

GEOTECHNICAL ENGINEERING REPORT

**Dixie and Dockstader Road,
Brampton, Ontario**

PREPARED FOR:

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1 Introduction

Region of Peel c/o Diamond Schmitt has retained Grounded Engineering Inc. to provide geotechnical engineering design advice for their proposed development at Dixie and Dockstader Road, in Brampton, Ontario.

The site is rectangular in shape, with a total area of approximately $16,210 \pm \text{m}^2$, and is currently vacant. Evidence of previous and current earthworks was noted during our site visits. The proposed project includes constructing a 2-storey structure, resting on grade with no underground basement levels. The ground finished floor elevation (FFE) is estimated to be at Elev. $253.0 \pm \text{m}$ as indicated to Grounded via email communication.

Revision 1 of this report includes the following changes:

- Updates to the Foundation Design Parameters section to include design recommendations for strip footings and mat foundations for stairs and elevator cores.
- Updates to the Earthquake Design Parameters Section to include results of geophysical testing for seismic site classification.
- Earth Pressure Design Parameters have been included to account for the shipping and receiving bays.
- Updates to Long-Term Groundwater and Seepage Control section to provide design recommendations for parts of the proposed structure extending below groundwater table

Grounded has been provided with the following reports and drawings to assist in our geotechnical scope of work:

- Site survey, prepared by KRCMAR (Jan 17, 2017).
- Architectural Drawings, "Dockstader PRPS, Brampton, Ontario"; Project P101B, dated Mar 3, 2021, prepared by Diamond Schmitt Architects.
- Structural Drawings, "500 Dupont Street, Toronto, Ontario"; Project 15-123, dated Feb 2, 2018 (Reissued for SPA), prepared by RJC.
- Geotechnical Desktop Review Report, "Geotechnical Desktop Review of Preliminary Geotechnical Investigation Report by Peto MacCullam Ltd. For Northwest of Dixie Rd & Dockstader Rd", File 221-02387-00 dated April 11, 2022, prepared by WSP.
- Email Communication, "FW: Dockstader – Preliminary Grading", sent to Grounded by MGauthier@dsai.ca, dated September 5, 2023, at 12:44 PM.
- Email Communication, "RE: Peel Region Paramedic Services (PRPS) Reporting Station – Dockstader Road", sent to Grounded by snorris@rjc.ca, dated October 23, 2023, at 11:41 PM.

Grounded has been provided with factual borehole information for the subject site from other consultants as listed above. Although the borehole logs are provided in a report signed and sealed by professional engineers, the borehole logs attached in the report provided to Grounded have been provided in a draft format. As such, this borehole information is only used for preliminary



information and is not relied upon for engineering analysis and recommendations provided in this report.

Grounded's subsurface investigation of the site to date includes fourteen (14) boreholes (Boreholes 1 to 14) which were advanced from June 19th to 21st, 2023.

Based on the borehole findings, geotechnical engineering advice for the proposed development is provided for foundations, seismic site classification, earth pressure design, slab on grade design, basement drainage, and pavement design. Construction considerations including excavation, groundwater control, and geostructural engineering design advice are also provided.

Grounded Engineering must conduct the on-site evaluation of founding subgrade as foundation and slab construction proceeds. This is a vital and essential part of the geotechnical engineering function and must not be grouped together with other "third-party inspection services". Grounded will not accept responsibility for foundation performance if Grounded is not retained to carry out all the foundation evaluations during construction.

2 Ground Conditions

The borehole results are detailed on the attached borehole logs. Our assessment of the relevant stratigraphic units is intended to highlight the strata as they relate to geotechnical engineering. The ground conditions reported here will vary between and beyond the borehole locations.

The stratigraphic boundary lines shown on the borehole logs are assessed from non-continuous samples supplemented by drilling observations. These stratigraphic boundary lines represent transitions between soil types and should be regarded as approximate and gradual. They are not exact points of stratigraphic change.

The boreholes were surveyed for horizontal coordinates and geodetic elevations with the Sokkia GCX3 system, connected to the Global Navigation Satellite System and the Can-Net Virtual Reference Station Network.

2.1 Stratigraphy

The following stratigraphic summary is based on the borehole results and the associated geotechnical laboratory testing on samples recovered from the boreholes.

A subsurface profile showing stratigraphy and engineering units is appended.

2.1.1 Topsoil and Earth Fill

Borehole 12 encountered 305 mm of topsoil at the existing ground surface. Topsoil thickness was observed in individual borehole locations through the top of the open borehole. Thicknesses may vary between and beyond each borehole location.



Underlying the topsoil in Borehole 12, and at ground surface on all other borehole locations, a layer of earth fill that extends to depths of 0.8 to 2.3 metres below grade (Elev. 253.3 to 250.6 metres) was observed. The earth fill generally consists of sandy silt, trace clay, trace gravel, and trace rootlets. The earth fill is typically light brown to orangey brown with grey, and moist.

Due to inconsistent placement and the inherent heterogeneity of earth fill materials, the relative density of the earth fill varies.

2.1.2 Glacial Till

Underlying the fill, all the boreholes encountered undisturbed native glacial till, consisting of sandy silt with trace to some clay, and trace gravel, at depths ranging from 0.8 to 2.3 m below grade (Elev. 253.3 to 250.6± m). Boreholes 1 to 5, 9, 10, and 13 were terminated in this unit at their target investigation depths of 3.2 to 5.0 m below grade (Elev. 250.6 to 247.5± m). The glacial till extends down to depths of 3.0 to 6.1 m below grade (Elev. 249.9 to 246.4± m) in Boreholes 6 to 8, 11, 12, and 14.

The glacial till is moist, and generally orangey brown to light brown with grey, turning grey at about 3.0± m below grade. This unit contains rock fragments inferring cobbles. There are occasional wet sandy seams within the till.

Standard Penetration Test (SPT) results (N-Values) measured in the glacial till range from 14 to greater than 50 blows per 300 mm of penetration ("bpf"), indicating a compact to very dense relative density.

2.1.3 Silt

Underlying the glacial till, Boreholes 6, 7, 8, 11, 12, and 14 encountered a native, undisturbed deposit of cohesionless silt with some clay, trace sand, and occasional sand and clay seams, at depths ranging from 3.0 to 6.1 metres below grade (Elev. 249.9 to 246.4 m) and extending down to the target investigation depths of 5.0 to 9.6 m below grade (Elev. 248.0 to 242.7 m). The deposit is generally brown to grey, and moist to wet. This unit contains rock fragments and inferred cobbles.

SPT N-values measured in this unit range from 20 to more than 50 bpf, indicating a compact to very dense relative density.

2.2 Groundwater

The depth to groundwater and caved soils was measured in each of the boreholes immediately following the drilling.



Monitoring wells were installed in select boreholes, and stabilized groundwater levels were measured in each of the installed monitoring wells in the weeks following drilling. The groundwater observations are shown on the Borehole Logs and are summarized as follows.

Borehole No.	Monitoring Well depth (m)	Upon completion of drilling		Strata Screened	Water Level in Well, highest (m)	
		Depth to cave (m)	Unstabilized water level (m)		Date	Depth/Elev.
6	6.1	open	7.3	Silts	2023-07-21	1.7 / 251.2
7	9.1	open	Dry	Silts	2023-07-21	1.8 / 250.7
8	4.6	open	Dry	Glacial Till	2023-07-21	0.9 / 252.1
10	4.6	open	Dry	Glacial Till	2023-07-21	0.6 / 251.9
14	9.1	open	7.3	Silts	2023-07-21	1.3 / 251.0

Groundwater levels will fluctuate with time depending on the amount of precipitation and surface runoff, and may be influenced by known or unknown dewatering activities at nearby sites.

The design groundwater table is about 1 to 2 m below grade, but for engineering purposes is at Elev. 252.1± m. The groundwater table is present in all native soil units. These deposits have a relatively low permeability and will yield only minor seepage in the long-term. Excavations may also encounter perched water in the earth fill.

Grounded has prepared a hydrogeological report for this site under separate cover (File No. 23-099).

2.3 Corrosivity and Sulphate Attack

Three (3) soil samples were submitted for corrosivity testing parameters (pH, Resistivity, Electrical Conductivity, Redox Potential, Sulphate, Sulphide and Chloride). The Certificate of Analyses and interpretation sheet is appended.

The soil samples were analysed for soluble sulphate concentration and compared to the Canadian Standard CAN3/CSA A23.1-M94 Table 3, *Additional Requirements for Concrete Subjected to Sulphate Attack*. Corrosivity parameters are also used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C-105 standard.

The analytical results only provide an indication of the potential for corrosion. The results of this analysis are in reference to only the soil samples collected from specific locations, and soil chemistry may vary between and beyond the locations of the analysed samples. In summary:

- All of the samples have negligible sulphate concentrations.
- All of the samples scored less than 10 points and corrosion protective measures are therefore not recommended for cast iron alloys.



- A more recent study by the AWWA has suggested that soil with a resistivity of less than about 2000 ohm.cm should be considered aggressive. All of the samples had resistivity measurements exceeding 2000 ohm.cm.

2.4 Frost Heave Susceptibility of Soils

A soil's susceptibility to frost heave is related to the percentage of silt and very fine sand in the soil, as frost heave impacts fine-grained soils with low cohesion and high capillarity. The site soils are classified for susceptibility to frost heave according to their grain size distributions on this basis. Geotechnical laboratory results for this site are appended. Per the Second Edition of the Pavement Design and Rehabilitation Manual by the Ministry of Transportation in Ontario, the following table summarizes the relationship between grain size and frost heave susceptibility:

Relationship Between Grain Size and Frost Susceptibility (MTO)

Grain Size Percentage between 5 and 75 μ m	Susceptibility to Frost Heaving
0 to 40%	Low
40 to 55%	Moderate
55 to 100%	High

Per the grain size data measured in the site soils, frost heave susceptibility is summarized accordingly:

Summary of Susceptibility to Frost Heave for Soils Encountered at the Site

Stratum	Grain Size Percentage between 5 and 75 μ m	Susceptibility to Frost Heaving
Earth Fill	Est. 25 to 50%	Low to Moderate
Glacial Till	35 to 40%	Low to Moderate
Silts	50 to 65%	Moderate to high

3 Geotechnical Engineering Recommendations

Based on the factual data summarized above, we are providing the following geotechnical engineering design recommendations. Contractors must review the factual data while bidding or scoping services for this project and must provide their own opinion as to means, methods, and schedule.

This report assumes that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards, and guidelines of practice. If there are any changes to the site development features, or there is any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Grounded should be retained to review the implications of these changes with respect to the contents of this report.



3.1 Site Grading

It is expected that cutting and/or filling will be necessary to achieve the desired site grade with a ground FFE of Elev. $231 \pm \text{m}$, for the proposed development.

3.1.1 Compacted Fill / Engineered Fill

Engineered fill is required wherever the fill material must provide structural support for foundations. For pavement areas, grade raises may comprise compacted fill or engineered fill. Compacted fill is suitable for raising grades to support new pavements, landscaping, and services.

An engineered fill earthworks specification is appended. Compacted fill is generally similar to engineered fill, with the following exceptions:

1. **Inspection and Testing:** Compacted fill does not need full-time inspection and testing, although it does need periodic geotechnical engineering testing and inspections for quality control. The frequency of periodic inspections can vary from once a day to once every 3 days and is to be confirmed after the construction schedule is available for review. Engineered fill requires full-time inspection and testing.
2. **Acceptable Subgrade:** Compacted fill can be made on an existing earth fill subgrade if it is proof rolled under the inspection of a qualified geotechnical technician and approved by a geotechnical engineer prior to fill placement. Engineered fill requires an approved subgrade of undisturbed (dewatered) native soils, which implies that the existing earth fill must be subexcavated down to the top of native soil across the site.
3. **Dewatering:** At this site, the stabilized groundwater table is shallow and within the fill materials, but the boreholes were generally open and dry through the expected zone of excavation. Engineered fill construction requires an undisturbed native subgrade for construction. If the top of native soil elevation is below the groundwater table, some dewatering may be necessary to maintain dry / dewatered working conditions. This can be achieved via properly placed sumps and pumps at the base of the excavation(s), as necessary. The existing fill and native soils have a relatively low permeability and will generally preclude the free flow of groundwater. Positive dewatering is not possible in these soils. Compacted fill does not require that the existing fill materials be excavated (so long as they are proof rolled and approved as described below), which can reduce the need for dewatering during construction. Note that compacted fill may still require occasional sub-excavation below the groundwater table, to remediate any obvious loose/weak areas exposed during proof rolling.
4. **Slab on Grade Design:** Compacted fill typically has a lower modulus of subgrade reaction than engineered fill (see Section 3.4). Slabs made on compacted fill may need to be thicker or have more reinforcement.

The choice of compacted vs. engineered fill will be determined to a large extent by foundation requirements, as well as the construction practicalities of regrading a site.



Although the stabilized groundwater table is within the fill at this site, positive dewatering may not be required as the boreholes were generally dry and open within about 3 to 5± m of ground surface. A professional dewatering subcontractor should be consulted.

3.1.2 Subgrade Approval

Both compacted fill and engineered fill shall comprise earth fill that is inorganic, clean, and geotechnically suitable soil sourced from the site or imported. It is recommended that all areas of grade raise be placed as engineered fill to ensure full-time quality control of the placed fill, and to anticipate future structures constructed within the pavement area.

Compacted fill may be made on inspector-approved existing clean non-organic earth fill, or native soil. Engineered fill must be made to bear on inspector-approved undisturbed (dewatered) native soil only.

Prior to placement of the engineered/compacted fill, the cut subgrade shall be proof-rolled and inspected under the supervision of a qualified geotechnical technician for obvious exposed loose or disturbed areas, or for areas containing excessive deleterious materials or moisture. These areas shall be recompacted in place and retested, or else replaced with Granular B placed as engineered fill (in lifts 150 mm thick or less and compacted to a minimum of 98 percent SPMDD). A static drum roller should be used to proof-roll the soils at this site, as vibration will cause unwanted disturbance, dilation, and strength reduction in the underlying native soils. The slab on grade should not be placed on frozen subgrade, to prevent settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

3.1.3 Construction

All fill must be placed on approved subgrade, in loose lifts of 150 mm and compacted to a minimum of 98% SPMDD at a moisture content within 2% of optimum. Engineered fill must be placed under the full-time supervision of a qualified geotechnical technician, who shall perform frequent in situ density measurements to ensure the uniformity and adequacy of the compaction effort. Upon completion, engineered fill must be certified by a Geotechnical Engineer.

In areas that are not sensitive to settlement (e.g. landscaping areas), it may be acceptable to place compacted fill in loose lifts of 200 mm and compact to a minimum of 95% SPMDD at a moisture content within 2% of optimum. We can review and comment on these areas as needed.

Soil that is used as engineered or compacted fill must have a moisture content within 2% of optimum and be free of deleterious materials, cobbles/boulders greater than 150 mm in diameter, topsoil, and other organics. Representative soil samples must be collected from the proposed fill material and tested using the Standard Proctor Maximum Dry Density (SPMDD) method to determine the optimum moisture content and maximum dry density prior to placement and compaction as common or engineered fill.



Prior to the arrival of imported soil materials, they must be tested per the requirements of O.Reg 406/19 and approved by the Environmental QP for the site.

The existing topsoil is not geotechnically suitable and must be removed from settlement sensitive areas (structures, pavements, etc.). Topsoil may be re-used in landscaped areas that are not sensitive to settlement, or wasted off-site.

Moisture content measurements made on earth fill soil samples from the boreholes range from 8 to 20% (on average, 12%). We estimate that potentially most of the existing fill and previously disturbed soils may be suitable for immediate re-use as common earth fill or engineered fill if it is sorted or blended to remove any excess organics, moisture, or other deleterious materials.

Moisture content measurements made on glacial till soil samples from the boreholes within 2 m of existing grade range from 6 to 17% (on average, 12%). We estimate that most of the undisturbed native soil at the site is likely suitable for immediate re-use on site.

As inferred by the boreholes, embedded cobbles and boulders should be anticipated in all existing fill and native soils.

Common earth fill or engineered fill may not be readily compacted in small volumes, such as trenches or in areas adjacent to foundations or catch basins. For areas of limited extent, compactable aggregate-source backfills like Granular B (OPSS.MUNI 1010) are recommended for post-construction grade integrity. All new fill shall be compacted to a minimum of 98% SPMDD.

Where engineered fill pads tie into existing grades, the engineered fill should extend for a distance of at least 2 m beyond the proposed structure footprints in every direction as measured at the founding level, and should extend downwards from this point at no steeper than 1 to 1 (horizontal to vertical) slope to the adjacent ground level.

3.1.4 Frost Susceptibility

Frost susceptible soils within 1.2 m of finished grades in unheated areas (e.g. pavements) could potentially cause pavements to heave or crack next to structures with no frost cover (e.g. curbs, catchbasins, pavements). The degree of heaving is unknown. If frost susceptibility is to be considered in design (to be determined by the Owner based on their own pavement performance criteria), all soil placed within 1.2 m of finished grades should be classified as having a low susceptibility to frost heaving, as defined in Section 2.4 above.

3.1.5 Post-Construction Settlement

Engineered/compacted fill can be expected to experience self-weight post-construction settlement on the order of about 1% of the depth of the compacted/engineered fill. The time period over which this settlement occurs depends on the composition of the engineered fill as follows (after initial placement):

- Sand or gravel soil – several days



- Silt soil – several weeks
- Clay or clayey soil (common earth fill) – several months

If the engineered fill is composed of sand or aggregate materials, then self-weight post-construction settlements of the engineered fill will be around 0.5% or less.

If compacted fill is constructed over an approved existing earth fill subgrade, the fill subgrade will also be prone to settlement due to the increase in effective vertical stress. Organics in the existing earth fill may also be subject to secondary consolidation (creep). For grade raises of over 0.5 m, we recommend allowing areas of grade raise made with compacted fill to sit for at least 3 months prior to the construction of pavements and site services, to mitigate this risk.

3.1.6 Winterized Building Pad

If the building pads are constructed and left over a winter, they must be winterized as follows:

- 1) The entire pad area shall be covered with two (2) 150 mm thick lifts of low permeability fill containing at least 25% fines (material passing the 0.075 mm sieve). The fill shall be compacted to a minimum of 95% SPMDD, which will act as a cover blanket to protect the underlying Building Pad surface from softening and water absorption due to precipitation and freeze-thaw cycles. This work is to ensure that the prepared pad is protected from the effects of winter weather; rain, snow, and miscellaneous construction traffic.
- 2) The surface of the cover blanket shall be finished with a smooth drum roller and sloped to a minimum of 2% in such a manner to prevent water from ponding on the surface and facilitates runoff to drain off the sides of the pad (and in no case shall the cover be less than 300 mm thick).

The glacial till and the earth fill at the site would meet the specification to be considered as low permeability fill for the winter cap.

Without the winter provisions laid out above, the top 900 mm (minimum) of the engineered fill will need to be stripped down to acceptable subgrade after the freeze-thaw cycle (as approved by Grounded), and replaced as engineered fill.

3.2 Foundation Design Parameters

3.2.1 General

The proposed project involves constructing a 2-storey structure resting on grade (no basement) for the Peel Region Paramedic Station. The topsoil and earth fill soils are considered unsuitable for the support of the proposed building foundations.

The following options are discussed:



- Conventional spread footing and mat foundations bearing on compact or dense to very dense native soils
- Conventional spread footing foundations bearing on engineered fill
- Helical pile foundations torqued into compact to dense native subgrade

If the capacities provided below for these foundation options are not sufficient, alternative foundation options can be assessed by Grounded. This may require additional subsurface investigation including boreholes and in-situ testing.

When exposed to ambient environmental temperatures, the design earth cover for frost protection of foundations and grade beams is 1.2 metres.

Footings stepped from one elevation to another should be offset at a slope not steeper than 7 vertical to 10 horizontal.

Foundation excavations must be dewatered during construction in order to preserve the in-situ integrity of the bearing subgrade. If the subsurface is not dewatered, the native soils will become disturbed by the ingress of groundwater and the following recommendations for bearing capacity will not be valid. It is expected that groundwater seepage will be limited based on the nature of the native and fill soils present at the site, and conventional sumps and pumps will suffice to control groundwater as necessary.

The founding subgrade must be cleaned of all unacceptable materials and approved by Grounded prior to pouring concrete for the footings. Such unacceptable materials may include disturbed or caved soils, ponded water, or similar as indicated by Grounded during founding subgrade inspection. During the winter, adequate temporary frost protection for the footing bases and concrete must be provided if construction proceeds during freezing weather conditions.

To avoid issues with differential settlement, it is recommended that individual foundation elements be founded entirely on native soil or engineered fill and designed accordingly. Spread footings, strip footings, and/or mat foundations should not span across different subgrade types (i.e. partially supported by native soils and engineered fill).

3.2.2 Spread Footings Bearing on Native Soils

Foundations made for the structure will bear on undisturbed native subgrade. Conventional spread footings may be designed to bear on compact or dense native glacial tills at approximately Elev. 251±m, using a maximum factored geotechnical resistance at ULS of 750 kPa. The maximum geotechnical reaction at SLS is 500 kPa, for an estimated total settlement of 25 mm. Strip footings can be constructed from 0.5 m in width up to 2 m in width without lowering the provided bearing capacities for conventional footings.

Individual spread footing foundations designed to these capacities must be at least 2000 mm wide. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS



refers to a settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

At this site, the SLS bearing pressures provided above also limit the maximum footing sizes for conventional strip and spread footings to 1500 and 3000 mm, respectively.

The boreholes indicate that the existing earth fills extend deeper than Elev. 251± in some localized areas. If these conditions are encountered during foundation excavation, conventional footings as described above must be lowered in order to bear on native glacial till. Alternatively, conventional spread and strip footings could be supported on engineered fill, as outlined in Section 3.2.3.

3.2.2.1 *Mat Foundations for Stairs and Elevator Core*

It is understood that stair corridors and the elevator core will be supported using mat foundations (approximately 6.0 m x 10.0 m in size), bearing at depths of about 1.8 to 2.2 metres below grade. These foundations must be constructed on native, undisturbed glacial till at about Elev. 251± m.

If existing fill is encountered at the proposed bearing elevation for mat foundations, they must be lowered to bear on native undisturbed glacial till. It is not recommended to construct mat foundations on engineered fill.

For a 6.0 m x 10.0 m sized mat foundation bearing on undisturbed glacial till as described above, and assuming a uniformly distributed load, mat foundations can be designed for 240 kPa for 25 mm of settlement at SLS.

The modulus of subgrade reaction for a 6.0 x 10.0 m mat foundation resting on native till as described above is 9,500 kPa/m.

3.2.3 *Spread Footings bearing on Engineered Fill*

Alternatively, the proposed structures may be supported on conventional spread footing foundations resting on engineered fill. This may be preferred if subexcavation to reach deeper native soils is not preferred. An engineered fill specification is appended and discussed in Section 3.1.

So long as the engineered fill is placed and compacted as indicated per the above noted specification, conventional spread and/or strip footings resting on engineered fill (comprising common earth fill) may be designed for a net geotechnical reaction of 150 kPa at SLS (for an estimated total settlement of 25 mm) and a factored geotechnical resistance of 225 kPa at ULS. These footings must be placed at least 0.6 m into the engineered fill strata.

Higher capacities are available if the engineered fill material comprises granular soil such as sand and gravel. These can be provided on request once the material grain sizes have been reviewed.

For footings supported on engineered fill, the minimum width for conventional strip footings must be 600 mm, and the minimum width of individual spread footings must be 1000 mm. These



minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to a settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

Engineered fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the engineered fill. The time period over which this settlement occurs depends on the composition of the engineered fill as follows (after initial placement):

- Sand or gravel soil – several days
- Silt soil – several weeks
- Clay or clayey soil (common earth fill) – several months

The timing of foundation construction must consider the post-construction settlement of the engineered fill.

Soils at the base of the foundation excavation shall not exceed a maximum particle size of 75 mm. Backfill shall not exceed a maximum particle size of 75 mm in foundation excavations exceeding 1 m in depth. If cobbles and boulders exceeding this maximum particle size are encountered, they will be deemed unsuitable and must be subexcavated and replaced with suitable material.

3.2.4 Helical Piles

Helical piles may be designed to carry new structural load. Since helical pile installations require little to no excavation, they are a suitable option in confined spaces such as existing underground levels. Helical piles can be installed using small equipment or by hand, with minimal ground disturbance and minimal excess soil cuttings.

Contractors specializing in helical pile design and installation can provide detailed information on installation methodology, detailed design, product quality, and certification. EBS Geostructural is one local specialist contractor that provides design-build services for Chance helical piles.

At this site, helical piles can be installed to bear into either the compact or dense glacial till, in order to obtain adequate resistance to support the new loads. Following helical pile installation, a pile cap or grade beam is constructed to transfer the building loads onto the underlying competent soils through the helical piles. The design earth cover (or equivalent insulation) for frost protection of grade beams exposed to ambient environmental temperatures is 1.2 metres for this location.

There are several helical pile products available. Helical pile detailed design will ultimately depend upon the loading considerations and the ground conditions. The project geotechnical information should be provided to a specialist design/build contractor to assess the feasibility of this foundation system and to determine probable helical pile refusal/installation depths, and capacities.



The actual installation depth of each helical pile is determined on site during installation based on depth and torque measurements made during installation, and the load support requirements. The load carrying capacity of each helical pile is confirmed by the helical pile contractor based on the torque measurements and a full-scale performance test of a prototype pile. Occasionally, field torque measurements indicate that helical piles must be advanced deeper than originally designed. Provision must be made in helical pile contracts to allocate and quantify risks associated with any extra time and materials utilized to achieve the required field torque readings.

The presence of debris/obstructions within fill materials or larger sized cobbles or boulders in native soil (although not specifically encountered in the borehole) could impede helical pile installation. Refer to the borehole logs for detailed subsurface information. Provision must be made in helical pile contracts to allocate risks associated with the time spent and equipment utilized to remove or work around such obstructions when encountered.

Uplift due to frost (also known as 'adfreezing') on the shaft of helical piles must also be considered in the design. Based on the Canadian Foundation Engineering Manual (4th Ed.), design adfreeze bonds vary from 65 kPa (fine grained soils frozen to wood/concrete) to 100 kPa (fine grained soils frozen to steel), to 150 kPa (gravel frozen to steel). These loads act in the upward direction on the portion of shaft that is above the design frost depth. Alternatively, bond breakers can be designed and applied to the shaft of the helical pile.

3.3 Earthquake Design Parameters

The Ontario Building Code (2012) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2012). The classification is based on the determination of the average shear wave velocity in the 30 metres of the site stratigraphy below spread footing/grade beam elevation, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated from the rational analysis of undrained shear strength (s_u) or penetration resistance (N-values) according to the OBC and National Building Code of Canada.

Site-specific Multichannel Analysis of Surface Waves (MASW) was carried out at the site to determine the average shear wave velocity in the top 30 metres of the site stratigraphy. Based on these results, the site designation for seismic analysis is Class C, per Table 4.1.8.4.A of the Ontario Building Code (2012). Tables 4.1.8.4.B and 4.1.8.4.C of the same code provide the applicable acceleration and velocity-based site coefficients. The results of the MASW testing are attached as Appendix F.



3.4 Earth Pressure Design Parameters

At this site, the design parameters for structures subject to unbalanced earth pressures such as retaining walls loading ramps are shown in the table below.

Stratigraphic Unit	γ	ϕ	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS.MUNI 1010)	21	32	0.31	0.47	3.25
Existing Earth Fill	19	29	0.35	0.52	2.88
Glacial Till, Elev. 252 to 249± m	21	34	0.28	0.44	3.54
Silts, Elev. 249 to 243± m	21	36	0.26	0.41	3.85

γ	=	soil bulk unit weight (kN/m ³)
ϕ	=	internal friction angle (degrees)
K_a	=	active earth pressure coefficient (Rankine, dimensionless)
K_o	=	at-rest earth pressure coefficient (Rankine, dimensionless)
K_p	=	passive earth pressure coefficient (Rankine, dimensionless)

These earth pressure parameters assume that grade is horizontal behind the retaining structure. If retained grade is inclined, these parameters do not apply and must be re-evaluated.

The following equation can be used to calculate the unbalanced earth pressure imposed on walls:

$$P = K[\gamma(h - h_w) + \gamma' h_w + q] + \gamma_w h_w$$

P	=	horizontal pressure (kPa) at depth h	γ	=	soil bulk unit weight (kN/m ³)
h	=	the depth at which P is calculated (m)	γ'	=	submerged soil unit weight ($\gamma - 9.8$ kN/m ³)
K	=	earth pressure coefficient	q	=	total surcharge load (kPa)
h_w	=	height of groundwater (m) above depth h			

If the wall backfill is drained such that hydrostatic pressures on the wall are effectively eliminated, this equation simplifies to:

$$P = K[\gamma h + q]$$

Where walls are made directly against shoring, prefabricated composite drainage panel covering the blind side of the wall is used to provide drainage. Water from the composite drainage panel is collected and discharged through the basement wall in solid ports directly to the sumps. This is discussed in Section 3.5.

The possible effects of frost on retaining earth structures must be considered. In frost-susceptible soils, pressures induced by freezing pore water are basically irresistible. Insulation typically addresses this issue. Alternatively, non-frost-susceptible backfill may be specified.

Foundation resistance to sliding is proportional to the friction between the soil subgrade and the base of the footing. The factored geotechnical resistance to friction (R_f) at ULS provided in the following equation:



$$R_f = \Phi N \tan \varphi$$

R_f	=	frictional resistance (kN)
Φ	=	reduction factor per Canadian Foundation Engineering Manual (CFEM) Ed. 4 (0.8)
N	=	normal load at base of footing (kN)
φ	=	internal friction angle (see table above)

3.5 Slab on Grade Design Parameters

The proposed structure is to rest at grade, with no basement. A conventional slab on grade would be made on very loose to compact earth fill. The earth fill soils are inferred to be native soils that have been disturbed or reworked in place by agricultural activities previously conducted at this site. Reworked soils are grouped within the earth fill unit based on their engineering properties and their suitability for foundations and pavements.

Very loose to loose earth fills are not competent for the support of a slab on grade. The very loose or loose earth fills should be compacted in place, proof-rolled, and inspected under the supervision of Grounded for obvious exposed loose or disturbed areas, or for areas containing excessive deleterious materials or moisture. Unacceptable material (as determined by Grounded) must be subexcavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The modulus of subgrade reaction appropriate for design of the slab on grade resting on compacted earth fill soils is 10,000 kPa/m.

The slab on grade may also be made on engineered fill. The modulus of subgrade reaction appropriate for design of the slab resting on engineered fill is 22,000 kPa/m.

3.6 Long-Term Groundwater and Seepage Control

To limit seepage to the extent practicable, exterior grades adjacent to foundation walls should be sloped at a minimum 2 percent gradient away from the wall for 1.2 m minimum.

For conventional slab-on-grade structures with no basement, perimeter drainage is not needed where the finished floor is 200 mm higher than exterior grade. To prevent impaired door function during winter months, subgrade adjacent to doors should be either drained or protected against potential frost heave. Perimeter drains should be connected directly to a sump, or positively discharged to grade if possible. Alternatively, subgrade adjacent to doors can be insulated for frost protection.

There are portions of the structure that will extend below the groundwater table (elevator pit, sump pits, shipping and receiving ramps, sand / oil interceptors). If these features are not constructed as drained structures, then, they must be designed as watertight structures, and designed to withstand hydrostatic pressures in both uplift (vertically) and laterally. They should have a waterproofing membrane designed to meet hydrostatic loads incurred from the groundwater table at Elev. 252.1± m.



Regardless of whether it is designed as a drained foundation or a watertight structure, the loading ramp(s) must include a trench drain at the lowest part of the ramp to prevent water from pooling at the base of the ramp.

3.7 Site Servicing

All services must have at least 1.2 metres of earth cover or equivalent insulation for frost protection.

Where site services are not installed below the basement levels of the proposed development, the following recommendations apply.

3.7.1 Bedding

The soil subgrade encountered within utility trenches on site may consist of either earth fill or native soil. If earth fill is encountered, the subgrade must be compacted in place to a minimum 98% SPMDD. The trench base must be inspected for obvious loose, wet, or disturbed material. Any unsuitable material must be subexcavated and replaced with imported fill compacted to 98% SPMDD.

If trenches extend below the groundwater table, the groundwater table must be lowered to 1.2 m below the lowest excavation elevation prior to excavation. At this site, the stabilized groundwater table is shallow and within the fill materials, but the boreholes were generally open and dry through the zone of excavation. Native soils are low permeability and will generally preclude the free flow of groundwater. Test pits may be advanced to observe seepage at trench invert elevation, to inform dewatering requirements.

Bedding material below the groundwater table must consist of well graded granular fill such as Granular A (OPSS.MUNI 1010). Clear stone is specifically prohibited below the groundwater table. The bedding material must be compacted to a minimum 98% SPMDD.

Where trenches are above the groundwater table, bedding material may consist of 19 mm clear stone (OPSS.MUNI 1004) or similar, vibrated to a dense state. Where the bedding material consists of clear stone, the bedding must be separated from the subgrade with a non-woven geotextile.

3.7.2 Backfill

Excavated earth fill and native soils on site will constitute adequate backfill material if the soil meets the backfill specifications:

- Any deleterious material in the earth fill is removed prior to reuse as backfill.
- The moisture content is within 2% of optimum, or moisture conditioned to within 2% of optimum.
- The backfill must be compacted to a minimum 98% SPMDD.



4 Pavement Design Advice

The following design pertains to asphaltic concrete pavements ('pavement') where the pavement will rest on a soil subgrade as described above.

The following Ontario Provincial Standards Specifications (OPSS.MUNI) apply to the pavement construction and material requirements:

- OPSS.MUNI 310 - Hot Mix Asphalt
- OPSS.MUNI 501 - Compacting
- OPSS.MUNI 1010 - Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
- OPSS.MUNI 1101 - Performance Graded Asphalt Cement
- OPSS.MUNI 1150 - Hot Mix Asphalt

The pavement construction and material should also follow the relevant city specifications, as applicable.

4.1 Pavement Subgrade Preparation

Topsoil and existing wet or organic rich earth fill soils are considered unsuitable for the pavement subgrade. These materials must be stripped down to acceptable subgrade prior to pavement construction.

Existing earth fill, if cleared of organic rich or wet soils, and native subgrade will provide adequate subgrade for the support of the pavement. The subgrade must be proof-rolled and inspected under the supervision of Grounded for obvious loose or disturbed soils or where there is deleterious materials or moisture. These areas can either be recompact in place and retested, or replaced with Granular B in lifts 150 mm thick or less, and compacted to a minimum of 98% SPMDD.

The subgrade for all pavement structures shall be frost tapered at a 3H to 1V slope to match with existing pavement structures, to reduce differential settlements due to frost heave.

4.2 Pavement Design

Minimum and performance asphaltic concrete pavement designs are outlined in the tables below.

The following **basic pavement design** will last for 8 to 10 years before significant maintenance is required, depending on the traffic volume.



Basic Pavement Structure	Compaction Requirement	Car Parking Minimum Component Thickness	Bus/Truck Traffic Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	65 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	N/A	50 mm
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	400 mm
Total Thickness		515 mm	640 mm

The following **performance pavement design** will last approximately twice as long before significant maintenance is required. The performance pavement design considers that the top layer of asphalt will be damaged over time, and therefore, will contribute less to the structural strength of the asphalt.

Performance Pavement Structure	Compaction Requirement	Car Parking Minimum Component Thickness	Bus/Truck Traffic Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	50 mm	80 mm
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	400 mm	500 mm
Total Thickness		640 mm	770 mm

The existing subgrade soils have a moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly. To reduce frost heave, soil subgrade that is susceptible to frost (as defined in the above Section 2) should be replaced to a depth of 60 to 70 percent of the frost penetration depth with non-frost susceptible soils or with granular materials. The most



effective ways of dealing with potential frost heave are to construct a good subsurface drainage system, and to stay above the groundwater table.

4.3 Pavement Drainage

Adequate drainage of the pavement subgrade is required. Prior to paving, the subgrade should be free of any depressions and sloped at a minimum grade of 2% to provide positive drainage. Perforated plastic subdrains (100 mm diameter) should be designed to collect subgrade water and positively outlet it at the catch basins. Typical pavement drainage details are appended.

Controlling surface water is important in keeping pavements in good maintenance. Grading adjacent pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb.

5 Considerations for Construction

5.1 Excavations

Excavations must be carried out in accordance with the *Occupational Health and Safety Act – Regulation 213/91 – Construction Projects (Part III - Excavations, Section 222 through 242)*. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes:

- The earth fill is a Type 3 soil
- The glacial till is a Type 2 soil
- The silts are Type 4 soils, or Type 3 soils if dewatered

In accordance with the regulation's requirements, the soil must be suitably sloped and/or braced where workers must enter a trench or excavation deeper than 1.2 m. Safe excavation slopes (of no more than 3 m in height) by soil type are stipulated as follows, per Section 234:

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 239 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes. Any excavation slopes greater than 3 m in height should be checked by Grounded for global stability issues.



Larger obstructions (e.g. buried concrete debris, other obstructions) not directly observed in the boreholes are likely present in the earth fill. Similarly, larger inclusions (e.g. cobbles and boulders) may be encountered in the native soils. The size and distribution of these obstructions cannot be predicted with boreholes, as the split spoon sampler is not large enough to capture particles of this size. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

Excess soil is now governed by Ontario Regulation 406/19: On-Site and Excess Soil Management. As of January 1, 2023, the Project Leader (typically the owner) may be required to file a notice in the excess soil registry and a Qualified Person (within the meaning of O.Reg. 153/04) may be required to prepare the associated planning documents and/or develop and implement a tracking system in accordance with the Soil Rules, to track each load of excess soil during its transportation and deposit before removing excess soil from the project area.

5.2 Short-Term Groundwater Control

Considerations pertaining to groundwater discharge quantities and quality are discussed in Grounded's hydrogeological report for the site, under separate cover.

For practical purposes, the groundwater table at this site may be assumed to be at Elev. 252.1± m, which corresponds to about 0.9 m below grade in the area of the proposed building pad. Excavations will generally be made below the groundwater table, in relatively low permeability native soils that preclude the free flow of water into excavations. Within the zone of excavation, the boreholes are generally dry and open.

Cohesionless wet zones were encountered in several of the boreholes. If these cohesionless zones are penetrated, some seepage from these wet zones should be anticipated. However, these zones are likely of limited extent and are not horizontally continuous layers.

On this basis, seepage into excavations may be allowed to drain into the excavation and then controlled by a conventional sump pump arrangement. Nevertheless, delays in excavation will occur as the seepage is controlled and these delays should be anticipated in the construction schedule.

The Region of Peel will require a Discharge Agreement in the short term, if any water is to be discharged to the storm or sanitary sewers during construction.

5.3 Site Work

To better protect wet undisturbed subgrade, excavations exposing wet soils must be cut neat, inspected, and then immediately protected with a skim coat of concrete (i.e. a mud mat). Wet sands are susceptible to degradation and disturbance due to even mild site work, frost, weather, or a combination thereof.



The effects of work on site can greatly impact soil integrity. Care must be taken to prevent this damage. Site work carried out during periods of inclement weather may result in the subgrade becoming disturbed, unless a granular working mat is placed to preserve the subgrade soils in their undisturbed condition. Subgrade preparation activities should not be conducted in wet weather and the project must be scheduled accordingly.

If site work causes disturbance to the subgrade, removal of the disturbed soils and the use of granular fill material for site restoration or underfloor fill will be required at additional cost to the project.

It is construction activity itself that often imparts the most severe loading conditions on the subgrade. Special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during placement of the granular base and other work may be required, especially if construction is carried out during unfavourable weather.

Adequate temporary frost protection for the founding subgrade must be provided if construction proceeds in freezing weather conditions. The subgrade at this site is susceptible to frost damage. The slab on grade should not be placed on frozen subgrade, to prevent settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation. Depending on the project context, consideration should be given to frost effects (heaving, softening, etc.) on exposed subgrade surfaces.

5.4 Engineering Review

By issuing this report, Grounded Engineering has assumed the role of Geotechnical Engineer of Record for this site. Grounded should be retained to review the structural engineering drawings prior to issue or construction to ensure that the recommendations in this report have been appropriately implemented.

All foundation installations must be reviewed in the field by Grounded, the Geotechnical Engineer of Record, as they are constructed. The on-site review of foundation installations and the condition of the founding subgrade as the foundations are constructed is as much a part of the geotechnical engineering design function as the design itself; it is also required by Section 4.2.2.2 of the Ontario Building Code. If Grounded is not retained to carry out foundation engineering field review during construction, then Grounded accepts no responsibility for the performance or non-performance of the foundations, even if they are constructed in general conformance with the engineering design advice contained in this report.

The long-term performance of a slab on grade is highly dependent upon the subgrade support and drainage conditions. Strict procedures must be maintained during construction to maintain the integrity of the subgrade to the extent possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by Grounded at



the time of construction to confirm material quality, thickness, and to ensure adequate compaction.

A visual pre-construction survey of adjacent lands and buildings is recommended to be completed prior to the start of any construction. This documents the baseline condition and can prevent unwarranted damage claims. Any shoring system, regardless of the execution and design, has the potential for movement. Small changes in stress or soil volume can cause cracking in adjacent buildings.

Fill placement is typically measured relative to Standard Proctor Maximum Dry Density (SPMDD).

6 Limitations and Restrictions

Grounded should be retained to review the structural and geotechnical engineering drawings prior to issue or construction to ensure that the recommendations in this report have been appropriately implemented.

This report provides specifications which are to be used as technical specifications only. These technical specifications do not cover contract issues (quantities, insurance, other tender specifications, etc.) and as such must not be regarded as final tender specifications. The technical specifications provided in this report may form part of a complete set of tender documents prepared by others.

6.1 Investigation Procedures

The geotechnical engineering analysis and advice provided are based on the factual borehole information observed and recorded by Grounded. The investigation methodology and engineering analysis methods used to carry out this scope of work are consistent with conventional standard practice by Grounded as well as other geotechnical consultants, working under similar conditions and constraints (time, financial and physical).

Borehole drilling services were provided to Grounded by a specialist professional contractor. The drilling was observed and recorded by Grounded's field supervisor on a full-time basis. Drilling was conducted using conventional drilling rigs equipped with solid stem augers. As drilling proceeded, groundwater observations were made in the boreholes. Based on examination of recovered borehole samples, our field supervisor made a record of borehole and drilling observations. The field samples were secured in air-tight clean jars and bags and taken to the Grounded soil laboratory where they were each logged and reviewed by the geotechnical engineering team and the senior reviewer.

The Split-Barrel Method technique (ASTM D1586) was used to obtain the soils samples. The sampling was conducted at conventional intervals and not continuously. As such, stratigraphic interpolation between samples is required and stratigraphic boundary lines do not represent



exact depths of geological change. They should be taken as gradual transition zones between soil or rock types.

A carefully conducted, fully comprehensive investigation and sampling scope of work carried out under the most stringent level of oversight may still fail to detect certain ground conditions. As such, users of this report must be aware of the risks inherent in using engineered field investigations to observe and record subsurface conditions. As a necessary requirement of working with discrete test locations, Grounded has assumed that the conditions between test locations are the same as the test locations themselves, for the purposes of providing geotechnical engineering advice.

It is not possible to design a field investigation with enough test locations that would provide complete subsurface information, nor is it possible to provide geotechnical engineering advice that completely identifies or quantifies every element that could affect construction, scheduling, or tendering. Contractors undertaking work based on this report (in whole or in part) must make their own determination of how they may be affected by the subsurface conditions, based on their own analysis of the factual information provided and based on their own means and methods. Contractors using this report must be aware of the risks implicit in using factual information at discrete test locations to infer subsurface conditions across the site and are directed to conduct their own investigations as needed.

6.2 Site and Scope Changes

Natural occurrences, the passage of time, local construction, and other human activity all have the potential to directly or indirectly alter the subsurface conditions at or near the project site. Contractual obligations related to groundwater or stormwater control, disturbed soils, frost protection, etc. must be considered with attention and care as they relate to potential site alteration.

The geotechnical engineering advice provided in this report is based on the factual observations made from the site investigations as reported. It is intended for use by the owner and their retained design team. If there are changes to the features of the development or to the scope, the interpreted subsurface information, geotechnical engineering design parameters, advice, and discussion on construction considerations may not be relevant or complete for the project. Grounded should be retained to review the implications of such changes with respect to the contents of this report.

6.3 Report Use

The authorized users of this report are Region of Peel c/o Diamond Schmitt and their design team, for whom this report has been prepared. Grounded Engineering Inc. maintains the copyright and ownership of this document. Reproduction of this report in any format or medium requires explicit prior authorization from Grounded Engineering Inc.



The local municipal governing bodies may also make use of and rely upon this report, subject to the limitations as stated.

7 Closure

If the design team has any questions regarding the discussion and advice provided, please do not hesitate to have them contact our office. We trust that this report meets your requirements at present.

For and on behalf of our team,



Deepak Kanraj, M.A.Sc., EIT
Project Manager

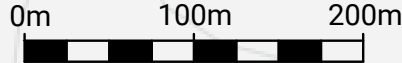
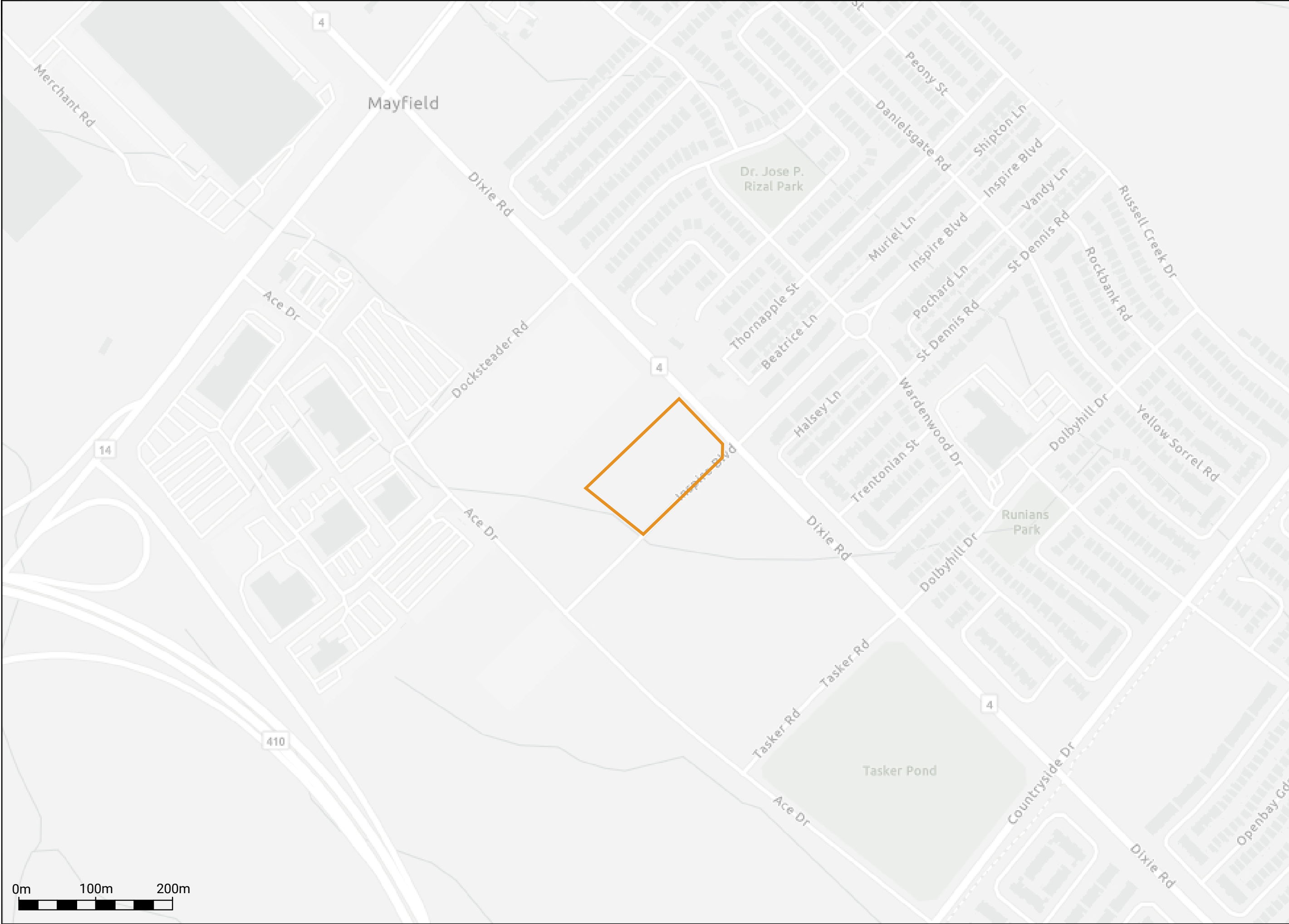
Kyle Byckalo, P.Eng.
Senior Geotechnical Engineer



Jason Crowder, Ph.D., P.Eng.
Principal

FIGURES





1 BANIGAN DRIVE, TORONTO, ONT., M4H 1G3
www.groundedeng.ca

LEGEND

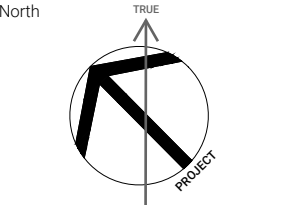
APPROXIMATE PROPERTY BOUNDARY

Note

Reference
ArcGIS My Map.

Project
**PRPS REPORTING
STATION
BRAMPTON, ONTARIO**

Figure Title
SITE LOCATION PLAN



Date
OCTOBER 2023

Scale
AS INDICATED

Job No
23-099

Figure No
FIGURE 1



GROUND
ENGINEERING

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- MONITORING WELL/BOREHOLE BY GROUND
- MONITORING WELL/BOREHOLE BY OTHERS

Note

Reference

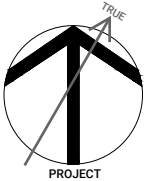
Project

**PRPS REPORTING
STATION
BRAMPTON, ONTARIO**

Figure Title

**BOREHOLE LOCATION PLAN -
EXISTING CONDITION**

North



Date

OCTOBER 2023

Scale

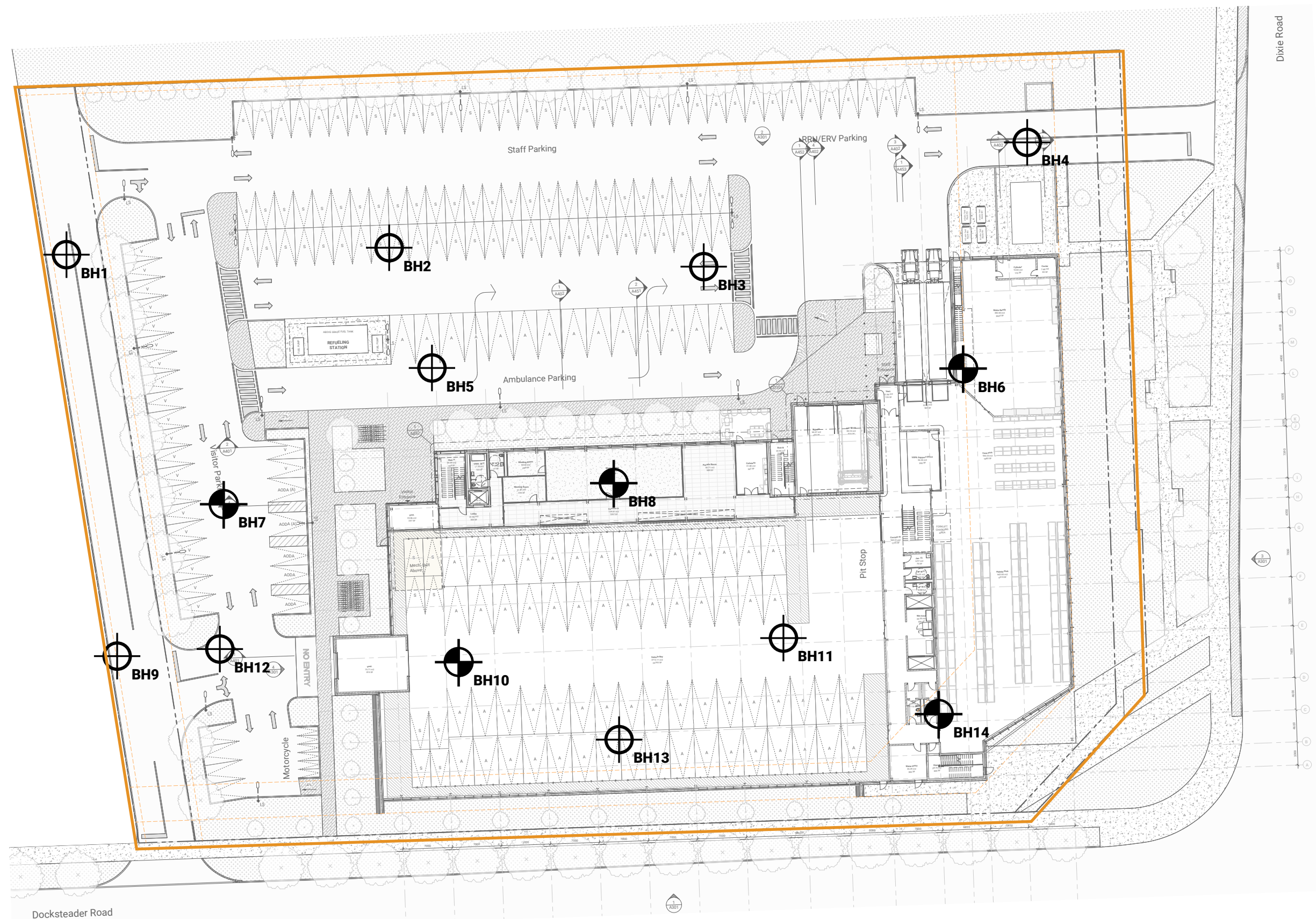
AS INDICATED

Job No

23-099

Figure No

FIGURE 2



LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- MONITORING WELL/BOREHOLE BY GROUND
- MONITORING WELL/BOREHOLE BY OTHERS

Note

Reference

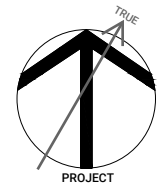
Project

**PRPS REPORTING
STATION
BRAMPTON, ONTARIO**

Figure Title

**BOREHOLE LOCATION PLAN -
PROPOSED SITE CONDITIONS**

North



Date

NOVEMBER 2023

Scale

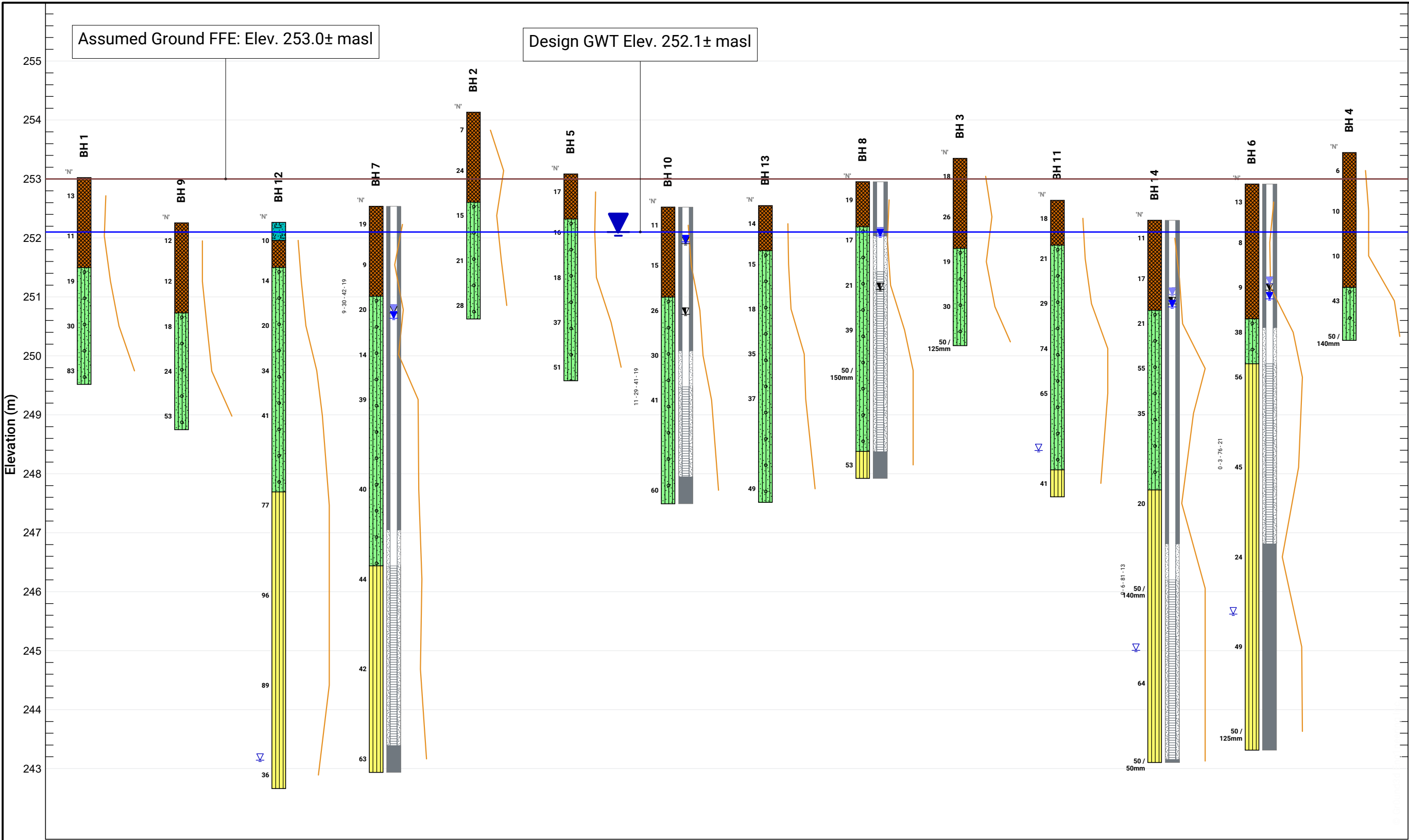
AS INDICATED

Job No

23-099

Figure No

FIGURE 3



LEGEND

- FILL
- GRAVELS (gravel to gravelly sand)
- SILT TO SAND (not till)
- COHESIONLESS TILLS
- COHESIVE SOILS (clayey silt to clay, incl. tills)
- DISTURBED/REWORKED/ORGANIC

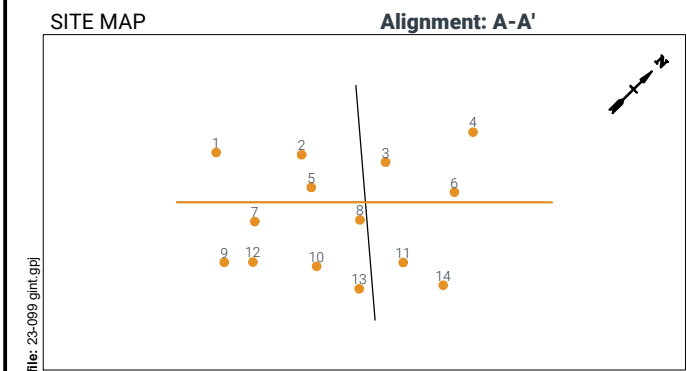
BH 101 BOREHOLES BY GROUNDED
T-BH7 BOREHOLES BY OTHERS

- water level, unstabalized
- water level, stabilized (latest)
- water level, stabilized (highest)

Project
**PRPS REPORTING STATION
BRAMPTON, ON**

Figure Title
SUBSURFACE PROFILE
A-A'

Date	OCTOBER 2023
Scale	AS INDICATED
Job No	23-099
Figure No	FIGURE 4



Boreholes Equally Spaced

BOREHOLE STRATIGRAPHY LEGEND

- Fill
- Sandy Silt Till
- Silt
- Topsoil





APPENDIX A



SAMPLING/TESTING METHODS

SS: split spoon sample
 AS: auger sample
 GS: grab sample
 FV: shear vane
 DP: direct push
 PMT: pressuremeter test
 ST: shelby tube
 CORE: soil coring
 RUN: rock coring

SYMBOLS & ABBREVIATIONS

MC: moisture content
 LL: liquid limit
 PL: plastic limit
 NP: non-plastic
 γ : soil unit weight (bulk)
 G_s : specific gravity
 S_u : undrained shear strength
 unstabalized water level
 1st water level measurement
 2nd water level measurement most recent
 water level measurement

ENVIRONMENTAL SAMPLES

M&I: metals and inorganic parameters
 PAH: polycyclic aromatic hydrocarbon
 PCB: polychlorinated biphenyl
 VOC: volatile organic compound
 PHC: petroleum hydrocarbon
 BTEX: benzene, toluene, ethylbenzene and xylene
 PPM: parts per million

FIELD MOISTURE (based on tactile inspection)

DRY: no observable pore water
MOIST: inferred pore water, not observable (i.e. grey, cool, etc.)
WET: visible pore water

COMPOSITION

Term	% by weight
trace silt	<10
some silt	10 - 20
silty	20 - 35
sand and silt	>35

COHESIONLESS

Relative Density	N-Value
Very Loose	<4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	>50

COHESIVE

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

ASTM STANDARDS**ASTM D1586 Standard Penetration Test (SPT)**

Driving a 51 mm O.D. split-barrel sampler ("split spoon") into soil with a 63.5 kg weight free falling 760 mm. The blows required to drive the split spoon 300 mm ("bpf") after an initial penetration of 150 mm is referred to as the N-Value.

ASTM D3441 Cone Penetration Test (CPT)

Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm² into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

ASTM D2573 Field Vane Test (FVT)

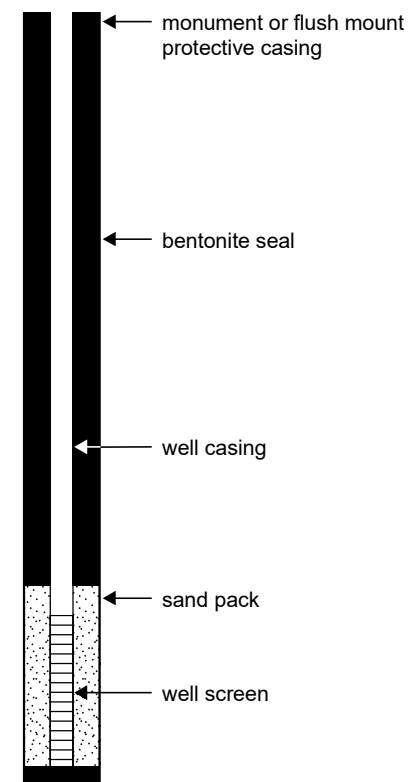
Pushing a four blade vane into soil and rotating it from the surface to determine the torque required to shear a cylindrical surface with the vane. The torque is converted to the shear strength of the soil using a limit equilibrium analysis.

ASTM D1587 Shelby Tubes (ST)

Pushing a thin-walled metal tube into the in-situ soil at the bottom of a borehole, removing the tube and sealing the ends to prevent soil movement or changes in moisture content for the purposes of extracting a relatively undisturbed sample.

ASTM D4719 Pressuremeter Test (PMT)

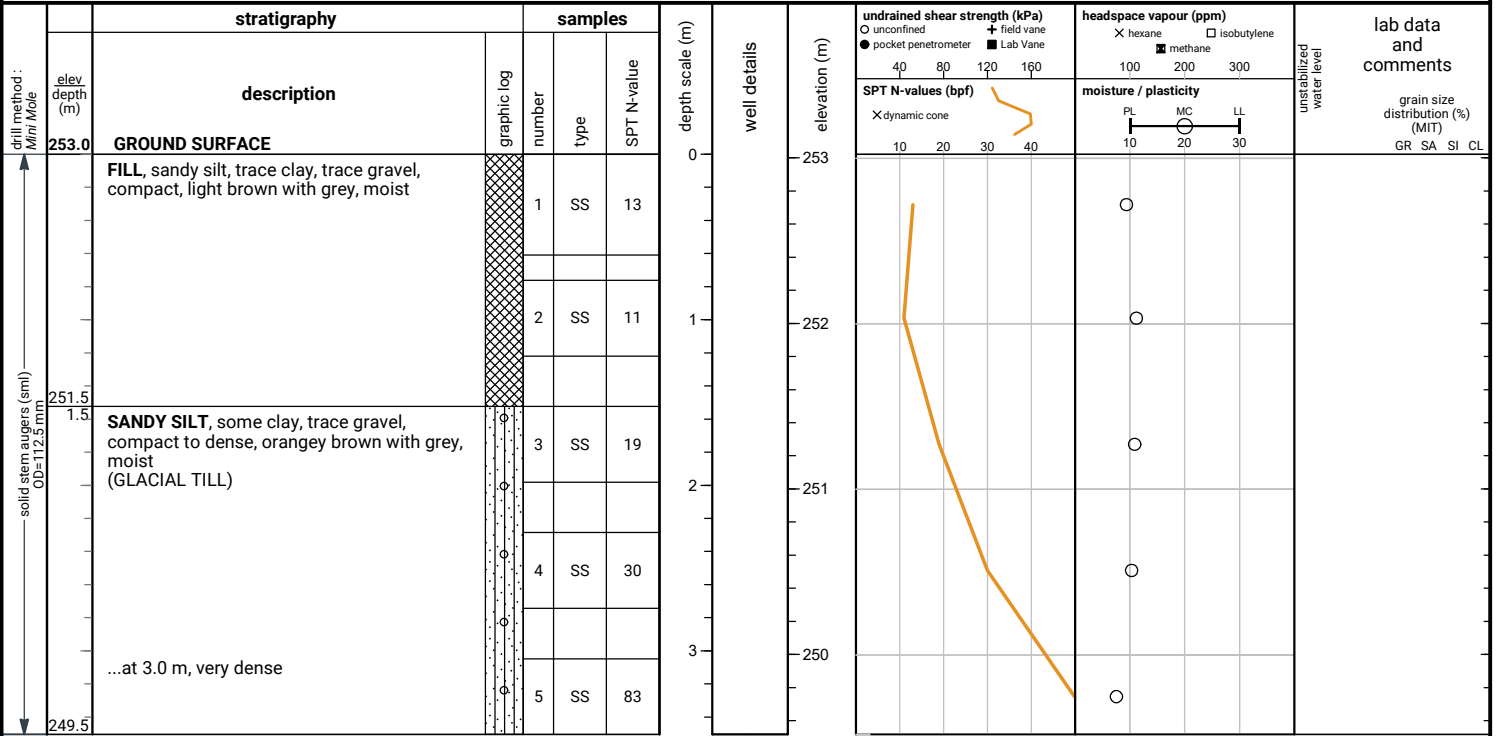
Place an inflatable cylindrical probe into a pre-drilled hole and expanding it while measuring the change in volume and pressure in the probe. It is inflated under either equal pressure increments or equal volume increments. This provides the stress-strain response of the soil.

WELL LEGEND

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



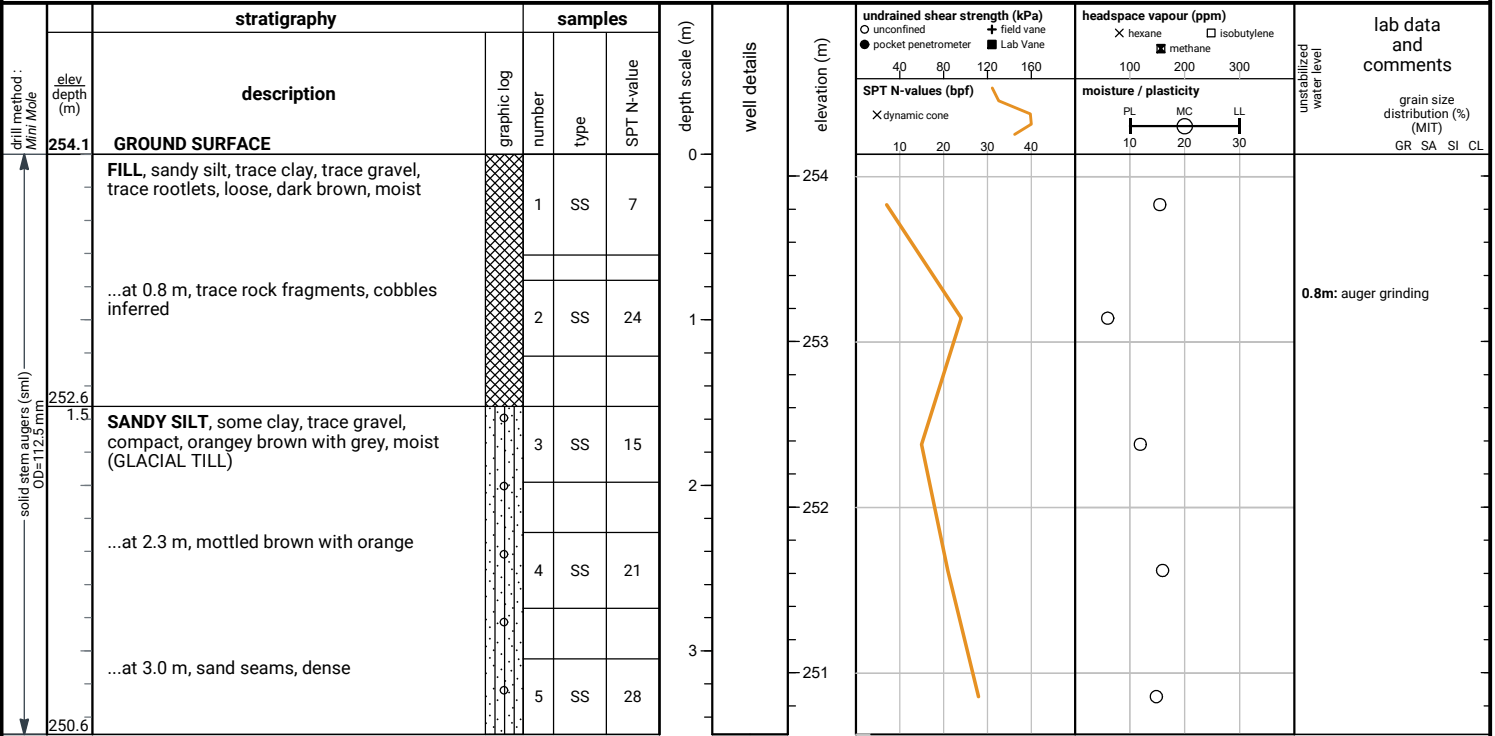
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



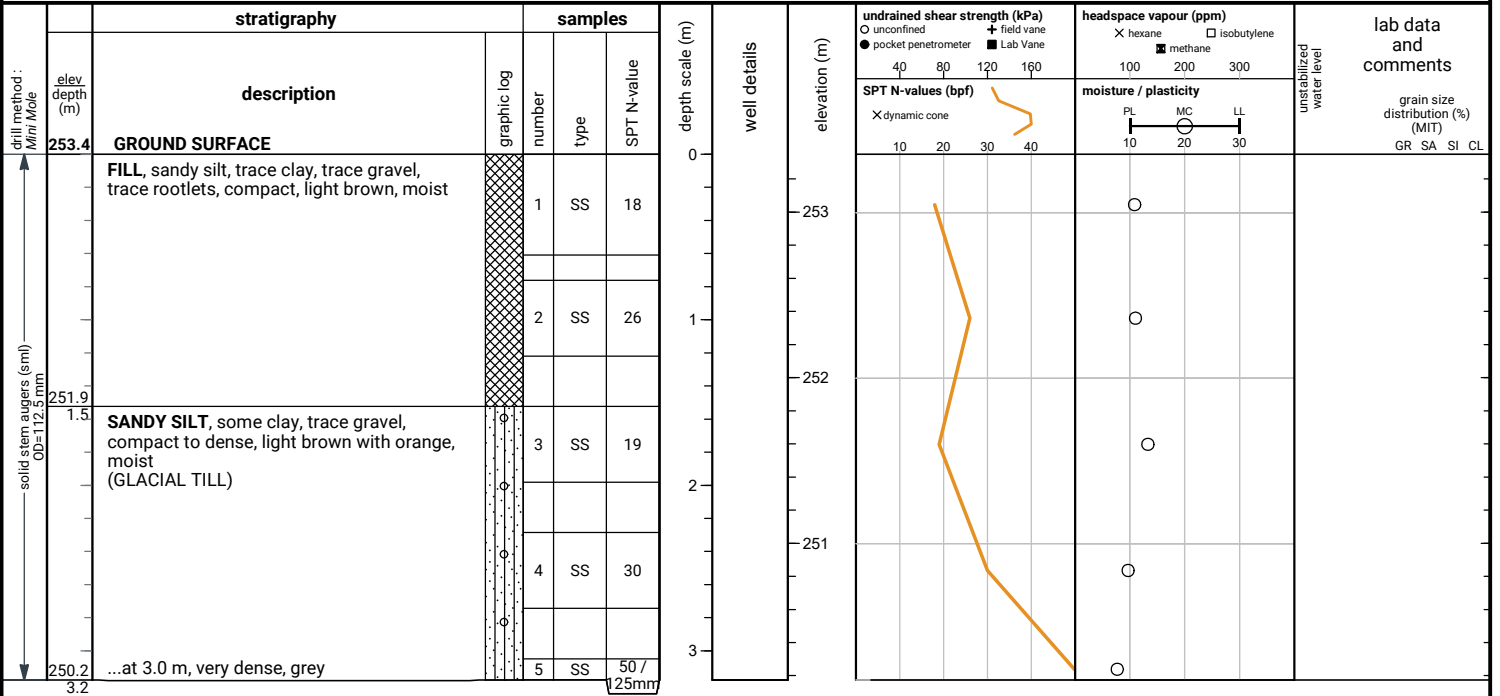
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



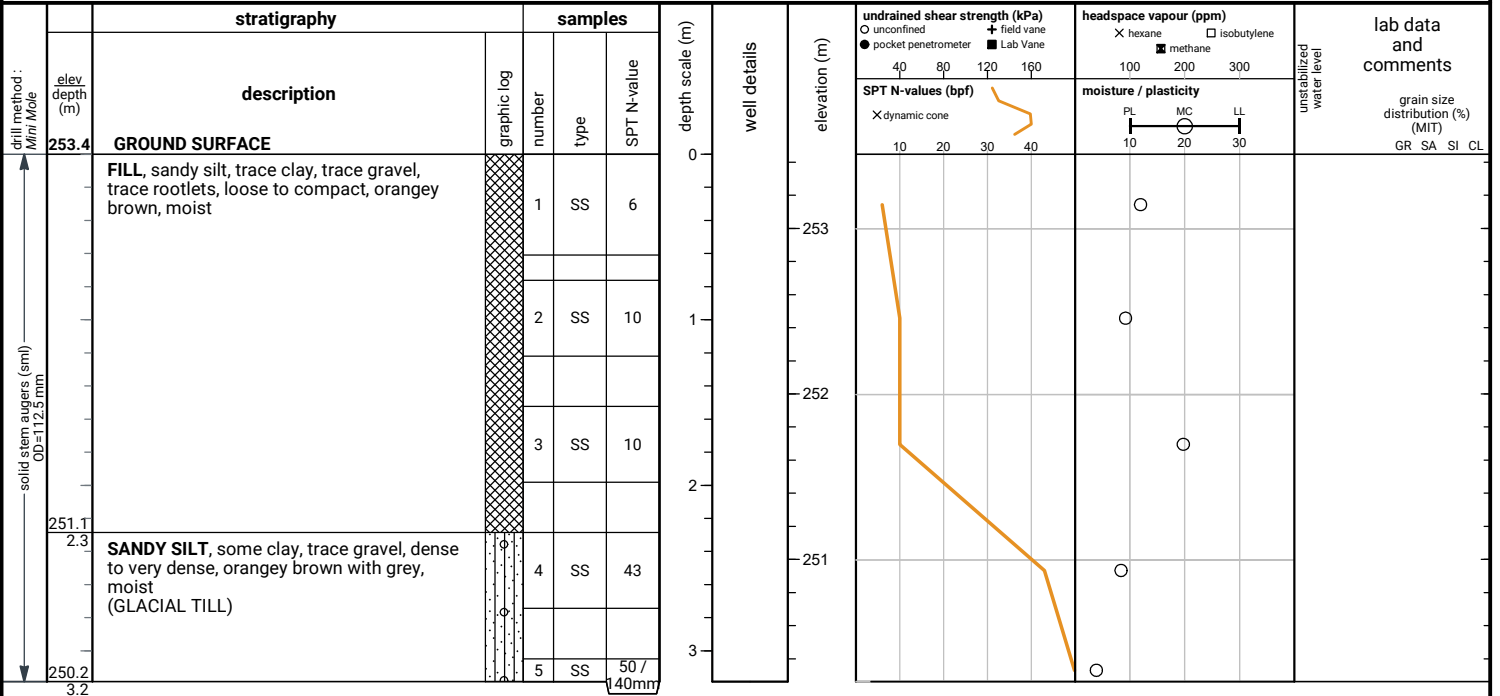
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



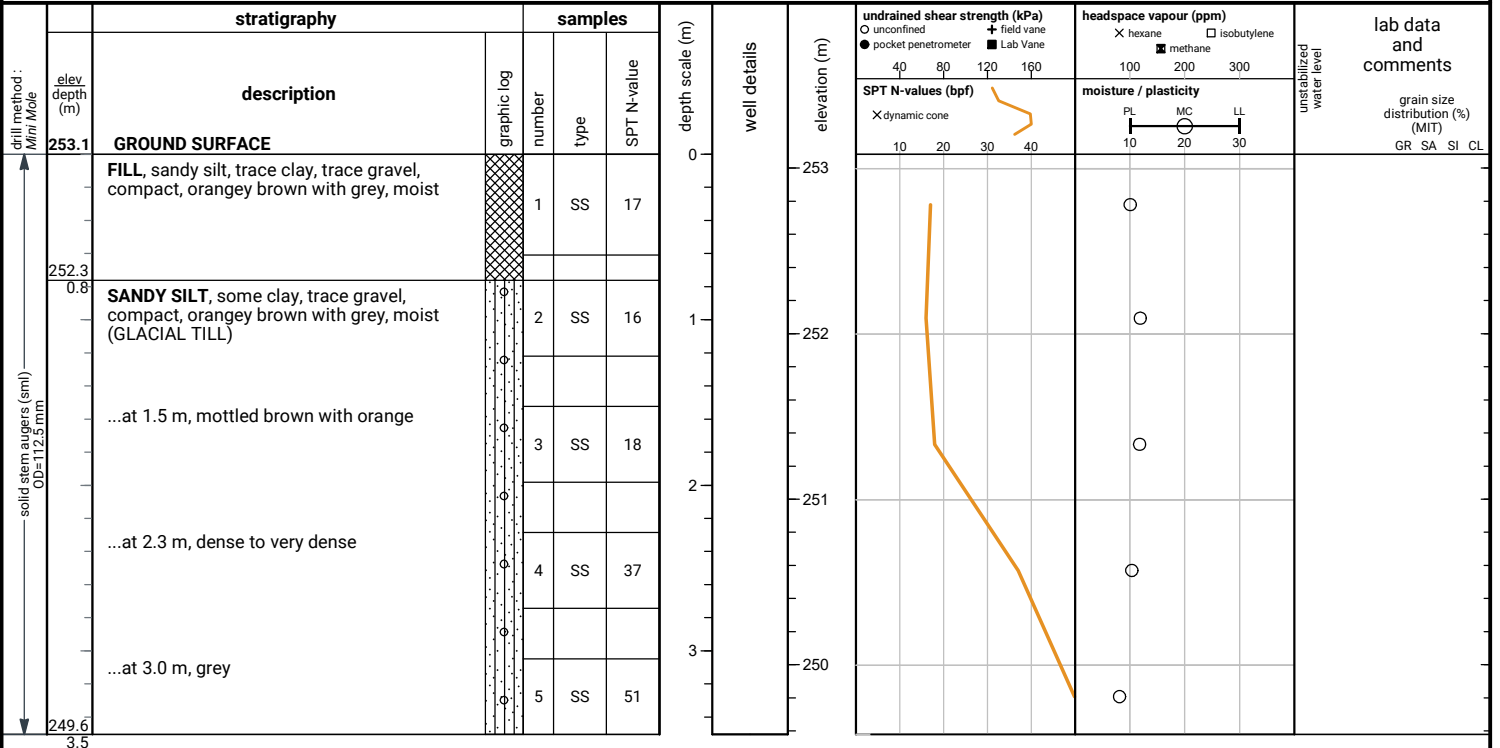
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



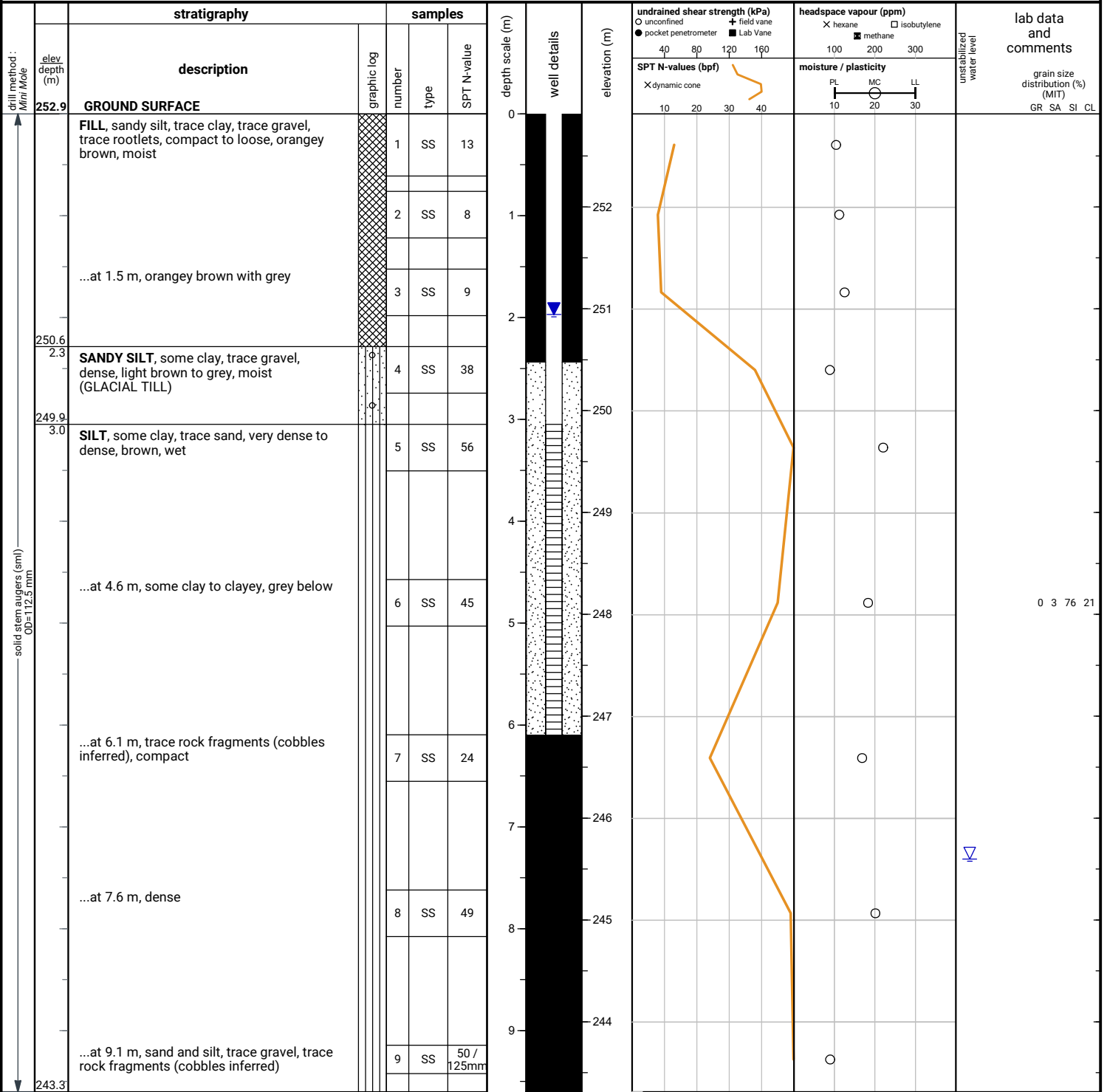
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



END OF BOREHOLE

Unstabilized water level measured at 7.3 m below ground surface; open upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

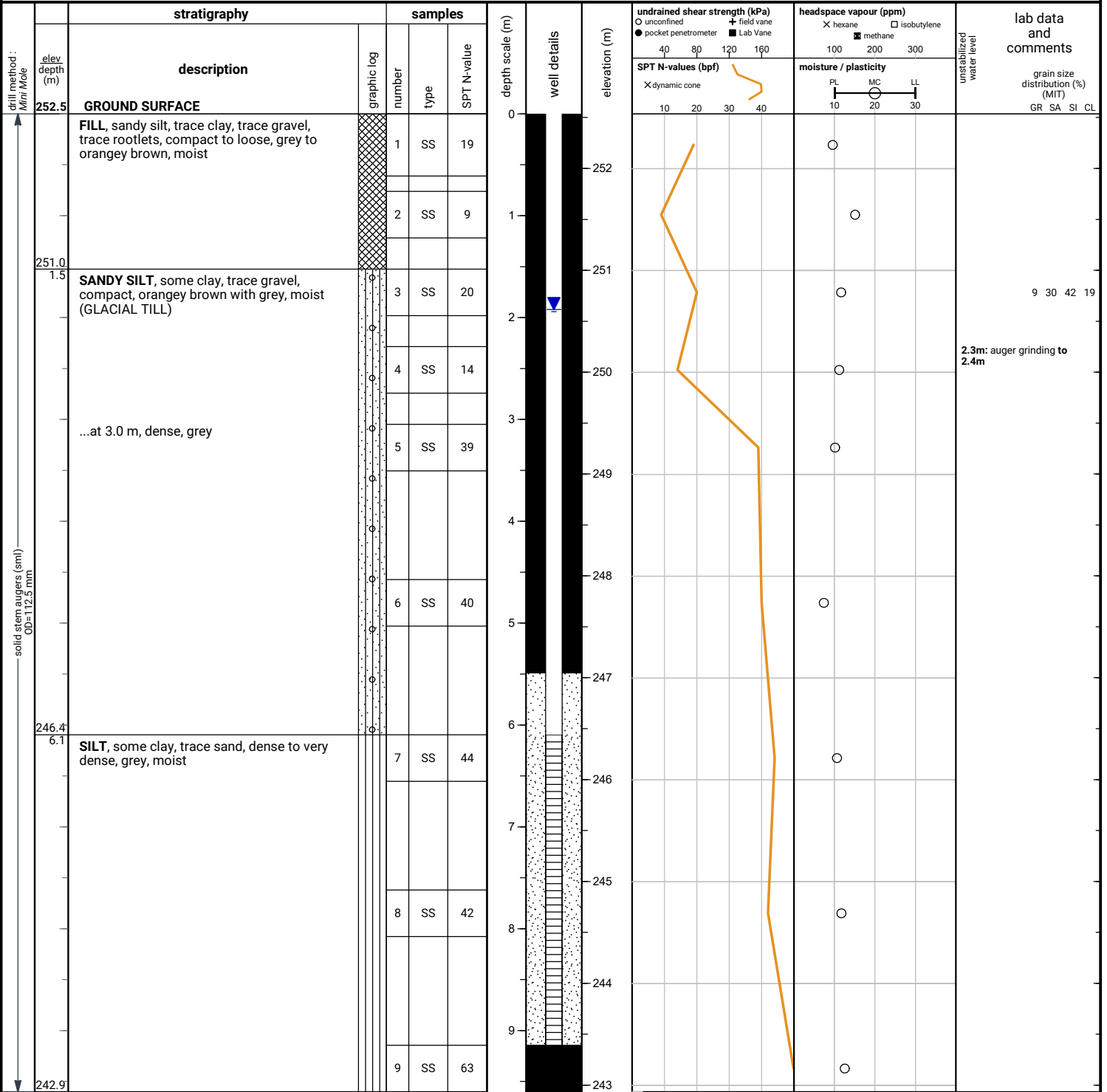
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 29, 2023	1.8	251.1
Jul 21, 2023	1.7	251.2
Aug 11, 2023	1.9	251.0
Sep 1, 2023	2.0	250.9

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



END OF BOREHOLE

Dry and open upon completion of drilling.
50 mm dia. monitoring well installed.
No. 10 screen

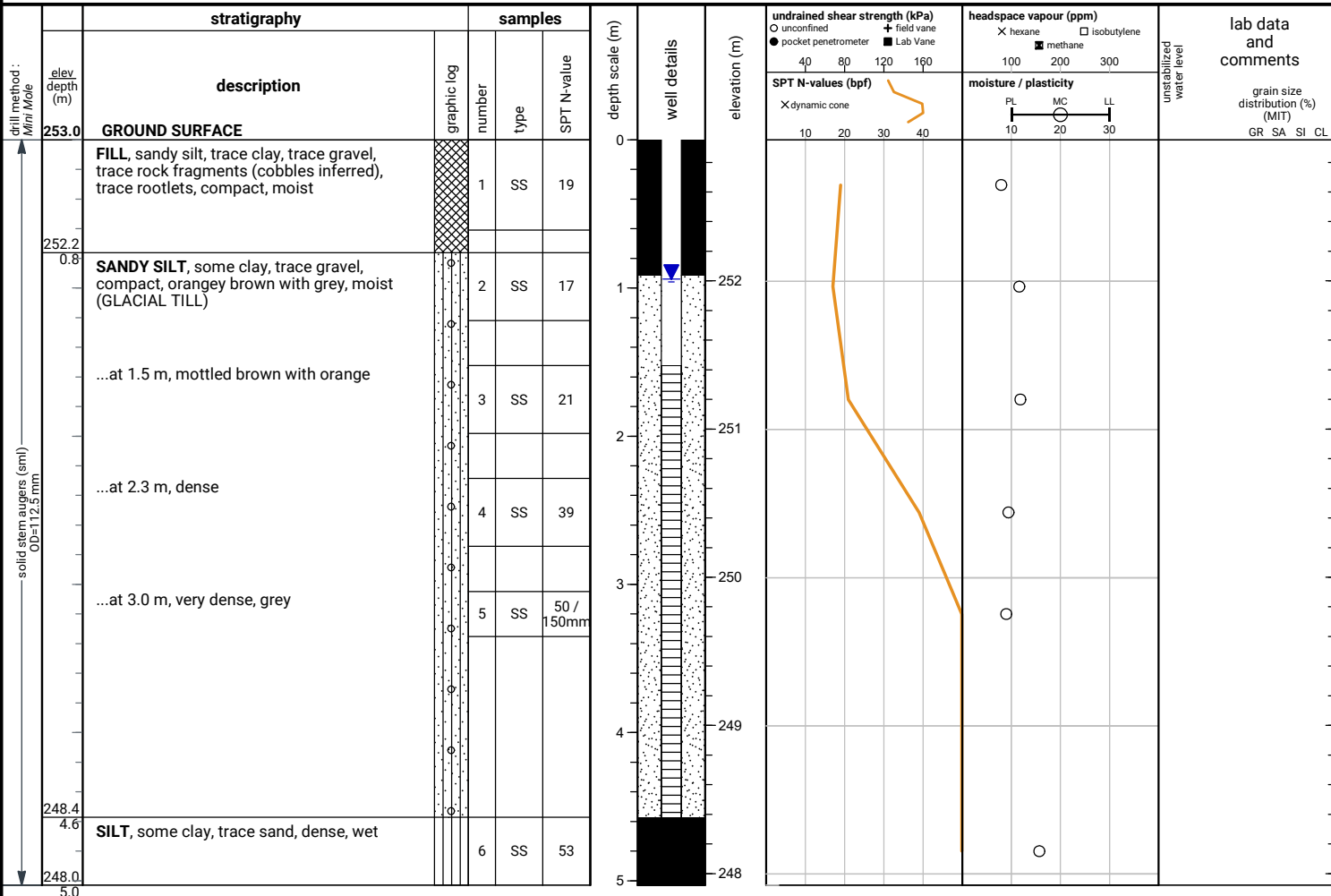
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 29, 2023	1.8	250.7
Jul 21, 2023	1.8	250.7
Aug 11, 2023	2.0	250.5
Sep 1, 2023	1.9	250.6

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



END OF BOREHOLE

Dry and open upon completion of drilling.
50 mm dia. monitoring well installed.
No. 10 screen

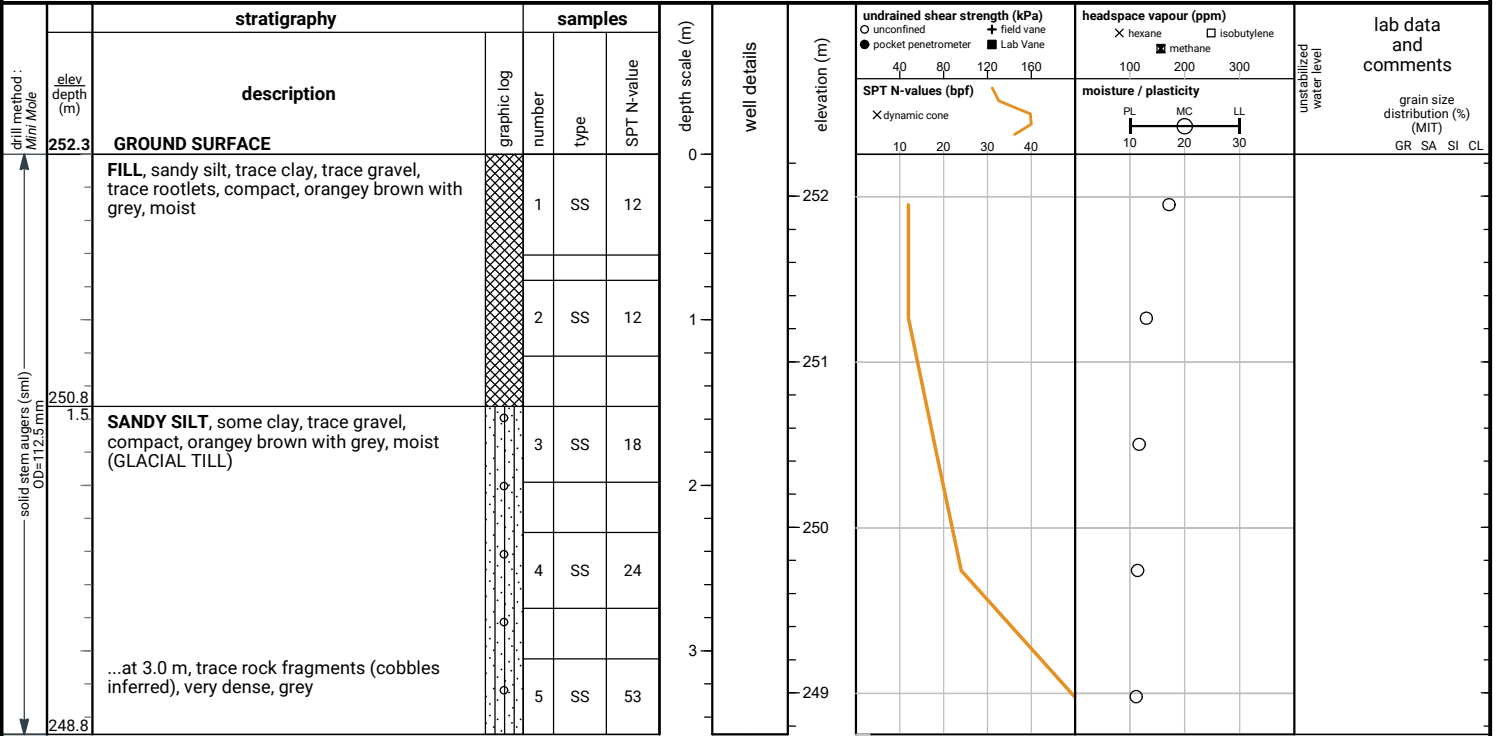
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 29, 2023	1.9	251.1
Jul 21, 2023	0.9	252.1
Aug 11, 2023	1.6	251.4
Sep 1, 2023	0.9	252.1

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



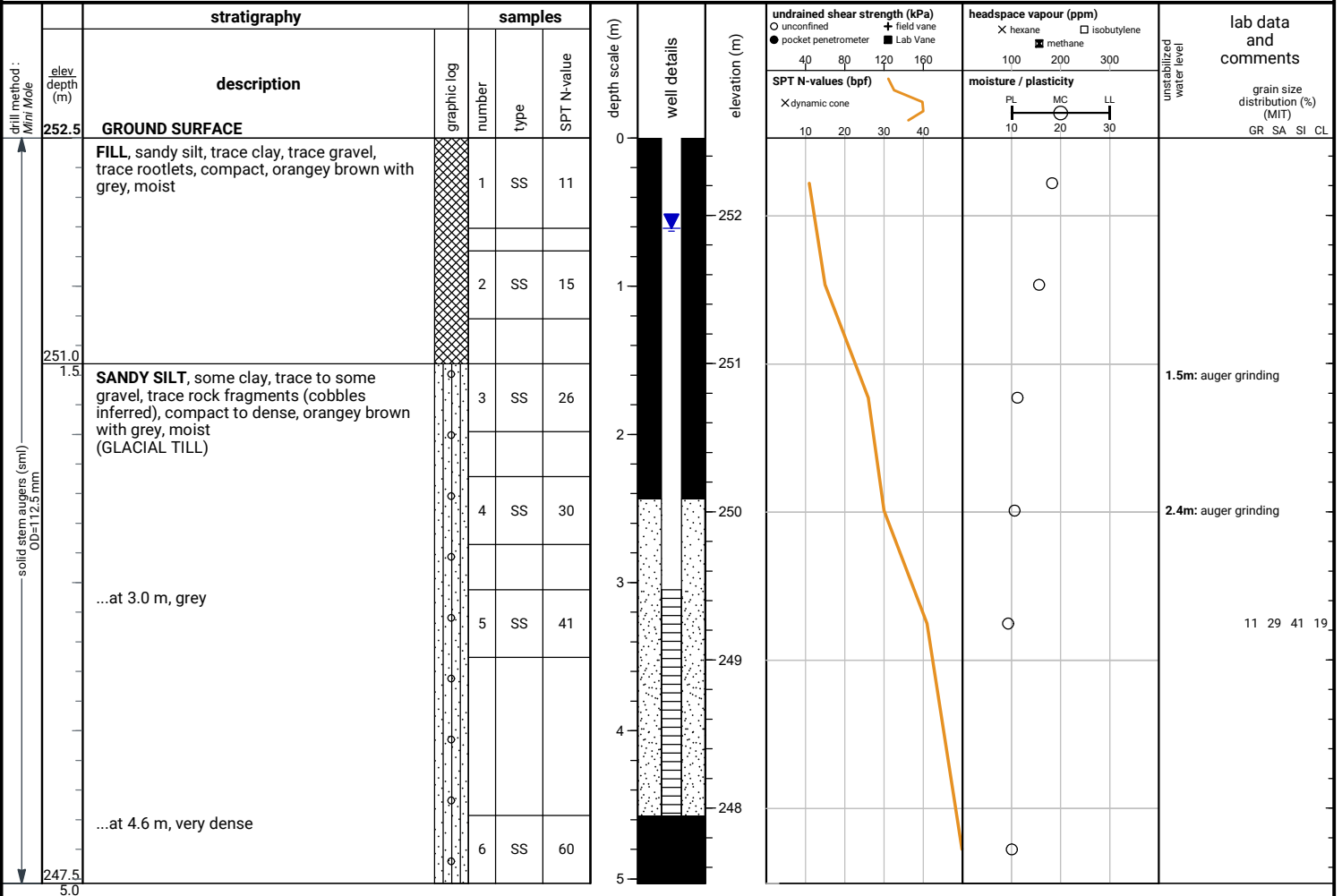
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt

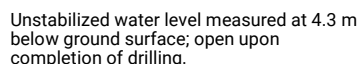


Dry and open upon completion of drilling.
50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 29, 2023	1.8	250.7
Jul 21, 2023	0.6	251.9
Aug 11, 2023	1.0	251.5
Sep 1, 2023	0.6	251.9

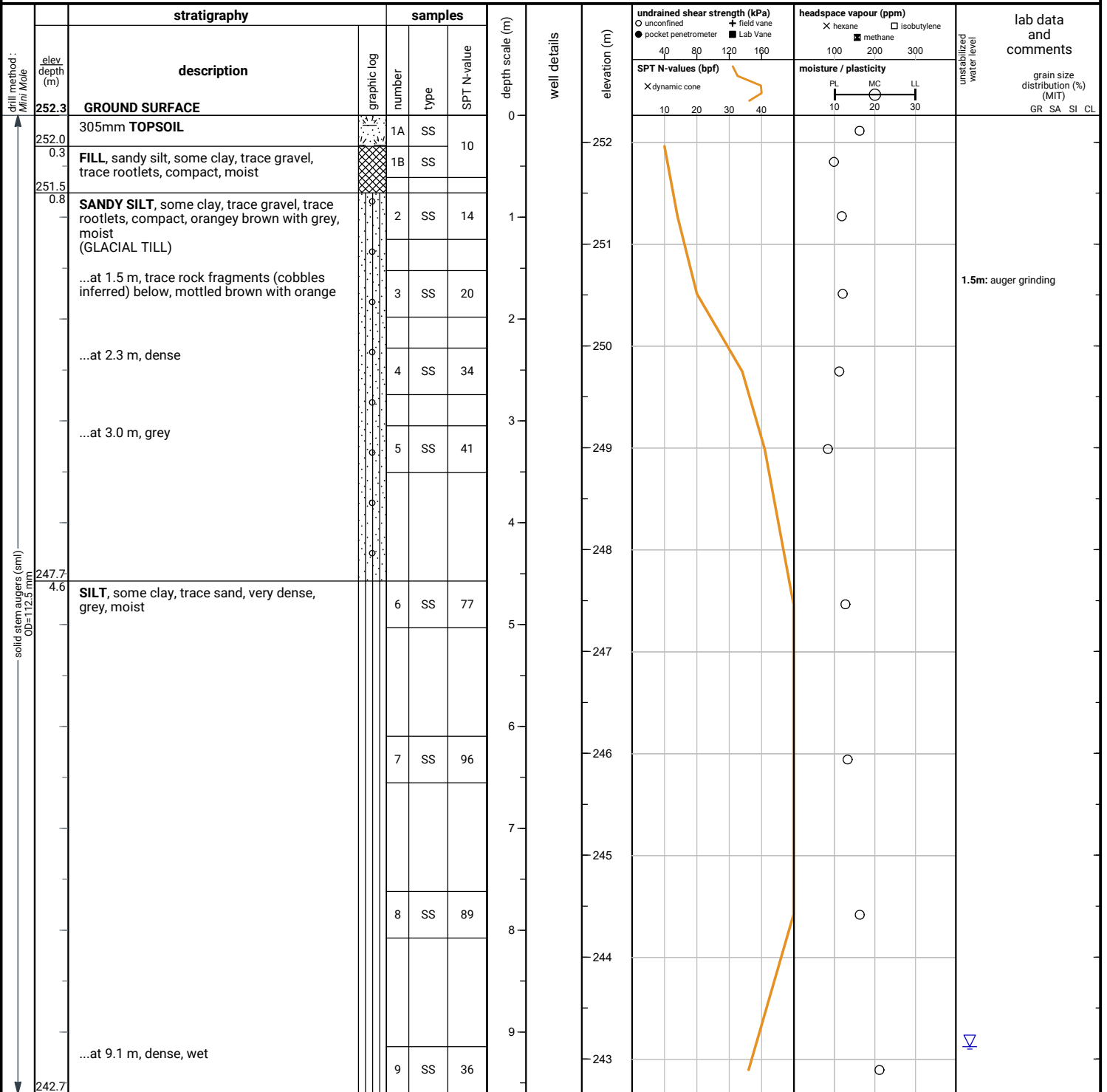
Client : Region of Peel c/o Diamond Schmitt



File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



END OF BOREHOLE

Unstabilized water level measured at 9.1 m below ground surface; open upon completion of drilling.

File No. : 23-099

Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt

stratigraphy		samples			depth scale (m)	well details	elevation (m)	undrained shear strength (kPa)	headspace vapour (ppm)	lab data and comments
description	graphic log	number	type	SPT N-value				O unconfined ● pocket penetrometer X dynamic cone	X hexane □ isobutylene ■ methane PL MC LL	
252.5 GROUND SURFACE					0					
FILL , sandy silt, trace clay, trace gravel, compact, orangey brown with grey, moist		1	SS	14						
251.7					1					
SANDY SILT , some clay, trace gravel, compact, orangey brown with grey, moist (GLACIAL TILL)		2	SS	15						
...at 1.5 m, mottled brown with orange		3	SS	18						
...at 2.3 m, trace rock fragments (cobbles inferred), dense, light grey		4	SS	35						2.3m: auger grinding
...at 3.0 m, grey below		5	SS	37						
		6	SS	49						4.3m: auger grinding
247.5					5					

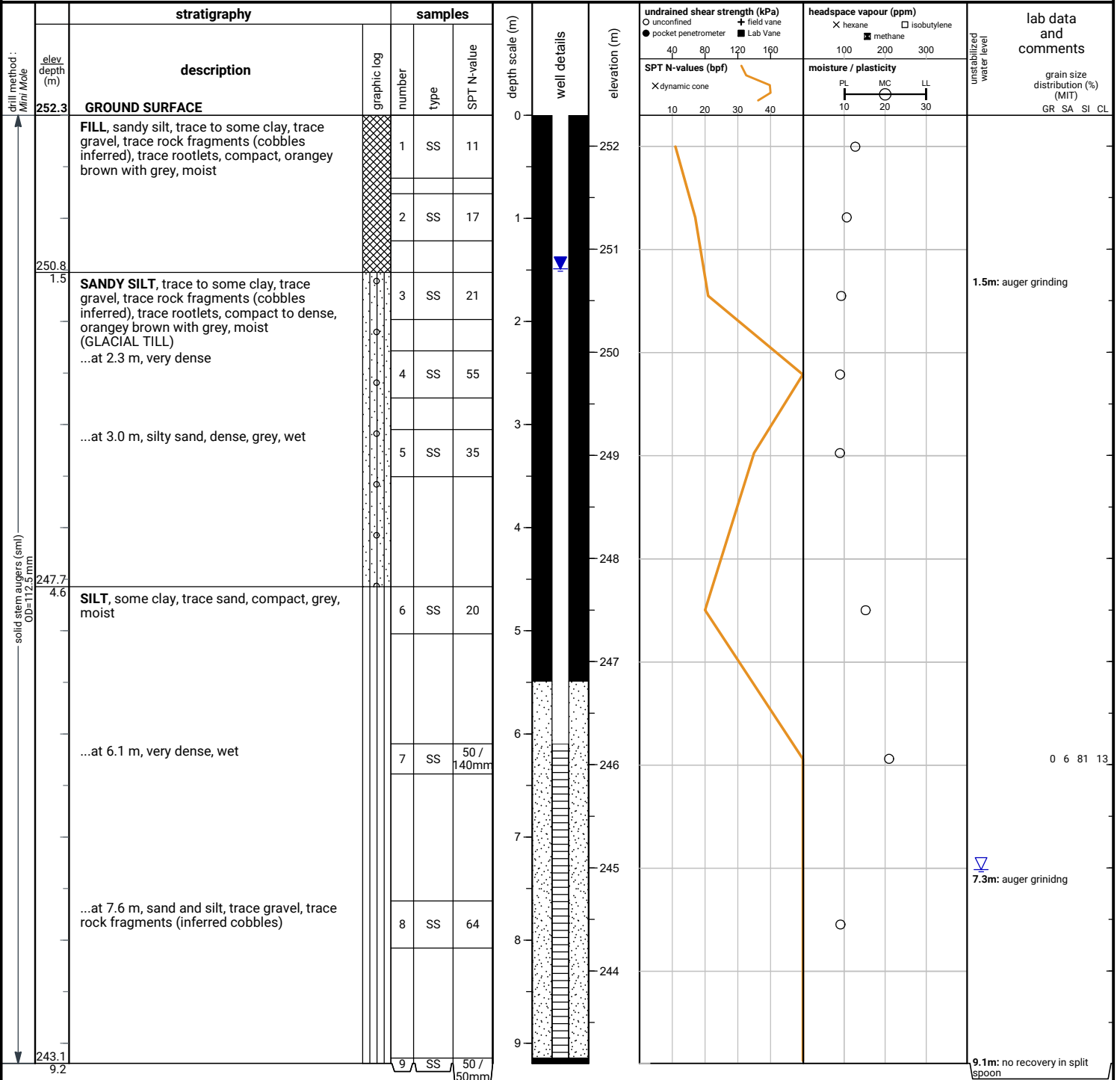
END OF BOREHOLE

Dry and open upon completion of drilling.

File No. : 23-099

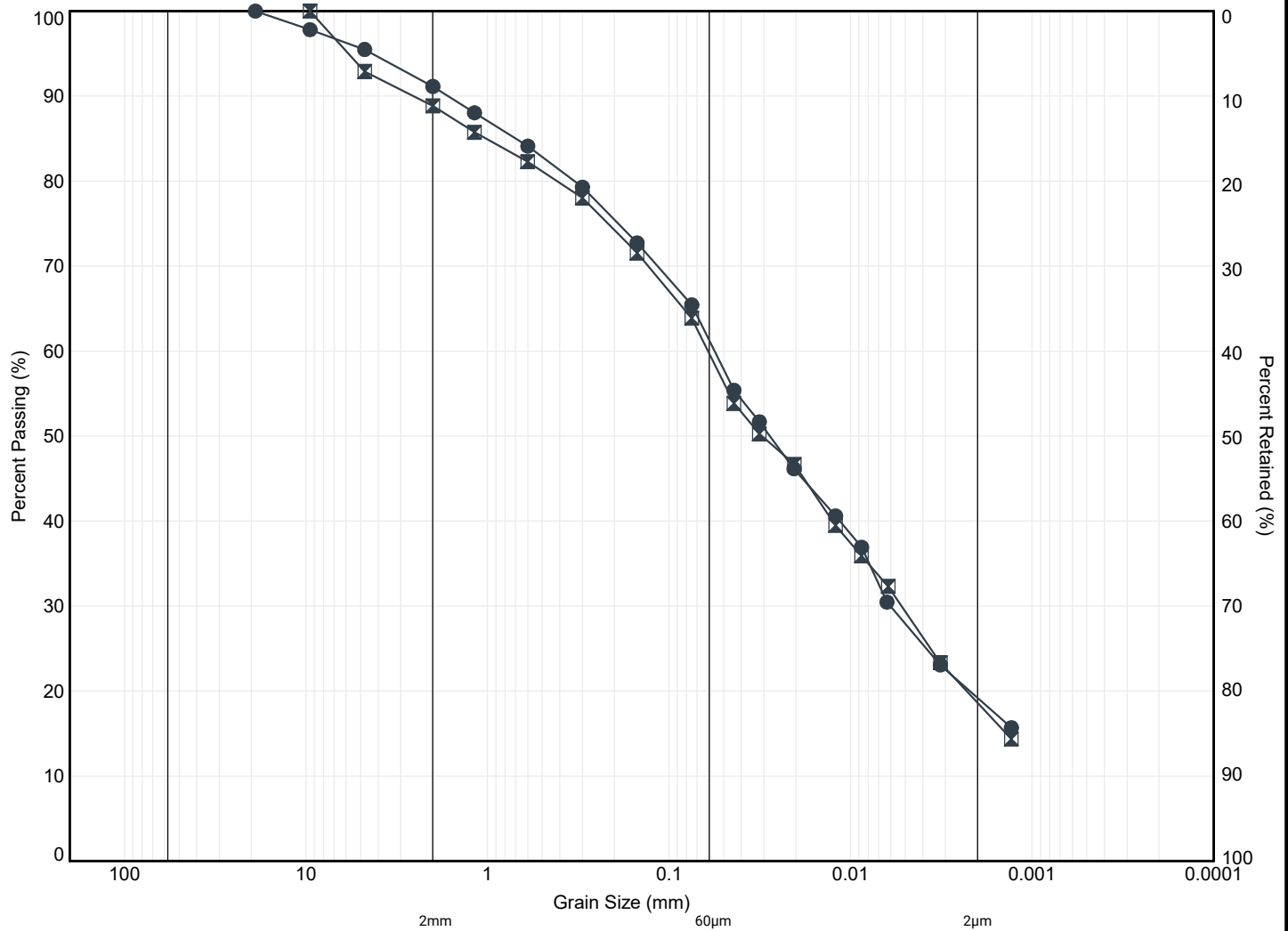
Project : PRPS Reporting Station, Brampton, ON

Client : Region of Peel c/o Diamond Schmitt



APPENDIX B





MIT SYSTEM

Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● BH 7	SS3	1.8	250.8	9	30	42	19
⊠ BH 10	SS5	3.3	249.2	11	29	41	19

GROUND
ENGINEERING

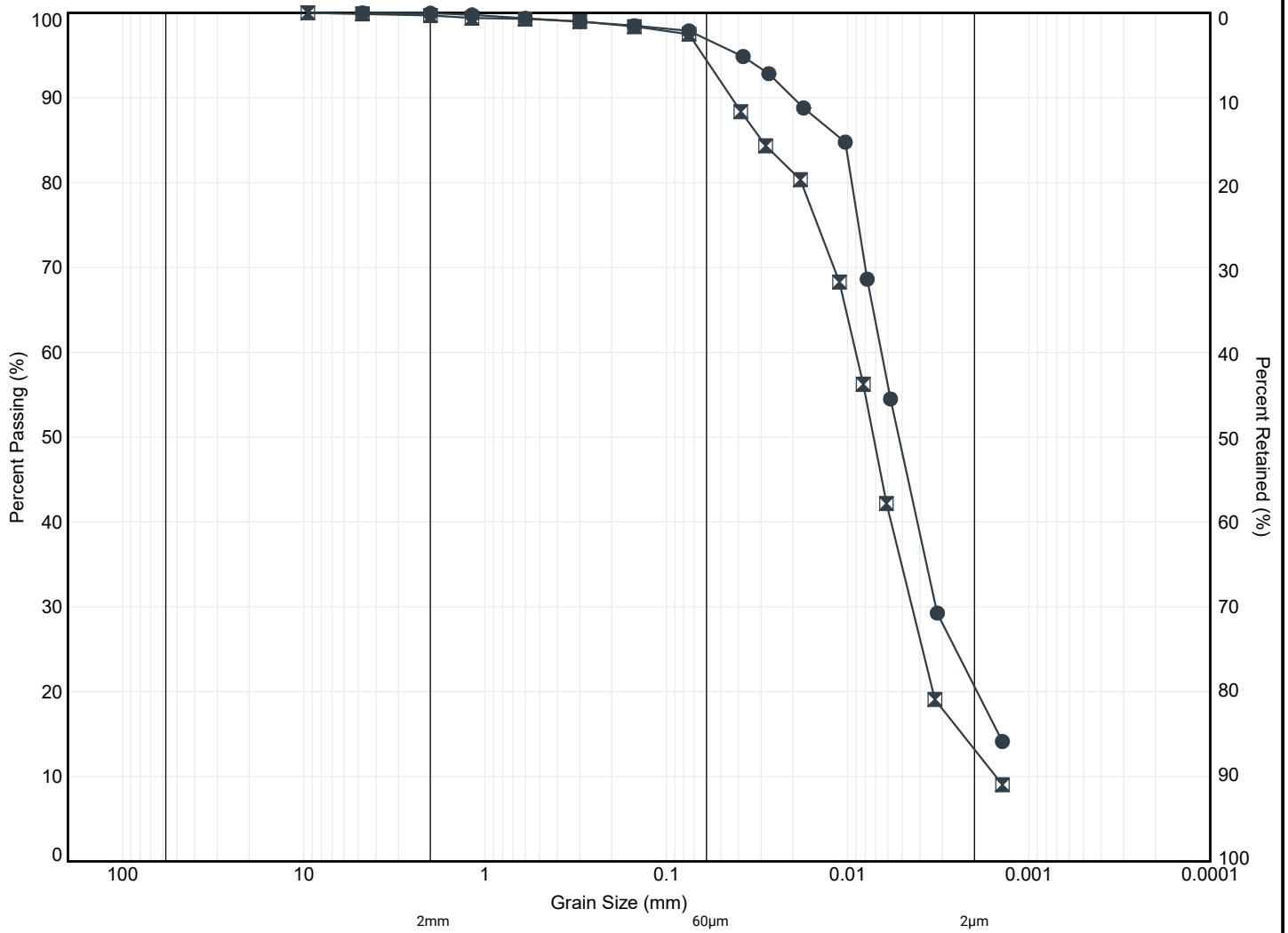


Title:

**GRAIN SIZE DISTRIBUTION
GLACIAL TILLS**

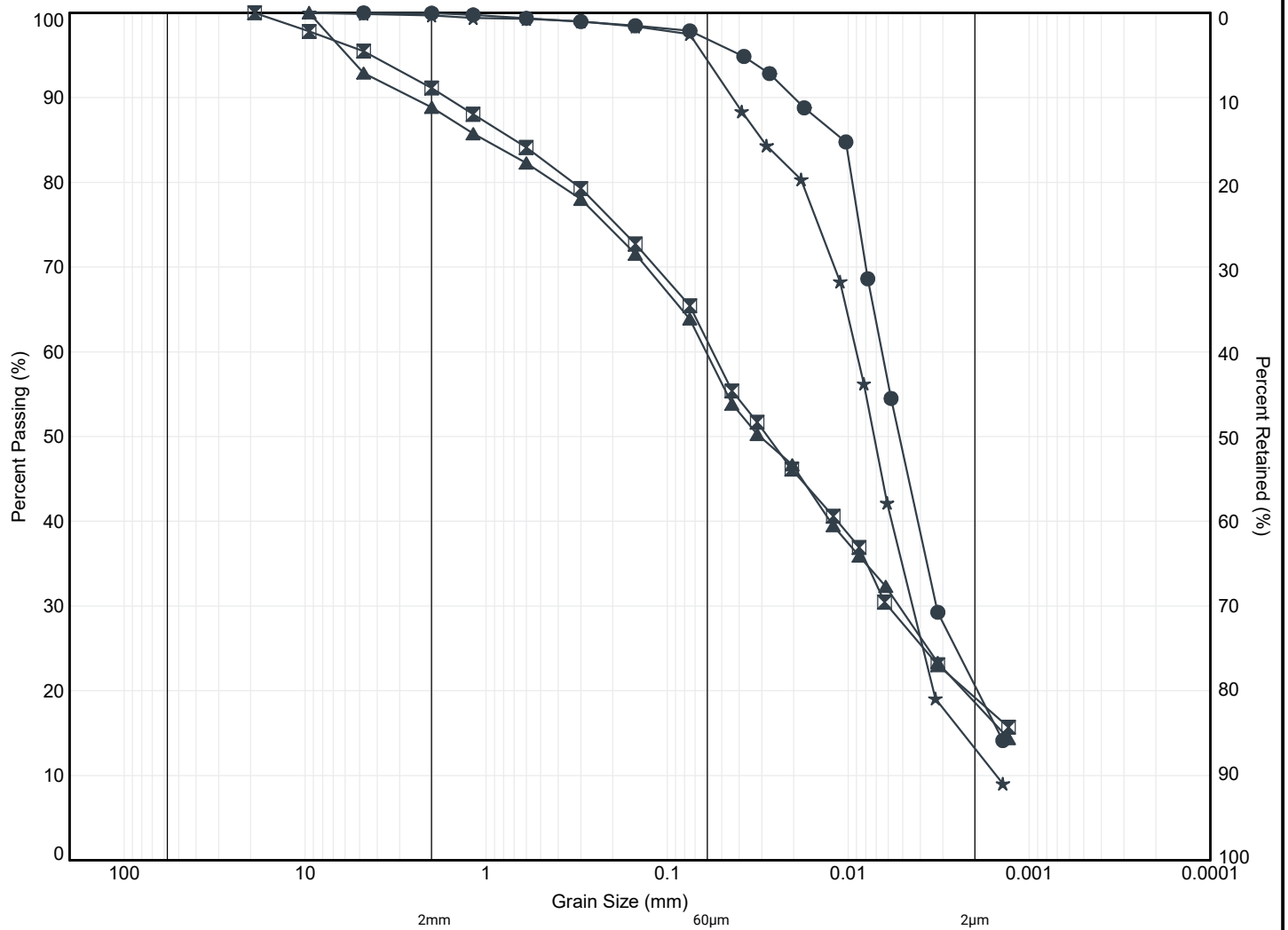
File No.:

23-099



MIT SYSTEM

Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● BH 6	SS6	4.8	248.1	0	3	76	21
⊠ BH 14	SS7	6.2	246.1	0	6	81	13



MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM

Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● BH 6	SS6	4.8	248.1	0	3	76	21
⊠ BH 7	SS3	1.8	250.8	9	30	42	19
▲ BH 10	SS5	3.3	249.2	11	29	41	19
★ BH 14	SS7	6.2	246.1	0	6	81	13

APPENDIX C



CORROSIVITY (ALS)



Results Summary WT2323878

Project 23-099
Report To Deepak Kanraj, Grounded Engineering Inc.
Date Received 02-Aug-2023 16:30
Issue Date 09-Aug-2023 16:34
Amendment 0

Client Sample ID			BH6-SS4	BH7-SS3	BH10-SS3
Date Sampled			31-Jul-2023	31-Jul-2023	31-Jul-2023
Time Sampled			16:00	16:00	16:00
ALS Sample ID			WT2323878-001	WT2323878-002	WT2323878-003
Analyte	Lowest Detection Limit	Units	Sub-Matrix: Soil/Solid	Sub-Matrix: Soil/Solid	Sub-Matrix: Soil/Solid

Physical Tests (Matrix: Soil/Solid)

Conductivity (1:2 leachate)	5.00	µS/cm	128	135	127
Moisture	0.25	%	8.90	9.91	9.07
Oxidation-reduction potential [ORP]	0.10	mV	308	317	317
Resistivity	100	ohm cm	7810	7410	7870
pH (1:2 soil:CaCl2-aq)	0.10	pH units	8.01	7.93	7.98

Inorganics (Matrix: Soil/Solid)

Sulfides, acid volatile	0.20	mg/kg	0.45	0.31	0.62
-------------------------	------	-------	------	------	------

Leachable Anions & Nutrients (Matrix: Soil/Solid)

Chloride, soluble ion content	5.0	mg/kg	20.8	11.4	12.7
Sulfate, soluble ion content	20	mg/kg	25	26	21

Inorganic Parameters (Soil)

Acid Volatile Sulphides	0.20	mg/kg	0.86	0.26	<0.20
-------------------------	------	-------	------	------	-------

INTERPRETATION

AWWA C-105 Standard

	Points	Points	Points
% Moisture	1	1	1
pH	3	3	3
Redox Potential	0	0	0
Resistivity	0	0	0
Acid Volatile Sulphides	3.5	2	0
TOTAL SCORE (AWWA C-105)	7.5	6	4
Sample	BH6-SS4	BH7-SS3	BH10-SS3
Corrosion Protection Recommended?	No	No	No
Resistivity less than 2000 ohm.cm?	No	No	No

Anions and Nutrients (Soil)

Sulphate	%	0.0025	0.0026	0.0021
CLASS OF EXPOSURE		Negligible	Negligible	Negligible

CERTIFICATE OF ANALYSIS

Work Order	: WT2323878	Page	: 1 of 3
Client	: Grounded Engineering Inc.	Laboratory	: ALS Environmental - Waterloo
Contact	: Deepak Kanraj	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: 647 264 7928	Telephone	: 1 416 817 2944
Project	: 23-099	Date Samples Received	: 02-Aug-2023 16:30
PO	: ----	Date Analysis Commenced	: 03-Aug-2023
C-O-C number	: 20-1043109	Issue Date	: 09-Aug-2023 16:34
Sampler	: DK		
Site	: ----		
Quote number	: 2023 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	Position	Laboratory Department
Greg Pokocky	Manager - Inorganics	Inorganics, Waterloo, Ontario
Niral Patel		Centralized Prep, Waterloo, Ontario



General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	Description
%	percent
µS/cm	microsiemens per centimetre
mg/kg	milligrams per kilogram
mV	millivolts
ohm cm	ohm centimetres (resistivity)
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.



Analytical Results

Sub-Matrix: Soil/Solid			Client sample ID		BH6-SS4	BH7-SS3	BH10-SS3	----	----
(Matrix: Soil/Solid)									
Client sampling date / time					31-Jul-2023 16:00	31-Jul-2023 16:00	31-Jul-2023 16:00	----	----
Analyte	CAS Number	Method/Lab	LOR	Unit	WT2323878-001	WT2323878-002	WT2323878-003	-----	-----
					Result	Result	Result	----	----
Physical Tests									
Conductivity (1:2 leachate)	----	E100-L/WT	5.00	µS/cm	128	135	127	----	----
Moisture	----	E144/WT	0.25	%	8.90	9.91	9.07	----	----
Oxidation-reduction potential [ORP]	----	E125/WT	0.10	mV	308	317	317	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A/WT	0.10	pH units	8.01	7.93	7.98	----	----
Resistivity	----	EC100R/WT	100	ohm cm	7810	7410	7870	----	----
Inorganics									
Sulfides, acid volatile	----	E396-L/WT	0.20	mg/kg	0.45	0.31	0.62	----	----
Leachable Anions & Nutrients									
Chloride, soluble ion content	16887-00-6	E236.Cl/WT	5.0	mg/kg	20.8	11.4	12.7	----	----
Sulfate, soluble ion content	14808-79-8	E236.SO4/WT	20	mg/kg	25	26	21	----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: WT2323878	Page	: 1 of 8
Client	: Grounded Engineering Inc.	Laboratory	: ALS Environmental - Waterloo
Contact	: Deepak Kanraj	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: 647 264 7928	Telephone	: 1 416 817 2944
Project	: 23-099	Date Samples Received	: 02-Aug-2023 16:30
PO	: ----	Issue Date	: 09-Aug-2023 16:34
C-O-C number	: 20-1043109		
Sampler	: DK		
Site	: ----		
Quote number	: 2023 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.

DQO: Data Quality Objective.

LOR: Limit of Reporting (detection limit).

RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "----" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.



Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: Soil/Solid

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E396-L	31-Jul-2023	03-Aug-2023	14 days	3 days	✓	03-Aug-2023	7 days	0 days	✓
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E396-L	31-Jul-2023	03-Aug-2023	14 days	3 days	✓	03-Aug-2023	7 days	0 days	✓
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E396-L	31-Jul-2023	03-Aug-2023	14 days	3 days	✓	03-Aug-2023	7 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E236.Cl	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E236.Cl	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E236.Cl	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E236.SO4	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓



Matrix: Soil/Solid

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E236.SO4	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E236.SO4	31-Jul-2023	08-Aug-2023	30 days	8 days	✓	09-Aug-2023	28 days	1 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E100-L	31-Jul-2023	04-Aug-2023	30 days	4 days	✓	08-Aug-2023	26 days	4 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E100-L	31-Jul-2023	04-Aug-2023	30 days	4 days	✓	08-Aug-2023	26 days	4 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E100-L	31-Jul-2023	04-Aug-2023	30 days	4 days	✓	08-Aug-2023	26 days	4 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E144	31-Jul-2023	----	----	----		03-Aug-2023	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E144	31-Jul-2023	----	----	----		03-Aug-2023	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E144	31-Jul-2023	----	----	----		03-Aug-2023	----	----	
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E125	31-Jul-2023	08-Aug-2023	180 days	7 days	✓	08-Aug-2023	173 days	1 days	✓



Matrix: Soil/Solid

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E125	31-Jul-2023	08-Aug-2023	180 days	7 days	✓	08-Aug-2023	173 days	1 days	✓
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E125	31-Jul-2023	08-Aug-2023	180 days	7 days	✓	08-Aug-2023	173 days	1 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP] BH10-SS3	E108A	31-Jul-2023	03-Aug-2023	30 days	3 days	✓	03-Aug-2023	27 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP] BH6-SS4	E108A	31-Jul-2023	03-Aug-2023	30 days	3 days	✓	03-Aug-2023	27 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP] BH7-SS3	E108A	31-Jul-2023	03-Aug-2023	30 days	3 days	✓	03-Aug-2023	27 days	0 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).



Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: ✖ = QC frequency outside specification; ✔ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	Method	QC Lot #	QC	Regular	Actual	Expected	Evaluation
Laboratory Duplicates (DUP)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1069812	1	9	11.1	4.7	✔
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1069652	1	13	7.6	5.0	✔
Moisture Content by Gravimetry	E144	1069398	1	20	5.0	5.0	✔
ORP by Electrode	E125	1074282	1	10	10.0	5.0	✔
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1069648	1	15	6.6	5.0	✔
Water Extractable Chloride by IC	E236.Cl	1070722	1	5	20.0	5.0	✔
Water Extractable Sulfate by IC	E236.SO4	1070723	1	5	20.0	5.0	✔
Laboratory Control Samples (LCS)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1069812	1	9	11.1	4.7	✔
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1069652	2	13	15.3	10.0	✔
Moisture Content by Gravimetry	E144	1069398	1	20	5.0	5.0	✔
ORP by Electrode	E125	1074282	1	10	10.0	5.0	✔
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1069648	1	15	6.6	5.0	✔
Water Extractable Chloride by IC	E236.Cl	1070722	2	5	40.0	10.0	✔
Water Extractable Sulfate by IC	E236.SO4	1070723	2	5	40.0	10.0	✔
Method Blanks (MB)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1069812	1	9	11.1	4.7	✔
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1069652	1	13	7.6	5.0	✔
Moisture Content by Gravimetry	E144	1069398	1	20	5.0	5.0	✔
Water Extractable Chloride by IC	E236.Cl	1070722	1	5	20.0	5.0	✔
Water Extractable Sulfate by IC	E236.SO4	1070723	1	5	20.0	5.0	✔



Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L ALS Environmental - Waterloo	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
pH by Meter (1:2 Soil:0.01M CaCl ₂ Extraction) - As Received	E108A ALS Environmental - Waterloo	Soil/Solid	MECP E3137A	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode.
ORP by Electrode	E125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Oxidation Reduction Potential (ORP) is reported as the oxidation-reduction potential of the platinum metal-reference electrode employed in the analysis, measured in mV.
Moisture Content by Gravimetry	E144 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Water Extractable Chloride by IC	E236.Cl ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Water Extractable Sulfate by IC	E236.SO ₄ ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S ₂ J	This analysis is carried out in accordance with the method described in APHA 4500 S ₂ -J. After extraction the Acid Volatile Sulphide is determined colourimetrically.
Resistivity Calculation for Soil Using E100-L	EC100R ALS Environmental - Waterloo	Soil/Solid	APHA 2510 B	Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
---------------------	--------------	--------	------------------	---------------------



Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 ALS Environmental - Waterloo	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Leach 1:2 Soil : 0.01CaCl ₂ - As Received for pH	EP108A ALS Environmental - Waterloo	Soil/Solid	MOEE E3137A	A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode.
Preparation of ORP by Electrode	EP125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Field-moist sample is extracted in a 1:2 ratio with DI water and then analyzed by ORP meter.
Anions Leach 1:10 Soil:Water (Dry)	EP236 ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	5 grams of dried soil is mixed with 50 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.
Distillation for Acid Volatile Sulfide in Soil	EP396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S ₂ J	Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis.

QUALITY CONTROL REPORT

Work Order	: WT2323878	Page	: 1 of 5
Client	: Grounded Engineering Inc.	Laboratory	: ALS Environmental - Waterloo
Contact	: Deepak Kanraj	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	:	Telephone	: 1 416 817 2944
Project	: 23-099	Date Samples Received	: 02-Aug-2023 16:30
PO	: ----	Date Analysis Commenced	: 03-Aug-2023
C-O-C number	: 20-1043109	Issue Date	: 09-Aug-2023 16:34
Sampler	: DK 647 264 7928		
Site	: ----		
Quote number	: 2023 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	Position	Laboratory Department
Greg Pokocky	Manager - Inorganics	Waterloo Inorganics, Waterloo, Ontario
Niral Patel		Waterloo Centralized Prep, Waterloo, Ontario



General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.

DQO = Data Quality Objective.

LOR = Limit of Reporting (detection limit).

RPD = Relative Percent Difference

= Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.



Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: Soil/Solid					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 1069398)											
EO2306841-001	Anonymous	Moisture	----	E144	0.25	%	9.05	8.81	2.65%	20%	----
Physical Tests (QC Lot: 1069648)											
EO2306874-001	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	8.05	8.02	0.373%	5%	----
Physical Tests (QC Lot: 1069652)											
WT2323861-001	Anonymous	Conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.371 mS/cm	305	19.5%	20%	----
Physical Tests (QC Lot: 1074282)											
EO2306874-001	Anonymous	Oxidation-reduction potential [ORP]	----	E125	0.10	mV	330	323	2.14%	25%	----
Inorganics (QC Lot: 1069812)											
EO2306874-001	Anonymous	Sulfides, acid volatile	----	E396-L	0.25	mg/kg	<0.25	<0.25	0.002	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1070722)											
EO2306874-001	Anonymous	Chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg	10.8	9.2	1.6	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1070723)											
EO2306874-001	Anonymous	Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	689	667	3.33%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: Soil/Solid						
Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 1069398)						
Moisture	----	E144	0.25	%	<0.25	----
Physical Tests (QCLot: 1069652)						
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	<5.00	----
Inorganics (QCLot: 1069812)						
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	<0.20	----
Leachable Anions & Nutrients (QCLot: 1070722)						
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	<5.0	----
Leachable Anions & Nutrients (QCLot: 1070723)						
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	----



Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: Soil/Solid

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 1069398)									
Moisture	----	E144	0.25	%	50 %	99.0	90.0	110	----
Physical Tests (QCLot: 1069648)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	100	98.0	102	----
Physical Tests (QCLot: 1069652)									
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	1409 µS/cm	97.5	90.0	110	----
Inorganics (QCLot: 1069812)									
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	2.496 mg/kg	75.3	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1070722)									
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	5000 mg/kg	100	80.0	120	----
Leachable Anions & Nutrients (QCLot: 1070723)									
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	5000 mg/kg	100	80.0	120	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1069652)									
	RM	Conductivity (1:2 leachate)	----	E100-L	1725.6 µS/cm	107	70.0	130	----
Physical Tests (QCLot: 1074282)									
	RM	Oxidation-reduction potential [ORP]	----	E125	475 mV	98.5	90.0	110	----
Leachable Anions & Nutrients (QCLot: 1070722)									
	RM	Chloride, soluble ion content	16887-00-6	E236.Cl	432 mg/kg	97.8	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1070723)									
	RM	Sulfate, soluble ion content	14808-79-8	E236.SO4	1070 mg/kg	100	70.0	130	----





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Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

COC Number: 20 - 1043109

Page 1 of 1

Report To: Contact and company name below will appear on the final report

Company: GROUNDWATER ENGINEERING

Contact: DEEPAK KANBAST

Phone: 647-265-0912

Street: 1 BAILLIAN DRIVE

City/Province: EAST YORK ON M4H 1G3

Postal Code: M4H 1G3

Invoice To: Same as Report To

Company: Copy of Invoice with Report

Contact: YES NO

Project Information

ALS Account # / Quote #: 23-099

Job #: 23-099

PO / AFE: Requestioner:

LSD: Location:

ALS Lab Work Order # (ALS use only): WT2323878

ALS Sample # (ALS use only):

Sample Identification and/or Coordinates (This description will appear on the report)

BH4-SS4

BH7-SS3

BH10-SS3

Reports / Recipients

Select Report Format: PDF EXCEL EDD (DIGITAL)

Merge QC/QCI Reports with COA YES NO N/A

Compare Results to Criteria of Report - provide details below if box checked

Select Distribution: EMAIL MAIL FAX

Email 1 or Fax: DEEPAK.KANBAST@GROUNDWATER.ENG.CA

Email 2

Email 3

Invoice Recipients

Select Invoice Distribution: EMAIL MAIL FAX

Email 1 or Fax: DEEPAK.KANBAST@GROUNDWATER.ENG.CA

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center:

Major/Minor Code:

Routing Code:

Requestioner:

Location:

ALS Contact:

Sampler: DK

Date (dd-mm-yy)

Time (hh:mm)

Sample Type

Turnaround Time (TAT) Requested

Standard [R] if received by 3pm M-F - no surcharges apply

4 day [P] if received by 3pm M-F - 20% rush surcharge minimum

3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum

2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum

1 day [E] if received by 3pm M-F - 100% rush surcharge minimum

Same day [E2] if received by 10am M-S - 200% rush surcharge. Add may apply for rush requests on weekends, statutory holidays and non-rush

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please indicate

Indicate Filtered (F), Preserved (P) or Filtered and

Analysis Re

Environmental Division

Waterloo

Work Order Reference

WT2323878

SAMPLES ON HOLD
EXTENDED STORAGE REQ
SUSPECTED HAZARD (see

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.
1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

201 708

APPENDIX D



1 GENERAL

These specifications are suitable for use as a technical specification only, relating to the engineering aspects as discussed in Grounded's corresponding geotechnical report for the site. If this technical specification is to be used as a tender document, the geotechnical report and this technical specification must be read in conjunction with the relevant supporting tender documents, prepared by others.

This specification must be read in conjunction with Grounded's geotechnical report for the site. Wherever there is conflicting advice, Grounded's geotechnical report for the site governs.

1.1 Description

Engineered Fill refers to earthworks (earth fill) designed and constructed with engineering inspection and testing to support foundations at SLS loads for a design net geotechnical reaction.

Site preparation for Engineered Fill operations must only be conducted under the full time inspection and testing of a Third Party Testing Agency (Testing Engineer), with review by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

Poured concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

The Engineered Fill to be constructed is shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section includes the following:

1. Topsoil stripping from the ground surface below all Engineered Fill areas,
2. Test pit excavating into the subgrade to a) investigate subgrade suitability for the support of Engineered Fill and b) observe and document any prior existing fill materials,
3. Proof-rolling of the subgrade below all Engineered Fill areas, to detect the presence and extent of unstable ground conditions,
4. Excavating and removing unstable/unacceptable subgrade materials, or the implementation of other approved subgrade stabilization measures (as required) prior to the placement of Engineered Fill,
5. Surveying of ground elevations prior to placing Engineered Fill,
6. Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,
7. Surveying of ground elevations on completion of Engineered Fill placement,
8. Providing and maintaining survey layout of the Engineered Fill areas, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.2 The Project Parties

1. The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of Engineered Fill.
2. The term Testing Engineer shall refer to the individual or firm who will be carrying out the full time inspection and testing of the earthworks related to preparation and construction of Engineered Fill.

3. The term Geotechnical Engineer shall refer to Grounded Engineering.
4. The term Design Civil Engineer shall refer to the individual or firm who will be carrying out the Site Grading Design (pre-grading), the determination of Design Foundation Grades for the structures on the site, and the choice of lots and site areas to receive Engineered Fill.

2 MATERIALS

2.1 Definitions

1. Topsoil is the layer of naturally organic soil typically found at the ground surface and commonly in the range of about 100 to 300 mm thick.
2. Earth Fill is soil material which has been placed by humans and has not been deposited by nature over a long period of time.
3. Subgrade Soil is the “in situ” (in place) native soil beneath any earth fill and/or topsoil layer(s).
4. Disturbed Soil is soil material which was originally deposited naturally but has since been disturbed or reworked in place, usually by agriculture activities. Disturbed Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.
5. Weathered Soil is soil material which is naturally deposited but weathered in place due to its exposure to the elements. Weathered Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.
6. Engineered Fill soils must consist of clean earth materials, not excessively wet, free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials. It is placed in thin lifts of no more than 150 mm in thickness. Cohesionless soils such as sand or gravel are the easiest to place and compact.
7. All values stated in metric units shall be considered as accurate.

3 ENGINEERED FILL DESIGN

3.1 Design Foundation Pressure

1. Engineered Fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered Fill. The time (after initial placement) over which this settlement typically occurs depends on the composition of the Engineered Fill as follows:
 - a) sand or gravel soil; several days
 - b) silt soil; several weeks
 - c) clay or clayey soil; several months.

The placement of Engineered Fill might also result in post-construction settlement of the natural soil.

The timing of foundation construction must consider the post-construction settlement of the Engineered Fill and the foundation soil.

2. Unless otherwise stated, the Engineered Fill is to be placed over the entire lot area or site area.
3. Engineered Fill is to extend up to at least 1 m above the highest level of required foundation support. Typically, this can be within 1 m of the design final grades. Additional common fill can be placed over the Engineered Fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

4. An allowable design foundation pressure (net geotechnical reaction at SLS for 25 mm of settlement) of 150 kPa is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.8 m for continuous strip footings, and minimum dimensions of 1 m for column footings.
5. At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.
6. Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for stiffening of basement foundation walls and for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.
7. At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,
 - a) placement of footing concrete, and
 - b) placement of foundation wall concrete.

4 CONSTRUCTION

4.1 Survey Layout

1. The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.
2. At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed. Benchmark positions may need to be reviewed by Grounded if consolidation settlement is expected to influence their elevations.
3. The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Testing Engineer.
4. The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.
5. On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.2 Topsoil Stripping

1. The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.
2. Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have been suitably stripped.

4.3 Test Holes Into Subgrade

1. After topsoil has been stripped, the exposed subgrade must be investigated for the presence of old buried fill or deleterious material, which may be unsuitable (as determined by the Testing Engineer or the Geotechnical Engineer) for the support of Engineered Fill.
2. Exploratory test pits must be dug using a small backhoe, on a suitable pattern, to observe an appropriate representation of the entire site area.
3. The Testing Engineer or Geotechnical Engineer must observe the digging and backfilling of the test pits; must log the test pit stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test pit.
4. If the test pits discover any old buried fill or deleterious materials, it must be excavated and removed from the Engineering Fill area down to undisturbed, stable native soil.
5. All test pits must be properly backfilled and compacted in thin lifts (max. 150mm thickness) to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Testing Engineer or Geotechnical Engineer must observe the backfilling and compaction of the test pits.

4.4 Subgrade Proof-rolling

1. Prior to placing any Engineered Fill, the exposed subgrade must be proofrolled under the observation of the Testing Engineer.
2. If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.5 Engineered Fill Placement

1. Engineered fill must not be placed without the approval of the Testing Engineer. Prior to placing any Engineered Fill, the topsoil must be stripped, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.
2. Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability both geotechnically and environmentally. Samples of the proposed fill material must be obtained and tested by the Testing Engineer. The samples must be tested in a geotechnical laboratory for Standard Proctor Maximum Dry Density. Samples must also be tested per the requirements of Ontario Regulation 406/19, prior to approval of the material for use as Engineered Fill. The results of the lab testing must be approved by the Geotechnical Engineer and the results of the environmental testing must be approved by the site Qualified Person, prior to import.
3. The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.
4. Field density tests must be taken by the Testing Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.
5. Engineered fill must not be placed during the period of the year when cold weather occurs, i.e. when there are freezing ambient temperatures during the daytime and overnight.

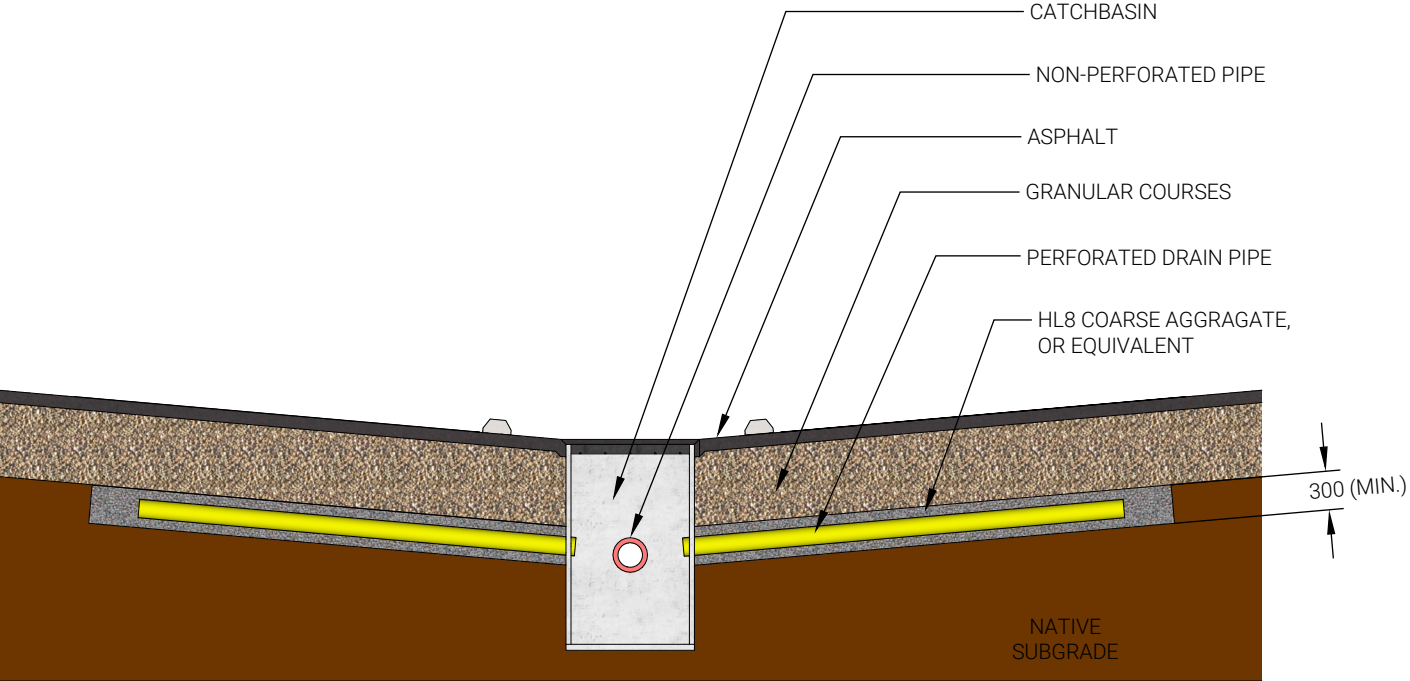
4.6 Certification

1. The Testing Engineer shall provide written summaries of the compaction and lab testing to the Geotechnical Engineer on a frequency of not less than every two weeks.
2. Upon Completion of the Engineered Fill placement the Testing Engineer will provide certification to the Geotechnical Engineer of General Compliance with this specification.
3. Upon receipt of the certification from the Testing Engineer, the Geotechnical Engineer will provide the owner with a Certificate of Engineered Fill

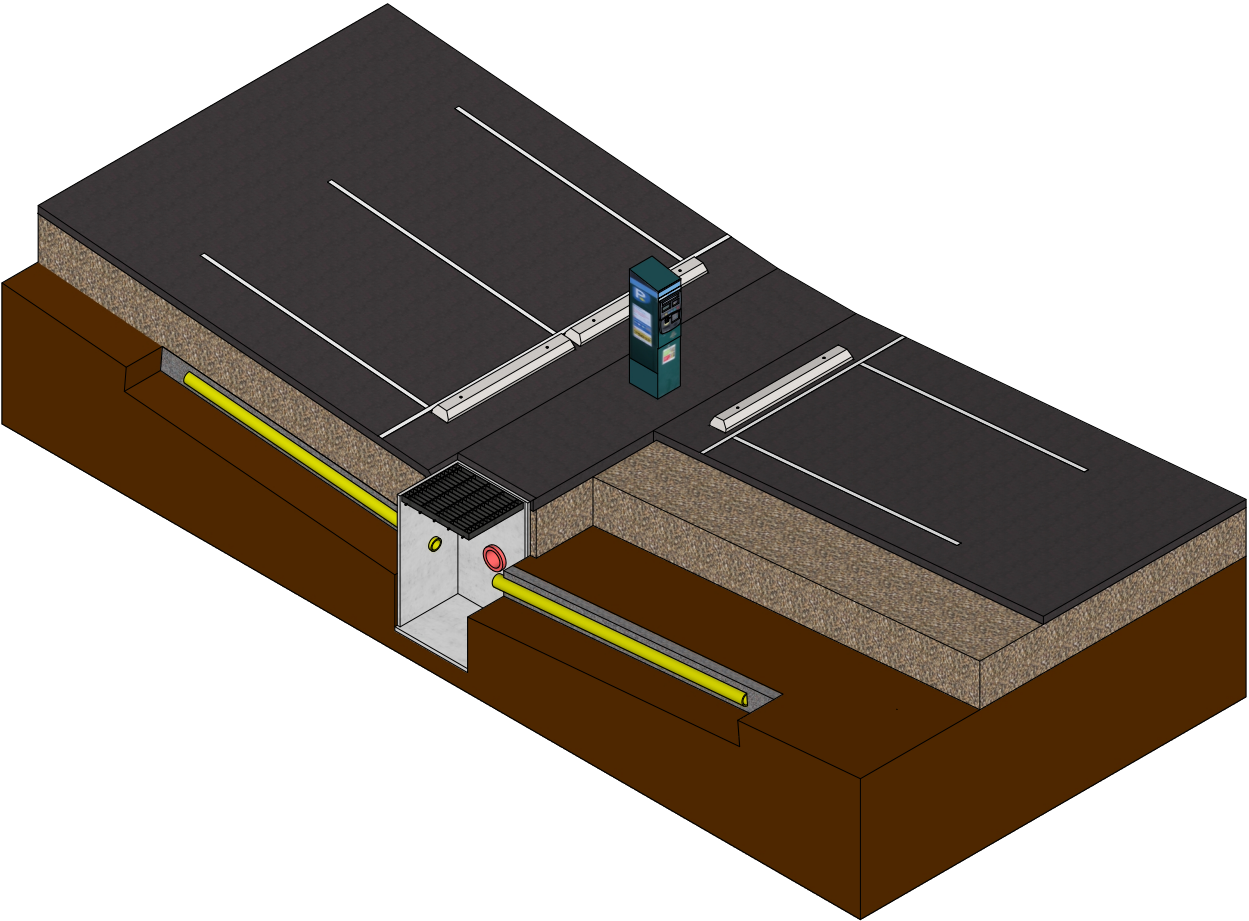
APPENDIX E



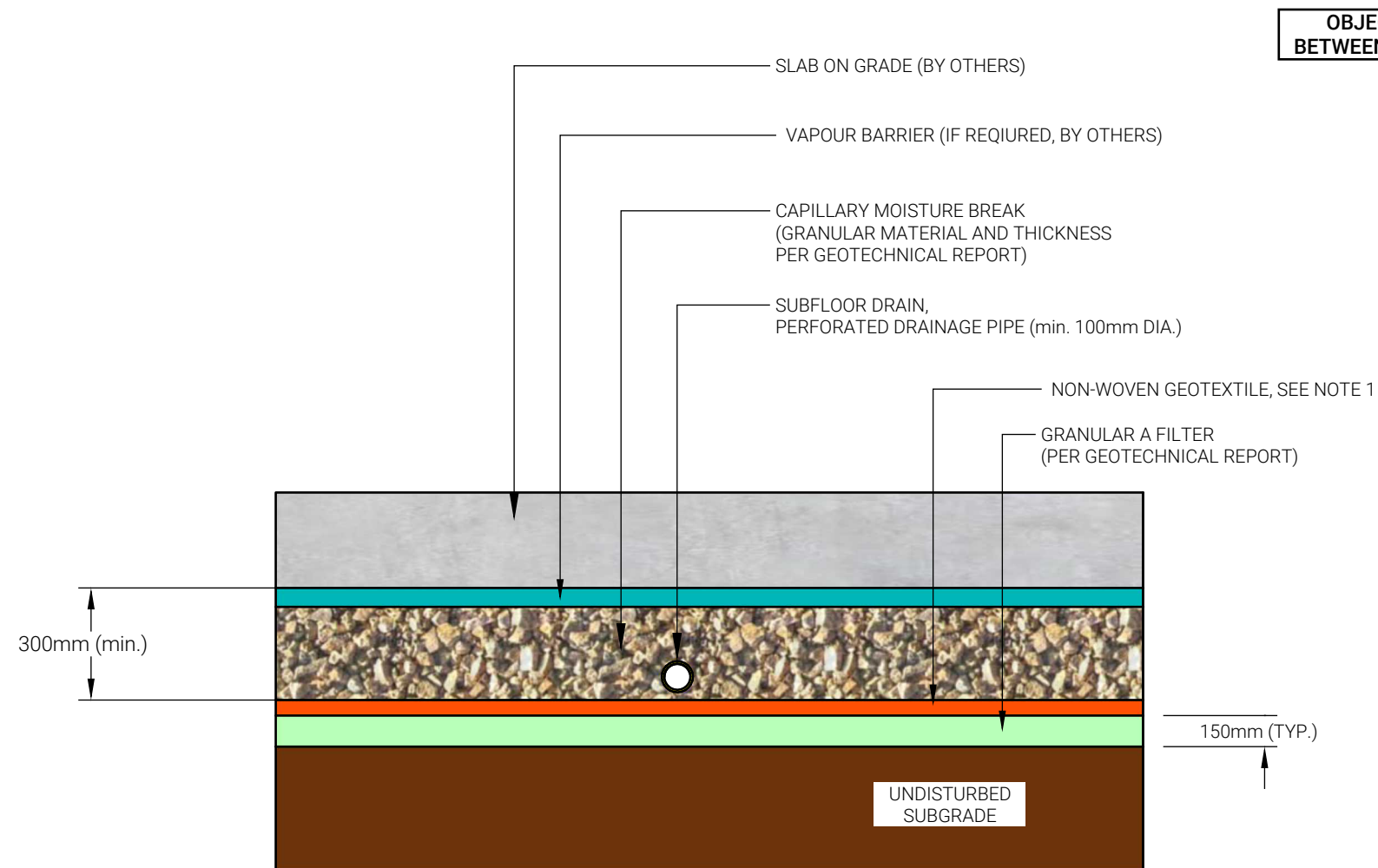
OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



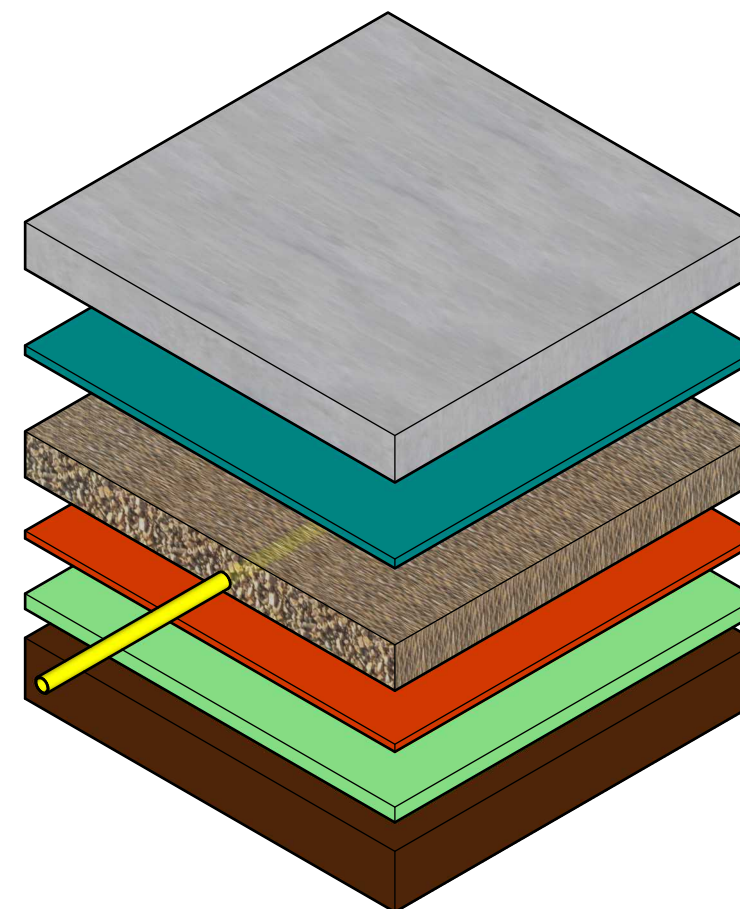
SECTIONAL VIEW



ISOMETRIC



OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW

ISOMETRIC VIEW

NOTES

1. WHEN THE SUBGRADE CONSISTS OF COHESIONLESS SOIL, IT MUST BE SEPARATED FROM THE SUBFLOOR DRAINAGE LAYER USING A NON-WOVEN GEOTEXTILE (WITH AN APPARENT OPENING SIZE OF $< 0.250\text{mm}$ AND A TEAR RESISTANCE OF $> 200\text{ N}$).
2. TYPICAL SCHEMATIC ONLY. MUST BE READ IN CONJUNCTION WITH GEOTECHNICAL REPORT.
3. THE GRANULAR A FILTER REQUIREMENT IS DUE TO LARGE GROUNDWATER VOLUMES. SEE GEOTECHNICAL REPORT FOR COMMENTARY.

APPENDIX F





GEOPHYSICS GPR INTERNATIONAL INC.

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November 20th, 2023

Transmitted by Email: dkanraj@groundedeng.ca

GPR file: T235010

Deepak Kanraj EIT
Project Coordinator, Geotechnical Engineering Services
Grounded Engineering Inc.
1 Banigan Drive
Toronto, ON
M4H 1G3

RE: Shear-wave velocity sounding at the Southwest corner of Dockstader Road & Dixie Road, Brampton, Ontario

Dear Mr. Kanraj:

Geophysics GPR International Inc. has been requested by Grounded Engineering Inc. to carry out a shear-wave velocity sounding at the above site in Brampton.

The investigation included the multi-channel analysis of surface waves (MASW), the micro-tremor array measurements (MAM), the Spatial AutoCorrelation (SPAC), and the refraction methods to generate a shear-wave velocity model.

The survey was performed on October 26th, 2023. Figure 1 shows the regional location of the site and Figure 2 illustrates the location of the seismic spread. Both figures are presented at the end of this report.

The following paragraphs describe the survey design, the principles of the test method, the methodology for interpreting the data, and provide a culmination of the results in table format.



MASW and MAM Surveys

Basic Theory

The Multi-channel Analysis of Surface Waves (MASW), the Micro-tremor Array Measurements (MAM) and the Spatial AutoCorrelation (SPAC) are seismic methods used to evaluate the shear-wave velocities of subsurface materials through the analysis of the dispersion properties of Rayleigh surface waves (“ground roll”). The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. Inversion of the Rayleigh wave dispersion curve yields a shear-wave (V_s) velocity depth profile (sounding). The SPAC is considered a “passive” method, using the low frequency “signals” produced far away. The method can also be used with “active” seismic source records. This method generally allows deeper V_s soundings. The dispersion curve can then be merged with the one of higher frequency from the MASW to calculate a more complete inversion. Figure 3 outlines the basic operating procedure for the MASW method. Figure 4 is an example image of a typical MASW record and resulting 1D V_s model. A more detailed description of the method can be found in the paper *Multi-channel Analysis of Surface Waves*, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); P. 800–808.

Survey Design

The geometry of an MASW survey is similar to that of a seismic refraction investigation. A seismic spread usually consists of 12 to 24 vibration-monitoring devices (geophones) in a linear array, connected to a seismograph (Abem Terraloc Pro/Mark 6). The fundamental principle involves intentionally generating an acoustic wave at the surface and digitally recording the surface waves from the moment of source impact with a linear series of geophones on the surface. This is referred to as an “active source” method. A sledgehammer was used as the primary energy source with traces being recorded at 6 locations: approximately 6 m off both ends, 25 to 30 m off both ends, and in the middle of the spread. Data were collected with a geophone spacing of 3 m and 1m for a total of 10 shot records per sounding.

Unlike the refraction method, which produces a data point beneath each geophone, the shear-wave depth profile is the average of the bulk area within the middle third of the geophone spread.

The theoretical maximum depth of penetration (34.5 m) is half of the maximum seismic array length (69 m), in practice the maximum depth of penetration is often influenced by the geology.

The MAM/passive survey used the same geophone array set up as for the MASW survey. Unlike the MASW survey, the MAM method is considered a “passive source” method in that there is no time break and the motions recorded are from



ambient energy generated by cultural noise such as traffic, wind, wave motion, etc. Data collection for the passive method involves recording approximately 10 minutes of background “noise.” The records generated by the MAM method contain lower frequency data, thus increasing the data resolution at greater depths of investigation. Typically the MAM results aid in clarifying the MASW results for depths greater than 20 m; however, the direction of noise propagation relative to the spread orientation can influence the results.

Interpretation Method and Accuracy of Results

The main processing sequence involved plotting, picking, and 1-D inversion of the MASW/MAM shot records using the SeisimagerSW™ software package and MASwAI from Geophysics GPR. The data inversions is done using the neural networks based algorithm MASwAI.

In theory, all MASW shot records should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation and localized surface variations. The results of the inversion process are inherently non-unique and the final model must be judged to be geologically realistic. The inversion modelling also assumes that all layering is flat/horizontal and laterally uniform.

The results of the MASW/MAM tests are presented in chart format as Figure 5. The chart presents the 1-D shear wave velocity values from the inversion models of the passive and active seismic records.

The V_{s30} value for the sounding is presented in Table 1. The V_{s30} values are based on the harmonic mean of the shear wave velocities over the upper 30 m. The V_{s30} value is calculated by dividing the total depth of interest (e.g. 30 m) by the sum of the time spent in each velocity layer up to that depth.

$$\bar{V}_{s30} = \frac{\sum_{i=1}^N H_i}{\sum_{i=1}^N H_i / V_i} \quad | \quad \sum_{i=1}^N H_i = 30 \text{ m}$$

(N: number of layers; H_i : thickness of layer "i" ; V_i : V_s of layer "i")

This harmonic mean value reflects the equivalent single layer response. Table 3 at the end of the report displays the V_{s30} calculations at various depths up to 30 meters.

The estimated error in the average V_{s30} value determined through MASW tests is typically +/-10 to 15% for overburden sites. The shear-wave velocities modelled through the MASW method within bedrock have a higher estimated error.



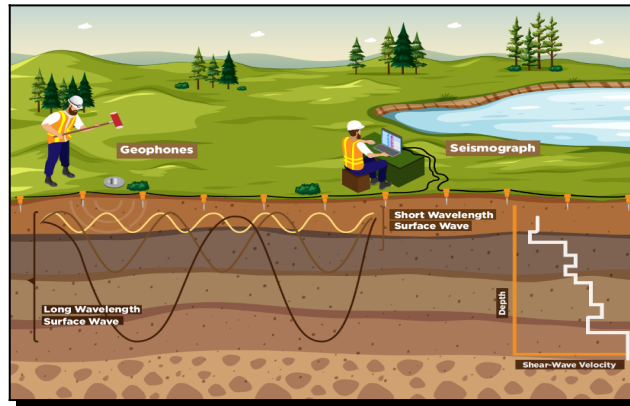


Figure 3: MASW Operating Principle

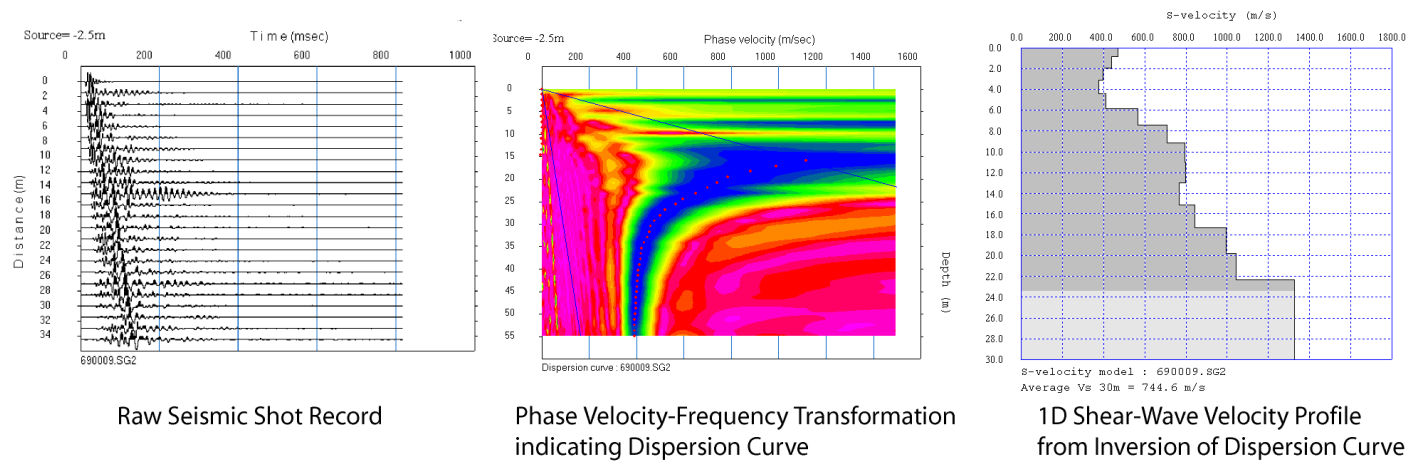


Figure 4: Example of a typical MASW shot record, phase velocity/frequency curve and resulting 1D shear-wave velocity model.



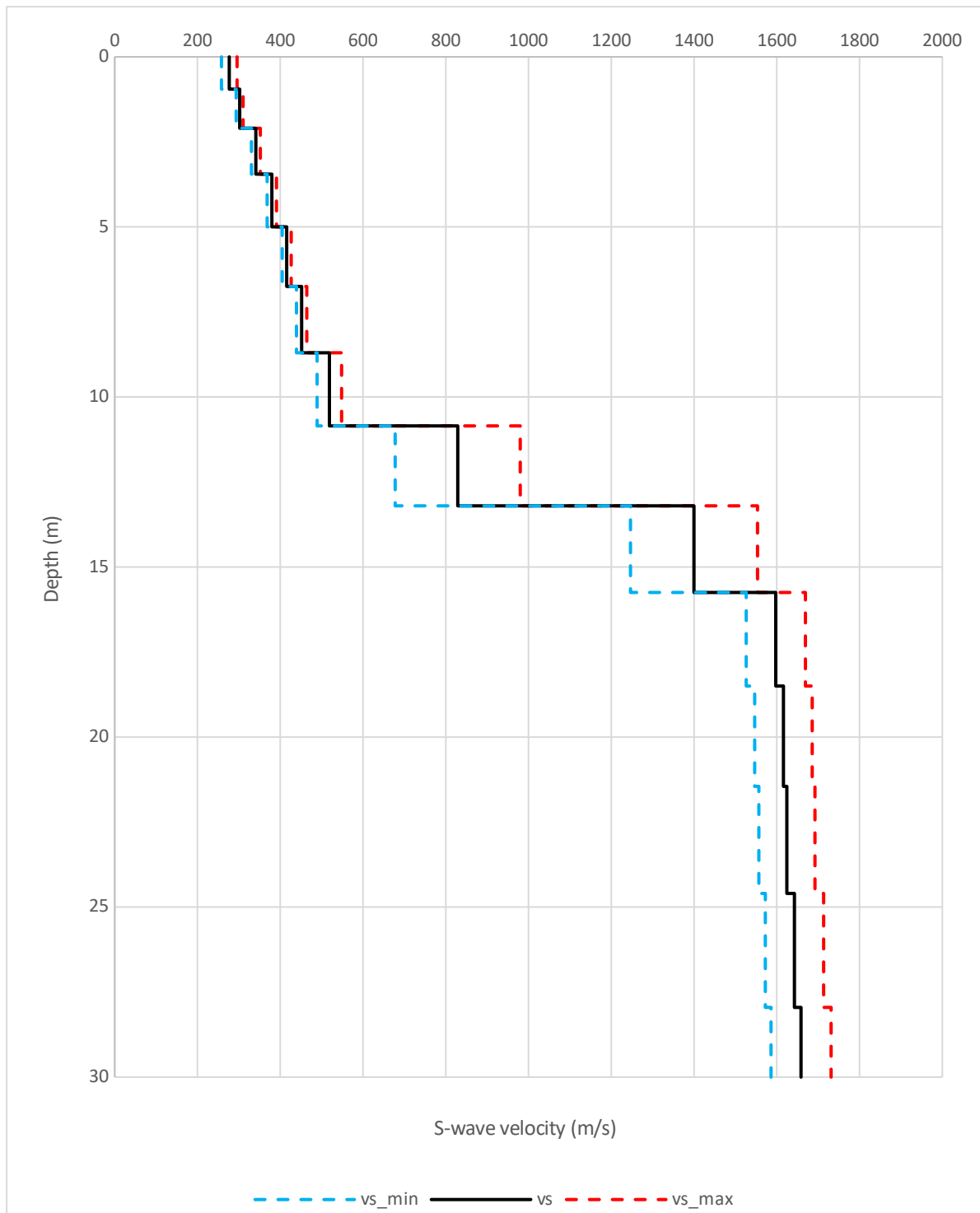


Figure 5: MASW Shear-wave Velocity Sounding



CONCLUSIONS

The approximate location of the shear-wave sounding is indicated in Figure 2.

The MASW shear-wave models are presented in Figure 5. The results are summarized in Table 1. The background seismic noise levels at this site were medium. The quality of the seismic records and the resulting dispersion curves was good.

Simple critical distance calculations from refracted P-waves show that a till could be at 2 m deep. The shale bedrock could be approximately at 12 m deep.

No borehole or geotechnical data were available at the time of this report.

Table 1: Calculated V_{s30} values (m/s) from the MASW data (0 to 30 m)

Sounding	Minimum	Average	Maximum	Site Class
1	686	725	762	C

The calculated average V_{s30} values from the 1D MASW soundings collected was 725 m/s +/-15 to 20%.

The V_{s30} values calculated for the minimum and the maximum envelopes ranged from 686 to 762 m/s.

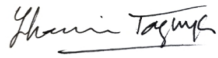
Based on the average V_{s30} values (as determined through the MASW method) and table 4.1.8.4.A of the National Building Code of Canada, 2015 Edition, the investigated area is site class “C” ($360 < V_{s30} \leq 760$ m/s).

It must be noted that the site classification provided in this report is based solely on the V_{s30} value as derived from the MASW method and that it can be superseded by other geotechnical information. This geotechnical information includes, but is not limited to, the presence of sensitive and/or liquefiable soils, more than 3 m of soft clays, high moisture content, etc. The reader is referred to section 4.1.8.4 of the National Building Code of Canada, 2015 Edition for more information on the requirements for site classification.

Processing of the seismic data was performed by Andrés M. Rincón R., M.Sc. Phys.



This report has been written by Lhoucin Taghya, P.Geo.



Lhoucin Taghya, P.Geo.
Geophysicist



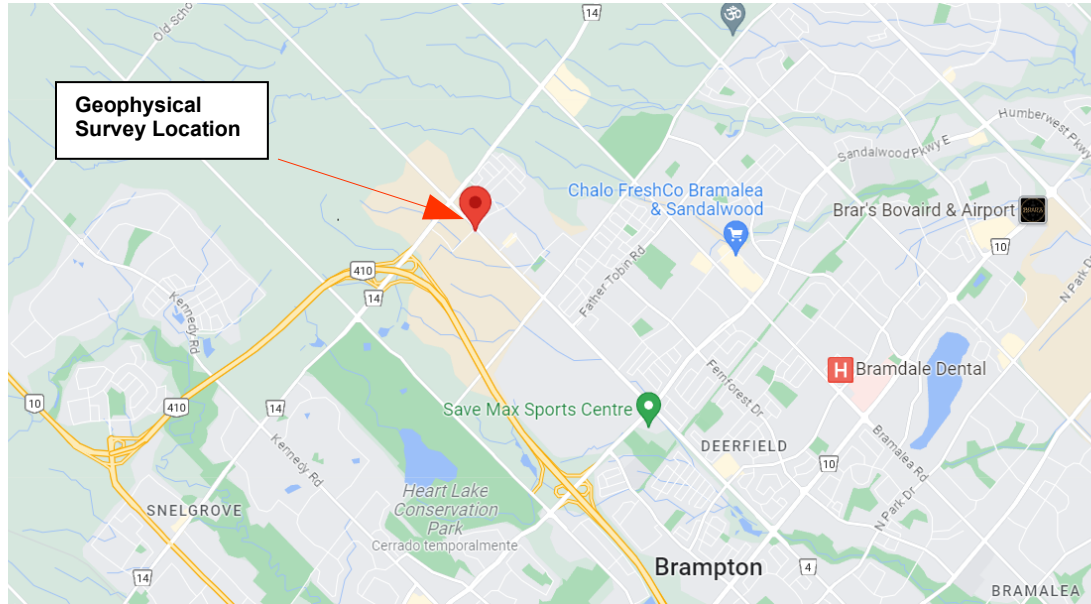


Figure 1: Regional location of the Site
(Source: GoogleMaps™)



Figure 2: Location of the seismic spread
(Source: Google Earth™)



Table 3: V_{s30} Calculation for the Site Class

Depth	Vs			Thicknes s	Cumulative Thickness	Delay for Med. Vs	Cumulative Delay	Vs at given Depth Min.
	Min.	Median	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(m)	(m/s)
0.0	258	277	296	Grade Level				
1.0	293	302	310	1.0	1.0	0.003432	0.003432	277
2.1	330	341	352	1.2	2.1	0.003809	0.007241	290
3.5	368	380	391	1.4	3.5	0.003958	0.011199	308
5.0	405	416	426	1.6	5.0	0.004083	0.015282	327
6.8	439	452	464	1.8	6.8	0.004212	0.019494	346
8.7	489	519	548	2.0	8.7	0.004317	0.023811	365
10.9	678	829	980	2.2	10.9	0.004144	0.027955	388
13.2	1246	1400	1553	2.4	13.2	0.002835	0.030790	429
15.8	1526	1598	1669	2.6	15.8	0.001822	0.032612	483
18.5	1547	1616	1686	2.8	18.5	0.001721	0.034333	539
21.5	1557	1624	1692	3.0	21.5	0.001825	0.036158	593
24.6	1572	1643	1713	3.2	24.6	0.001939	0.038097	646
28.0	1586	1659	1731	3.4	28.0	0.002039	0.040136	696
30.0	1602	1671	1741	2.1	30.0	0.001236	0.041372	725

V_{s30} (m/s)	725
Class	C

