Geotechnical Engineering

Environmental Engineering

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Archaeological Services

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Geotechnical Investigation
Proposed Commercial Building
2 Bill Leathem Drive - Ottawa

Prepared For

BBS Construction Ltd.

August 6, 2020

Report: PG5257-1 Revision 1

Table of Contents

Page

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by BBS Construction to conduct a geotechnical investigation for the proposed commercial building located at 2 Bill Leathem Drive, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the investigation was to:

❑ determine the subsoil and groundwater conditions at this site by means of test holes.

❑ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

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

Investigating the presence or potential presence of contamination on the subject property was part of the scope of work of this present investigation.

2.0 Proposed Development

Based on available drawings, it is understood that the proposed development will consist of single storey commercial warehouse building of slab-on-grade construction along with associated access lanes, delivery areas, parking areas and landscaped areas. It is also understood that the proposed building will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

The current field program was carried out by Paterson on February 26 and 27, 2020. At the time 7 boreholes were advances to a maximum depth of 7.5 m below existing grade. A previous field program was carried out on May 6, 2008. At that time, one borehole was advanced to a maximum depth of 14.3 m below existing grade. The test hole locations were distributed across the site in a manner to provide general coverage of the subject site. The locations of the boreholes are shown on Drawing PG5257-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered from the auger flights or using a 50 mm diameter split-spoon sampler. The split-spoon samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the auger flight and split-spoon samples were recovered from the boreholes are depicted as AU and SS, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

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

Undrained shear strength testing, using a vane apparatus, was carried out at regular intervals in cohesive soils.

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

The overburden thickness was evaluated during the course of the investigation by dynamic cone penetration testing (DCPT) at BH1 and BH3-20. 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.

Groundwater

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

3.2 Field Survey

The test hole locations were selected by Paterson personnel to provide general coverage of the site. The locations of these test holes inand the ground surface elevation at the test hole locations were surveyed by Paterson field personnel at the time of the field program. All elevation are referred to a geodetic datum.

The locations of the test holes and the ground surface elevation at each borehole location are presented on Drawing PG5257-1 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging.

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 sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is mostly grass covered, relatively flat and at grade with nearby roadways. Evidence of fill placement and topsoil stripping was noted in the central portion of the site. An overhead distribution line was noted along the west boundary of the site.

Bill Leathem Drive is situated east, vacant and agricultural lands are situated to the north and west and the Canada Post distribution center is located south of the site.

4.2 Subsurface Profile

Generally, the soil conditions encountered at the test hole locations consists of topsoil overlying a deep silty clay deposit followed by a glacial till deposit. Practical refusal to augering or DCPT was completed at all test hole locations at depths varying between 15.9 to 21.9 m. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profiles encountered at each test hole location.

Silty Clay

A weathered silty clay crust varying in depth between 2.3 and 3.7 m was encountered at all borehole locations. In situ shear vane field testing carried out in the lower portion of the weathered crust yielded undrained shear strength values ranging from approximately 65 to 149 kPa. These values are indicative of a stiff to hard consistency.

Grey silty clay was encountered below the weathered crust at all borehole locations. In situ shear vane field testing carried out in the grey silty clay yielded undrained shear strength values ranging between 38 and 120 kPa. These values are indicative of a firm to very stiff consistency.

Bedrock

Based on available geological mapping, the site is located in an area where the bedrock consists of interbedded sandstone and dolostone of the March formation. Also, the bedrock surface is expected at depths ranging from 15 to 25 m.

4.3 Groundwater

Groundwater level readings were recorded on March 4, 2020 at the piezometer locations. The groundwater level readings are presented in the Soil Profile and Test Data sheets in Appendix 1. It should be noted that surface water can become trapped within a backfilled borehole that can lead to higher than typical groundwater level observations. Long-term groundwater level can also be estimated based on the observed color, moisture levels and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level is expected between 3.5 to 4.0 m depth. It should be noted that groundwater levels are subject to seasonal fluctuations, therefore the groundwater levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed commercial development. It is expected that the proposed building can be constructed over conventional shallow footings placed on an undisturbed very stiff brown silty clay bearing surface.

Due to the presence of silty clay deposit along the eat portion of the subject site, the site will be subjected to a permissible grade raise restriction. A permissible grade raise restriction of **2.0 m** is recommend for areas where settlement sensitive structures are founded over the silty clay deposit.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building footprint, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. It should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building area should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. 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. 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.

Fill used for grading beneath the base and subbase layers of paved areas should consist, unless otherwise specified, of clean imported granular fill, such as OPSS Granular A, Granular B Type II or select subgrade material. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the paved areas should be compacted to at least 95% of its SPMDD.

5.3 Foundation Design

Bearing Resistance Values (Shallow Foundation)

Footings placed on an undisturbed, a very stiff brown silty clay bearing surface can be designed using a factored bearing resistance value at SLS of **150 kPa** and a bearing resistance value at ULS of **250kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

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

The bearing resistance values are provided on the assumption that the footings are placed on undisturbed soil bearing surfaces. An undisturbed soil bearing surface consists of one 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 a stiff silty clay or compact silty sand above the groundwater table 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.

Permissible Grade Raise Restriction

Based on the current borehole information, a **permissible grade raise restriction of 2.0 m** is recommended for the proposed building and settlement sensitive structures where founded over a silty clay deposit. A post-development groundwater lowering of 0.5 m was assumed for our calculations.

5.4 Design for Earthquakes

A seismic site response **Class D** should be used for design of the proposed building at the subject site according to the OBC 2012. The soils underlying the site are not susceptible to liquefaction.

5.5 Slab on Grade Construction

With the removal of all topsoil and deleterious materials, within the footprint of the proposed building, the native soil or approved fill surface will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The upper 200 mm of sub-slab fill should consist of an OPSS Granular A crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

Loading Dock

The foundation wall at the loading dock, if the loading dock grade is depressed, will act as a retaining wall. Therefore, it should be designed to resist the lateral earth pressure of the fill material on the inside of the foundation wall. The wall should be designed using a triangular earth pressure distribution with a maximum stress value at the base of the wall equal to $K_a \gamma H$ where:

K_a = 0.35 - active earth pressure coefficient if some movement can be tolerated and 0.5 if no movement can be tolerated
γ = 22 kN/m^3, unit weight of the fill
H = height of the retaining wall, m

It should be noted that the fill on the inside of the wall should consist of free draining material such as OPSS Granular Type I or II.

The excavation side slope of the footing/foundation wall excavation should be tapered at 3H:1V or flatter on the pavement side of the loading dock and backfilled with OPSS Granular B Type I or II to minimize frost heaving. The fill material should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's standard Proctor dry density. The depressed area should be properly drained to minimize total and differential frost heaving.

The loading dock ramps may require protection against frost action depending on the founding depth. Unheated structures, such as the access ramp wall footings, may be required to be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided.

5.6 Pavement Design

Car only parking areas, access lanes and loading areas are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 1 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 2 - Recommended Pavement Structure - Access Lanes and Heavy Truck Loading Areas

Thickness (mm)	Material Description
40	**Wear Course** - Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**Base** - OPSS Granular A Crushed Stone
450	**Subbase** - OPSS Granular B Type II
Subgrade - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill	

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory 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. For areas where silty clay is encountered at subgrade level, it is recommended that subdrains be installed 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

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

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or equivalent. 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 required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided in this regard.

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 side slopes of excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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

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

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for bedding for sewer and water pipes when placed on soil subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

Generally, it should be possible to re-use the moist, not wet, silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. The wet silty clay should be given a sufficient drying period to decrease its moisture content to an acceptable level to make compaction possible prior to being re-used.

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 that are located in the areas underlain by silty clay. The seals should be at least 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 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

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

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

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

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

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

6.7 Corrosion Potential and Sulphate

One sample was submitted for testing. The analytical test results of the soil sample indicate that the sulphate content is less than 0.01%. These results along with the chloride and pH value are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The results of the resistivity indicate the presence of a low to moderately aggressive environment for exposed ferrous metals at this site, which is typical of silty clay samples submitted for the subject area. It is anticipated that standard measures for corrosion protection are sufficient for services placed within the silty clay deposit.

6.8 Landscaping Considerations

Tree Planting Restrictions

Paterson completed Atterberg's limit sample testing for the previous geotechnical investigation completed in 2008. Based on the results of the testing the silty clay deposit across the site is considered to be a low to medium sensitivity clay soil (Plasticity index < 40%) . Therefore, as per the most recent tree planting restriction guidelines issued by the City of Ottawa, the tree planting setbacks can be lowered.

Based on our review of the silty clay deposit, a tree planting setback limit of 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) is recommended across the subject site provided that the following conditions are met.

- ❏ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied 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 as indicated procedural changes below.

- A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 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 surround 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.

7.0 Recommendations

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

❏ Review master grading plan from a geotechnical perspective, once available.

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

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

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

❏ Observation of all subgrades prior to backfilling.

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

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

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

8.0 Statement of Limitations

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

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well 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 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 BBS Construction Ltd. or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Aug. 6, 2020
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Joey R. Villeneuve, M.A.Sc, P.Eng. Faisal I. Abou-Seido, P.Eng.

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

ATTERBERG LIMIT TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5257**

REMARKS

HOLE NO. **BH 1-20**

BORINGS BY CME 55 Power Auger

DATE 2020 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.85
TOPSOIL 0.25		AU	1				
		SS	2	96	11	1	89.85
Very stiff, dark brown to grey **SILTY CLAY,** some sand		SS	3	88	9	2	88.85
		SS	4	100	5	3	87.85
3.51							
End of Borehole							
(BH dry - March 4, 2020)							

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

○ Water Content %

20 40 60 80

120

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

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Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2020 February 26

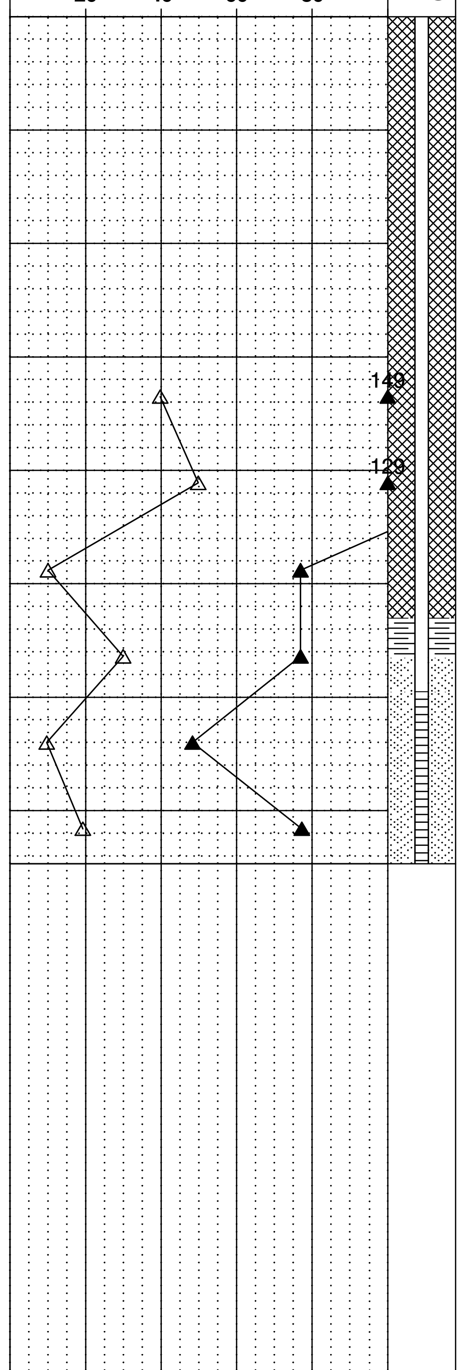
FILE NO. PG5257

HOLE NO. BH 2-20

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	90.89
TOPSOIL 0.25	AU	1				
Very stiff to stiff, dark brown **SILTY CLAY** with sand seams	SS	2	88	9	1	89.89
	SS	3	100	8	2	88.89
	SS	4	100	3	3	87.89
- grey by 2.9m depth	SS	5	100	P	4	86.89
					5	85.89
					6	84.89
7.47					7	83.89
End of Borehole						
(BH dry - March 4, 2020)						

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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SOIL PROFILE AND TEST DATA

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REMARKS

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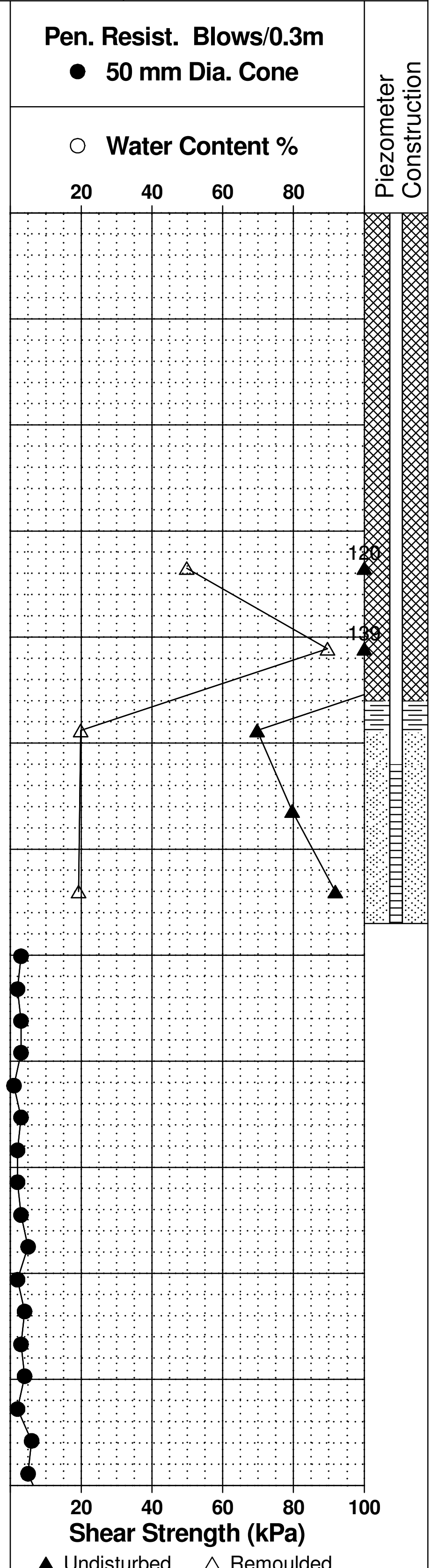
FILE NO. PG5257

HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.16
TOPSOIL — 0.25		AU	1				
		SS	2	33	10	1	90.16
		SS	3	100	10	2	89.16
Very stiff to stiff, brown **SILTY CLAY**		SS	4	100	4		
- grey by 2.3m depth						3	88.16
						4	87.16
						5	86.16
— 6.70						6	85.16
Dynamic Cone Penetration Test commenced at 6.70m depth.						7	84.16
						8	83.16
						9	82.16
						10	81.16
						11	80.16
						12	79.16



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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REMARKS

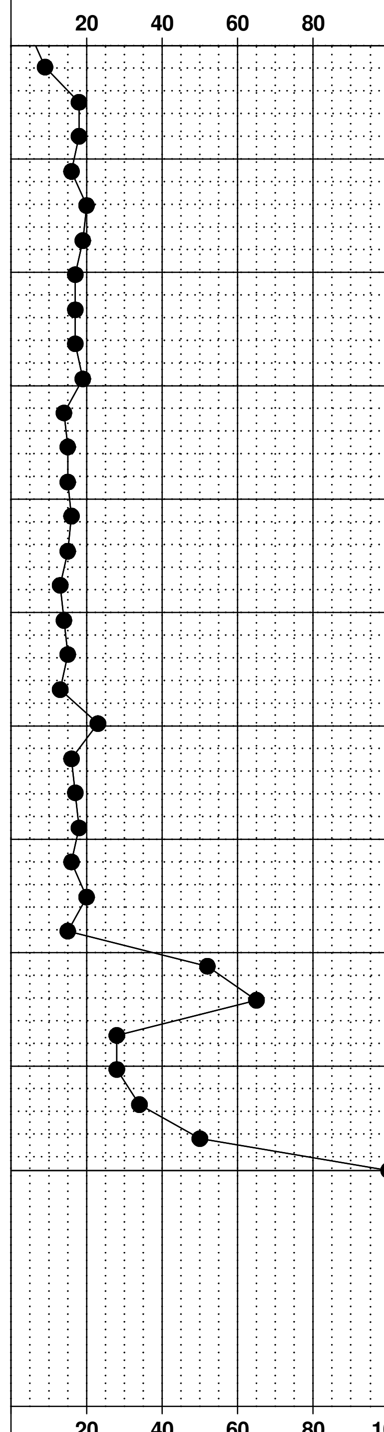
BORINGS BY CME 55 Power Auger

DATE 2020 February 26

FILE NO. PG5257

HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						12	79.16		
						13	78.16		
						14	77.16		
						15	76.16		
						16	75.16		
						17	74.16		
						18	73.16		
						19	72.16		
						20	71.16		
						21	70.16		
21.92									
End of Borehole Practical DCPT refusal at 21.92m depth (Piezometer destroyed - March 4, 2020)									



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2020 February 26

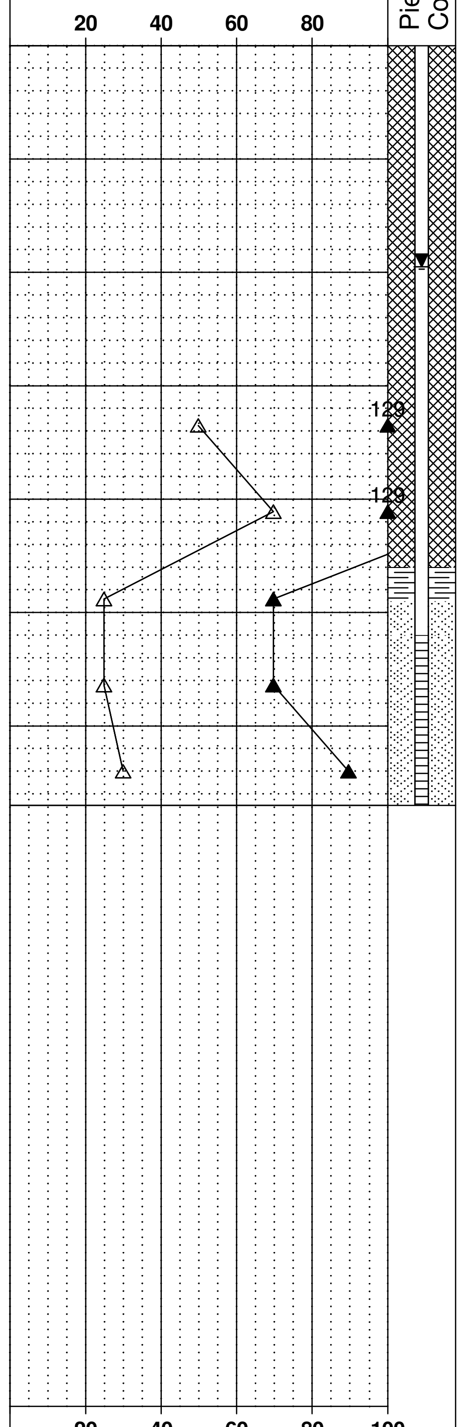
FILE NO. PG5257

HOLE NO. BH 4-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.03
TOPSOIL 0.13		AU	1				
		SS	2	50	7	1	90.03
		SS	3	100	10	2	89.03
Very stiff to stiff, brown **SILTY CLAY**		SS	4	100	4		
- grey by 3.0m depth						3	88.03
						4	87.03
						5	86.03
						6	85.03
6.70							
End of Borehole							
(GWL @ 1.95m - March 4, 2020)							

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2020 February 26

FILE NO. PG5257

HOLE NO. BH 5-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	90.64		
TOPSOIL 0.30		AU	1						
Very stiff, brown **SILTY CLAY**		SS	2	88	9	1	89.64		
2.13		SS	3	100	6	2	88.64		
End of Borehole									
(BH dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2020 February 27

FILE NO. PG5257

HOLE NO. BH 6-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.20
TOPSOIL 0.25		AU	1				
Very stiff to stiff, brown **SILTY CLAY**		SS	2	83	12	1	90.20
		SS	3	96	8	2	89.20
		SS	4	100	3	3	88.20
3.66		SS	5	96	3		
End of Borehole							
(BH dry - March 4, 2020)							

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

○ Water Content %

20 40 60 80

Piezometer Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Warehouse Bldg. - 2 Bill Leathem Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

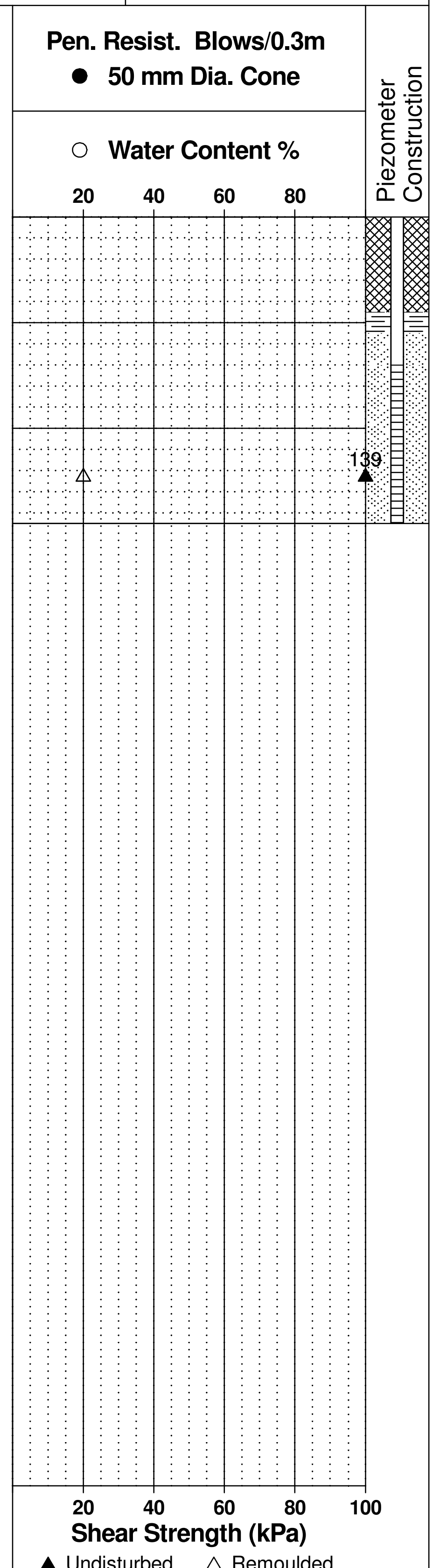
BORINGS BY CME 55 Power Auger

DATE 2020 February 27

FILE NO. PG5257

HOLE NO. BH 7-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.71
TOPSOIL 0.25		AU	1				
Very stiff, brown **SILTY CLAY**		SS	2	83	9	1	89.71
		SS	3	92	4	2	88.71
2.90		SS	4	92			
End of Borehole							
(BH dry - March 4, 2020)							



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
South Merivale Business Park, Bill Leathem Drive
Ottawa, Ontario

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

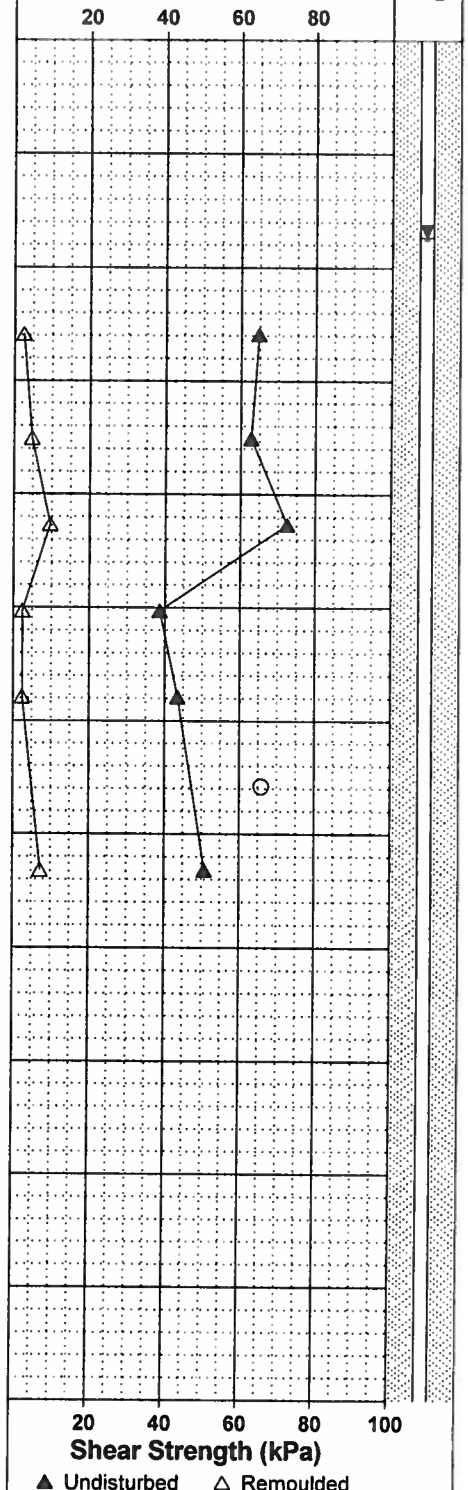
REMARKS

BORINGS BY CME 55 Power Auger **DATE** 9 May 08

FILE NO. PG1658

HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	90.74
TOPSOIL 0.10	AU	1				
Stiff, brown SILTY CLAY, some sand seams	SS	2	50	16	1	89.74
	SS	3	75	9	2	88.74
- grey by 3.7m depth					3	87.74
					4	86.74
					5	85.74
					6	84.74
	TW	4	100		7	83.74
	SS	5	25	13	8	82.74
8.53						
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles	SS	6	17	9	9	81.74
	SS	7	33	10	10	80.74
	SS	8	8	11		
	SS	9	12	13	11	79.74
	SS	10	12	5	12	78.74



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
South Merivale Business Park, Bill Leathem Drive
Ottawa, Ontario

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

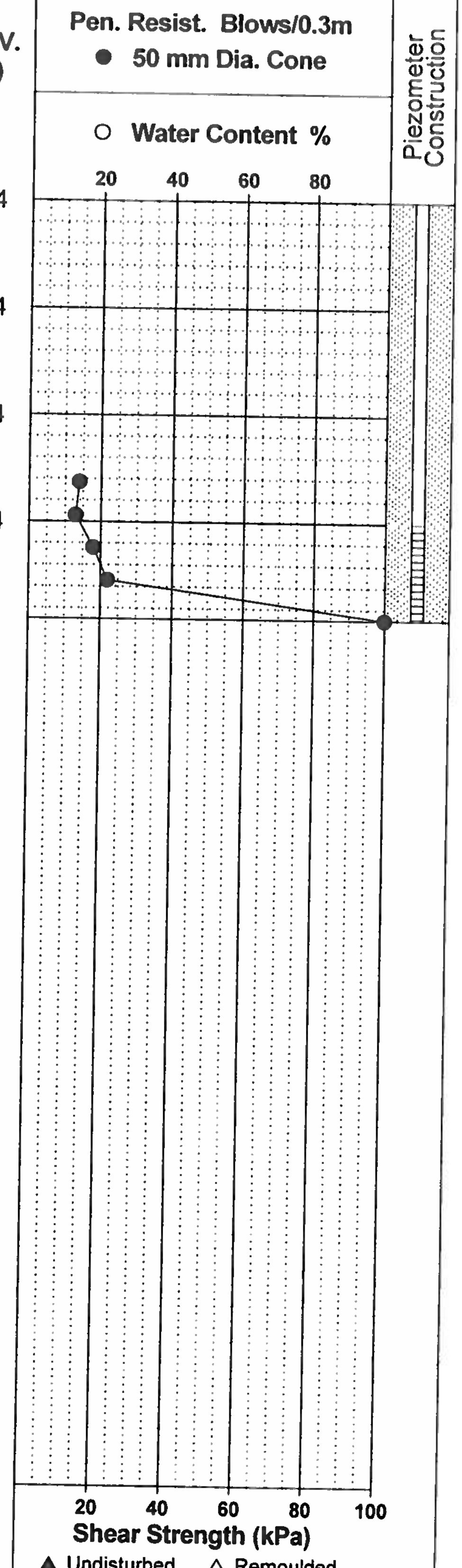
FILE NO. PG1658

REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger **DATE** 9 May 08

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
						12	78.74
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles		SS	11	12	7		
						13	77.74
		SS	12	33	15	14	76.74
14.33							
Dynamic Cone Penetration Test commenced @ 14.33m depth Inferred **GLACIAL TILL**						15	75.74
15.90							
End of Borehole Practical DCPT refusal @ 15.90m depth (GWL @ 1.73m-June 10/08)							



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

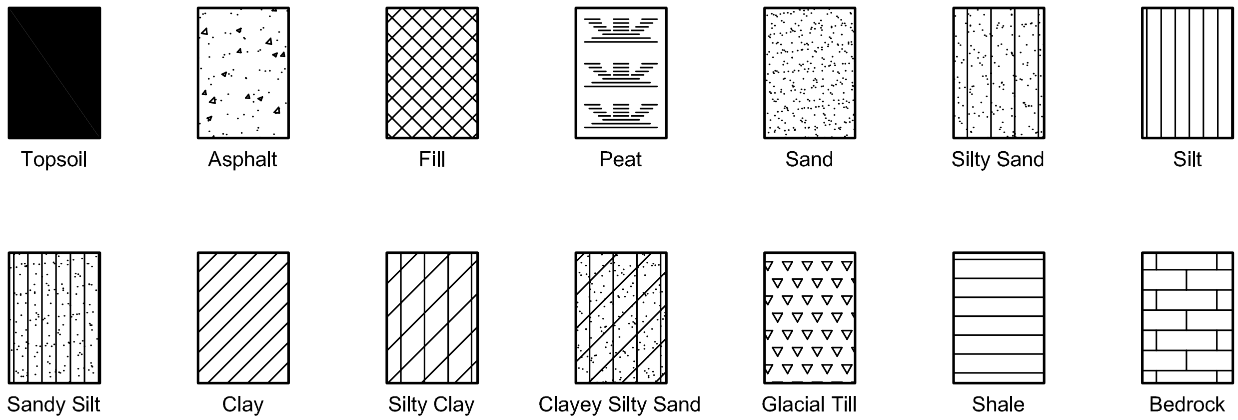
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void 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.

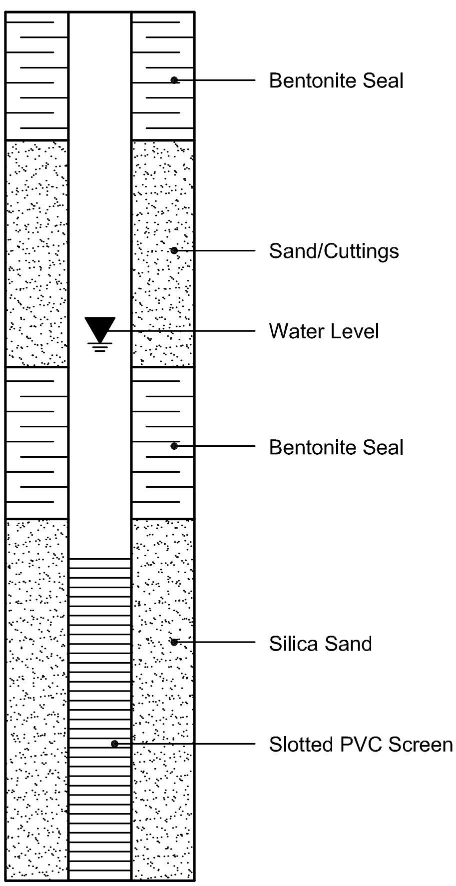
SYMBOLS AND TERMS (continued)

STRATA PLOT

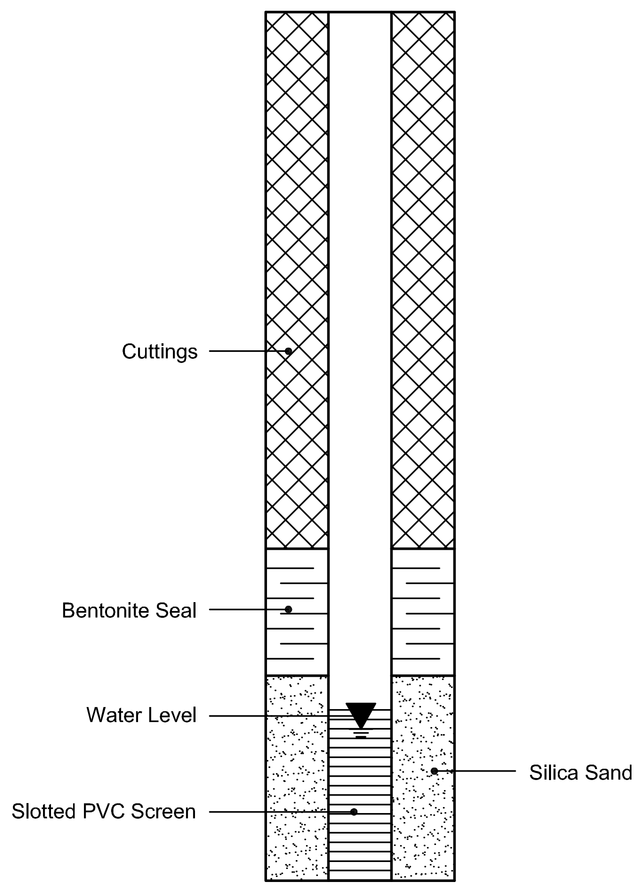


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

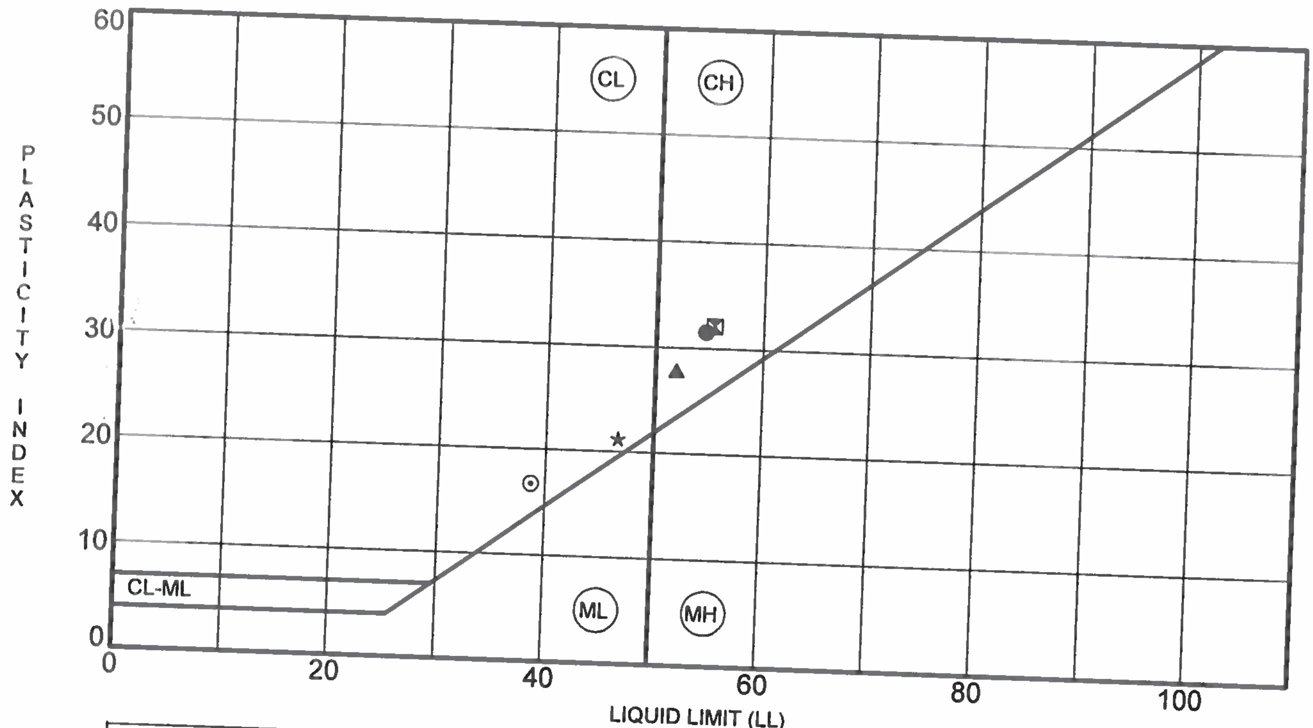
Client PO: 29592

Report Date: 05-Mar-2020

Order Date: 2-Mar-2020

Project Description: PG5257

	Client ID:	BH7 SS2 2.5' - 4.5'	-	-	-
	Sample Date:	27-Feb-20 10:00	-	-	-
	Sample ID:	2010057-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	75.2	-	-	-
General Inorganics					
pH	0.05 pH Units	7.14	-	-	-
Resistivity	0.10 Ohm.m	86.4	-	-	-
Anions					
Chloride	5 ug/g dry	11	-	-	-
Sulphate	5 ug/g dry	32	-	-	-



	Specimen Identification	LL	PL	PI	Fines	Classification
●	BH 1	55	23	32		
⊠	BH 3	55	23	32		
▲	BH 4	52	24	28		
★	BH 5	47	26	21		
⊙	BH 6	39	22	17		

CLIENT Minto Communities Inc.

PROJECT Geotechnical Investigation - South Merivale Business Park, Bill Leathem Drive

FILE NO. PG1658

DATE 7 May 08

patersongroup Consulting Engineers
28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

ATTERBERG LIMITS' RESULTS

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2A & 2B - SLOPE STABILITY CROSS SECTION

DRAWING PG5257-1 - TEST HOLE LOCATION PLAN

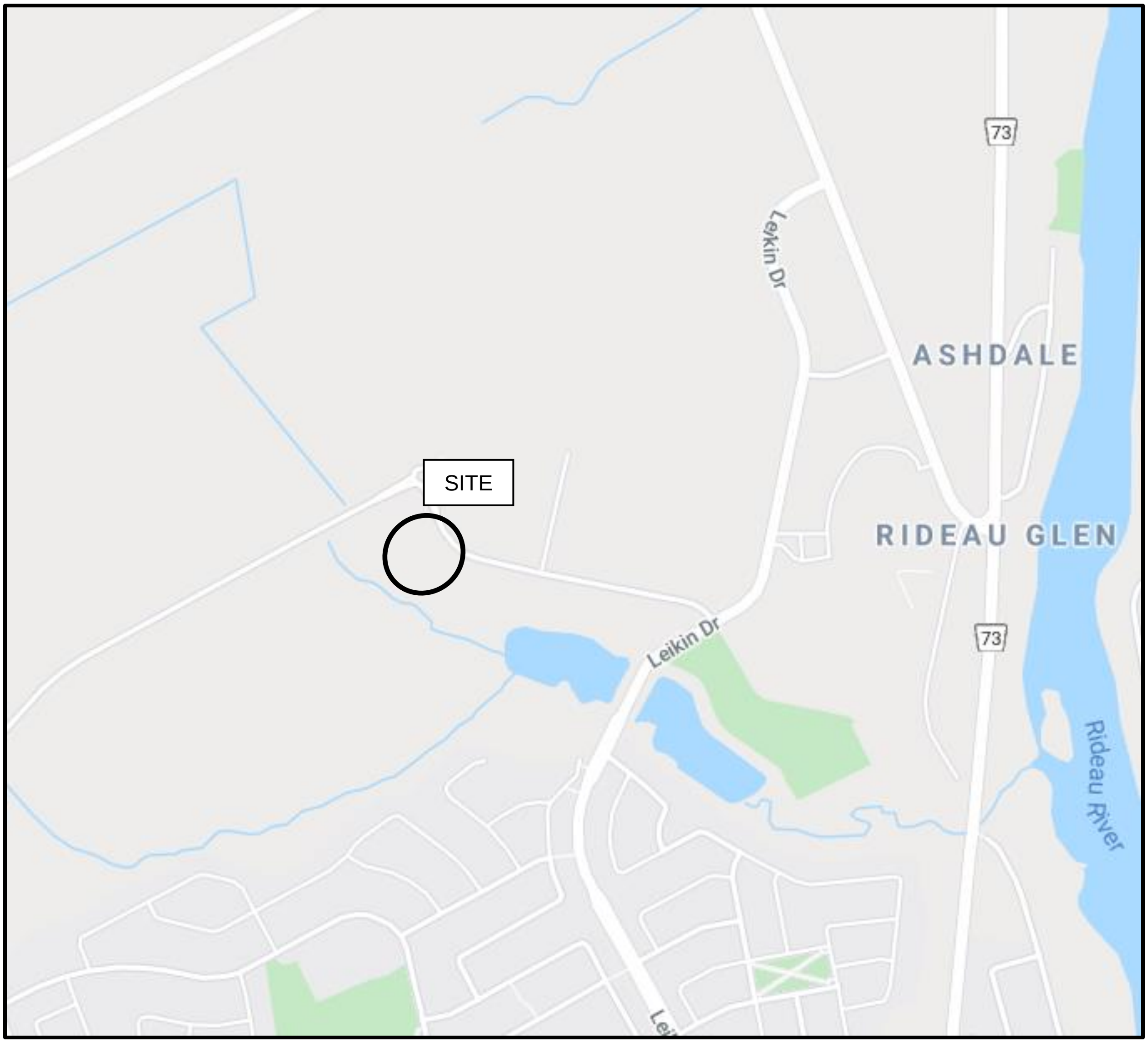
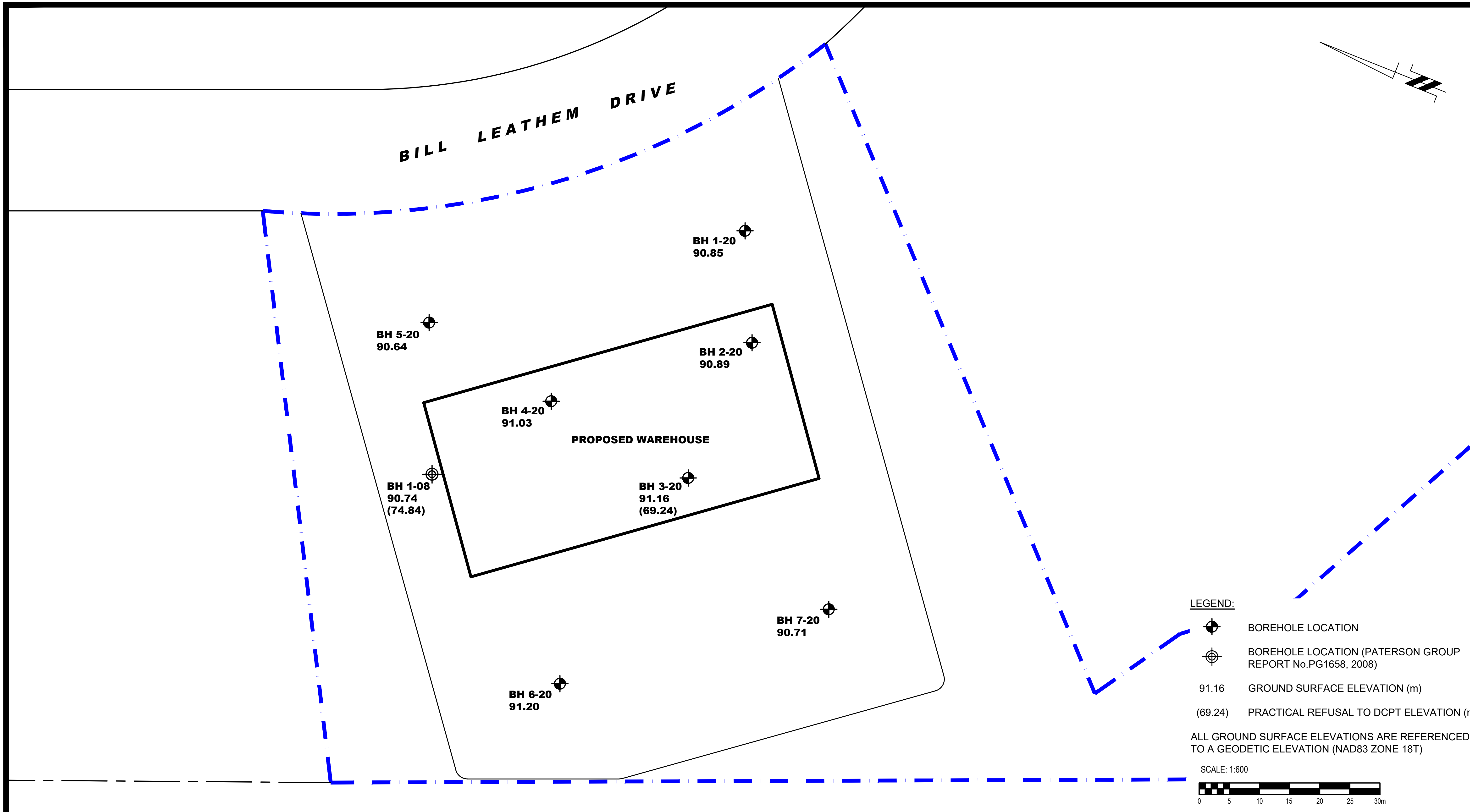


FIGURE 1

KEY PLAN



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

NO.	REVISIONS	DATE	INITIAL

BBS CONSTRUCTION

GEOTECHNICAL INVESTIGATION
2 BILL LEATHEM DRIVE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:600	Date: 03/2020
Drawn by: NFRV	Report No.: PG5257-1
Checked by: JV	Dwg. No.: **PG5257-1**
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg52xx\pg5257\pg5257-1 test hole location plan(rev).dwg