patersongroup

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Commercial Development
2165 Robertson Road - Ottawa

Prepared For

Huntington Properties

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November 16, 2018

Report: PG4694-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Huntington Properties to conduct a geotechnical investigation for the proposed commercial development to be located at 2165 Robertson Road, in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

- ☐ determine the subsurface soil and groundwater conditions based on test hole information completed within the subject site.

- ☐ 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. The report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed development as understood at the time of this report.

2.0 Proposed Development

The proposed development is understood to consist of two (2) commercial slab-on-grade buildings with associated at-grade parking areas, access lanes and landscaped areas. It is further anticipated that the development will be serviced by future municipal services.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was carried out on October 19, 2018. At that time, a total of three (3) boreholes were drilled to a maximum depth of 6.4 m below existing ground surface and four (4) test pits were excavated to a maximum depth of 3 m below existing ground surface. The test hole locations were placed in a manner to provide general coverage of the subject site. The locations of the test holes are presented on Drawing PG4694-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two-person crew. The drilling procedures consisted of augering to the required depths at the selected locations, sampling and testing the overburden. The test pits were excavated using a rubber tired backhoe. The testing procedure consisted of excavating to the required depths at the selected locations and regularly sampling the overburden. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from our geotechnical department.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler or from the auger flights. Grab samples were collected from excavation side walls of the test pits. The depths at which the auger, split spoon, and grab samples were recovered from the test holes are shown as AU, SS and G, 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 at regular depth intervals in cohesive soils.

Overburden thickness was evaluated during the course of the investigation by dynamic cone penetration testing (DCPT) completed at BH 1 and BH 3. 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.

All soil samples were classified on site, placed in sealed plastic bags and were transported to our laboratory for visual inspection.

Subsurface conditions observed in the test holes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test hole locations

Groundwater

Flexible polyethylene standpipes were installed in all boreholes, while the depth of groundwater infiltration was noted at all test pit locations. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test hole locations were selected in the field by Paterson personnel in a manner to provide general coverage of the proposed development taking into consideration existing site features. Ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top of spindle of a fire hydrant located in front of 2165 Robertson Road. A geodetic elevation of 94.27 m was provided for the TBM by Annis O’Sullivan Vollebekk. The location of the test holes and the ground surface elevation at each test hole location are presented on Drawing PG4694-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

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 sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site consists of a gravel finished parking lot used by the car dealership in the neighboring property. The site is relatively flat and at grade with the neighboring properties and Robertson Road. A hydro easement with overhead wires was noted to cross the central portion of the subject site. Based on historical aerial photographs, a portion of the existing building from the adjacent property used to occupy the southern portion of the subject site.

The site is bordered to the north by the Trans Canada Trail followed by vacant land, to the east and west by commercial developments and to the south by Robertson Road.

4.2 Subsurface Profile

Overburden

Generally, the soil profile encountered at the test hole locations consist of a gravel finished parking lot underlain by fill material comprised of silty sand with gravel and crushed stone. The above noted layers are underlain by a hard to stiff brown silty clay crust followed by a stiff to firm grey silty clay deposit. Practical refusal to DCPT was encountered at a depth of 12 m and 8.1 m in BH 1 and BH 3, respectively. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Bedrock

Based on available geological mapping, the bedrock in this area mostly consists of interbedded sandstone and dolomite of the March Formation with an overburden drift thickness of 5 to 10 m depth.

4.3 Groundwater

Based on our field observations of the water infiltration within the open holes during our field program, groundwater level readings in the installed standpipes, moisture levels and colour of the recovered soil samples, the long-term groundwater level is anticipated to range between 3 to 4 m depth below ground surface. Groundwater levels are subject to seasonal fluctuations and therefore, the groundwater levels could vary at the time of construction. The groundwater level readings are presented in the Soil Profile and Test Data sheets in Appendix 1.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for a proposed commercial development. It is expected that the proposed commercial buildings will be founded by conventional shallow footings placed on an undisturbed, hard to very stiff silty clay bearing surface.

Due to the presence of a silty clay deposit, a permissible grade raise restriction is required for the subject site.

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

5.2 Site Grading and Preparation

Stripping Depth

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

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

Proof Rolling

Where existing fill is present within the proposed paved areas, it is recommended that the subgrade surface be proof-rolled **under dry conditions** by an adequately sized roller making several passes to achieve optimum compaction levels. The compaction program should be reviewed and approved by the geotechnical consultant. In poor performing areas, consideration may be given to removing the poor performing fill and replace with an approved granular fill.

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 building areas should be compacted to at least 98% of the 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. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. Site excavated, brown silty clay under dry conditions and approved by the geotechnical consultant at the time of placement can be used to build up the subgrade level for areas to be paved. The brown silty clay should be placed in maximum 300 mm loose lifts and compacted to a minimum density of 95% of its 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.

5.3 Foundation Design

Bearing Resistance Values

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed on an undisturbed, hard to very stiff 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 was applied to the above-noted bearing resistance value at ULS.

An undisturbed soil bearing surface consists of a surface 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.

Settlement

Footings placed on a soil bearing surface and designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to the in-situ bearing medium soils above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Permissible Grade Raise

A permissible grade raise restriction has been determined for the subject site based on the undrained shear strength values completed within the silty clay deposit. Based on the testing results, a permissible grade raise restriction of **2.0 m** above existing ground surface is recommended for the subject site.

To reduce potential long term liabilities, consideration should be given to providing means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the settlement sensitive structures, etc.). It should be noted that building over silty clay deposits increases the likelihood of building movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking as compared to unreinforced foundations.

5.4 Design for Earthquakes

The proposed buildings can be designed using a seismic site response **Class C** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A). The soils underlying the site are not susceptible to liquefaction.

5.5 Slab-on-Grade Construction

With the removal of all topsoil and deleterious fill, containing organic matter, within the footprints of the proposed buildings, undisturbed native soil surface or approved existing fill reviewed by Paterson will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction. It should be noted that approved existing fill will be required to be proof-rolled using suitable compaction equipment making several passes prior to the placement of backfill material.

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. It is recommended that the upper 200 mm of sub-slab fill consist of OPSS Granular A crushed stone for slab on grade construction. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

5.6 Pavement Structure

As a general guideline, the pavement structure shown in Table 1 and 2 can be used for car only parking areas and access lanes at this site, respectively.

Table 1 - 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 2 - Recommended Pavement Structure - Access Lanes and Heavy Truck 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
400	**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 I or Type II material.

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

Pavement Structure Drainage

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

Where silty clay is anticipated at subgrade level, consideration should be given to installing subdrains during the pavement construction. The sub-drain 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 Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 150 mm in diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structures. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover (or equivalent) should be provided in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

Excavations will be mostly through fill material and silty clay. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. 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 City of Ottawa.

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extent at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

Generally, it should be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

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.

6.5 Groundwater Control

Due to the relatively impervious nature of the silty clay materials, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

Permit to Take Water

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

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.

Long-term Groundwater Control

Our recommendations for the proposed development long-term groundwater control are presented in Subsection 6.1. Any groundwater infiltration will be directed to the proposed building's sump pit. Once steady state is achieved, it's expected that groundwater flow will be low (less than 10,000 L/day) with higher volumes during peak periods noted after significant precipitation events. A more accurate estimate can be provided at the time of construction, once groundwater infiltration levels are observed. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

Impacts on Neighbouring Structures

It is understood that the proposed commercial development will consist of two (2) slab-on-grade buildings. Based on the existing groundwater level and low permeability of the adjacent soils, the extent of any significant groundwater lowering will take place within a limited range of the proposed buildings. Based on the proximity of neighbouring buildings and minimal zone impacted by the groundwater lowering, the proposed development will not negatively impact the neighbouring structures. It should be noted that no issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed buildings.

6.6 Winter Construction

The subsurface conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

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, 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.

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. 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%. These results are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The results of the chloride content, pH and resistivity indicate the presence of a moderate to aggressive environment for exposed ferrous metals at this site.

6.8 Landscaping Considerations

Tree Planting Restrictions

The proposed development is located in an area of low sensitive silty clay deposits for tree planting. Based on our review of the subsurface profile below the subject site, the underlying silty clay crust within the upper 3.5 m is relatively dry and designated as a hard to stiff silty clay. Therefore, the proposed development is located within an area of low sensitive silty clay deposits for tree planting.

Based on the above discussion, it is recommended that trees placed within 5 m of the foundation wall consist of street trees with shallow roots systems that extend less than 1.5 m below ground surface. The following tree planting setbacks are recommended for the low to medium sensitivity area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the conditions noted below are met.

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 design data provided herein to be applicable that a materials testing and observation services program including the following aspects be performed by the geotechnical consultant.

❏ Observation of all bearing surfaces prior to the placement of concrete.

❏ Sampling and testing of the concrete and granular 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 request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test hole locations, we request 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 Huntington Properties 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.

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Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEET

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

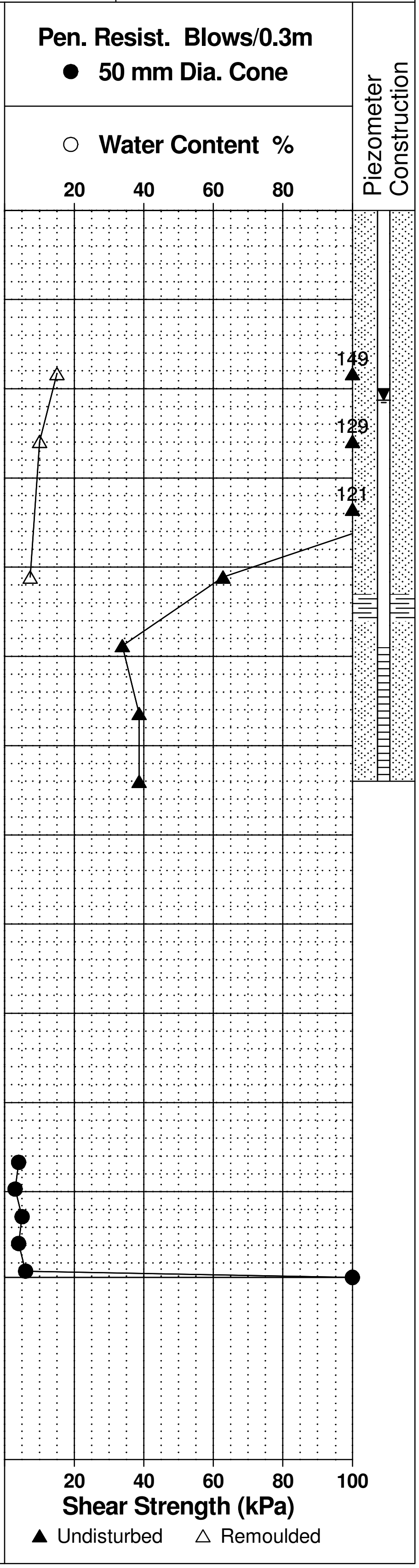
BORINGS BY CME 55 Power Auger

DATE October 19, 2018

FILE NO. PG4694

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.22
FILL: Gravel, some sand 0.36		AU	1				
FILL: Brown silty sand 0.60		G	2				
		SS	3	75	8	1	92.22
						2	91.22
Very stiff to stiff, brown **SILTY CLAY**							
						3	90.22
- stiff to firm and grey by 3.8m depth							
						4	89.22
						5	88.22
						6	87.22
6.40							
Dynamic Cone Penetration Test (DCPT) commenced at 6.40m depth. Cone pushed to 10.4m depth.							
						7	86.22
						8	85.22
						9	84.22
						10	83.22
						11	82.22
11.96							
End of Borehole Practical DCPT refusal at 11.96m depth (GWL @ 2.13m - Oct. 26, 2018)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

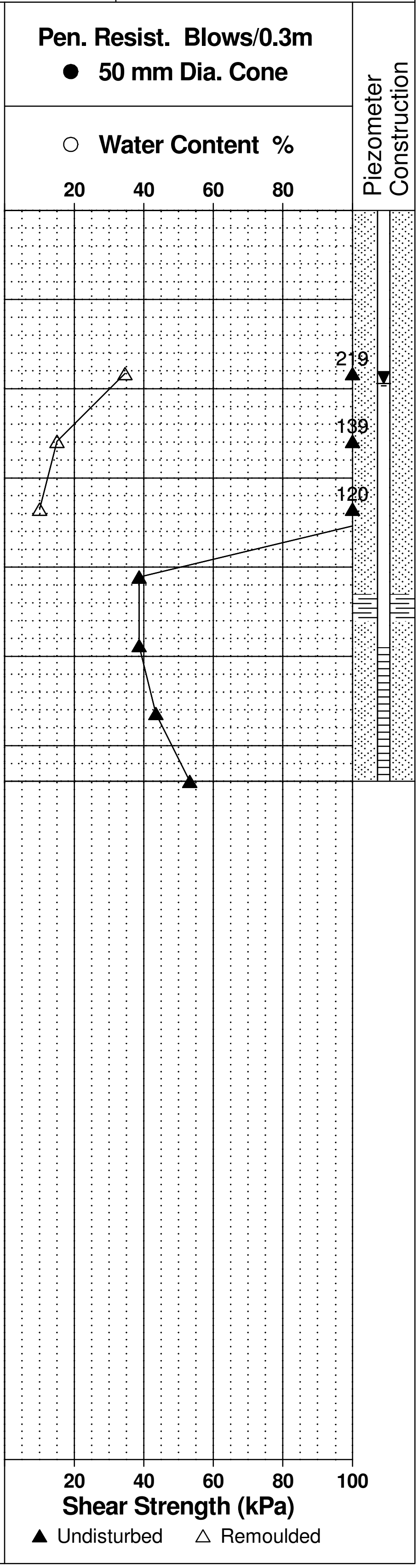
BORINGS BY CME 55 Power Auger

DATE October 19, 2018

FILE NO. PG4694

HOLE NO. BH 2

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.24
FILL: Crushed stone, some sand 0.30	AU	1				
FILL: Brown silty sand 0.51	G	2				
	SS	3	75	8	1	92.24
					2	91.24
Hard to very stiff, brown **SILTY CLAY**						
					3	90.24
- stiff to firm and grey by 3.8m depth						
					4	89.24
					5	88.24
					6	87.24
6.40						
End of Borehole						
(GWL @ 1.94m - Oct. 26, 2018)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

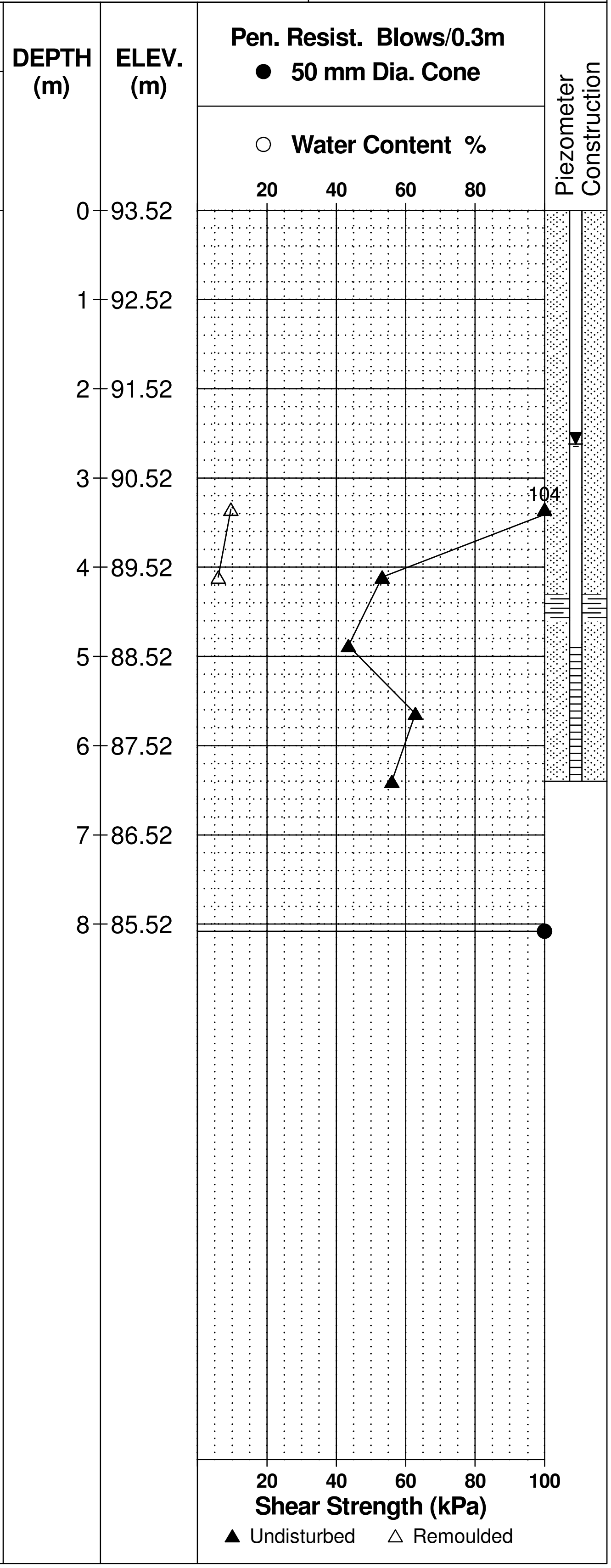
BORINGS BY CME 55 Power Auger

DATE October 19, 2018

FILE NO. PG4694

HOLE NO. BH 3

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Gravel, some sand — 0.60	AU	1		
FILL: Brown clayey silt with sand — 1.52	SS	2	79	10
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.8m depth — 6.40	SS	3	100	5
Dynamic Cone Penetration Test (DCPT) commenced at 6.40m depth. Cone pushed to 7.9m depth. — 8.08				
End of Borehole Practical DCPT refusal at 8.08m depth (GWL @ 2.62m - Oct. 26, 2018)				



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY Backhoe

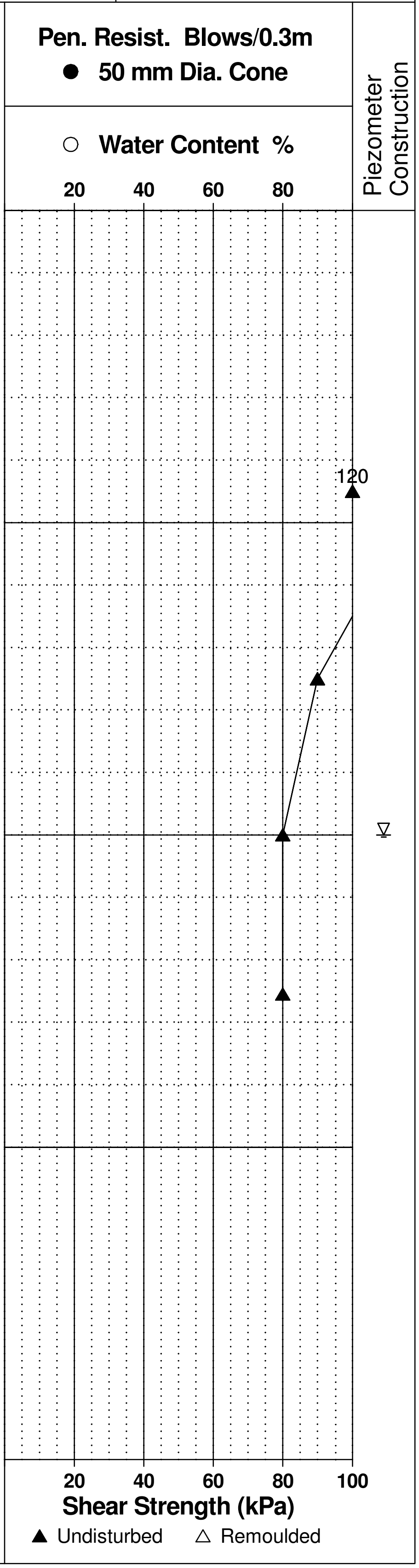
DATE October 19, 2018

FILE NO. PG4694

HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Gravel, some sand		G	1		
0.55					
FILL: Brown silty sand, trace gravel		G	2		
0.75					
Very stiff to stiff, brown **SILTY CLAY**		G G G	3 4 5		
2.80					
End of Test Pit (Groundwater infiltration at 2.0m depth)					

DEPTH (m)	ELEV. (m)
0	93.26
1	92.26
2	91.26
3	90.26



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

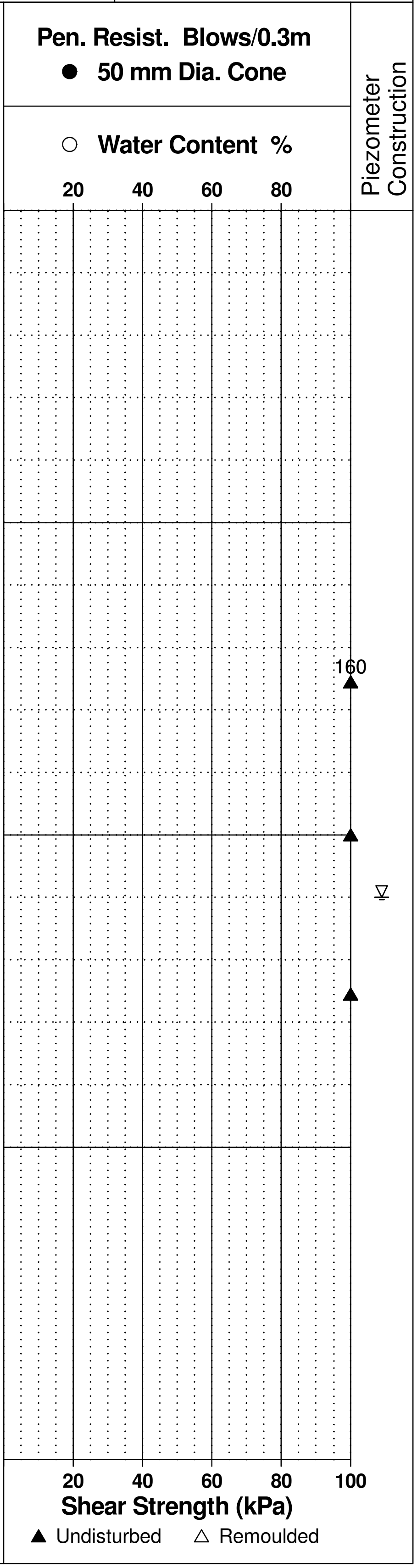
BORINGS BY Backhoe

DATE October 19, 2018

FILE NO. PG4694

HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.68
FILL: Gravel, some sand		G	1				
0.80							
FILL: Brown silty sand, some gravel, occasional cobbles and boulders		G	2			1	92.68
1.30							
Very stiff to stiff, brown **SILTY CLAY**		G	3				
						2	91.68
		G	4				
3.00						3	90.68
End of Test Pit (Groundwater infiltration at 2.2m depth)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY Backhoe

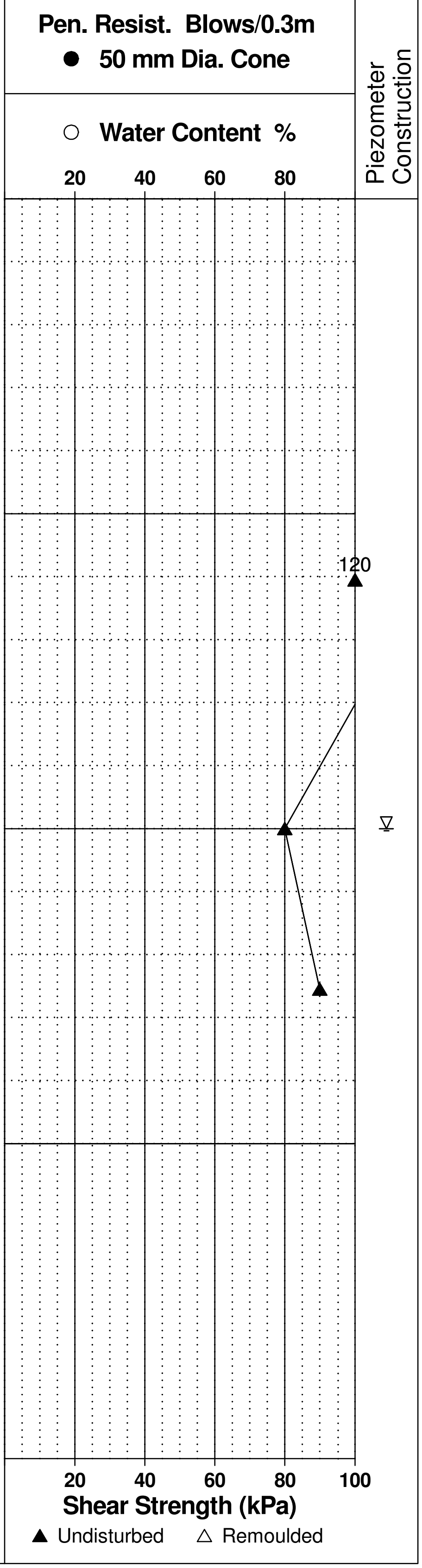
DATE October 19, 2018

FILE NO. PG4694

HOLE NO. TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Gravel, some sand	⊠	G	1		
0.55					
FILL: Brown silty sand, some gravel, occasional cobbles and boulders	⊠	G	2		
1.00					
Very stiff to stiff, brown **SILTY CLAY**	▨	G G	3 4		
3.00					
End of Test Pit (Groundwater infiltration at 2.0m depth)					

DEPTH (m)	ELEV. (m)
0	93.48
1	92.48
2	91.48
3	90.48



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 2165 Robertson Rd.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located in front of 2165 Robertson Road. Geodetic elevation = 94.27m, per Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

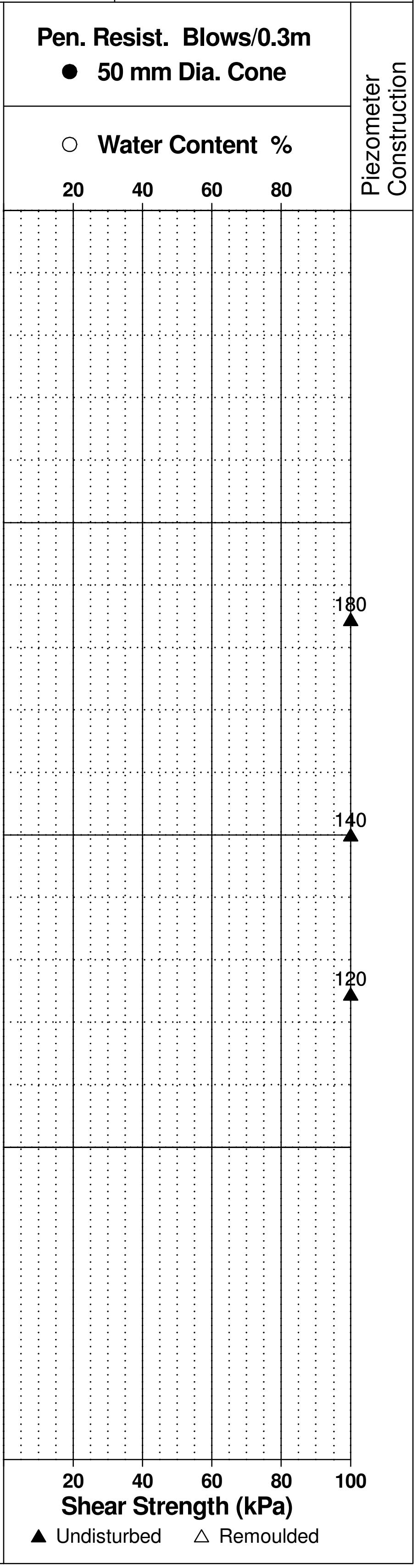
BORINGS BY Backhoe

DATE October 19, 2018

FILE NO. PG4694

HOLE NO. TP 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.47
FILL: Gravel, some sand	▩	G	1				
0.70							
FILL: Brown silty sand, trace gravel	▩	G	2				
1.00						1	92.47
Very stiff, brown **SILTY CLAY**	▨	G	3				
						2	91.47
		G	4				
3.00						3	90.47
End of Test Pit (Groundwater infiltration at 3.0m depth)							



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 strength of cohesionless soils is the relative density, 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.

Relative Density	‘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 vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

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 is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

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 NXL size core. However, it can be used on smaller core sizes, such as BX, 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
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture 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 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 x 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)

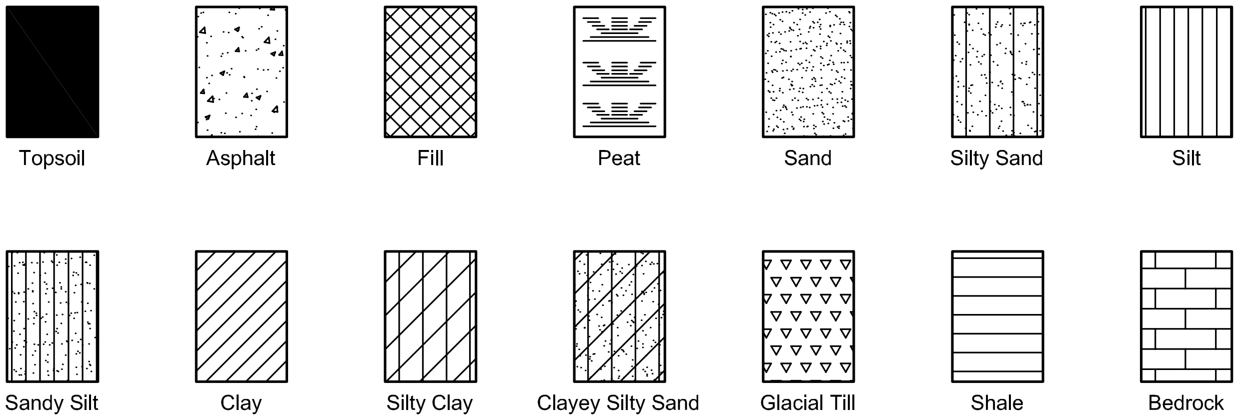
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

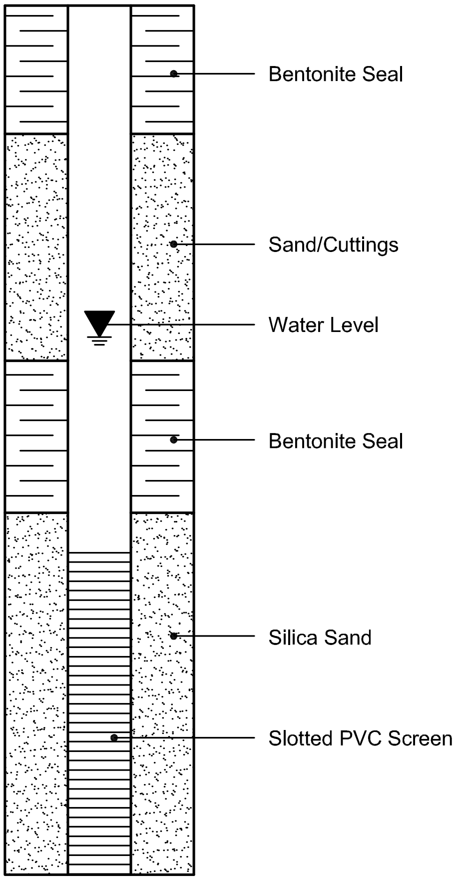
SYMBOLS AND TERMS (continued)

STRATA PLOT

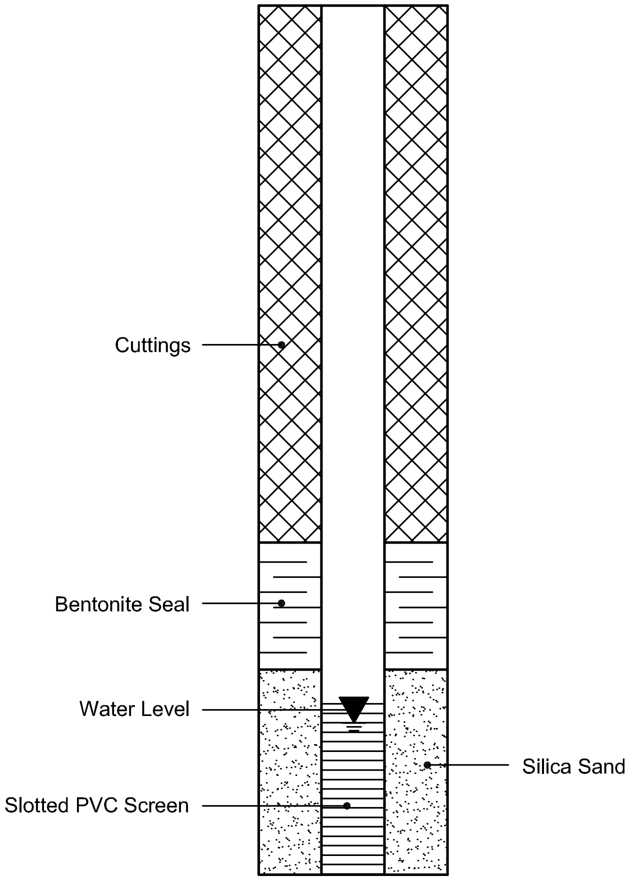


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 24734

Report Date: 25-Oct-2018

Order Date: 22-Oct-2018

Project Description: PG4694

	Client ID:	BH2-18-SS3	-	-	-
	Sample Date:	10/19/2018 09:00	-	-	-
	Sample ID:	1843119-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	70.6	-	-	-
General Inorganics					
pH	0.05 pH Units	7.44	-	-	-
Resistivity	0.10 Ohm.m	21.4	-	-	-
Anions					
Chloride	5 ug/g dry	89	-	-	-
Sulphate	5 ug/g dry	82	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4694-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

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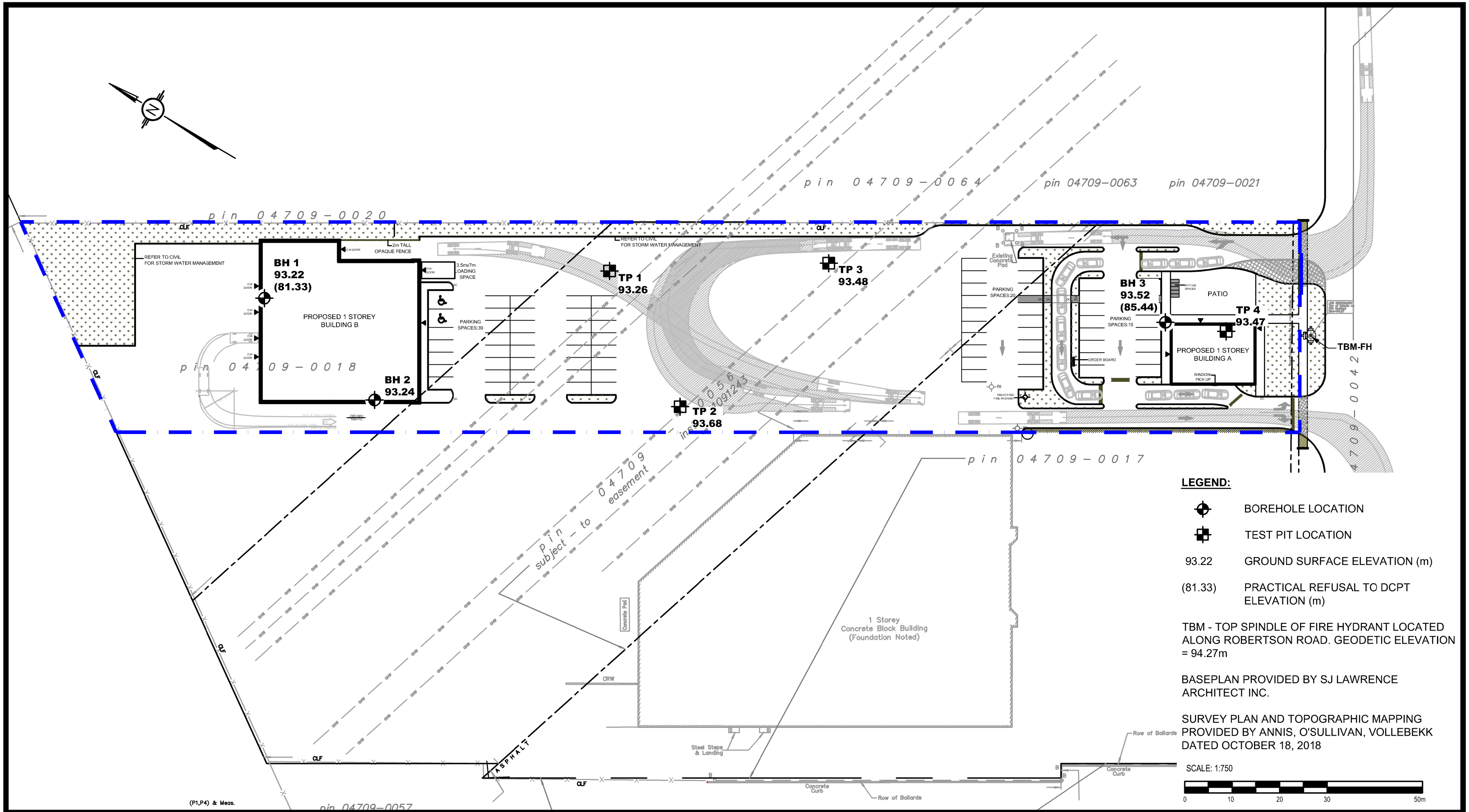

LEGEND:

⌖	BOREHOLE LOCATION
◼	TEST PIT LOCATION
93.22	GROUND SURFACE ELEVATION (m)
(81.33)	PRACTICAL REFUSAL TO DCPT ELEVATION (m)

TBM - TOP SPINDLE OF FIRE HYDRANT LOCATED ALONG ROBERTSON ROAD. GEODETIC ELEVATION = 94.27m

BASEPLAN PROVIDED BY SJ LAWRENCE ARCHITECT INC.

SURVEY PLAN AND TOPOGRAPHIC MAPPING PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK DATED OCTOBER 18, 2018

SCALE: 1:750

0 10 20 30 50m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
2	UPDATED TO LATEST BASE PLAN	11/12/2018	FA
1	UPDATED TO LATEST BASE PLAN	12/11/2018	FA

HUNTINGTON PROPERTIES

GEOTECHNICAL INVESTIGATION - PROPOSED COMMERCIAL DEVELOPMENT
2165 ROBERTSON ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:750
Date: 10/2018
Drawn by: RCG
Report No.: PG4694-1
Checked by: FA
Dwg. No.: PG4694-1
Approved by: DJG
Revision No.: 2

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