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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Geotechnical Investigation

Proposed Residential Development
762 March Road and 335 Sandhill Road
Ottawa, Ontario

Prepared For

Minto Communities

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Report PG2234-2 Revision 3

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Minto Communities to conduct a geotechnical investigation for the proposed residential development to be located at 762 March Road and 335 Sandhill Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the current investigation were to:

- ☐ determine the subsoil and groundwater conditions at this site by means of test holes.
- ☐ to provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

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

2.0 Proposed Development

Based on the available drawings, the proposed residential development consists of townhouse blocks with associated asphalt-paved parking areas, access lanes, and landscaped margins. The Stage 1 development is proposed on the west side of Shirley's Brook, with future phase(s) to be located on the east side.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on September 29, 2010 and June 3, 2011. A previous geotechnical investigation was also completed for others by Paterson at the subject site. The previous investigation was carried out on August 14, 2009. The borehole and test pit locations were distributed in a manner to provide general coverage of the proposed development. The locations of the test holes are shown on Drawing PG2234-2 - Test Hole Location Plan included in Appendix 2.

A supplemental soils review was also completed on October 29, 2018 which included six (6) additional test pits across the subject site.

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

Sampling and In Situ Testing

Soil samples were recovered from the boreholes using a 50 mm diameter split-spoon sampler or from the auger flights, and as grab samples from the test pit sidewalls. The soil samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the split-spoon, auger and grab samples were recovered from the boreholes are shown as SS, AU and G, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing was carried out in cohesive soils using a field vane apparatus.

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

Groundwater

Flexible standpipes were installed at all borehole locations, with the exception of BH 1-10, to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Groundwater infiltration levels were noted at the time of excavation at the test pit locations.

Sample Storage

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

3.2 Field Survey

The ground surface elevations at the borehole locations of the previous investigation were provided by Annis O'Sullivan Vollebekk and are referenced to a geodetic datum. The current borehole locations were surveyed by Paterson and the ground surface at the borehole locations are referenced to the existing borehole elevations. The locations and the ground surface elevation for the borehole locations are presented on Drawing PG2234-4 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging. One (1) soil sample was submitted for grain size distribution (sieve and hydrometer) analysis.

Additional soil review was carried out in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) and included additional laboratory testing, consisting of six (6) Atterberg limits tests, one (1) supplemental grain size distribution test and one (1) shrinkage limit test. The results are summarized in Section 4.0 and are further discussed in Subsection 6.8.

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 was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the soil. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7 of this report.

4.0 Observations

4.1 Surface Conditions

The subject site is located between March Road and Sandhill Road. The site is undeveloped and grass covered with several full grown trees throughout. Shirley's Brook crosses the site in a north-south direction within the west portion of the site. The east and west portions of the site slope gradually down towards Shirley's Brook. A low lying area with standing water was noted within the east portion of the site.

4.2 Subsurface Profile

Generally, the soil profile at the subject site consists of topsoil underlain by a thin silty sand layer followed by a stiff silty clay deposit and/or a glacial till layer. Practical refusal to augering was encountered at several borehole locations at depths varying between 1.6 to 7.4 m. Specific details of the soil 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 consists of interbedded sandstone and dolomite of the March formation with an overburden thickness between 5 and 15 m.

Hydraulic Conductivity Estimates

It is understood that hydraulic conductivity estimates were requested to determine the infiltration rates of the native soils. Based on our grain size testing results and our experience with the encountered soils, a range of hydraulic conductivities are provided in Table 1.

Table 1 - Range of Hydraulic Conductivity for Undisturbed, Native Soils

Material	Hydraulic Conductivity, K (cm/sec)
Silty Sand/Sandy Silt	10^{-5} to 10^{-3}
Silty Clay	10^{-9} to 10^{-6}
Glacial Till (as per above)	10^{-5} to 10^{-3}

The hydraulic conductivities noted for the silty sand, sandy silt, silty clay and glacial till are of a medium to low permeability. Due to the presence of the silty clay and/or glacial till deposit, the subject site is not conducive to local infiltration measures as a means to handle storm water management for the proposed development.

Laboratory Testing

Atterberg limits testing, as well as associated moisture content testing, was completed on the recovered silty clay samples at selected locations throughout the subject site.

The results of the Atterberg limits tests are presented in Table 2 and on the Atterberg Limits Results sheet in Appendix 1. The tested silty clay samples classify as inorganic clays of high plasticity (CH) in accordance with the Unified Soil Classification System.

Table 2 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
TP 1-18	2.95	58	22	35	33	CH
TP 2-18	2.2	64	23	41	42	CH
TP 3-18	2.4	67	21	46	48	CH
TP 4-18	3.35	59	21	38	50	CH
TP 5-18	2.8	65	23	42	55	CH
TP 6-18	4.9	68	29	39	49	CH

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content;
CH: Inorganic Clay of High Plasticity

The results of the shrinkage limit test indicate a shrinkage limit of 20% and a shrinkage ratio of 1.77.

Grain size distribution (sieve and hydrometer analysis) was also completed on two (2) selected soil samples. The results of the grain size analysis are summarized in Table 3 and presented on the Grain Size Distribution Results sheets in Appendix 1.

Table 3 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP 2-18	G5	0	0.5	40	59.5
TP 4	G1	5.1	23.1	33.8	38

4.3 Groundwater

Groundwater levels were recorded at the borehole locations following the completion of the drilling program. The groundwater level readings are presented in Table 4.

Table 4 - Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	77.14	3.84	73.30	August 28, 2009
BH 2	76.41	1.57	74.84	August 28, 2009
BH 3	73.74	2.48	71.26	August 28, 2009
BH 4	75.97	3.64	72.33	August 28, 2009
BH 5	76.63	2.97	73.66	August 28, 2009
BH 6	76.42	2.52	73.90	August 28, 2009
BH 2-10	77.55	4.63	72.92	October 12, 2010
BH 3-10	72.77	0.58	72.19	October 12, 2010

Note: The ground surface elevations at the borehole locations were provided by Annis O'Sullivan Vollebekk and are assumed to be referenced to a geodetic datum.

It should be noted that groundwater level readings can be influenced by infiltration of surface water into the backfilled borehole.

Long-term groundwater levels can also be estimated based on observations, such as the colouring, consistency and moisture content of the recovered soil samples. Based on these observations, the long-term groundwater level is estimated at 3 to 4 m depth. Groundwater levels are subject to seasonal fluctuations, and therefore levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed residential development. It is expected that the proposed residential buildings will be founded on conventional shallow footings placed on an undisturbed, stiff silty clay or compact silty sand bearing surface, or on engineered fill placed over an undisturbed, stiff silty clay or compact silty sand bearing surface.

Shirley's Brook corridor was noted crossing north-south within the west portion of the site. At the time of our field investigation, the water course was noted to be 2 to 3 m wide and approximately 0.5 m deep. The water course is confined by 0.5 to 1 m high bank walls. The bank walls were noted to be well vegetated and stable. Based on the water course width and sidewall dimensions, it is expected that any geotechnical setback determined for limit of hazard lands will be superceded by the development setback requirements of the City of Ottawa.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Fill Placement

Fill used for grading beneath the proposed buildings, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. It 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 building areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane connected to the perimeter drainage system is provided.

5.3 Foundation Design

Shallow Foundation

Spread footings, up to 3 m wide, and pad footings, up to 6 m wide, placed on an undisturbed, stiff silty clay bearing surface, or on engineered fill placed over an undisturbed, stiff silty clay bearing surface, can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**. Footings placed on a compact, silty sand bearing surface, or on engineered fill placed over an undisturbed, silty sand bearing surface, can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **150 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance values at ULS. The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

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

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a silty clay bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as the soil.

Permissible Grade Raise and Settlement

Shear strengths recorded at the borehole locations within the silty clay deposit were indicative of very stiff to hard consistency. Therefore, a permissible grade raise of up to 3 m is available for this site.

Where higher than permissible grade raises are proposed, lightweight fill and/or other measures will be required to reduce the risks of unacceptable long-term post construction total and differential settlements.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the foundations considered at this site. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code (OBC) 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and fill containing deleterious materials within the footprint of the proposed buildings, the native soil will be considered an acceptable subgrade surface on which to commence backfilling for floor slab construction. OPSS Granular B Type II, with a maximum particle size of 50 mm, is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Design

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

Table 5 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 6 - Recommended Pavement Structure - Local Roadways

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either in situ soils or OPSS Granular B Type I or II material placed over in situ soil	

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or II material.

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

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition.

Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the 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. Along local streets, the drains should be placed along the edges of the pavement. The subdrains should consist of 150 mm diameter perforated corrugated plastic pipe, wrapped in a suitable filter cloth and surrounded on all sides by 150 mm of 19 mm clear crushed stone. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

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

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

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

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for exterior unheated footings, not thermally connected to a heated space, such as exterior columns and/or wing walls.

It is understood that several of the proposed units have a walk-out style basement, where soil cover will be minimal over the proposed footings. Typical insulation details for footings with a minimal soil cover and founded over a frost susceptible bearing medium are presented in Figure 2 in Appendix 2.

6.3 Excavation Side Slopes

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

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

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides. Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

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

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

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

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

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

6.5 Groundwater Control

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. It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps and pumps.

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

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 and 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 completed by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

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

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

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 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 moderately aggressive corrosive environment.

6.8 Landscaping Considerations

Tree planting restrictions have been prepared for two scenarios. The first is considering tree planting on a public right-of-way (ROW) according to City guidelines. The second scenario considers a private ROW and tree planting restrictions based on conventional tree setback designs.

Scenario 1 - Tree Planting Restrictions - Public Right-of-Way

Paterson completed a soils review of the site to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) for trees planted within a public ROW. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Sieve analysis testing was also completed on selected soil samples. The abovenoted test results were completed on samples taken at depths between proposed design underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 2 and 3 in Subsection 4.2 and in Appendix 1.

Based on the results of our review, two tree planting setback areas are present within the proposed development. The two areas are detailed below and have been outlined on Drawing PG2234-5 - Tree Planting Setback Recommendations presented in Appendix 2.

Area 1 - Low to Medium Sensitivity Area

A low to medium sensitivity clay soil was encountered between the anticipated design underside of footing elevations and 3.5 m below finished grade as per City Guidelines in the areas outlined in Drawing PG2234-5 - Tree Planting Setback Recommendations in Appendix 2. Based on our Atterberg limits test results, the modified plasticity index does not exceed 40% in these areas. The following tree planting setbacks are recommended for the low to medium sensitivity area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to **4.5 m** for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the conditions noted below are met.

☐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan.

☐ A small tree must be provided with a minimum of 25 m^3 of available soils volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

☐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

☐ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

☐ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Area 2 - High Sensitivity Area

High sensitivity clay soils were encountered between the anticipated design underside of footing elevations and 3.5 m below finished grade as per City Guidelines at the areas outlined in PG2234-5 - Tree Planting Setback Recommendations in Appendix 2. Based on our Atterberg limits test results, the modified plasticity index generally exceeds 40% in these areas. The following tree planting setbacks are recommended for these high sensitivity areas. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits are 7.5 m for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the following conditions are met:

☐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan.

☐ A small tree must be provided with a minimum of 25 m^3 of available soils volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

☐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

☐ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

☐ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Scenario 2 - Tree Planting Restrictions - Private Right-of-Way

It is understood that a portion of the proposed development will include private roads, and tree planting could be carried out within the private ROW. It is anticipated that the combination of proposed finished grades combined with the thickness of the underlying weathered clay crust will provide an approximately 4 to 5 m buffer to the underlying firm silty clay deposit.

Tree planting in areas of the subject development, within a private ROW, will be limited to low water demand trees. The minimum permissible distance from the foundation will depend on the nature of the tree, the depth of the clay crust and the final grade raise in relation to the permissible grade raise. For a private ROW, this minimum distance can be taken as **4.5 m** for the subject site for small (mature height up to 7.5 m) and medium size trees (mature height 7.5 to 14 m), with roots extending to a maximum of 2 m below ground surface.

Small and medium size trees should be provided with a minimum available soil volume of 25 m^3 and 30 m^3, respectively, as determined by the Landscape Architect. Care should be taken to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

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.

Aboveground Swimming Pools

The in-situ soils are considered to be acceptable for in-ground swimming pools. Above ground swimming pools must be placed at least 5 m away from the residence foundation and neighbouring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer’s recommendations.

Aboveground Hot Tubs

Additional grading around hot tubs should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Decks and Building Additions

Additional grading around proposed decks or additions should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

6.9 Construction Effects on Neighbouring Private Services

Based on the impervious nature of the silty clay layer, the zone of influence of the proposed development construction will be minimal and should not extend beyond a 2H:1V from the proposed service inverts. The glacial till layer can be considered to be a more permeable layer than the silty clay deposit. However, within the glacial till layer the zone of influence due to temporary dewatering activities associated with service placement is still considered to be limited to a 5H:1V slope from the base of the excavation. Therefore, the zone of influence for any dewatering activities will be well contained within the property boundaries of the proposed development and any existing neighbouring wells will not be negatively effected.

It is our understanding that several of the adjacent properties have private septic systems. Provided that surface water from the construction site is prevented from flowing to the adjacent properties, and that the septic systems were constructed using the minimum setback distances, the private septic systems should be unaffected from construction activities.

It should further be noted that based on available information, it is expected that the majority of the adjacent properties are serviced by municipal water. However, based on historic water well records, potable wells could still service some of the adjacent properties. Based on available well record data, the private wells in the area were sealed into the bedrock and taking from the bedrock aquifer.

The proposed services and building foundations are not expected to encounter bedrock across the proposed development, and hence will not impact any neighbouring wells appropriately sealed into the bedrock.

6.10 Global Stability Analysis of Retaining Wall

A global stability analysis of the proposed retaining wall to be located to the east of Blocks TE-1, TE-2, and TE-3 was completed using SLIDE, a computer program which permits a two-dimensional slope stability analysis using several methods including Bishop's method, which is a widely used and accepted analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to those favouring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain that the risks of failure are acceptable.

One cross section was analysed as the possible worst case scenario through the proposed retaining wall. The location of the cross section analyzed is presented on Drawing PG2234-4 - Test Hole Location Plan in Appendix 2.

Static Loading Analysis

The results of the static loading analysis for the proposed conditions at Section A is shown in Figure 3 provided in Appendix 2. The minimum slope stability factor of safety was calculated to be 1.56 which is greater than the minimum recommended factor of safety of 1.5 for static conditions. Based on the results, the proposed conditions are considered stable under static loading.

Seismic Loading Analysis

An analysis considering seismic loading was also completed for Section A. A horizontal seismic acceleration, K_h, of 0.16G was considered for the analysed section. A factor of safety of 1.1 is considered to be satisfactory for stability analysis including seismic loading.

The results of the analysis including seismic loading is shown in Figure 4 in Appendix 2. The overall slope stability factor of safety for the subject section when considering seismic loading was found to be greater than 1.1. Based on the results, the slope is considered stable under seismic loading.

7.0 Recommendations

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

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

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

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

❑ Observation of all subgrades prior to backfilling

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

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

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

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. Our recommendations should be reviewed when the drawings and specifications are complete.

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

A soils investigation of this nature is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Minto Communities or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Scott Dennis

Scott S. Dennis, P.Eng.

LICENSED PROFESSIONAL ENGINEER
April 16-2019
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

David J. Gilbert, P.Eng.

Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS RESULTS

GRAIN SIZE DISTRIBUTION SHEETS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE October 29, 2018

FILE NO. PG2234

HOLE NO. TP 1-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	77.98
FILL: Brown silty clay with organics, trace sand	▨	G	1				
0.50							
FILL: Brown silty sand	▨	G	2				
						1	76.98
	▨	G	3				
1.70							
	▨					2	75.98
Very stiff, brown **SILTY CLAY**	▨	G	4				
	▨	G	5				
3.00						3	74.98
End of Test Pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m

● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE October 29, 2018

FILE NO. PG2234

HOLE NO. TP 2-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	75.73		
FILL: Brown silty sand with organics, trace sand 0.20		G	1						
FILL: Brown silty sand with clay 0.40		G	2						
		G	3						
Stiff, brown **SILTY CLAY**						1	74.73		
		G	4						
						2	73.73		
2.30		G	5						
End of Test Pit (TP dry upon completion)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE October 29, 2018

FILE NO. PG2234

HOLE NO. TP 3-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	74.75		
FILL: Brown silty sand, some clay and organics 0.10		G	1						
FILL: Brown silty sand		G	2						
		G	3						
1.00						1	73.75		
Stiff, brown **SILTY CLAY**		G	4						
						2	72.75		
2.50		G	5						
End of Test Pit (TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE October 29, 2018

FILE NO. PG2234

HOLE NO. TP 4-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE									
FILL: Brown silty sand with organics	▨	G	1			0	77.87		
0.20									
FILL: Brown silty sand	▨	G	2						
	▨					1	76.87		
1.30									
Stiff, brown **SILTY CLAY**	▨	G	3						
	▨					2	75.87		
	▨					3	74.87		
	▨	G	4						
3.50									
End of Test Pit									
(TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE October 29, 2018

FILE NO. PG2234

HOLE NO. TP 5-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	76.39		
FILL: Brown silty sand with organics 0.20	▨	G	1						
FILL: Brown silty sand 1.00	▨	G	2						
						1	75.39		
Stiff, brown **SILTY CLAY**	▨	G	3						
						2	74.39		
3.00	▨	G	4						
End of Test Pit (TP dry upon completion)						3	73.39		

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 760 March Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG2234

REMARKS

HOLE NO. TP 6-18

BORINGS BY Backhoe

DATE October 29, 2018

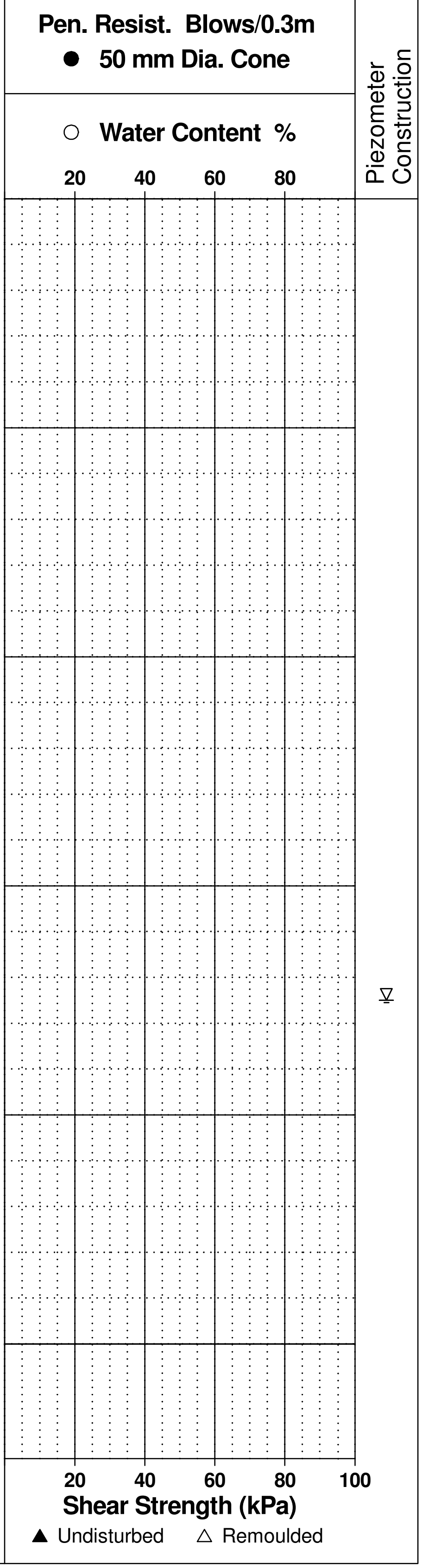
SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown silty sand with organics, trace clay	0.20
FILL: Brown silty sand	1.20
FILL: Crushed stone	2.00
Brown **SANDY SILT**	2.40
Stiff, brown **SILTY CLAY**	5.00

End of Test Pit

(Groundwater infiltration at 3.5m depth)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
G	1		
G	2		
G	3		
G	4		
G	5		
G	6		
G	7		

DEPTH (m)	ELEV. (m)
0	75.94
1	74.94
2	73.94
3	72.94
4	71.94
5	70.94



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 29 September 2010

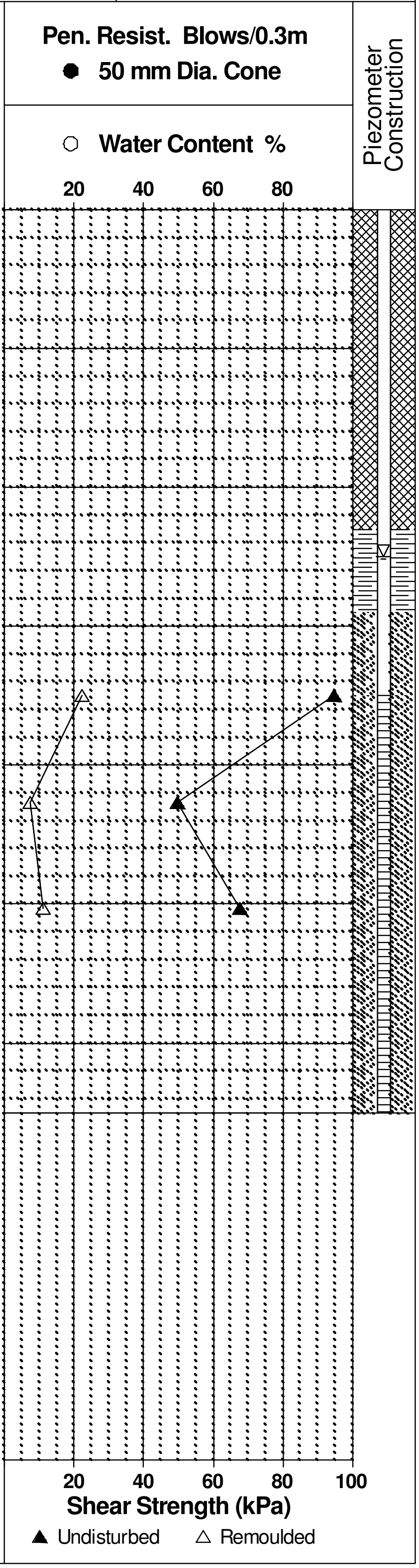
FILE NO. PG2234

HOLE NO. BH 1-10

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.48
Loose, brown **SILTY SAND**	1.04
Stiff, brown **SILTY CLAY** - grey by 3.0m depth	5.18
GLACIAL TILL: Grey silty sand with clay, gravel, cobbles and boulders	6.50
End of Borehole Practical refusal to augering @ 6.50m depth (GWL @ 2.5m depth based on field observations)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	79	6
SS	2	92	6
SS	3	83	5
SS	4	92	2
SS	5	100	6

DEPTH (m)	ELEV. (m)
0	74.02
1	73.02
2	72.02
3	71.02
4	70.02
5	69.02
6	68.02



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 29 September 2010

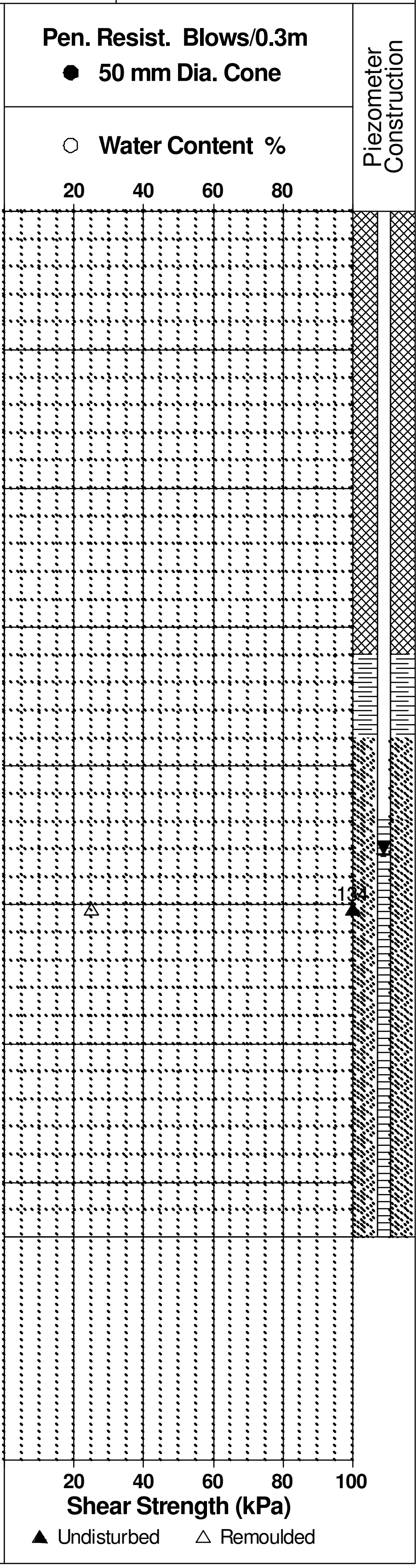
FILE NO. PG2234

HOLE NO. BH 2-10

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
Loose to compact, brown **SILTY SAND**	1.45
Very stiff, grey-brown **SILTY CLAY** - grey by 3.7m depth	5.18
GLACIAL TILL: Grey silty clay with gravel, cobbles and boulders	7.39
End of Borehole Practical refusal to augering @ 7.39m depth (GWL @ 4.63m-Oct. 12/10)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	92	5
SS	2	88	12
SS	3	67	10
SS	4	92	11
SS	5	100	6
SS	6	100	5
SS	7		2
SS	8	100	6

DEPTH (m)	ELEV. (m)
0	77.55
1	76.55
2	75.55
3	74.55
4	73.55
5	72.55
6	71.55
7	70.55



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

FILE NO. PG2234

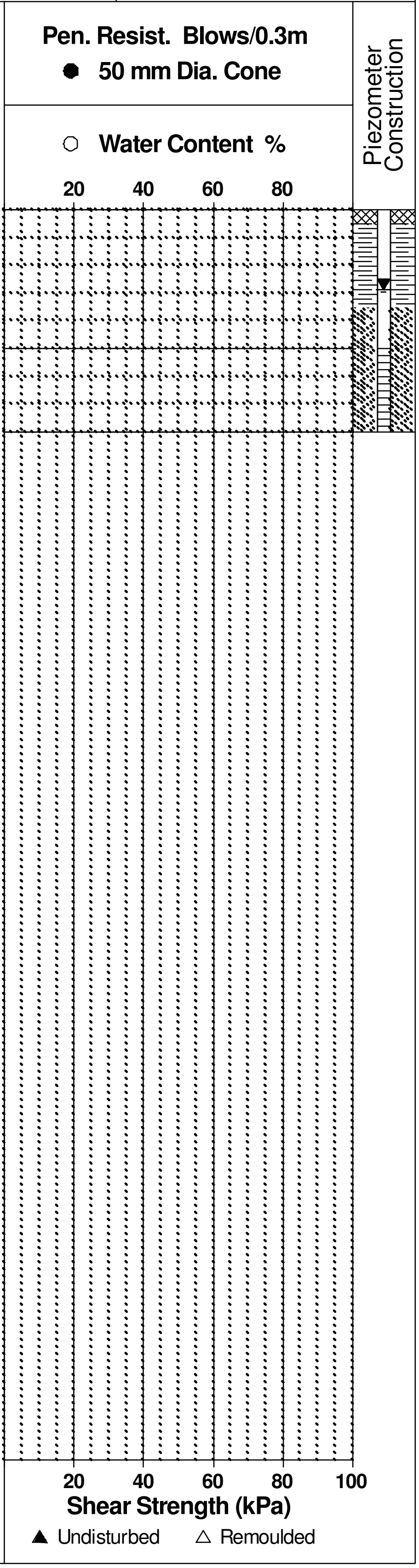
REMARKS

HOLE NO. BH 3-10

BORINGS BY CME 55 Power Auger

DATE 29 September 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	72.77
TOPSOIL 0.13							
Loose, brown **SANDY SILT,** some clay 0.56		SS	1	92	4		
GLACIAL TILL: Grey silty clay to silty sand with clay, gravel, cobbles and boulders		SS	2	62	2	1	71.77
1.60		SS	3	100	50+		
End of Borehole Practical refusal to augering @ 1.60m depth (GWL @ 0.58m-Oct. 12/10)							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE 14 August 2009

FILE NO. PG1927

HOLE NO. BH 1

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.08
Compact, brown **SILTY SAND**	0.76
Hard, brown **SILTY CLAY**	5.49

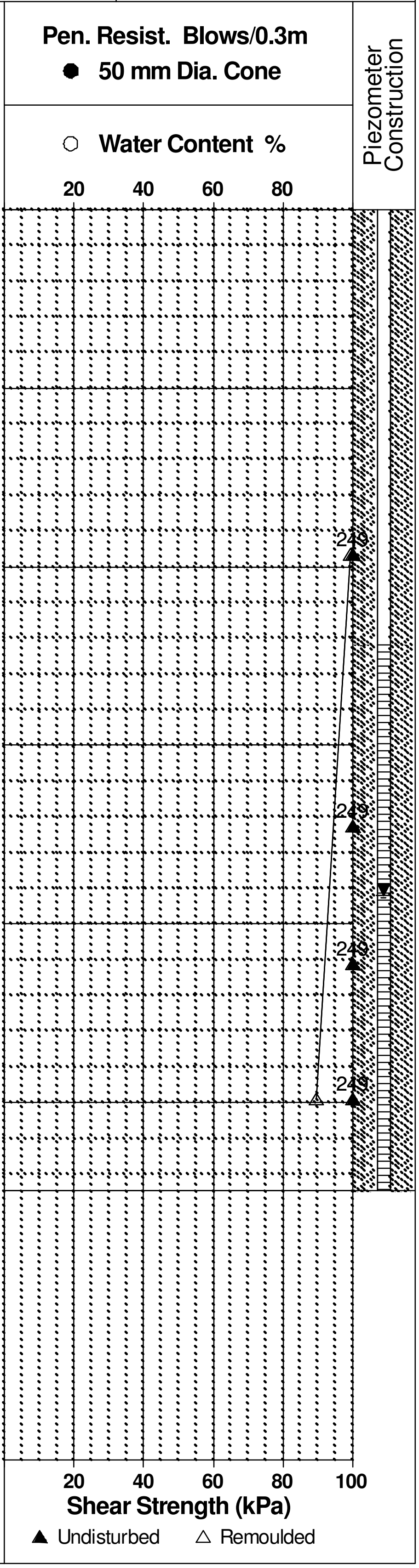
End of Borehole

Practical refusal to augering @ 5.49m depth

(GWL @ 3.84m-Aug. 28/09)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	13
SS	3	67	P
SS	4	100	7

DEPTH (m)	ELEV. (m)
0	77.14
1	76.14
2	75.14
3	74.14
4	73.14
5	72.14



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE 14 August 2009

FILE NO. PG1927

HOLE NO. BH 2

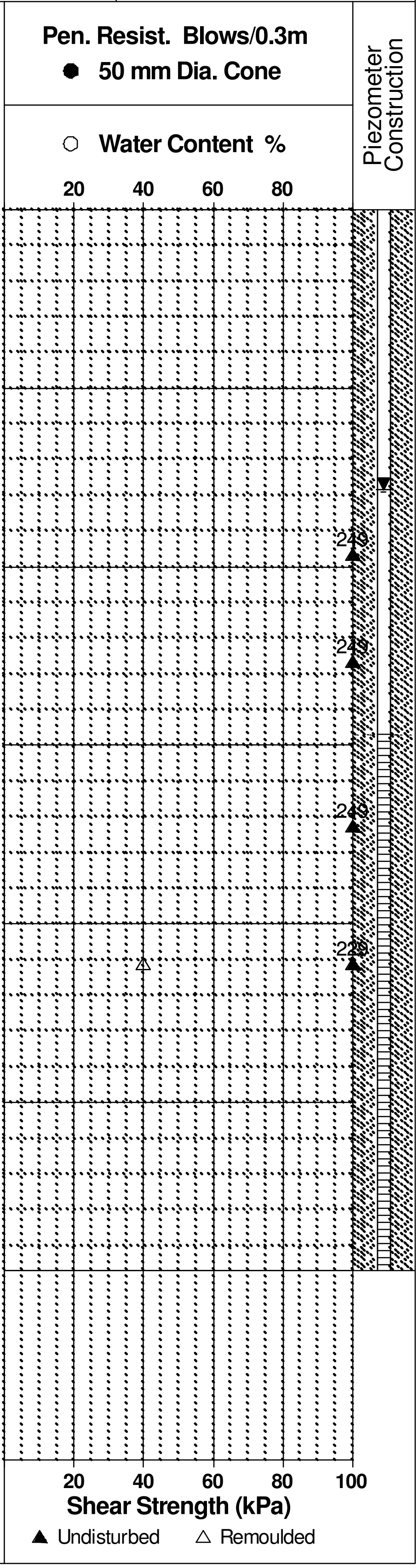
SOIL DESCRIPTION	Depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.08				
Compact, brown **SILTY SAND**	0.76	AU	1		
Hard, brown **SILTY CLAY**	4.40	SS	2	83	14
		SS	3	100	P
GLACIAL TILL: Grey silty sand with gravel, cobbles and boulders	5.94	SS	4	25	4
		SS	5	100	50+

End of Borehole

Practical refusal to augering @ 5.94m depth

(GWL @ 1.57m-Aug. 28/09)

DEPTH (m)	ELEV. (m)
0	76.41
1	75.41
2	74.41
3	73.41
4	72.41
5	71.41



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

FILE NO. **PG1927**

REMARKS

HOLE NO. **BH 3**

BORINGS BY CME 55 Power Auger

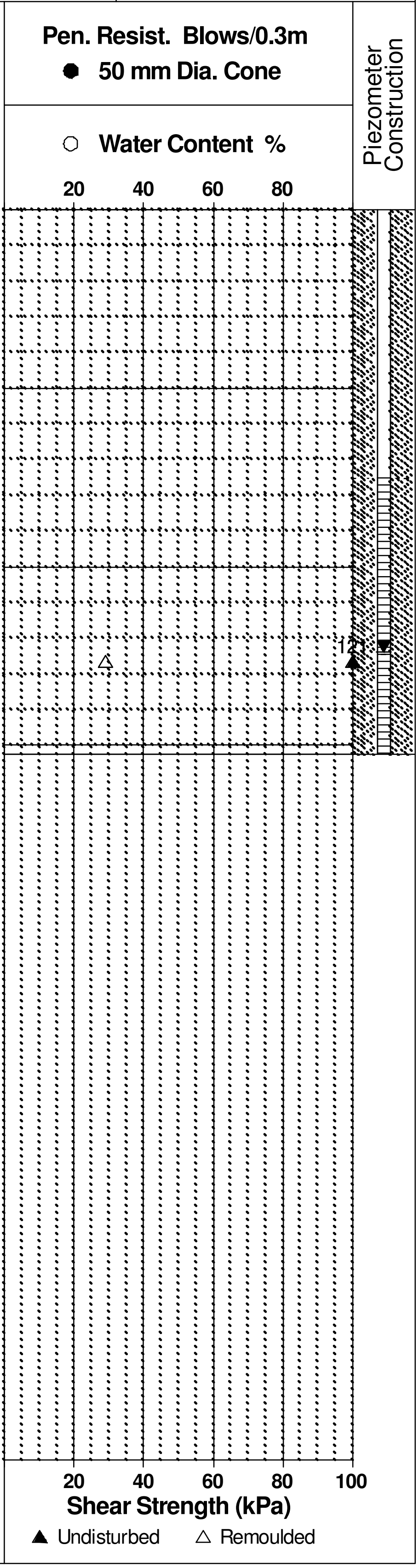
DATE 14 August 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	73.74
TOPSOIL 0.08						
Compact to loose, brown **SILTY SAND**	AU	1				
	SS	2	25	6	1	72.74
1.37						
Very stiff, brown **SILTY CLAY**	SS	3	42	2	2	71.74
3.05					3	70.74

End of Borehole

Practical refusal to augering @ 3.05m depth

(GWL @ 2.48m-Aug. 28/09)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

REMARKS

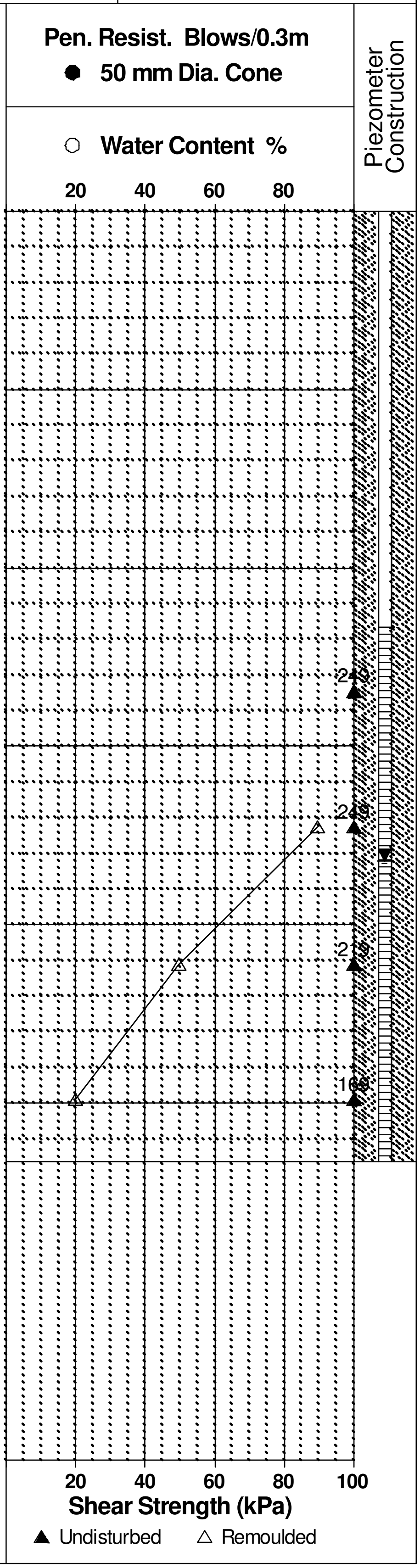
BORINGS BY CME 55 Power Auger

DATE 14 August 2009

FILE NO. PG1927

HOLE NO. BH 4

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.97
TOPSOIL	0.05						
Compact to loose, brown **SILTY SAND**		AU	1				
	1.30	SS	2	25	8	1	74.97
Hard, brown **SILTY CLAY**		SS	3	83	7	2	73.97
						3	72.97
						4	71.97
- very stiff and grey by 4.4m depth	5.33	SS	4	100	P	5	70.97
End of Borehole Practical refusal to augering @ 5.33m depth (GWL @ 3.64m-Aug. 28/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

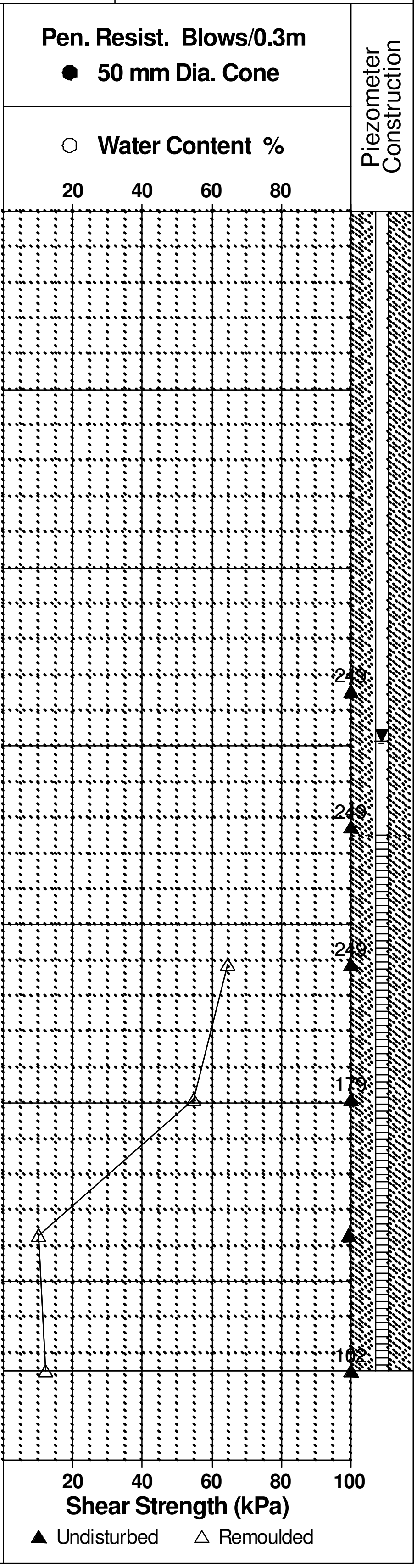
DATE 14 August 2009

FILE NO. PG1927

HOLE NO. BH 5

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.06				
Compact to loose, brown **SILTY SAND**	AU	1		
	SS	2	33	9
1.37				
Hard, brown **SILTY CLAY**	SS	3	83	9
	SS	4	100	P
- very stiff and grey by 4.4m depth				
	SS	5	100	P
6.50				
End of Borehole				
(GWL @ 2.97m-Aug. 28/09)				

DEPTH (m)	ELEV. (m)
0	76.63
1	75.63
2	74.63
3	73.63
4	72.63
5	71.63
6	70.63



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Sandhill Road
Ottawa, Ontario

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE 14 August 2009

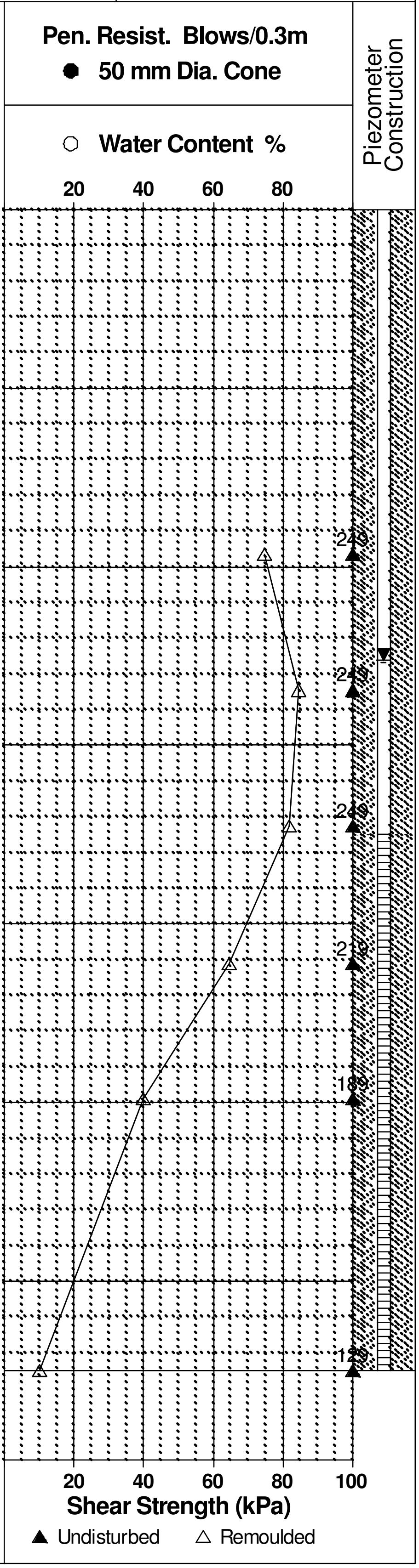
FILE NO. PG1927

HOLE NO. BH 6

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.05
Hard to very stiff, brown **SILTY CLAY** - grey by 5.3m depth	6.50
End of Borehole (GWL @ 2.52m-Aug. 28/09)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	7
SS	3	100	P
SS	4	100	P

DEPTH (m)	ELEV. (m)
0	76.42
1	75.42
2	74.42
3	73.42
4	72.42
5	71.42
6	70.42



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

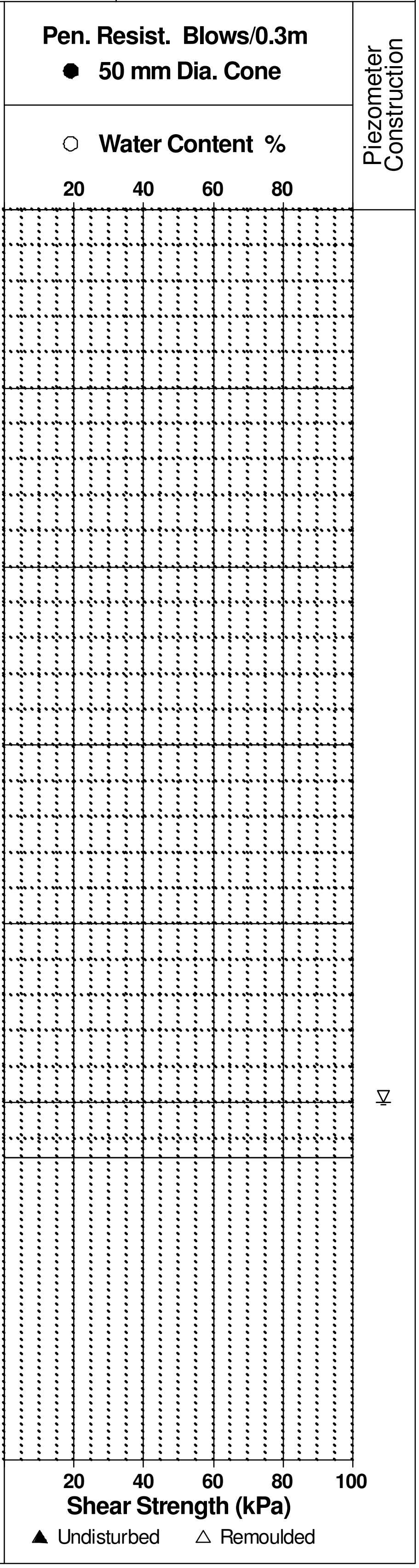
BORINGS BY Backhoe

DATE 3 June 2011

FILE NO. PG2234

HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0		
TOPSOIL 0.38								
Loose, brown **SILTY SAND** 1.35						1		
Very stiff to stiff, brown **SILTY CLAY** 5.31		G	1			2 3 4 5		▽
End of Test Pit TP terminated on bedrock surface @ 5.31m depth (GWL @ 5.0m based on field observations)								



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

FILE NO. PG2234

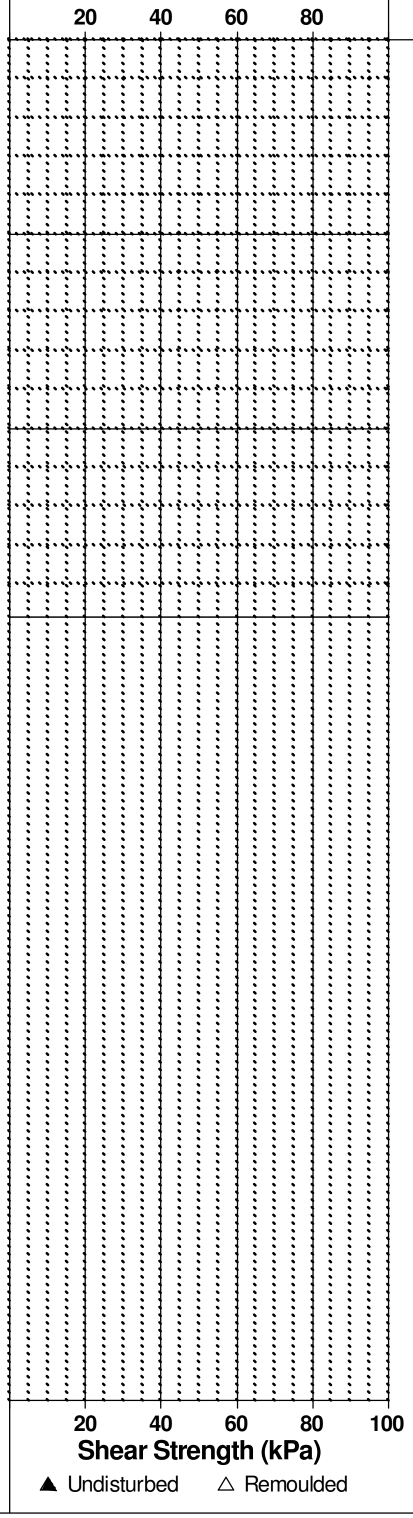
REMARKS

HOLE NO. TP 2

BORINGS BY Backhoe

DATE 3 June 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.36									
Brown **SILTY SAND** 1.14						1			
Brown **SILTY CLAY** 2.97		G	1			2			▽
End of Test Pit TP terminated on bedrock surface @ 2.97m depth (GWL @ 2.7m based on field observations)									



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

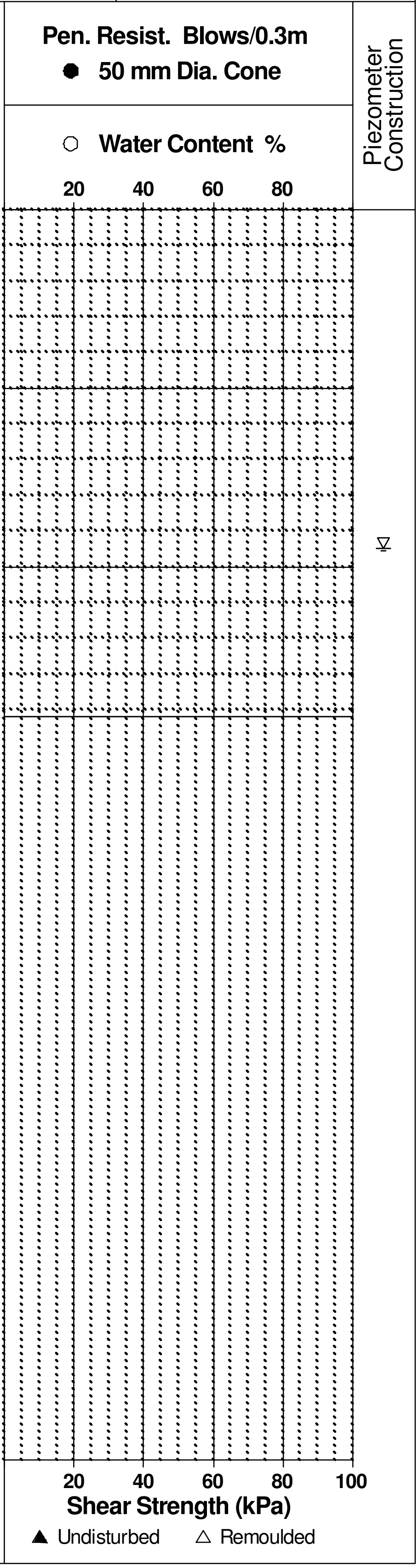
BORINGS BY Backhoe

DATE 3 June 2011

FILE NO. **PG2234**

HOLE NO. **TP 3**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL 0.15							
Grey-brown **SILTY SAND** 1.65						1	
Stiff, brown **SILTY CLAY** 2.84		G	1			2	
End of Test Pit TP terminated on bedrock surface @ 2.84m depth (GWL @ 1.9m based on field observations)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

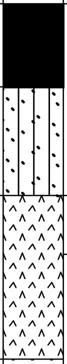
BORINGS BY Backhoe

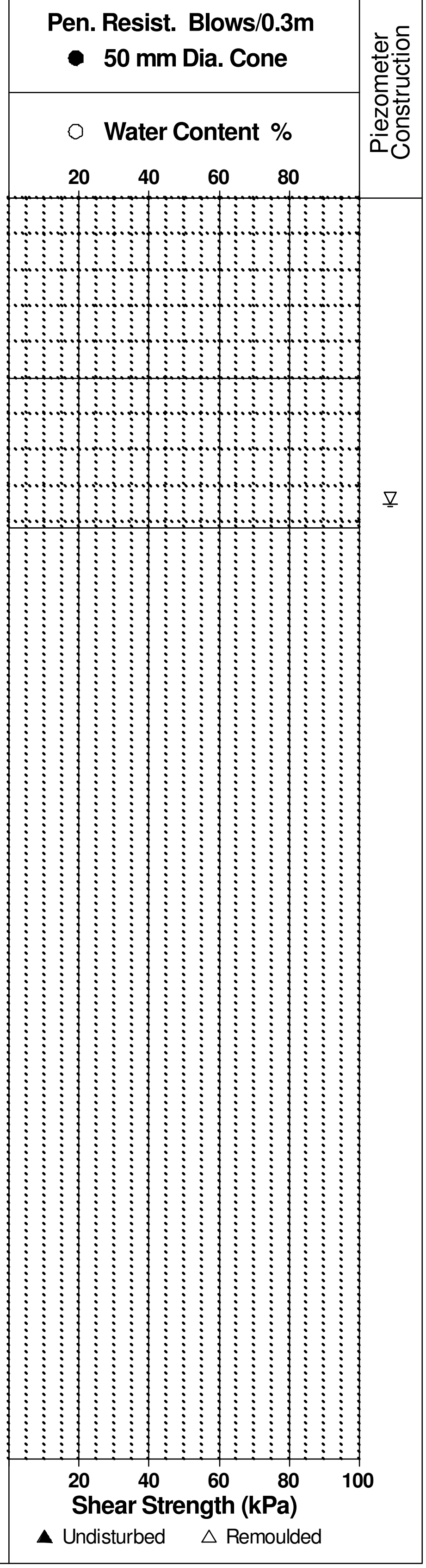
DATE 3 June 2011

FILE NO. PG2234

HOLE NO. TP 4

SOIL DESCRIPTION	SAMPLE				DEPTH (m)	ELEV. (m)
	TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE					0	
TOPSOIL 0.43						
Brown **SILTY SAND** 0.99					1	
GLACIAL TILL: Grey silty clay to silty sand with gravel, cobbles and boulders 1.83	G	1				
End of Test Pit TP terminated on bedrock surface @ 1.83m depth (GWL @ 1.7m based on field observations)						





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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

FILE NO. **PG2234**

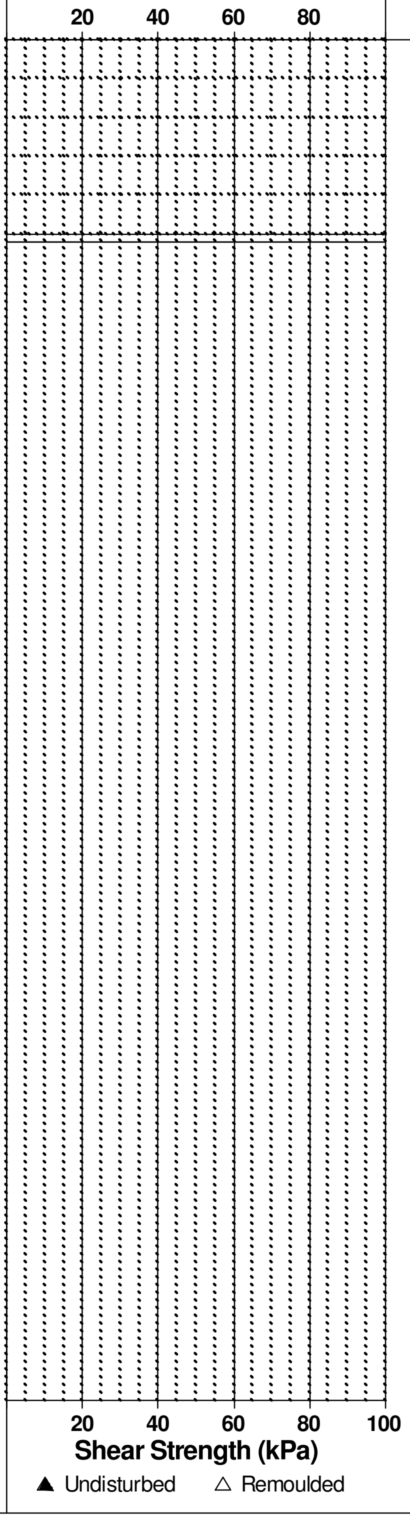
REMARKS

HOLE NO. **TP 5**

BORINGS BY Backhoe

DATE 3 June 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.13									
Brown **SILTY SAND,** some clay 0.30									
Brown **SILTY CLAY** 1.04		G	1			1			▽
End of Test Pit (GWL @ 1.0m based on field observations)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 June 2011

FILE NO. PG2234

HOLE NO. TP 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.28									
Loose, brown **SILTY SAND** 0.46									
Stiff, brown **SILTY CLAY** 1.22		G	1			1			
End of Test Pit									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 June 2011

FILE NO. PG2234

HOLE NO. TP 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.15									
Grey to brown **SILTY SAND** 0.60									
PEAT 0.71									▽
Stiff, brown **SILTY CLAY** 1.65		G	1			1			
End of Test Pit (GWL @ 0.8m based on field observations)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup **Consulting Engineers**

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Sandhill Road
Ottawa, Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 June 2011

FILE NO. **PG2234**

HOLE NO. **TP 8**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0			
TOPSOIL 0.33									
Loose, brown **SILTY SAND** 0.91									
Very stiff, brown **SILTY CLAY** 1.45		G	1			1			▽
End of Test Pit (GWL @ 1.4m based on field observations)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

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

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

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

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

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)

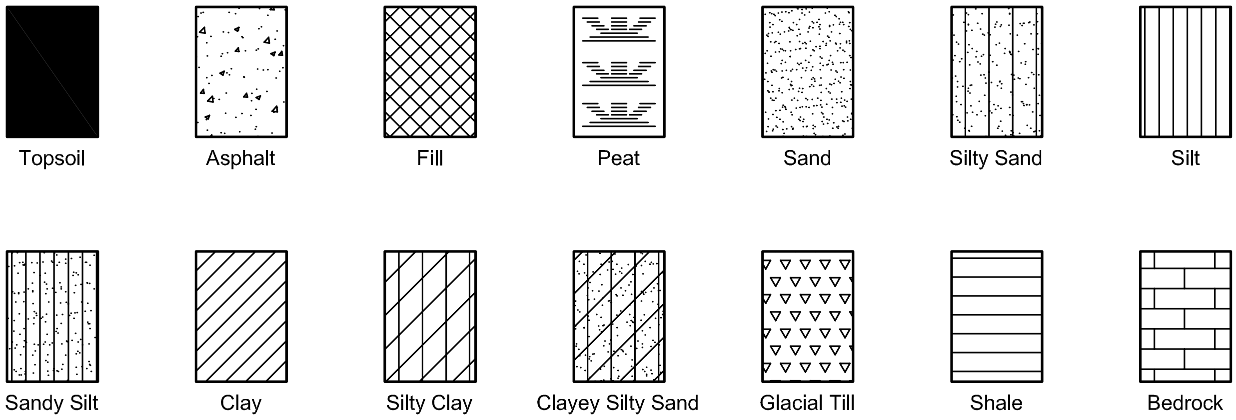
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

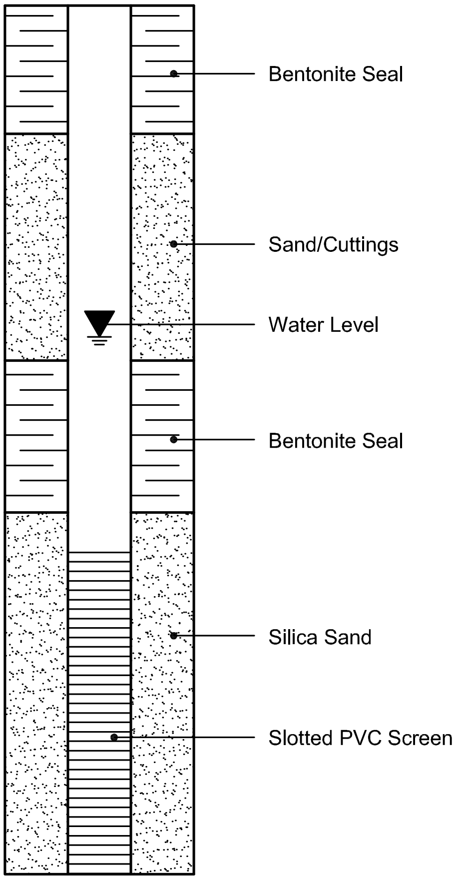
SYMBOLS AND TERMS (continued)

STRATA PLOT

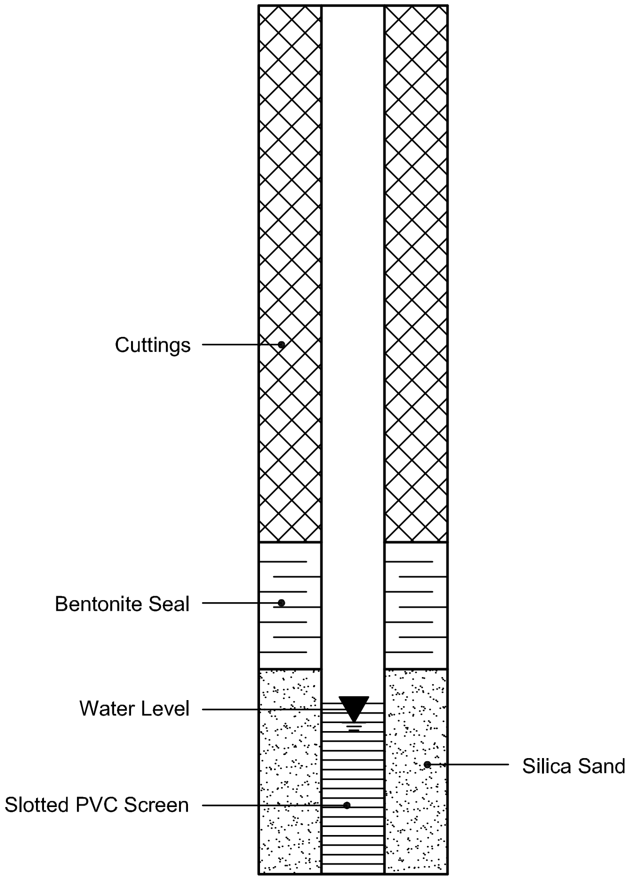


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



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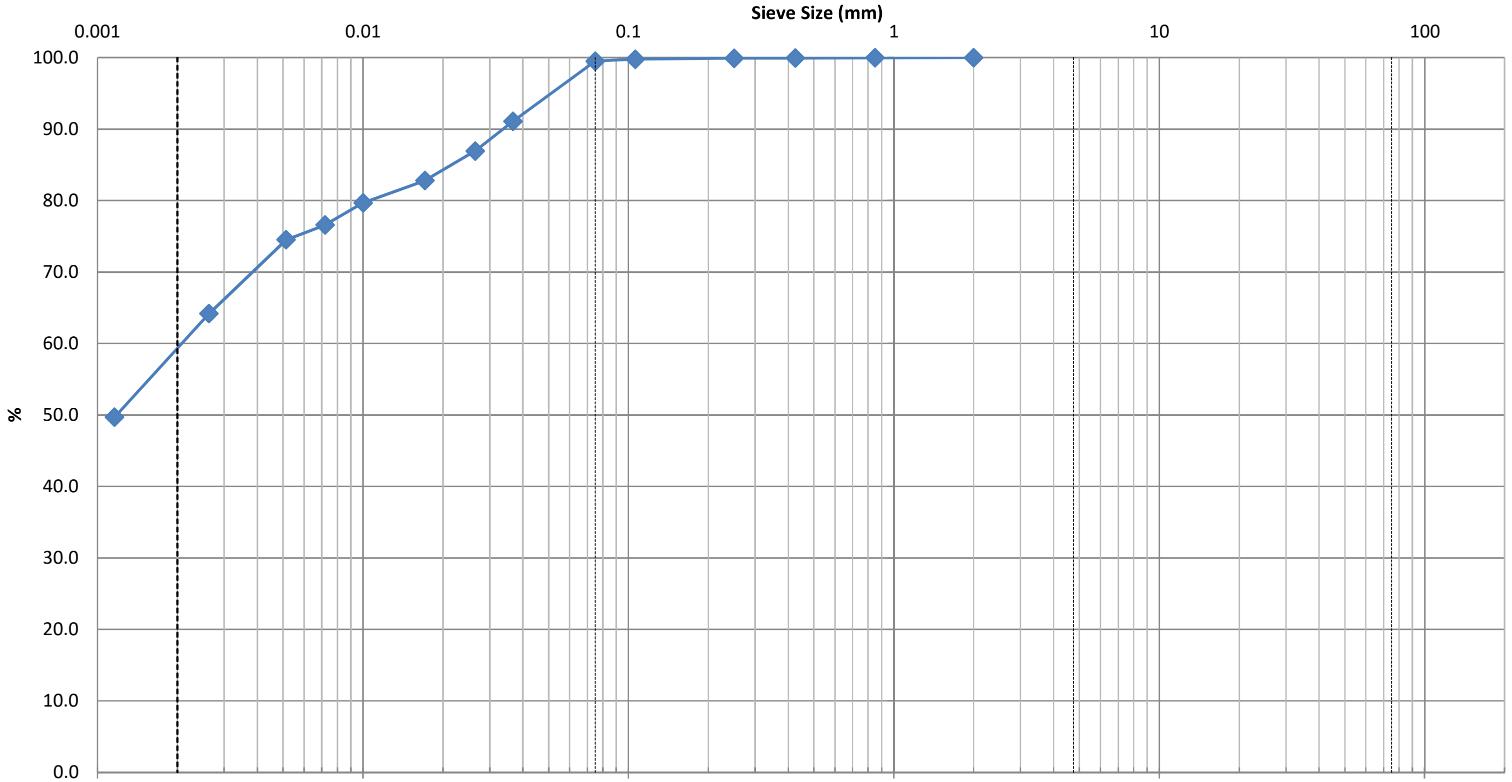
CLIENT:	Minto Communities	DEPTH:	-	FILE NO:	PG2234
CONTRACT NO.:		BH OR TP No.:	TP2-18 G5	LAB NO:	05914
PROJECT:	760 March Road			DATE RECEIVED:	1-Nov-18
				DATE TESTED:	5-Nov-18
DATE SAMPLED:	29-Oct-18			DATE REPORTED:	7-Nov-18
SAMPLED BY:	N. Giamberardino			TESTED BY:	D. Bertrand



	Clay	Silt	Sand			Gravel		Cobble	
			Fine	Medium	Coarse	Fine	Coarse		

Identification	Soil Classification	MC(%)	LL	PL	PI	Cc	Cu
		26.1					

D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
				0.0	0.5	40.0	59.5

Comments	

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HYDROMETER
LS-702 ASTM-422

CLIENT:	Minto Communities	DEPTH:	-	FILE NO.:	PG2234
PROJECT:	760 March Road	BH OR TP No.:	TP2-18 G5	DATE SAMPLED:	29-Oct-18
LAB No. :	05914	TESTED BY:	D. Bertrand	DATE RECEIVED:	1-Nov-18
SAMPLED BY:	N. Giamberardino	DATE REPT'D:	7-Nov-18	DATE TESTED:	5-Nov-18

SAMPLE INFORMATION

SAMPLE MASS	117.2	50.00
SPECIFIC GRAVITY (Gs)	2.700	
HYGROSCOPIC MOISTURE	Tare No.	
TARE Wt.	50.00	ACTUAL Wt.
AIR DRY (Wa)	150.00	100.00
OVEN DRY (Wo)	145.55	95.55
F=(Wo/Wa)	0.956	
INITIAL Wt. (Ma)	50.00	
Wt. CORRECTED	47.78	
Wt. AFTER WASH BACK SIEVE	0.27	
SOLUTION CONCENTRATION	40 g / L	

REMARKS

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
63.0			
53.0			
37.5			
26.5			
19.0			
16.0			
13.2			
9.5			
4.75			
2.0	**0.0**	0.0	100.0
Pan	**117.2**		
0.850	**0.02**	0.0	100.0
0.425	**0.04**	0.1	99.9
0.250	**0.05**	0.1	99.9
0.106	**0.12**	0.2	99.8
0.075	**0.25**	0.5	99.5
Pan	**0.27**		
SIEVE CHECK 0.0	MAX = 0.3%		

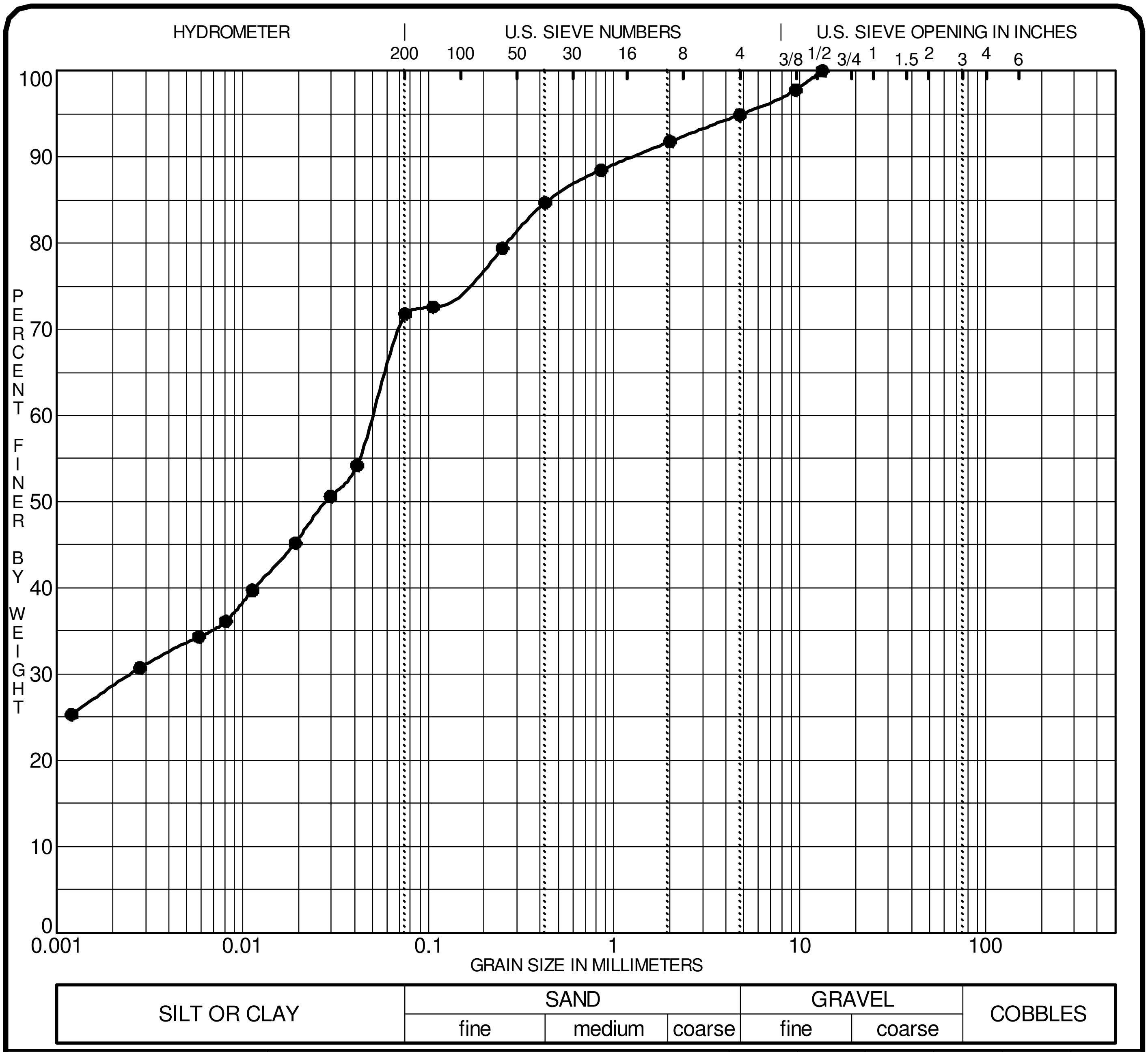
HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	10:22	50.0	6.0	22.0	0.0367	91.1	91.1
2	10:23	48.0	6.0	22.0	0.0265	86.9	86.9
5	10:26	46.0	6.0	22.0	0.0171	82.8	82.8
15	10:36	44.5	6.0	22.0	0.0100	79.7	79.7
30	10:51	43.0	6.0	22.0	0.0072	76.6	76.6
60	11:21	42.0	6.0	22.0	0.0051	74.5	74.5
250	14:31	37.0	6.0	22.0	0.0026	64.2	64.2
1440	10:21	30.0	6.0	22.0	0.0012	49.7	49.7

COMMENTS

Moisture Content = 26.1%

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



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 4**	**G 1**	**ML - Clayey silt with sand, trace**						
			gravel and cobbles						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 4**	**G 1**	**13.20**	**0.05**	**0.003**		**5.1**	**23.1**	**71.8**	

CLIENT **Minto Communities Inc.**

FILE NO. **PG2234**

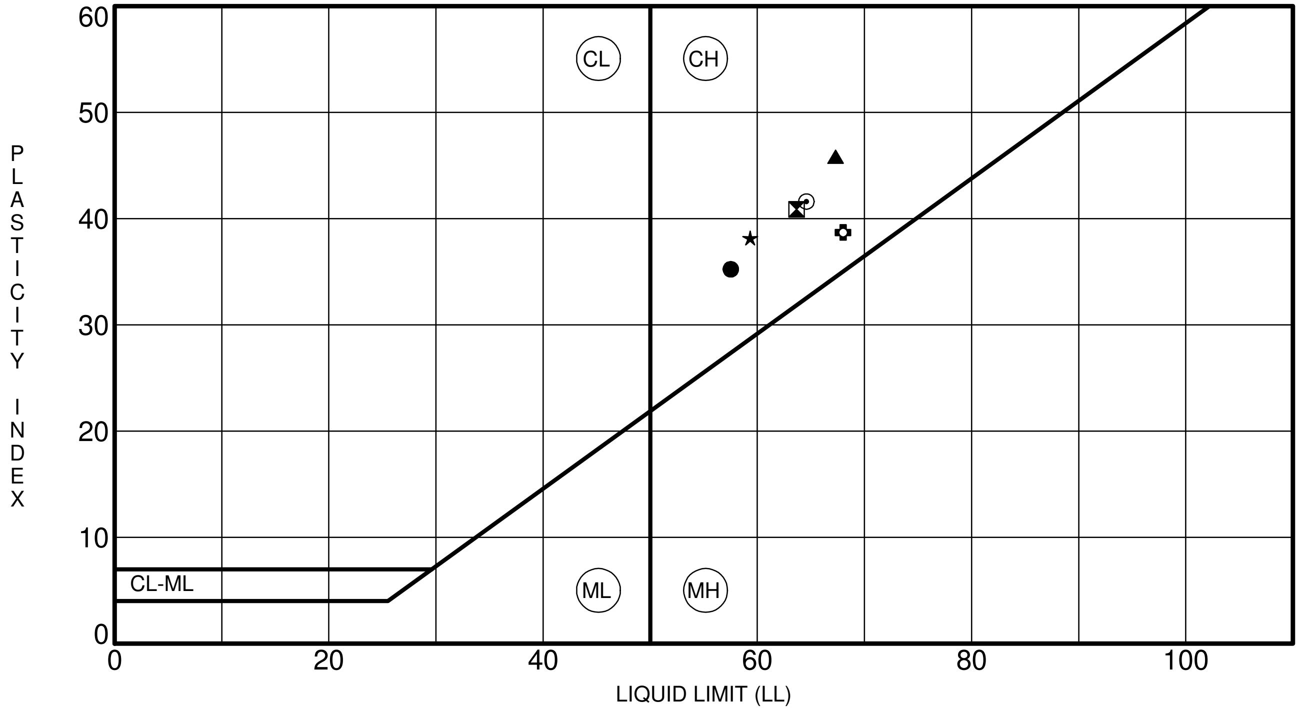
PROJECT **Geotechnical Investigation - Proposed Residential Development - Sandhill Road**

DATE **3 Jun 11**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

GRAIN SIZE DISTRIBUTION



Specimen Identification			LL	PL	PI	Fines	Classification
●	**TP 1-18**	**G 5**	**58**	**22**	**35**		**CH - Inorganic clays of high plasticity**
⧗	**TP 2-18**	**G 5**	**64**	**23**	**41**		**CH - Inorganic clays of high plasticity**
▲	**TP 3-18**	**G 5**	**67**	**21**	**46**		**CH - Inorganic clays of high plasticity**
★	**TP 4-18**	**G 4**	**59**	**21**	**38**		**CH - Inorganic clays of high plasticity**
⊙	**TP 5-18**	**G 4**	**65**	**23**	**42**		**CH - Inorganic clays of high plasticity**
✤	**TP 6-18**	**G 5**	**68**	**29**	**39**		**CH - Inorganic clays of high plasticity**

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Prop. Residential Development - 760 March Road**

FILE NO. **PG2234**

DATE **29 Oct 18**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

Certificate of Analysis

Report Date: 24-Aug-2009
Order Date:17-Aug-2009

Client: **Paterson Group Consulting Engineers**
Client PO: 8368
Project Description: PG1927

	Client ID:	BH5-SS3	-	-	-
	Sample Date:	14-Aug-09	-	-	-
	Sample ID:	0934058-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	65.6	-	-	-
General Inorganics					
pH	0.05 pH Units	6.41	-	-	-
Resistivity	0.10 Ohm.m	68.4	-	-	-
Anions					
Chloride	5 ug/g dry	16	-	-	-
Sulphate	5 ug/g dry	11	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 - TYPICAL INSULATION DETAIL DRAWING

FIGURE 3 - GLOBAL STABILITY ANALYSIS - STATIC CONDITIONS - SECTION A

FIGURE 4 - GLOBAL STABILITY ANALYSIS - SEISMIC CONDITIONS - SECTION A

DRAWING PG2234-4 - TEST HOLE LOCATION PLAN

DRAWING PG2234-5 - TREE PLANTING SETBACK RECOMMENDATIONS

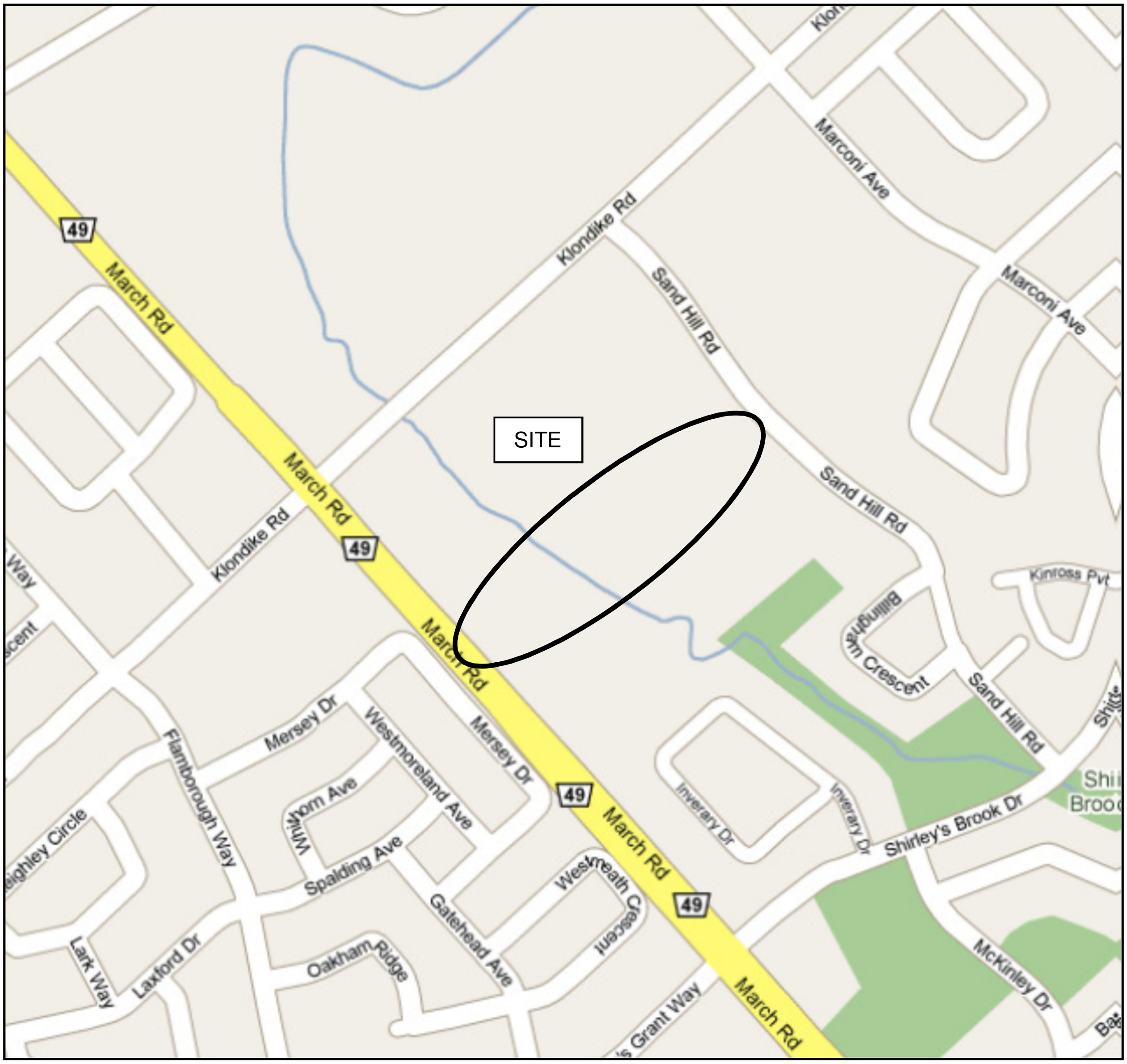
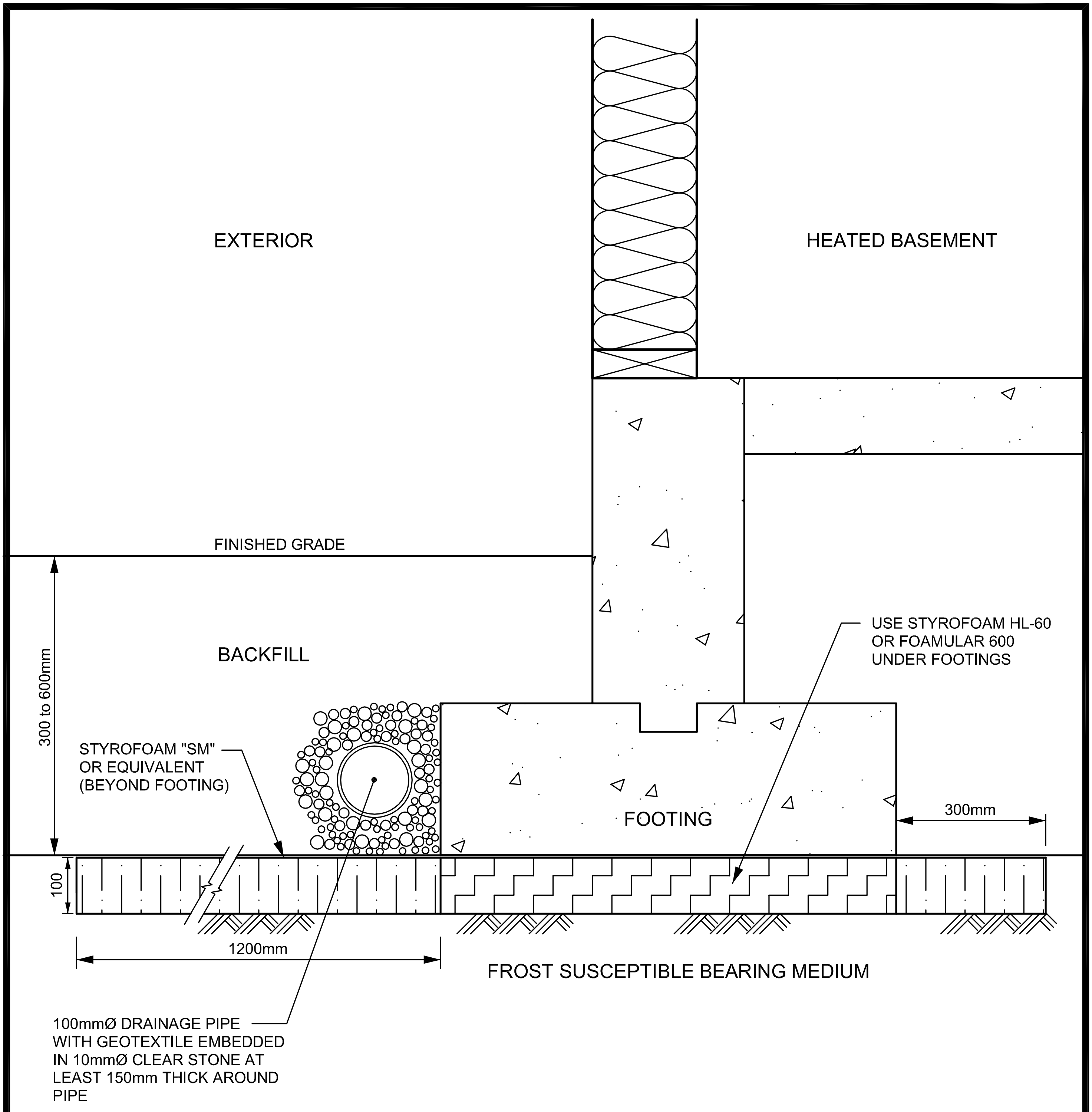


FIGURE 1

KEY PLAN



NOTE: SUBFOOTING INSULATION IS TO BE UNIFORMLY BEDDED ON BEARING MEDIUM WITH NO GAPS. USE A THIN LAYER OF SAND OR SCREENINGS OR WORK INSULATION INTO A CONCRETE MUD SLAB.

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FIGURE 2

TYPICAL INSULATION DETAIL DRAWING FOOTING WITH 300 TO 600mm SOIL COVER FOUNDED ON FROST SUSCEPTIBLE MEDIUM

Report No.: PG2234-2
Scale: N.T.S.
Date: 07/2011
Drawn: MPG
Approved: DG

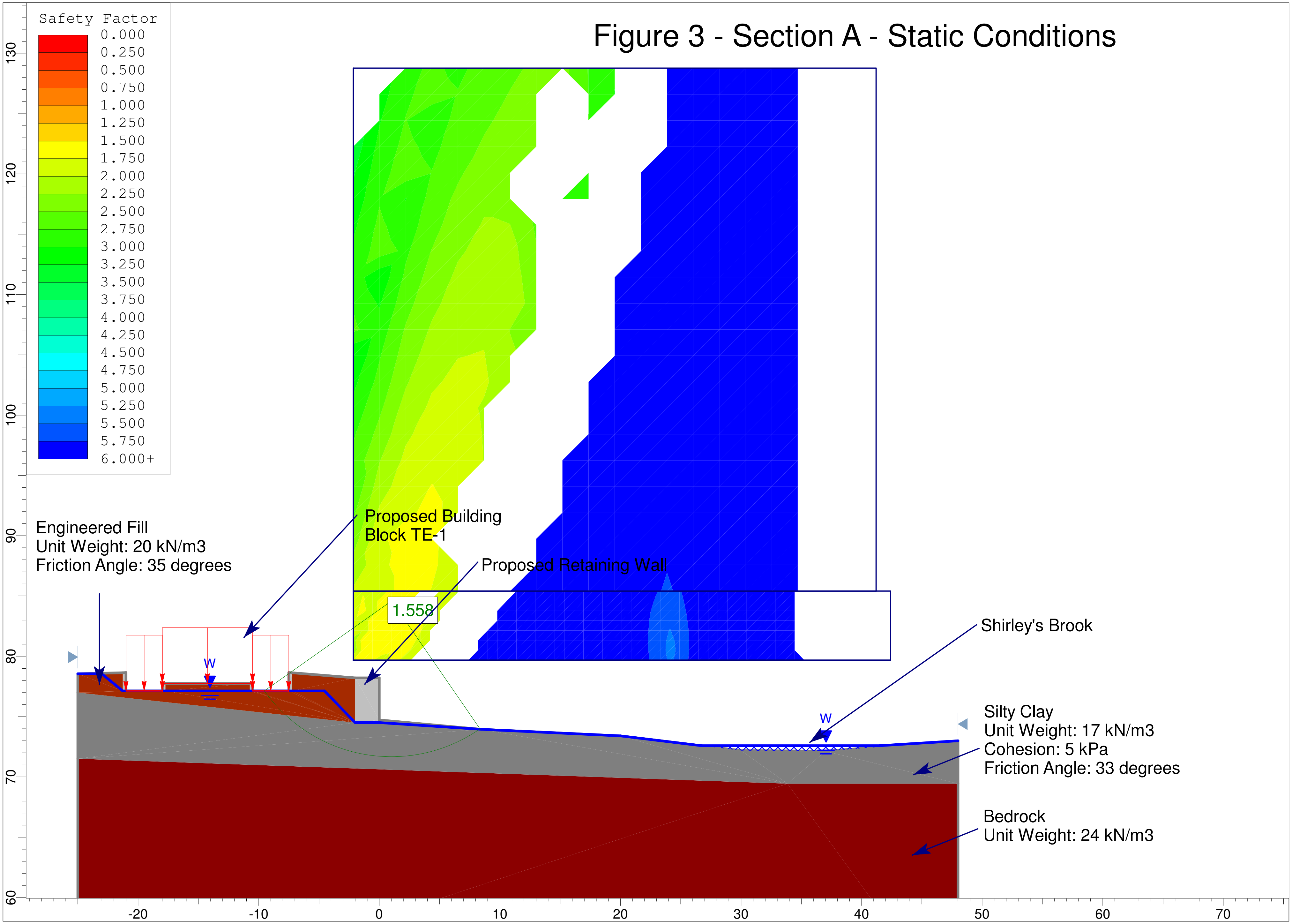


Figure 3 - Section A - Static Conditions

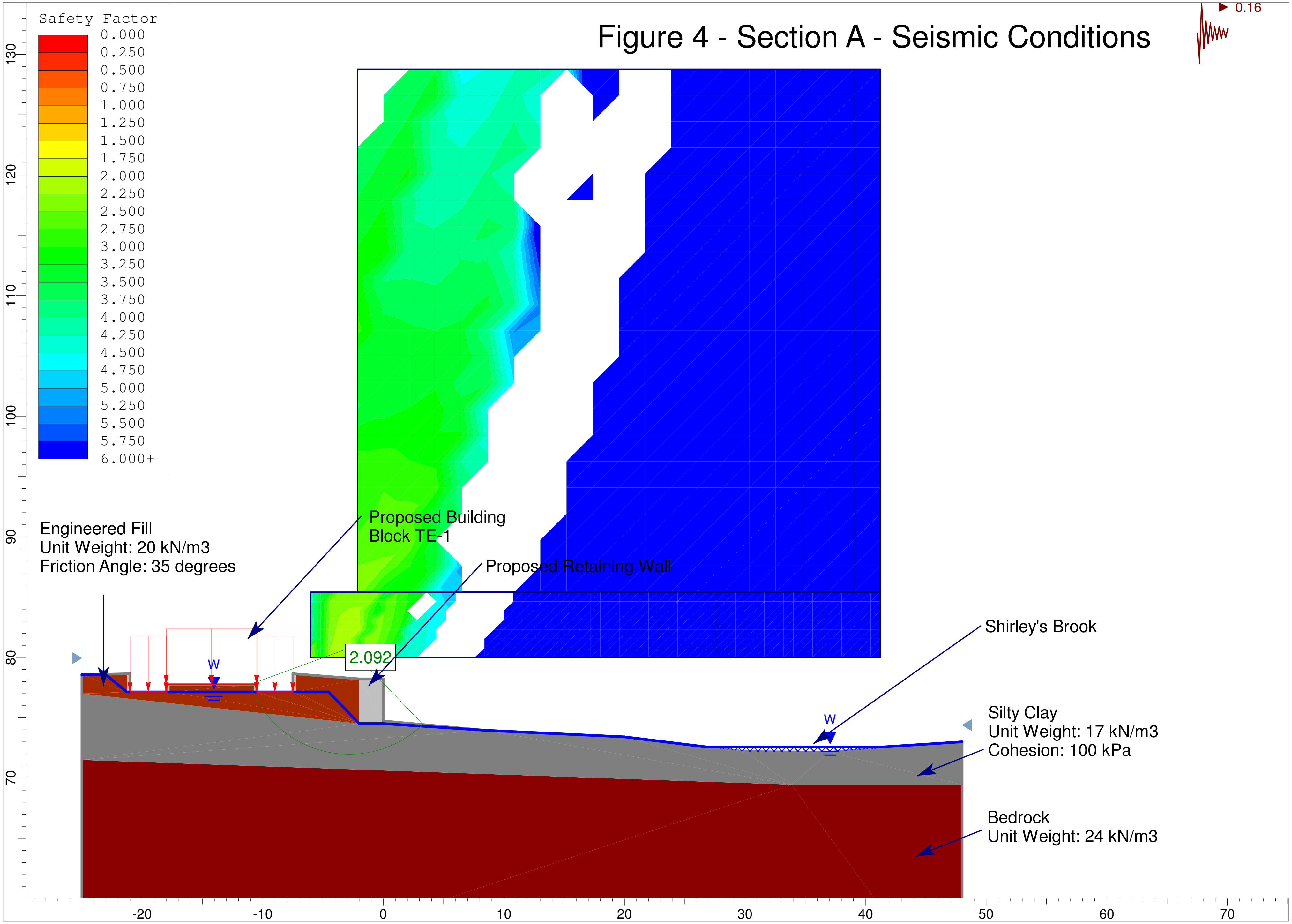
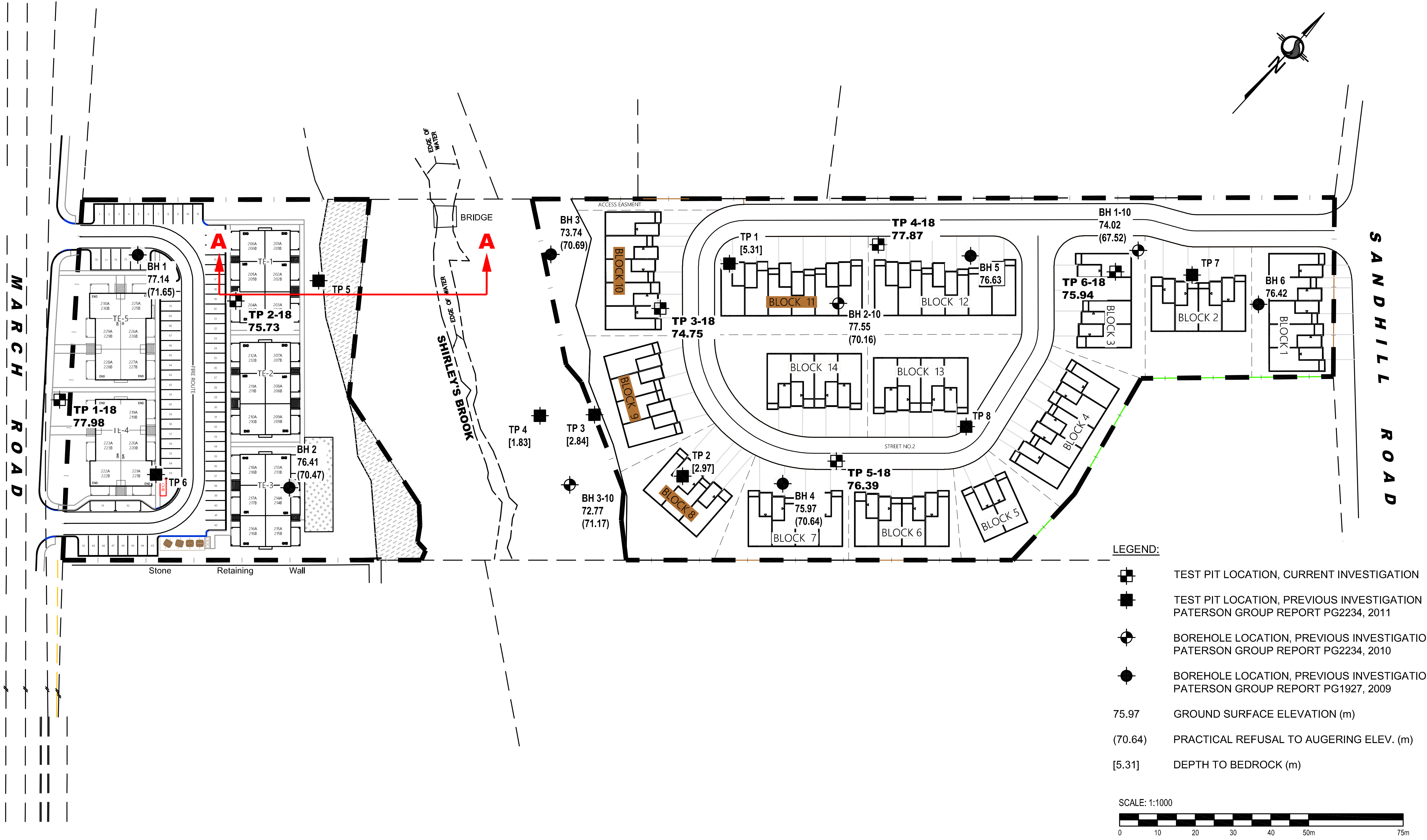


Figure 4 - Section A - Seismic Conditions



LEGEND:

⊠	TEST PIT LOCATION, CURRENT INVESTIGATION
■	TEST PIT LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG2234, 2011
⊕	BOREHOLE LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG2234, 2010
●	BOREHOLE LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG1927, 2009
75.97	GROUND SURFACE ELEVATION (m)
(70.64)	PRACTICAL REFUSAL TO AUGERING ELEV. (m)
[5.31]	DEPTH TO BEDROCK (m)

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consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

MINTO COMMUNITIES INC.

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - 762 MARCH ROAD AND 335 SANDHILL ROAD
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000
Date: 11/2018
Drawn by: MPG
Report No.: PG2234
Checked by: NC
Dwg. No.: PG2234-4
Approved by: DJG
Revision No.: 0

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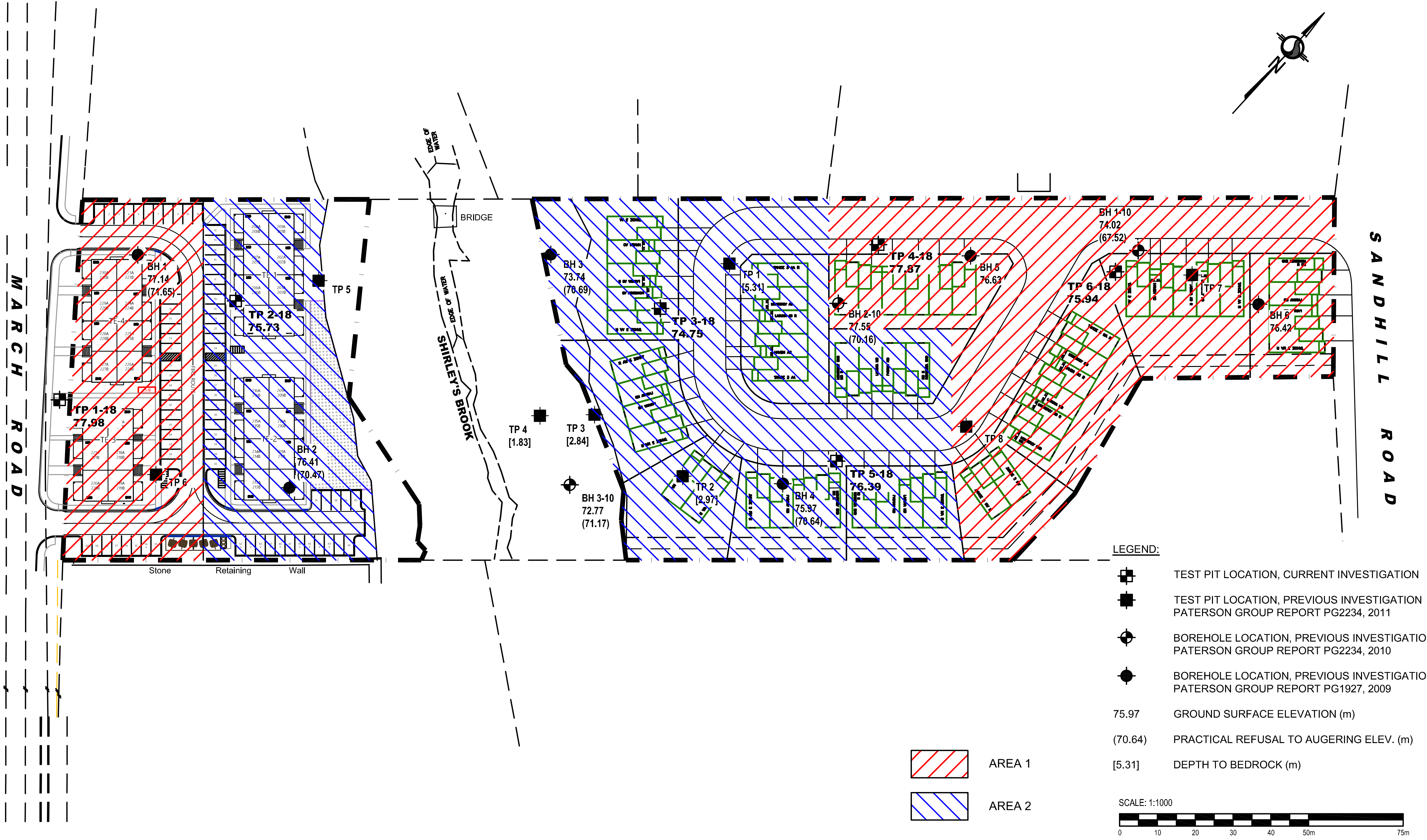

LEGEND:

⊞	TEST PIT LOCATION, CURRENT INVESTIGATION
■	TEST PIT LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG2234, 2011
⊕	BOREHOLE LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG2234, 2010
●	BOREHOLE LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG1927, 2009
75.97	GROUND SURFACE ELEVATION (m)
(70.64)	PRACTICAL REFUSAL TO AUGERING ELEV. (m)
[5.31]	DEPTH TO BEDROCK (m)

🟥	AREA 1
▨	AREA 2

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NO.	REVISIONS	DATE	INITIAL
0			

MINTO COMMUNITIES INC.

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - 760 MARCH ROAD
OTTAWA, ONTARIO

Title:
TREE PLANTING SETBACK RECOMMENDATIONS

Scale: 1:1000	Date: 11/2018
Drawn by: MPG	Report No.: PG2234
Checked by: NC	Dwg. No.: PG2234-5
Approved by: DJG	Revision No.: 0

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