FINAL

Geotechnical Investigation – Proposed Residential Development

2025 and 2035 Othello Avenue, Ottawa, Ontario

Prepared for:

Osgoode Properties
1284 Wellington Street
Ottawa, ON K1Y 3A9

May 28, 2024

Pinchin File: 335920

Issued to:	**Osgoode Properties**
Issued on:	**May 28, 2024**
Pinchin File:	**335920**
Issuing Office:	**Kanata, ON**

Megan Keon

Author: Megan Keon, EIT.
Project Manager, Geotechnical Services
613.608.5350
mkeon@pinchin.com

Reviewer: Vanessa Marshall, M.Eng., P.Eng.
National Practice Leader, Geotechnical Services
519.904.4660
vmarshall@pinchin.com

LICENSED PROFESSIONAL ENGINEER
V. M. MARSHALL
100079066
2024-05-28
PROVINCE OF ONTARIO

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION AND SCOPE

Pinchin Ltd. (Pinchin) was retained by Osgoode Properties (Client) to conduct a Geotechnical Investigation and provide subsequent geotechnical design recommendations for the proposed residential development to be located at 2025 and 2035 Othello Avenue, Ottawa, Ontario (Site). The Site location is shown on Figure 1.

Based on information provided by the Client, it is Pinchin's understanding that the Client wishes to develop the western portion of their current property with four (4) 3.5-storey, 10-unit townhouse blocks and three (3) 3.5-storey, 8-unit townhouse blocks. All townhouse blocks are to consist of a single basement level and will be completed with new Site services and asphalt surfaced access roadways and parking areas. Based on this design and for the purpose of this proposal, Pinchin has assumed an approximate depth of 3.0 meters below ground surface (mbgs) to the underside of the footings for the proposed basement levels.

Pinchin's geotechnical comments and recommendations are based on the results of the Geotechnical Investigation and our understanding of the project scope. Concurrently, Pinchin is completing a Hydrogeological Assessment of the Site which will be reported under a separate cover.

The purpose of the Geotechnical Investigation was to delineate the subsurface conditions and soil engineering characteristics by advancing a total of six (6) sampled boreholes (Boreholes BH1 to BH6), at the Site. The information gathered from the Geotechnical Investigation will allow Pinchin to provide geotechnical design recommendations for the proposed development.

Based on a desk top review and the results of the Geotechnical Investigation, the following geotechnical data and engineering design recommendations are provided herein:

- A detailed description of the soil and groundwater conditions;
- Site preparation recommendations;
- Open cut excavations;
- Anticipated groundwater management;
- Site service trench design;
- Foundation design recommendations including soil bearing resistances at Ultimate Limit States (ULS) and Serviceability Limit States (SLS) design;
- Potential total and differential settlements;
- Foundation frost protection and engineered fill specifications and installation;
- Seismic Site classification for seismic Site response;

- Basement design;
- Concrete floor slab-on-grade support recommendations;
- Asphaltic concrete pavement structure design; and
- Potential construction concerns.

Abbreviations terminology and principle symbols commonly used throughout the report, borehole logs and appendices are enclosed in Appendix I.

2.0 SITE DESCRIPTION AND GEOLOGICAL SETTING

The Site is located on the east side of Othello Avenue, approximately 100 m west of the intersection of Pleasant Park Road and St. Laurent Boulevard in Ottawa, Ontario. The Site is currently developed with two residential apartment buildings, asphalt surfaced parking lots and grass areas. The lands adjacent to the Site are developed with commercial/retail buildings and residential dwellings.

Data obtained from the Ontario Geological Survey Maps, as published by the Ontario Ministry of Natural Resources, indicates that the Site is located on a fine textured glaciomarine deposit consisting of massive to well laminated silt and clay with minor sand and gravel deposits (Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV). The underlying bedrock at this Site is of the Georgian Bay Formation, Blue Mountain Formation and Billings Formation consisting of shale, limestone, dolostone and siltstone (Ontario Geological Survey Map 1972, published 1978).

3.0 GEOTECHNICAL FIELD INVESTIGATION AND METHODOLOGY

Pinchin completed a field investigation at the Site on March 7 and 8, 2024 by advancing a total of six sampled boreholes throughout the Site. The boreholes were advanced to sampled depths of approximately 8.2 to 11.7 metres below existing ground surface (mbgs). Two Dynamic Cone Penetration Tests were completed in Boreholes BH3 and BH4 and were advanced to assess the soil with depth and to find a probable bedrock depth. The approximate spatial locations of the boreholes advanced at the Site are shown on Figure 2. Based on the locations of the proposed development, Borehole BH1, BH2 and BH3 were drilled on the south corner of the lot and Borehole BH4, BH5 and BH6 were drilled on the north side of the lot.

The boreholes were advanced with the use of a Geoprobe 7822 DT direct push drill rig which was equipped with standard soil sampling equipment. Soil samples were collected at 0.8 and 1.5 m intervals using a 51 mm outside diameter (OD) split spoon barrel in conjunction with Standard Penetration Tests (SPT) “N” values (ASTM D1586). The SPT “N” values were used to assess the compactness condition of the non-cohesive soil. Approximate shear strengths of the cohesive deposits were measured by completing shear vane tests during the field investigation and the results are presented on the appended borehole logs.

Monitoring wells were installed in Boreholes BH1, BH3 and BH4 to allow measurement of groundwater levels. The monitoring wells were constructed using flush-threaded 50 mm diameter Trilock pipe with 3.0 meter long 10-slot well screens, delivered to the Site in pre-cleaned individually sealed plastic bags. The screen and riser pipes were not allowed to come into contact with the ground or drilling equipment prior to installation.

A completed well record was submitted to the property owner and the Ministry of the Environment, Conservation and Parks for Ontario (MECP) as per Ontario Regulation 903, as amended. A licensed well technician must properly decommission the monitoring wells prior to construction according to Regulation 903 of the Ontario Water Resources Act.

Groundwater observations and measurements were obtained from the open boreholes during and upon completion of drilling. Groundwater levels were measured in the monitoring wells on April 4, 2024. The groundwater observations and measurements recorded are included on the appended borehole logs.

The borehole locations and ground surface elevations were located at the Site by Pinchin personnel. The ground surface elevation at each borehole location was referenced to the following temporary benchmark as shown on Figure 2:

- TBM: Top nut of fire hydrant, at the approximate location shown on Figure 2; and
- Elevation: 100.00 m (Local Datum).

The field investigation was monitored by experienced Pinchin personnel. Pinchin logged the drilling operations and identified the soil samples as they were retrieved. The recovered soil samples were sealed into plastic bags and carefully transported to an independent and accredited materials testing laboratory for detailed analysis and testing. All soil samples were classified according to visual and index properties by the project engineer.

The field logging of the soil and groundwater conditions was performed to collect geotechnical engineering design information. The borehole logs include textural descriptions of the subsoil in accordance with a modified Unified Soil Classification System (USCS) and indicate the soil boundaries inferred from non-continuous sampling and observations made during the borehole advancement. These boundaries reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The modified USCS classification is explained in further detail in Appendix I. Details of the soil and groundwater conditions encountered within the boreholes are included on the Borehole Logs within Appendix II.

Select soil samples collected from the boreholes were submitted to a material testing laboratory to determine the grain size distribution and Atterberg limits of the soil. A copy of the laboratory analytical reports is included in Appendix III. In addition, the collected samples were compared against previous geotechnical information from the area, for consistency and calibration of results.

4.0 SUBSURFACE CONDITIONS

4.1 Borehole Soil Stratigraphy

In general, the soil stratigraphy at the Site comprises surficial organics overlying clay, sand and glacial till to the maximum borehole termination depths of approximately 11.7 mbgs. The appended borehole logs provide detailed soil descriptions and stratigraphies, results of SPT and shear vane testing, details of monitoring well installations, and groundwater measurements.

4.1.1 Asphalt

Asphalt was encountered surficially within Boreholes BH1 to BH5 and ranged in thickness between 25 and 75 mm.

4.1.2 Organics

Surficial organics was only encountered within Borehole BH6 and was approximately 100 mm in thickness. The organics were damp at the time of sampling.

4.1.3 Fill

Fill was encountered underlying the surficial organics or asphalt within all the boreholes. The fill generally comprised sand and gravel, trace silt (consistent with a granular material), sandy lean clay and lean clay with sand. The fill extended to depths ranging between 0.8 and 2.6 mbgs. The results of two particle size distribution analyses completed on samples of the sandy lean clay and lean clay with sand are provided in Appendix III and indicate that the samples contain 0 to 7% gravel, 22 to 40% sand, 29 to 37% silt and 24 to 40% clay. The moisture contents of the samples tested were 21 to 27%. Atterberg limit results of the lean clay with sand revealed a liquid limit of 35%, a plastic limit of 17% and a plasticity index of 18%.

4.1.4 Clay

Lean and fat clay was encountered underlying the fill within all of the boreholes and extended to depths ranging between 6.1 and 7.9 mbgs. Lean clay was encountered more on the south side of the Site while fat clay was noted to be located more on the north side of the property. The clay had a very soft to very stiff consistency based on shear strengths measured from shear vane readings recorded in the field of 10 to 147 kPa and on SPT 'N' values of 1 to 7 blows per 300 mm penetration of a split spoon sampler. The remoulded shear strengths of the soil ranged from 5 to 58 kPa, resulting in a sensitivity of 1.0 to 10.0.

The results of two particle size distribution analyses completed on samples of the lean clay are provided in Appendix III and indicate that the samples contain 1 to 2% sand, 45 to 71% silt and 26 to 54% clay. Atterberg Limit testing indicates that the material has a liquid limit between 37 and 58%, a plastic limit between 20 and 26% and a plasticity index between 17 and 32%. The moisture content of the samples tested ranged between 35 and 52%, indicating that the samples tested were wetter than plastic limit (WTPL) at the time of sampling.

4.1.5 Till

A clay till material was encountered underlying the clay layer within all boreholes except for Borehole BH6. The till comprised clayey sand with gravel. The non-cohesive glacial till had a very loose to loose relative density based on SPT 'N' values of 1 to 9 blows per 300 mm penetration of a split spoon sampler. The results of one particle size distribution analysis completed on a sample of the till is provided in Appendix III and indicates that the sample contains 24% gravel, 42% sand, 25% silt and 9% clay. The moisture content of the sample tested was 8%.

4.2 Bedrock

Auger and cone refusal on probable bedrock was encountered in Boreholes BH2, BH3, BH4 and BH5 at depths between approximately 8.2 and 11.7 mbgs. Bedrock was not encountered in Boreholes BH1 and BH6.

4.3 Groundwater Conditions

Groundwater observations and measurements were obtained in the open boreholes at the completion of drilling and are summarized on the appended borehole logs. Groundwater monitoring wells were installed in Boreholes BH1, BH3 and BH4. Stabilized groundwater levels were recorded on April 4, 2024, and ranged between 1.9 and 2.9 mbgs. We refer to the hydrogeological assessment completed for the Site for additional details on the groundwater levels at the Site.

Seasonal variations in the water table should be expected, with higher levels occurring during wet weather conditions in the spring and fall and lower levels occurring during dry weather conditions.

5.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

5.1 General Information

The recommendations presented in the following sections of this report are based on the information available regarding the proposed construction, the results obtained from the geotechnical investigation, and Pinchin's experience with similar projects. Since the investigation only represents a portion of the subsurface conditions, it is possible that conditions may be encountered during construction that are substantially different than those encountered during the investigation. If these situations are encountered, adjustments to the design may be necessary. A qualified geotechnical engineer should be on-Site during the foundation preparation to ensure the subsurface conditions are the same/similar to what was observed during the investigation.

Based on information provided by the Client, it is Pinchin's understanding that the Client wishes to develop the western portion of their current property with four (4) 3.5-storey, 10-unit townhouse blocks and three (3) 3.5-storey, 8-unit townhouse blocks. All townhouse blocks are to consist of a single basement level and will be completed with new Site services and asphalt surfaced access roadways and parking areas. Based on this design and for the purpose of this proposal, Pinchin has assumed an approximate depth of 3.0 meters below ground surface (mbgs) to the under side of the footings for the proposed basement levels.

5.2 Site Preparation

The existing surficial organics, asphalt, and fill are not considered suitable to remain below the proposed townhome buildings, driveways and roadways and will need to be removed. In calculating the approximate quantity of material to be removed, we recommend that the surficial organics, asphalt and fill thicknesses provided on the individual borehole logs be increased by 50 mm to account for variations and some stripping of the mineral soil below.

Due to the potential settlement of the clay soils at the Site, grade raises are not recommended. It is recommended that once final grades are set, Pinchin would be allowed to review any potential grade changes to determine whether the raises will result in excess settlement of the Site.

Pinchin recommends that any engineered fill required at the Site be compacted in accordance with the criteria stated in the following table:

Type of Engineered Fill	Maximum Loose Lift Thickness (mm)	Compaction Requirements	Moisture Content (Percent of Optimum)
Structural fill to support foundations and floor slabs	200	100% SPMDD	Plus 2 to minus 4
Subgrade fill beneath parking lots and access roadways	300	98% SPMDD	Plus 2 to minus 4

Prior to placing any fill material at the Site, the subgrade should be inspected by a qualified geotechnical engineer and loosened/soft pockets should be sub excavated and replaced with engineered fill.

It is recommended that any fill required to raise grades below the proposed building addition comprise imported Ontario Provincial Standard Specification (OPSS) 1010 Granular 'B' Type I material. If the work is carried out during very dry weather, water may have to be added to the material to improve compaction.

A qualified geotechnical engineering technician should be on site to observe fill placement operations and perform field density tests at random locations throughout each lift, to indicate the specified compaction is being achieved.

The above noted recommendations are from a geotechnical perspective and additional analytical requirements may need to be reviewed in order to ensure compliance with Ontario Regulation 406/19, On-Site and Excess Soil Management.

5.3 Open Cut Excavations

Due to the presence of a basement level, it is anticipated that the foundations will be constructed at approximately 3.0 mbgs.

Based on the subsurface information obtained from within the boreholes, it is anticipated that the excavated material will predominately consist of organics, asphalt, fill, sandy clay and lean and fat clay material.

Where workers must enter trench excavations deeper than 1.2 m, the trench excavations should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act (OHSA), Ontario Regulation 213/91, Construction Projects, July 1, 2011, Part III - Excavations, Section 226. Alternatively, the excavation walls may be supported by either closed shoring, bracing, or trench boxes complying with sections 235 to 239 and 241 under O. Reg. 231/91, s. 234(1). The use of trench boxes can most likely be used for temporary support of vertical side walls. The appropriate trench should be designed/confirmed for use in this soil deposit.

Based on the OHSA, the natural clay soils would be classified as Type 3 soil and temporary excavations in these soils must be sloped at an inclination of 1 horizontal to 1 vertical (H to V) from the base of the excavation. Excavations extending below the groundwater table would be classified as a Type 4 soil and temporary excavations will have to be sloped back at 3 horizontal to 1 vertical from the base of the excavation. Excavations made through more than one soil type must be sloped as per the requirements of the soil type with the highest number.

In addition to compliance with the OHSA, the excavation procedures must also be in compliance to any potential other regulatory authorities, such as federal and municipal safety standards.

5.4 Anticipated Groundwater Management

Groundwater was measured in the monitoring wells installed in Boreholes BH1, BH3 and BH4 at depths ranging from approximately 1.9 to 2.9 mbgs and is expected to be encountered during excavations for the building foundations and site services. We refer the reader to Pinchin's Hydrogeological Assessment of the Site for the anticipated groundwater quantities.

The design of the dewatering system should be left to the contractor's discretion, and the system should meet a performance specification to maintain and control the groundwater at least 0.50 m below the excavation base. It is recommended that Pinchin review the final grading plan to confirm this recommendation.

Seasonal variations in the water table should be expected, with higher levels occurring during wet weather conditions in the spring and fall and lower levels occurring during dry weather conditions. If construction commences during wet periods (typically spring or fall), there is a greater potential that the groundwater elevation could be higher and/or perched groundwater may be present. Any potential precipitation of perched groundwater should be able to be controlled from pumping from filtered sumps.

Prior to commencing excavations, it is critical that all existing surface water and potential surface water is controlled and diverted away from the Site to prevent infiltration and subgrade softening. At no time should excavations be left open for a period of time that will expose them to precipitation and cause subgrade softening.

All collected water is to discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures, such as a silt fence should be installed at the discharge point of the dewatering system. The utmost care should be taken to avoid any potential impacts on the environment.

It is the responsibility of the contractor to propose a suitable dewatering system based on the groundwater elevation at the time of construction. The method used should not adversely impact any nearby structures.

5.5 Site Services

5.5.1 Pipe Bedding and Cover Materials for Flexible and Rigid Pipes

The subgrade soil conditions beneath the Site services will comprise either lean or fat clay or till materials and no support problems are anticipated for flexible or rigid pipes founded on this type of material. Pinchin should be allowed to review the Site servicing plans once available to confirm that the following recommendations are valid for the depth of the pipes. It is also noted that substantial changes in grade could cause long-term consolidation settlement of the soils, and the elevations of service pipes could be affected by that settlement.

Service pipes require an adequate base to ensure proper pipe connection and positive flow is maintained post construction. As such, pipe bedding should be placed to be of uniform thickness and compactness. The pipe bedding and cover material should conform to OPSD 802.010 and 802.013 specifications for flexible pipes and to OPSD 802.031 to 802.033 with Class “B” bedding for rigid pipes.

The pipe bedding material should consist of a minimum thickness of 150 mm Granular “A” (OPSS 1010) below the pipe and extend up the sides to the spring line. However, the bedding thickness may have to be increased depending on the pipe diameter or if wet or weak subgrade conditions are encountered. The pipe cover material from the spring line should consist of a Granular “B” Type I (OPSS 1010) and should extend to a minimum of 300 mm above the top of the pipe. All granular fill material is to be placed in maximum 200 mm thick loose lifts compacted to a minimum of 98% SPMDD.

The bedding material, pipe and cover material should be installed as soon as practically possible after the excavation subgrade is exposed. The longer the excavated subgrade soil remains open to weather conditions and groundwater seepage, the greater the chance for construction problems to occur.

There is the potential at this Site that it will be difficult to stabilize the subgrade due to groundwater or due to the material with a higher than the optimum moisture content, and the use of a Granular “B” Type II material may be required to stabilize the base. Alternatively, if constant groundwater infiltration becomes an issue, then an approximate 150 mm granular pad consisting of 19 mm clear stone gravel (OPSS 1004) wrapped in a non-woven geotextile (Terrafix 270R or equivalent) should be considered to maintain the integrity of the natural subgrade soils. The clear stone should contain a minimum of 50% crushed particles. Water collected within the stone should be controlled through sumps and filtered pumps.

5.5.2 Trench Backfill

The trench backfill should be compacted in maximum 300 mm thick lifts to 98% SPMDD within 4% of the optimum moisture content. Based on the observed moisture content of the natural overburden deposits, it may be difficult to achieve the specified density on all of the trench backfill. Nevertheless, it is recommended that the natural soils be used as backfill in the trenches to prevent problems with differential frost heaving of imported subgrade material.

If necessary, compensation for wet trench backfill conditions can be made with additional Granular ‘B’ in the pavement structure. It should be noted, however, that the wet backfill material must be compacted to at least 90% SPMDD or post-construction settlements could occur.

Portions of the lean and fat clay will have a blocky/lumpy texture. If the large interclump voids are not closed completely by thorough compaction, then long-term softening/settlement will occur. The trench backfill should be placed in thin lifts (less than 300 mm) and compacted with a sheepsfoot roller. Particular attention must be made to backfilling service connections where the trenches are narrow.

All stockpiled material should be protected from deleterious materials, additional moisture and be kept from freezing.

Quality control will be the utmost importance when selecting the material. The selection of the material should be done as early in the contract as possible to allow sufficient time for gradation and proctor testing on representative samples to ensure it meets the project specifications.

Where the natural soil will be exposed, adequate compaction may prove difficult if the material becomes wet (i.e., above the optimum moisture content). Depending on the moisture content of the natural materials at the time of construction, they may either require moisture to be added or stockpiled and left to dry to achieve moisture content within plus 2% to minus 4% of optimum. The natural soil at this Site is subject to moisture content increase during wet weather. As such, stockpiles should be protected to help minimize moisture absorption during wet weather.

Alternatively, an imported drier material of similar gradation as the soil (i.e., clay) may be mixed to decrease the overall moisture content and bring it to within plus 2% to minus 4% of optimum. Depending on weather conditions at the time of construction, an imported material may be required regardless to achieve adequate compaction. If the imported material is not the same/similar to the soil observed on the side walls of the excavation, then a horizontal transition between the materials should be sloped as per frost heave taper OPSD 205.60. Any natural material is to be placed in maximum 300 mm thick lifts compacted to 95% SPMDD within plus 2% to minus 4% optimum moisture content. Imported material should consist of a Granular “A”, Granular “B” Type I, or Select Subgrade Material (OPSS 1010). Heavy construction equipment and truck traffic should not cross any pipe until at least 1 m of compacted soil is placed above the top of the pipe.

Post compaction settlement of finer grained soil can be expected, even when placed to compaction specifications. As such, fill materials should be installed as far in advance as possible before finishing the roadway in order to mitigate post compaction settlements.

5.5.3 Frost Protection

The frost penetration depth in Ottawa, Ontario is estimated to extend to approximately 1.8 mbgs in open roadways cleared of snow. As such, it is recommended to place water services at a minimum depth of 300 mm below this elevation with the top of the pipe located at 2.1 mbgs or lower as dictated by municipal service requirements. If a minimum of 2.1 m of soil cover cannot be provided, then the pipe should be insulated with a rigid polystyrene insulation (DOW Styrofoam HI40, or equivalent) or a pre-insulated pipe be utilized.

The insulation design configuration may either consist of placing horizontal insulation to a specified design distance beyond the outside edge of the pipe or an inverted “U” surrounding the top and sides of the pipe. Any method chosen requires suitable design and installation in accordance with the manufacture’s recommendations. To accommodate the placement of horizontal insulation a wider excavation trench may be required.

5.6 Foundation Design

5.6.1 Discussion

At the time that the Geotechnical Report was prepared, final design of the townhomes was not finished so Pinchin has provided multiple foundation solutions that are suitable for the current specifications.

The results of the field investigation indicates that the natural clay soil typically decreases in strength with depth and possess a very soft to stiff consistency below approximately 3.0 m throughout the Site. It was also noted that on the northern portion of the Site where Boreholes BH4 to BH6 were advanced, there appears to be a crust layer of soil that has higher shear strength values and lower sensitivity. However, due to the overall softness and sensitivity of the clay soil on the Site, Pinchin has not provided any shallow foundation recommendations. Once final grades for the have been established, Pinchin can review the potential for use of shallow foundations for the townhomes intending to go on the northern portion of the Site to confirm whether it is feasible.

Probable bedrock was encountered within the boreholes advanced for the proposed townhouse buildings (i.e., Boreholes BH2, BH3, BH4 and BH5) at depths ranging from approximately 8.2 to 11.7 mbgs. Based on the subsurface soil conditions encountered within the boreholes advanced at the Site, the lean and fat clay are not considered suitable to support the proposed buildings and Pinchin has provided the following foundation options herein:

- Support the building on deep foundations consisting of helical piles (screw piles) end bearing on the probable bedrock surface located between approximately 8.2 to 11.7 mbgs; and
- Densify the soils using a ground improvement method such as Controlled Modulus Columns and support the building on the ground improvement method.

5.6.2 Helical Piles (Screw Piles) Founded in Natural Clay and Till Materials

Deep foundations consisting of helical piles (screw piles) founded within the till and on bedrock may be utilized to support the proposed buildings. Helical piles provide the least amount of disturbance as they are driven into the underlying soil utilizing a helix to advance through the soil matrix. The supporting grade beam system for the structure would bear upon the helical piles.

The number and size of helical piles are determined based on the building loads and configuration. Since helical piles are a proprietary system, it is recommended that the piles be designed by an experienced design build contractor in conjunction with the soil characteristics provided by Pinchin. For the natural subgrade soil encountered within the boreholes advanced, the following strength characteristics are to be used for the pile design:

Soil Type	**Bulk Unit Weight (kN/m^3)**	**Friction Angle (°)**	**Cohesion (kPa)**
Lean & Fat Clay	17.5	26	3
Till	19.0	26	0

To provide frost protection, we would also recommend that the helical piles be lined with a plastic sleeve or be epoxy coated galvanized steel to protect against corrosion.

Helical pile capacity can often be determined as a function of the installation torque at termination; however, at this site most boreholes encountered soft to very soft soils overlying probable bedrock, and it is anticipated that helical piles would spin out once the tip of the pile reaches bedrock. As such, on-site load testing of helical piles end bearing on bedrock is recommended if this deep foundation system is chosen.

5.6.3 Ground Improvement Methods with Shallow Foundations

Ground improvement involves modifying the engineering properties of soils to increase bearing capacity and provide added stability. Two possible ground improvement techniques for this Site include grouted rammed aggregate pier (RAP) soil reinforcing elements and rigid inclusions.

Grouted RAP are installed by drilling a 0.76 m diameter cavity and ramming thin lifts of well graded aggregate including grout within the cavity to form very stiff, high-density aggregate piers. The drilled holes typically extend from 3.0 to 7.5 m below grade and 2.1 to 6.1 m below footing bottoms. The first lift of aggregate/grout forms a bulb below the bottoms of the piers, thereby pre-stressing and pre-straining the soils to a depth equal to at least one pier diameter below the base of the drill cavity. Subsequent lifts are typically about 300 mm in thickness. Ramming takes place with a high-energy bevelled tamper that both densifies the aggregate and forces the aggregate laterally into the sidewalls of the drill cavity. This action increases the lateral stress in surrounding soil; thereby further stiffening the stabilized composite soil mass.

Rigid inclusions follow a similar technique but utilizes concrete in place of stone columns. Rigid inclusions require a higher density bearing layer at depth.

The result of the above ground improvement techniques is a significant strengthening and stiffening of subsurface soils that then support conventional shallow foundations. The above ground improvement techniques are proprietary in design and will require input from specialized contractors and engineers. Whichever technique is selected, the installation/fieldwork should be monitored on a full-time basis by a qualified geotechnical consultant.

Controlled Modulus Columns (CMCs) are a proven ground improvement technique that has been used in the Ottawa region in the sensitive clay deposits as well as the Champlain clay deposits in Quebec. CMCs are designed and constructed by a specialty contractor.

5.6.4 Site Classification for Seismic Site Response & Soil Behaviour

The following information has been provided to assist the building designer from a geotechnical perspective only. These geotechnical seismic design parameters should be reviewed in detail by the structural engineer and be incorporated into the design as required.

The seismic site classification has been based on the 2012 OBC. The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4.A of the OBC. The site classification is based on the average shear wave velocity in the top 30 m of the site stratigraphy. If the average shear wave velocity is not known, the site class can be estimated from energy corrected

Standard Penetration Resistance (N60) and/or the average undrained shear strength of the soil in the top 30 m.

The boreholes advanced at this Site extended to approximately 11.7 mbgs and were terminated in the till soil deposit. SPT "N" values within the soil deposit ranged between 1 and greater than 50 blows per 300 mm. As such, based on Table 4.1.8.4.A of the OBC, this Site has been classified as Class E. A Site Class E has an average shear wave velocity (Vs) of less than 180 m/s.

5.6.5 Building Drainage and Frost Protection

To assist in maintaining the building dry from surface water seepage, it is recommended that exterior grades around the buildings be sloped away at a 2% gradient or more, for a distance of at least 2.0 m. Roof drains should discharge a minimum of 1.5 m away from the structure to a drainage swale or appropriate storm drainage system.

Exterior perimeter foundations drains are not required, where the finished floor elevation is established a minimum of 150 mm above the exterior final grades or that the exterior gradient is properly sloped to divert surface water away from the building.

In the Ottawa, Ontario area, exterior perimeter foundations for heated buildings require a minimum of 1.8 m of soil cover above the underside of the footing to provide soil cover for frost protection.

Where the foundations for heated buildings do not have the minimum 1.8 m of soil cover frost protection, they should be protected from frost with a combination of soil cover and rigid polystyrene insulation, such as Dow Styrofoam or equivalent product. If required, Pinchin can provide appropriate foundation frost protection recommendations as part of the design review.

5.7 Basement Design

It is understood that the proposed townhome buildings will include a basement level, with the underside of the footing presumed to be located approximately 3.0 mbgs. As previously mentioned, groundwater was measured in the monitoring wells installed at depths ranging from approximately 1.9 to 2.9 mbgs. As such, Pinchin recommends that foundation drains be provided for the portions of the building which will have the foundation walls exposed on the interior of the building. Pinchin also recommends that these foundations drains be extended around the entire perimeter of the building to ensure proper drainage and to mitigate the potential for water to build up where drains are not installed. Pinchin's Hydrogeological report should be referred to for the quantity of groundwater expected for around the buildings.

The foundation drains should consist of a minimum 150 mm diameter fabric wrapped perforated drainage tile surrounded by 19 mm diameter clear stone (OPSS 1004) with a minimum cover of 150 mm on top and sides and 50 mm below the drainage tile. Since the natural soil contains a significant amount of silt sized particles, the clear stone gravel should be wrapped in a non-woven geotextile (Terrafix 270R or equivalent). The water collected from the weeping tile should be directed away from the building to appropriate drainage areas; either through gravity flow or interior sump pump systems. All subsurface walls should be waterproofed.

In addition, an underfloor drainage system should be installed beneath the basement level slab, in addition to the installation of perimeter weeping tiles at the footing level. The floor slab sub drains should be constructed in a similar fashion to the foundation drains and be connected to a suitable frost-free outlet or sump.

To minimize potential frost movements from soil frost adhesion, the basement wall backfill should consist of a free draining granular material, such as a Granular 'B' Type I (OPSS 1010) or an approved sand fill, extending a minimum lateral distance of 600 mm beyond the foundation. The existing clay material is too wet for reuse and not considered suitable for reuse as foundation wall backfill. All granular material is to be placed in maximum 300 mm thick lifts compacted to a minimum of 100% SPMDD in hard landscaping areas and 95% SPMDD in soft landscaping areas. It is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure compaction requirements are achieved.

The walls must also be designed to resist lateral earth pressure. Depending on the design of the building the earth pressure computations must consider the groundwater level at the Site. For calculating the lateral earth pressure, the coefficient of at-rest earth pressure (K_0) may be assumed at 0.5 for cohesive clay and non-cohesive till material. The bulk unit weight of the retained backfill may be taken as 20 kN/m^3 for well compacted soil. An appropriate factor of safety should be applied.

5.8 Floor Slabs

Prior to the installation of the engineered fill material, all organics, asphalt, fill, sandy lean clay and deleterious materials should be removed to the underlying organic free in-situ soil. The natural subgrade soil is to be proof roll compacted with a minimum 10 tonne non-vibratory steel drum roller to observe for weak/soft spots. It is noted that some locations will not be accessible by the steel drum roller; as such, these locations can be proof roll compacted with a minimum 450 kg vibratory plate compactor.

The in-situ inorganic clay material encountered within the boreholes is considered adequate for the support of the concrete floor slabs provided it is proof roll compacted as outlined above. Any soft area(s) encountered during proof rolling should be excavated and replaced with a similar soil type.

Once the subgrade soil is exposed it is to be inspected and approved by a qualified geotechnical engineering consultant to ensure that the material conforms to the soil type and consistency observed during the subsurface investigation work.

Based on the in-situ soil conditions, it is recommended to establish the concrete floor slab on a minimum 300 mm thick layer of Granular “A” (OPSS 1010). Alternatively, consideration may also be given to using a 200 mm thick layer of uniformly compacted 19 mm clear stone placed over the approved subgrade. Any required up fill should consist of a Granular “B” Type I or Type II (OPSS 1010).

The installation of a vapour barrier may be required under the floor slab. If required, the vapour barrier should conform to the flooring manufacturers and designer’s requirements. Consideration may be given to carrying out moisture emission and/or relative humidity testing of the slab to determine the concrete condition prior to flooring installation. To minimize the potential for excess moisture in the floor slab, a concrete mixture with a low water-to-cement ratio (i.e. 0.5 to 0.55) should be used.

The following table provides the unfactored modulus of subgrade reaction values:

Material Type	Modulus of Subgrade Reaction (kN/m^3)
Granular A (OPSS 1010)	85,000
Granular “B” Type I (OPSS 1010)	75,000
Granular “B” Type II (OPSS 1010)	85,000
Lean and Fat Clay	15,000

The values in the table above are for loaded areas of 0.3 m x 0.3 m.

5.9 Soil Corrosivity and Sulphate Attack on Concrete

One soil sample was submitted to SGS Laboratories in Lakefield, Ontario to assess the corrosivity of the soil and potential for sulphate attack on concrete. The assessment was completed using the 10-point soil evaluation procedure, provided in the Appendix to the American Water Work Association A21.5 Standard, as recommended by the Ductile Iron Pipe Research Association (DIPRA). The soil sample was evaluated for the following parameters: soil resistivity, pH, redox potential, sulfides, and moisture. Each parameter is assessed and assigned a point value, and the points are totalled. If the total is equal or greater than 10, the soil is considered corrosive to ductile iron pipe. In this case, protective measures are required.

The following table summarizes the 10-point soil evaluation for the tested samples:

Parameter	BH4, SS3 2.3 – 2.7 mbgs	
	Results	**Points**
Resistivity (ohm-cm)	1230	10
pH	7.69	0
Redox Potential (mV)	258	0
Sulfide	<0.01	0
Moisture	Poor drainage, continuously wet	2
Total Points		**12**

In summary, the tested sample does indicate a potential for soil corrosivity, and additional protective measures are required. The results should be reviewed by the structural engineer.

The results of the sulphate testing indicate that the Site possesses low sulphate exposure. The results should be reviewed by the structural engineer to ensure conformance to the concrete exposures.

5.10 Asphaltic Concrete Pavement Structure Design for Parking Lot and Driveways

5.10.1 Discussion

Parking areas and driveway access will be constructed around the proposed buildings. The in-situ clay is considered a sufficient bearing material for an asphaltic concrete pavement structure provided all organics, asphalt, fill and deleterious materials are removed prior to installing the engineered fill material and the subgrade prepared as detailed in an earlier section.

At this time Pinchin is unaware of the proposed final grades for the parking lot and access roadways. As such, provided the pavement structure overlies the in-situ clay, the following pavement structure is recommended.

5.10.2 Pavement Structure

The following table presents the minimum specifications for a flexible asphaltic concrete pavement structure:

Pavement Layer	Compaction Requirements	Parking Areas /Driveways	Roadways
Surface Course Asphaltic Concrete HL-3 (OPSS 1150)	92% MRD as per OPSS 310	40 mm	40 mm
Binder Course Asphaltic Concrete HL-8 (OPSS 1150)	92 % MRD as per OPSS 310	50 mm	80 mm
Base Course: Granular “A” (OPSS 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular “B” Type I (OPSS 1010)	100% Standard Proctor Maximum Dry Density (ASTM D698)	400 mm	600 mm

Notes:

I. Prior to placing the pavement structure, the subgrade soil is to be proof rolled with a smooth drum roller without vibration to observe weak spots and the deflection of the soil; and

II. The recommended pavement structure may have to be adjusted according to the City of Ottawa standards. Also, if construction takes place during times of substantial precipitation and the subgrade soil becomes wet and disturbed, the granular thickness may have to be increased to compensate for the weaker subgrade soil. In addition, the granular fill material thickness may have to be temporarily increased to allow heavy construction equipment to access the Site, in order to avoid the subgrade from “pumping” up into the granular material.

Performance grade PG 58-34 asphaltic concrete should be specified for Marshall mixes.

5.10.3 Pavement Structure Subgrade Preparation and Granular up Fill

The proper placement of base and subbase fill materials becomes very important in addressing the proper load distribution to provide a durable pavement structure. Due to the soil deposits encountered at the Site, it should be noted that any grade raises at the Site will result in potential long term settlement of the pavement structure.

The pavement subgrade materials should be inspected by a geotechnical engineering prior to placement of the Granular ‘B’ subbase course. Due to the nature of the subgrade soils, it is recommended that vibration be to a minimum on the surface of the subgrade. If any unstable areas are noted, then the Granular ‘B’ thickness may need to be increased to support pavement construction traffic. This should be left as a field decision by a qualified geotechnical engineer at the time of construction, but it is recommended that additional Granular ‘B’ be carried as a provisional item under the construction contract.

Where fill material is required to increase the grade to the underside of the pavement structure it should consist of Granular 'B' Type I (OPSS 1010). The up fill material is to be placed in maximum 300 mm thick lifts compacted to 98% SPMDD within 4% of the optimum moisture content.

Samples of both the Granular 'A' and Granular 'B' Type I aggregates should be tested for conformance to OPSS 1010 prior to utilization on Site and during construction. All stockpiled material should be protected from deleterious materials, additional moisture and be kept from freezing.

Post compaction settlement of fine grained soil can be expected, even when placed to compaction specifications. As such, fill material should be installed as far in advance as possible before finishing the parking lot and access roadways for best grade integrity.

Where the subgrade material types differ below the underside of the pavement structure, the transition between the materials should be sloped as per frost heave taper OPSD 205.60.

5.10.4 Drainage

Control of surface water is a critical factor in achieving good pavement structure life. The pavement thickness designs are based on a drained pavement subgrade via sub-drains or ditches.

The clay soils have poor natural drainage and therefore it is recommended that pavement subdrains be installed in the lower areas and be connected to the catch basins. Subdrains should comprise 150 mm perforated pipe bedded in concrete sand. The top of subdrain bedding should be at the lower limit of the subbase, and the subgrade below the subbase should be sloped towards the subdrain.

The surface of the roadways should be free of depressions and be sloped at a minimum grade of 1% in order to drain to appropriate drainage areas. Subgrade soil should slope a minimum of 3% toward stormwater collection points. Positive slopes are very important for the proper performance of the drainage system. The granular base and subbase materials should extend horizontally to any potential ditches or swales.

In addition, routine maintenance of the drainage systems will assist with the longevity of the pavement structure. Ditches, culverts, sewers and catch basins should be regularly cleared of debris and vegetation.

6.0 TREE PLANTING RECOMMENDATIONS

In accordance with the City of Ottawa guideline for Geotechnical Investigations, Pinchin reviewed the City of Ottawa report entitled “Trees and Foundations Strategy in Areas of Sensitive Marine Clay in the City of Ottawa” dated September 9, 2005. The sensitive clay soils encountered at the Site were compared against the proposed building foundation design to determine if tree planting restrictions are required for the proposed development.

Pinchin has proposed deep foundation methods for the development with the intention to extend down to the underlying bedrock surface. As such, moisture depletion of the clay soil from the demand of trees will not have an impact on the proposed foundations.

Pinchin recommends that any trees proposed for the development be planted a minimum of 4.5 m from the proposed building foundation system.

7.0 SITE SUPERVISION & QUALITY CONTROL

It is recommended that all geotechnical aspects of the project be reviewed and confirmed under the appropriate geotechnical supervision, to routinely check such items. This includes but is not limited to inspection and confirmation of the undisturbed natural subgrade material prior to subgrade preparation, pouring any foundations or footings, backfilling, or engineered fill installation to ensure that the actual conditions are not markedly different than what was observed at the borehole locations and geotechnical components are constructed as per Pinchin’s recommendations. Compaction quality control of engineered fill material (full-time monitoring) is recommended as standard practice, as well as regular sampling and testing of aggregates and concrete, to ensure that physical characteristics of materials for compliance during installation and satisfies all specifications presented within this report.

8.0 TERMS AND LIMITATIONS

This Geotechnical Investigation was performed for the exclusive use of Osgoode Properties (Client) in order to evaluate the subsurface conditions at 2025 and 2035 Othello Avenue, Ottawa, Ontario. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practises in the field of geotechnical engineering for the Site. Classification and identification of soil, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood. Conclusions derived are specific to the immediate area of study and cannot be extrapolated extensively away from sample locations.

Performance of this Geotechnical Investigation to the standards established by Pinchin is intended to reduce, but not eliminate, uncertainty regarding the subgrade soil at the Site, and recognizes reasonable limits on time and cost.

Regardless how exhaustive a Geotechnical Investigation is performed; the investigation cannot identify all the subsurface conditions. Therefore, no warranty is expressed or implied that the entire Site is representative of the subsurface information obtained at the specific locations of our investigation. If during construction, subsurface conditions differ from then what was encountered within our test location and the additional subsurface information provided to us, Pinchin should be contacted to review our recommendations. This report does not alleviate the contractor, owner, or any other parties of their respective responsibilities.

This report has been prepared for the exclusive use of the Client and their authorized agents. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third parties. If additional parties require reliance on this report, written authorization from Pinchin will be required. Pinchin disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs. No other warranties are implied or expressed. Furthermore, this report should not be construed as legal advice.

The liability of Pinchin or our officers, directors, shareholders or staff will be limited to the lesser of the fees paid or actual damages incurred by the Client. Pinchin will not be responsible for any consequential or indirect damages. Pinchin will only be liable for damages resulting from the negligence of Pinchin. Pinchin will not be liable for any losses or damage if the Client has failed, within a period of two years following the date upon which the claim is discovered (Claim Period), to commence legal proceedings against Pinchin to recover such losses or damage unless the laws of the jurisdiction which governs the Claim Period which is applicable to such claim provides that the applicable Claim Period is greater than two years and cannot be abridged by the contract between the Client and Pinchin, in which case the Claim Period shall be deemed to be extended by the shortest additional period which results in this provision being legally enforceable.

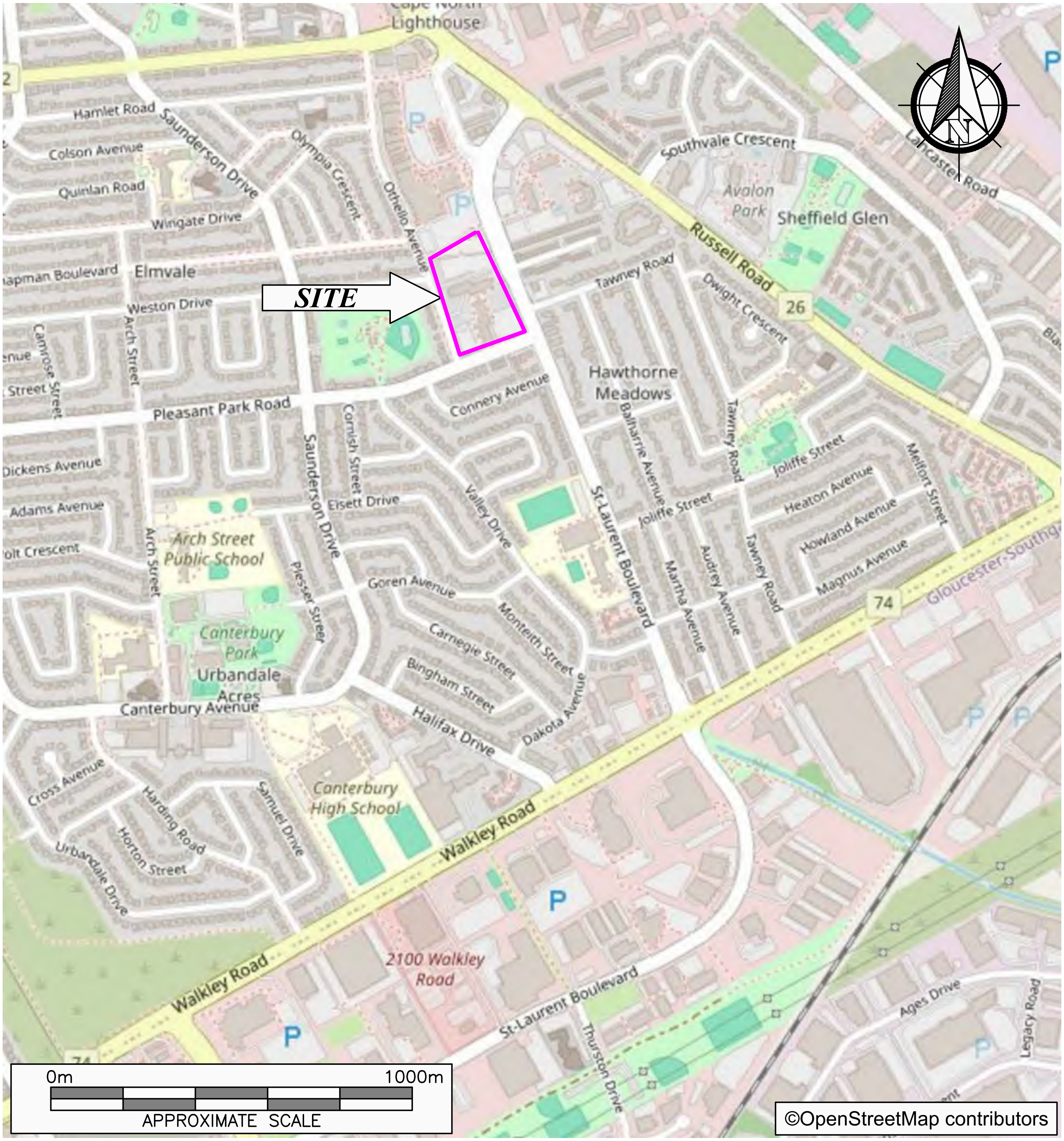
Pinchin makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this report, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and these interpretations may change over time. Please refer to Appendix IV, Report Limitations and Guidelines for Use, which pertains to this report.

Specific limitations related to the legal and financial and limitations to the scope of the current work are outlined in our proposal, the attached Methodology and the Authorization to Proceed, Limitation of Liability and Terms of Engagement which accompanied the proposal.

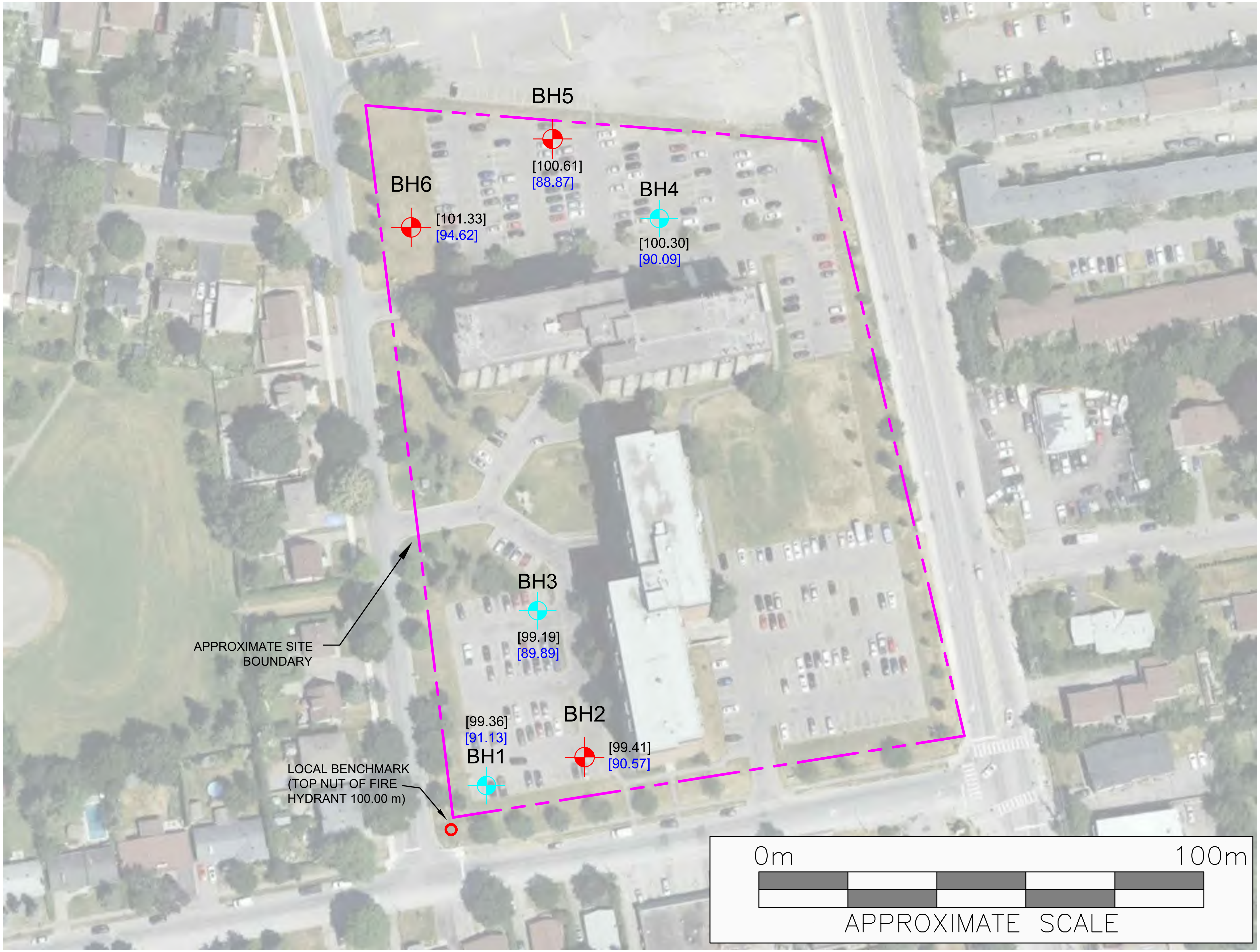
Information provided by Pinchin is intended for Client use only. Pinchin will not provide results or information to any party unless disclosure by Pinchin is required by law. Any use by a third party of reports or documents authored by Pinchin or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted. No other warranties are implied or expressed.

\\pinchin.com\Ott\Job\335000s\0335920.000 Osgoode,2025OthelloAve,GEO,FID\Deliverables\335920 Geotechnical Investigation 2025 2035 Othello Ave Ottawa ON Osgoode.docx
Template: Master Geotechnical Investigation Report – Ontario, GEO, September 2, 2021

FIGURES



PROJECT NAME	GEOTECHNICAL INVESTIGATION
CLIENT NAME	OSGOODE PROPERTIES
PROJECT LOCATION	2025 & 2035 OTHELLO AVENUE, OTTAWA, ONTARIO
FIGURE NAME	KEY MAP
FIGURE NO.	1
APPROXIMATE SCALE	AS SHOWN
PROJECT NO.	335920
DATE	MAY 2024



N

LEGEND

BOREHOLE LOCATION

MONITORING WELL LOCATION

[99.48] LOCAL GROUND SURFACE ELEVATION (m)

[92.78] LOCAL TERMINATION ELEVATION (m)

PINCHIN

PROJECT NAME
GEOTECHNICAL INVESTIGATION

CLIENT NAME
OSGOODE PROPERTIES

PROJECT LOCATION
2025 & 2035 OTHELLO AVENUE, OTTAWA, ONTARIO

FIGURE NAME
BOREHOLE/MONITORING WELL LOCATION PLAN

APPROXIMATE SCALE	PROJECT NO.
AS SHOWN	335920
DATE	FIGURE NO.
MAY 2024	2

APPENDIX I

Abbreviations, Terminology and Principle Symbols used in Report and Borehole Logs

ABBREVIATIONS, TERMINOLOGY & PRINCIPAL SYMBOLS USED

Sampling Method

AS	Auger Sample	**w**	Washed Sample
SS	Split Spoon Sample	**HQ**	Rock Core (63.5 mm diam.)
ST	Thin Walled Shelby Tube	**NQ**	Rock Core (47.5 mm diam.)
BS	Block Sample	**BQ**	Rock Core (36.5 mm diam.)

In-Situ Soil Testing

Standard Penetration Test (SPT), "N" value is the number of blows required to drive a 51 mm outside diameter spilt barrel sampler into the soil a distance of 300 mm with a 63.5 kg weight free falling a distance of 760 mm after an initial penetration of 150 mm has been achieved. The SPT, "N" value is a qualitative term used to interpret the compactness condition of cohesionless soils and is used only as a very approximation to estimate the consistency and undrained shear strength of cohesive soils.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60 degree apex attached to "A" size drill rods continuously into the soil for each 300 mm penetration with a 63.5 kg weight free falling a distance of 760 mm.

Cone Penetration Test (CPT) is an electronic cone point with a 10 cm2 base area with a 60 degree apex pushed through the soil at a penetration rate of 2 cm/s.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

Soil Descriptions

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories; coarse grained, fine grained and highly organic soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75 mm. To aid in quantifying material amounts by weight within the respective grain size fractions the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	< 0.002 mm		
Silt	0.002 to 0.06 mm	"trace", trace sand, etc.	1 to 10%
Sand	0.075 to 4.75 mm	"some", some sand, etc.	10 to 20%
Gravel	4.75 to 75 mm	Adjective, sandy, gravelly, etc.	20 to 35%
Cobbles	75 to 200 mm	And, and gravel, and silt, etc.	>35%
Boulders	>200 mm	Noun, Sand, Gravel, Silt, etc.	>35% and main fraction

Notes:

- Soil properties, such as strength, gradation, plasticity, structure, etcetera, dictate the soils engineering behaviour over grain size fractions; and
- With the exception of soil samples tested for grain size distribution or plasticity, all soil samples have been classified based on visual and tactile observations. The accuracy of visual and tactile observation is not sufficient to differentiate between changes in soil classification or precise grain size and is therefore an approximate description.

The following table outlines the qualitative terms used to describe the compactness condition of cohesionless soil:

Cohesionless Soil	
Compactness Condition	**SPT N-Index (blows per 300 mm)**
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT, N-Index:

Cohesive Soil		
Consistency	**Undrained Shear Strength (kPa)**	**SPT N-Index (blows per 300 mm)**
Very Soft	<12	<2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

Note: Utilizing the SPT, N-Index value to correlate the consistency and undrained shear strength of cohesive soils is only very approximate and needs to be used with caution.

Soil & Rock Physical Properties

General

W	Natural water content or moisture content within soil sample
γ	Unit weight
γ'	Effective unit weight
γ_d	Dry unit weight
γ_{sat}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of Water
ρ_d	Dry density
ρ_{sat}	Saturated density e Void ratio
n	Porosity
S_r	Degree of saturation
E_{50}	Strain at 50% maximum stress (cohesive soil)

Consistency

W_L Liquid limit

W_P Plastic Limit

I_P Plasticity Index

W_S Shrinkage Limit

I_L Liquidity Index

I_C Consistency Index

e_{max} Void ratio in loosest state

e_{min} Void ratio in densest state

I_D Density Index (formerly relative density)

Shear Strength

C_u, S_u Undrained shear strength parameter (total stress)

C'_d Drained shear strength parameter (effective stress)

r Remolded shear strength

τ_p Peak residual shear strength

τ_r Residual shear strength

ø' Angle of interface friction, coefficient of friction = tan ø'

Consolidation (One Dimensional)

C_C Compression index (normally consolidated range)

C_r Recompression index (over consolidated range)

C_S Swelling index

m_V Coefficient of volume change

c_V Coefficient of consolidation

T_V Time factor (vertical direction)

U Degree of consolidation

σ'_o Overburden pressure

σ'_p Preconsolidation pressure (most probable)

OCR Overconsolidation ratio

Permeability

The following table outlines the terms used to describe the degree of permeability of soil and common soil types associated with the permeability rates**:**

Permeability (k cm/s)	Degree of Permeability	Common Associated Soil Type
> 10^{-1}	Very High	Clean gravel
10^{-1} to 10^{-3}	High	Clean sand, Clean sand and gravel
10^{-3} to 10^{-5}	Medium	Fine sand to silty sand
10^{-5} to 10^{-7}	Low	Silt and clayey silt (low plasticity)
>10^{-7}	Practically Impermeable	Silty clay (medium to high plasticity)

Rock Coring

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section is broken due to mechanical or handling, the pieces are fitted together and if 100 mm or greater included in the total sum**.**

RQD is calculated as follows:

$$\text{RQD (\%)} = \frac{\Sigma \text{ Length of core pieces} > 100 \text{ mm} \times 100}{\text{Total length of core run}}$$

The following is the Classification of Rock with Respect to RQD Value:

RQD Classification	RQD Value (%)
Very poor quality	**<25**
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Excellent quality	90 to 100

APPENDIX II
Pinchin's Borehole Logs

Log of Borehole: BH1

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 07, 2024 **Project Manager:** MK

SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)
0	Ground Surface	99.36 / 0.00
0–0.08	**Asphalt** Asphaltic concrete - 75 mm	
	Fill Dark grey, sand and gravel, some pieces of brick, loose, moist to sandy lean clay, APL	97.53 / 1.83
1.83	**Clay** Grey lean clay, firm, APL to WTPL	93.27 / 6.10
6.10	**Till** Clayey sand with gravel, very loose to loose, grey, wet	91.13 / 8.23
8.23	End of Borehole Borehole was terminated at 8.2 mbgs.	

Monitoring Well Details: Bentonite, Riser, Silica Sand, Screen

Water level = 2.87 mbgs, as measured on April 4, 2024

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	30	9				
SS	2	70	4	21.3			Hyd.
SS	3	80	6				
SS	4	100	1				
FV	1	NA	NA				
SS	5	100	1				
FV	2	NA	NA				
SS	6	100	3				
SS	7	40	6				

Standard Penetration N-Value: 20 40 60

Shear Strength kPa: 100 200

Contractor: Strata Drilling Inc. **Grade Elevation:** 99.36 m

Drilling Method: Direct Push **Top of Casing Elevation:** N/A

Well Casing Size: 50 mm **Sheet:** 1 of 1

Log of Borehole: BH2

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 07, 2024 **Project Manager:** MK

SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)	Monitoring Well Details
	Ground Surface	99.41	
0	**Asphalt** ~ 25 mm	0.00	No Monitoring Well Installed
	Fill Dark brown, sand and gravel, to sandy lean clay, firm		
1.52	**Clay** Grey lean clay, stiff to firm, WTPL	97.88 / 1.52	
6.10	**Till** Brown, clayey sand with gravel, wet, loose	93.31 / 6.10	
8.84	End of Borehole Borehole was terminated at 8.8 mbgs upon auger refusal on possible bedrock. At drilling completion, groundwater was encountered at 2.6	90.57 / 8.84	

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	30	7				
SS	2	80	7				
FV	1	NA	NA				
SS	3	100	1				
FV	2	NA	NA				
SS	4	70	1				
SS	5	80	9	8.7			Hyd.

Standard Penetration N-Value: 20 40 60

Shear Strength kPa: 100 200

Contractor: Strata Drilling Inc. **Grade Elevation:** 99.41 m

Drilling Method: Direct Push **Top of Casing Elevation:** NA

Well Casing Size: NA **Sheet:** 1 of 1

Log of Borehole: BH3

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 07, 2024 **Project Manager:** MK

SUBSURFACE PROFILE

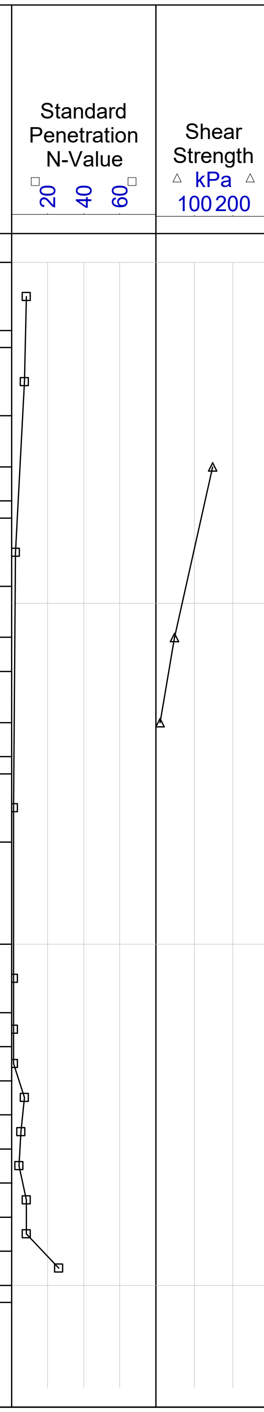
Depth (m)	Description	Elevation (m) / Depth (m)
0	Ground Surface	99.19 / 0.00
0	**Asphalt** Asphaltic concrete - 50 mm	
0.05	**Fill** Brown silty sand, trace clay, some gravel, loose, damp	98.12 / 1.07
1.07	**Clay** Grey lean clay, very stiff, WTPL	95.83 / 3.35
3.35	Firm	95.07 / 4.11
4.11	Very soft	93.09 / 6.10
6.10	**Till** Brown, clayey sand with gravel, Very loose, wet	92.48 / 6.71
6.71	**Dynamic Cone Penetration Test (DCPT)** Unsampled	89.89 / 9.30
9.30	End of Borehole. Borehole was terminated at 9.5 mbgs upon sampler refusal on possible bedrock.	

Monitoring Well Details: Riser; Bentonite; Silica Sand; Screen

Water level = 1.87 mbgs, as measured on April 4, 2024

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	40	8				
SS	2	70	7				
FV	1	NA	NA				
SS	3	40	2				
FV	2	NA	NA				
FV	3	NA	NA				
SS	4	100	1	35.1			Hyd. Att. Lim.
SS	5	50	1				
DCP	NA	NA	1				
DCP	NA	NA	1				
DCP	NA	NA	7				
DCP	NA	NA	5				
DCP	NA	NA	4				
DCP	NA	NA	8				
DCP	NA	NA	8				
DCP	NA	NA	26				
	NA		>50				



Contractor: Strata Drilling Inc. **Grade Elevation:** 99.19 m

Drilling Method: Direct Push **Top of Casing Elevation:** N/A

Well Casing Size: 50 mm **Sheet:** 1 of 1

Log of Borehole: BH4

Project #: 335920.000 **Logged By:** MK

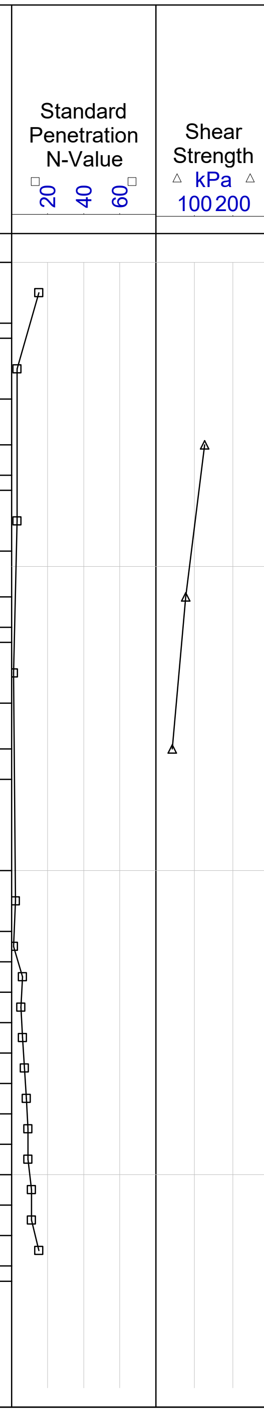
Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 08, 2024 **Project Manager:** MK

SUBSURFACE PROFILE				SAMPLE								
Depth (m)	Description	Elevation (m)	Monitoring Well Details	Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis	
	Ground Surface	100.30										
0	**Asphalt** Asphaltic concrete - 50 mm	0.00		SS	1	50	15					
	Fill Brown sand and gravel, trace silt to sandy lean clay, compact, damp	99.54 / 0.76		SS	2	50	3					
	Clay Grey fat clay, WTPL, very stiff to stiff		Riser	FV	1	NA	NA					
			Bentonite	SS	3	100	3					
				FV	2	NA	NA					
			Silica Sand	SS	4	100	1	52.9			Hyd. Att. Lim.	
			Screen	FV	3	NA	NA					
	Till Grey clayey sand with gravel, very loose, wet	93.90 / 6.40	Water level = 2.35 mbgs, as measured on April 4, 2024	SS	5	50	2					
	Dynamic Cone Penetration test (DCPT) Unsampled			DCP	NA	NA	1					
				DCP	NA	NA	6					
				DCP	NA	NA	5					
				DCP	NA	NA	6					
				DCP	NA	NA	7					
				DCP	NA	NA	8					
				DCP	NA	NA	9					
				DCP	NA	NA	9					
				DCP	NA	NA	11					
				DCP	NA	NA	11					
				DCP	NA	NA	15					
					NA		>50					
	End of Borehole	90.09 / 10.21										
	Borehole was terminated at 10.2 mbgs upon sampler refusal on possible bedrock.											



Contractor: Strata Drilling Inc. **Grade Elevation:** 100.30 m

Drilling Method: Direct Push **Top of Casing Elevation:** N/A

Well Casing Size: 50 mm **Sheet:** 1 of 1

Log of Borehole: BH5

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 08, 2024 **Project Manager:** MK

SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)
	Ground Surface	100.61
0.00	**Asphalt** Asphaltic concrete - 50 mm	
0.76	**Fill** Brown sand and gravel, some silt to sandy lean clay, very dense, damp	99.84
1.22	Wet, loose	99.39
1.22	**Clay** Grey to brown fat clay, stiff, WTPL, very stiff	
7.92	**Till** Grey clayey sand with gravel, wet, compact, loose to very loose	92.68

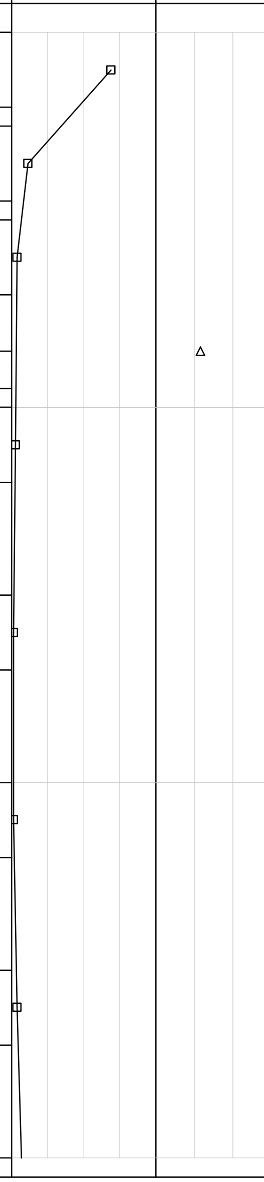
Monitoring Well Details: No Monitoring Well Installed

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value
SS	1	30	55
SS	2	60	9
SS	3	90	3
FV	1	NA	NA
SS	4	100	2
SS	5	100	1
SS	6	100	1
SS	7	60	3

Standard Penetration N-Value: 20 40 60

Shear Strength kPa: 100 200



Water Content (%) | Sample ID | Soil Vapour Concentration (ppm) | Laboratory Analysis

Contractor: Strata Drilling Inc. **Grade Elevation:** 100.61 m

Drilling Method: Direct Push **Top of Casing Elevation:** NA

Well Casing Size: NA **Sheet:** 1 of 2

Log of Borehole: BH5

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

Drill Date: March 08, 2024 **Project Manager:** MK

SUBSURFACE PROFILE					SAMPLE									
Depth (m)	Symbol	Description	Elevation (m)	Monitoring Well Details	Sample Type	Sampler #	Recovery (%)	SPT N-Value	Standard Penetration N-Value (20 40 60)	Shear Strength kPa (100 200)	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
					SS	8	30	6						
10														
11					SS	9	70	4						
			88.87											
12		End of Borehole Borehole was terminated at 11.7 mbgs upon auger refusal on possible bedrock.	11.73											
13														
14														
15														
16														
17														
18														

Contractor: Strata Drilling Inc. **Grade Elevation:** 100.61 m

Drilling Method: Direct Push **Top of Casing Elevation:** NA

Well Casing Size: NA **Sheet:** 2 of 2

Log of Borehole: BH6

Project #: 335920.000 **Logged By:** MK

Project: Geotechnical Investigation

Client: Osgoode Properties

Location: 2025 Othello Avenue, Ottawa, Ontario

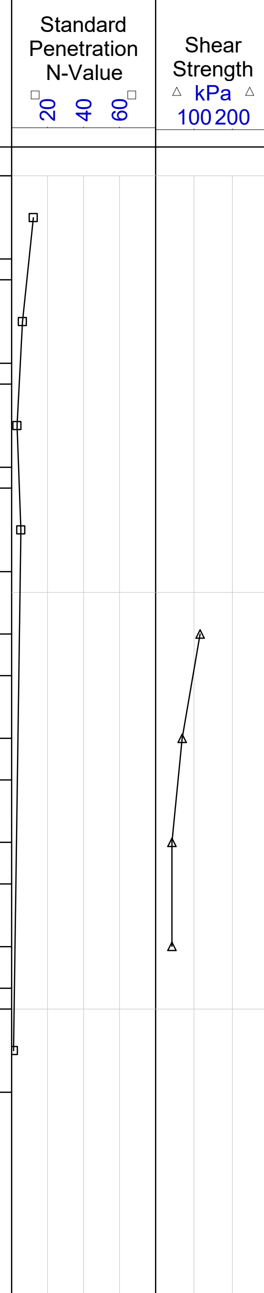
Drill Date: March 08, 2024 **Project Manager:** MK

SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)	Monitoring Well Details
0	Ground Surface	101.33 0.00	No Monitoring Well Installed
0–0.1	**Organics** Organics - 100 mm		
0.1–1.52	**Fill** Brown sandy lean clay, stiff to firm, APL		
1.52–2.59	Lean clay with sand, soft	99.80 1.52	
2.59–4.11	**Clay** Grey silty clay, very stiff, WTPL	98.74 2.59	
4.11–4.88	Stiff	97.21 4.11	
4.88–6.71	Firm	96.45 4.88	
6.71	End of Borehole Borehole was terminated at 6.7 mbgs. Groundwater was encountered at 2.6 mbgs.	94.62 6.71	

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	50	12				
SS	2	50	6				
SS	3	60	3	26.8			Hyd. Att. Lim.
SS	4	40	5				
FV	1	NA	NA				
FV	2	NA	NA				
FV	3	NA	NA				
FV	4	NA	NA				
SS	5	100	1				



Contractor: Strata Drilling Inc. **Grade Elevation:** 101.33 m

Drilling Method: Direct Push **Top of Casing Elevation:** NA

Well Casing Size: NA **Sheet:** 1 of 1

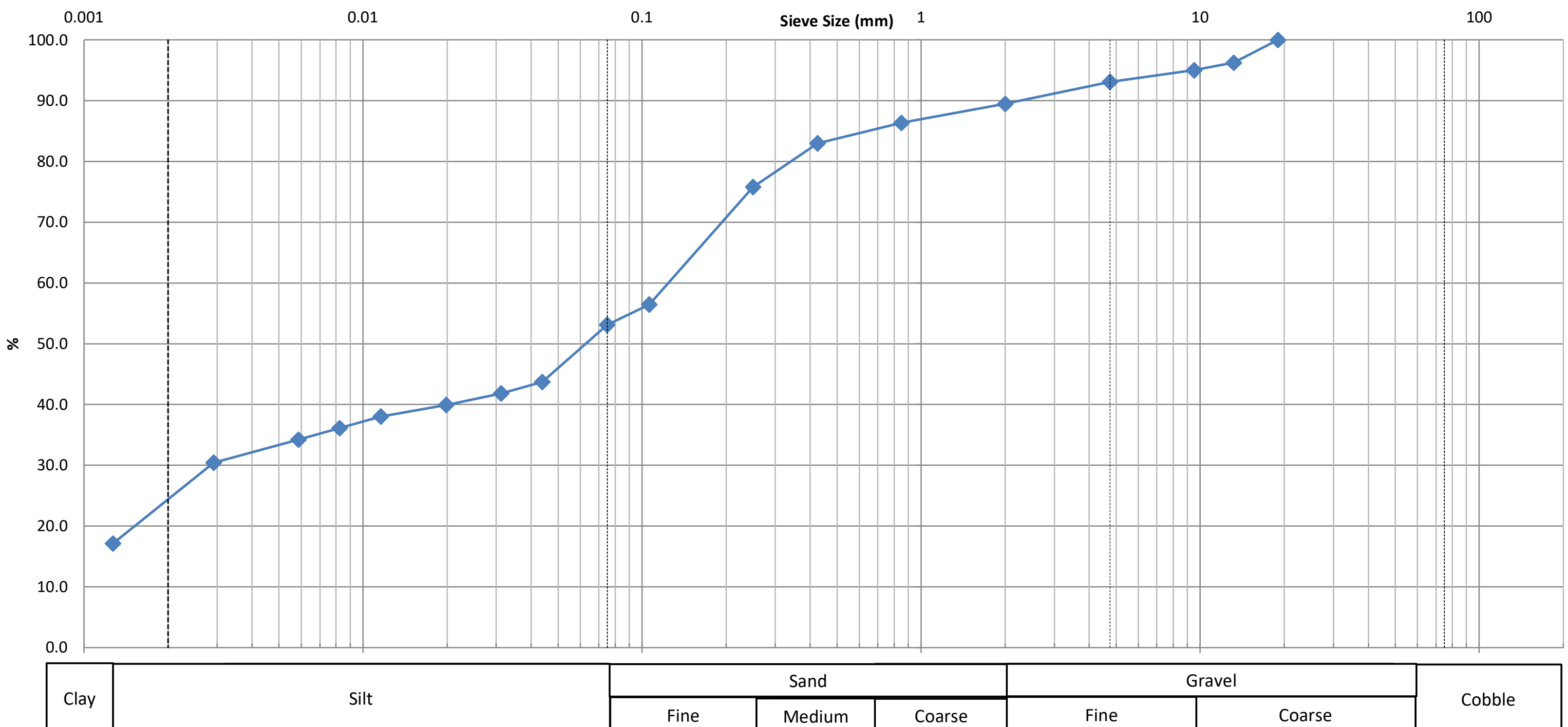
APPENDIX III

Laboratory Testing Reports for Soil Samples

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	2.5-4.5	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH1 SS2	LAB NO:	51349
PROJECT:	335920			DATE RECEIVED:	26-Mar-24
				DATE TESTED:	27-Mar-24
DATE SAMPLED:	25-Mar-24			DATE REPORTED:	1-Apr-24
SAMPLED BY:	-			TESTED BY:	D.K



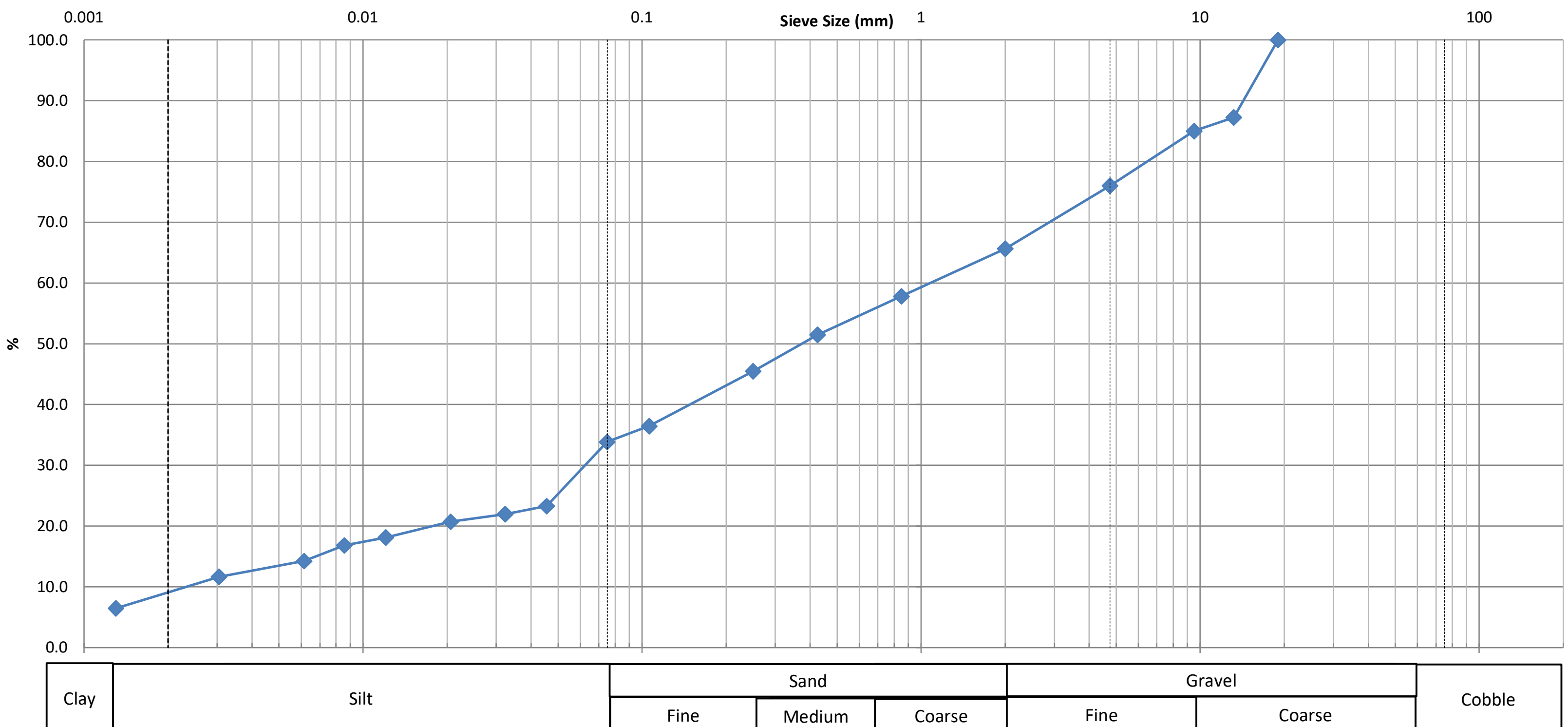
Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					21.3%					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	
					6.9	40.0	29.1		24.0	

Comments:

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

PATERSON GROUP	**SIEVE ANALYSIS** **ASTM C136**

CLIENT:	Pinchin	DEPTH:	25-27	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH2 SS5	LAB NO:	51348
PROJECT:	335920			DATE RECEIVED:	26-Mar-24
				DATE TESTED:	27-Mar-24
DATE SAMPLED:	25-Mar-24			DATE REPORTED:	1-Apr-24
SAMPLED BY:	-			TESTED BY:	D.K



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					8.7%					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		
					24.0	42.2	24.8	9.0		

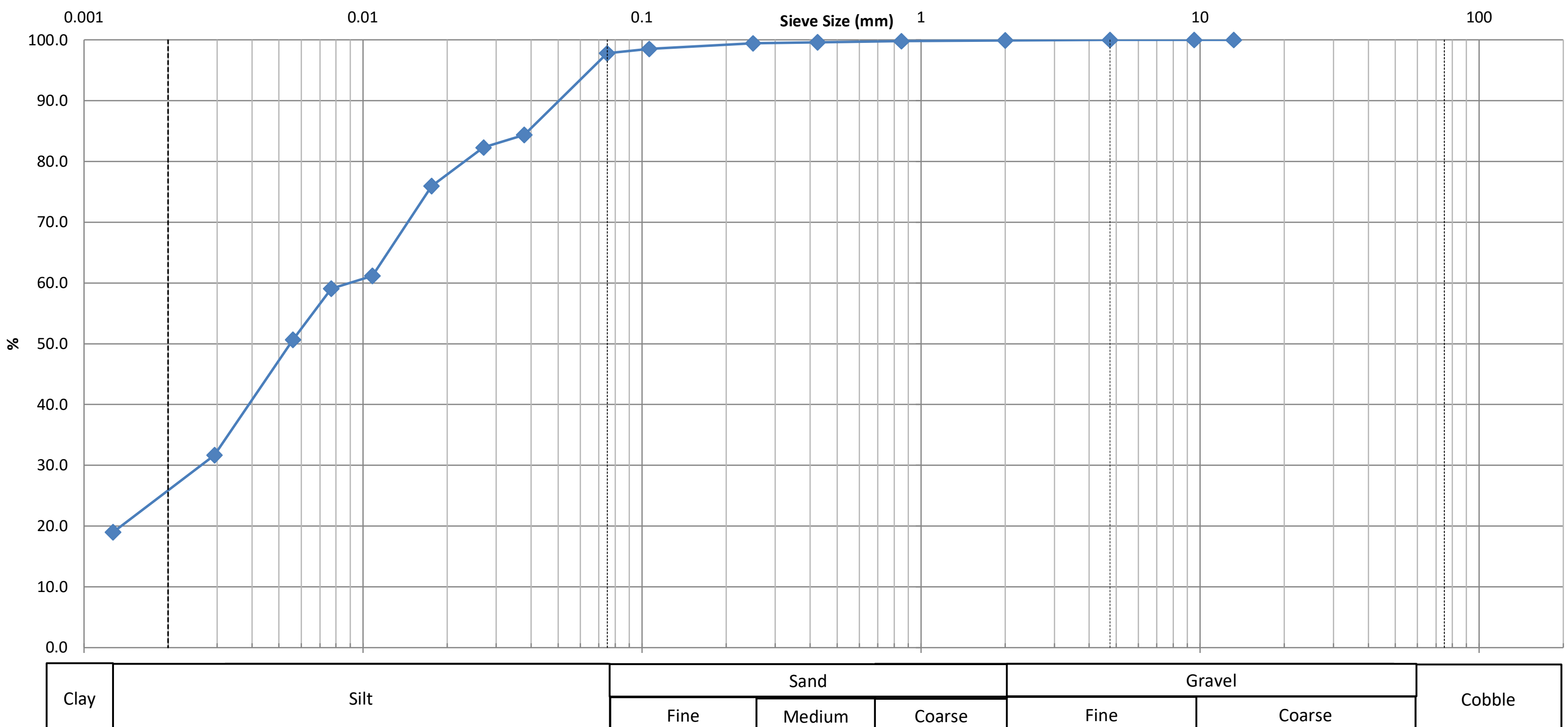
Comments:

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

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	15-17	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH3 SS4	LAB NO:	51345
PROJECT:	335920			DATE RECEIVED:	26-Mar-24
				DATE TESTED:	27-Mar-24
DATE SAMPLED:	25-Mar-24			DATE REPORTED:	1-Apr-24
SAMPLED BY:	-			TESTED BY:	D.K



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					35.1%					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		
					0.0	2.2	71.3	26.5		

Comments:

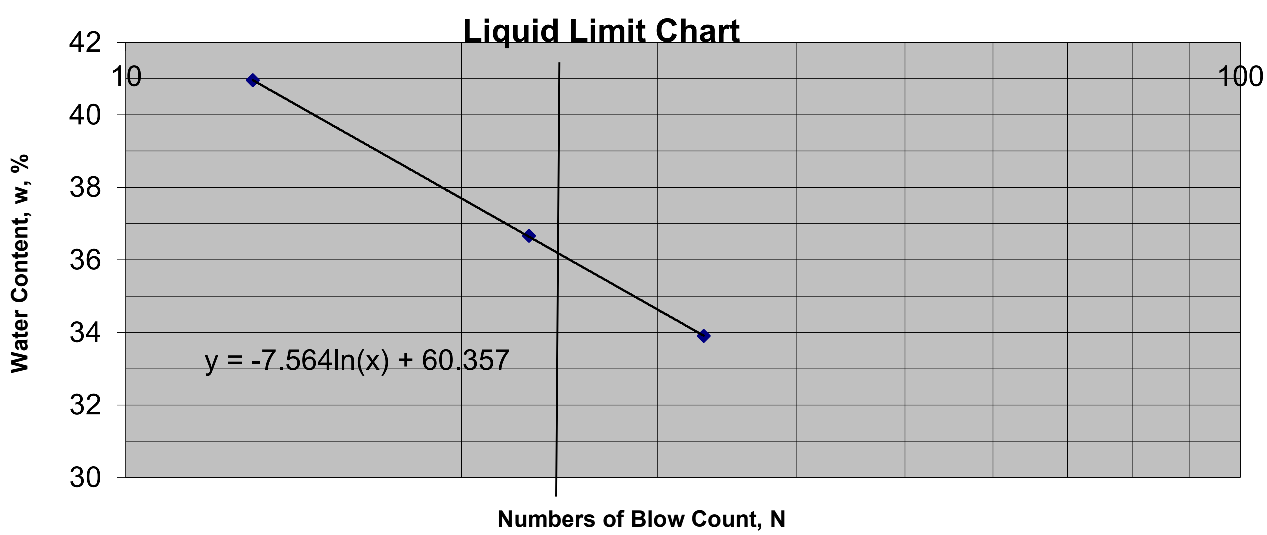
REVIEWED BY:	**Curtis Beadow**	**Joe Forsyth, P. Eng.**

PATERSON GROUP		ATTERBERG LIMITS LS-703/704	
CLIENT:	Pinchin	FILE NO.:	PM4184
PROJECT:	335920	DATE SAMPLED:	25-Mar
LOCATION:	BH3 SS4 @ 15 - 17	DATE REPORTED:	1-Apr

CAN NO.	**21**	**11**	**12**				
WT. OF CAN	8.66	8.72	8.72				
WT. OF SOIL & CAN	22.67	20.65	18.24				
WT. OF DRY SOIL & CAN	18.60	17.45	15.83				
WT. OF MOISTURE	4.07	3.2	2.41				
WT. OF DRY SOIL & CAN	9.94	8.73	7.11				
WATER CONTENT, w, %	**40.95**	**36.66**	**33.9**				
NO. OF BLOWS, N	13	23	33				

CAN NO.	**9**	**2**
WT. OF CAN	19.36	19.92
WT. OF SOIL & CAN	29.22	29.65
WT. OF DRY SOIL & CAN	27.58	28.04
WT. OF MOISTURE	1.64	1.61
WT. OF DRY SOIL & CAN	8.22	8.12
WATER CONTENT, w, %	**19.95**	**19.83**

RESULTS	
LIQUID LIMIT	**37**
PLASTIC LIMIT	**20**
PLASTICITY INDEX	**17**

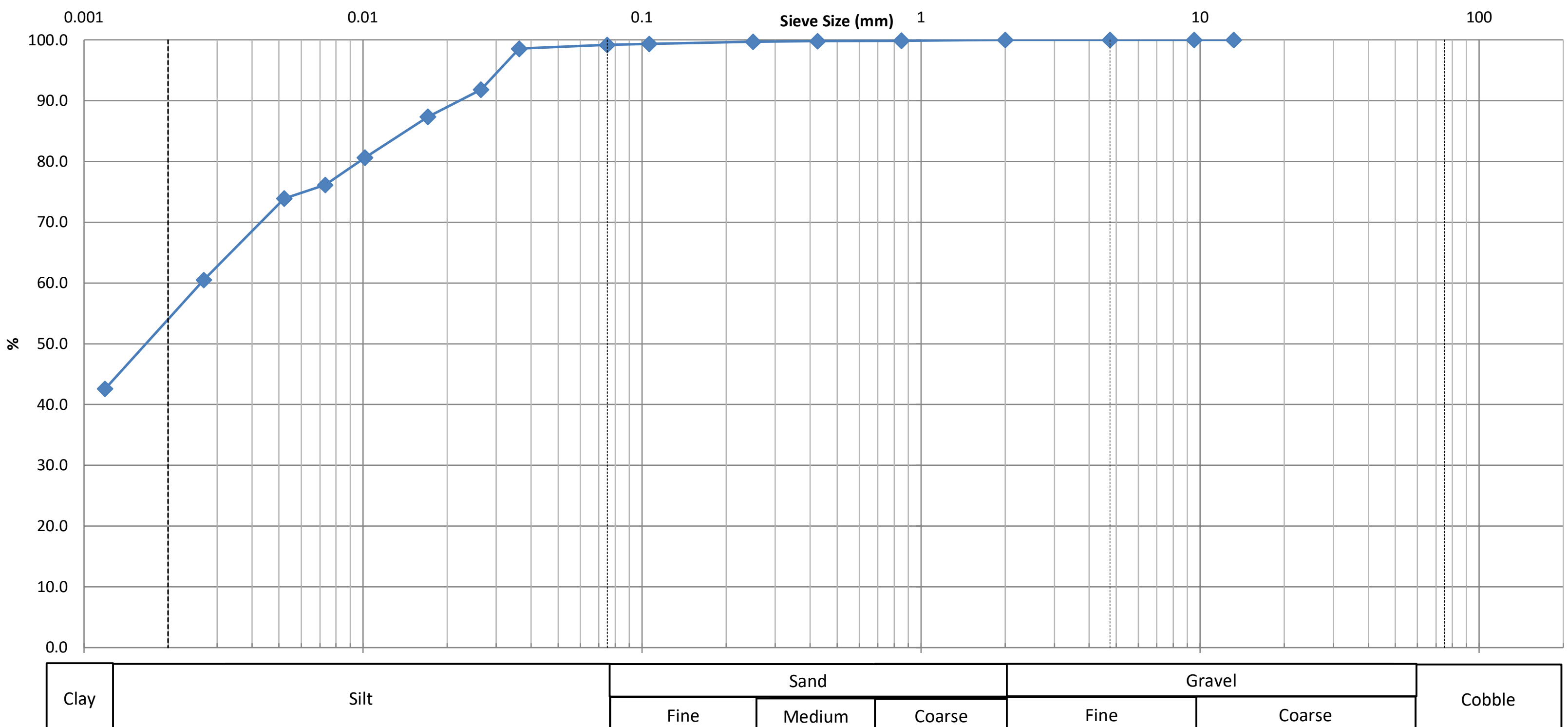


TECHNICIAN: CP	**REVIEWED BY:**	**C. Beadow**	**J. Forsyth, P. Eng.**

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	12.5-14.5	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH4 SS4	LAB NO:	51346
PROJECT:	335920			DATE RECEIVED:	26-Mar-24
				DATE TESTED:	27-Mar-24
DATE SAMPLED:	25-Mar-24			DATE REPORTED:	1-Apr-24
SAMPLED BY:	-			TESTED BY:	D.K



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					52.9%					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	
					0.0	0.8	45.2		54.0	

Comments:

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

PATERSON GROUP

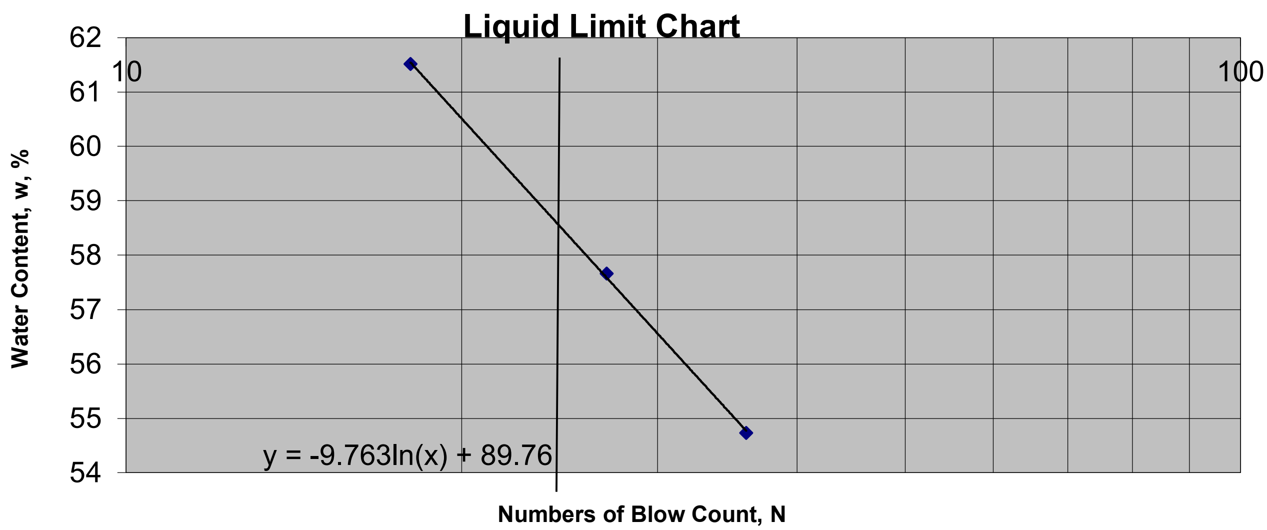
ATTERBERG LIMITS
LS-703/704

CLIENT:	Pinchin	FILE NO.:	PM4184
PROJECT:	335920	DATE SAMPLED:	25-Mar
LOCATION:	BH4 SS4 @ 12.5 - 14.5	DATE REPORTED:	1-Apr

CAN NO.	**17**	**30**	**31**			
WT. OF CAN	4.37	4.37	4.34			
WT. OF SOIL & CAN	13.77	15.80	19.89			
WT. OF DRY SOIL & CAN	10.19	11.62	14.39			
WT. OF MOISTURE	3.58	4.18	5.50			
WT. OF DRY SOIL & CAN	5.82	7.25	10.05			
WATER CONTENT, w, %	**61.51**	**57.66**	**54.73**			
NO. OF BLOWS, N	18	27	36			

CAN NO.	**1**	**10**
WT. OF CAN	19.85	19.77
WT. OF SOIL & CAN	28.49	27.60
WT. OF DRY SOIL & CAN	26.69	25.97
WT. OF MOISTURE	1.8	1.63
WT. OF DRY SOIL & CAN	6.84	6.2
WATER CONTENT, w, %	**26.32**	**26.29**

RESULTS	
LIQUID LIMIT	**58**
PLASTIC LIMIT	**26**
PLASTICITY INDEX	**32**

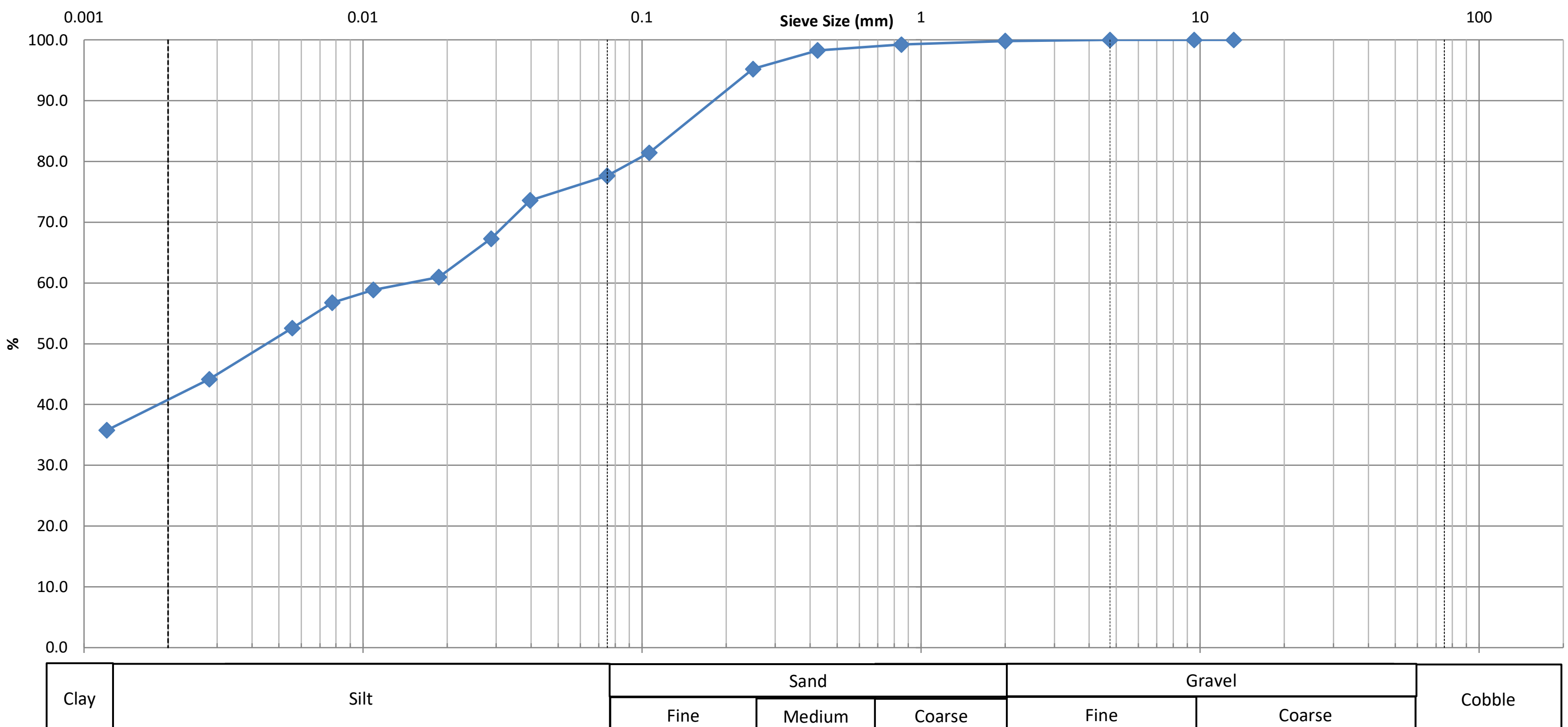


TECHNICIAN: CP	**REVIEWED BY:**	**C. Beadow**	**J. Forsyth, P. Eng.**

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	5-7	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH6 SS3	LAB NO:	51347
PROJECT:	335920			DATE RECEIVED:	26-Mar-24
				DATE TESTED:	27-Mar-24
DATE SAMPLED:	25-Mar-24			DATE REPORTED:	1-Apr-24
SAMPLED BY:	-			TESTED BY:	D.K



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					26.8%					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		
					0.0	22.3	37.2	40.5		

Comments:

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

PATERSON GROUP

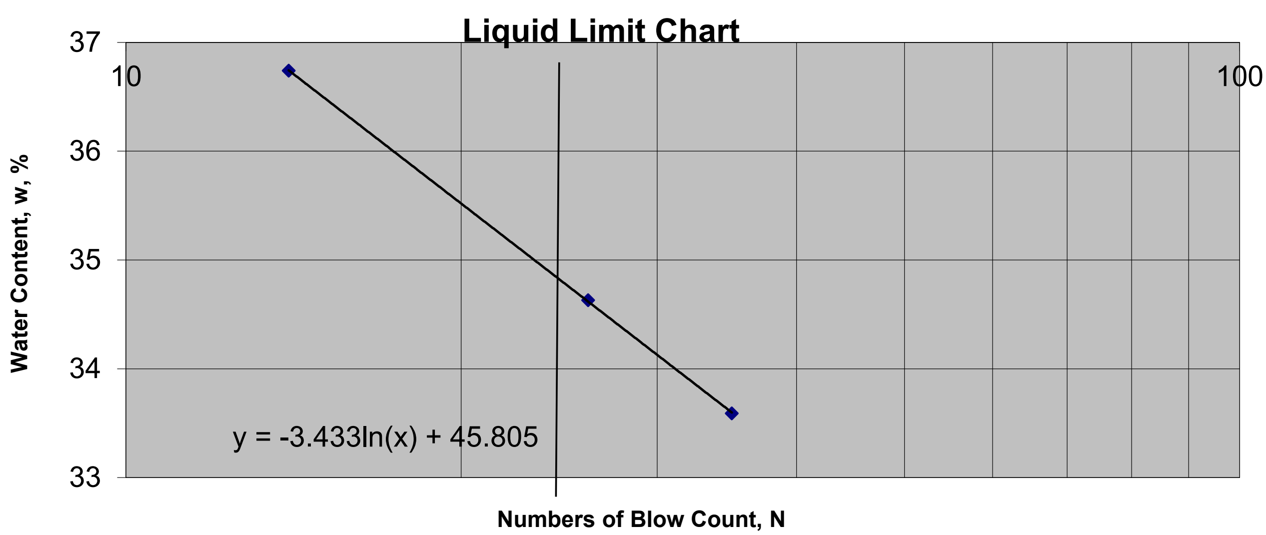
ATTERBERG LIMITS
LS-703/704

CLIENT:	Pinchin	FILE NO.:	PM4184
PROJECT:	335920	DATE SAMPLED:	25-Mar
LOCATION:	BH6 SS3 @ 5 - 7	DATE REPORTED:	1-Apr

CAN NO.	**13**	**18**	**128**				
WT. OF CAN	8.65	8.71	6.39				
WT. OF SOIL & CAN	21.64	22.55	18.60				
WT. OF DRY SOIL & CAN	18.15	18.99	15.53				
WT. OF MOISTURE	3.49	3.56	3.07				
WT. OF DRY SOIL & CAN	9.5	10.28	9.14				
WATER CONTENT, w, %	**36.74**	**34.63**	**33.59**				
NO. OF BLOWS, N	14	26	35				

CAN NO.	**15**	**18**
WT. OF CAN	19.9	20.00
WT. OF SOIL & CAN	29.26	29.61
WT. OF DRY SOIL & CAN	27.89	28.18
WT. OF MOISTURE	1.37	1.43
WT. OF DRY SOIL & CAN	7.99	8.18
WATER CONTENT, w, %	**17.15**	**17.48**

RESULTS	
LIQUID LIMIT	**35**
PLASTIC LIMIT	**17**
PLASTICITY INDEX	**18**



TECHNICIAN: CP	**REVIEWED BY:**	**C. Beadow**	**J. Forsyth, P. Eng.**

FINAL REPORT

CA15279-MAR24 R1

335920.000

Prepared for

Pinchin Ltd

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Pinchin Ltd	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	1 Hines Road, Suite 200 Kanata, ON K2K 3C7, Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Megan Keon	Telephone	2165
Telephone	613-608-5350	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	mkeon@Pinchin.com	SGS Reference	CA15279-MAR24
Project	335920.000	Received	03/28/2024
Order Number		Approved	04/03/2024
Samples	Soil (1)	Report Number	CA15279-MAR24 R1
		Date Reported	04/03/2024

COMMENTS

Temperature of Sample upon Receipt: 12 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes

Chain of Custody Number: n/a

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

Jill Campbell

TABLE OF CONTENTS

FINAL REPORT

CA15279-MAR24 R1

Client: Pinchin Ltd
Project: 335920.000
Project Manager: Megan Keon
Samplers: Megan Keon

MATRIX: SOIL

Sample Number	5
Sample Name	BH4 SS3 7.5-9.5 ft
Sample Matrix	Soil
Sample Date	08/03/2024

Parameter	Units	RL		Result
Corrosivity Index				
Corrosivity Index	none	1		11
Soil Redox Potential	mV	no		258
Sulphide (Na2CO3)	%	0.01		< 0.01
pH	pH Units	0.05		7.69
Resistivity (calculated)	ohms.cm	-9999		1230
General Chemistry				
Conductivity	uS/cm	2		815
Metals and Inorganics				
Moisture Content	%	0.1		27.2
Sulphate	µg/g	0.4		230
Other (ORP)				
Chloride	µg/g	0.4		690

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0004-APR24	µg/g	0.4	<0.4	17	35	103	80	120	108	75	125
Sulphate	DIO0004-APR24	µg/g	0.4	<0.4	1	35	93	80	120	94	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0001-APR24	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0034-APR24	uS/cm	2	< 2	0	20	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0034-APR24	pH Units	0.05	NA	1		101			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY (Mining)

SGS Environmental Services - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Toll Free: 877-747-7658 Fax: 705-652-6365 Web: www.ca.sgs.com {4}

SGS Environmental Services - London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com {4}

Laboratory Information Section

Received Date (mm/dd/yyyy): MAR 28 2024	LAB LIMS #: Mar-15279 MM
Skid # (if applicable):	Temperature Upon Receipt (°C): 12

Billing & Reporting Information

Invoice/Receipt to {3}:	
Company:	Pinchin Ltd.
Attention:	Megan Keon & Accounts Payable.
Address:	1 Hines Rd Kanata, ON
Email:	mkeon@pinchin.com / AP@pinchin.
Project Name/Number:	335920.000
P.O. #:	

Quote #:	2024 660
Attached Parameter List:	☐ YES ☐ NO
Turnaround Time	
Is *Rush Turnaround Time Required?	☐ YES ☑ NO
Specify:	Regular 5-7 day turn around is fine.

* Rush TA Requests Require Lab Approval

Client Information/Report To:

Company Name:	Pinchin Ltd.	Phone Number:	613-608-5350
Contact Name:	Megan Keon	Fax Number:	
Address:	1 Hines Rd, Kanata, ON	E-mail:	mkeon@pinchin.com
Copy to:		Client Lab #:	

Samples will be sent to paid storage after 3 months unless otherwise requested. Additional storage and shipping costs will be charged to the client. If the samples should be returned, please provide courier account information.

After analysis samples are to be:	Disposed ☑	Stored (At client's cost) *Default ☐	Multi-phase project (Automatic storage) ☐
Returned to client ☐	Return courier:	Acct:	

IMPORTANT: If samples contain known Hazards, please label accordingly and identify below:

☐ NORM (Normally Occuring Radioactive Material) ☐ Asbestos ☐ Other:

Special Instructions : ☐ See Attached or:

Sample Information

Analysis Requested (please enter the analysis required below and check off which analysis applies to each sample)

Sample Identifier	Date Sampled (mm/dd/yy) ✓	Time Sampled	# of Containers	pH	conductivity	resistivity	Redox (ORP) potential	sulfide	chloride	sulphate	
BH4 - SS3 7.5-9.5ft	03/08/24	pm	1	✓	✓	✓	✓	✓	✓	✓	

Sampled By {1}:	(Name) Megan Keon	(Signature) Megan Keon	Date: 03/08/24	(mm/dd/yy)
Relinquished by {2}:	(Name) Megan Keon	(Signature) Megan Keon	Date: 03/25/24	(mm/dd/yy)

Note: {1} Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. {2} Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). {3} Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. {4} Completion of work may require the subcontracting of samples between the London and Lakefield laboratories.

10:30 MM

APPENDIX IV

Report Limitations and Guidelines for Use

REPORT LIMITATIONS & GUIDELINES FOR USE

This information has been provided to help manage risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report was prepared for the exclusive use of the Client and their authorized agents, subject to the conditions and limitations contained within the duly authorized work plan. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third parties. If additional parties require reliance on this report, written authorization from Pinchin will be required. Pinchin disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs. No other warranties are implied or expressed. Furthermore, this report should not be construed as legal advice.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical report is based on the existing conditions at the time the study was performed, and Pinchin's opinion of soil conditions are strictly based on soil samples collected at specific test hole locations. The findings and conclusions of Pinchin's reports may be affected by the passage of time, by manmade events such as construction on or adjacent to the Site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations.

LIMITATIONS TO PROFESSIONAL OPINIONS

Interpretations of subsurface conditions are based on field observations from test holes that were spaced to capture a 'representative' snap shot of subsurface conditions. Site exploration identifies subsurface conditions only at points of sampling. Pinchin reviews field and laboratory data and then applies professional judgment to formulate an opinion of subsurface conditions throughout the Site. Actual subsurface conditions may differ, between sampling locations, from those indicated in this report.

LIMITATIONS OF RECOMMENDATIONS

Subsurface soil conditions should be verified by a qualified geotechnical engineer during construction. Pinchin should be notified if any discrepancies to this report or unusual conditions are found during construction.

Sufficient monitoring, testing and consultation should be provided by Pinchin during construction and/or excavation activities, to confirm that the conditions encountered are consistent with those indicated by the test hole investigation, and to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated. In addition, monitoring, testing and consultation by Pinchin should be completed to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Pinchin for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions. However, please be advised that any construction/excavation observations by Pinchin is over and above the mandate of this geotechnical evaluation and therefore, additional fees would apply.

MISINTERPRETATION OF GEOTECHNICAL ENGINEERING REPORT

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Pinchin confer with appropriate members of the design team after submitting the report. Also retain Pinchin to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Pinchin participate in pre-bid and preconstruction conferences, and by providing construction observation. Please be advised that retaining Pinchin to participation in any 'other' activities associated with this project is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

CONTRACTORS RESPONSIBILITY FOR SITE SAFETY

This geotechnical report is not intended to direct the contractor's procedures, methods, schedule or management of the work Site. The contractor is solely responsible for job Site safety and for managing construction operations to minimize risks to on-Site personnel and to adjacent properties. It is ultimately the contractor's responsibility that the Ontario Occupational Health and Safety Act is adhered to, and Site conditions satisfy all 'other' acts, regulations and/or legislation that may be mandated by federal, provincial and/or municipal authorities.

SUBSURFACE SOIL AND/OR GROUNDWATER CONTAMINATION

This report is geotechnical in nature and was not performed in accordance with any environmental guidelines. As such, any environmental comments are very preliminary in nature and based solely on field observations. Accordingly, the scope of services do not include any interpretations, recommendations, findings, or conclusions regarding the, assessment, prevention or abatement of contaminants, and no conclusions or inferences should be drawn regarding contamination, as they may relate to this project. The term "contamination" includes, but is not limited to, molds, fungi, spores, bacteria, viruses, PCBs, petroleum hydrocarbons, inorganics, pesticides/insecticides, volatile organic compounds, polycyclic aromatic hydrocarbons and/or any of their by-products.

Pinchin will not be responsible for any consequential or indirect damages. Pinchin will only be held liable for damages resulting from the negligence of Pinchin. Pinchin will not be liable for any losses or damage if the Client has failed, within a period of two years following the date upon which the claim is discovered within the meaning of the Limitations Act, 2002 (Ontario), to commence legal proceedings against Pinchin to recover such losses or damage.