Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

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Geotechnical Investigation

Proposed Commercial Development
16th Street East at 20th Avenue
Owen Sound, Ontario

Prepared For

Thompson Centres

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Report PG5220-1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Thompson Centres to conduct a geotechnical investigation for the proposed commercial development to be located a the intersection of 16th Street East and 20th Avenue in the City of Owen Sound, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were 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 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 subject development as they are understood at the time of writing this report.

2.0 Proposed Development

Based on the available drawings, it is understood that the proposed commercial development will consist of four, one-storey commercial buildings of slab-on-grade construction. Access lanes, loading areas, parking areas and landscaping are also anticipated as part of the proposed development. Furthermore, it is anticipated that a retaining wall is also proposed as part of the proposed development. The subject site is anticipated to be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was carried out on September 15, 2020. At that time, six (6) test pits were advanced to a maximum depth of 2.8 m below the existing ground surface. The test hole locations were distributed in a manner to provide general coverage of the subject site. The approximate locations of the test holes are shown on Drawing PG5220-1 - Test Hole Location Plan included in Appendix 2.

All test pits were excavated using a hydraulic mini-excavator. The test pitting procedure consisted of excavating to the required depths at the selected locations, sampling and testing the overburden. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer.

Sampling and In Situ Testing

Soil samples were recovered directly from the test holes. All samples were visually inspected and initially classified on site and subsequently placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the samples were recovered from the test pits are shown as G, on the Soil Profile and Test Data sheets presented in Appendix 1.

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 of this report.

3.2 Field Survey

The location of the test pits were recovered in the field by Paterson personnel. The ground surface elevation at each test hole location was inferred from a topographic survey plan prepared by Dinsmore & England Ltd. for the subject site. The location and ground surface elevation at each test hole location is presented on Drawing PG5220-1 - 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 logging. Soil samples will be stored for a period of one month after this report is completed, unless otherwise directed.

A total of 2 grain size distribution analyses were completed on selected soil samples. The results of our testing are presented in Subsection 4.2 and on Grain-Size Distribution and Hydrometer Testing sheets are attached in Appendix 1.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the potential for exposed ferrous metals and the sulphate potential 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

The subject site is currently heavily tree-covered throughout the west half and lightly vegetated along the east portion. Based on historical aerial photographs, the subject site was once occupied by a slab-on-grade residential dwelling along the south-east portion of the subject site. The residential dwelling has been since demolished while its debris remains in its footprint. Gravel-covered access roads extend from 16th Street East and are approximately 1.5 to 2.0 m above the average existing surround grades.

The subject site is bordered by 16th Street East to the south, a 1 m deep ditch and further by 17th Street East to the north, a commercial property to the west and undeveloped land to the east. The existing ground surface slopes gradually downward from south to north with approximate geodetic elevations of 225 to 221 m. The existing grade throughout the south and north portions of the subject site are approximately 4 m lower and at-grade with 16th Street East and 17th Street East, respectively.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations located within the subject site consists of a topsoil layer followed by a compact to very dense glacial till deposit consisting of silty clay with sand, gravel, cobbles and boulders. The glacial till layer transitioned from a weathered brown and/or reddish brown to an unweathered grey glacial till consisting of silty clay with gravel, cobbles and boulders at 2.4 m depth below the existing ground surface in TP1-20. Cobble and boulder content was generally observed to increase with depth at all test hole locations. The soil profiles are presented in greater detail on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Bedrock

Based on available geological mapping from the Ontario Geological Survey and Ontario Well Records publically available Ontario's Ministry of the Environment, the bedrock generally consists of lower Silurian sandstone, shale, dolomite and siltstone of the Clinton/Cataract group, with a drift thickness between 5 to 15 m.

Grain Size Distribution and Hydrometer Testing

Grain size distribution (sieve and hydrometer analysis) was completed on two (2) soil samples recovered from stockpiles located off-site and being considered for use as grade raise fill for the proposed development. The results of the grain size analysis are summarized in Table 1 and presented on the Grain-Size Distribution and Hydrometer Testing Results sheets in Appendix 1.

Table 1 - Summary of Grain Size Distribution Analysis

Sample ID and Approximate Location	Sample Type	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
Off-Site #1 16th Street East and Highway 26	Test Pit	10.1	30.5	36.7	22.7
Off-Site #2 20th Street East and Future 20th Avenue	Side-slope	60.7	31.4	6.9	1.0

4.3 Groundwater

All test holes were generally observed to be dry upon completion of the sampling program with the exception of minor infiltration noted along the test pit sidewalls at the above-noted depths. Based on the moisture levels and colouring of the recovered soil samples, the long-term groundwater table is expected at depths between 3 to 4 m below ground surface. The recorded groundwater levels are noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level 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 development. It is expected that the Building B and Building C will be founded on conventional shallow footings bearing on an undisturbed, compact to very dense glacial till bearing surface. It is further anticipated that Building A and Building D will be founded on conventional shallow footings bearing upon either an engineered fill pad or lean-concrete infilled trenches, both extending to an undisturbed, compact to very dense glacial till bearing surface.

Imported non-specified fill will be required to accommodate the proposed finished grades throughout the subject site. Recommendations pertaining to the placement and use of imported fill materials are provided in Section 5.2 to accommodate the proposed site grading. It should be noted that the off-site fill analyzed is considered acceptable to raise the grade within the subject site.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, concrete, construction remnants and fill, containing significant amounts of deleterious or organic materials, should be stripped from under any building, paved areas, pipe bedding and other settlement sensitive structures.

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

Fill Placement

Fill used for grading beneath the proposed buildings and settlement sensitive structures, such as retaining walls, should consist of clean imported granular fill, or engineered 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 lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building and paved areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

Non-specified existing fill, non-specified imported fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids throughout these areas.

Where non-specified imported fill material is considered to build up the subgrade level for areas to be paved, it should be compacted in thin lifts (ie. - maximum 300 mm thick loose lifts) to at least 95% of the material's SPMDD. The non-specified fill should be compacted using a suitably sized vibratory roller, while clay-dominant soils should be compacted using a suitably sized sheepsfoot roller. Importing and placement of non-specified fill should be reviewed and approved by the geotechnical consultant at the time of construction.

Imported Fill Material

The fill material is recommended to be free of deleterious materials, organics, and debris that may break down and reduce the load-carrying capacity of the material. Unsuitable deleterious materials that should be segregated from grade raise fill includes, but is not limited to organics such as peat, logs/stumps and notable amounts of grass and similar organic matter, debris such as asphalt, concrete, steel, plastic, rubber, glass, etc.

All non-specified engineered fill should be placed **under try conditions and above freezing temperatures** and should be approved by the geotechnical consultant at the time of construction. It is further recommended that all soil and fill particles with a diameter greater than 300 mm in their longest dimension be segregated from the fill prior to placement of the fill to minimize voids created by their presence in the fill layers.

Placement of imported, non-engineered fill material during winter months increases the risk of placing frozen material which may result in poor performing areas that may require sub-excavation of the material and subsequent reinstatement. Any soft or poor performing areas should be inspected by the geotechnical consultant and replaced with OPSS Granular A or Granular B Type II and compacted to a minimum 98% of the material's SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a composite drainage membrane.

In-Filling Existing Ditches

In-filling the site's existing ditches should be completed in a stepped fashion within the lateral support of the proposed buildings. The fill should consist of clean imported granular fill, such as OPSS Granular A or Granular B Type II material. The steps should have a minimum horizontal length of 1.5 m and minimum vertical height of 0.5 m and should be compacted using suitable compaction equipment to a minimum 98% of the material's SPMDD. All backfilling and compaction efforts should be reviewed and approved by Paterson personnel at the time of construction.

5.3 Foundation Design

Based on the proposed preliminary finished floor elevations (FFE) and footing embedment depth as governed by protection from frost action, the following procedures are recommended to be carried out for design and construction of the proposed buildings to limit post-construction total and differential settlements to 25 and 20 mm, respectively:

Building B and Building C - Bearing Resistance Values

Based on the proposed FFE's, Buildings B and C will be founded directly upon the in-situ undisturbed glacial till bearing medium. Conventional spread footings placed on an undisturbed, compact glacial till bearing surface can be designed using a bearing resistance values at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

Building A and Building D - Bearing Resistance Values

Based on review of the site topographic survey and the conceptual site plan provided, it is anticipated that the underside of footings elevations will require fill in some areas to build up to proposed grade. For these areas it is recommended to place the footings on a native, undisturbed bearing surface by one of the following methods:

☐ lowering the footings to the underside of the topsoil layer, and placing the footings on an undisturbed, compact to dense glacial till bearing surface.
☐ raising the grade from below the underside of the topsoil layer to the proposed USF elevation using an engineered fill pad such as OPSS Granular A or Granular B Type II and compacted to 98% of the material's SPMDD, or
☐ placing the footings at the design USF elevation upon a zero entry, vertical trenches in-filled with lean concrete and extended to a native, undisturbed glacial till bearing medium.

Conventional spread footings placed on an engineered fill pad, upon a zero-entry, near vertical lean concrete in-filled trench or extended to be placed directly upon an undisturbed, compact glacial till bearing surface can be designed using a bearing resistance values at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

An undisturbed soil bearing surface consists of a surface from which topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings. The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlement of 25 and 20 mm, respectively.

Lean Concrete Filled Trenches

Where the native, undisturbed bearing medium is encountered below the design underside of footing elevation, consideration may be given to excavating zero entry, vertical trenches to expose the underlying native, undisturbed bearing medium and backfilling with lean concrete (**15 MPa** 28-day compressive strength). Typically, the excavation sidewalls will be used as the form to support the concrete. The additional width of the concrete poured against an undisturbed trench sidewall will suffice in providing a direct transfer of the footing load to the underlying native, undisturbed soil bearing surface.

The effectiveness of this operation will depend on the ability of maintaining vertical trenches until the lean concrete can be poured. It is suggested that once the bottom of the excavation is exposed, an assessment should be completed to determine the water infiltration and stability of the excavation sidewalls extending to the glacial till bearing surface.

The trench excavation should be at least 150 mm wider than all sides of the footing at the base of the excavation. The excavation bottom should be relatively clean using the hydraulic shovel only (workers will not be permitted in the excavation below a 1.5 m depth). Once approved by Paterson personnel, lean concrete can be poured up to the proposed founding elevation.

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 glacial till bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as the soil.

5.4 Design for Earthquakes

A seismic site response **Class C** may be considered for the design of the proposed buildings at the subject site according to the OBC 2012. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the OBC 2012 for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of all existing building remnants, debris, topsoil and fill containing significant amounts of, deleterious or organic materials, an approved engineered fill or native soil subgrade approved by geotechnical consultant at the time of excavation will be considered an acceptable subgrade surface on which to commence backfilling for slab-on-grade construction.

The upper 300 mm of sub-slab fill should consist of an OPSS Granular A crushed stone for slab-on-grade construction. All backfill material within the proposed building footprint should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of the SPMDD using a suitably sized smooth-drum vibratory compactor.

Any loose 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, heavy truck parking areas and access lanes are anticipated at the subject site. The proposed pavement structures are presented 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** - 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 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 99% of the material’s SPMDD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed buildings to ensure frost heave is limited below perimeter sidewalks adjacent to the proposed buildings. 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, which is placed at the footing level around the exterior perimeter of the structure or at least 10 m below finished grade. 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 Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

Concrete Walkways Adjacent to Proposed Buildings

To avoid differential settlements within the proposed concrete sidewalks adjacent to the proposed buildings, it is recommended that the upper 600 mm of backfill placed below the sidewalks adjacent to the building footprints consist of free draining, non frost susceptible material such as, Granular A or Granular B Type II. The granular material should be placed in maximum 300 mm loose lifts and compacted to 98% of the material's SPMDD using suitable compaction equipment. The subgrade material should be shaped to promote positive drainage towards the building's perimeter drainage pipe. Consideration could be given to placing a rigid insulation layer below the granular fill layer to prevent frost heave issues at the building entrances.

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. Generally, a minimum of 1.2 m thick soil cover (or an equivalent combination of soil cover and foundation insulation) should be provided in this regard.

Exterior unheated footings 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 1.8 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 expected 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 excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsurface soils are considered to be a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should 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 protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

6.4 Pipe Bedding and Backfill

A minimum of a 150 mm layer of OPSS Granular A crushed stone should be placed for pipe bedding for sewer and water pipes for a 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. The bedding and cover materials should be placed in maximum 300 mm thick lifts compacted to a minimum of 95% of the SPMDD.

It should generally be possible to re-use the site materials above the cover material if the operations are carried out in dry weather conditions. The site excavated material may be placed above cover material if the excavation operations are completed in dry weather conditions and the site excavated material is approved by the geotechnical consultant. All cobbles greater than 200 mm in the longest dimension should be removed prior to the site materials being reused.

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) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material standard Proctor maximum dry density.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of the shallow excavation. 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.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16.

If a project qualifies for a PTTW based upon anticipated conditions, and EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

Impacts on Neighbouring Structures

Based on the proposed grades, site servicing excavation activities are not anticipated to extend within the long-term groundwater table. Should they extend sufficiently deep it should be noted that the extent of any significant groundwater lowering will be negligible due dense and low hydraulically conductive nature of the glacial till deposit encountered throughout the subject site.

The neighboring structures are expected to be founded within the glacial till deposit encountered throughout the subject site. Therefore, no issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed buildings.

6.6 Winter Construction

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

The subsoil conditions at this site mostly 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, tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches.

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 low to moderately aggressive corrosive environment.

7.0 Recommendations

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

☐ 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 request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

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

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

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

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

Paterson Group Inc.

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Report Distribution

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

GRAIN-SIZE DISTRIBUTION TESTING RESULTS

ANALYTICAL TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

REMARKS

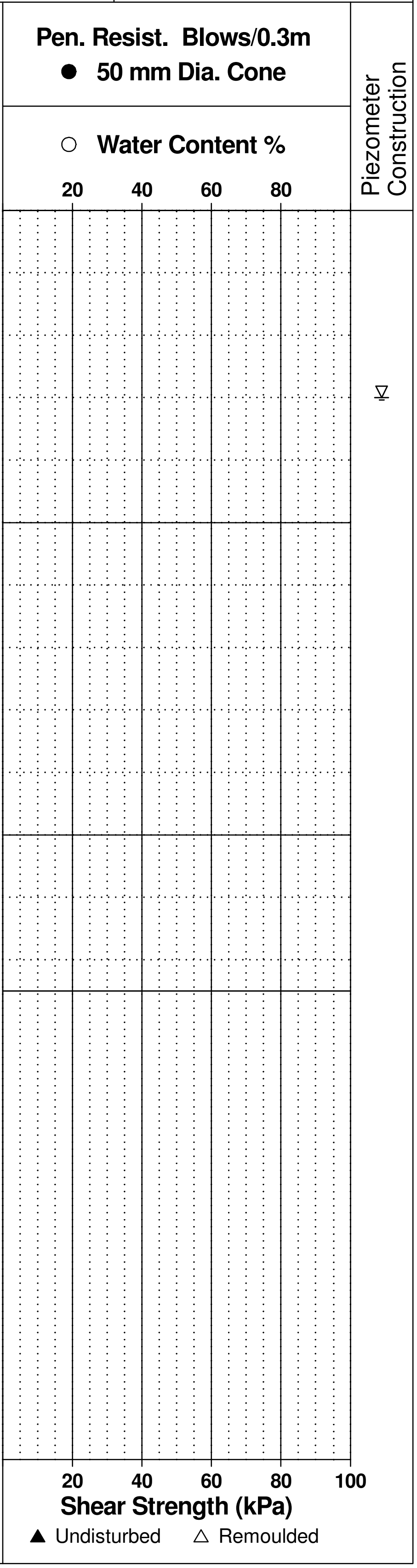
BORINGS BY Mini-Excavator

DATE September 15, 2020

FILE NO. PG5220

HOLE NO. TP 1-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	225.60
TOPSOIL 0.30							
SILTY SAND with rootlets and organic matter 0.45		G	1				
		G	2				
						1	224.60
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders							
- cobble and boulder content increasing with depth		G	3				
						2	223.60
		G	4				
- brownish grey and very dense by 2.4m depth		G	5				
2.50 End of Test Pit							
(Groundwater infiltration at 0.6m depth)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

FILE NO. PG5220

REMARKS

HOLE NO. TP 2-20

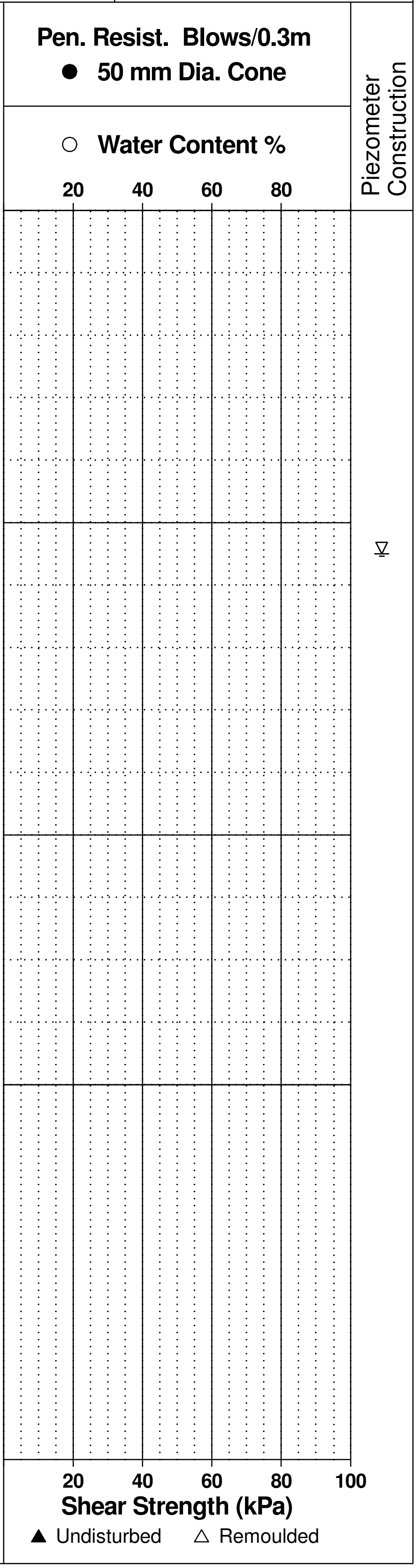
BORINGS BY Mini-Excavator

DATE September 15, 2020

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.30
SILTY SAND with rootlets and organic matter	0.40
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders - cobble content increasing with depth	2.80
End of Test Pit (Groundwater infiltration at 1.1m depth)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
G	1		
G	2		
G	3		
G	4		

DEPTH (m)	ELEV. (m)
0	224.50
1	223.50
2	222.50



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

FILE NO. PG5220

REMARKS

HOLE NO. TP 3-20

BORINGS BY Mini-Excavator

DATE September 15, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	222.20	
TOPSOIL 0.30		G	1					
SILTY SAND with rootlets and organic matter 0.50								
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders - cobble content increasing with depth 2.60		G G G	2 3 4			1 2	221.20 220.20	
End of Test Pit (TP dry upon completion)								

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

○ **Water Content %**

20 40 60 80

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

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Mini-Excavator

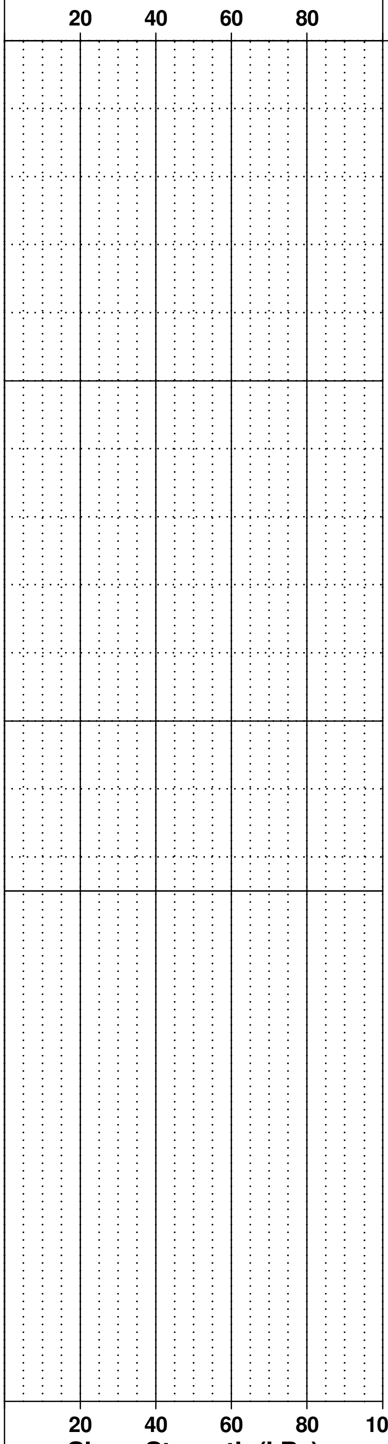
DATE September 15, 2020

FILE NO. PG5220

HOLE NO. TP 4-20

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL				
0.30	G	1		
SILTY SAND with rootlets and organic matter				
0.60				
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders - reddish brown by 1.4m depth - cobble and boulder content increasing with depth	G	2		
	G	3		
	G	4		
2.50				
End of Test Pit (TP dry upon completion)				

DEPTH (m)	ELEV. (m)
0	222.20
1	221.20
2	220.20



Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Mini-Excavator

DATE September 15, 2020

FILE NO. PG5220

HOLE NO. TP 5-20

SOIL DESCRIPTION		STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
			TYPE	NUMBER	% RECOVERY	N VALUE or RQD			20 40 60 80	
GROUND SURFACE							0	223.20		
TOPSOIL	0.30		G	1						
SILTY SAND with rootlets and organic matter	0.40									
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders			G	2			1	222.20		
- cobble and boulder content increasing with depth			G	3			2	221.20		
	2.30		G	4						
End of Test Pit (TP dry upon completion)										

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Dev. - 16th Street East at 20th Ave.
Owen Sound, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Mini-Excavator

DATE September 15, 2020

FILE NO. PG5220

HOLE NO. TP 6-20

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	223.60
TOPSOIL 0.30	G	1				
SILTY SAND with rootlets and organic matter 0.50						
GLACIAL TILL: Compact to dense, brown silty clay with gravel, cobbles and boulders - cobble and boulder content increasing with depth	G	2			1	222.60
2.20	G	3			2	221.60
End of Test Pit (TP dry upon completion)						

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

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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC% - Natural water 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 at 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)

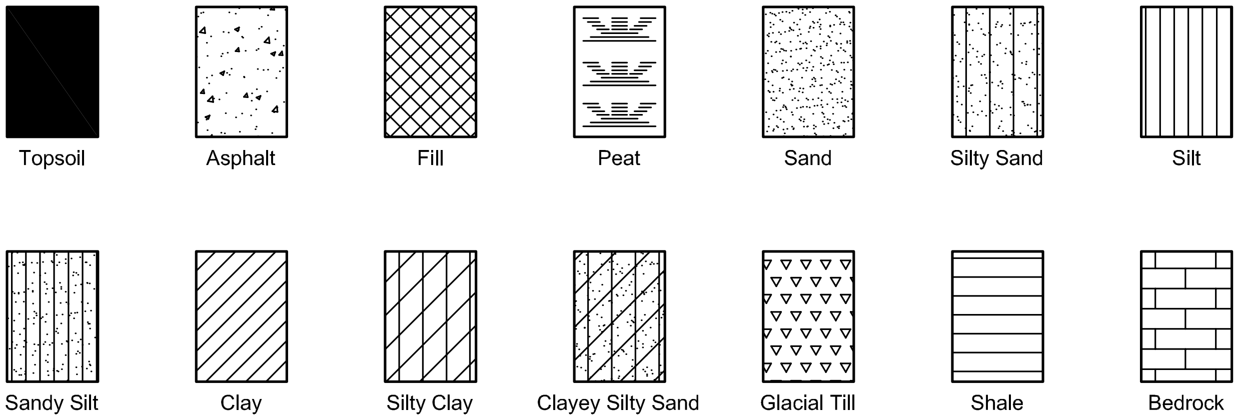
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

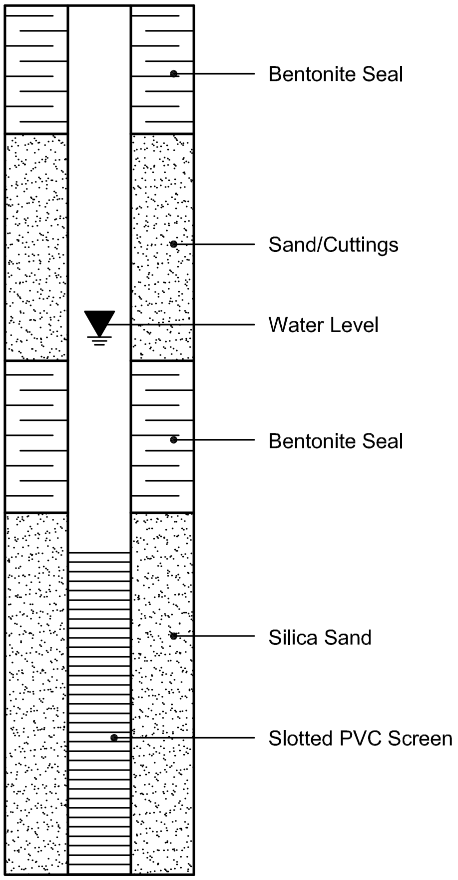
SYMBOLS AND TERMS (continued)

STRATA PLOT

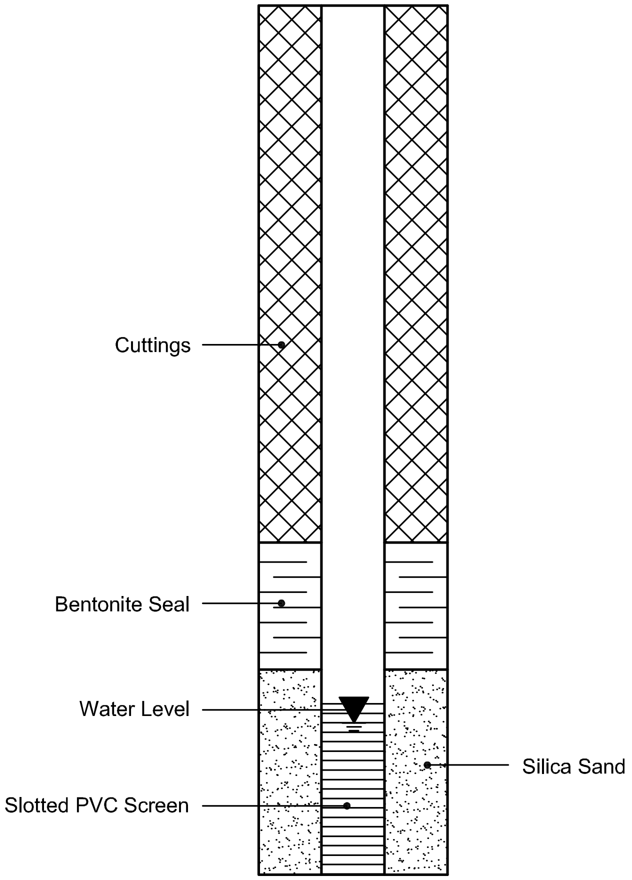


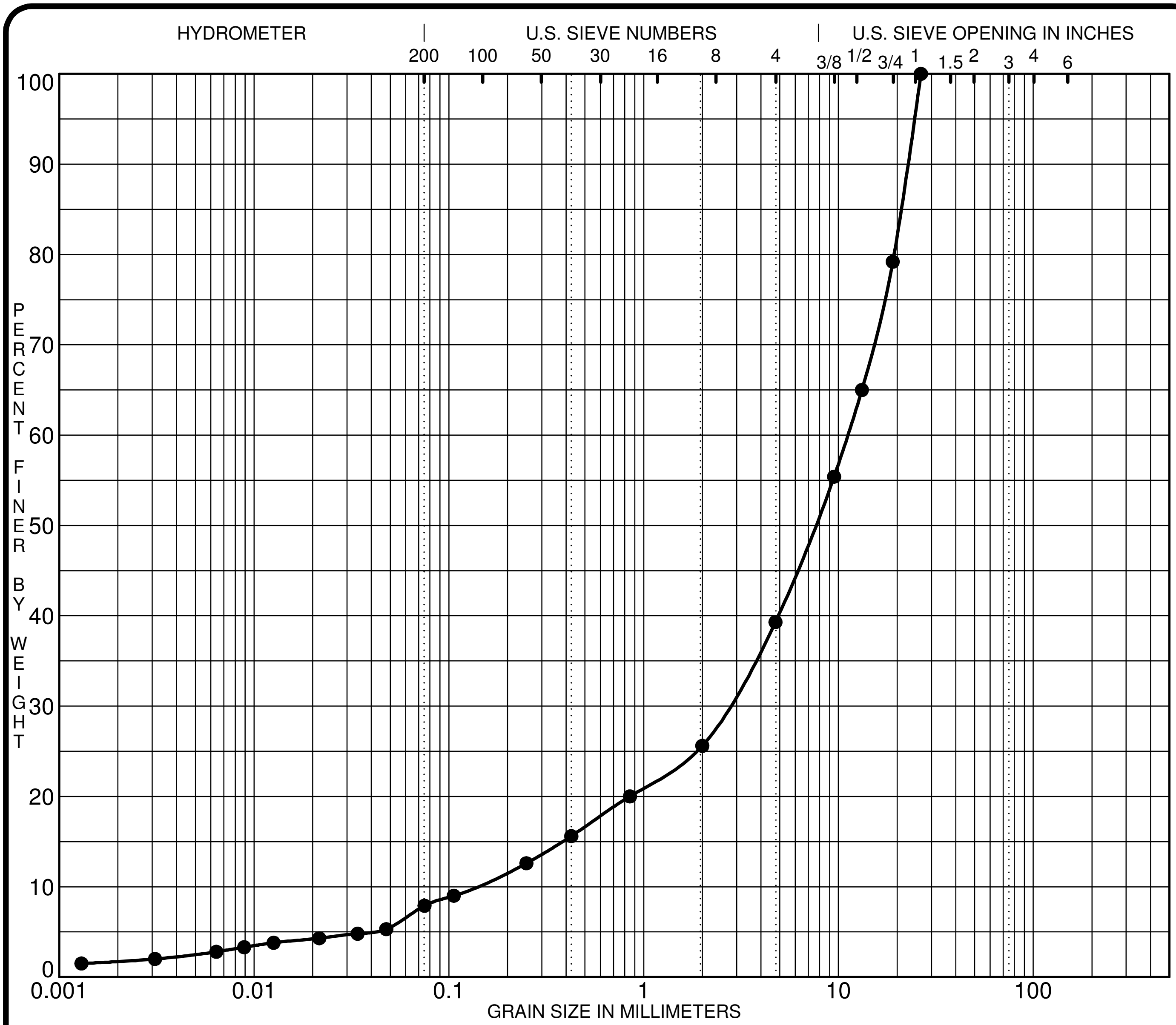
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**OFF-SITE 1**	**GP-SM - Poorly Graded Gravel with Sand and**					**4.66**	**82.7**
		Silt (Stockpile Test Pit Sample)						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**OFF-SITE 1**	**26.50**	**11.12**	**2.640**	**0.1345**	**60.7**	**31.4**	**7.9**	

CLIENT **Thompson Centres**

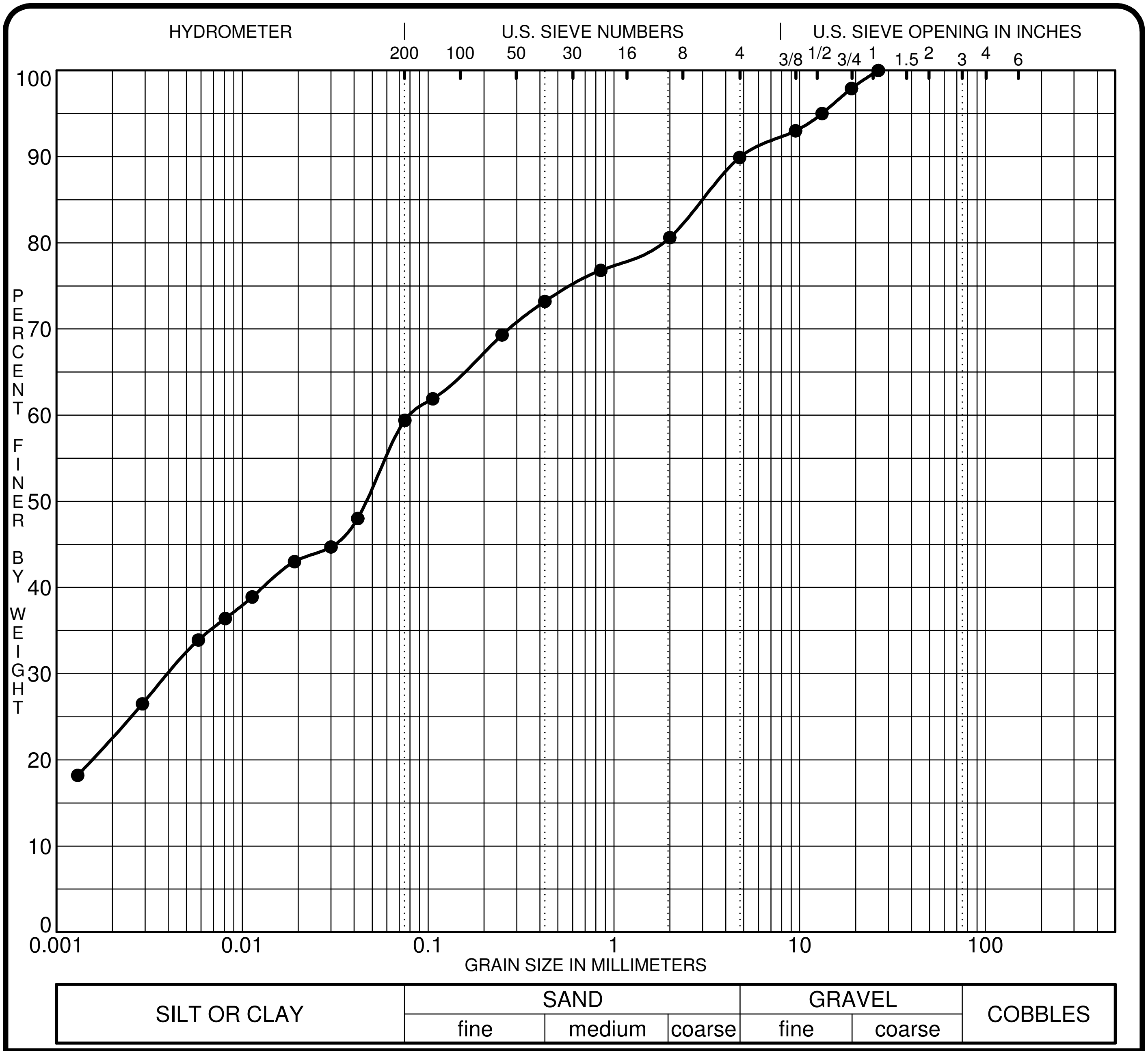
FILE NO. **PG5220**

PROJECT **Geotechnical Investigation - Prop. Commercial**
Dev. - 16th Street East at 20th Ave.

DATE **24 Sep 20**

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

GRAIN SIZE DISTRIBUTION



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **OFF-SITE 2**	**Silt and Sand with clay, some gravel**						
	(Stockpile Side-Slope Sample)						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **OFF-SITE 2**	**26.50**	**0.08**	**0.004**		**10.1**	**30.5**	**59.4**	

CLIENT **Thompson Centres**

FILE NO. **PG5220**

PROJECT **Geotechnical Investigation - Prop. Commercial Dev. - 16th Street East at 20th Ave.**

DATE **24 Sep 20**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION

Certificate of Analysis

Report Date: 25-Sep-2020

Client: Paterson Group Consulting Engineers

Order Date: 21-Sep-2020

Client PO: 30854

Project Description: PG5220

Client ID:		TP5-G3	-	-	-
Sample Date:		15-Sep-20 11:00	-	-	-
Sample ID:		2039104-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	92.6	-	-	-
General Inorganics					
pH	0.05 pH Units	7.67	-	-	-
Resistivity	0.10 Ohm.m	67.9	-	-	-
Anions					
Chloride	5 ug/g dry	29	-	-	-
Sulphate	5 ug/g dry	7	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG5220-1 - TEST HOLE LOCATION PLAN

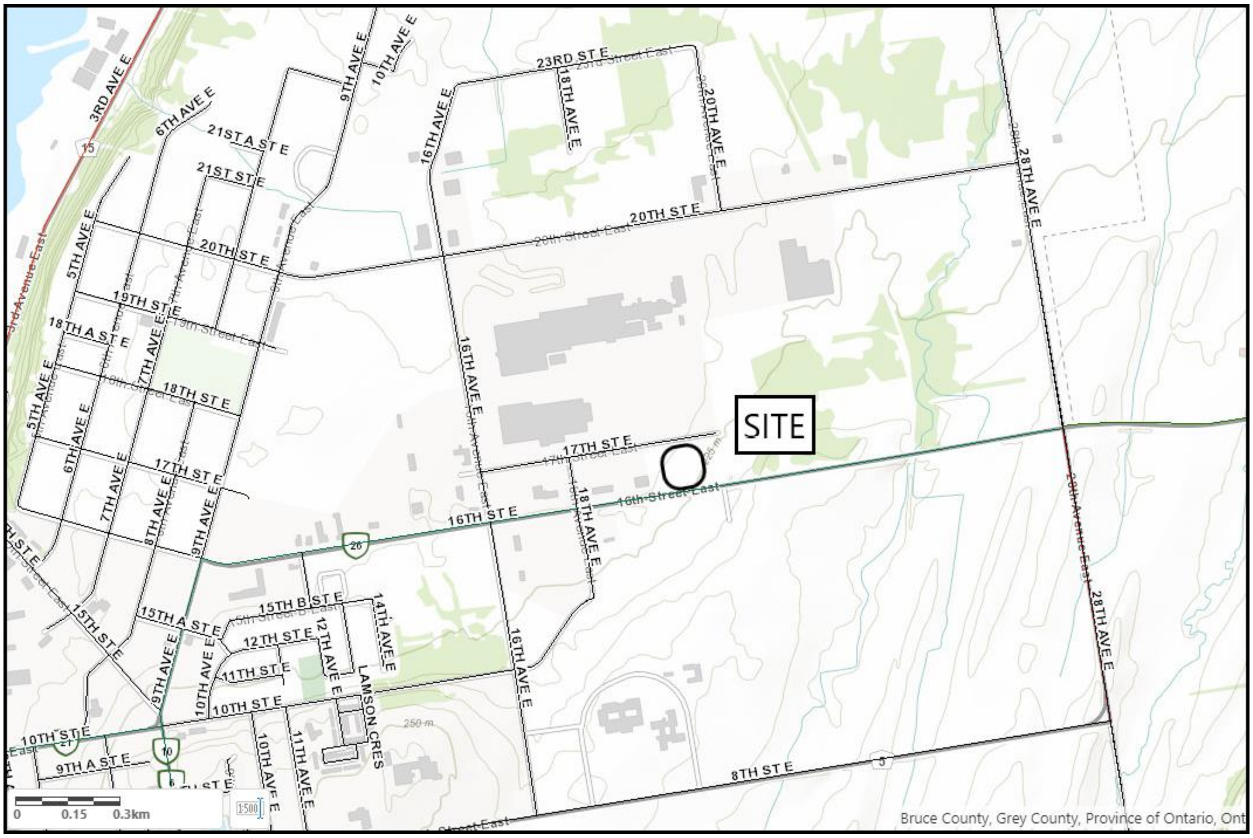
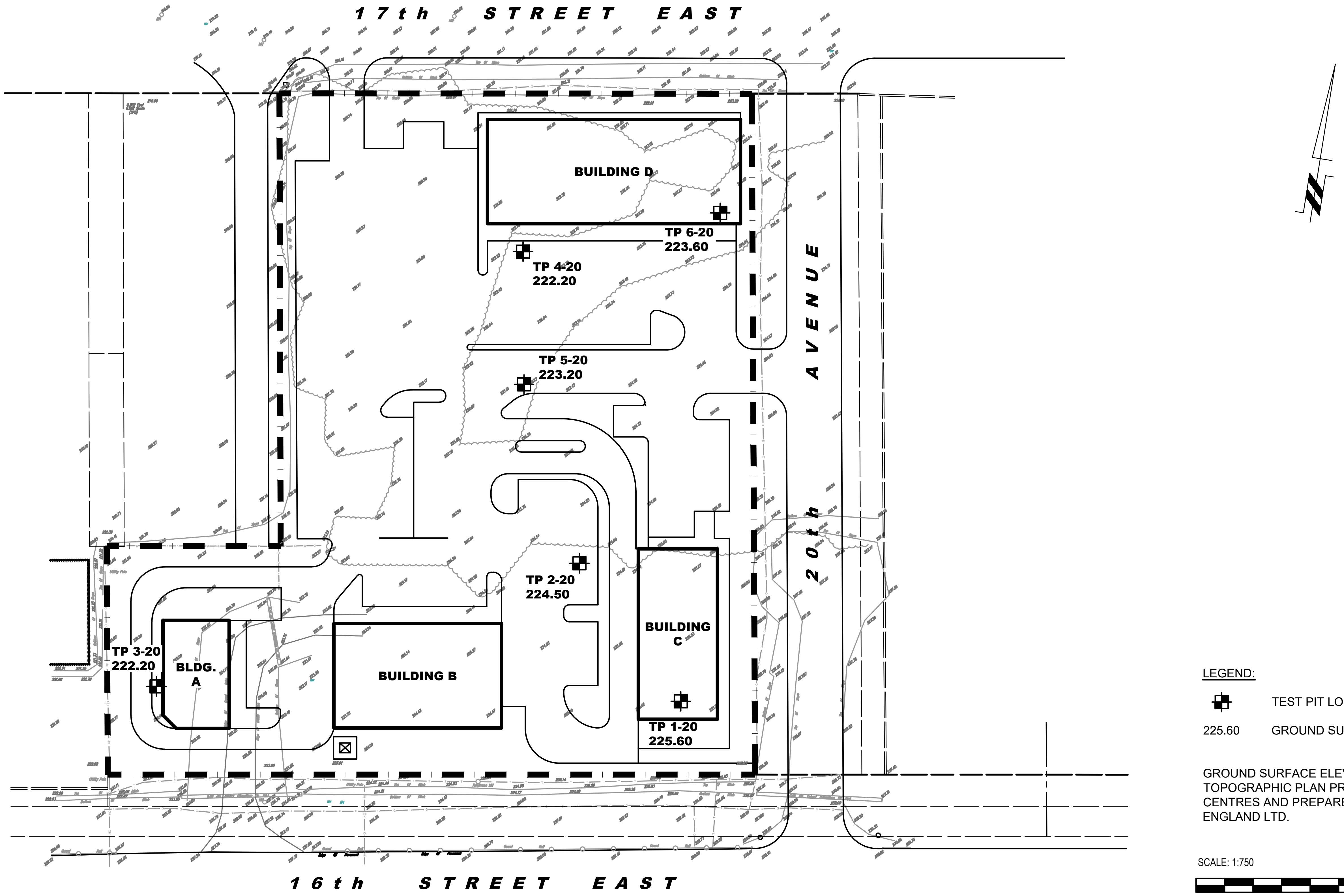


FIGURE 1

KEY PLAN



LEGEND:

⊞ TEST PIT LOCATION

225.60 GROUND SURFACE ELEVATION (m)

GROUND SURFACE ELEVATIONS INFERRED FROM TOPOGRAPHIC PLAN PROVIDED BY THOMPSON CENTRES AND PREPARED BY DINSMORE & ENGLAND LTD.

SCALE: 1:750

0 10 20 30 50m

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

THOMPSON CENTRES

GEOTECHNICAL INVESTIGATION
PROP. COMMERCIAL DEVELOPMENT - 16th STREET E. AT 20th AVENUE
OWEN SOUND, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:750
Date: 09/2020
Drawn by: MPG
Report No.: PG5220-1
Checked by: DP
Dwg. No.: PG5220-1
Approved by: FA
Revision No.:

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