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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Residential Development
21 Withrow Avenue
Ottawa, Ontario

Prepared For

Theberge Developments

November 30, 2018

Report: PG4194-1 Revision 1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Theberge Developments to conduct a geotechnical investigation for the proposed residential development to be located at 21 Withrow Avenue, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

- ❏ Obtain subsurface soil and groundwater information by means of boreholes completed within the subject site.
- ❏ Provide geotechnical recommendations for 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

Based on the available conceptual drawings, it is understood that the proposed residential development will consist of several single residential dwellings with the associated basement level. It is also expected that access lanes, associated parking areas and landscaped areas are to be constructed for the proposed development. It should be noted that the existing stand-alone garage structure occupying the northwestern portion of the subject site will be demolished as part of the proposed development.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for our geotechnical investigation was completed on July 11, 2017. At that time, a total of seven (7) boreholes were completed across the subject site to provide general coverage for the proposed development. Several probeholes were completed to confirm refusal depths at selected boreholes. The boreholes were advanced to a maximum depth of 3.9 m below existing ground surface. The locations of the boreholes are shown on Drawing PG4194-1 - Test Hole Location Plan included in Appendix 2.

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

Sampling and In Situ Testing

Soil samples from the boreholes were recovered from the auger flights or a 50 mm diameter split-spoon sampler. All soil samples were visually inspected and classified on site. The auger and split spoon samples were placed in sealed plastic bags and transported to our laboratory for further examination and classification. The depths at which the auger and split spoon samples were recovered from the test holes are shown as, AU and SS, respectively, on the Soil Profile and Test Data sheets presented 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 was carried out at BH 5, BH 6 and BH 7 to assess the bedrock quality. A recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are shown on the Soil Profile and Test Data sheets in Appendix 1. The recovery value is the ratio, in percentage, of the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the ratio, in percentage, of the total length of intact rock pieces longer than 100 mm in one drilled section over the length of the drilled section. 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 logged on the Soil Profile and Test Data sheets presented in Appendix 1.

Groundwater

Flexible polyethylene standpipes were installed in selected boreholes to permit the monitoring of groundwater levels subsequent to the completion of the field program.

Sample Storage

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

3.2 Field Survey

The location and ground surface elevation at each borehole location was surveyed by Paterson personnel. The ground surface elevation at the borehole locations were surveyed with respect to a temporary benchmark (TBM), consisting of top of nail on a utility pole located within the southwest corner of 21 Withrow Avenue. A geodetic elevation of 99.48 m was provided for the TBM by Farley, Smith and Denis Surveying Limited.

The borehole locations and ground surface elevation at the borehole locations along with the TBM location are presented on Drawing PG4194-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

3.4 Analytical Testing

One soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The samples were analyzed to determine the concentrations of sulphate and chloride, the resistivity and the pH of the sample. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

Currently, the subject site is predominantly grass-covered with mature trees throughout. The northwest portion of the subject site is occupied by a 2 storey residential dwelling and a stand-alone private garage with a driveway extending to Withrow Avenue. The majority of the ground surface across the site is relatively flat and at grade with the neighbouring properties with the exception of the north corner which was observed to be lower than the remainder of the site.

4.2 Subsurface Profile

Generally, the soil profile encountered at the borehole locations consists of a thin layer of topsoil underlain by glacial till consisting of silty clay with varying amounts of gravel, cobbles and boulders. Trace of crushed brick was observed within the topsoil layer at borehole location BH 2. Practical refusal was encountered at all borehole locations at depths ranging between 0.6 to 1.6 m below the existing ground surface. A very poor to fair quality limestone bedrock was cored at BH 5, BH 6 and BH 7 within the upper 1.5 m. A good quality grey limestone was encountered below the above noted layer at BH 7.

Based on available geological mapping, interbedded limestone and dolomite of the Gull River Formation is present in this area with an overburden thickness ranging between 1 to 2 m.

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

4.3 Groundwater

Groundwater level readings were taken by Paterson personnel at the borehole locations on July 18, 2017. Our groundwater measurements indicate that the long-term groundwater was not encountered at the final depth of our borehole locations. Based on the field observations, experience in the local area, moisture levels and colour of the recovered soil samples, the long-term groundwater level is expected to be within the bedrock. 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 residential development. The proposed residential development is expected to be constructed over conventional shallow foundations and placed on a clean, surface sounded bedrock bearing surface.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, asphalt and deleterious fill, such as those containing organic materials, should be stripped from under the proposed buildings, paved areas, pipe bedding and other settlement sensitive structures.

Due to the relatively shallow depth of the bedrock surface and the anticipated founding level for the proposed buildings, all existing overburden material should be excavated from within the proposed building footprint.

Existing foundation walls and other construction debris should be entirely removed from within any proposed 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 building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings and paved areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD.

Bedrock Removal

It is expected that line-drilling in conjunction with hoe-ramming or controlled blasting will be required to remove the bedrock. In areas of weathered bedrock and where only a small quantity of bedrock is to be removed, bedrock removal may be possible by hoe-ramming.

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

As a general guideline, peak particle velocity (measured at the structures) should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing structures.

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

Excavation side slopes in sound bedrock can be carried out using almost vertical side walls. A minimum 1 m horizontal ledge, should be left between the bottom of the overburden excavation and the top of the bedrock surface to provide an area to allow for potential sloughing or to provide a stable base for the overburden shoring system.

Vibration Considerations

Construction operations are also the cause of vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain, as much as possible, a cooperative environment with the residents.

The following construction equipments could be a source of vibrations: piling rig, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of the shoring system using soldier piles or sheet piling will require the use of these equipments. Vibrations, whether it is caused by blasting operations or by construction operations, could be the cause of the source of detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters are used to determine the permissible vibrations, namely, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). It should be noted that these guidelines are for today's construction standards. Considering that several old or sensitive buildings are encountered in the vicinity of the subject site, considerations should be given to lowering these guidelines. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, it is recommended that a pre-construction survey be completed to minimize the risks of claims during or following the construction of the proposed buildings.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on a clean, surface sounded bedrock surface can be designed using a factored bearing resistance value at ULS of **1,500 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value.

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 bearing on surface sounded bedrock and designed using the above mentioned bearing resistance values will be subjected to negligible post-construction total and differential settlements.

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

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the foundations considered at the subject site. A higher site class, such as A or B may be applicable for this site. However, the higher site class has to be confirmed by a site-specific shear wave velocity test. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious materials, within the footprint of the proposed buildings, a clean surface-sounded bedrock, approved by the geotechnical consultant at the time of construction is considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The upper 300 mm of sub-slab fill should consist of a 19 mm clear crushed stone fill. All backfill material within the proposed building footprints should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% of the SPMDD.

5.6 Pavement Structure

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

Table 1 - 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 in situ soil, fill or OPSS Granular B Type I or II material placed over in situ soil or fill.	

Table 2 - Recommended Pavement Structure - Access Lanes

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
400	**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 backfilled 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, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the buildings.

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 drainage geocomposite, such as system Platon or Miradrain G100N, connected to the perimeter foundation drainage system.

It is understood that sump pits will be installed within the proposed buildings. The perimeter foundation drainage system should be provided with an inlet to the sump pit. The sump pit system should be designed in general accordance with City of Ottawa Technical Bulletin ISTB-2018-04 dated June 27, 2018. Refer to Drawing PG4194-2 - Sump Pit Connection To Storm Sewer With Porch provided in Appendix 2 for general sump pit construction details.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided.

Exterior unheated footings, such as isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

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 insulation to protect footings. It is preferable to pour footings on the insulation overlying weathered bedrock. However, due to the potential undulating bedrock surface, consideration may have to be given to adopting an insulation detail that allows the footing to be poured directly on the weather bedrock.

6.3 Excavation Side Slopes

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

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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

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

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD. The bedding material should extend at least to the spring line of the pipe. The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

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.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, 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.

Long-term Groundwater Control

Our recommendations for the proposed buildings' long-term groundwater control are presented in Subsection 6.1. Any groundwater encountered along the building perimeter or sub-slab drainage system will be directed to the interior sump pits. It is expected that groundwater flow will be low (i.e. less than 20,000 L/day) with peak periods noted after rain events. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

Impacts on Neighbouring Structures

Based on our observations, the long-term groundwater level is located below the drilling depth at all test hole locations completed during the current investigation. Therefore, long-term groundwater lowering is anticipated to be negligible for the area.

Based on available soils information, neighbouring structures are anticipated to be founded within the bedrock. No issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed development.

6.6 Winter Construction

Precautions should be considered if construction occurs during the winter. The subsurface soil conditions consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

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

Trench excavations and pavement construction are difficult activities to complete during winter without introducing frost in the excavation subgrade base or walls. Precautions should be considered if such activities are to be completed during sub-zero temperatures.

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 corrosive environment.

7.0 Recommendations

The following material testing and observation program should be performed by a geotechnical consultant and is required for the foundation design data provided herein to be applicable:

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

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

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

☐ Observation of all subgrades prior to backfilling.

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

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

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

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. 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 Theberge 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.

Nathan

Nathan F. S. Christie, P.Eng.

LICENSED PROFESSIONAL ENGINEER
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Report Distribution

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

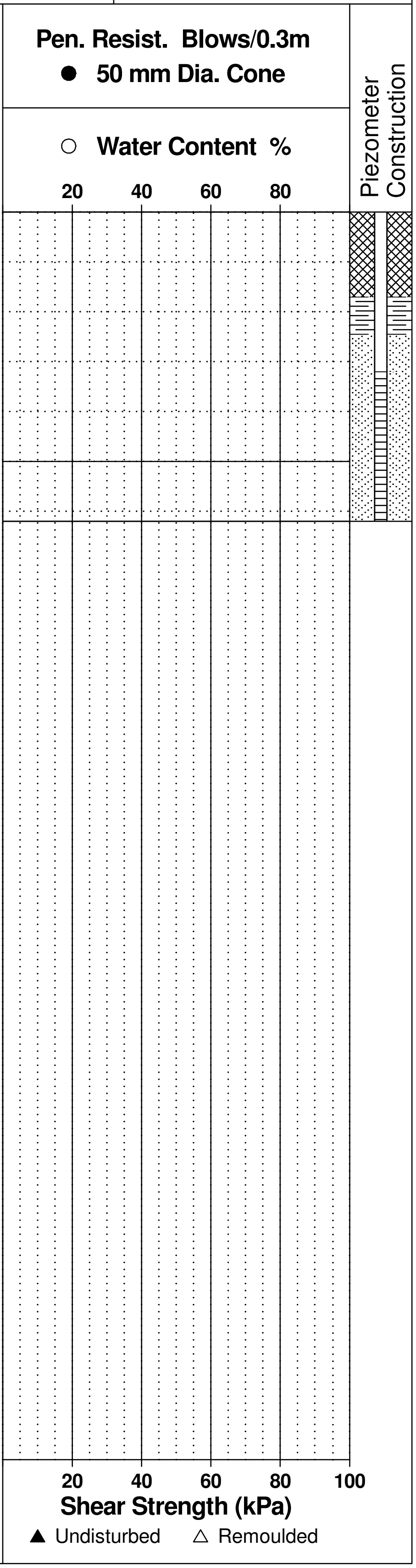
HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	98.52
TOPSOIL with organics 0.30		AU	1				
GLACIAL TILL: Brown silty clay, some cobbles and boulders, trace organics 0.76							
BEDROCK: Weathered limestone		SS	2	80	50+		
		AU	3			1	97.52
1.24							

End of Borehole

Practical refusal to augering at 1.24m depth.

(BH dry - July 18, 2017)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 21 Withrow Avenue
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DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 1B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	98.55		
OVERBURDEN									
						1	97.55		
1.24									
End of Borehole Practical refusal to augering at 1.24m depth.									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

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DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

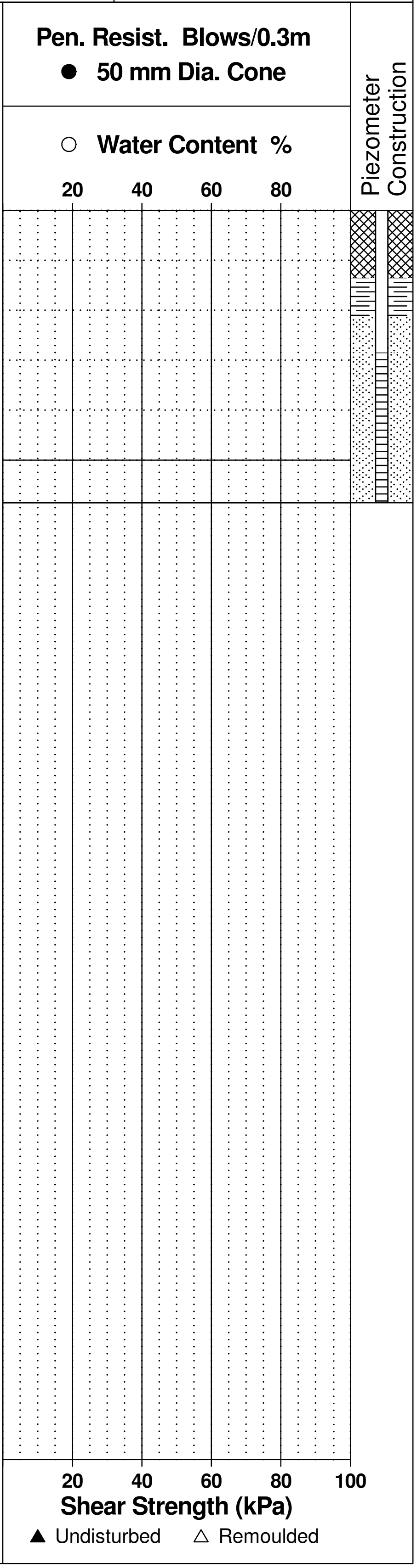
HOLE NO. BH 2

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	98.24
TOPSOIL with organics, trace brick (to 0.36)	AU	1				
GLACIAL TILL: Brown silty clay, some gravel, cobbles, trace boulders and organics (to 0.81)						
BEDROCK: Weathered limestone (to 1.17)	SS	2	50	50+		
					1	97.24
	AU	3				

End of Borehole

Practical refusal to augering at 1.17m depth.

(BH dry - July 18, 2017)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

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DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 2B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	98.26		
OVERBURDEN						1	97.26		
1.17									
End of Borehole Practical refusal to augering at 1.17m depth.									

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. Residential Development - 21 Withrow Avenue
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DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

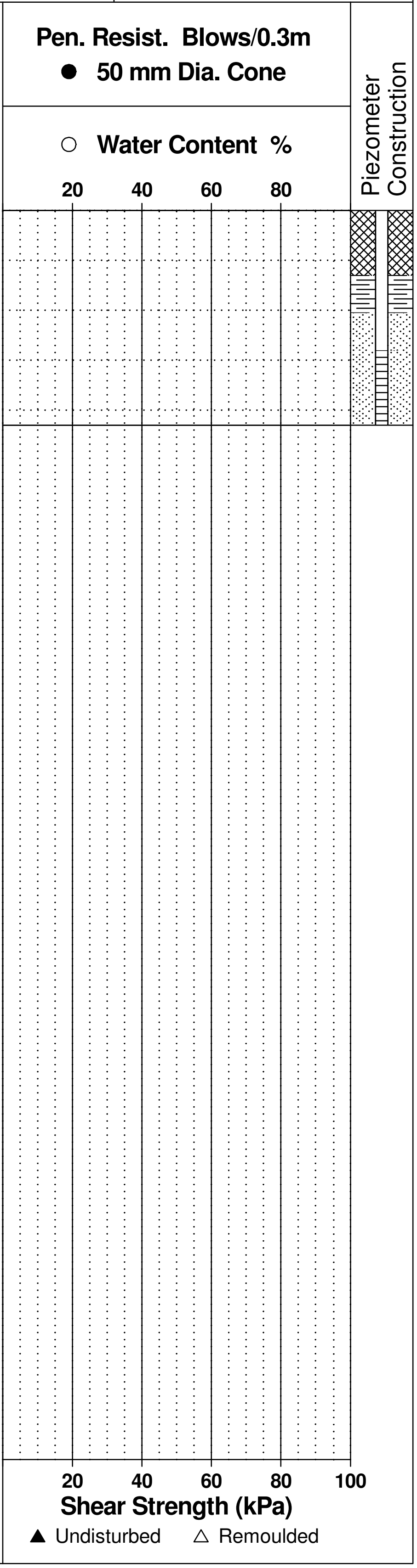
BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 3

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	98.46
TOPSOIL with organics — 0.28	AU	1				
GLACIAL TILL: brown silty clay, some topsoil, gravel, cobbles and organics — 0.86	SS	2	75	50+		
End of Borehole Practical refusal to augering at 0.86m depth. (BH dry - July 18, 2017)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

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BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 3B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	98.47		
OVERBURDEN						1	97.47		
1.65									
End of Borehole Practical refusal to augering at 1.65m depth.									

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. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 3C

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	98.48		
OVERBURDEN									
1.07						1	97.48		
End of Borehole Practical refusal to augering at 1.07m depth.									

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. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

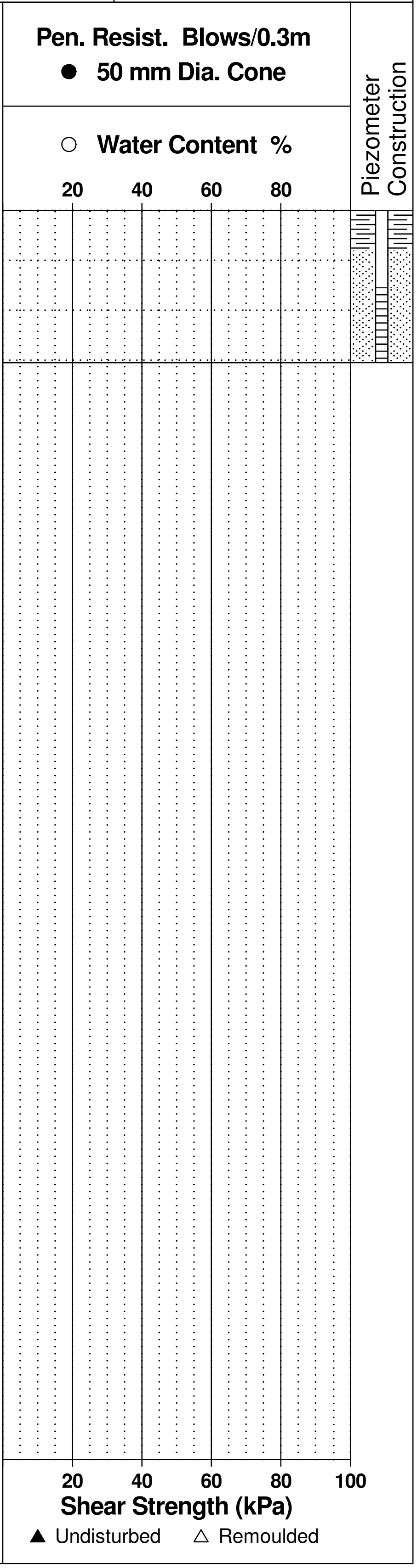
BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 4

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	97.58
TOPSOIL 0.20	AU	1				
GLACIAL TILL: Brown silty sand to silty clay, some gravel, cobbles, trace boulders and organics 0.61						
End of Borehole Practical refusal to augering at 0.61m depth.						



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

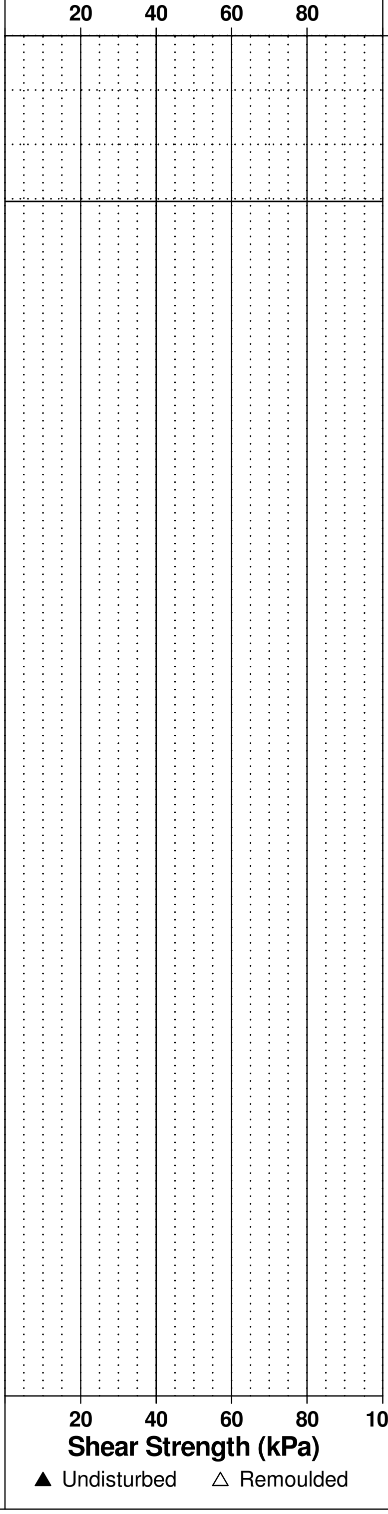
BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 4B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	97.61		
OVERBURDEN 0.61									
End of Borehole Practical refusal to augering at 0.61m depth.									



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	97.58		
OVERBURDEN									
0.51									
BEDROCK: Grey limestone	▤	RC	1	100	0	1	96.58		
		RC	2	59	0				
						2	95.58		
		RC	3	100	27				
						3	94.58		
3.07									
End of Borehole (BH dry upon completion)									

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. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	98.50		
OVERBURDEN									
0.76									
BEDROCK: Grey limestone						1	97.50		
		RC	1	96	0				
						2	96.50		
		RC	2	98	23				
						3	95.50		
		RC	3	89	32				
3.50									
End of Borehole (BH dry upon completion)									

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. Residential Development - 21 Withrow Avenue
Ottawa, Ontario

DATUM TBM - 2 Nails in pole located at the southwest corner of property. Geodetic elevation = 99.48m, as per Farley, Smith & Denis Surveying Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 11, 2017

FILE NO. PG4194

HOLE NO. BH 7

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	98.39
OVERBURDEN (to 0.84)						
					1	97.39
BEDROCK: Grey limestone (0.84 – 3.95)	RC	1	100	0		
					2	96.39
	RC	2	92	47		
					3	95.39
	RC	3	100	78		
End of Borehole (3.95) (BH 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 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 = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = $D60 / D10$

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

CONSOLIDATION TEST

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

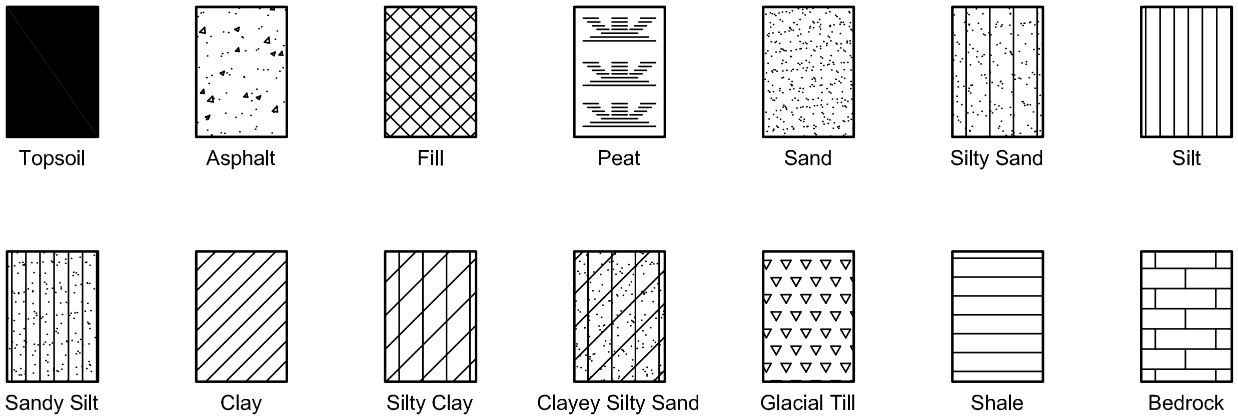
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

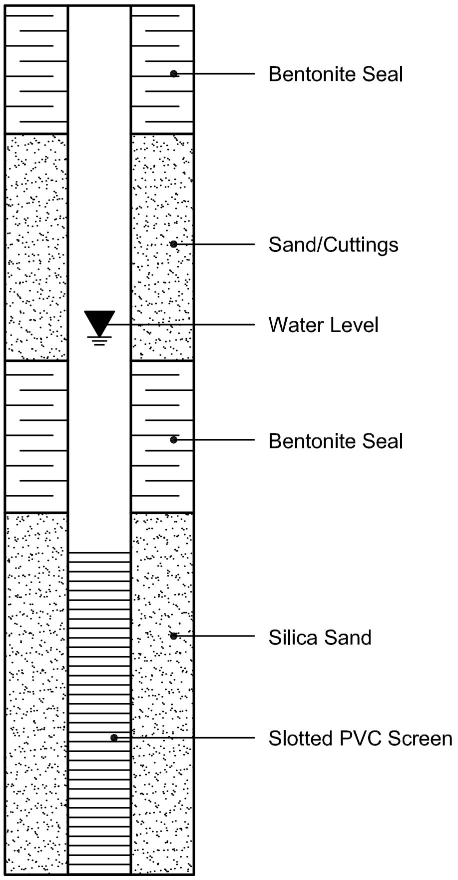
SYMBOLS AND TERMS (continued)

STRATA PLOT

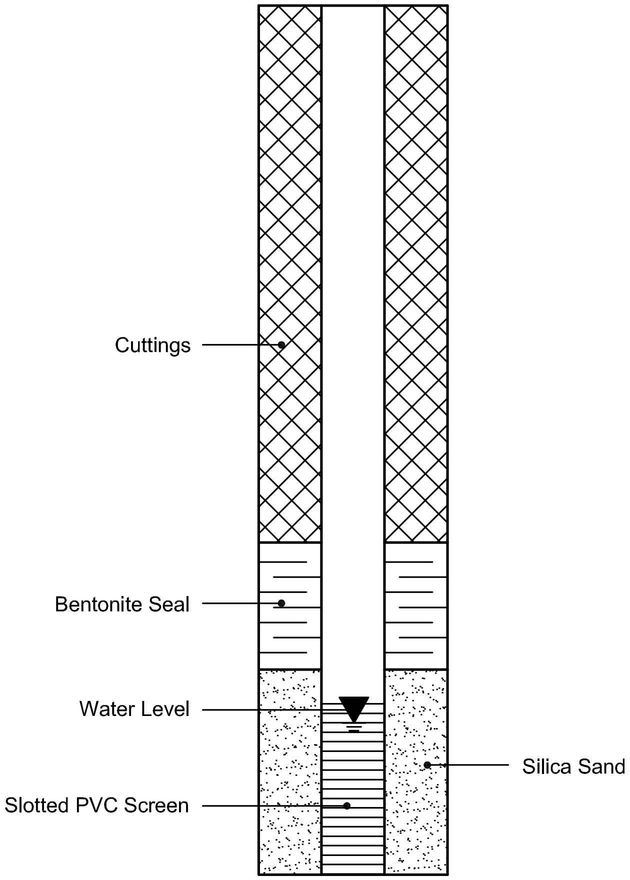


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 21949

Report Date: 21-Jul-2017

Order Date: 17-Jul-2017

Project Description: PG4194

	Client ID:	BH3-SS2	-	-	-
	Sample Date:	14-Jul-17	-	-	-
	Sample ID:	1729076-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	90.9	-	-	-
General Inorganics					
pH	0.05 pH Units	7.56	-	-	-
Resistivity	0.10 Ohm.m	56.6	-	-	-
Anions					
Chloride	5 ug/g dry	11	-	-	-
Sulphate	5 ug/g dry	9	-	-	-

APPENDIX 2

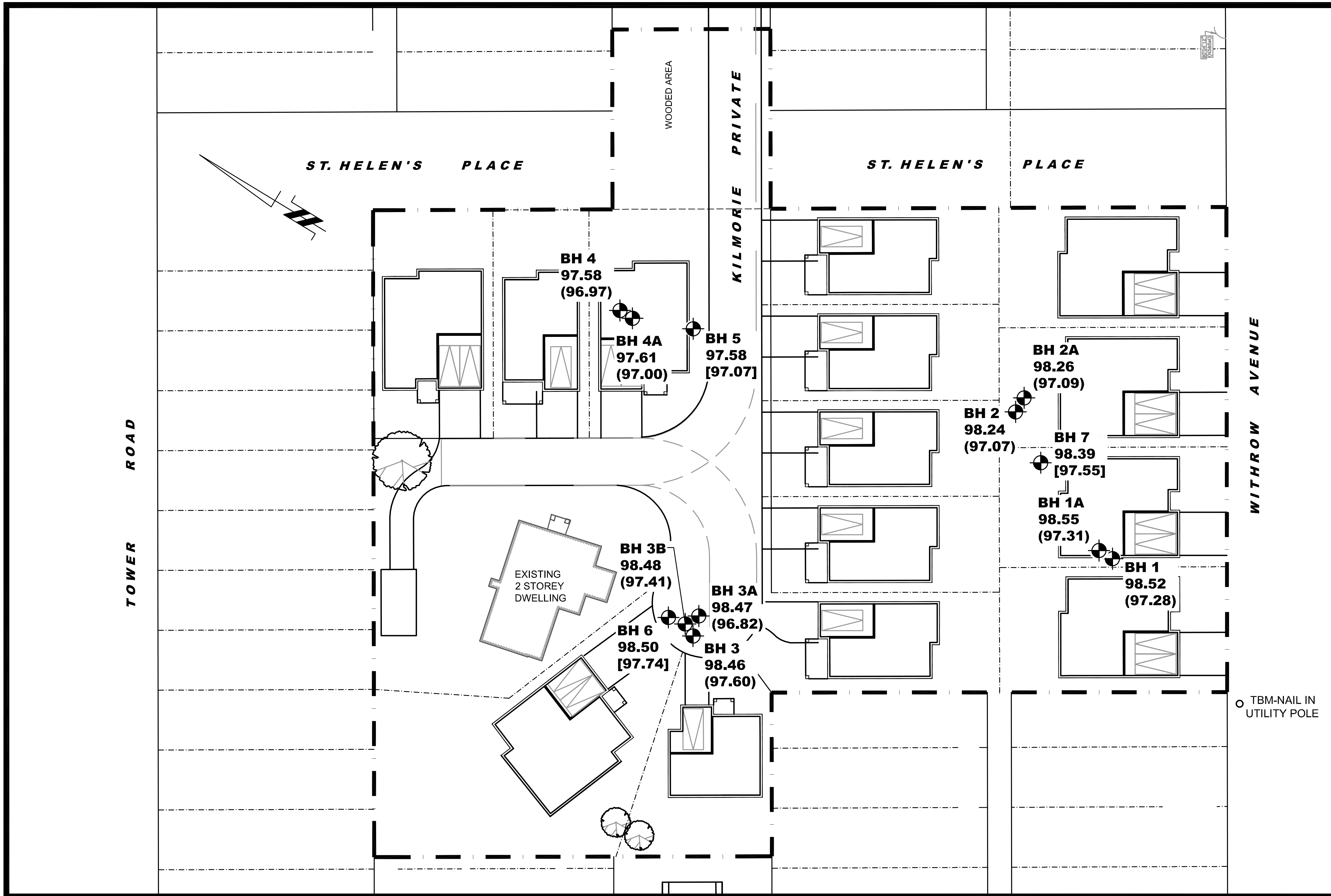
FIGURE 1 - KEY PLAN

DRAWING PG4194-1 - TEST HOLE LOCATION PLAN

DRAWING PG4194-2 - SUMP PIT CONNECTION TO STORM SEWER WITH PORCH

FIGURE 1

KEY PLAN



LEGEND:

⊕	BOREHOLE LOCATION
98.52	GROUND SURFACE ELEVATION (m)
(97.28)	PRACTICAL REFUSAL TO AUGERING ELEVATION (m)
[97.07]	BEDROCK SURFACE ELEVATION (m)

TBM - NAIL IN UTILITY POLE LOCATED NEAR THE SOUTHWEST PROPERTY CORNER OF THE SUBJECT SITE. GEODETIC ELEVATION = 99.48m PROVIDED BY FARLEY , SMITH & DENIS SURVEYING LTD.

BASE PLAN PROVIDED BY URBANDIVA INC.

SCALE: 1:500

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			

THEBERGE DEVELOPMENTS

GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT
21 WITHROW AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:500
Drawn by: RCG
Checked by: NZ
Approved by: DJG
Date: 07/2017
Report No.: PG4194-1
Dwg. No.: PG4194-1
Revision No.: 0

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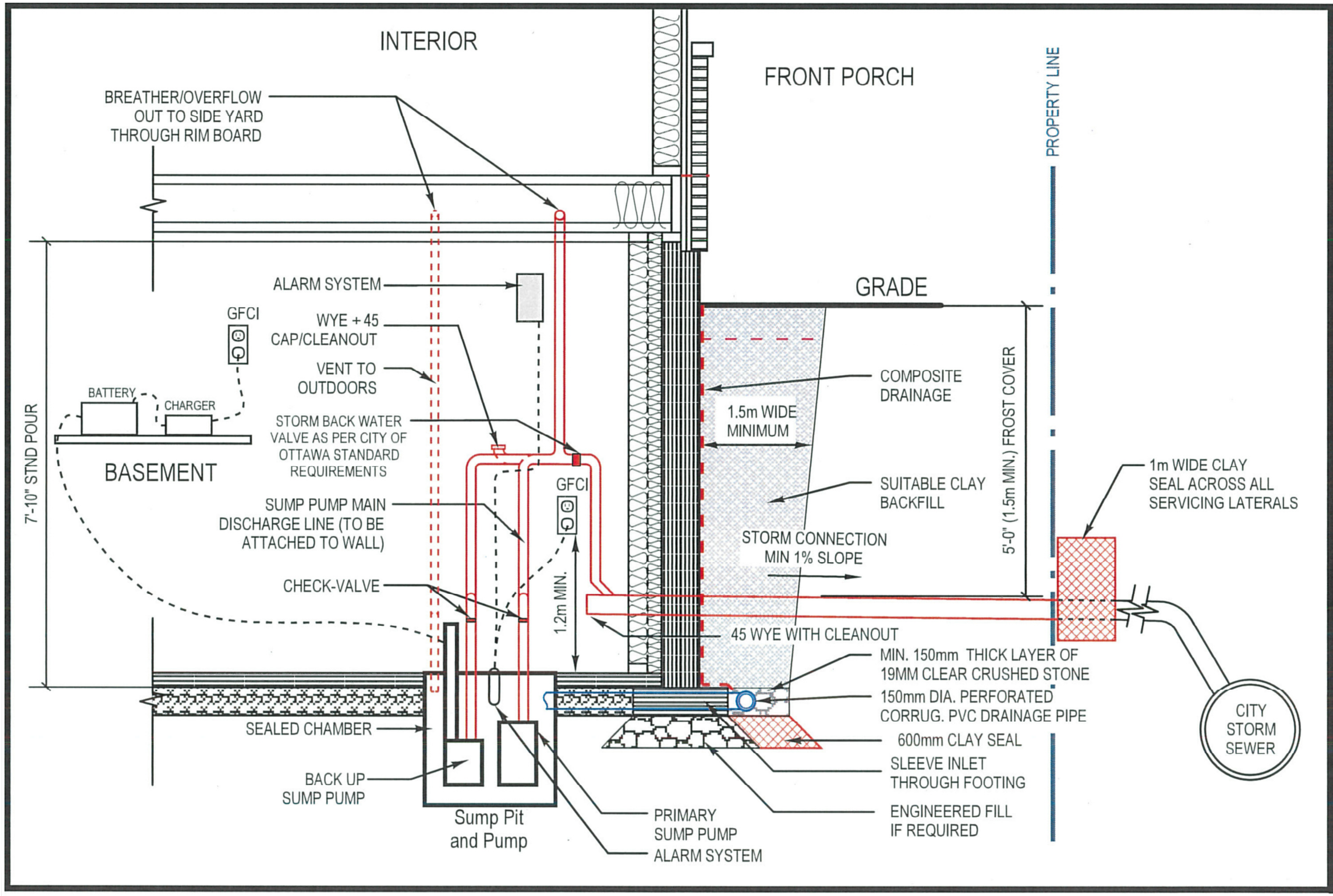
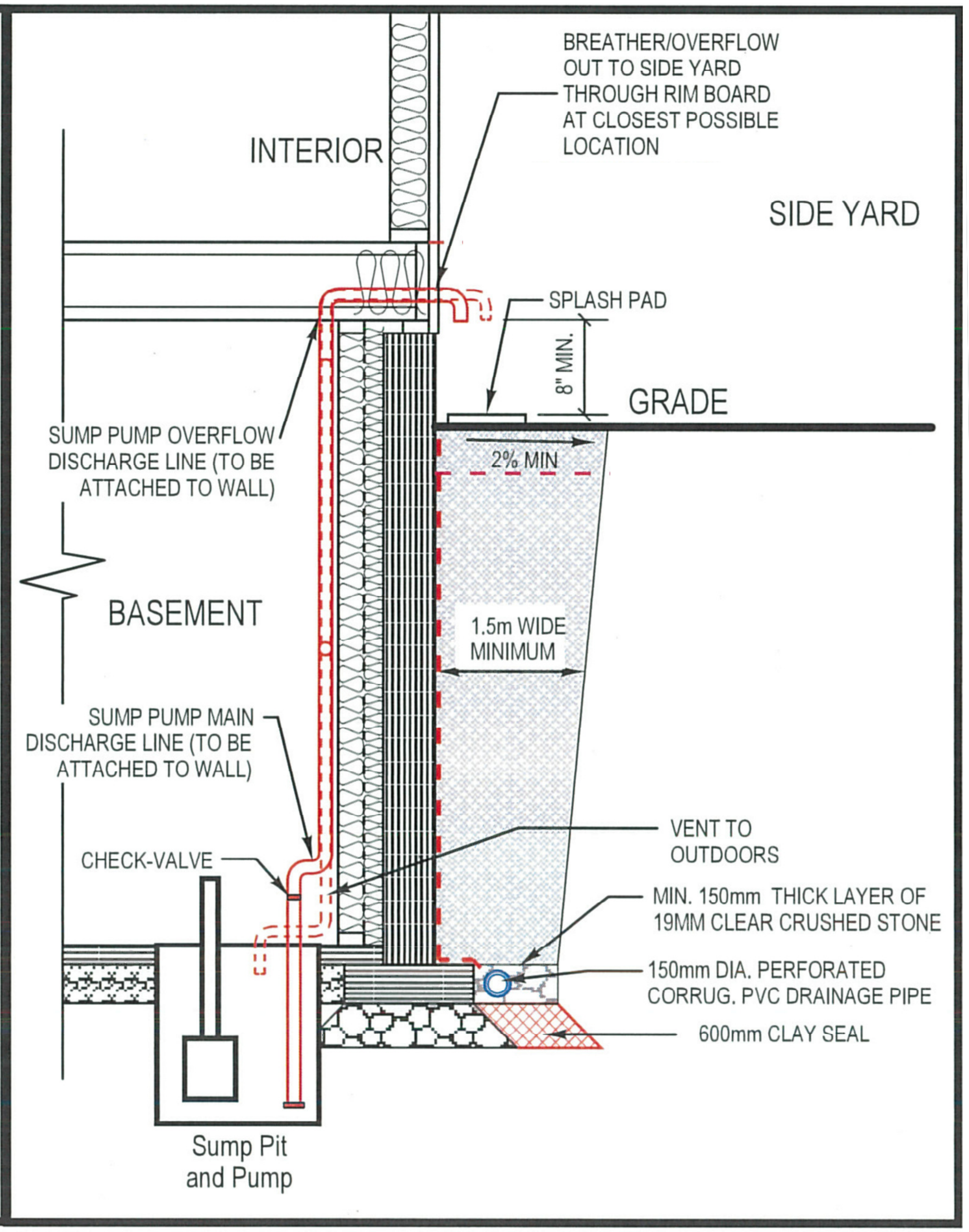


SECTION: FRONT TO BACK



SECTION: SIDE TO SIDE

THROUGH RIMBOARD AT CLOSEST POSSIBLE LOCATION

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

THEBERGE HOMES
GEOTECHNICAL INVESTIGATION
21 WITHROW AVENUE
OTTAWA, ONTARIO

Title:
SUMP PIT CONNECTION TO STORM SEWER WITH PORCH

Scale: N.T.S.
Date: 11/2018
Drawn by: MPG
Report No.: PG4194
Checked by: NC
Dwg. No.: PG4194-2
Approved by: DJG
Revision No.: 0

p:\autocad drawings\geotechnical\pg41xx\pg4194\pg4194-2 sump pit detail.dwg

APPENDIX 3

MEMORANDUMS

patersongroup
consulting engineers

memorandum

re: **Geotechnical Response to City Comments**
Proposed Residential Development
21 Withrow Avenue - Ottawa
to: Theberge Homes - **Mr. Joey Theberge** - joeytheberge@thebergehomes.com
cc: DSEL - **Mr. Steve Merrick** - SMerrick@dsel.ca
date: November 30, 2018
file: PG4194-MEMO.01

Further to your request, Paterson Group (Paterson) prepared the following responses to city comments regarding the proposed development at the aforementioned site.

This memorandum should be read in conjunction with our Report PG4194-1 Revision 1 dated November 30, 2018.

Comment 1: *At detailed design, please provide a letter from the geotechnical engineer with their recommendation on loading above sewer, as specified on the plan.*

Response: Paterson reviewed the following drawing prepared by David Schaeffer Engineering Ltd. (DSEL):

- ☐ Project No. 17-931 - Drawing No. SSP-1 - Site Servicing Plan Revision 3 dated June 7, 2018.

Based on our review of the above noted drawing, it is understood that the entirety of the proposed water pipes, including mains and service laterals, will be located within the frost zone (i.e. 2.4 m vertical separation between finished grade and pipe obvert). Reference is made to City of Ottawa Standard W22 - Thermal Insulation For Watermains In Shallow Trenches. Paterson accepts the detail noted in Standard W22 as a suitable alternative to soil cover alone. However, it is recommended that insulation be placed horizontally across the top of the water pipes, to a horizontal distance of 1.2 m beyond the outside extent of the pipe. Vertical insulation panels, which are difficult to place correctly, will not be required if insulation is placed horizontally as described herein.

Paterson also reviewed the above noted drawing to determine if any underground utilities would be adversely impacted by loads from the proposed buildings. Based on the proposed underside of footing (USF) elevations and proximity of footings to utility pipes, no utilities will be located within the lateral support zone of the proposed building footings and utilities are not anticipated to be impacted.

Comment 2: *Show pavement structure and how subgrade is to be drained in road cross sections*.

Response: From a geotechnical perspective, adequate drainage is provided due to the fractured bedrock subgrade. Subdrains are not required to provide adequate drainage.

Comment 3: *Section 5.4.4: Enhanced grassed swales for LID purposes is to have site considerations including proximity to water table and bedrock. The bottom of swale needs to be 1 m from both.*

Response: Our field observations showed practical refusal to augering at depths ranging from 0.6 to 1.6 m below existing ground surface. This included augering through weathered limestone bedrock in some locations. At borehole locations where coring was completed, low to very low RQD values (i.e. less than 50) were noted within the upper 3 m profile during our laboratory review. This is indicative of high concentrations of fractures present within the bedrock. It should be noted that such weathered limestone can be considered to have a generally high hydraulic conductivity due to the layer separation characteristic to this rock type.

It should be further noted that standpipes were installed within several boreholes upon completion of coring to maximum 4.0 m depth. Paterson did not observe water in the standpipes following completion of the drilling program. Therefore, it is anticipated that the long-term, stabilized groundwater level is within the bedrock, below the depth of the drilled boreholes.

The fractured upper layers of bedrock, combined with the low groundwater table, can be taken as good hydrogeological conditions for providing adequate road drainage with enhanced grass swales. Minimal bedrock removal is anticipated to be required due to its highly fractured nature allowing for good drainage from below the pavement structure.

Based on the depth of the groundwater table and the observed bedrock conditions, it is suggested that the proposed roads can be constructed with minimal to no bedrock removal in order to satisfy the requirement of the bottom of swale having a minimum vertical separation of 1 m from bedrock surface. The upper bedrock profile consists of a highly fractured and weathered bedrock, consistent across the site at our test hole locations. The low groundwater table is anticipated to further promote good road drainage.

Comment 4: *the freeboard for the 5 year storm to have the water surface elevation set below the pavement structure, and where applicable, below the inverts of the pavement subdrains and inletting swales.*

Response: Based on the findings of the field program and laboratory review programs, the anticipated impact of a 5 year storm event will include temporary surface ponding and retention within swales. However, the subsurface profile and anticipated long-term groundwater level both indicate that high infiltration rates are likely. Therefore, stormwater retention at surface is anticipated to be short term and any surface water should drain from the site quickly following a significant precipitation event.

Comment 5: *The Geotechnical report shall detail the sump pump design.*

Response: The sump pump design is presented in Appendix 2 of Report PG4194-1 Revision 1 dated November 30, 2018.

We trust that this information satisfies your immediate requirements.

Paterson Group Inc.

Nathan F. S. Christie, P.Eng.

David J. Gilbert, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Nov. 30-2018
D. J. GILBERT
100116130
PROVINCE OF ONTARIO