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Geotechnical Engineering

Environmental Engineering

Hydrogeology

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Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Development
Palladium Drive at Huntmar Drive
Ottawa, Ontario

Prepared For

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July 24, 2015

Report: PG3520-1

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1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by 2325483 Ontario Inc. to conduct a geotechnical investigation for the proposed development to be located along Palladium Drive at Huntmar Drive in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the current investigation were to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of test holes.

- ☐ Provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

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

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

2.0 PROPOSED DEVELOPMENT

Details of the proposed development were not known at the time of the investigation.

3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

The field program for the present investigation was conducted on June 9 and 10, 2015. At that time, 19 boreholes were advanced to a maximum depth of 13 m.

The test holes were distributed in a manner to provide general coverage of the proposed development. The locations were determined in the field by Paterson personnel taking into consideration site features and underground services. Approximate locations of the test holes are shown in Drawing PG3520-1 - Test Hole Location Plan included in Appendix 2.

Boreholes were put down using a track-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer from our geotechnical department. The drilling procedure consisted of hollow stem augering to the required depths at select locations, sampling and testing the overburden. Sampling and testing the overburden was completed in general accordance with ASTM D5434-12 - Guide for Field Logging of Subsurface Explorations of Soil and Rock.

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. The split-spoon and auger samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the split-spoon and auger samples were recovered from the boreholes are shown as SS and AU, 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. This testing was done in general accordance with ASTM D1586-11 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils. Undrained shear strength testing in boreholes was completed using a MTO field vane apparatus. This testing was done in general accordance with ASTM D2573-08 - Standard Test Method for Field Vane Shear Test in Cohesive Soil.

Overburden thickness was also evaluated during the course of the investigation by Dynamic Cone Penetration Test (DCPT) at BH 1. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, and 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 at each 300 mm increment

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 standpipe piezometers were installed in all boreholes with the exception of BH 2, BH 3, BH 4 and BH 5, to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. All groundwater observations are noted on the Soil Profile and Test Data sheets presented in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test hole locations were selected by Paterson and surveyed by Thomas Cavanagh Construction. All test hole elevations are referenced to a geodetic datum.

The ground surface elevations at the test hole locations are presented on Drawing PG3520-1 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were visually examined in our laboratory to review the results of the field logging. The subsurface soils were classified in general accordance with ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

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 samples were 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 ground surface across the subject site slopes gradually downward to the east and is grass or tree covered. The east portion of the site consists of an agricultural field and the remainder of the site is within an undeveloped, wooded area. An existing residential development is located along the central portion of the south property boundary of the subject site.

4.2 Subsurface Profile

Generally, the subsurface profile encountered at the boreholes within the east and north portions of the subject site consists of a topsoil layer/ agriculturally disturbed zone overlying a silty clay layer and glacial till deposit.

The soil profile encountered at the remainder of the test hole locations consists of topsoil underlain by a silty sand and/or a glacial till deposit. Practical refusal to augering on inferred bedrock was encountered between 0.3 and 3.7 m depth.

Specific details of the soil profile at each test hole location are provided on the Soil Profile and Test Data sheets in Appendix 1.

Based on available geological mapping (NR Can), the subject site is located in an area where the bedrock consists of interbedded limestone and shale of the Verulam formation and interbedded limestone and dolomite of the Gull River formation in the east and west, respectively. The overburden drift thickness is estimated to be between 0 to 10 m below the west portion of the site, and 10 to 25 m below the east portion of the site.

4.3 Groundwater

Groundwater levels (GWLs) were measured on June 16, 2015 in the standpipes installed in the boreholes. The results are summarized in Table 1.

Table 1
Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date
BH 1	101.32	1.64	99.68	June 16, 2015
BH 6	106.69	0.13	106.56	June 16, 2015
BH 7	106.80	2.40	104.40	June 16, 2015
BH 8	104.71	0.00	104.71	June 16, 2015
BH 9	106.01	1.20	104.81	June 16, 2015
BH 10	105.85	1.87	103.98	June 16, 2015
BH 11	105.77	1.23	104.54	June 16, 2015
BH 12	105.53	2.27	103.26	June 16, 2015
BH 13	104.10	0.75	103.35	June 16, 2015
BH 14	102.55	3.85	98.70	June 16, 2015

Note: A piezometer standpipe was not installed at BH 2 to BH 5 due to the shallow bedrock encountered. The soil profile at BH 2 to BH 5 was noted to be dry at the time of drilling and the long-term groundwater table was not encountered.

It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled borehole, which can lead to higher than normal groundwater level readings. However, the long-term groundwater level can also be estimated based on the recovered soil samples' moisture levels and consistency at the test hole locations. Based on these observations, the long-term groundwater table is estimated to be between 2 to 3 m below existing ground surface. 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 satisfactory for the proposed development. A permissible grade raise restriction is required within the east and north portions of the site where a silty clay layer is present below the proposed buildings.

The above and other considerations are discussed in the following paragraphs.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and any deleterious fill, such as those containing organics, should be stripped from under any buildings and other settlement sensitive structures. Other settlement sensitive structures include, but are not limited to, underground services and paved areas.

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 material. 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 should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill 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.

5.3 Foundation Design

Structures at the subject site can be founded over conventional shallow footings placed on an undisturbed, compact glacial till or stiff silty clay bearing surface.

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, founded on an undisturbed, stiff silty clay bearing surface can be designed using the 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.

Footings founded on an undisturbed, compact silty sand/glacial till or engineered fill bearing surface can be designed using the bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **225 kPa**.

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

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

Footings placed directly over a clean, bedrock bearing surface can be designed using a bearing resistance value at SLS of 500 kPa and a factored bearing resistance value at ULS of 1,000 kPa.

Permissible Grade Raise Restrictions

Due to the presence of the underlying silty clay layer within the north and east portions of the site, a permissible grade raise restriction of **2 m** is recommended in the immediate area of settlement sensitive structures. The areas requiring a permissible grade raise restriction are outlined in Drawing PG3520-2 - Permissible Grade Raise Plan in Appendix 2. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise restriction 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.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided to a compact glacial till, stiff silty clay, or engineered fill 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.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D** for the foundations within the east portion of the subject site, where a silty clay deposit is present below footing level. Foundations within the remainder of the subject site can be designed using a **Class C**. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab/Slab-on-Grade Construction

With the removal of all topsoil and deleterious fill, such as those containing organic materials, from within the footprint of the proposed buildings, the native soil surface or approved engineered fill surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

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-floor fill consist of 19 mm clear crushed stone for a basement slab. The upper 200 mm of sub-floor fill should consist of a 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 layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Design

Car only parking and local roadways are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 3 - Recommended Pavement Structure - Local Roadways

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

6.0 DESIGN AND CONSTRUCTION PRECAUTIONS

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 100 to 150 mm 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 structure. 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 site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls unless placed in conjunction with a composite drainage system, such as Delta Drain 6000, Miradrain G100N or equivalent. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings, of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 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

The side slopes of excavations in the soil and fill overburden materials should be either 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 assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The 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.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept at least 3 m 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

At least 150 mm of OPSS Granular A crushed stone should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A crushed stone. The bedding and cover materials should be placed in maximum 225 mm thick lifts and compacted to a minimum of 95% of the material’s 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 should be given a sufficient drying period to decrease its moisture content to an acceptable level to make compaction possible prior to being re-used.

Trench backfill material within the frost zone (approximately 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce 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.

To reduce long-term lowering of the groundwater level at this site within the north and east portions of the site where silty clay is present at pipe invert level, clay seals should be provided in the service trenches in areas where the sidewalls of the excavation consist of in situ silty clay at no more than 60 m intervals in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the 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. Where excavations are extended within the glacial till material, the groundwater infiltration is anticipated to be low to moderate. However, pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

A temporary MOE permit to take water (PTTW) will be required for this project if more than 50,000 L/day are to be pumped during the construction phase. At least 3 to 4 months should be allowed for completion of the application and issuance of the permit by the MOE.

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.

6.6 Winter Construction

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

The subsoil conditions for the silty-clay area of the site consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

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

Trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The analytical testing results are presented in Table 4 along with industry standards for the applicable threshold values. These results are indicative that Type 10 Portland cement (Type GU, or normal cement) would be appropriate for this site.

Table 4 - Corrosion Potential

Parameter	Laboratory Results	Threshold	Commentary
	TP1 G1		
Chloride	6 µg/g	Chloride content less than 400 mg/g	Negligible concern
pH	7.68	pH value less than 5.0	Neutral Soil
Resistivity	106,000 ohm.cm	Resistivity greater than 1,500 ohm.cm	Low Corrosion Potential
Sulphate	10 µg/g	Sulphate value greater than 1 mg/g	Negligible Concern

6.8 Landscaping Considerations

Based on our review of the subsurface conditions, a silty clay deposit was encountered within the north and east portions of the subject site. It is recommended that trees placed within 4 m of the foundation wall should consist of low water demanding trees with shallow roots systems that extend less than 1.5 m in depth for areas where buildings are founded over the silty clay deposits encountered within the subject site. Trees placed greater than 4 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum depth of 2 m below ground surface.

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 the following material testing and observation program be performed by the geotechnical consultant.

❏ Review detailed grading plan(s) from a geotechnical perspective.

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

❏ Sampling and testing of the concrete and fill materials used.

❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

❏ Observation of all subgrades prior to backfilling

❏ Field density tests to determine the level of compaction achieved.

❏ Sampling and testing of the bituminous concrete including mix design reviews.

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

8.0 STATEMENT OF LIMITATIONS

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

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

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than 2325483 Ontario Inc. or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

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Stephanie Boisvenue, P.Eng. David J. Gilbert, P.Eng.

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TEST RESULTS

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

FILE NO. PG3520

REMARKS

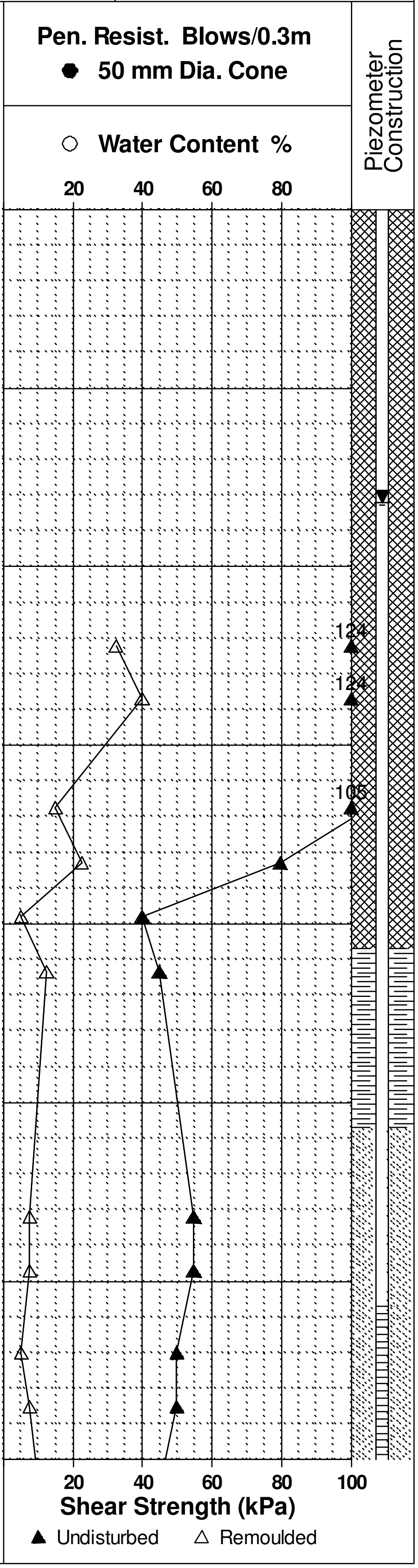
HOLE NO. BH 1

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.23				
Brown **CLAYEY SILT,** some sand	AU	1		
	SS	2	100	2
1.40				
Very stiff to stiff, brown **SILTY CLAY**	SS	3	100	1
- firm to stiff and grey by 4.0m depth	TW	4		

DEPTH (m)	ELEV. (m)
0	101.32
1	100.32
2	99.32
3	98.32
4	97.32
5	96.32
6	95.32
7	94.32



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

FILE NO. PG3520

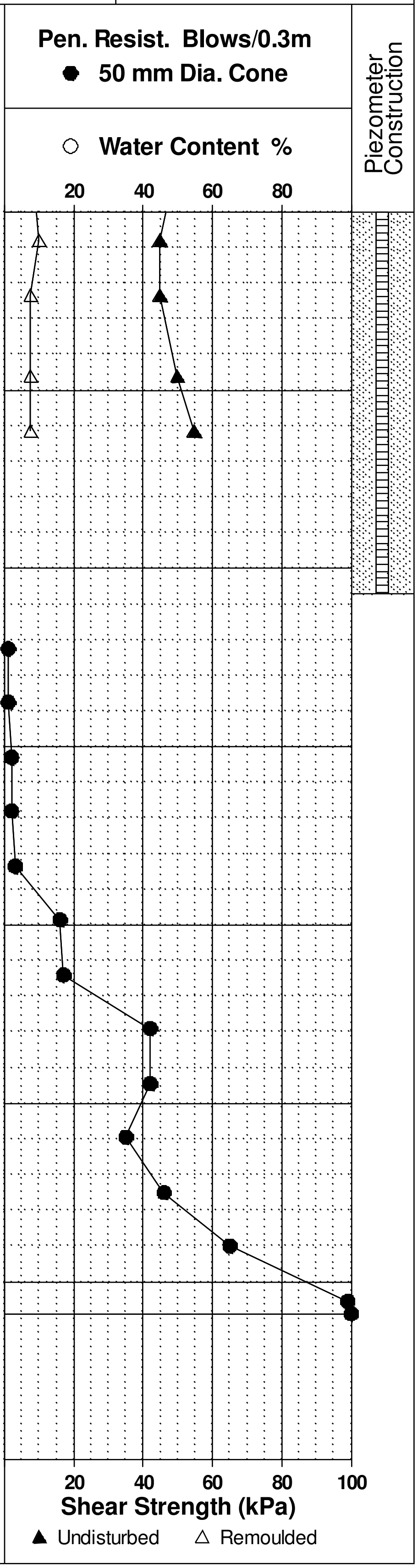
REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						7	94.32
Stiff, grey **SILTY CLAY**						8	93.32
8.40							
GLACIAL TILL: Grey silty sand with clay, gravel, cobbles and boulders		SS	5		11		
9.14						9	92.32
Dynamic Cone Penetration Test commenced at 9.14m depth.						10	91.32
Inferred **GLACIAL TILL**						11	90.32
						12	89.32
						13	88.32
13.18							
End of Borehole Practical DCPT refusal at 13.18m depth (GWL @ 1.64m-June 16, 2015)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

FILE NO. **PG3520**

REMARKS

HOLE NO. **BH 2**

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE									
TOPSOIL 0.25						0	103.28		
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 1.04		SS AU	1 2		50+	1	102.28		
End of Borehole Practical refusal to augering at 1.04m depth									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

REMARKS

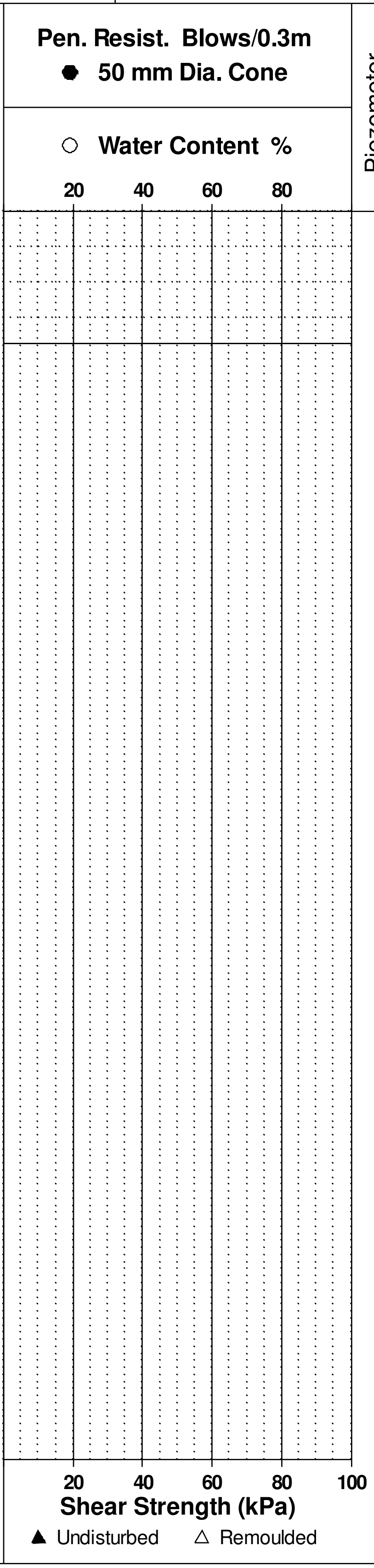
BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 2A

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	103.28	
TOPSOIL 0.25	■							
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 0.74	^^^	AU	1					
End of Borehole Practical refusal to augering at 0.74m depth								



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 2B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	103.28		
TOPSOIL 0.25	■								
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 0.86	^^^								
End of Borehole Practical refusal to augering at 0.86m depth									

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
Ottawa, Ontario

DATUM Ground surface elevations provided by Cavanaugh Construction.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	104.71		
TOPSOIL 0.25									
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 0.76		AU	1						
End of Borehole Practical refusal to augering at 0.76m depth									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 3A

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	104.71		
TOPSOIL 0.23									
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 0.81		AU	1						
End of Borehole Practical refusal to augering at 0.81m depth									

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

SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 3B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	104.71		
TOPSOIL 0.23		SS	1	75	4				
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders 0.51									
End of Borehole Practical refusal to augering at 0.51m depth									

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

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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
TOPSOIL 0.05						0	106.80		
GLACIAL TILL: Brown silty sand with gravel and weathered bedrock 0.30		SS	1	50	50+				
End of Borehole Practical refusal to augering at 0.30m depth									

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

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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	106.69		
TOPSOIL 0.08									
Loose, brown **SILTY SAND,** some clay 0.60		SS	1	100	4				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders 1.45		SS	2	83	58	1	105.69		
End of Borehole Practical refusal to augering at 1.45m depth									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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REMARKS

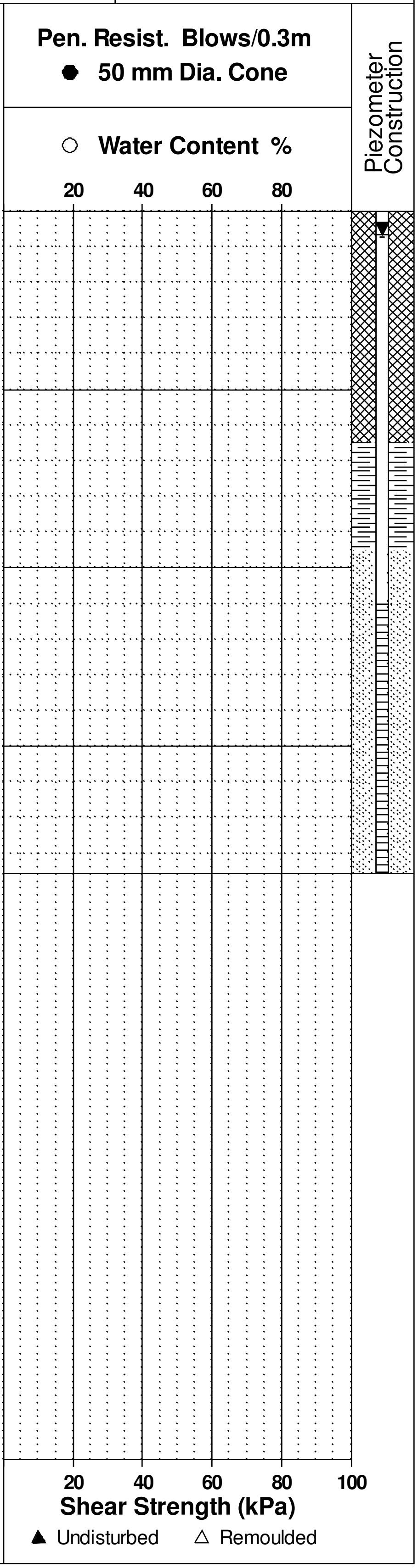
BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	107.24
TOPSOIL 0.10							
		SS	1	75	4		
						1	106.24
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders		SS	2	92	34		
		SS	3	100	41		
- grey by 2.0m depth						2	105.24
		SS	4	78	59		
						3	104.24
		SS	5	75	33		
3.71							
End of Borehole Practical refusal to augering @ 3.71m depth (GWL @ 0.13m-June 16, 2015)							



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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 9, 2015

FILE NO. PG3520

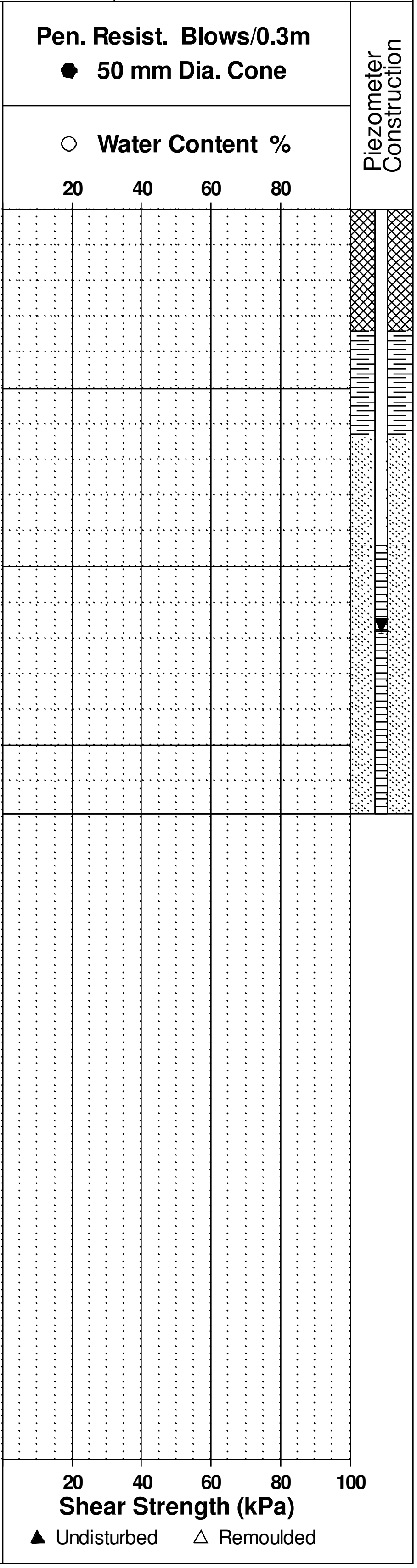
HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.77
TOPSOIL 0.30							
Brown **SILTY CLAY,** some sand		AU	1				
		SS	2	58	24	1	104.77
1.30							
GLACIAL TILL: Grey silty sand with clay, gravel, cobbles and boulders		SS	3	42	8	2	103.77
		SS	4	100	2		
		SS	5	100	50+	3	102.77
3.38							

End of Borehole

Practical refusal to augering at 3.38m depth

(GWL @ 2.36m-June 16, 2015)



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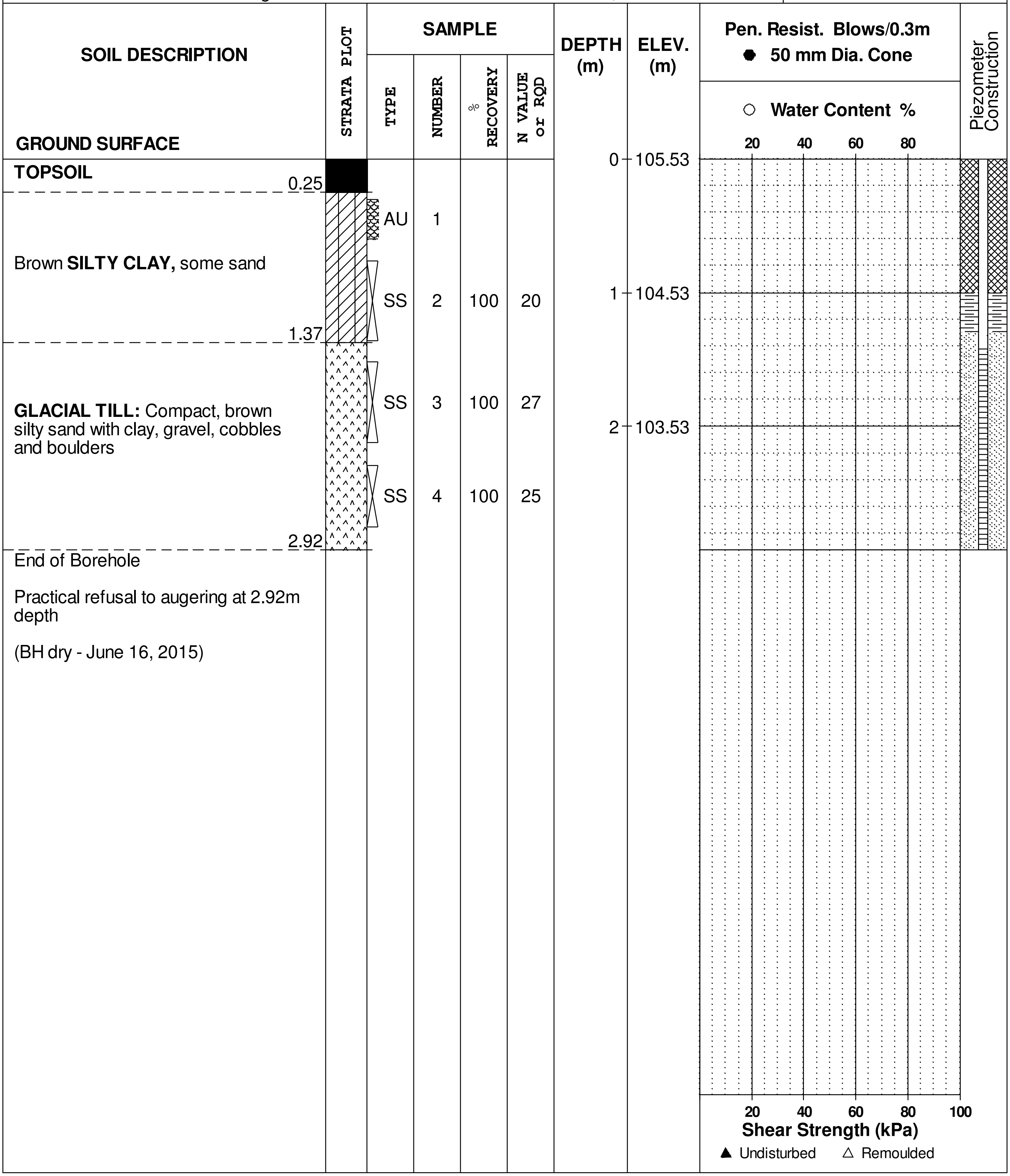
FILE NO. **PG3520**

REMARKS

HOLE NO. **BH 8**

BORINGS BY CME 55 Power Auger

DATE June 10, 2015



SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	105.53
TOPSOIL (0.25)						
Brown **SILTY CLAY,** some sand (1.37)	AU	1				
	SS	2	100	20	1	104.53
GLACIAL TILL: Compact, brown silty sand with clay, gravel, cobbles and boulders (2.92)	SS	3	100	27	2	103.53
	SS	4	100	25		

End of Borehole

Practical refusal to augering at 2.92m depth

(BH dry - June 16, 2015)

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Palladium Dr. & Huntmar Dr.
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FILE NO. **PG3520**

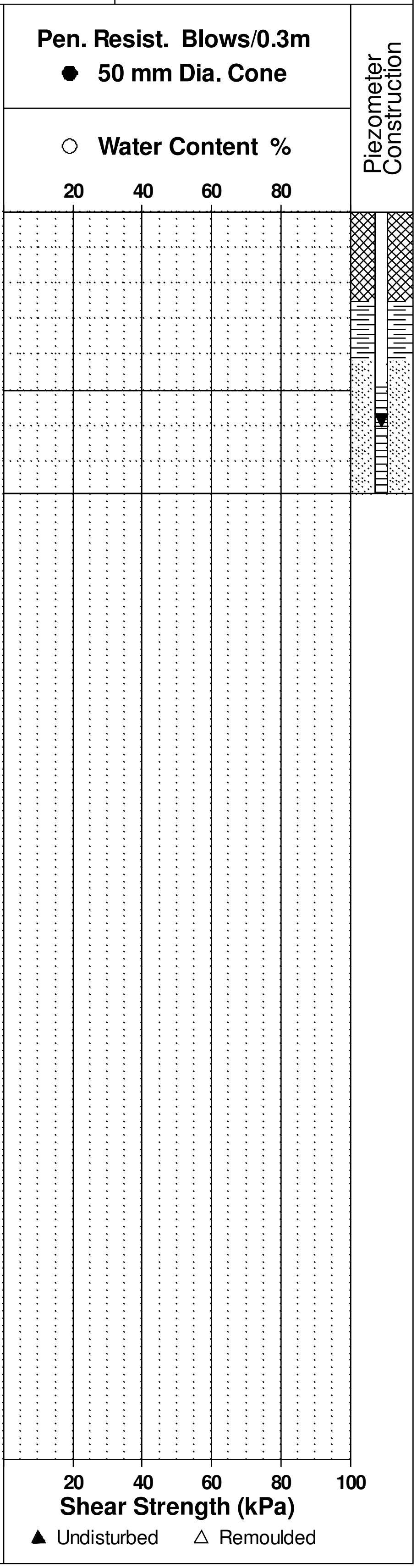
REMARKS

HOLE NO. **BH 9**

BORINGS BY CME 55 Power Auger

DATE June 10, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.01
TOPSOIL 0.10		AU	1				
GLACIAL TILL: Compact, brown silty sand with clay, gravel, cobbles and boulders		SS	2	100	16	1	105.01
1.58							
End of Borehole Practical refusal to augering at 1.58m depth (GWL @ 1.20m-June 16, 2015)							



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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 10, 2015

FILE NO. PG3520

HOLE NO. BH 9A

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20, 40, 60, 80)	Piezometer Construction
GROUND SURFACE						0	106.01		
OVERBURDEN						1	105.01		
1.55									
End of Borehole Practical refusal to augering at 1.55m depth									

Shear Strength (kPa): 20, 40, 60, 80, 100

▲ Undisturbed △ Remoulded

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 10, 2015

FILE NO. PG3520

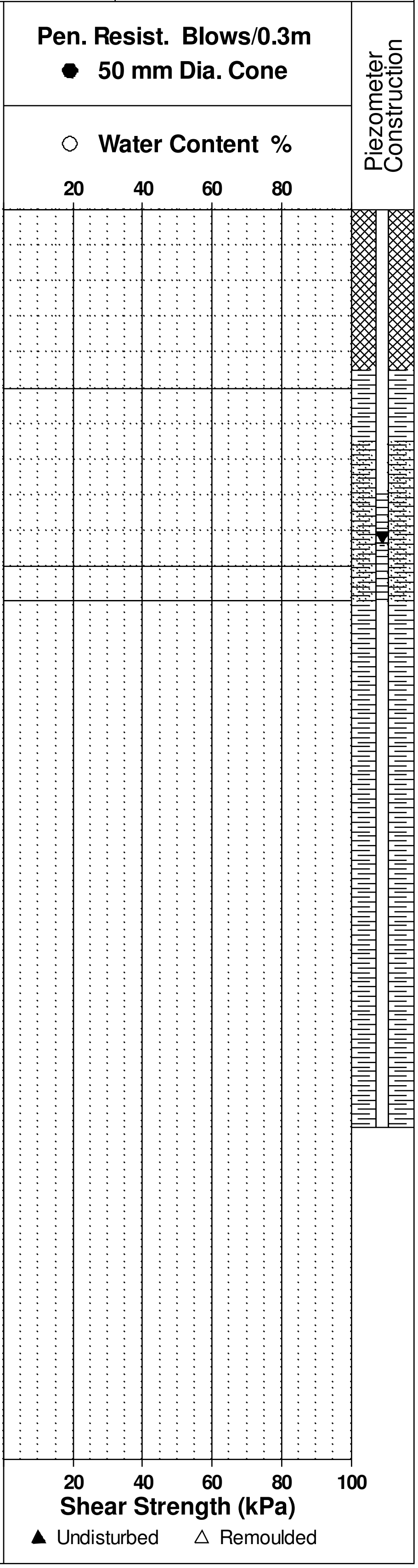
HOLE NO. BH10

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.85
TOPSOIL	0.15						
Brown **SILTY SAND,** some clay	0.76	AU	1				
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders		SS	2	100	7	1	104.85
	2.13	SS	3	61	16	2	103.85

End of Borehole

Practical refusal to augering at 2.13m depth

(GWL @ 1.87m-June 16, 2015)



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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 10, 2015

FILE NO. PG3520

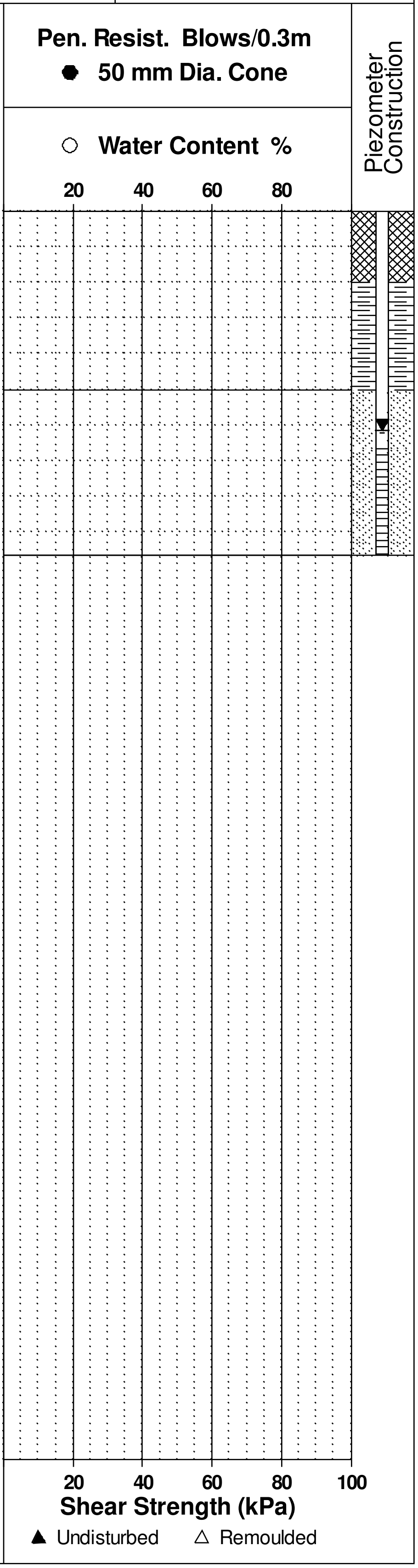
HOLE NO. BH11

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	106.09
TOPSOIL 0.10						
Loose, brown **SILTY SAND,** trace clay 0.76	AU	1				
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders	SS	2	50	3	1	105.09
- grey by 1.5m depth 1.93	SS	3	67	50+		

End of Borehole

Practical refusal to augering at 1.93m depth

(GWL @ 1.23m-June 16, 2015)



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SOIL PROFILE AND TEST DATA

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REMARKS

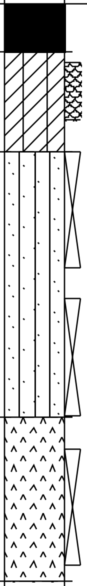
BORINGS BY CME 55 Power Auger

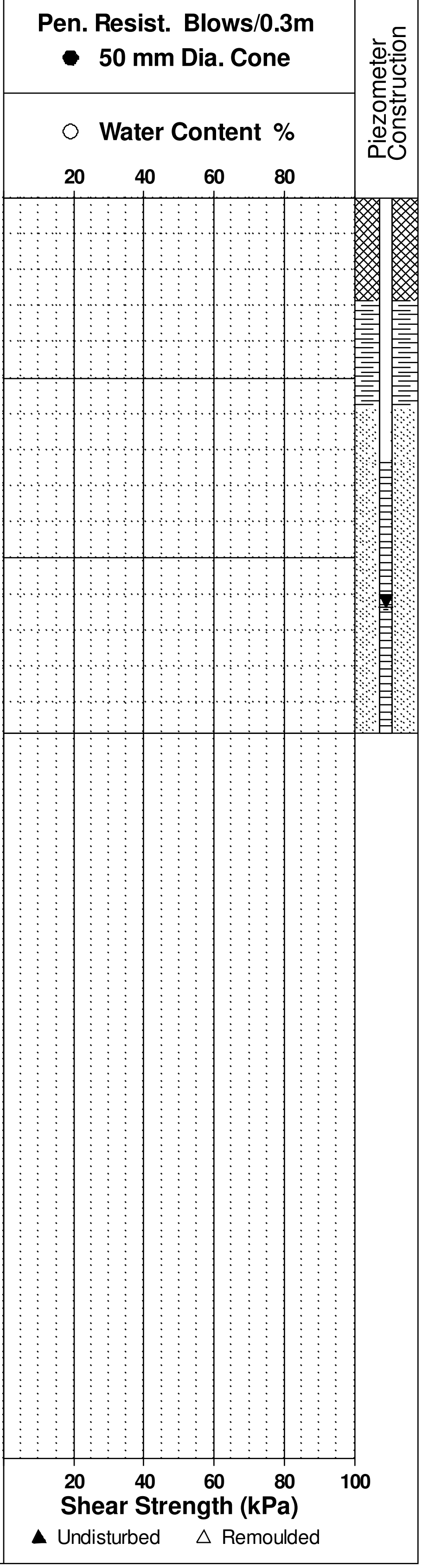
DATE June 10, 2015

FILE NO. PG3520

HOLE NO. BH12

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	104.10
TOPSOIL 0.25						
Brown **SILTY CLAY,** trace sand 0.76	AU	1				
Dense to very dense, brown **SILTY SAND,** trace clay	SS	2	100	36	1	103.10
	SS	3	100	54		
2.13					2	102.10
GLACIAL TILL: Dense, brown silty sand with gravel, cobbles and boulders 2.97	SS	4	75	34		





End of Borehole

Practical refusal to augering at 2.97m depth

(GWL @ 2.27m-June 16, 2015)

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REMARKS

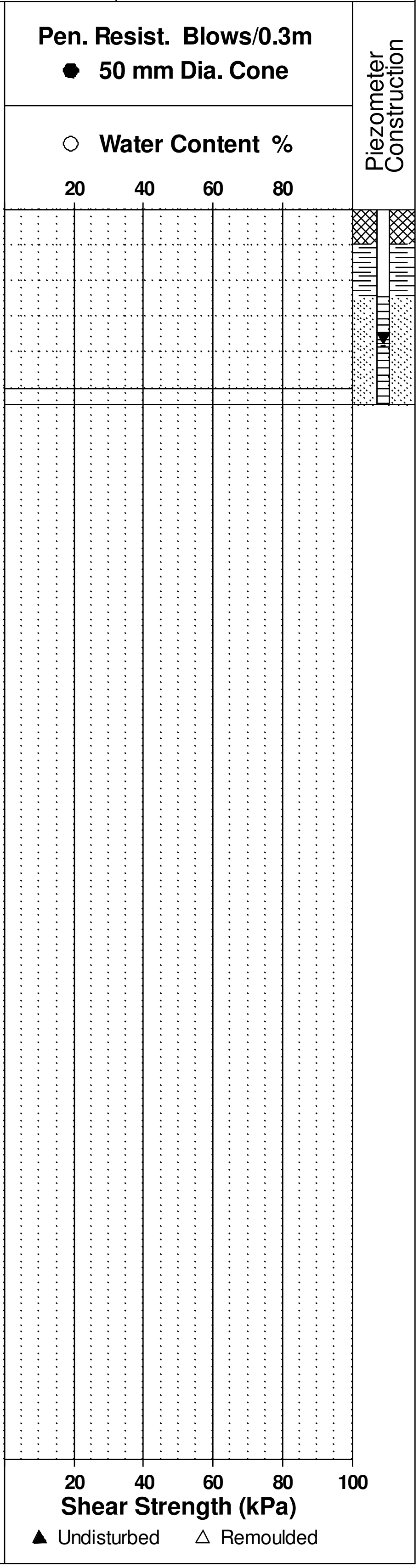
BORINGS BY CME 55 Power Auger

DATE June 10, 2015

FILE NO. PG3520

HOLE NO. BH13

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	105.64
TOPSOIL 0.15							
Brown **CLAYEY SILT,** some sand 0.76		AU	1				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders 1.09		SS	2	91	50+	1	104.64
End of Borehole Practical refusal to augering at 1.09m depth (GWL @ 0.75m-June 16, 2015)							



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DATUM Ground surface elevations provided by Cavanaugh Construction.

FILE NO. PG3520

REMARKS

HOLE NO. BH14

BORINGS BY CME 55 Power Auger

DATE June 10, 2015

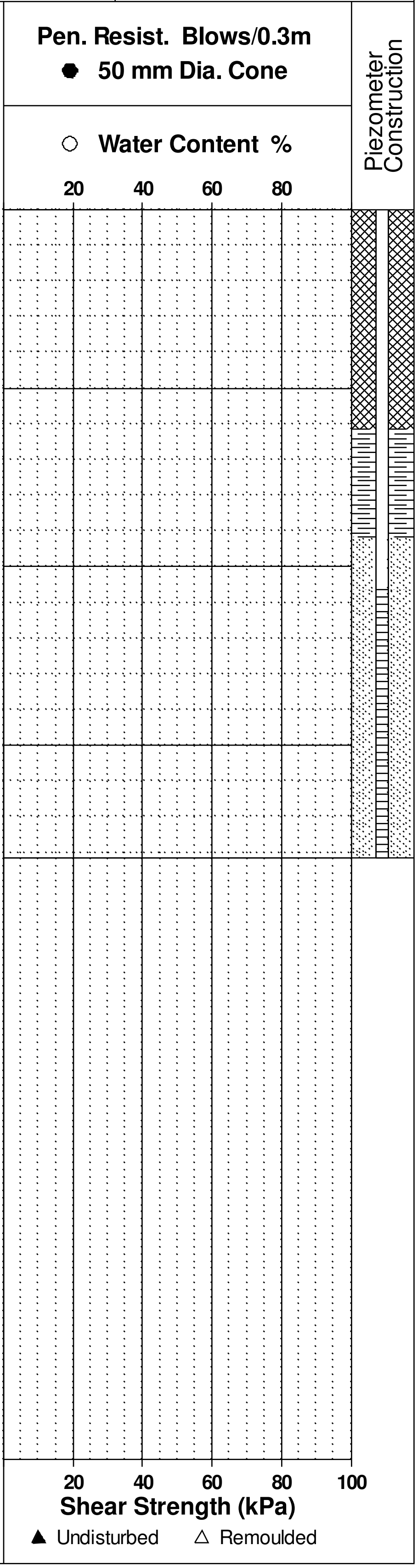
SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.25				
Brown **SILTY CLAY,** trace sand	AU	1		
	SS	2	100	1
	SS	3	100	2
2.90	SS	4	100	15
GLACIAL TILL: Grey silty sand with clay and gravel 3.63	SS	5	100	2

End of Borehole

Practical refusal to augering at 3.63m depth

(BH dry - June 16, 2015)

DEPTH (m)	ELEV. (m)
0	102.55
1	101.55
2	100.55
3	99.55



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

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

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

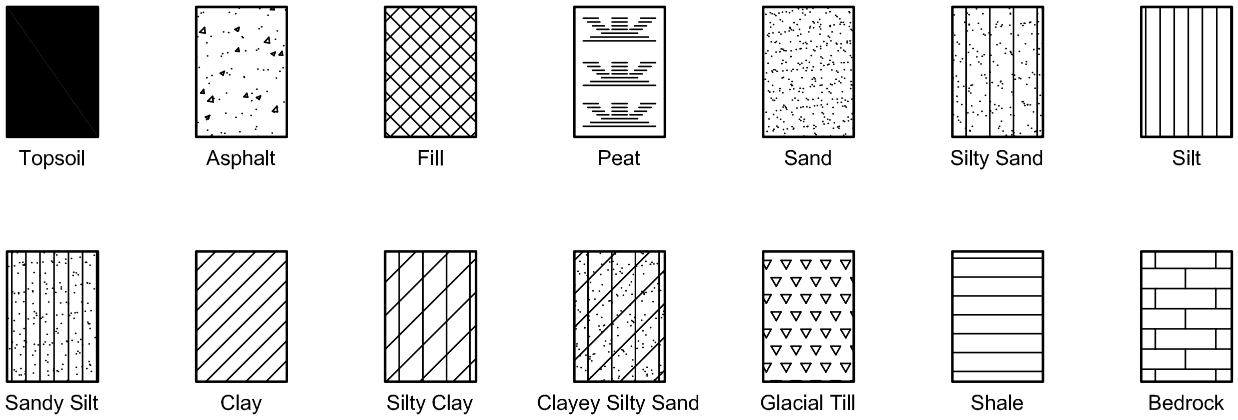
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

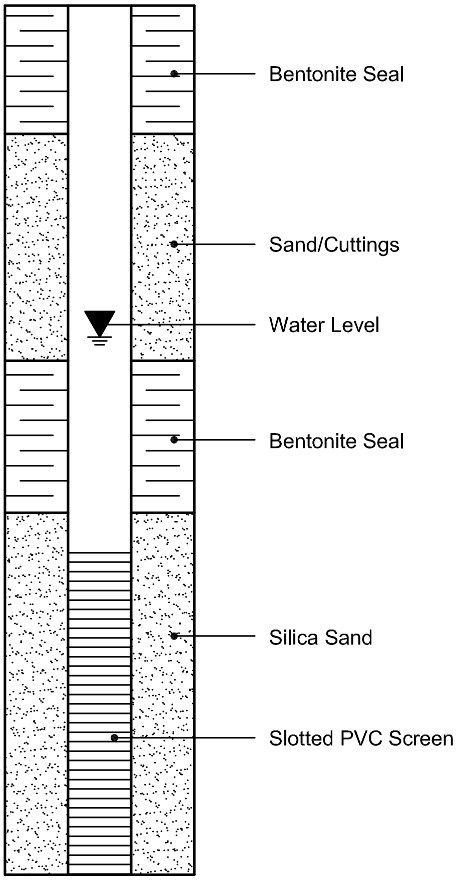
SYMBOLS AND TERMS (continued)

STRATA PLOT

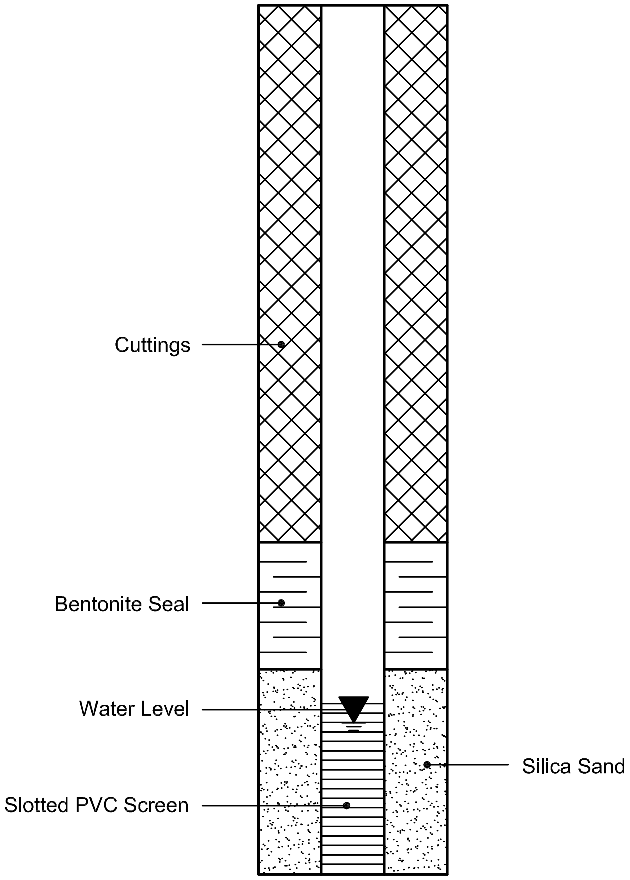


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 24-Jun-2015
Client: **Paterson Group Consulting Engineers**
Order Date:18-Jun-2015
Client PO: 17978
Project Description: PG3520

	Client ID:	BH14 SS4	-	-	-
	Sample Date:	10-Jun-15	-	-	-
	Sample ID:	1525340-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	79.5	-	-	-
General Inorganics					
pH	0.05 pH Units	7.68	-	-	-
Resistivity	0.10 Ohm.m	106	-	-	-
Anions					
Chloride	5 ug/g dry	6	-	-	-
Sulphate	5 ug/g dry	10	-	-	-

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Point Edward, ON N7V 1X4

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KINGSTON
1058 Gardiners Rd.
Kingston, ON K7P 1R7

Page 3 of 7

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG3520-1 - TEST HOLE LOCATION PLAN

DRAWING PG3520-2 - PERMISSIBLE GRADE RAISE PLAN

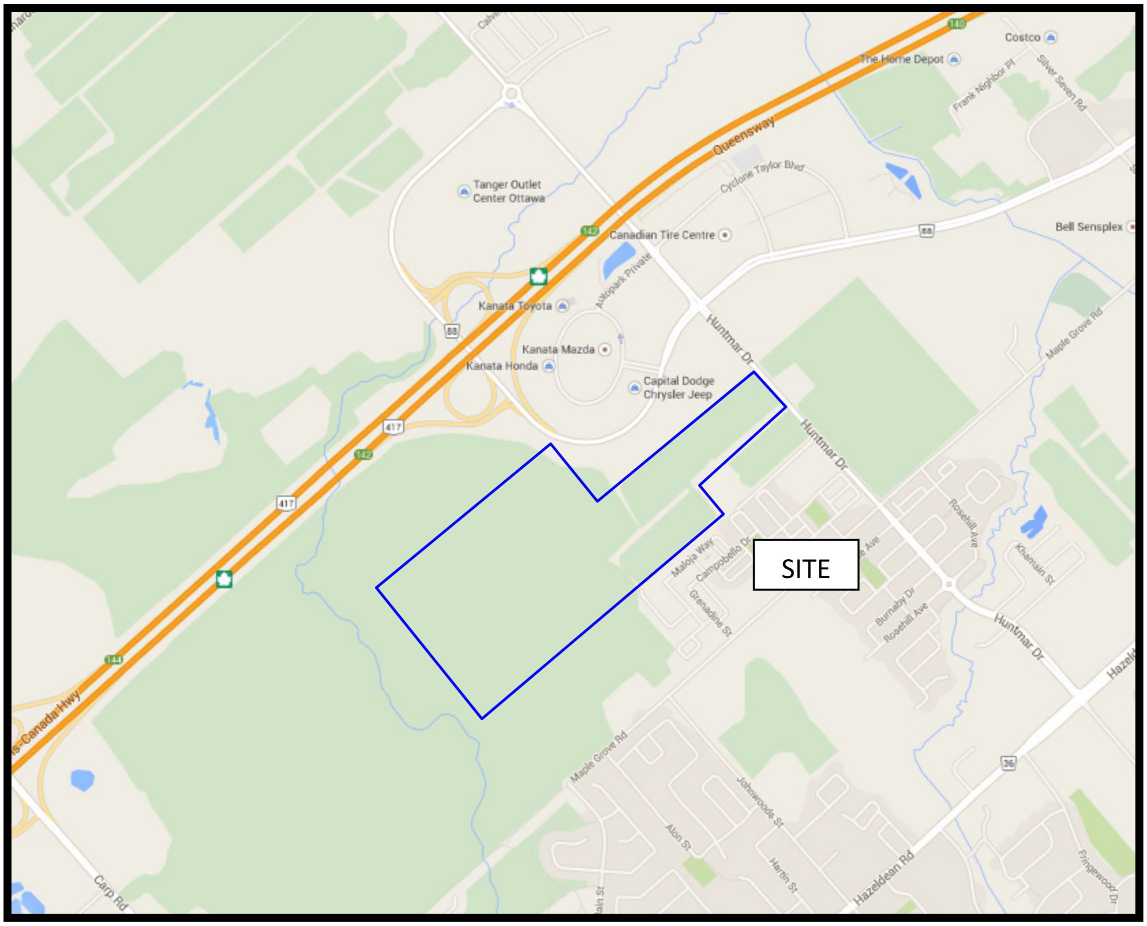
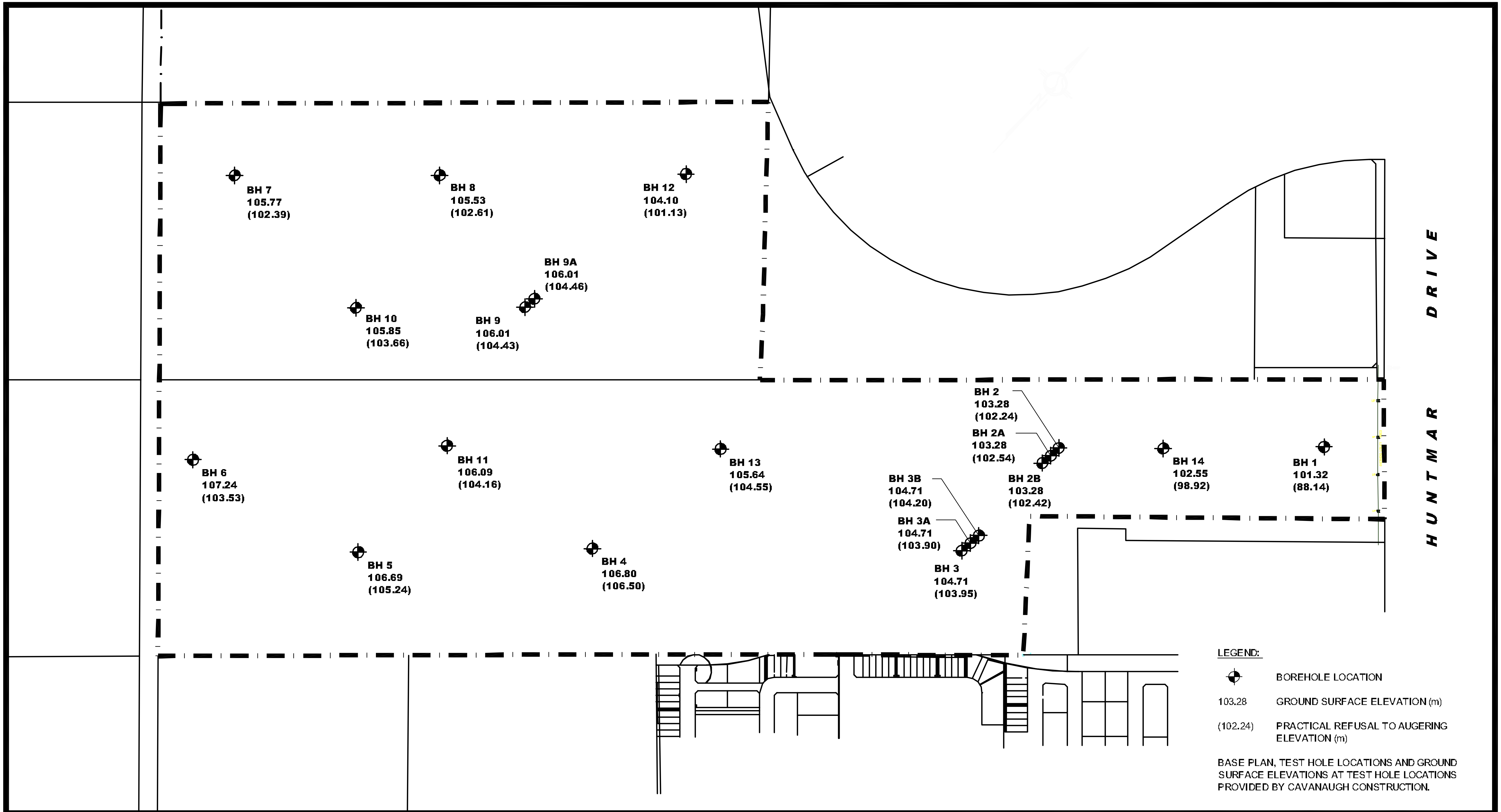


FIGURE 1

KEY PLAN



LEGEND:

⌖	BOREHOLE LOCATION
103.28	GROUND SURFACE ELEVATION (m)
(102.24)	PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS PROVIDED BY CAVANAUGH CONSTRUCTION.

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NO.	REVISIONS	DATE	INITIAL

2325483 ONTARIO INC.

GEOTECHNICAL INVESTIGATION
PROP. DEVELOPMENT - PALLADIUM DRIVE AT HUNTMAR DRIVE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:4000
Date: 06/2015
Drawn by: MPG
Report No.: PG3520-1
Checked by: SB
Drawing No.: PG3520-1
Approved by: DJG
Revision No.:

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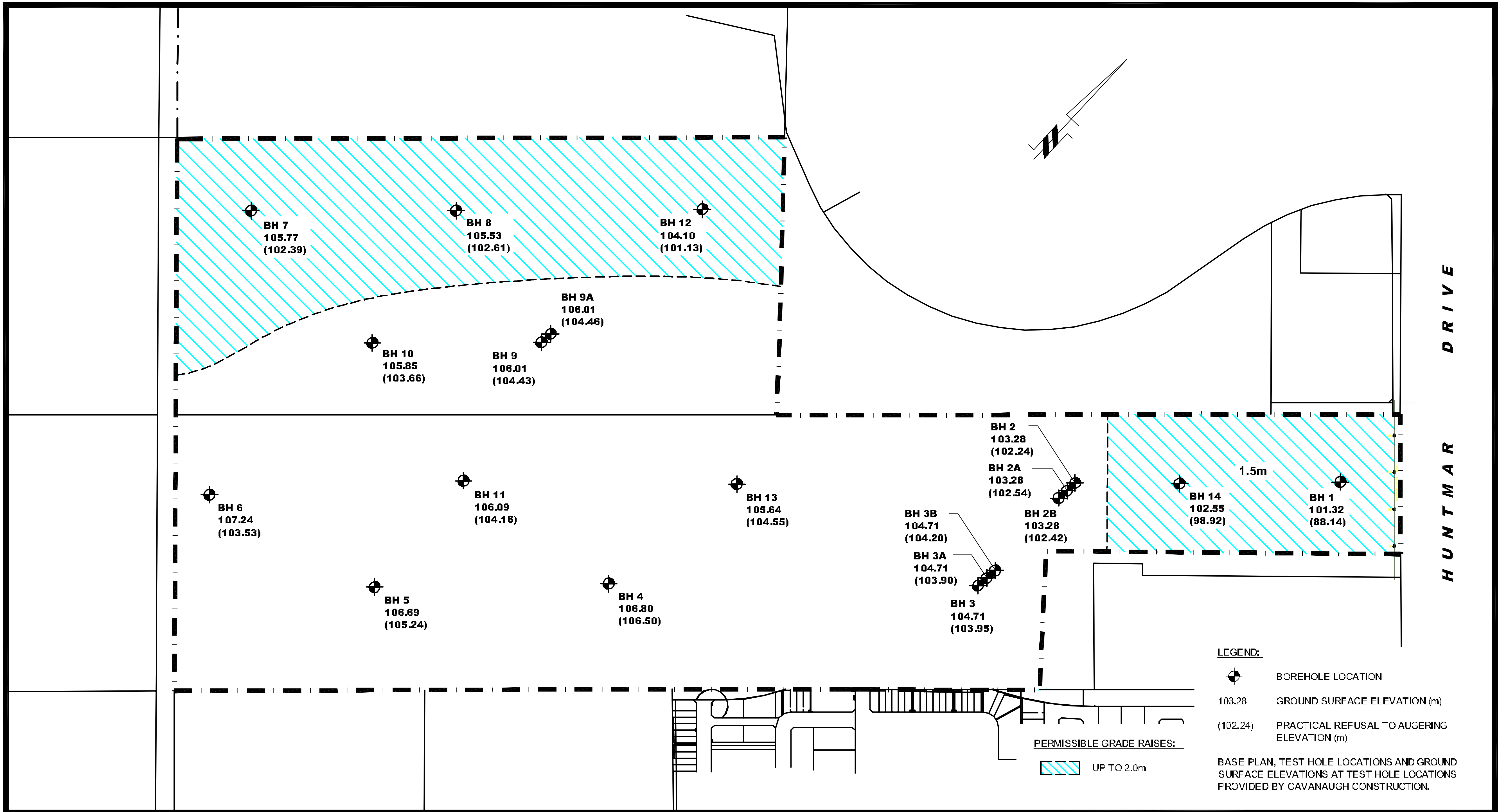

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