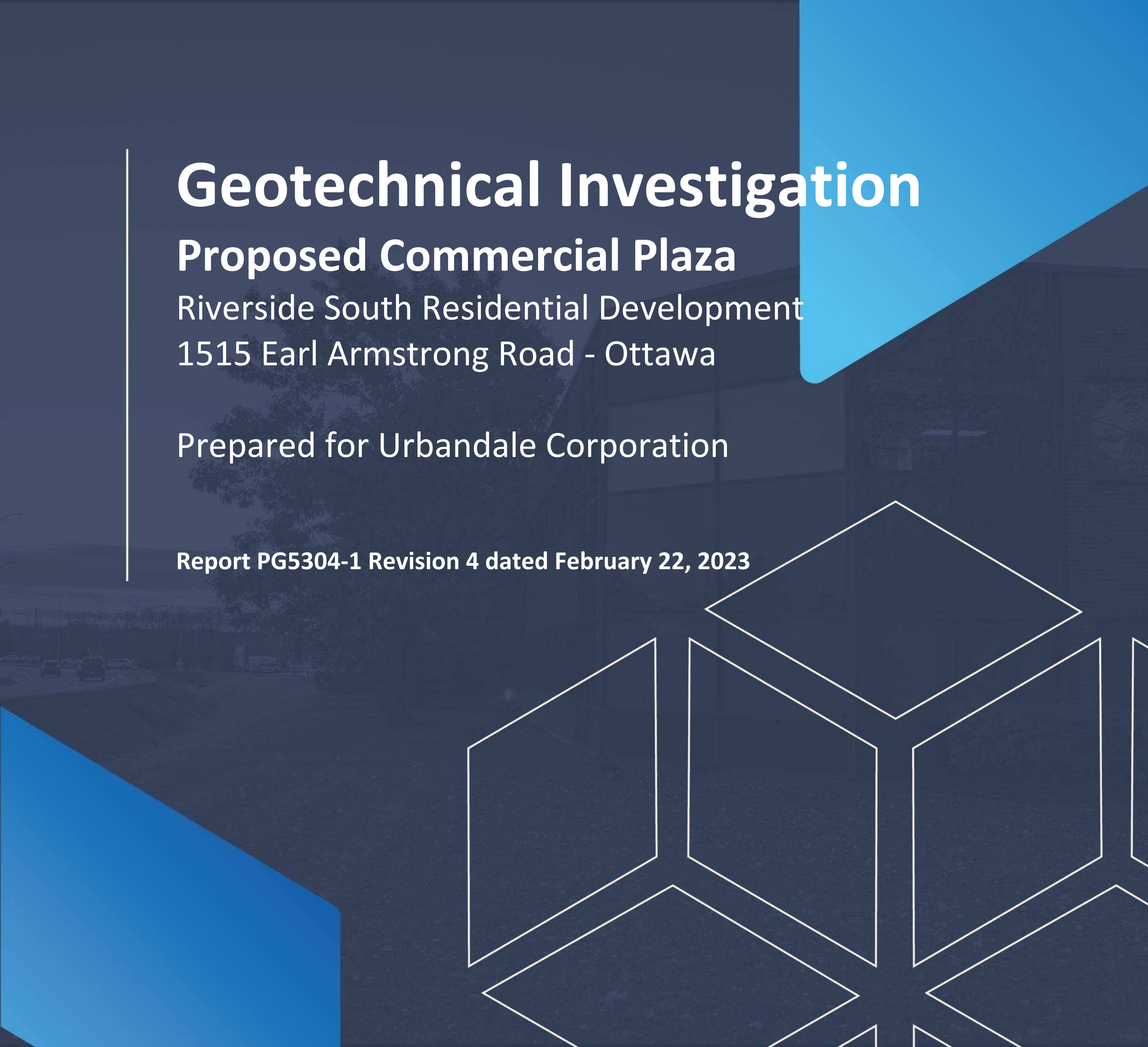
Geotechnical Investigation

Proposed Commercial Plaza

Riverside South Residential Development
1515 Earl Armstrong Road - Ottawa

Prepared for Urbandale Corporation

Report PG5304-1 Revision 4 dated February 22, 2023



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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Urbandale Corporation to conduct a geotechnical investigation for the proposed development to be located at 1515 Earl Armstrong Road in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

- ☐ determine the subsurface soil and groundwater conditions by means of boreholes and monitoring well program.

- ☐ provide geotechnical recommendations for the design of the proposed development based on the results of the test holes and other soil information available.

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

2.0 Proposed Development

Based on available drawings, it is understood that the proposed development will consist of a commercial plaza comprised of 1-storey buildings of slab-on-grade construction, with the exception of Building I. It is understood that Building I is anticipated to consist of a multi-storey commercial building of slab-on-grade construction. Associated access roads, parking areas and landscaped areas are also anticipated within the development.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current investigation was conducted on March 17, 2022, and consisted of 6 test pits excavated to a maximum depth of 3.4 m below existing ground surface. Two previous field investigations were completed by this firm. A field program was conducted between March 23 and 25, 2020, and consisted of 10 boreholes advanced to a maximum depth of 6.7 m below the existing ground surface. Further, a geotechnical investigation was completed by this firm in May, 2011. At that time, 11 boreholes were advanced at the subject site to a maximum depth of 9.6 m. The test holes were distributed in a manner to provide general coverage of the subject site. The approximate locations of the boreholes are shown on Drawing PG5304-1 - Test Hole Location Plan included in Appendix 2.

All boreholes were advanced using a track-mounted auger drill rig, which was operated by a two person crew. The test pits were excavated with a hydraulic excavator. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths and at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. Grab samples (G) were collected from the open test holes during excavation. All samples were visually inspected and initially classified on site and subsequently placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the auger, split-spoon, and grab samples were recovered from the test holes are shown as AU, SS, and G, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

A Standard Penetration Test (SPT) was conducted at each borehole 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 in cohesive soils using a field vane apparatus.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed at boreholes BH 3-20 and BH 4-20 of the current investigation as well as BH 1 of the 2011 investigation. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Flexible piezometers were installed in all the boreholes to monitor the groundwater level subsequent to the completion of the sampling program. Water infiltration levels were measured within the open test pits at the time of excavation. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test hole locations were selected by Paterson to provide general coverage of the proposed development taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson with respect to a geodetic datum. The location of the test holes and ground surface elevations at each test hole location are presented on Drawing PG5304-1 - 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. Atterberg Limits, shrinkage, hydrometer, and moisture content testing was completed on select samples obtained from the geotechnical investigations. The results of this testing are discussed in section 4.2 and are provided in Appendix 1.

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 sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently undeveloped and grass covered with the exception of a gravel surfaced access road located off of Earl Armstrong Road at the southwest corner of the subject site.

However, based on available aerial photos, the subject site was used to stockpile soil and store construction material as recently as 2007. Additionally, an asphalt paved municipal road, which ran east-west through the center of the site, was in use as recently as 2002 and was no longer maintained in 2005. Reference should be made to the aerial photographs in Figure 2 - Aerial Photograph - 2002, Figure 3 - Aerial Photograph - 2007 and Figure 4 - Aerial Photograph - 2017 which illustrate the former and present site conditions, respectively.

The subject site is bordered to the northeast by a storm water management pond, to the east by Limebank Road, to the south by Earl Armstrong Road and to the west and northwest by residential dwellings of the adjacent residential development. The existing ground surface across the subject site is relatively flat with an approximate geodetic elevation of 92 to 93 m.

4.2 Subsurface Profile

Generally, the subsurface profile at the test hole locations consists of an approximate 0.1 to 0.2 m thick topsoil layer overlying a very stiff to firm brown silty clay crust with some silty sand. The silty clay crust is further underlain by a deep deposit of firm to stiff grey silty clay at approximate depths between 2.3 to 3.8 m below the existing ground surface.

An approximate 0.1 to 3.7 m thick layer of fill material was encountered either at surface or underlying the topsoil in the northwest corner of the subject site as well as in boreholes BH 3 and BH 4 along the eastern limits of the property. The fill material was observed to consist of silty clay with sand and gravel.

Practical refusal to DCPT was encountered at depths of 15.4, 15.3 and 15.5 m in boreholes BH 1, BH 3-20 and BH 4-20 respectively.

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

Bedrock

Based on available geological mapping, the bedrock at the subject site consists of interbedded sandstone and dolomite of the March formation with an overburden thickness of 10 to 15 m.

Laboratory Testing

Atterberg limits testing, as well as associated moisture content testing, was completed on the recovered silty clay samples where encountered. The results of the Atterberg limits tests are presented in Table 1 and on the Atterberg Limits Results sheet in Appendix 1. The tested silty clay samples classify as inorganic silts of high plasticity (CH) or inorganic clay of low plasticity (CL) in accordance with the Unified Soil Classification System.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
BH 2-20	1.14	75	36	39	43.7	MH
BH 4-20	1.83	39	20	19	32.5	CL
BH 7-20	1.83	38	18	20	35.9	CL
TP 1-22	1.65	64	33	31	44	MH
TP 2-22	1.45	68	32	36	46.5	CH
TP 3-22	1.65	36	19	17	35.7	CL
TP 4-22	2.45	56	25	31	29.1	CH
TP 5-22	1.65	38	21	17	36.8	CL
TP 6-22	1.65	38	18	20	33.8	CL

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content;
MH: Inorganic Silt of High Plasticity CL: Inorganic Clay of Low Plasticity

Grain size distribution analysis was completed on a sample recovered from 1.65 m depth at TP 5-22 and yielded a sand content of 29.1%, a silt content of 45.9%, and a clay content of 25.0%. The results of the grain size analysis are presented on the Grain Size Distribution Results sheets in Appendix 1.

Linear shrinkage testing was completed on a sample recovered from 1.65 m depth at TP 1-22 and yielded a shrinkage limit of 24.59 and a shrinkage ratio of 1.75. The results of the shrinkage testing is presented on the Linear Shrinkage sheet in Appendix 1.

4.3 Groundwater

Groundwater level readings were measured at the peizometer locations on March 31, 2020. The observed groundwater levels are summarized in Table 2.

Table 2 – Summary of Groundwater Level Readings

Test Hole Number	Groundwater Surface Elevation (m)	Groundwater Levels (m)	Groundwater Elevation (m)	Recording Date
BH 1	92.18	1.99	90.19	June 7, 2011
BH 2	92.05	2.07	89.98	June 7, 2011
BH 3	91.70	1.54	90.16	June 7, 2011
BH 4	92.44	1.90	90.54	June 7, 2011
BH 5	92.15	1.17	90.98	June 7, 2011
BH 6	92.22	0.89	91.33	June 7, 2011
BH 7	92.11	1.28	90.83	June 7, 2011
BH 8	92.20	0.59	91.61	June 7, 2011
BH 9	91.94	0.39	91.55	June 7, 2011
BH 10	95.25	3.77	91.48	June 7, 2011
BH 11	92.21	0.95	91.26	June 7, 2011
BH 1-20	92.12	0.03	92.09	March 31, 2020
BH 2-20	91.90	0.04	91.86	March 31, 2020
BH 3-20	91.89	0.11	91.78	March 31, 2020
BH 4-20	92.15	At Surface	92.15	March 31, 2020
BH 5-20	92.22	0.41	91.81	March 31, 2020
BH 6-20	93.09	0.36	92.73	March 31, 2020
BH 7-20	91.78	Peizometer Blocked	-	March 31, 2020
BH 8-20	92.16	0.71	91.45	March 31, 2020
BH 9-20	91.79	Peizometer Blocked	-	March 31, 2020
BH 10-20	91.93	0.94	90.99	March 31, 2020

Note: Ground surface elevations at test hole locations were surveyed by Paterson and are referenced to a geodetic datum.

It should be noted that groundwater levels could be influenced by surface water infiltrating the backfilled boreholes. Long-term groundwater levels can also be estimated based on the observed color, moisture content and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level is expected between **2 to 4 m** depth. It should be noted that groundwater levels are subject to seasonal fluctuations, therefore the groundwater levels could vary at the time of construction.

4.4 Infiltration Testing

A total of 8 constant head Pask (Constant Head Well) permeameter tests were conducted at 5 test pit locations within the proposed development to determine the infiltration rates of the underlying soils. Testing was completed at various depths ranging between 0.4 and 2 m depth below ground surface. The permeameter test locations were selected by Paterson in a manner to provide general coverage of the proposed development and representation of the silty clay deposit. Preparation and testing of this investigation are in accordance with the Canadian Standards Association (CSA) B65-12 - Annex E. The field saturated hydraulic conductivity (Kfs) and estimated infiltration values at each test pit location are presented in Table 3.

Field saturated hydraulic conductivity values were determined using Engineering Technologies Canada (ETC) Ltd. reference tables provided in the most recent ETC Pask Permeameter User Guide dated March 2016. The field saturated hydraulic conductivity values were used to estimate the infiltration rates based on the approximate relationship between infiltration rate and hydraulic conductivity, as described in the 2010 Low Impact Development Stormwater Management Planning and Design Guide prepared by the CVC and the TRCA. Given the subsurface profile encountered across the subject site, a conservative safety correction factor of 2.5 has been applied to the estimated infiltration rates of the silty clay (CVC and TRCA, 2010).

Table 3 - Field Saturated Hydraulic Conductivity and Infiltration Results

Test Hole ID	Invert of Permeameter Testing (m bgs)	Material	K_{fs} (m/sec)	Infiltration Rate (mm/hr)	Reduced Infiltration Rate (mm/hr)
TP 1-22	0.6	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	< 4
TP 2-22	0.4	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	< 4
	1.0	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	
TP 3-22	0.6	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	< 4
	1.2	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	
TP 4-22	1.2	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	< 4
	2.0	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	
TP 5-22	0.6	Brown Silty Clay	$< 3.1 \times 10^{-9}$	< 10	< 4

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed development. It is anticipated that the proposed slab-on-grade commercial buildings will be founded on conventional shallow footings bearing on an undisturbed, stiff, brown silty clay crust bearing surface.

However, if the provided bearing resistance values for conventional footings are insufficient for the design building load of the multi-storey building, a raft foundation bearing on the undisturbed stiff brown silty clay may be considered.

Due to the presence of a deep silty clay deposit, a permissible grade raise restriction is required for the subject site.

It should be noted that the slopes of the existing SWMP located northeast of the subject site are considered to be stable and the proposed development will not negatively impact overall slope stability of the existing slopes.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any building, paved areas, pipe bedding and other settlement sensitive structures. Existing construction debris should be entirely removed from within the perimeter of all buildings.

Fill Placement

Fill used for grading beneath the proposed building footprints should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The material should be tested and approved prior to delivery to the site. The fill should be placed in loose lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, 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 the material's 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.

Protection of Subgrade (Raft Foundation)

Should the proposed multi-storey building be founded on a raft slab foundation, a lean concrete mud slab will be required once the subgrade is exposed at the founding elevation. It is recommended that a minimum 50 to 75 mm thick concrete mud slab be poured on an undisturbed silty clay subgrade using a minimum 15 MPa 28-day compressive strength lean concrete.

The final excavation to the raft bearing surface level and the placing of the mud slab should be done in smaller sections to avoid exposing large areas of the silty clay to potential disturbance due to drying.

5.3 Foundation Design

Conventional Spread Footings

Pad footings, up to 5 m wide, and strip footings up to 3 m wide, placed on an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

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

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

Raft Foundation

As noted above, it is expected that a raft foundation may be required to support the proposed multi-storey building. For our design calculations, slab-on-grade construction was assumed. The maximum SLS contact pressure is **100 kPa** for a raft foundation bearing on the undisturbed, stiff brown silty clay. It should be noted that the weight of the raft slab and everything above has to be included when designing with this value. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load. The factored bearing resistance (contact pressure) at ULS can be taken as **180 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

The modulus of subgrade reaction was calculated to be **3 MPa/m** for a contact pressure of **100 kPa**. The design of the raft foundation is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium. A common method of modeling the soil structure interaction is to consider the bearing medium to be elastic and to assign a subgrade modulus. However, silty clay is not elastic and limits have to be placed on the stress ranges of a particular modulus.

The proposed building can be designed using the above parameters with total and differential settlements of 25 and 15 mm, respectively.

Permissible Grade Raise

Due to the presence of the silty clay deposit, a permissible grade raise restriction of **1.5 m** is recommended within 5 m of the proposed buildings. A permissible grade raise restriction of **2 m** is recommended in the parking areas and access lanes. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise calculations.

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.

End Bearing Piled Foundation

If the raft slab bearing resistance values are insufficient for the proposed mid-rise building, a deep foundation system driven to refusal in the bedrock will be recommended for foundation support of the proposed buildings. For deep foundations, concrete-filled steel pipe piles are generally utilized in the Ottawa area. Applicable pile resistance values at SLS and ULS are given in Table 4. A resistance factor of 0.4 has been incorporated into the factored ULS values. Note that these are all geotechnical axial resistance values.

The geotechnical pile resistance values were estimated using the Hiley dynamic formula, to be confirmed during pile installation with a program of dynamic monitoring. Re-striking of all piles at least once will also be required after at least 48 hours have elapsed since initial driving.

Table 4 – Pile Foundation Design Data

Pile Outside Diameter (mm)	Pile Wall Thickness (mm)	Geotechnical Axial Resistance		Final Set (blows/12 mm)	Transferred Hammer Energy (kJ)
		SLS (kN)	Factored at ULS (kN)		
245	9	940	1130	10	29
245	11	1175	1410	10	35
245	13	1375	1650	10	42

The minimum centre-to-centre pile spacing is 2.5 times the pile diameter. The closer the piles are spaced, however, the more potential that the driving of subsequent piles in a group could have influence on piles in the group that have already been driven. These effects, primarily consisting of uplift of previously driven piles, are checked as part of the field review of the pile driving operations.

Prior to the commencement of production pile driving, a limited number of indicator piles should be installed across the site. It is recommended that each indicator pile be dynamically load tested to evaluate pile stresses, hammer efficiency, pile load transfer, and end-of-driving criteria for end-bearing in the bedrock.

Buildings founded on piles driven to refusal in the bedrock will have negligible post-construction settlement.

5.4 Design for Earthquakes

A seismic shear wave velocity test was completed for the subject site to accurately determine the applicable seismic site classification for the proposed buildings based on Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity test was completed by Paterson personnel. Two seismic shear wave velocity profiles from the on-site testing are presented in Appendix 2. settlements.

Field Program

The seismic shear wave test was completed at the subject site, as presented in Drawing PG5304 -1 - Test Hole Location Plan in Appendix 2. Paterson field personnel placed 24 horizontal geophones in a straight line in roughly a north-south orientation. The 4.5 Hz. horizontal geophones were mounted to the surface by means of a 75 mm ground spike attached to the geophone land case. The geophones were spaced at 3 m intervals and were connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was connected to a laptop and a hammer trigger switch attached to a 12 pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is strikes an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four to eight times at each shot location to improve signal to noise ratio. The shot locations are completed in forward and reverse directions (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot locations are located at the center of the geophone array, as well as 2, 3, 4.5 and 20 m away from the first and last geophones.

Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was completed by reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves. The interpretation is repeated at each shot location to provide an average shear wave velocity, Vs30, of the upper 30 m below the structures foundation. The layer intercept times, velocities from different layers and critical distances are interpreted from the shear wave records to compute the bedrock depth at each location. The bedrock velocity was interpreted by the main refractor wave velocity, which is considered a conservative estimate of the bedrock velocity due to the increasing quality of the bedrock with depth. As bedrock quality increases, the bedrock shear wave velocity also increases.

The bedrock and overburden soil shear wave velocities were calculated to be 2,413 m/s and 203 m/s, respectively. Based on our field investigation, bedrock depth is approximately 15 m below ground surface.

The Vs_{30} was calculated using the standard equation for average shear wave velocity from the Ontario Building Code (OBC) 2012.

$$V_{s30} = \frac{Depth_{OfInterest}(m)}{\left(\frac{Depth_{Layer1}(m)}{Vs_{Layer1}(m/s)} + \frac{Depth_{Layer2}(m)}{Vs_{Layer2}(m/s)}\right)}$$

$$V_{s30} = \frac{30m}{\left(\frac{15m}{203m/s} + \frac{15m}{2{,}413m/s}\right)}$$

$$V_{s30} = 374m/s$$

Based on the seismic test results, the average shear wave velocity, Vs30, for shallow foundations at the subject site is 374 m/s. Therefore, a Site Class C is applicable for design of the proposed buildings, as per Table 4.1.8.4.A of the OBC 2012. The soils underlying the subject site are not considered to be susceptible to liquefaction.

5.5 Slab on Grade Construction

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

It is recommended that the upper 300 mm of sub-floor fill consists of OPSS Granular A crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

If a raft slab is considered for Building I, a granular layer of OPSS Granular A crushed stone will be required to allow for the installation of sub-floor services above the raft slab foundation. The thickness of the OPSS Granular A crushed stone will be dependent on the piping requirements.

5.6 Pavement Structure

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

Table 5 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 6 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on 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 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

Foundation Drainage System - Slab on Grade Structures

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

Foundation Raft Slab Construction Joints

If this foundation design option is selected, it is expected that the raft slab will be poured in sections. For the construction joint at each pour, a rubber water stop along with a chemical grout (Xypex or equivalent) should be applied to the entire vertical joint of the raft slab. Furthermore, a rubber water stop should be incorporated in the horizontal interface between the foundation wall and the raft slab.

Foundation Backfill

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 materials will be frost susceptible and, as such, are not recommended for placement as backfill against the foundation walls unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular materials, should be placed for this purpose.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover should be provided for adequate frost protection of heated structured.

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

The proposed underground parking level may require protection against frost action depending on the founding depth. Unheated structures, such as the access ramp wall footings, may be required to be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided.

6.3 Excavation Side Slopes

The side slopes of the 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.

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

At least 150 mm of OPSS Granular A crushed stone should be used for pipe bedding for sewer and water pipes. Where the pipe bedding is located within the firm to stiff grey silty clay, the thickness of the bedding should be increased to a minimum 300 mm. 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 or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 98% of the material’s 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 1.5 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick lifts and compacted to 95% of the materials SPMDD.

To reduce long-term lowering of the groundwater level at the subject 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 a relatively dry and compatible 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

Due to the relatively impervious nature of the silty clay materials, it is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. 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.
Permit to Take Water

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 of 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, 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 MECP review of the PTTW application.

6.6 Winter Construction

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

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

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

6.7 Corrosion Potential and Sulphate

One (1) sample was submitted for testing. The analytical test results of the soil sample indicate that the sulphate content is less than 0.01%. These results along with the chloride and pH value are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a non aggressive to slightly aggressive corrosive environment.

6.8 Landscaping Considerations

Paterson completed a soils review of the site to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines). Atterberg limits testing was completed for recovered silty clay samples throughout the subject site. The above-noted test results were completed on samples taken at depths between the anticipated underside of footing elevation and a 3.5 m depth below anticipated finished grade. The results of our testing are presented in Table 1 in Subsection 4.2 and in Appendix 1.

Based on the results of our review, tree planting setbacks are required for the subject site. The recommended tree planting setbacks should be reviewed by Paterson, once the proposed grading plan has been prepared. The tree planting setback requirements are detailed below.

Low to Medium Sensitivity Clays

A low to medium sensitivity clay soil was encountered between the anticipated design underside of footing elevations and 3.5 m below finished grade as per City Guidelines for the entire site. Based on our Atterberg limits test results, the modified plasticity index does not exceed 40% across the site. **The following tree planting setback is recommended for the entire subject site due to the presence of low to medium sensitivity clays.** Large trees (mature height over 14 m) can be planted within these areas 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 height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the conditions noted below are met.

☐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade 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.

☐ A small tree must be provided with a minimum of 25 m3 of available soils 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 surrounding 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

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

☐ A review of the site grading plan(s) from a geotechnical perspective, once available.

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

☐ A review of waterproofing details for elevator shaft and building sump pits, if applicable.

☐ Review and inspection of the underfloor drainage system and all foundation drainage systems.

☐ 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 placing backfilling materials.

☐ Observation of clay seal placement at specified locations.

☐ Field density tests to ensure 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 Paterson's recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and the test hole log are furnished as a matter of general information only. Test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

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, Paterson requests to be notified immediately in order to permit reassessment of the 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 Urbandale Corporation 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.

Patey

LICENSED PROFESSIONAL ENGINEER
Feb. 22, 2023
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Nicole R.L. Patey, B.Eng.

David J. Gilbert, P.Eng

Report Distribution:

☐ Urbandale Corporation
☐ Paterson Group

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS RESULTS

ANALYTICAL TEST RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

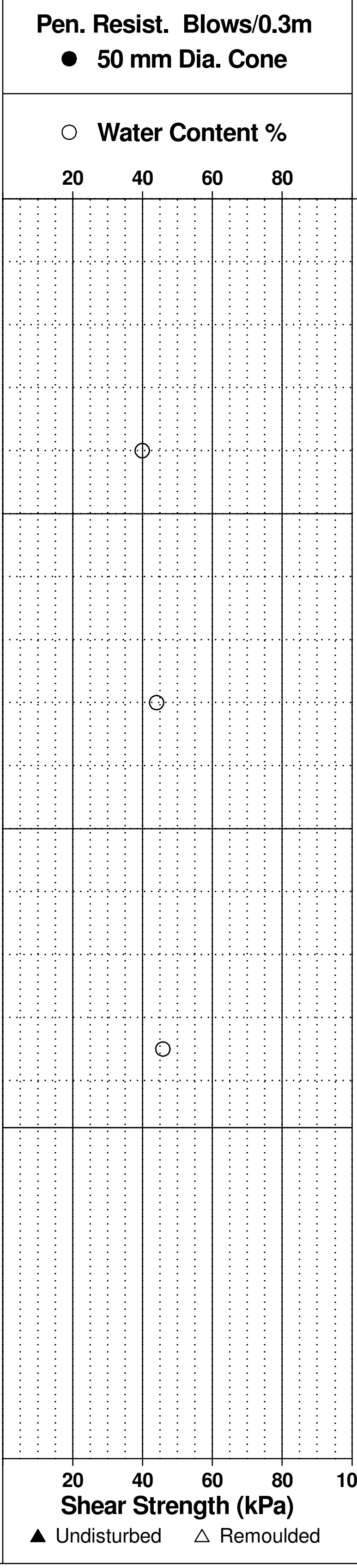
FILE NO. **PG5304**

REMARKS

HOLE NO. **TP1-22**

BORINGS BY Excavator **DATE** 2022 March 17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	92.26	
TOPSOIL 0.11								
Very stiff to stiff brown **SILTY CLAY** some sand		G	1					
						1	91.26	
		G	2					
- Decreasing sand content with depth								
						2	90.26	
		G	3					
2.95								
End of Test Pit (Water infiltration at 2.8 m depth)								



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

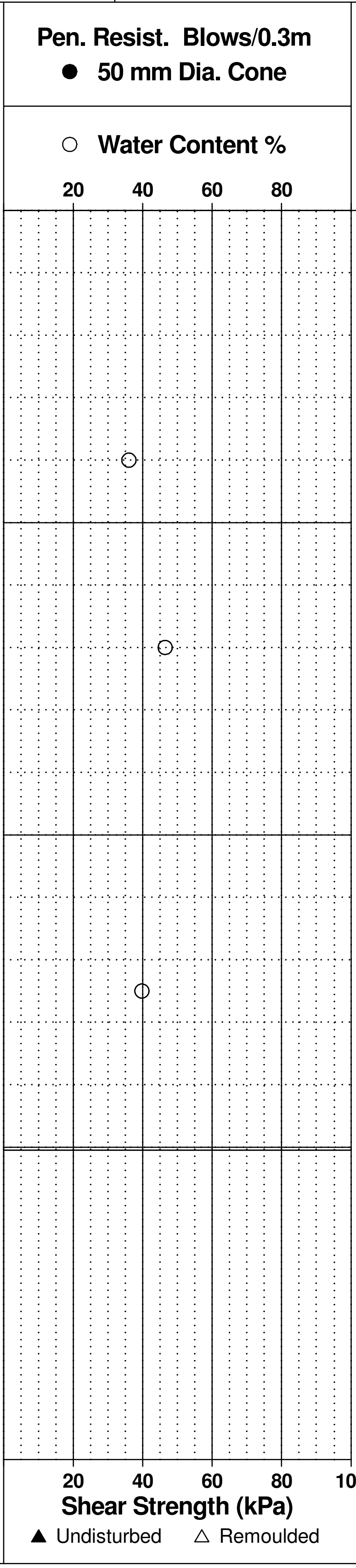
BORINGS BY Excavator

DATE 2022 March 17

FILE NO. PG5304

HOLE NO. TP2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	92.28	
TOPSOIL 0.09	■							
Very stiff to stiff brown **SILTY CLAY** some sand	▨							
	▨	G	1					
	▨					1	91.28	
	▨	G	2					
	▨					2	90.28	
	▨	G	3					
3.01						3	89.28	
End of Test Pit (Water infiltration at 2.5 m depth)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

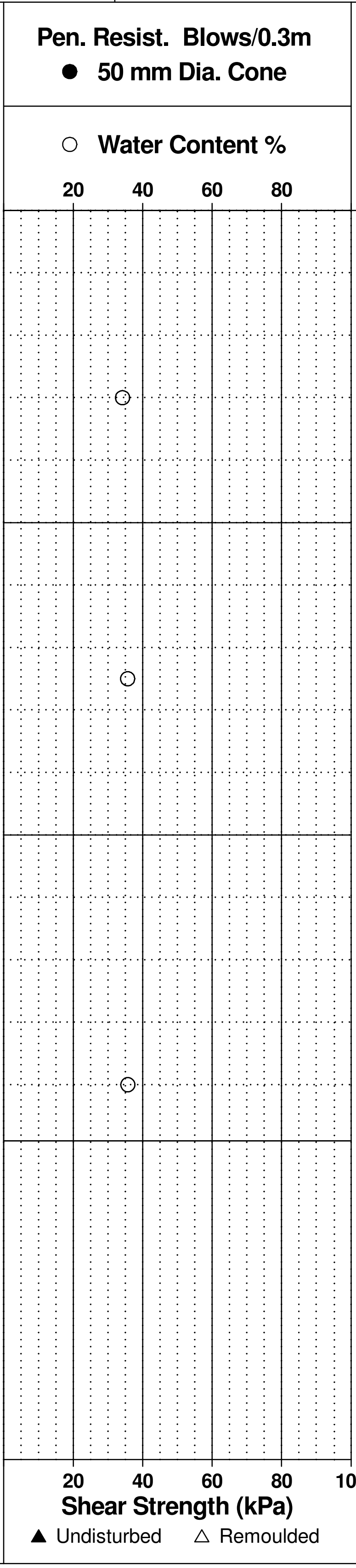
BORINGS BY Excavator

DATE 2022 March 17

FILE NO. PG5304

HOLE NO. TP3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	92.25	
TOPSOIL 0.18	■							
Very stiff to stiff brown **SILTY CLAY** some sand	▨	G	1					
						1	91.25	
		G	2					
						2	90.25	
2.98		G	3					
End of Test Pit (Water infiltration at 2.8 m depth)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5304**

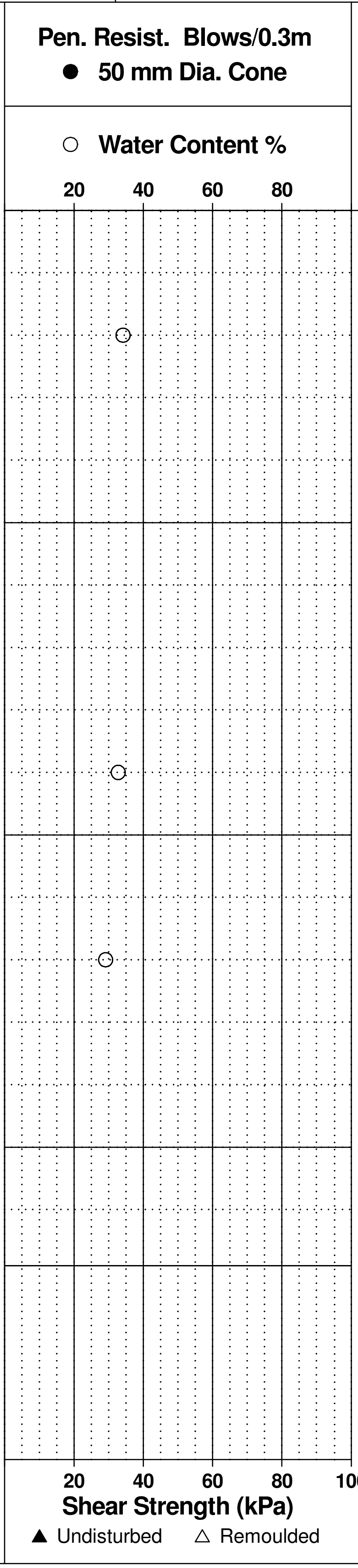
REMARKS

BORINGS BY Excavator

DATE 2022 March 17

HOLE NO. **TP4-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	91.82	
TOPSOIL 0.19								
Very stiff to stiff brown **SILTY CLAY** some sand		G	1					
						1	90.82	
		G	2					
						2	89.82	
		G	3					
						3	88.82	
3.38								
End of Test Pit (Water infiltration at 2.8 m depth)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

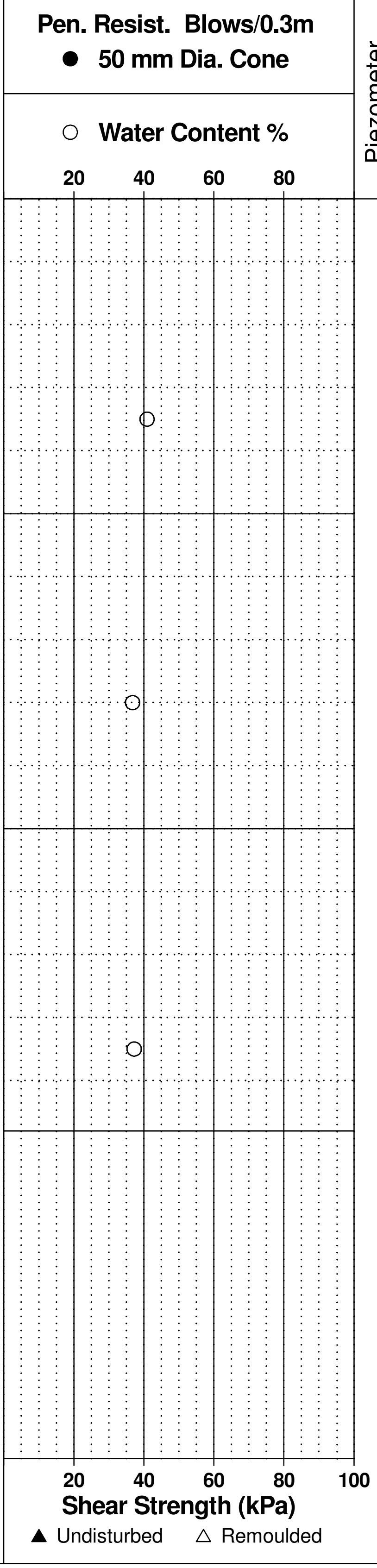
BORINGS BY Excavator

DATE 2022 March 17

FILE NO. PG5304

HOLE NO. TP5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.27
TOPSOIL 0.13	■						
Very stiff to stiff brown **SILTY CLAY** some sand	▨	G	1				
						1	91.27
		G	2				
						2	90.27
2.96		G	3				
End of Test Pit (Water infiltration at 2.1 m depth)							



Piezometer Construction

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

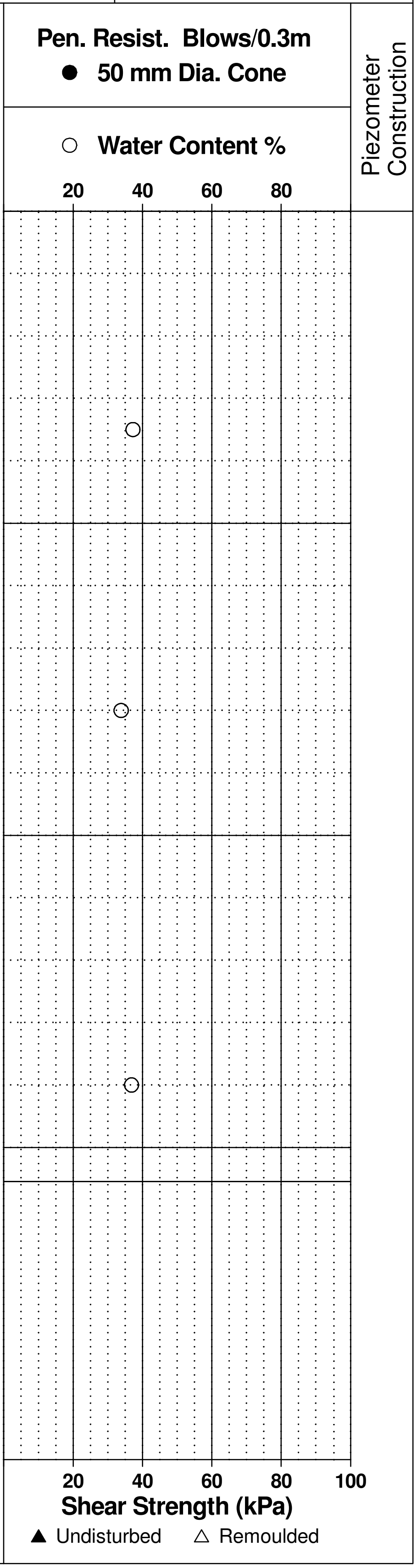
BORINGS BY Excavator

DATE 2022 March 17

FILE NO. PG5304

HOLE NO. TP6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.14
TOPSOIL 0.12							
Very stiff to stiff brown **SILTY CLAY** some sand		G	1				
						1	91.14
		G	2				
						2	90.14
		G	3				
						3	89.14
3.11 End of Test Pit (Ponding water at surface)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

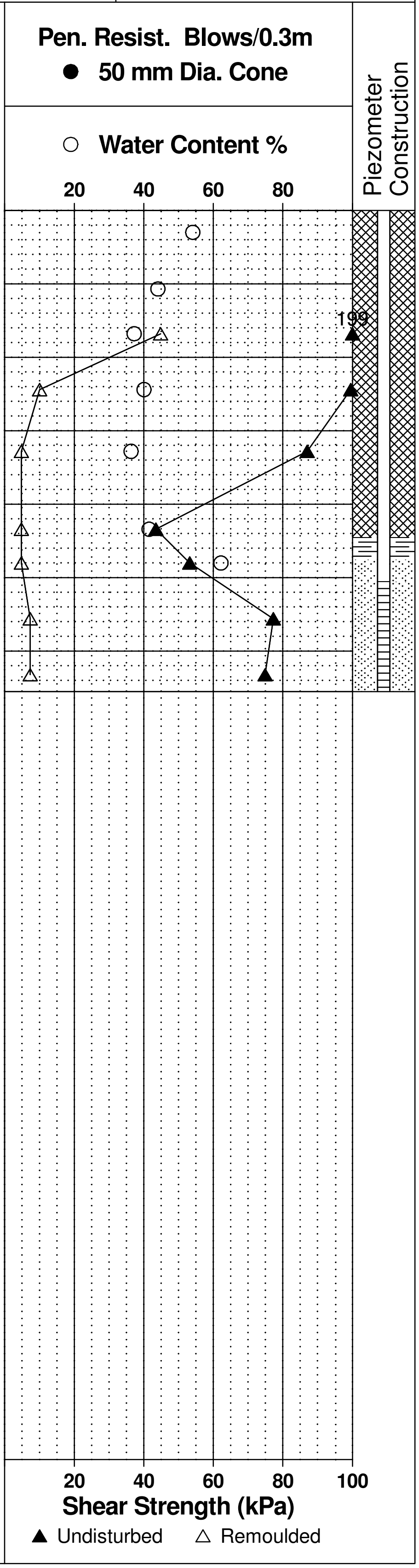
BORINGS BY CME 55 Power Auger

DATE March 25, 2020

FILE NO. PG5304

HOLE NO. BH 1-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.12
TOPSOIL 0.10		AU	1				
		SS	2		6	1	91.12
						2	90.12
Very stiff to stiff, brown **SILTY CLAY,** some sand, trace organics						3	89.12
- firm to stiff and grey by 3.8m depth						4	88.12
						5	87.12
						6	86.12
6.55							
End of Borehole							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

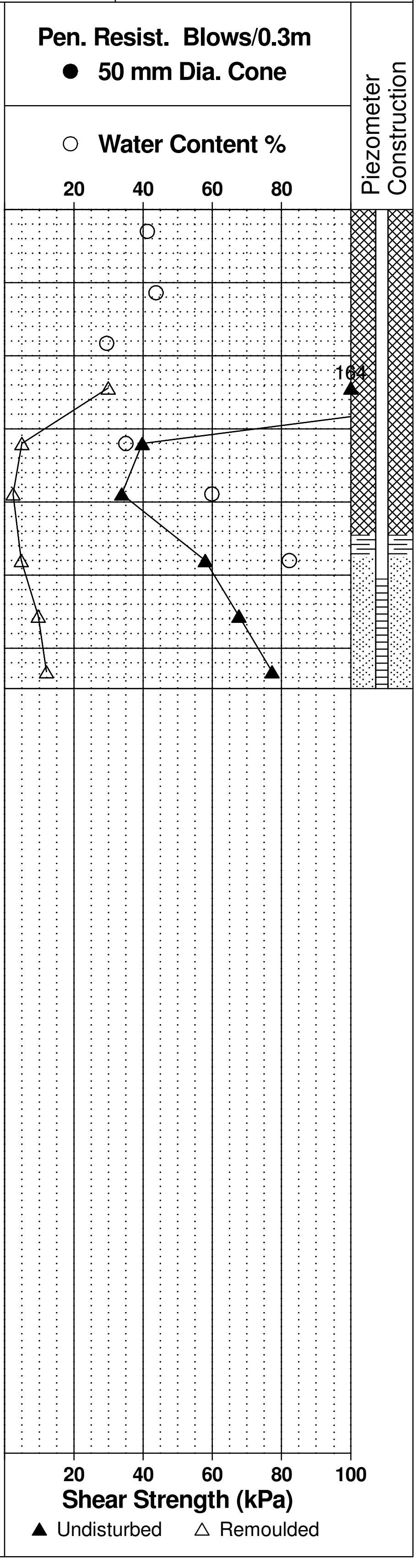
BORINGS BY CME 55 Power Auger

DATE March 25, 2020

FILE NO. PG5304

HOLE NO. BH 2-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.13		AU	1			0	91.90
FILL: Brown silty clay, trace gravel and organics 0.86		SS	2	67	9	1	90.90
Very stiff to stiff, brown **SILTY CLAY,** some sand - firm to stiff and grey by 3.0m depth		SS	3	100	5	2	89.90
						3	88.90
						4	87.90
						5	86.90
6.55						6	85.90
End of Borehole							



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SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

DATUM Geodetic

REMARKS

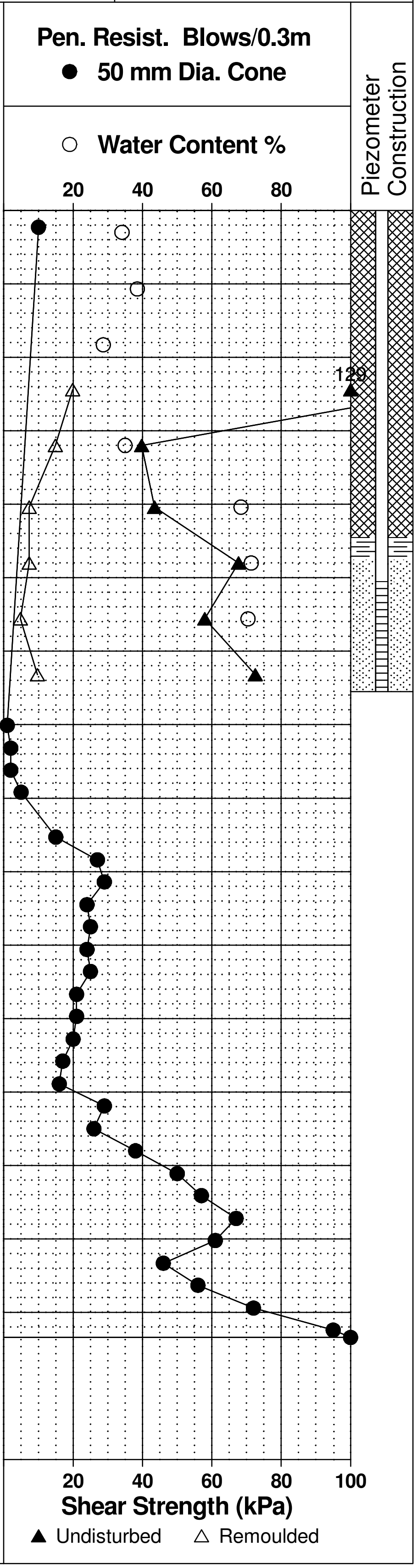
BORINGS BY CME 55 Power Auger

DATE March 25, 2020

FILE NO. PG5304

HOLE NO. BH 3-20

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	91.89
TOPSOIL 0.08	SS	1	42	8		
FILL: Brown silty clay, some gravel, trace organics 0.91	SS	2		7	1	90.89
Very stiff to stiff, brown **SILTY CLAY,** some sand, trace organics - firm to stiff and grey by 3.0m depth	SS	3		4	2	89.89
					3	88.89
					4	87.89
					5	86.89
					6	85.89
6.55						
Dynamic Cone Penetration Test commenced at 6.55m depth					7	84.89
					8	83.89
					9	82.89
					10	81.89
					11	80.89
					12	79.89
					13	78.89
					14	77.89
					15	76.89
15.34						
End of Borehole Practical DCPT refusal at 15.34m depth.						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5304

REMARKS

HOLE NO. BH 4-20

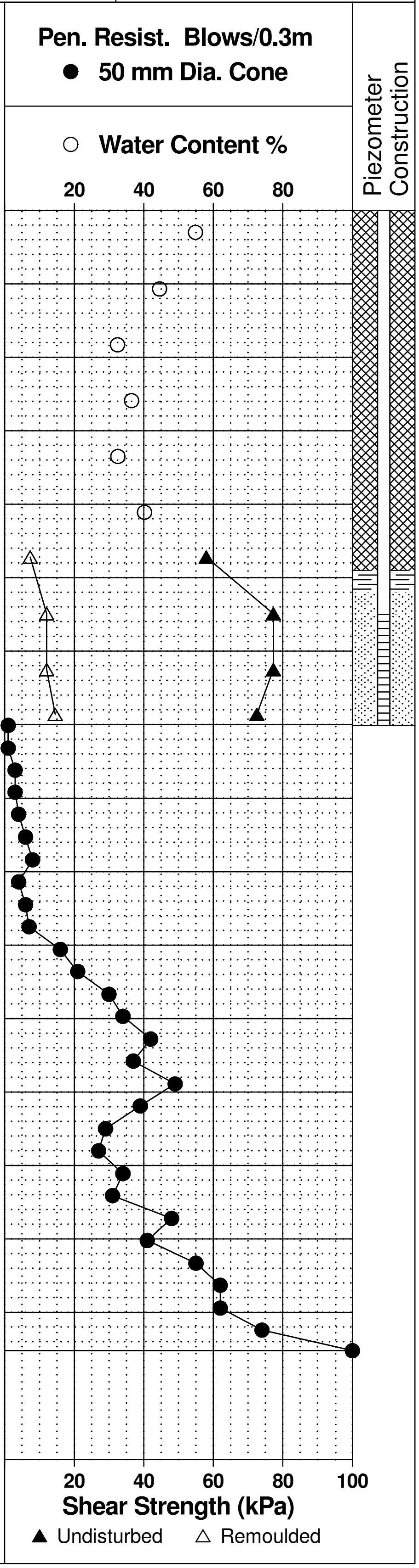
BORINGS BY CME 55 Power Auger

DATE March 23, 2020

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.10
Very stiff to stiff, brown **SILTY CLAY,** some sand, trace organics - firm to stiff and grey by 3.0m depth	7.01
Dynamic Cone Penetration Test commenced at 7.01m depth	15.52
End of Borehole Practical DCPT refusal at 15.52m depth	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	8
SS	3	88	5
SS	4	100	2
SS	5	100	1
SS	6	100	P

DEPTH (m)	ELEV. (m)
0	92.15
1	91.15
2	90.15
3	89.15
4	88.15
5	87.15
6	86.15
7	85.15
8	84.15
9	83.15
10	82.15
11	81.15
12	80.15
13	79.15
14	78.15
15	77.15



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5304**

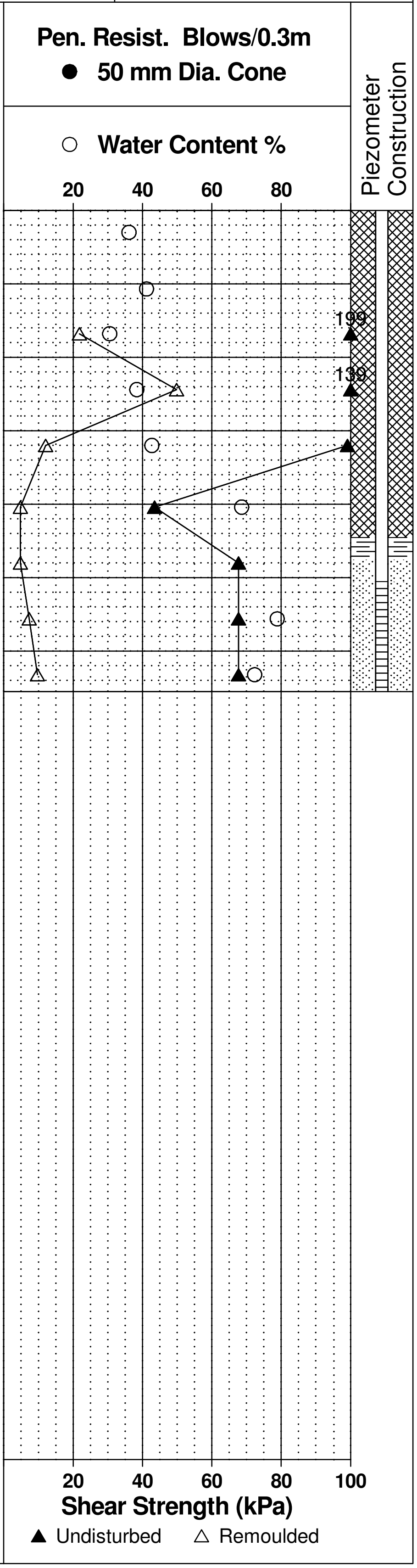
REMARKS

HOLE NO. **BH 5-20**

BORINGS BY CME 55 Power Auger

DATE March 23, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.22
TOPSOIL 0.08		AU	1				
Very stiff to stiff, brown **SILTY CLAY,** some sand, trace organics - firm to stiff and grey by 3.0m depth		SS	2	75	6	1	91.22
						2	90.22
						3	89.22
						4	88.22
						5	87.22
						6	86.22
6.55 End of Borehole							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

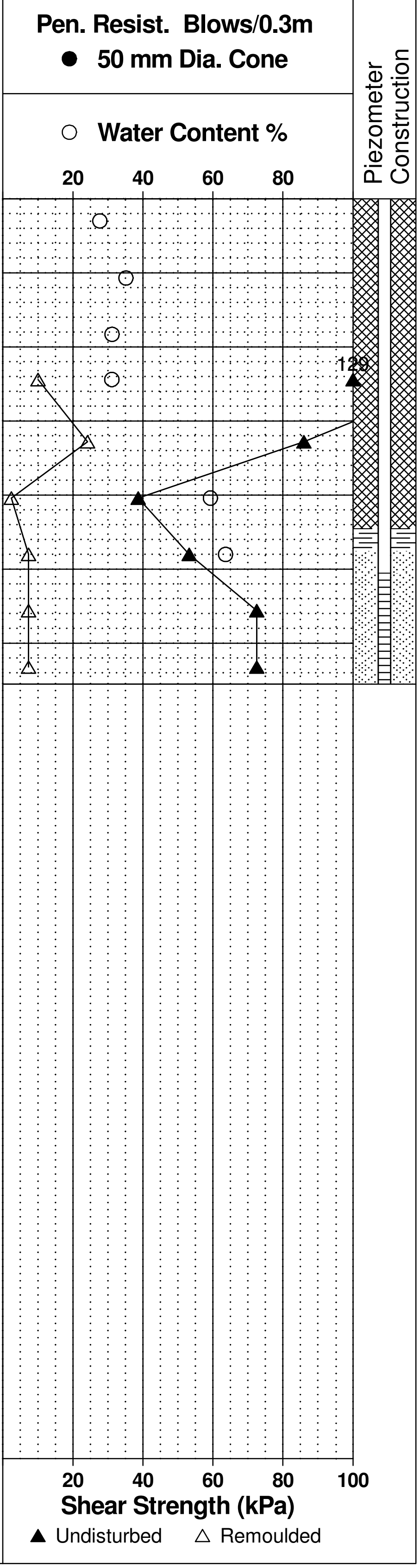
BORINGS BY CME 55 Power Auger

DATE March 23, 2020

FILE NO. PG5304

HOLE NO. BH 6-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.10		AU	1			0	93.09
		SS	2	83	9	1	92.09
		SS	3		4	2	91.09
Very stiff to stiff, brown **SILTY CLAY,** some sand						3	90.09
- firm to stiff and grey by 3.8m depth						4	89.09
						5	88.09
						6	87.09
6.55							
End of Borehole							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5304

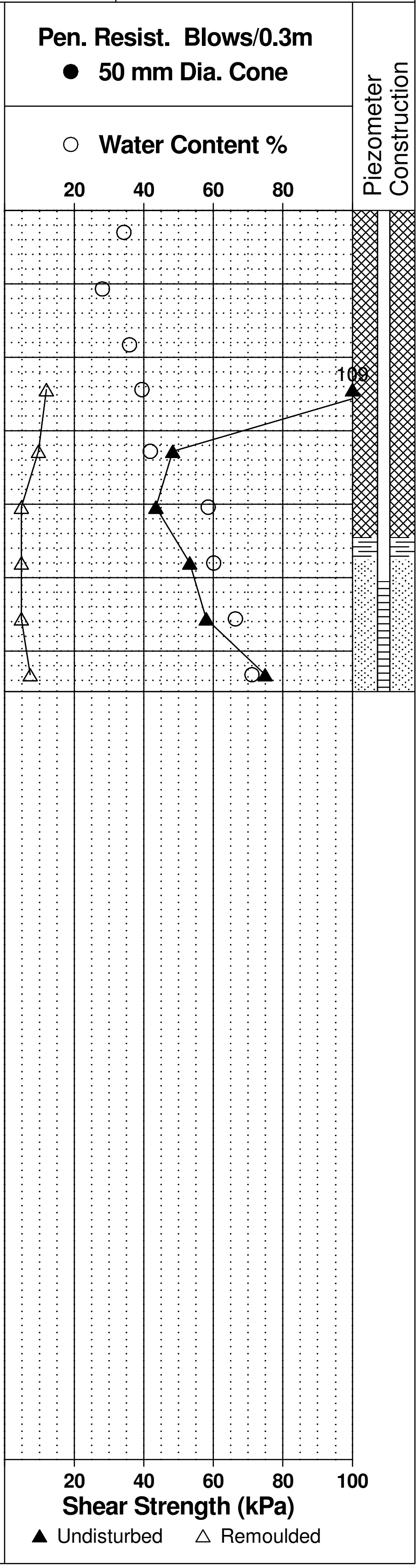
REMARKS

HOLE NO. BH 7-20

BORINGS BY CME 55 Power Auger

DATE March 23, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	91.78
TOPSOIL 0.10		AU	1				
		SS	2	75	7	1	90.78
		SS	3	100	3	2	89.78
Very stiff to stiff, brown **SILTY CLAY,** some sand							
						3	88.78
- firm to stiff and grey by 3.0m depth							
						4	87.78
						5	86.78
						6	85.78
6.55							
End of Borehole							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

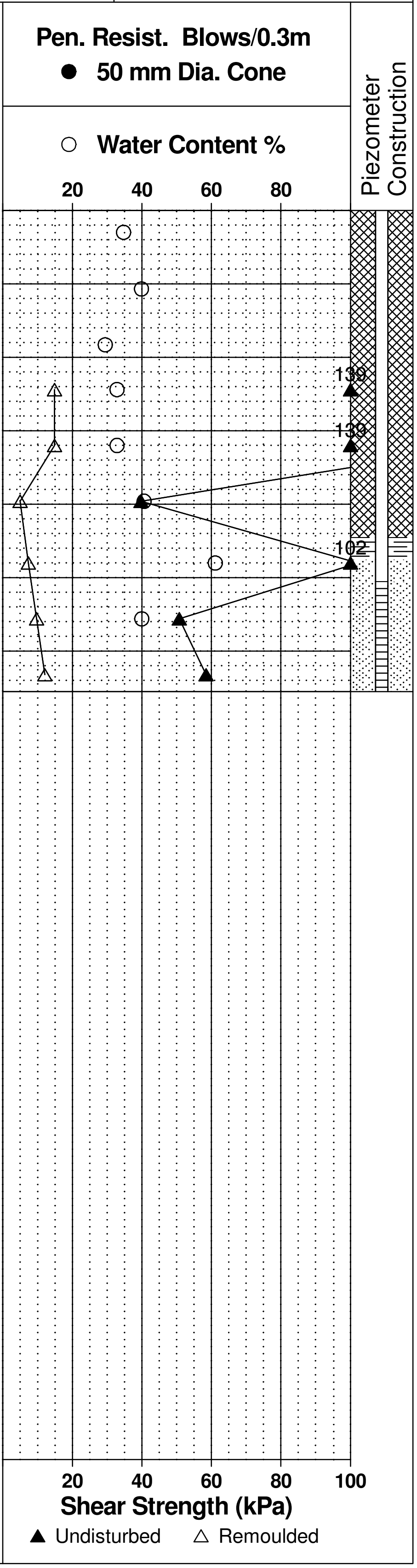
BORINGS BY CME 55 Power Auger

DATE March 23, 2020

FILE NO. PG5304

HOLE NO. BH 8-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.16
TOPSOIL 0.10		AU	1				
		SS	2	25	10	1	91.16
		SS	3	100	5	2	90.16
Very stiff to stiff, brown **SILTY CLAY,** some sand						3	89.16
- firm to stiff and grey by 3.8m depth						4	88.16
						5	87.16
						6	86.16
6.55							
End of Borehole							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5304**

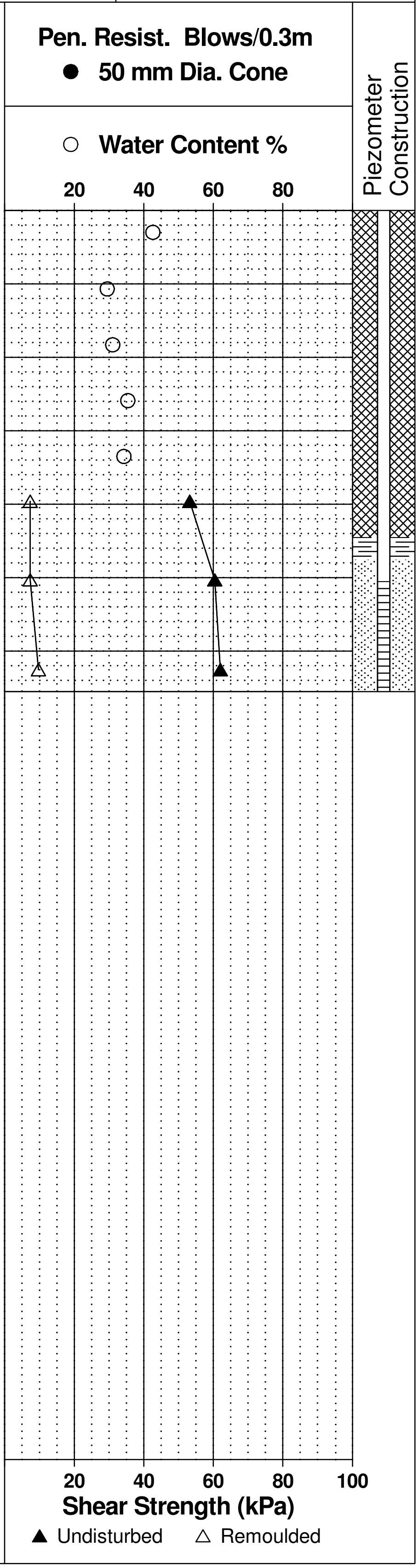
REMARKS

HOLE NO. **BH 9-20**

BORINGS BY CME 55 Power Auger

DATE March 23, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.79
TOPSOIL 0.10		AU	1				
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	2	100	6	1	90.79
		SS	3	100	3	2	89.79
		SS	4	100	2	3	88.79
- firm to stiff and grey by 3.0m depth		SS	5	100	P	4	87.79
						5	86.79
6.55						6	85.79
End of Borehole							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Plaza - 1515 Earl Armstrong Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

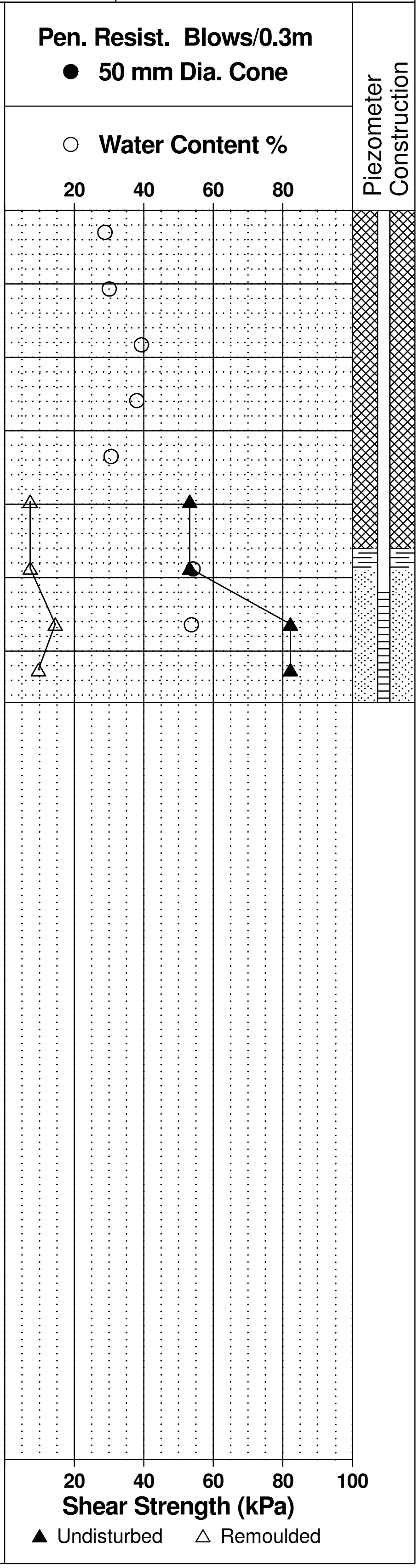
BORINGS BY CME 55 Power Auger

DATE March 23, 2020

FILE NO. PG5304

HOLE NO. BH10-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.93
TOPSOIL 0.10		AU	1				
Very stiff to stiff, brown **SILTY CLAY,** some sand - firm to stiff and grey by 3.0m depth		SS	2	100	4	1	90.93
		SS	3	100	5	2	89.93
		SS	4	100	2	3	88.93
		SS	5	100	1	4	87.93
		SS	6	100	P	5	86.93
6.70		SS	7	100	P	6	85.93
End of Boreole							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG2404

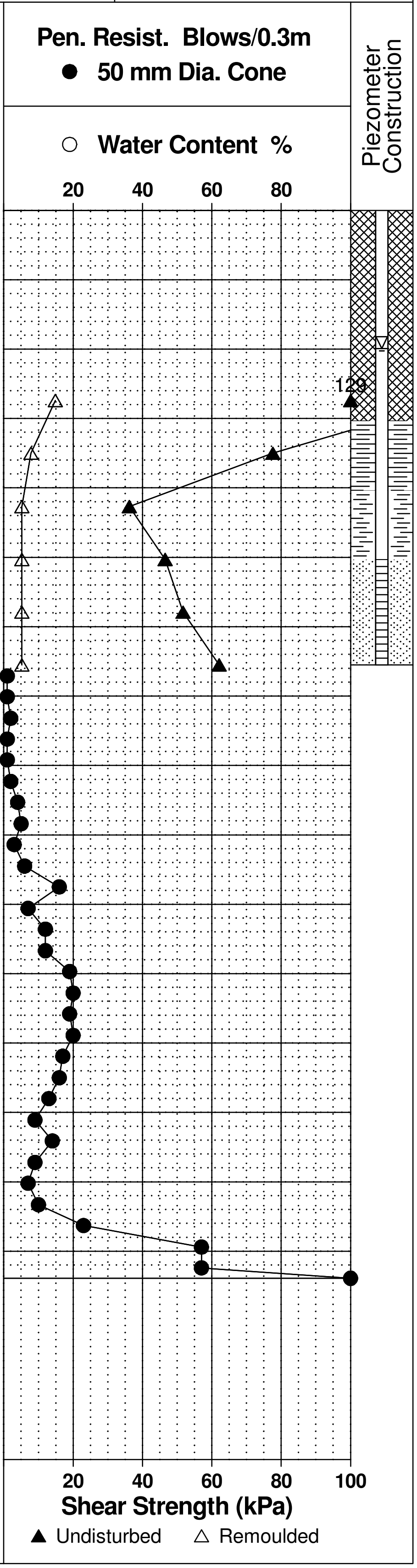
REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger

DATE 31 May 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	92.18
TOPSOIL 0.15							
Very stiff to stiff, brown **SILTY CLAY**		SS	1	92	10	1	91.18
- grey-brown by 1.2m depth		SS	2	0	3		
						2	90.18
- grey by 2.3m depth						3	89.18
						4	88.18
						5	87.18
6.55						6	86.18
Dynamic Cone Penetration Test commenced @ 6.55m depth						7	85.18
						8	84.18
						9	83.18
						10	82.18
						11	81.18
						12	80.18
						13	79.18
						14	78.18
15.39						15	77.18
End of Borehole Practical refusal to DCPT @ 15.39m depth. (GWL @ 1.99m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG2404

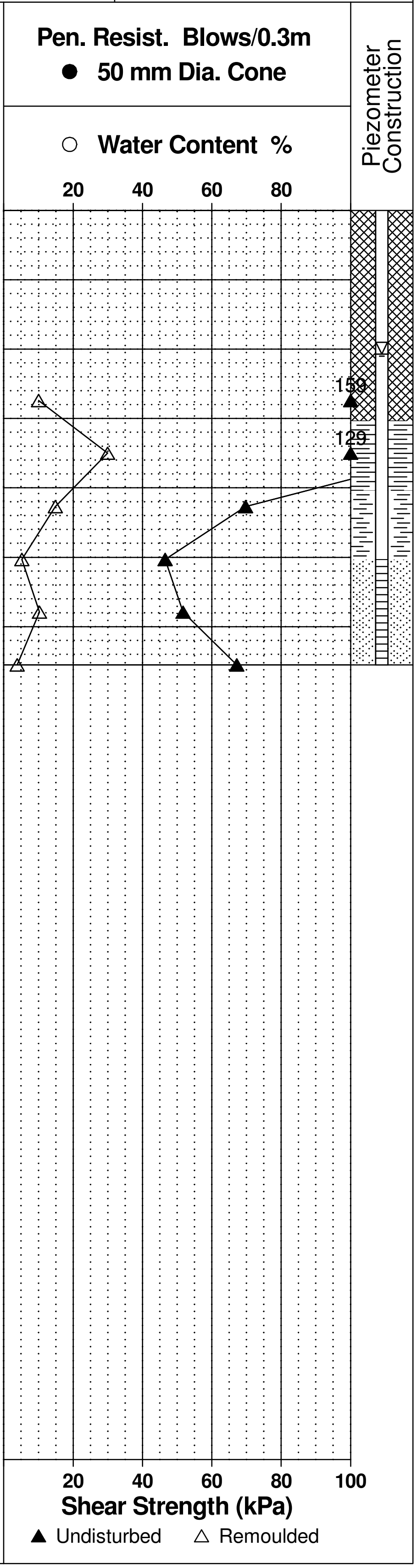
REMARKS

HOLE NO. BH 2

BORINGS BY CME 55 Power Auger

DATE 30 May 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.05
TOPSOIL 0.13							
-silty clay by 2.9m depth							
		SS	1	100	6	1	91.05
		SS	2	92	4		
						2	90.05
Very stiff to stiff, grey-brown **SILTY CLAY** with sand						3	89.05
						4	88.05
						5	87.05
						6	86.05
6.55							
End of Borehole							
(GWL @ 2.07m - June 7/11)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG2404

REMARKS

HOLE NO. BH 3

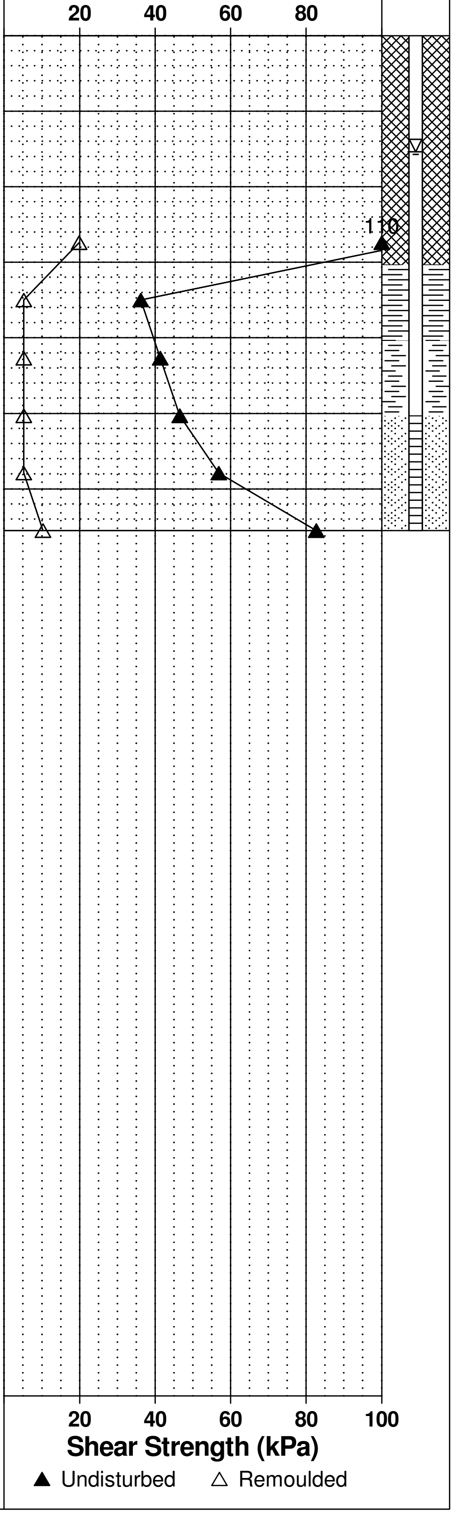
BORINGS BY CME 55 Power Auger

DATE 31 May 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	91.70
FILL: Brown silty clay with sand and gravel 0.06	AU	1				
Very stiff to stiff, brown **SILTY CLAY** with sand	SS	2	100	8	1	90.70
- grey-brown by 1.5m depth	SS	3	96	4	2	89.70
- grey and silty clay by 3.0m depth					3	88.70
					4	87.70
					5	86.70
					6	85.70
6.55						
End of Borehole (GWL @ 1.54m - June 7/11)						

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**
○ **Water Content %**

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG2404

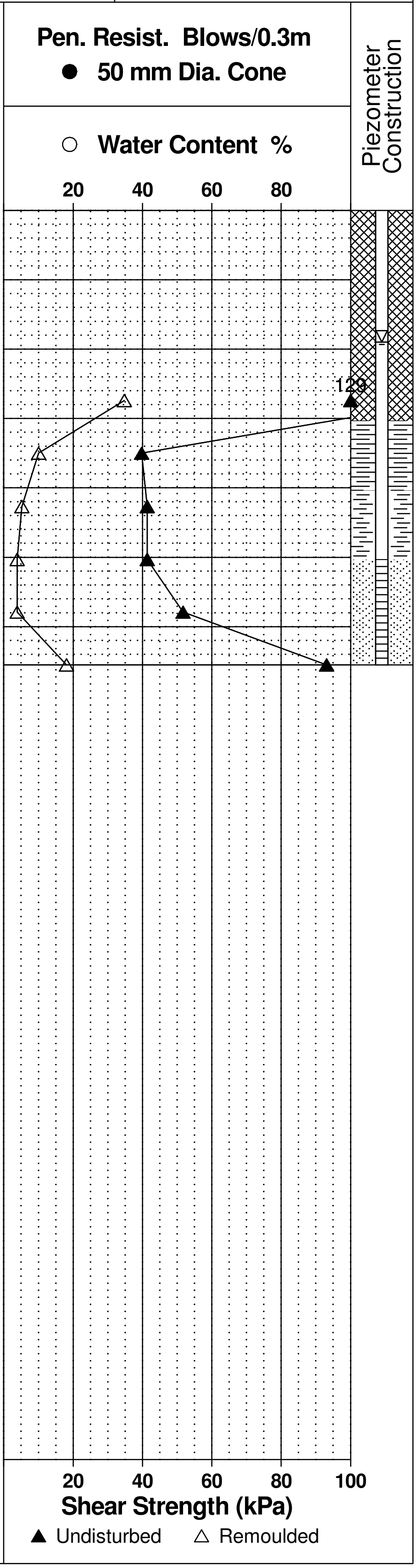
REMARKS

HOLE NO. BH 4

BORINGS BY CME 55 Power Auger

DATE 31 May 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.44
FILL: Brown silty clay with sand and gravel 0.30		AU	1				
		SS	2	100	8	1	91.44
		SS	3	33	4	2	90.44
Very stiff to firm, grey-brown **SILTY CLAY** with sand - grey and silty clay by 3.0m depth						3	89.44
						4	88.44
						5	87.44
						6	86.44
6.55							
End of Borehole (GWL @ 1.90m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 31 May 2011

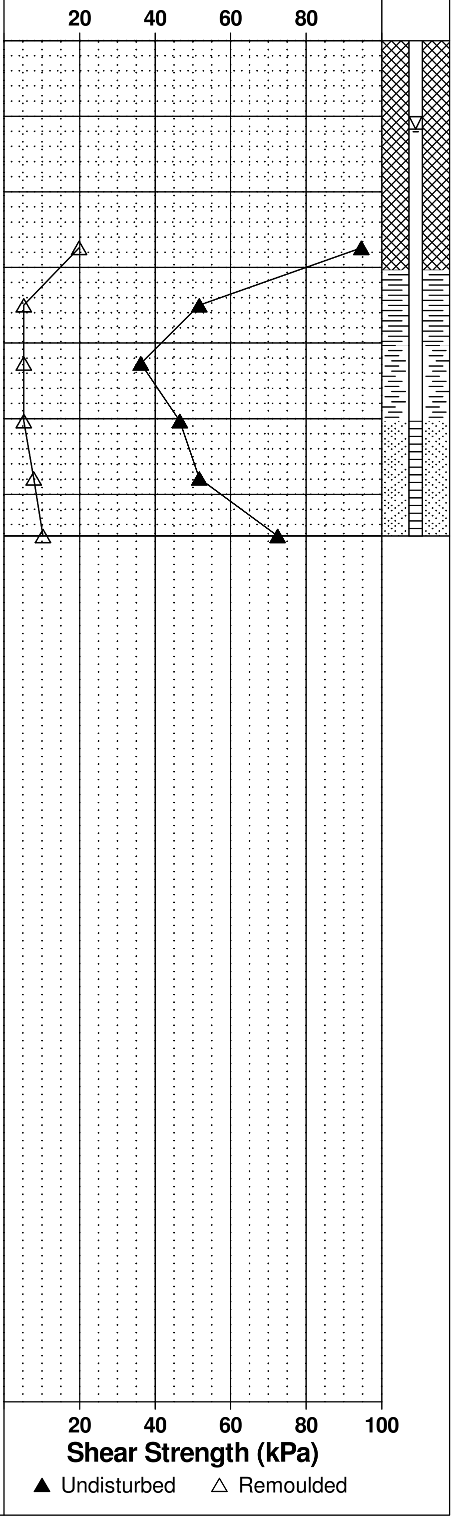
FILE NO. PG2404

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.15
Stiff to firm, brown **SILTY CLAY** with sand		SS	1	75	6		
		SS	2	100	8	1	91.15
- grey-brown by 1.1m depth		SS	3	12	3	2	90.15
- grey by 2.4m depth						3	89.15
- silty clay by 3.7m depth						4	88.15
						5	87.15
						6	86.15
6.55							
End of Borehole							
(GWL @ 1.17m - June 7/11)							

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

○ Water Content %



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

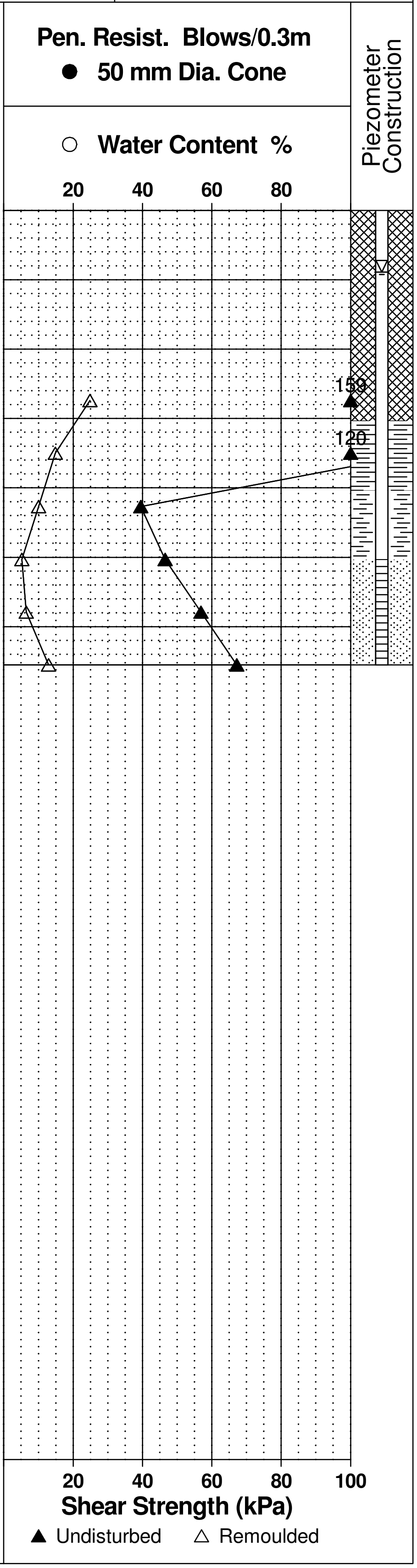
BORINGS BY CME 55 Power Auger

DATE 30 May 2011

FILE NO. PG2404

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.22
TOPSOIL 0.13							
		SS	1	96	6	1	91.22
		SS	2	88	4		
Very stiff to stiff, brown **SILTY CLAY** with sand						2	90.22
- grey by 2.7m depth						3	89.22
- silty clay by 3.7 m depth						4	88.22
						5	87.22
						6	86.22
6.55							
End of Borehole (GWL @ 0.89m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 30 May 2011

FILE NO. PG2404

HOLE NO. BH 7

SOIL DESCRIPTION

GROUND SURFACE

TOPSOIL 0.15

Very stiff to stiff, grey-brown **SILTY CLAY** with sand

- silty clay by 1.8 m depth

- grey by 3.0m depth

6.55

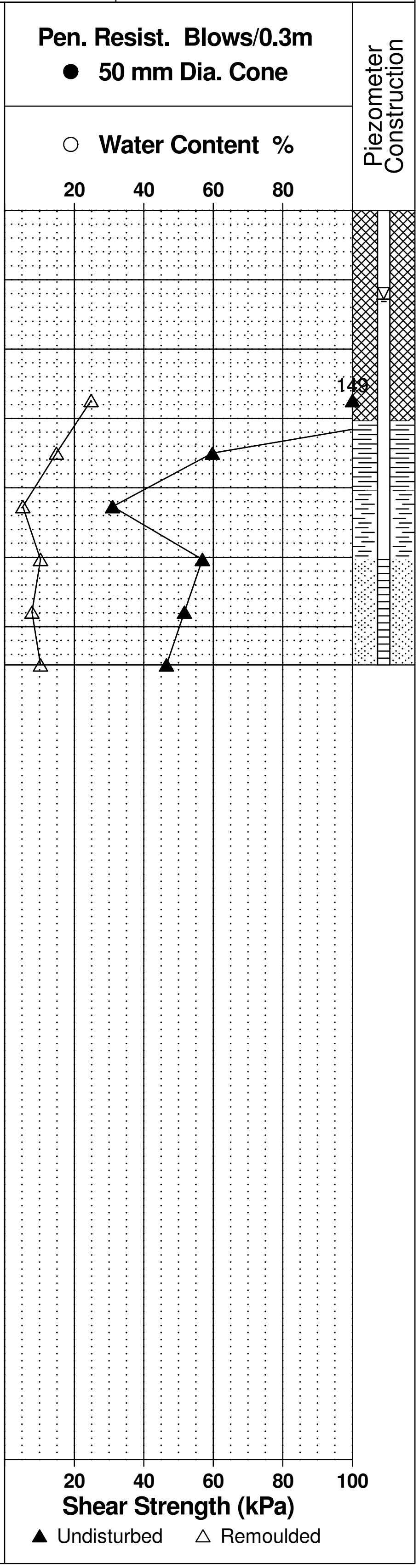
End of Borehole

(GWL @ 1.28m - June 7/11)

SAMPLE

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	7
SS	2	58	4

DEPTH (m)	ELEV. (m)
0	92.11
1	91.11
2	90.11
3	89.11
4	88.11
5	87.11
6	86.11



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG2404**

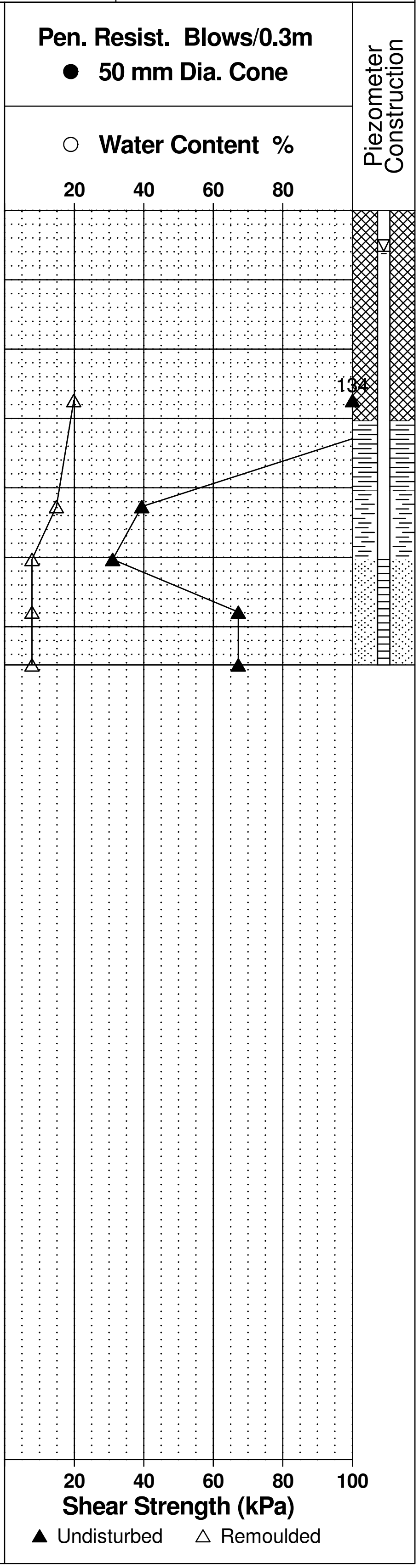
REMARKS

HOLE NO. **BH 8**

BORINGS BY CME 55 Power Auger

DATE 30 May 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	92.20
TOPSOIL 0.13							
		SS	1	100	6	1	91.20
		SS	2	88	4	2	90.20
Very stiff to stiff, brown **SILTY CLAY** with sand - grey by 2.9m depth - silty clay by 3.1m depth						3	89.20
		SS	3	100	1		
						4	88.20
						5	87.20
6.55						6	86.20
End of Borehole (GWL @ 0.59m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

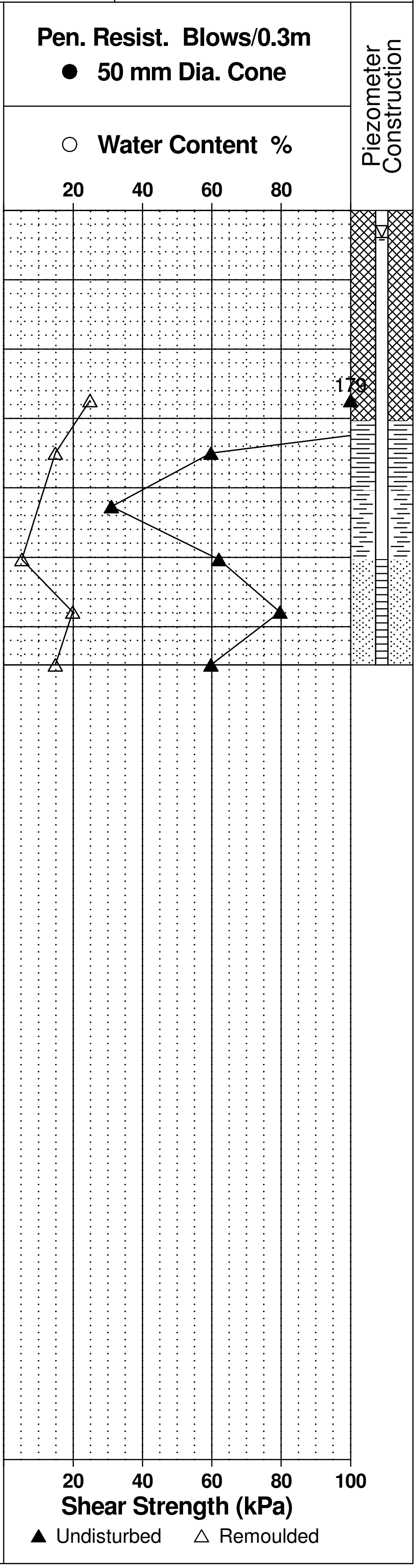
BORINGS BY CME 55 Power Auger

DATE 30 May 2011

FILE NO. PG2404

HOLE NO. BH 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.94
TOPSOIL 0.10							
FILL: Brown silty sand and gravel 0.71							
		SS	1	100	5	1	90.94
		SS	2	96	3	2	89.94
Very stiff to stiff, brown **SILTY CLAY** with sand - grey by 2.3m depth - silty clay by 3.1 m depth						3	88.94
						4	87.94
						5	86.94
						6	85.94
6.55							
End of Borehole (GWL @ 0.39m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG2404

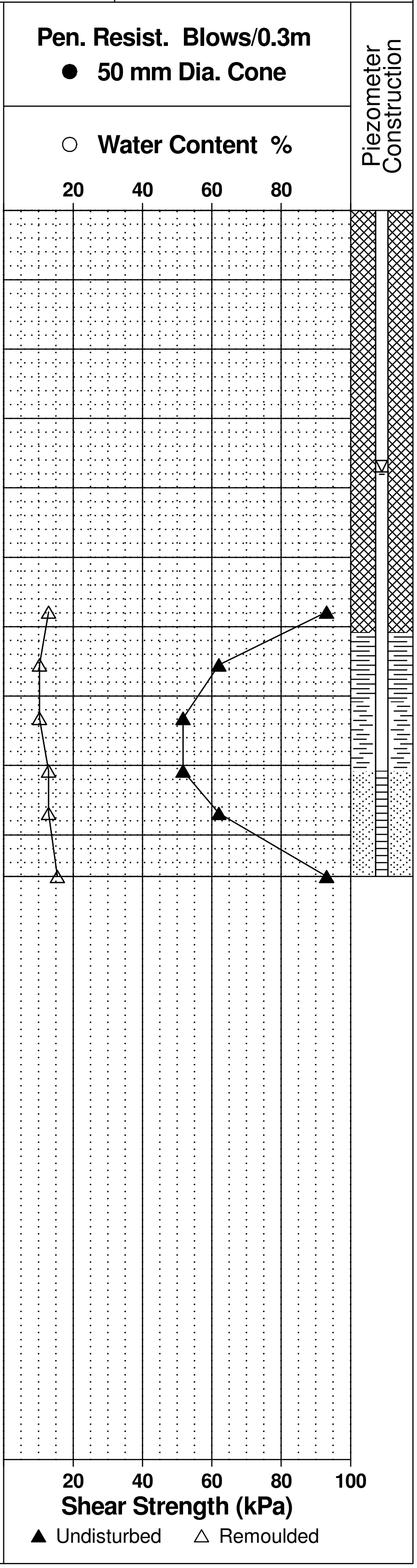
REMARKS

HOLE NO. BH10

BORINGS BY CME 55 Power Auger

DATE 31 May 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	95.25
		AU	1				
						1	94.25
FILL: Grey-brown silty clay		AU	2				
						2	93.25
		AU	3				
						3	92.25
3.66		SS	4	83	11		
						4	91.25
Grey-brown **SILTY CLAY**		SS	5	100	8		
- with sand and brown by 4.4m depth		SS	6	100	1		
						5	90.25
- grey by 5.5m depth							
						6	89.25
- silty clay by 7.3m depth							
						7	88.25
						8	87.25
						9	86.25
9.60							
End of Borehole							
(GWL @ 3.77m - June 7/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development-Earl Armstrong Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

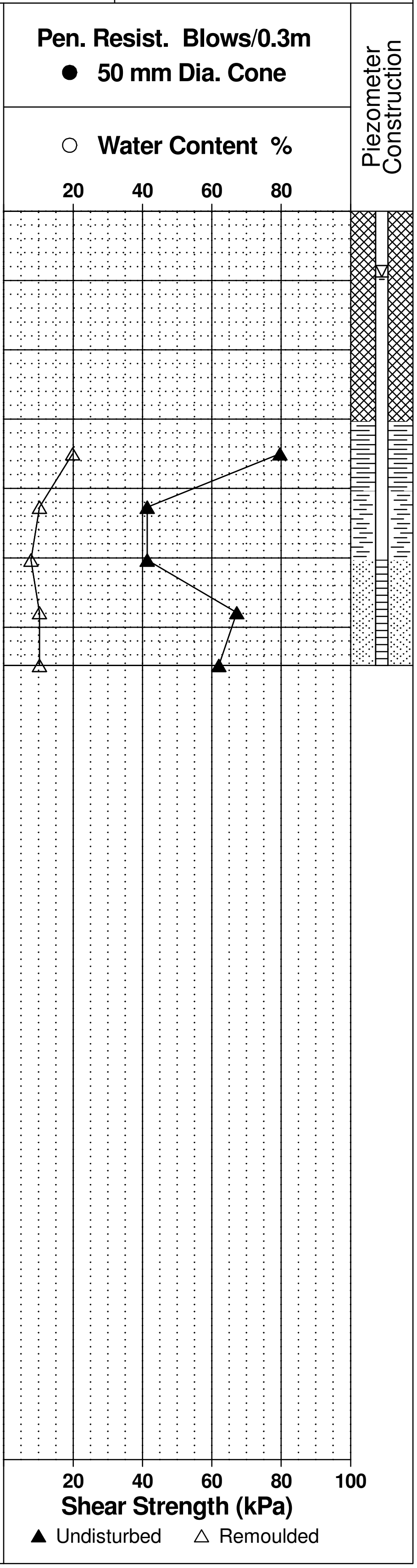
BORINGS BY CME 55 Power Auger

DATE 30 May 2011

FILE NO. PG2404

HOLE NO. BH11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.21
FILL: Brown silty clay with sand 0.60	▩	SS	1	71	7		
Stiff to firm, brown **SILTY CLAY** with sand - grey by 2.4m depth	▨	SS	2	100	9	1	91.21
	▨	SS	3	83	5	2	90.21
	▨	SS	4	100	2	3	89.21
	▨					4	88.21
	▨					5	87.21
	▨					6	86.21
6.55							
End of Borehole (GWL @ 0.95m - June 7/11)							



SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu - Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

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

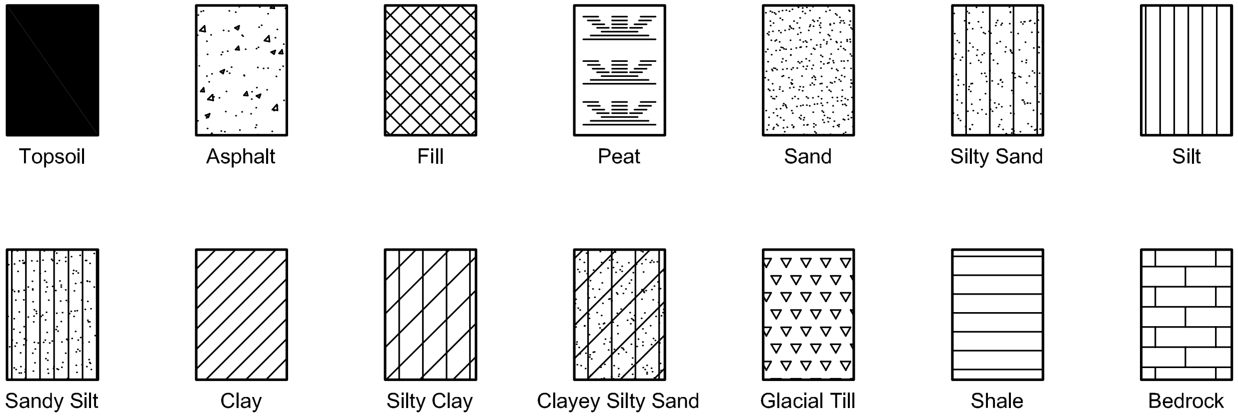
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

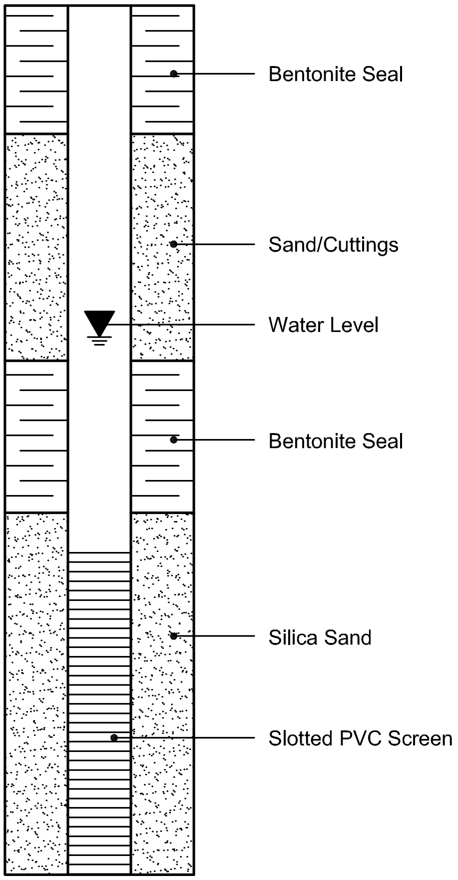
SYMBOLS AND TERMS (continued)

STRATA PLOT

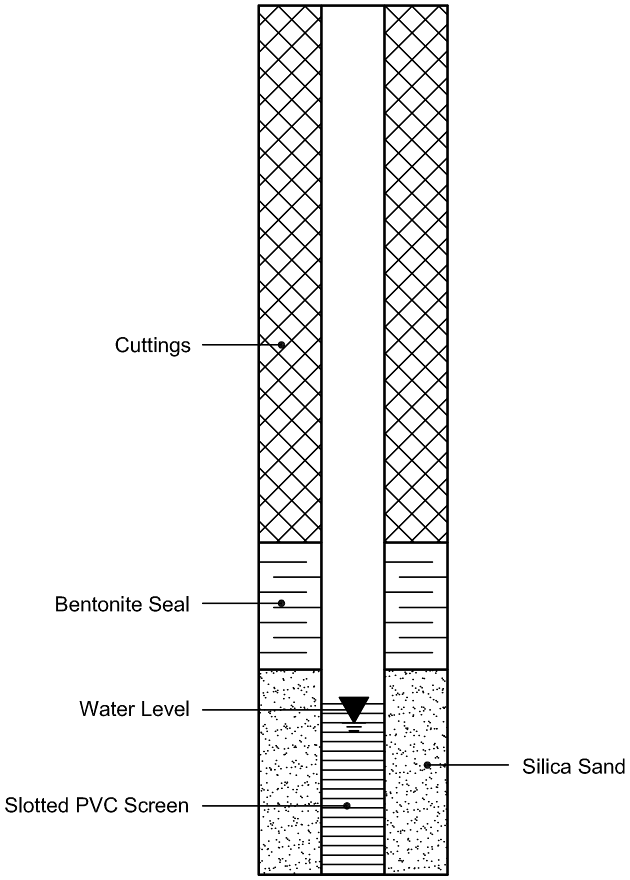


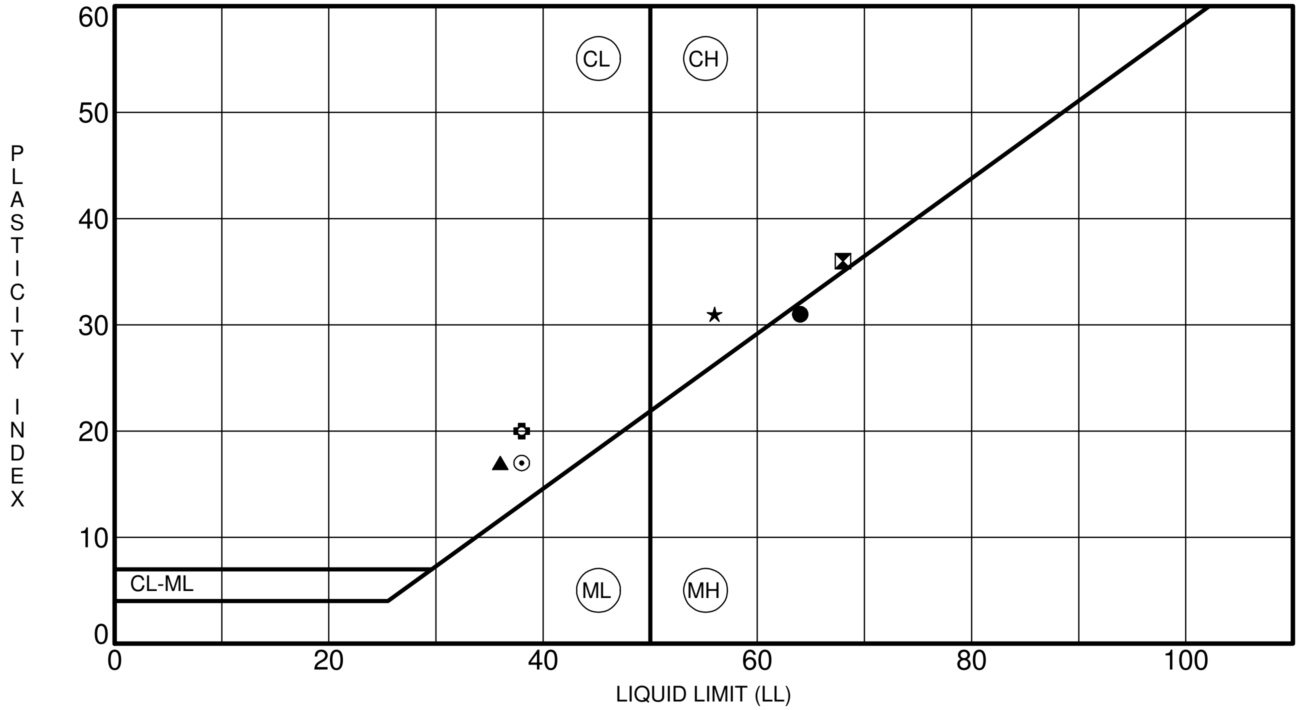
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP1-22 G2**	**64**	**33**	**31**		**MH = Inorganic Silts of High Plasticity**
⧗	**TP2-22 G2**	**68**	**32**	**36**		**CH = Inorganic Clays of High Plasticity**
▲	**TP3-22 G2**	**36**	**19**	**17**		**CL = Inorganic Clays of Low Plasticity**
★	**TP4-22 G3**	**56**	**25**	**31**		**CH = Inorganic Clays of high Plasticity**
⊙	**TP5-22 G2**	**38**	**21**	**17**		**CL = Inorganic Clays of Low Plasticity**
✿	**TP6-22 G2**	**38**	**18**	**20**		**CL = Inorganic Clays of Low Plasticity**

CLIENT **Urbandale**

PROJECT **Geotechnical Investigation - Prop. Commercial Plaza - Earl Armstrong Road**

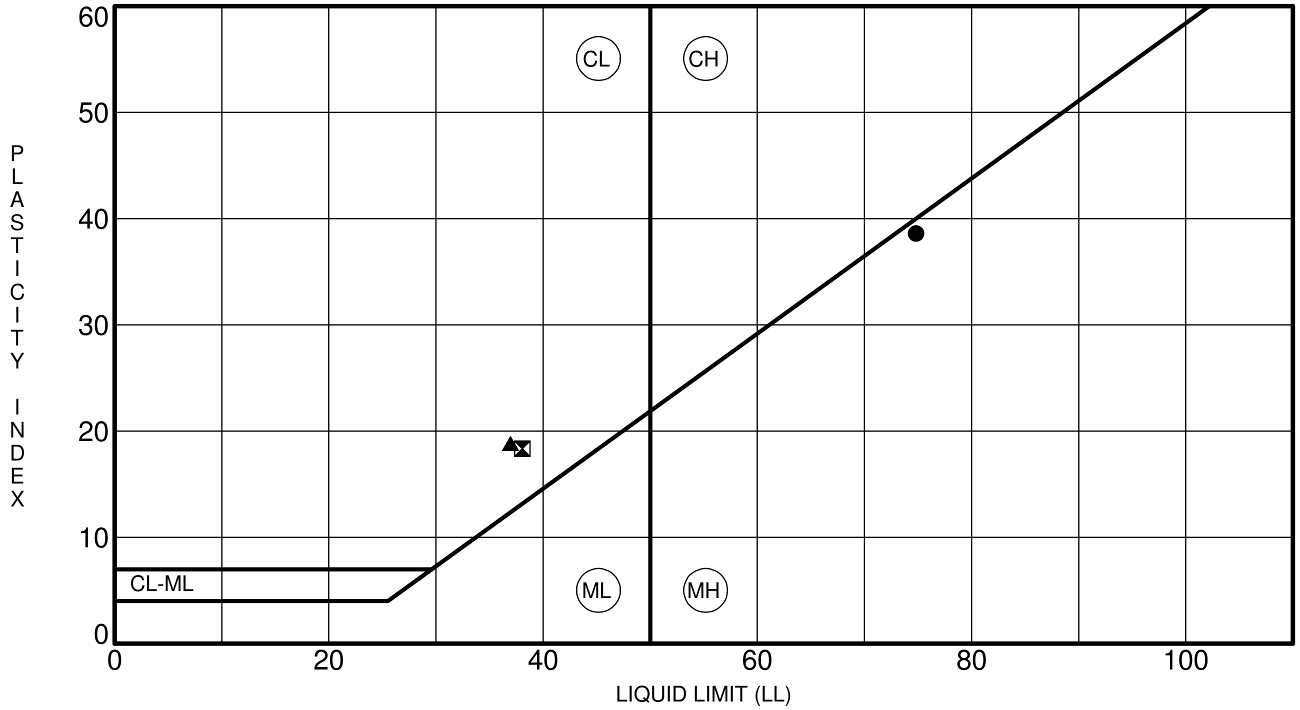
FILE NO. **PG5304**

DATE **17 Mar 22**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS



Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH 2-20**	**SS 2**	**75**	**36**	**39**		**MH - Inorganic silts of high plasticity**
⧗	**BH 4-20**	**SS 3**	**38**	**20**	**18**		**CL - Inorganic clays of low plasticity**
▲	**BH 7-20**	**SS 3**	**37**	**18**	**19**		**CL - Inorganic clays of low plasticity**

CLIENT **Urbandale Corporation**
PROJECT **Geotechnical Investigation - Prop. Commercial Plaza - 1515 Earl Armstrong Road**
FILE NO. **PG5304**
DATE **23 Mar 20**

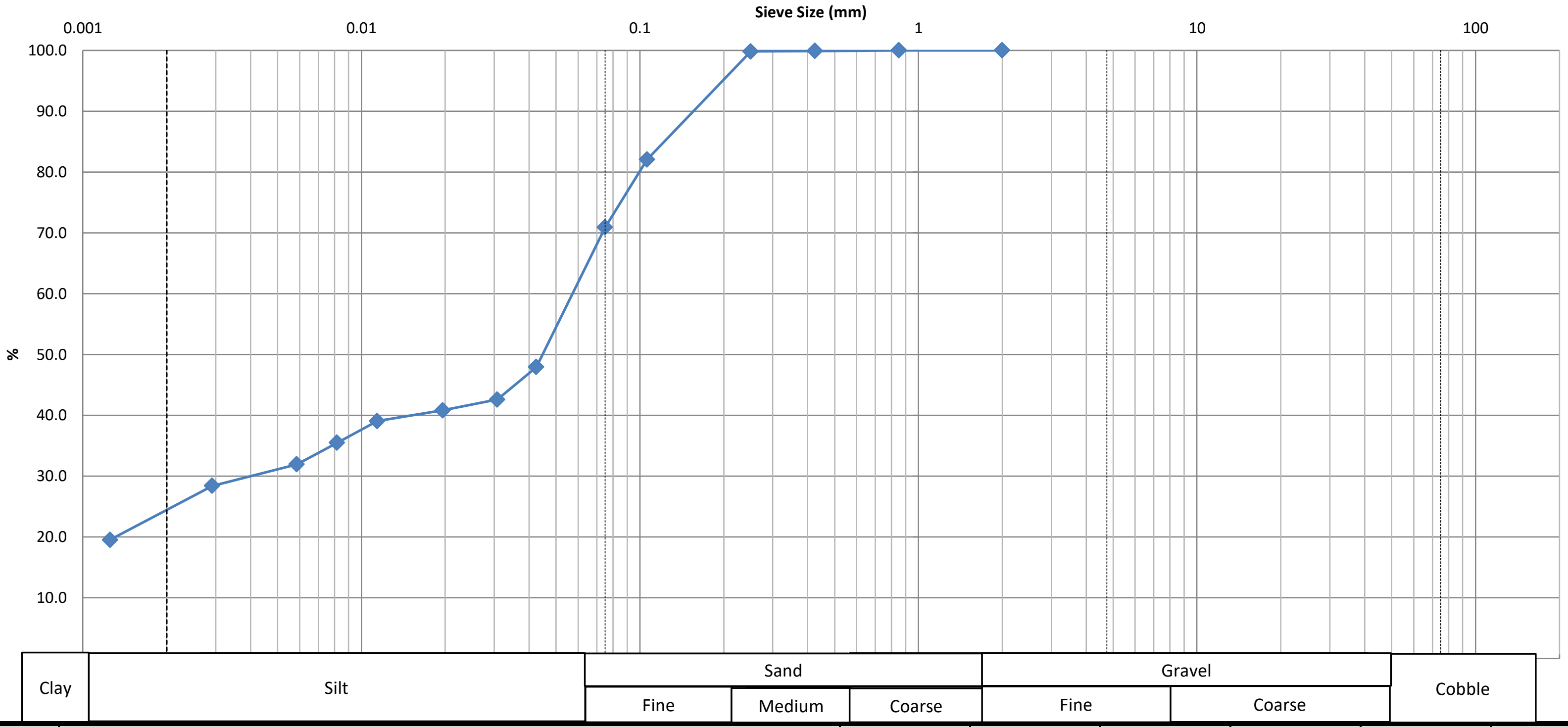
patersongroup **Consulting Engineers**
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

patersongroup
consulting engineers

SIEVE ANALYSIS
ASTM C136

CLIENT:	Urbandale	DEPTH:	1.6 - 1.7m	FILE NO:	PG5307
CONTRACT NO.:		BH OR TP No.:	TP5-22 G2	LAB NO:	32048
PROJECT:	1515 Earl Armstrong			DATE RECEIVED:	17-Mar-22
				DATE TESTED:	28-Mar-22
DATE SAMPLED:	17-Mar-22			DATE REPORTED:	30-Mar-22
SAMPLED BY:	G.P.			TESTED BY:	CS



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					33.0					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)
					0.0	29.1		45.9		25.0

Comments:

REVIEWED BY:	Curtis Beadow	Joe Forsyth, P. Eng.

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HYDROMETER
LS-702 ASTM-422

CLIENT:	Urbandale	DEPTH:	1.6 - 1.7m	FILE NO.:	PG5307
PROJECT:	1515 Earl Armstrong	BH OR TP No.:	TP5-22 G2	DATE SAMPLE	17-Mar-22
LAB No. :	32048	TESTED BY:	CS	DATE RECEIVE	17-Mar-22
SAMPLED BY:	G.P.	DATE REPT'D:	30-Mar-22	DATE TESTED:	28-Mar-22

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
147.6	2.700

		HYGROSCOPIC MOISTURE		
INITIAL WEIGHT	50.00			
WEIGHT CORRECTED	55.73	TARE WEIGHT	50.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	15.35	AIR DRY	163.50	113.50
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	176.50	126.50
		CORRECTED	1.115	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75			
2.0	**0.0**	0.0	**100.0**
Pan	**147.6**		
0.850	**0.00**	0.0	**100.0**
0.425	**0.04**	0.1	**99.9**
0.250	**0.09**	0.2	**99.8**
0.106	**8.99**	18.0	**82.0**
0.075	**14.55**	29.1	**70.9**
Pan	**15.35**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (°C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	9:21	33.0	6.0	23.0	0.0425	47.9	**47.9**
2	9:22	30.0	6.0	23.0	0.0307	42.6	**42.6**
5	9:25	29.0	6.0	23.0	0.0196	40.8	**40.8**
15	9:35	28.0	6.0	23.0	0.0114	39.0	**39.0**
30	9:50	26.0	6.0	23.0	0.0082	35.5	**35.5**
60	10:20	24.0	6.0	23.0	0.0059	31.9	**31.9**
250	1:30	22.0	6.0	23.0	0.0029	28.4	**28.4**
1440	9:20	17.0	6.0	23.0	0.0013	19.5	**19.5**

Moisture = 32.99%

REVIEWED BY:	C. Beadow	Joe Forsyth, P. Eng.

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Linear Shrinkage
ASTM D4943-02

CLIENT:	Urbandale	DEPTH	1.6 m to 1.7 m	FILE NO.:	PG5304
PROJECT:	1515 Earl Armstrong	BH OR TP No:	TP1-22 G2	DATE SAMPLED	17-Mar
LAB No:	32047	TESTED BY:	CP / AL / CS	DATE RECEIVED	18-Mar
SAMPLED BY:	GP	DATE REPORTED:	30-Mar-22	DATE TESTED	23-Mar

LABORATORY INFORMATION & TEST RESULTS

Moisture	No. of Blows(8)	Calibration (Two Trials)	Tin NO.(x22)	
Tare	5.14	Tin	4.9	4.91
Soil Pat Wet + Tare	67.27	Tin + Grease	5.17	5.18
Soil Pat Wet	62.13	Glass	48.97	48.97
Soil Pat Dry + Tare	42.01	Tin + Glass + Water	91.44	91.37
Soil Pat Dry	36.87	Volume	37.30	37.22
Moisture	**68.51**	**Average Volume**	**37.26**	

Soil Pat + String	37.07
Soil Pat + Wax + String in Air	38.31
Soil Pat + Wax + String in Water	15.85
Volume Of Pat (Vdx)	22.46

RESULTS:

Shrinkage Limit	**24.59**
Shrinkage Ratio	**1.750**
Volumetric Shrinkage	**76.866**
Linear Shrinkage	**17.309**

REVIEWED BY:	**Curtis Beadow**	**Joe Forsyth, P. Eng.**

Certificate of Analysis

Client: **Paterson Group Consulting Engineers**

Client PO: 29777

Report Date: 30-Mar-2020

Order Date: 25-Mar-2020

Project Description: PG5304

	Client ID:	BHD-SS6	-	-	-
	Sample Date:	23-Mar-20 13:00	-	-	-
	Sample ID:	2013230-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	65.6	-	-	-
General Inorganics					
pH	0.05 pH Units	7.90	-	-	-
Resistivity	0.10 Ohm.m	50.5	-	-	-
Anions					
Chloride	5 ug/g dry	7	-	-	-
Sulphate	5 ug/g dry	36	-	-	-

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURE 2 – AERIAL PHOTOGRAPH – 2002

FIGURE 3 – AERIAL PHOTOGRAPH – 2007

FIGURE 4 – AERIAL PHOTOGRAPH – 2017

FIGURES 5 AND 6 – SEISMIC SHEAR WAVE VELOCITY PROFILES

DRAWING PG5304-1 – TEST HOLE LOCATION PLAN

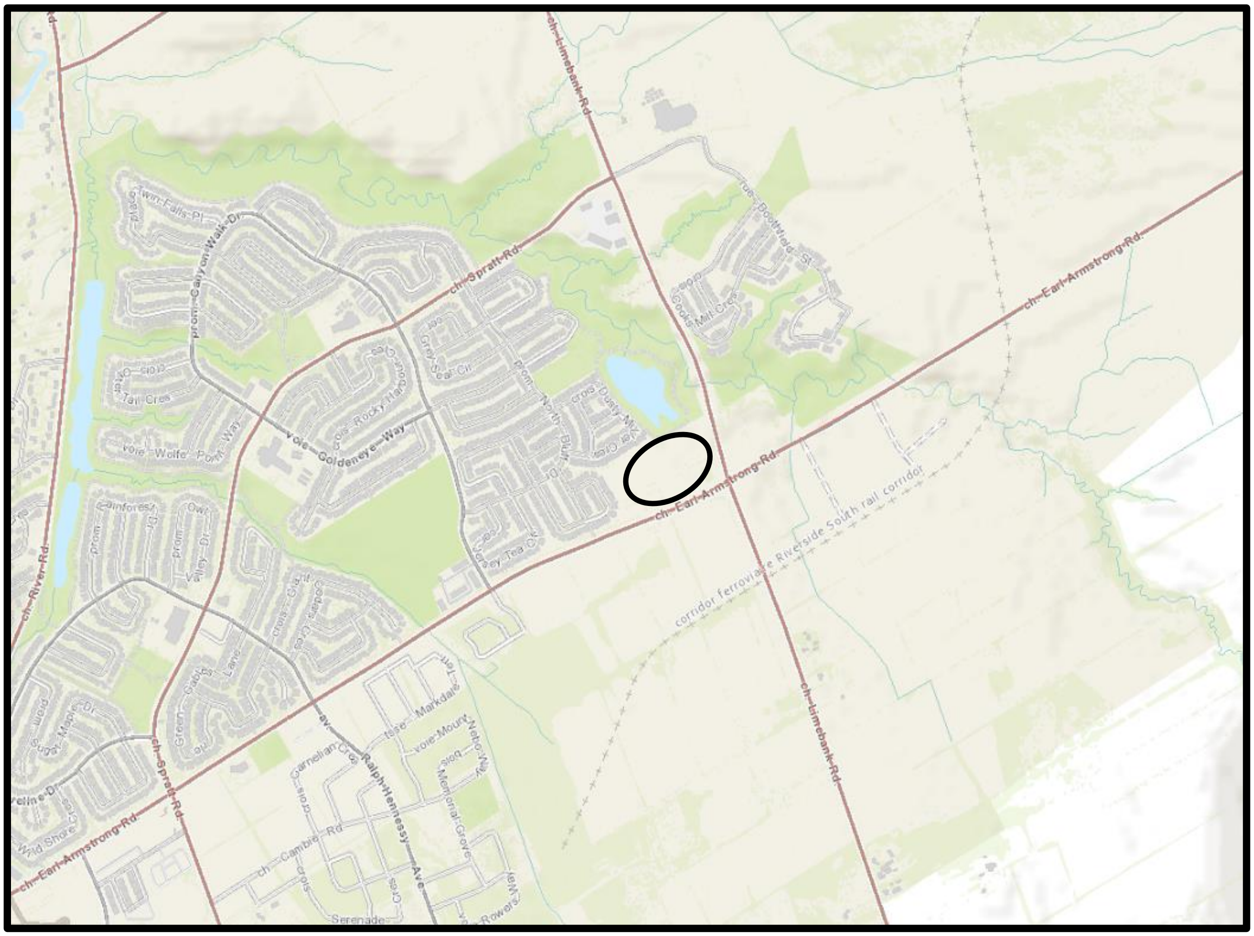


FIGURE 1

KEY PLAN

PATERSON
GROUP

FIGURE 2

Aerial Photograph - 2002

PATERSON GROUP

FIGURE 3

Aerial Photograph - 2007

PATERSON GROUP

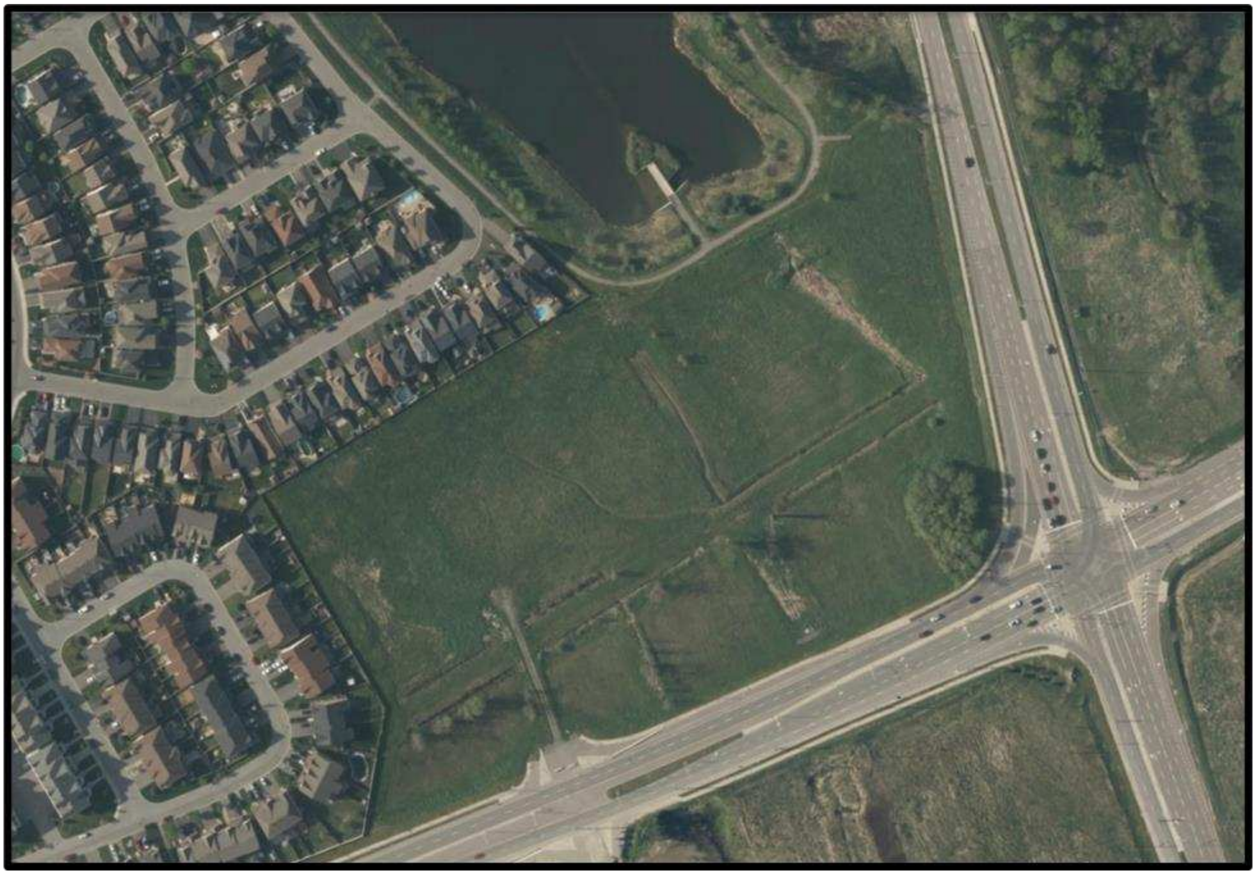


FIGURE 4

Aerial Photograph - 2017

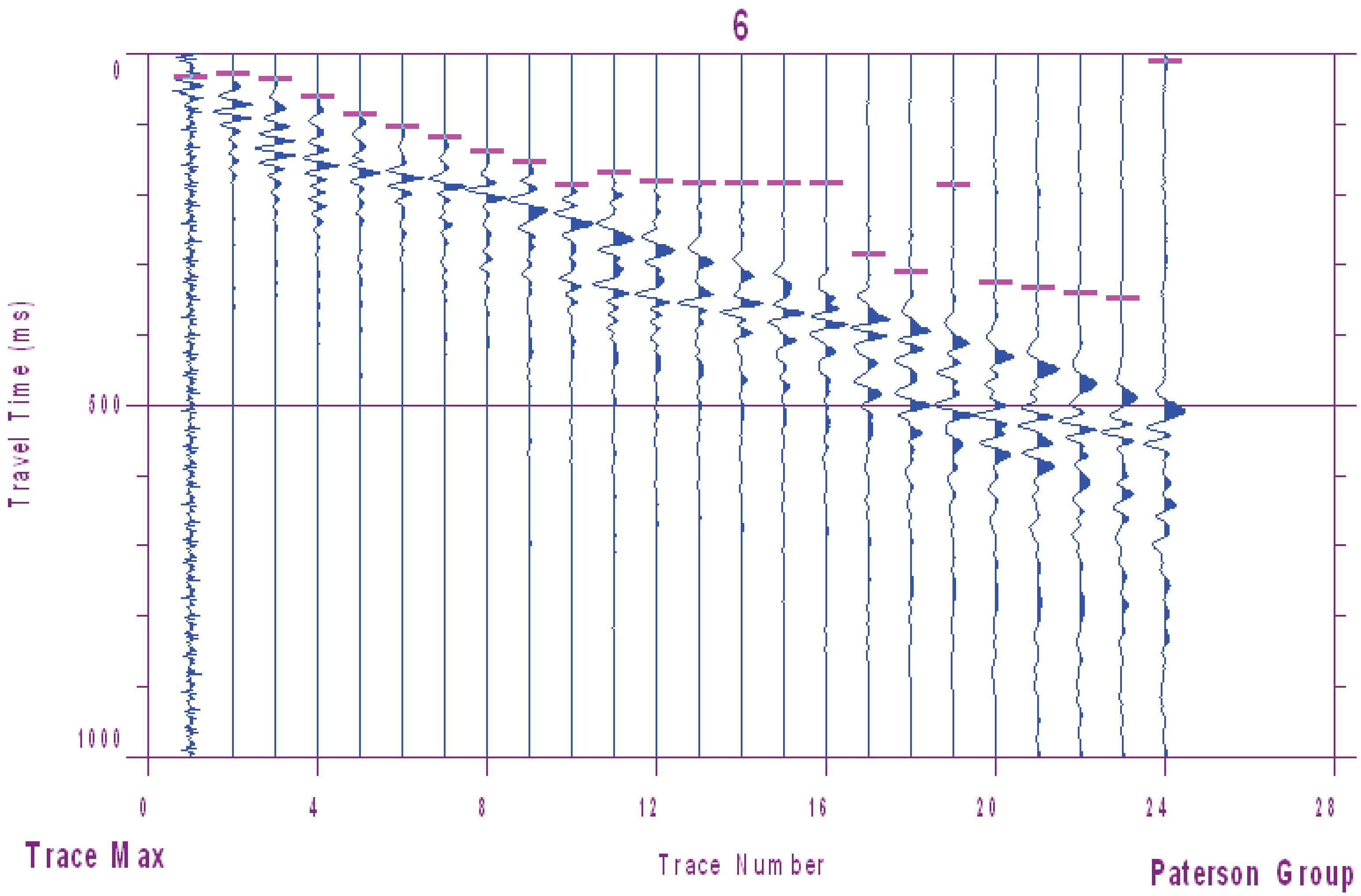


FIGURE 5 - Shear Wave Velocity Profile at Shot Location -3 m

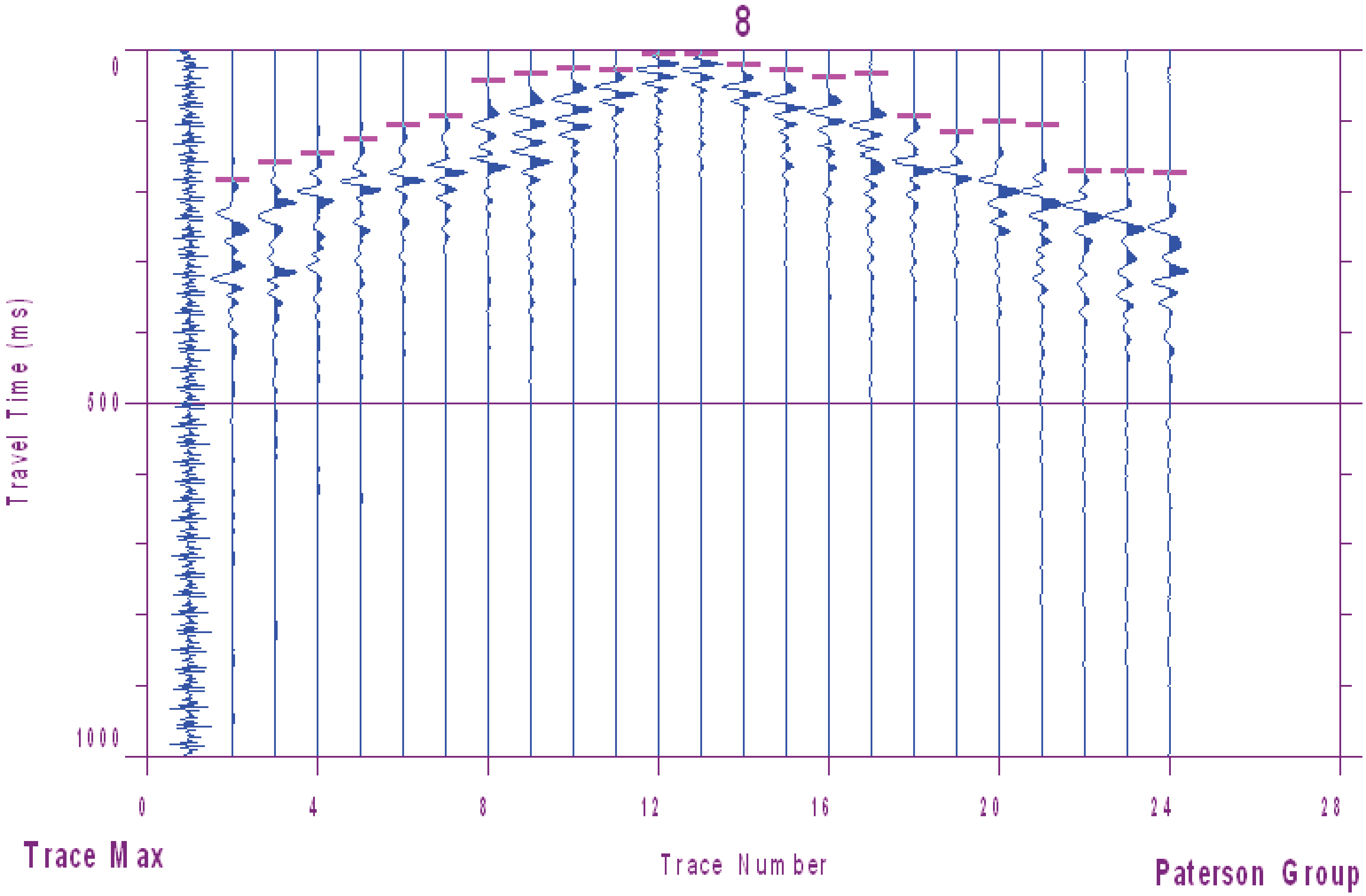
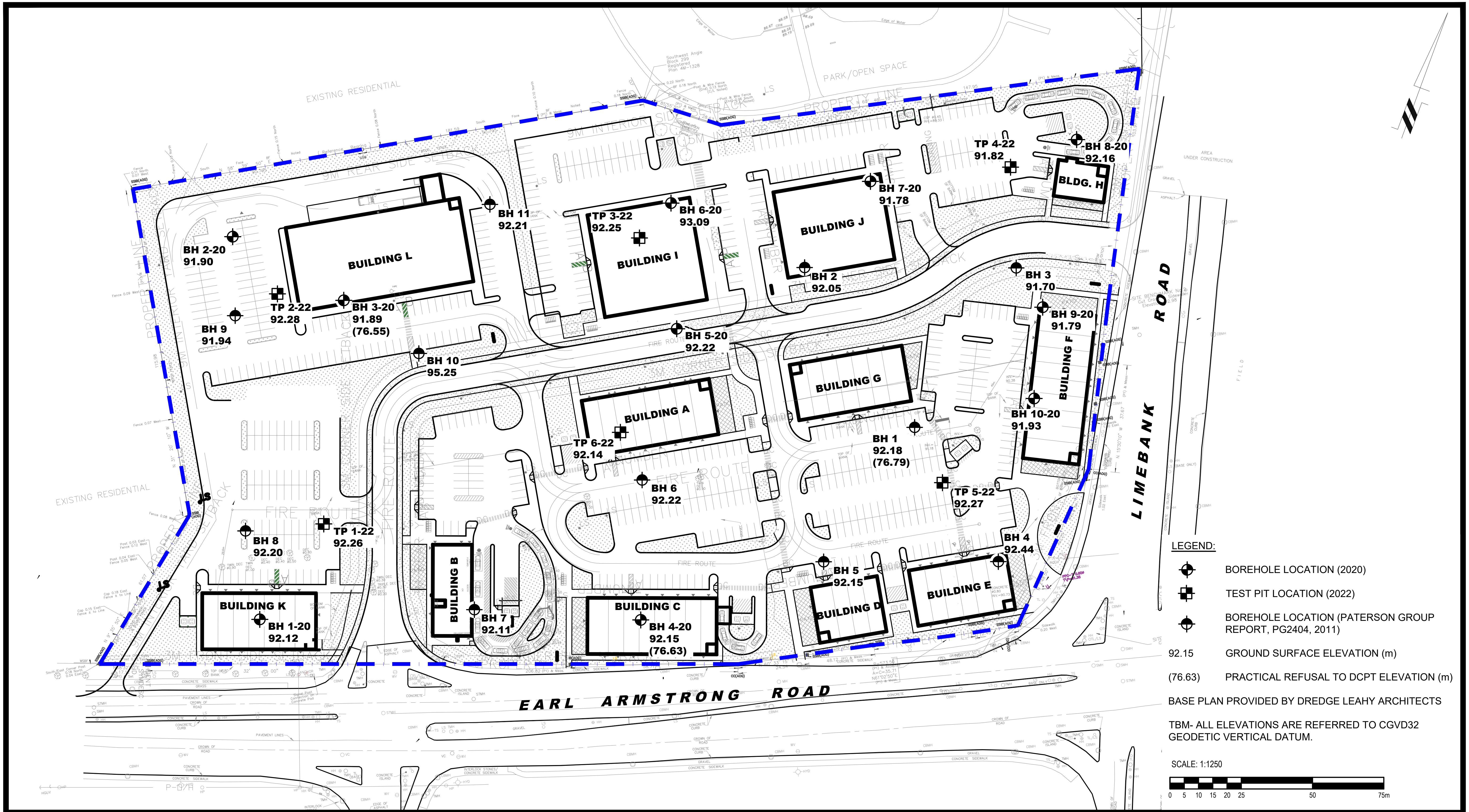


FIGURE 6 - Shear Wave Velocity Profile at Shot Location 34.5 m



LEGEND:

⌖	BOREHOLE LOCATION (2020)
▣	TEST PIT LOCATION (2022)
⌖	BOREHOLE LOCATION (PATERSON GROUP REPORT, PG2404, 2011)
92.15	GROUND SURFACE ELEVATION (m)
(76.63)	PRACTICAL REFUSAL TO DCPT ELEVATION (m)

BASE PLAN PROVIDED BY DREDGE LEAHY ARCHITECTS

TBM- ALL ELEVATIONS ARE REFERRED TO CGVD32 GEODETIC VERTICAL DATUM.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

PATERSON GROUP
SOLUTION ORIENTED ENGINEERING

NO.	REVISIONS	DATE	INITIAL
3	UPDATED CONCEPTUAL PLAN ADDED TO DRAWING	22/02/2023	NP
2	UPDATED CONCEPTUAL PLAN ADDED TO DRAWING	13/07/2022	NP
1	2022 TEST PITS ADDED TO PLAN	04/01/2022	NP

URBANDALE CORPORATION
GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL PLAZA-RIVERSIDE SOUTH RESIDENTIAL DEVELOPMENT
EARL ARMSTRONG ROAD
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:1250
Date: 04/2020
Drawn by: YA
Report No.: PG5304-1
Checked by: DP
Dwg. No.: PG5304-1
Approved by: DJG
Revision No.: 3

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