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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Residential Development
Half Moon Bay South (Phase 5)
Greenbank Road
Ottawa, Ontario

Prepared For

Mattamy Homes

February 8, 2019

Report: PG4803-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Mattamy Homes to conduct a geotechnical investigation for the current phase of the proposed residential development to be located within the Half Moon Bay South subdivision 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.

2.0 Proposed Development

Based on the available conceptual drawings, it is our understanding that the proposed development consists of a series of townhomes and/or single family residential houses with associated driveways, access lanes, local roadways and landscaped areas. It is further understood that the proposed development will be serviced by future municipal water, sanitary and storm services.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current geotechnical investigation was conducted on February 5, 2019 which consisted of extending a total of 8 test pits (TP1-19 to TP8-19) to a maximum depth of 5.0 m. Previous field programs were conducted in March and December, 2015. During that time, a total of 7 test holes were advanced to a maximum depth of 9.8 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 PG4803-1 - 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. The test pits were excavated using a hydraulic excavator. 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 augering to the required depths at the selected locations, sampling and testing the overburden. The excavating procedures consisted of advancing each test hole to the required depths at the selected locations and sampling the overburden.

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. Soil samples from the open test pits were recovered from the excavation side walls. All soil samples were placed in sealed plastic bags and transported to our laboratory. 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.

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

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

Monitoring wells consisting of 50 mm diameter rigid PVC pipe were installed in 3 borehole locations and flexible standpipe piezometers were installed in 2 borehole locations during the course of the previous field investigations to permit monitoring of the groundwater levels. Groundwater infiltration throught the side walls of the test pits was recorded during the current field 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 for the current field investigation were selected by Paterson and surveyed in the field by Agrodrain Services Ltd. (ASL). The elevations at the test hole locations are referenced to a geodetic datum. Ground surface elevations at the test hole locations from previous investigations were surveyed by J.D. Barnes Ltd. or were inferred based on available topographic mapping. The ground surface elevations at the test hole locations are presented on Drawing PG4803-1 - 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.

4.0 Observations

4.1 Surface Conditions

The ground surface across the subject site generally slopes down towards the east and northeast, with a change in elevation of approximately 4 to 5 m. It should be noted that the site is slightly lower than Alex Polowin Avenue towards the northeast portion of the site. The subject site is bordered to the east and northeast by the existing Half Moon Bay subdivision and to the north, west and south by vacant lands. Several fill piles were noted across the subject site due to ongoing construction operations.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile encountered at the test holes consists of a topsoil or fill layer consisting of silty clay with sand and trace gravel and organics overlying a loose to compact silty sand. A glacial till deposit was encountered below the silty sand layer consisting of silty sand with gravel, cobbles and boulders. Specific details of the soil profile at each test hole location are provided on the Soil Profile and Test Data sheets in Appendix 1.

Bedrock

Based on available geological mapping, the local bedrock consists of dolomite of the Oxford formation with an anticipated overburden thickness of 15 to 25 m.

4.3 Groundwater

Groundwater levels were measured in the monitoring wells and standpipes installed at the borehole locations following completion of the previous investigations. The results are summarized in Table 1 and provided on the Soil Profile and Test Data sheets in Appendix 1.

Table 1 - Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date
BH 5-15 (PG3607)	108.75	Dry	-	July 28, 2016
BH 6-15 (PG3607)	102.59	Dry	-	July 28, 2016
BH 12-15 (PG3607)	105.26	Dry	-	July 28, 2016
BH 5-15 (PG3450)	103.02	7.15 6.80 6.76	95.87 96.22 96.26	March 23, 2015 April 21, 2015 May 12, 2015
BH 6-15 (PG3450)	101.42	2.93 0.99 1.45	98.49 100.43 99.97	March 23, 2015 April 21, 2015 May 12, 2015

Note: Ground surface elevations at PG3607 test hole locations were inferred based on available topographic mapping. Ground surface elevations at PG3450 test hole locations were provided by J.D. Barnes Ltd. and are understood to be referenced to a geodetic datum.

Based on our observations during the current field program, all test pits were noted to be dry within no infiltration through the side walls of the open test pits. 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 4 to 5 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. It is anticipated that the proposed buildings can be constructed using conventional shallow footings placed on an undisturbed, compact silty sand or glacial till bearing surface.

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, such as underground services or 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 could be placed as general landscaping fill where surface settlement is of minor concern. The existing materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If the existing materials are to be placed to increase the subgrade level for areas to be paved, the non-specified existing fill should be compacted in 300 mm lifts and compacted to a minimum density of 95% of the respective SPMDD.

5.3 Foundation Design

Footings placed on an undisturbed, compact silty sand bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **100 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **175 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance value at ULS. If the subgrade medium is noted to be in a loose state of compactness, it is recommended to proof-roll the bearing medium under dry conditions and above freezing temperature using appropriate compaction equipment. The subgrade should be inspected by a Paterson at the time of construction.

Footings placed on an undisturbed, glacial till 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 reported bearing resistance value at ULS.

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

Settlement

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.

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 considered at the subject site. 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

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. 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.

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 diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 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 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 an equivalent combination of soil cover and foundation insulation should be provided in this regard.

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

6.3 Excavation Side Slopes

The 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 should be used for bedding for sewer pipes when placed on soil subgrade. 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 (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s standard Proctor maximum dry density (SPMDD).

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 sand above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty sand 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

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. It is anticipated that groundwater infiltration into the excavations should be moderate, if encountered, and controllable using open sumps.

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 of 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.

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.

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 our recommendations when the grading plan, drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests immediate notification 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 Mattamy Homes 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.

LICENSED PROFESSIONAL ENGINEER
Feb. 6-2019
F. I. ABOU-SEIDO
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PROVINCE OF ONTARIO

Nathan F. S. Christie, P.Eng.

Faisal I. Abou-Seido, P.Eng.

Report Distribution:

❑ Mattamy Homes (3 copies)
❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Half Moon Bay South
Ottawa, Ontario

DATUM Ground surface elevations provided by Agrodrain Systems Limited Contractors (ASL)

REMARKS

BORINGS BY Excavator

DATE 2019 February 5

FILE NO. **PG4803**

HOLE NO. **TP 1-19**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Reddish brown silt and sand, some cobbles, trace topsoil 0.30					
Loose to compact, light brown coarse **SILTY SAND** 1.50		G	1		
Compact, light greyish brown fine **SILTY SAND** 4.30		G	2		
		G	3		
		G	4		
		G	5		
Compact, grey **SILTY SAND** 4.50		G	6		
End of Test Pit (TP dry upon completion)					

DEPTH (m)	ELEV. (m)
0	104.31
1	103.31
2	102.31
3	101.31
4	100.31

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

○ **Water Content %**

20 40 60 80

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

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Half Moon Bay South
Ottawa, Ontario

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REMARKS

BORINGS BY Excavator

DATE 2019 February 5

FILE NO. PG4803

HOLE NO. TP 2-19

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	101.36		
Brown **SILTY SAND**, trace topsoil 0.15		G	1						
Loose to compact, light brown **SILTY SAND**		G	2						
						1	100.36		
		G	3						
						2	99.36		
		G	4						
						3	98.36		
		G	5						
						4	97.36		
4.10 End of Test Pit (TP dry upon completion)		G	6						

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Half Moon Bay South
Ottawa, Ontario

DATUM Ground surface elevations provided by Agrodrain Systems Limited Contractors (ASL)

REMARKS

BORINGS BY Excavator

DATE 2019 February 5

FILE NO. PG4803

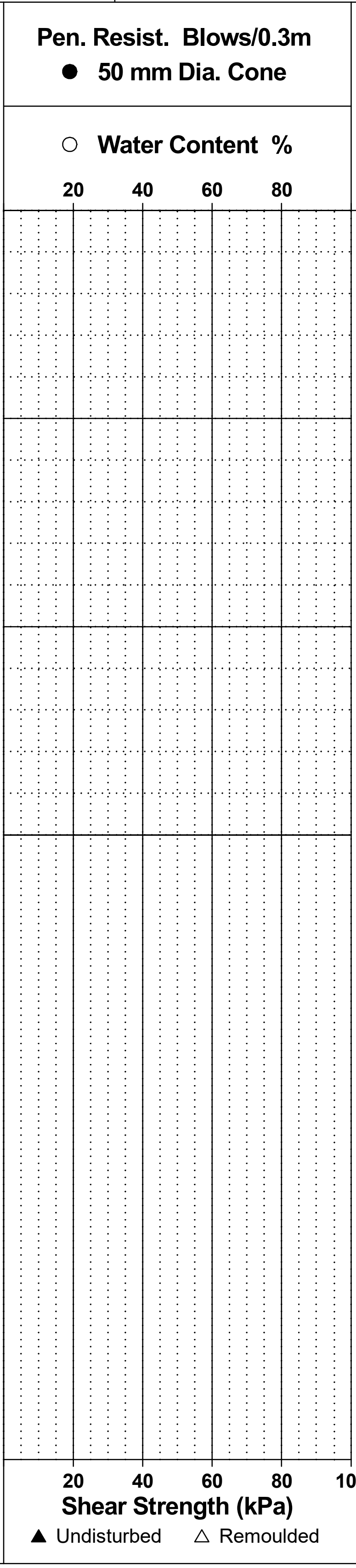
HOLE NO. TP 3-19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	101.16	
FILL: Dark brown clayey silt with sand, topsoil and gravel — 0.50		G	1					
Loose, brown **SILTY SAND** with clay and some gravel — 1.50		G	2			1	100.16	
GLACIAL TILL: Coarse, brown to grey sand with gravel, cobbles and boulders — 3.00		G G G	3 4 5			2 3	99.16 98.16	

End of Borehole

Refusal to excavation on boulder @ 3m depth

(TP dry upon completion)



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SOIL PROFILE AND TEST DATA

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DATE 2019 February 5

FILE NO. **PG4803**

HOLE NO. **TP 4-19**

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	104.60		
Loose, light brown **SAND**, trace clay and topsoil 0.15									
Loose, light brown **SILTY SAND**, trace clay		G	1			1	103.60		
1.40									
Compact, light brown **SILTY SAND** with trace silt		G	2			2	102.60		
		G	3			3	101.60		
		G	4			4	100.60		
		G	5						
4.10		G	6						
End of Test Pit (TP dry upon completion)									

Chart scales: 20 40 60 80 (Water Content %); 20 40 60 80 100 **Shear Strength (kPa)**

▲ Undisturbed △ Remoulded

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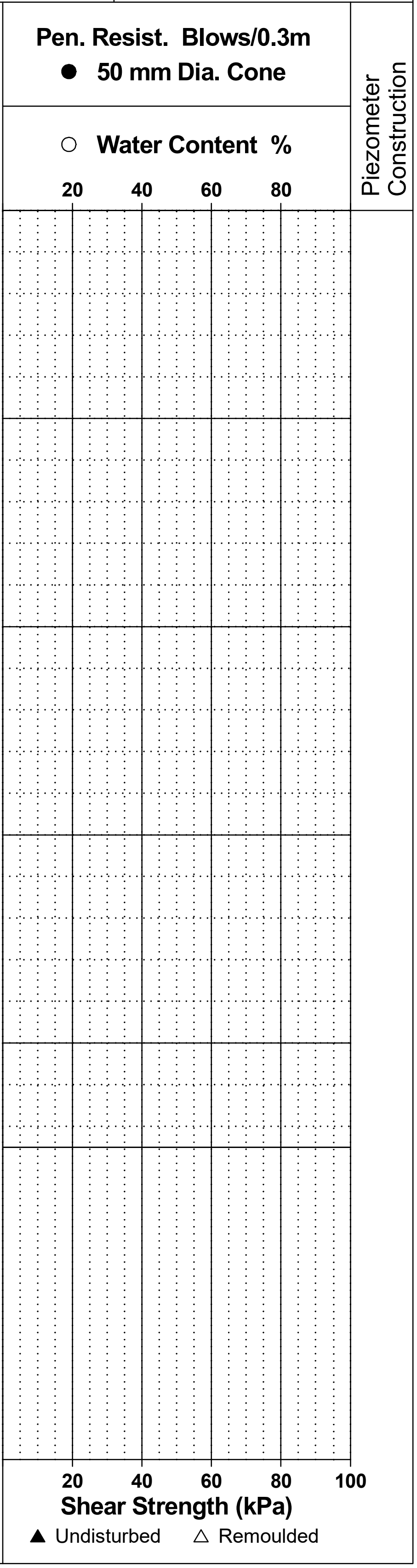
FILE NO. **PG4803**

HOLE NO. **TP 5-19**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.52
FILL: Silty sand with cobbles, trace clay 0.30							
Loose to compact, light brown **SILTY SAND**		G	1				
						1	104.52
		G	2				
						2	103.52
		G	3				
		G	4				
						3	102.52
		G	5				
						4	101.52
4.50		G	6				
End of Test Pit (TP dry upon completion)							



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DATE 2019 February 5

FILE NO. PG4803

HOLE NO. TP 6-19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			20 40 60 80	
GROUND SURFACE						0	104.12		
TOPSOIL 0.30	■	G	1						
FILL: Brown silty sand with clay, gravel and cobbles 0.60	▨								
		G	2						
Light brown, loose to compact **SAND**, trace silt	░					1	103.12		
		G	3						
						2	102.12		
		G	4						
						3	101.12		
		G	5						
						4	100.12		
		G	6						
5.00		G	7			5	99.12		
End of Test Pit (TP dry upon completion)									

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

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DATE 2019 February 5

FILE NO. PG4803

HOLE NO. TP 7-19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	101.50
TOPSOIL — 0.30		G	1				
GLACIAL TILL: Brown silty sand with cobbles and boulders — 0.60							
GLACIAL TILL: Brown sand with cobbles and boulders — 1.80		G G	2 3			1	100.50
GLACIAL TILL: Dense silt with gravel, trace sand — 2.40		G	4			2	99.50
GLACIAL TILL: Light brown, fine sand with cobbles and boulders — 4.00		G G G	5 6 7			3	98.50
End of Test Pit (TP dry upon completion)		G	8			4	97.50

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

Piezometer Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Half Moon Bay South
Ottawa, Ontario

DATUM Ground surface elevations provided by Agrodrain Systems Limited Contractors (ASL)

REMARKS

BORINGS BY Excavator

DATE 2019 February 5

FILE NO. PG4803

HOLE NO. TP 8-19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.41
FILL: Brown silty clay with sand, trace topsoil — 0.60	▨						
FILL: Grey silty clay with sand — 0.90	▨	G	1				
GLACIAL TILL: Sand with cobbles and boulders	^^^					1	101.41
	^^^	G	2				
	^^^					2	100.41
— 2.80	^^^	G	3				
End of Test Pit (TP dry upon completion)							

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

○ **Water Content %**

20 40 60 80

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

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

FILE NO. PG3607

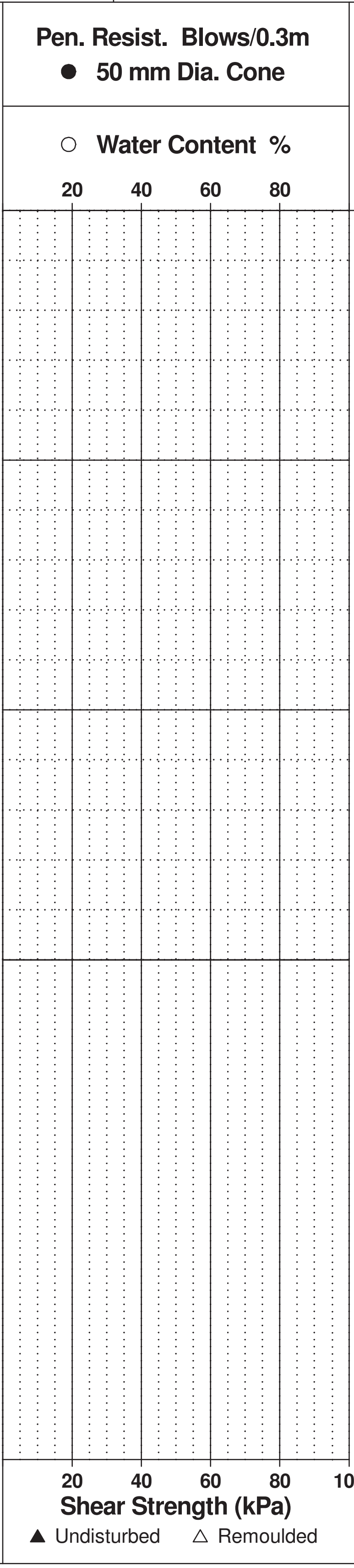
REMARKS

HOLE NO. TP 1-15

BORINGS BY Backhoe

DATE December 2, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.10		G	1			0	105.10
Compact, brown **SILTY SAND**, trace boulders and cobbles						1	104.10
		G	2				
3.00						2	103.10
End of Test Pit (TP dry upon completion)						3	102.10



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

REMARKS

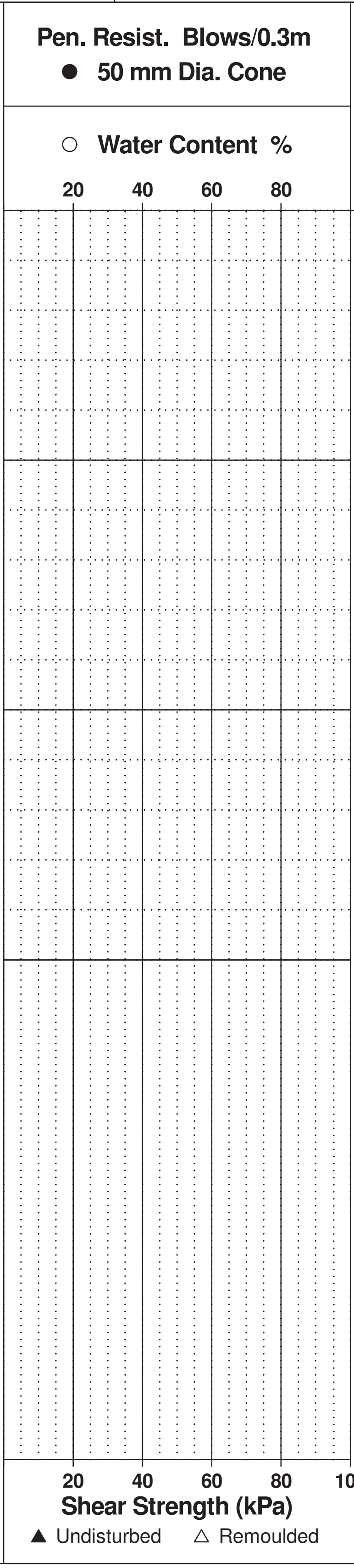
BORINGS BY Backhoe

DATE December 2, 2015

FILE NO. PG3607

HOLE NO. TP 2-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			
GROUND SURFACE						0	106.80	
TOPSOIL 0.10								
		G	1					
						1	105.80	
Compact, brown **SILTY SAND**								
						2	104.80	
		G	2					
3.00						3	103.80	
End of Test Pit (TP dry upon completion)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

REMARKS

BORINGS BY CME 75 Power Auger

DATE December 10, 2015

FILE NO. PG3607

HOLE NO. BH 5-15

SOIL DESCRIPTION

GROUND SURFACE

FILL: Grey silty sand with clay, gravel and wood

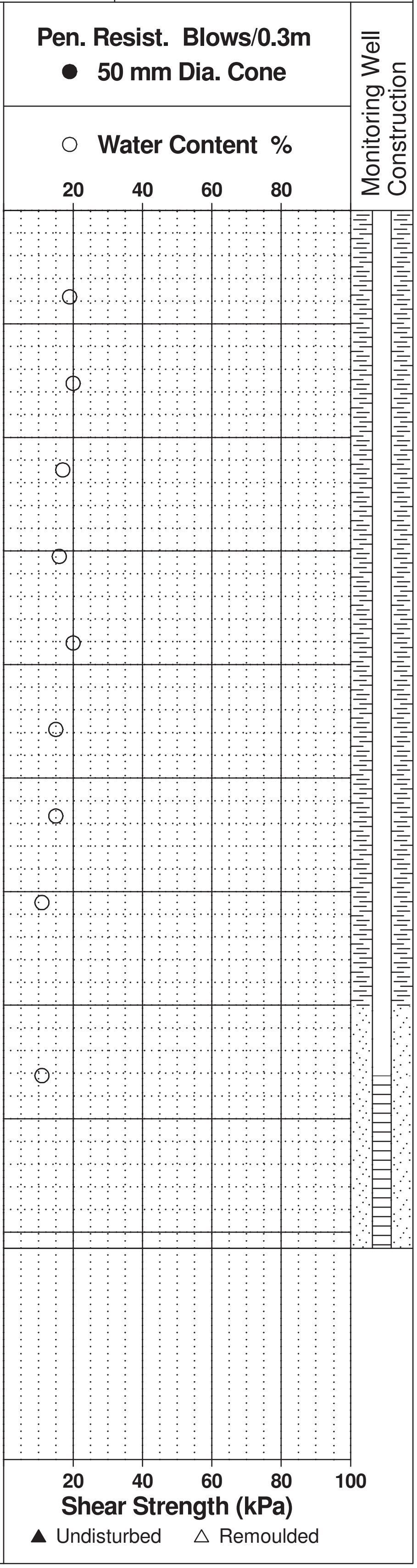
9.14

End of Borehole

(BH dry to 9.14m depth - July 28, 2016)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	42	13
SS	2	25	21
SS	3	33	5
SS	4	42	4
SS	5	42	3
SS	6	42	3
SS	7	17	5
SS	8	25	37
SS	9	0	50+
SS	10	58	9
SS	11	0	1

DEPTH (m)	ELEV. (m)
0	108.75
1	107.75
2	106.75
3	105.75
4	104.75
5	103.75
6	102.75
7	101.75
8	100.75
9	99.75



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

FILE NO. PG3607

REMARKS

HOLE NO. BH 6-15

BORINGS BY CME 75 Power Auger

DATE December 3, 2015

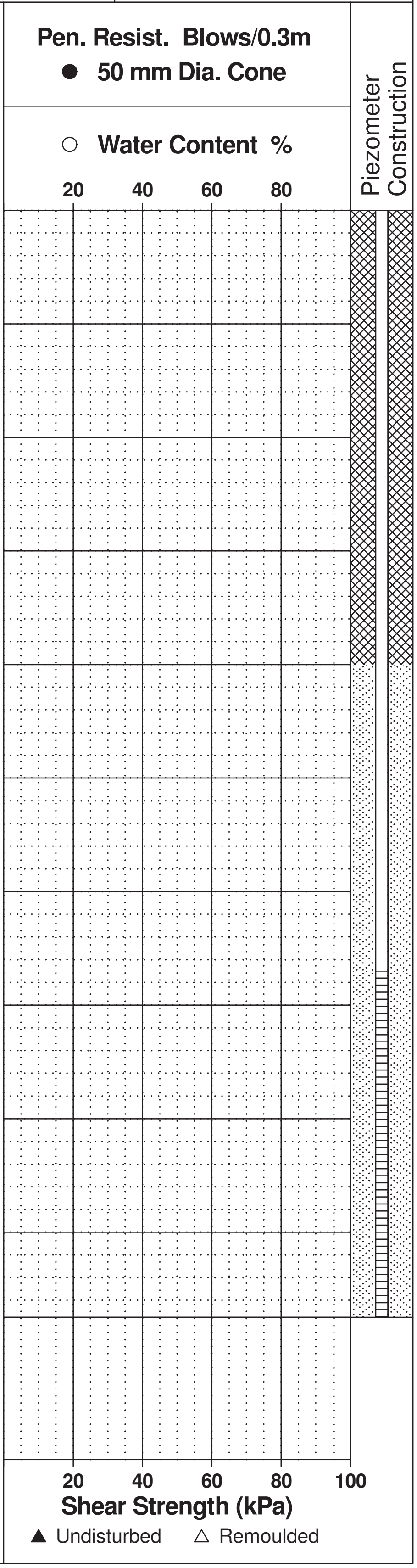
GROUND SURFACE

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
Dense to very dense, grey-brown **SILTY SAND** with gravel, cobbles and boulders	AU	1		
	SS	2	75	31
	SS	3	100	50+
2.29				
Compact to dense, grey-brown **SILTY SAND**	SS	4	83	27
	SS	5	58	27
	SS	6	67	26
	SS	7	71	31
	SS	8	67	30
	SS	9	63	30
	SS	10	75	25
	SS	11	100	19
	SS	12	100	15
	SS	13	100	15
9.75				

End of Borehole

(BH dry to4.40m depth - July 28, 2016)

DEPTH (m)	ELEV. (m)
0	102.59
1	101.59
2	100.59
3	99.59
4	98.59
5	97.59
6	96.59
7	95.59
8	94.59
9	93.59



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

REMARKS

BORINGS BY CME 75 Power Auger

DATE December 2, 2015

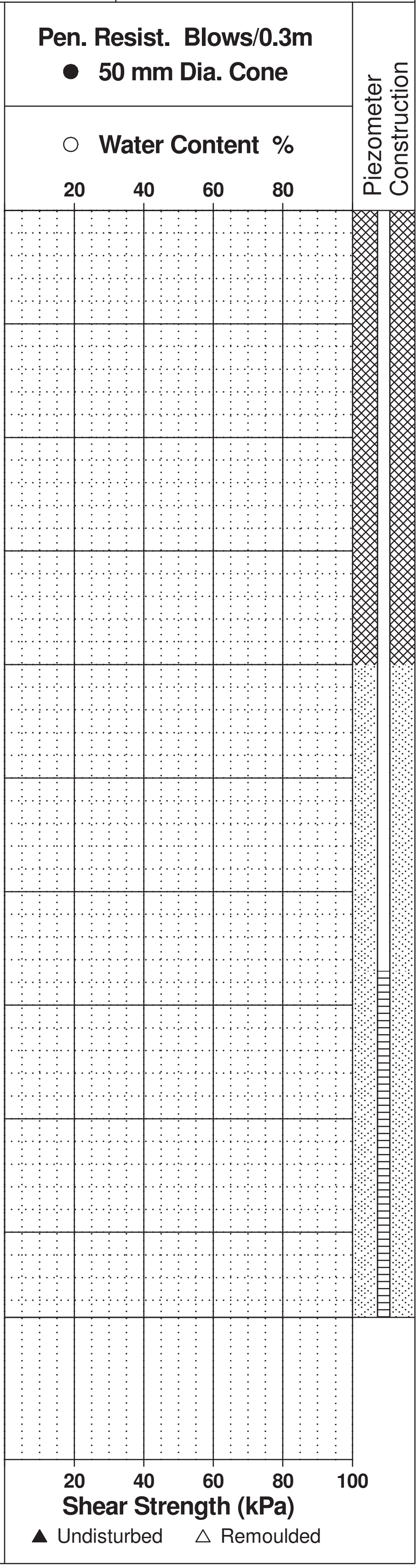
FILE NO. PG3607

HOLE NO. BH12-15

SOIL DESCRIPTION				
GROUND SURFACE				
Dense to very dense, brown **SILTY SAND** with gravel, cobbles and boulders - rootlets in upper 100mm	3.35			
Dense, brown **SILTY SAND** - grey by 7.6m depth	9.75			
End of Borehole (BH dry to 7.79m depth - July 28, 2016)				

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	88	42
SS	3	33	50+
SS	4	67	50+
SS	5	83	58
SS	6	100	31
SS	7	75	47
SS	8	92	30
SS	9	79	31
SS	10	75	35
SS	11	92	34
SS	12	100	32
SS	13	88	37

DEPTH (m)	ELEV. (m)
0	105.26
1	104.26
2	103.26
3	102.26
4	101.26
5	100.26
6	99.26
7	98.26
8	97.26
9	96.26



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SOIL PROFILE AND TEST DATA

Hydrogeological Investigation
Residential Development - Half Moon Bay South
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

FILE NO. PG3450

REMARKS

HOLE NO. BH 5-15

BORINGS BY CME 55 Power Auger

DATE March 6, 2015

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Dark brown silty fine sand with topsoil and gravel	3.50
Dense, brown **SILTY FINE SAND,** with gravel, trace clay	4.42
Dense to compact, light brown **SILTY FINE SAND** - trace to some medium sand by 6.1m depth - running sand by 7.0m depth	7.62

End of Borehole

(GWL @ 7.15m-March 23, 2015)

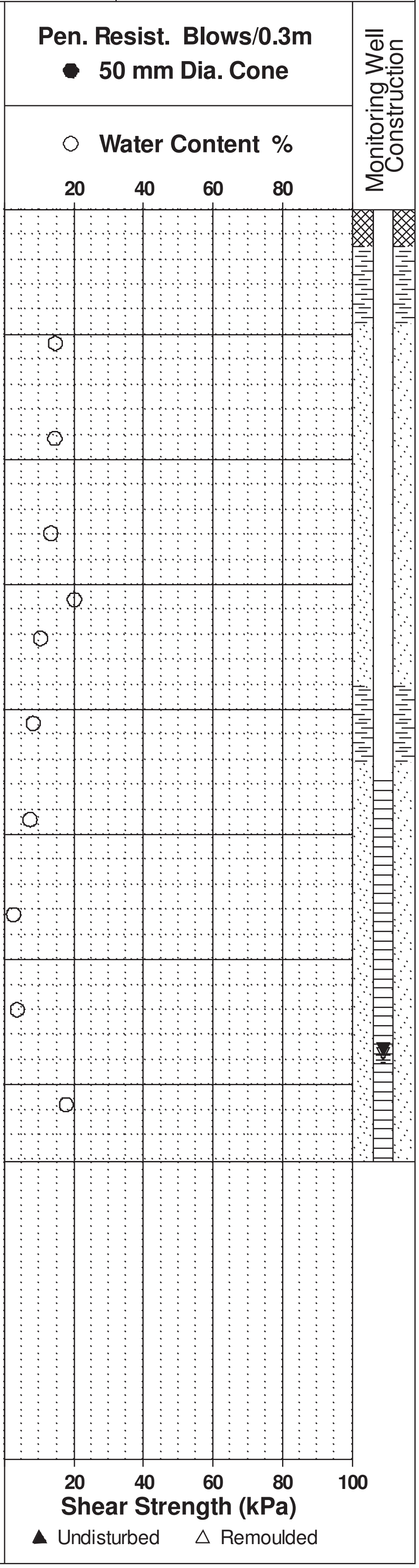
(GWL @ 6.80m-April 21, 2015)

(GWL @ 6.76m-May 12, 2015)

High groundwater infiltration rate

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	61
SS	2	42	5
SS	3	67	3
SS	4	67	6
SS	5	100	49
SS	6	92	46
SS	7	83	38
SS	8	67	40
SS	9	83	26

DEPTH (m)	ELEV. (m)
0	103.02
1	102.02
2	101.02
3	100.02
4	99.02
5	98.02
6	97.02
7	96.02



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SOIL PROFILE AND TEST DATA

Hydrogeological Investigation
Residential Development - Half Moon Bay South
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.
FILE NO. PG3450

REMARKS

HOLE NO. BH 6-15

BORINGS BY CME 55 Power Auger
DATE March 5, 2015

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	101.42
FILL: Brown silty clay with sand, trace gravel and topsoil 0.60						
Very stiff, brown **SILTY CLAY**	SS	1	42	14	1	100.42
	SS	2	67	12	2	99.42
- 75mm thick sand seams at 2.1 and 2.7m depths	SS	3	67	7	3	98.42
3.20						
Compact to dense, brown **SILTY FINE SAND,** trace gravel - running sand at 3.2 to 4.1m depth	SS	4	92	17	4	97.42
4.11	SS	5	92	50		
GLACIAL TILL: Very dense, brown to grey silty sand with clay, gravel, trace cobbles	SS	6	92	52	5	96.42
5.18						

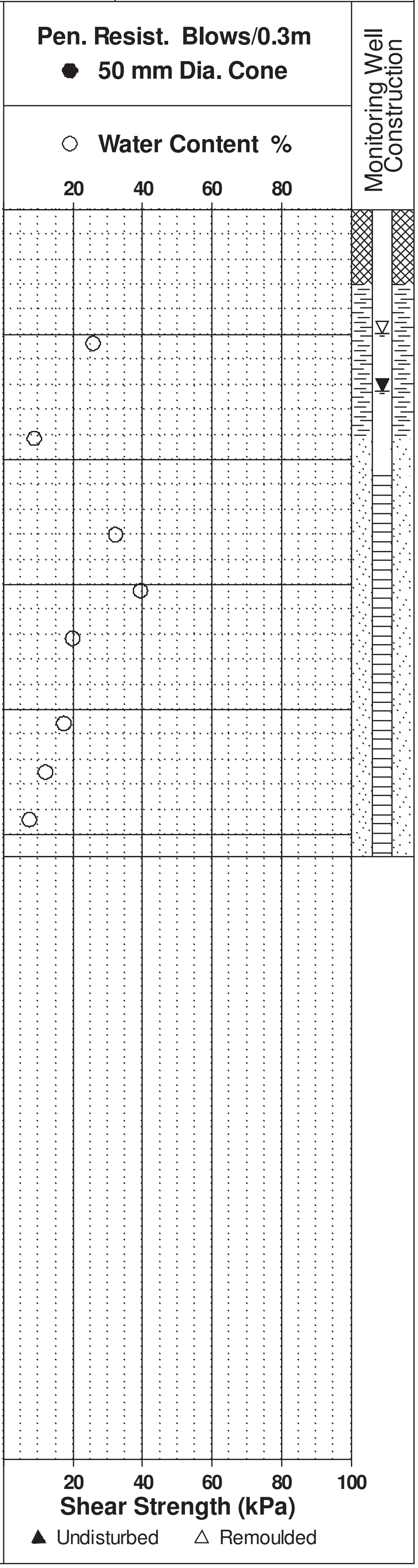
End of Borehole

(GWL @ 2.93m-March 23, 2015)

(GWL @ 0.99m-April 21, 2015)

(GWL @ 1.45m-May 12, 2015)

High groundwater infiltration rate



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)

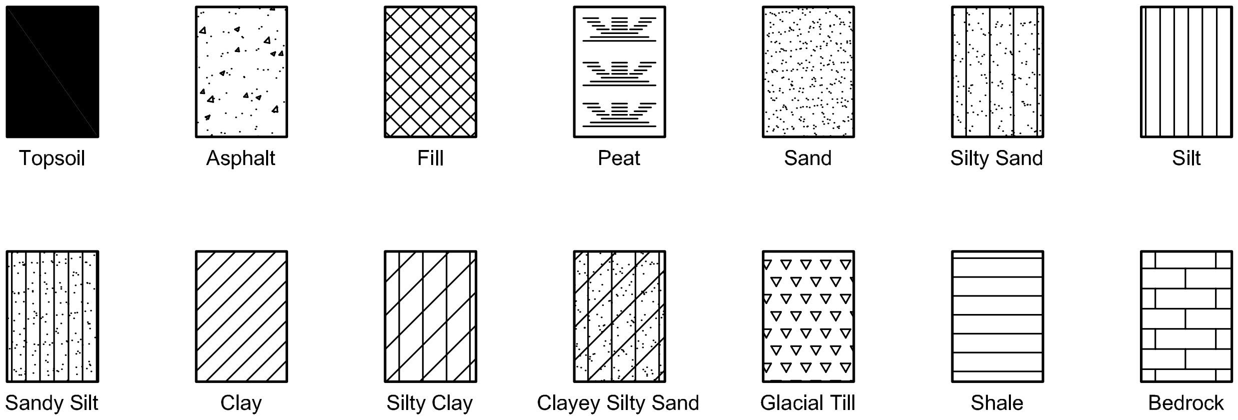
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

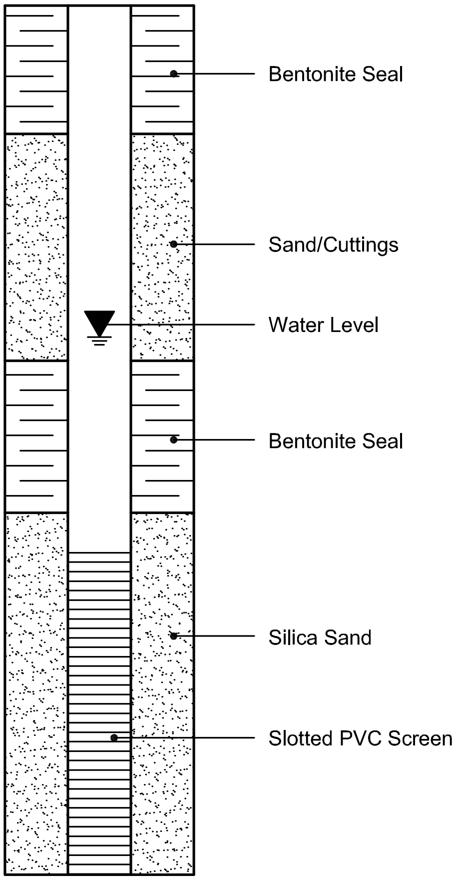
SYMBOLS AND TERMS (continued)

STRATA PLOT

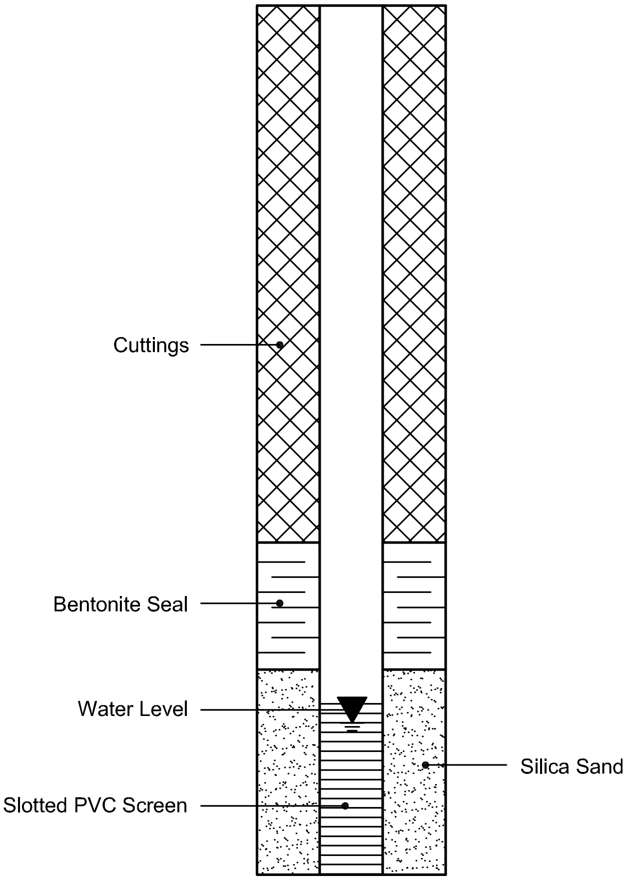


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4803-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

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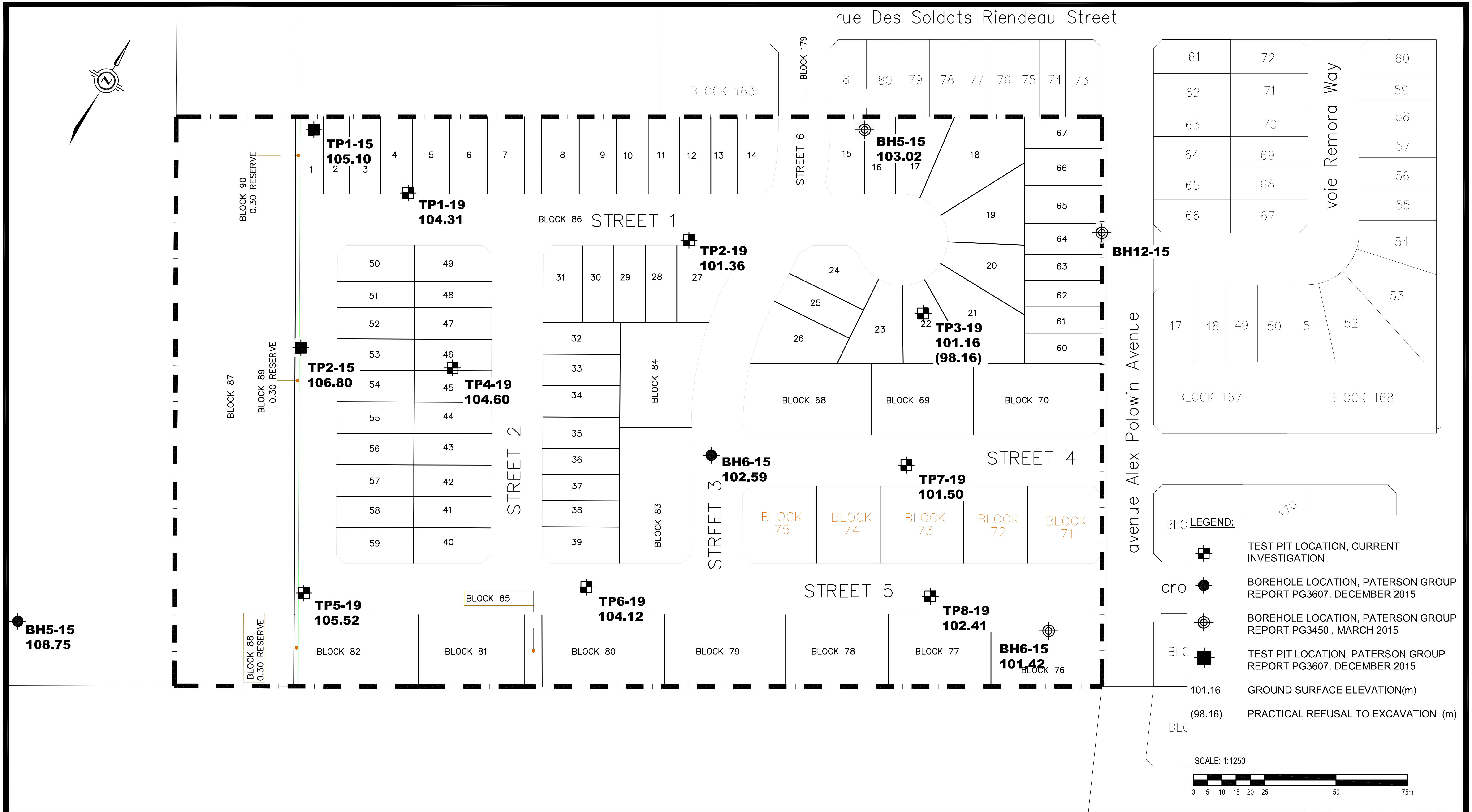

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NO.	REVISIONS	DATE	INITIAL

MATTAMY HOMES
GEOTECHNICAL INVESTIGATION
HALF MOON BAY SOUTH - GREENBANK ROAD
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:1250
Date: 01/2019
Drawn by: MPG
Report No.: PG4803-1
Checked by: NC
Approved by: DJG
PG4803-1
Revision No.:

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