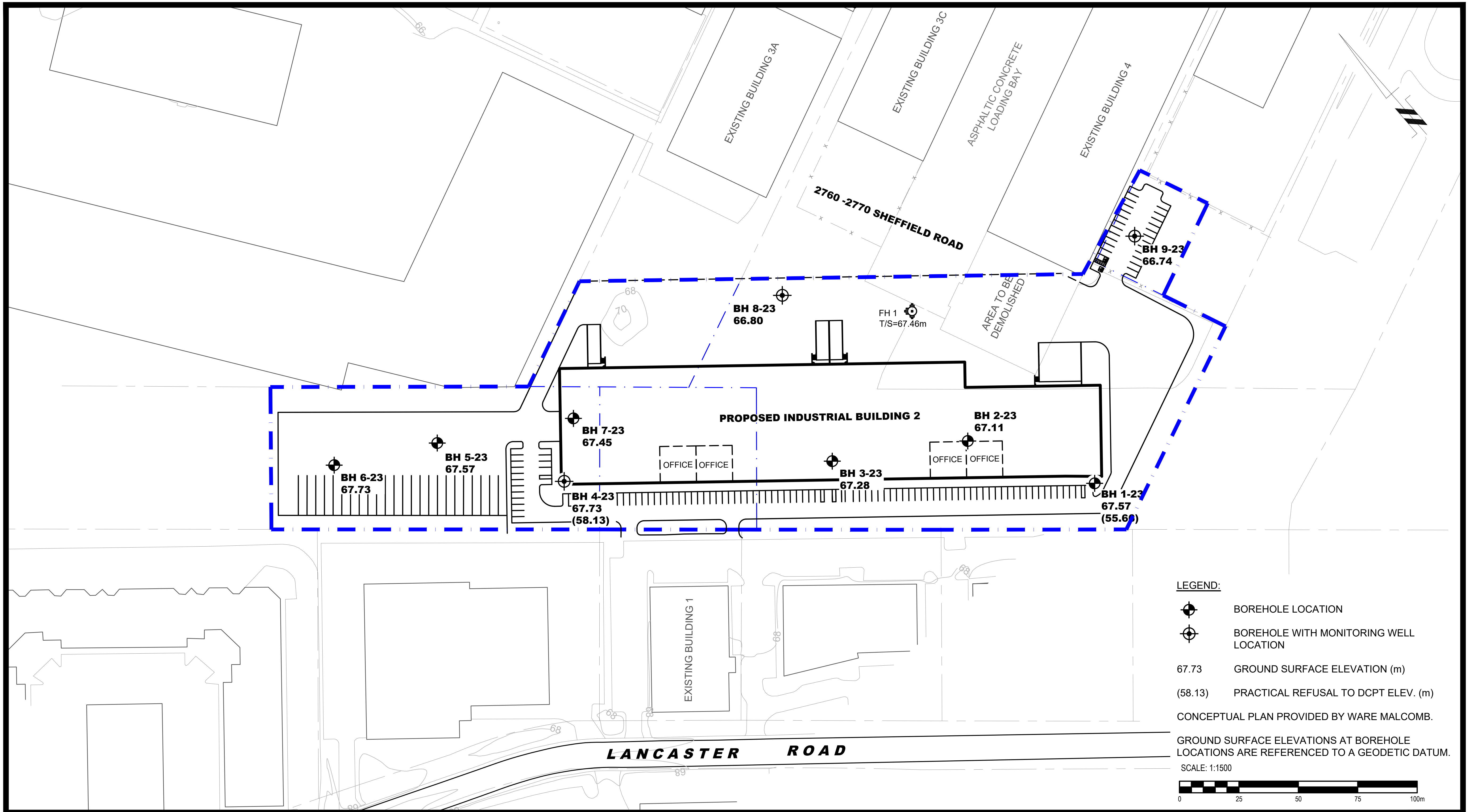


FIGURE 1

KEY PLAN

PATERSON
GROUP



LEGEND:

⊕	BOREHOLE LOCATION
⊕	BOREHOLE WITH MONITORING WELL LOCATION
67.73	GROUND SURFACE ELEVATION (m)
(58.13)	PRACTICAL REFUSAL TO DCPT ELEV. (m)

CONCEPTUAL PLAN PROVIDED BY WARE MALCOMB.

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

SCALE: 1:1500

PATERSON GROUP

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

NO.	REVISIONS	DATE	INITIAL

RICHCRAFT HOMES
GEOTECHNICAL INVESTIGATION
PROPOSED INDUSTRIAL BUILDING
2760 - 2770 SHEFFIELD DRIVE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1500	**Date:** 01/2023
Drawn by: YA	**Report No.:** PG6530-1
Checked by: PB	**Dwg. No.:** PG6530-1
Approved by: SD	**Revision No.:**

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