Geotechnical Engineering

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Geotechnical Investigation

Proposed Residential Development
Riverfront Estates - Future Expansion Lands
1218 Old Almonte Road - Almonte

Prepared For

Houchaimi Holdings Inc.

December 7, 2020

Report PG5576-1

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Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Houchaimi Holdings Inc. to conduct a geotechnical investigation for the proposed Future Expansion Lands as part of the Riverfront Estates residential development located along Old Almonte Road in the Village of Almonte, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

- ❏ Determine the subsoil and groundwater conditions at this site by means of test holes.
- ❏ Provide geotechnical recommendations for the design of the proposed development including construction considerations pertaining to the design which may affect its design.

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

2.0 Proposed Development

It is anticipated that the proposed development will consist of single and townhouse style residential dwellings with associated paved parking areas and local roadways. It is further anticipated that the site will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on November 11 and 12, 2020. At that time, a total of forty-two (42) test pits were excavated to a maximum depth of 2.6 m below existing grade using a hydraulic excavator. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The test pitting procedure consisted of excavating to the required depths at the selected locations and sampling the overburden. The test holes were distributed in a manner to provide general coverage of the subject site taking into consideration site features. The approximate locations of the test holes are shown on Drawing PG5576-1 - Test Hole Location Plan included in Appendix 2.

Sampling and In Situ Testing

Soil samples from the test pits from the current investigation were recovered from the side walls of the open excavation and all soil samples were initially classified on site. All samples were placed in sealed plastic bags and transported to our laboratory for further examination and classification. The depths at which the grab samples were recovered from the test pits are shown as “G” on the Soil Profile and Test Data sheets in Appendix 1.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils. Undrained shear strength testing in test pits was completed using a handheld, portable vane apparatus (field inspection vane tester Roctest Model H-60).

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 location.

Groundwater

Open hole groundwater infiltration levels were observed at the time of excavation at two test pit locations. Our observations are presented in the Soil Profile and Test Data sheets in Appendix 1.

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 locations and ground surface elevations at each test hole location were surveyed by Paterson personnel and referenced to a geodetic datum using a Trimble GPS unit. The test hole locations and ground surface elevations at the test hole locations are presented on Drawing PG5576 -1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples recovered from the subject site were visually examined in our laboratory to review the field logs.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the sulphate potential against subsurface concrete structures. The results are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently undeveloped agricultural land which is relatively flat and approximately at grade with the surrounding area and Old Almonte Road. Appleton Side Road, to the southeast, by agricultural lands, to the southwest by Old Almonte Road and residential areas, and to the northwest by agricultural lands and Orchard View Long Term Care Home and agricultural land The ground surface across the site is relatively flat and approximately at grade with Old Almonte Road.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations completed within the Future Expansion Lands residential development consisted of a thin layer of top soil overlying a stiff brown silty clay to clayey silt and/or glacial till overlying inferred. Practical refusal to excavation on inferred bedrock was encountered at all test pits at depths ranging from 0.1 to 2.8 m below the existing ground surface.

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

Bedrock

Based on available geological mapping, the subject site consists of interbedded dolostone and limestone of the Gull River formation with an anticipated drift thickness between 1 to 2 m.

4.3 Groundwater

All test holes were generally observed to be dry upon completion of the sampling program with the exception of minor infiltration noted along the test pit sidewalls these included; TP24-20, TP29-20 , TP30-20, TP37-20, and TP39-20 where the groundwater was measured at a depth of 0.5 to 2.1 m. The measured groundwater level (GWL) readings are presented the Soil Profile and Test Data sheets in Appendix 1. It should be noted that groundwater levels are subject to seasonal fluctuations, therefore, the groundwater level could vary at the time of construction.

Based on the moisture levels and coloring of the recovered soil samples, and our experience with the local area, the long-term groundwater table is expected to be near or perched within the bedrock surface. The recorded groundwater levels are noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered satisfactory for the proposed development. It is expected that the proposed residential buildings will be founded on conventional style footing placed on a stiff silty clay, clayey silt, glacial till, and/or bedrock bearing surface.

It is anticipated that some bedrock removal will be required in areas across the site for building construction and service installation. All contractors should be prepared for bedrock removal within the subject site. Additionally, due to the presence of a silty clay deposit underlying the subject site, a permissible grade raise restriction will be required for settlement sensitive structures founded within the clay deposit.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Bedrock Removal

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

Prior to considering blasting operations, the blasting effects on the existing services, buildings and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in proximity of the blasting operations should be completed prior to commencing site activities.

The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries/claims related to the blasting operations.

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

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

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

Vibration Considerations

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

The following construction equipments could be the source of vibrations: hoe ram, compactor, dozer, crane, truck traffic, etc. Vibrations, whether caused by blasting operations or by construction operations, could be the source of detrimental vibrations on the nearby buildings and structures. Therefore, all vibrations are recommended to be limited.

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

Fill Placement

Fill placed for grading beneath the proposed structure(s) or other settlement sensitive areas should consist of clean imported granular fill unless otherwise specified, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The engineered fill should be placed in maximum 300 mm thick lifts and compacted using suitable compaction equipment for the specified lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

To in-fill existing channels/ditches below building areas, roadways or other settlement sensitive structures, it is recommended to place Granular A, Granular B Type I or II, well graded blast rock (maximum 200 mm diameter) or select subgrade material). The backfill material should be placed under dry conditions, in above freezing temperatures and approved by the geotechnical consultant. The backfill should be placed in maximum 300 mm loose lifts and compacted to 98% of its SPMDD.

Non-specified existing fill along with site-excavated soil can be placed as general landscaping fill where surface settlement is a minor concern. The backfill materials should be spread in thin lifts and at a minimum compacted by the tracks of the spreading equipment to minimize voids. If the non-specified backfill is to be placed to increase the subgrade level for areas to be paved, the fill should be compacted in maximum 300 mm lifts and compacted to 98% of the material's SPMDD. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

If excavated rock is to be used as fill, it should be suitably fragmented to produce a well-graded material with a maximum particle size of 300 mm. This material should be used structurally only to build up the subgrade for roads and paved areas. Where the fill is open-graded, a blinding layer of finer granular fill or a woven geotextile, such as Terratrack 200 or equivalent, may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements. This can be determined at the time of construction

5.3 Foundation Design

Bearing resistance values are provided in Table 1 for footings placed on an undisturbed silty clay, sandy silt, glacial till or clean bedrock bearing surface. Footings designed using the bearing resistance values at SLS provided in Table 1 will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively. Footings placed on clean, surface sounded bedrock will be subjected to negligible settlements.

An undisturbed soil bearing surface consists of a surface from which all organic materials 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. A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Table 1 - Bearing Resistance Values		
Bearing Surface	**Factored Bearing Resistance Values at ULS (kPa)**	**Bearing Resistance Values at SLS or Allowable Bearing Pressure (kPa)**
Stiff Sandy Silt	200	100
Stiff Silty Clay	250	150
Glacial Till	250	150
Engineered fill (Granular A or Granular B Type II)	250	150
Clean Surface Sounded Bedrock	1000	-

Notes:
- ❑ A geotechnical resistance factor of 0.5 was applied to the provided bearing resistance values at ULS

Where a building is founded partly on bedrock and partly on soil, it is recommended to decrease the soil bearing resistance value by 25% for the footings placed on soil bearing media to reduce the potential long term total and differential settlements. Also, at the soil/bedrock and bedrock/soil transitions, it is recommended that the upper 0.5 m of the bedrock be removed for a minimum length of 2 m (on the bedrock side) and replaced with nominally compacted OPSS Granular A or Granular B Type II material. The width of the subexcavation should be at least the proposed footing width plus 0.5 m. Steel reinforcement, extending at least 3 m on both sides of the 2 m long transition, should be placed in the top part of the footings and foundation walls.

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 stiff silty clay above the groundwater table 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 of the same or higher capacity as the bearing medium soil. A bedrock bearing medium will require a lateral support zone of 1H:6V.

Bedrock/Soil Transition

Where a building is founded partly on bedrock and partly on soil, it is recommended to decrease the soil bearing resistance value by 25% for the footings placed on soil bearing media to reduce the potential long term total and differential settlements. Also, at the soil/bedrock and bedrock/soil transitions, it is recommended that the upper 0.5 m of the bedrock be removed for a minimum length of 2 m (on the bedrock side) and replaced with nominally compacted OPSS Granular A or Granular B Type II material. The width of the sub-excavation should be at least the proposed footing width plus 0.5 m. Steel reinforcement, extending at least 3 m on both sides of the 2 m long transition, should be placed in the top part of the footings and foundation walls.

Permissible Grade Raise

Based on the undrained shear strength testing results and experience with the local silty clay deposit, a permissible grade raise restriction of **2.0 m** is recommended for settlement sensitive structures founded within the clay deposit.

5.4 Design for Earthquakes

The subject site can be taken as seismic site response **Class C** as defined in Table 4.1.8.4.A of the Ontario Building Code (OBC) 2012 for foundations considered at this site. A higher seismic class may be applicable, such as Class A or B, provided the footings are within 3 m of the bedrock surface. However, this would need to be confirmed by performing a seismic shear wave velocity test at the subject site. The soils underlying the site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious fill, such as those containing organic materials, within the footprint of the proposed buildings, the native soil surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction. Provision should be made for proof rolling the soil subgrade using heavy vibratory compaction equipment prior to placing any fill. Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. All backfill material within the footprint of the proposed building(s) should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD.

5.6 Pavement Structure

The subgrade materials for the pavement structure are anticipated to be stiff silty clay, glacial till or compacted engineered fill. Car only parking, local and collector roadways are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

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, or OPSS Granular B Type I or II material placed over in situ soil or fill

Table 4 - Recommended Pavement Structure - Local Roadways and Collector Roadways without Bus Traffic

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

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

For residential driveways and car only parking areas, an Ontario Traffic Category A will be used. For local and collector roadways, an Ontario Traffic Category B should be used for design purposes.

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 Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of the material's SPMDD using suitable compaction 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 extend in four orthogonal directions or longitudinally when placed along a curb. The clear crushed stone surrounding the drainage lines or the pipe, should be wrapped with suitable filter cloth. 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. All subdrains should be provided with a positive outlet to the storm sewer.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

A perimeter foundation drainage system is recommended to be provided for the proposed structure. The system should consist of a 100 to 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.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose. 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 composite drainage blanket, such as Miradrain G100N or Delta Drain 6000.

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.

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 structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

Frost Susceptibility of Bedrock

When bedrock is encountered above the proposed founding depth and soil frost cover is less than 1.5 m, the frost susceptibility of the bedrock should be determined. This can be accomplished as follows:

- ❏ Drill probeholes within the bedrock and assess its frost susceptibility.
- ❏ Examine service trench profiles extending in bedrock in the vicinity of the foundation to determine if weathering is extensive.

If the bedrock is considered to be **non-frost susceptible**, the footings can be poured directly on the bedrock without any further frost protective measures.
If the bedrock is considered to be **frost susceptible**, the following measures should be implemented for frost protection:

- ❑ Option A - Sub-excavate the weathered bedrock to sound bedrock or to the required frost cover depth. Pour footings at the lower level.

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

6.3 Excavation Side Slopes

Temporary Side Slopes

The temporary excavation side slopes should be excavated to acceptable slopes from the beginning 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). In bedrock, almost vertical side slopes can be used provided that all loose rock and blocks with unfavourable weak planes are removed or stabilized.

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

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should 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 be installed at all times 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 be remain exposed for extended periods of time.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material for areas over a soil subgrade. However, the bedding thickness should be increased to 300 mm for areas over a bedrock subgrade, if encountered. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of its SPMDD. The bedding material should extend at a minimum to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A crushed stone, should extend from the spring line of the pipe to a minimum of 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of its SPMDD.

Generally, it should be possible to re-use the moist (not wet) silty sand and glacial till above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet sub-excavated soil should be given a sufficient drying period to decrease its moisture content to an acceptable level to make compaction possible prior to being re-used. All stones greater than 300 mm in their greatest dimension should be removed prior to reuse of site-generated glacial till.

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 consist of 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 98% of the SPMDD.

Typically, clay seals are recommended to be placed within service trenches where silty clay is present at invert level. Paterson has reviewed the available service profile drawings for the current phase. Based on our review and existing subsoils information, the silty clay deposit where encountered along proposed service alignment is located above the lowest service pipe invert level. Therefore, clay seals are not required. However, if silty clay is encountered at the lowest service invert level, it is recommended that, clay seals be provided in the service trenches at no more than 60 m intervals in the service trenches.

The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. 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 SPMDD.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of 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.

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. Provisions in the contract documents should be provided to protect the excavation walls from freezing, if applicable.

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 excavation base 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 difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be considered if such activities are to be completed during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results on analytical testing show that the sulphate content is less than 0.1%. The results are indicative that Type 10 Portland Cement (Type GU) 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 in indicative of a aggressive to very aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Restrictions

The proposed residential dwellings founded over a silty clay deposit are located in a low to moderate sensitivity area with respect to tree planting. It is recommended that trees placed within 5 m of the foundation wall should consist of low water demanding trees with shallow roots systems that extend less than 1.5 m below ground surface for buildings where footings are founded over a silty clay deposit. Trees placed greater than 5 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.

7.0 Recommendations

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

- ❑ Review detailed grading plan(s) from a geotechnical perspective.
- ❑ Review of architectural and structural drawings to ensure adequate frost protection is provided to the subsoil.
- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ Sampling and testing of the concrete and fill materials used.
- ❑ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❑ Observation of all subgrades prior to backfilling.
- ❑ Field density tests to determine the level of compaction achieved.
- ❑ Sampling and testing of the bituminous concrete including mix design reviews.

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

8.0 Statement of Limitations

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

A geotechnical investigation is a limited sampling of a site. Should any conditions encountered during construction differ from the test pit locations, Paterson requests immediate notification to permit reassessment of the recommendations provided herein.

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

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 Houchaimi Holdings Inc. or their agent(s) is not authorized without review by Paterson for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Otillia McLaughlin B.Eng.

David J Gilbert P.Eng.

Report Distribution:

- ❑ Houchaimi Holdings Inc. (1 digital copy)
- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

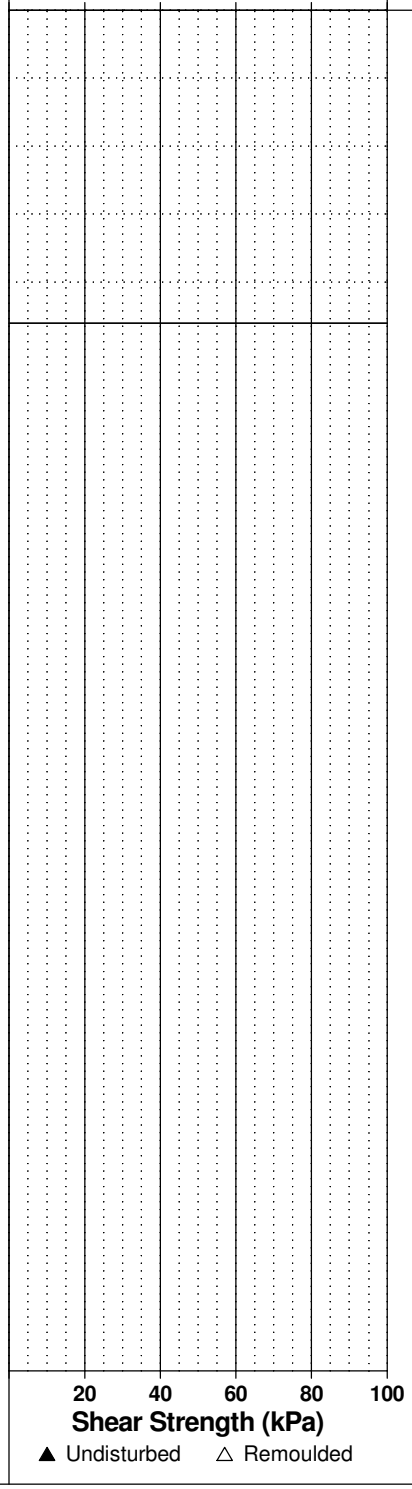
FILE NO. PG5576

REMARKS

HOLE NO. TP 1-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.14		
TOPSOIL 0.30		G	1						
Brown **CLAYEY SILT**		G	2						
0.92		G	3						
End of Test Pit TP terminated on inferred bedrock surface at 0.92m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

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HOLE NO. TP 2-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	130.41		
TOPSOIL									
0.37									
Brow **SILTY CLAY,** trace gravel		G	1						
0.63									
GLACIAL TILL: Brown silty clay, some sand, gravel and cobbles		G	2						
1.01						1	129.41		
End of Test Pit									
TP terminated on inferred bedrock surface at 1.01m depth									
(TP dry upon completion)									

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

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

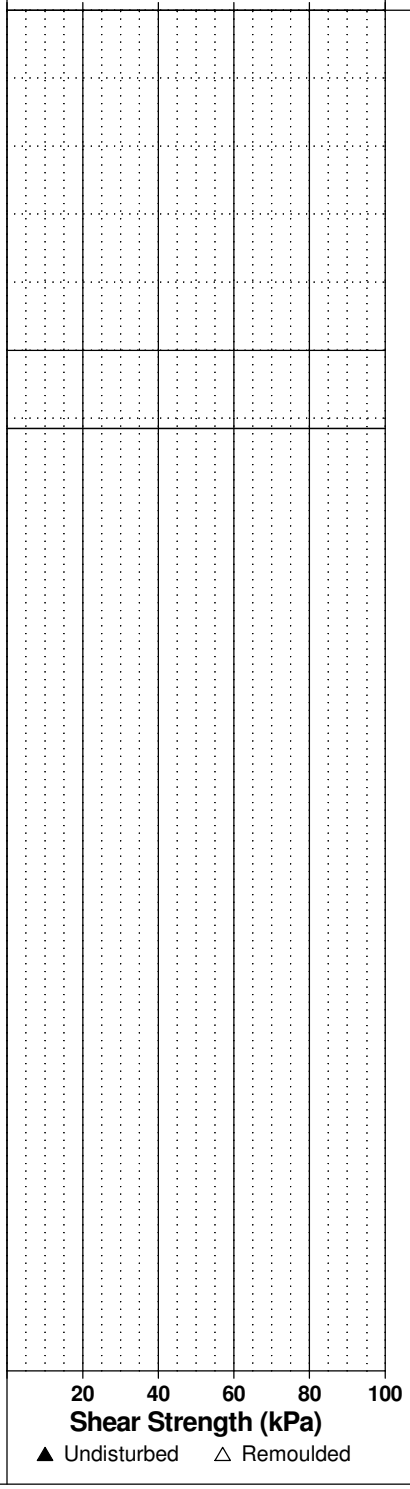
FILE NO. PG5576

REMARKS

HOLE NO. TP 3-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	130.42		
TOPSOIL 0.33		G	1						
Brown **CLAYEY SILT**		G	2						
		G	3			1	129.42		
1.23									
End of Test Pit									
TP terminated on inferred bedrock surface at 1.23m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

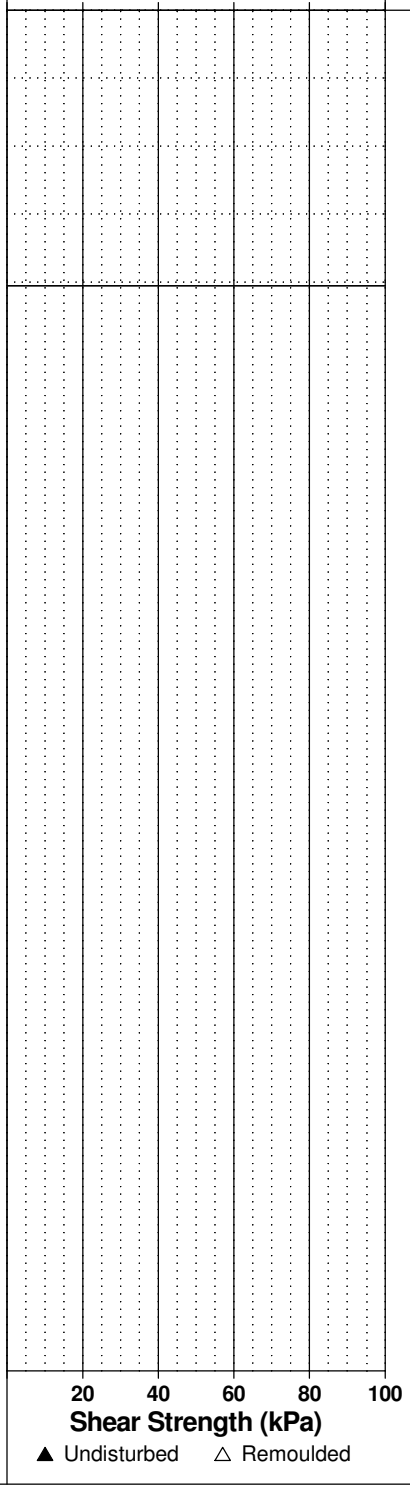
FILE NO. PG5576

REMARKS

HOLE NO. TP 4-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.00		
TOPSOIL		G	1						
0.37									
Brown **SILTY CLAY**		G	2						
0.53									
GLACIAL TILL: Brown silty clay, some sand, gravel, cobbles and boulders		G	3						
0.81									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.81m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

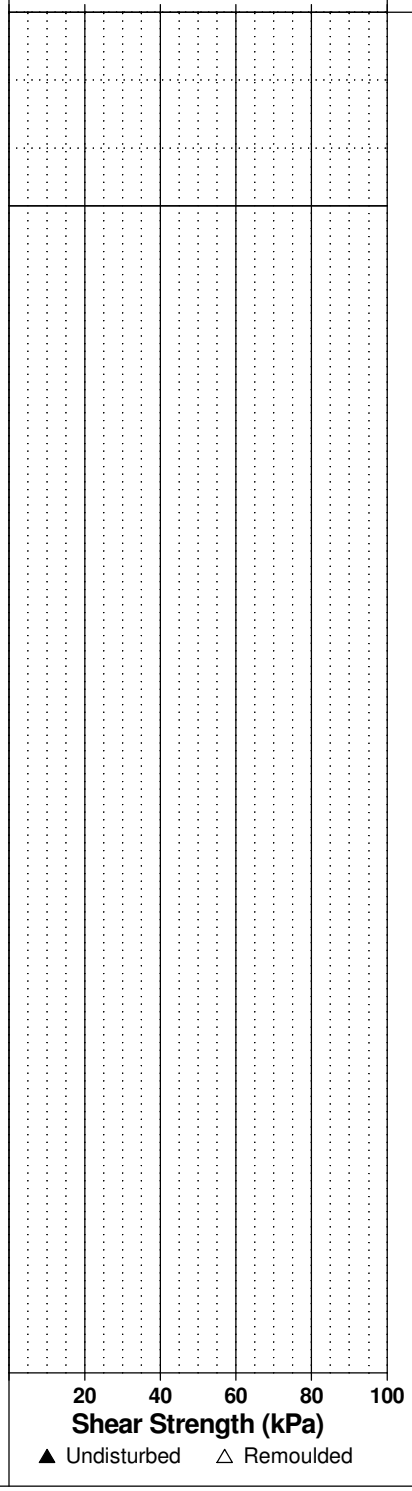
FILE NO. PG5576

REMARKS

HOLE NO. TP 5-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.44		
TOPSOIL		G	1						
0.39									
Brown **SILTY CLAY**		G	2						
0.57									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.57m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

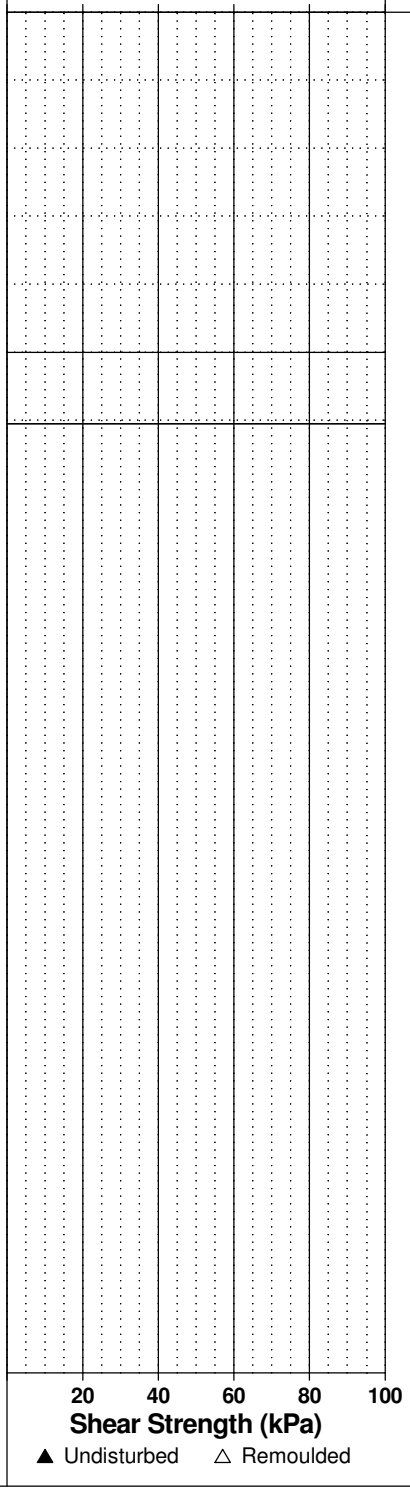
FILE NO. PG5576

REMARKS

HOLE NO. TP 6-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.94		
TOPSOIL 0.23		G	1						
Brown **SILTY CLAY to CLAYEY SILT** 0.52		G	2						
GLACIAL TILL: Brow nsilty clay, some sand, gravel, cobbles and boulders		G	3			1	130.94		
1.21									
End of Test Pit									
TP terminated on inferred bedrock surface at 1.21m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

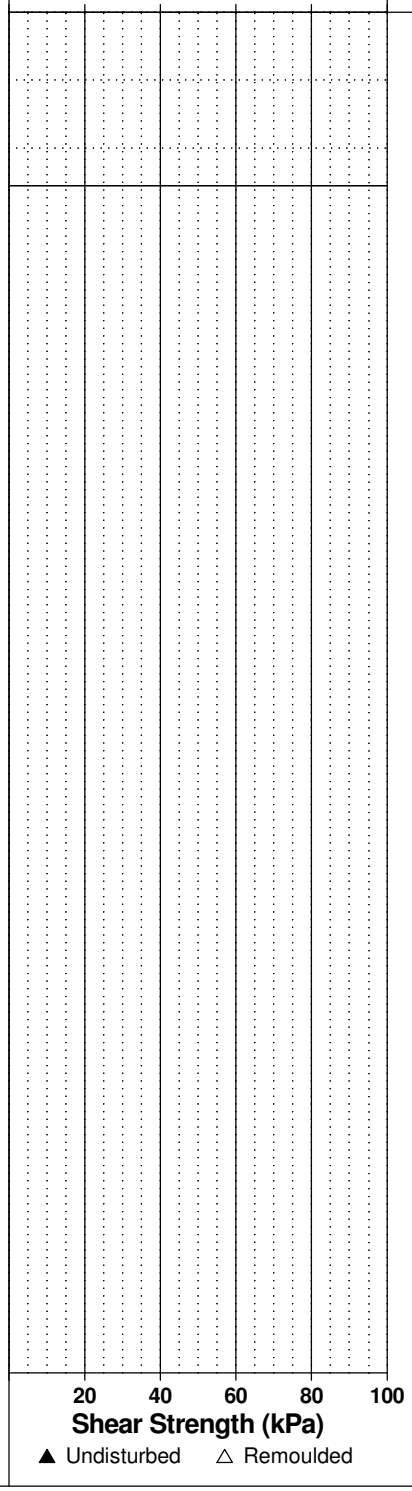
FILE NO. PG5576

REMARKS

HOLE NO. TP 7-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.52		
TOPSOIL 0.21									
Brown **SILTY CLAY,** trace sand and gravel 0.51		G	1						
End of Test Pit TP terminated on inferred bedrock surface at 0.51m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

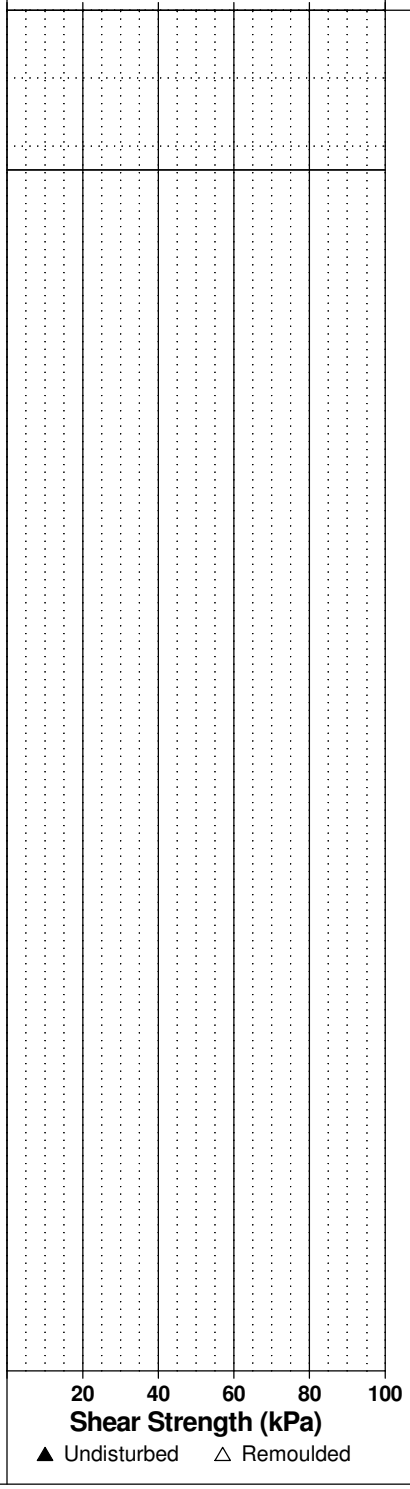
FILE NO. PG5576

REMARKS

HOLE NO. TP 8-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	132.47		
TOPSOIL 0.11									
GLACIAL TILL: Brown silty clay with weathered bedrock, trace sand and gravel		G	1						
0.47									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.47m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

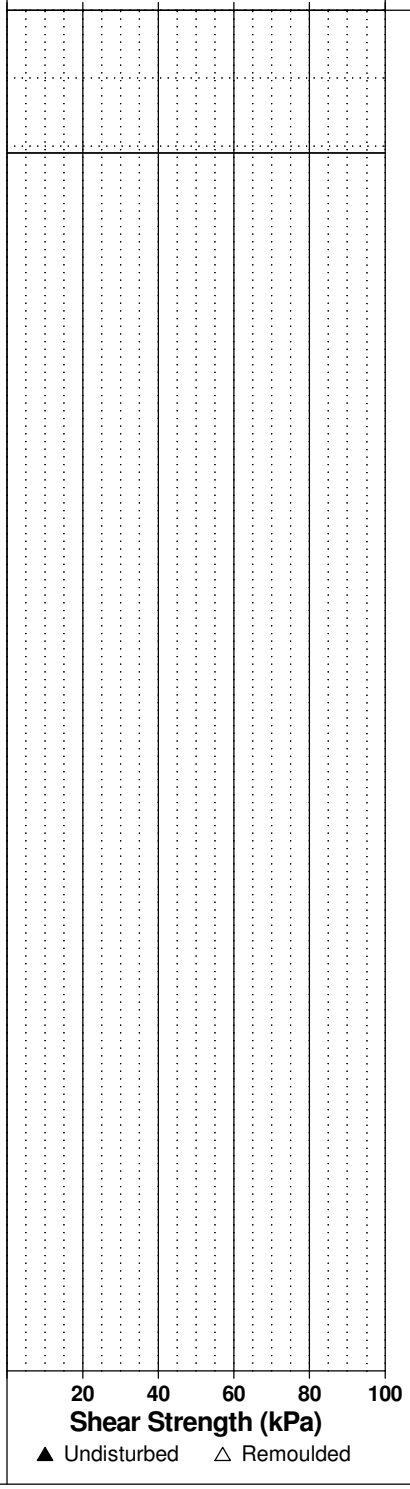
FILE NO. PG5576

REMARKS

HOLE NO. TP 9-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.52		
TOPSOIL 0.19		G	1						
GLACIAL TILL: Brown silty clay with weathered bedrock 0.42		G	2						
End of Test Pit									
TP terminated on inferred bedrock surface at 0.42m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

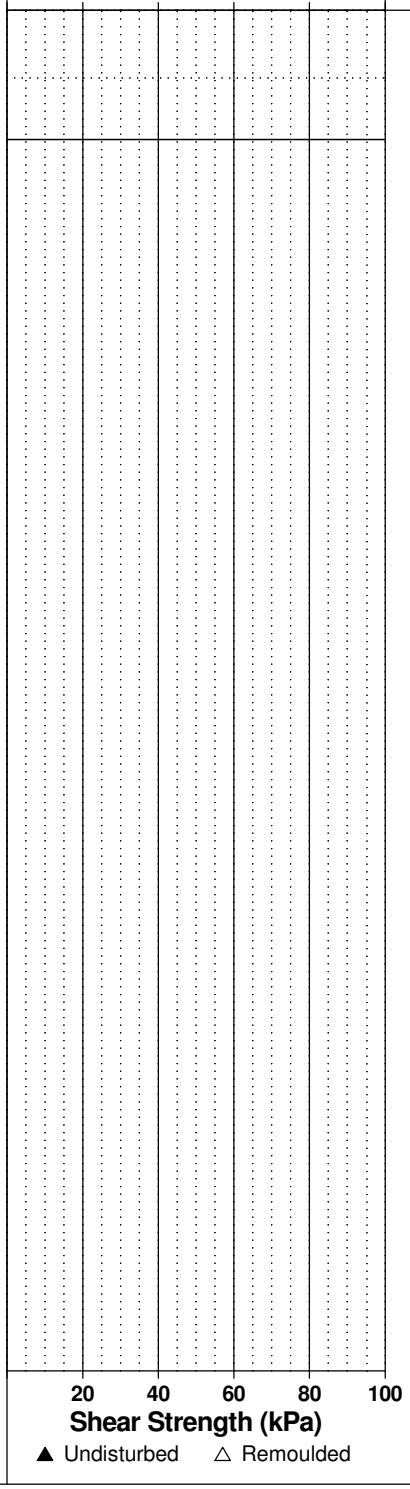
FILE NO. PG5576

REMARKS

HOLE NO. TP10-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.97	20 40 60 80	
TOPSOIL		G	1						
0.38									
End of Test Pit TP terminated on inferred bedrock surface at 0.38m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

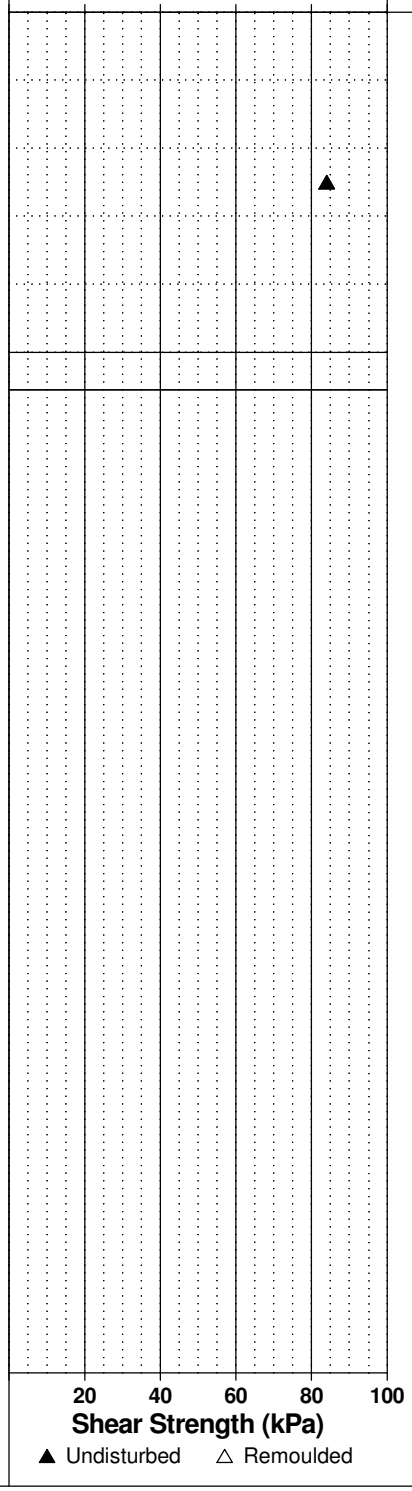
FILE NO. PG5576

REMARKS

HOLE NO. TP11-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	132.09		
TOPSOIL									
0.31									
Stiff, brown **SILTY CLAY**		G	1						
0.62									
GLACIAL TILL: Brown silty clay, some sand and gravel		G	2			1	131.09		
1.11									
End of Test Pit									
TP terminated on inferred bedrock surface at 1.11m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

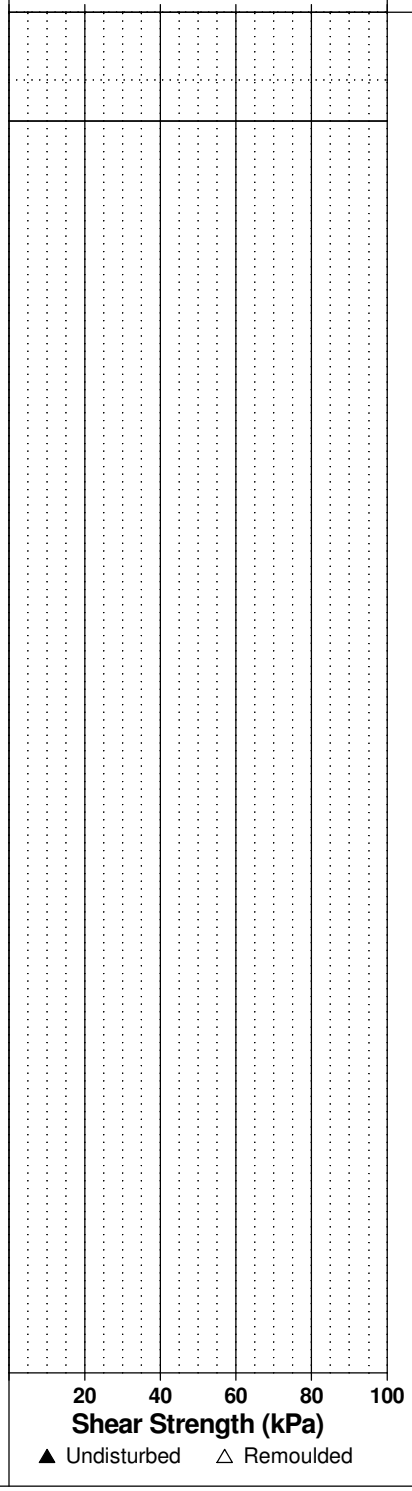
FILE NO. PG5576

REMARKS

HOLE NO. TP12-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	131.87		
TOPSOIL		G	1						
0.32									
End of Test Pit TP terminated on inferred bedrock surface at 0.32m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP13-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.74		
TOPSOIL		G	1						
0.34									
GLACIAL TILL: Brown silty clay, some gravel and weathered bedrock		G	2						
0.53									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.53m depth									
(TP dry upon completion)									

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

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

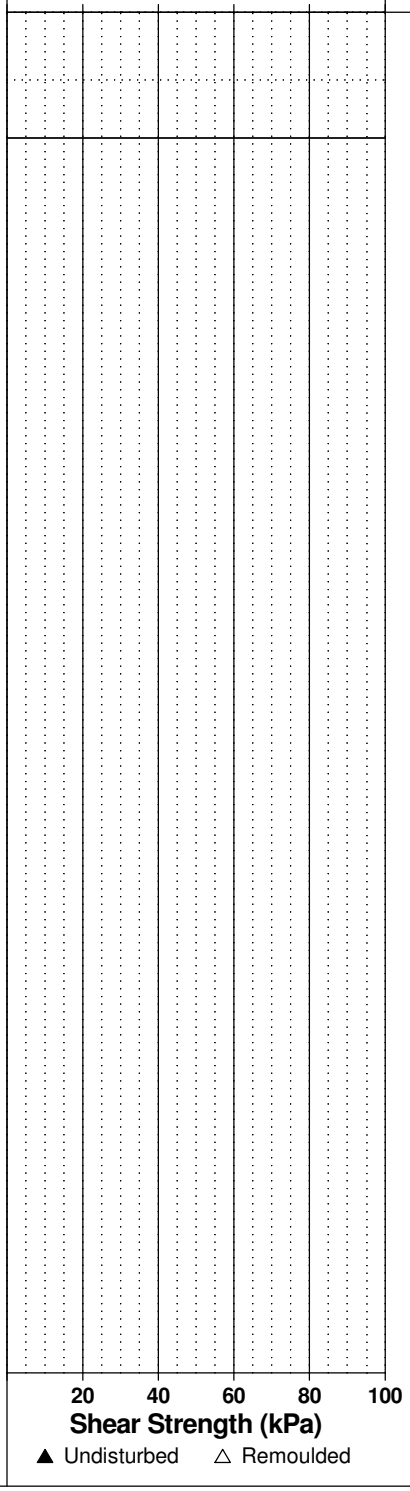
FILE NO. PG5576

REMARKS

HOLE NO. TP14-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.27		
TOPSOIL 0.25		G	1						
GLACIAL TILL: Brown silty clay with weathered bedrock 0.37									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.37m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

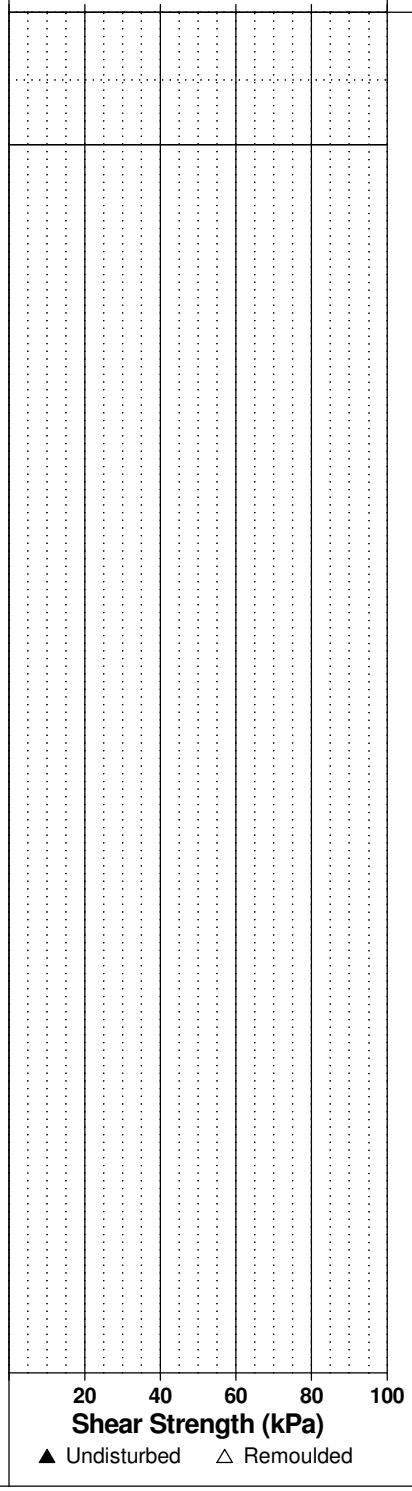
FILE NO. PG5576

REMARKS

HOLE NO. TP15-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	135.24		
TOPSOIL		G	1						
0.39									
End of Test Pit TP terminated on inferred bedrock surface at 0.39m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

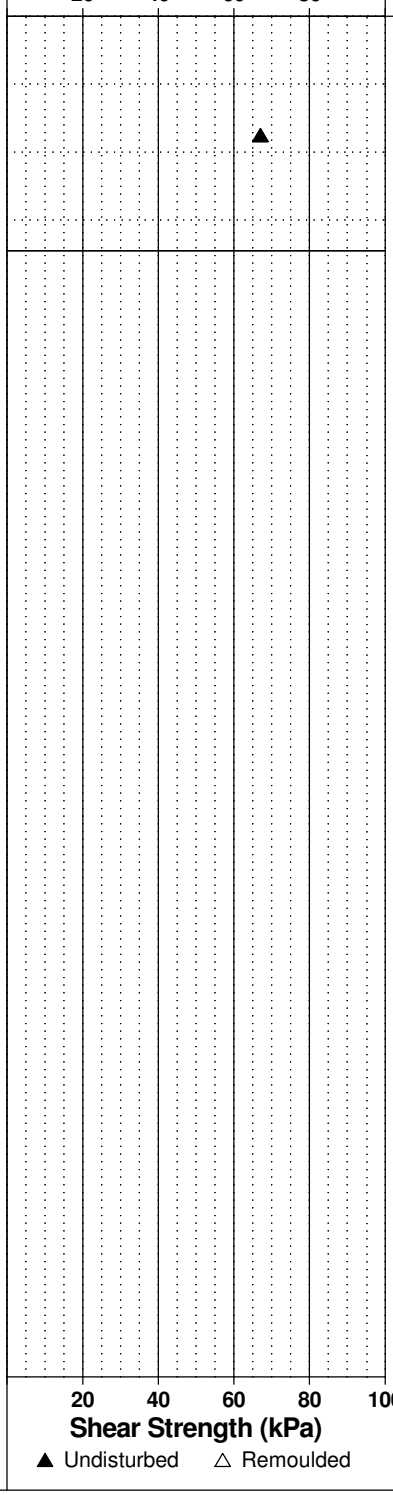
FILE NO. PG5576

REMARKS

HOLE NO. TP16-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.74		
0.19		G	1						
Stiff, brown **SILTY CLAY** **TOPSOIL**		G	2						
0.47									
GLACIAL TILL: Brown silty clay, some sand and gravel		G	3						
0.69									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.69m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

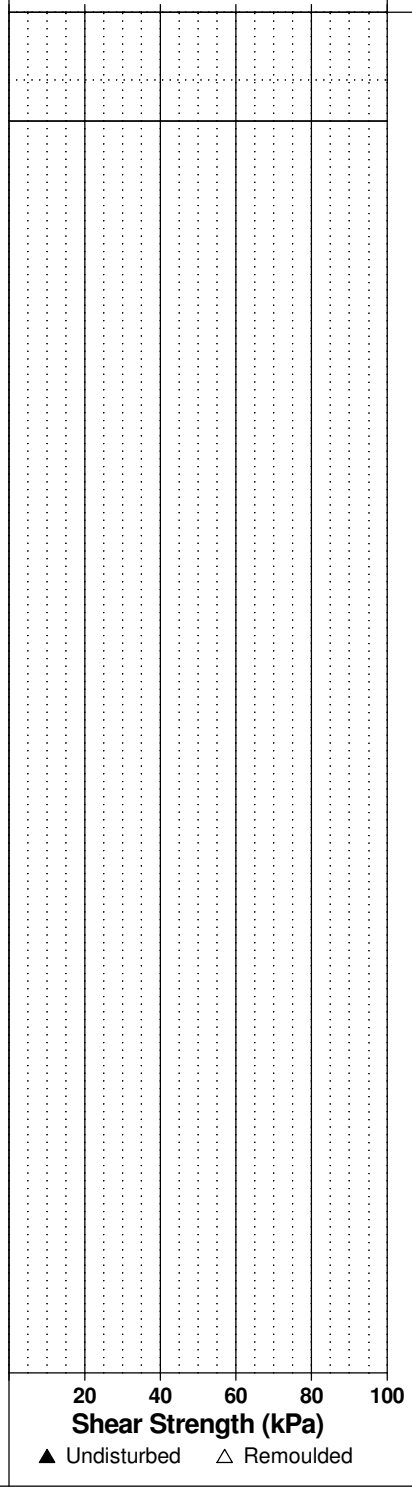
FILE NO. PG5576

REMARKS

HOLE NO. TP17-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.57		
TOPSOIL		G	1						
0.32									
End of Test Pit TP terminated on inferred bedrock surface at 0.32m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

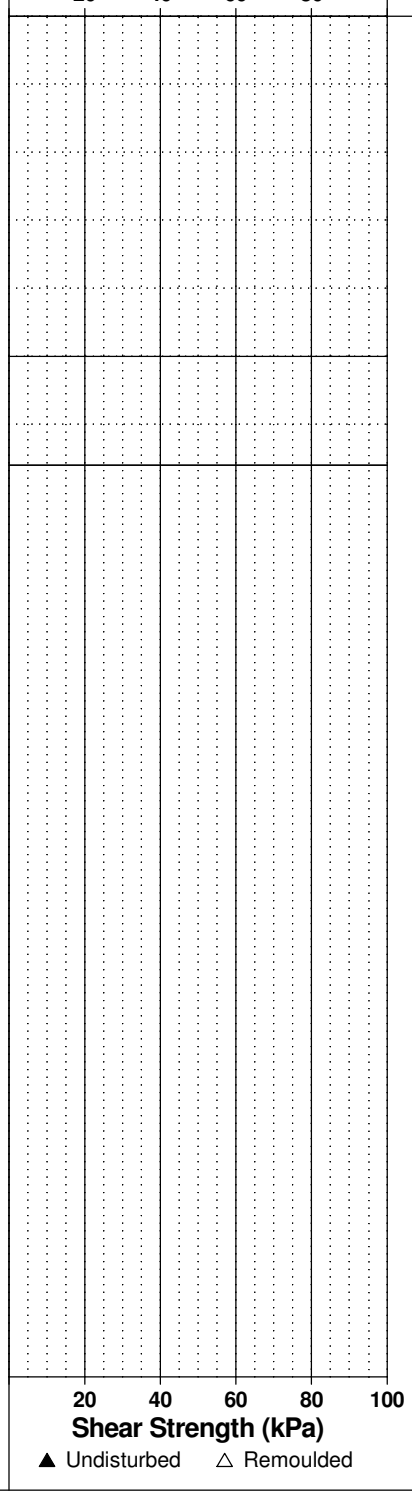
FILE NO. PG5576

REMARKS

HOLE NO. TP18-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.37		
TOPSOIL		G	1						
0.35									
		G	2						
GLACIAL TILL: Brown silty clay, some sand and gravel		G	3			1	132.37		
1.32									
End of Test Pit									
TP terminated on inferred bedrock surface at 1.32m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

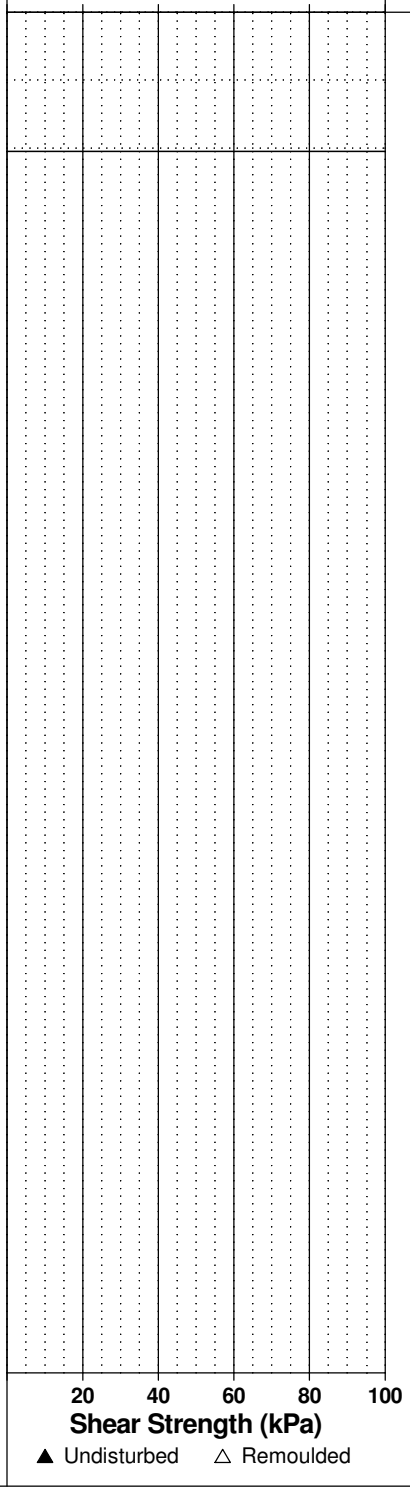
FILE NO. PG5576

REMARKS

HOLE NO. TP19-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.36		
TOPSOIL		G	1						
0.41									
End of Test Pit TP terminated on inferred bedrock surface at 0.41m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP20-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	132.78		
TOPSOIL		G	1						
0.31									
Stiff, brown **SILTY CLAY**		G	2						
0.83									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.83m depth									
(TP dry upon completion)									

Pen. Resist. Blows/0.3m: ● 50 mm Dia. Cone; ○ Water Content %; 20 40 60 80

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

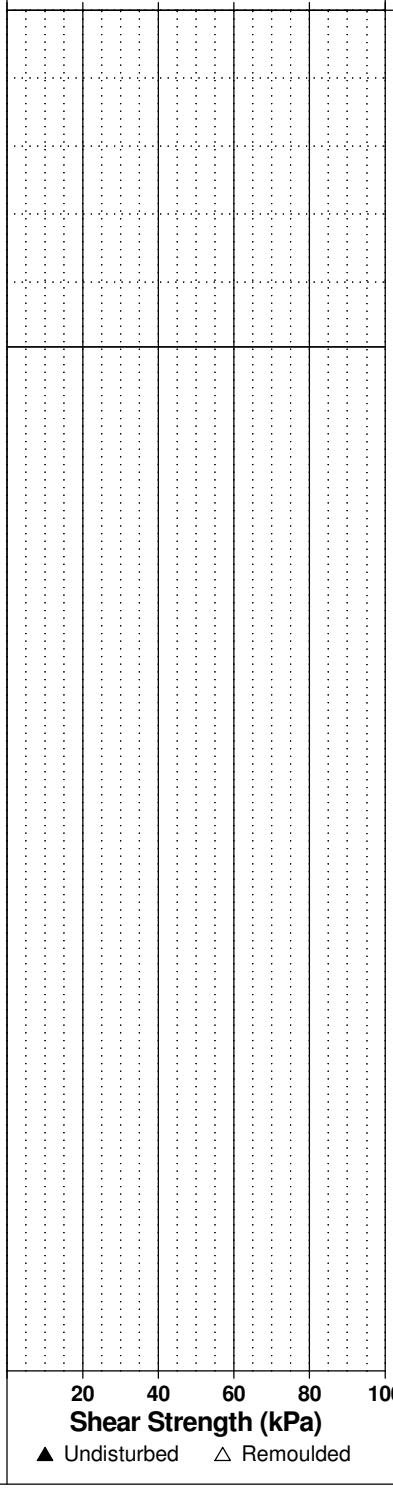
FILE NO. PG5576

REMARKS

HOLE NO. TP21-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.81		
TOPSOIL		G	1						
0.32									
GLACIAL TILL: Brown silty clay with weathered bedrock		G	2						
0.99									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.99m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

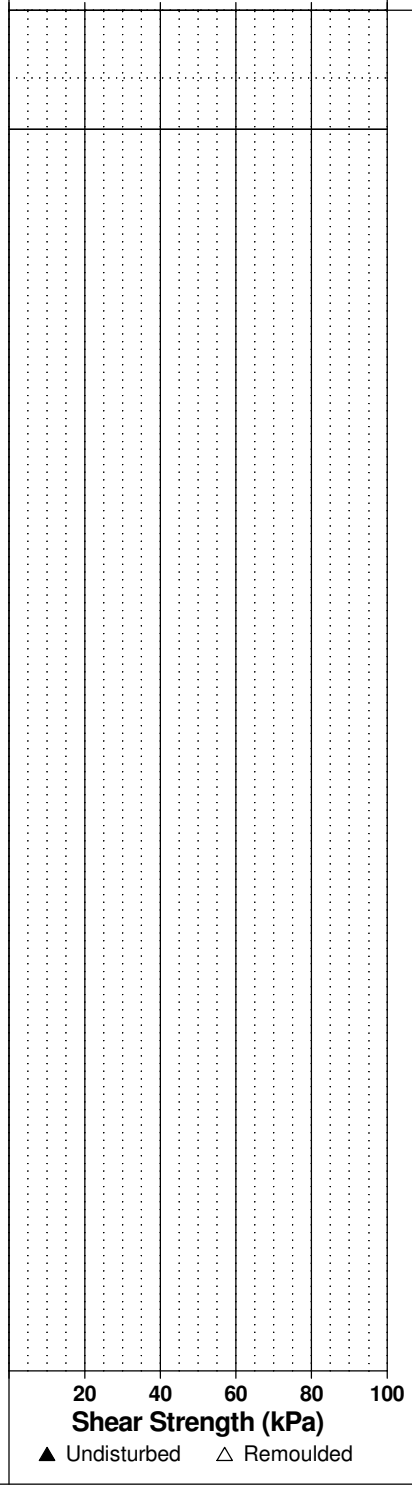
FILE NO. PG5576

REMARKS

HOLE NO. TP22-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	135.28		
TOPSOIL		G	1						
0.35									
End of Test Pit TP terminated on inferred bedrock surface at 0.35m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

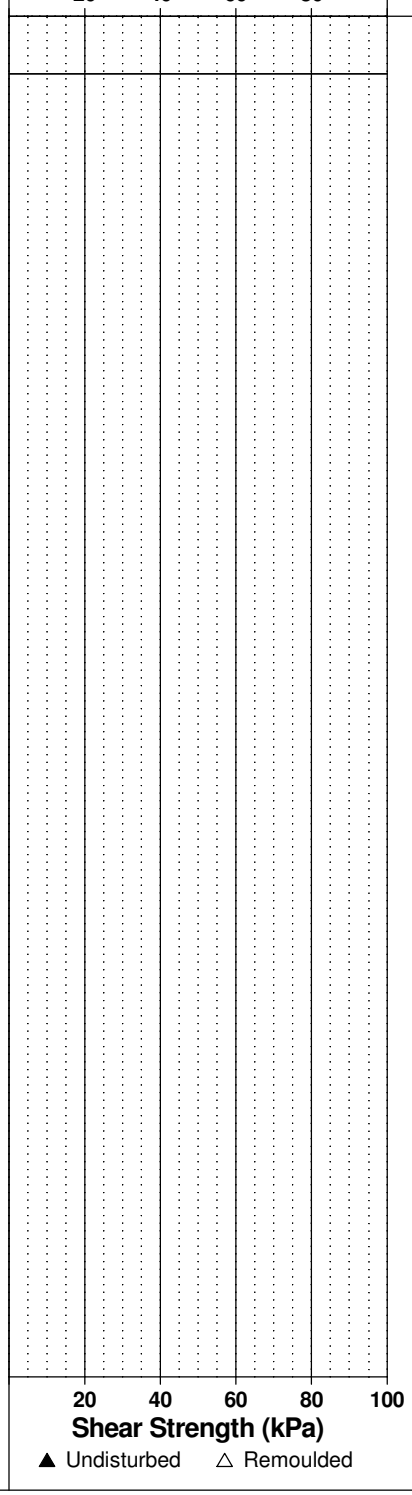
FILE NO. PG5576

REMARKS

HOLE NO. TP23-20

BORINGS BY Backhoe **DATE** November 11, 2020

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									
TOPSOIL		G	1			0	135.23		
0.17									
End of Test Pit TP terminated on inferred bedrock surface at 0.17m depth (TP dry upon completion)									



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Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

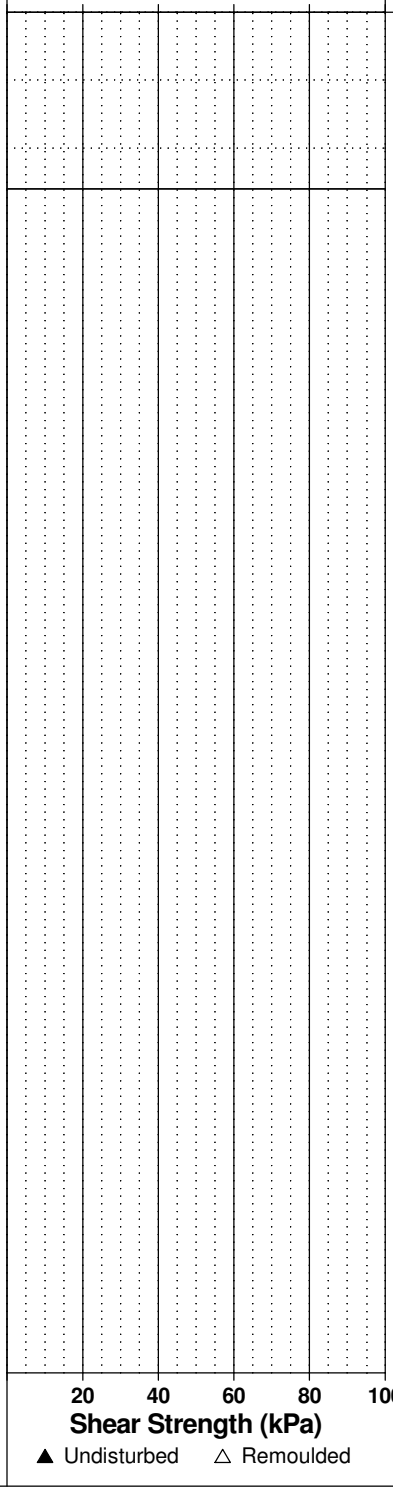
FILE NO. PG5576

REMARKS

HOLE NO. TP24-20

BORINGS BY Backhoe **DATE** November 11, 2020

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	133.89		
TOPSOIL		G	1						
0.29									
Stiff, brown **SILTY CLAY,** trace sand and gravel									
0.52									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.52m depth									
(Groundwater infiltration at 0.5m depth)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

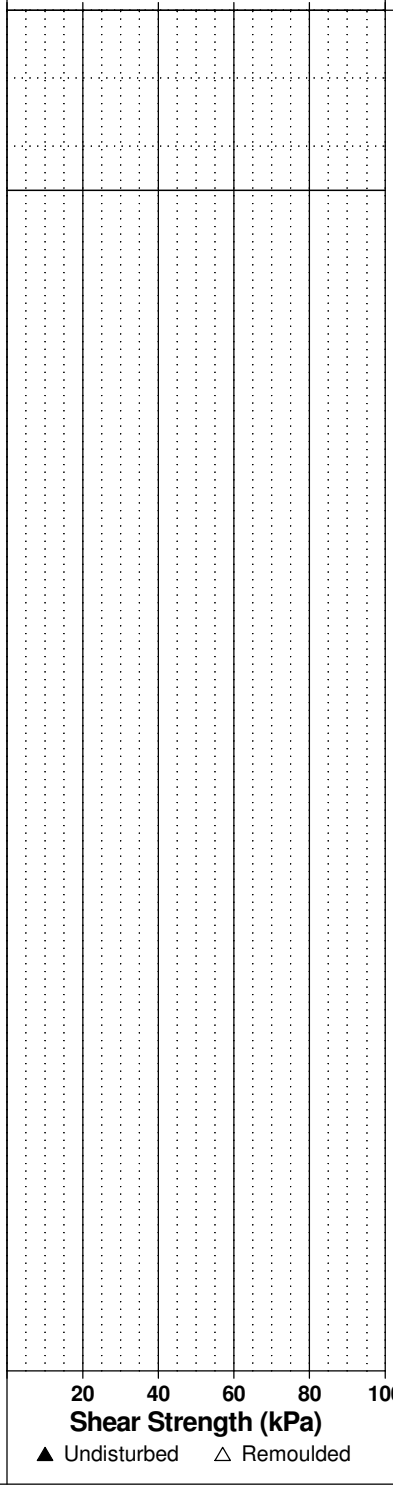
FILE NO. PG5576

REMARKS

HOLE NO. TP25-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	134.61		
TOPSOIL		G	1						
0.24									
Stiff, brown **CLAYEY SILT**		G	2						
0.53									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.53m depth									
(TP dry upon completion)									



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Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

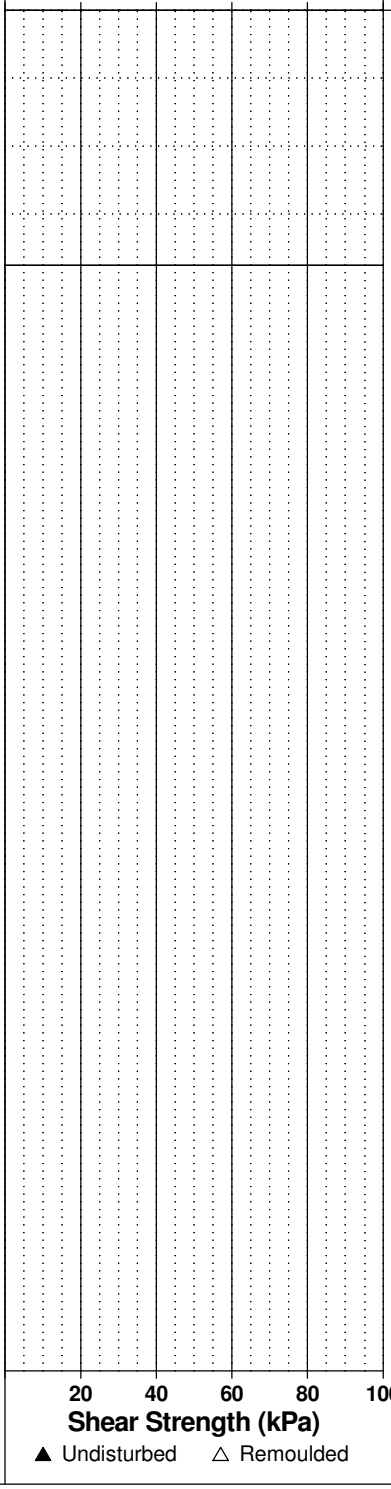
FILE NO. PG5576

REMARKS

HOLE NO. TP26-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	132.81		
TOPSOIL 0.25		G	1						
GLACIAL TILL: Brown silty clay, some sand and gravel 0.75		G	2						
End of Test Pit									
TP terminated on inferred bedrock surface at 0.75m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

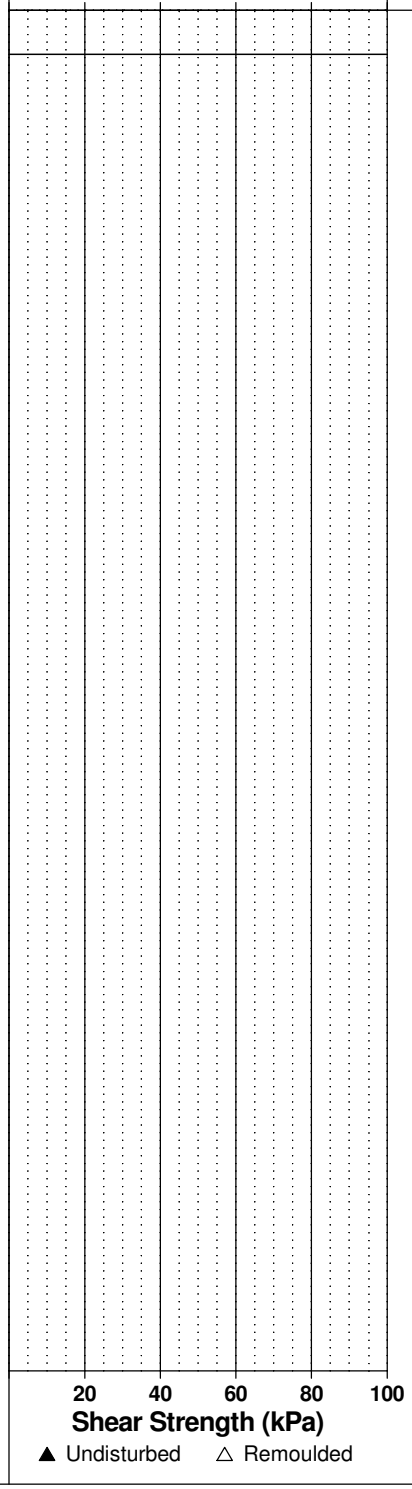
FILE NO. PG5576

REMARKS

HOLE NO. TP27-20

BORINGS BY Backhoe **DATE** November 12, 2020

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									
TOPSOIL 0.13		G	1			0	134.72		
End of Test Pit TP terminated on inferred bedrock surface at 0.13m depth (TP dry upon completion)									



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Geotechnical Investigation
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Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

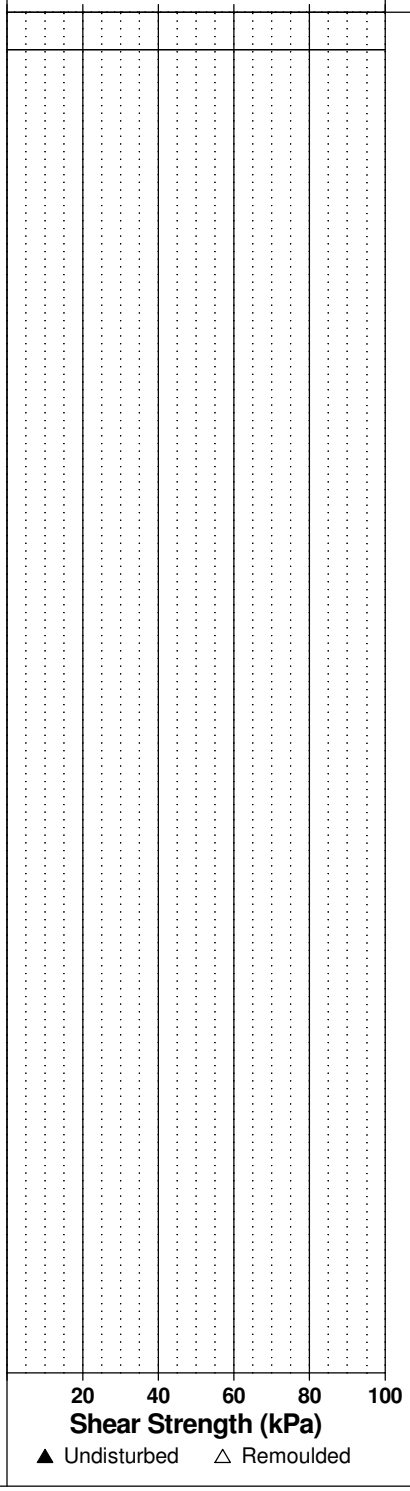
FILE NO. PG5576

REMARKS

HOLE NO. TP28-20

BORINGS BY Backhoe **DATE** November 12, 2020

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									
TOPSOIL 0.11		G	1			0	135.27		
End of Test Pit TP terminated on inferred bedrock surface at 0.11m depth (TP dry upon completion)									



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Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP29-20

BORINGS BY Backhoe **DATE** November 12, 2020

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									
TOPSOIL		G	1			0	132.76		
0.19									
GLACIAL TILL: Brown silty clay, some sand and gravel		G	2						▽
0.98									
End of Test Pit TP terminated on inferred bedrock surface at 0.92m depth (Groundwater infiltration at 0.9m depth)									

Pen. Resist. Blows/0.3m: ● 50 mm Dia. Cone; ○ Water Content %; 20 40 60 80

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

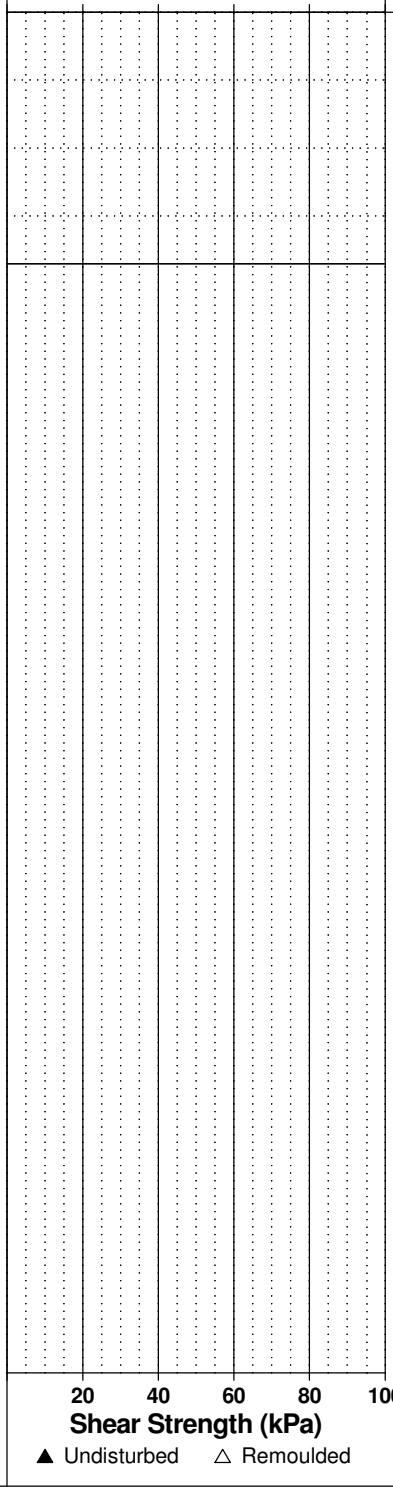
FILE NO. PG5576

REMARKS

HOLE NO. TP30-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	132.81		
TOPSOIL 0.26		G	1						
GLACIAL TILL: Brown silty clay, some sand and gravel		G	2						▽
0.74 End of Test Pit									
TP terminated on inferred bedrock surface at 0.74m depth									
(Groundwater infiltration at 0.6m depth)									



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Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

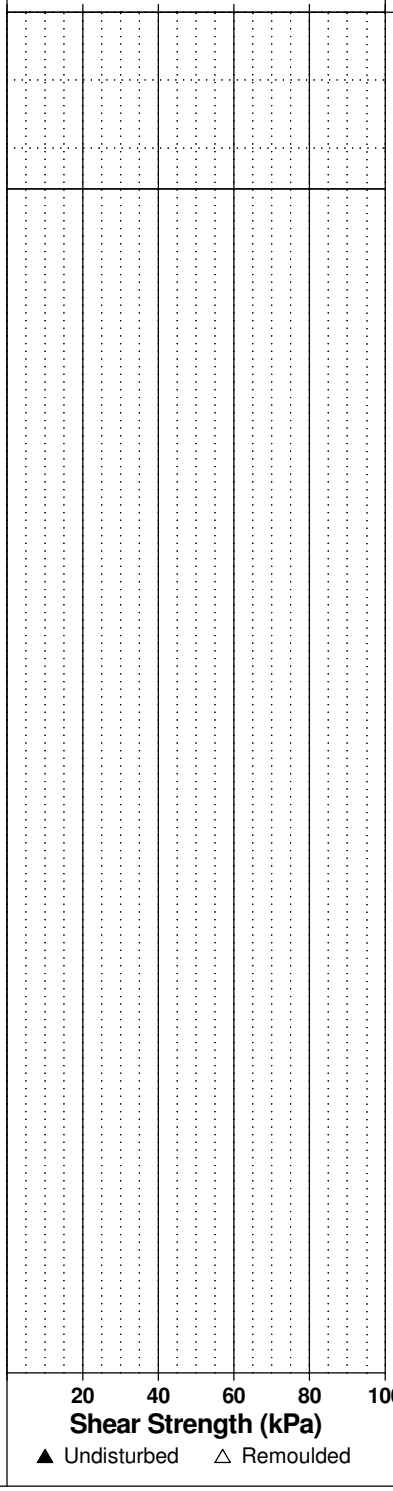
FILE NO. PG5576

REMARKS

HOLE NO. TP31-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	132.73		
TOPSOIL 0.21		G	1						
GLACIAL TILL: Brown silty clay with sand, gravel and cobbles 0.52		G	2						
End of Test Pit TP terminated on inferred bedrock surface at 0.52m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

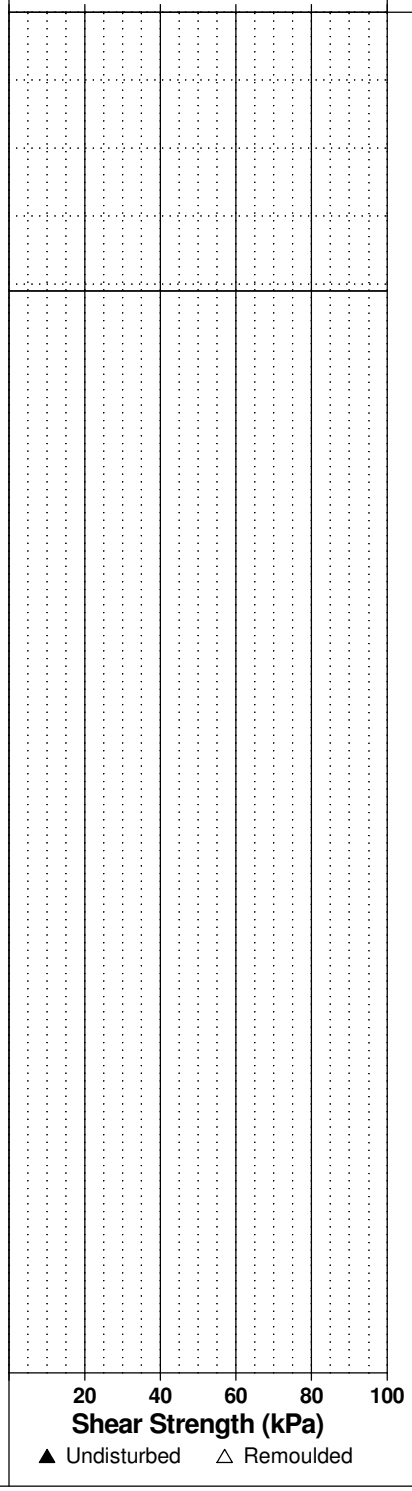
FILE NO. PG5576

REMARKS

HOLE NO. TP32-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.56		
TOPSOIL		G	1						
0.31									
GLACIAL TILL: Brown silty clay with sand, gravel and cobbles		G	2						
0.82									
End of Test Pit TP terminated on inferred bedrock surface at 0.82m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

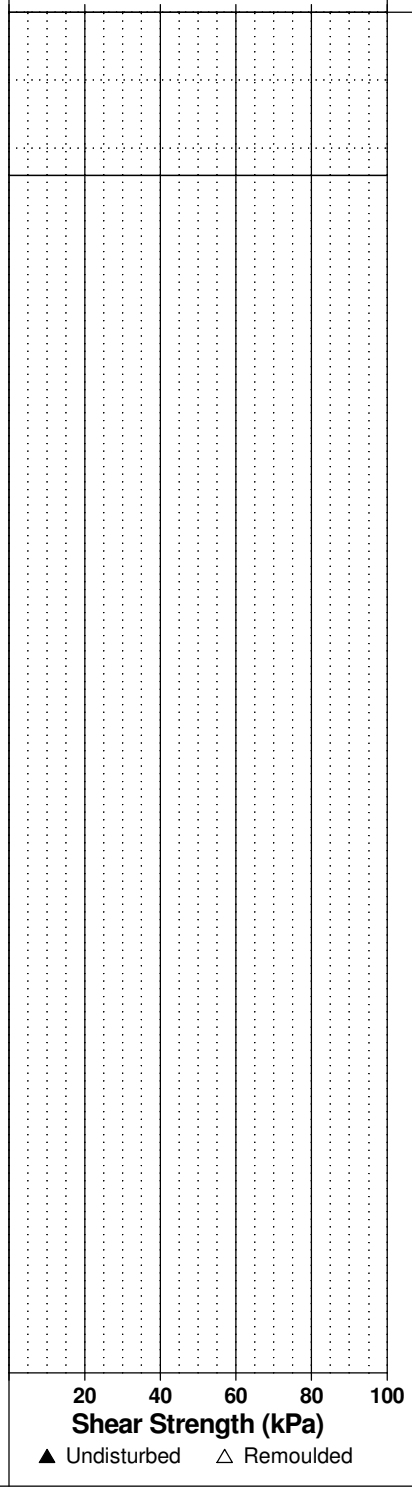
FILE NO. PG5576

REMARKS

HOLE NO. TP33-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	132.75		
TOPSOIL		G	1						
						0.39			
GLACIAL TILL: Brown silty clay, some sand and gravel		G	2			0.48			
End of Test Pit									
TP terminated on inferred bedrock surface at 0.48m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

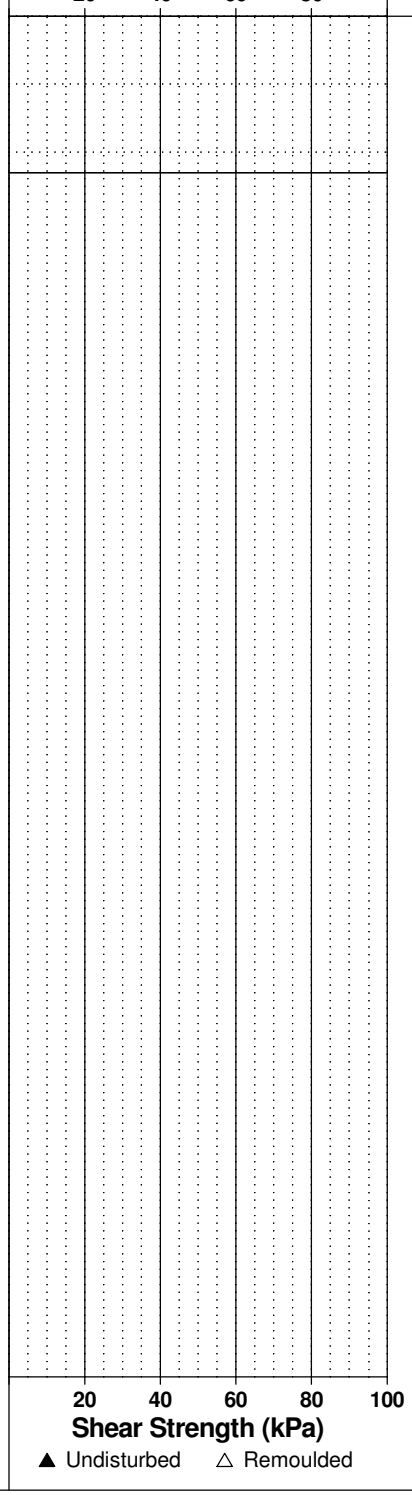
FILE NO. PG5576

REMARKS

HOLE NO. TP34-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	132.19		
TOSPOIL 0.12		G	1						
Stiff, brown **CLAYEY SILT,** trace gravel		G	2						
0.46									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.46m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

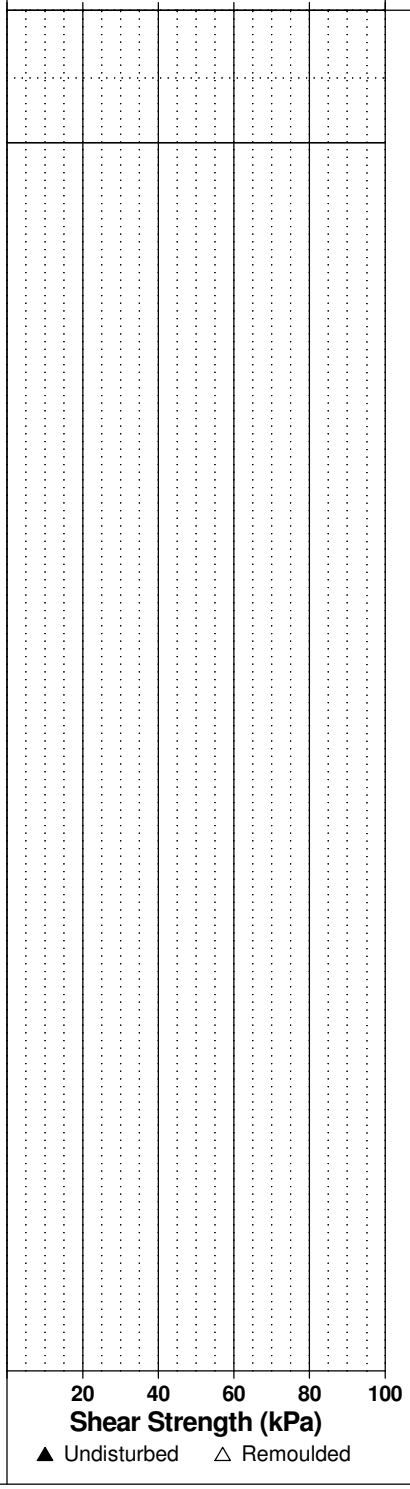
FILE NO. PG5576

REMARKS

HOLE NO. TP35-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.42		
TOPSOIL 0.13									
GLACIAL TILL: Brown silty clay with sand, gravel and cobbles 0.39		G	1						
End of Test Pit TP terminated on inferred bedrock surface at 0.39m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

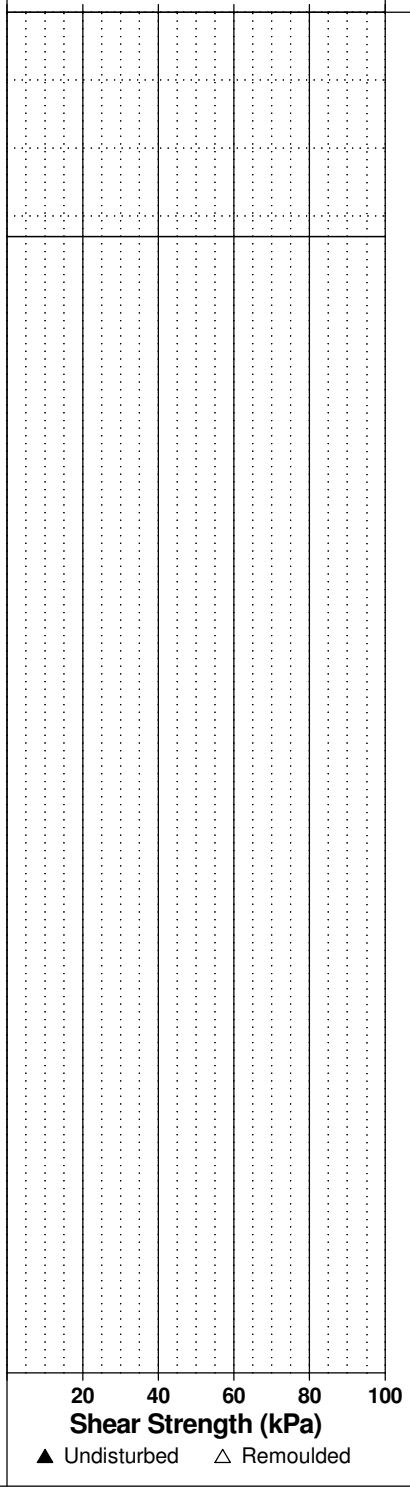
FILE NO. PG5576

REMARKS

HOLE NO. TP36-20

BORINGS BY Backhoe **DATE** November 12, 2020

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									
TOPSOIL						0	131.14		
0.23									
GLACIAL TILL: Brown silt clay, trace sand, gravel, cobbles, boulders		G	1						
		G	2						
0.66									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.66m depth									
(TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP37-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.23		
TOPSOIL									
0.39									
GLACIAL TILL: Brown silty clay, some sand, gravel, cobbles and boulders		G	1			1	130.23		▽
1.21									
End of Test Pit TP terminated on inferred bedrock surface at 1.21m depth (Groundwater infiltration at 1.1m depth)									

Pen. Resist. Blows/0.3m: ○ Water Content % — 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

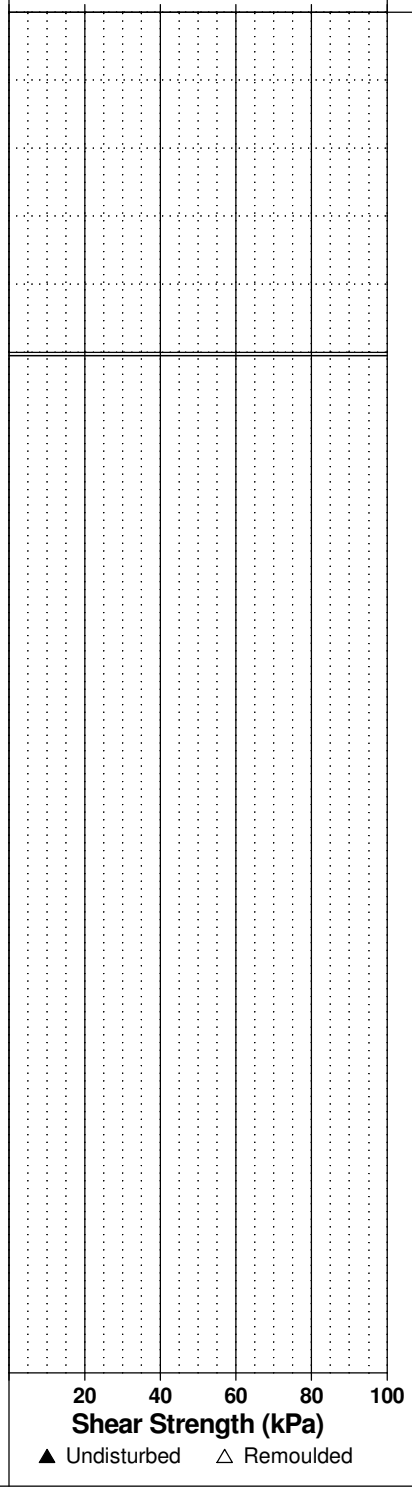
FILE NO. PG5576

REMARKS

HOLE NO. TP38-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.06		
TOPSOIL 0.29									
Stiff, brown **SILTY CLAY**		G	1						
1.01						1	130.06		
End of Test Pit TP terminated on inferred bedrock surface at 1.01m depth (TP dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

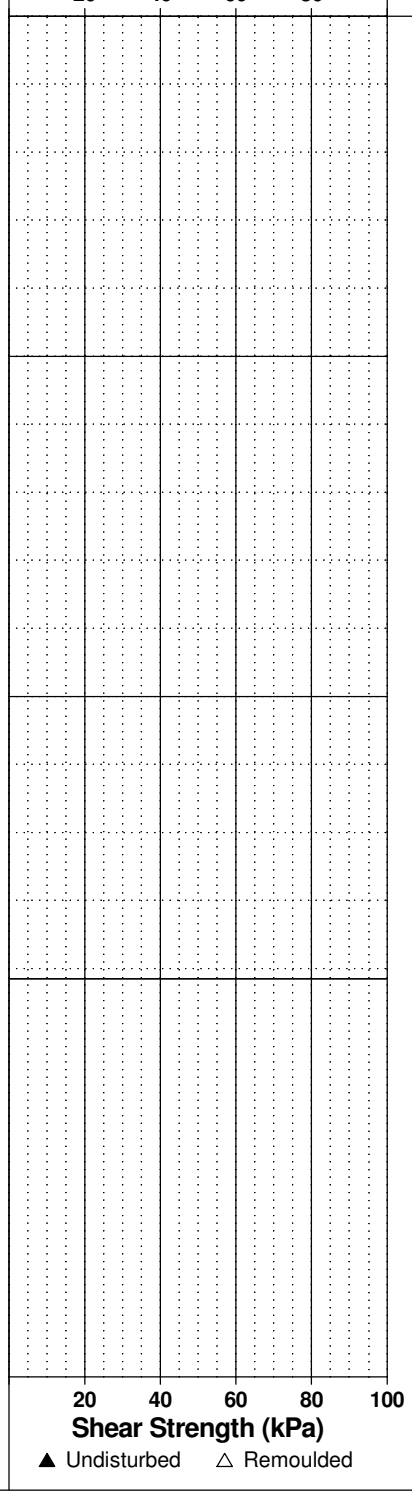
FILE NO. PG5576

REMARKS

HOLE NO. TP39-20

BORINGS BY Backhoe **DATE** November 12, 2020

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									
TOPSOIL 0.23						0	131.64		
Stiff, brown **SILTY CLAY,** trace sand 0.54		G	1						
		G	2			1	130.64		
GLACIAL TILL: Brown silty clay, some sand, gravel, cobbles, boulders		G	3			2	129.64		▽
2.83									
End of Test Pit TP terminated on inferred bedrock surface at 2.83m depth (Groundwater infiltration at 2.1m depth)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP40-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.66		
TOPSOIL									
0.31									
Stiff, brown **CLAYEY SILT** with organics		G	1						
0.72		G	2			1	130.66		
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		G	3					135	
2.65						2	129.66		
End of Test Pit TP terminated on inferred bedrock surface at 2.65m depth (TP dry upon completion)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

FILE NO. PG5576

REMARKS

HOLE NO. TP41-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.91	20 40 60 80	
TOPSOIL									
0.39									
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles		G	1						
0.81									
End of Test Pit TP terminated on inferred bedrock surface at 0.81m depth (TP dry upon completion)									

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision - Future Expansion Lands
Riverfront Estates, Mississippi Mills, Ontario

DATUM Geodetic

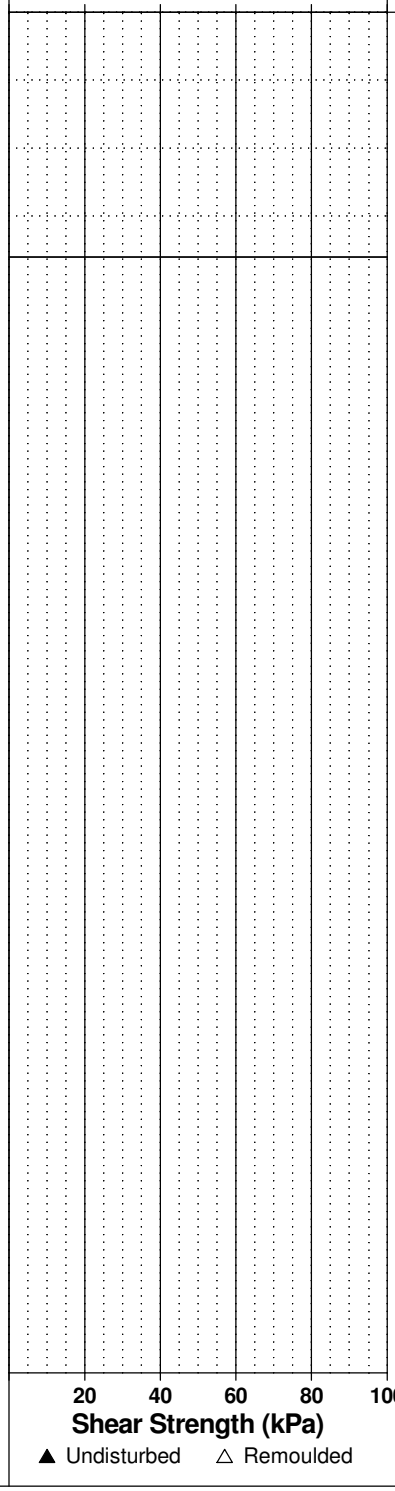
FILE NO. PG5576

REMARKS

HOLE NO. TP42-20

BORINGS BY Backhoe **DATE** November 12, 2020

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	131.21		
TOPSOIL 0.26									
GLACIAL TILL; Brown silty clay with sand, gravel, cobbles		G	1						
0.72									
End of Test Pit									
TP terminated on inferred bedrock surface at 0.72m depth									
(TP dry upon completion)									



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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of "P" denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	'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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water 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 at 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

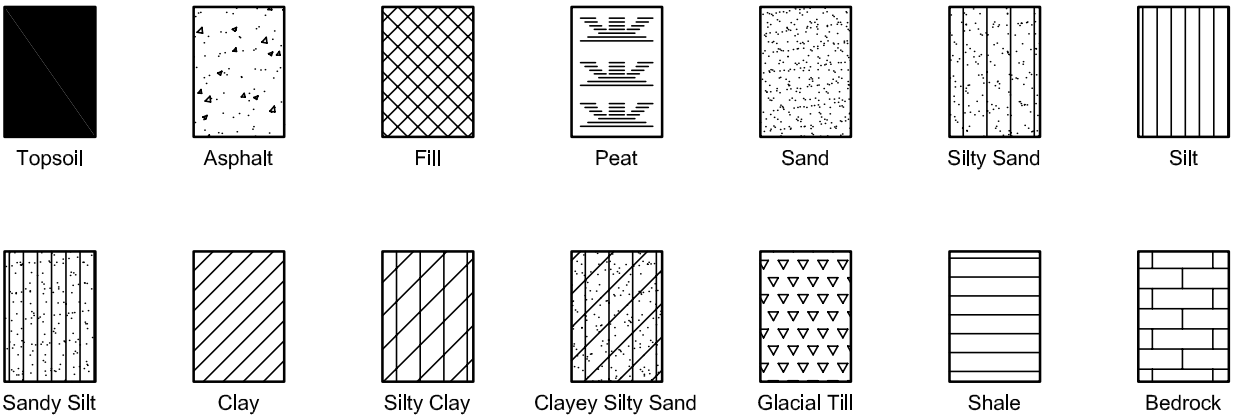
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void 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.

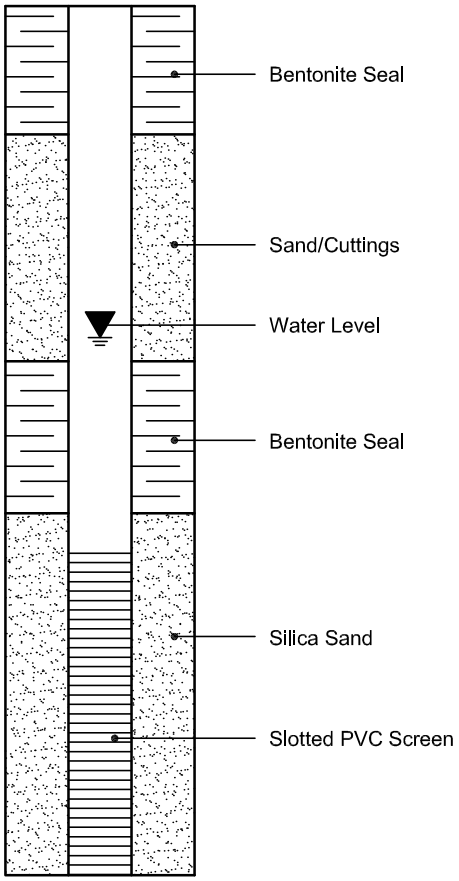
SYMBOLS AND TERMS (continued)

STRATA PLOT

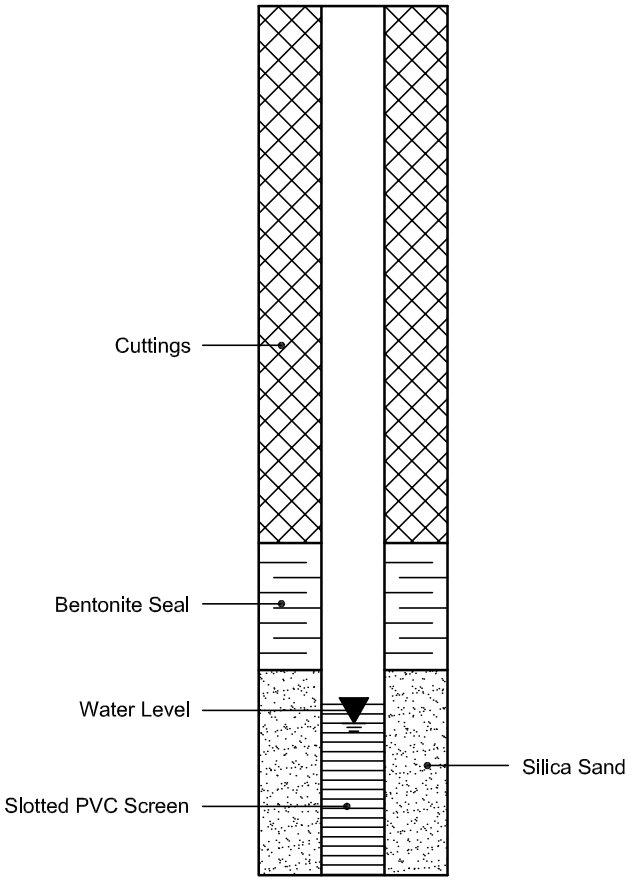


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 26-Nov-2020

Client: Paterson Group Consulting Engineers

Order Date: 23-Nov-2020

Client PO: 31279

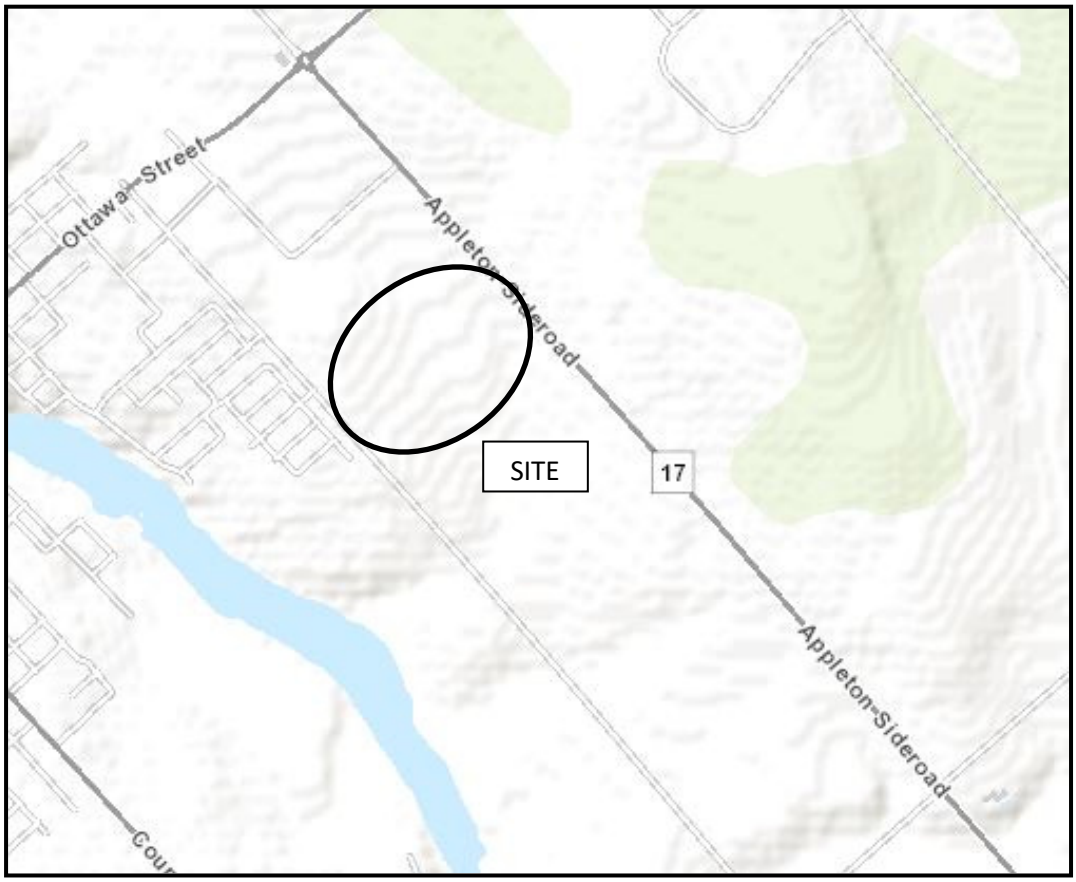
Project Description: PG5576

	Client ID:	TP40-20	-	-	-
	Sample Date:	12-Nov-20 13:00	-	-	-
	Sample ID:	2048113-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	71.8	-	-	-
General Inorganics					
pH	0.05 pH Units	7.46	-	-	-
Resistivity	0.10 Ohm.m	57.6	-	-	-
Anions					
Chloride	5 ug/g dry	13	-	-	-
Sulphate	5 ug/g dry	27	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

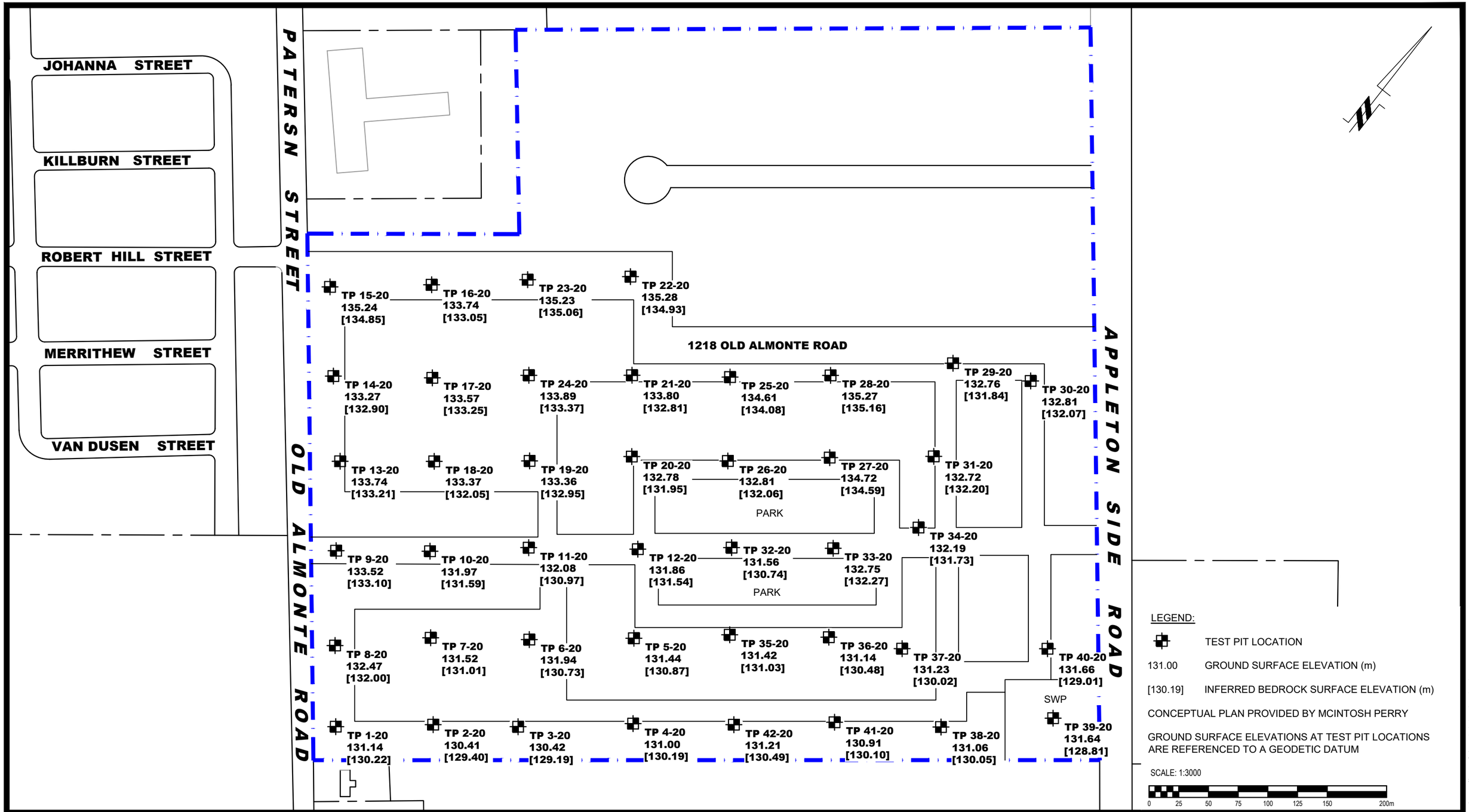
DRAWING PG5576-1 - TEST HOLE LOCATION PLAN



Source: GeoOttawa

FIGURE 1

KEY PLAN



LEGEND:

TEST PIT LOCATION

131.00 GROUND SURFACE ELEVATION (m)

[130.19] INFERRED BEDROCK SURFACE ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY MCINTOSH PERRY

GROUND SURFACE ELEVATIONS AT TEST PIT LOCATIONS ARE REFERENCED TO A GEODETIC DATUM

SCALE: 1:3000

0 25 50 75 100 125 150 200m

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NO.	REVISIONS	DATE	INITIAL

HOUCHAIMI HOLDINGS

GEOTECHNICAL INVESTIGATION
RIVERFRONT ESTATES FUTURE DEVELOPMENT
1218 OLD ALMONTE ROAD

ALMONTE, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:3000	Date: 11/2020
Drawn by: YA	Report No.: PG5576-1
Checked by: OC	Dwg. No.: PG5576-1
Approved by: DJG	Revision No.:

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