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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation
Proposed Residential Development
Kenwood Avenue at Edison Avenue
Ottawa, Ontario

Prepared For

Uniform Urban Developments

May 12, 2017

Report PG0949-2

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Uniform Urban Developments Limited (Uniform) to conduct a geotechnical investigation for a proposed residential development, which is to be located on the south side of Kenwood Avenue between Edison Avenue and Melbourne Avenue in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The investigation objectives were to:

- ❏ determine the subsurface soil and groundwater conditions by means of boreholes.
- ❏ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

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

2.0 Proposed Development

It is understood that the development will include the construction of 16 residential dwellings with the associated access lanes, driveways and landscaped areas within the south side of the subject development. It should be noted that the subject site consists of the next phase of the existing residential development the north of the subject site. It should also be noted that all existing buildings within the site are anticipated to be demolished as part of the proposed development.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on February 2 and 6, 2007. At that time, six (6) boreholes were advanced to depths varying between 1.5 to 3.6 m. Two (2) of the proposed boreholes were not completed due to the limited access along the east property line. The borehole locations were selected in the field by Paterson personnel in a manner to provide general coverage of the subject, taking into consideration the presence of underground services and access difficulties. The approximate borehole locations are shown on Drawing PG0949-2 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a truck-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, and sampling and testing the overburden. The bedrock was cored at three (3) locations using diamond drilling procedures.

Sampling and In Situ Testing

Soil samples were recovered using a 50 mm diameter split-spoon sampler or from the auger flights. The split-spoon and auger samples were classified on site and placed in sealed plastic bags. Rock cores were recovered using diamond drilling procedures. The cores were logged and placed in hard cardboard core boxes. All samples were transported to our laboratory. The depths at which the split-spoon, auger and core samples were recovered from the boreholes are shown as SS, AU, and RC, 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.

Diamond drilling using an NW size casing was carried out in BHs 1, 2 and 3 to determine the nature of the bedrock. Recovery values and Rock Quality Designation (RQD) values were calculated for the drilled sections (core runs) of bedrock and are shown on the borehole logs. The recovery value is the ratio, in percentage, of the length of the bedrock sample recovered over the length of the drilled section (core run). The RQD value is the ratio, in percentage, of the total length of rock pieces longer than 100 mm in one core run over the length of the core run. All these values are indicative of the quality of the bedrock.

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 of this report.

Groundwater

Flexible standpipes were installed in BH 1, BH 2 and BH 3 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 determined in the field by Paterson personnel with consideration of existing site features, such as trees, underground and aboveground services. The ground surface elevations at the boreholes were referenced to a temporary benchmark (TBM) consisting of the top of spindle of the fire hydrant located at the southeast corner of the intersection of Kenwood Avenue and Melbourne Avenue. A geodetic elevation of 76.17 m was provided for the TBM as shown on the survey plan provided by Uniform. The locations and ground surface elevations of the boreholes are presented on Drawing PG0949-2 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

4.0 Observations

4.1 Surface Conditions

The ground surface was observed to be relatively flat and at grade with the nearby roadways. The north portion of the site is occupied by residential dwellings constructed as part of the early phase of the subject development.

The current phase of the development is currently occupied by landscaped areas covered with trees within the north and east portions. It should be noted that 4 single homes occupy the south east corner of the site in which they will be demolished as part of the subject development. An existing shed occupies the northeast corner of the site whereas parking areas and access lanes occupy the remainder of the site.

The site is bordered by a Cornerstone Women's Residence (373 Princeton Avenue) within the southwest corner. A retaining wall was noted to be supporting the existing residential dwellings bordering this phase within the north portion.

4.2 Subsurface Profile

Generally, the soil conditions encountered at the boreholes consist of topsoil or asphaltic concrete overlying fill and/or sandy silt/silty sand. Weathered shale with frequent sandy silt seams was encountered below the overburden at all boreholes. Fresh to faintly weathered interbedded limestone and dolostone bedrock was encountered below the weathered shale at BH 1, BH 2 and BH 3. A borehole was completed in the southwest corner of the site where the subsoil profile consisted of asphaltic concrete overlying fill crushed stone and clayey sand layer and glacial till. Practical refusal to augering was encountered at all boreholes, at depths varying between 1.4 ans 2.3 m. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at the boreholes.

Bedrock

Practical refusal to augering was encountered in all boreholes, at depths ranging from 1.4 m at BH 3 to 2.3 m at BH 5. Based mainly on observations during the drilling operations, due to the very low recovery values of the split-spoon samples, it is inferred that weathered shale with frequent sandy silt seams was encountered at BH 1, and BH 3 to BH 6, at depths ranging from 0.7 m to 1.1 m.

Faintly weathered to sound bedrock is inferred below the weathered shale. At BH 1, BH 2 and BH 3, the bedrock was cored, below the practical refusal to augering depths, to determine the bedrock type and quality. Generally, the bedrock was found to consist of faintly weathered to fresh dolostone. The recovery values vary between 90 and 100%, and the RQD values range from 39 to 94%. These values are indicative of a poor to excellent quality.

Based on available geological mapping, the subject site is located in an area where bedrock consists of limestone and dolomite (dolostone) of the Gull River Formation, and is expected at depths between 0 to 2 m.

4.3 Groundwater

The groundwater levels were measured in the standpipes at BH 1, BH 2 and BH 3 on February 16, 2007. The measured groundwater levels are presented in Table 1.

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

Table 1
Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	75.65	2.70	72.95	February 16, 2007
BH 2	74.93	1.09	73.84	February 16, 2007
BH 3	75.73	Dry @ 2.5 m	-	February 16, 2007
BH 1-17	74.81	2.06	72.75	April 13, 2017

Note: The ground surface elevation at each borehole was referenced to a temporary benchmark (TBM), which consists of the top spindle of the fire hydrant located at the southeast corner of the intersection of Kenwood Avenue and Melbourne Avenue. A geodetic elevation of 76.17 m was provided for the TBM.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed development. it is expected that the proposed buildings will be founded on conventional shallow footings placed on weathered shale bedrock and/or faintly weathered to fresh dolostone/limestone.

Bedrock removal may be required for the construction of the foundations/basements of the proposed buildings, and to complete the service trenches. Hoe ramming could be used where only small quantities of bedrock need to be removed. Line drilling and controlled blasting could be used where large quantities of bedrock need to be removed. The blasting operations should be planned and carried out under the guidance of a professional engineer with experience in blasting operations.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, containing significant amounts of organic or deleterious materials, should be removed from within the perimeter of the proposed building and other settlement sensitive structures.

Consideration could be given to leaving the existing fill, free of significant amounts of deleterious materials, below the proposed building floor slab outside of the lateral support zone of the proposed footings and within the proposed parking areas and access lanes. However, it is recommended that the existing fill be approved by the geotechnical consultant once the subgrade level is exposed. The approved existing fill material should be proof-rolled using suitable compaction equipment under dry conditions and reviewed by Paterson personnel. Poor performing areas should be removed and replaced with engineered fill.

Under paved areas, existing construction remnants, such as foundation walls, should be excavated to a minimum depth of 1.0 m below final grade.

Bedrock Removal

It is expected that the weathered shale can be excavated using an hydraulic shovel. Faintly weathered and fresh bedrock removal can be accomplished by hoe ramming where only small quantity of the bedrock need to be removed; line drilling and controlled blasting can be used where a large quantity of bedrock needs to be removed. Prior to considering blasting, the blasting effects on the existing buildings and structures should be considered.

As a general guideline, peak particle velocities should not exceed 50 mm/sec (measured at the structures) during the blasting operation to reduce the risks of damages to the existing structures.

The blasting operations should be carried out under the supervision of a licensed professional engineer who is also a blasting expert.

A pre-blast or preconstruction survey of the existing surrounding structures 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.

Fill Placement

Fill used for grading beneath the buildings should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or B Type II. These materials 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 buildings should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

The zone of influence of a footing is considered to be the area beneath the footing limited by planes extending down and out from the bottom edges of the footing, at a slope of 1H:1V, to the in situ soil.

Non-specified existing fill along with 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 reduce voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a prefabricated drainage system (such as system Platon or Miradrain G100N) connected to a perimeter drainage system is provided.

If excavated rock is to be used as fill, it should be suitably fragmented to produce a well-graded material with a maximum particle size of 300 mm. This material should only be used structurally to build up the subgrade for roads and pavements. Where the fill is open-graded, a blinding layer of finer granular fill or a geotextile may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on a clean, surface sounded shale bedrock surface can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **1,500 kPa**, incorporating a geotechnical resistance factor of 0.5.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Footings placed on clean, weathered bedrock can be designed using a bearing resistance value at ULS of **500 kPa**, incorporating a geotechnical resistance factor of 0.5.

A clean, weathered bedrock surface consists of one from which all topsoil, soils, deleterious materials and loose rock have been removed prior to concrete placement.

Footings bearing on an acceptable bedrock bearing surface and designed using the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support. Near vertical (1H:6V) slopes can be used for unfractured bedrock bearing media; a 1H:1V slope can be used for fractured/weathered bedrock.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as Class C for the structures considered at this site. A higher seismic site class of A or B can be given to the subject site provide a shear wave velocity testing is completed. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab / Slab on Grade Construction

With the removal of all topsoil, and fill, containing significant amounts of organic or deleterious materials, within the footprint of the proposed buildings, the native soil or approved fill surface will be considered to be an acceptable subgrade surface on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone for the basement floor slab. The upper 200 mm of sub-slab fill should consist of a Granular A crushed stone for slab-on-grade construction.

5.6 Pavement Structure

Driveways and/or car only parking areas are expected at this site at the proposed residential dwellings. The subgrade material is expected to consist of silty sand/sandy silt. The proposed pavement structures are presented in Table 2 below:

Table 2
Recommended Pavement Structure - Car only parking areas and Local Driveways

Thickness mm	Material Description
50	**WEAR COURSE -** HL 3 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either in situ soil, fill 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.

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 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, placed around the exterior perimeter of the structures. The clear stone should be wrapped in a non-woven geotextile. 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. Imported granular materials, such as clean sand or OPSS Granular B Type I material, should be used for this purpose. 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 a prefabricated drainage system, such as Delta Drain 6000 or equivalent, connected to a perimeter drainage system is provided.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures should be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover (or insulation equivalent) should be provided in this regard.

A minimum 2.1 m thick soil cover (or insulation equivalent) should be provided for other exterior unheated footings, such as those for isolated exterior piers.

Frost Susceptibility of Bedrock

When bedrock is encountered above the proposed founding depth and soil frost cover is less than 1.5 m, the frost susceptibility of the bedrock should be determined. This can be accomplished as follows:

☐ Drill probeholes within the bedrock and assess its frost susceptibility.
☐ Examine service trench profiles extending in bedrock in the vicinity of the foundation to determine if weathering is extensive.

If the bedrock is considered to be **non-frost susceptible**, the footings can be poured directly on the bedrock without any further frost protective measures.

If the bedrock is considered to be **frost susceptible**, the following measures should be implemented for frost protection:

☐ Option A - Sub-excavate the weathered bedrock to sound bedrock or to the required frost cover depth. Pour footings at the lower level.

☐ Option B - Use a rigid insulation to protect footings. It is preferable to pour footings on the insulation overlying weathered bedrock. However, due to potential undulating bedrock surface, consideration may have to be given to adopting a rigid insulation detail that allows the footing to be poured directly on the weathered bedrock.

6.3 Excavation Side Slopes

The side slopes of the shallow excavations anticipated at this site should either be cut back at acceptable slopes or 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 to permit the building excavations to be undertaken by open-cut methods (i.e. unsupported excavations).

Above the groundwater level, within the overburden and the weathered shale bedrock, the excavation side slopes extending to a maximum depth of 3.5 m should be cut back at 1H:1V. In fresh to faintly weathered dolostone/limestone, almost vertical side slopes can be used provided that all loose rock and blocks with unfavourable weak planes are removed or stabilized.

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

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.

A minimum of150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. If the bedding is placed on bedrock, the thickness of the bedding should be increased to 300 mm for sewer pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 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 and compacted to 95% of the SPMDD.

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 reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

Where blast-rock fill is used as trench fill, it should be well-graded and of maximum 300 mm in size. The use of a blinding layer or woven geotextile may be required for open-graded blast-rock.

6.5 Groundwater Control

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.

Impacts on Neighbouring Properties

Based on the proximity of neighbouring buildings. the proposed development will not negatively impact the neighbouring structures. It should be noted that no issues are expected with respect to groundwater lowering that would cause long term adverse effects to adjacent structures surrounding the proposed building.

6.6 Winter Construction

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. Placing concrete directly on a cold bedrock surface is not recommended.

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

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 these works have been completed in general accordance with our recommendations could be issued following the completion of a satisfactory materials testing and observation 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. Also, our recommendations should be reviewed when the project drawings and specifications are complete.

A soils 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 that we be notified 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 Uniform Urban Developments or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

May 12, 2017
F. I. ABOU-SEIDO
100156744

Faisal I. Abou-Seido, P.Eng.

David J. Gilbert, P.Eng.

Report Distribution:

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APPENDIX 1

SOIL PROFILE & TEST DATA SHEETS

SYMBOLS AND TERMS

patersongroup Consulting Engineers

154 Colonnade Road, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located across the street from 524 Melbourne Avenue. A geodetic elevation of 75.79 was provided for the TBM

REMARKS

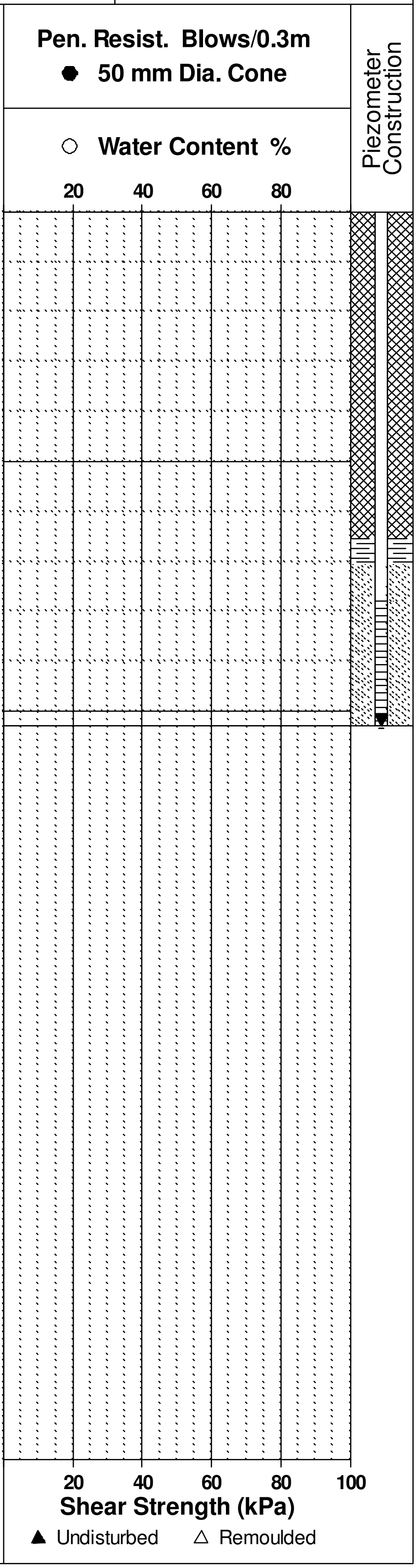
BORINGS BY CME 55 Power Auger

DATE 3 Apr 17

FILE NO. PG0949

HOLE NO. BH 1-17

SOIL DESCRIPTION		STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
			TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE							0	74.81
Asphaltic concrete	0.05							
FILL: Crushed stone	0.28							
FILL: Brown clayey sand, some silt and gravel	0.76							
GLACIAL TILL: Brown clayey sand, some silt, gravel, cobbles and boulders			SS		1	42	1	73.81
			SS		2	25		
	2.06						2	72.81
End of Borehole Practical refusal to augering at 2.06m depth (GWL @ 2.06m-April 13, 2017)								



patersongroup Consulting Engineers
28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

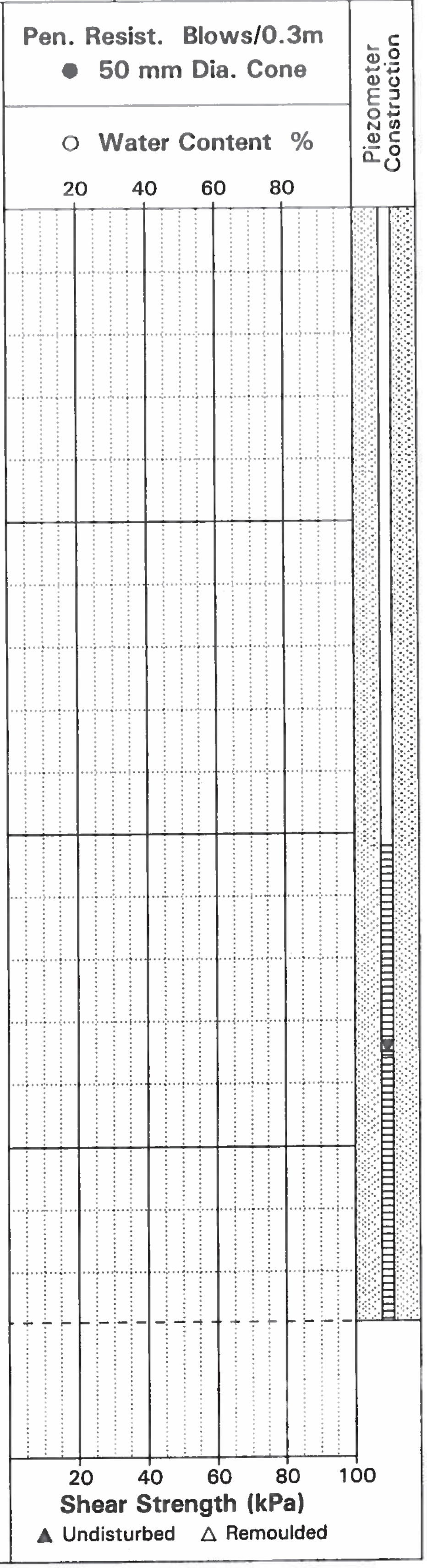
BORINGS BY CME 75 Power Auger

DATE 2 FEB 07

FILE NO. PG0949

HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	75.65
25mm Topsoil Brown SANDY SILT, trace gravel	AU	1				
0.69						
BEDROCK: Weathered, black shale fragments with sandy silt seams throughout	SS	2	100	50+		
					1	74.65
- Practical refusal to augering	SS	3	33	63+		
1.96						
- Start of diamond drilling					2	73.65
BEDROCK: 0.3m of grey faintly weathered to fresh limestone over faintly weathered to fresh grey-black dolomite - horizontal fractures @ 75, 289, 330, 355 and 395mm from top of RC1	RC	1	90	50		
	RC	2	92	92	3	72.65
3.56						
End of Borehole (GWL @ 2.70m-Feb. 16/07)						



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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

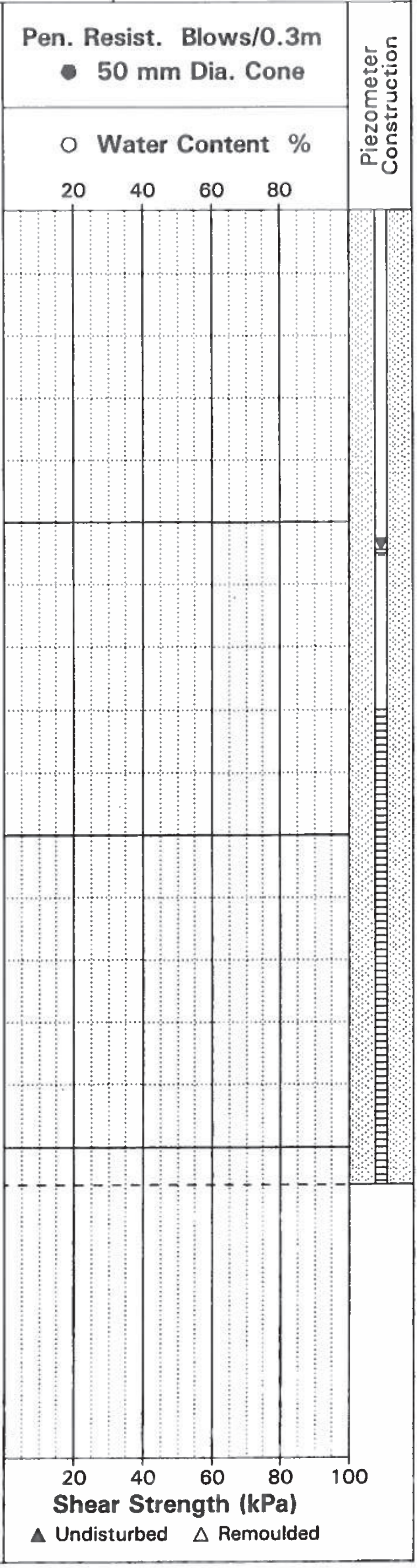
BORINGS BY CME 75 Power Auger

DATE 2 FEB 07

FILE NO. PG0949

HOLE NO. BH 2

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	74.93
TOPSOIL 0.18						
FILL: Brown sandy silt with organic matter 0.60						
FILL: Brown sandy silt with clay and gravel	SS	1	46	7	1	73.93
- Practical refusal to augering 1.52						
- Start of diamond drilling					2	72.93
BEDROCK: 175mm of faintly weathered to fresh black shale over faintly weathered to fresh black-grey dolomite	RC	1	94	39		
	RC	2	100	94	3	71.93
3.12 End of Borehole						
(GWL @ 1.09m-Feb. 16/07)						



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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

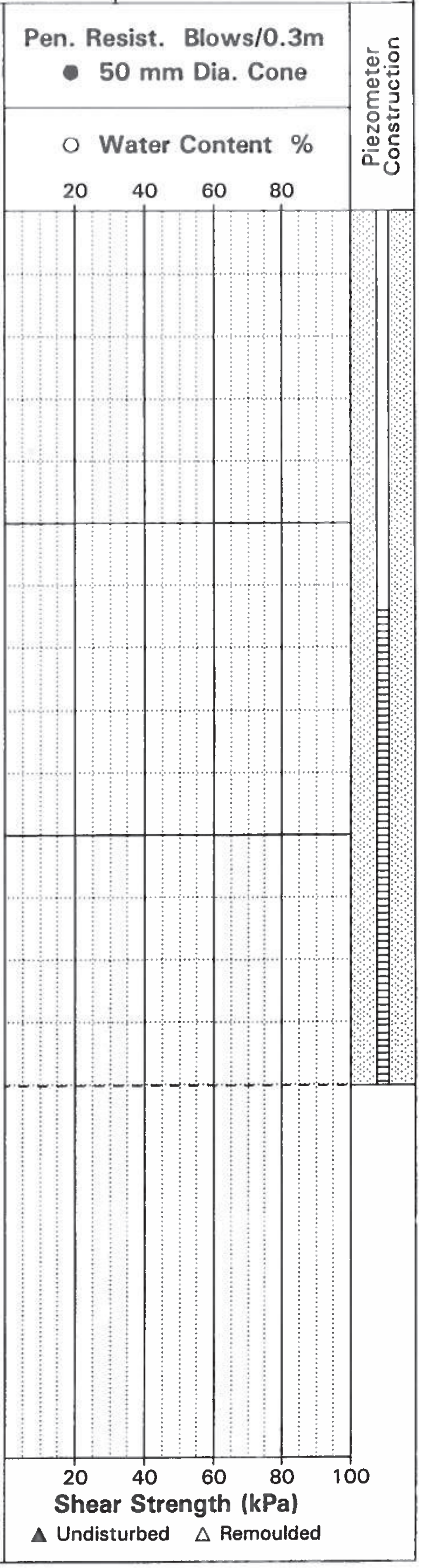
BORINGS BY CME 75 Power Auger

DATE 6 FEB 07

FILE NO. PG0949

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.73
TOPSOIL 0.15							
Brown SILTY SAND, trace gravel 0.71							
BEDROCK: Weathered, black shale fragments with sandy silt seams throughout - Practical refusal to augering 1.40						1	74.73
- Start of diamond drilling BEDROCK: Faintly weathered to fresh, grey-black dolomite - 45 degree fracture @ 1575 and 1625mm from top of RC1 2.80		RC	1	100	87	2	73.73
End of Borehole (BH dry-Feb. 16/07)							



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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

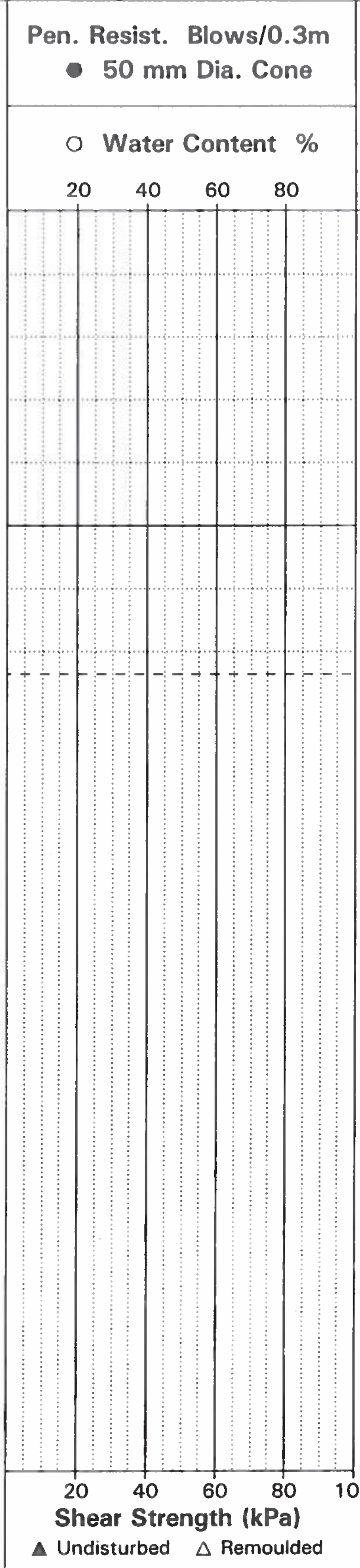
BORINGS BY CME 75 Power Auger

DATE 6 FEB 07

FILE NO. PG0949

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.78
25mm Asphaltic concrete over crushed stone FILL 0.18							
FILL: Brown silty sand with gravel 0.60		AU	1				
TOPSOIL 0.71							
BEDROCK: Weathered, black shale fragments with sandy silt seams throughout 1.47		SS	2	67	50+	1	74.78
End of Borehole Practical refusal to augering @ 1.47m depth							



Piezometer Construction

patersongroup Consulting Engineers

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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

BORINGS BY CME 75 Power Auger

DATE 6 FEB 07

FILE NO. PG0949

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.15
TOPSOIL 0.08							
FILL: Brown silty sand with gravel 0.46							
Loose, brown SANDY SILT, trace organic matter 1.07		SS	1	25	5	1	74.15
BEDROCK: Weathered, black shale fragments with sandy silt seams		SS	2	44	50+	2	73.15
2.26							
End of Borehole Practical refusal to augering @ 2.26m depth							

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

Piezometer Construction

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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Residential Development, Kenwood Avenue
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, intersection of Kenwood Avenue and Melbourne Avenue. Assumed geodetic elevation = 76.17m.

REMARKS

BORINGS BY CME 75 Power Auger

DATE 6 FEB 07

FILE NO. **PG0949**

HOLE NO. **BH 6**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	75.39
25mm Asphaltic concrete over crushed stone FILL 0.20						
TOPSOIL 0.33						
Brown SANDY SILT 0.97	SS	1	44	50+		
					1	74.39
BEDROCK: Weathered, black shale fragments with sandy silt seams 1.50						
End of Borehole Practical refusal to augering @ 1.50m depth						

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 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)

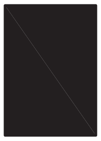
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

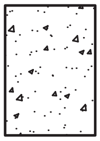
PERMEABILITY TEST

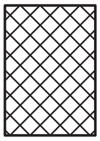
k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during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

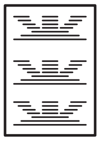
SYMBOLS AND TERMS (continued)

STRATA PLOT


Topsoil


Asphalt


Fill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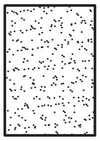
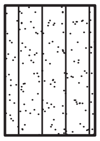
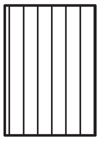
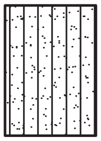
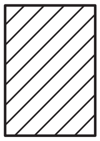
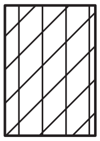

Sand

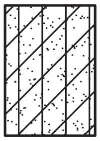

Silty Sand

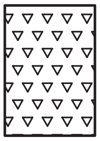

Silt

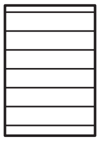

Sandy Silt

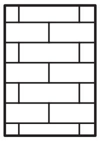

Clay


Silty Clay


Clayey Silty Sand

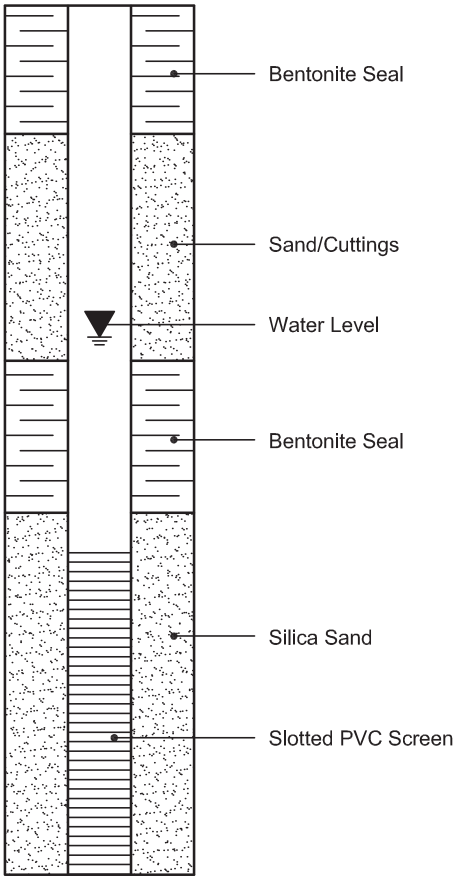

Glacial Till


Shale

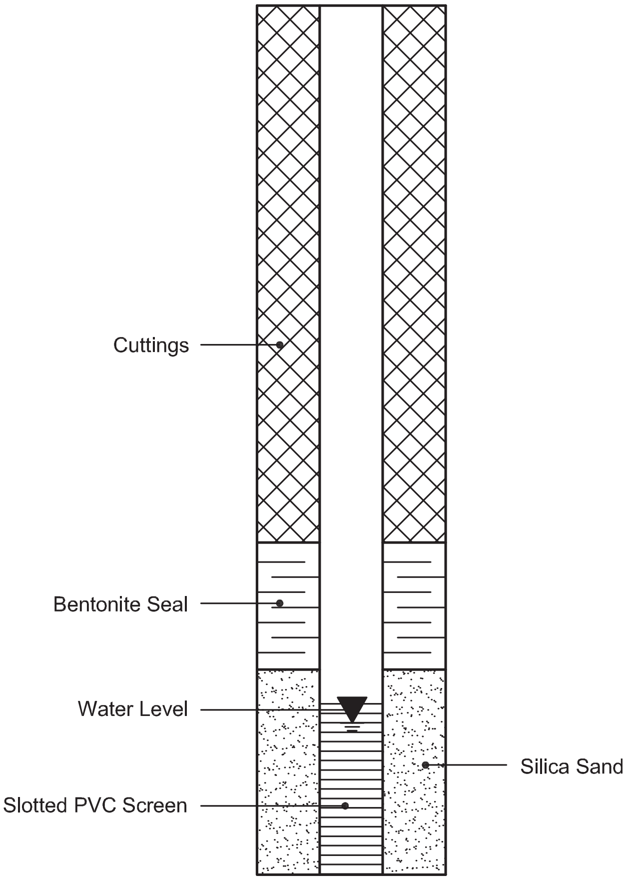

Bedrock

MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG0949-2 - TEST HOLE LOCATION PLAN

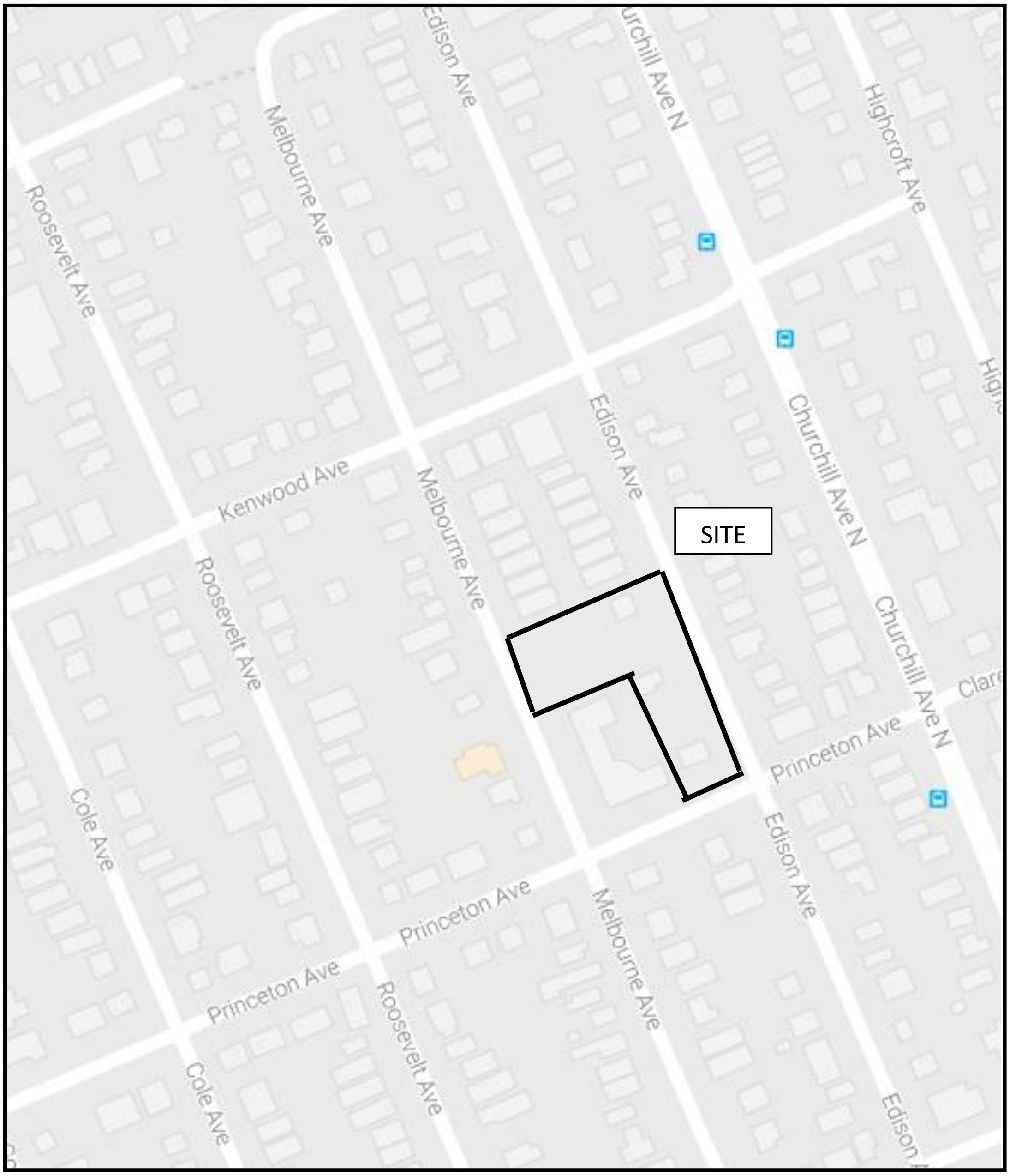


FIGURE 1

KEY PLAN

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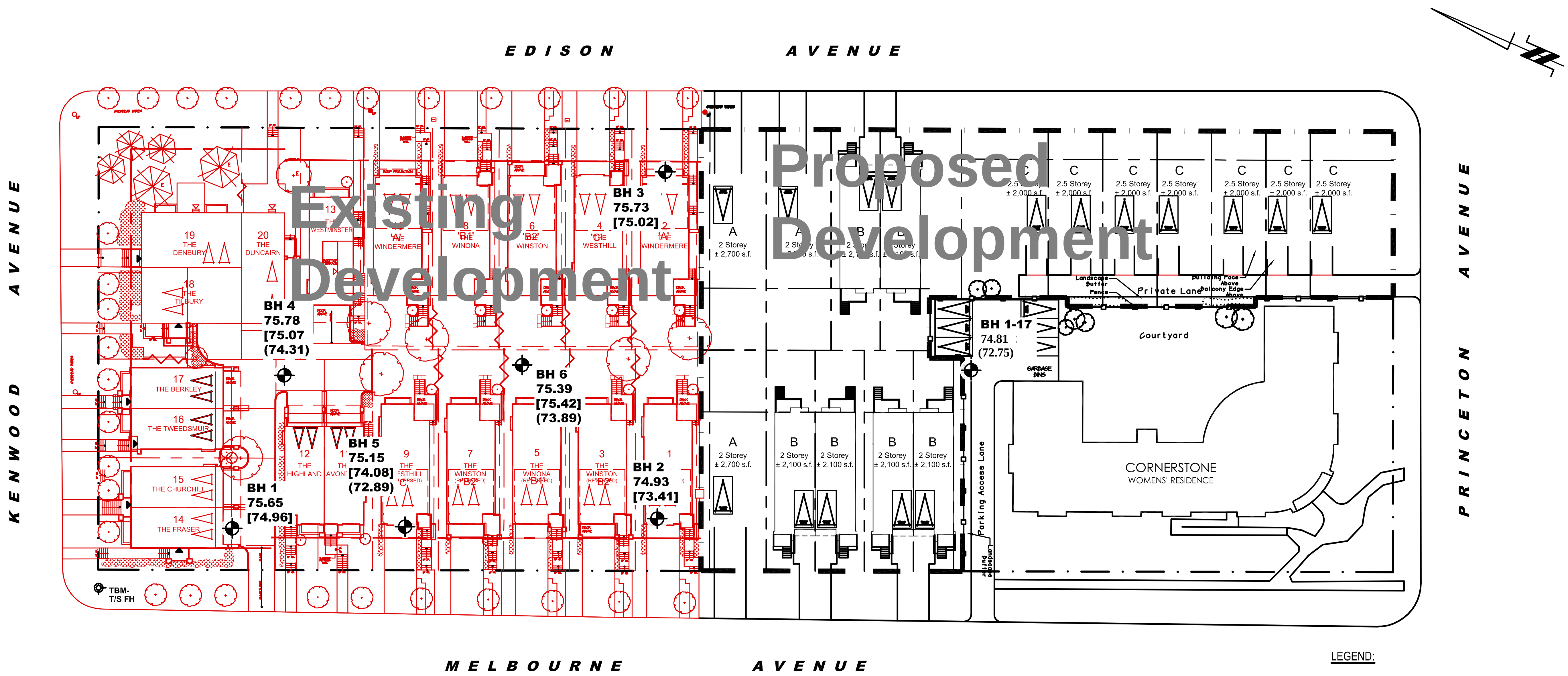

LEGEND:

⌖	BOREHOLE LOCATION
75.78	GROUND SURFACE ELEVATION (m)
[75.7]	BEDROCK SURFACE ELEVATION (m)
(74.31)	PRACTICAL REFUSAL TO AUGERING ELEV. (m)

TBM - TOP SPINDLE OF FIRE HYDRANT. GEODETIC ELEVATION = 76.17m.

SCALE: 1:600

0 5 10 15 20 25 30m

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

UNIFORM URBAN DEVELOPMENTS
GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - KENWOOD AVE. AT EDISON AVE.
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:600	Date: 05/2017
Drawn by: MPG	Report No.: PG0949-2
Checked by: FA	Dwg. No.: PG0949-2
Approved by: DJG	Revision No.: 0

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