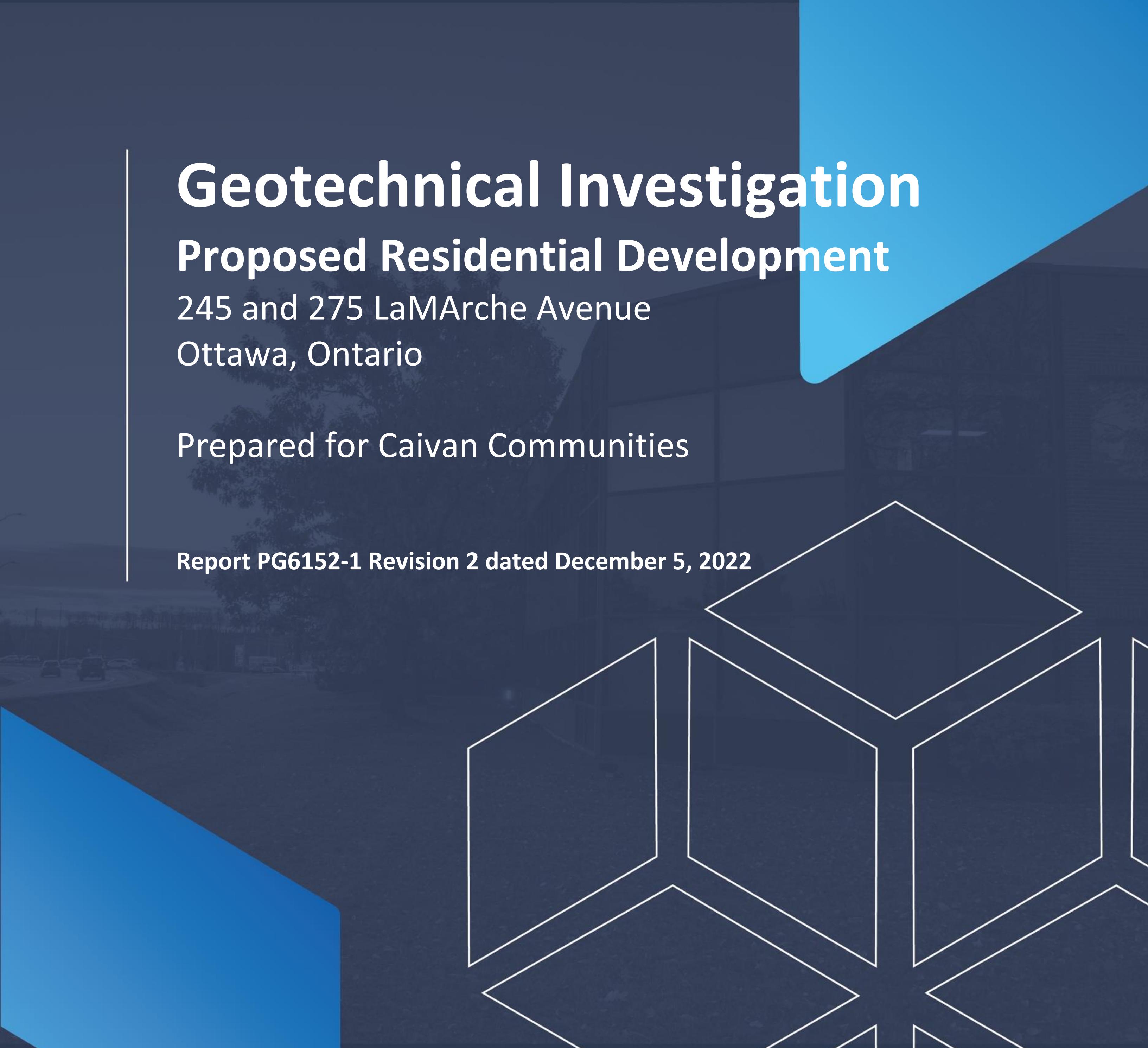

Geotechnical Investigation

Proposed Residential Development

245 and 275 LaMArche Avenue
Ottawa, Ontario

Prepared for Caivan Communities

Report PG6152-1 Revision 2 dated December 5, 2022

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Caivan Communities to conduct a geotechnical investigation for the current phase of the proposed Orleans Village residential development to be located at 245 and 275 LaMarche Avenue in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

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

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject 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 the present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

Based on the available drawings, it is understood that the current phase of the proposed development will consist of townhomes and back-to-back residential units. Associated access lanes, at-grade parking and landscaped areas, parks and walkways are also anticipated as part of the proposed development. 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 current geotechnical investigation was carried out on March 14, 2022 and consisted of advancing a total of 8 test pits to a maximum depth of 4.2 m below existing ground surface. The test hole locations were determined by the Paterson, taking into consideration underground utilities and site features. Previous geotechnical investigations were completed by Paterson and others within the subject site. At that time, 3 boreholes and 47 probe holes were located within the current project area and were advanced to a maximum depth of 2.5 m or refusal over bedrock surface. The test hole locations are shown on Drawing PG6152-1 - Test Hole Location Plan included in Appendix 2.

The test holes were completed using a hydraulic shovel operated by a two- person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The excavation procedure consisted of excavating to the required depth at the selected location and sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered from the sidewalls of the test pits. All soil samples were visually inspected and classified on site. The soil samples were placed in sealed plastic bags and transported to our laboratory for further examination and classification. The depths at which the soil samples were recovered from the test pits are shown as G on the Soil Profile and Test Data sheets presented in Appendix 1.

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

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

Groundwater

Where present, the depth at which groundwater was encountered at the completion of excavation was noted in the field.

Sample Storage

All samples will be stored in the laboratory for a period of one (1) month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The test hole locations and ground surface elevation at each test hole location during the current investigation were surveyed by Paterson using a high precision handheld GPS and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG6152-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. A total of 6 Atterberg limits tests, 2 grain size distribution analyses, 1 shrinkage test and moisture content testing were completed on selected soil samples.

All test results are presented in Subsection 4.2 and on Grain Size Distribution and Hydrometer Testing, and Atterberg Limit's Results and Shrinkage Test Results sheets presented in Appendix 1.

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 samples. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject is currently vacant, and grass covered. The ground surface across the subject site is generally flat with a slight downward slope toward the south and east. The west portion of the site was observed to be approximately at grade with Avenue de LaMarche. At the time of the current investigation, two fill piles having approximate fill height of 2 to 2.5 m, were observed to be present along the south east portion of the site. Based on the nature of the fill material, it is expected that the site has been used for stockpiling fill material during the construction of adjacent developments.

The subject site is bordered to the north by vacant lands and commercial buildings followed by Innes Road, to the east by a vacant land and industrial development, to the south by Crevier Walk, and to the west by Avenue de LaMarche followed by a mixed-use development.

4.2 Subsurface Profile

Generally, the soil profile at the test hole locations consists of topsoil/fill/and or crushed stone followed by hard to very stiff brown silty clay deposit. The encountered fill consisted of brown silty clay with topsoil, trace sand and gravel. A layer of silty sand to sandy silt with boulders was encountered below the crushed stone layer at the location of TP 2-22, extending down to an approximate depth of 0.7m below existing ground surface. A layer of compact glacial till was encountered below the fill at the location of TP 2-22 and below the brown silty clay layer at the location of TP 8-22. The glacial till deposit was found to consist of compact brown silty sand/clay, gravel, cobbles, and boulders. Refusal to excavation on bedrock surface was encountered at the locations of TP 1-22, TP 2-22, TP 3-22, TP 4-22, and TP 8-22 at an approximate depth between 0.7 m and 3.5 m below existing ground surface. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at borehole location.

Bedrock

Based on available geological mapping, the bedrock in this area consists of limestone and shale of the Lindsay Formation with an overburden drift thickness of 1 to 7 m depth.

Grain Size Distribution and Hydrometer Testing

Two sieve analyses were completed to classify selected soil samples according to the Unified Soil Classification System (USCS). The results are summarized in Table 1 and presented in Appendix 1.

Table 1 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP 5-22	G3	0.0	1.2	39.3	59.5
TP 8-22	G3	0.0	0.4	40.1	59.5

Atterberg Limit Tests

Three selected silty clay samples were submitted for Atterberg Limit testing. The test results indicate that high plasticity silty clays/clayey silts are anticipated at the subject site. The results are summarized in Table 2 and presented in Appendix 1.

Table 2 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	Classification
TP 3-22 G3	1.6-1.8	76	40	36	MH
TP 4-22 G2	0.5-0.7	67	31	36	CH
TP 5-22 G2	0.5-0.7	73	36	37	MH
TP 6-22 G3	1.0-1.2	62	32	30	MH
TP 7-22 G2	0.5-0.7	74	36	38	MH
TP 8-22 G2	05 – 0.8	73	42	31	MH

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index;
CH: Inorganic Clay of High Plasticity MH: Inorganic Silt of High Plasticity

Shrinkage Test

The results of the shrinkage limit test indicate a shrinkage limit of 25.09% and a shrinkage ratio of 1.656.

4.3 Groundwater

During the current investigation, the groundwater infiltration into the excavated test pits was observed and reported. The majority of the test pits were dry upon completion. The recorded groundwater infiltration levels are shown on Table 3, are also noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

Table 3 - Measured Groundwater Levels – Current Investigation

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Level / Groundwater Infiltration at Test Pits		Dated Recorded
		Depth (m)	Elevation (m)	
TP 1-22	90.52	Dry	-	March 14, 2021
TP 2-22	90.93	Dry	-	
TP 3-22	89.35	Dry	-	
TP 4-22	89.30	Dry	-	
TP 5-22	88.57	Dry	-	
TP 6-22	88.85	2.80	86.05	
TP 7-22	89.40	2.50	86.90	
TP 8-22	89.00	2.30	86.70	

Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS and are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered adequate for the proposed development. It is recommended that the proposed residential buildings be founded over conventional style shallow foundations placed on undisturbed, hard to very stiff brown silty clay, compact to dense glacial till, clean, surface sounded bedrock bearing surface, or on near vertical, zero entry, concrete in-filled trenches extending to a clean, surface-sounded bedrock surface.

Due to the presence of a silty clay deposit within the southern portion of the site, a permissible grade raise restriction of **3 m** will be required for buildings founded on the silty clay deposit within this portion of the site.

Where bedrock removal is required, consideration should be given to hoe-ramming or controlled blasting. In areas of weathered bedrock and where only a small quantity of bedrock is to be removed, bedrock removal may be possible by 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 carried out 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.

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

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 significant amounts of organic materials, or construction debris/remnants 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 almost vertical side walls. A minimum 1 m horizontal ledge should remain between the overburden excavation and the bedrock surface. The ledge will provide an area to allow for potential sloughing or a stable base for the overburden shoring system.

Vibration Considerations

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

The following construction equipment could be a source of vibrations: piling rig, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of the shoring system using soldier piles or sheet piling will require the use of these equipment. Vibrations, whether it is caused by blasting operations or by construction operations, could be the cause of the source of detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations 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). It should be noted that these guidelines are for today's construction standards.

Considering that several old or sensitive buildings are encountered in the vicinity of the subject site, considerations should be given to lowering these guidelines. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, it is recommended that a pre-construction survey be completed to minimize the risks of claims during or following the construction of the proposed building.

Fill Placement

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

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

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 pavements. Where the fill is open-graded, a blinding layer of finer granular fill and/or a woven geotextile may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements. This can be assessed at the time of construction.

5.3 Foundation Design

Bearing Resistance Values (Conventional Shallow Foundation)

Bedrock Medium

Footings placed on a clean, surface sounded bedrock surface can be designed using a bearing resistance value at ULS of **2,000 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS. Alternatively, footings placed over zero entry, near vertical trenches extending to bedrock and in-filled with lean concrete (15 MPa) to underside of footing level can be designed using the values provided above. It is recommended that the trench sidewalls extend at least 300 mm beyond the outside face of the 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.

Footings bearing on surface sounded bedrock and designed using the above noted bearing resistance values will be subjected to negligible post-construction total and differential settlements.

Overburden

Isolated shallow footings placed on an undisturbed, compact to dense glacial till bearing surface can be designed using a bearing resistance value at SLS of **150 kPa** and at ULS of **225 kPa**. A geotechnical resistance factor of 0.5 was incorporated into the above noted bearing resistance values at ULS.

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

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

Where fill is required to raise the grade below the footing level, the fill located within the zone of influence of the footings should consist of approved engineered fill. The engineered fill should consist of OPSS Granular A or Granular B Type II placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% of its SPMDD. The preliminary allowable bearing pressures for footings placed on the approved engineered fill should be taken as **150 kPa** at SLS.

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

Lateral Support

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

Adequate lateral support is provided to a sound bedrock bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:6V (or flatter) passes only through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete.

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.

Lean Concrete Filled Trenches

Where bedrock is encountered below the design underside of footing elevation, consideration should be given to excavating vertical trenches to expose the underlying bedrock surface and backfilling with lean concrete (**15 MPa** 28-day compressive strength). Typically, the excavation sidewalls will be used as the form to support the concrete. The additional width of the concrete poured against an undisturbed trench sidewall will suffice in providing a direct transfer of the footing load to the underlying bedrock.

The effectiveness of this operation will depend on the ability of maintaining vertical trenches until the lean concrete can be poured. It is suggested that once the bottom of the excavation is exposed, an assessment should be completed to determine the water infiltration and stability of the excavation sidewalls extending to the bedrock surface.

The trench excavation should be at least 150 mm wider than all sides of the footing at the base of the excavation. The excavation bottom should be relatively clean using the hydraulic shovel only (workers will not be permitted in the excavation below a 1.5 m depth). Once approved by the geotechnical engineer, lean concrete can be poured up to the proposed founding elevation.

Footings placed on lean concrete filled trenches extending to the bedrock surface can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **2,000 kPa**.

Permissible Grade Raise and Settlements

Due to the presence of the silty clay deposit within the south portion of the site, a permissible grade raise restriction is recommended. The recommended grade raise restrictions are shown on Drawing PG6152-3 - Permissible Grade Raise Plan in Appendix 2. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise calculations.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

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

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for foundations to be constructed within the subject site. The soils underlying the proposed shallow foundations are not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement / Floor Slab

With the removal of all topsoil and deleterious fill, containing significant amounts of organic material, within the footprint of the proposed buildings, the existing soil and bedrock surface, which is reviewed and approved by Paterson personnel at the time of construction, will be considered an acceptable subgrade upon which to commence backfilling for floor slab construction.

An engineered fill such as an OPSS Granular A or Granular B Type II compacted to 98% of its SPMDD could be placed around the proposed footings. The upper 200 mm below the basement/floor slab should consist of a 19 mm clear crushed stone. Alternatively, excavated limestone bedrock could be used as select subgrade material around the proposed building footings, provided the excavated bedrock is suitably crushed to 50 mm in its longest dimension and approved by the geotechnical consultant at the time of placement.

In consideration of the groundwater conditions encountered during the investigation, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone backfill under the lower basement floor. Pipe spacing requirements should be determined at the time of excavation when the groundwater infiltration can be better assessed.

If the floor slab is constructed in the areas of shallow bedrock, it is recommended that a minimum 300 mm thick layer (native soil plus crushed stone layer) be present between the floor slab and the bedrock surface to reduce the risks of bending stresses developing in the concrete slab. The bending stress could lead to cracking of the concrete slab. This requirement could be waived in areas where the bedrock surface is relatively flat within the footprint of the building.

This recommendation does not refer to potential concrete shrinkage cracking which should be controlled in the usual manner.

5.8 Pavement Design

Car only parking areas, access and heavy traffic access areas are expected at this site. The subgrade material will consist of native soil and possibly bedrock. The proposed pavement structures are presented in Tables 4 and 5.

Table 4 – Recommended Pavement Structure – Car Only Parking Areas and Driveways

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 5 – Recommended Pavement Structure – Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Wear Course –** HL-8 or Superpave 19 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
450	**SUBBASE –** OPSS Granular B Type II
Subgrade – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil, bedrock or concrete fill.	

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

Pavement Structure Drainage

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

Where silty clay is anticipated at subgrade level, consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed buildings. The system should consist of a 150 mm diameter perforated corrugated plastic pipe wrapped in a geosock, 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 clear stone should be wrapped in a non-woven geotextile. The pipe should have a positive outlet, such as a gravity connection to the storm sewer or sump pump pit.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining, non-frost susceptible granular materials. The greater part of the site 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 effects of frost action. A minimum 1.5 m thick soil cover (or insulation equivalent) should be provided in this regard.

Other exterior unheated footings, such as those for isolated exterior piers and retaining walls, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover (or insulation equivalent).

6.3 Excavation Side Slopes

The side slopes of excavations in the overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room

will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).
Where space restrictions exist, or to reduce the trench width, the excavation can be carried out within the confines of a fully braced steel trench box.

Unsupported Side Slopes

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.

In bedrock, almost vertical side slopes can be used provided that all loose rock and blocks with unfavorable weak planes are removed or stabilized.

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

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

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

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa. At least 150 mm of OPSS Granular A 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 or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 95% of the material’s standard Proctor maximum dry density.

It should generally be possible to re-use the upper portion of the dry to moist (not wet) silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Well fractured bedrock should be acceptable as backfill for the lower portion of the trenches when the excavation is within bedrock provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones are 300 mm or smaller in their longest dimension.

The backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce potential differential frost heaving. The backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

6.5 Groundwater Control

Groundwater Control for Building Construction

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be low to moderate 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.

Permit to Take Water

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 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, typically 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.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 slightly aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Restrictions

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Grain size distribution and hydrometer testing were also completed on selected soil samples. The above noted soil samples were recovered from elevations below the anticipated design underside of footing elevation and 3.5 m depth below anticipated finished grade. The results of our testing are presented 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 in Drawing PG6152-4 – Tree Planting Setback Recommendations presented in Appendix 2.

Area 1 - No Tree Planting Setbacks

Based on the subsoil profile at the test hole locations, silty sand and or glacial and shallow bedrock will be encountered at the future footing elevations at the locations identified on Drawing PG6152-4- Tree Planting Setback Recommendations. As a result, no tree planting restrictions are required for Area 1.

Area 2 - Low/Medium Sensitivity Clay Soils

A low to medium sensitivity clay soil is present within the subject site. The following tree planting setbacks are recommended for areas identified on Drawings PG6152-4- Tree Planting Setback Recommendations.

It should be noted that in areas where design finished grades and top of the silty clay layer is greater than 3.5 m, no tree planting setbacks will be required. This will be defined by the geotechnical consultant by a lot-by-lot basis upon review of the site grading plan.

Large trees (mature height over 14 m) can be planted within Area 2 provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below. Based on our review of the silty clay crust at the founding elevation, this number can be lowered to 1.9 m due to the depth of the groundwater table and our assessment of the impacts of tree planting on the founding medium.

- A small tree must be provided with a minimum of 25 m^3 of available soil 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.

Aboveground Swimming Pools, Hot Tubs, Decks and Additions

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 neighboring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

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

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

7.0 Recommendations

A material 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 of the grading plan from a geotechnical perspective.
- Review the implementation of the perimeter and underfloor drainage system, from a geotechnical perspective.
- Observation of all bearing surfaces prior to the placement of concrete.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Sampling and testing of the concrete and fill materials used.
- 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.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

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

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests immediate notification to permit reassessment of our recommendations.

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

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

Paterson Group Inc.

Maha Saleh, P.Eng (Prov)

LICENSED PROFESSIONAL ENGINEER
December 5, 2022
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

David J. Gilbert, P.Eng

Report Distribution:

☐ Caivan Communities (Digital copy)
☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

BOREHOLE LOGS BY OTHERS

ANALYTICAL TEST RESULTS

ATTERBERG LIMIT TESTING RESULTS

GRAIN SIZE DISTRIBUTION AND HYDROMETER TESTING RESULTS

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE 2022 March 14

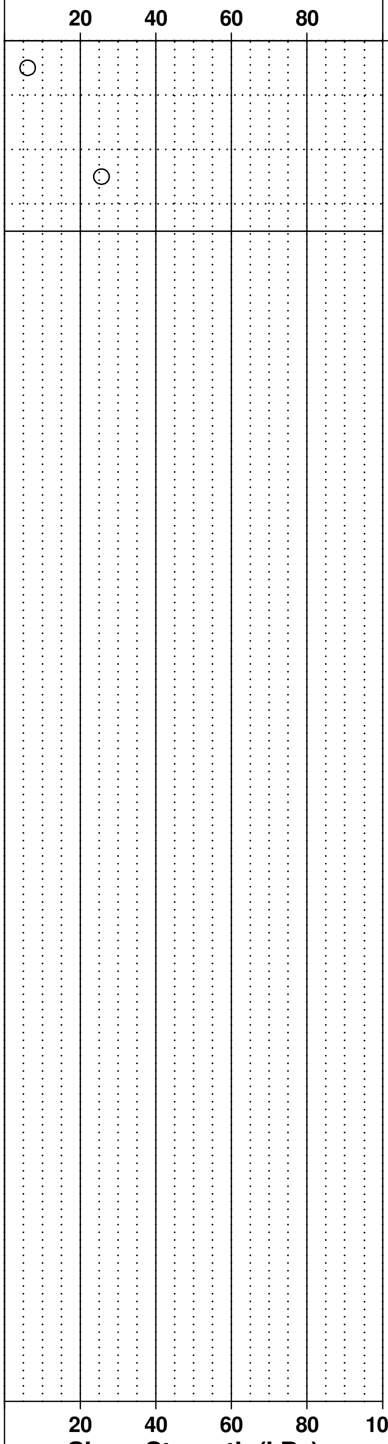
FILE NO. PG6152

HOLE NO. TP 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.52
FILL: Crushed stone, trace sand		G	1				
0.40							
Compact, brown **SILTY SAND to SANDY SILT** with boulders		G	2				
0.70							
End of Test Pit TP terminated on bedrock surface at 0.70m depth (TP dry upon completion)							

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

○ Water Content %



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE 2022 March 14

FILE NO. PG6152

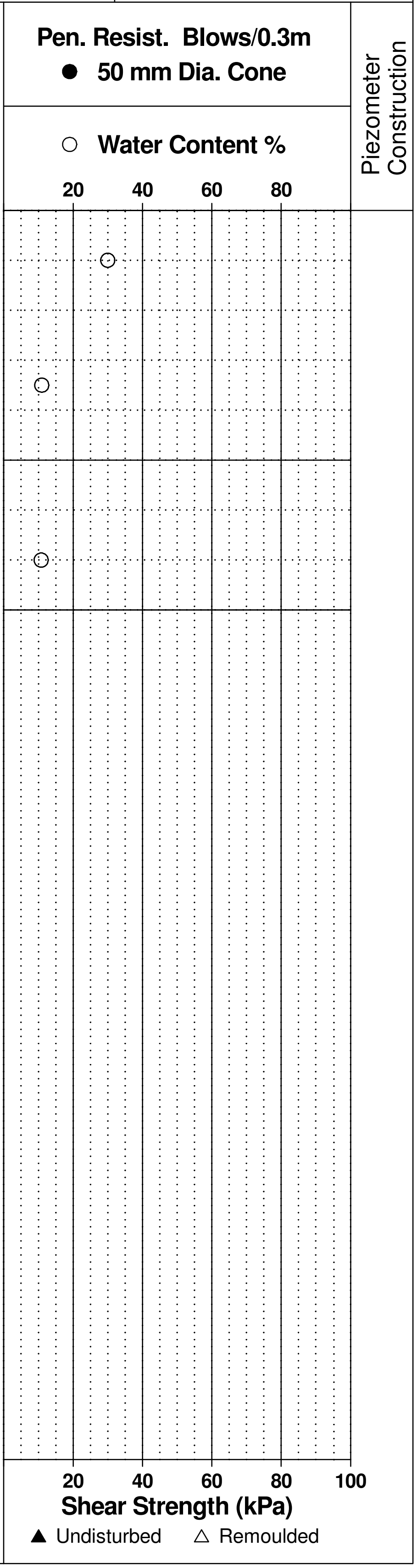
HOLE NO. TP 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.93
TOPSOIL 0.15	■						
FILL: Topsoil, some clay, trace gravel 0.70	▨	G	1				
GLACIAL TILL: Compact, brown silty sand with gravel		G	2			1	89.93
- occasional cobbles and boulders by 1.3m depth 1.60		G	3				

End of Test Pit

TP terminated on bedrock surface at 1.60m depth.

(TP dry upon completion)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

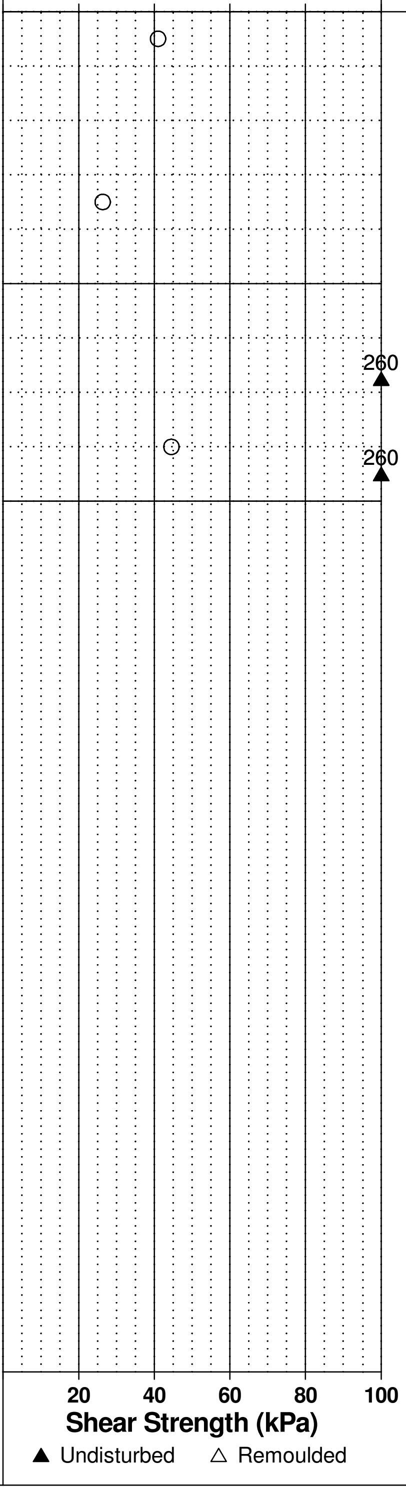
BORINGS BY Excavator

DATE 2022 March 14

FILE NO. PG6152

HOLE NO. TP 3-22

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	89.35		
TOPSOIL 0.25		G	1						
FILL: Brown silty clay with topsoil, trace sand 1.10		G	2			1	88.35		
Hard, brown **SILTY CLAY** 1.80		G	3						
End of Test Pit TP terminated on bedrock surface at 1.80m depth (TP dry upon completion)									



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

FILE NO. PG6152

REMARKS

HOLE NO. TP 4-22

BORINGS BY Excavator

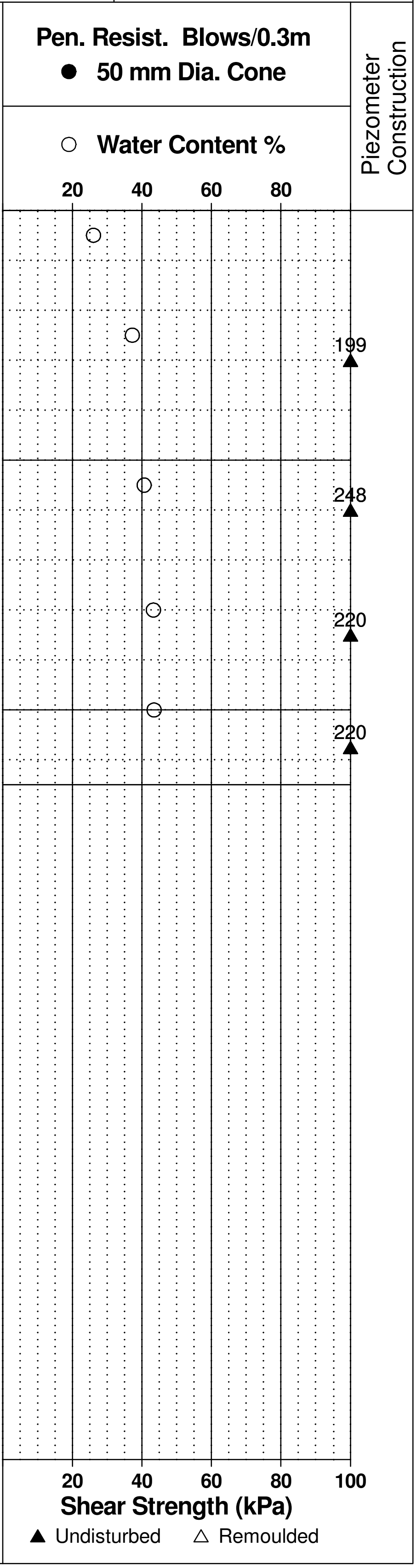
DATE 2022 March 14

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.30
TOPSOIL 0.18							
FILL: Brown silty clay with topsoil, trace sand 0.40		G	1				
		G	2				
						1	88.30
Hard, brown **SILTY CLAY**		G	3				
		G	4				
						2	87.30
2.30		G	5				

End of Test Pit

TP terminated on bedrock surface at 2.30m depth.

(TP dry upon completion)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

FILE NO. PG6152

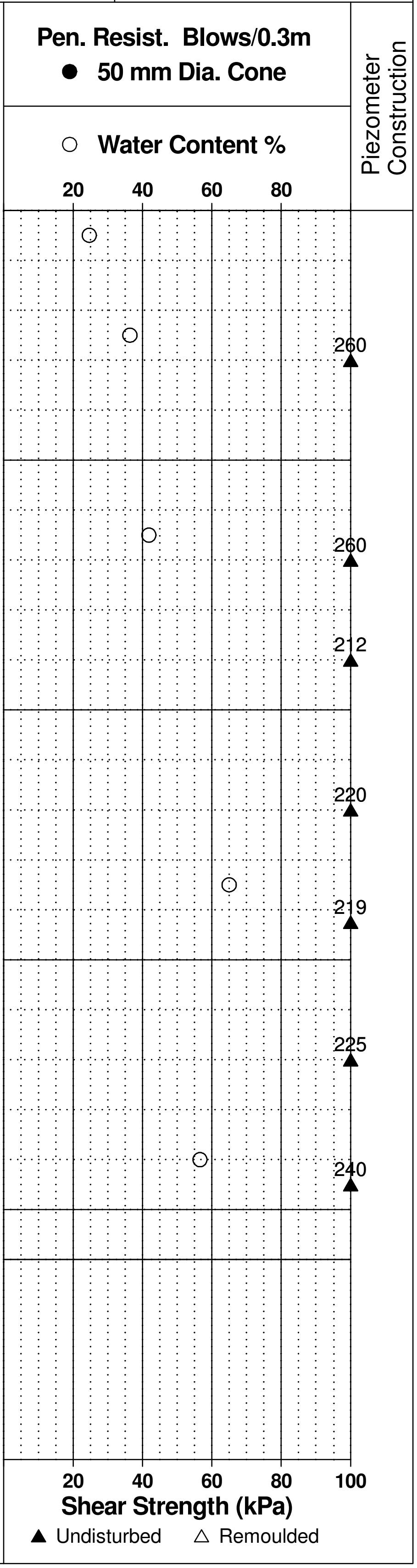
REMARKS

HOLE NO. TP 5-22

BORINGS BY Excavator

DATE 2022 March 14

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.57
TOPSOIL 0.25		G	1				
FILL: Brown silty clay with topsoil, trace sand 0.40							
		G	2				
						1	87.57
		G	3				
						2	86.57
Hard. brown **SILTY CLAY**							
		G	4				
						3	85.57
		G	5				
4.20						4	84.57
End of Test Pit (TP dry upon completion)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

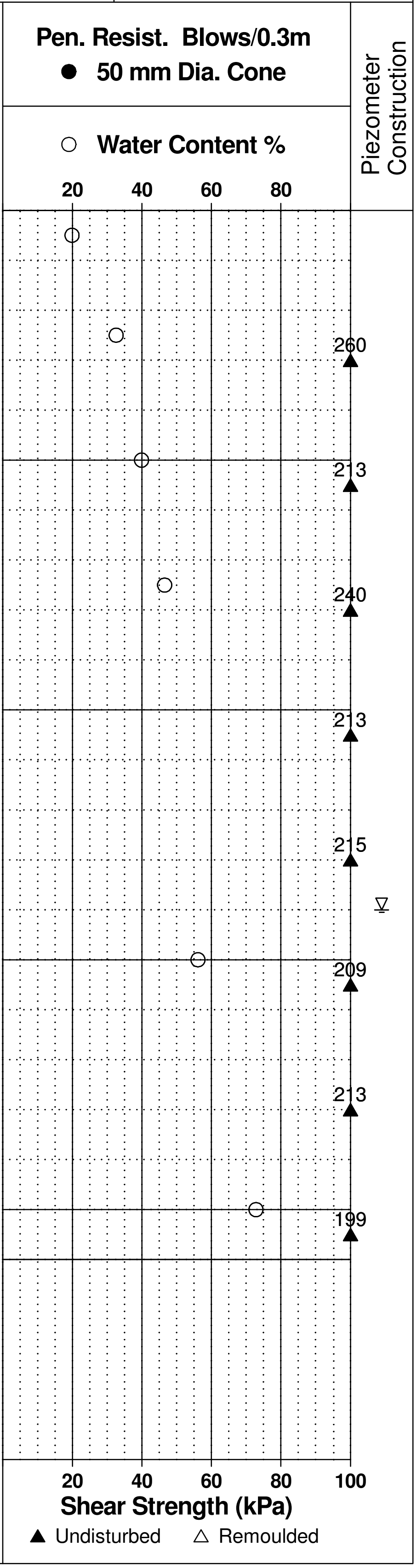
BORINGS BY Excavator

DATE 2022 March 14

FILE NO. PG6152

HOLE NO. TP 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.85
TOPSOIL 0.20		G	1				
FILL: Brown silty clay with topsoil. trace sand 0.40							
		G	2				
		G	3			1	87.85
		G	4				
Hard to very stiff, brown **SILTY CLAY**						2	86.85
		G	5			3	85.85
4.20		G	6			4	84.85
End of Test Pit (Groundwater infiltration at 2.8m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

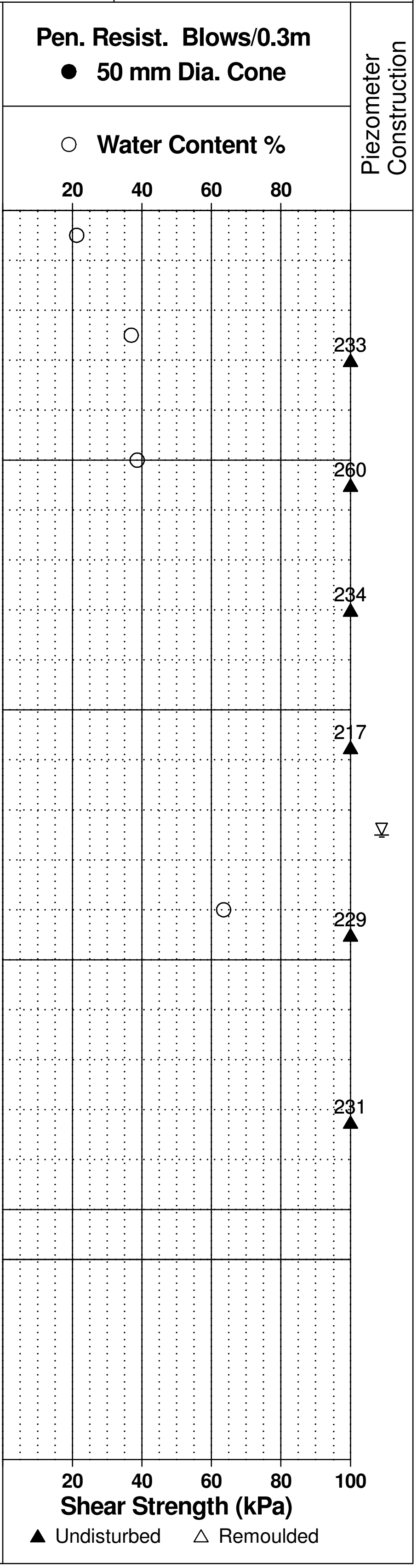
BORINGS BY Excavator

DATE 2022 March 14

FILE NO. PG6152

HOLE NO. TP 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.40
TOPSOIL 0.10							
FILL: Topsoil with brown silty clay, sand and gravel 0.40		G	1				
Hard, brown **SILTY CLAY**		G	2				
		G	3			1	88.40
						2	87.40
		G	4			3	86.40
4.20						4	85.40
End of Test Pit (Groundwater infiltration at 2.5m depth)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
245 and 275 Lamarche Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE 2022 March 14

FILE NO. **PG6152**

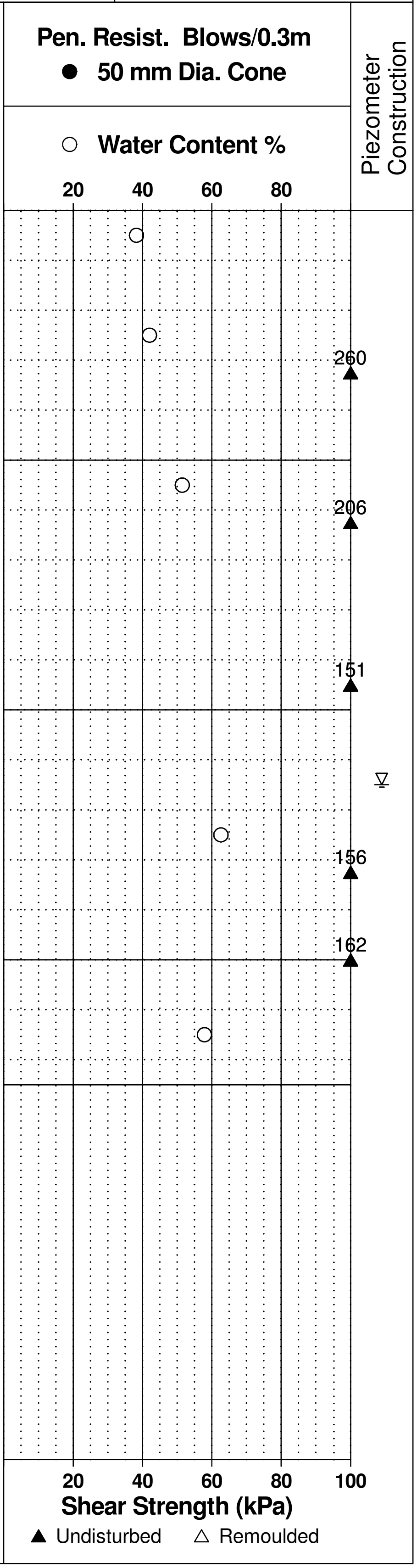
HOLE NO. **TP 8-22**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	89.00
TOPSOIL 0.30	G	1				
FILL: Brown silty clay with topsoil, trace sand 0.40						
Hard to very stiff, brown **SILTY CLAY**	G	2				
					1	88.00
	G	3				
					2	87.00
	G	4				
					3	86.00
3.30						
GLACIAL TILL: Brown silty clay, some sand, trace gravel 3.50	G	5				

End of Test Pit

TP terminated on bedrock surface at 3.50m depth.

(Groundwater infiltration at 2.3m depth)



SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

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

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

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

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

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

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

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
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)

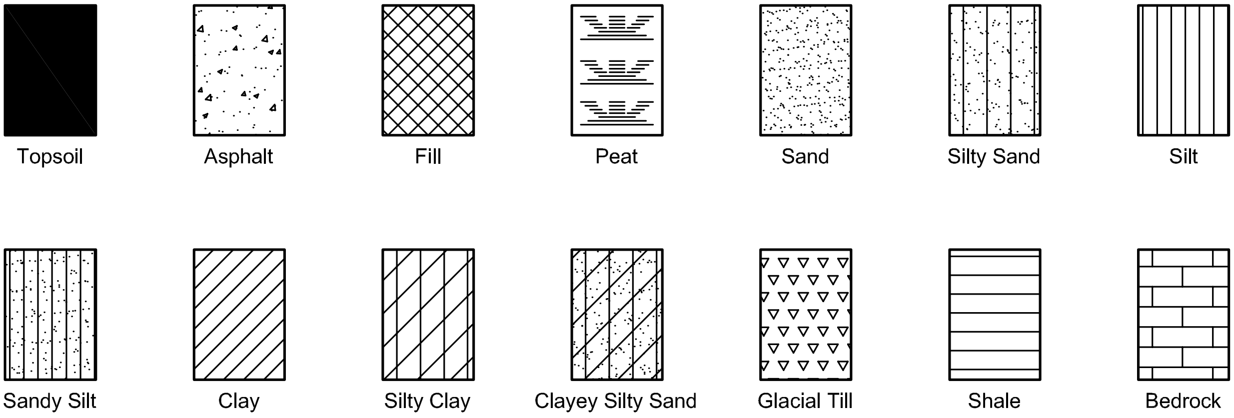
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

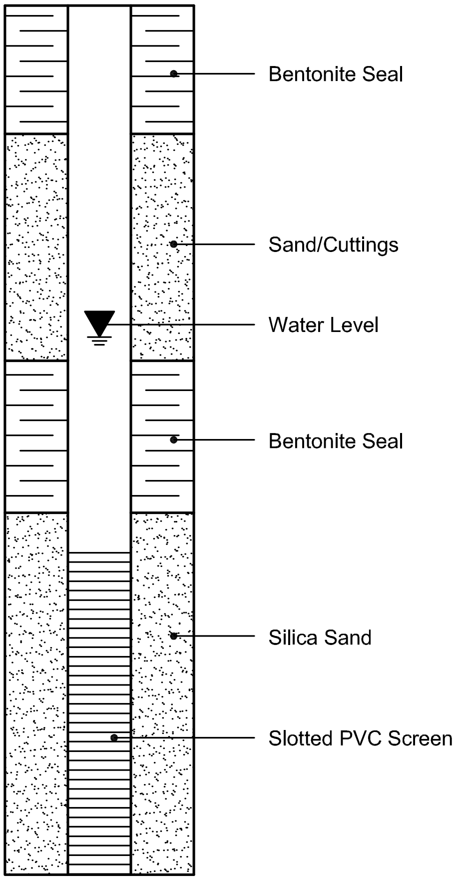
SYMBOLS AND TERMS (continued)

STRATA PLOT

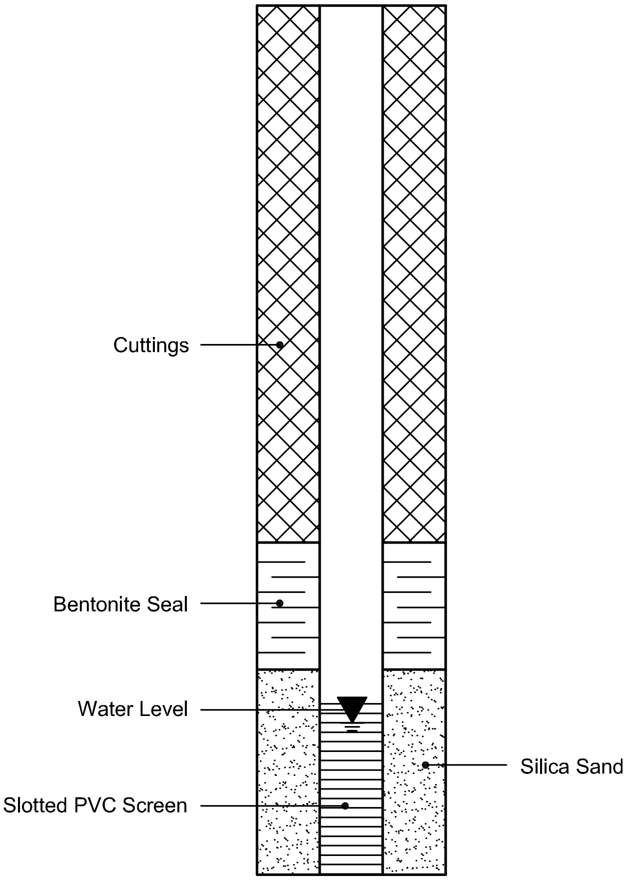


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PROJECT: 1660030

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: N 5034649.4 ;E 381258.4

BORING DATE: November 1, 2016

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.23							
0	Power Auger 200 mm Diam. (HS)	FILL - (SP) gravelly SAND, some non-plastic fines; grey brown; non-cohesive, moist, compact	▨	0.00	1	SS	26				
		FILL - (SM/SC) SILTY SAND to CLAYEY SAND, trace gravel; grey brown; non-cohesive, moist	▨	89.93 0.30	2	SS	>50				
1		End of Borehole Auger Refusal		89.32 0.91							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DWM

CHECKED: WAM

PROJECT: 1660030

RECORD OF BOREHOLE: 16-2A

SHEET 1 OF 1

LOCATION: 1.8 m East of BH 16-2

BORING DATE: November 1, 2016

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.23							
0	Power Auger 200 mm Diam. (Hollow Stem)	For Stratigraphy see RECORD OF BOREHOLE 16-2		0.00							
				89.26							
1		End of Borehole Auger Refusal		0.97							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DWM

CHECKED: WAM

PROJECT: 1660030

RECORD OF BOREHOLE: 16-5

SHEET 1 OF 1

LOCATION: N 5034535.9 ;E 381317.6

BORING DATE: November 10, 2016

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		89.36							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL/TOPSOIL - (ML) sandy SILT; brown		0.00							
		FILL - (ML) CLAYEY SILT, trace sand; brown with red mottling, contains rootlets (reworked native soil); cohesive, w<PL		89.13 0.23	1	SS	5				
1		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown with red mottling (WEATHERED CRUST); cohesive, w>PL, very stiff		88.75 0.61	2	SS	10				
2		(SM) SILTY SAND, some gravel; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, loose to very dense		87.53 1.83	3 4	SS SS	6 >50				
		End of Borehole Auger Refusal		86.82 2.54							
3											
4											
5											
6											
7											
8											
9											
10											

MIS-BHS 001 1660030-GEOTECH.GPJ GAL-MIS.GDT 12/03/18 JEM

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DWM

CHECKED: WAM

PROJECT: 1660030

RECORD OF BOREHOLE: 16-7

SHEET 1 OF 1

LOCATION: N 5034408.7 ;E 381270.1

BORING DATE: November 2, 2016

DATUM: CGVD28

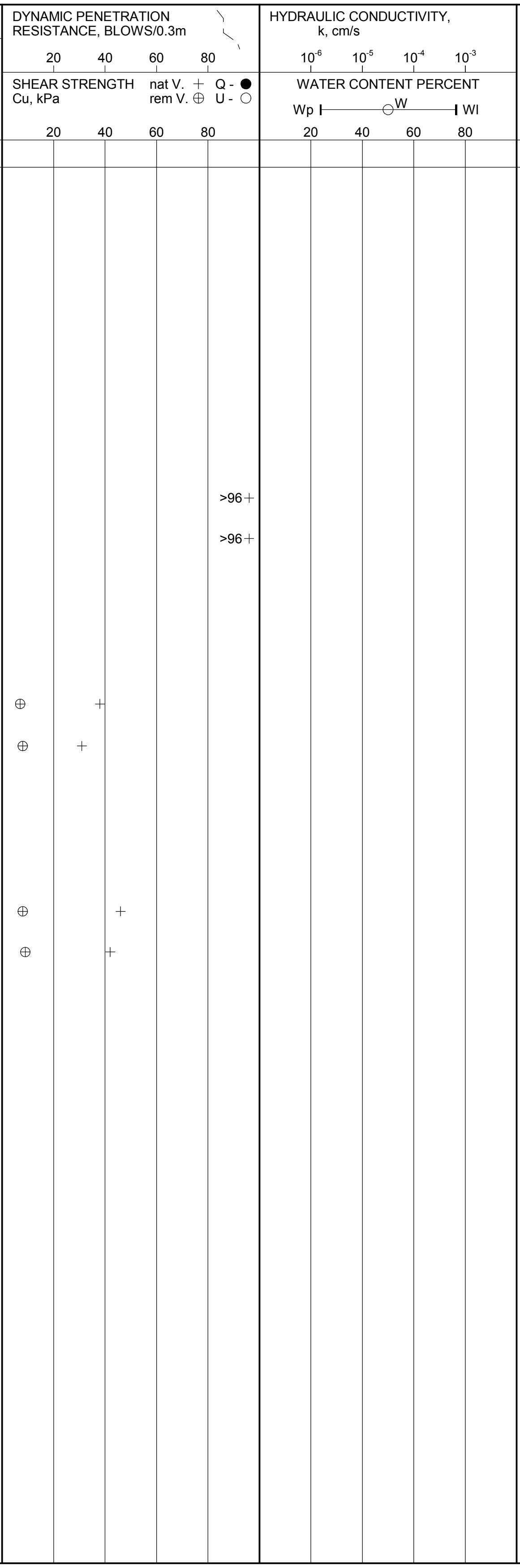
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		88.71
TOPSOIL - (ML) sandy SILT; brown		0.00
(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown with red mottling (WEATHERED CRUST); cohesive, w>PL, very stiff		0.08
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm		85.66 3.05
(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, loose to very dense		82.46 6.25
End of Borehole Auger Refusal		81.70 7.01

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	8
2	SS	5
3	SS	5
4	SS	PH
5	SS	PH
6	SS	5
7	SS	>50



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DWM

CHECKED: WAM

MIS-BHS 001 1660030-GEOTECH.GPJ GAL-MIS.GDT 12/03/18 JEM

Certificate of Analysis

Client: Paterson Group Consulting Engineers

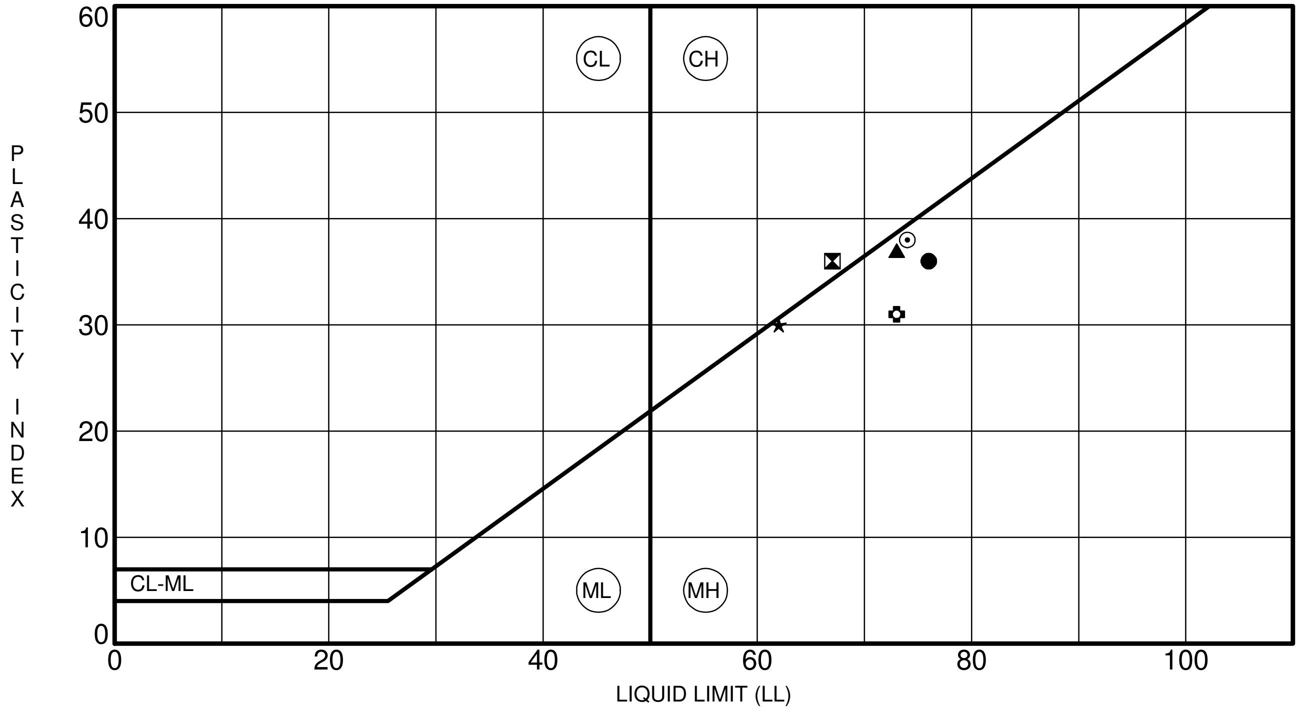
Client PO: 33939

Report Date: 24-Mar-2022

Order Date: 21-Mar-2022

Project Description: PG6152

	Client ID:	TP3-22 G3	-	-	-
	Sample Date:	15-Mar-22 09:00	-	-	-
	Sample ID:	2213100-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	71.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.05	-	-	-
Resistivity	0.10 Ohm.m	92.8	-	-	-
Anions					
Chloride	5 ug/g dry	18	-	-	-
Sulphate	5 ug/g dry	25	-	-	-



	Specimen Identification	LL	PL	PI	Fines	Classification
●	**TP 3-22 G3**	**76**	**40**	**36**		**MH = Inorganic Silts of High Plasticity**
⧗	**TP 4-22 G2**	**67**	**31**	**36**		**CH = Inorganic Clays of High Plasticity**
▲	**TP 5-22 G2**	**73**	**36**	**37**		**MH = Inorganic Silts of High Plasticity**
★	**TP 6-22 G3**	**62**	**32**	**30**		**MH = Inorganic Silts of High Plasticity**
⊙	**TP 7-22 G2**	**74**	**36**	**38**		**MH = Inorganic Silts of High Plasticity**
✿	**TP 8-22 G2**	**73**	**42**	**31**		**MH = Inorganic Silts of High Plasticity**

CLIENT **Caivan Communities**

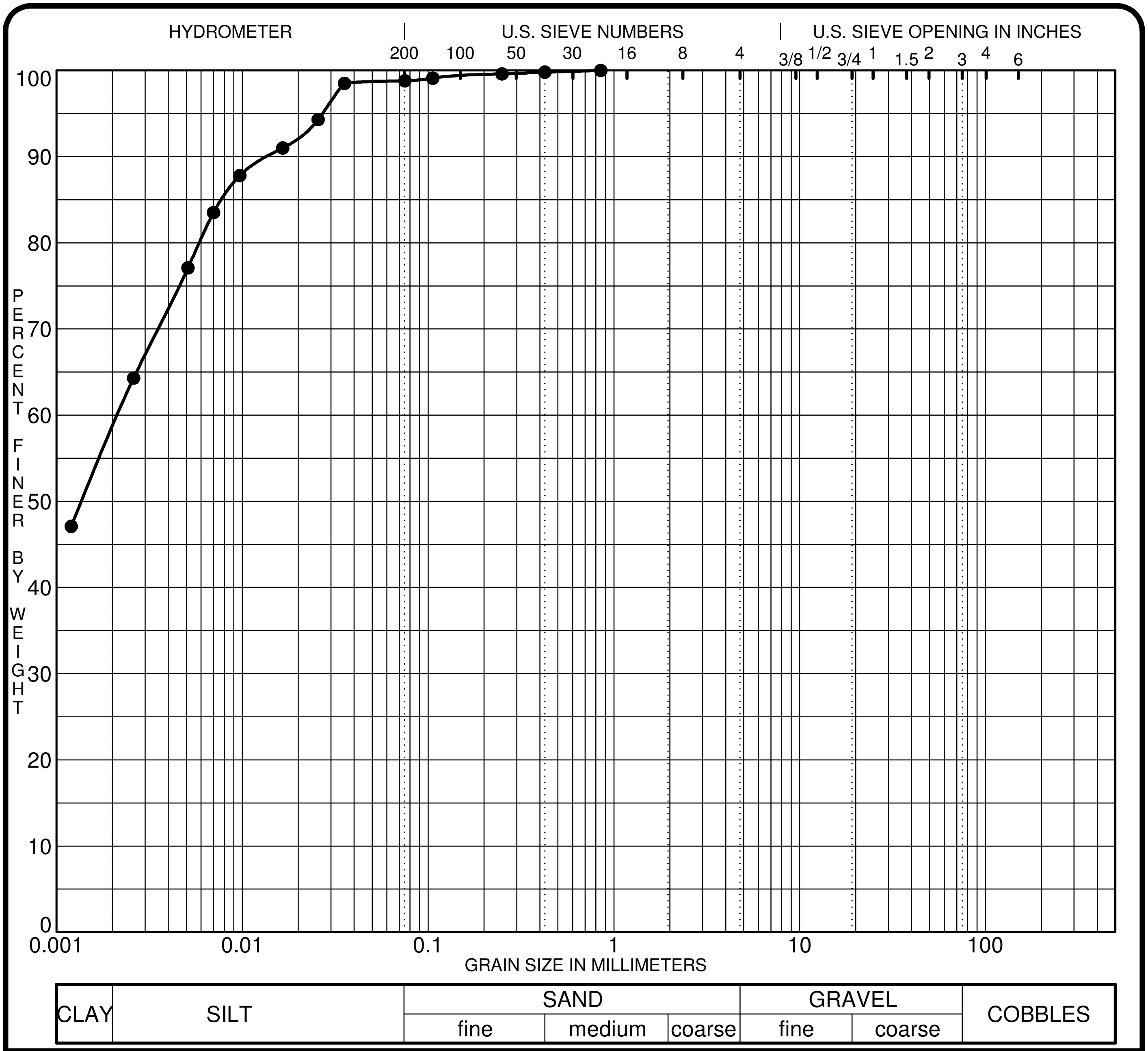
FILE NO. **PG6152**

PROJECT **Geotechnical Investigation - Proposed Residential Development - 245 and 275 Lamarch Avenue, Ottawa**

DATE **14 Mar 22**

patersongroup **Consulting Engineers**

ATTERBERG LIMITS' RESULTS



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 5-22 G3**		**40.7**					
☒								
▲								
★								

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 5-22 G3**	**0.85**	**0.00**			**0.0**	**1.2**	**39.3**	**59.5**
☒									
▲									
★									

CLIENT **Caivan Communities**

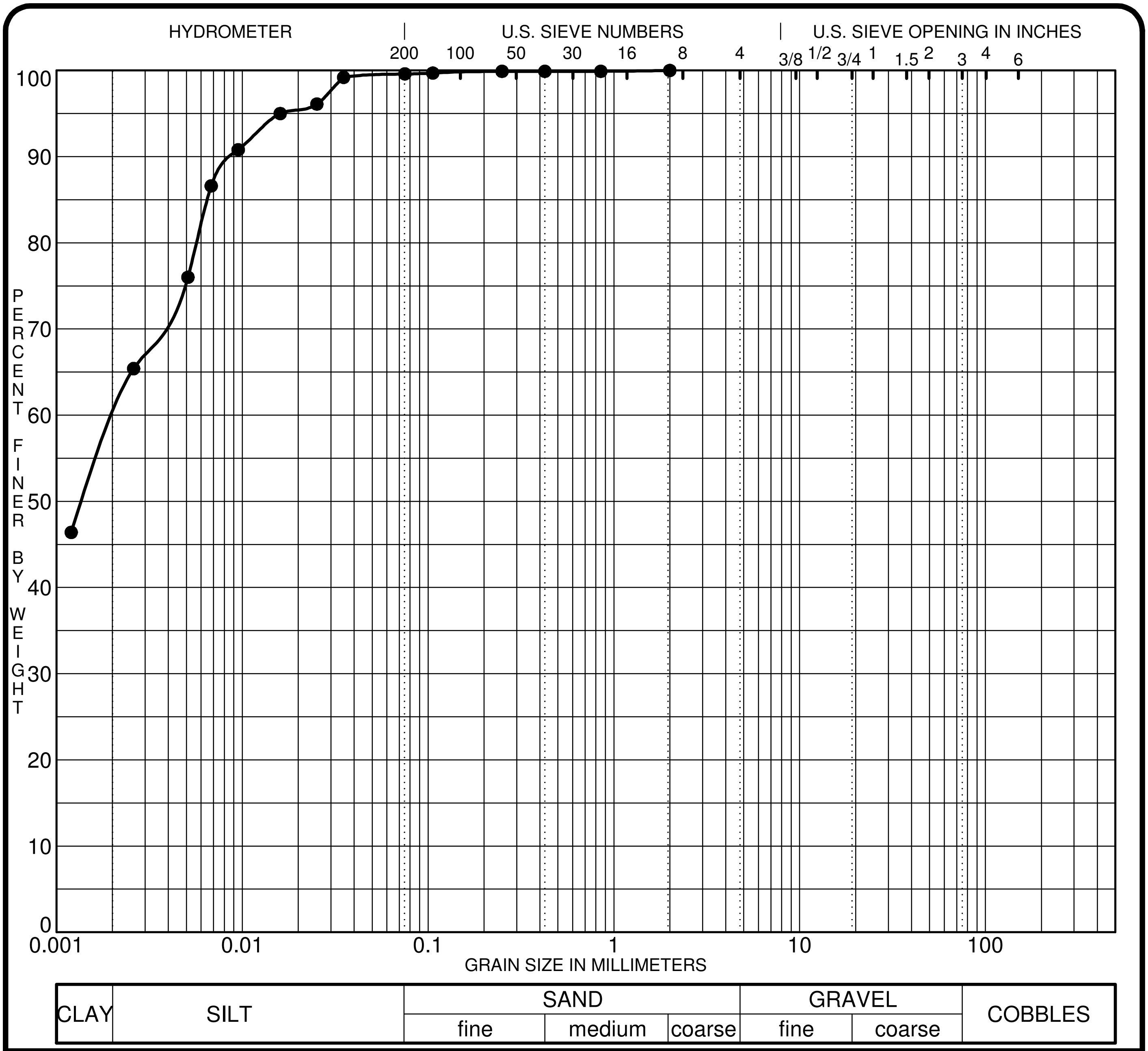
FILE NO. **PG6152**

PROJECT **Geotechnical Investigation - Proposed Residential Development - 245 and 247 Lamarche Avenue, Ottawa**

DATE **14 Mar 22**

patersongroup **Consulting Engineers**

GRAIN SIZE DISTRIBUTION



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **TP 8-22 G3**		**47.3**					
⊠							
▲							
★							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP 8-22 G3**	**2.00**	**0.00**			**0.0**	**0.4**	**40.1**	**59.5**
⊠								
▲								
★								

CLIENT **Caivan Communities**
FILE NO. **PG6152**
PROJECT **Geotechnical Investigation - Proposed Residential Development - 245 and 247 Lamarche Avenue, Ottawa**
DATE **14 Mar 22**

patersongroup **Consulting Engineers**

GRAIN SIZE DISTRIBUTION

APPENDIX 2

FIGURE 1 – KEY PLAN

DRAWING PG6152-1 – TEST HOLE LOCATION PLAN

DRAWING PG6152-2 – BEDROCK CONTOUR PLAN

DRAWING PG6152-3 – PERMISSIBLE GRADE RAISE PLAN

DRAWING PG6152-4 – TREE PLANTING SETBACK RECOMMENDATIONS

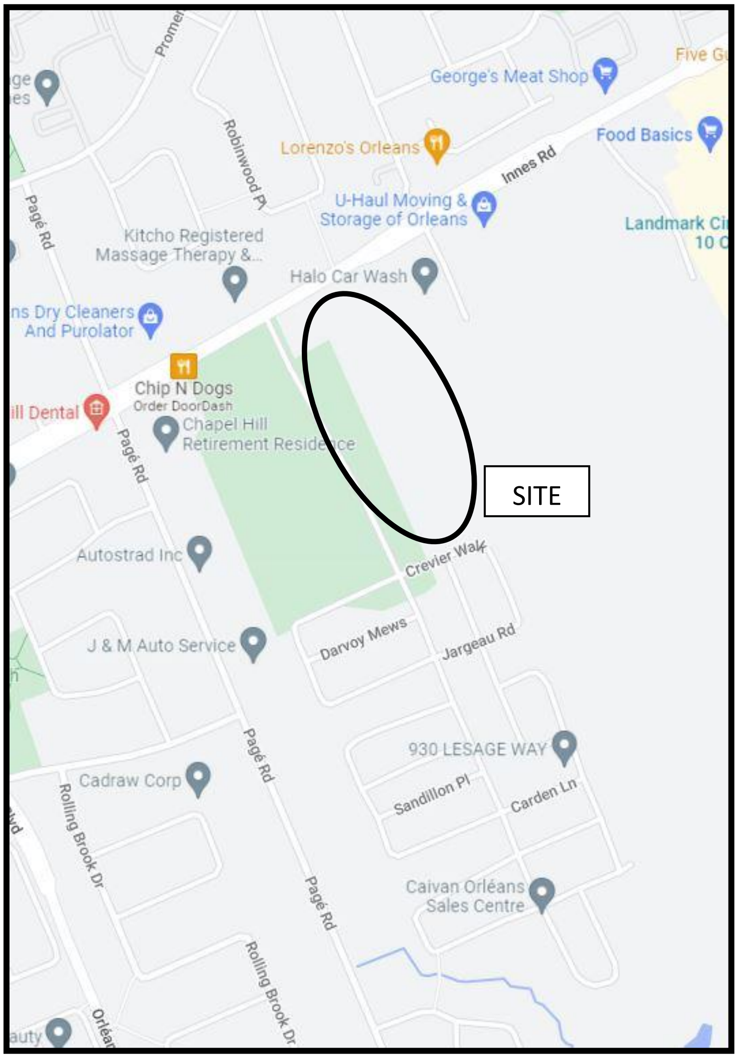
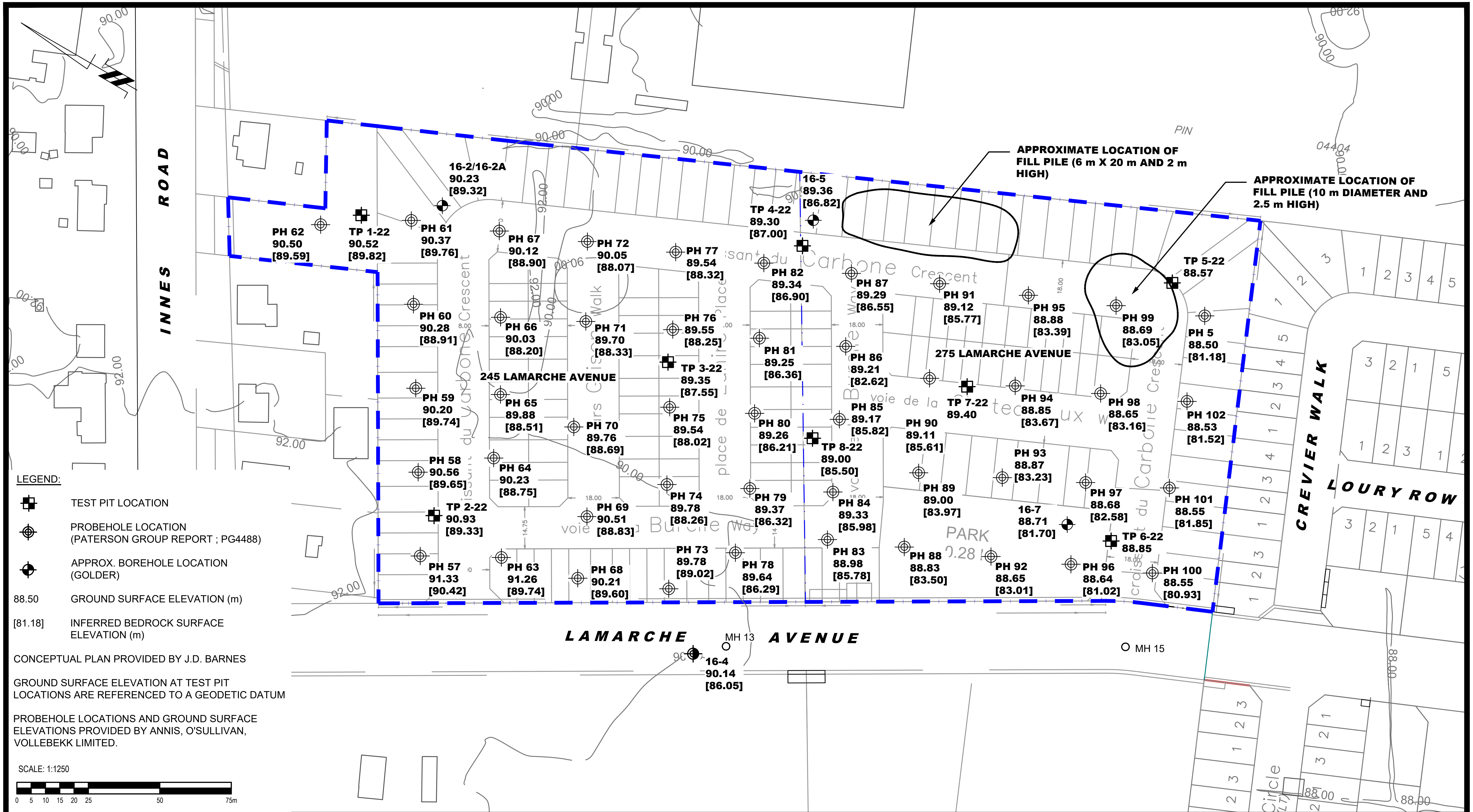


FIGURE 1

KEY PLAN



LEGEND:

■	TEST PIT LOCATION
⊕	PROBEHOLE LOCATION (PATERSON GROUP REPORT ; PG4488)
●	APPROX. BOREHOLE LOCATION (GOLDER)
88.50	GROUND SURFACE ELEVATION (m)
[81.18]	INFERRED BEDROCK SURFACE ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY J.D. BARNES

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

PROBEHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	02/12/2022	MS

CAIVAN COMMUNITIES

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
245 AND 275 LAMARCHE AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1250	Date: 03/2022
Drawn by: YA	Report No.: PG6152-1
Checked by: MS	Dwg. No.: PG6152-1
Approved by: DJG	Revision No.: 1

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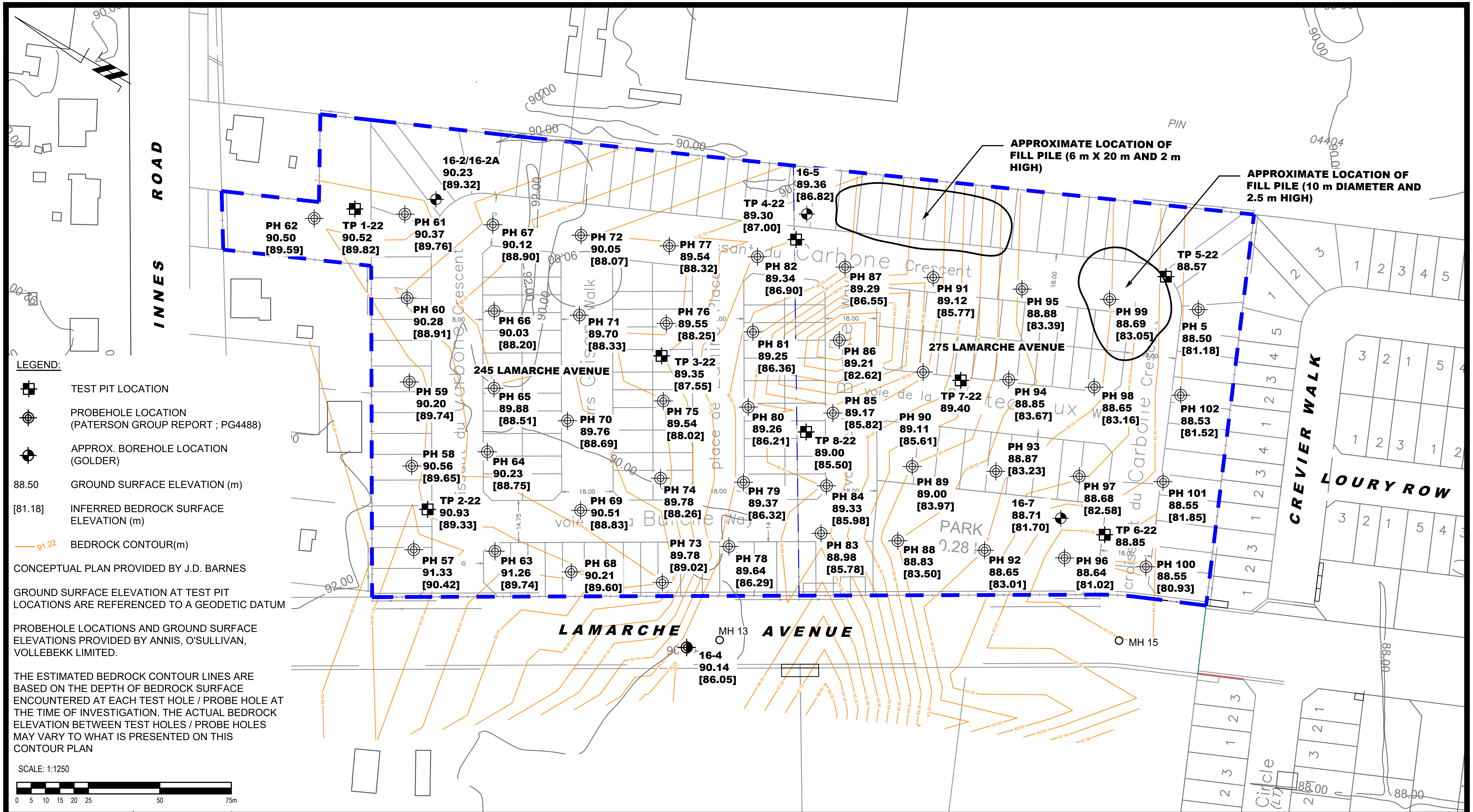

LEGEND:

▣	TEST PIT LOCATION
⊕	PROBEHOLE LOCATION (PATERSON GROUP REPORT ; PG4488)
◉	APPROX. BOREHOLE LOCATION (GOLDER)
88.50	GROUND SURFACE ELEVATION (m)
[81.18]	INFERRED BEDROCK SURFACE ELEVATION (m)
—91.22	BEDROCK CONTOUR(m)

CONCEPTUAL PLAN PROVIDED BY J.D. BARNES

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

PROBEHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

THE ESTIMATED BEDROCK CONTOUR LINES ARE BASED ON THE DEPTH OF BEDROCK SURFACE ENCOUNTERED AT EACH TEST HOLE / PROBE HOLE AT THE TIME OF INVESTIGATION. THE ACTUAL BEDROCK ELEVATION BETWEEN TEST HOLES / PROBE HOLES MAY VARY TO WHAT IS PRESENTED ON THIS CONTOUR PLAN

SCALE: 1:1250

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	02/12/2022	MS

CAIVAN COMMUNITIES
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
245 AND 275 LAMARCHE AVENUE

OTTAWA, ONTARIO

Title:

BEDROCK CONTOUR PLAN

Scale: 1:1250
Date: 03/2022
Drawn by: YA
Report No.: PG6152-1
Checked by: MS
Dwg. No.: PG6152-2
Approved by: DJG
Revision No.: 1

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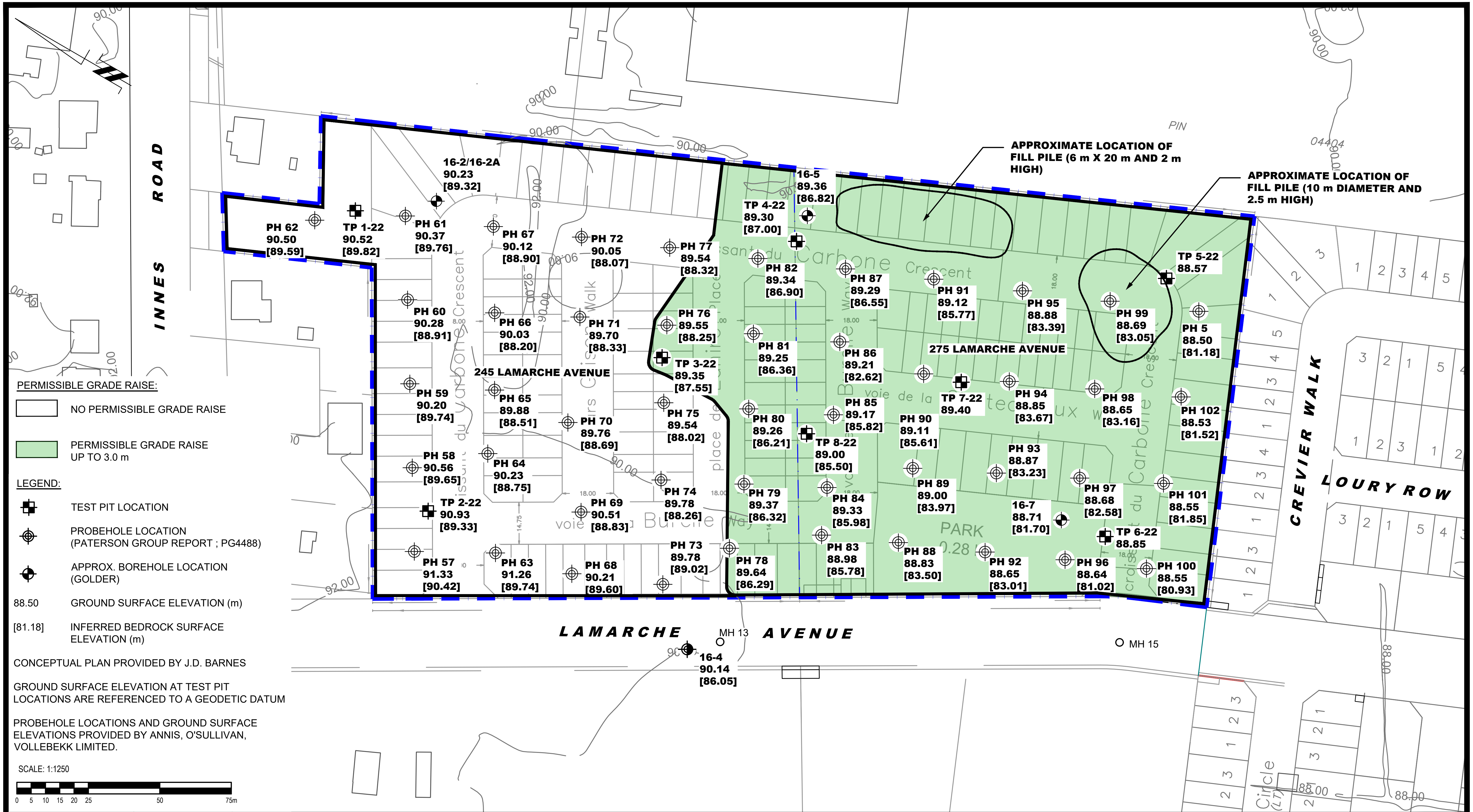

PERMISSIBLE GRADE RAISE:

☐	NO PERMISSIBLE GRADE RAISE
🟩	PERMISSIBLE GRADE RAISE UP TO 3.0 m

LEGEND:

⊞	TEST PIT LOCATION
⊕	PROBEHOLE LOCATION (PATERSON GROUP REPORT ; PG4488)
◐	APPROX. BOREHOLE LOCATION (GOLDER)
88.50	GROUND SURFACE ELEVATION (m)
[81.18]	INFERRED BEDROCK SURFACE ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY J.D. BARNES

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

PROBEHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	02/12/2022	MS

CAIVAN COMMUNITIES
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
245 AND 275 LAMARCHE AVENUE

OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:1250
Date: 03/2022
Drawn by: YA
Report No.: PG6152-1
Checked by: MS
Dwg. No.: PG6152-3
Approved by: DJG
Revision No.: 1

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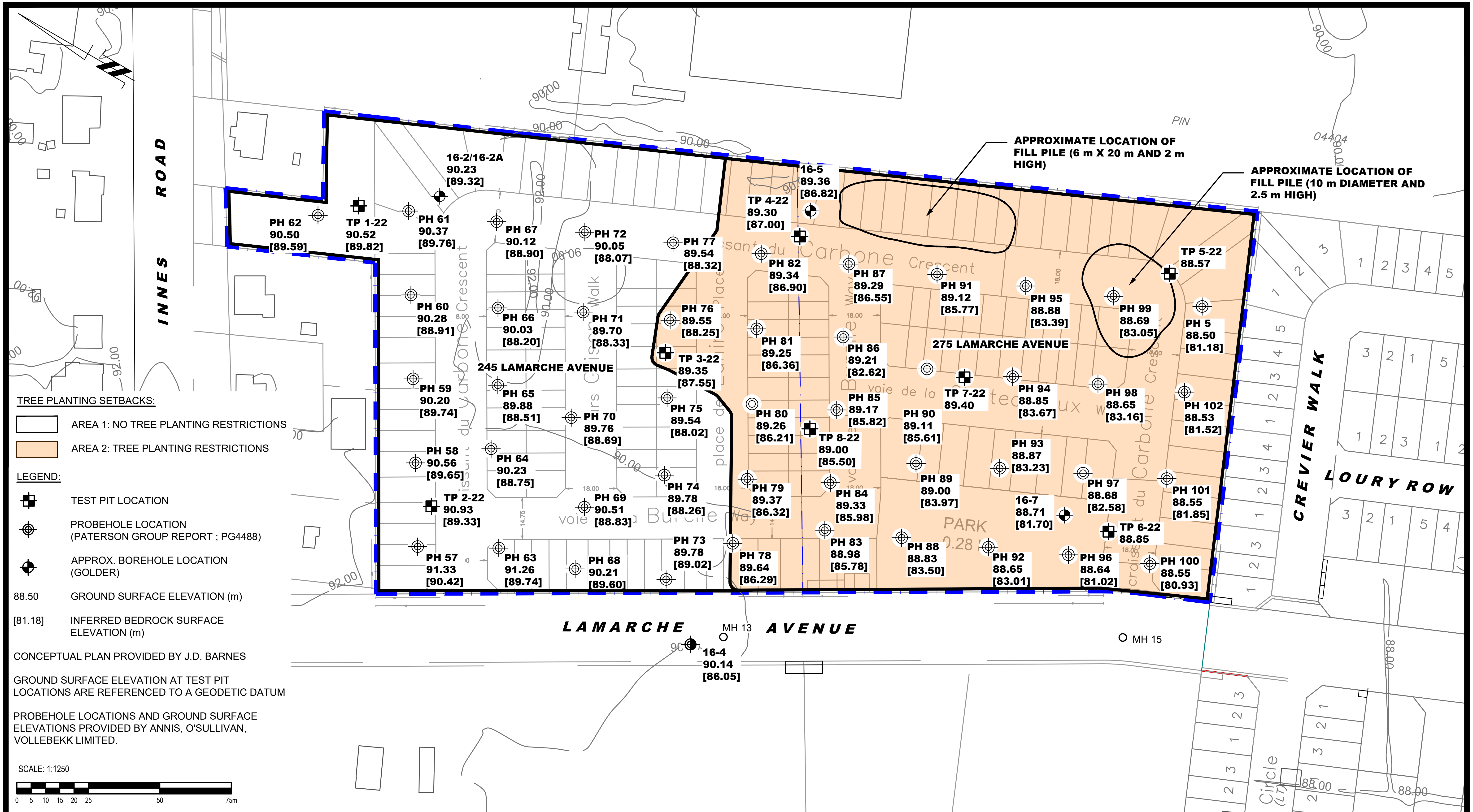

TREE PLANTING SETBACKS:

☐ AREA 1: NO TREE PLANTING RESTRICTIONS

🟧 AREA 2: TREE PLANTING RESTRICTIONS

LEGEND:

⊞	TEST PIT LOCATION
⊕	PROBEHOLE LOCATION (PATERSON GROUP REPORT ; PG4488)
●	APPROX. BOREHOLE LOCATION (GOLDER)
88.50	GROUND SURFACE ELEVATION (m)
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CONCEPTUAL PLAN PROVIDED BY J.D. BARNES

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PROBEHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

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NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	02/12/2022	MS

CAIVAN COMMUNITIES
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
245 AND 275 LAMARCHE AVENUE
OTTAWA, ONTARIO

Title:
TREE PLANTING SETBACK RECOMMENDATIONS

Scale: 1:1250
Date: 03/2022
Drawn by: YA
Report No.: PG6152-1
Checked by: MS
Dwg. No.: PG6152-4
Approved by: DJG
Revision No.: 1

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