

Geotechnical
Engineering

Environmental
Engineering

Hydrogeology

Geological
Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Commercial Building
44 Iber Road
Ottawa, Ontario

Prepared For

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Report PG4089-1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Huntington Construction and Development Inc. to conduct a geotechnical investigation for the proposed commercial building to be located at 44 Iber Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the current investigation were to:

- ❑ Determine the subsoil and groundwater conditions at this site by means of 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. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed building as they are understood at the time of writing this report.

2.0 Proposed Project

It is understood that the proposed project consists of a one storey commercial building of slab-on-grade construction to be constructed behind the parking area for the existing commercial building along Iber Road. Associated at-grade parking areas, access lanes, and landscaped areas are also anticipated as part of the proposed project.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on March 24, 2017. At that time, five (5) boreholes were completed across the subject site along with three (3) probeholes where shallow refusal to augering was encountered. The test hole locations were selected in a manner to provide general coverage of the proposed development. The locations were determined in the field by Paterson personnel and are shown in Drawing PG4089-1 - Test Hole Location Plan included in Appendix 2.

The boreholes completed for the investigation were drilled 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, sampling and testing the overburden.

Sampling and In Situ Testing

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

Standard Penetration Tests (SPT) were conducted and 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 the initial penetration of 150 mm using a 63.5 kg hammer falling from a height of 760 mm.

The subsurface conditions observed in the boreholes 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 standpipe piezometers were installed in four of the boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. All groundwater observations are noted on the Soil Profile and Test Data sheets presented in Appendix 1.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless otherwise directed.

3.2 Field Survey

The test hole locations and elevations were surveyed in the field by Paterson. The ground surface elevation at the test hole locations was referenced to a temporary benchmark (TBM), consisting of the top of spindle of a fire hydrant located south of the site along Iber Road. A geodetic elevation of 106.59 m for the TBM was provided by Annis O'Sullivan Vollebakk Ltd. The test hole locations and ground surface elevations at the test hole locations along with the TBM location are presented on Drawing PG4089-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

All soil samples were recovered from the subject site and visually examined in our laboratory to review the soil investigation results.

3.4 Analytical Testing

One soil sample from the subject site 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 analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

Currently, the proposed building footprint and proposed parking area are being used by a tenant as a storage area for landscaping stones. Several wood pallets and small construction equipment were also present on site. Generally, the ground surface across the site is relatively flat.

4.2 Subsurface Profile

Generally, the subsurface profile at the test hole locations consists of a crushed stone fill layer at ground surface underlain by varying fill layer over a compact to very dense, sandy silt and/or stiff silty clay deposit. A glacial till deposit, consisting of a silty sand and sandy silt with gravel, cobbles and boulders, was encountered below the above-noted layers at BH 2, BH 4 and BH 5. Practical refusal to augering was encountered at all boreholes and probeholes between 0.8 to 3.3 m depth.

Specific details of the soil profile at each test hole location are presented on the Soil Profile and Test Data sheets provided in Appendix 1.

Based on available geological mapping, bedrock in the area of the subject site consists of interbedded limestone and dolomite of the Gull River formation. The overburden thickness is anticipated to be between 3 to 5 m depth.

4.3 Groundwater

Groundwater levels were measured in the boreholes on March 30, 2017. The measured groundwater level (GWL) readings are presented in Table 1 below and in the Soil Profile and Test Data sheets in Appendix 1. It should be noted that the water levels observed within the piezometers could be due to rain water or spring melt water trapped within the backfilled borehole. Long-term groundwater levels can also be estimated based on the observed colouring, moisture levels and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater table can be expected between **2.5 to 3 m** depth. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

| Table 1 - Measured Groundwater Levels | | | | |
|--|-------------------------------------|--------------------------|----------------------|----------------|
| Test Hole Location | Ground Surface Elevation (m) | Groundwater Level | | Date |
| | | Depth (m) | Elevation (m) | |
| BH 2 | 104.51 | 0.35 | 104.16 | March 30, 2017 |
| BH 3 | 104.63 | 0.15 | 104.48 | March 30, 2017 |
| BH 4 | 104.44 | 0.00 | 104.44 | March 30, 2017 |
| BH 5 | 104.72 | 0.00 | 104.72 | March 30, 2017 |

5.0 Discussion

5.1 Geotechnical Assessment

The subject site is considered adequate from a geotechnical perspective for the proposed building. It is expected that the proposed structure will be founded by conventional shallow spread footings bearing on an undisturbed, compact sandy silt, glacial till or limestone bedrock bearing surface.

Shallow bedrock may be encountered above design footing elevation and service invert levels. Consideration could be given to raising underside of footing level where shallow bedrock is encountered and rigid insulation could be placed over service pipes to provide sufficient frost protection to limit bedrock removal volumes. Bedrock removal, if required, can be completed by hoe ramming where only small quantities of rock removal are required. However, line drilling in conjunction with controlled blasting would be required for areas where significant bedrock removal would be required.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Bedrock Removal

If required, prior to undertaking the blasting operations, the blasting effects on the existing services, buildings and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in proximity of the blasting operations should be carried out prior to commencing site activities. The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries/claims related to the blasting operations.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm per second during the blasting program to reduce the risks of damage to the existing structures, especially the multi-storey building to the west.

The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Fill Placement

Fill used for grading beneath the building footprints, 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 due to the frost heave potential of the site excavated soils below settlement sensitive areas, such as concrete sidewalks and exterior concrete entrance areas.

5.3 Foundation Design

Shallow Footings

Conventional shallow footings placed on an undisturbed, compact sandy silt or glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. Footings placed over a clean, bedrock bearing surface can be designed using a factored bearing resistance value at ULS of **750 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

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

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

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a compact glacial till above the groundwater table 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 of the same or higher capacity as the bearing medium soil.

Permissible Grade Raise Restriction

Due to the silty clay deposit encountered below the subject site, a permissible grade raise restriction of **2 m** is recommended.

5.4 Design for Earthquakes

The proposed site can be taken as seismic site response **Class C** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A) for foundations considered at this site. A higher site class, such as Class A or B, may be applicable for foundation design. However, a site specific seismic shear wave velocity test is required to confirm the higher site class. The underlying strata are not considered to be 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 engineered fill surface will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The upper 150 mm of sub-slab fill should consist of an OPSS Granular A crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

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.

5.6 Pavement Structure

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

| Table 2 - Recommended Pavement Structure - Car Only Parking Areas | |
|--|--|
| Thickness (mm) | Material Description |
| 50 | Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete |
| 150 | BASE - OPSS Granular A Crushed Stone |
| 300 | SUBBASE - OPSS Granular B Type II |
| | SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill |

| Table 3 - Recommended Pavement Structure Access Lanes and Heavy Truck Parking 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 SPMD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structure. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non-frost susceptible granular materials, such as clean sand or OPSS Granular B Type I granular material. 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. A drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system is recommended.

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

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

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.

6.5 Groundwater Control

Groundwater Control for Building Construction

It is anticipated that groundwater infiltration into the excavations should be low to moderate 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 and Climate Change (MOECC) 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 MOECC.

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 MOECC 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

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 to slightly aggressive corrosive environment.

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.

- 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 Huntington Construction and Development 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.

Shahin Masoumzadeh, P.Eng.



David J. Gilbert, P.Eng.

Report Distribution:

- Huntington Construction & Development Inc. (3 copies)
- Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TEST RESULTS

DATUM TBM - Top spindle of fire hydrant located near the entrance to 57 Iber Road.
Geodetic elevation = 106.59m.
REMARKS 18T 428633E; 5014444N

FILE NO.
PG4089

HOLE NO.
BH 3

BORINGS BY CME 55 Power Auger

DATE March 24, 2017

| 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 | | | | | | 0 | 104.63 | | | | | | |
| FILL: Brown sand, trace organics | 0.08 | AU | 1 | | | | | | | | | | |
| FILL: Brown to black silty clay, trace sand, gravel and organics | 0.58 | AU | 2 | | | | | | | | | | |
| Compact to very dense, brown SANDY SILT | | SS | 3 | 75 | 13 | 1 | 103.63 | | | | | | |
| | | SS | 4 | 36 | 50+ | | | | | | | | |
| End of Borehole | 1.70 | | | | | | | | | | | | |
| Practical refusal to augering at 1.70m depth (GWL @ 0.15m-March 30, 2017) | | | | | | | | | | | | | |

○ Water Content %

20 40 60 80 100
Shear Strength (kPa)

▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Building - 44 Iber Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located near the entrance to 57 Iber Road.
Geodetic elevation = 106.59m.

REMARKS

FILE NO.
PG4089

HOLE NO.
PH 1

BORINGS BY CME 55 Power Auger

DATE March 24, 2017

| 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 | | | | | | 0 | 104.61 | | | | | | |
| OVERBURDEN | | | | | | 1 | 103.61 | | | | | | |
| End of Probehole | | | | | | | | | | | | | |
| Practical refusal to augering at 1.62m depth | | | | | | | | | | | | | |

1.62

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Building - 44 Iber Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located near the entrance to 57 Iber Road.
Geodetic elevation = 106.59m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 24, 2017

FILE NO.
PG4089

HOLE NO.
PH 2

| 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 | | | | | | 0 | 104.55 | | | | | | | |
| OVERBURDEN | | | | | | 1 | 103.55 | | | | | | | |
| | | | | | | 2 | 102.55 | | | | | | | |
| | | | | | | | 2.16 | | | | | | | |
| End of Probehole Practical refusal to augering at 2.16m depth | | | | | | | | | | | | | | |

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

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. |
|---|---|--|

SYMBOLS AND TERMS (continued)

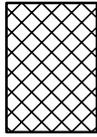
STRATA PLOT



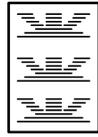
Topsoil



Asphalt



Fill



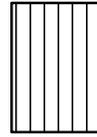
Peat



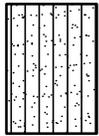
Sand



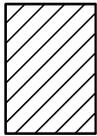
Silty Sand



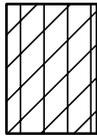
Silt



Sandy Silt



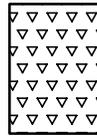
Clay



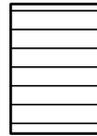
Silty Clay



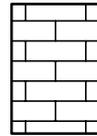
Clayey Silty Sand



Glacial Till



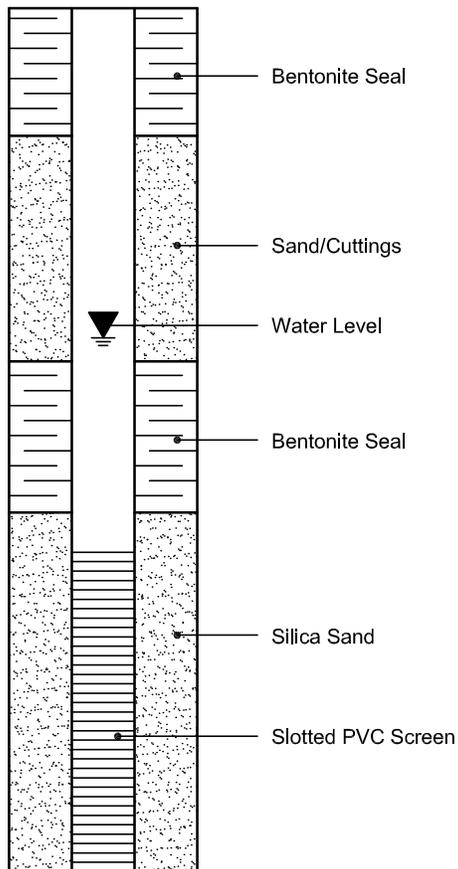
Shale



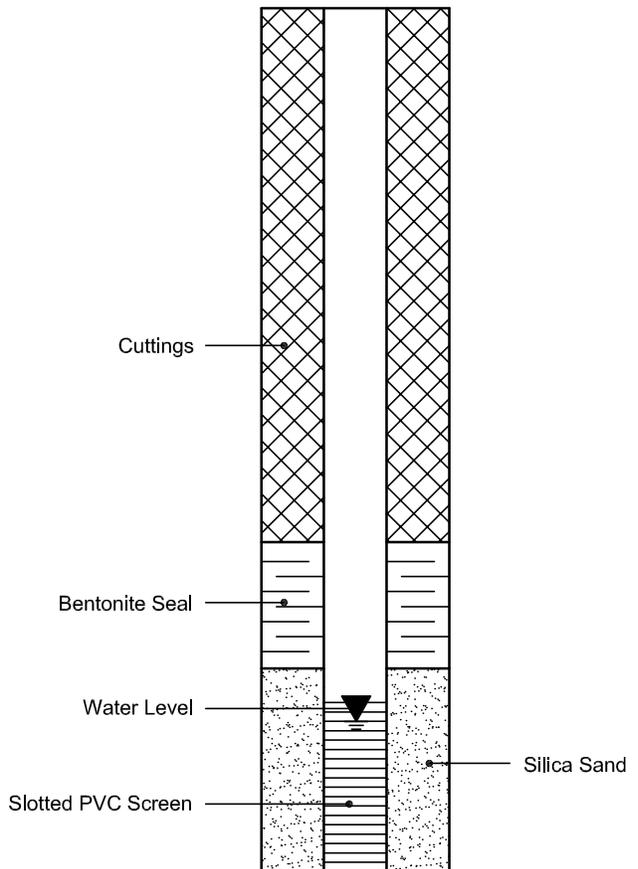
Bedrock

MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis
 Client: Paterson Group Consulting Engineers
 Client PO: 21275

Report Date: 30-Mar-2017

Order Date: 27-Mar-2017

Project Description: PG4089

| | | | | |
|---------------------|------------|---|---|---|
| Client ID: | BH2-SS3 | - | - | - |
| Sample Date: | 24-Mar-17 | - | - | - |
| Sample ID: | 1713071-01 | - | - | - |
| MDL/Units | Soil | - | - | - |

Physical Characteristics

| | | | | | |
|----------|--------------|------|---|---|---|
| % Solids | 0.1 % by Wt. | 91.8 | - | - | - |
|----------|--------------|------|---|---|---|

General Inorganics

| | | | | | |
|-------------|---------------|------|---|---|---|
| pH | 0.05 pH Units | 7.98 | - | - | - |
| Resistivity | 0.10 Ohm.m | 63.7 | - | - | - |

Anions

| | | | | | |
|----------|------------|----|---|---|---|
| Chloride | 5 ug/g dry | 21 | - | - | - |
| Sulphate | 5 ug/g dry | 36 | - | - | - |

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4089-1 - TEST HOLE LOCATION PLAN

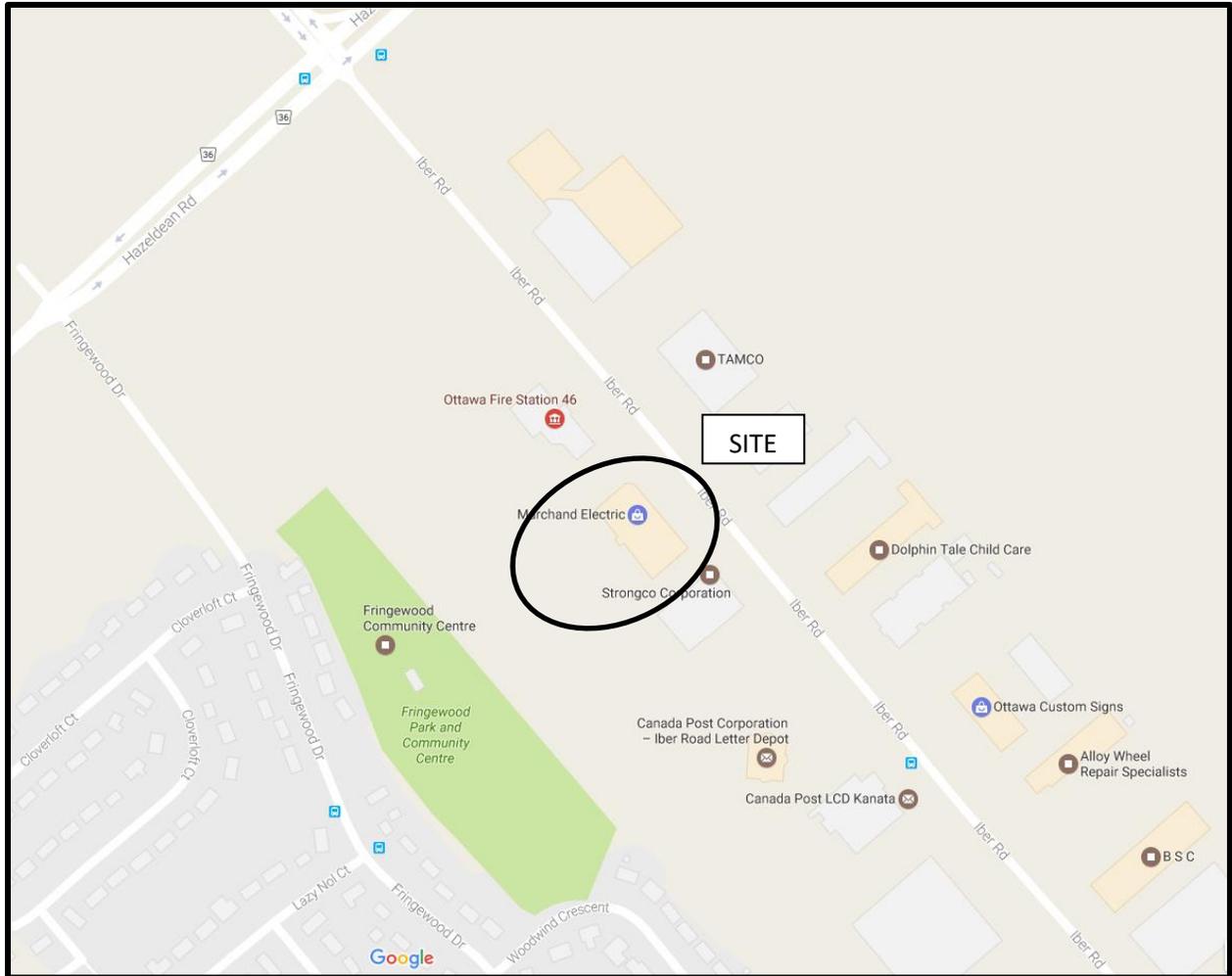
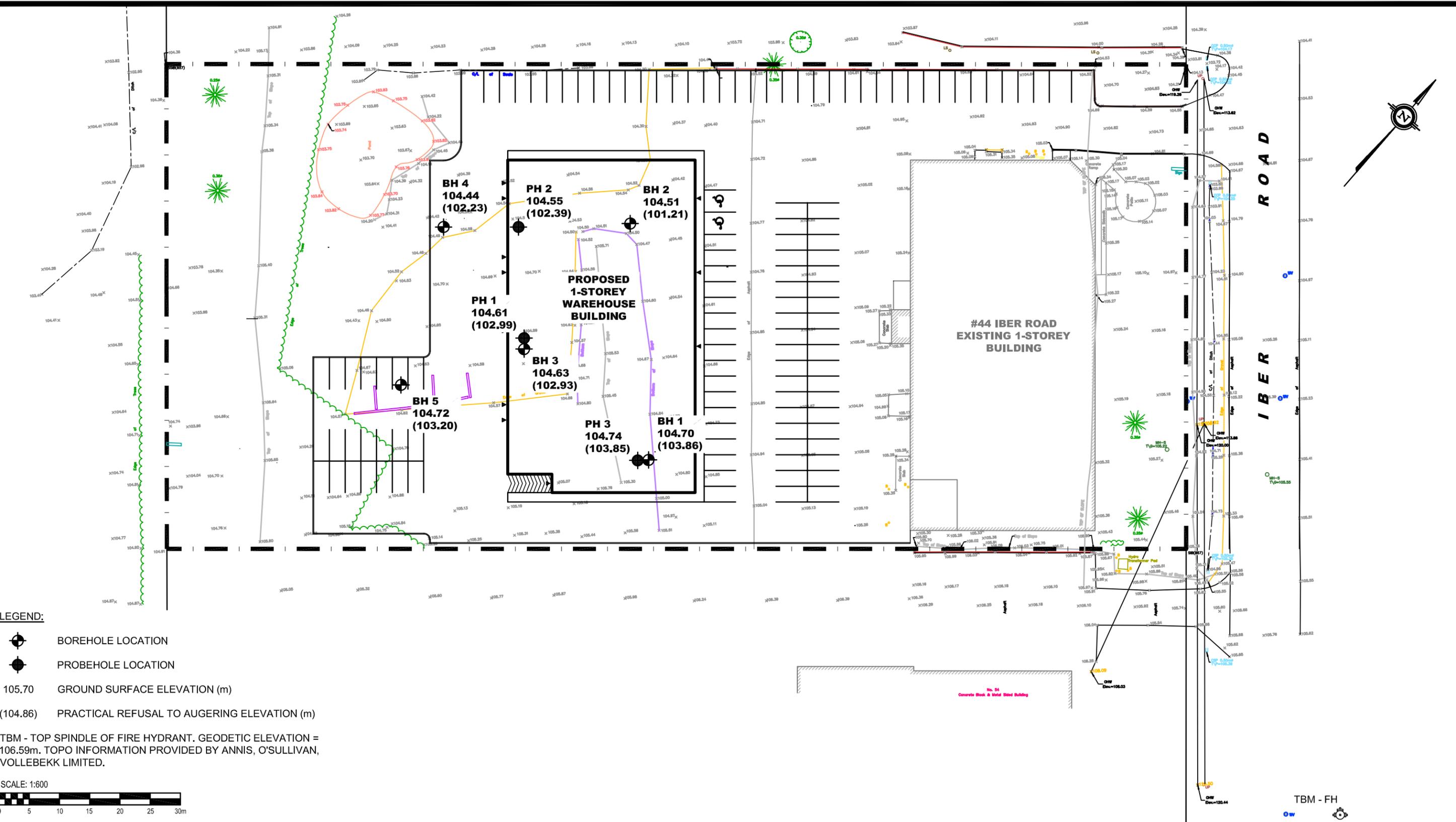


FIGURE 1
KEY PLAN



LEGEND:

- BOREHOLE LOCATION
- PROBEHOLE LOCATION
- 105.70 GROUND SURFACE ELEVATION (m)
- (104.86) PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

TBM - TOP SPINDLE OF FIRE HYDRANT. GEODETIC ELEVATION = 106.59m. TOPO INFORMATION PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

SCALE: 1:600

patersongroup
consulting engineers

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Ottawa, Ontario K2E 7J5
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| NO. | REVISIONS | DATE | INITIAL |
|-----|-----------|------|---------|
| 0 | | | |

HUNTINGTON CONSTRUCTION & DEVELOPMENT INC.

GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL BUILDING - 44 IBER ROAD

OTTAWA, ONTARIO

TEST HOLE LOCATION PLAN

| | | | |
|--------------|-------|---------------|-----------------|
| Scale: | 1:600 | Date: | 03/2017 |
| Drawn by: | MPG | Report No.: | PG4089-1 |
| Checked by: | SM | Dwg. No.: | PG4089-1 |
| Approved by: | DJG | Revision No.: | 0 |