

Geotechnical  
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## Geotechnical Investigation

Proposed Residential Development

760 River Road  
Ottawa, Ontario

Prepared For

Claridge Homes

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December 17, 2018

Report PG4728-1

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## **APPENDICES**

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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by Claridge Homes to conduct a geotechnical investigation for the proposed residential development to be located at 760 River Road, 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 Project

It is understood that the proposed residential development will consist of single family residential dwellings and landscaped areas. It is expected that the development will be municipally serviced with local paved roadways.

## **3.0 Method of Investigation**

### **3.1 Field Investigation**

#### **Field Program**

The field program for the current investigation was conducted on November 1, 2018. At that time, a total of five (5) boreholes were drilled and sampled to a maximum depth of 5.9 m below existing ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site taking into consideration site features. The locations of the boreholes are shown on Drawing PG4728-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were advanced using a track-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer from our geotechnical department. The drilling procedures consisted of augering to the required depths at the selected locations, and sampling and testing 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. A dynamic cone penetration test (DCPT) was completed at several boreholes.

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.

The overburden thickness was also evaluated during the investigation by completing a dynamic cone penetration test (DCPT) at borehole BH 5. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

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 and sampling of the groundwater subsequent to the completion of the geotechnical drilling program.

### **Sample Storage**

All samples from the current investigation 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 borehole locations were selected in the field by Paterson personnel in a manner to provide general coverage of the proposed development taking into consideration existing site features. The borehole locations and ground surface elevations at the borehole locations were surveyed by Annis O'Sullivan Vollebakk Ltd and are referenced to a geodetic datum. The locations and ground surface elevations of the boreholes are presented on Drawing PG4728-1 - Test Hole Location Plan in Appendix 2.

## **3.3 Laboratory Testing**

The soil samples recovered from the our field investigation were examined in our laboratory. A total of five (5) Atterberg limit tests were completed on selected silty clay samples. Grain Size distribution (hydrometer) testing was also completed on one (1) soil sample and one (1) soil sample was submitted for shrinkage testing. The results are presented in Subsection 4.2 of our current report and in Appendix 1.

## **3.4 Analytical Testing**

One (1) soil sample was submitted to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analyzed to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are discussed in Subsection 6.7 and shown in appendix 1.

## **4.0 Observations**

### **4.1 Surface Conditions**

Currently, the subject site is undeveloped and in the initial grading stages for the proposed residential development. Access roads and fill piles have been observed throughout the site. A sales centre for the future residential development and associated gravel parking lot was noted to be under construction within the southeast corner of the subject site. Prior to any of the current works noted, the site was predominantly grass and tree covered.

Based on historical aerial photographs, a residential dwelling was identified within the central portion of the subject and was demolished in 2016.

The ground surface is relatively flat within the eastern portion of the subject site and at a slightly lower elevation than River Road. Overall, the site slopes down towards the Rideau River.

### **4.2 Subsurface Profile**

#### **Overburden**

Generally, the subsurface profile at the borehole locations consists of topsoil or fill material comprised of brown silty clay with varying amounts of sand, gravel and organics. The abovenoted layers are underlain by a hard to stiff brown silty clay crust followed by a very stiff to firm grey silty clay deposit. Practical refusal to DCPT was observed at a depth of 13.6 m at BH 5. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

#### **Atterberg and Shrinkage Testing Results**

The results of Atterberg Limits tests conducted within the silty clay are presented below in Table 1 - Summary of Atterberg Limits' Results and on the Atterberg Limits' Results sheet in Appendix 1. The tested silty clay samples had measured liquid limits of 41 to 53% and plasticity indices ranging from 23 to 34%, which classifies them as inorganic clays of low to high plasticity (CL to CH) in accordance with the Unified Soil Classification System.

The results of the shrinkage testing of BH 5 - SS 2 resulted in a shrinkage limit of 17% with a shrinkage ratio of 1.91.

<b>Table 1 - Summary of Atterberg Limits' Results</b>				
<b>Sample</b>	<b>Liquid Limit %</b>	<b>Plastic Limit %</b>	<b>Plasticity Index %</b>	<b>Classification</b>
BH 1 - SS 2	42	17	24	CL
BH 2 - SS 2	41	18	23	CL
BH 3 - SS 2	41	17	23	CL
BH 4 - SS 2	43	17	26	CL
BH 5 - SS 2	53	19	34	CH

### Grain Size Distribution and Hydrometer Testing

Two (2) samples were submitted for grain size distribution and hydrometer testing. The results are summarized in Table 2 and presented on the Grain Size Distribution sheets in Appendix 1.

<b>Table 2 - Summary of Grain Size Distribution and Hydrometer Tests</b>				
<b>Sample</b>	<b>Gravel (%)</b>	<b>Sand (%)</b>	<b>Fines Content</b>	
			<b>Silt (%)</b>	<b>Clay (%)</b>
BH 1 - SS 2	0	27.8	37.7	34.5
BH 3 - SS 2	0	16.1	40.9	43.0

### Bedrock

Based on available geological mapping, bedrock in the northern half of the subject site consists of interbedded sandstone and dolomite of the March formation with an overburden drift thickness of 10 to 25 m depth. Bedrock in the southern half of the subject site consists of dolomite of the Oxford Formation with an overburden drift thickness of 10 to 15 m depth.

## 4.3 Groundwater

The groundwater levels were measured in the borehole locations on November 13, 2018, and are presented in the Soil Profile and Test Data sheets in Appendix 1. It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled borehole, which can lead to higher than typical groundwater levels. The long-term groundwater level can also be estimated based on moisture levels and colouring of the recovered soil samples. Based on these observations at the borehole locations, the long-term groundwater level is expected at a 4 to 5 m depth.



<b>Table 3 - Summary of Groundwater Level Readings</b>				
<b>Test Hole Number</b>	<b>Ground Elevation (m)</b>	<b>Groundwater Levels (m)</b>		<b>Recording Date</b>
		<b>Depth</b>	<b>Elevation</b>	
BH 1	88.09	0.48	87.61	November 13, 2018
BH 2	87.63	Damaged	n/a	November 13, 2018
BH 3	87.55	1.30	86.25	November 13, 2018
BH 4	87.65	0.90	86.75	November 13, 2018
BH 5	87.01	0.94	86.07	November 13, 2018
<p><b>Note:</b>                      -The ground surface elevations at the borehole locations were provided by Annis O'Sullivan Vollebakk Ltd.</p>				

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

## **5.0 Discussion**

### **5.1 Geotechnical Assessment**

From a geotechnical perspective, the subject site is considered suitable for the proposed development. It is expected that the proposed buildings will be founded over conventional shallow footings placed on an undisturbed, hard to very stiff silty clay or an engineered fill pad placed over a very stiff silty clay bearing surface.

Due to the presence of the silty clay deposit, the subject site will be subjected to a permissible grade raise.

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

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

#### **Stripping Depth**

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

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

#### **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. Granular material should be tested and approved prior to delivery to the site. The fill should be placed in loose lifts of 300 mm thick or less and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the Standard Proctor Maximum Dry Density (SPMDD).

Alternatively, select fill material, free of significant amounts of deleterious materials and organics, can be reviewed by the geotechnical consultant to determine suitability for placement below the proposed building footprints. It is expected that a glacial till, free of boulders, or stiff brown silty clay can be placed under dry and above freezing conditions to provide an adequate building pad and roadway subgrade. It is recommended that suitable fill materials be approved by the geotechnical consultant and reviewed during placement activities. It is recommended that all approved fill be placed in maximum 300 mm loose lifts and compacted using suitable compaction equipment making several passes to ensure adequate compaction is met.

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density 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**

### **Bearing Resistance Values**

Strip footings, up to 3 m wide, and pad footings, up to 6 m wide, placed on an undisturbed, very stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

Footings placed on engineered fill pad approved by the geotechnical consultant and placed over a very stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

Footings designed using the above-noted bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

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.

## **Lateral Support**

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

## **Permissible Grade Raise Recommendations**

A permissible grade raise restriction has been determined for the subject site based on the undrained shear strength values completed within the silty clay deposit. Based on the testing results, a permissible grade raise restriction of **3 m** above existing ground surface is recommended for the subject site.

## **5.4 Design for Earthquakes**

The site class for seismic site response can be taken as **Class D** for the foundations considered at this site. A higher seismic site class, such as Class C, may be applicable for the subject site. However, the higher seismic site class would have to be confirmed by a site-specific seismic shear wave velocity test. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code (OBC) 2012 for a full discussion of the earthquake design requirements.

## **5.5 Basement Wall**

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction 30 degrees and a bulk (drained) unit weight of 20 kN/m<sup>3</sup>.

Two distinct conditions, static and seismic, should be reviewed for design calculations. The parameters for design calculations for the two conditions are presented below.

## Lateral Earth Pressures

The static horizontal earth pressure ( $P_A$ ) can be calculated using a triangular earth pressure distribution equal to  $K_o \cdot \gamma \cdot H$  where:

$K_o$  = at-rest earth pressure coefficient of the applicable retained soil, 0.5

$\gamma$  = unit weight of fill of the applicable retained soil ( $\text{kN/m}^3$ )

H = height of the wall (m)

An additional pressure having a magnitude equal to  $K_o \cdot q$  and acting on the entire height of the wall should be added to the above diagram for any surcharge loading,  $q$  (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure should only be applicable for static analyses and should not be calculated in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

## Seismic Earth Pressures

The seismic earth pressure ( $\Delta P_{AE}$ ) can be calculated using the earth pressure distribution equal to  $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$  where:

$a_c = (1.45 - a_{\max}/g)a_{\max}$

$\gamma$  = unit weight of fill of the applicable retained soil ( $\text{kN/m}^3$ )

H = height of the wall (m)

g = gravity,  $9.81 \text{ m/s}^2$

The peak ground acceleration, ( $a_{\max}$ ), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The total earth pressure ( $P_{AE}$ ) is considered to act at a height,  $h$  (m), from the base of the wall, where:

$$h = \{P_a \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\} / P_{AE}$$

The earth pressures calculated are unfactored. For the ULS case, the earth pressure loads should be factored as live loads, as per OBC 2012.

## 5.6 Basement Slab

With the removal of all topsoil and deleterious fill, such as those containing organic materials, within the footprint of the proposed buildings, the native soil surface or approved fill pad 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 are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-floor fill consists of 19 mm clear crushed stone for a basement slab. 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 the SPMDD.

## 5.7 Pavement Structure

Car only parking areas and access lanes are anticipated at this site. The proposed pavement structures are presented in Tables 4 and 5.

<b>Table 4 - Recommended Pavement Structure - Residential Driveways</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 5 - Recommended Pavement Structure - Local Roadways</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
40	<b>Wear Course</b> - Superpave 12.5 Asphaltic Concrete
50	<b>Binder Course</b> - 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. For residential driveways and car only parking areas, an Ontario Traffic Category A will be used. For local roadways, an Ontario Traffic Category B should be used for design purposes.

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 98% of the SPMDD using suitable compaction equipment.

### **Pavement Structure Drainage**

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

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

## **6.0 Design and Construction Precautions**

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

#### **Perimeter Drainage**

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

#### **Foundation Backfill**

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

### **6.2 Protection of Footings Against Frost Action**

Perimeter footings of heated structures are recommended to be protected against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a combination of soil cover and foundation insulation should be provided.

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 a combination of soil cover and foundation insulation.

### **6.3 Excavation Side Slopes**

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 subsurface soil 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 maintain safe working 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**

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

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

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

To reduce 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**

### **Groundwater Control for Building Construction**

Due to existing groundwater level and inferred depths of the proposed footings, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

### **Permit to Take Water**

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

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

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

## **6.6 Winter Construction**

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

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

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

## **6.7 Corrosion Potential and Sulphate**

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a non aggressive corrosive environment.

## **6.8 Landscaping Considerations**

### **Tree Planting Restrictions**

Paterson completed a soils review of the site to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) for trees planted within a public right-of-way (ROW). Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Sieve analysis testing was also completed on selected soil samples. The above-noted test results were completed on selected samples taken at depths between the anticipated underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 1 and 2 in Subsection 4.2 and in Appendix 1.

Based on the testing results, a low to medium sensitivity clay soil was encountered between the anticipated design underside of footing elevations and 3.5 m below finished grade as per City Guidelines. Based on our Atterberg limits test results, the modified plasticity index does not exceed 40% across the subject site. The following tree planting setbacks are recommended for the low to medium sensitivity area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to **4.5 m** for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the conditions noted below are met.

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan.
- ❑ A small tree must be provided with a minimum of 25 m<sup>3</sup> of available soils volume while a medium tree must be provided with a minimum of 30 m<sup>3</sup> of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.
- ❑ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.
- ❑ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).
- ❑ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

### **Swimming Pools**

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 5 m away from the residence foundation and neighbouring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer's requirements.

### **Installation of Decks or Additions**

If consideration is given to construction of a deck or addition, a geotechnical consultant should be retained by the homeowner to review the site conditions. Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

## 7.0 Recommendations

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

- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and granular fill materials used.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to backfilling.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

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

## 8.0 Statement of Limitations

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

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test hole locations, we request immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Claridge Homes or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

### Paterson Group Inc.



Nicholas Zulinski, P.Geo., géo.



David J. Gilbert, P.Eng.

### Report Distribution:

- Claridge Homes (3 copies)
- Paterson Group (1 copy)

# **APPENDIX 1**

**SOIL PROFILE AND TEST DATA SHEETS**

**SYMBOLS AND TERMS**

**ATTERBERG LIMIT TESTING RESULTS**

**GRAIN SIZE DISTRIBUTION RESULTS**

**ANALYTICAL TESTING RESULTS**

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebakk Ltd.

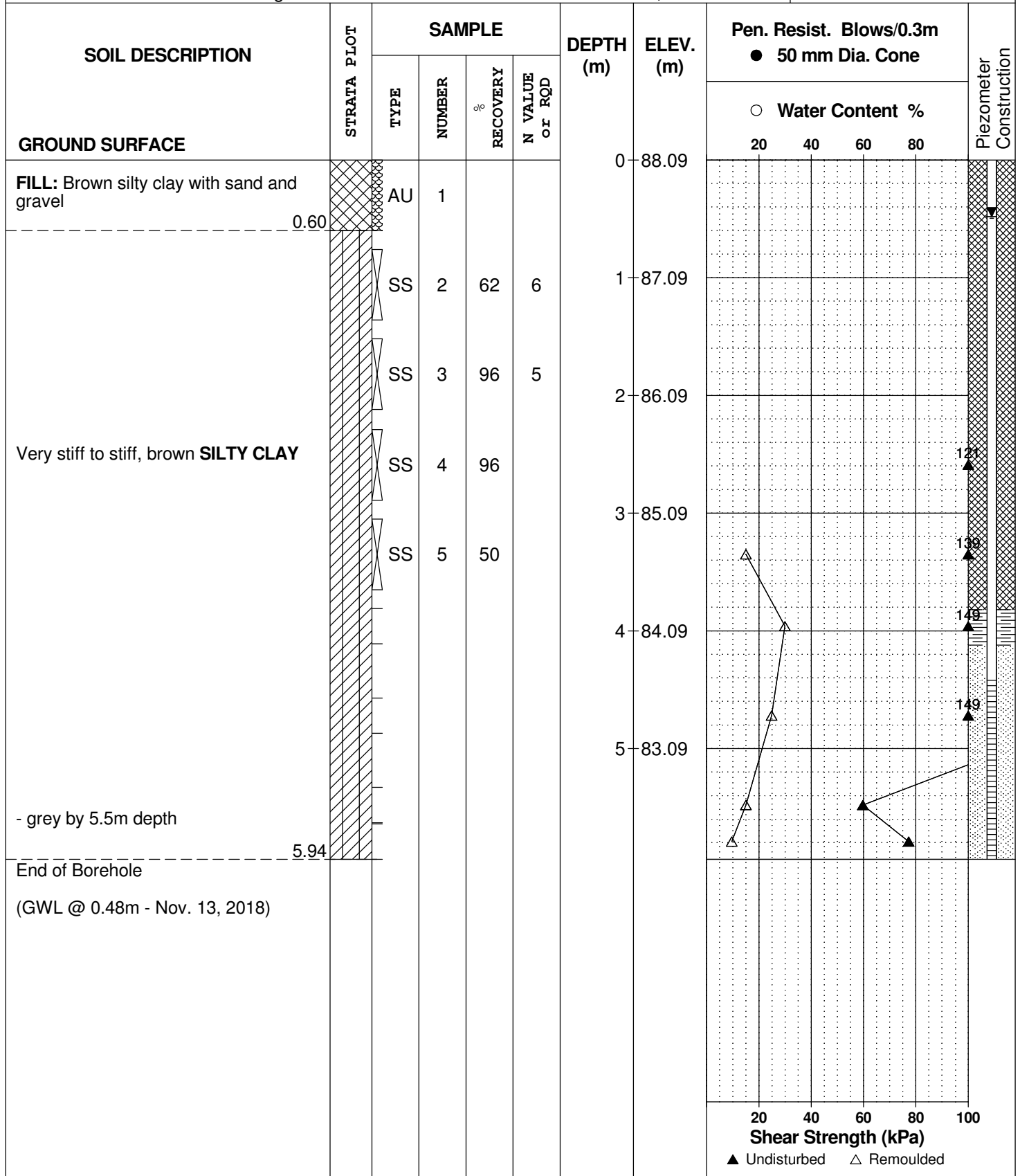
FILE NO. **PG4728**

REMARKS

HOLE NO. **BH 1**

BORINGS BY CME 55 Power Auger

DATE November 1, 2018





DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebakk Ltd.

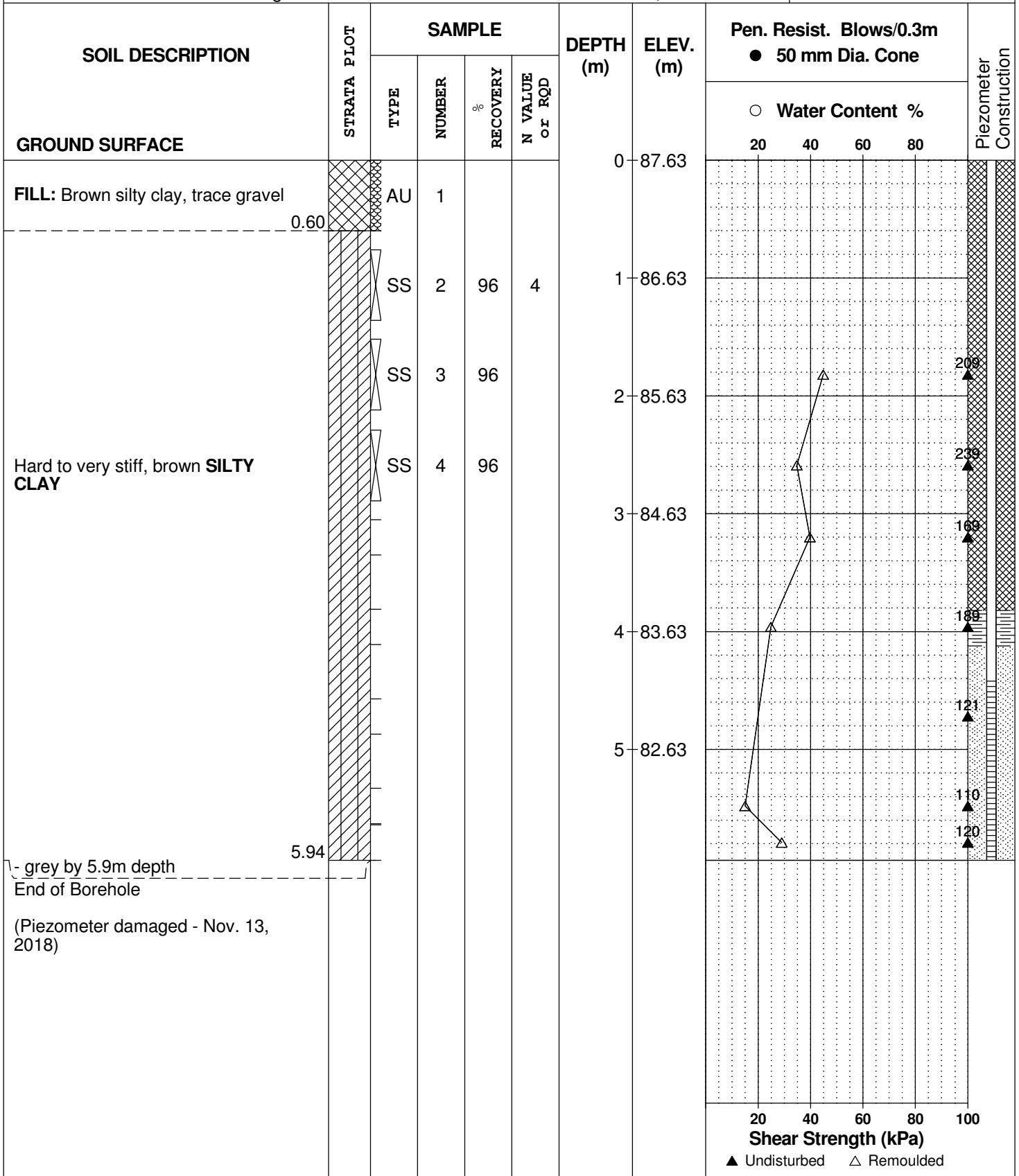
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REMARKS

HOLE NO. **BH 2**

BORINGS BY CME 55 Power Auger

DATE November 1, 2018



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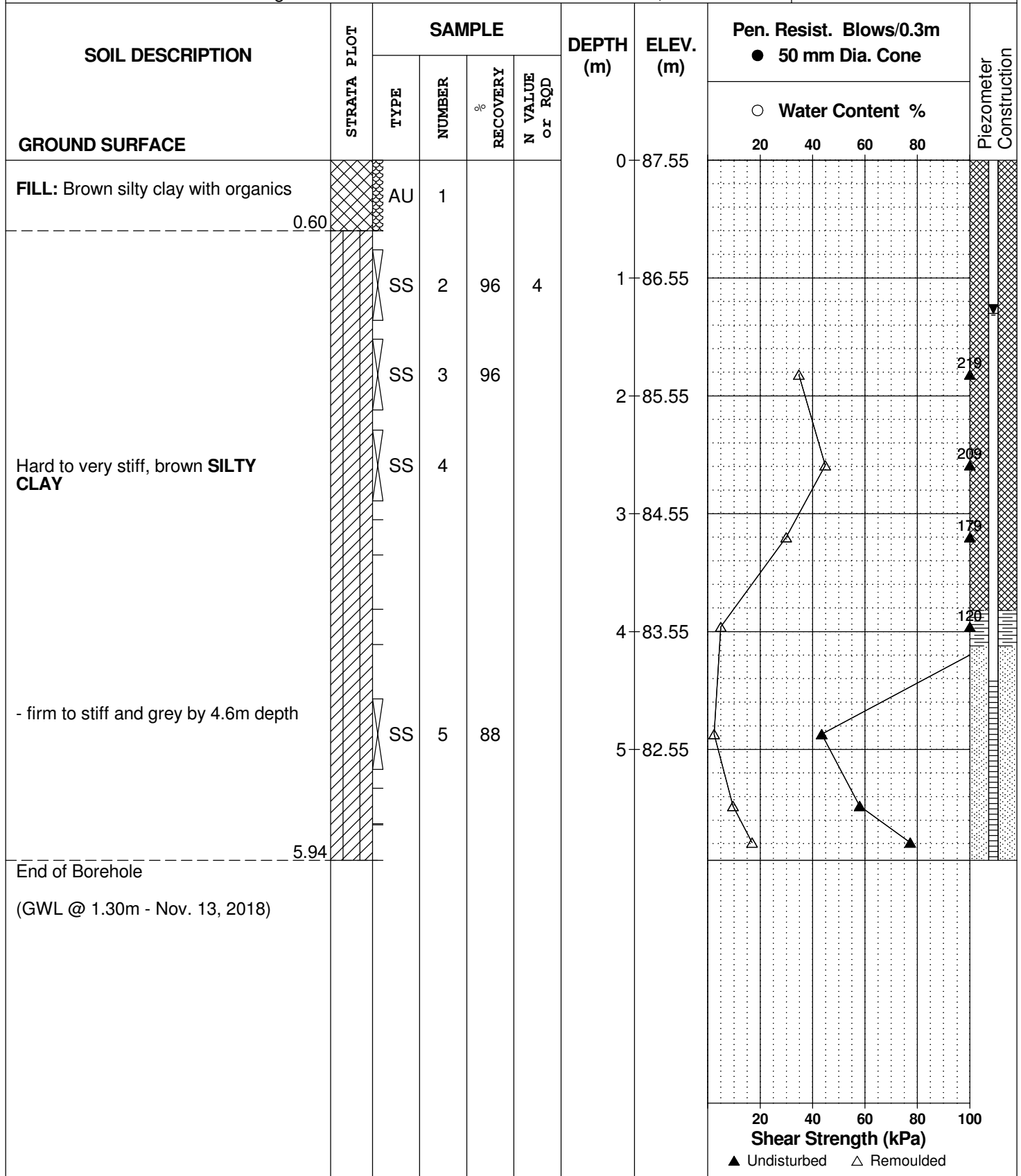
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REMARKS

HOLE NO. **BH 3**

BORINGS BY CME 55 Power Auger

DATE November 1, 2018



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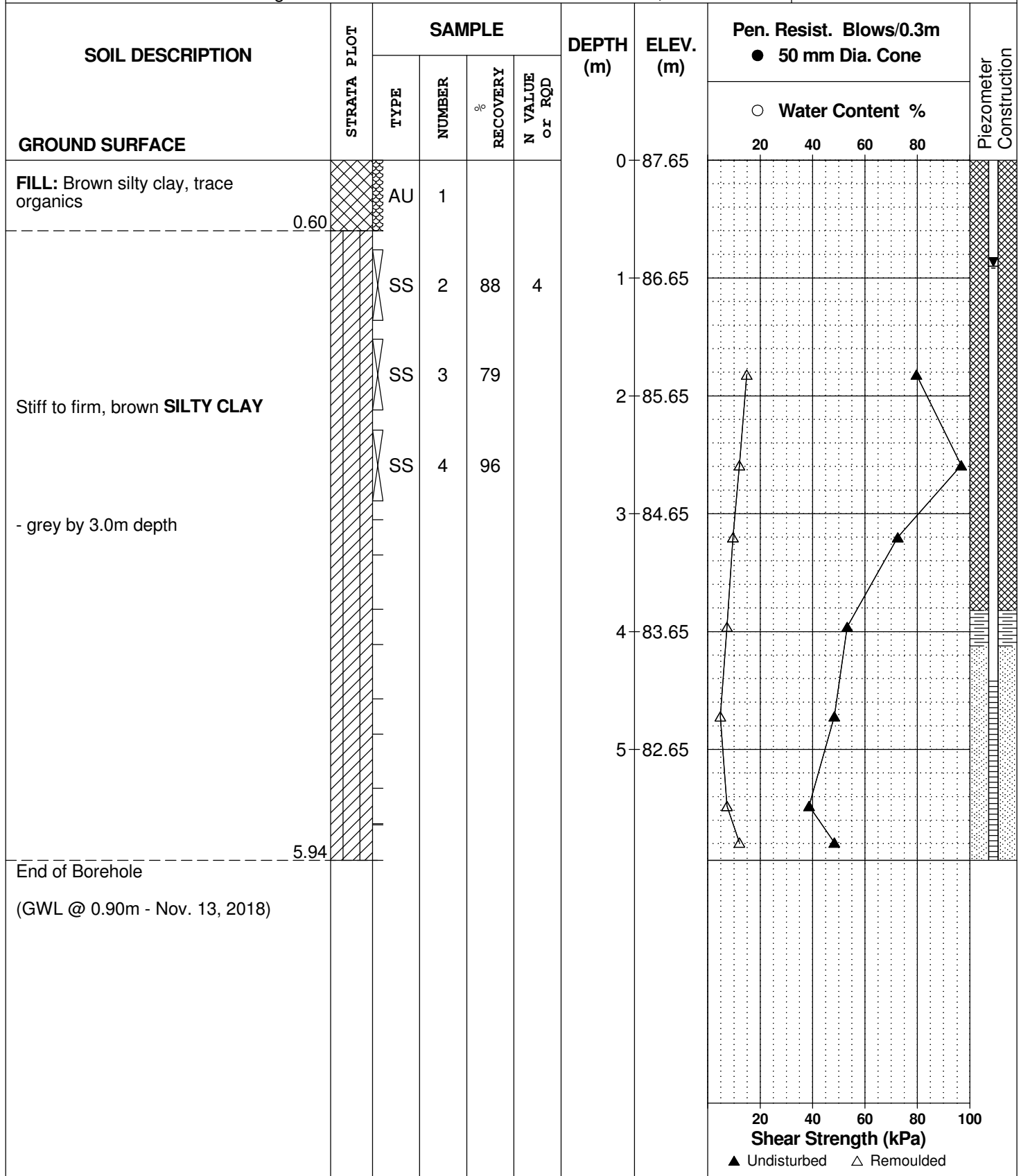
FILE NO. **PG4728**

REMARKS

HOLE NO. **BH 4**

BORINGS BY CME 55 Power Auger

DATE November 1, 2018



DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebakk Ltd.

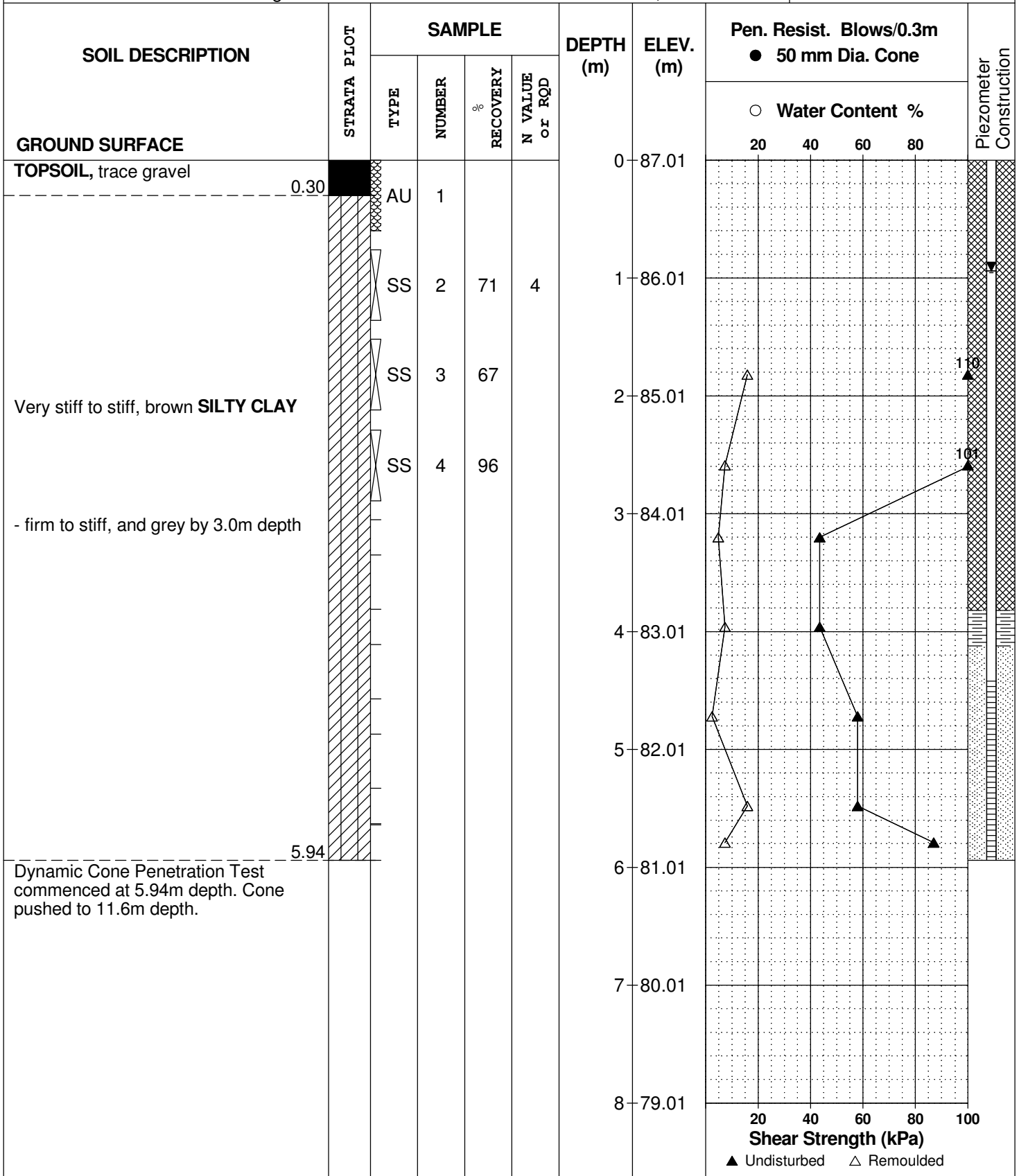
FILE NO. **PG4728**

REMARKS

HOLE NO. **BH 5**

BORINGS BY CME 55 Power Auger

DATE November 1, 2018



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

**REMARKS**

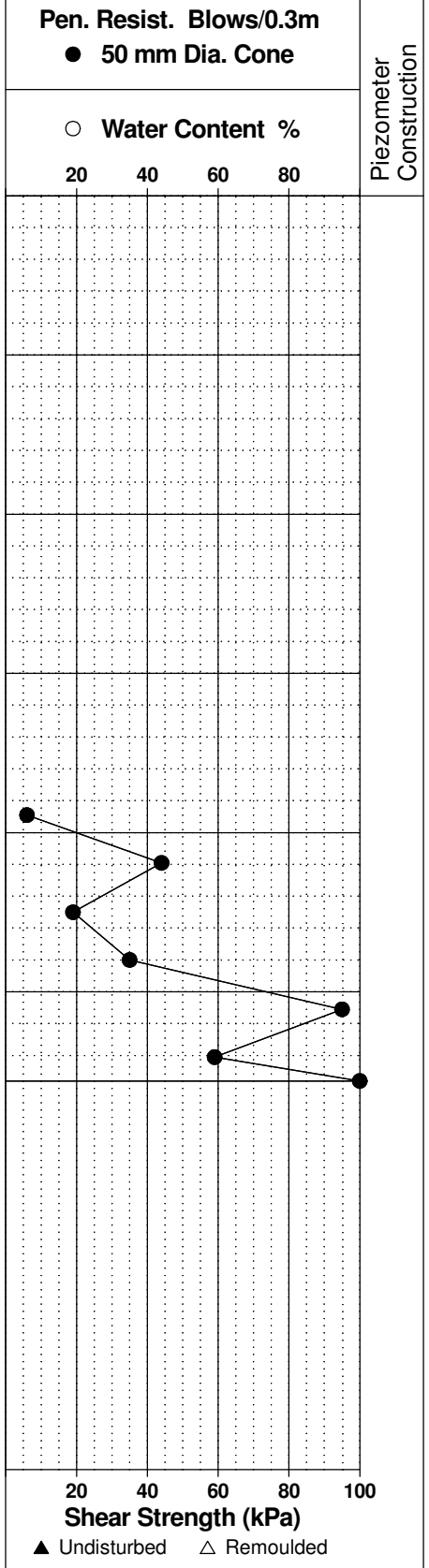
**BORINGS BY** CME 55 Power Auger

**DATE** November 1, 2018

**FILE NO.**  
PG4728

**HOLE NO.**  
BH 5

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			20	40	60	80		
GROUND SURFACE						8	79.01						
						9	78.01						
						10	77.01						
						11	76.01						
						12	75.01						
						13	74.01						
End of Borehole							13.56						
Practical DCPT refusal at 13.56m depth (GWL @ 0.94m - Nov. 13, 2018)													



# 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 = $(D_{30})^2 / (D_{10} \times D_{60})$
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)

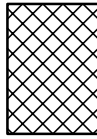
### STRATA PLOT



Topsoil



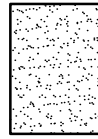
Asphalt



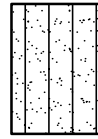
Fill



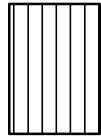
Peat



Sand



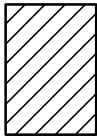
Silty Sand



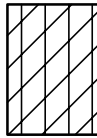
Silt



Sandy Silt



Clay



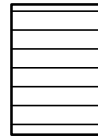
Silty Clay



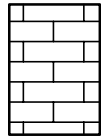
Clayey Silty Sand



Glacial Till



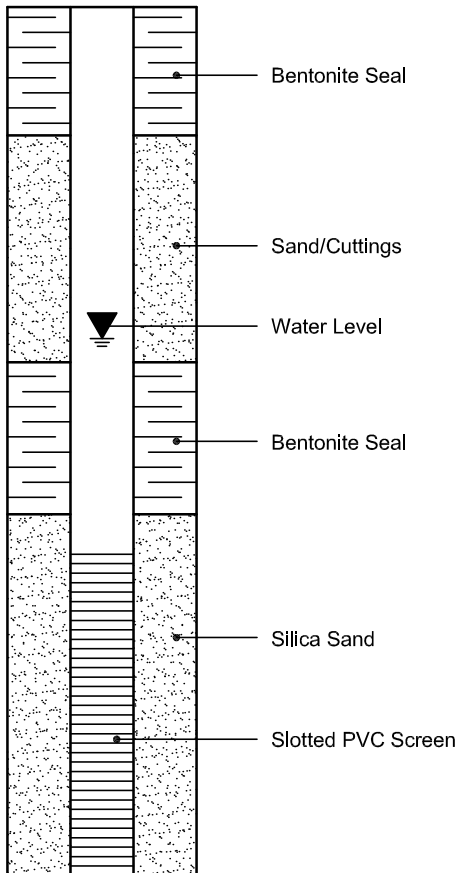
Shale



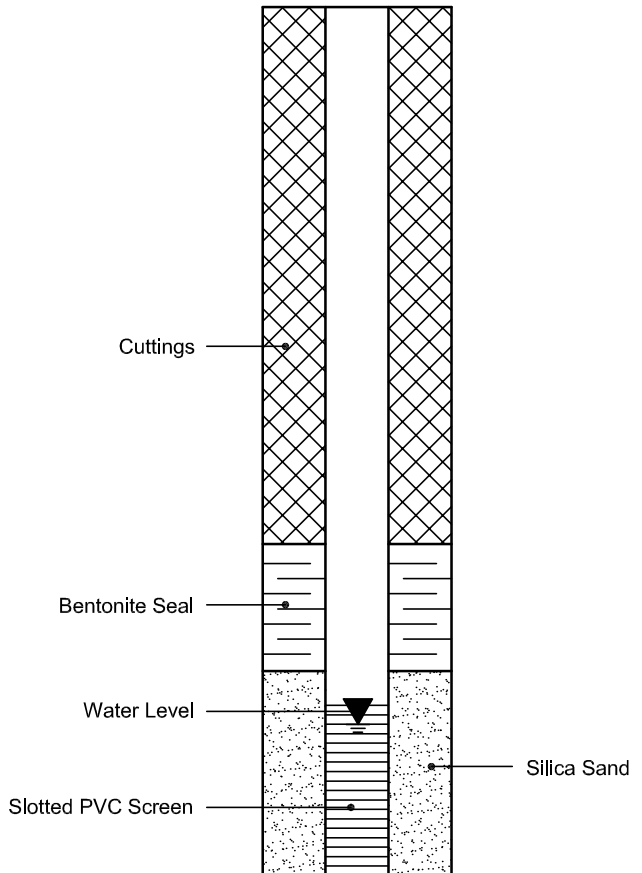
Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION

#### MONITORING WELL CONSTRUCTION

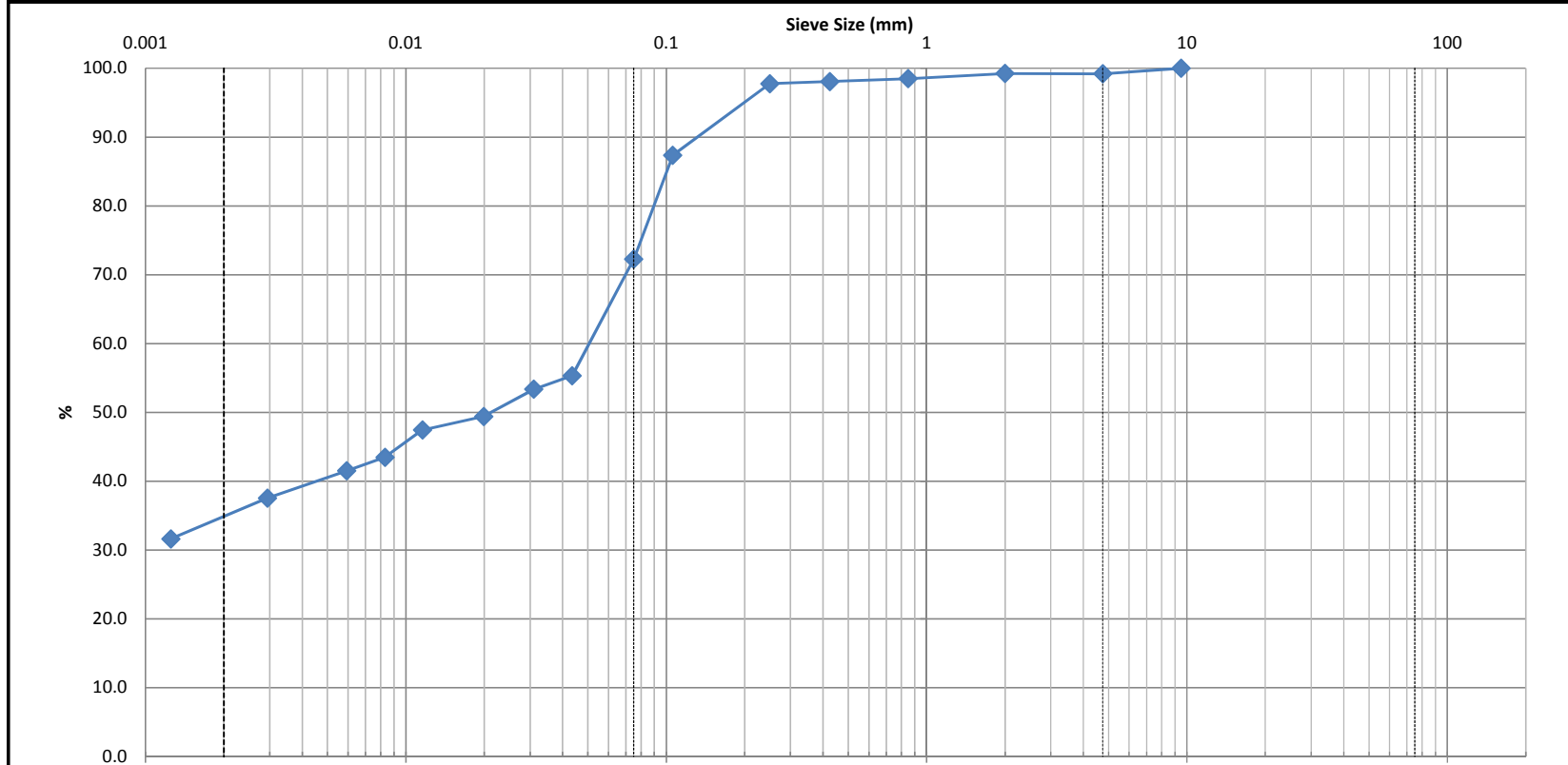


#### PIEZOMETER CONSTRUCTION





CLIENT:	Claridge Homes	DEPTH:	2' 6" - 4' 6"	FILE NO:	PG4728
CONTRACT NO.:		BH OR TP No.:	BH1	LAB NO:	06249
PROJECT:	760 River Road			DATE RECEIVED:	15-Nov-18
DATE SAMPLED:	15-Nov-18			DATE TESTED:	19-Nov-18
SAMPLED BY:	N. Zulinski			DATE REPORTED:	22-Nov-18
				TESTED BY:	D. Bertrand



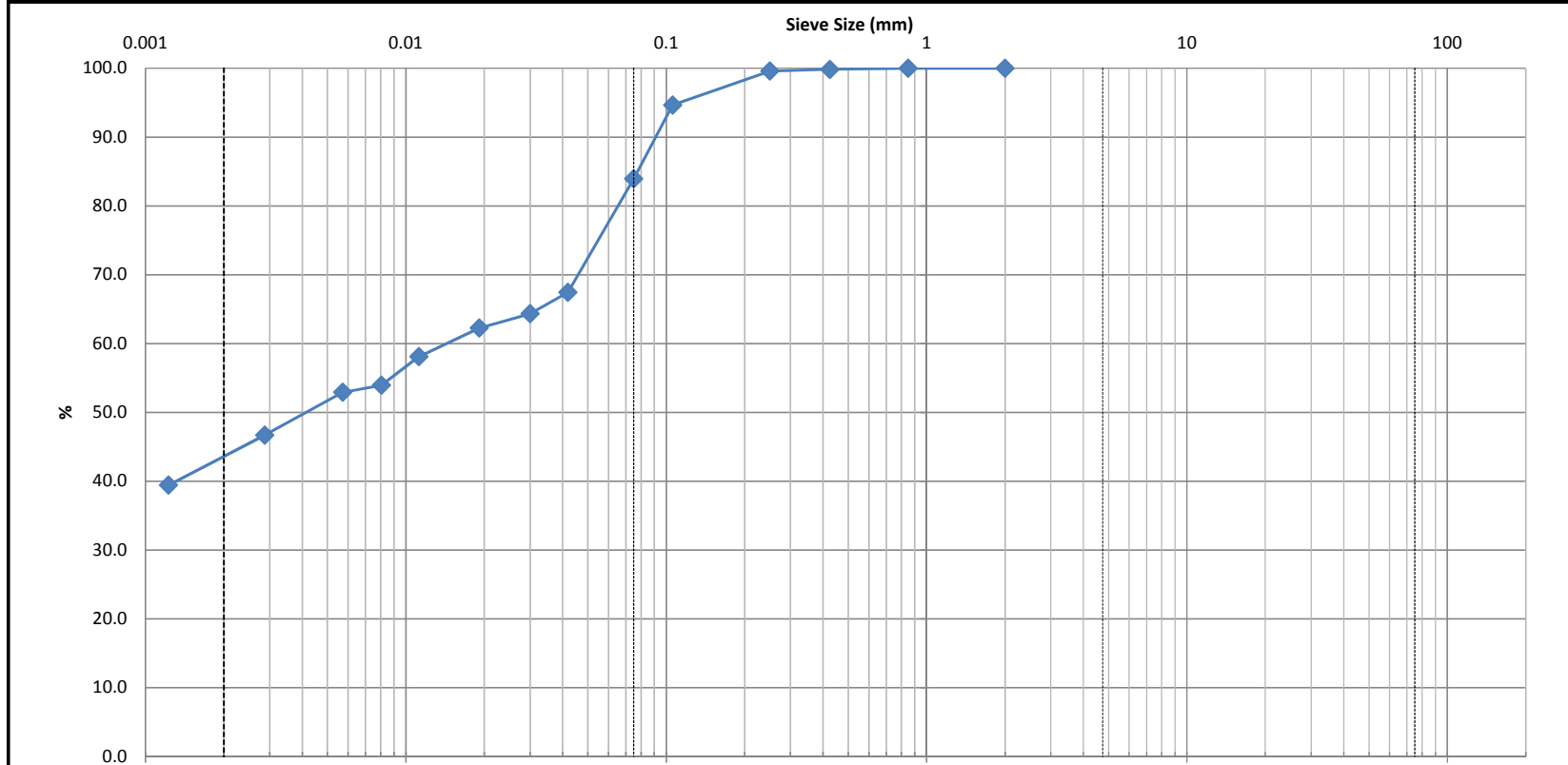
Clay	Silt	Sand			Gravel		Cobble
		Fine	Medium	Coarse	Fine	Coarse	

<b>Identification</b>	<b>Soil Classification</b>					<b>MC(%)</b>	<b>LL</b>	<b>PL</b>	<b>PI</b>	<b>Cc</b>	<b>Cu</b>
						19.6					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)	
					0.0	27.8		37.7		34.5	

Comments	
----------	--

*Lawrence*      *J. A.*

CLIENT:	Claridge Homes	DEPTH:	2' 6" - 4' 6"	FILE NO:	PG4728
CONTRACT NO.:		BH OR TP No.:	BH3	LAB NO:	06250
PROJECT:	760 River Road			DATE RECEIVED:	15-Nov-18
DATE SAMPLED:	15-Nov-18			DATE TESTED:	19-Nov-18
SAMPLED BY:	N. Zulinski			DATE REPORTED:	22-Nov-18
				TESTED BY:	D. Bertrand



Clay	Silt				Sand			Gravel		Cobble
					Fine	Medium	Coarse	Fine	Coarse	

Identification	Soil Classification					MC(%)	LL	PL	PI	Cc	Cu
						23.9					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)			
				0.0	16.1	40.9	43.0				

Comments	
----------	--

*N. Zulinski*

*D. Bertrand*

Certificate of Analysis  
**Client: Paterson Group Consulting Engineers**  
**Client PO: 25232**

Report Date: 09-Nov-2018

Order Date: 5-Nov-2018

**Project Description: PG4728**

<b>Client ID:</b>	BH5-SS3	-	-	-
<b>Sample Date:</b>	11/05/2018 09:00	-	-	-
<b>Sample ID:</b>	1845147-01	-	-	-
<b>MDL/Units</b>	Soil	-	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	73.0	-	-	-
----------	--------------	------	---	---	---

**General Inorganics**

pH	0.05 pH Units	7.29	-	-	-
Resistivity	0.10 Ohm.m	49.2	-	-	-

**Anions**

Chloride	5 ug/g dry	54	-	-	-
Sulphate	5 ug/g dry	18	-	-	-

# **APPENDIX 2**

**FIGURE 1 - KEY PLAN**

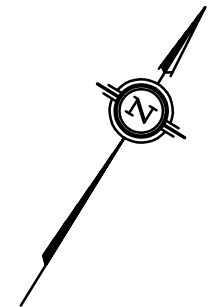
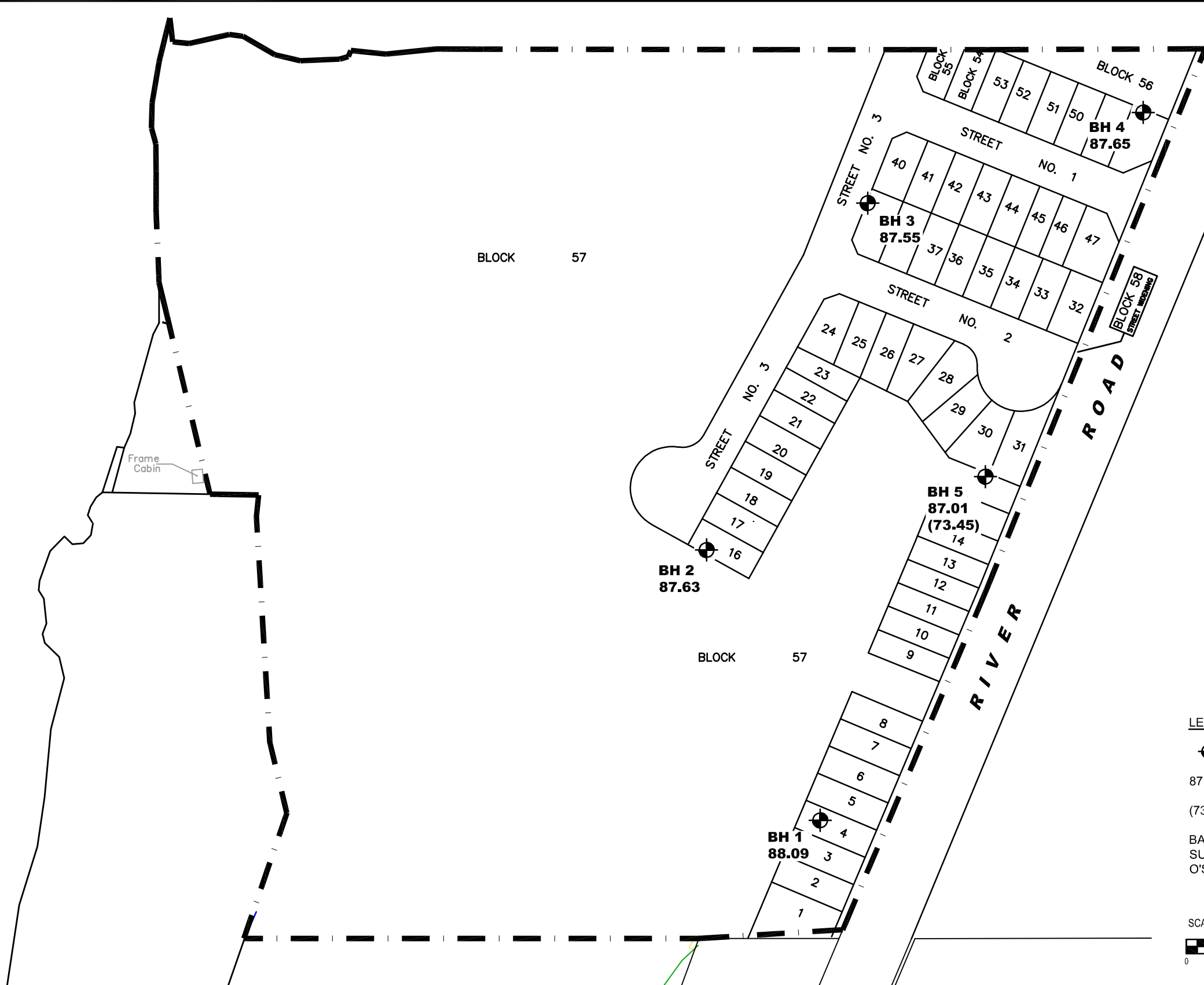
**DRAWING PG4728-1 - TEST HOLE LOCATION PLAN**




FIGURE 1  
KEY PLAN

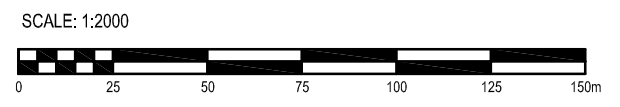
**patersongroup**

**RIDEAU RIVER**  
FLOW



**LEGEND:**  
 BOREHOLE LOCATION  
 87.01 GROUND SURFACE ELEVATION (m)  
 (73.45) PRACTICAL DCPT REFUSAL ELEVATION (m)

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.



**patersongroup**  
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

**CLARIDGE HOMES**  
**GEOTECHNICAL INVESTIGATION**  
**PROPOSED RESIDENTIAL DEVELOPMENT - 760 RIVER ROAD**  
 OTTAWA, ONTARIO  
 Title: **TEST HOLE LOCATION PLAN**

Scale:	1:2000	Date:	11/2018
Drawn by:	MPG	Report No.:	PG4728-1
Checked by:	NZ	Dwg. No.:	<b>PG4728-1</b>
Approved by:	DJG	Revision No.:	0

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