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Geotechnical Investigation

Proposed Long-Term Care Facility
Block 4 - 850 Champlain Street
Ottawa, Ontario

Prepared For

Revera Living

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Report PG4025-1 Revision 2

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Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Revera Living to undertake a geotechnical investigation for a proposed long-term care facility to be located at Block 4 at 850 Champlain Street in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

- ☐ Determine the subsurface soil and groundwater conditions by means of boreholes.

- ☐ Provide geotechnical recommendations for the design of the proposed building including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. This report contains the 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 subject property was not part of the scope of work for this geotechnical investigation.

2.0 Proposed Development

The proposed development is understood to consist of a 5storey long-term care facility with one basement level with associated access lanes and parking areas (Block 4). Landscaped areas are also understood to encompass the east portion of the subject site.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current investigation was carried out on December 19, 20 and 21, 2016. At that time, 12 boreholes were drilled to a maximum depth of 7.9 m below existing ground surface. The test hole locations were selected in a manner to provide general coverage for the proposed building footprint and gazebo structure. A previous geotechnical investigation was completed by this firm and a separate study was completed by others for the subject site. The locations of the boreholes are shown on Drawing PG4025-1 - Test Hole Location Plan included in Appendix 2.

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

Sampling and In Situ Testing

Soil samples were recovered with a 50 mm diameter split-spoon sampler or from the auger flights. The split-spoon and auger samples were classified on site, placed in sealed plastic bags, and transported to the laboratory for further review. The depths at which the split-spoon and auger samples were recovered from the boreholes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets and 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, using a vane apparatus, was carried out at regular intervals of depth in cohesive soils.

The overburden soil thickness was evaluated during the course of the investigation by dynamic cone penetration testing (DCPT) at BH 10-16. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its 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 depth increment.

Subsurface conditions observed in the test holes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test hole locations.

Groundwater

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

Sample Storage

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

3.2 Field Survey

The test hole locations were located in the field by Annis O’Sullivan Vollebekk. It is understood that the elevations are referenced to a geodetic datum. The locations of the test holes and the ground surface elevation at each test hole location are presented on Drawing PG4025-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in the laboratory to review the field log results.

3.4 Analytical Testing

One (1) 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 is analyzed to determine the concentrations of sulphate and chloride, the resistivity and the pH of the sample. The results are included in Appendix 1 and are further discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently an undeveloped, grass covered former agricultural land bordered to the north by Jeanne D'Arc Boulevard and to the east by Champlain Street. The west property limits are bordered by Bilberry Drive and Du Bois Avenue and to the south by the existing OC - Transpo Park n' Ride.

The ground surface at the subject site gradually slopes down towards the north portion of the site. It should be noted the southeast corner of the subject site was previously occupied by a one storey building with an attached garage structure.

4.2 Subsurface Profile

Generally, the subsurface profile encountered at the test hole locations consists of a topsoil layer or fill material underlain by a deep hard to brown stiff silty clay deposit. Firm to stiff grey silty clay was encountered below the above noted layers in all boreholes.

A dynamic cone penetration test was completed at BH10-16 to a maximum depth of 36.6 m. However, practical refusal was not encountered within the depth of the test. Specific details of the subsurface profile at each test hole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

Based on available geological mapping, the subject site is located in an area where the bedrock towards the north consists of interbedded dolomite and limestone from the Gull River formation, while the central and southern portion of the site consists of limestone from the Bobcaygeon formation. Based on available geological mapping, the overburden thickness is expected to range from 25 to 50 m.

4.3 Groundwater

The groundwater level (GWL) readings are presented in Table 1. It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled boreholes. Groundwater conditions can also be estimated based on the observed colour, moisture levels and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater level can be expected between 3 to 4 m below existing ground surface. Due to the low permeability of the silty clay deposit, spring melt water and heavy precipitation events do not significantly influence the long-term groundwater table due to a large portion of this water consisting of surface run-off. Also, it should be noted that the seasonally high groundwater level will be further reduced by the proposed development due to the introduction of hard surfaces along with a storm sewer system. For design purposes, the seasonally high groundwater level should be taken at a 2.5 to 3 m depth below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations and therefore levels could differ at the time of construction.

Table 1 - Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1-16	62.74	2.01	60.73	January 5, 2017
BH 2-16	62.37	0.23	62.14	January 5, 2017
BH 3-16	62.00	Blocked	n/a	January 5, 2017
BH 4-16	62.20	0.76	61.44	January 5, 2017
BH 5-16	62.34	1.13	61.21	January 5, 2017
BH 6-16	60.65	0.68	59.97	January 5, 2017
BH 7-16	60.09	Blocked	60.09	January 5, 2017
BH 8-16	60.81	1.03	59.78	January 5, 2017
BH 9-16	60.55	0.74	59.81	January 5, 2017
BH 10-16	60.31	2.49	57.82	January 5, 2017
BH 11-16	58.89	0.67	58.22	January 5, 2017
BH 12-16	59.98	0.07	59.91	January 5, 2017

Note: The test hole locations were located in the field and surveyed by Annis O'Sullivan Vollebekk. It is understood that the elevations are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

The subject site is considered satisfactory from a geotechnical perspective for the proposed long-term care facility at Block 4. It is anticipated that the proposed building will be founded on conventional spread footings or raft foundation placed on the undisturbed silty clay bearing surface. End bearing piles do not appear to be a practical foundation due to the depth of bedrock (ie.- greater than 30 m).

Due to the presence of silty clay layer, the proposed building will be subjected to a grade raise restriction. Our permissible grade raise recommendations are discussed in Subsection 5.3. 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 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 the building footprint, paved areas, pipe bedding and other settlement sensitive structures. Existing foundation walls and other construction debris should be entirely removed from within the building perimeter. Under paved areas, existing construction remnants, such as foundation walls, should be excavated to a minimum of 1 m below final grade.

Fill Placement

Fill placed for grading beneath the building area should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill material should be tested and approved prior to delivery to the site. The fill should be placed in maximum 300 mm thick lifts and compacted to 98% of the material’s standard Proctor maximum dry density (SPMDD).

Site-excavated soil can be placed as general landscaping fill where settlement is a minor concern of the ground surface. 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 placed to increase the subgrade level for areas to be paved, the fill should be compacted in maximum 300 mm thick lifts and to a minimum density of 95% of the respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls due to the frost heave potential of the site excavated soils below settlement sensitive areas, such as concrete sidewalks and exterior concrete entrance areas.

Fill used for grading beneath the base and subbase layers of paved areas should consist, unless otherwise specified, of clean imported granular fill, such as OPSS Granular A, Granular B Type II or select subgrade 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 paved areas should be compacted to at least 95% of its SPMDD.

5.3 Foundation Design

Conventional Shallow Footings

Strip footings, up to 3 m wide, and pad footings, up to 6 m wide, placed over an undisturbed, stiff silty clay bearing surface can be designed using 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 reported bearing resistance values 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 prior to the placement of concrete for footings. The bearing resistance value given for footings at SLS will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided to a stiff silty clay 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.

Raft Foundation

If the above bearing resistance values are insufficient for the proposed building, consideration may be given to placing the proposed building on a raft foundation.

Based on the following assumptions for the raft foundation, the proposed building can be designed using the above parameters and a total and differential settlement of 25 and 15 mm, respectively. It is expected that the base of the slab is located at or below 4 m depth, the long term groundwater level will be at or below 4 m depth, the raft slab is impervious and the basement walls will be provided with a perimeter foundation drainage system.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. A bearing resistance value at SLS (contact pressure) of **200 kPa** can be used. 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 **280 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 **10 MPa/m** for a contact pressure of **200 kPa**. The design of the raft foundation is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium.

Lateral Support

The bearing medium under footing-supported structured is required to provide adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to the soil subgrade 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.

Permissible Grade Raise

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 **2.0 m** above existing ground surface is recommended for the subject site.

To reduce potential long term liabilities, consideration should be given to providing means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the settlement sensitive structures, etc.). It should be noted that building over silty clay deposits increases the likelihood of building movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking as compared to unreinforced foundations.

5.4 Design for Earthquakes

Shear wave velocity testing was completed for the subject site to accurately determine the applicable seismic site classification for the proposed buildings from Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity testing was completed by Paterson personnel. The results of the shear wave profile at two (2) shot locations are presented in Appendix 2.

Field Program

The shear wave testing was located within the central portion of the site , as presented in Drawing PG4025-1 - Test Hole Location Plan presented in Appendix 2. Paterson field personnel placed 24 horizontal geophones in a straight line in roughly an east-west 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 also connected to a computer 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 used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four (4) to eight (8) times at each shot location to improve signal to noise ratio. The shot locations are also 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 centre of the geophone array and 3, 4.5 and 30 m away from the first and last geophone.

The methods of testing completed by Paterson are guided by the standard testing procedures used by the expert seismologists at Carleton University and Geological Survey of Canada (GSC).

Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using 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, Vs_{30}, of the upper 30 m profile, immediately below the building's 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 using 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. It should be noted that as bedrock quality increases, the bedrock shear wave velocity also increases.

The overburden and bedrock velocities were noted to be 182 and 2,445 m/s, respectively, based on our findings. The bedrock was noted to be greater than 30 m depth in the area of the seismic array testing location.

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

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

$$V_{s30} = \frac{30m}{\left(\frac{30m}{182m/s}\right)}$$

$$V_{s30} = 182m/s$$

Based on the results of the seismic testing, the average shear wave velocity, Vs_{30}, is 182 m/s for the subject site. Therefore, a **Site Class D** is applicable for foundation design within the current phase of the proposed development, as per Table 4.1.8.4.A of the OBC 2012.

5.5 Basement Slab/Slab on Grade Construction

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

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

All backfill materials within the footprint of the proposed building should be placed in maximum 300 mm loose lifts and compacted to, at least, 98% of the material's SPMDD.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a dry unit weight of 20 kN/m^3. The applicable effective unit weight of the retained soil can be estimated as 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when calculating the effective unit weight.

Lateral Earth Pressures

The static horizontal earth pressure (P_o) can be calculated by a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil, 0.5
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire wall height should be incorporated to the diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be calculated with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to stay at least 0.3 m away from the walls with the compaction equipment.

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) could be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45 - a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. The vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions could be calculated using $P_o = 0.5\ K_o \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions presented above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.7 Pavement Structure

Minimum 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 2 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 3 - Recommended Pavement Structure - Access Lanes and Fire Route and Heavy Duty Asphalt Areas

Thickness mm	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil, select subgrade material 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 keeping the contact zone between the subgrade material and the base stone in a dy condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fin subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the impervious nature of the subgrade materials, consideration should be given to installing subdrains during the pavement construction. These drains should be installed at each catch basin, be at least 3 m long and should extend in four orthogonal directions or longitudinally when placed along a curb. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be shaped to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended to be provided for the proposed buildings. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 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. A drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system with a positive outlet to the site storm sewer is also recommended. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

Under floor Drainage

It is anticipated that underfloor drainage will be required to control water accumulation during spring melt and after heavy rain events due to the low permeability of the underlying silty clay subgrade. For preliminary design purposes, we recommend that 150 mm diameter perforated pipes be placed at 6 m centres. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration/accumulation can be better assessed.

Concrete Sidewalks Adjacent to Building(s)

To avoid differential settlements within the proposed sidewalks adjacent to the proposed buildings, it is recommended that the upper 600 mm of backfill placed below the concrete sidewalks to consist of free draining, non-frost susceptible material such as, Granular A or Granular B Type II, instead of site excavated material which in most cases considered frost susceptible. The granular material should be placed in maximum 300 mm loose lifts and compacted to 95% of the material's SPMDD using suitable compaction equipment. The subgrade material should be shaped to promote positive drainage towards the building's perimeter drainage pipe.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with adequate foundation insulation, should be provided.

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.

6.3 Excavation Side Slopes

Temporary Side Slopes

The temporary excavation side slopes anticipated should either be excavated to acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

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 subsurface soil 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 maintain safe working distance from the excavation sides.

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

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

6.4 Pipe Bedding and Backfill

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

A minimum of 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. The thickness of the pipe bedding should be increased to 300 mm where the subgrade consists of firm, grey silty clay. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 300 mm above the obvert of the pipe should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts and compacted to 95% of the material's SPMDD.

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

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 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 stratigic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

Groundwater Control for Building Construction

It is anticipated that groundwater infiltration into the excavations should be low through the sides of the excavation 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, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

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

Long-term Groundwater Control

Any groundwater encountered along the building's perimeter or sub-slab drainage system will be directed to the proposed building's sump pit. It is expected that groundwater flow will be low (i.e.- less than 30,000 L/day) with peak periods noted after rain events. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

6.6 Winter Construction

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

The subsurface conditions 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 installation of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until 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 and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions.

6.7 Landscaping Considerations

Tree Planting Restrictions

The proposed development is located in an area of medium sensitive silty clay deposits for tree planting. It is expected that the thickness of the underlying weathered clay crust will provide approximately 1 to 2 m thick buffer to the underlying firm silty clay deposit.

It is recommended that trees placed within 4 m of the foundation wall consist of low water demanding trees with shallow roots systems that extend less than 1.5 m below ground surface. Trees placed greater than 4 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum depth of 2 m below ground surface.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, they should not be considered in the landscaping design.

6.8 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a non aggressive to slightly aggressive corrosive environment.

7.0 Recommendations

For the foundation design data provided herein to be applicable that a materials testing and observation services program is required to be completed. The following aspects be performed by the geotechnical consultant:

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

❏ Sampling and testing of the concrete and fill materials.

❏ Observation of the placement of the foundation insulation, if applicable.

❏ 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.

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

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

A report confirming the construction has been conducted in general accordance with the recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

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 immediate notification to permit reassessment of our recommendations.

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

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

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Mar 30, 2020
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Joey R. Villeneuve, M.A.Sc,, P.Eng.

David J. Gilbert, P.Eng.

Report Distribution

- ☐ Revera Living
- ☐ Paterson Group

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

BOREHOLE LOGS BY OTHERS

ANALYTICAL TESTING RESULTS

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. PG4025

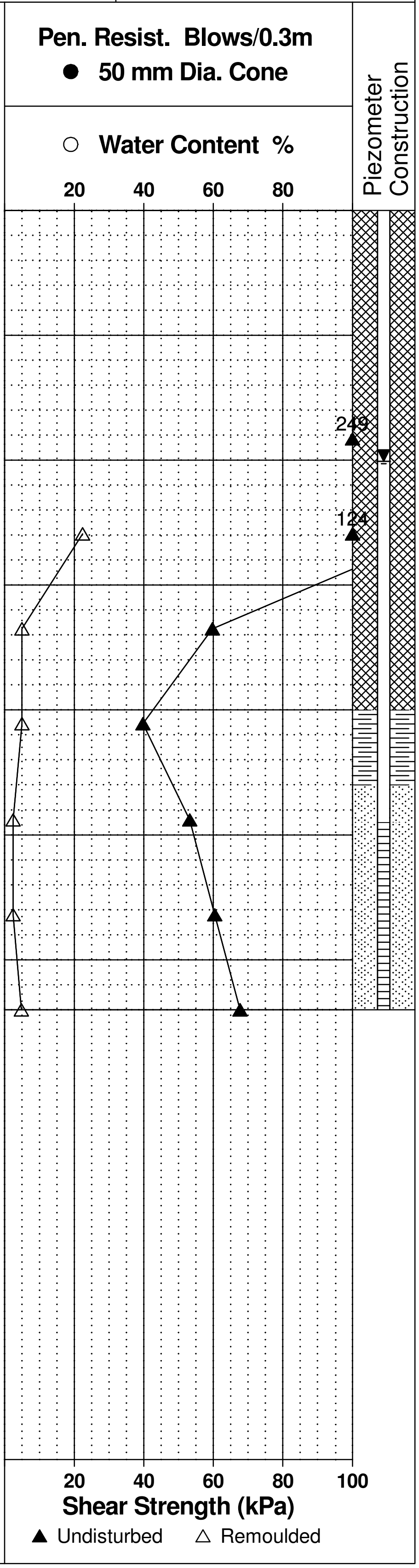
REMARKS

HOLE NO. BH 1-16

BORINGS BY CME 55 Power Auger

DATE December 19, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.74
FILL: Brown sand, trace gravel and cobbles		AU	1				
1.07		SS	2	83	8	1	61.74
Hard to stiff, brown **SILTY CLAY**						2	60.74
						3	59.74
3.80							
Firm to stiff, grey **SILTY CLAY**						4	58.74
						5	57.74
						6	56.74
6.40							
End of Borehole (GWL @ 2.01m-Jan. 5, 2017)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. PG4025

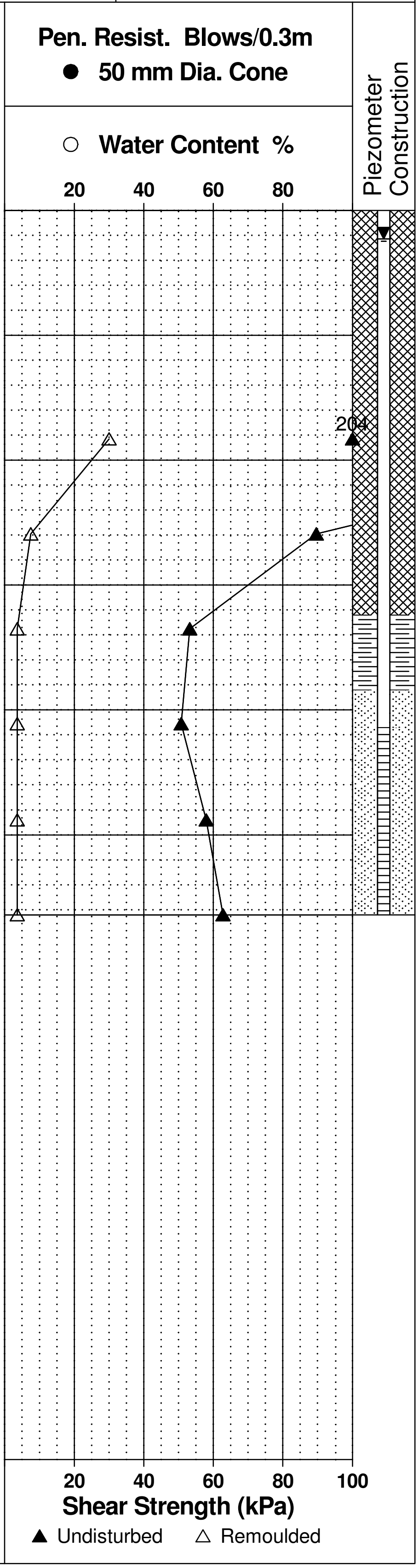
REMARKS

HOLE NO. BH 2-16

BORINGS BY CME 55 Power Auger

DATE December 19, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.37
FILL: Brown silty sand with clay, trace to some gravel and organics 0.53		AU	1				
		SS	2	83	7	1	61.37
Hard to stiff, brown **SILTY CLAY**						2	60.37
						3	59.37
3.80							
						4	58.37
Stiff, grey **SILTY CLAY**						5	57.37
5.64							
End of Borehole (GWL @ 0.23m-Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

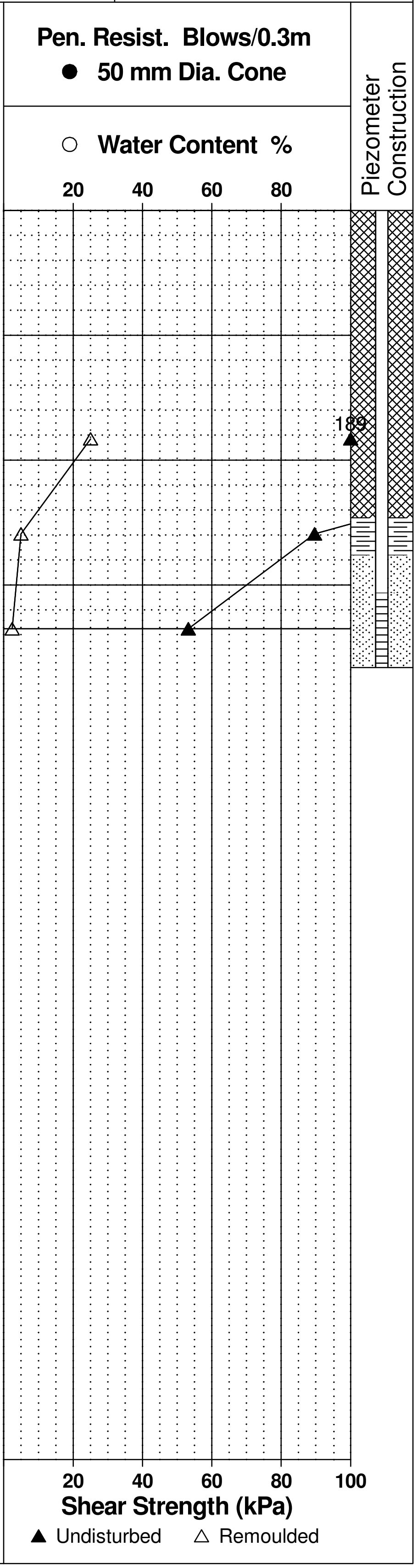
DATE December 19, 2016

FILE NO. PG4025

HOLE NO. BH 3-16

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	62.00
TOPSOIL 0.25	AU	1				
	SS	2	100	8	1	61.00
Very stiff to stiff, brown **SILTY CLAY**					2	60.00
3.05					3	59.00
Stiff, grey **SILTY CLAY** 3.35						
End of Borehole						

(Piezometer blocked at 0.19m depth - Jan. 5, 2017)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. **PG4025**

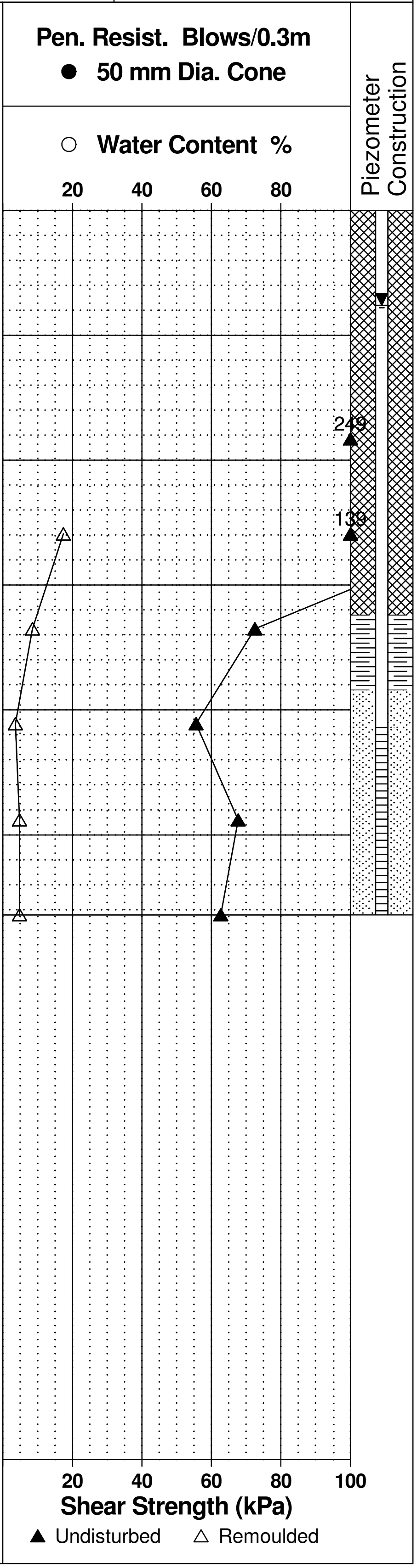
REMARKS

HOLE NO. **BH 4-16**

BORINGS BY CME 55 Power Auger

DATE December 19, 2016

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	62.20
FILL: Brown silty clay, some sand, gravel and organics 0.59	AU	1				
Hard to stiff, brown **SILTY CLAY**	SS	2	100	7	1	61.20
					2	60.20
					3	59.20
4.60					4	58.20
Stiff, grey **SILTY CLAY** 5.64					5	57.20
End of Borehole (GWL @ 0.76m-Jan. 5, 2017)						



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

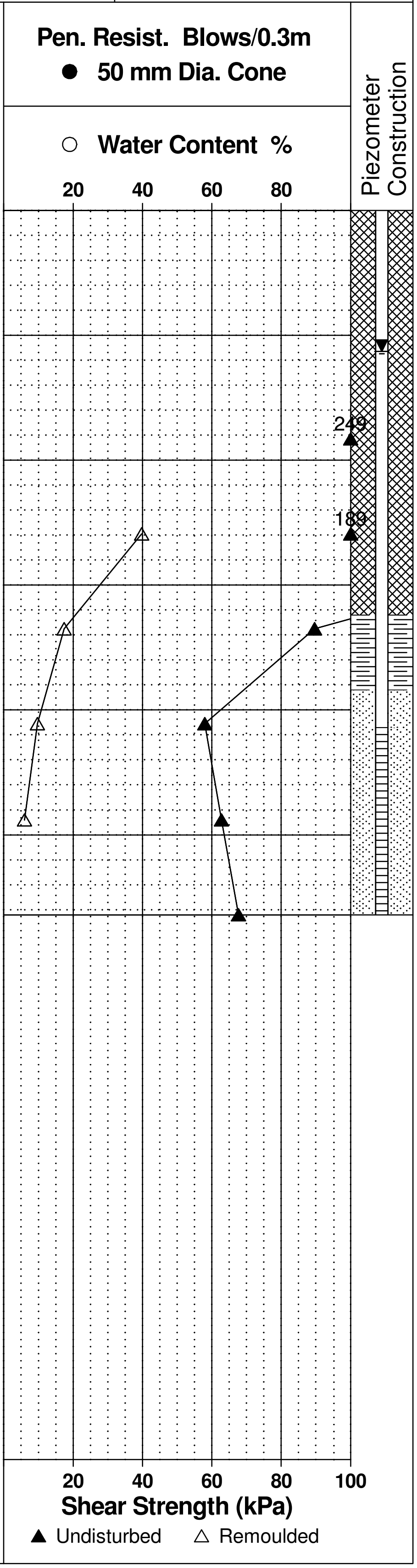
BORINGS BY CME 55 Power Auger

DATE December 19, 2016

FILE NO. PG4025

HOLE NO. BH 5-16

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	62.34
FILL: Brown silty clay with crushed stone and sand 0.59	AU	1				
Hard to stiff, brown **SILTY CLAY,** trace sand 3.80	SS	2	96	8	1	61.34
					2	60.34
					3	59.34
Stiff, grey **SILTY CLAY** 5.64					4	58.34
					5	57.34
End of Borehole (GWL @ 1.13m-Jan. 5, 2017)						



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. **PG4025**

REMARKS

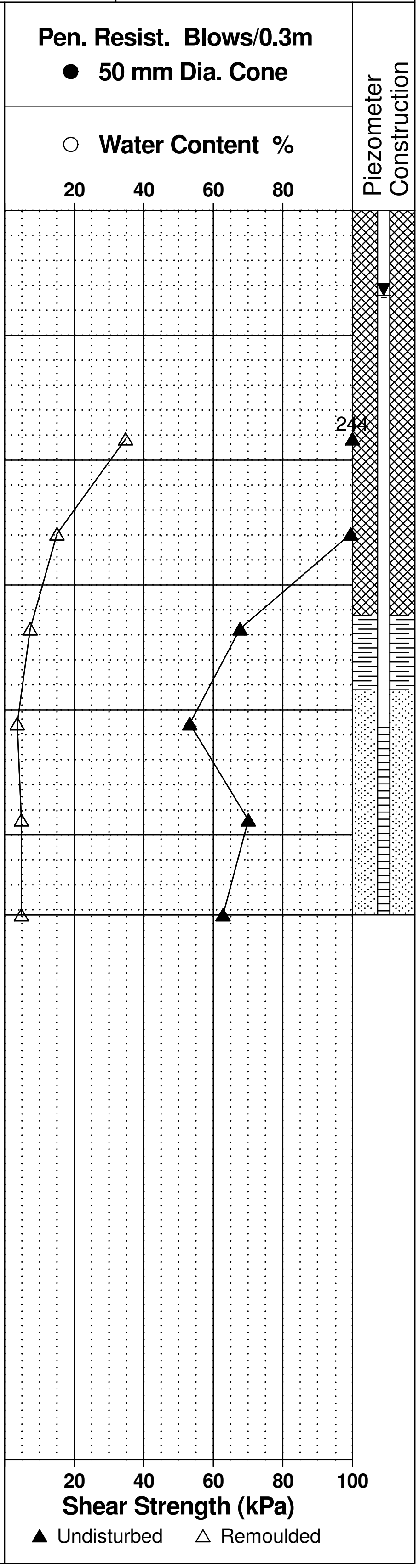
HOLE NO. **BH 6-16**

BORINGS BY CME 55 Power Auger

DATE December 19, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.38		AU	1		
Hard to stiff, brown **SILTY CLAY** 3.80		SS	2	100	7
Stiff, grey **SILTY CLAY** 5.64					
End of Borehole (GWL @ 0.68m-Jan. 5, 2017)					

DEPTH (m)	ELEV. (m)
0	60.65
1	59.65
2	58.65
3	57.65
4	56.65
5	55.65



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. PG4025

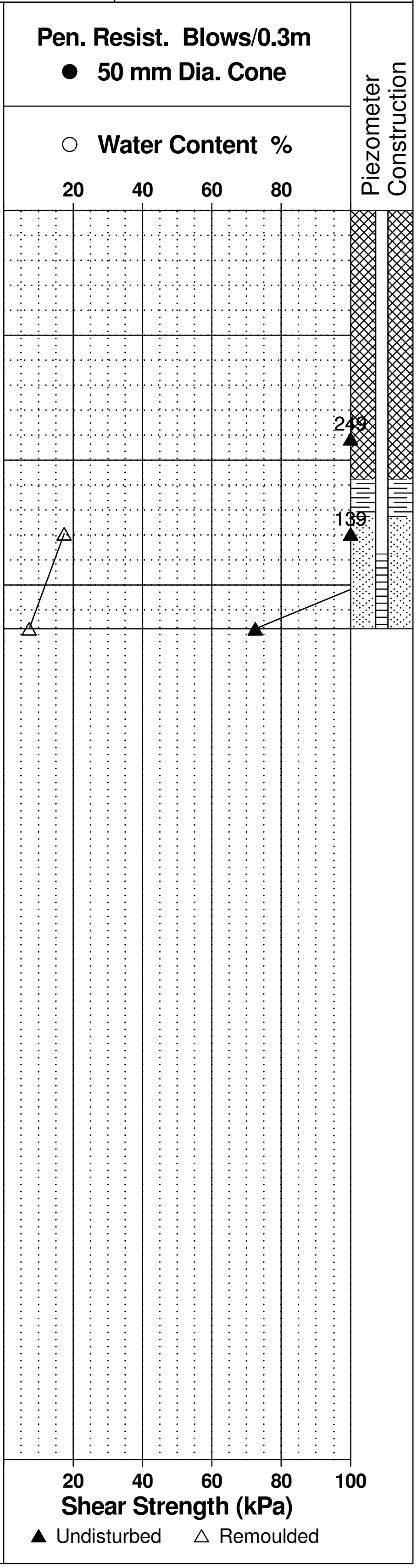
REMARKS

HOLE NO. BH 7-16

BORINGS BY CME 55 Power Auger

DATE December 19, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	60.09
TOPSOIL 0.41		AU	1				
Hard to stiff, brown **SILTY CLAY**		SS	2	100	8	1	59.09
						2	58.09
3.35						3	57.09
End of Borehole (Piezometer blocked at 0.89m - Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. **PG4025**

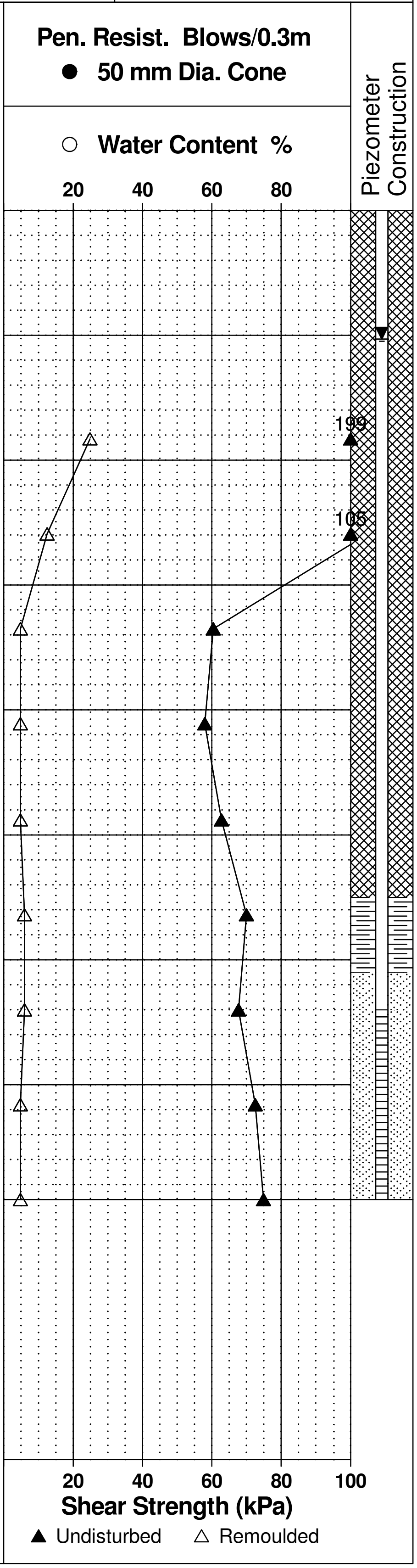
REMARKS

HOLE NO. **BH 8-16**

BORINGS BY CME 55 Power Auger

DATE December 20, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.33		AU	1			0	60.81
Very stiff to stiff, brown **SILTY CLAY**		SS	2	100	8	1	59.81
		SS	3	100	P	2	58.81
3.80						3	57.81
Stiff, grey **SILTY CLAY**						4	56.81
						5	55.81
						6	54.81
						7	53.81
7.92 End of Borehole							
(GWL @ 1.03m-Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

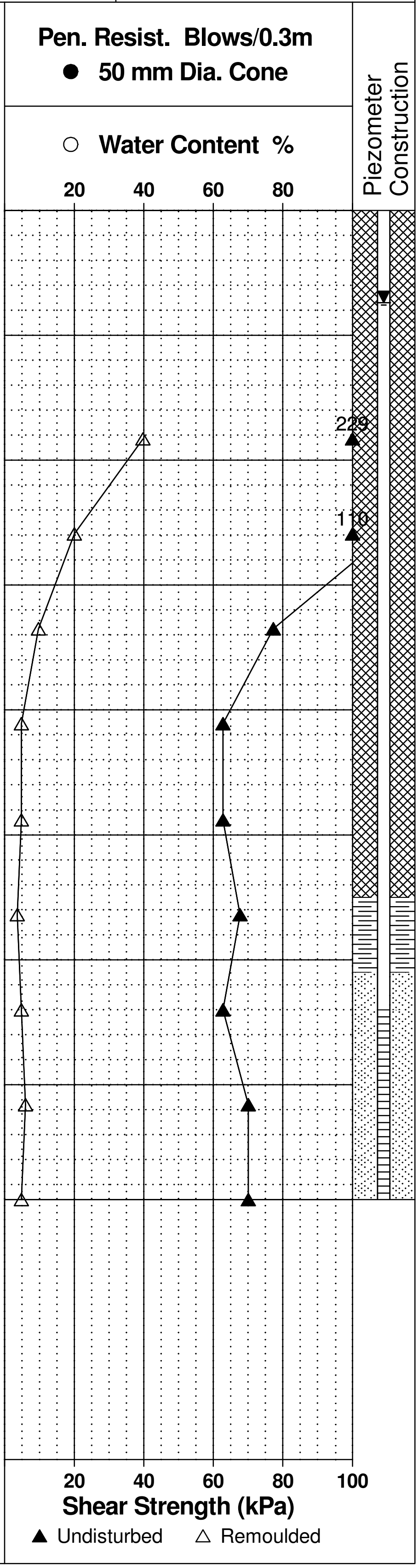
BORINGS BY CME 55 Power Auger

DATE December 20, 2016

FILE NO. PG4025

HOLE NO. BH 9-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	60.55
TOPSOIL 0.36		AU	1				
		SS	2	100	8	1	59.55
Hard to stiff, brown **SILTY CLAY**						2	58.55
3.80						3	57.55
Stiff, grey **SILY CLAY**						4	56.55
						5	55.55
						6	54.55
7.92						7	53.55
End of Borehole (GWL @ 0.74m-Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 20, 2016

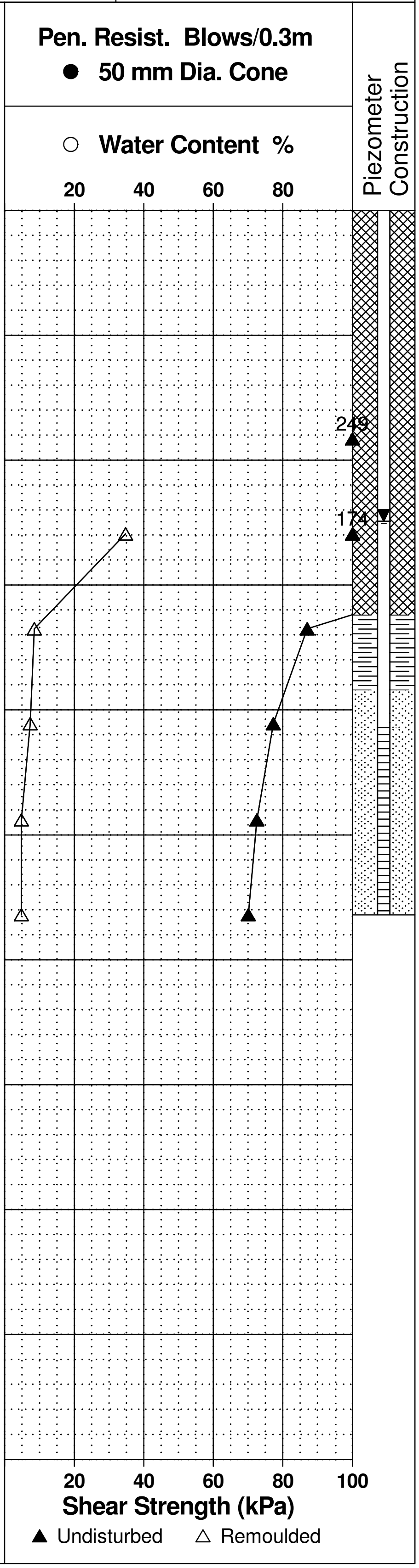
FILE NO. PG4025

HOLE NO. BH10-16

SOIL DESCRIPTION	Depth
GROUND SURFACE	
TOPSOIL	0.30
Hard to stiff, brown **SILTY CLAY,** trace rootlets	4.60
Stiff, grey **SILTY CLAY**	5.64
Dynamic Cone Penetration Test commenced at 5.64m depth. Cone pushed to 21m depth	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2		8
SS	3		P

DEPTH (m)	ELEV. (m)
0	60.31
1	59.31
2	58.31
3	57.31
4	56.31
5	55.31
6	54.31
7	53.31
8	52.31
9	51.31
10	50.31



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

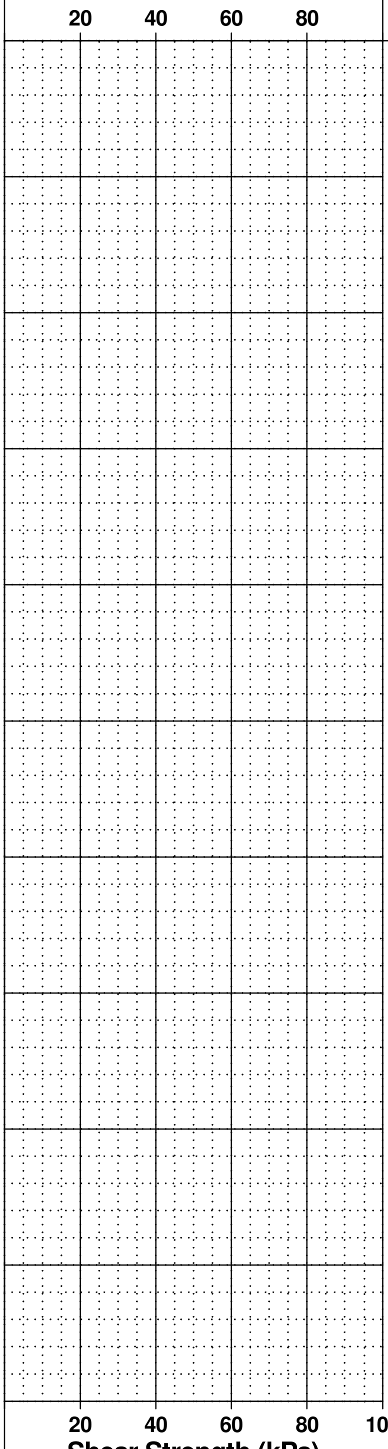
BORINGS BY CME 55 Power Auger

DATE December 20, 2016

FILE NO. PG4025

HOLE NO. BH10-16

SOIL DESCRIPTION GROUND SURFACE	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
						10	50.31		
						11	49.31		
						12	48.31		
						13	47.31		
						14	46.31		
						15	45.31		
						16	44.31		
						17	43.31		
						18	42.31		
						19	41.31		
						20	40.31		



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. PG4025

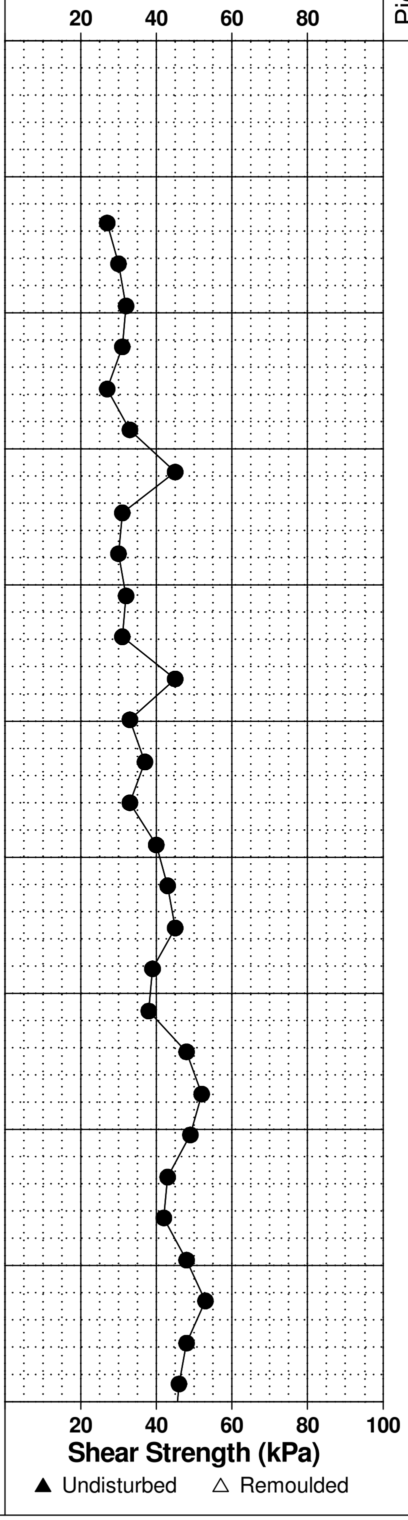
REMARKS

HOLE NO. BH10-16

BORINGS BY CME 55 Power Auger

DATE December 20, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						20	40.31		
						21	39.31		
						22	38.31		
						23	37.31		
						24	36.31		
						25	35.31		
						26	34.31		
						27	33.31		
						28	32.31		
						29	31.31		
						30	30.31		



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

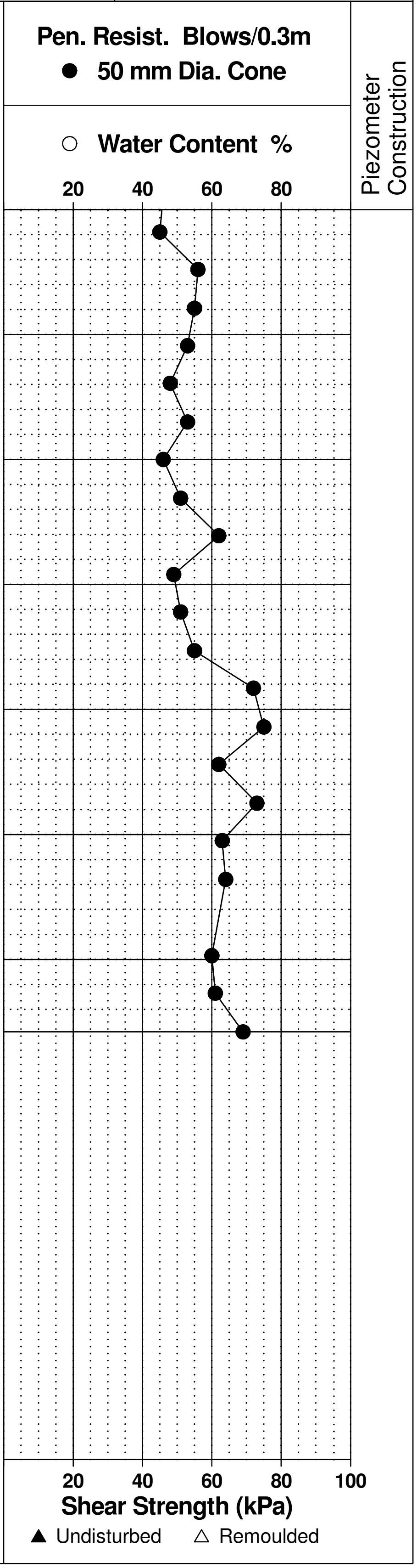
BORINGS BY CME 55 Power Auger

DATE December 20, 2016

FILE NO. PG4025

HOLE NO. BH10-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
						30	30.31
						31	29.31
						32	28.31
						33	27.31
						34	26.31
						35	25.31
						36	24.31
36.58							
End of Borehole (GWL @ 2.49m-Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

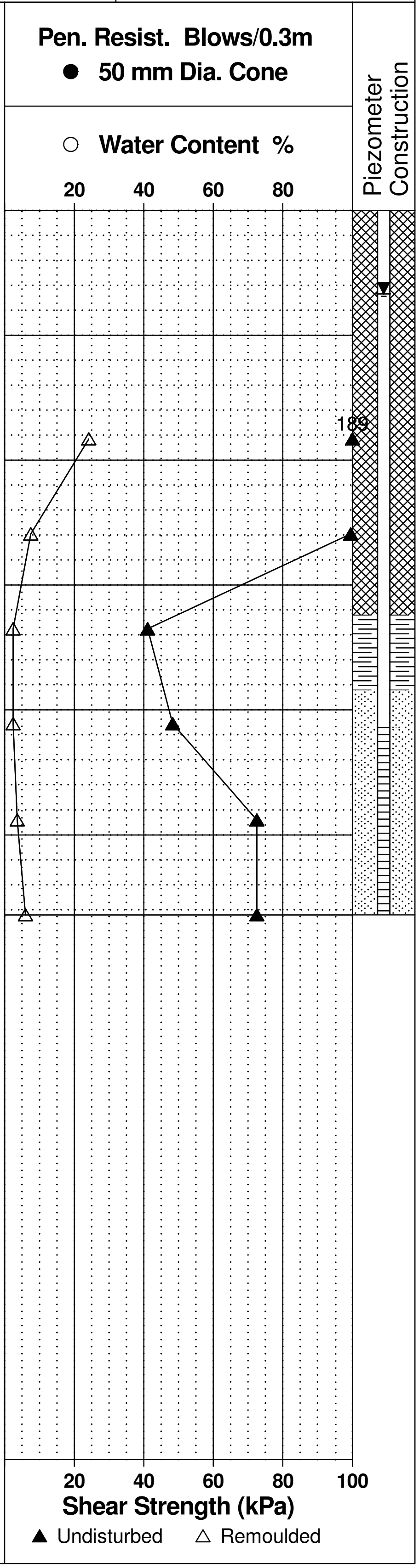
BORINGS BY CME 55 Power Auger

DATE December 21, 2016

FILE NO. PG4025

HOLE NO. BH11-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	58.89
TOPSOIL 0.38		AU	1				
Very stiff to stiff, brown **SILTY CLAY**		SS	2	96	4	1	57.89
						2	56.89
3.05						3	55.89
Firm to stiff, grey **SILTY CLAY**						4	54.89
						5	53.89
5.64							
End of Borehole (GWL @ 0.67m-Jan. 5, 2017)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Long Term Facility - 850 Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

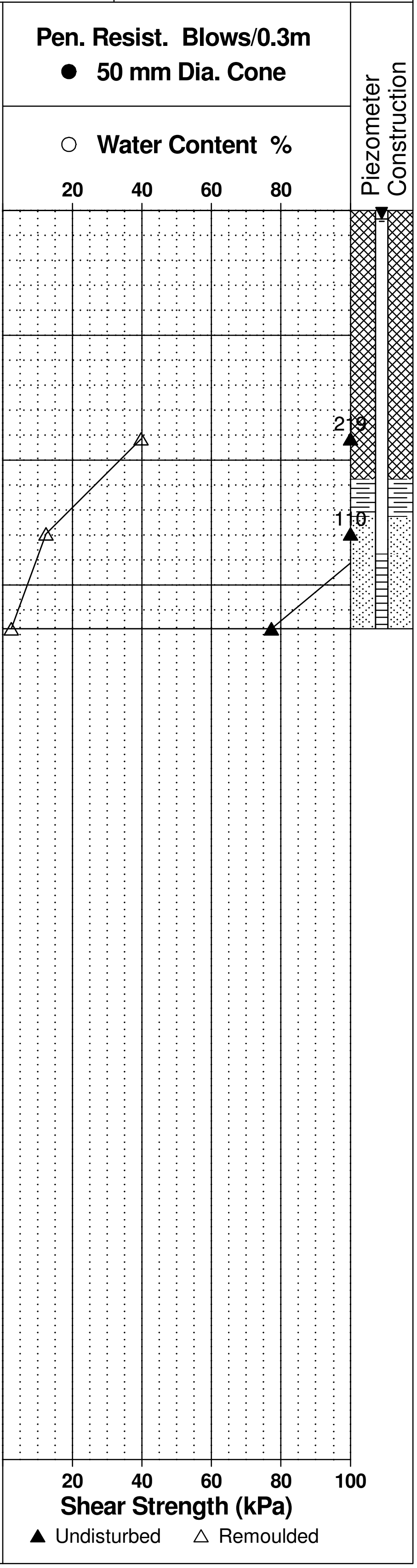
BORINGS BY CME 55 Power Auger

DATE December 21, 2016

FILE NO. PG4025

HOLE NO. BH12-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	59.98
TOPSOIL	0.30	AU	1				
Hard to very stiff, brown **SILTY CLAY**		SS	2	100	5	1	58.98
						2	57.98
	3.05					3	56.98
Stiff, grey **SILTY CLAY**	3.35						
End of Borehole (GWL @ 0.07m-Jan. 5, 2017)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 22 November 2010

FILE NO. PG2274

HOLE NO. BH 1

SOIL DESCRIPTION

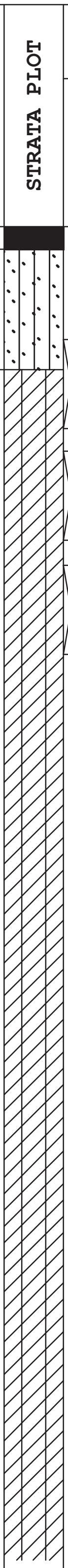
GROUND SURFACE

TOPSOIL 0.15

Compact, brown **SILTY SAND** 0.97

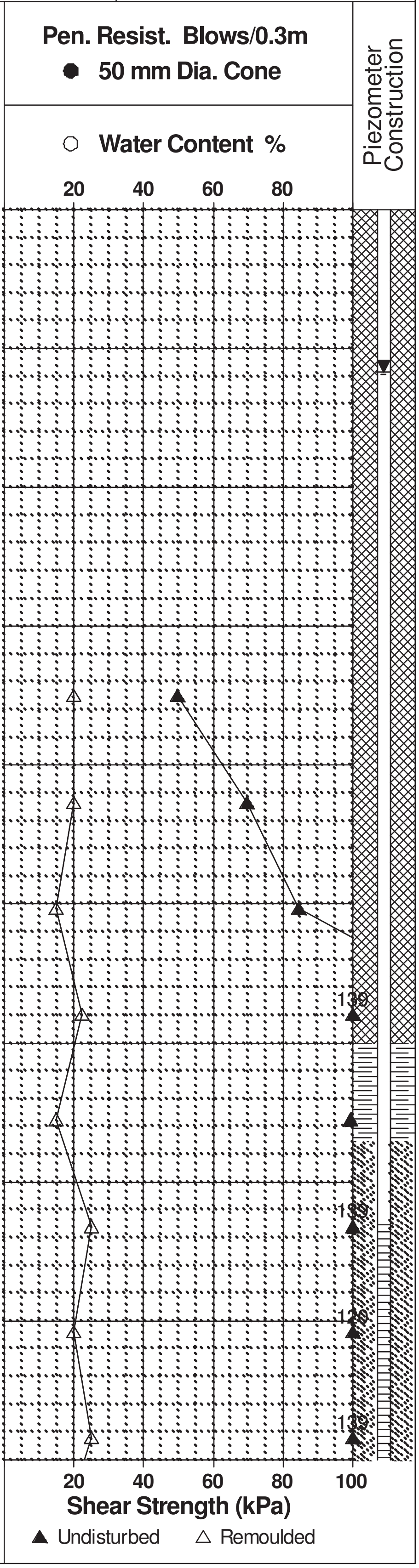
Stiff, brown **SILTY CLAY**

- very stiff and grey by 4.4m depth



SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	83	16
SS	2	92	6
SS	3	92	4

DEPTH (m)	ELEV. (m)
0	58.62
1	57.62
2	56.62
3	55.62
4	54.62
5	53.62
6	52.62
7	51.62
8	50.62
9	49.62



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

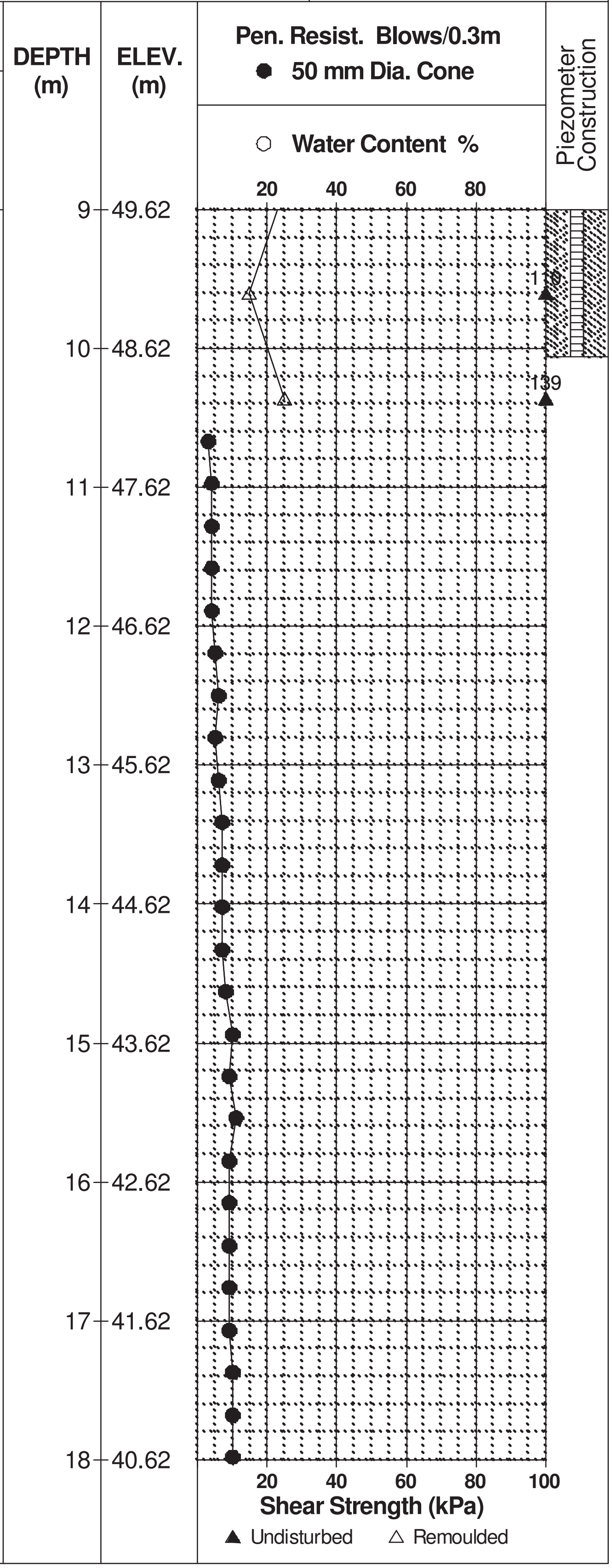
BORINGS BY CME 55 Power Auger

DATE 22 November 2010

FILE NO. PG2274

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
Very stiff, grey **SILTY CLAY**	▨				
10.36					
Dynamic Cone Penetration Test commenced @ 10.36m depth					



patersongroup Consulting Engineers

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

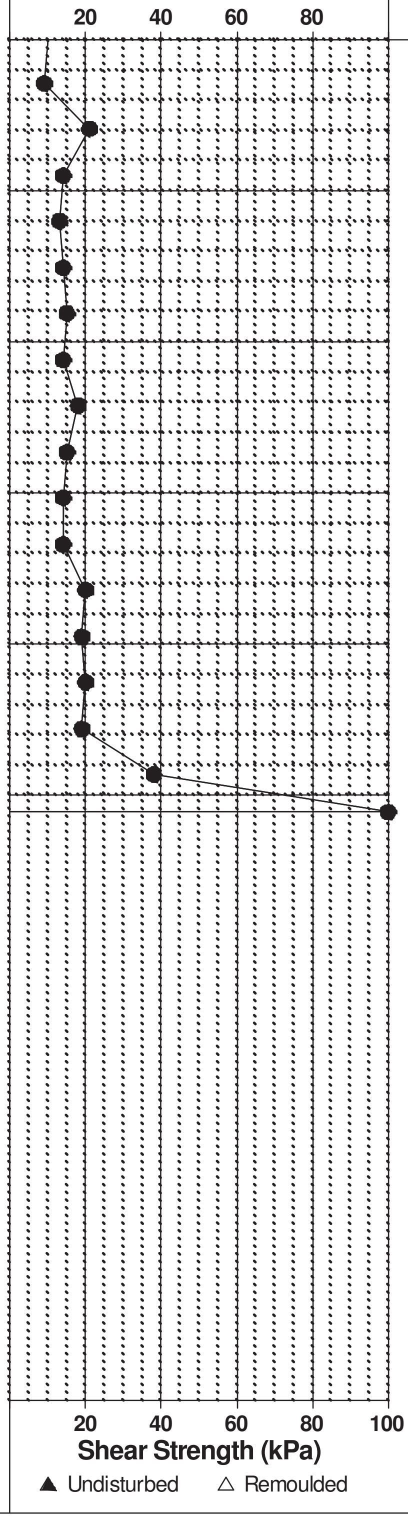
BORINGS BY CME 55 Power Auger

DATE 22 November 2010

FILE NO. PG2274

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						18	40.62		
						19	39.62		
						20	38.62		
						21	37.62		
						22	36.62		
23.11						23	35.62		
End of Borehole Practical refusal to DCPT @ 23.11m depth (GWL @ 1.17m-Nov. 30/10)									



patersongroup **Consulting Engineers**

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

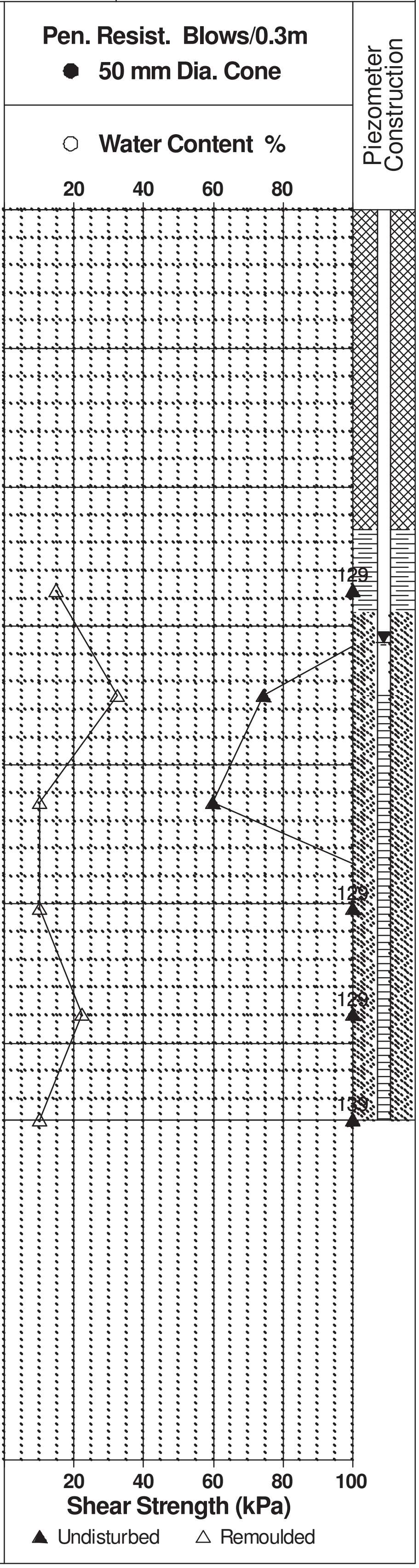
BORINGS BY CME 55 Power Auger

DATE 22 November 2010

FILE NO. PG2274

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	58.11
TOPSOIL 0.18							
		SS	1	92	4		
		SS	2	92	7	1	57.11
		SS	3	100	8	2	56.11
Stiff to very stiff, brown **SILTY CLAY**						3	55.11
						4	54.11
						5	53.11
- grey-brown by 5.2m depth							
						6	52.11
6.55							
End of Borehole							
(GWL @ 3.12m-Nov. 30/10)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

HOLE NO. BH 3

SOIL DESCRIPTION

GROUND SURFACE

Firm to stiff, brown **SILTY CLAY**

- grey by 4.4m depth

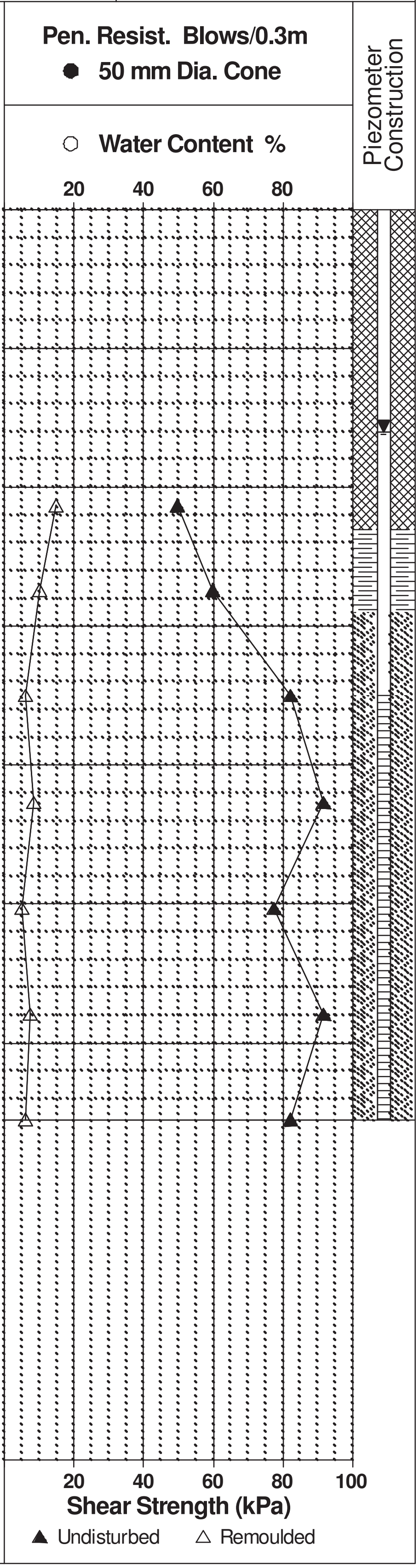
6.55

End of Borehole

(GWL @ 1.60m-Nov. 30/10)

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

DEPTH (m)	ELEV. (m)
0	57.03
1	56.03
2	55.03
3	54.03
4	53.03
5	52.03
6	51.03



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

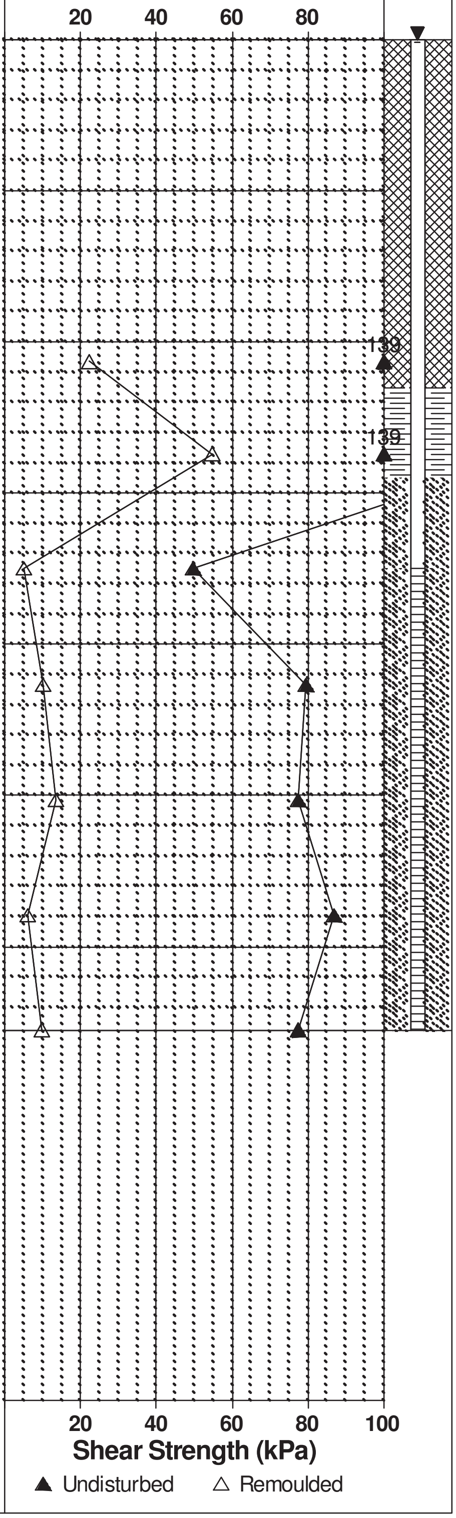
HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	57.53
TOPSOIL 0.13		SS	1		5		
		SS	2		10	1	56.53
						2	55.53
Very stiff to stiff, brown **SILTY CLAY**						3	54.53
						4	53.53
- grey by 4.4m depth						5	52.53
						6	51.53
6.55 End of Borehole							
(GWL @ ground surface - Nov. 30/10)							

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

○ **Water Content %**

Piezometer Construction



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

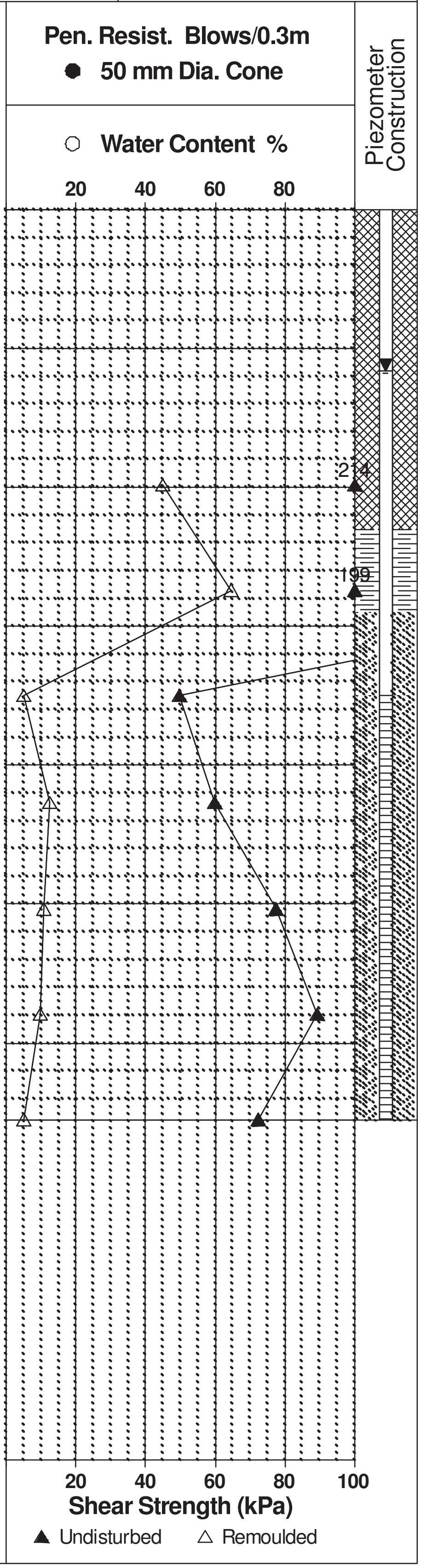
BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

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	59.34
TOPSOIL 0.18							
		SS	1		10		
		SS	2		14	1	58.34
						2	57.34
Hard to stiff, brown **SILTY CLAY**						3	56.34
						4	55.34
						5	54.34
- grey by 5.2m depth							
						6	53.34
6.55							
End of Borehole							
(GWL @ 1.16m-Nov. 30/10)							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

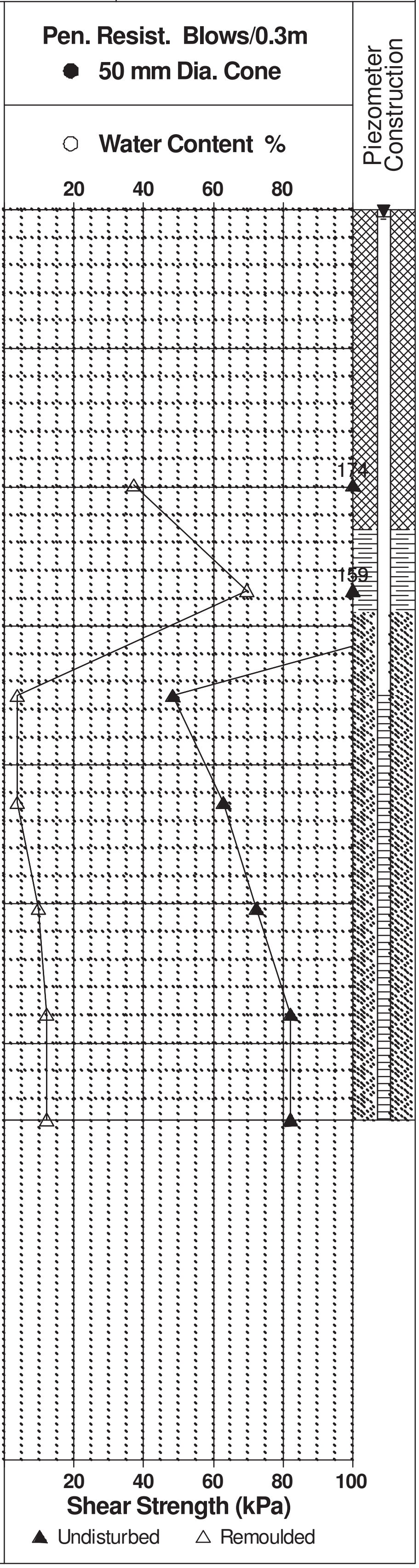
BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

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	58.49
TOPSOIL 0.15		SS	1		6		
		SS	2		11	1	57.49
						2	56.49
Very stiff to stiff, brown **SILTY CLAY**						3	55.49
						4	54.49
- grey-brown by 4.4m depth							
						5	53.49
						6	52.49
6.55 End of Borehole (GWL @ 0.05m-Nov. 30/10)							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 24 November 2010

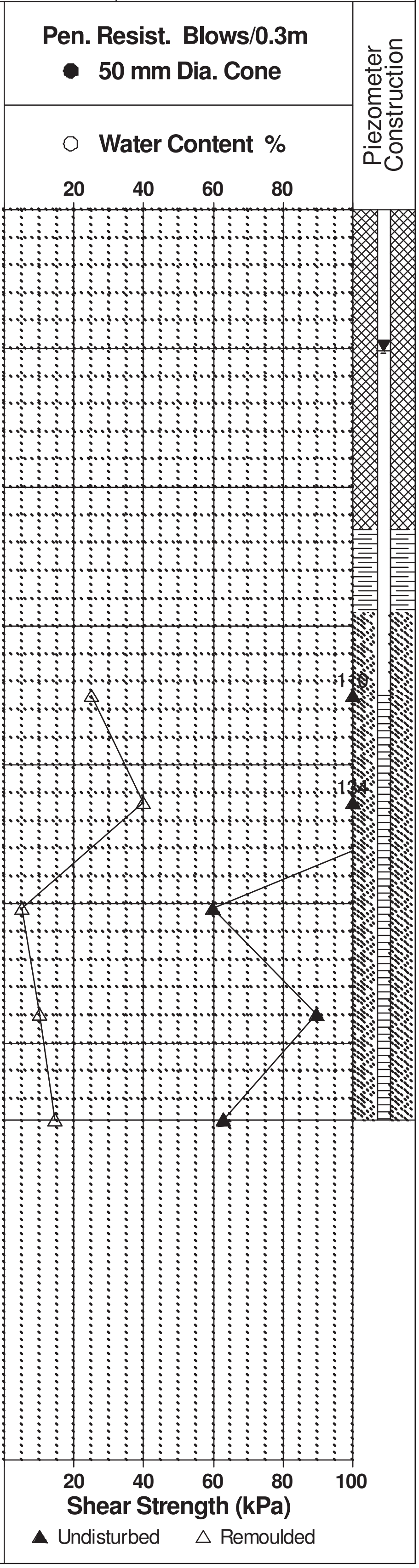
FILE NO. PG2274

HOLE NO. BH 7

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
Brown **SILTY SAND**	0.10
Very stiff to stiff, brown **SILTY CLAY**	6.55
End of Borehole (GWL @ 1.02m-Nov. 30/10)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	67	
SS	2	8	
SS	3	92	16
SS	4	92	7

DEPTH (m)	ELEV. (m)
0	62.20
1	61.20
2	60.20
3	59.20
4	58.20
5	57.20
6	56.20



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

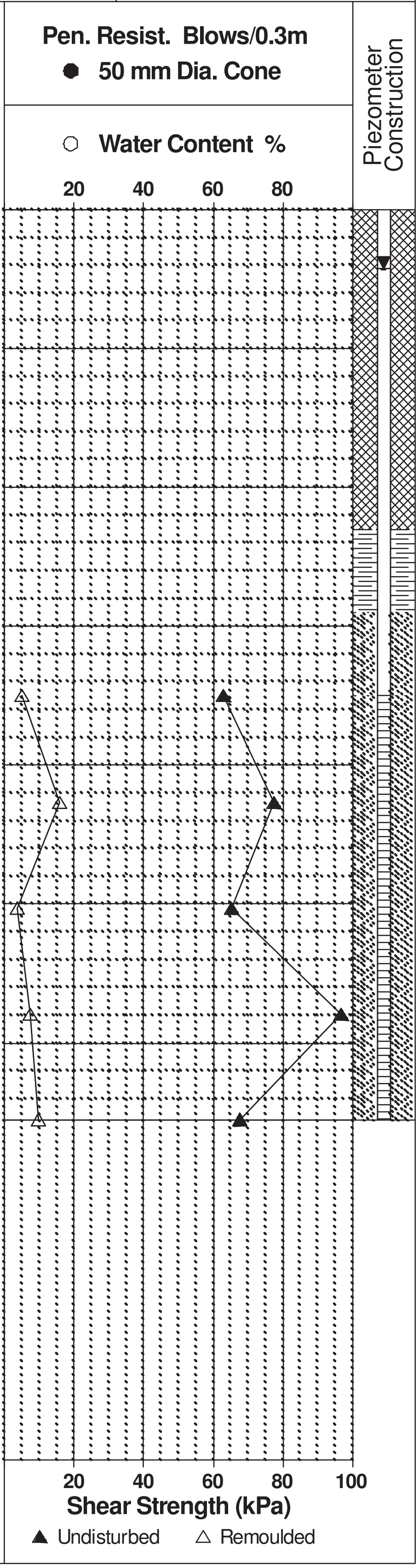
BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	60.79
TOPSOIL 0.15							
		SS	1	67	6		
		SS	2	92	8	1	59.79
		SS	3	100	11	2	58.79
		SS	4	100	4		
Stiff, brown **SILTY CLAY**						3	57.79
						4	56.79
- grey by 4.4m depth							
						5	55.79
						6	54.79
6.55							
End of Borehole							
(GWL @ 0.42m-Nov. 30/10)							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

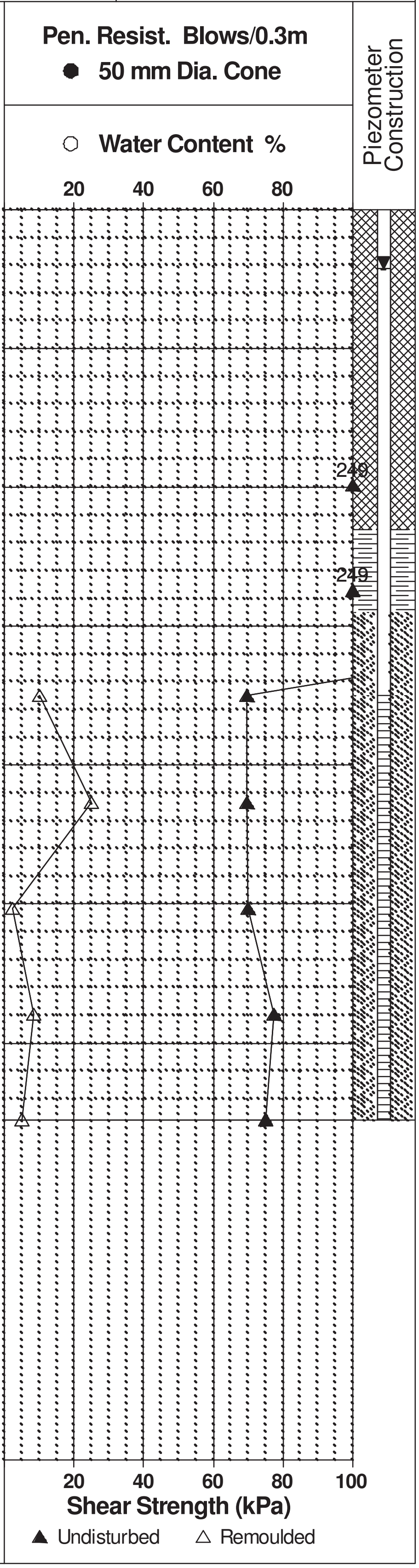
DATE 23 November 2010

FILE NO. PG2274

HOLE NO. BH 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.15					
		SS	1		6
		SS	2		10
Hard to stiff, brown **SILTY CLAY**					
- grey by 5.2m depth					
6.55					
End of Borehole					
(GWL @ 0.42m-Nov. 30/10)					

DEPTH (m)	ELEV. (m)
0	60.62
1	59.62
2	58.62
3	57.62
4	56.62
5	55.62
6	54.62



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

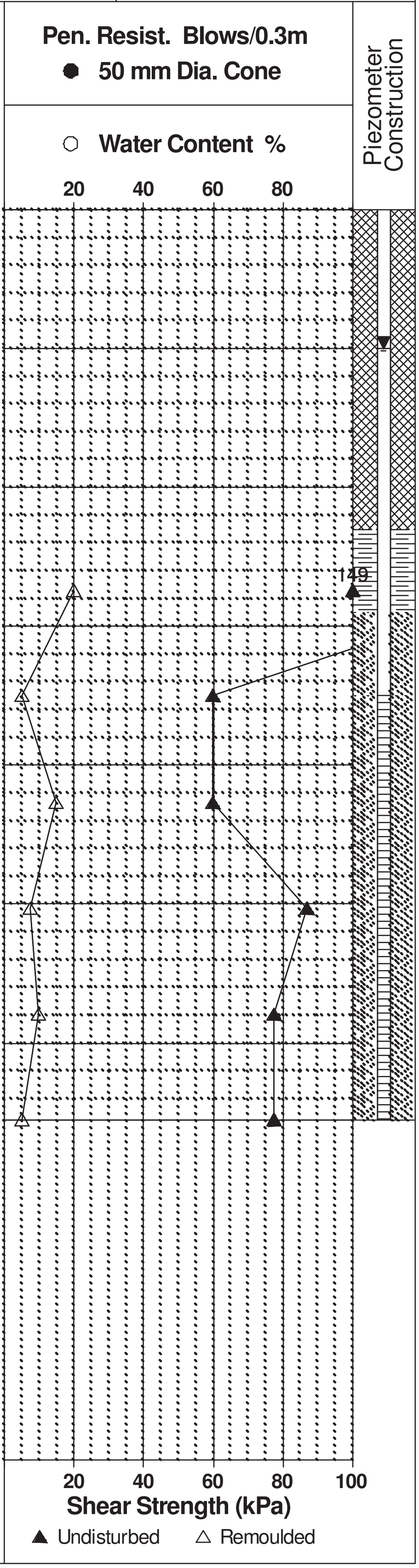
BORINGS BY CME 55 Power Auger

DATE 23 November 2010

FILE NO. PG2274

HOLE NO. BH10

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	58.79
TOPSOIL 0.15	SS	1	67	9		
	SS	2	92	12	1	57.79
	SS	3	92	9		
Very stiff to stiff, brown **SILTY CLAY**					2	56.79
- grey-brown by 2.9m depth					3	55.79
					4	54.79
					5	53.79
					6	52.79
6.55						
End of Borehole						
(GWL @ 1.00m-Nov. 30/10)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

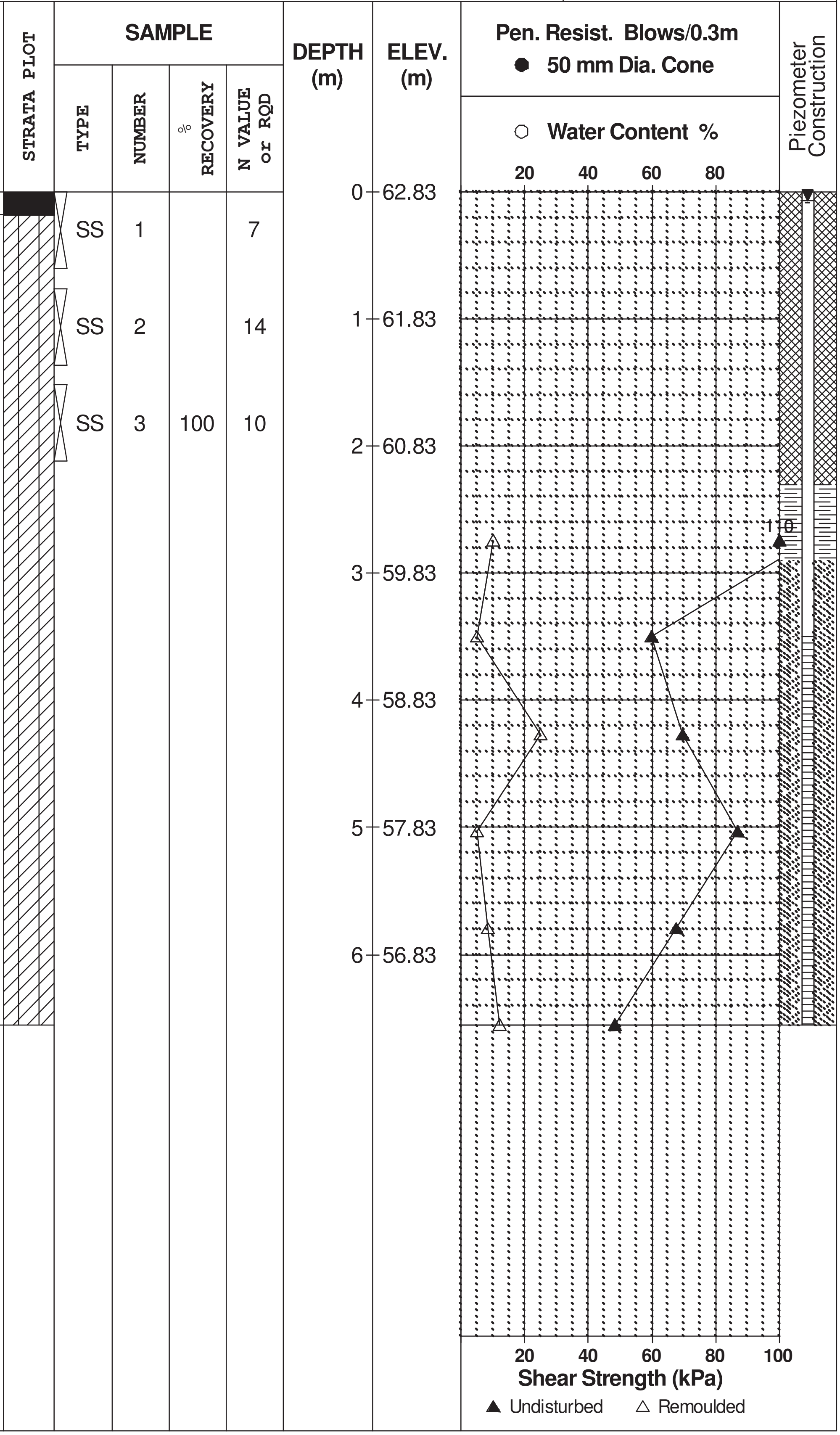
BORINGS BY CME 55 Power Auger

DATE 24 November 2010

FILE NO. PG2274

HOLE NO. BH11

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	62.83
TOPSOIL 0.18	SS	1		7		
	SS	2		14	1	61.83
	SS	3	100	10	2	60.83
					3	59.83
Very stiff to stiff, brown **SILTY CLAY**					4	58.83
					5	57.83
					6	56.83
6.55 End of Borehole (GWL @ 0.07m-Nov. 30/10)						



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

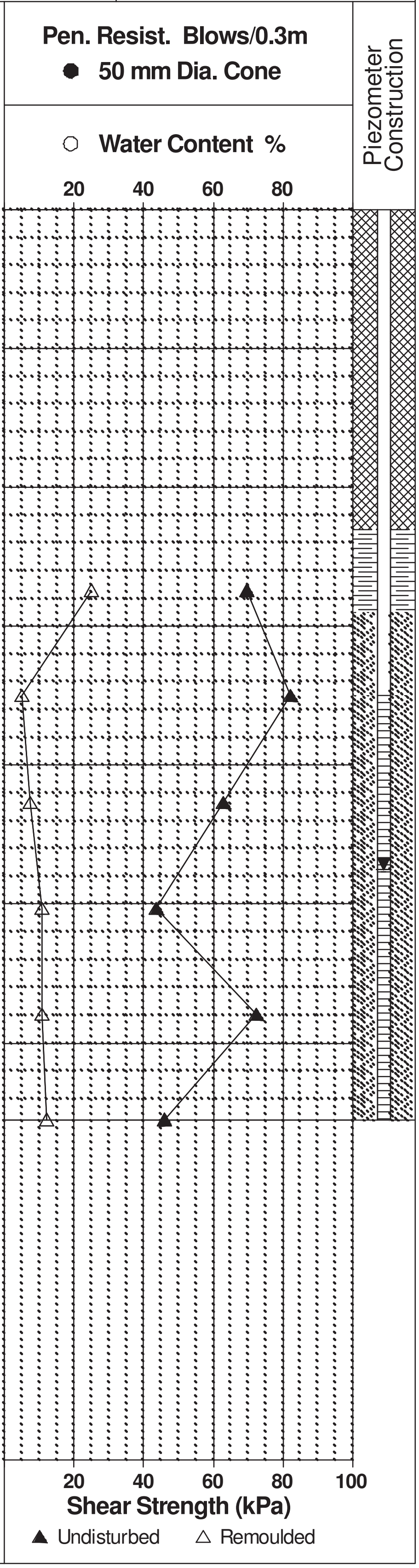
DATE 24 November 2010

FILE NO. PG2274

HOLE NO. BH12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.15				
Loose, brown **SILTY SAND** 0.69	SS	1	54	7
Stiff to firm, brown **SILTY CLAY**	SS	2	100	8
	SS	3	100	9
6.55				
End of Borehole (GWL @ 4.75m-Nov. 30/10)				

DEPTH (m)	ELEV. (m)
0	62.80
1	61.80
2	60.80
3	59.80
4	58.80
5	57.80
6	56.80



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Champlain Centre - Champlain Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

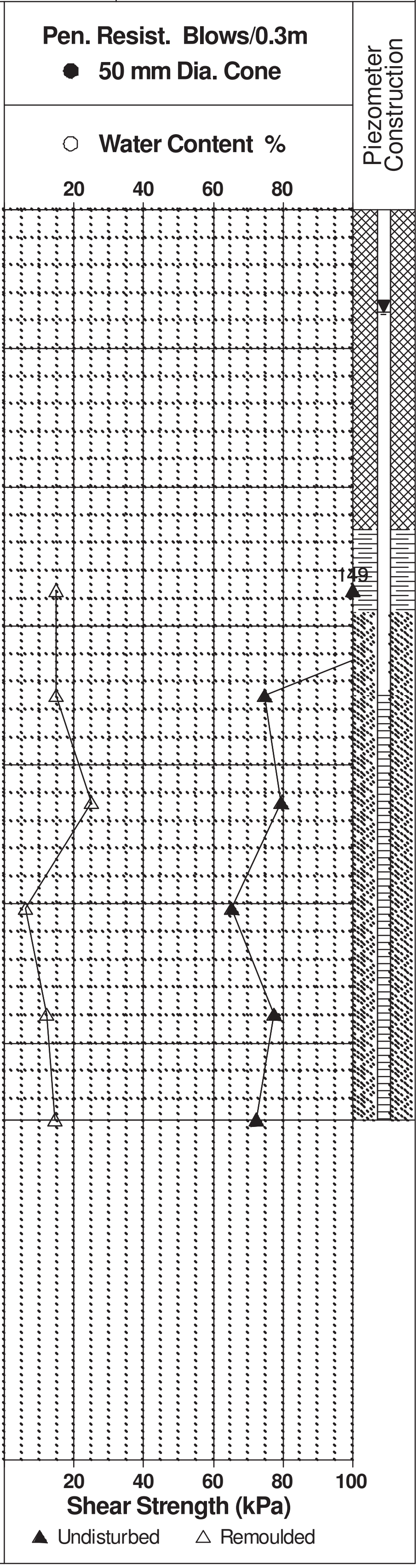
BORINGS BY CME 55 Power Auger

DATE 24 November 2010

FILE NO. PG2274

HOLE NO. BH13

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.49
TOPSOIL 0.10							
Loose, brown **SILTY SAND** with clay 0.69		SS	1	67	8		
		SS	2	92	10	1	61.49
		SS	3	67	7		
						2	60.49
						3	59.49
Very stiff to stiff, brown **SILTY CLAY**							
						4	58.49
						5	57.49
						6	56.49
6.55							
End of Borehole (GWL @ 0.74m-Nov. 30/10)							



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)

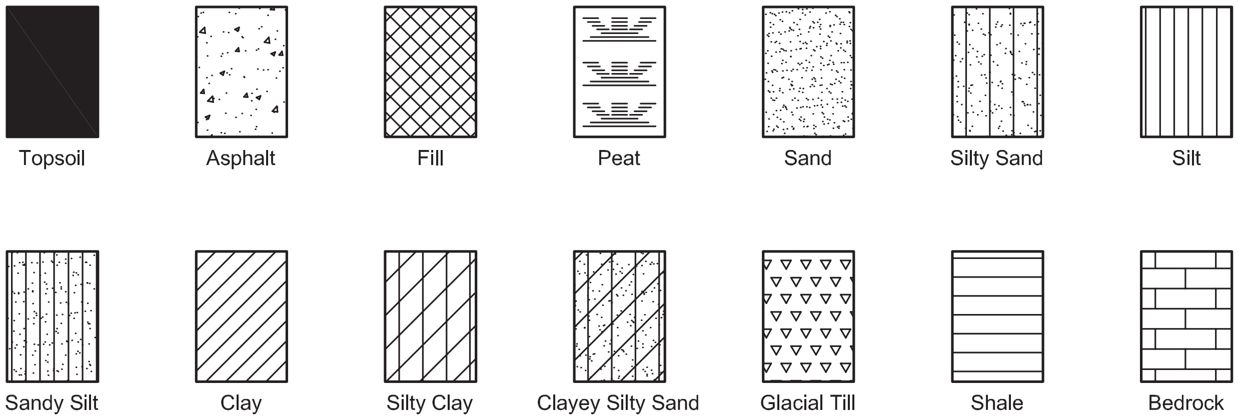
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

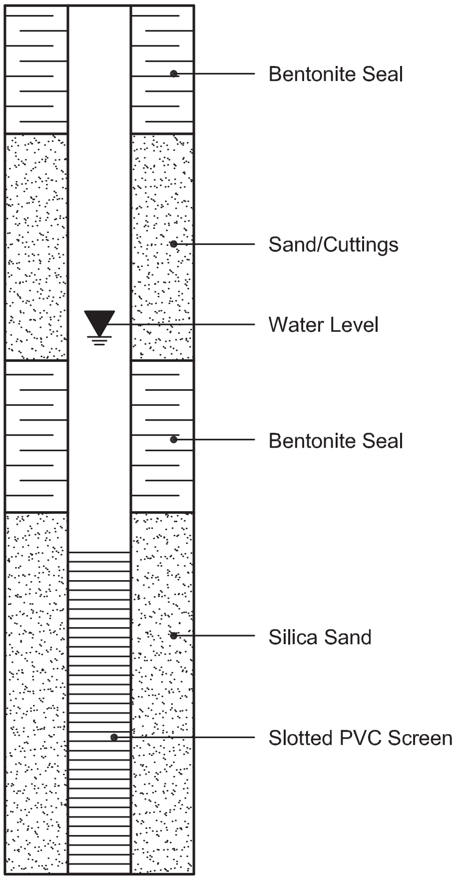
SYMBOLS AND TERMS (continued)

STRATA PLOT

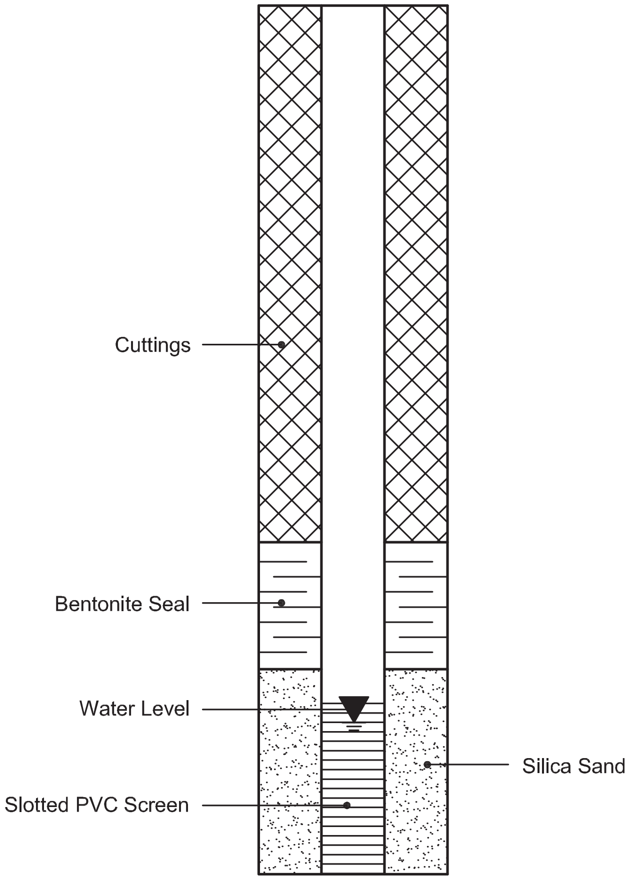


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



0-7576

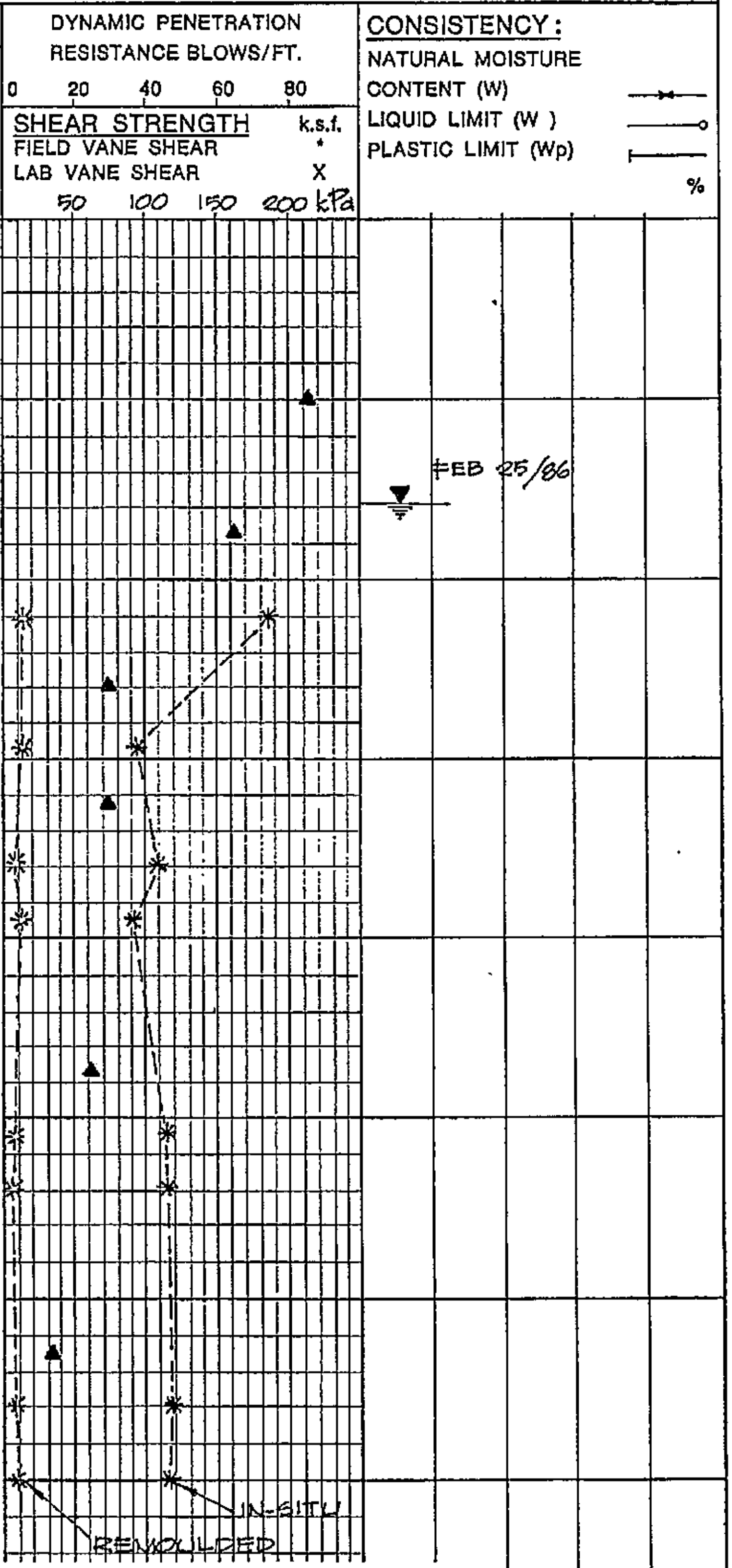
FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-1

PROJECT Preliminary Soil Investigation
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
DATUM Geodetic BOREHOLE TYPE CME 55

DRILLING DATE 86-02-24
REPORT DATE March 1986
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES			
Elev. Depth	DESCRIPTION	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
58.29 0.0	150 mm Topsoil over Silty sand, fine grained, dark brown, frozen.				
57.84 0.45	Silty Clay, trace fine sand, very stiff, moist, brown				
57.29 1.0		1	SS	8	
56.7 1.59	wet lenses	2	SS	8	
56.29 2.0					
	becoming stiff and very moist brown	3	SS	4	
55.29 3.0	grey, saturated, stiff, becoming firm.	4	SS	1	
54.29 4.0					
		5	SS	–	
53.29 5.0					
52.29 6.0					
		6	SS	–	
21.29 7.0	END OF BOREHOLE				



Notes:
1. Water Level Records.

Time	Water Level (m)
On Compl.	5.33
5 hrs	2.07
1 day	1.59

2. ▲ Pocket Penetrometer Values

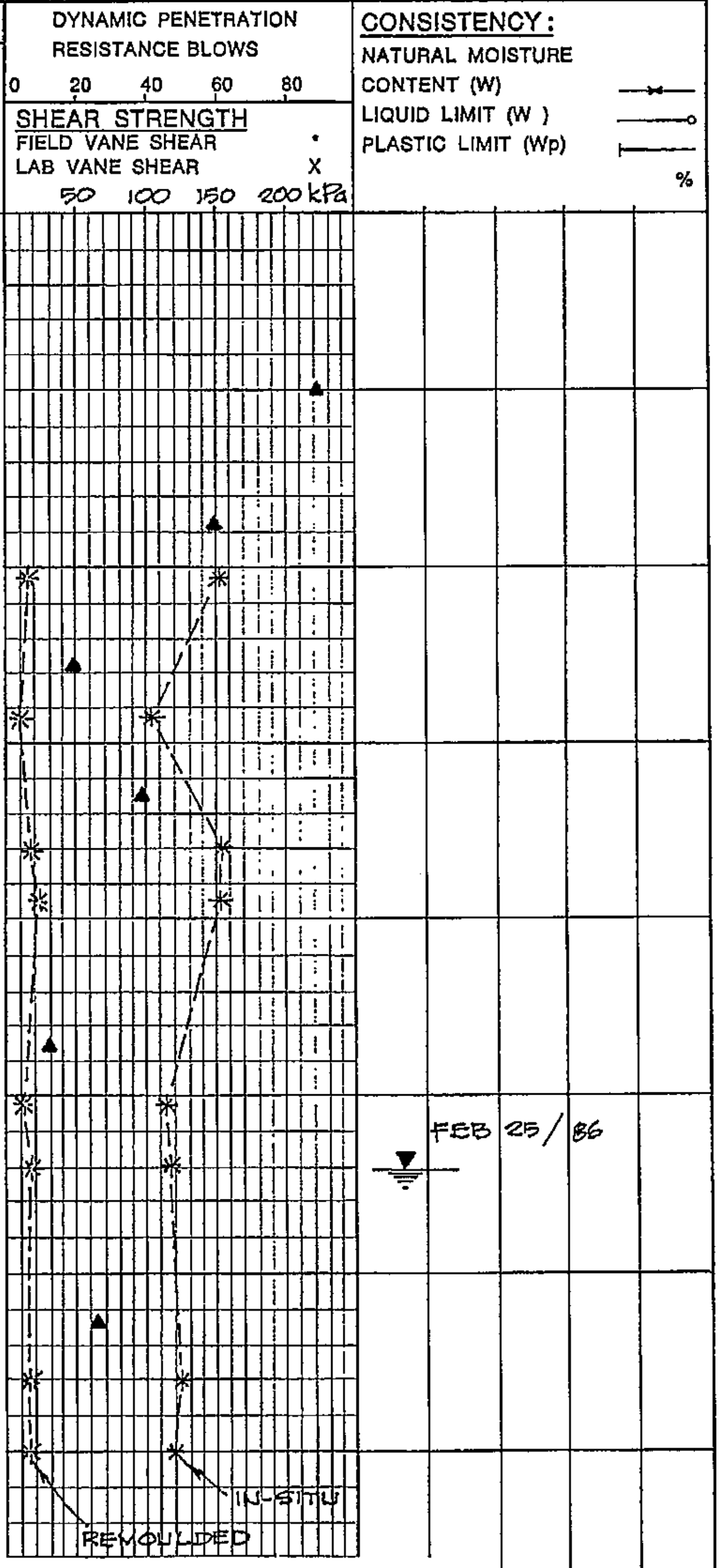
0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-2

PROJECT Preliminary Soil Investigation
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
DATUM Geodetic BOREHOLE TYPE CME 55
DRILLING DATE 86-02-24
REPORT DATE March 1986
DRAWN BY NGC

Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS: (N)	% RECOVERY
58.02 0.0	200 mm Topsoil over Silty clay, trace fine sand, very stiff, moist, brown					
57.02 1.0			1	SS	13	
			2	SS	7	
56.02 2.0						
	becoming stiff, very moist, brown		3	SS	2	
55.02 3.0	saturated, grey, stiff becoming firm		4	SS	1	
54.02 4.0						
			5	SS	2	
53.02 5.0						
52.61 5.41						
52.02 6.0			6	SS	—	
51.02 7.0	END OF BOREHOLE					



Notes:
1. Water level Records
Time Water Level (m)
On compl. Dry
1 day 5.41

2. ▲ Pocket Penetrometer Values

0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-3

PROJECT Preliminary Soil Investigation

DRILLING DATE 86-02-24

LOCATION Block "I", Champlain and Jeanne d'Arc, Gloucester

REPORT DATE March 1986

DATUM Geodetic

BOREHOLE TYPE CME 55

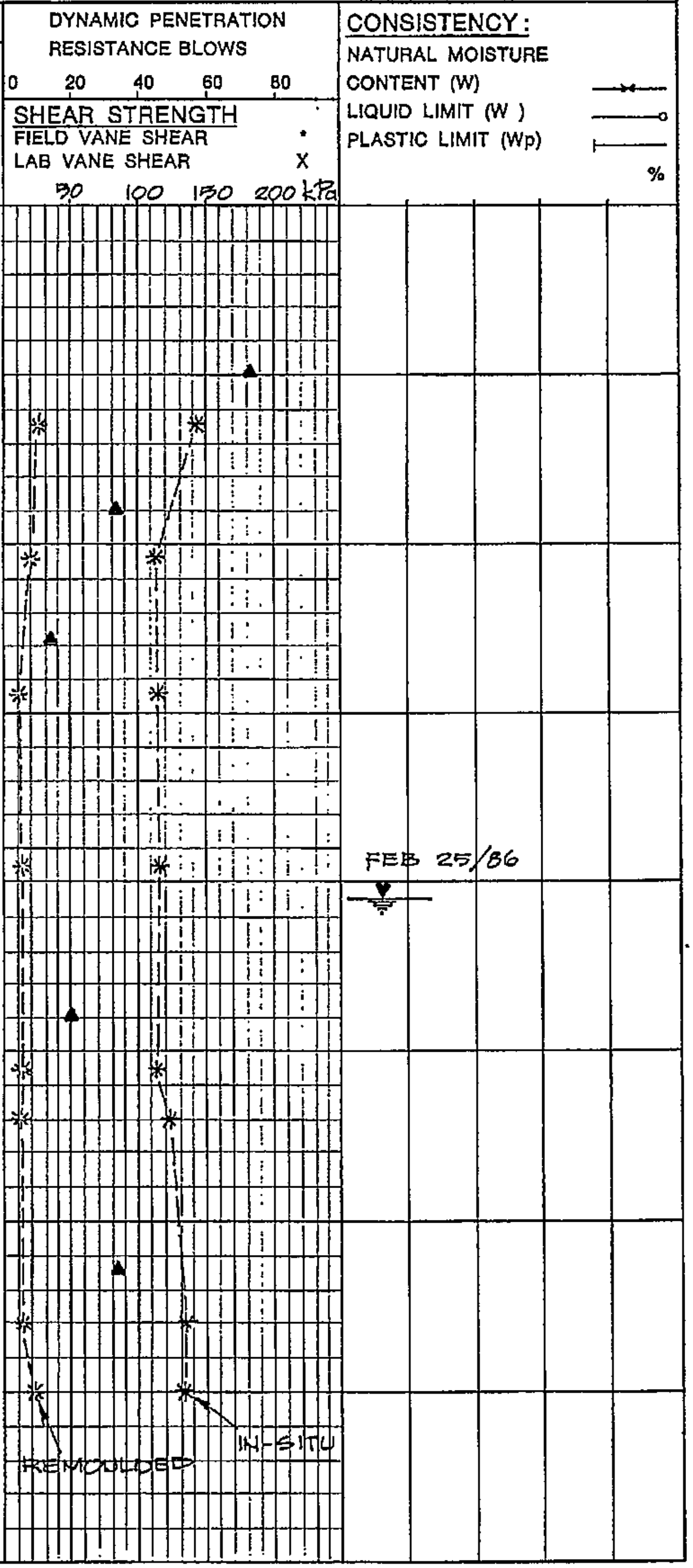
DRAWN BY NGC

Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
57.15 0.0	150 mm Topsoil over Silty clay; trace fine sand, very stiff, moist, brown					
56.15 1.0			1	SS	5	
	– stiff, very moist, brown		2	SS	2	
55.15 2.0	– grey, saturated, stiff, becoming firm		3	SS	–	
54.15 3.0			4	SS	2	
53.15 4.0			5	SS	–	
52.15 5.0						
51.15 6.0			6	SS	2	
50.15 7.0	END OF BOREHOLE					

Notes:
1. A Standpipe piezometer installed to 6.4 m.
2. Water Level Record

Time	Water Level (m)
on compl.	5.64
1 day	4.11

3. ▲ Pocket Penetrometer Values



0-7576

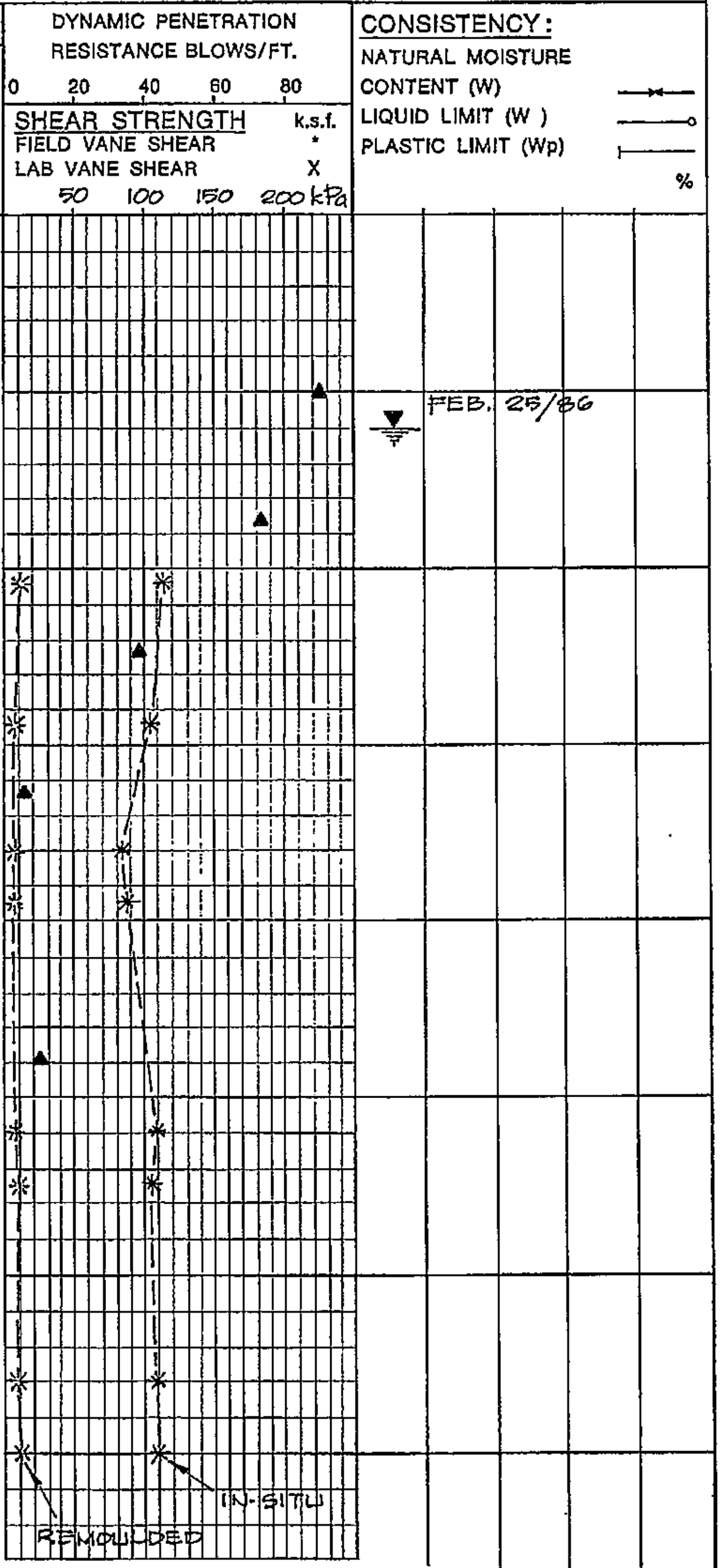
FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-4

PROJECT Preliminary Soil Investigation
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
DATUM Geodetic BOREHOLE TYPE CME 55

DRILLING DATE 86-02-21
REPORT DATE March 1986
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES				
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
59.45 0.0	150 mm Topsoil over Silty clay, trace fine sand, very stiff, moist, brown					
58.45 1.0			1	SS	13	
			2	SS	7	
57.45 2.0	– becoming stiff and very moist, brown		3	SS	4	
56.45 3.0	– grey, free water, saturated, firm		4	SS	–	
55.45 4.0			5	SS	–	
54.45 5.0						
53.45 6.0			6	SS	–	
52.45 7.0	END OF BOREHOLE					



Notes:
1. Standpipe Piezometer installed to 6.4 m
2. Water Level Records

Time	Water level (m)
on compl.	Dry
4 days	1.2

3. ▲ Pocket Penetrometer Values

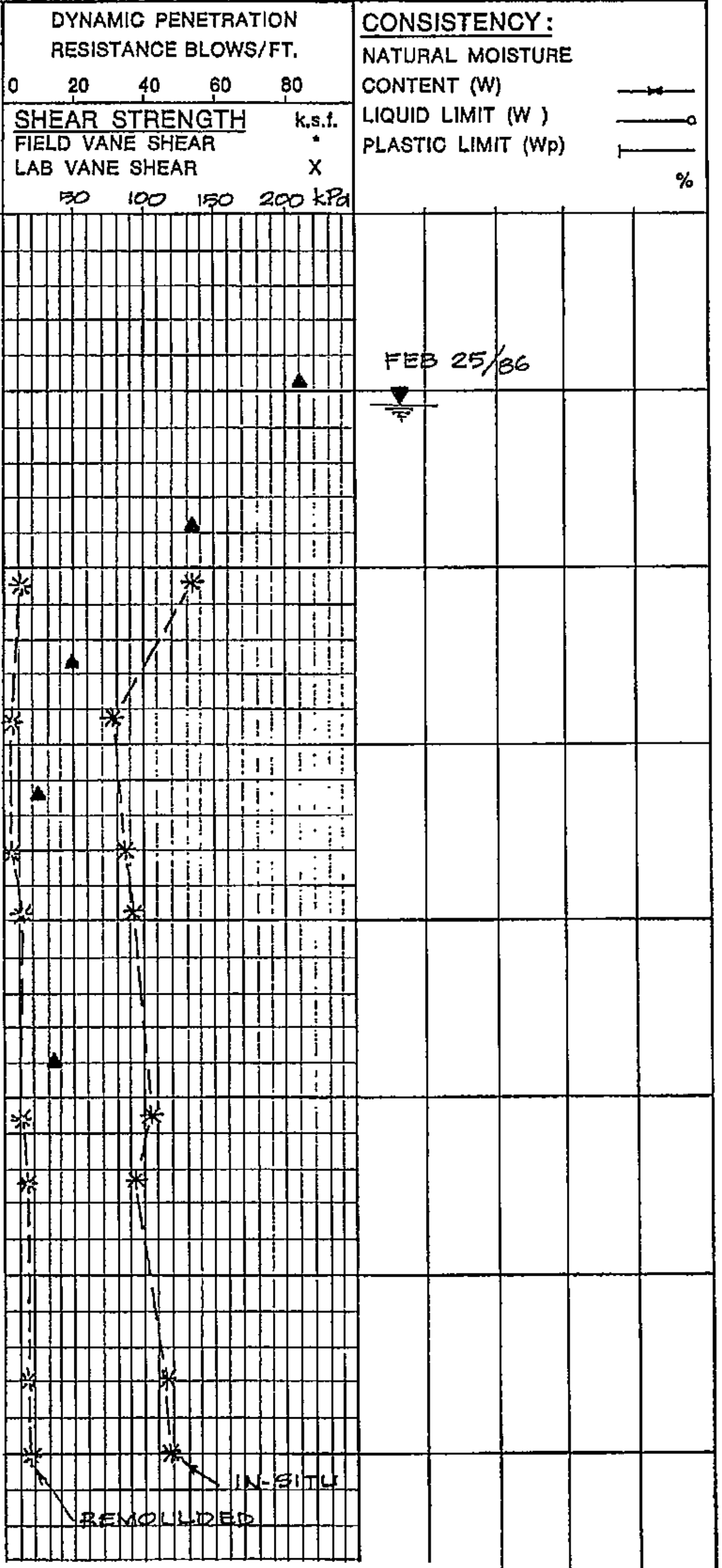
0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-5

PROJECT Preliminary Soil Investigation
DRILLING DATE 86-02-21
LOCATION Block "I", Champlain and Jeanne d'Arc, Gloucester
REPORT DATE March 1986
DATUM Geodetic BOREHOLE TYPE CME 55
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES				
Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
58.38 / 0.0	200 mm Topsoil over silty clay, trace fine sand, very stiff, moist, brown					
57.38 / 1.0			1	SS	10	
			2	SS	9	
56.38 / 2.0						
	becoming stiff to firm, very moist, brown		3	SS	2	
55.38 / 3.0	grey, saturated		4	SS	1	
54.38 / 4.0						
			5	SS	–	
53.38 / 5.0						
52.38 / 6.0			6	SS		
51.38 / 7.0	END OF BOREHOLE					



Notes:
1. Water Level Record

Time	Water Level(m)
On compl.	5.76
2 hrs	5.40
4 days	1.07

2. ▲ Pocket Penetrometer Values

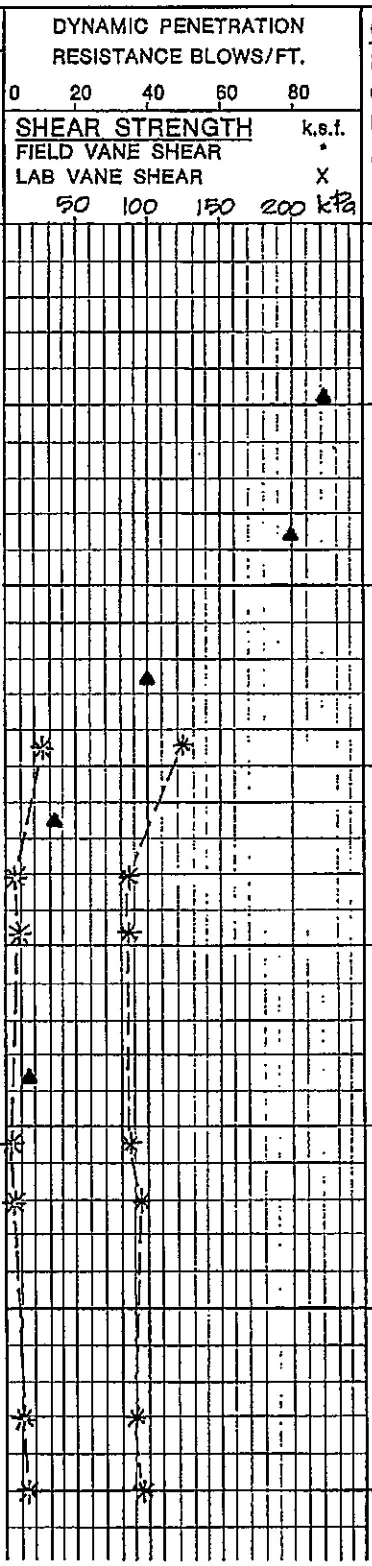
0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-6

PROJECT Preliminary Soil Investigation
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
DATUM Geodetic BOREHOLE TYPE CME 55
DRILLING DATE 86-02-24 & 25
REPORT DATE March 1986
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES				
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
61.69 0.0	300 mm Topsoil over Silty clay, trace fine sand, very stiff, moist, brown					
60.69 1.0			1	SS	19	
			2	SS	11	
59.69 2.0	- becoming stiff, very moist, brown		3	SS	6	
58.69 3.0	- brown becoming grey, firm, saturated		4	SS	2	
57.69 4.0			5	SS	—	
56.69 5.0						
55.69 6.0			6	SS	—	
54.69 7.0	END OF BOREHOLE					



CONSISTENCY:
NATURAL MOISTURE CONTENT (W)
LIQUID LIMIT (W)
PLASTIC LIMIT (Wp)
%

Notes:
1. Water Level Records
Time Water Level (m)
on compl. 5.51

2. ▲ Pocket Penetrometer Values

0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-7

PROJECT Preliminary Soil Investigation

DRILLING DATE 86-02-20

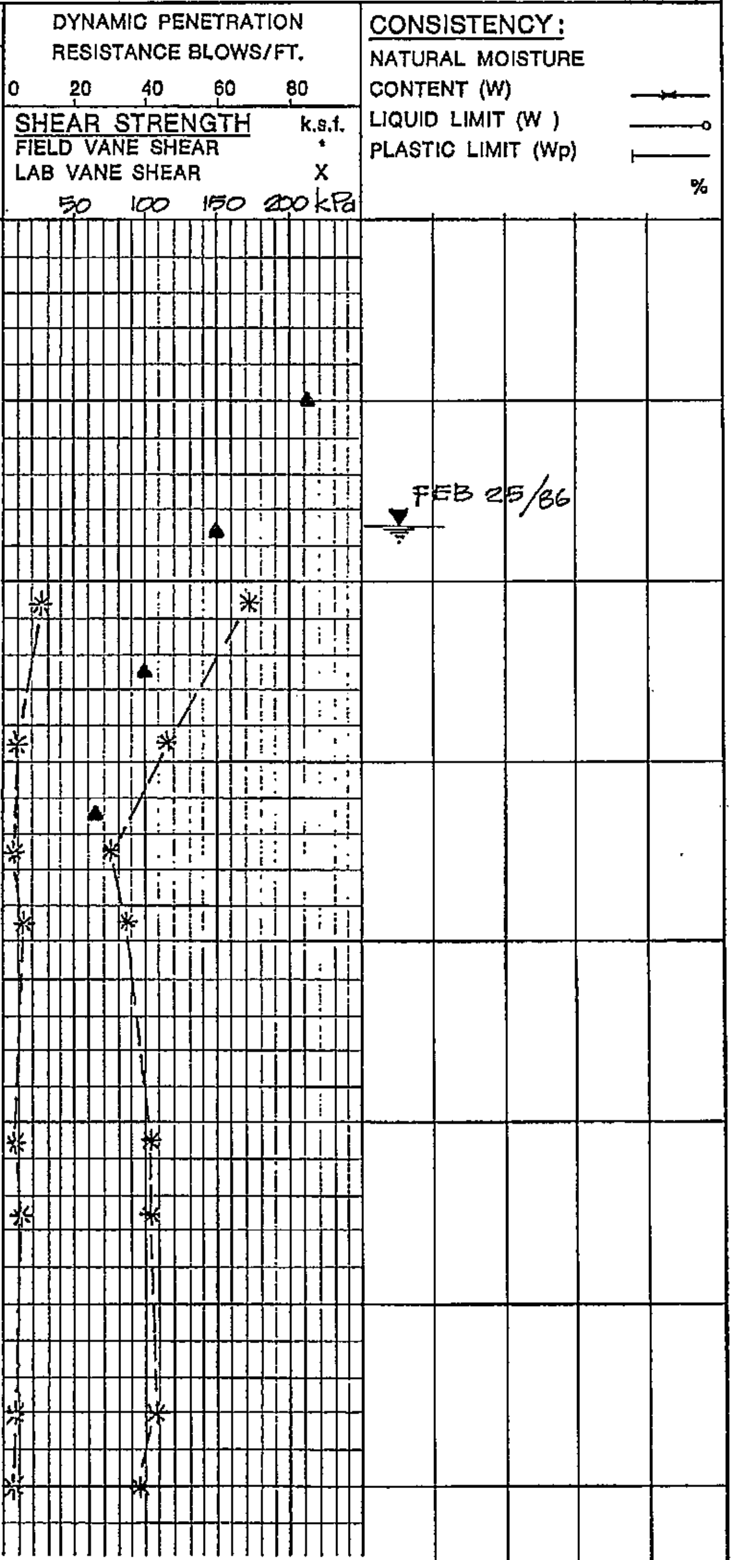
LOCATION Block "I", Champlain and Jeanne D'Arc

REPORT DATE March 1986

DATUM Geodetic BOREHOLE TYPE CME 55

DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES			
Elev. Depth	DESCRIPTION	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
62.72 0.0	200 mm Topsoil over Silty clay, trace fine sand, very stiff moist, brown				
61.72 1.0		1	SS	12	
61.04 1.68 60.72 2.0		2	SS	8	
	— becoming stiff, very moist, brown	3	SS	2	
59.72 3.0	— grey, firm, saturated	4	SS	1	
58.72 4.0					
		5	SS	—	
57.72 5.0					
56.72 6.0		6	SS	—	
55.72 7.0	END OF BOREHOLE				



Notes:
1. Water Level Records

Time	Water Level (m)
On compl.	Dry
1 day	1.77
5 days	1.68

2. ▲ Pocket Penetrometer Values

0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-8

PROJECT Preliminary Soil Investigation

DRILLING DATE 86-02-21

LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester

REPORT DATE March 1986

DATUM Geodetic BOREHOLE TYPE CME 55

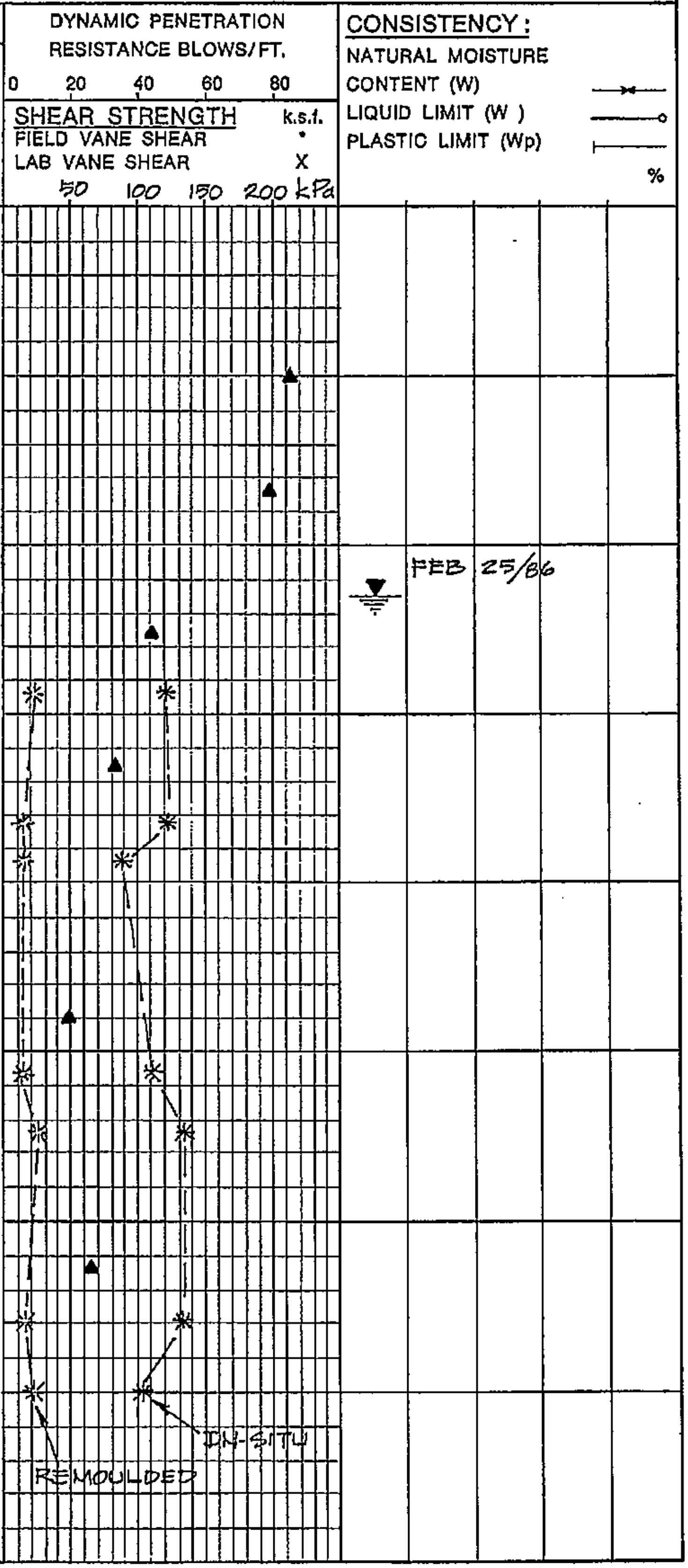
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES				
Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
63.22 0.0	400 mm Topsoil over Silty clay, trace fine sand, very stiff moist, brown					
62.22 1.0			1	SS	10	
			2	SS	10	
61.22 2.0						
60.91 2.31	becoming stiff, very moist		3	SS	3	
60.22 3.0			4	SS		
59.22 4.0						
	grey, firm, saturated		5	SS		
58.22 5.0						
57.22 6.0			6	SS		
56.22 7.0	END OF BOREHOLE					

Notes:
1. Standpipe piezometer installed at 6.4 m
2. Water Level Records

Time	Water Level(m)
On compl.	3.60
4 days	2.31

3. ▲ Pocket Penetrometer Values



0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-9

PROJECT Preliminary Soil Investigation

LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester

DATUM Geodetic BOREHOLE TYPE CME 55

DRILLING DATE 86-02-25

REPORT DATE March 1986

DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 0 20 40 60 80 SHEAR STRENGTH k.s.f. FIELD VANE SHEAR * LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY		
65.48 0.0	200 mm of sand and gravel over Silty sand, trace clay, loose to very loose, moist, dark brown		1	AS				
64.48 1.0			2	SS	3			
			3	SS	1/150 mm			
63.68 1.8	END OF BOREHOLE at practical refusal on bedrock.							

0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER BH-10

PROJECT Preliminary Soil Investigation
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
DATUM Geodetic
BOREHOLE TYPE CME 55
DRILLING DATE 86-02-25
REPORT DATE March 1986
DRAWN BY NGC

GEOLOGIC PROFILE

SAMPLES

DYNAMIC PENETRATION RESISTANCE BLOWS/FT.
0 20 40 60 80

SHEAR STRENGTH k.s.f.
FIELD VANE SHEAR •
LAB VANE SHEAR X

CONSISTENCY:
NATURAL MOISTURE CONTENT (W)
LIQUID LIMIT (W)
PLASTIC LIMIT (Wp)
%

Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY
65.30 0.0	Silty sand, fine grained, trace gravel loose, moist, dark brown		1	AS		
64.3 1.0	becoming very moist to wet		2	SS	5	
			3	SS	3/150mm	
63.4 1.9	END OF BOREHOLE at practical refusal on bedrock.					

0-7576

FONDEX LTD.
FOUNDATION ENGINEERS

BOREHOLE NUMBER PH-1

PROJECT Preliminary Soil Investigation
DRILLING DATE 86-02-25
LOCATION Block "I", Champlain and Jeanne D'Arc, Gloucester
REPORT DATE March 1986
DATUM Geodetic BOREHOLE TYPE CME 55
DRAWN BY NGC

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 0 20 40 60 80 SHEAR STRENGTH k.s.f. FIELD VANE SHEAR • LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) —×— LIQUID LIMIT (W) ——o PLASTIC LIMIT (Wp) ├—— %
Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY		
65.3 0.0	Silty sand, fine grained, frozen, very moist, dark brown.							
62.4 0.9	END OF BOREHOLE at practical refusal on bedrock.							

APPENDIX 'C'

Borehole Logs

January, 1989 Investigation

O-8626

FONDEX

BOREHOLE NUMBER BH-11

PROJECT Proposed Multi-storey Development
DRILLING DATE 88-12-19&20
LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans
REPORT DATE 89-01
DATUM Geodetic
BOREHOLE TYPE CME-55
DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS 0 20 40 60 80 SHEAR STRENGTH kPa FIELD VANE SHEAR • LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY		
58.30 0.0	Augered with conventional flight auger to 30.6 m through clay soil							
57.30 1.0								
56.30 2.0								
28.30 30.0	Lowered casing to elevation 27.72 m							
27.72 30.58	Granular Till, sand, some cobbles, easy drilling							
27.30 31.0			1	RC				
26.30 32.0			2	RC		100		
25.98 32.32	END OF BOREHOLE in possible boulder							

Notes:

1. Water Level at 6.1 m prior to coring and at 3.05 m at completion.

O-8626

FONDEX

BOREHOLE NUMBER BH-12

PROJECT Proposed Multi-storey Development
LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans
DATUM Geodetic BOREHOLE TYPE CME-55
DRILLING DATE 88-12-20
REPORT DATE 89-01
DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS 0 20 40 60 80 SHEAR STRENGTH kPa FIELD VANE SHEAR • LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY		
63.90 0.0	Augered to practical auger refusal with conventional flight auger equipment through clay soil							
62.90 1.0								
61.90 2.0								
52.90 11.0								
52.47 11.43	Constant grinding noise from augers noted from 11.43 m to 20.57 m. Possible Till or sloping bedrock.							
51.90 12.0								
50.90 13.0								
44.90 19.0	Constant grinding noted.							
43.90 20.0								
43.33 20.57	END OF BOREHOLE at Practical Auger Refusal							

Notes:

Three 1.5 m lengths of conventional augers broke during augering and were left in the borehole. Broken augers were attributed to possible sloping bedrock.

O-8626

FONDEX

BOREHOLE NUMBER BH-13

PROJECT Proposed Multi-storey Development

LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans

DATUM Geodetic BOREHOLE TYPE CME-55

DRILLING DATE 88-12-21

REPORT DATE 89-01

DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS 0 20 40 60 80 SHEAR STRENGTH kPa FIELD VANE SHEAR • LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY		
65.70 0.0	Fill, rock, sand and gravel, -difficult drilling required relocating three times prior to penetrating the fill.							
64.70 1.0								
63.70 2.0								
63.26 2.44	Silty Clay							
62.70 3.0								
61.70 4.0								
60.98 4.72	Limestone bedrock, heavily weathered, highly fractured. R.Q.D. = 34%		1	RC		100		
60.70 5.0								
	- poor quality rock. R.Q.D. = 0%		2	RC		45.3		
59.45 6.25	END OF BOREHOLE							

O-8626

FONDEX

BOREHOLE NUMBER BH-14

PROJECT Proposed Multi-storey Development
LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans
DATUM Geodetic BOREHOLE TYPE CME-55

DRILLING DATE 88-12-22,23 & 24
REPORT DATE 89-01
DRAWN BY

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS 0 20 40 60 80 SHEAR STRENGTH kPa FIELD VANE SHEAR • LAB VANE SHEAR X	CONSISTENCY: NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY		
60.30 0.0	Augered through crust to 3 m. Washed bored with casing to 23.95 m through silty clay							
59.30 1.0								
58.30 2.0								
	Wash boring							
25.30 35.0								
24.30 36.0								
23.95 36.35	Granular Till, coarse sand, some gravel, occasional cobble.							
23.30 37.0								
22.30 38.0								
21.30 39.0								
20.30	Casing blocked with cobbles.							
20.07 40.23	END OF BOREHOLE							

O-8626

FONDEX

BOREHOLE NUMBER BH-15

PROJECT Proposed Multi-storey Development

LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans

DATUM Geodetic BOREHOLE TYPE CME-55

DRILLING DATE 88-12-29&30

REPORT DATE 89-01

DRAWN BY N.G.C.

GEOLOGIC PROFILE

SAMPLES: STRATIGRAPHY, NUMBER, TYPE, BLOWS (N), % RECOVERY

DYNAMIC PENETRATION RESISTANCE BLOWS: 0 20 40 60 80

SHEAR STRENGTH kPa
FIELD VANE SHEAR •
LAB VANE SHEAR X

CONSISTENCY:
NATURAL MOISTURE CONTENT (W)
LIQUID LIMIT (W)
PLASTIC LIMIT (Wp)
%

Elev. Depth	DESCRIPTION
58.60 0.0	Augered through crust to 8 m followed by wash boring with casing to 38.4 m
57.60 1.0	
56.60 2.0	
	Wash boring
21.60 37.0	
20.60 38.0	
20.20 38.4	Granular Till, - medium to coarse sand
19.60 39.0	- some fine sand was noted in wash water
18.60 40.0	- cobbles & boulders
17.60 41.0	
16.60 42.0	
15.60 43.0	
14.80 43.74	END OF BOREHOLE

O-8626

FONDEX

BOREHOLE NUMBER BH-16

PROJECT Proposed Multi-storey Development
LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans
DATUM Geodetic BOREHOLE TYPE CME-55

DRILLING DATE 89-01-03&04
REPORT DATE 89-01
DRAWN BY N.G.C.

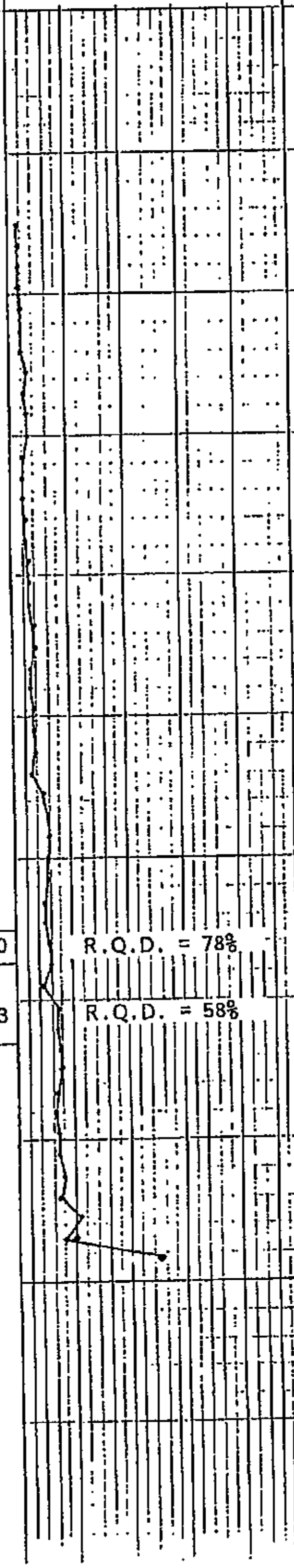
GEOLOGIC PROFILE		SAMPLES				
Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY
63.20 0.0	Augered to 9.0 m with hollow stem augers followed by wash boring with casing to 13.12 m.					
61.20 2.0						
59.20 4.0						
57.20 6.0						
55.20 8.0						
53.20 10.0						
51.20 12.0	Practical wash boring refusal at 13.12 m.					
50.08 13.12	Limestone bedrock, highly fractured, moderately sound		1	RC		60
49.20			2	RC		93
48.58 14.62	END OF BOREHOLE					

Notes:

1. Cone Penetration Test performed 1.32 m north of Borehole to refusal at 17.71 m.

DYNAMIC PENETRATION RESISTANCE BLOWS

SHEAR STRENGTH kPa
FIELD VANE SHEAR •
LAB VANE SHEAR X



CONSISTENCY:
NATURAL MOISTURE CONTENT (W)
LIQUID LIMIT (W)
PLASTIC LIMIT (Wp)
%

O-8626

FONDEX

BOREHOLE NUMBER CP-17

PROJECT Proposed Multi-storey Development

LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans

DATUM Geodetic BOREHOLE TYPE CME-55

DRILLING DATE 89-01-04

REPORT DATE 89-01

DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES				
Elev. / Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY
62.17	Cone Penetration Test					
58.17 / 4.0						
54.17 / 8.0						
50.17 / 12.0						
46.17 / 16.0						
42.17 / 20.0						
38.17 / 24.0						
34.17 / 28.0						
	— Possible till deposit					
30.17 / 32.0						
26.17 / 36.0	End of Cone Penetration Test @ Practical Refusal @ 36.58 m (Elev. 25.82 m)					

DYNAMIC PENETRATION RESISTANCE BLOWS

0 20 40 60 80

SHEAR STRENGTH kPa

FIELD VANE SHEAR •

LAB VANE SHEAR X

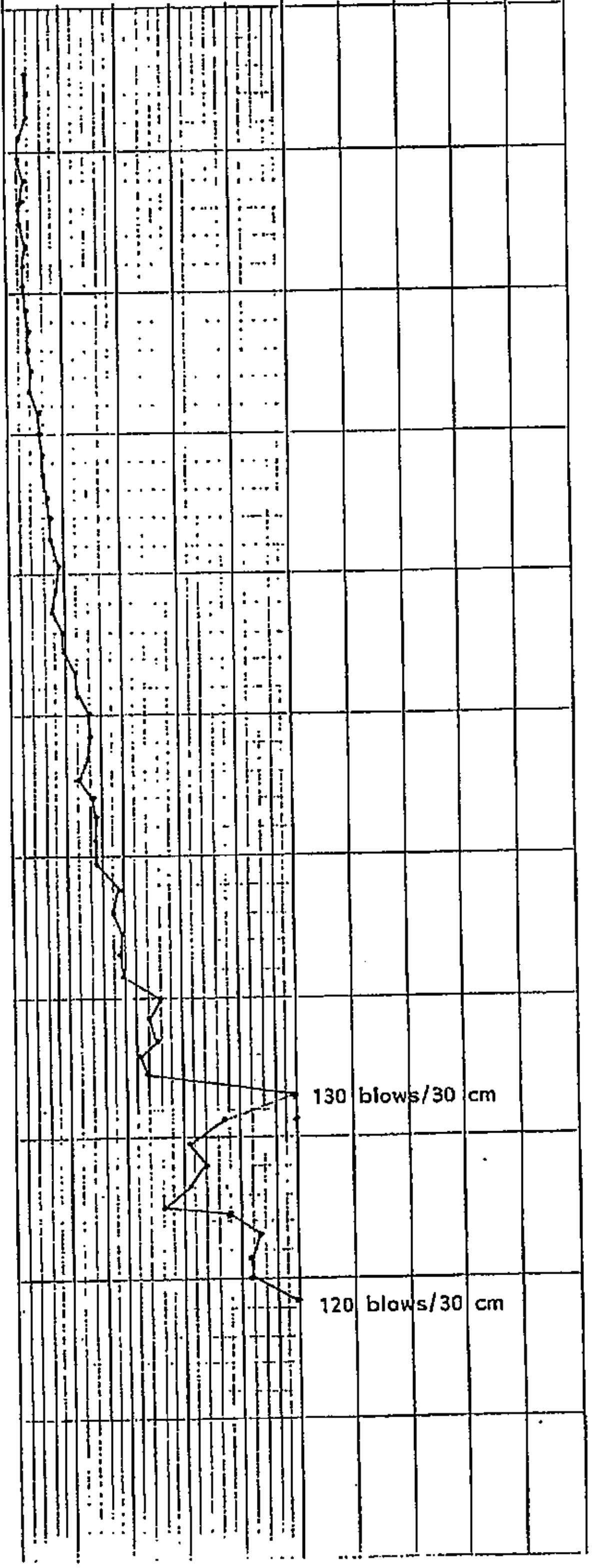
CONSISTENCY:

NATURAL MOISTURE CONTENT (W)

LIQUID LIMIT (W)

PLASTIC LIMIT (Wp)

%



O-8626

FONDEX

BOREHOLE NUMBER CP-18

PROJECT Proposed Multi-storey Development

DRILLING DATE 89-01-04&05

LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans

REPORT DATE 89-01

DATUM Geodetic BOREHOLE TYPE CME-55

DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES				
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY
62.10 0.0	Cone Penetration Test					
58.10 4.0						
54.10 8.0						
50.10 12.0						
46.10 16.0						
42.10 20.0						
38.10 24.0						
	Penetration test stopped on Jan. 4 and continued on Jan. 5					
34.10 28.0						
	Possible Till deposit					
30.10 32.0	End of Cone Penetration Test @ Practical Refusal					

DYNAMIC PENETRATION RESISTANCE BLOWS

0 20 40 60 80

SHEAR STRENGTH kPa

FIELD VANE SHEAR •

LAB VANE SHEAR X

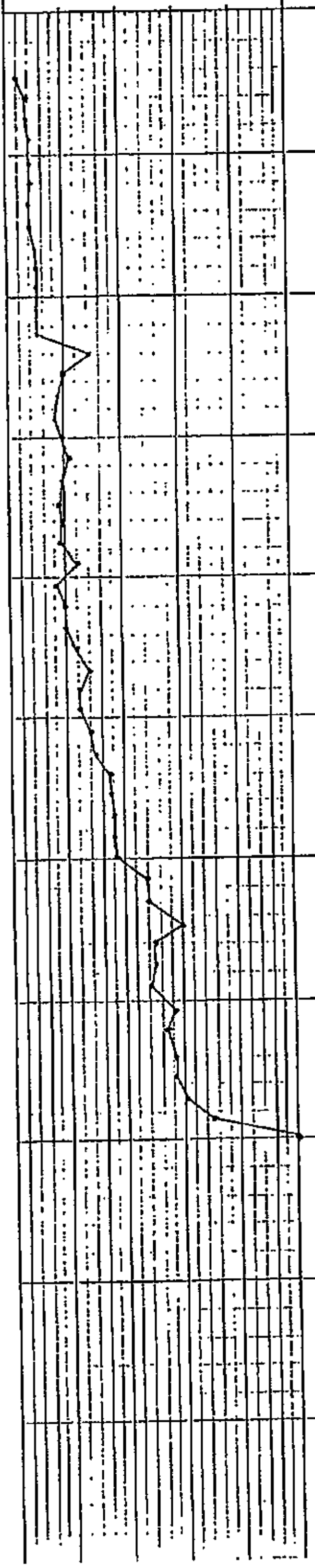
CONSISTENCY:

NATURAL MOISTURE CONTENT (W)

LIQUID LIMIT (W)

PLASTIC LIMIT (Wp)

%



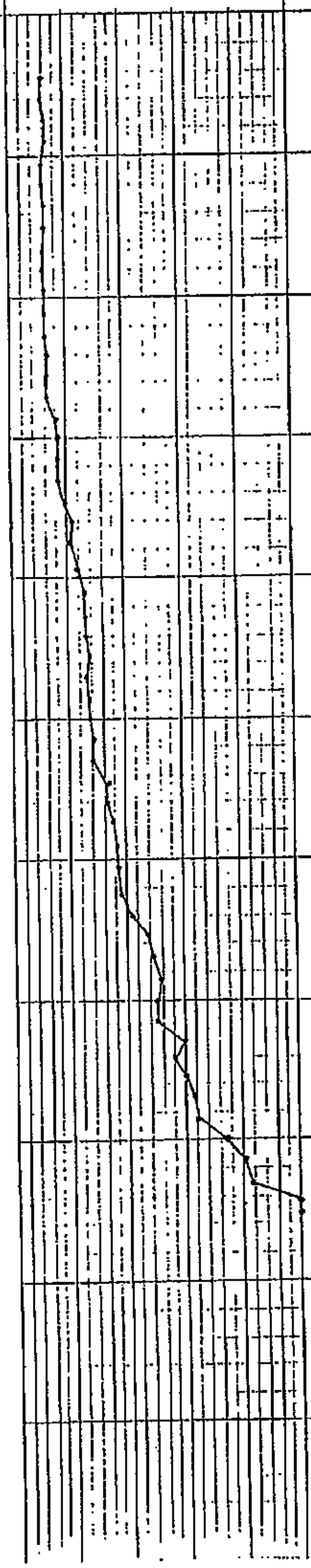
O-8626

FONDEX

BOREHOLE NUMBER CP-19

PROJECT Proposed Multi-storey Development
LOCATION Block 'I', Champlain & Jeanne D'Arc, Orleans
DATUM Geodetic BOREHOLE TYPE CME-55
DRILLING DATE 89-01-05
REPORT DATE 89-01
DRAWN BY N.G.C.

GEOLOGIC PROFILE		SAMPLES					DYNAMIC PENETRATION RESISTANCE BLOWS	CONSISTENCY:
Elev. Depth	DESCRIPTION	STRATIGRAPHY	NUMBER	TYPE	BLOWS (N)	% RECOVERY	0 20 40 60 80 SHEAR STRENGTH kPa FIELD VANE SHEAR • LAB VANE SHEAR X	NATURAL MOISTURE CONTENT (W) LIQUID LIMIT (W) PLASTIC LIMIT (Wp) %
61.5 0.0	Cone Penetration Test							
57.5 4.0								
53.5 8.0								
49.5 12.0								
45.5 16.0								
41.5 20.0								
37.5 24.0								
33.5 28.0								
30.7 30.8	Possible Till deposit							
29.5 32.0								
27.36 34.14	End of Cone Penetration Test @ Practical Refusal							



Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 21283

Report Date: 28-Dec-2016

Order Date: 21-Dec-2016

Project Description: PG4025

Client ID:		BH8-SS3	-	-	-
Sample Date:		20-Dec-16	-	-	-
Sample ID:		1652218-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	66.6	-	-	-
General Inorganics					
pH	0.05 pH Units	6.99	-	-	-
Resistivity	0.10 Ohm.m	18.5	-	-	-
Anions					
Chloride	5 ug/g dry	210	-	-	-
Sulphate	5 ug/g dry	72	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURES 2 AND 3 - SEISMIC SHEAR WAVE VELOCITY PROFILES

DRAWING PG4025-1 - TEST HOLE LOCATION PLAN

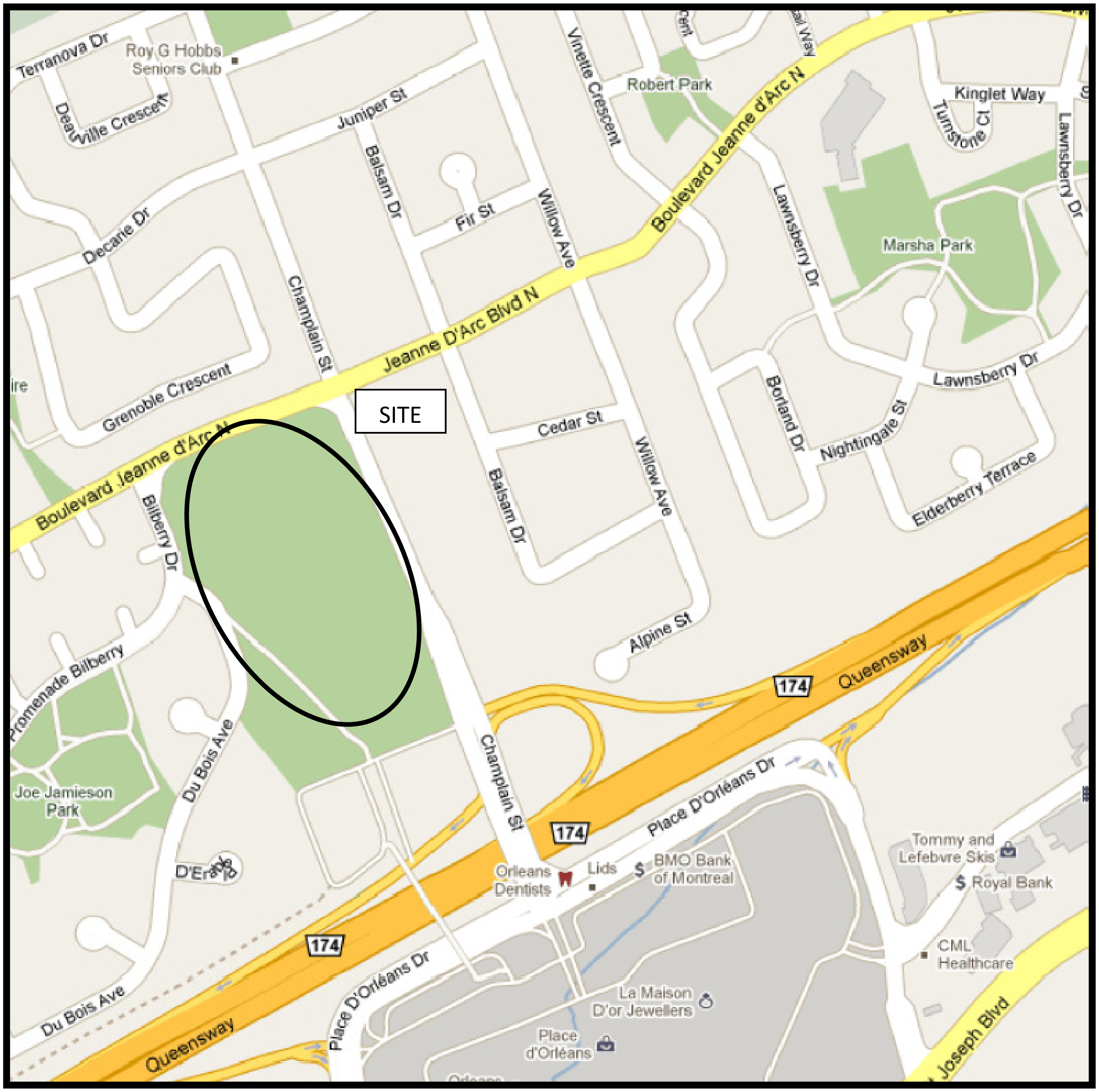


FIGURE 1

KEY PLAN

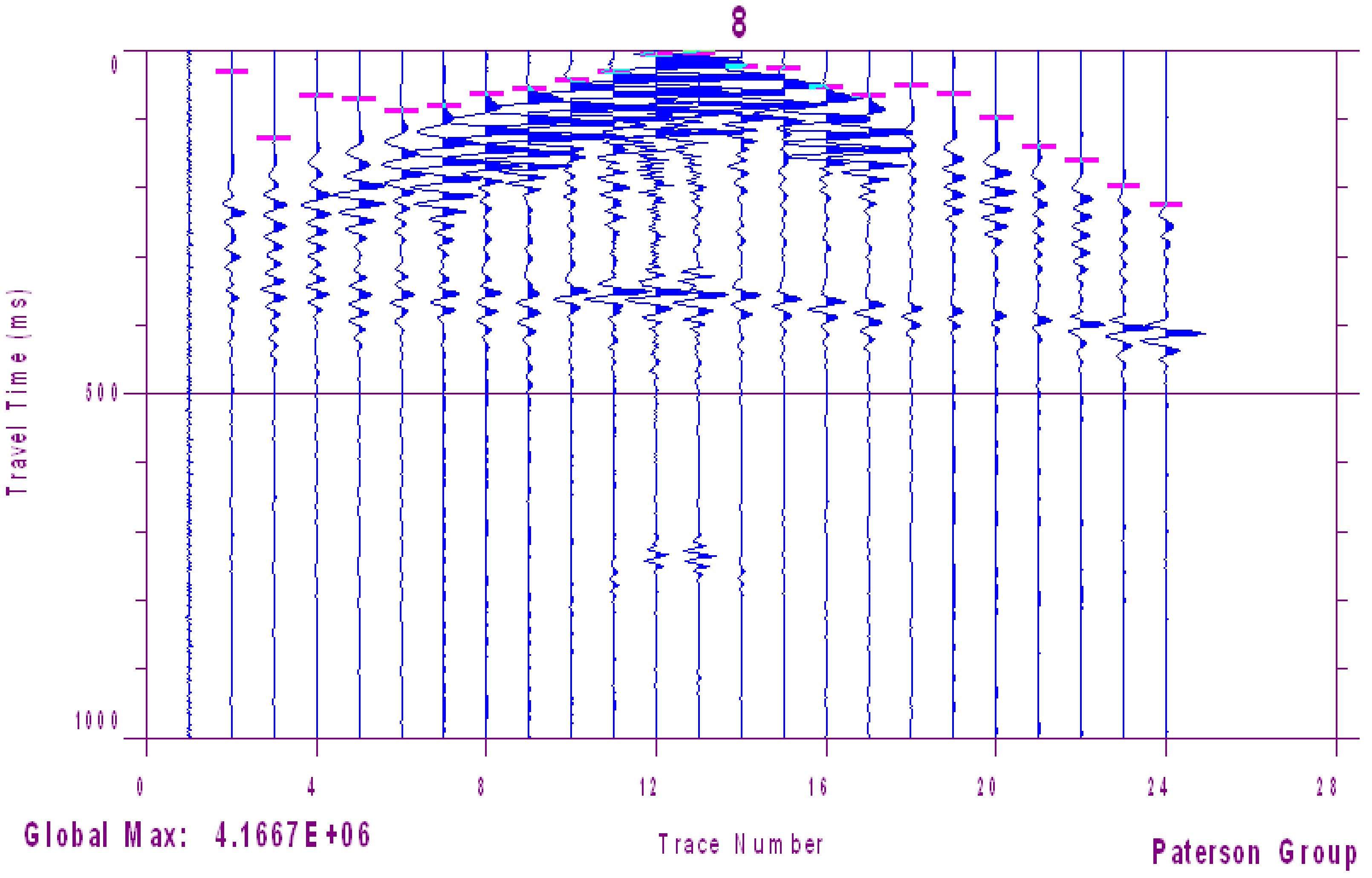


Figure 2 – Shear Wave Velocity Profile at Shot Location 34.5 m

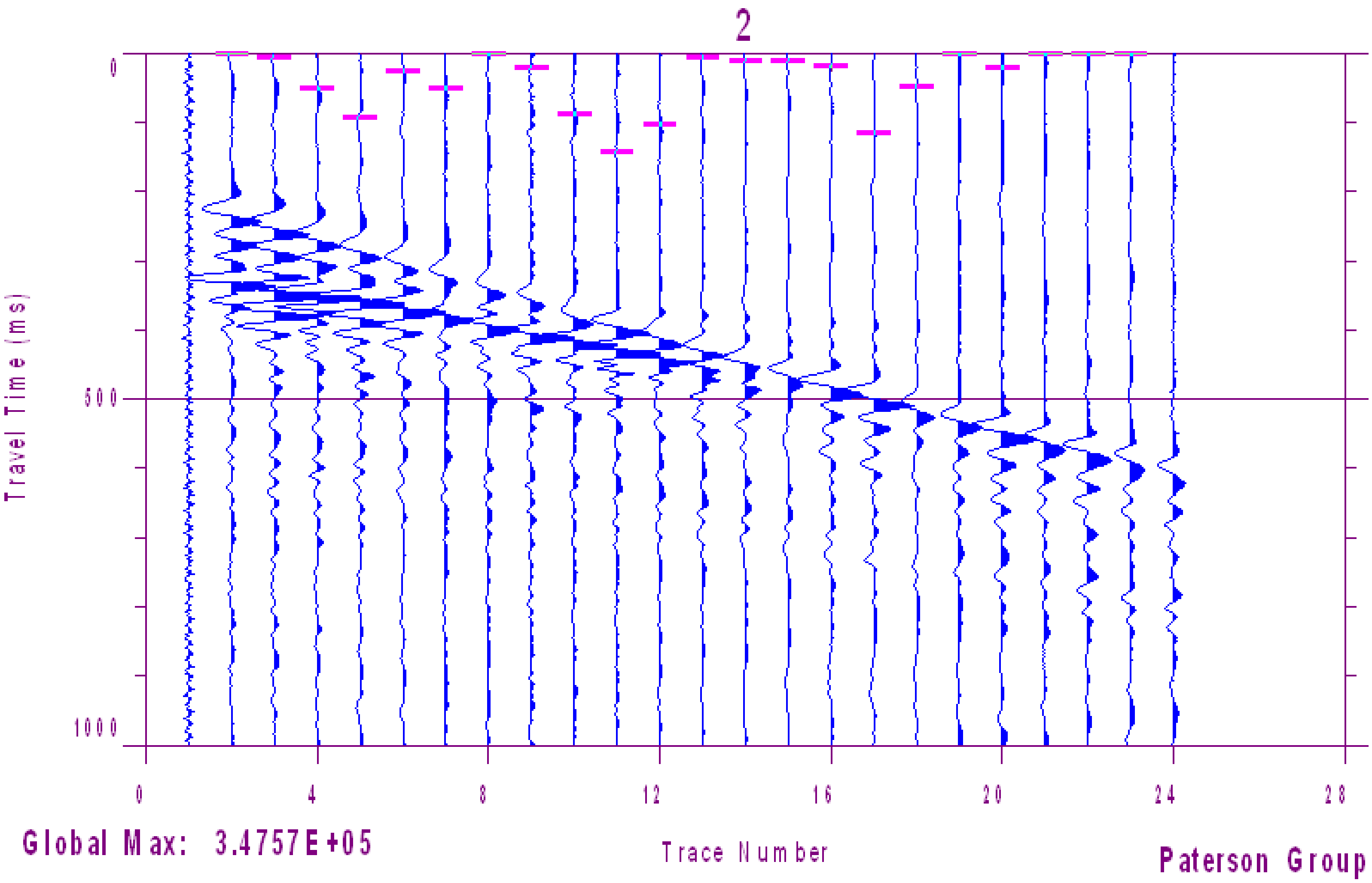
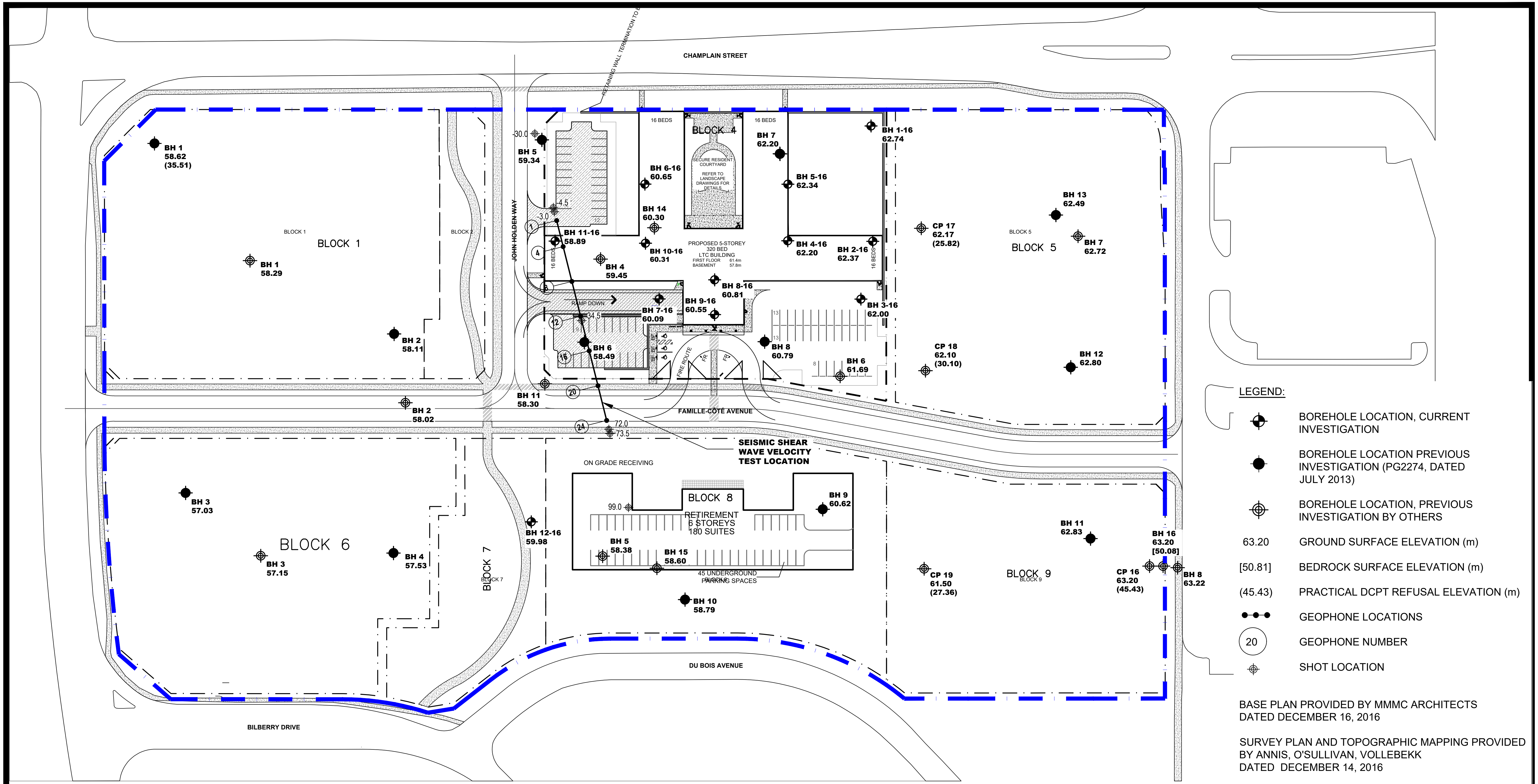


Figure 3 – Shear Wave Velocity Profile at Shot Location -30 m



LEGEND:

⊕	BOREHOLE LOCATION, CURRENT INVESTIGATION
●	BOREHOLE LOCATION PREVIOUS INVESTIGATION (PG2274, DATED JULY 2013)
⌖	BOREHOLE LOCATION, PREVIOUS INVESTIGATION BY OTHERS
63.20	GROUND SURFACE ELEVATION (m)
[50.81]	BEDROCK SURFACE ELEVATION (m)
(45.43)	PRACTICAL DCPT REFUSAL ELEVATION (m)
●-●-●	GEOPHONE LOCATIONS
(20)	GEOPHONE NUMBER
⌖	SHOT LOCATION

BASE PLAN PROVIDED BY MMMC ARCHITECTS
DATED DECEMBER 16, 2016

SURVEY PLAN AND TOPOGRAPHIC MAPPING PROVIDED
BY ANNIS, O'SULLIVAN, VOLLEBEKK
DATED DECEMBER 14, 2016

SCALE: 1:1250

0 5 10 15 20 25 50 75m

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NO.	REVISIONS	DATE	INITIAL
1	UPDATED BLOCK 4 CONCEPTUAL PLAN	30/03/2020	CB

REVERA LIVING
GEOTECHNICAL INVESTIGATION
PROPOSED LONG-TERM CARE FACILITY - 850 CHAMPLAIN STREET
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1250
Date: 12/2016
Drawn by: RCG
Report No.: PG4025
Checked by: CB
Dwg. No.: PG4025-1
Approved by: DJG
Revision No.: 1

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