

Geotechnical
Engineering

Environmental
Engineering

Hydrogeology

Geological
Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation

Proposed Commercial Development
1015 March Road
Ottawa, Ontario

Prepared For

Kanata United

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Report: PG5014-1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Kanata United to conduct a geotechnical review for the proposed commercial development to be located at 1015 March Road, in the City of Ottawa, Ontario (Refer to Figure 1 - Key Plan in Appendix 2)

The objectives of the current geotechnical review were:

- ☐ to determine the subsurface soil and groundwater conditions at this site by means of boreholes.
- ☐ to provide geotechnical recommendations pertaining to 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. The report contains the geotechnical findings and recommendations pertaining to the design and construction of the subject development as understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the proposed development was not part of the scope of work. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

It is understood that the proposed development will consist of several commercial slab-on-grade structures. It is also anticipated that the development will include associated car parking areas, access lanes and landscaped areas.

It is further understood that the proposed development will be serviced by future municipal water, sanitary and storm services.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current investigation was conducted on July 24, 2019. At that time, a total of ten (10) boreholes were advanced to a maximum depth of 4.5 m below existing ground surface or practical auger refusal. The boreholes were distributed in a manner to provide general coverage of the subject site taking into consideration site features and underground and overhead utilities. The locations of the test holes are shown on Drawing PG5014-1 included in Appendix 2.

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

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler. All soil samples were visually inspected, initially classified on site and placed in sealed plastic bags. All samples were transported to our laboratory for examination and classification. The depths at which the split-spoon, auger samples were recovered from the boreholes are shown as SS, AU 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.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils. All soil samples were classified on site, placed in sealed plastic bags and were transported to our laboratory for visual inspection.

The subsurface conditions observed at the borehole locations were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

Groundwater

Flexible standpipes were installed in all boreholes to monitor the groundwater levels subsequent to the completion of the sampling program.

3.2 Field Survey

The borehole locations were determined by Paterson personnel taking into consideration the presence of underground and aboveground surfaces. The location and ground surface elevation at each borehole location were referenced to a temporary benchmark (TBM) consisting of the edge of asphalt at the existing entrance to the subject site. An arbitrary elevation of 100.00 m was assigned to the TBM. The location of the TBM, boreholes and ground surface elevation at each borehole location are presented on Drawing PG5014-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were visually examined in our laboratory to review the results of the field logging. A total of three (3) Atterberg limit tests were completed on selected silty clay samples. Grain size distribution analysis (hydrometer testing) was also completed on one (1) soil sample and one (1) soil sample was submitted for shrinkage testing. The results are presented in Subsection 4.2 and in Appendix 1.

3.4 Analytical Testing

One (1) soil sample was submitted to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analyzed to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are discussed in Subsection 6.7 and shown in Appendix 1.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by a single family residential dwelling located within the south portion of the subject site and is generally surround by agricultural land with the exception of a single family residential dwelling located to the north of the subject site. The site is sparsely surrounded by several mature trees and bordered to the east by a shallow ditch which travels parallel to March Road. The site is relatively flat and slightly lower in elevation than March Road.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the borehole locations consist of a layer of topsoil with organic content, varying in thickness between 0.15 and 0.4 m, overlying a stiff to hard weathered brown silty clay crust extending to depths varying between 2.3 to 4.1m below existing ground surface at the test hole locations. The silty clay was generally found to be underlain by a compact to dense glacial till consisting of a brown silty sand with clay, gravel, cobbles and occasional boulders.

Practical refusal to augering was encountered at all boreholes locations at depth varying between 2.6 and 4.5 m below existing ground surface.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Atterberg Limits Results

The results of the Atterberg Limit tests conducted within the silty clay are presented below in Table 1 - Summary of Atterberg Limits Results and are presented in Appendix 1. The tested material was classified as Inorganic Clays of High Plasticity (CH).

Table 1 - Summary of Atterberg Limits Results					
Sample	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Classification
BH 3 - SS 2	26.9	55	21	33	CH
BH 8 - SS 3	27.3	53	19	34	CH
BH 10 - SS 2	29.8	58	27	32	CH

Hydrometer Testing

One (1) representative soil sample was submitted for grain size distribution analysis (hydrometer testing). The results are summarized in Table 2 and presented on the Grain Size Distribution sheets in Appendix 1.

Table 2 - Summary of Grain Size Distribution Analysis (Hydrometer Testing)				
Sample	Gravel %	Sand %	Fines Content	
			Silt %	Clay %
BH 4 - SS 3	0	1.4	47.6	51.0

Bedrock

Based on available geological mapping, the bedrock in the area consists of sandstone interbedded with dolomite, belonging to the March formation with an overburden thickness of ranging from 2 to 5 m.

4.3 Groundwater

The groundwater level (GWL) readings were recorded at the borehole locations on July 30, 2019 and are presented in the Soil Profile and Test Data sheets. It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled borehole due to the seasonal changes, which can lead to water perching inside the boreholes resulting in higher water levels than noted during the investigation. The long-term groundwater level can also be estimated based on moisture levels and color of the recovered soil samples. Based on these observations at the borehole locations, the long-term groundwater level is expected to be at a 2 to 3 m depth. It should be noted that groundwater levels are subject to seasonal fluctuations and therefore groundwater levels could differ at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered adequate for development. It is expected that low rise commercial buildings can be founded by conventional style shallow foundations placed on undisturbed, stiff to hard silty clay or glacial till.

Due to the presence of the silty clay deposit, the subject site will be subjected to a permissible grade raise. If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Due to the relatively shallow depth of the bedrock surface, bedrock removal may be required for site servicing.

Bedrock Removal

Bedrock removal can be accomplished by hoe ramming where only a small quantity of the bedrock needs to be removed. Sound bedrock may be removed by line drilling and controlled blasting and/or hoe ramming.

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

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm/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 also an experienced blasting consultant.

Excavation side slopes in sound bedrock can be excavated almost vertical side walls. A minimum 1 m horizontal ledge, should remain between the overburden excavation and the bedrock surface. The ledge will provide an area to allow for potential sloughing or a stable base for the overburden shoring system.

Vibration Considerations

Construction operations are 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 the source of vibrations: hoe ram, compactor, dozer, crane, truck traffic, etc. Vibrations, whether caused by blasting operations or by construction operations, could be the source of detrimental vibrations on the nearby buildings and structures. Therefore, all vibrations are recommended to 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). The guidelines are for current construction standards. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended be completed to minimize the risks of claims during or following the construction of the proposed building.

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 material. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings 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 excavated stiff brown silty clay, free of organics and deleterious materials, is to be used to build up the subgrade level for areas to be paved, the silty clay, under dry conditions, 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 composite drainage blanket connected to a perimeter drainage system is provided.

5.3 Foundation Design

Bearing Resistance Values

Strip footings up to 3 m wide and pad footings up to 5 m wide founded on an undisturbed, hard to stiff silty clay can be designed using the bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

Footings placed on a glacial till, or engineered fill bearing surface can be designed using a bearing resistance value at SLS of **150 kPa** and at ULS of **225 kPa**. A geotechnical resistance factor of 0.5 was incorporated into the bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed, in the dry, prior to the placement of concrete for footings.

Footings bearing on an undisturbed soil bearing surface and designed using the bearing resistance values provided herein will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to an undisturbed soil bearing surface above the groundwater table when a plane extending horizontally and vertically from the bottom edge of the footing at a minimum of 1.5H:1V, passing through in situ soil of the same or higher capacity as the bearing medium soil.

Permissible Grade Raise Recommendations

A permissible grade raise restriction has been determined for the subject site based on the undrained shear strength values completed within the silty clay deposit. Based on the testing results, a permissible grade raise restriction of **2.5 m** above existing ground surface is recommended for the subject site.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C**. A higher site class, such as Class A or B may be applicable for the subject site, however, would need to be confirmed with site specific shear wave velocity testing. The soils underlying the proposed shallow foundations are not susceptible to liquefaction. 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 Slab on Grade Construction

With the removal of all topsoil and fill, containing deleterious or organic materials, the native soil or existing granular fill approved by the geotechnical consultant at the time of excavation will be considered to be an acceptable subgrade surface on which to commence backfilling for slab on grade construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. All backfill materials within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Structure

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

Table 3 - 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 soils or OPSS Granular B Type I or II material placed over in situ soil	

Table 4 - Recommended Pavement Structure Access Lanes/Heavy Truck Parking Areas	
Thickness (mm)	Material Description
40	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete
50	Binder Course - HL-8 or Superpave 19.0 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
400	SUBBASE - OPSS Granular B Type II
SUBGRADE - Either in situ soils or OPSS Granular B Type I or II material placed over in situ soil	

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 I or II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the low permeability of the subgrade materials consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

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

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls where frost heave sensitive structures, such as a concrete sidewalk, will be placed. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material may be used for this purpose. A composite drainage system, such as Delta Drain 6000, Miradrain G100 or equivalent, should be placed against the foundation wall to promote drainage toward the perimeter drainage pipe.

6.2 Protection Against Frost Action

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

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

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

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

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

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

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

6.4 Pipe Bedding and Backfill

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

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

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

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

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

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 shallow excavations. 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 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.

6.6 Winter Construction

The subsurface conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

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

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials 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. In addition, 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. Additional information could be provided, if required.

6.7 Corrosion 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 results of the chloride content, pH and resistivity indicate the presence of a non aggressive to slightly aggressive environment for exposed ferrous metals at this site.

6.8 Landscaping Considerations

Tree Planting Setbacks

In general accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing and grain size distribution analysis (hydrometer testing) was completed for recovered silty clay samples at selected locations throughout the subject site. The abovenoted test results were completed between design underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Table 1 and Table 2 in Subsection 4.2 and in Appendix 1.

The results of the shrinkage testing of BH 9 - SS3 resulted in a shrinkage limit of **19%** with a shrinkage ratio of **1.78**.

Based on the results of the representative soil samples recovered between the designed underside of footing (USF) and 3.5 m from the proposed design grades at the residential dwellings, the subject site is considered as a low/medium sensitive area for tree planting according to the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines).

Low/Medium Sensitivity Clay Soils

Since the modified plasticity limit generally does not exceed 40%, the following tree planting setbacks are recommended for the site. Large trees (mature height over 14 m) can be planted at the site provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- ☐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.
- ☐ A small tree must be provided with a minimum of 25 m³ of available soil volume while a medium tree must be provided with a minimum of 30 m³ of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- ☐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.
- ☐ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).
- ☐ Grading surround the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

7.0 Recommendations

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

- ☐ Grading plan review from a geotechnical perspective, once the final grading plan is available.
- ☐ Observation of all bearing surfaces prior to the placement of concrete.
- ☐ Sampling and testing of the concrete and fill materials used.
- ☐ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ☐ Observation of all subgrades prior to backfilling.
- ☐ Field density tests to determine the level of compaction achieved.
- ☐ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, 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. We request that we be permitted to review the grading plan once available. 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 Kanata United 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.



Richard Groniger, C. Tech.



David J. Gilbert, P.Eng



Report Distribution:

- ☐ Kanata United (3 copies)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS' TESTING RESULTS

GRAIN SIZE DISTRIBUTION ANALYSIS (HYDROMETER TESTING)

ANALYTICAL TESTING RESULTS

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

FILE NO.
PG5014

HOLE NO.
BH 1

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
								20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.15					0	100.22					
Very stiff, brown SILTY CLAY , trace sand		AU	1									
		SS	2	100	15	1	99.22					
		SS	3	100	13	2	98.22					
		SS	4	100	9	3	97.22					
	3.40											
GLACIAL TILL: Brown silty sand with gravel, some clay, cobbles and boulders		SS	5	100	22							
		SS	6	0	50+	4	96.22					
End of Borehole	4.04											
Practical refusal to augering at 4.04m depth												
(GWL @ 1.10m - July 30, 2019)												
								20	40	60	80	100
								Shear Strength (kPa)				
								▲ Undisturbed △ Remoulded				

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO.
PG5014

HOLE NO.
BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
								20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.15					0	100.73					
Very stiff to hard, brown SILTY CLAY , trace sand		AU	1									
		SS	2	100	11	1	99.73					
		SS	3	96	12	2	98.73					
		SS	4	100	9							
		SS	5	100	8	3	97.73					
	4.09	SS	6	100	21	4	96.73					
GLACIAL TILL: Brown silty sand with clay and gravel												
	4.52											
End of Borehole												
Practical refusal to augering at 4.52m depth												
(GWL @ 1.70m - July 30, 2019)												
								20	40	60	80	100
								Shear Strength (kPa)				
								▲ Undisturbed △ Remoulded				

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
1015 March Road
Ottawa, Ontario

FILE NO. PG5014

HOLE NO. **BH 3**

DATE 2019 July 24

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			○ Water Content %				
								20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.30	AU	1			0	99.99					
Very stiff, brown SILTY CLAY , trace sand		SS	2	100	12	1	98.99					
		SS	3	100	13	2	97.99					
		SS	4	100	11							
		SS	5	67	50+	3	96.99					
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders	3.05											
End of Borehole	3.18											
Practical refusal to augering at 3.18m depth												
(GWL @ 1.32m - July 30, 2019)												

Shear Strength (kPa)
▲ Undisturbed △ Remoulded

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO.
PG5014

HOLE NO.
BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
								20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.35	AU	1			0	99.92					
Very stiff, brown SILTY CLAY , trace sand		SS	2	100	12	1	98.92					
		SS	3	100	9	2	97.92					
		SS	4	100	6	3	96.92					
		SS	5	100	6	4	95.92					
GLACIAL TILL: Brown silty sand with clay and gravel	3.30	SS	6	42	18	4	95.92					
End of Borehole	4.50											
Practical refusal to augering at 4.50m depth (GWL @ 1.03m - July 30, 2019)												
								20	40	60	80	100
								Shear Strength (kPa)				
								▲ Undisturbed △ Remoulded				

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

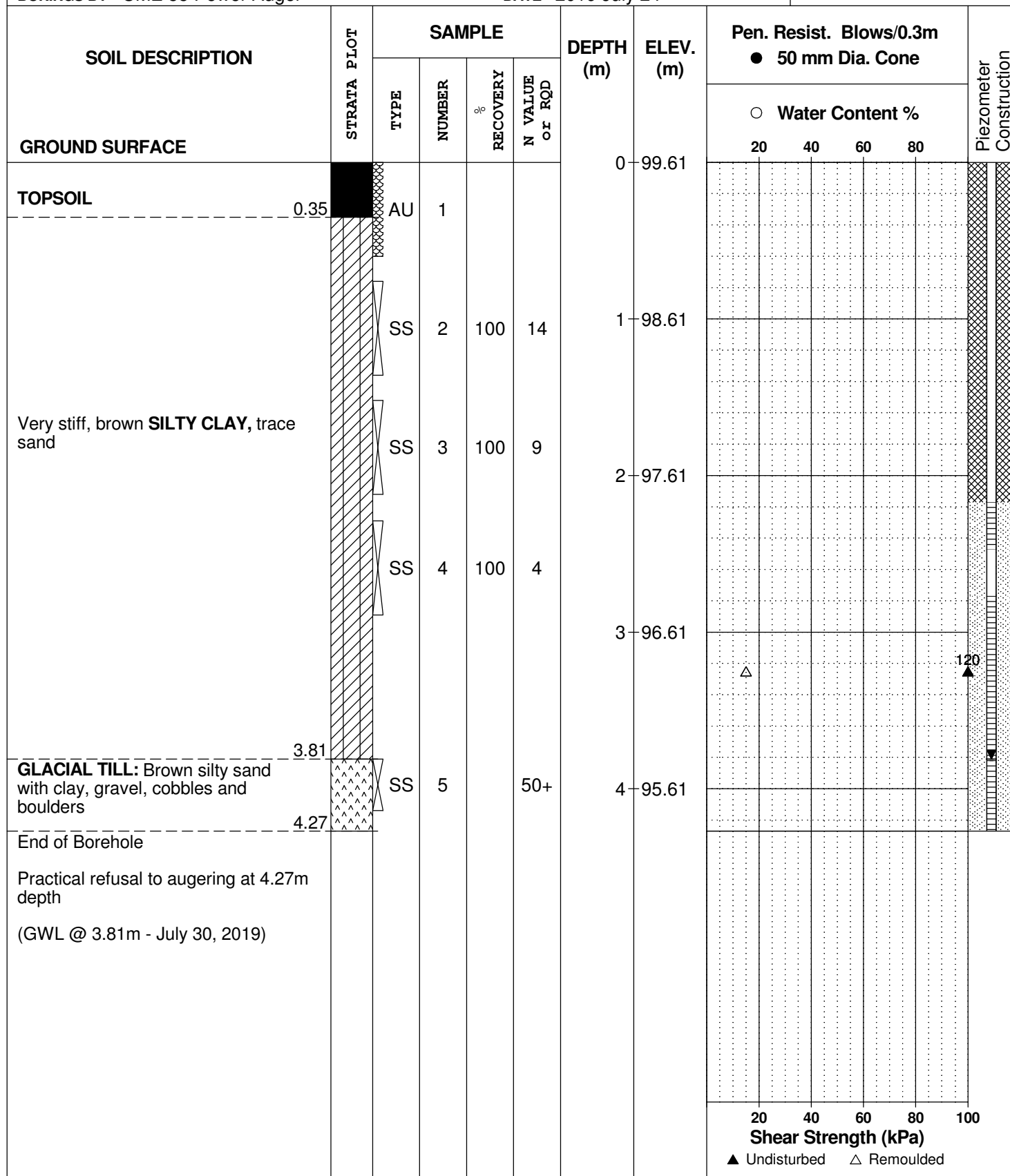
REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO.
PG5014

HOLE NO.
BH 5



DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

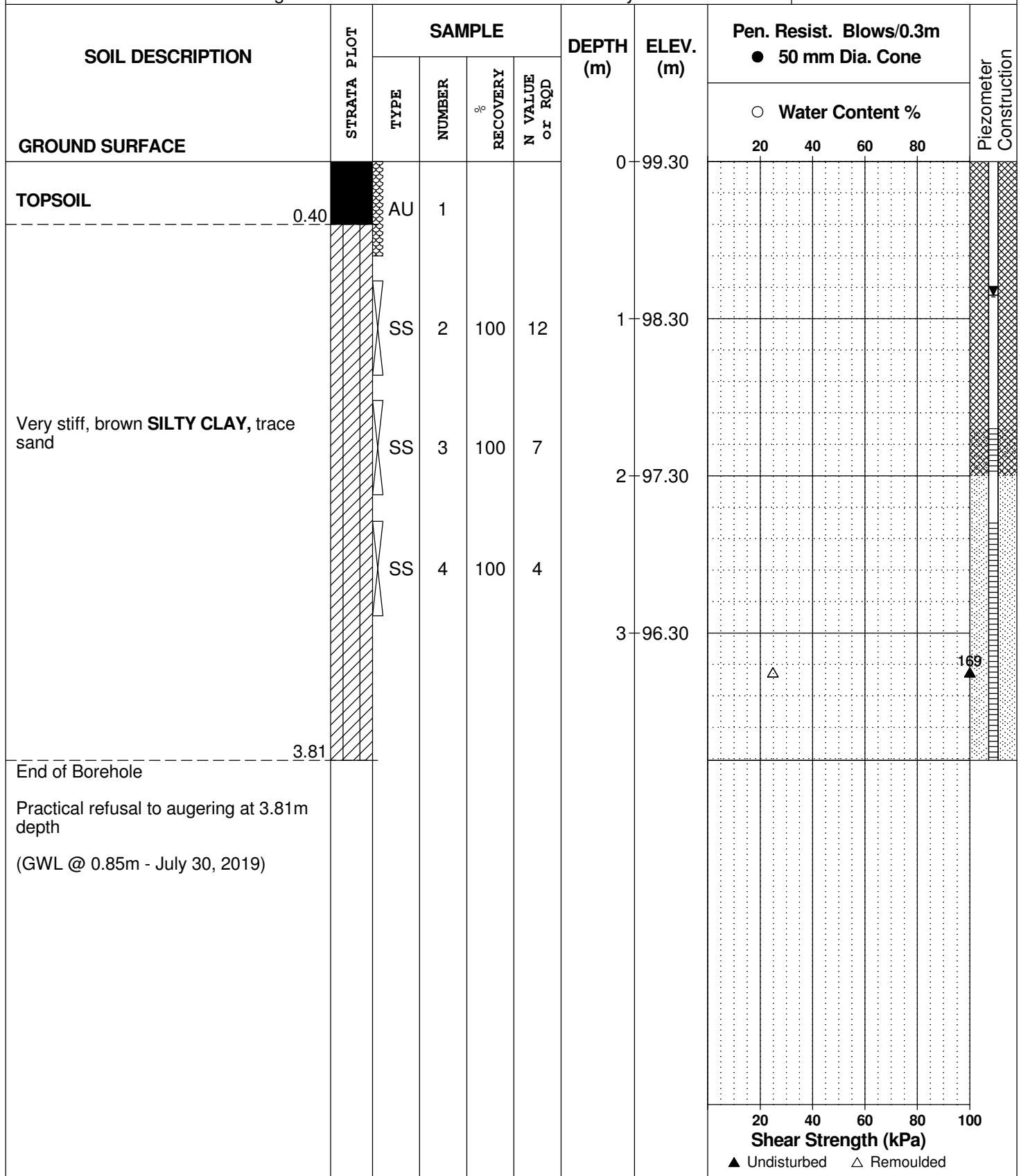
REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO.
PG5014

HOLE NO.
BH 6



DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO. PG5014

HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
GROUND SURFACE											20	40	60
TOPSOIL	0.30	AU	1			0	100.17						
Very stiff, brown SILTY CLAY , trace sand		SS	2	100	11	1	99.17						
		SS	3	100	9	2	98.17						
		SS	4	100	7								
		SS	5	82	50+	3	97.17						
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders	3.05												
End of Borehole	3.51												
Practical refusal to augering at 3.51m depth													
(GWL @ 1.23m - July 30, 2019)													

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

FILE NO.
PG5014

HOLE NO.
BH 8

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
								20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.30	AU	1			0	100.68					
Very stiff, brown SILTY CLAY , trace sand		SS	2	100	9	1	99.68					
		SS	3	100	11	2	98.68					
		SS	4	86	50+							
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders	2.29 2.57											
End of Borehole												
Practical refusal to augering at 2.57m depth												
(GWL @ 1.27m - July 30, 2019)												

DATUM TBM - Edge of asphalt in front of existing entrance to subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

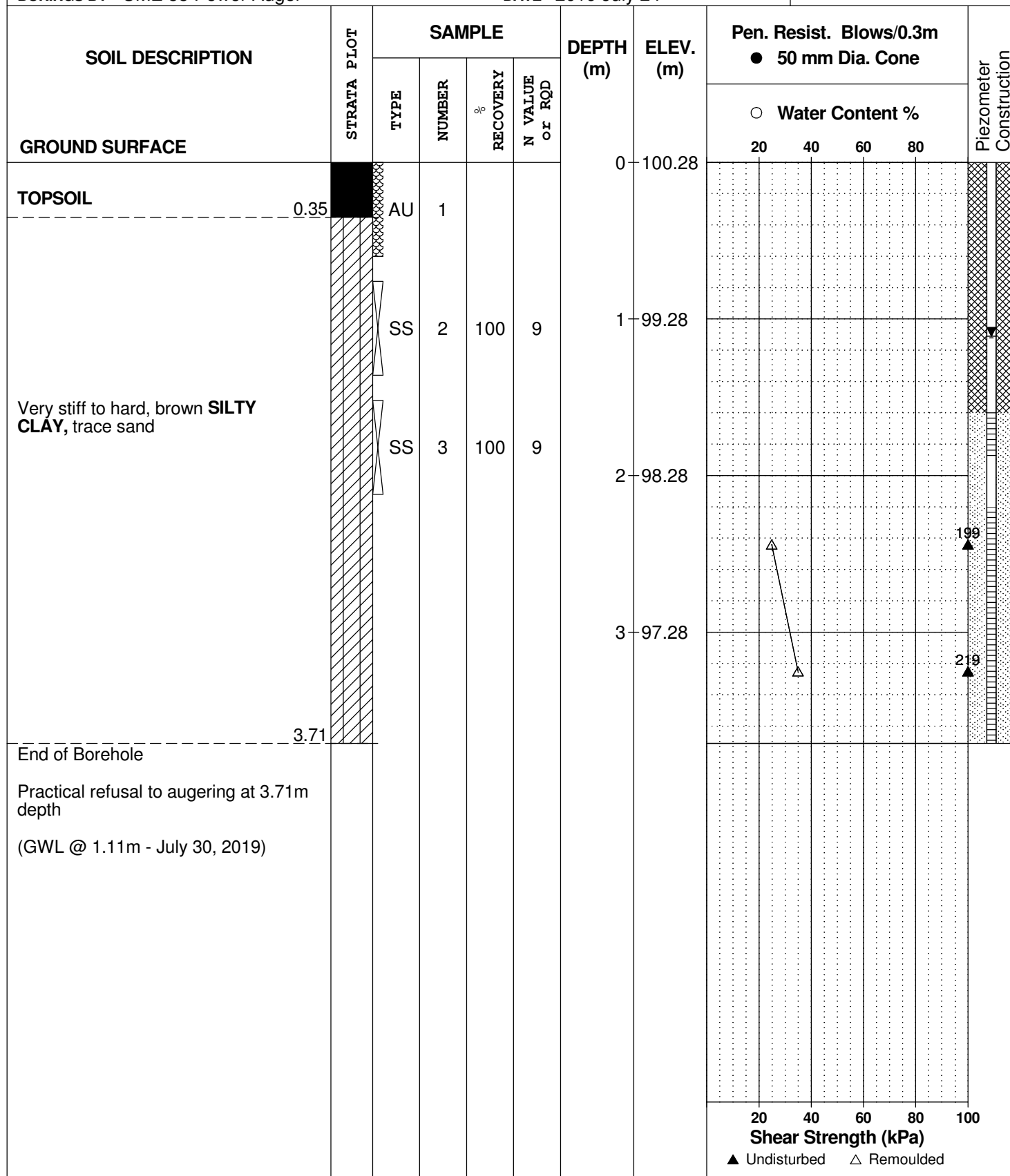
REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 July 24

FILE NO.
PG5014

HOLE NO.
BH 9



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
1015 March Road
Ottawa, Ontario

FILE NO. PG5014

HOLE NO. **BH10**

DATE 2019 July 24

[illegible]

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)
D _{xx}	-	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
D ₁₀	-	Grain size at which 10% of the soil is finer (effective grain size)
D ₆₀	-	Grain size at which 60% of the soil is finer
C _c	-	Concavity coefficient = $(D_{30})^2 / (D_{10} \times D_{60})$
C _u	-	Uniformity coefficient = D_{60} / D_{10}

C_c and C_u are used to assess the grading of sands and gravels:

Well-graded gravels have: $1 < C_c < 3$ and $C_u > 4$

Well-graded sands have: $1 < C_c < 3$ and $C_u > 6$

Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.

C_c and C_u 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
C _{cr}	-	Recompression index (in effect at pressures below p' _c)
C _c	-	Compression index (in effect at pressures above p' _c)
OC Ratio		Overconsolidation ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
W _o	-	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.
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SYMBOLS AND TERMS (continued)

STRATA PLOT



Topsoil



Asphalt



Fill



Peat



Sand



Silty Sand



Silt



Sandy Silt



Clay



Silty Clay



Clayey Silty Sand



Glacial Till



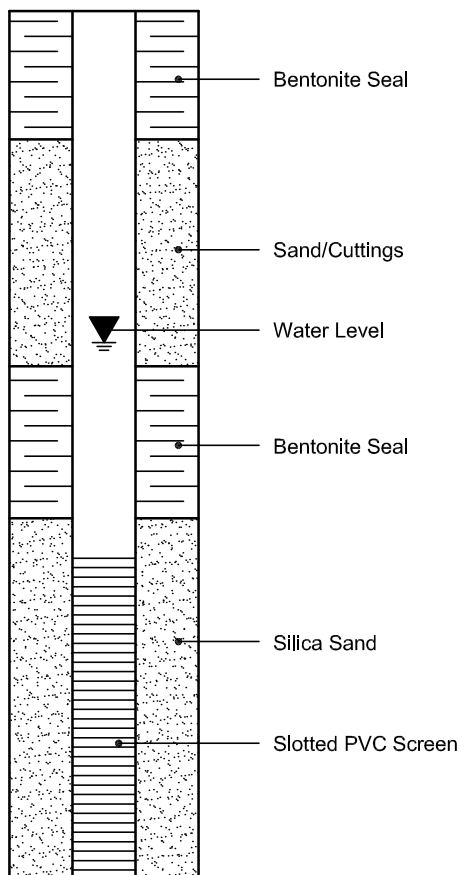
Shale



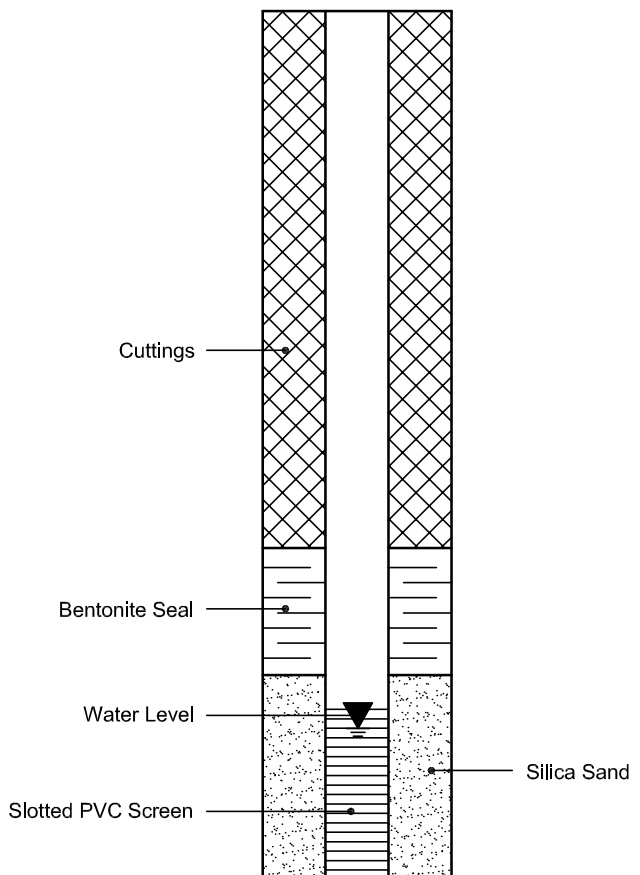
Bedrock

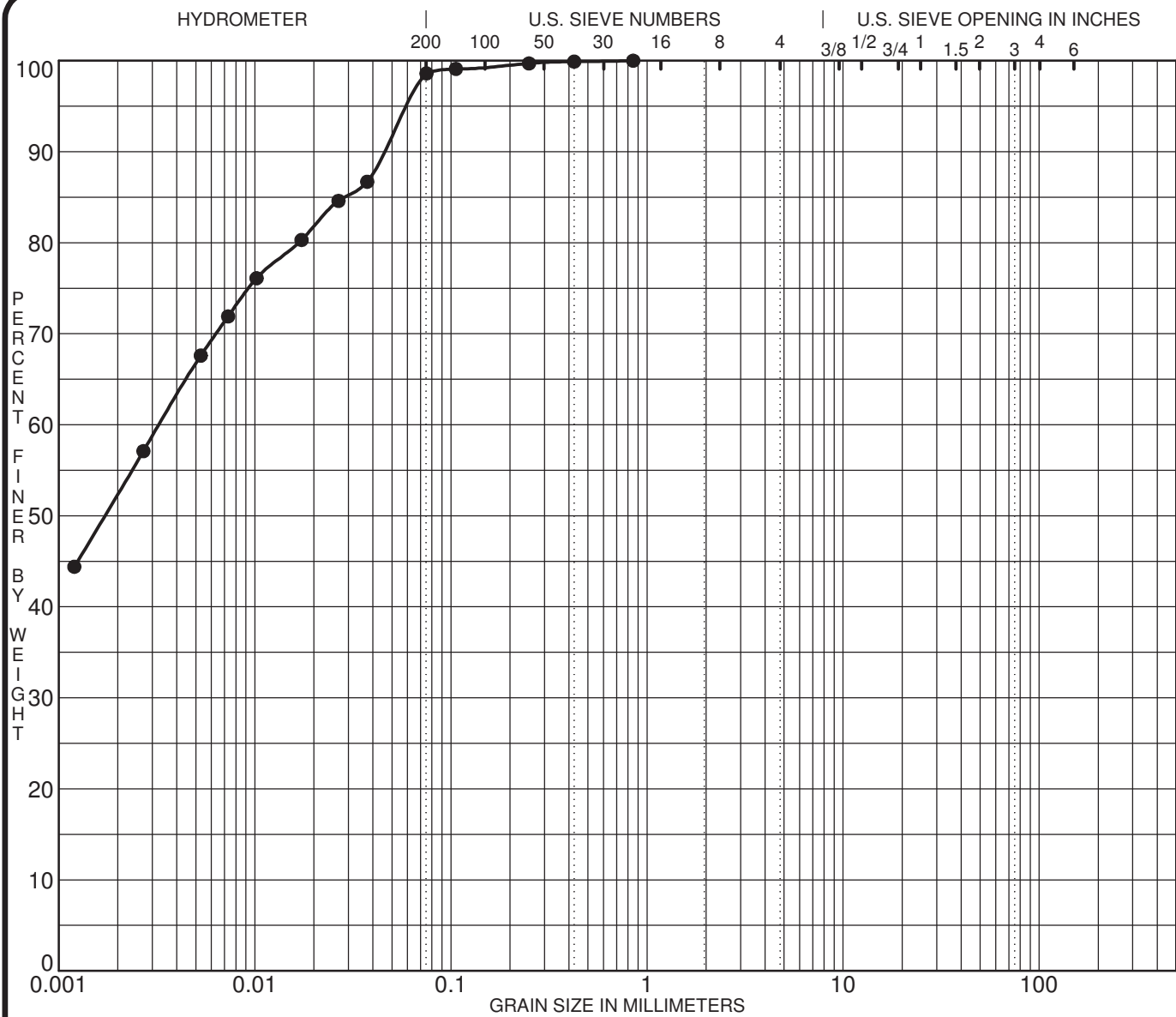
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Specimen Identification			Classification				MC%	LL	PL	PI	Cc	Cu
●	BH 4	SS 3	CH - Inorganic clay of high plasticity									
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
●	BH 4	SS 3	0.85	0.00			0.0	1.4	47.6	51.0		

CLIENT Kanata United

PROJECT Geotechnical Investigation - 1015 March Road

FILE NO. PG5014

DATE 24 Jul 19

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 27678

Report Date: 16-Aug-2019

Order Date: 12-Aug-2019

Project Description: PG5014

Client ID:	BH9-SS3	-	-	-
Sample Date:	24-Jul-19 13:00	-	-	-
Sample ID:	1933119-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	72.6	-	-	-
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General Inorganics

pH	0.05 pH Units	8.10	-	-	-
Resistivity	0.10 Ohm.m	98.4	-	-	-

Anions

Chloride	5 ug/g dry	5	-	-	-
Sulphate	5 ug/g dry	8	-	-	-

APPENDIX 2

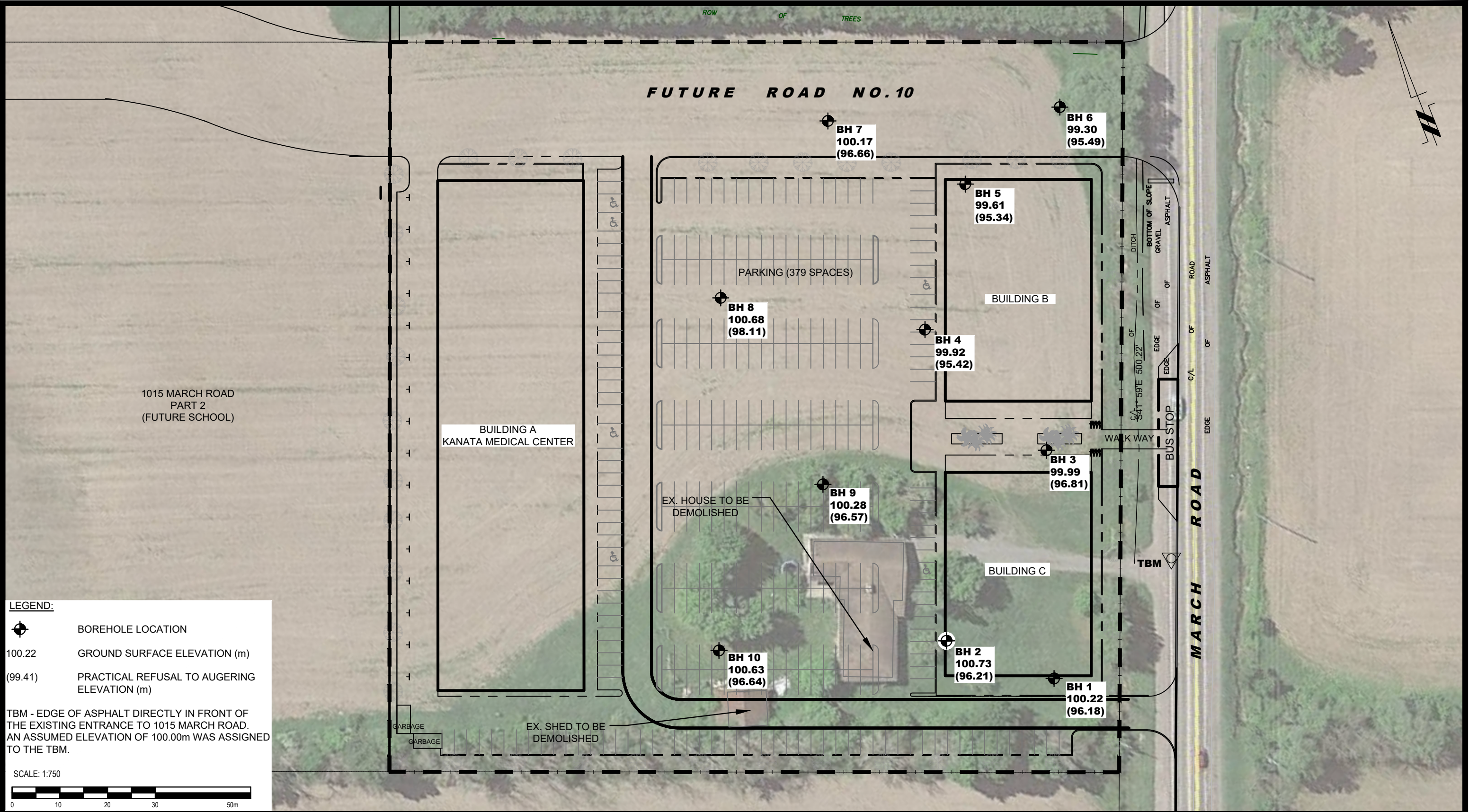
FIGURE 1 - KEY PLAN

DRAWING PG5014 - 1 TEST HOLE LOCATION PLAN



FIGURE 1

KEY PLAN



LEGEND:

BOREHOLE LOCATION

100.22 GROUND SURFACE ELEVATION (m)

(99.41) PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

TBM - EDGE OF ASPHALT DIRECTLY IN FRONT OF THE EXISTING ENTRANCE TO 1015 MARCH ROAD. AN ASSUMED ELEVATION OF 100.00m WAS ASSIGNED TO THE TBM.

SCALE: 1:750

<div><div><div>patersongroup</div><div>consulting engineers</div></div><div>154 Colonnade Road South Ottawa, Ontario K2E 7J5 Tel: (613) 226-7381 Fax: (613) 226-6344</div></div>					<div>KANATA UNITED</div> <div>GEOTECHNICAL INVESTIGATION</div> <div>1015 MARCH ROAD - PROPOSED COMMERCIAL DEVELOPMENT</div> <div>OTTAWA, ONTARIO</div> <div>Title: TEST HOLE LOCATION PLAN</div>	Scale: 1:750	Date: 09/2019
						Drawn by: YA	Report No.: PG5014-1
						Checked by: RG	Dwg. No.: PG5014-1
	1	UPDATED NEW CONCEPTUAL PLAN	05/10/2020	RG		Approved by: DJG	
	NO.	REVISIONS	DATE	INITIAL			