Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

patersongroup

Geotechnical Investigation

Proposed Elementary School
Block 548 Fernbank Community Development
Fernbank Road
Ottawa, Ontario

Prepared For

Conseil des Écoles Publiques
de l'Est de l'Ontario

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November 18, 2013

Report: PG3093-1

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1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by Conseil des écoles publiques de l'Est de L'Ontario (CEPEO) to conduct a geotechnical investigation for the proposed school to be located at Block 548 of the Fernbank Community development, located along Fernbank Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of our investigation was to:

☐ determine the subsurface soil and groundwater conditions by means of test holes.

☐ provide geotechnical recommendations for the design of the proposed development based on the test holes results.

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

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

2.0 PROPOSED PROJECT

It is understood that the proposed project consists of an elementary school of slab-on-grade construction to be constructed at the subject site (Block 548). It is expected that associated parking areas, access lanes and landscaped areas are also anticipated for the subject site.

3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

Field Program

The field program for the investigation was conducted on October 23, 2013. Seven (7) boreholes were completed across the subject site for the geotechnical investigation. The test hole locations were located in the field by Paterson to provide general coverage of the subject site. The borehole locations are presented on Drawing PG3093-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled with a track-mounted power auger 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 division. The drilling procedure consisted of augering to the required depths at the selected locations, sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples from the boreholes were recovered from the auger flights or a 50 mm diameter split-spoon sample. All soil samples were classified on site, placed in sealed plastic bags and transported to the laboratory for further review. The depths at which the auger and split spoon samples were recovered from the test hole are presented as, AU and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

Standard Penetration Testing (SPT) was conducted and 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 sample 300 mm into the soil after a 150 mm initial penetration with a 63.5 kg hammer falling from a height of 760 mm. This testing was done in general accordance with ASTM D1586-11 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented 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 levels subsequent to the completion of the sampling 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. The samples will then be discarded unless directed otherwise.

3.2 Field Survey

The test hole locations were selected in the field by Paterson personnel to provide general coverage of the subject site with consideration to existing site features. The ground surface elevations at the borehole locations were provided by Annis, O'Sullivan and Vollebekk Limited. The ground surface elevations at the borehole locations are referenced to a geodetic datum. The locations and ground surface elevations of the test holes are presented on Drawing PG3093-1 - 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 results of the field logs. Selected soil samples were weighed and dried to determine moisture contents.

3.4 Analytical Testing

One soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The results are presented in Appendix 1 and are discussed further in Subsection 6.8.

4.0 OBSERVATIONS

4.1 Surface Conditions

The subject site is currently undeveloped and consists of an agricultural field within the east portion of the site and a brush covered area within the west portion of the site. The ground surface across the subject site is relatively flat and at grade with surrounding properties.

4.2 Subsurface Profile

Generally, the subsurface profile encountered at the borehole locations, consists of topsoil underlain by a very stiff to hard silty clay layer overlying a dense glacial till deposit. The glacial till consisted of a fine soil matrix of silty clay with some sand, gravel, cobbles and boulders. Also, roots and some organics were noted within the upper portion of the silty clay layer. The roots and organics were noted to extend to depths of 0.2 to 0.7 m depth where encountered.

Reference to the Soil Profile and Test Data sheets in Appendix 1 for details of the soil profiles encountered at each test hole location.

Available Geological Mapping

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded dolostone and limestone of the Gull River formation. The overburden drift thickness is estimated to be between 0 to 10 m.

4.3 Groundwater

Groundwater levels were measured in the piezometers installed at the borehole locations on May 23, 2013. It should be noted that surface water can become perched within the backfilled boreholes and lead to higher than normal groundwater level readings. Based on field observations, such as recovered soil samples' colour and consistency, the long term groundwater level is expected between 3 and 4 m depth. Groundwater levels are subject to seasonal fluctuations and therefore, the groundwater levels could be different at the time of construction.

Table 1 - Groundwater Levels

Borehole Locations	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date
BH 1	106.11	0.26	105.85	November 4, 2013
BH 2	106.11	0.35	105.76	November 4, 2013
BH 3	106.12	Damaged	-	November 4, 2013
BH 4	106.03	0.0	106.03	November 4, 2013
BH 5	106.15	0.86	105.29	November 4, 2013
BH 6	106.39	0.89	105.50	November 4, 2013
BH 7	106.19	0.76	105.43	November 4, 2013

5.0 DISCUSSION

5.1 Geotechnical Assessment

Based on our findings, the subject site is adequate for the proposed building from a geotechnical perspective. It is anticipated that the proposed building will be founded by conventional style footings placed over a very stiff silty clay or dense glacial till bearing surface.

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

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, deleterious fill and soils containing significant amounts of organics, should be stripped from under any buildings and other settlement sensitive structures. Precautions should be taken to ensure that all bearing surfaces and subgrade soils remain undisturbed during site preparation activities.

Fill Placement

Fill placed for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% of its standard Proctor maximum dry density (SPMDD).

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

Strip footings, up to 3 m wide, and pad footings, up to 6 m wide, placed on an undisturbed, stiff silty clay bearing surface or engineered fill over an undisturbed, stiff silty clay bearing surface, can be designed with 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**. Footings placed on an undisturbed, dense glacial till bearing surface can be designed using a bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **250 kPa**. A geotechnical resistance factor of 0.5 was applied to the above bearing resistance values at ULS. Footings designed with the abovenoted bearing resistance values at SLS could expect potential post-construction total and differential settlements of up to 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, under dry conditions, prior to the placement of concrete for footings.

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 an engineered fill or in situ soils when a plane extending horizontally and vertically from the underside of the footing at a minimum of 1.5H:1V passing through in situ soil of the same or higher bearing capacity as the bearing medium soil.

Settlement/Grade Raise

Consideration must also 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. For buildings, a minimum value of 50% of the live load is often recommended by Paterson. A post-development groundwater lowering of 0.5 m was assumed.

A permissible grade raise restriction of **3 m** is recommended within 5 m of the proposed building footprint. A permissible grade raise restriction of **4 m** is recommended for parking and landscaped areas.

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 estimated to be a **Class C** for the foundations considered. The soils underlying the proposed shallow foundations are not susceptible to liquefaction. Reference should be made to the latest revision of the 2006 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of all topsoil, soils containing significant amounts of organics and/or deleterious fill within the proposed building footprint, the native soil surface will be considered an acceptable subgrade surface on which to commence backfilling for floor slab construction. Provision should be provided for proof-rolling the soil subgrade with heavy vibratory compaction equipment prior to placing any fill. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of an OPSS Granular A crushed stone.

5.6 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be designed for car only parking areas and access lanes.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas and Fire Access Lanes

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

Table 3 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either approved fill, in situ soils or OPSS Granular B Type I or II material placed over in situ soil or fill	

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

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

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on maintaining 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 fines being pumped into the stone subbase voids, thereby reducing the load bearing capacity.

Due to the impervious nature of the subgrade materials consideration should be provided to installing subdrains during the pavement construction. These drains should extend in four orthogonal directions or longitudinally when placed along a curb. The clear crushed stone surrounding the drainage lines or the pipe, should be wrapped with suitable filter cloth. 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 foundation drainage system is recommended to be provided for the proposed structure. The system should consist of a 100 mm to 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

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

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum 1.5 m thick soil cover (or equivalent) 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. The recommended minimum thickness of soil cover is 2.1 m (or equivalent).

6.3 Excavation Side Slopes

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

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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

A trench box is recommended to be installed at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with City of Ottawa standards and specifications.

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 maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD. The bedding material should extend at a minimum 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 a minimum of 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 the SPMDD.

Generally, the dry brown silty clay should be possible to place above the cover material if the excavation and backfilling operations are completed in dry weather conditions. The wet silty clay materials could be difficult to place and compact, due to the high water content.

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 consist of 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 SPMDD.

To reduce long-term lowering of the groundwater level, clay seals should be provided in the service trenches. The seals should be a minimum of 1.5 m long (in the trench direction) 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 to clayey silt placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries, roadway intersections and at a maximum distance of every 50 m in the service trenches.

6.5 Groundwater Control

Due to the relatively impervious nature of the in situ soils, groundwater infiltration into the excavations should be low to moderate and controllable by open sumps. 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.

A temporary MOE permit to take water (PTTW) may be required if more than 50,000 L/day is expected to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the application and issuance of the permit by the MOE.

6.6 Winter Construction

Precautions should be provided if winter construction is considered for this project. The subsurface soil conditions 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.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. 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 to avoid the introduction of frozen materials, snow or ice 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 during construction. 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 Landscaping Considerations

Tree Planting Restrictions

The proposed building is located in a low to moderate sensitivity area with respect to tree plantings over a silty clay deposit. It is recommended that trees placed within 4 m of the foundation wall should consist of low water demand trees with shallow roots systems that extend less than 1.5 m below ground surface. Trees placed greater than 4 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum depth of 2 m below ground surface.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, they should not be considered in the landscaping design.

6.8 Corrosion Potential and Sulphate

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

The results of analytical testing presented in Appendix 1 were evaluated according to industry accepted standards. It should be noted that extremely acidic soils (below a pH of 4.5) and very strong alkaline soils (above a pH of 9.1) are considered to have a significantly high corrosion loss rate.

The soil resistivity/corrosion rate potential was evaluated according to the following table:

Table 4 - Corrosion Potential

Resistance Classification	Soil Resistivity (ohm-cm)	Corrosion Potential
Low	0-2,000	Severe
Medium	2,000-10,000	Moderate
High	10,000-30,000	Mild
Very High	Above 30,000	Unlikely

The Canadian Standards Association (CSA) outlines the requirements for sulphate content in A23.1-04, Table 3. AASHTO T290-91 outlines the requirements for chloride content.

The results show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland 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 and the resistivity is indicative of an ‘moderate’ corrosion potential rating as indicated in Table 4.

7.0 RECOMMENDATIONS

The following is recommended to be completed once the site plan and development are determined:

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

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

☐ Observation of all subgrades prior to backfilling.

☐ Field density tests to ensure that the specified level of compaction has been achieved.

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

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

A report confirming the construction has been completed in general accordance with the recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 STATEMENT OF LIMITATIONS

The report recommendations are in accordance with the present understanding of the project. Paterson request permission to review the grading plan once available and 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 could 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 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 are intended for the 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, 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 Conseil des écoles publiques de l'Est de L'Ontario 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.

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

FILE NO. PG3093

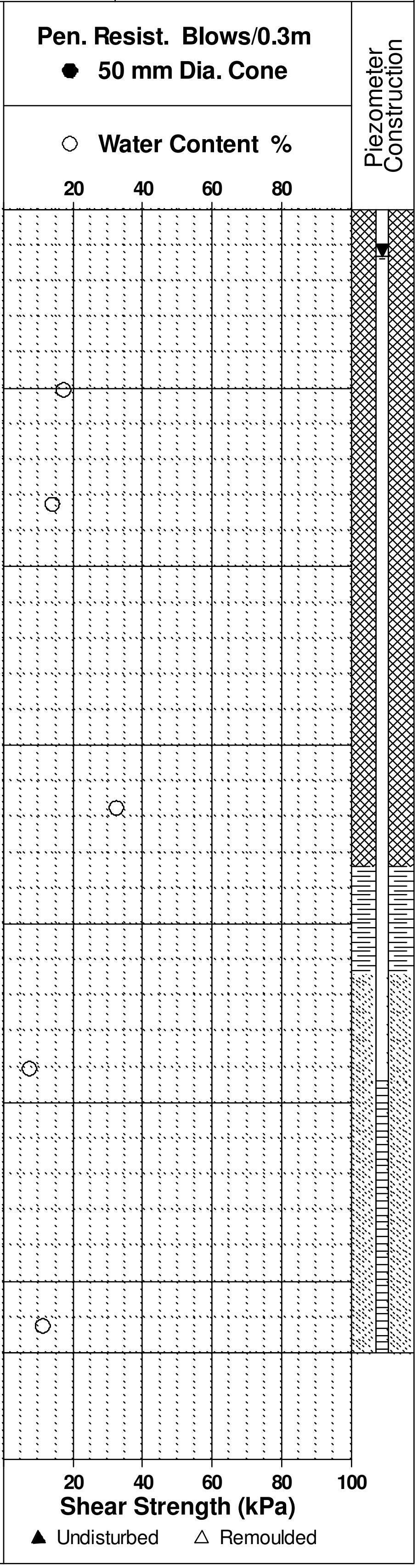
REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.11
TOPSOIL 0.33							
		AU	1				
Hard, grey-brown **SILTY CLAY**		SS	2	60	62	1	105.11
1.78		SS	3	100	50+		
						2	104.11
						3	103.11
		SS	4	67	8		
GLACIAL TILL: Dense, grey silty clay with gravel, cobbles and boulders							
						4	102.11
		SS	5	63	47		
						5	101.11
						6	100.11
6.40		SS	6	83	50+		
End of Borehole (GWL @ 0.26m-Nov. 4, 2013)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

FILE NO. **PG3093**

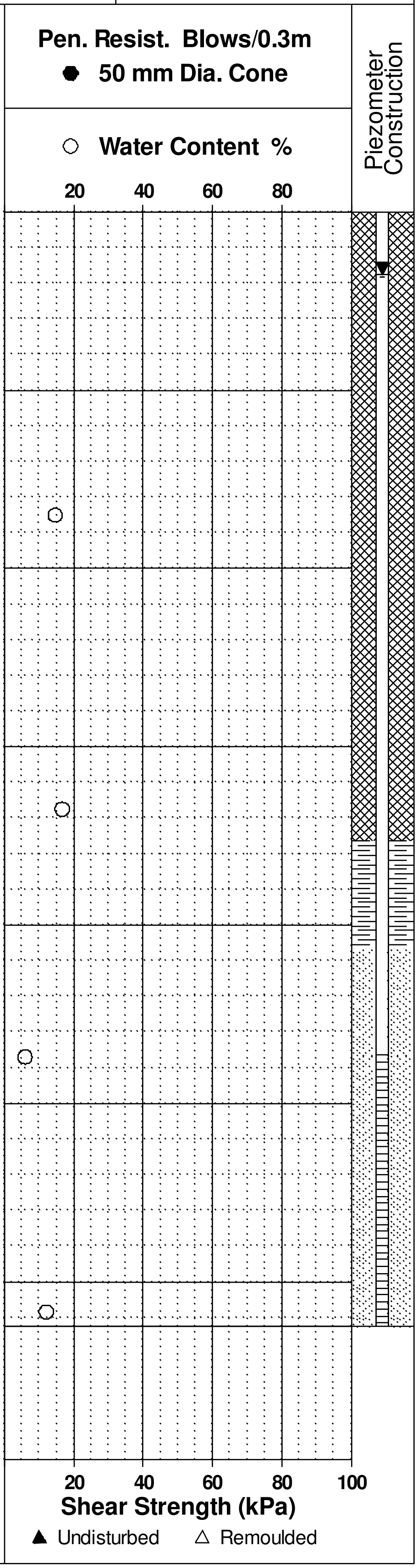
REMARKS

HOLE NO. **BH 2**

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	106.11
TOPSOIL 0.23						
Hard, grey-brown **SILTY CLAY**	SS	1	83	40	1	105.11
1.83	SS	2	60	50+		
					2	104.11
					3	103.11
GLACIAL TILL: Dense, grey silty clay with gravel, cobbles and boulders	SS	3	50	17		
					4	102.11
	SS	4	92	50+		
					5	101.11
					6	100.11
6.25	SS	5	50	50+		
End of Borehole (GWL @ 0.35m-Nov. 4, 2013)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

FILE NO. PG3093

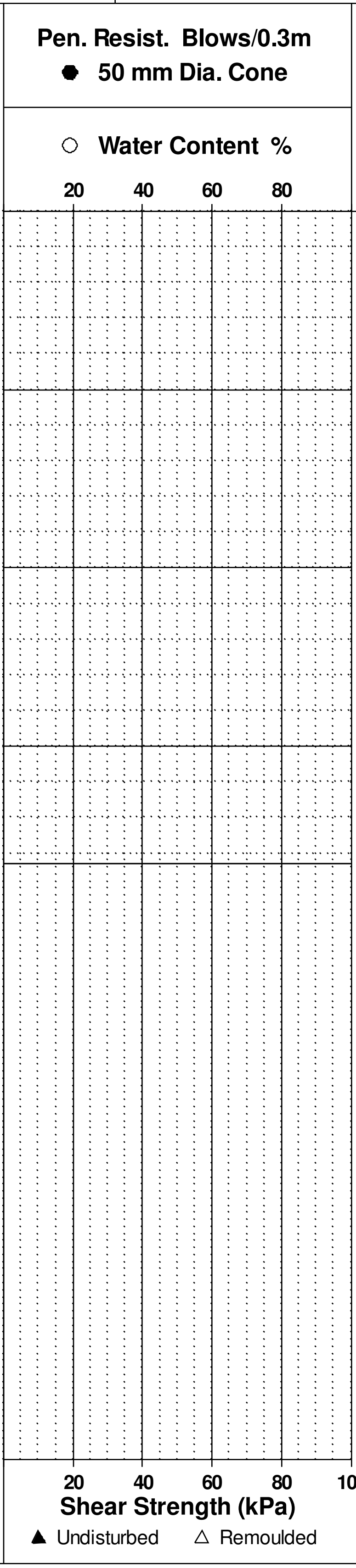
REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	106.12
TOPSOIL 0.25						
Hard to very stiff, grey-brown **SILTY CLAY**	SS	1	50	25	1	105.12
	SS	2	91	50+		
					2	104.12
2.74						
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders					3	103.12
	SS	3	58	12		
3.66 End of Borehole						
(BH dry upon completion)						



Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

FILE NO. PG3093

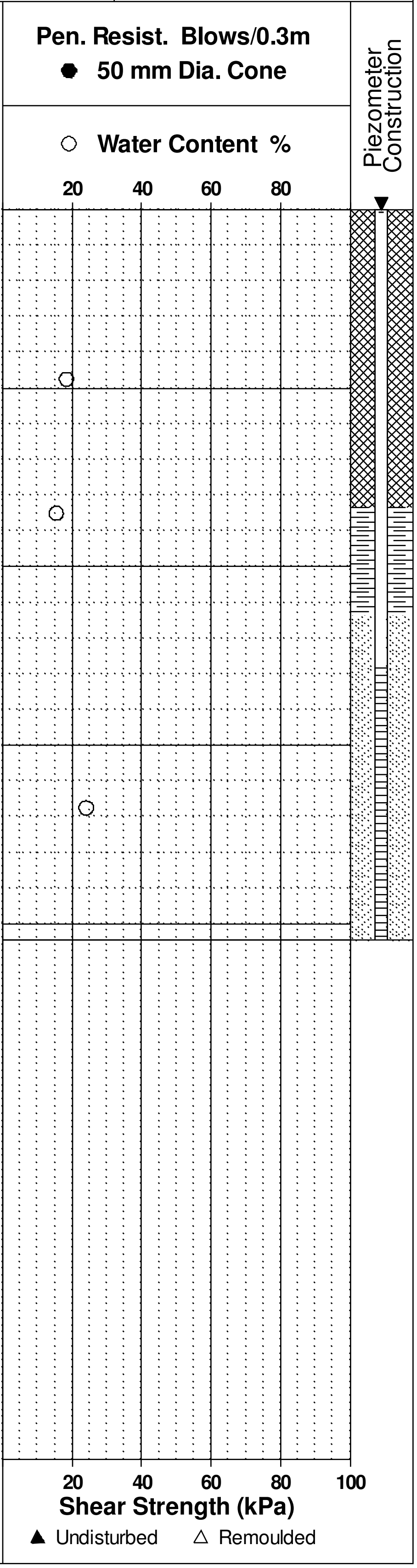
HOLE NO. BH 4

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						
TOPSOIL 0.23					0	106.03
	AU	1				
	SS	2	100	50+	1	105.03
Hard to very stiff, grey-brown **SILTY CLAY**	SS	3	62	50+		
					2	104.03
					3	103.03
- grey by 3.4m depth 3.66	SS	4	38	10		
GLACIAL TILL: Grey silty clay with gravel, cobbles and boulders 4.09					4	102.03

End of Borehole

Practical refusal to augering at 4.09m depth

(GWL @ ground surface - Nov. 4, 2013)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
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DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

FILE NO. PG3093

REMARKS

HOLE NO. BH 5

BORINGS BY CME 55 Power Auger

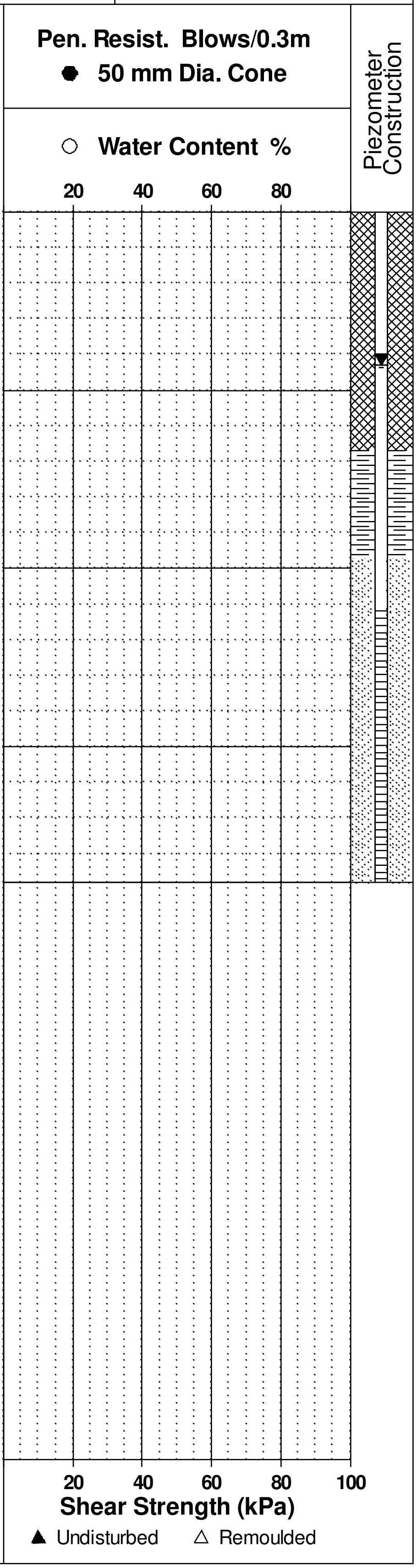
DATE October 23, 2013

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	106.15
TOPSOIL 0.18						
Very stiff, brown **SILTY CLAY**	AU	1				
	SS	2	83	25	1	105.15
	SS	3	83	24	2	104.15
2.59						
					3	103.15
GLACIAL TILL: Grey silty clay with gravel, cobbles and boulders	SS	4	44	50+		
3.76						

End of Borehole

Practical refusal to augering at 3.76m depth

(GWL @ 0.86m-Nov. 4, 2013)



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

FILE NO. PG3093

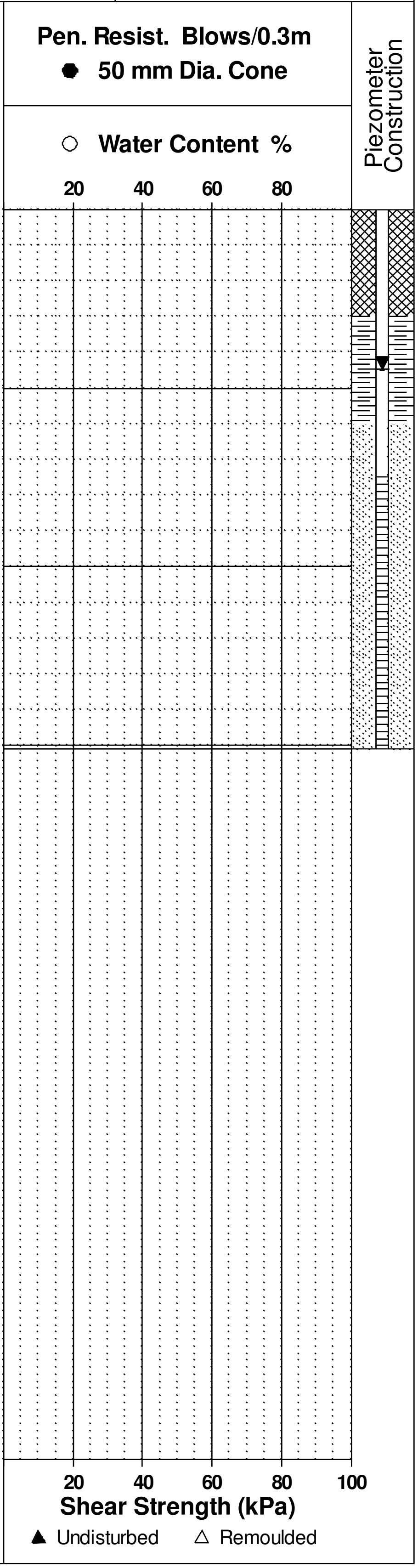
REMARKS

HOLE NO. BH 6

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.39
TOPSOIL 0.20	■	AU	1				
	▨	AU	2				
Hard, brown **SILTY CLAY** with sand	▨	SS	3	83	42	1	105.39
1.45							
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders	^	SS	4	56	20	2	104.39
3.02						3	103.39
End of Borehole Practical refusal to augering at 3.02m depth (GWL @ 0.89m-Nov. 4, 2013)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed School, Block 548 - Fernbank Community
Fernbank Road, Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 23, 2013

FILE NO. PG3093

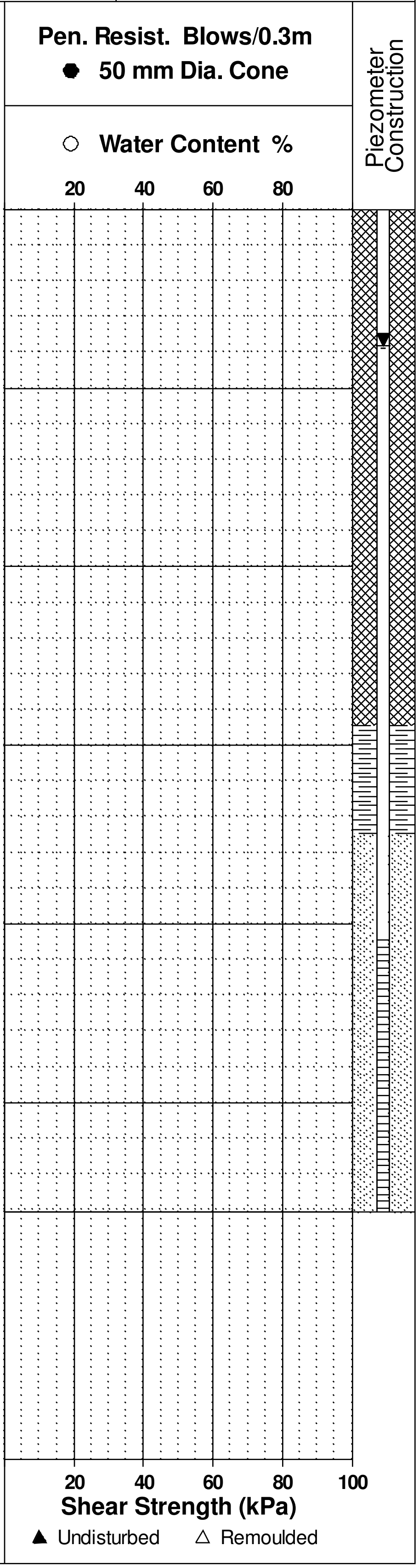
HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.19
TOPSOILB 0.28		AU	1				
Very stiff, brown **SILTY CLAY,** trace sand 0.60		AU	2				
GLACIAL TILL; Brown silty clay with sand, gravel, cobbles and boulders		SS	3	83	41	1	105.19
		SS	4	60	34		
						2	104.19
2.59							
						3	103.19
GLACIAL TILL: Dense, grey silty sand with clay, gravel, cobbles and boulders		SS	5	40	46		
						4	102.19
		SS	6	34	50+		
						5	101.19
5.61							

End of Borehole

Practical refusal to augering at 5.61m depth

(GWL @ 0.76m-Nov. 4, 2013)



SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

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

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu - Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

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

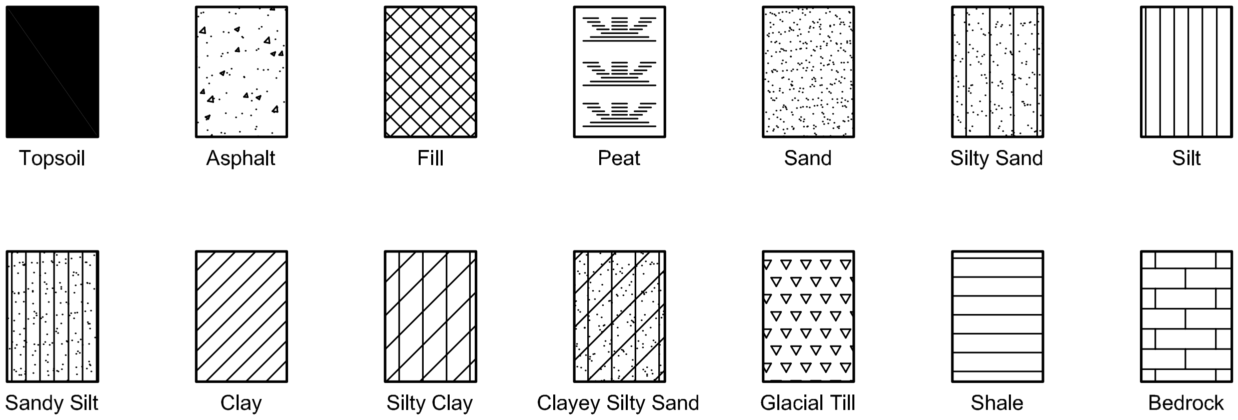
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

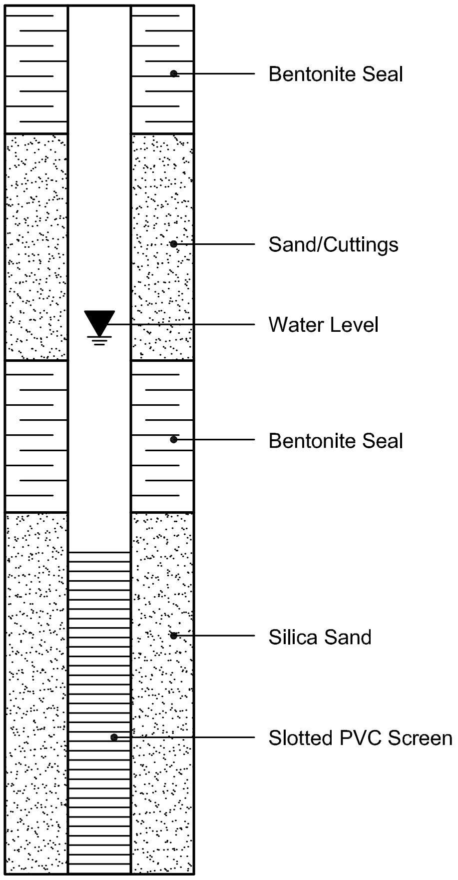
SYMBOLS AND TERMS (continued)

STRATA PLOT

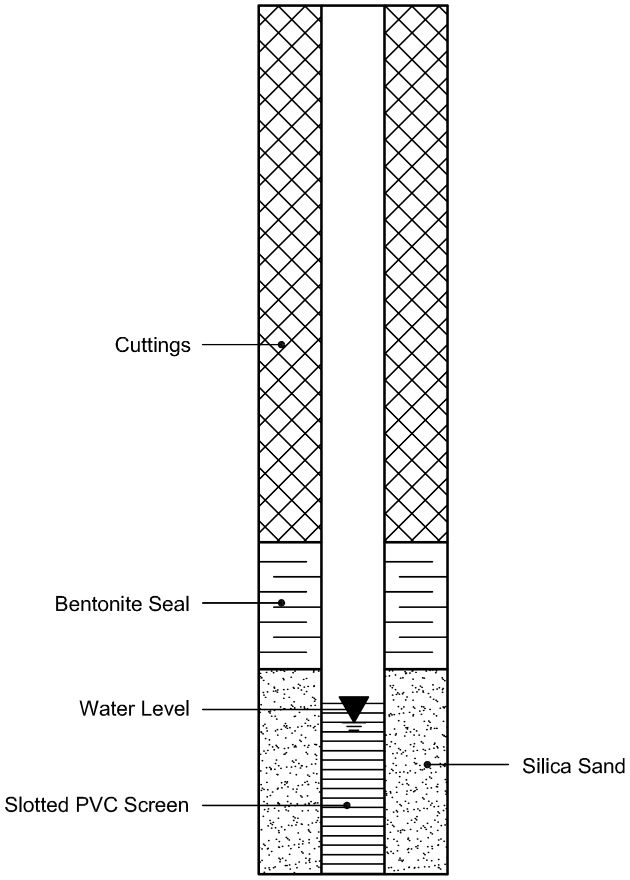


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 31-Oct-2013
Order Date:25-Oct-2013

Client: **Paterson Group Consulting Engineers**
Client PO: 15099
Project Description: PG3093

	Client ID:	BH3-SS2	-	-	-
	Sample Date:	23-Oct-13	-	-	-
	Sample ID:	1343378-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	85.3	-	-	-
General Inorganics					
pH	0.05 pH Units	7.80	-	-	-
Resistivity	0.10 Ohm.m	69.6	-	-	-
Anions					
Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	14	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG3093-1 - TEST HOLE LOCATION PLAN

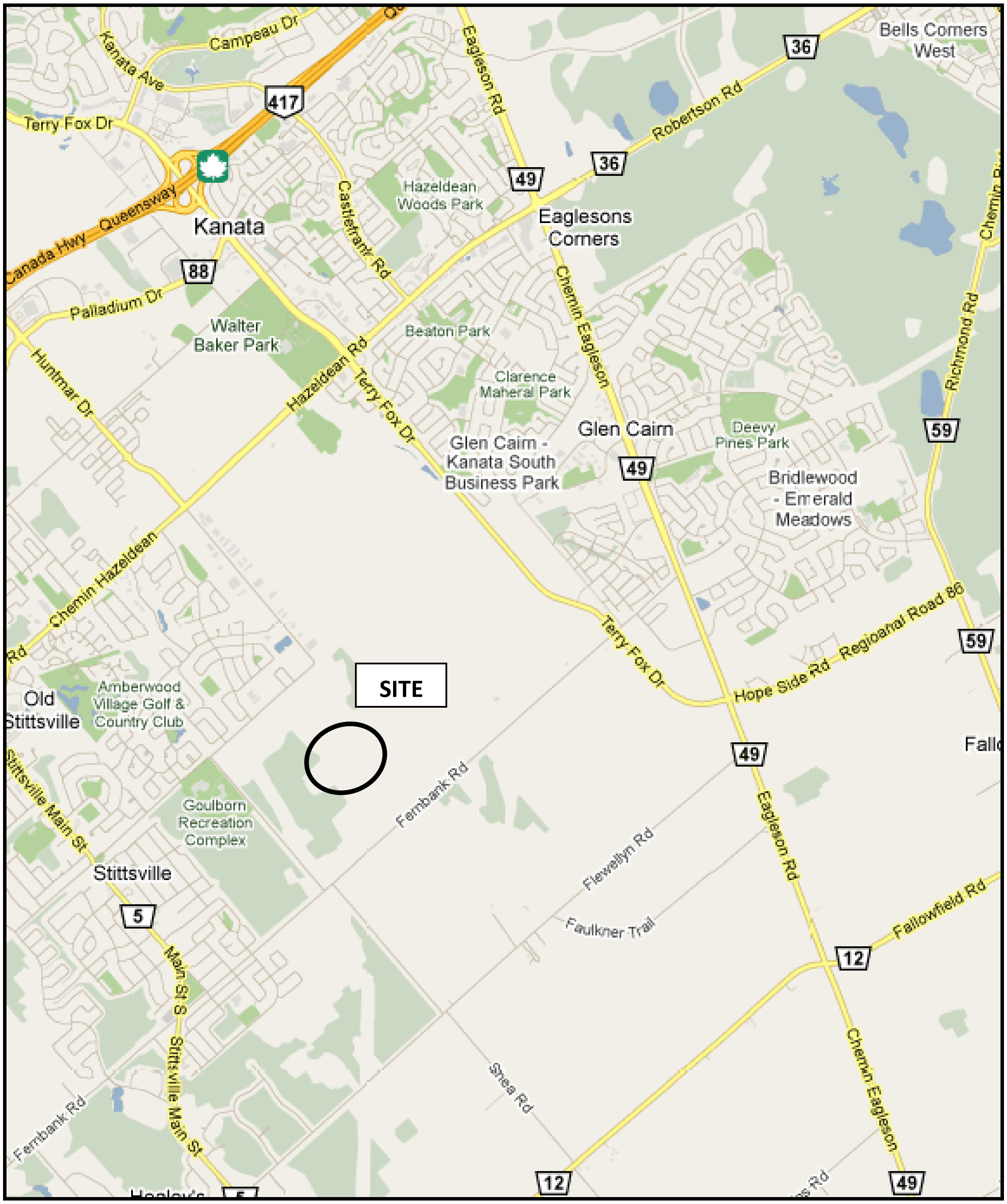
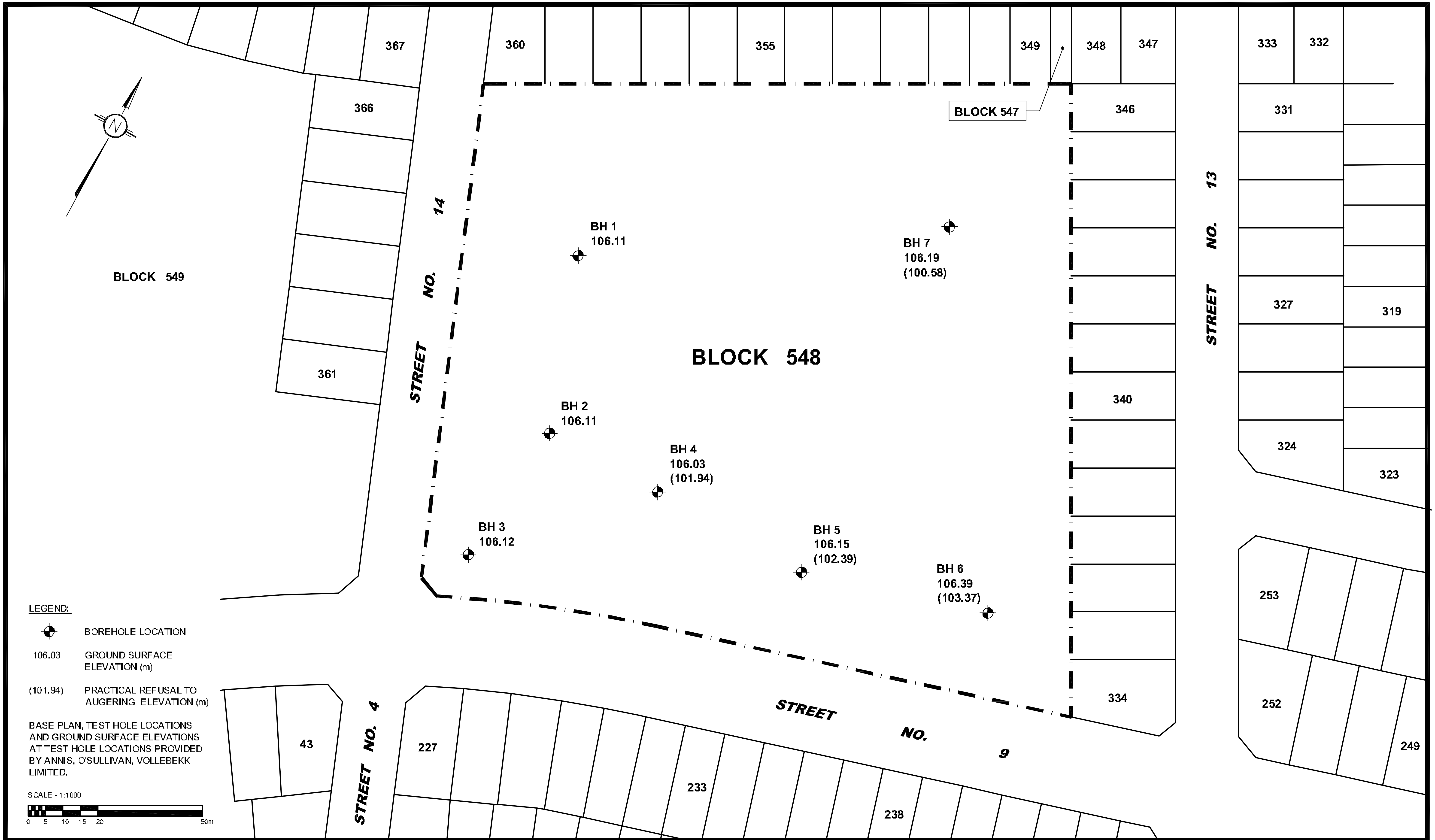


FIGURE 1

KEY PLAN



LEGEND:

⊕	BOREHOLE LOCATION
106.03	GROUND SURFACE ELEVATION (m)
(101.94)	PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

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

paterson group
consulting engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Scale: 1:1000
Des.: DG
Dwn: MPG
Chkd: DG

CEPEO
GEOTECHNICAL INVESTIGATION
PROP. SCHOOL - BLOCK 548, FERNBANK COMMUNITY
OTTAWA, ONTARIO

TEST HOLE LOCATION PLAN

Dwg. No. **PG3093-1**
Report No.: PG3093-1
Date: 11/2013

11x17