

Geotechnical  
Engineering

Environmental  
Engineering

Hydrogeology

Geological  
Engineering

Materials Testing

Building Science

Archaeological Services

## Geotechnical Investigation

Proposed Commercial Development  
Terry Fox Drive at Kanata Avenue  
Ottawa, Ontario

Prepared For

Trimterra Development Corporation

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November 7, 2018

Report PG4564-1 Revision 1

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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by Trimterra Development Corporation to conduct a geotechnical investigation for the proposed commercial development to be located at 471 Terry Fox Drive, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The investigation objectives were to:

- ❑ determine the subsurface soil and groundwater conditions by means of boreholes.
- ❑ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

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

## 2.0 Proposed Development

It is understood that the proposed development consists of several slab-on-grade buildings, with associated at-grade parking areas and access lanes. A gas station is also anticipated to be constructed as part of the proposed development.

## **3.0 Method of Investigation**

### **3.1 Field Investigation**

#### **Field Program**

The geotechnical data for the current investigation was gathered from previous investigations, conducted in July 2015 and June 2008. A total of 11 boreholes were advanced to a maximum depth of 11 m. Four (4) supplemental boreholes were drilled on October 14, 2018 to a maximum depth of 17.4 m. The locations of the boreholes are provided on Drawing PG4564-1 - Test Hole Location Plan included in Appendix 2.

Four (4) supplemental boreholes were drilled to provide additional information on October 4, 2018. The boreholes were advanced to a maximum depth of 17.4 m.

The boreholes were drilled with a track-mounted drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from the geotechnical department. The drilling 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 recovered from auger flights or a 50 mm diameter split-spoon sample. The soil samples were classified on site, placed in sealed bags and transported to our laboratory. The depths at which the auger and split-spoon samples were recovered from the boreholes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets.

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 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Overburden thickness was evaluated by dynamic cone penetration tests (DCPT) at BH 2-15, BH 4-15 and at BH1-18 to BH4-18. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded every 300 mm increment.

Undrained shear strength tests were completed in cohesive soils with a shear vane apparatus.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets in Appendix 1.

### **Groundwater**

Flexible polyethylene standpipes were installed in all boreholes to permit monitoring of the groundwater subsequent to the completion of the geotechnical drilling program.

## **3.2 Field Survey**

The test hole locations were determined in the field by Paterson personnel with consideration of underground and aboveground services. The location and ground surface elevation at each borehole location completed as part of the 2015 investigation was surveyed by Annis O'Sullivan Vollebekk Ltd. and are understood to be referenced to a geodetic datum. All other borehole locations were determined in the field by Paterson personnel at the time of the respective investigations. The borehole locations and available geodetic elevations are provided on Drawing PG4564-1 - Test Hole Location Plan in Appendix 2.

## **3.3 Laboratory Testing**

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

Consolidation testing and Atterberg Limits testing was completed on select soil samples as part of the previous investigations. Results are provided in Appendix 1 and are discussed in Subsections 4.2 and 5.3.

## **3.4 Analytical Testing**

One soil sample from the previous investigation 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 results of the analytical testing are provided in Appendix 1 and discussed further in Subsection 6.7.

## **4.0 Observations**

### **4.1 Surface Conditions**

The subject site is currently vacant and grass covered. The majority of the ground surface across the subject site is at grade with the surrounding roadways. A grassed and stable slope is located along the north property boundary with the north neighbouring buildings located at the top of slope. Signs of in-filling were observed across the subject site based on historical aerial photographs. Based on the site conditions observed during previous investigations, the original ground surface sloped downward to the south.

### **4.2 Subsurface Profile**

#### **Overburden**

Generally, the subsurface profile at the borehole locations consists of silty sand fill overlying a stiff brown silty clay (weathered crust) and a firm grey silty clay deposit. A glacial till layer, consisting of a silty sand matrix with gravel, cobbles and boulders was encountered below the silty clay deposit. Practical refusal to augering was encountered at BH 1-15 at 6.2 m and practical refusal to DCPT was encountered at BH 2-15 and BH 4-15 at 11 m and 8.8 m depths, respectively. Practical refusal to DCPT was encountered at depths ranging from 10.5 to 17.4 m in BH1-18 to BH4-18. In vegetated areas, it is expected that roots extend between 200 to 300 mm below ground surface.

Based on available geological mapping, the local consists of sandstone of the Nepean Formation with an anticipated overburden thickness of 3 to 10 m.

#### **Sensitive Silty Clay**

Based on a previous geotechnical investigation on the subject site, three silty clay samples were selected for unidimensional consolidation testing. The results are presented in Appendix 1. The results indicate that the silty clay is overconsolidated with overconsolidation ratios between 1.7 to 2.2.

The results of Atterberg Limits tests conducted on samples of silty clay obtained from BH1, BH3 and BH5 are presented in Table 1 and on the Atterberg Limits Results sheet in Appendix 1. The tested silty clay samples classify as an inorganic clays of high plasticity (CH) in accordance with the Unified Soil Classification System.

<b>Table 1 - Atterberg Limits Results</b>						
<b>Sample</b>	<b>Depth (m)</b>	<b>LL (%)</b>	<b>PL (%)</b>	<b>PI (%)</b>	<b>w (%)</b>	<b>Symbol</b>
BH 1 TW 5	5.7	42	21	21	52	CH
BH 3 TW 6	12.6	39	20	18	50	CH
BH 5 TW 4	5.7	49	23	26	65	CH
LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index w: water content CH: Inorganic Clays of High Plasticity						

### 4.3 Groundwater

Groundwater levels were measured in the standpipes installed in the boreholes upon completion of the sampling program. The groundwater level readings are presented in Table 2 and on the Soil Profile and Test Data Sheets in Appendix 1.

<b>Table 2 Summary of Groundwater Level Readings</b>				
<b>Borehole Number</b>	<b>Ground Surface Elevation (m)</b>	<b>Groundwater Levels (m)</b>		<b>Recording Date</b>
		<b>Depth</b>	<b>Elevation</b>	
BH 1-15	96.02	2.69	93.33	August 10, 2015
BH 2-15	94.81	1.76	93.05	August 10, 2015
BH 3-15	95.97	3.49	92.48	August 10, 2015
BH 4-15	95.98	2.15	93.83	August 10, 2015
BH 5-15	96.05	2.63	93.42	August 10, 2015
BH 6-15	95.66	Dry	--	August 10, 2015
BH 1-18	96.07	2.56	93.51	October 10, 2018
BH 2-18	96.08	2.41	93.67	October 10, 2018
BH 3-18	94.10	0.42	93.68	October 10, 2018
BH 4-18	93.95	0.35	93.60	October 10, 2018
<b>Note:</b> Ground surface elevations at the test hole locations were provided by Annis O'Sullivan Vollebakk Ltd and are assumed to be referenced to a geodetic datum.				

It should be noted that groundwater levels can be influenced by surface water infiltrating the backfilled boreholes.



Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater table can be expected at approximately 3 to 4 m below ground surface.

It should be noted that groundwater levels are subject to seasonal fluctuations, and could therefore vary at the time of construction.

## **5.0 Discussion**

### **5.1 Geotechnical Assessment**

The subject site is satisfactory for the proposed development from a geotechnical perspective. However, due to the presence of the silty clay layer, the proposed development will be subjected to grade raise restrictions.

A significant slope presently exists along the north property line. Depending on the finished grading for the proposed development, a retaining wall or slope stabilization may be required.

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

### **5.2 Site Grading and Preparation**

#### **Stripping Depth**

Topsoil and fill, containing significant amounts of deleterious materials, should be stripped from under any buildings and other settlement sensitive structures. Care should be taken not to disturb adequate bearing soils below the subgrade level during site preparation activities.

The existing fill material, free of deleterious material and significant amounts of organics and approved by Paterson personnel at the time of construction, can be left in place below the proposed building footprint (outside of footing lateral support zones), proposed car parking areas and access lanes. However, it is recommended that the existing fill layer be proof-rolled using heavy vibratory equipment and approved by Paterson at the time of construction. Any poor performing areas noted during the proof-rolling operation should be removed and replaced with Ontario Provincial Standard Specifications (OPSS) Granular B Type II, placed in maximum 300 mm thick lifts and compacted to 98% of its standard Proctor maximum dry density (SPMDD).

#### **Fill Placement**

Fill used for grading beneath the proposed buildings, unless otherwise specified, should consist of clean imported granular fill, such as OPSS Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. The granular material should be placed in lifts at a maximum of 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings should be compacted to 98% of its SPMDD.

Non-specified existing fill along with site-excavated soil could 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 compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be placed to build up the subgrade level for areas to be paved, the material should be compacted in thin lifts to of 95% of the SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

## 5.3 Foundation Design

### Conventional Shallow Foundation

Strip footings, up to 3 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, stiff silty clay (within the weathered crust) 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 **250 kPa**.

Strip footings, up to 3 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, firm silty clay bearing surface can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **180 kPa**.

A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

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

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

## **Permissible Grade Raise Restrictions**

Consideration must be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied. A minimum value of 50% of the live load is often recommended by Paterson.

Due to the presence of the underlying silty clay layer and existing fill layers in areas across the site, a permissible grade raise restriction using geodetic elevations has been prepared for the site. The permissible grade raise areas are presented in Drawing PG4564-2 - 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.

## **5.4 Design for Earthquakes**

The site class for seismic site response is a **Class D** for the foundations considered. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code for a full discussion of the earthquake design requirements.

## **5.5 Slab on Grade Construction**

With the removal of the topsoil and deleterious fill, containing organic matter, within the footprint of the proposed buildings, the native soil surface or existing fill approved by Paterson as per Subsection 5.2 will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

It is recommended that a concrete floor slab be poured over a minimum 200 mm thick layer of sub-slab fill, consisting of a 19 mm clear crushed stone to allow drainage of any water which may have accumulated below the floor slab.

Any soft or poor performing 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, is recommended for backfilling below the floor slab. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

## 5.6 Pavement Structure

### Minimum Pavement Structure Requirements

Car only parking and heavy truck parking areas, as well as access lanes are anticipated. The proposed pavement structures are presented in Tables 3 and 4.

<b>Table 3 - Recommended Pavement Structure - Car Only Parking Areas</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
50	<b>Wear Course</b> - HL-3 or Superpave 12.5 Asphaltic Concrete
150	<b>BASE</b> - OPSS Granular A Crushed Stone
300	<b>SUBBASE</b> - OPSS Granular B Type II
	<b>SUBGRADE</b> - In situ soil, or OPSS Granular B Type I or II material placed over in situ soil

<b>Table 4 - Recommended Pavement Structure Access Lanes and Heavy Truck Parking Areas</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
40	<b>Wear Course</b> - HL-3 or Superpave 12.5 Asphaltic Concrete
50	<b>Binder Course</b> - HL-8 or Superpave 19.0 Asphaltic Concrete
150	<b>BASE</b> - OPSS Granular A Crushed Stone
450	<b>SUBBASE</b> - OPSS Granular B Type II
	<b>SUBGRADE</b> - In situ soil, or OPSS Granular B Type I or II material placed over in situ soil

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the SPMDD with suitable vibratory equipment.

### **Pavement Structure Drainage**

Satisfactory performance of the pavement structure is largely dependent on 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 could result in the subgrade soil being pumped into the voids in the stone subbase, thereby reducing load bearing capacity.

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction. These drains should be installed at each catch basin, be at least 3 m long and should extend in four orthogonal directions. The subdrains should consist of 150 mm perforated corrugated plastic pipe, wrapped in a suitable filter cloth and surrounded on all sides by at least 150 mm of 19 mm clear crushed stone. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be shaped to promote water flow to the drainage lines.

## **6.0 Design and Construction Precautions**

### **6.1 Foundation Drainage and Backfill**

A perimeter drainage system is recommended to be provided for the proposed structures to provide an outlet for any water trapped within the backfill material below any paved areas or sidewalk structures. Trapped water within subgrade soils can lead to more significant frost heave for sidewalks adjacent to slab-on-grade buildings. The system should consist of a 150 mm geotextile-wrapped, 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 greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a composite drainage blanket, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I material should otherwise 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.

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 either be excavated to acceptable slopes or should be retained by shoring systems from the beginning 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 constructed 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 excavated at 1H:1V or flatter. The flatter slope is recommended for excavation below groundwater level. The subsurface soils are considered to be a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain a safe distance from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

## **6.4 Pipe Bedding and Backfill**

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. The material should be placed in a maximum loose lift thickness of 300 mm and compacted to 95% of the SPMDD. The bedding material should extend at least to the spring line of the pipe.

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

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) 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 95% of the SPMDD.



To reduce the long term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long and should extend from trench wall to trench wall. Generally, 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 material's SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

## **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 low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

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

The trench excavations should be carried out in a manner to avoid introduction of frozen materials, snow or ice into the trenches. Furthermore, pavement construction is difficult during the winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. Also, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure.

## **6.7 Corrosion Potential and Sulphate**

The results of the analytical testing show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland cement (i.e. normal cement) would be appropriate for this site. The results of the chloride and sulphate content, pH and resistivity indicate the presence of a non-aggressive to slightly aggressive environment for exposed ferrous metals at this site.

## 7.0 Recommendations

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

- ☐ Review 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 these works have been completed in general accordance with our recommendations could be issued following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

## 8.0 Statement of Limitations

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

A geotechnical investigation of this nature 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. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

The recommendations provided in this report are intended for the use of design professionals associated with this project. Contractors bidding on or undertaking the work should examine the factual information contained in this report and the site conditions, and satisfy themselves as to the adequacy of the information provided for construction purposes, supplement the factual information if required, and develop their own interpretation of the factual information based on both their and their subcontractors construction methods, equipment capabilities and schedules.

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 Trimterra Development Corporation or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

### Paterson Group Inc.



Nathan F. S. Christie, P.Eng.



David J. Gilbert, P.Eng.

### Report Distribution

- ☐ Trimterra Development Corporation (3 copies)
- ☐ Paterson Group (1 copy)

# **APPENDIX 1**

**SOIL PROFILE AND TEST DATA SHEETS**

**SYMBOLS AND TERMS**

**CONSOLIDATION TESTING RESULTS**

**ATTERBERG LIMIT TESTING RESULTS**

**ANALYTICAL TESTING RESULTS**

**DATUM** TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

FILE NO. PG4564

REMARKS

HOLE NO. **BH 1-18**

**BORINGS BY CME 55 Power Auger**

**DATE** October 4, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			○ Water Content %  20      40      60      80				
<b>GROUND SURFACE</b>												
<b>FILL:</b> Brown silty clay with topsoil, organics, trace sand, gravel, occasional cobbles		AU	1			0	96.07					
----- 1.52		SS	2	67	12	1	95.07					
Very stiff to stiff, brown <b>SILTY CLAY</b> , trace sand		SS	3	88	7	2	94.07					
- some sand between 2.3 and 2.9m depth		SS	4	100	5	3	93.07					
- sand content decreasing with depth						4	92.07					
----- 4.88						5	91.07					
Dynamic Cone Penetration Test (DCPT) commenced at 4.88m depth.						6	90.07					
						7	89.07					
						8	88.07					
						9	87.07					
----- 10.52						10	86.07					
End of Borehole												
Practical DCPT refusal at 10.52m depth												
(GWL @ 2.56m - Oct. 10, 2018)												

**Shear Strength (kPa)**

▲ Undisturbed    △ Remoulded

**DATUM** TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

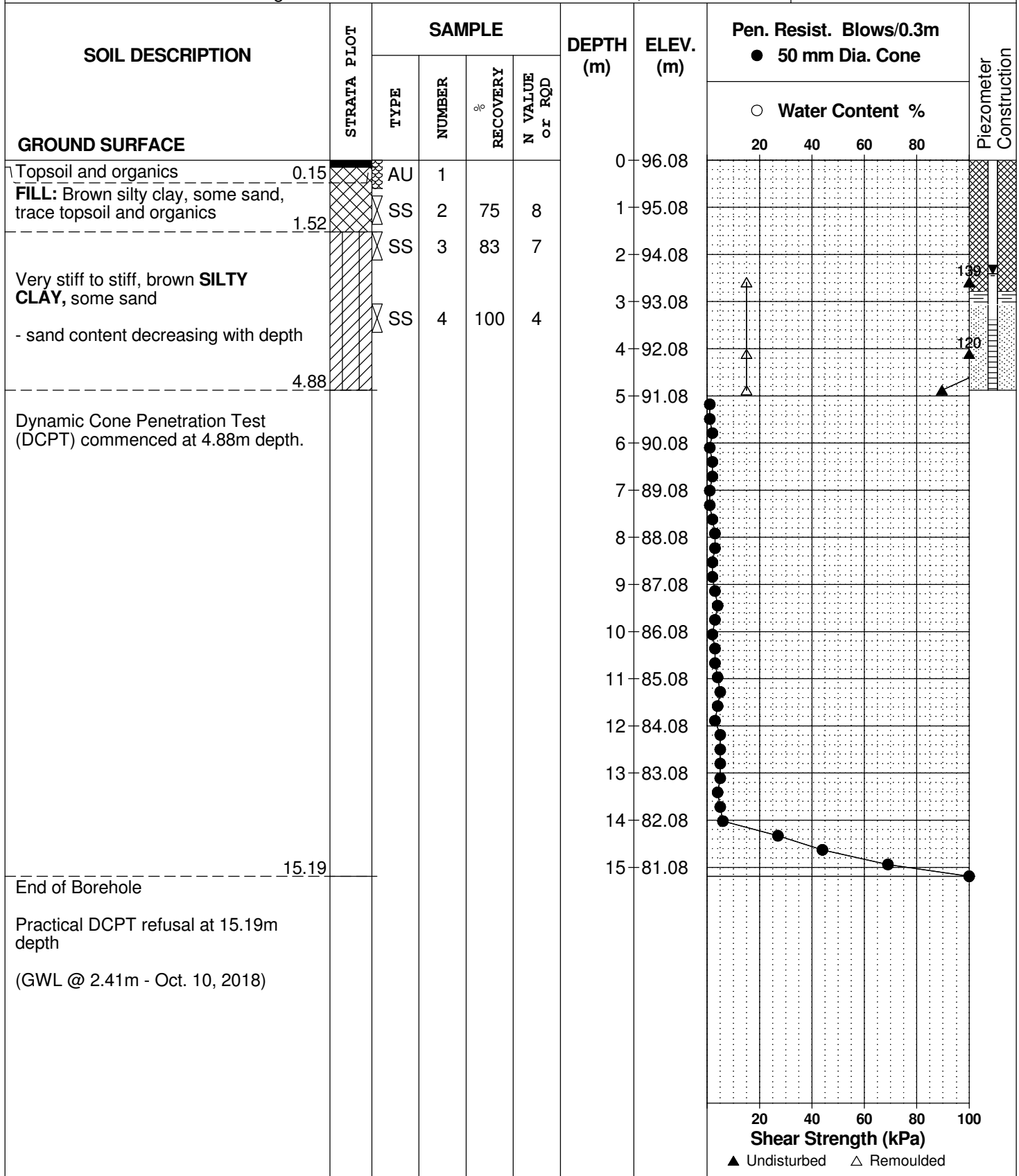
**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** October 4, 2018

**FILE NO.**  
**PG4564**

**HOLE NO.**  
**BH 2-18**



**DATUM** TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

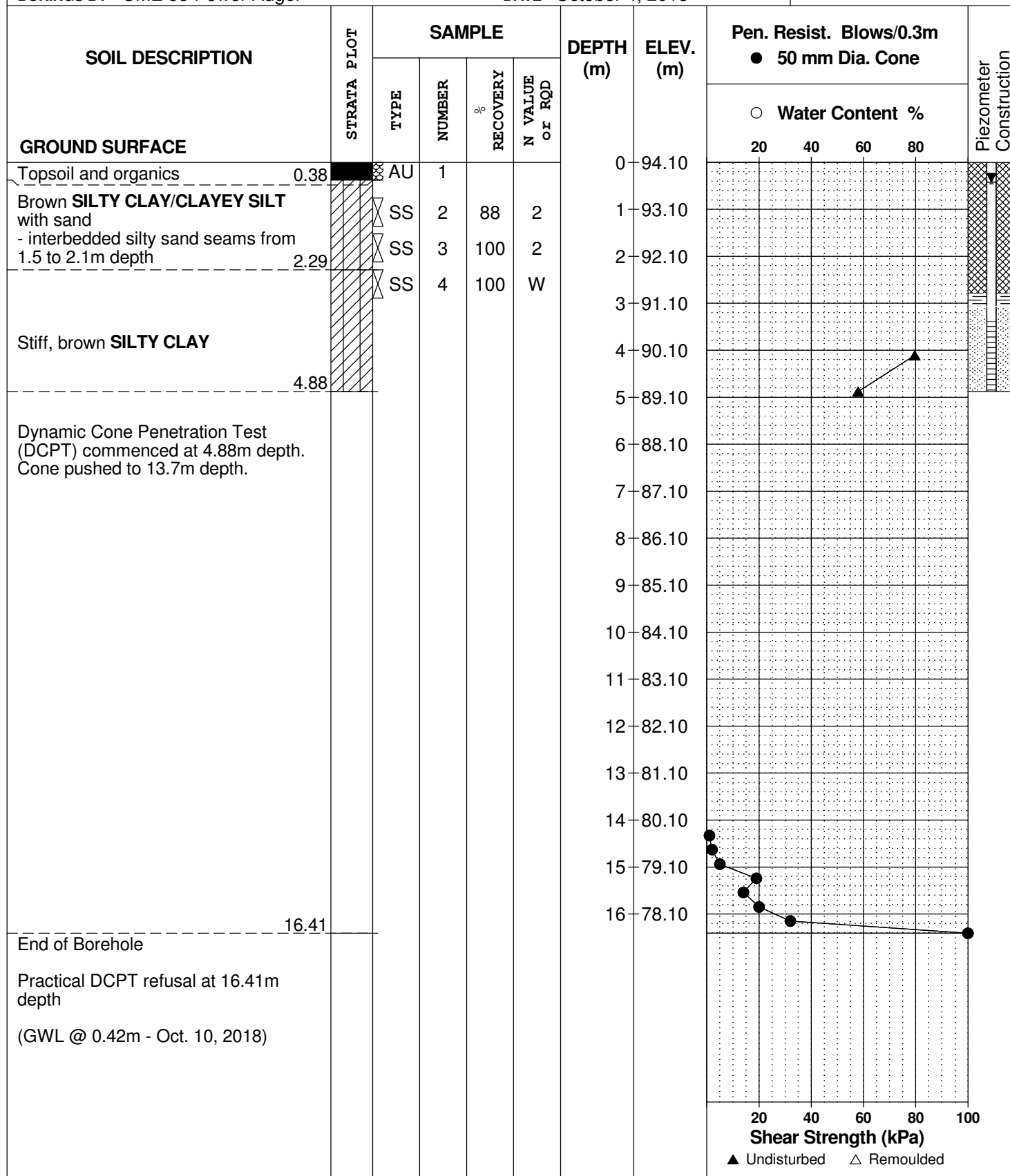
**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** October 4, 2018

**FILE NO.**  
**PG4564**

**HOLE NO.**  
**BH 3-18**





## SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation  
Proposed Heritage Hills Commercial Development  
Terry Fox Drive, Ottawa, Ontario

**DATUM** TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

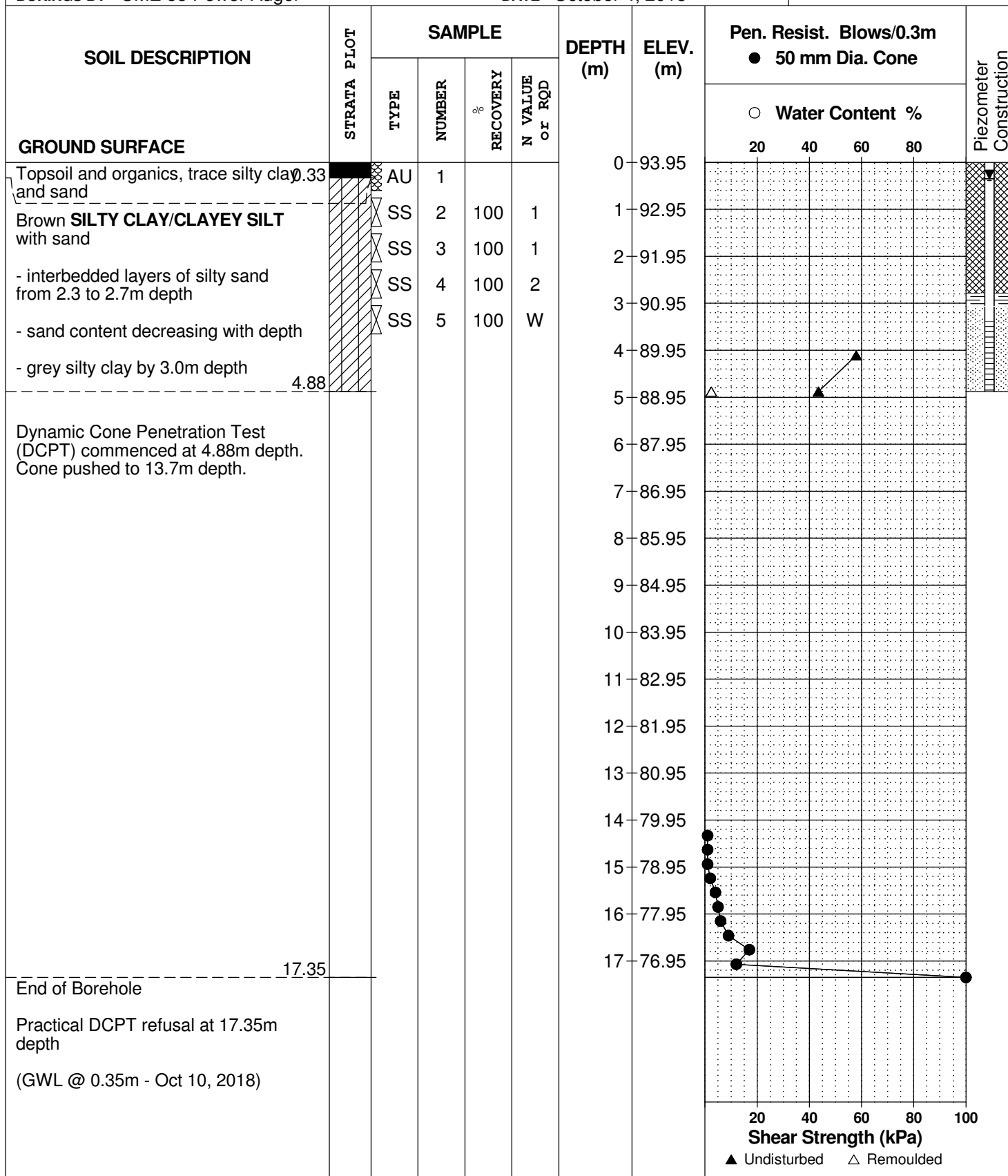
**REMARKS**

**FILE NO.**  
**PG4564**

**HOLE NO.**  
**BH 4-18**

**BORINGS BY** CME 55 Power Auger

**DATE** October 4, 2018



## SOIL PROFILE AND TEST DATA

### Geotechnical Investigation

Prop. Development - Terry Fox Drive at Kanata Ave.  
Ottawa, Ontario

**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

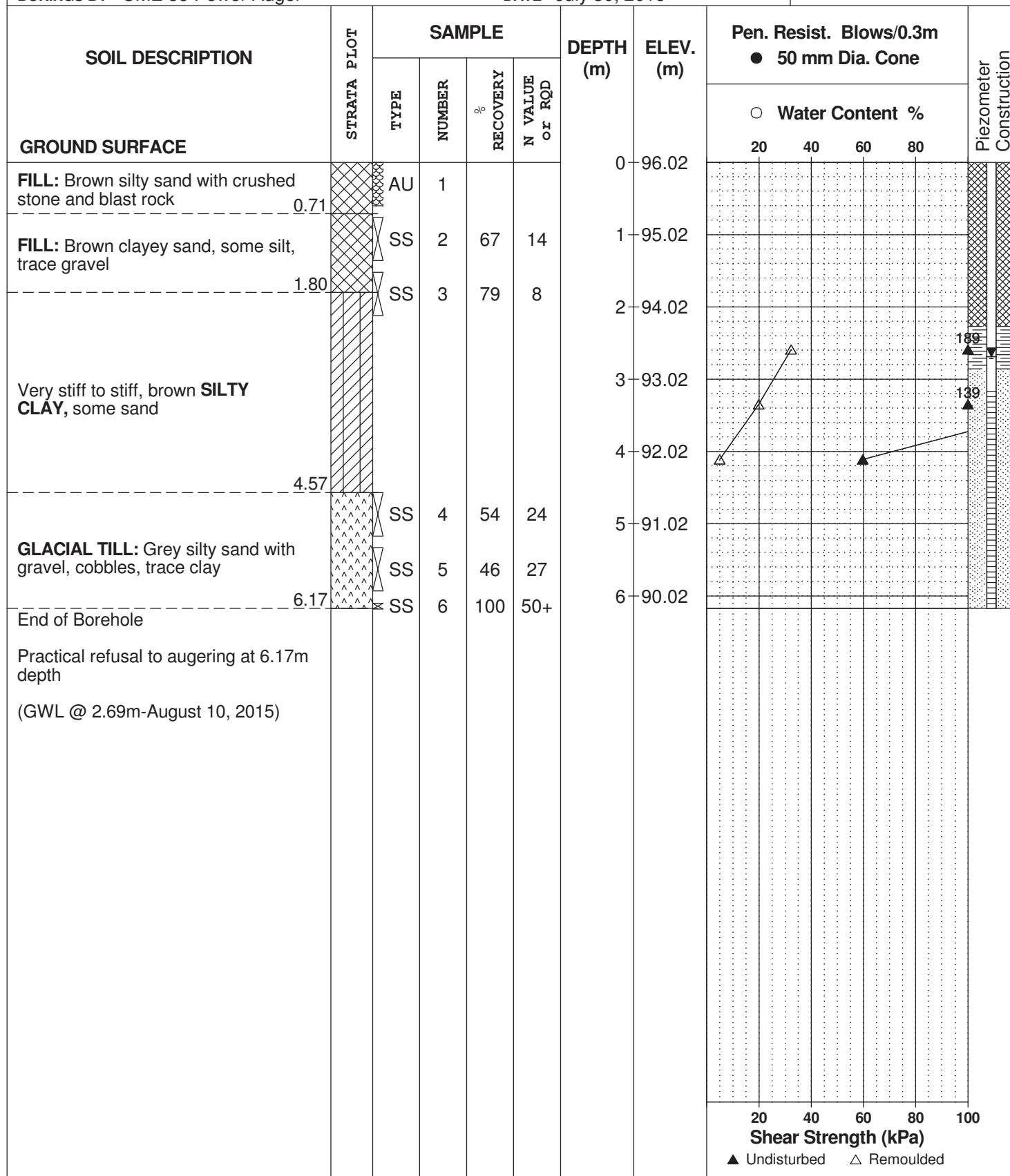
**FILE NO.**  
**PG3562**

**REMARKS**

**HOLE NO.**  
**BH 1-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 30, 2015



## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Prop. Development - Terry Fox Drive at Kanata Ave.  
Ottawa, Ontario

**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

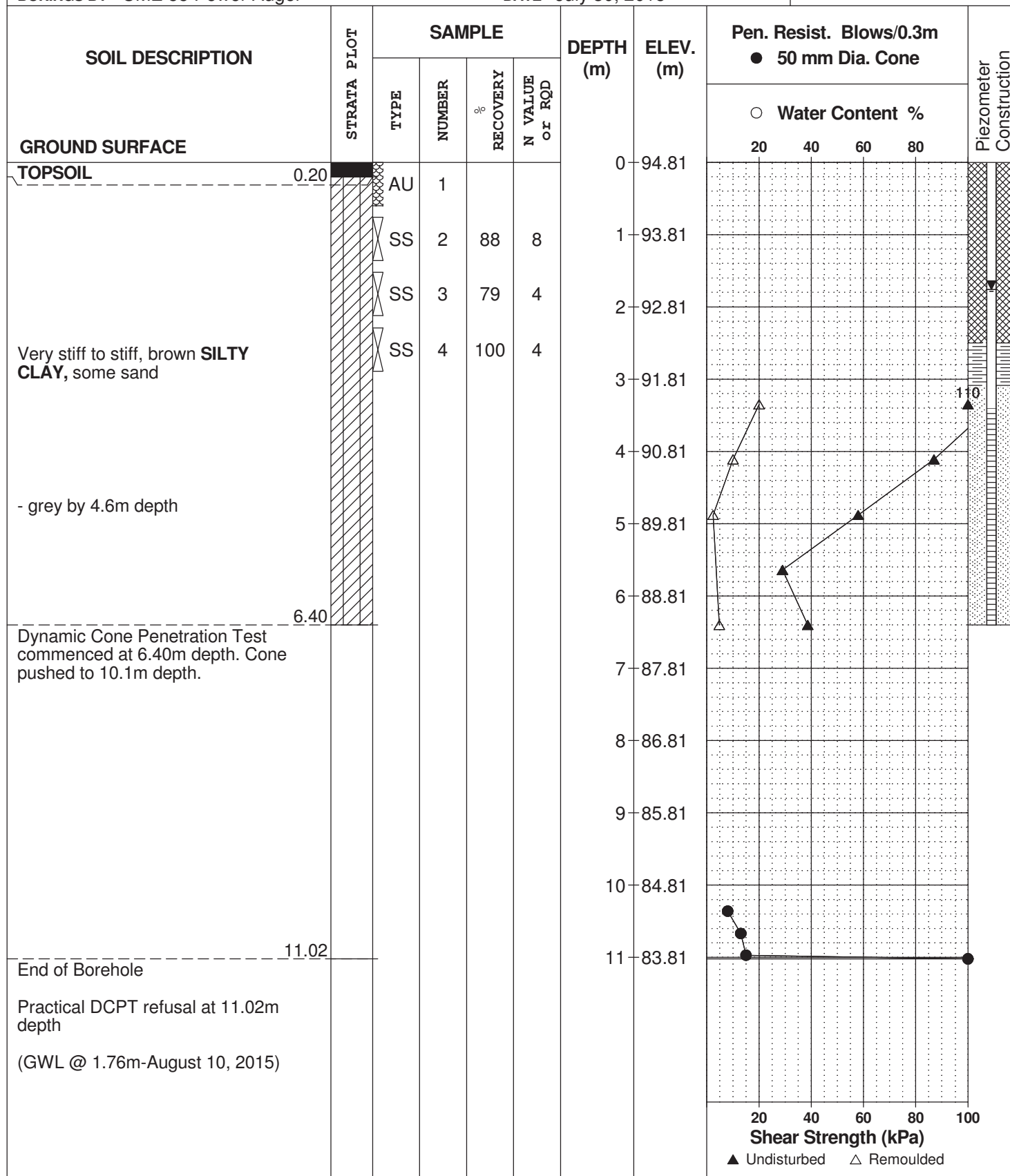
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**REMARKS**

**HOLE NO.**  
**BH 2-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 30, 2015



**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

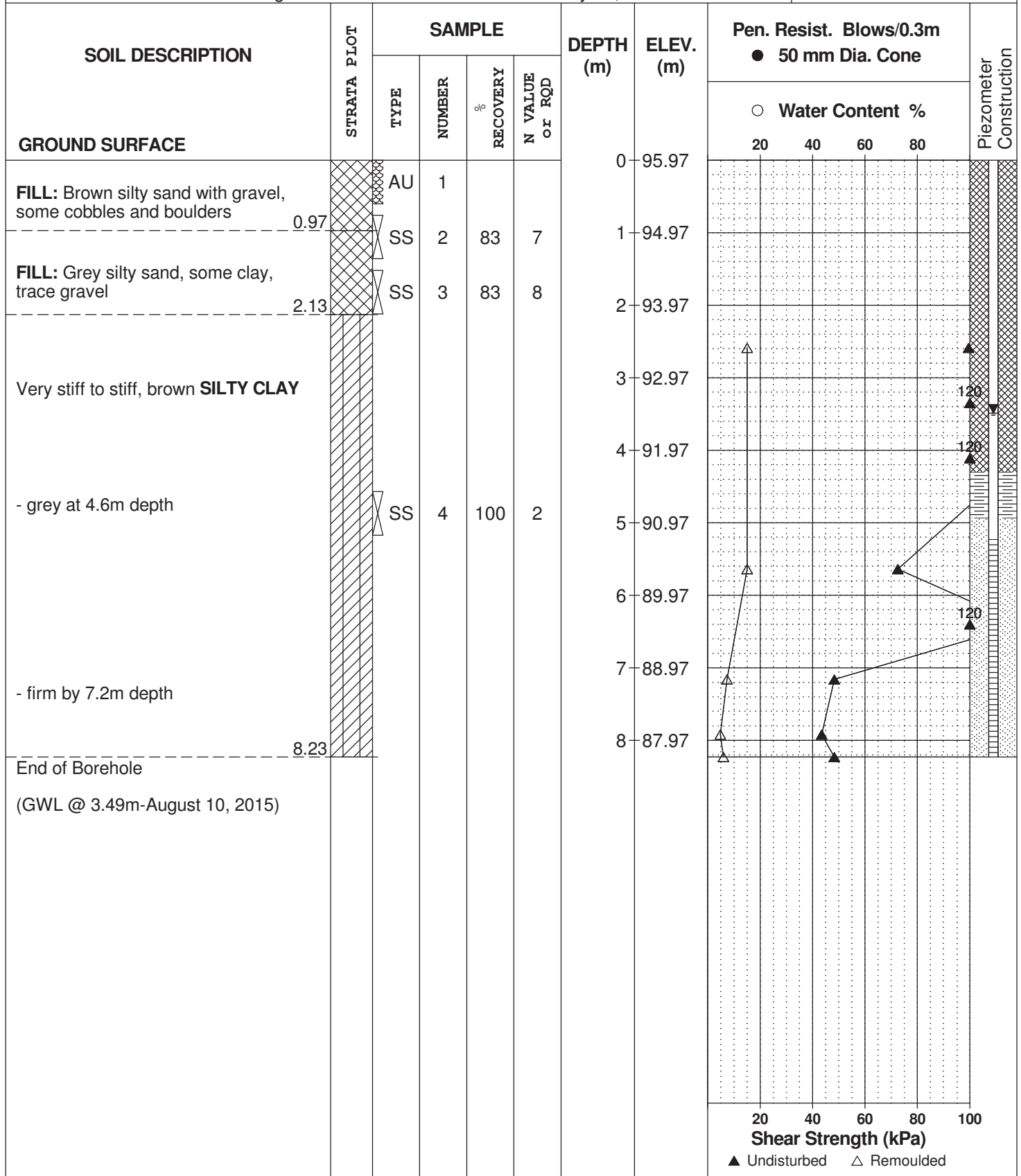
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**REMARKS**

**HOLE NO.**  
**BH 3-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 30, 2015



**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

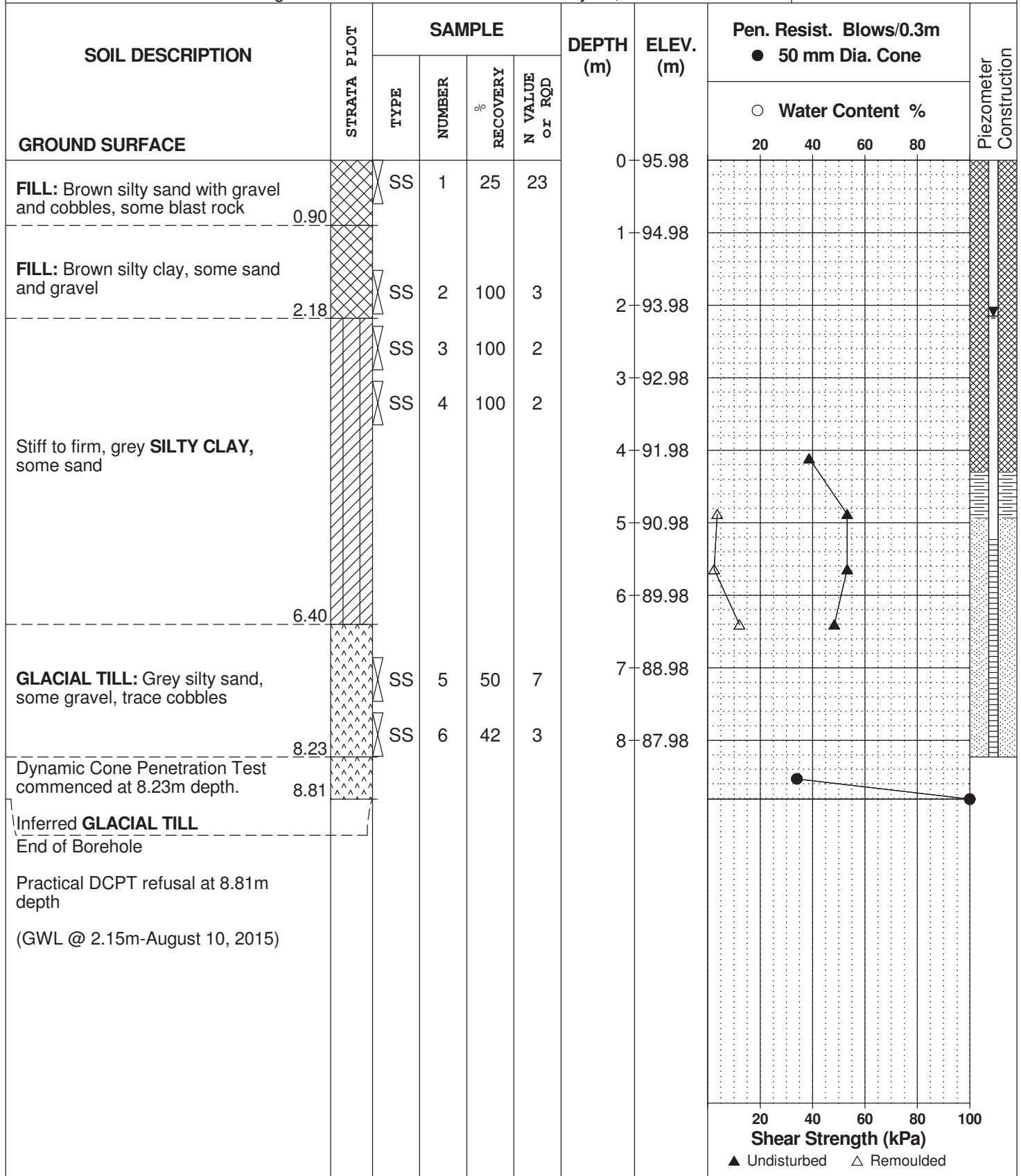
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**REMARKS**

**HOLE NO.**  
**BH 4-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 30, 2015



**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

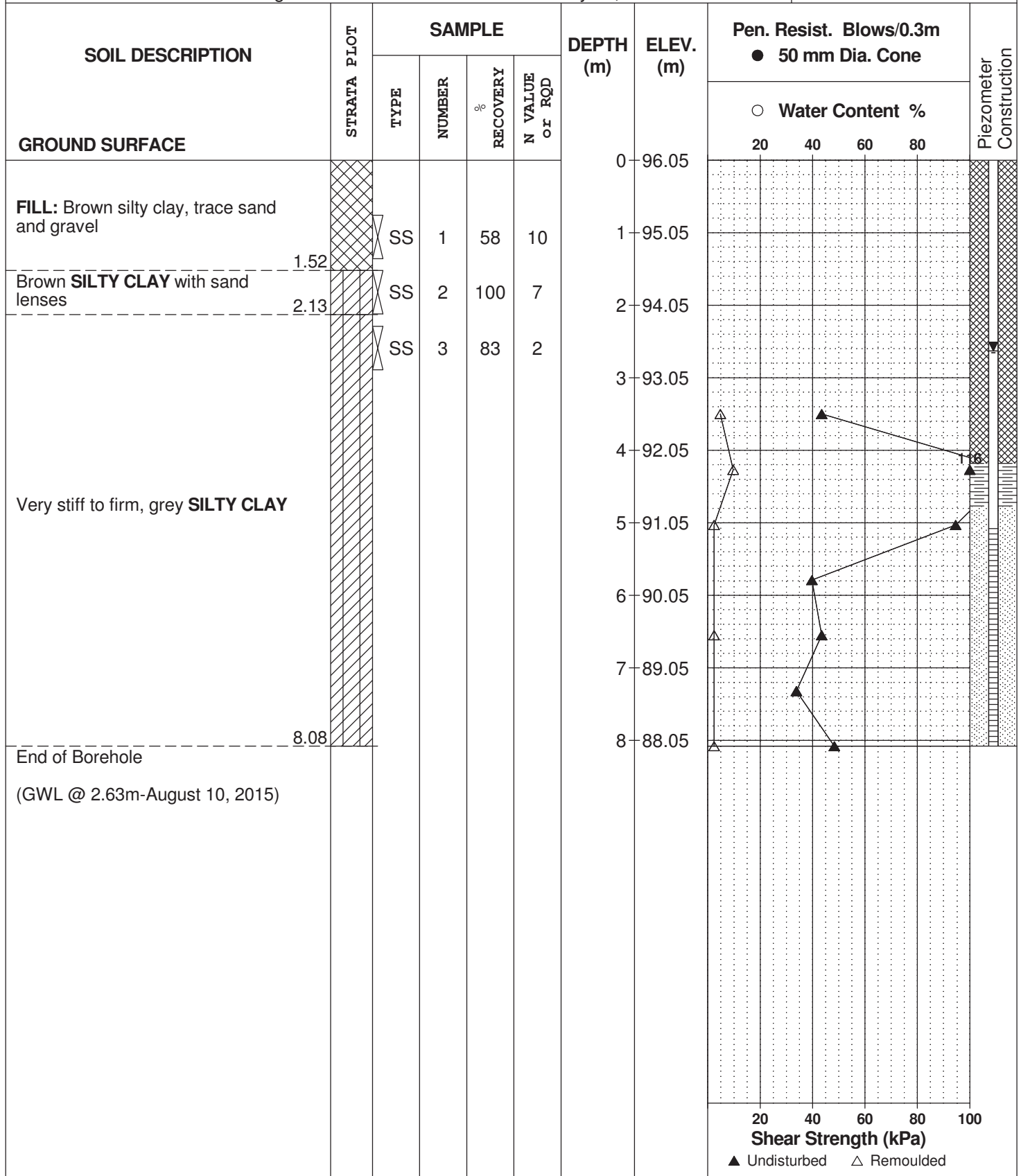
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**PG3562**

**REMARKS**

**HOLE NO.**  
**BH 5-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 31, 2015



## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Prop. Development - Terry Fox Drive at Kanata Ave.  
Ottawa, Ontario

**DATUM** Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

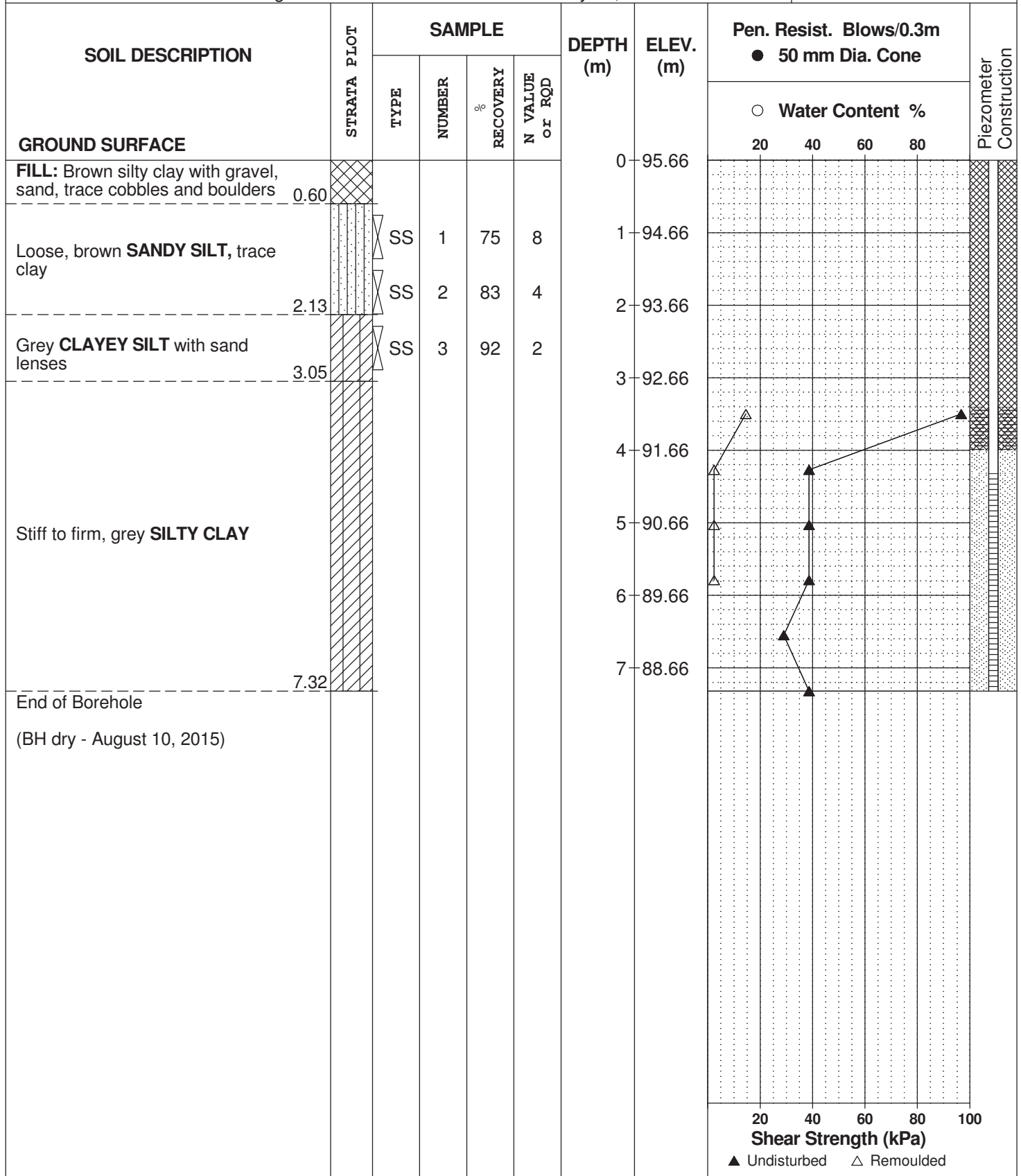
**FILE NO.**  
**PG3562**

**REMARKS**

**HOLE NO.**  
**BH 6-15**

**BORINGS BY** CME 55 Power Auger

**DATE** July 31, 2015



DATUM

REMARKS

BORINGS BY CME 55 Power Auger

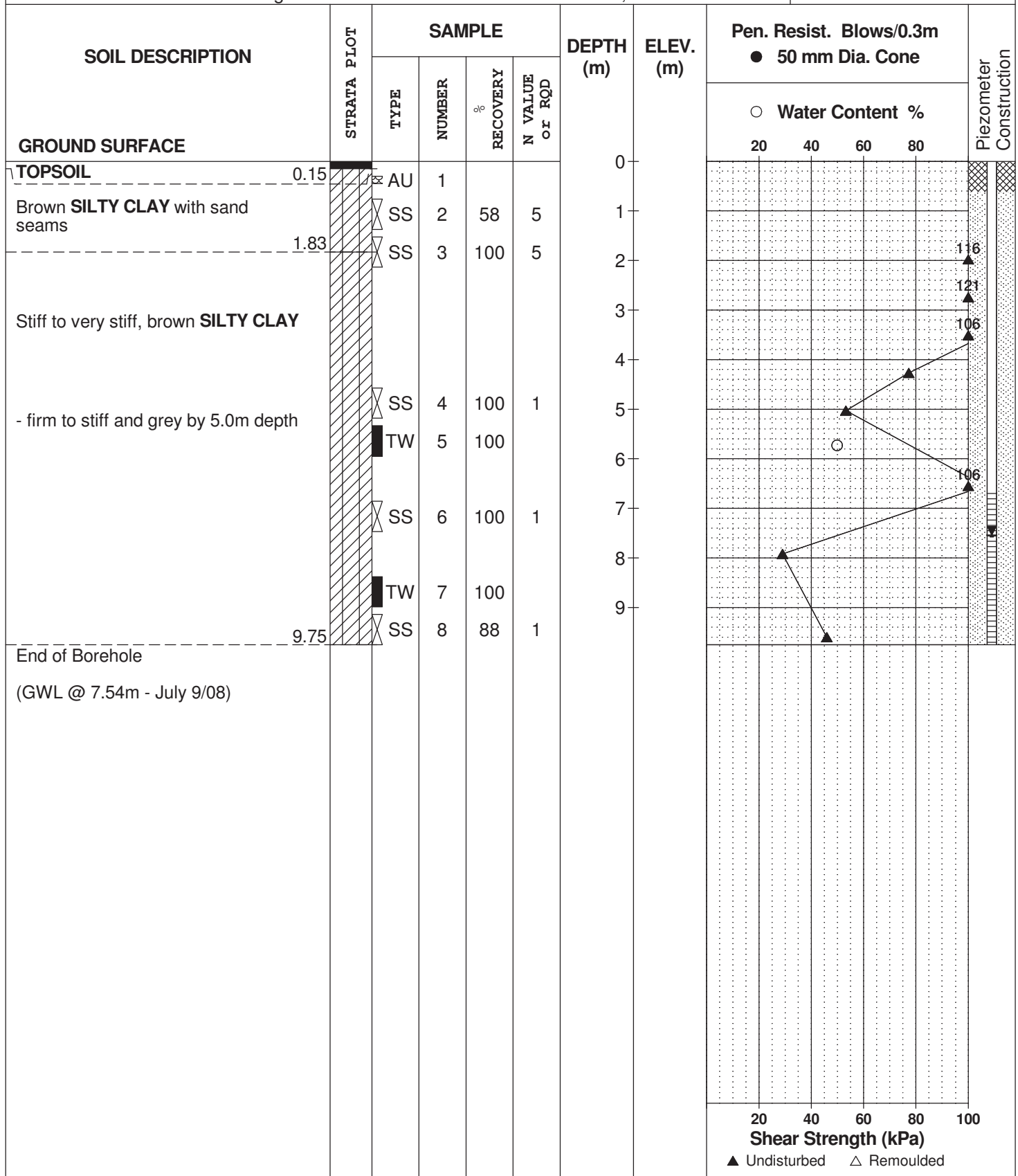
DATE June 24, 2008

FILE NO.

PG1703

HOLE NO.

BH 1





DATUM

REMARKS

BORINGS BY CME 55 Power Auger

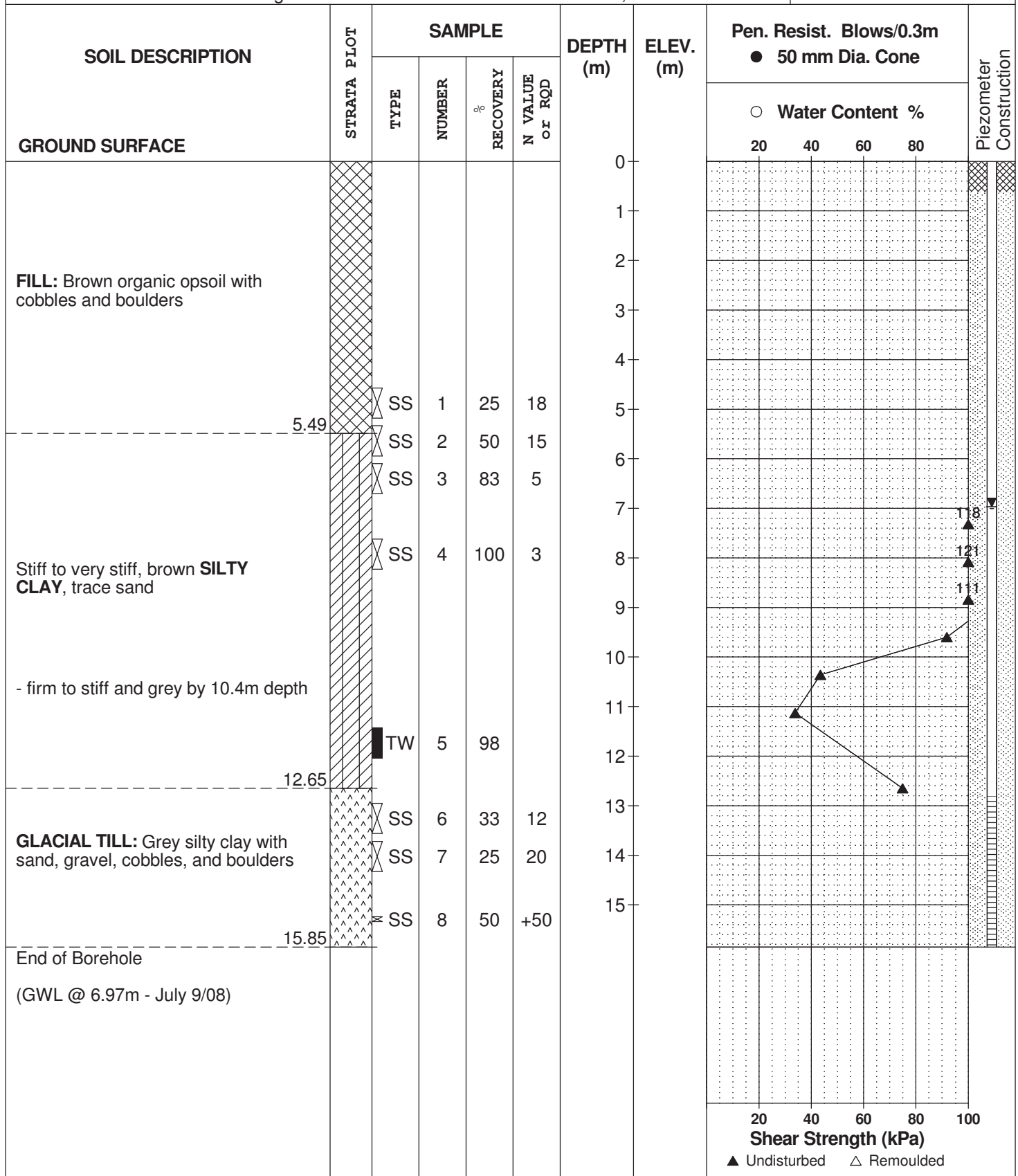
DATE June 24, 2008

FILE NO.

PG1703

HOLE NO.

BH 2



**DATUM**

FILE NO.

PG1703

REMARKS

HOLE NO.

**BH 3**

**BORINGS BY** CME 55 Power Auger

**DATE** June 25, 2008

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			○ Water Content % 20    40    60    80				
GROUND SURFACE												
<b>FILL:</b> Brown organic topsoil with sand, cobbles and boulders throughout						0						
						1						
						2						
						3						
						4						
						5						
		SS	1	50	35	6						
		SS	2	100	20	7						
		SS	3	42	12	8						
		SS	4	100	6	9						
		SS	5	100	6	10						
Stiff to very stiff, brown <b>SILTY CLAY</b>						11						
- firm and grey by 12.0m depth		TW	6	100		12						
		TW	7	96		13						
		SS	8	33	9	14						
<b>GLACIAL TILL:</b> Grey silty clay with gravel, cobbles, and boulders		SS	9	58	26	15						
End of Borehole						16						
(GWL @ 8.40m - July 9/08)						17						

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

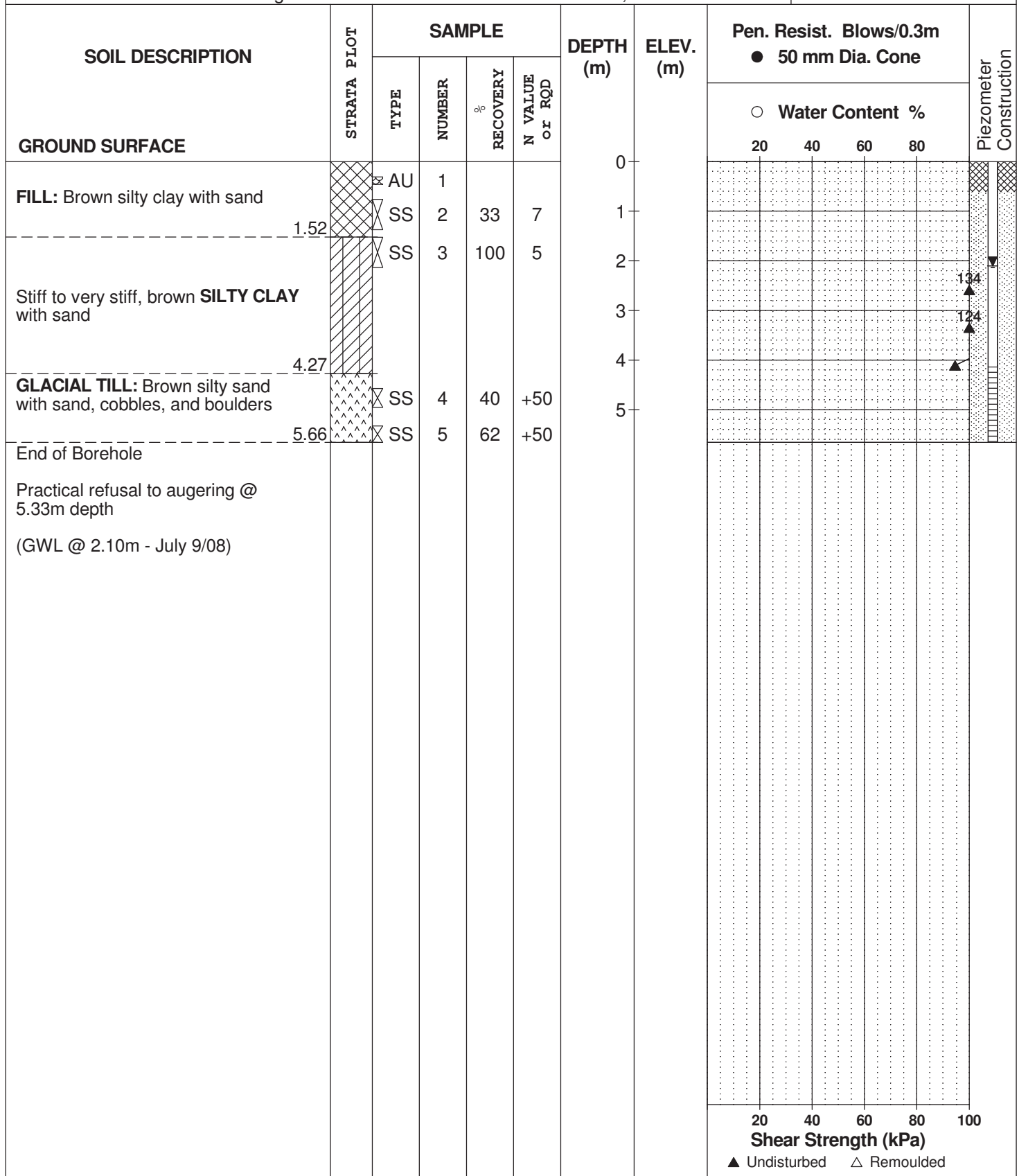
DATE June 25, 2008

FILE NO.

PG1703

HOLE NO.

BH 4



DATUM

REMARKS

BORINGS BY CME 55 Power Auger

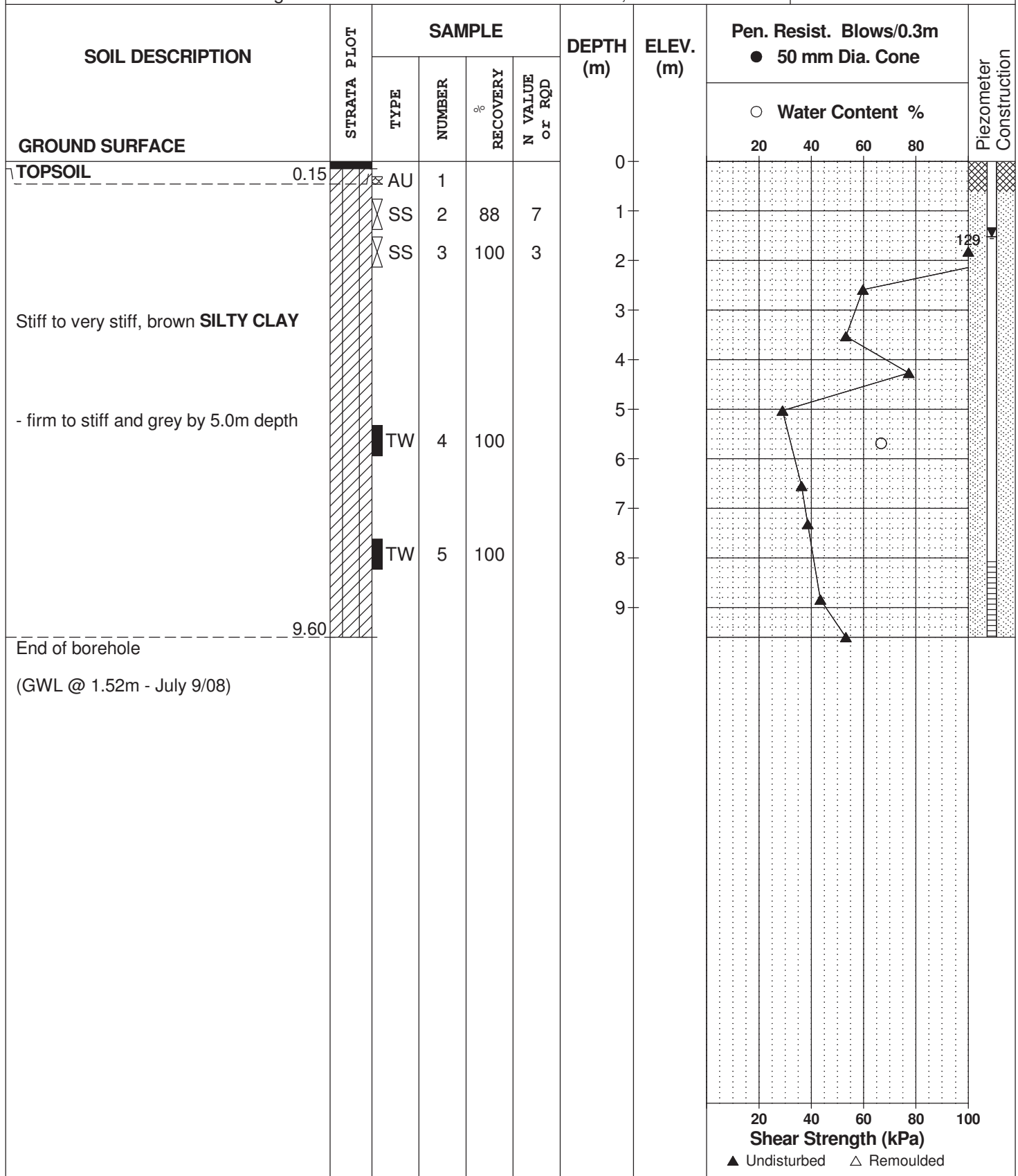
DATE June 26, 2008

FILE NO.

PG1703

HOLE NO.

BH 5



# 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.

<b>RQD %</b>	<b>ROCK QUALITY</b>
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 = $(D_{30})^2 / (D_{10} \times D_{60})$
Cu	-	Uniformity coefficient = $D_{60} / D_{10}$

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		Overconsolidation 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.
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## SYMBOLS AND TERMS (continued)

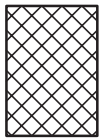
### STRATA PLOT



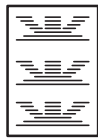
Topsoil



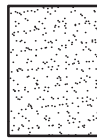
Asphalt



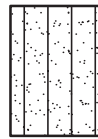
Fill



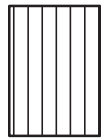
Peat



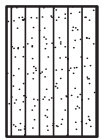
Sand



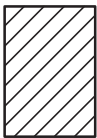
Silty Sand



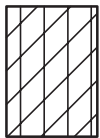
Silt



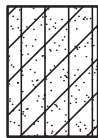
Sandy Silt



Clay



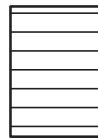
Silty Clay



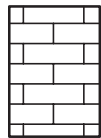
Clayey Silty Sand



Glacial Till



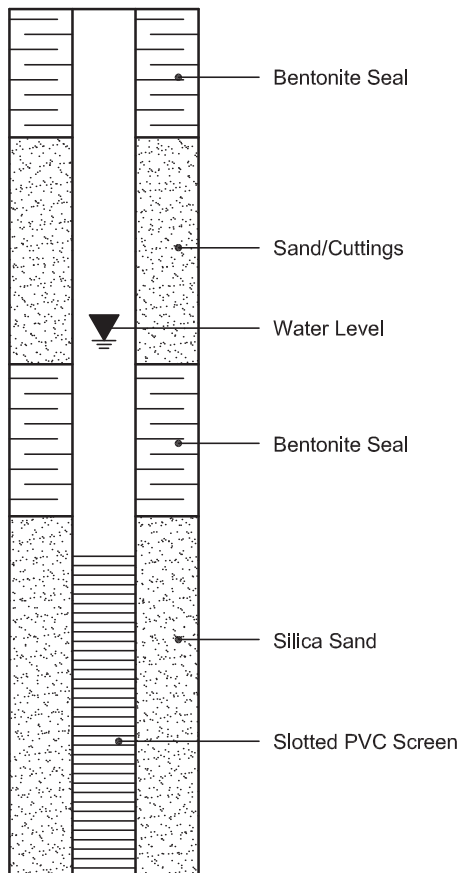
Shale



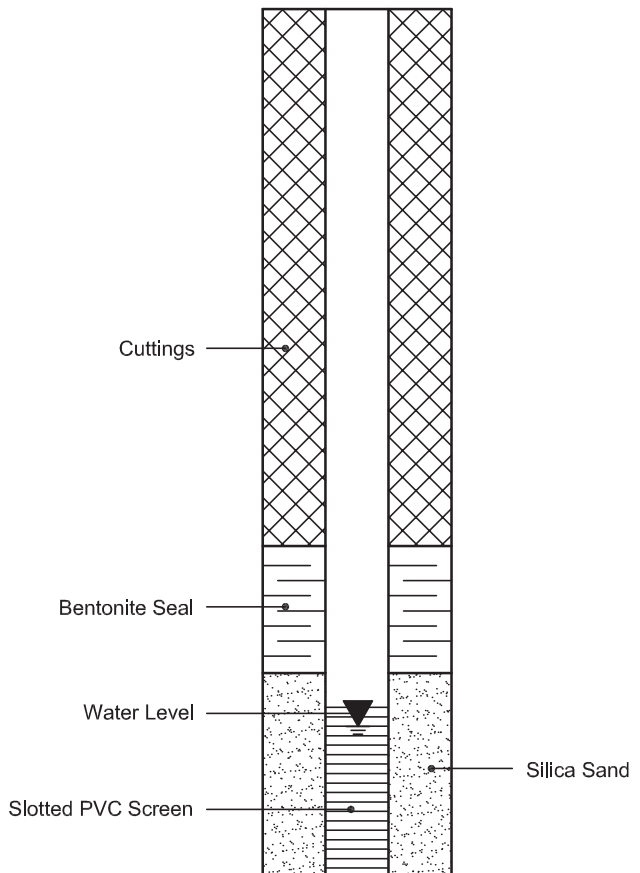
Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION

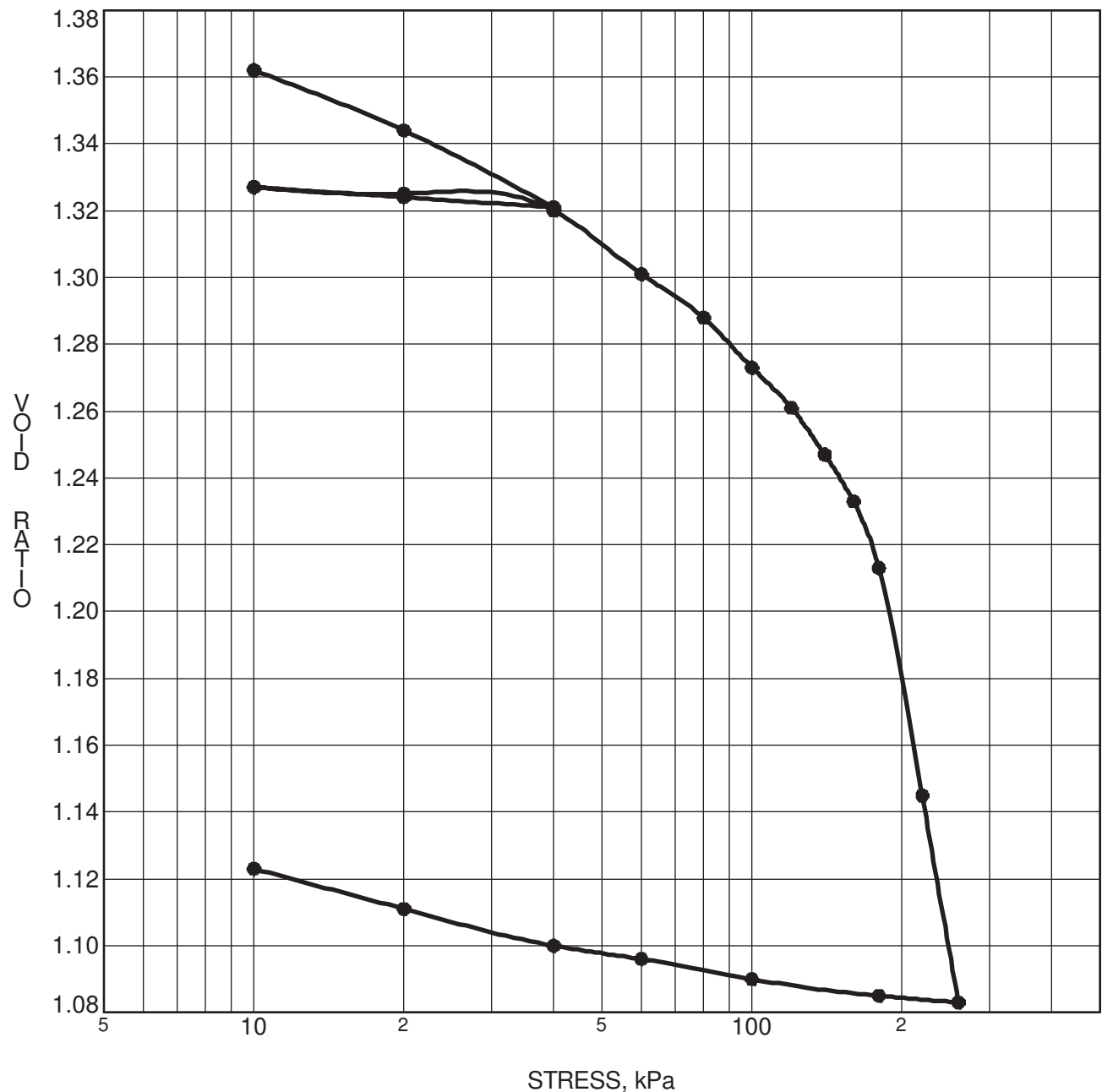
#### MONITORING WELL CONSTRUCTION



#### PIEZOMETER CONSTRUCTION







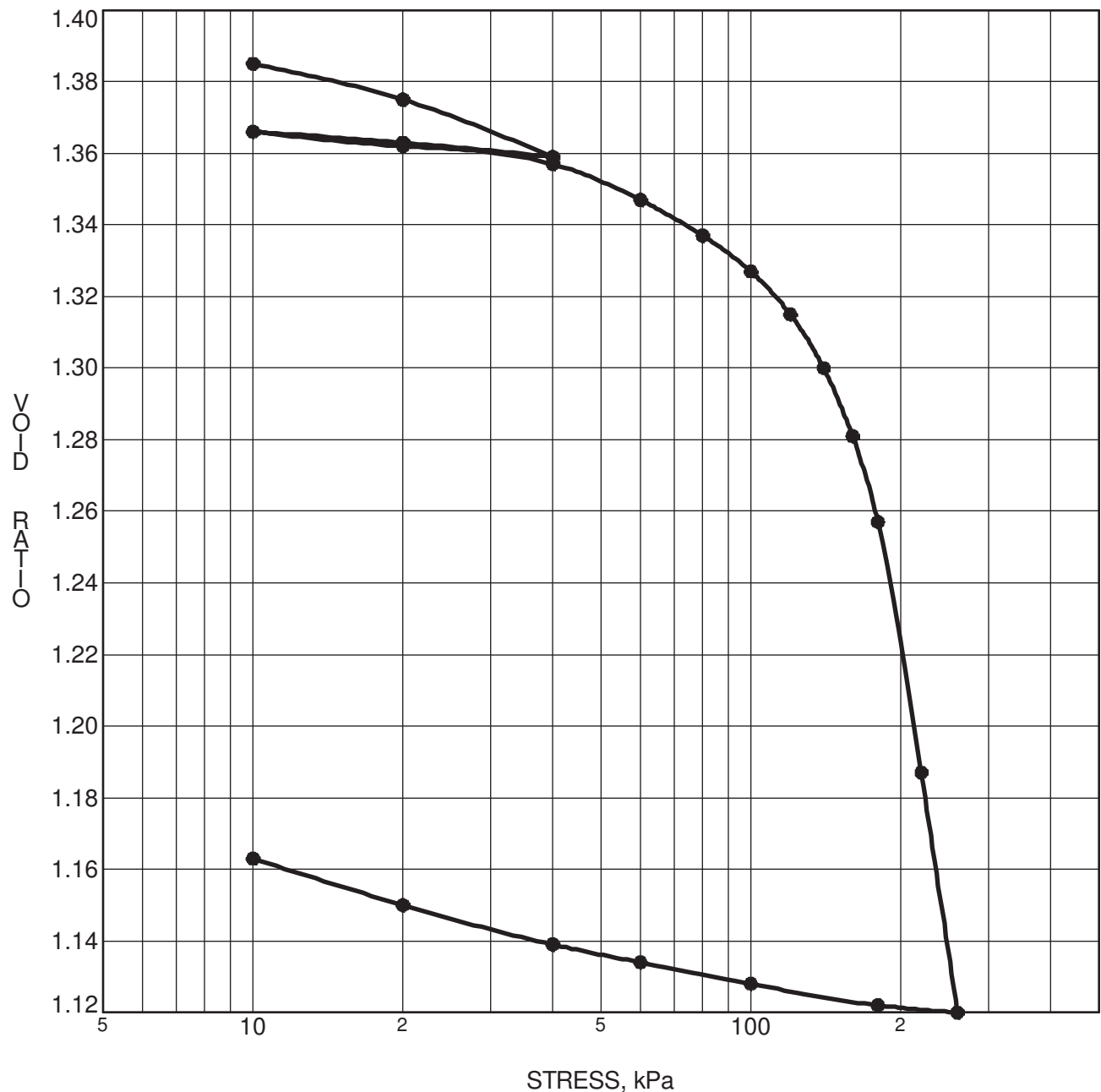
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	<b>BH 1</b>	$p'_o$	<b>78 kPa</b>	$C_{cr}$	<b>0.011</b>
Sample No.	<b>TW 5</b>	$p'_c$	<b>174 kPa</b>	$C_c$	<b>0.864</b>
Sample Depth	<b>5.73 m</b>	OC Ratio	<b>2.2</b>	$W_o$	<b>49.9 %</b>
Sample Elev.	<b>93.52 m</b>	Void Ratio	<b>1.371</b>	Unit Wt.	<b>17.3 kN/m<sup>3</sup></b>

CLIENT **Richcraft Group of Companies**  
 PROJECT **Geotechnical Investigation - Proposed**  
**Commercial Development - Broughton Lands**

FILE NO. **PG1703**  
 DATE **June 27, 2008**

**patersongroup** Consulting Engineers  
 154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**CONSOLIDATION  
TEST**



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	<b>BH 3</b>	$p'_o$	<b>74 kPa</b>	$C_{cr}$	<b>0.013</b>
Sample No.	<b>TW 6</b>	$p'_c$	<b>164 kPa</b>	$C_c$	<b>1.260</b>
Sample Depth	<b>12.60 m</b>	OC Ratio	<b>2.2</b>	$W_o$	<b>50.7 %</b>
Sample Elev.	<b>93.41 m</b>	Void Ratio	<b>1.395</b>	Unit Wt.	<b>17.2 kN/m<sup>3</sup></b>

**NOTE: Overburden stress calculated from original ground surface (~98.4m)**

CLIENT Richcraft Group of Companies

PROJECT Geotechnical Investigation - Proposed

Commercial Development - Broughton Lands

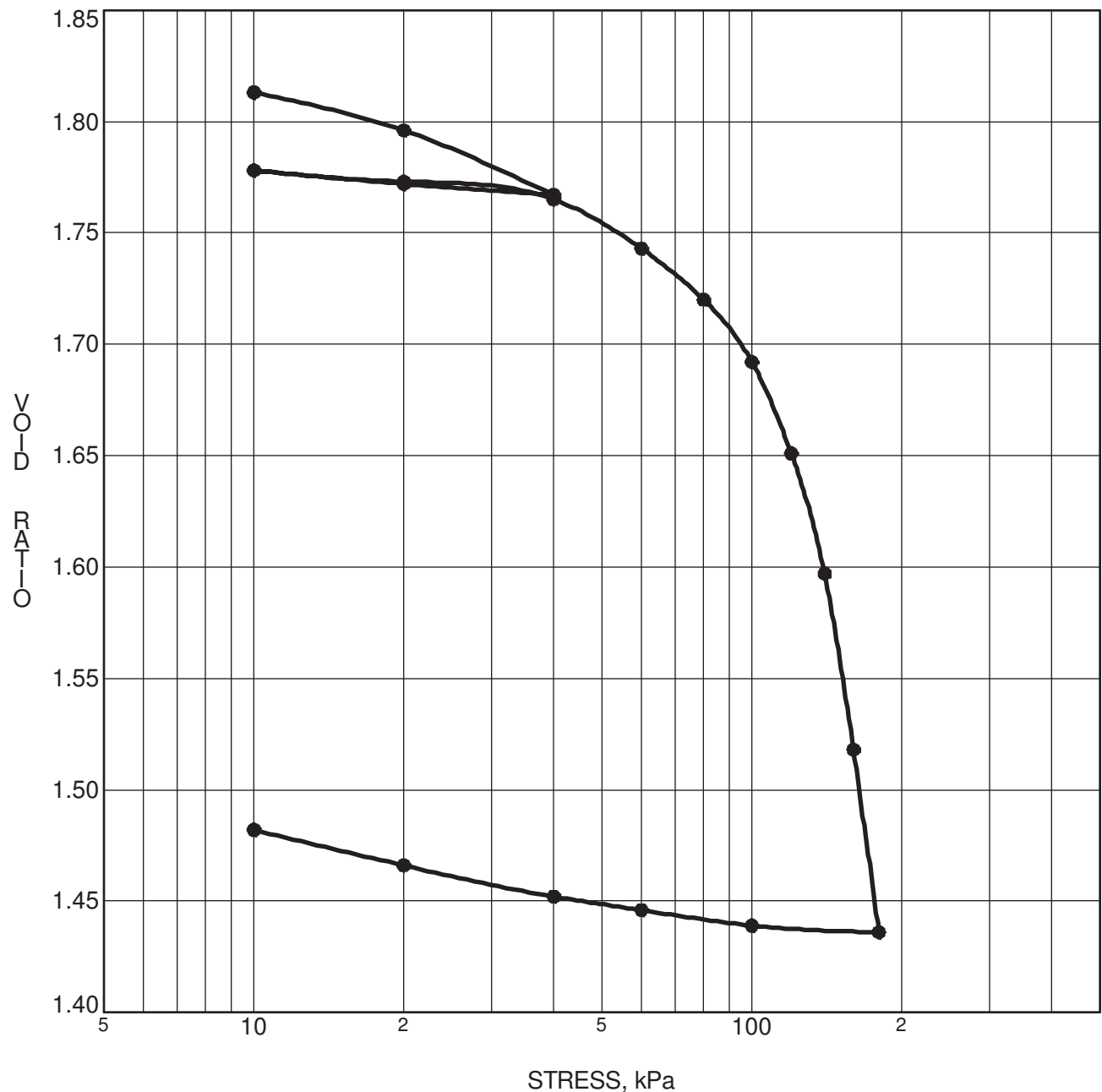
FILE NO. PG1703

DATE June 27, 2008

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**CONSOLIDATION TEST**



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	<b>BH 5</b>	$p'_o$	<b>72 kPa</b>	$C_{cr}$	<b>0.021</b>
Sample No.	<b>TW 4</b>	$p'_c$	<b>124 kPa</b>	$C_c$	<b>1.906</b>
Sample Depth	<b>5.69 m</b>	OC Ratio	<b>1.7</b>	$W_o$	<b>66.7 %</b>
Sample Elev.	<b>94.12 m</b>	Void Ratio	<b>1.834</b>	Unit Wt.	<b>16.1 kN/m<sup>3</sup></b>

CLIENT **Richcraft Group of Companies**

PROJECT **Geotechnical Investigation - Proposed**

**Commercial Development - Broughton Lands**

FILE NO. **PG1703**

DATE **June 27, 2008**

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**CONSOLIDATION  
TEST**



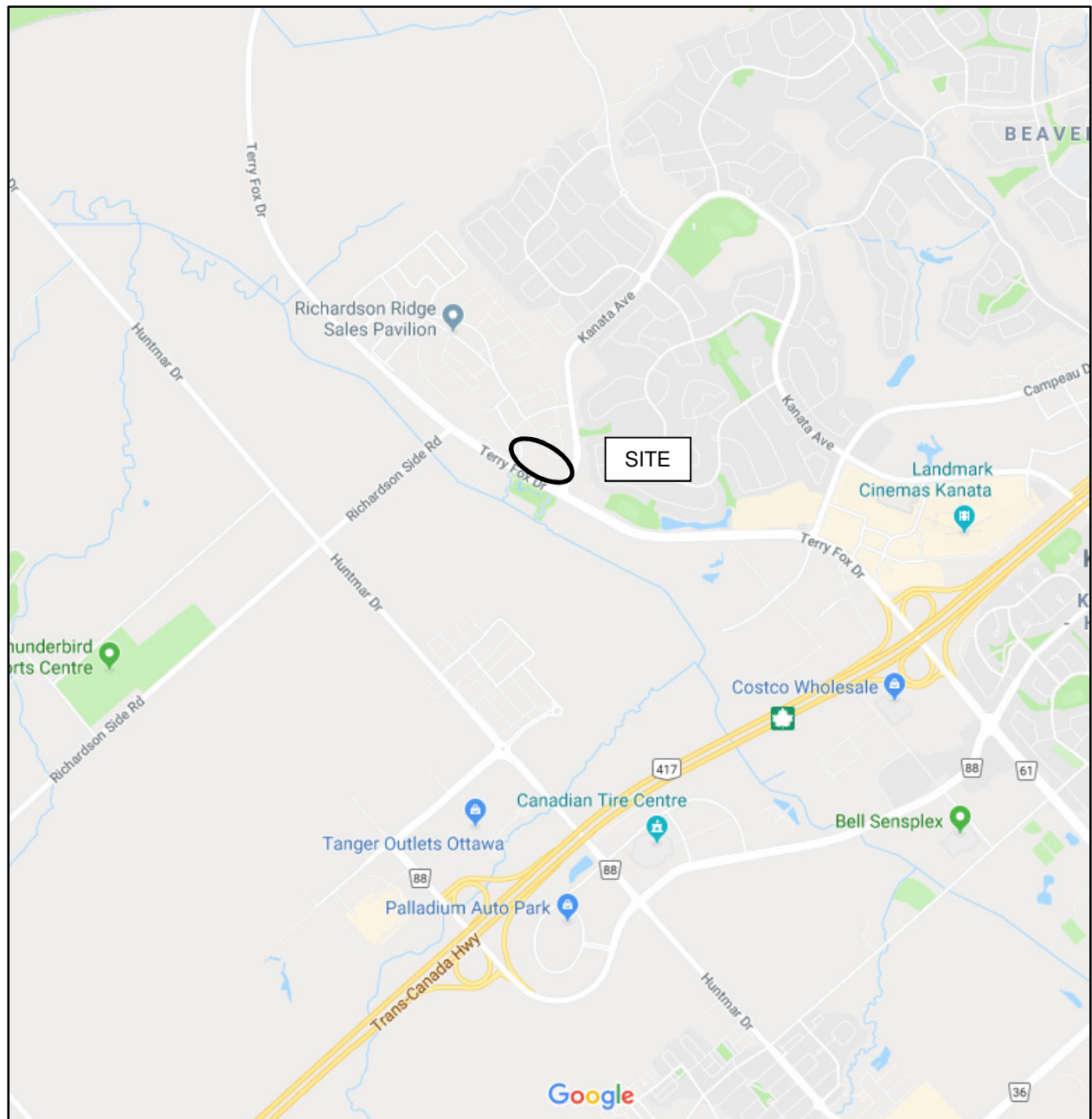
# **APPENDIX 2**

**FIGURE 1 - KEY PLAN**

**HISTORICAL AERIAL PHOTOGRAPHS**

**DRAWING PG4564-1 - TEST HOLE LOCATION PLAN**

**DRAWING PG4564-2 - PERMISSIBLE GRADE RAISE PLAN**



**FIGURE 1**

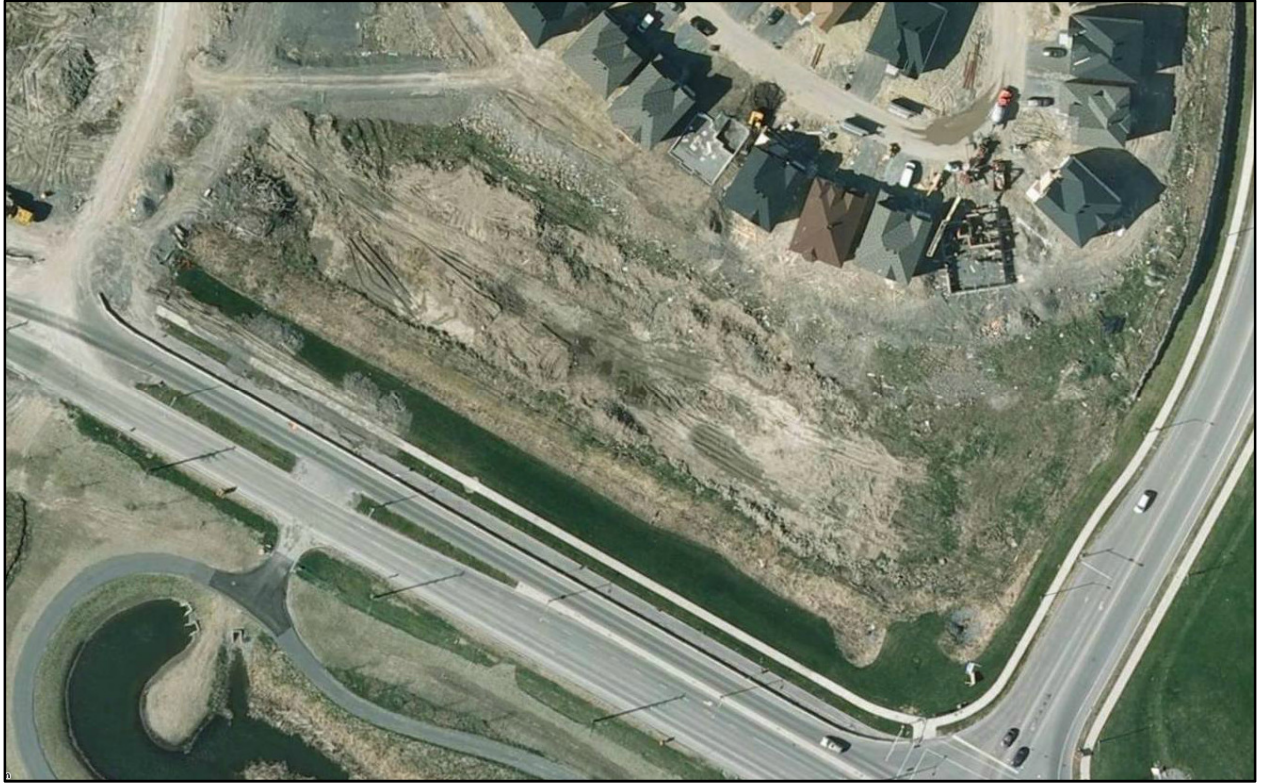
**KEY PLAN**



## FIGURE 2

2008 AERIAL PHOTOGRAPH

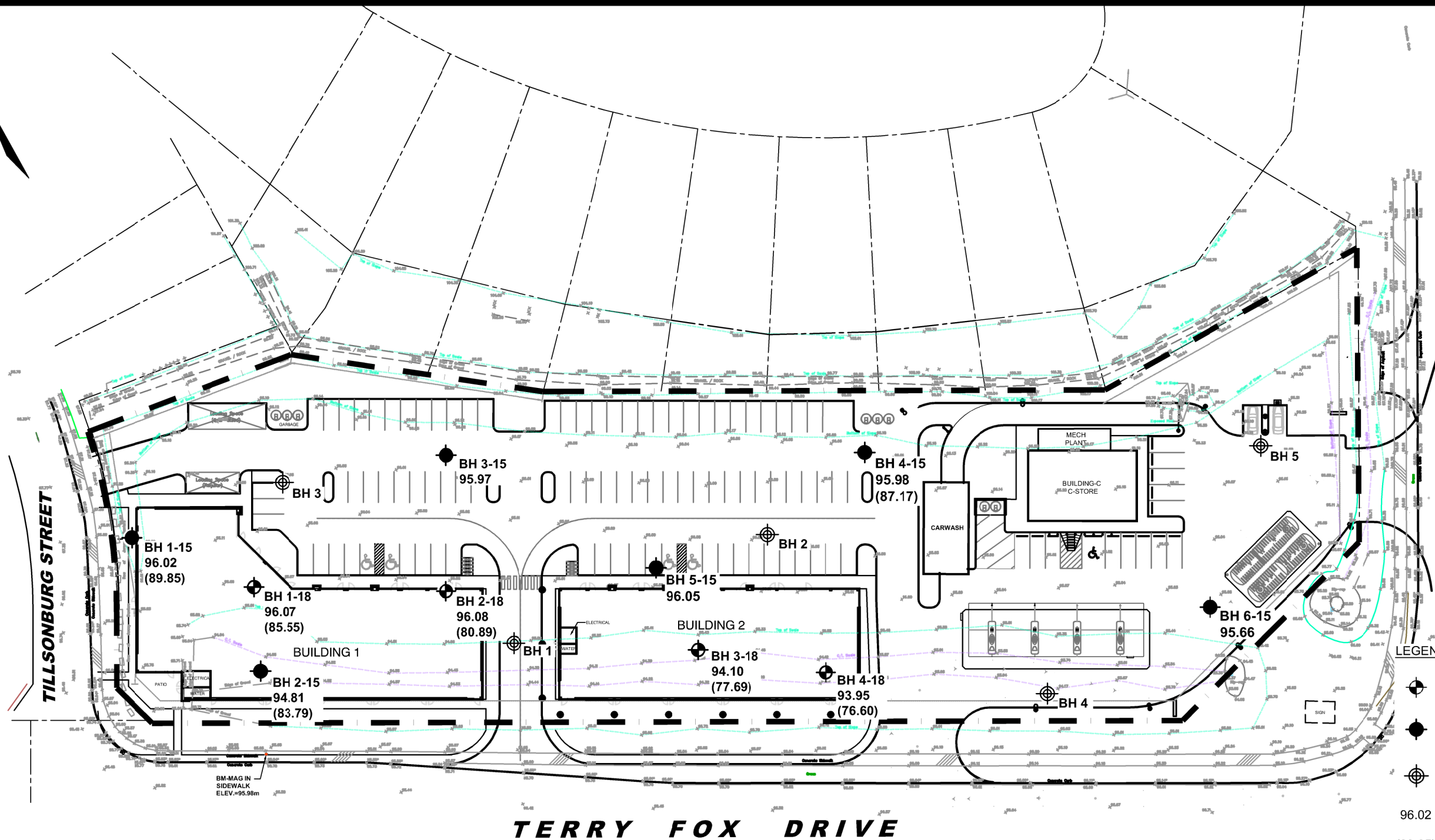




## FIGURE 3

2011 AERIAL PHOTOGRAPH





LEGEND:

- BOREHOLE LOCATION, CURRENT INVESTIGATION
- BOREHOLE LOCATION (PATERSON GROUP REPORT PG3562, 2015)
- BOREHOLE LOCATION (PATERSON GROUP REPORT PG703, 2008)
- 96.02 GROUND SURFACE ELEVATION (m)
- (89.85) PRACTICAL REFUSAL TO DCPT / AUGERING ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

SCALE: 1:750



**patersongroup**  
consulting engineers

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

1	2018 BOREHOLES ADDED TO PLAN	10/10/2018	RG
NO.	REVISIONS	DATE	INITIAL

TRIMTERRA DEVELOPMENT CORPORATION

GEOTECHNICAL INVESTIGATION

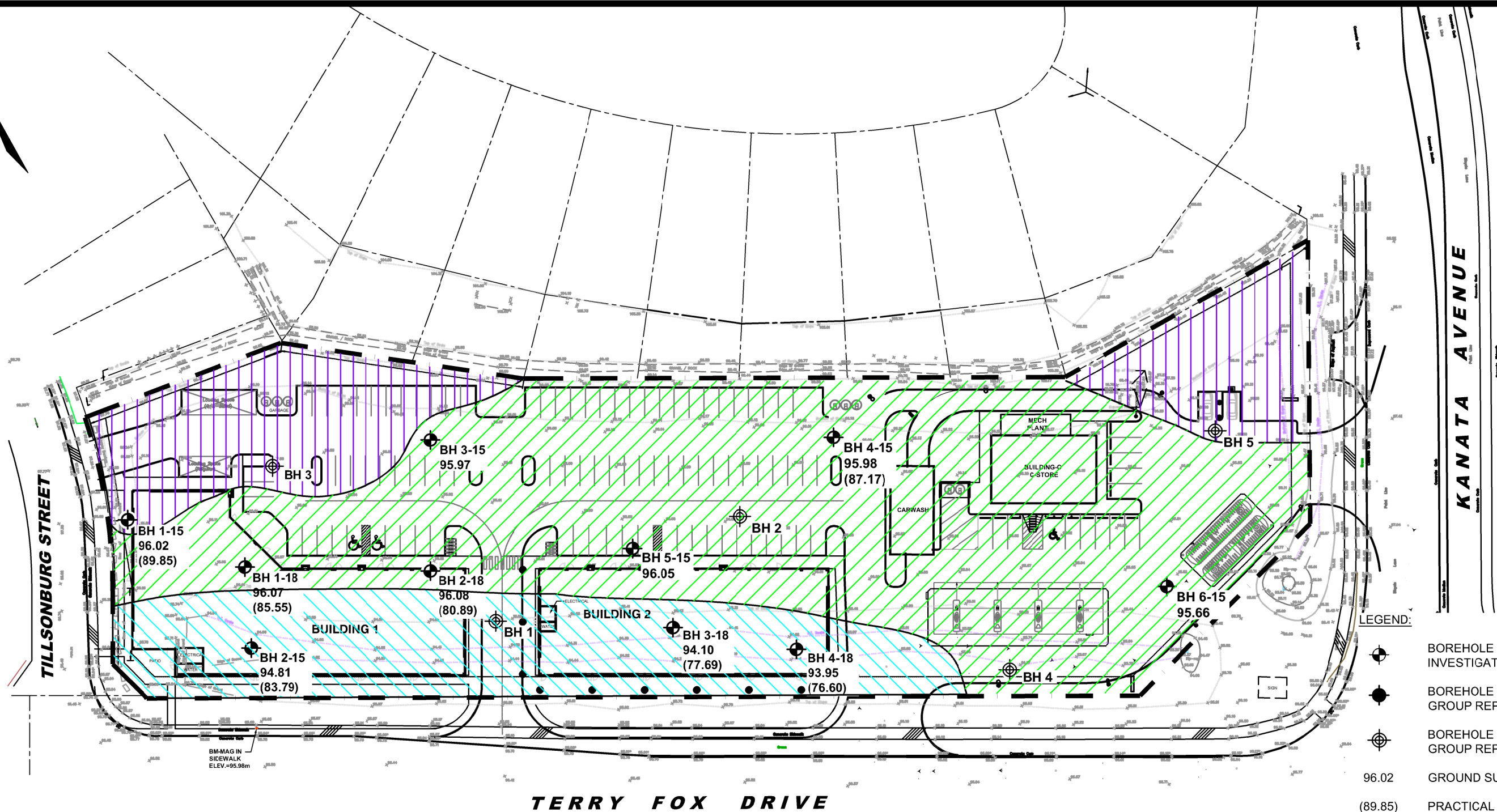
PROP. COMMERCIAL DEVELOPMENT - TERRY FOX DRIVE AT KANATA AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale:	1:750	Date:	09/2018
Drawn by:	RCG	Report No.:	PG4564-1
Checked by:	NC	Dwg. No.:	PG4564-1
Approved by:	DJG	Revision No.:	1



LEGEND:

- BOREHOLE LOCATION, CURRENT INVESTIGATION
- BOREHOLE LOCATION (PATERSON GROUP REPORT PG3562, 2015)
- BOREHOLE LOCATION (PATERSON GROUP REPORT PG703, 2008)
- 96.02 GROUND SURFACE ELEVATION (m)
- (89.85) PRACTICAL REFUSAL TO DCPT / AUGERING ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

SCALE: 1:750



PERMISSIBLE GRADE RAISE

- UP TO ELEVATION 99.0m
- UP TO ELEVATION 97.0m
- UP TO ELEVATION 96.0m

**patersongroup**  
consulting engineers

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

1	2018 BOREHOLES ADDED TO PLAN	10/10/2018	RG
NO.	REVISIONS	DATE	INITIAL

TRIMTERRA DEVELOPMENT CORPORATION

GEOTECHNICAL INVESTIGATION

PROP. COMMERCIAL DEVELOPMENT - TERRY FOX DRIVE AT KANATA AVENUE

OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale:	1:750	Date:	09/2018
Drawn by:	RCG	Report No.:	PG4564-1
Checked by:	NC	Dwg. No.:	PG4564-2
Approved by:	DJG	Revision No.:	1