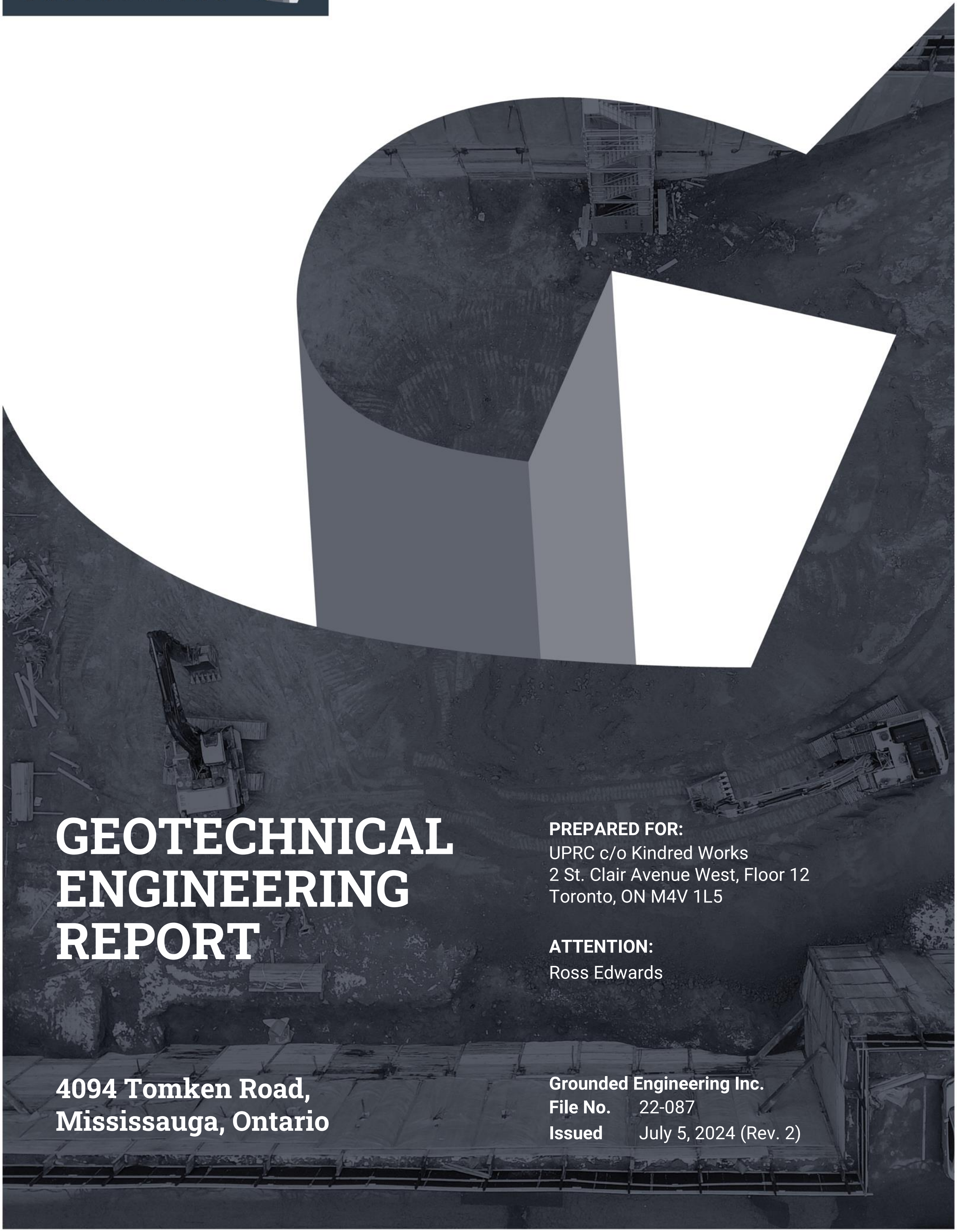

GEOTECHNICAL ENGINEERING REPORT

PREPARED FOR:
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File No. 22-087
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1 Introduction

UPRC c/o Kindred Works has retained Grounded Engineering Inc. (“Grounded”) to provide geotechnical engineering design advice for their proposed development at 4094 Tomken Road, in Mississauga, Ontario.

The proposed project includes constructing two 12-storey residential structures (Building 1 in the north area of the site, and Building 2 in the south area of the site), with three underground parking levels (P3) underneath each building. The lowest P3 Level for Building 1 is set at a lowest Finished Floor Elevation (FFE) of 125.9 m, and the lowest P3 Level for Building 2 set at a lowest FFE of 128.5± m.

This report has been revised (Rev 2) to reflect the changes from the latest architectural drawings and includes additional groundwater monitoring information at the site.

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

- Site survey, prepared by Speight, Van Nostrand & Gibson Limited (Dec 3, 2021).
- Architectural Drawings, “UCC Westminster United Church”; Project 2112, dated April 12, 2024, prepared by KPMG Architects Inc.

Grounded’s subsurface investigation of the site to date includes:

- three (3) boreholes (Boreholes 1 to 3) which were advanced from June 8th to 10th, 2022.
- eight (8) boreholes (Boreholes 201 to 208) which were advanced from April 2nd to 8th, 2024.

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.

Elevations are measured relative to geodetic datum (Mississauga Benchmark No. 685). The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM) geographic coordinate system.

Surficial fill (pavements, aggregate, topsoil, etc.) thicknesses were observed in individual borehole locations through the top of the open borehole. Thicknesses may vary between and beyond each borehole location.

2.1 Stratigraphy

The following stratigraphy summary is based on the borehole results and the geotechnical laboratory testing.

A subsurface profile showing stratigraphy and engineering units is appended.

2.1.1 Surficial and Earth Fill

Boreholes 2, 3, 201, 202, 203, and 208 encountered an asphalt pavement ranging between 75 to 150 mm thick. In Boreholes 2 and 3, a 75 mm thick aggregate base was encountered underlying the asphalt layer. A sand and gravel layer varying in thickness was encountered underneath the asphalt pavement in Boreholes 201, 202, 203, and 208. Boreholes 1, 204, 205, 206, and 207 encountered 50 to 600 mm of topsoil at the existing ground surface.

Underlying the surficial materials, the boreholes observed a layer of earth fill that extends to depths of 0.8 to 2.3 metres below grade (Elev. 137.3 to 134.4± metres). The earth fill varies in composition but generally consists of sandy silt or clayey silt, with trace gravel and rock fragments. The earth fill is generally dark brown to brown and moist. Due to the variation and inconsistent placement of the earth fill materials at the site, the relative density of the earth fill could be variable.

2.1.2 Glacial Till

Underlying the fill materials, the boreholes encountered an undisturbed cohesive glacial till deposit at depths of 0.8 to 2.3 m below grade (Elev. 137.2 to 136.7 m) extending to depths of 3.0 to 4.6 m below grade (Elev. 135.8 to 133.3± m). The glacial till generally consists of clayey silt to silt some clay with trace to some sand, trace gravel, as well as shale and limestone fragments. The glacial till is generally brownish grey with orange staining, and moist. Standard Penetration Test (SPT) N-values measured in this unit range from 16 to 98 blows per 300 mm of penetration indicating a relative density ranging from very stiff to hard (on average, hard).

2.1.3 Bedrock

Bedrock was either observed or inferred in all Boreholes underlying the clayey silt till at depths of 3.0 to 4.6± m below grade (Elev. 135.8 to 133.3± m). Bedrock was confirmed by rock cores recovered in Boreholes 1, 201, 205 and 208 to depths of 7.2 to 16.5± m below grade (Elev. 131.6 to 121.7 m). Where coring was not conducted, the top of weathered bedrock was inferred through auger cuttings, split spoon samples, and auger grinding/resistance observations.

Detailed core logs are included with the corresponding borehole logs. Photographs of the recovered rock core and a guide of rock core terminology are appended. The rock core terminology sheet defines many of the descriptive terms used below.

The bedrock beneath the site is the Georgian Bay Formation, which typically comprises thin to medium bedded grey shale and limestone of Ordovician age. The fissile shale is interbedded with non-fissile calcareous shale, limestone, dolostone, and calcareous sandstone (conventionally grouped together as “limestone”) which are typically laterally discontinuous. Per the appended terminology, the Georgian Bay shale is typically classified as “weak” whereas the limestone interbedding is classified as “medium strong to strong”. The percentage of strong limestone beds in each run is reported on the rock core logs. The overall percentage of limestone found in Borehole 1, 201, 205, and 208 were 10%, 18%, 17%, and 8%, respectively.

Joints occurring within the shale are closely to very closely spaced, and typically weathered with a veneer to coating of clay. Widely-spaced subvertical joints (closed, planar, clean) were also observed within the shale.

A summary of the engineering properties of the Georgian Bay Formation is presented in the Ontario Ministry of Transportation and Communications document RR229, *Evaluation of Shales for Construction Projects* (March 1983). The relevant parameters from that document are as follows:

Summary of MTO Georgian Bay Formation Parameters

	Uniaxial Compressive Strength (MPa)	Young’s Modulus (GPa)	Dynamic Modulus (GPa)	Poisson’s Ratio
Average	28	4	19	0.19
Range	8 to 41	0.5 to 12	6 to 38	0.1 to 0.25

Rock core samples were submitted for testing of unconfined compressive strength (ASTM D7012) and elastic moduli in uniaxial compression (ASTM D7012). The detailed rock laboratory testing results are appended. The test results are summarized as follows:

Borehole ID	Core ID	Depth (m)	Elevation (m)	Bulk Density (kg/m^3)	UCS (MPa)	Young's Modulus, E (GPa)	Lithology
205	CS1	12.5 - 12.7	125.6 - 125.4	2634	20.7	3.4	Shale
201	CS2	11.7 - 11.9	126.5 - 126.3	2605	19.0	2.1	Shale

Directly below the overburden soils, the uppermost portion of bedrock is typically weathered. The MTO (Ontario Ministry of Transportation and Communications document RR229, *Evaluation of Shales for Construction Projects)* provides a *typical weathering profile of a low durability shale* reproduced from Skempton, Davis, and Chandler, which characterizes weathered versus unweathered shale as follows:

Typical Weathering Profile of a Low Durability Shale

	Zone	Description	Notes
Fully Weathered	IVb	Soil-like matrix only	indistinguishable from glacial drift deposits, slightly clayey, may be fissured
Partially Weathered	IVa	Soil-like matrix with occasional pellets of shale less than 3 mm dia.	little or no trace of rock structure, although matrix may contain relic fissures
	III	Soil-like matrix with frequent angular shale particles up to 25 mm dia.	moisture content of matrix greater than the shale particles
	II	angular blocks of unweathered shale with virtually no matrix separated by weaker chemically weathered but intact shale	spheroidal chemical weathering of shale pieces emanating from relic joints and fissures, and bedding planes
Unweathered (Sound)	I	shale	regular fissuring

In glacial till overburden soils directly overlying bedrock, a zone of till with fragmented shale is often observed and interpreted as either the lowest portion of the till, or as partially weathered Zone III rock. This interpretation is subjective and depends on the investigator. There is occasionally a concentration of boulders in the soil just above the bedrock that can be mistakenly identified as bedrock where rock coring is not performed. Weathering Zones III and IV are frequently not present due to glacial scouring action, which often removes these zones from the bedrock surface.

The bedrock surface as indicated on the Borehole Logs from this investigation is intended to be consistently interpreted as the surface of Zone II unless noted otherwise. Based on examination of the rock cores from this site, the partially weathered rock (Zone II) ranges between 4.5 and 1.0 metres thick at the locations of Boreholes 1, 201, 205 and 208. Weathered and sound bedrock elevations are summarized as follows:

Borehole	**Ground Surface Elevation (m)**	**Partially Weathered (Zone II) Bedrock**		**Unweathered/Sound (Zone I) Bedrock**	
		Depth (m)	**Elevation (m)**	**Depth (m)**	**Elevation (m)**
1	137.9	3.0	134.9	7.5	130.4
2	138.0	3.8	134.2	n/a	n/a
3	138.2	3.8	134.4	n/a	n/a
201	138.2	4.6	133.6	8.1	130.1
202	137.9	4.6	133.3	n/a	n/a
203	138.0	4.6	133.4	n/a	n/a
204	136.6	3.0	133.6	n/a	n/a
205	138.1	3.0	135.1	7.1	131.0
206	137.1	3.0	134.1	n/a	n/a
207	136.7	3.0	133.7	n/a	n/a
208	138.8	3.0	135.8	6.9	131.9

n/a: bedrock not cored – sound bedrock elevation not observed

Rock Quality Designation (RQD) is an index measurement that refers to the total length of pieces of sound core in a core run that are at least 100 mm in length, expressed as a percentage of the total length of that core run. Only natural discontinuities are used in assessing RQD. The RQD of the recovered rock cores ranged from 0% to 23% in the weathered bedrock, and varies between 25% and 100% in the sound bedrock.

RQD underrepresents the competency of the Georgian Bay Formation and is not appropriate for horizontally bedded fissile shale. In this formation, the RQD is typically low due to the fissility of the shale as well as the closely spaced horizontal bedding planes. Our results are typical of this formation.

There are near-vertical joint sets within this shale that are typically very widely spaced at over 2 m apart. There are also several faults typically referred to as “shear zones” found within the formation, which are observed as zones of rock rubble within the cores. These faults defy discovery in conventional vertical boreholes.

The jointing and crush zones in the rock are related to the state of stress in the deposit. Research in the Greater Toronto Area has revealed that the bedrock contains locked-in horizontal stresses that could be remnants of the foreshortening that occurred in the earth’s crust during continental glaciation several thousand years ago. Documented experiments have indicated that the major principal stress is of the order of 2 MPa in the upper 1 to 2 metres of the deposit where the rock is weathered and contains more fractures. Intact rock can have an internal major principal stress as high as 4 to 5 MPa. The major and minor principal stresses are horizontal and may be oriented in any direction. The empirical approach to vertical stress below the top of bedrock is to use a uniform pressure distribution below the top of bedrock elevation that is equal to the maximum earth pressure calculated for the lowest level of soil in the profile.

The Georgian Bay Formation has been known to issue gases when penetrated. There are instances where both methane and hydrogen sulphide gas emissions have been detected in excavations made in the Georgian Bay Formation. While there was no specific indication of gas emissions from the boreholes made in this investigation, the potential for gas emissions from this formation is recognized as a design issue to be addressed.

2.2 Groundwater

The depth to groundwater and caved soils was measured in each of the boreholes immediately following the drilling. On completion of drilling, Boreholes 1, 201, 205, and 208 was filled with drill fluid (from rock coring) and measuring the unstabilized groundwater level after drilling was not practical. Monitoring wells were installed in select boreholes, and stabilized groundwater levels were measured in each of the monitoring wells one week after the completion of drilling. The boreholes were cased by hollow stem augers on completion, and cave measurement was not practical.

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 measured (m)**	
		Depth to cave (m)	**Unstabilized water level (m)**		**Date**	**Depth/Elev.**
1	20.3	n/a	Filled with drill water	Bedrock	2022-06-27	4.1 / 133.8
2	20.2	n/a	Dry	Bedrock	2024-05-10	3.9 / 134.1
3	23.5	n/a	Dry	Glacial Till / Bedrock	2024-04-16	4.2 / 134.0
201	16.5	n/a	Filled with drill water	Bedrock	2024-04-16	**3.9 / 134.3**
205	15.6	n/a	Filled with drill water	Bedrock	2024-04-10	5.7 / 132.4
207	3.1	n/a	Dry	Fill / Glacial Till	2024-04-16	2.1 / 134.6
208	7.2	n/a	Filled with drill water	Bedrock	2024-04-26	4.6 / 134.2

Groundwater levels 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 for engineering purposes is at Elev. 134.3± m.

The groundwater table is in the bedrock which has a very low permeability and will yield minor seepage in the long-term via fractures in the weathered and sound zones.

Grounded has prepared a hydrogeological report for this site (File No. 22-087) under separate cover.

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 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 results are appended.

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:

- Two of the samples have negligible sulphate concentrations. One sample did not have enough soil to complete the analysis due to limited recovery during drilling.
- 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:

Table 2.1 – Relationship Between Grain Size and Frost Susceptibility (MTO)

Grain Size Percentage between 5 and 75 µm	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:

Table 2.2 – Summary of Susceptibility to Frost Heave

Stratum	Grain Size Percentage between 5 and 75 µm	Susceptibility to Frost Heaving
Earth Fill	Est. 25 to 50%	Low to Moderate
Glacial Till	30 to 45%	Low to Moderate

3 Geotechnical Engineering Recommendations

Based on the factual data summarized above, geotechnical engineering recommendations are provided. 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 Foundation Design Parameters

The proposed development will include two P3 parking structures, which will both extend several metres into the bedrock.

Footings stepped from one level to another should be at a slope not exceeding 1 vertical to 1 horizontal for the above bearing pressures to be applicable. There must be a minimum of 300 mm between the edge of any footing and the top of a sloped 2V:1H sound rock cut down to another footing.

When exposed to ambient environmental temperatures in the Greater Toronto Area, the design earth cover for frost protection of foundations and grade beams is 1.2 metres. The lowest levels of unheated underground parking structures two or more levels deep are, although unheated, still warmer than typical outdoor winter temperatures in the Greater Toronto Area. Interior foundations (or pile caps) with 900 mm of frost cover perform adequately, as do perimeter foundations with 600 mm of frost cover. Where foundations are next to ventilation shafts or are exposed to typical outdoor temperatures, 1.2 m of earth cover (or equivalent insulation) is required for frost protection.

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. The bedrock surface can weather and deteriorate on exposure to the atmosphere or surface water; hence, foundation bases which remain open for an extended period of time should be protected by a skim coat of lean concrete.

Foundations made below the proposed P3 levels (Elev. 125.9 and 128.5 m) will bear on sound bedrock. Conventional spread footings made to bear on sound bedrock may be designed using a maximum factored geotechnical resistance at ULS of 10 MPa. The net geotechnical reaction at SLS is 6 MPa, for an estimated total settlement of 25 mm.

Individual spread footing foundations must be at least 1000 mm wide and must be embedded a minimum of 600 mm below FFE. 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.

3.2 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 top 30 metres of the site stratigraphy, 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.

Below the nominal founding elevations (for spread footings or grade beams) of 128-125± metres, the boreholes observed sound bedrock. Based on this information, the site designation for seismic analysis is **Class B**, 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.

3.3 Earth Pressure Design Parameters

At this site, the design parameters for structures subject to unbalanced earth pressures such as basement walls and retaining walls 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	21	32	0.31	0.47	3.25
Sound Bedrock	26	28		n/a	

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

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

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

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 rock 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)

3.4 Rock Swell

The earth pressure design approach for foundation walls below the top of bedrock is empirical and assumes a uniform pressure distribution below the top of bedrock elevation equal to the maximum earth pressure calculated for the lowest level of soil overtop. This approach is conventional and likely conservative, but it is practical insofar as it acknowledges that requirement of having a foundation wall of a consistent width at the lower levels.

However, this approach does not recognize the potential for pressures on the basement wall due to time-dependent rock swell that results when locked in horizontal stresses are released. For structures deeper than 2 m below the top of sound rock, rock swell must also be considered. The simplest approach to dealing with rock swell is scheduling. If there is a 120-day gap between rock excavation and construction of the permanent structure that will restrain the rock, experience on similar structures indicates the rock will de-stress and swell, and no significant stresses are imposed on the structural wall. This requirement typically only impacts the lowest basement level (or two) in bedrock, acknowledging the 120-day window.

If the construction schedule does not allow for a 120-day gap, mitigation measures will be required. For structures subjected unbalanced rock swell pressure (i.e. lowest exterior foundation walls, sumps, elevators, other features cast directly against the rock face), rock squeeze effects can be addressed by providing a crushable layer between the rock and the concrete, such as 50 mm thick Ethafoam 220 Polyethylene Foam planks. The subject walls are typically designed for the 50% compressive strength resistance of the foam. At 50% compression, a 220 Ethafoam 220 Polyethylene Foam plank provides 124 kPa of resistance. At 10% compression (which allows for concrete placement), this material provides 50 kPa of resistance.

Deeper protrusions (sumps, elevator pits, etc.) can be over-excavated as they are not typically constrained by the property lines or adjacent footings. In this case the rock can be horizontally over-excavated by a minimum 600 mm on all sides. Precast pits and sumps are then placed and backfilled with 19 mm clear stone (OPSS.MUNI 1004). The clear stone backfill then accommodates the rock swell.

Rock squeeze effects are not relevant to foundation excavations as the earth pressures exerted on foundation elements are balanced, and concrete is strong enough to resist the swell pressure and render it null.

3.5 Slab on Grade Design Parameters

The lowest basement slabs of the proposed structures (P3) will be approximately 10 to 12± metres below grade; and will therefore be set on sound bedrock, which constitutes an adequate subgrade for support of a slab on grade. The modulus of subgrade reaction appropriate for design of the slab resting on an aggregate drainage layer overlying unweathered (sound) bedrock is 80,000 kPa/m.

The slab on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slab on a minimum 300 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state.

Subfloor drains are typically installed in trenches below the capillary moisture break drainage layer per the typical detail appended. If trenches are to be avoided for whatever reason, the subfloor drainage system can be incorporated into the capillary moisture break and drainage layer. In this case, the subfloor drains are laid directly on the flat subgrade and backfilled with a minimum 300 mm thick layer of 19 or 9.5 mm clear stone (OPSS.MUNI 1004), High Performance Bedding (HPB), or approved equivalent, vibrated to a dense state. Any solid collection pipes must be sloped so that they positively discharge to the sumps.

The use of excavated bedrock spoil to restore subgrade elevations is to be specifically prohibited. This bedrock spoil cannot be adequately compacted to provide support for the slab on grade and is not to be reused below any settlement sensitive areas.

3.6 Long-Term Groundwater and Seepage Control

For a conventional drained basement approach, perimeter and subfloor drainage systems are required for the underground structure. Subfloor drainage collects and removes the seepage that infiltrates under the floor. Perimeter drainage collects and removes seepage that infiltrates at the foundation walls. Typical basement drainage details are appended.

Subfloor drainage pipes are to be spaced at an average 6 m (measured on-centres). If subdrain elevation conflicts with top of footing elevation, footings should be lowered as necessary.

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.

The walls of the substructure are to be fully drained to eliminate hydrostatic pressure. Where drained basement walls are made directly against shoring, prefabricated composite drainage panel covering the blind side of the wall is used to provide drainage. Seepage from the composite drainage panel is collected and discharged through the basement wall in solid ports directly to the sumps. A layer of waterproofing placed between the drain core product and the basement wall should be considered to protect interior finishes from moisture.

The perimeter and subfloor drainage systems are critical structural elements since they eliminate hydrostatic pressure from acting on the basement walls and floor slab. The sumps that ensure the performance of these systems must have a duplexed pump arrangement providing 100% redundancy, and they must be on emergency power. The sumps should be sized by the mechanical engineer to adequately accommodate the estimated volume of water seepage.

The permanent dewatering requirements are provided in Grounded’s Hydrogeological Report (File No. 22-087).

If any water is to be discharged to the storm or sanitary sewers, the City of Mississauga and/or the Region of Peel will require Discharge Agreements to be in place.

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, native soil, or bedrock. 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 within the bedrock, any water must be pumped from the base of the excavation. 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.

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

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.

Excavated shale material (i.e. if there is over-excavation at the perimeter of the foundations) is not a suitable material for backfill of the excavations. The shale cannot be broken down and effectively compacted. If buried, reused shale will slake and collapse with time. Over-excavation can be restored with lean concrete (minimum 10 MPa unconfined compressive strength).

4 Pavement Engineering Recommendations

4.1 Pavement on Top of Parking Structure

It is expected that most of the pavements will be placed on top of the reinforced concrete parking structures and not on soil subgrade. In this case, the pavements resting on top of the concrete parking structure should consist of the following:

Component	Compaction Requirement	Pavement on Concrete Parking Structure Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	50 mm
Granular Base Course Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm
Total Thickness		**240 mm**

A waterproof membrane will be required between the asphalt and concrete parking structure deck. For pavements placed on top of the underground parking structure, all drainage, waterproofing, and protection considerations for these areas must be designed separately and in conjunction with the civil engineering design of the underground parking structure. Wherever they have to connect to the adjacent roadways or driveways, those adjacent pavement profiles will be different and so taper transitions and run-outs must be designed for the connections.

4.2 Asphalt Pavement on Soil Subgrade

The following design pertains to asphaltic concrete pavements (‘pavement’) where the pavement will rest on a soil subgrade.

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.

4.2.1 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 recompacted 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 existing subgrade 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.

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.

4.2.2 Asphalt 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.

<u>Performance</u> 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.

4.2.3 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

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:

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 238 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.

Bedrock is not considered a soil under the Act. Vertical excavations made in sound bedrock are generally self-supporting provided the rock bedding is horizontally oriented. If deemed necessary, rock bolts can be used to anchor a layer of protective mesh that will protect workers from loose rock spalling from the face of excavation. The rock face must be inspected by Grounded to determine that no other support system is required to prevent the spalling of loose rock, and to confirm that all loose spall material at risk of falling upon a worker is removed (Section 233 of the above noted regulations).

The exposed vertical bedrock face deteriorates with time and exposure. Exposed excavation faces have been found to flake and recede as much as 300 mm within a 12 month exposure. This recession generally takes the form of coin-sized shale particles dropping from the face on a constant basis. If deemed necessary, debris netting draped over the rock face can be used to contain and collect these coin-sized shale particles.

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 governed by Ontario Regulation 406/19: On-Site and Excess Soil Management (ESM). 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.

Excavations will penetrate weathered and sound bedrock. Georgian Bay Formation bedrock is a rippable rock that can be removed with conventional excavation equipment once it has been broken by ripper tooth or hoe ram. Creating detailed excavation shapes for foundations etc. is normally accomplished by hoe ram. The removal of rock from a vertical face without over-excavation, which can happen inadvertently by dislodging additional rock, is largely dependent on machine operator skill. If excavation faces must be made neat (such as beside an existing footing), a line of excavation can be provided by line drilling the rock a series of closely-spaced vertical holes (100 mm diameter, spaced at 300 mm on centre) to provide a preferential vertical break path for the excavation face.

Georgian Bay Formation bedrock contains beds of harder calcareous beds (e.g. limestone). When excavating this bedrock, it should be expected that these harder layers will be encountered. Hard layers interbedded within the shale are normally broken with hoe mounted hydraulic rams before excavation.

Limestone beds may also be found to straddle the founding elevation, in which case the entire thickness of the hard limestone layer must be removed to expose founding subgrade as it is not possible to remove part of one of these layers. This will in turn result in excess rock removal not intrinsic to the project requirements. The risk and responsibility for the excess rock removal under these circumstances, and the supply and placement of the extra concrete to restore the foundation grade, must be addressed in the contract documents for foundations, excavation, and shoring contractors.

The Georgian Bay Formation has been known to issue gases. There are instances where both methane and hydrogen sulphide gas emissions have been detected in excavations made in the Georgian Bay Formation. The potential for gas emissions from this formation is recognized as a design and constructability issue to be addressed.

5.2 Short-Term Groundwater Control

Considerations pertaining to groundwater discharge quantities and quality are discussed in Grounded’s hydrogeological report for the site (File No. 22-087), under separate cover.

The design groundwater table at Elev. 134.6± m is above the bulk excavation level for the P3 underground structures. The soils and bedrock at the site are generally low permeability geological units. On this basis, groundwater may be allowed to drain into the excavations and then pumped out. The volume of seepage anticipated in open excavations is limited to the extent that temporary pumping from the excavations is expected to sufficiently control groundwater seepage. Regardless, excavation delays will occur as seepage (however limited) is controlled. These delays should be anticipated in the construction schedule. Positive dewatering of the bedrock is not required. Groundwater seepage is expected to be handled by conventional sump pump arrangements.

A professional dewatering contractor should be consulted to review the subsurface conditions and to design a site-specific dewatering system. It is the dewatering contractor's responsibility to assess the factual data and to provide recommendations on dewatering system requirements.

The City of Mississauga and/or 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 Earth-Retention Shoring Systems

No excavation shall extend below the foundations of existing adjacent structures without adequate alternative support being provided.

Excavation zone of influence guidelines are appended.

Continuous interlocking caisson wall shoring is to be used where the excavation must be constructed as a rigid shoring system. Caisson wall shoring preserves the support capabilities and integrity of the soil beneath existing foundations of adjacent buildings, in a state akin to the at-rest condition. Otherwise, excavations can be supported using conventional soldier pile and lagging walls.

The excavation for the P3 level will extend below the foundations of existing adjacent structures in bedrock. The excavation walls must be inspected by the geotechnical engineer for any fracturing or movement during excavation and construction. Based on the inspection, Grounded may recommend additional monitoring (e.g. multi-point borehole extensometers (MPBX)) or additional rock mass support such as a combination of shotcrete, rock pins, or rock bolts for alternative support. Rock mass support must be designed by the Geostructural Engineer, in consultation with the Geotechnical Engineer of Record.

5.3.1 Lateral Earth Pressure Distribution

If the shoring is supported with a single level of earth anchor or bracing, a triangular earth pressure distribution like that used for the basement wall design is appropriate.

Where multiple rows of lateral supports are used to support the shoring walls, research has shown that a distributed pressure diagram more realistically approximates the earth pressure on a shoring system of this type, when restrained by pre-tensioned anchors. A multi-level supported shoring system can be designed based on an earth pressure distribution with a maximum pressure defined by:

$$\boldsymbol{P = 0.8\,K[\gamma H + q] + \gamma_w h_w}$$

P = maximum horizontal pressure (kPa)
K = earth pressure coefficient (see Section 3.3)
H = total depth of the excavation (m)
h_w = height of groundwater (m) above the base of excavation
γ = soil bulk unit weight (kN/m3)
q = total surcharge loading (kPa)

Where shoring walls are drained to effectively eliminate hydrostatic pressure on the shoring system (e.g. pile and lagging walls), h_w is equal to zero. For the design of impermeable shoring, a design groundwater table at Elev. 134.6± m must be accounted for.

In cohesive soils, the lateral earth pressure distribution is trapezoidal, uniformly increasing from zero to the maximum pressure defined in the equation above over the top and bottom quarter (H/4) of the shoring.

Where the excavation penetrates the bedrock, the rock excavation is nominally self-supporting in a vertical face, provided the rock bedding is horizontally oriented. The requirement for extending lagging into partially weathered rock depends on the quality of the excavation cut and the degree of weathering.

5.3.2 Soldier Pile Toe Embedment

Soldier pile toes will be made in sound bedrock. Soldier pile toes resist horizontal movement due to the passive earth pressure acting on the toe below the base of excavation. The maximum factored vertical geotechnical resistance at ULS for the design of a pile embedded in the sound bedrock is 10 MPa. The maximum factored lateral geotechnical resistance at ULS of the undisturbed rock is 1 MPa.

Exposed bedrock of the Georgian Bay Formation deteriorates with time. Within 12 months of exposure, excavation faces made within this bedrock flake and recede as much as 300 mm, generally in the form of coin-size shale particles dropping from the face on a constant basis. The deteriorated rock loses internal integrity and bearing capability. Solider piles for the shoring system are typically advanced at least 1 metre below the base of the excavation (to be confirmed by the geostructural engineer) to accommodate this weathering and still ensure that the required lateral and vertical bearing resistances can be utilized.

5.3.3 Lateral Bracing Elements

The shoring system at this site will require lateral bracing. If feasible, the shoring system should be supported by pre-stressed rock anchors (tiebacks) extending into the subgrade of the adjacent properties. To limit the movement of the shoring system as much as is practically possible, tiebacks are installed and stressed as excavation proceeds. The use of tiebacks through adjacent properties requires the consent (through encroachment agreements) of the adjacent property owners.

Conventional earth anchors made in Georgian Bay Formation bedrock can be designed using a working adhesion of 620 kPa. Anchors made in the glacial till tend to creep over time and therefore anchors should be made in the bedrock.

At least one prototype anchor per tieback level must be performance-tested to 200% of the design load to demonstrate the anchor capacity and validate design assumptions. Given the potential variability in soil conditions or installation quality, all production anchors must also be proof-tested to 133% of the design load.

The sound bedrock below the proposed FFE is suitable for the placement of raker foundations. Raker footings established on sound bedrock at an inclination of 45 degrees can be designed for a maximum factored geotechnical resistance at ULS of 2500 kPa.

5.4 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.

The exposed Georgian Bay Formation deteriorates with time. Exposed excavation faces have been found to flake and recede as much as 300 mm with 12 months exposure. This recession generally takes the form of coin size shale particles dropping from the face on a constant basis. The deteriorated rock loses internal integrity and bearing capability. If bedrock is to be exposed for prolonged periods of time, it is recommended that a skim coat of concrete be used to protect the surface of bedrock from slaking and other degradation resulting from weathering.

5.5 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 and geostructural 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.

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 should be monitored by Grounded at the time of construction to confirm material quality, and thickness.

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.

6 Limitations and Restrictions

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

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 hollow stem augers. Rock coring was carried out with HQ size diamond bit core drilling barrels. 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 this 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 UPRC c/o Kindred Works 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/regional governing bodies may 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,

GROUNDED
ENGINEERING

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Senior Geotechnical Engineer

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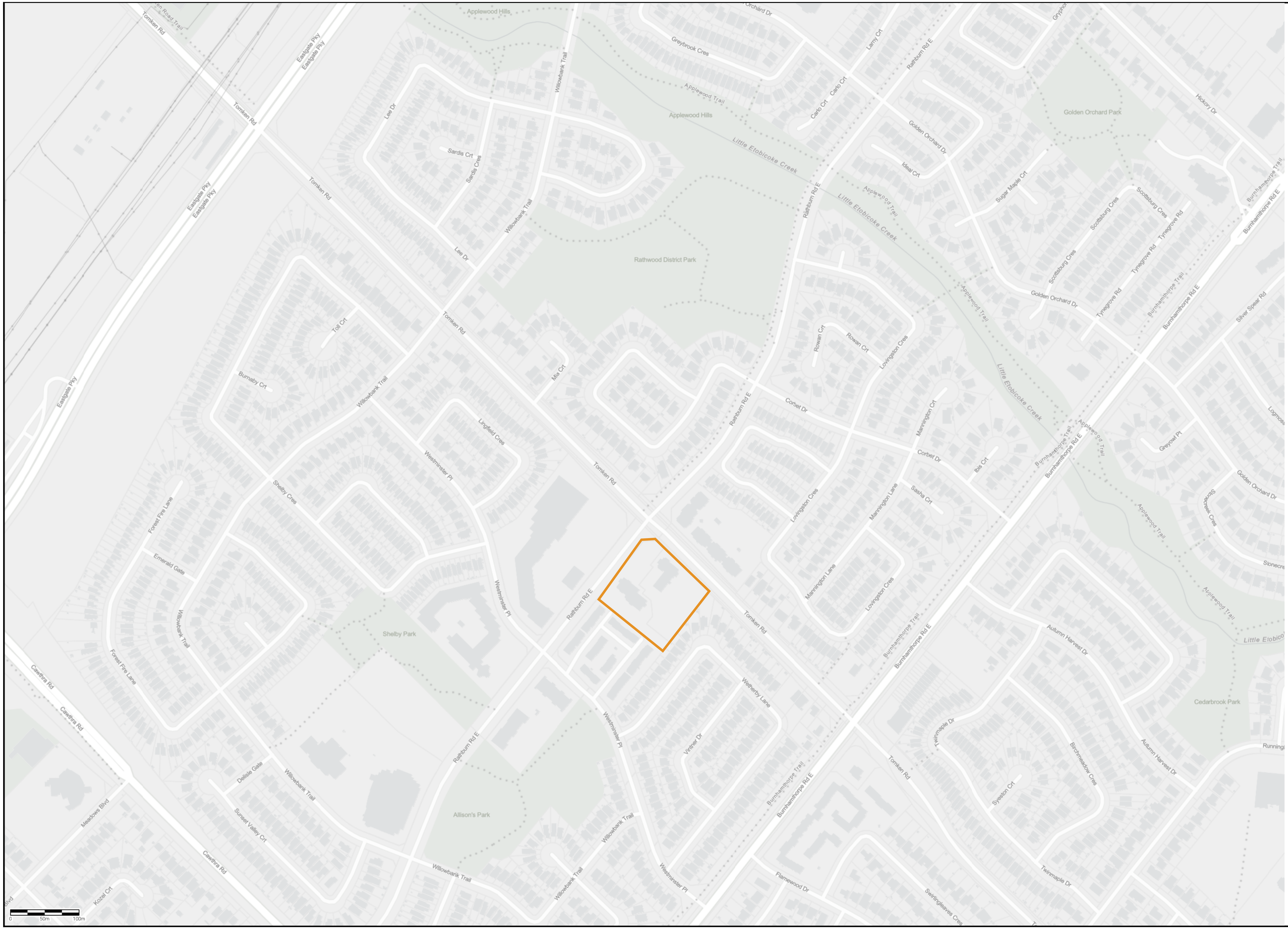
Principal

FIGURES



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LEGEND

APPROXIMATE PROPERTY BOUNDARY

Note

Reference

ArcGIS Map 2022

Project

UPRC - WESTMINSTER, MISSISSAUGA, ONTARIO

Figure Title

SITE LOCATION

North

TRUE
PROJECT

Date

MAY 2024

Scale

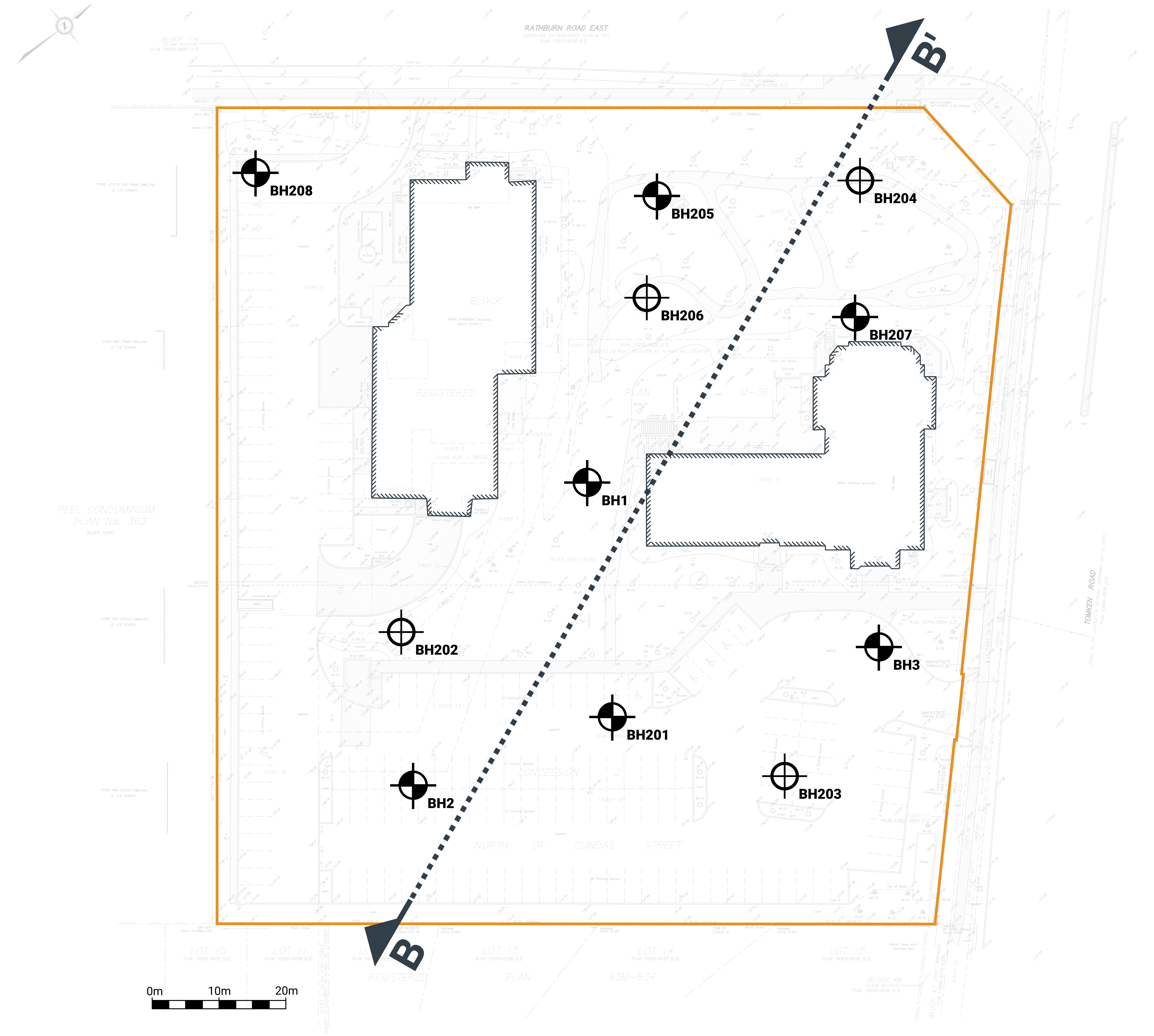
AS INDICATED

Job No

22-087

Figure No

FIGURE 1



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LEGEND

— APPROXIMATE PROPERTY BOUNDARY

▨ EXISTING BUILDING STRUCTURE

▲- - -▲ CROSS SECTION LINE

Note

Reference

Survey Drawing Job no. 201-0277
Completed Dated: December 3, 2021.
Prepared by Speight, Van Nostrand & Gibson Limited
Received on June 6 2022.

Project

UPRC - WESTMINSTER, MISSISSAUGA, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - EXISTING SITE CONDITIONS

North

PROJECT

TRUE

Date

MAY 2024

Scale

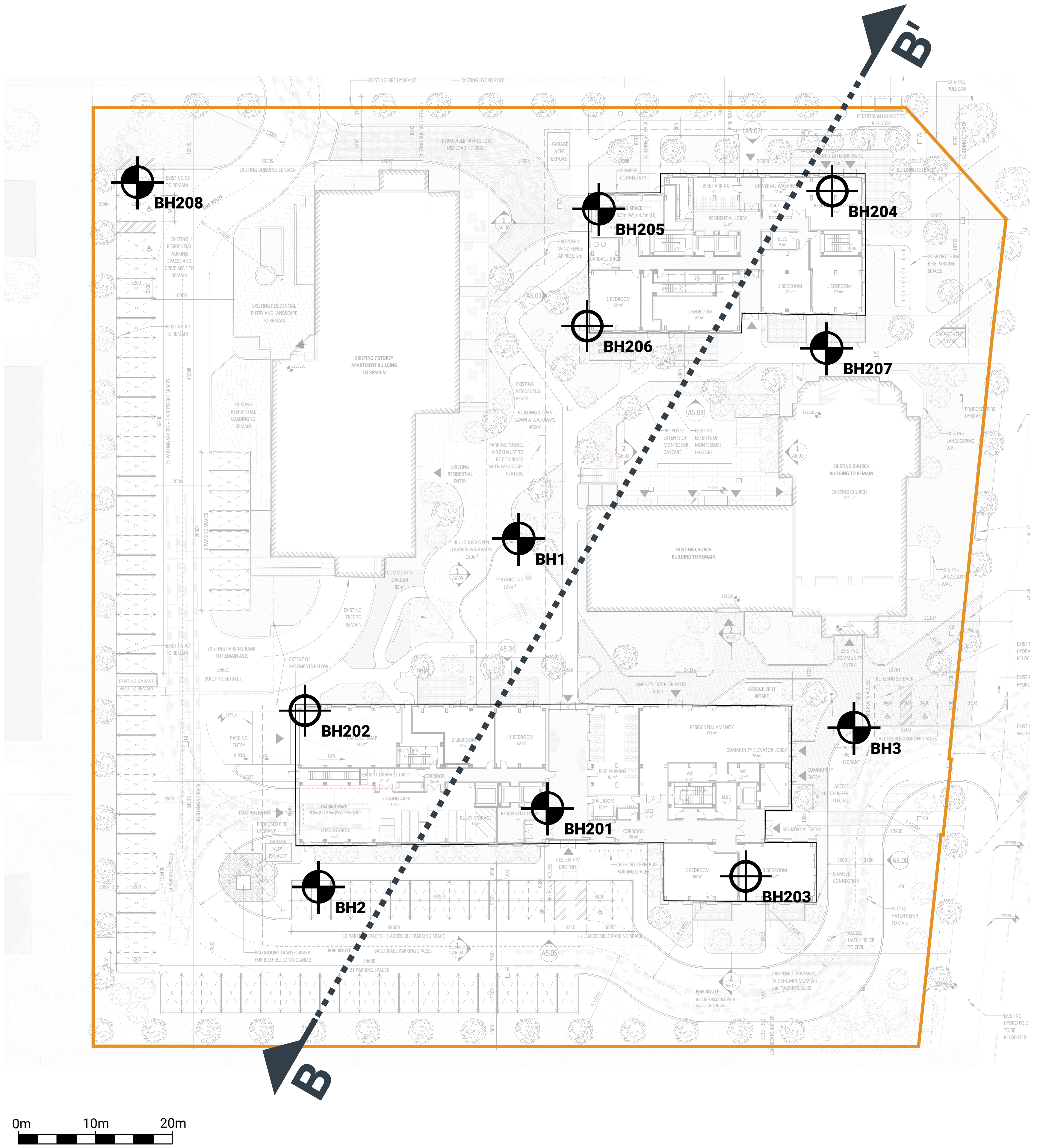
AS INDICATED

Job No

22-087

Figure No

FIGURE 2



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LEGEND

🟧	APPROXIMATE PROPERTY BOUNDARY
—	APPROX EXTENT OF PROPOSED BUILDING STRUCTURE
▲- -▲	CROSS SECTION LINE

Note

Reference

Architectural Drawing, "Kindred Works Westminster United Mississauga, 4094 Tomken Rd, Mississauga, ON, L4W 1J5", job no. 2112
Dated April 12, 2024
Prepared by KPMB ARCHITECTS.

Project

UPRC - WESTMINSTER, MISSISSAUGA, ONTARIO

Figure Title

BOREHOLE AND MONITORING WELL LOCATION PLAN - PROPOSED SITE CONDITIONS

North

TRUE
PROJECT

Date

JULY 2024

Scale

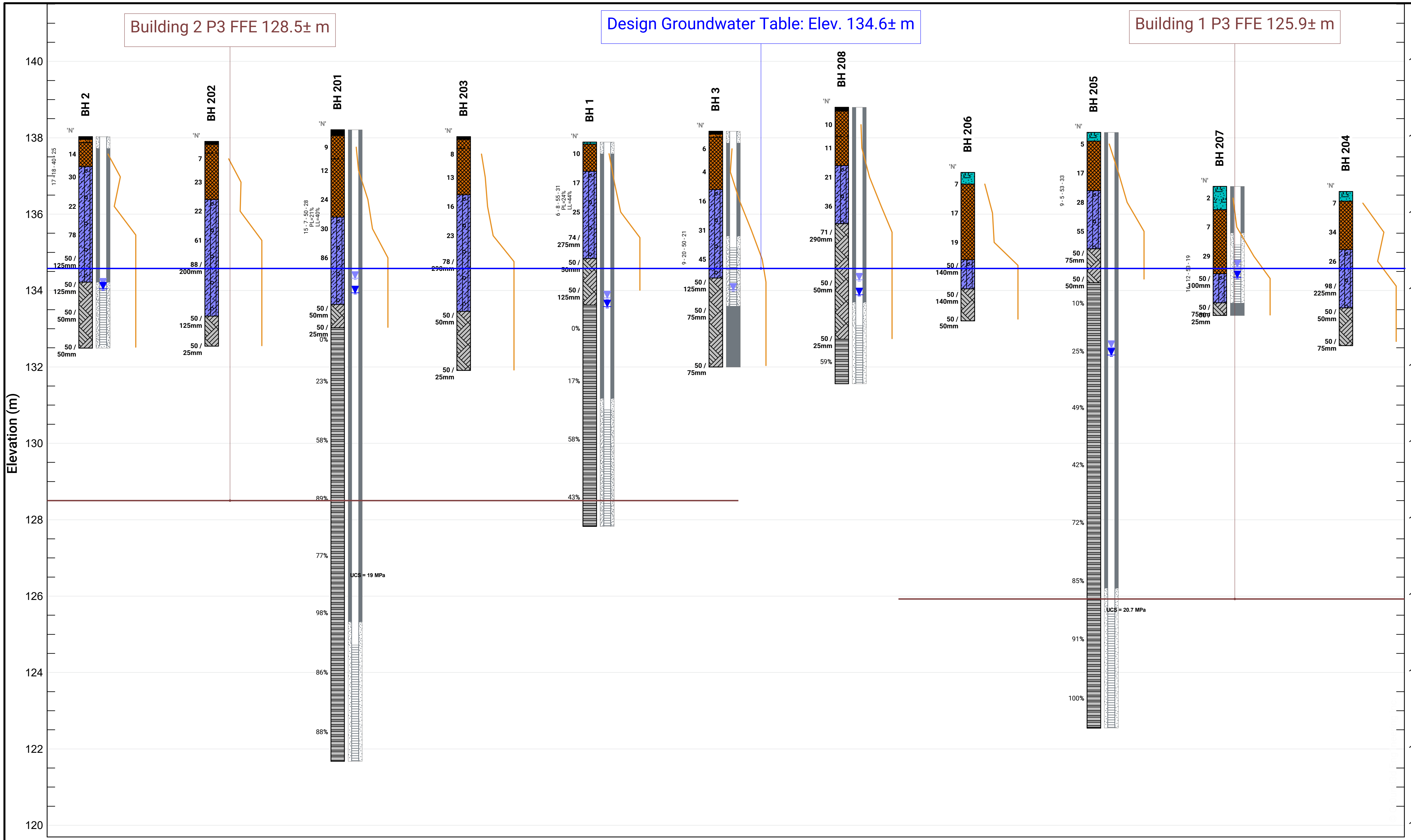
AS INDICATED

Job No

22-087

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

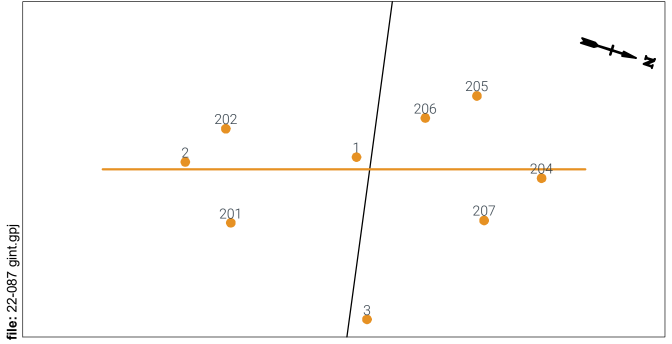
▽ water level, unstabilized

▼ water level, stabilized (latest)

▼ water level, stabilized (highest)

SITE MAP

Alignment: B-B'



Boreholes Equally Spaced

BOREHOLE STRATIGRAPHY LEGEND

▨ Topsoil

▨ Bedrock (cored)

▨ Fill

■ Asphalt

▨ Clayey Silt Till

▨ Aggregate

▨ Bedrock (inferred)

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Project

UPRC - WESTMINSTER - 4094 TOMKEN RD. MISSISSAUGA, ON

Figure Title

SUBSURFACE PROFILE

B-B'

Date

JULY 2024

Scale

AS INDICATED

Job No

22-087

Figure No

FIGURE 5

APPENDIX A

BOREHOLE LOG TERMINOLOGY

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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
▽ unstabilized water level
▼ water level measurement
▼ highest 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
silt***y***	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.

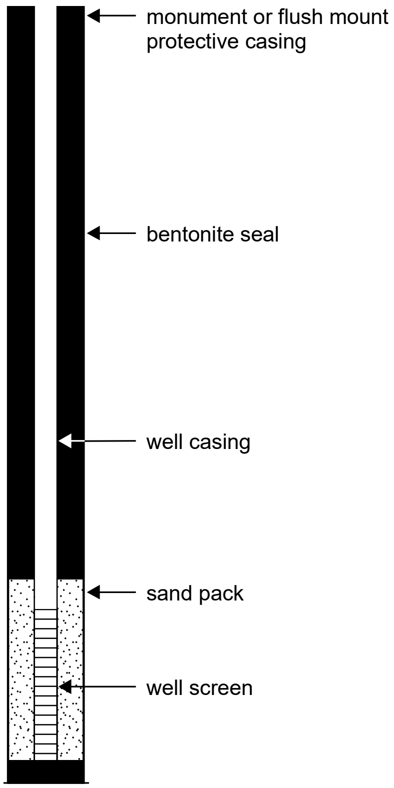
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



ROCK CORE TERMINOLOGY (MTO SHALE)

TCR	**Total Core Recovery** the total length of recovery (soil or rock) per run, as a percentage of the drilled length
SCR	**Solid Core Recovery** the total length of sound full-diameter rock core pieces per run, as a percentage of the drilled length
RQD	**Rock Quality Designation** the sum of all pieces of sound rock core in a run which are 10 cm or greater in length, as a percentage of the drilled length

Natural Fracture Frequency (typically per 0.3 m) The number of natural discontinuities (joints, faults, etc.) which are present per 0.3m. Ignores mechanical or drill-induced breaks, and closed discontinuities (e.g. bedding planes).

LOGGING DISCONTINUITIES

Discontinuity Type

BP	bedding parting
CL	cleavage
CS	crushed seam
FZ	fracture zone
MB	mechanical break
IS	infilled seam
JT	Joint
SS	shear surface
SZ	shear zone
VN	vein
VO	void

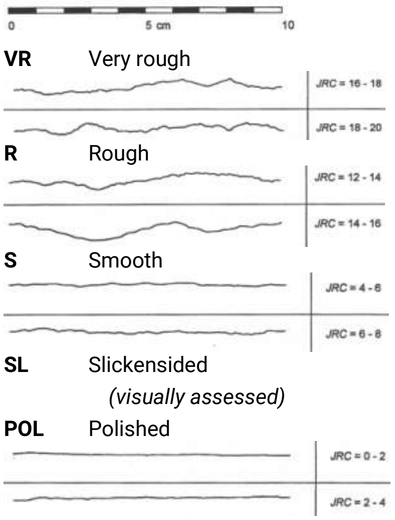
Coating

CN	Clean
SN	Stained
OX	Oxidized
VN	Veneer
CT	Coating (>1 mm)

Dip Inclination

H	horizontal/flat	0 - 20°
D	dipping	20 - 50°
SV	sub-vertical	50 - 90°
V	vertical	90±°

Roughness (Barton et al.)



VR	Very rough
R	Rough
S	Smooth
SL	Slickensided *(visually assessed)*
POL	Polished

Spacing in Discontinuity Sets
(ISRM 1981)

VC	very close	< 60 mm
C	close	60 – 200 mm
M	mod. close	0.2 to 0.6 m
W	wide	0.6 to 2 m
VW	very wide	> 2 m

Aperture Size

T	closed / tight	< 0.5 mm
GA	gapped	0.5 to 10 mm
OP	open	> 10 mm

Planarity

PR	Planar
UN	Undulating
ST	Stepped
IR	Irregular
DIS	Discontinuous
CU	Curved

GENERAL

Degree of Weathering (*after MTO, RR229 Evaluation of Shales for Construction Projects*)

Zone	**Degree**	**Description**
Z1	unweathered	shale, regular jointing
Z2	partially weathered	angular blocks of unweathered shale, no matrix, with chemically weathered but intact shale
Z3		soil-like matrix with frequent angular shale fragments < 25mm diameter
Z4a		soil-like matrix with occasional shale fragments < 3mm diameter
Z4b	fully weathered	soil-like matrix only

Strength classification (*after Marinos and Hoek, 2001; ISRM 1981b*)

Grade		**UCS (MPa)**	**Field Estimate (Description)**
R6	extremely strong	> 250	can only be chipped by geological hammer
R5	very strong	100 - 250	requires many blows from geological hammer
R4	strong	50 - 100	requires more than one blow from geological hammer
R3	medium strong	25 - 50	can't be scraped, breaks under one blow from geological hammer
R2	weak	5 - 25	can be peeled / scraped with knife with difficulty
R1	very weak	1 - 5	easily scraped / peeled, crumbles under firm blow of geo. hammer
R0	extremely weak	< 1	indented by thumbnail

Bedding Thickness (*Q. J. Eng. Geology, Vol 3, 1970*)

Very thickly bedded	> 2 m
Thickly bedded	0.6 – 2m
Medium bedded	200 – 600mm
Thinly bedded	60 – 200mm
Very thinly bedded	20 – 60mm
Laminated	6 – 20mm
Thinly Laminated	< 6mm

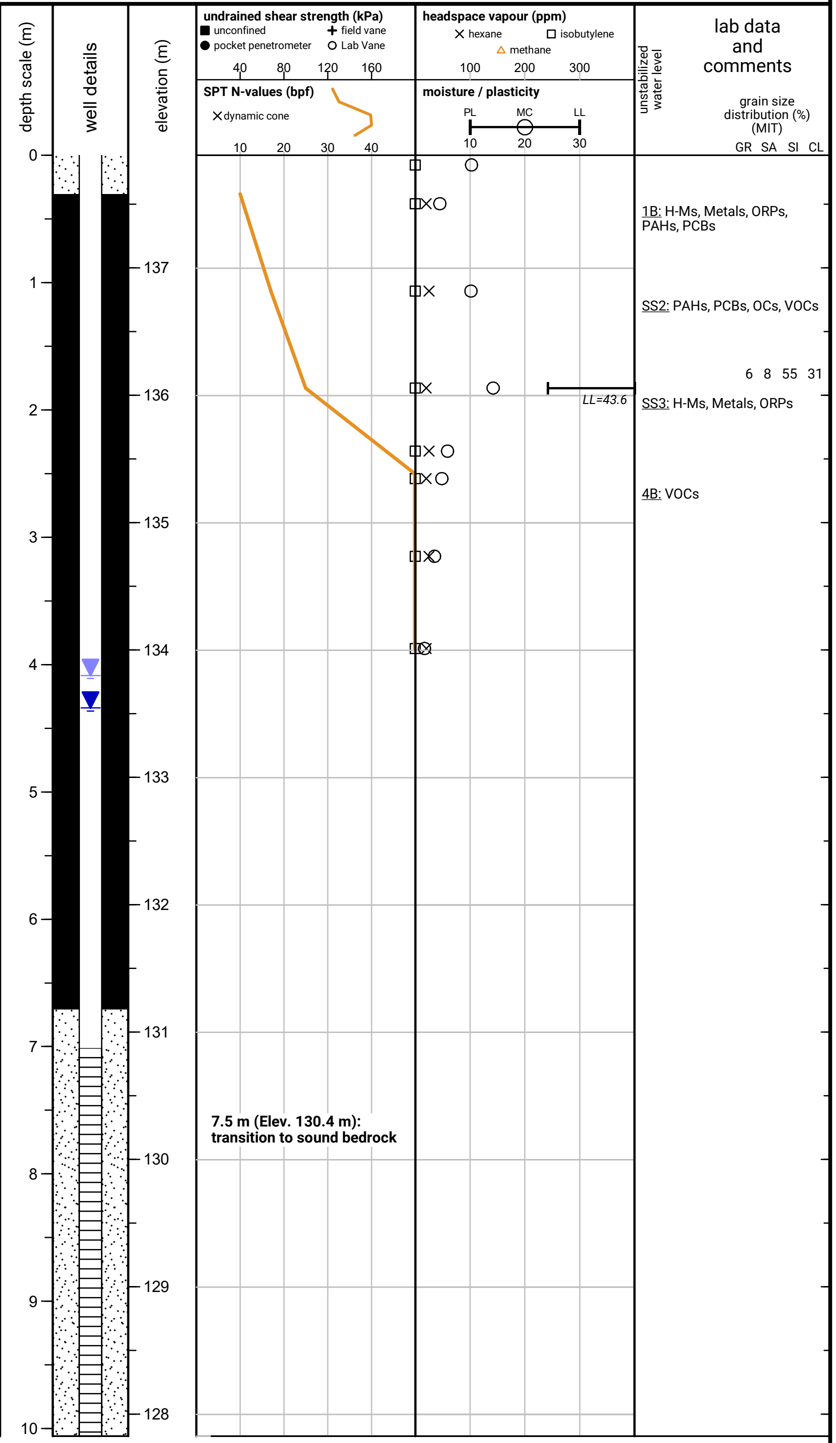
GROUNDED ENGINEERING

Date Started : Jun 10, 2022
Position : E: 611693, N: 4830108 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 1

File No. : 22-087
Project : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON
Client : UPRC

drill method : B-57	elev depth (m)	stratigraphy description	samples number	samples type	SPT N-value
	137.9	**GROUND SURFACE**			
hollow stem augers OD=215 mm		50mm **TOPSOIL**	1A		
		FILL, sandy silt, clayey, trace gravel, trace rock fragments, compact, brown, moist	1B	SS	10
	137.1 0.8	**CLAYEY SILT**, trace sand, trace gravel, orange staining, very stiff, brownish grey, moist (GLACIAL TILL)	2	SS	17
			3	SS	25
		...at 2.4 m, some shale and limestone fragments, hard	4A 4B	SS	74 / 275mm
	134.9 3.0	**INFERRED BEDROCK**, shale fragments, limestone fragments, grey	5	SS	50 / 50mm
			6	SS	50 / 125mm
rock coring (HQ) OD=96 mm	133.6 4.3	**GEORGIAN BAY FORMATION** (See rock core log for details)	1	RUN	
			2	RUN	
			3	RUN	
			4	RUN	
	127.8 10.1	**END OF BOREHOLE**			



Borehole was filled with drill water upon completion of drilling.

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

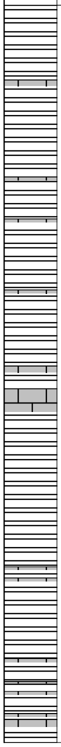
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 27, 2022	4.1	133.8
Jul 29, 2022	4.2	133.7
Aug 18, 2022	4.4	133.5
Apr 16, 2024	4.3	133.6
Apr 26, 2024	4.3	133.6
May 10, 2024	4.3	133.6
May 24, 2024	4.3	133.6
Jun 7, 2024	4.3	133.6

Date Started : Jun 10, 2022
Position : E: 611693, N: 4830108 (UTM 17T)
Elev. Datum : Geodetic

ROCK CORE LOG 1

File No. : 22-087
Project : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON
Client : UPRC



stratigraphy

Rock coring started at 4.3m below grade

GEORGIAN BAY FORMATION
Shale, grey, very thinly bedded to medium bedded, weak; joints are horizontal, closed, clean, smooth, planar;

interbedded with **limestone**, light grey, laminated to thinly bedded, medium strong, occasionally fossiliferous

Overall shale: 90%, limestone: 10%

Run 1 : 4% limestone
96% shale

Run 2 : 5% limestone
95% shale

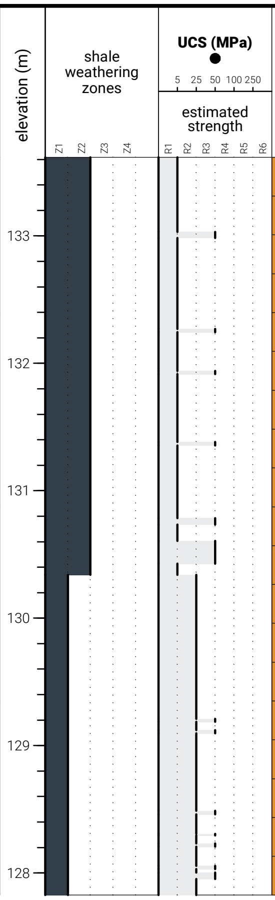
... at 7.5 m (Elev. 130.4 m), transition to sound rock

Run 3 : 15% limestone
85% shale

Run 4 : 12% limestone
88% shale

END OF COREHOLE

Run elev depth (m)	recovery
133.6	
4.3 R1 132.4	TCR = **88%** SCR = **56%** RQD = **0%**
5.5 R2 130.9	TCR = **97%** SCR = **63%** RQD = **17%**
7.0 R3 129.4	TCR = **83%** SCR = **67%** RQD = **58%**
8.5 R4 127.8	TCR = **103%** SCR = **98%** RQD = **43%**
10.1m	



natural fracture frequency
>10
>10
6
4
6
>10
5
3
4
N/A
RZ+5
2
3
2
3
3
1
2
3

laboratory testing

notes and comments

4.3 / 133.6 - 4.6 / 133.3m: Rubblized Zone
4.7 / 133.2m: JT T CN
5.6 / 132.3m: IS clay
5.6 / 132.3m: JT T CN
5.8 / 132.1m: Rubblized Zone
5.9 / 132.0m: IS clay
6.2 / 131.6m: IS clay
6.5 / 131.4m: JT T CN
6.7 / 131.2m: JT T CN
7.0 / 130.9 - 7.3 / 130.6m: No recovery, washed out
8.5 / 129.4m: IS clay
9.0 / 128.9m: Rubblized Zone

elevation (m)
133
132
131
130
129
128

file: 22-087 gint.gpi

Tech : AJ | **PM** : SB | **Rev** : KB

GROUNDED ENGINEERING

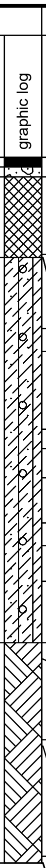
Date Started : Jun 8, 2022
Position : E: 611712, N: 4830055 (UTM 17T)
Elev. Datum : Geodetic

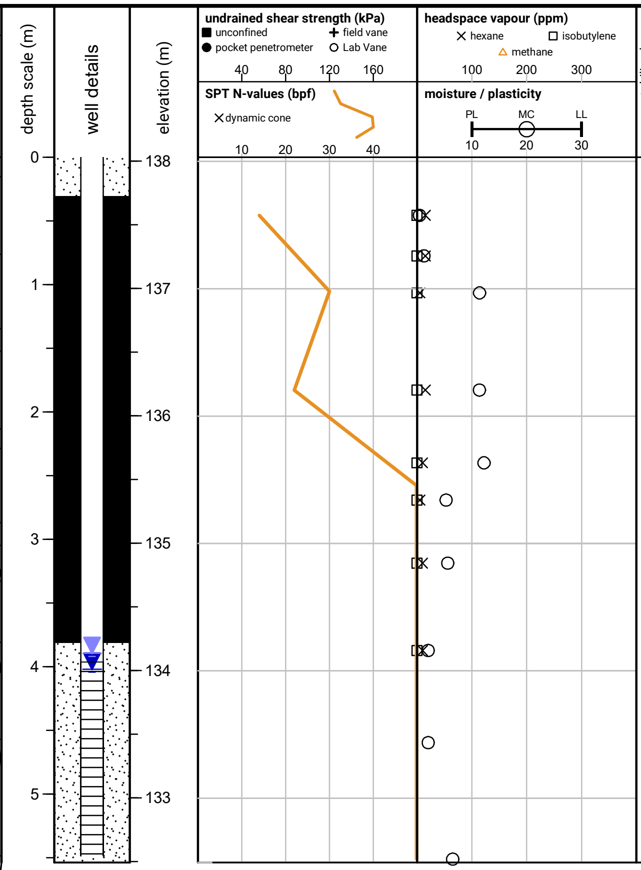
BOREHOLE LOG 2

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

drill method : B-57
hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value	lab data and comments (grain size distribution (%) (MIT) GR SA SI CL)
138.0	**GROUND SURFACE**				
137.8 0.2	75mm **ASPHALT**				
	75mm **AGGREGATE**				
	FILL, sand, trace silt, trace gravel, stiff, brown, moist	1	SS	14	
137.2 0.8	**CLAYEY SILT**, some sand, trace gravel, orange staining, hard, brownish grey, moist (GLACIAL TILL)	2A 2B	SS	30	17 18 40 25 2B: PAHs, PCBs, VOCs
	...at 1.5 m, very stiff	3	SS	22	SS3: H-Ms, Metals, ORPs
	...at 2.3 m, trace rock fragments, grey, hard	4A 4B	SS	78	4B: H-Ms, Metals, ORPs, OCs
		5	SS	50 / 125mm	SS5: PAHs, PCBs, VOCs
134.2 3.8	**INFERRED BEDROCK**, shale fragments, limestone fragments, grey	6	SS	50 / 125mm	
		7	SS	50 / 50mm	
132.5 5.5	...at 5.5 m, wet	8	SS	50 / 50mm	





END OF BOREHOLE

Borehole was dry upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 27, 2022	4.5	133.5
Jul 29, 2022	4.5	133.5
Aug 18, 2022	4.6	133.4
Apr 16, 2024	4.1	133.9
Apr 26, 2024	4.0	134.0
May 10, 2024	3.9	134.1
May 24, 2024	4.0	134.0
Jun 7, 2024	4.0	134.0

file: 22-087 gint.gpi

GROUNDED ENGINEERING

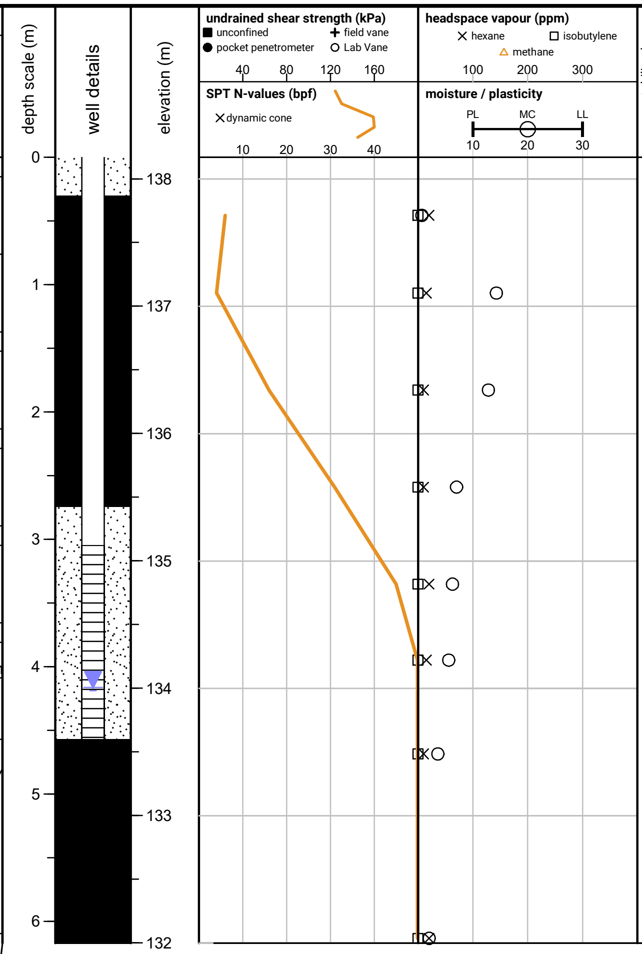
Date Started : Jun 8, 2022
Position : E: 611743, N: 4830128 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 3

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

drill method : B-57
hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value
138.2	**GROUND SURFACE**			
138.0 0.2	75mm **ASPHALT**			
	75mm **AGGREGATE**			
	FILL, sand, trace silt, trace gravel, loose, brown, moist ...at 0.8 m, clayey silt, some sand, trace black staining, grey, moist, firm	1	SS	6
		2	SS	4
136.7 1.5	**CLAYEY SILT**, some sand, trace gravel, orange staining, very stiff, brownish grey, moist (GLACIAL TILL) ...at 2.3 m, hard ...at 3.0 m, sandy	3	SS	16
		4	SS	31
		5	SS	45
134.4 3.8	**INFERRED BEDROCK**, shale fragments, limestone fragments, grey	6	SS	50 / 125mm
		7	SS	50 / 75mm
132.0 6.2		8	SS	50 / 75mm



lab data and comments	grain size distribution (%) (MIT) GR	SA	SI	CL
SS2: VOCs				
SS3: H-Ms, Metals, ORPs, PAHs, PCBs				
SS4: H-Ms, Metals, ORPs, PAHs, PCBs, OCs				
SS5: VOCs	9	20	50	21

END OF BOREHOLE

Borehole was dry upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 27, 2022	4.3	133.9
Jul 29, 2022	4.5	133.7
Aug 18, 2022	4.6	133.6
Apr 16, 2024	4.2	134.0
Apr 26, 2024	damaged	n/a
May 10, 2024	damaged	n/a

file: 22-087 gint.gpj

Tech : AJ | **PM** : SB | **Rev** : KB

GROUNDED
ENGINEERING

Date Started : Apr 3, 2024
Position : E: 611727, N: 4830075 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 201

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

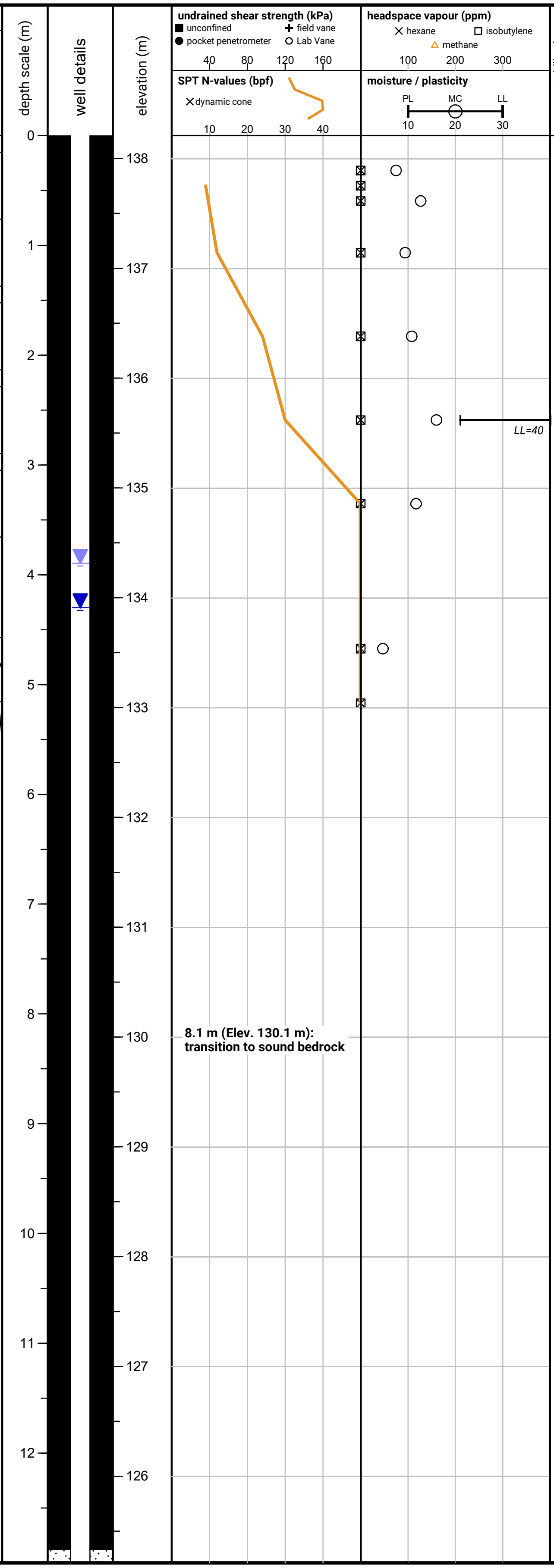
drill method : *CME TRACK*

hollow stem augers OD=215 mm

rock coring (HQ) OD=96 mm

elev / depth (m)	stratigraphy: description
138.2	**GROUND SURFACE**
138.0 / 0.2	150mm **ASPHALT**
	FILL, sand and gravel, trace silt, trace rock fragments, loose, brown, moist
137.4 / 0.8	**FILL**, clayey silt, trace to some sand, trace gravel, trace rock fragments, stiff to very stiff, grey with orange, moist
135.9 / 2.3	**CLAYEY SILT**, some gravel, trace sand, hard, grey with orange, moist (GLACIAL TILL) ...at 3.0 m, trace rock fragments, cobbles (inferred)
133.6 / 4.6	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist
133.0 / 5.2	**GEORGIAN BAY FORMATION** (See rock core log for details)

number	type	SPT N-value
1A	SS	9
1B	SS	
2	SS	12
3	SS	24
4	SS	30
5	SS	86
6	SS	50 / 50mm
7	SS	50 / 25mm
1	RUN	
2	RUN	
3	RUN	
4	RUN	
5	RUN	
6	RUN	



8.1 m (Elev. 130.1 m): transition to sound bedrock

lab data and comments

grain size distribution (%) (MIT)

GR	SA	SI	CL
15	7	50	28

SS2: BTEX, H-Ms, Metals, ORPs, PAHs, VOCs

1.5m: Auger grinding **to 1.8m**

3.4m: Auger grinding

4.6m: Auger grinding **to 5.2m**

5.2m: Auger refusal

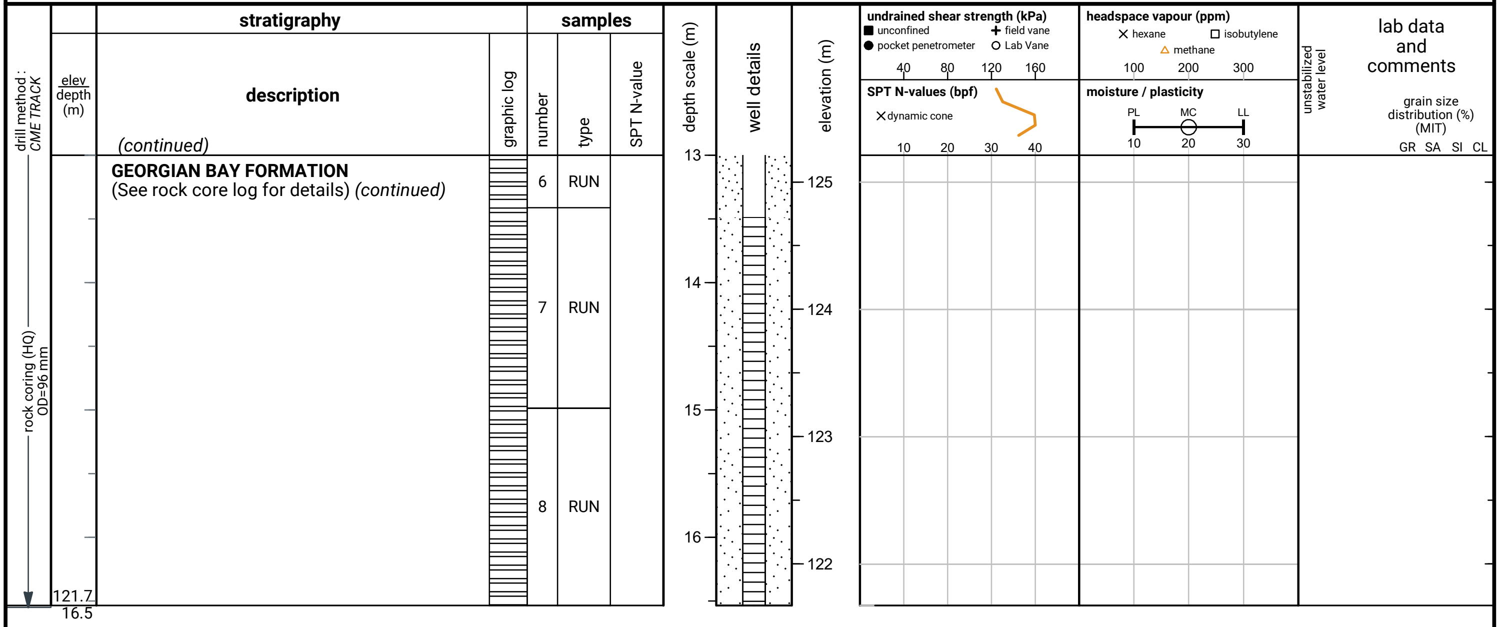
file: 22-087 gint.gpj

(continued next page)

Date Started : Apr 3, 2024
Position : E: 611727, N: 4830075 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 201

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC



GEORGIAN BAY FORMATION
(See rock core log for details) *(continued)*

number	type
6	RUN
7	RUN
8	RUN

END OF BOREHOLE

Borehole was filled with drill water upon completion of drilling.

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

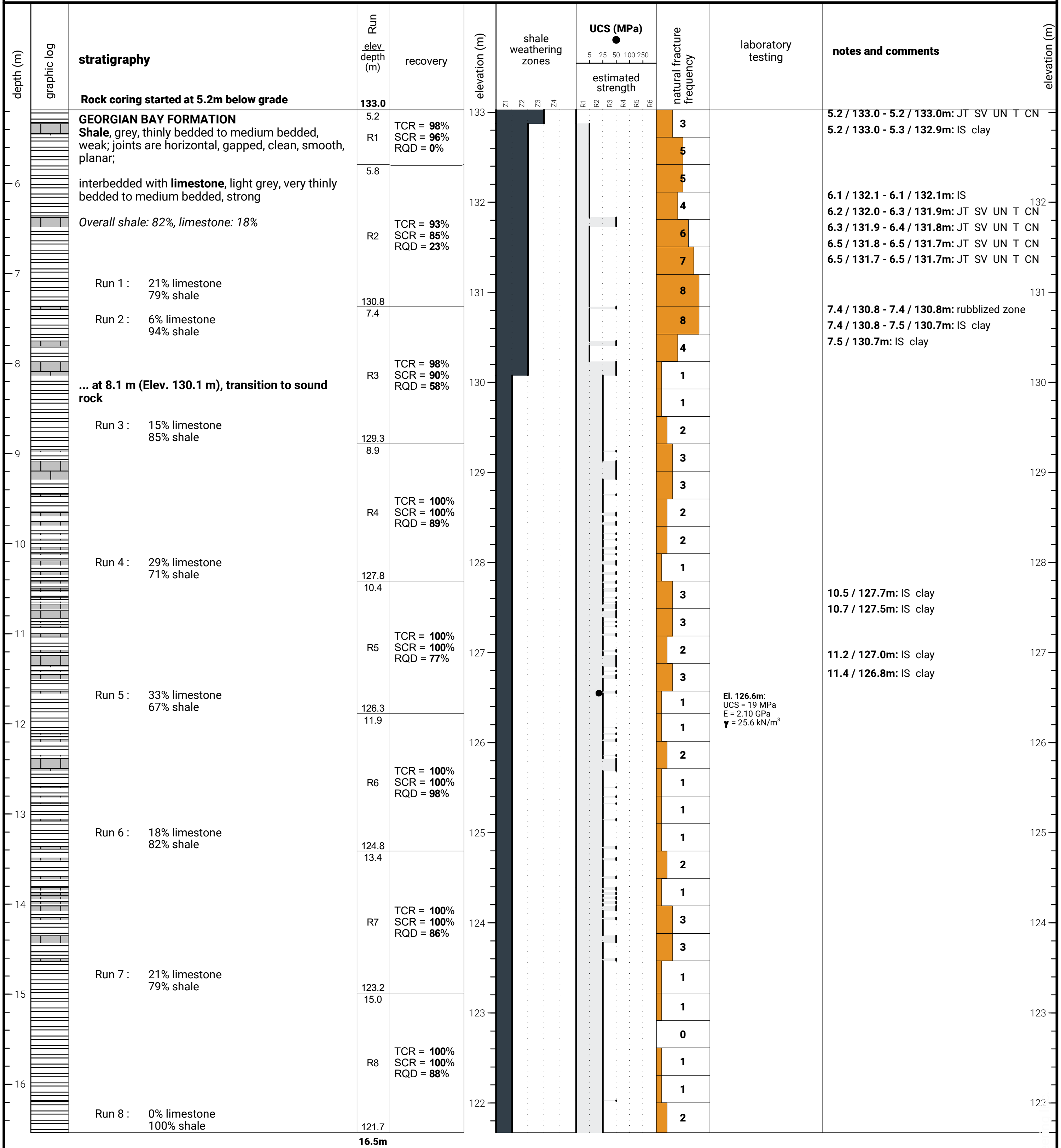
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 10, 2024	4.4	133.8
Apr 16, 2024	3.9	134.3
Apr 26, 2024	4.4	133.8
May 10, 2024	4.3	133.9
May 24, 2024	4.4	133.8
Jun 7, 2024	4.3	133.9

Date Started : Apr 3, 2024
Position : E: 611727, N: 4830075 (UTM 17T)
Elev. Datum : Geodetic

ROCK CORE LOG 201

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC



stratigraphy

Rock coring started at 5.2m below grade

GEORGIAN BAY FORMATION
Shale, grey, thinly bedded to medium bedded, weak; joints are horizontal, gapped, clean, smooth, planar;

interbedded with **limestone**, light grey, very thinly bedded to medium bedded, strong

Overall shale: 82%, limestone: 18%

Run 1 : 21% limestone, 79% shale

Run 2 : 6% limestone, 94% shale

... at 8.1 m (Elev. 130.1 m), transition to sound rock

Run 3 : 15% limestone, 85% shale

Run 4 : 29% limestone, 71% shale

Run 5 : 33% limestone, 67% shale

Run 6 : 18% limestone, 82% shale

Run 7 : 21% limestone, 79% shale

Run 8 : 0% limestone, 100% shale

END OF COREHOLE

Run	elev depth (m)	recovery
	133.0	
R1	5.2 – 5.8	TCR = 98% SCR = 96% RQD = 0%
R2	5.8 – 7.4 (130.8)	TCR = 93% SCR = 85% RQD = 23%
R3	7.4 – 8.9 (129.3)	TCR = 98% SCR = 90% RQD = 58%
R4	8.9 – 10.4 (127.8)	TCR = 100% SCR = 100% RQD = 89%
R5	10.4 – 11.9 (126.3)	TCR = 100% SCR = 100% RQD = 77%
R6	11.9 – 13.4 (124.8)	TCR = 100% SCR = 100% RQD = 98%
R7	13.4 – 15.0 (123.2)	TCR = 100% SCR = 100% RQD = 86%
R8	15.0 – 16.5m (121.7)	TCR = 100% SCR = 100% RQD = 88%

laboratory testing

El. 126.6m:
UCS = 19 MPa
E = 2.10 GPa
γ = 25.6 kN/m³

notes and comments

5.2 / 133.0 - 5.2 / 133.0m: JT SV UN T CN
5.2 / 133.0 - 5.3 / 132.9m: IS clay
6.1 / 132.1 - 6.1 / 132.1m: IS
6.2 / 132.0 - 6.3 / 131.9m: JT SV UN T CN
6.3 / 131.9 - 6.4 / 131.8m: JT SV UN T CN
6.5 / 131.8 - 6.5 / 131.7m: JT SV UN T CN
6.5 / 131.7 - 6.5 / 131.7m: JT SV UN T CN
7.4 / 130.8 - 7.4 / 130.8m: rubblized zone
7.4 / 130.8 - 7.5 / 130.7m: IS clay
7.5 / 130.7m: IS clay
10.5 / 127.7m: IS clay
10.7 / 127.5m: IS clay
11.2 / 127.0m: IS clay
11.4 / 126.8m: IS clay

file: 22-087 gint.gpj

Tech : LB | **PM** : EL/DL | **Rev** : KB

GROUNDED
ENGINEERING

Date Started : Apr 5, 2024
Position : E: 611697, N: 4830064 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 202

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

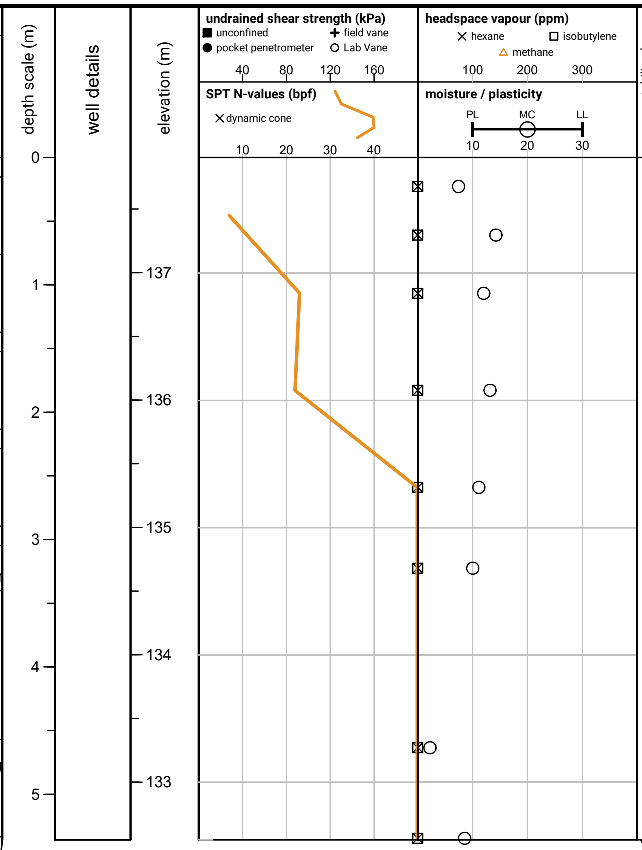
drill method : *CME TRACK*

hollow stem augers OD=215 mm

elev depth (m)	stratigraphy: description	samples: number	type	SPT N-value
137.9	**GROUND SURFACE**			
	75mm **ASPHALT**			
137.6 0.3	**FILL**, sand and gravel, trace silt, trace clay, loose, brown, moist	1A	SS	7
	FILL, clayey silt, trace sand, trace gravel, trace rock fragments, firm, greyish brown with orange, moist ...at 0.8 m, trace brick fragments, very stiff	1B	SS	
		2	SS	23
136.4 1.5	**CLAYEY SILT**, some gravel, trace sand, very stiff to hard (GLACIAL TILL)	3	SS	22
		4	SS	61
	...at 3.0 m, trace rock and shale fragments	5	SS	88 / 200mm
133.3 4.6	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	6	SS	50 / 125mm
132.5 5.4		7	SS	50 / 25mm

END OF BOREHOLE
Auger refusal on inferred bedrock

Borehole was dry upon completion of drilling.



unstabilized water level

lab data and comments

grain size distribution (%) (MIT)

GR SA SI CL

3.8m: Auger grinding **to 4.6m**

4.6m: Spoon bouncing
4.6m: Auger grinding **to 5.3m**

5.3m: Spoon bouncing

file: 22-087 gint.gpj

Tech : LB | **PM** : EL/DK | **Rev** : KB

Date Started : Apr 5, 2024
Position : E: 611758, N: 4830103 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 203

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

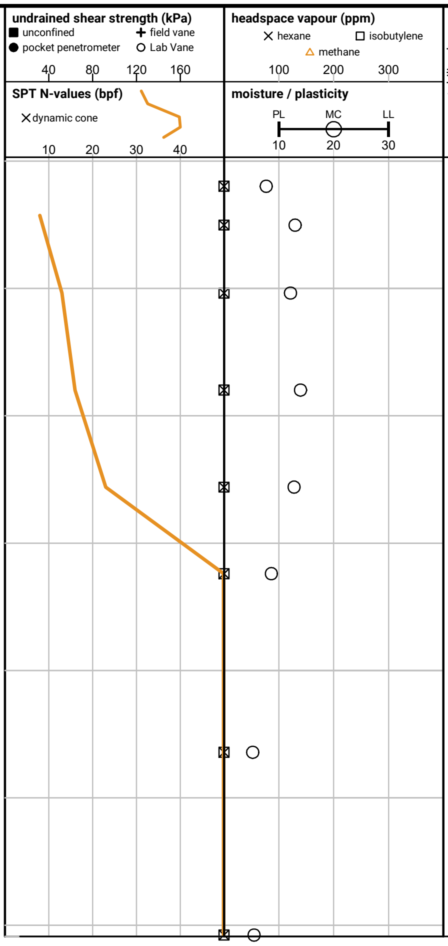
drill method : CME TRACK

hollow stem augers OD=215 mm

elev depth (m)	stratigraphy description	samples number	type	SPT N-value	lab data and comments
138.0	**GROUND SURFACE**				
	75mm **ASPHALT**	1A	SS		
137.7 0.3	**FILL**, sand and gravel, trace silt, loose, brown, moist	1B	SS	8	
	FILL, clayey silt, trace to some sand, trace gravel, firm, dark grey with orange, moist ...at 0.8 m, stiff	2	SS	13	
136.5 1.5	**CLAYEY SILT**, trace sand, trace gravel, very stiff, greyish brown to grey, moist (GLACIAL TILL)	3	SS	16	
		4	SS	23	
	...at 3.0 m, trace rock fragments, hard, grey with orange	5	SS	78 / 290mm	
					4.3m: auger grinding **to 4.6m**
133.4 4.6	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	6	SS	50 / 50mm	**4.6m:** auger grinding **to 5.2m**
131.9 6.1		7	SS	50 / 25mm	**6.1m:** spoon bouncing

END OF BOREHOLE
Auger refusal on inferred bedrock

Unstabilized water level measured at 5.9 m below ground surface upon completion of drilling.



depth scale (m): 0, 1, 2, 3, 4, 5, 6
elevation (m): 138, 137, 136, 135, 134, 133, 132
well details
unstabilized water level
grain size distribution (%) (MIT): GR SA SI CL

file: 22-087 gint.gpj

Tech : LB | **PM** : EL/DK | **Rev** : KB

Date Started : Apr 4, 2024
Position : E: 611681, N: 4830169 (UTM 17T)
Elev. Datum : Geodetic

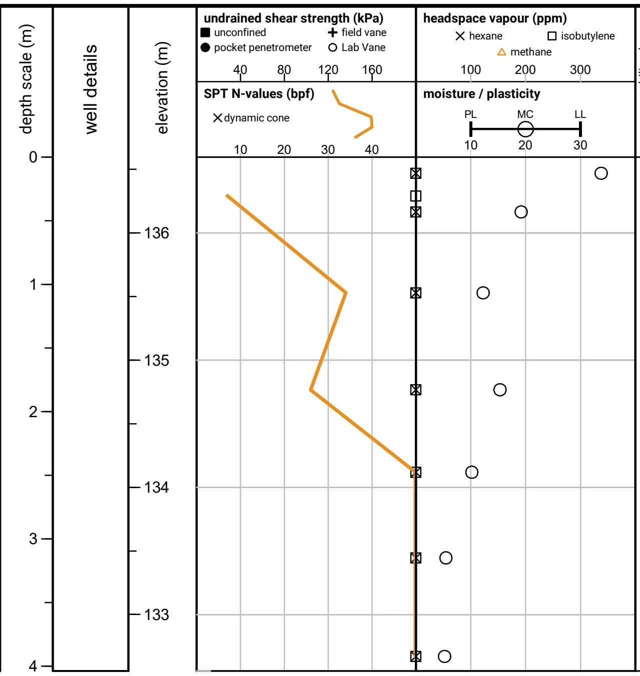
BOREHOLE LOG 204

File No. : 22-087   **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON   **Client** : UPRC

drill method : *CME TRACK*

hollow stem augers OD=215 mm

stratigraphy			samples		
elev depth (m)	description	graphic log	number	type	SPT N-value
136.6	**GROUND SURFACE**				
136.3	250mm **TOPSOIL**		1A	SS	7
0.3	**FILL**, clayey silt, trace to some sand, trace gravel, trace rootlets, firm, dark brown to greyish brown, moist ...at 0.8 m, rock fragments, hard		1B	SS	
			2	SS	34
135.1 1.5	**CLAYEY SILT**, some gravel, trace sand, very stiff, grey, moist (GLACIAL TILL)		3	SS	26
	...at 2.3 m, rock fragments, hard		4	SS	98 / 225mm
133.6 3.0	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist		5	SS	50 / 50mm
			6	SS	50 / 75mm
132.6 4.0					



unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

SS1B: H-Ms, Metals, ORPs, PAHs

SS2: VOCs

3.8m: Auger refusal

END OF BOREHOLE
Auger refusal on inferred bedrock

Borehole was dry upon completion of drilling.

file: 22-087 gint.gpi

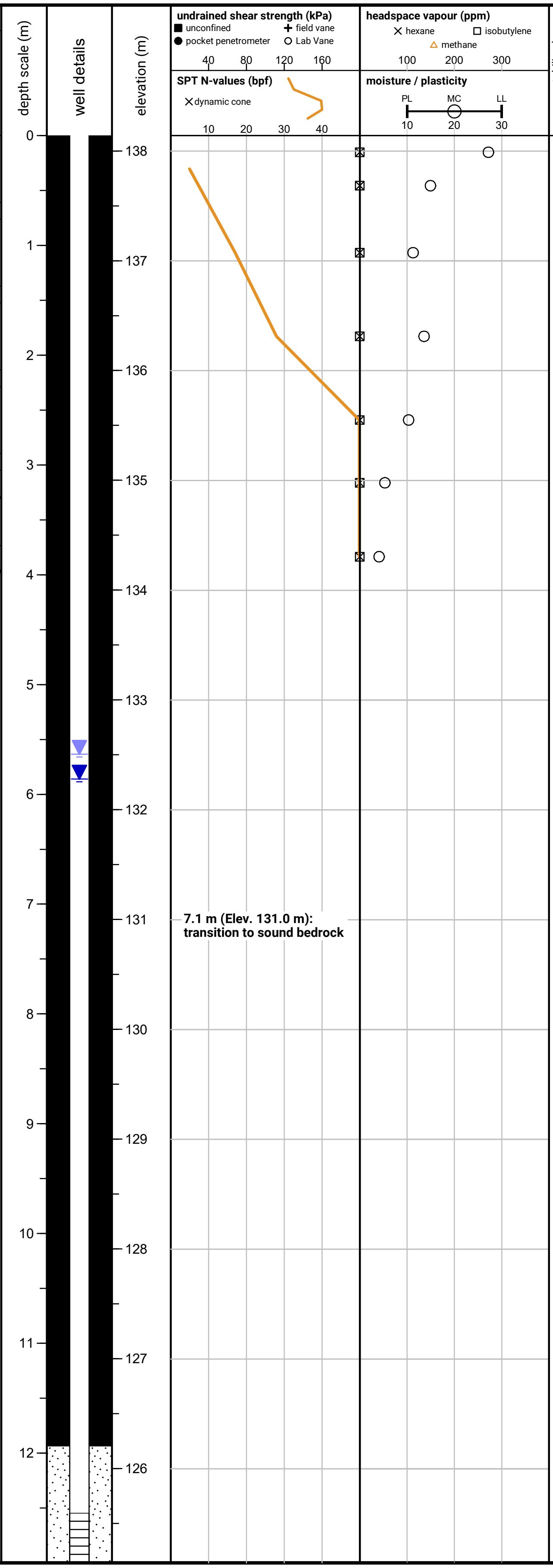
Tech : LB | **PM** : EL/DK | **Rev** : KB

Date Started : Apr 2, 2024
Position : E: 611662, N: 4830140 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 205

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

drill method : *CME TRACK*	elev depth (m)	stratigraphy description	samples number	type	SPT N-value
	138.1	**GROUND SURFACE**			
hollow stem augers OD=215 mm	137.9	225mm **TOPSOIL**	1A	SS	5
	0.2	**FILL**, clayey silt, trace to some sand, trace gravel, trace rootlets, firm, dark brown, moist	1B	SS	
		...at 0.8 m, very stiff	2	SS	17
	136.6 1.5	**CLAYEY SILT**, some gravel, trace sand, trace rock fragments, cobbles (inferred), very stiff to hard, grey, moist (GLACIAL TILL)	3	SS	28
			4	SS	55
	135.1 3.0	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	5	SS	50 / 75mm
			6	SS	50 / 50mm
rock coring (HQ) OD=96 mm	134.2 3.9	**GEORGIAN BAY FORMATION** (See rock core log for details)	1	RUN	
			2	RUN	
			3	RUN	
			4	RUN	
			5	RUN	
			6	RUN	
			7	RUN	



unstabilized water level

lab data and comments

grain size distribution (%) (MIT)

GR	SA	SI	CL
9	5	53	33

SS2: H-Ms, Metals, ORPs, PAHs, VOCs

SS4: VOCs

file: 22-087 gint.gpj

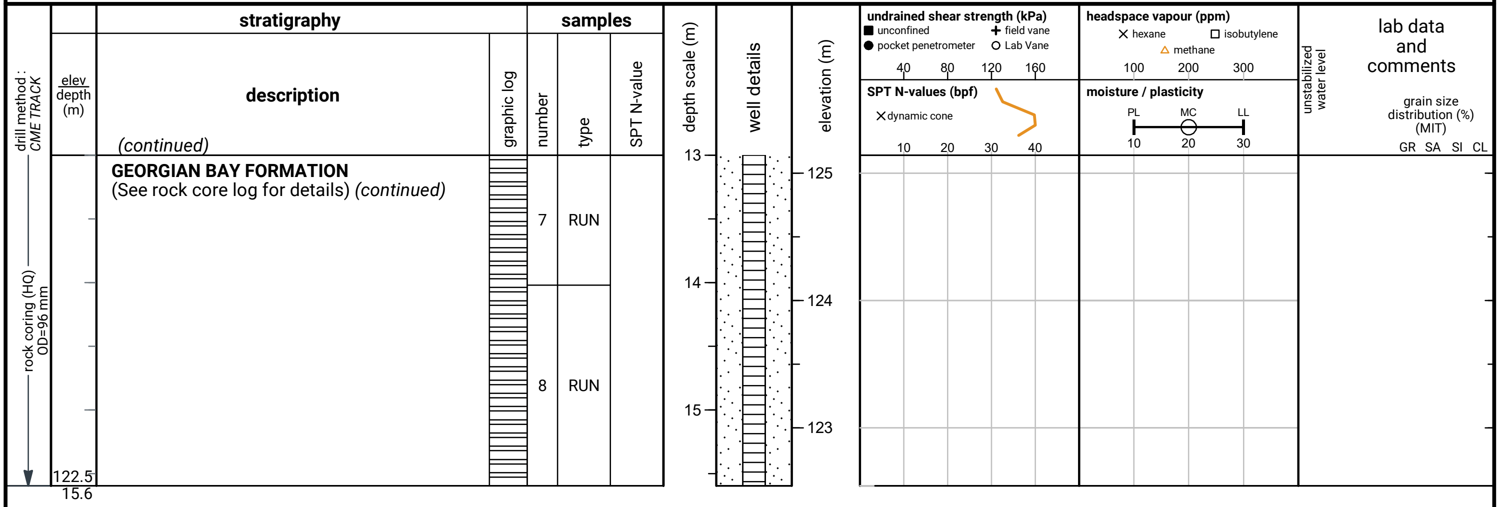
(continued next page)

GROUNDED ENGINEERING

Date Started : Apr 2, 2024
Position : E: 611662, N: 4830140 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 205

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC



END OF BOREHOLE

Borehole was dry upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 10, 2024	5.7	132.4
Apr 16, 2024	5.7	132.4
Apr 26, 2024	5.8	132.3
May 10, 2024	5.8	132.3
May 24, 2024	5.9	132.2
Jun 7, 2024	5.9	132.2

file: 22-087 gint.gpi

Tech : LB | **PM** : EL/DK | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Apr 2, 2024
Position : E: 611662, N: 4830140 (UTM 17T)
Elev. Datum : Geodetic

ROCK CORE LOG 205

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

Rock coring started at 3.9m below grade

GEORGIAN BAY FORMATION
Shale, grey, thinly bedded to medium bedded, weak; joints are horizontal, gapped, clean, smooth, planar;

interbedded with **limestone**, light grey, very thinly bedded to thinly bedded, strong

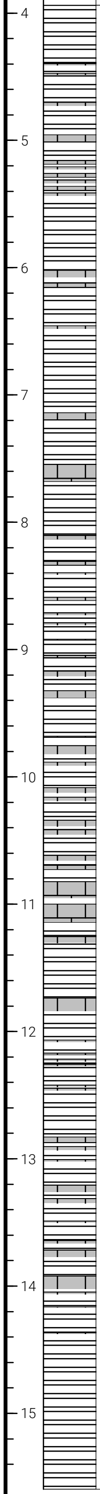
Overall shale: 83%, limestone: 17%

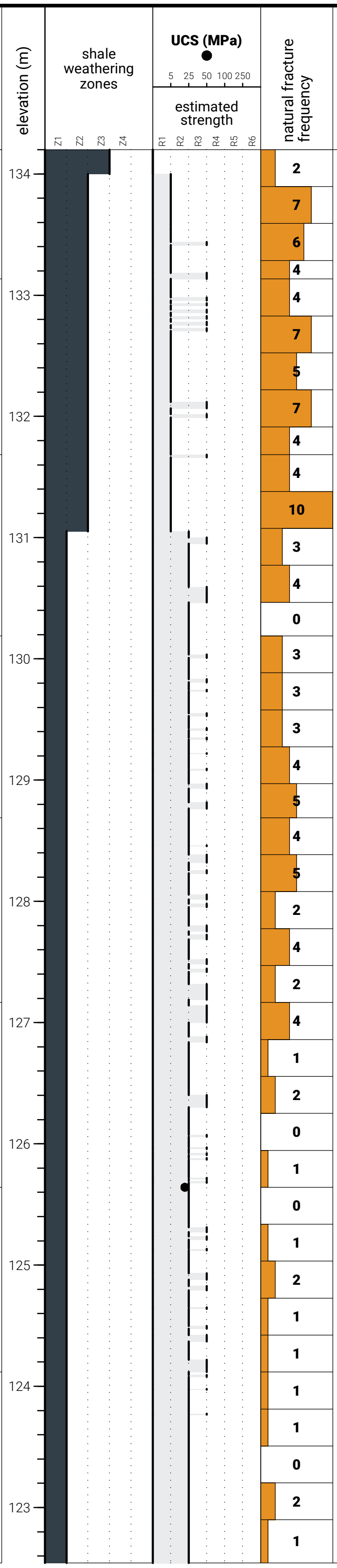
... at 7.1 m (Elev. 131.0 m), transition to sound rock

Run	elev / depth (m)	recovery	stratigraphy
R1	134.2 / 3.9 – 133.1 / 5.0	TCR = **100%** SCR = **67%** RQD = **10%**	Run 1 : 10% limestone 90% shale
R2	133.1 / 5.0 – 131.6 / 6.5	TCR = **100%** SCR = **98%** RQD = **25%**	Run 2 : 15% limestone 85% shale
R3	131.6 / 6.5 – 130.2 / 7.9	TCR = **100%** SCR = **90%** RQD = **49%**	Run 3 : 14% limestone 86% shale
R4	130.2 / 7.9 – 128.7 / 9.4	TCR = **100%** SCR = **93%** RQD = **42%**	Run 4 : 15% limestone 85% shale
R5	128.7 / 9.4 – 127.1 / 11.0	TCR = **100%** SCR = **100%** RQD = **72%**	Run 5 : 29% limestone 71% shale
R6	127.1 / 11.0 – 125.6 / 12.5	TCR = **100%** SCR = **100%** RQD = **85%**	Run 6 : 24% limestone 76% shale
R7	125.6 / 12.5 – 124.1 / 14.0	TCR = **100%** SCR = **100%** RQD = **91%**	Run 7 : 23% limestone 77% shale
R8	124.1 / 14.0 – 122.5 / 15.6	TCR = **100%** SCR = **100%** RQD = **100%**	Run 8 : 2% limestone 98% shale

15.6m

END OF COREHOLE





laboratory testing

El. 125.6m:
UCS = 20.7 MPa
E = 3.40 GPa
γ = 25.8 kN/m³

notes and comments

3.9 / 134.2 - 4.1 / 134.0m: IS clay
4.1 / 134.0 - 4.2 / 133.9m: rubblized zone
4.4 / 133.7 - 4.5 / 133.7m: rubblized zone
4.6 / 133.6 - 4.6 / 133.5m: rubblized zone
5.0 / 133.2 - 5.0 / 133.2m: CS
5.3 / 132.9m: IS T clay
5.4 / 132.7m: IS GA clay
5.5 / 132.7m: IS GA clay
6.7 / 131.4m: IS clay
6.8 / 131.4 - 6.8 / 131.4m: CS
6.9 / 131.3m: IS clay
7.0 / 131.1 - 7.0 / 131.1m: CS
7.1 / 131.1m: IS clay
7.2 / 131.0m: IS clay
7.2 / 131.0 - 7.2 / 131.0m: CS
7.2 / 131.0 - 7.2 / 130.9m: IS clay
8.6 / 129.5 - 8.6 / 129.5m: CS
9.1 / 129.0m: IS clay
9.4 / 128.7 - 9.4 / 128.7m: rubblized zone
9.6 / 128.5m: IS clay
9.6 / 128.5m: IS clay
9.7 / 128.5m: JT D UN T CN
9.8 / 128.4m: IS clay
9.8 / 128.4m: IS clay
10.0 / 128.1m: IS clay
10.1 / 128.0m: JT D UN T CN
10.3 / 127.8m: IS clay
10.3 / 127.8m: JT D UN T CN
10.4 / 127.8m: IS clay
10.5 / 127.7m: IS clay
10.8 / 127.3m: IS clay
11.2 / 127.0m: IS clay
11.2 / 126.9m: IS clay
15.2 / 122.9m: IS clay

elevation (m): 134, 133, 132, 131, 130, 129, 128, 127, 126, 125, 124, 123

file: 22-087 gint.gpj

Tech : LB | **PM** : EL/DK | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Apr 4, 2024
Position : E: 611674, N: 4830126 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 206

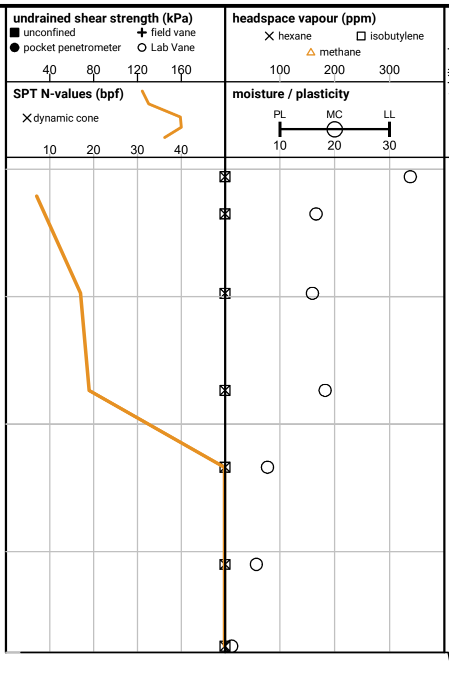
File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

drill method : *CME TRACK*
hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value
137.1	**GROUND SURFACE**			
	300mm **TOPSOIL**	1A	SS	7
136.8 0.3	**FILL**, clayey silt, trace to some sand, trace gravel, trace rootlets, firm, dark brown, moist ...at 0.8 m, some rootlets, very stiff, light grey with orange	1B	SS	
		2	SS	17
		3	SS	19
134.8 2.3	**CLAYEY SILT**, some gravel, trace sand, trace shale fragments, hard, light grey with brown, moist (GLACIAL TILL)	4	SS	50 / 140mm
134.1 3.0	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	5	SS	50 / 140mm
133.2 3.9		6	SS	50 / 50mm

END OF BOREHOLE
Auger refusal on inferred bedrock

Water level and cave not measured upon completion of drilling.



lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

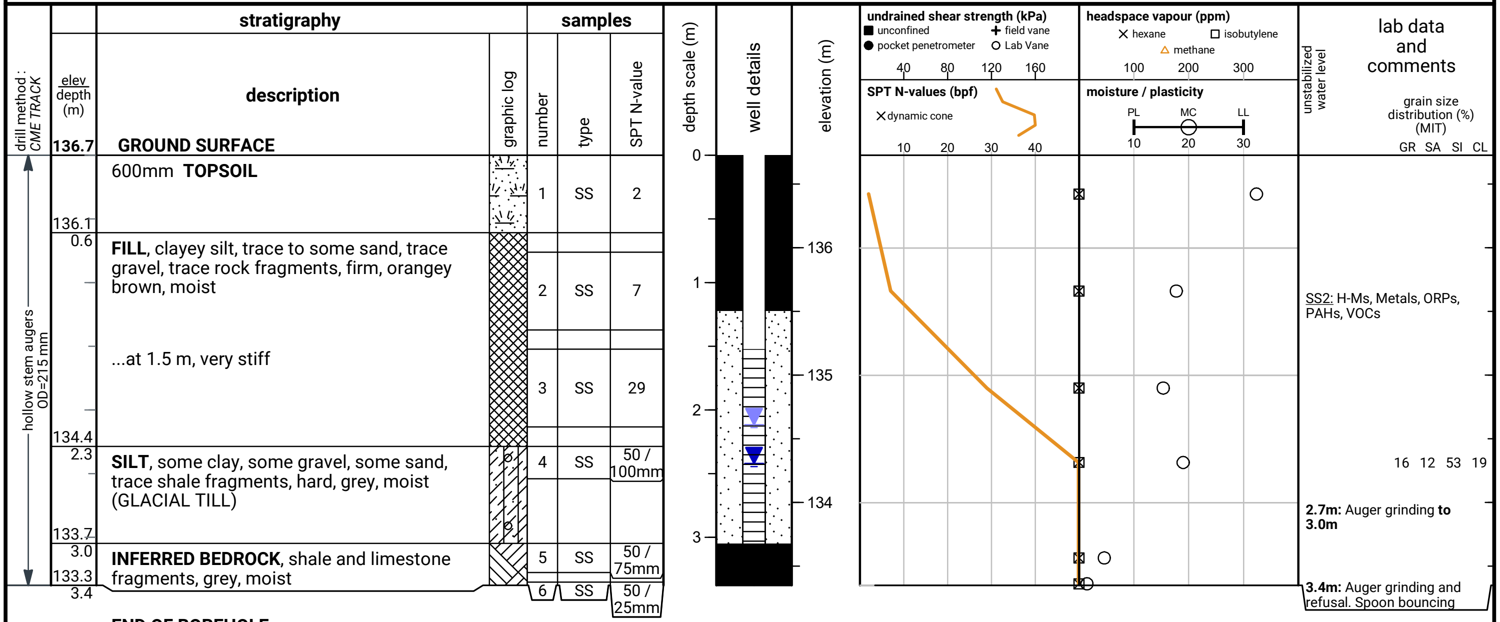
<u>SS1B:</u> H-Ms, Metals, ORPs, PAHs, VOCs

3.8m: Auger grinding and refusal. Spoon bouncing

Date Started : Apr 3, 2024
Position : E: 611700, N: 4830155 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 207

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC



elev depth (m)	description	number	type	SPT N-value	lab data and comments
136.7	**GROUND SURFACE**				
	600mm **TOPSOIL**	1	SS	2	
136.1 0.6	**FILL**, clayey silt, trace to some sand, trace gravel, trace rock fragments, firm, orangey brown, moist	2	SS	7	SS2: H-Ms, Metals, ORPs, PAHs, VOCs
	...at 1.5 m, very stiff	3	SS	29	
134.4 2.3	**SILT**, some clay, some gravel, some sand, trace shale fragments, hard, grey, moist (GLACIAL TILL)	4	SS	50 / 100mm	16 12 53 19 **2.7m:** Auger grinding **to 3.0m**
133.7 3.0	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	5	SS	50 / 75mm	
133.3 3.4		6	SS	50 / 25mm	**3.4m:** Auger grinding and refusal. Spoon bouncing

END OF BOREHOLE
Auger refusal on inferred bedrock

Borehole was dry upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 10, 2024	2.5	134.2
Apr 16, 2024	2.1	134.6
Apr 26, 2024	2.2	134.5
May 10, 2024	2.2	134.5
May 24, 2024	2.5	134.2
Jun 7, 2024	2.4	134.3

file: 22-087 gint.gpj

Tech : LB | **PM** : EL/DK | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Apr 4, 2024
Position : E: 611628, N: 4830095 (UTM 17T)
Elev. Datum : Geodetic

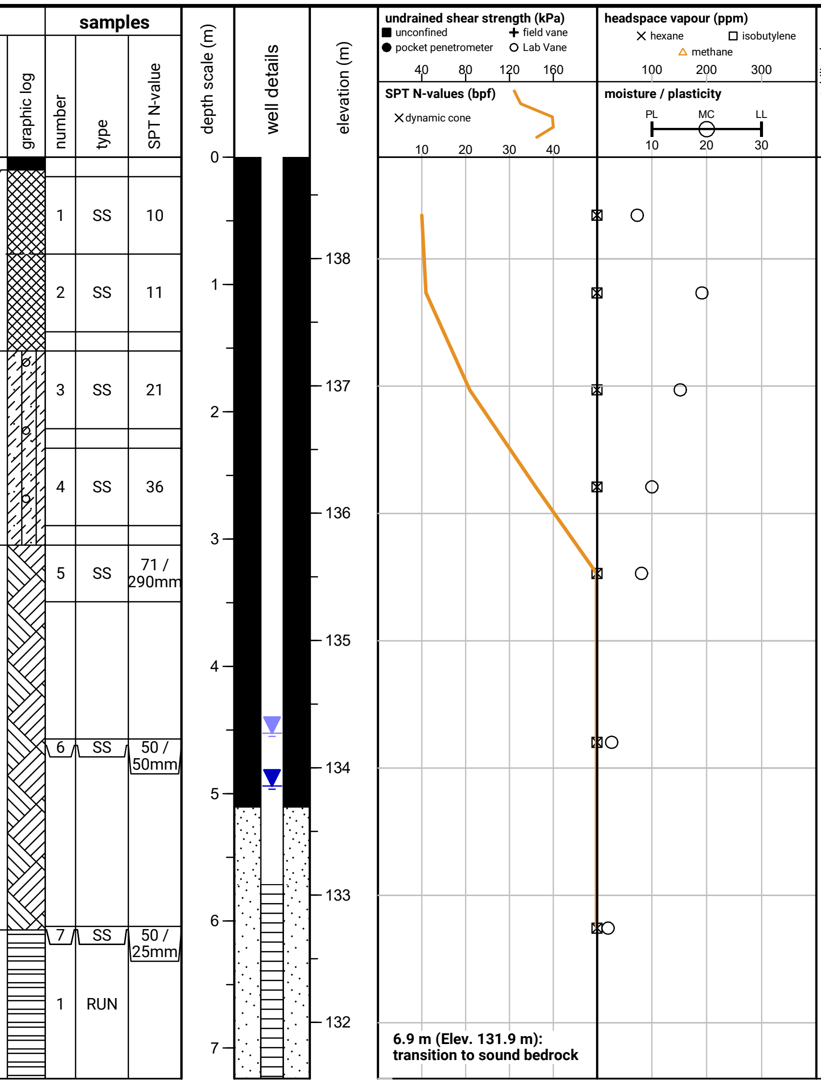
BOREHOLE LOG 208

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

drill method : *CME TRACK*

elev depth (m)	description	number	type	SPT N-value
138.8	**GROUND SURFACE**			
	100mm **ASPHALT**			
	FILL, sand and gravel, trace silt, trace rock fragments, trace asphalt, loose to compact, dark brown, moist	1	SS	10
138.0 0.8	**FILL**, clayey silt, trace to some sand, trace gravel, trace rock fragments, stiff, orangey brown with grey, moist	2	SS	11
137.3 1.5	**CLAYEY SILT**, some gravel, trace sand, trace rock fragments, very stiff to hard, grey, moist (GLACIAL TILL)	3	SS	21
		4	SS	36
135.8 3.0	**INFERRED BEDROCK**, shale and limestone fragments, grey, moist	5	SS	71 / 290mm
		6	SS	50 / 50mm
132.7 6.1	**GEORGIAN BAY FORMATION** (See rock core log for details)	7	SS	50 / 25mm
		1	RUN	
131.6 7.2				

hollow stem augers OD=215 mm (0 to 6.1 m)
rock coring (HQ) OD=96 mm (6.1 to 7.2 m)



unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

SS2: H-Ms, Metals, ORPs, PAHs

SS3: VOCs

4.6m: Spoon bounching
4.6m: Auger grinding **to 6.1m**

6.1m: Spoon bouncing

END OF BOREHOLE

Borehole was filled with drill water upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 10, 2024	7.0	131.8
Apr 16, 2024	6.5	132.3
Apr 26, 2024	4.6	134.2
May 10, 2024	4.6	134.2
May 24, 2024	4.8	134.0
Jun 7, 2024	4.9	133.9

file: 22-087 gint.gpi

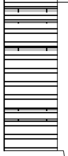
Tech : LB | **PM** : EL/DK | **Rev** : KB

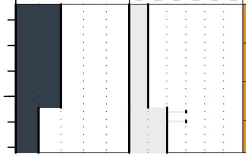
Date Started : Apr 4, 2024
Position : E: 611628, N: 4830095 (UTM 17T)
Elev. Datum : Geodetic

ROCK CORE LOG 208

File No. : 22-087 **Project** : UPRC - Westminster - 4094 Tomken Rd., Mississauga, ON **Client** : UPRC

depth (m)	graphic log	stratigraphy	Run elev depth (m)	recovery	elevation (m)	shale weathering zones Z1 Z2 Z3 Z4	UCS (MPa) ● 5 25 50 100 250 estimated strength R1 R2 R3 R4 R5 R6	natural fracture frequency	laboratory testing	notes and comments	elevation (m)
		Rock coring started at 6.1m below grade	**132.7**								
7		**GEORGIAN BAY FORMATION** **Shale**, grey, thinly bedded to medium bedded, weak; joints are horizontal, gapped, clean, smooth, planar; interbedded with **limestone**, light grey, very thinly bedded to medium bedded, strong	6.1 R1 131.6	TCR = **99%** SCR = **97%** RQD = **59%**	132			**3** **3** **5** **3**		**6.1 / 132.7 - 6.1 / 132.7m:** rubblized and sand seams	132
		Overall shale: 92%, limestone: 8% **... at 6.9 m (Elev. 131.9 m), transition to sound rock**	**7.2m**								

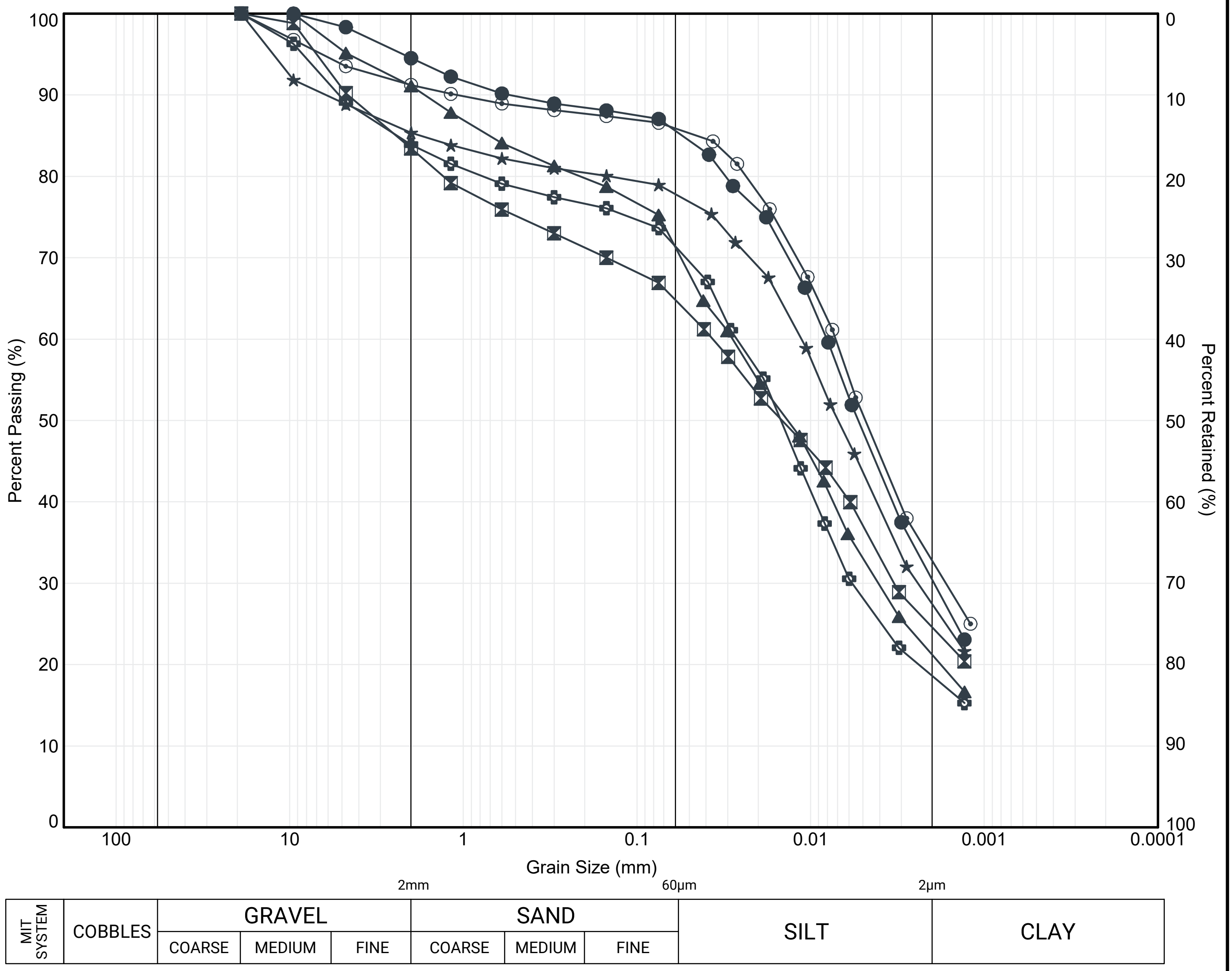




END OF COREHOLE

file: 22-087 gint.gpj

APPENDIX B



MIT SYSTEM

	Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**BH 1**	SS3	1.8	136.1	6	8	55	31	*(0)*
☒	**BH 2**	2B	1.1	137.0	17	18	40	25	*(0)*
▲	**BH 3**	SS5	3.4	134.8	9	20	50	21	*(0)*
★	**BH 201**	SS4	2.6	135.6	15	7	50	28	*(0)*
⊙	**BH 205**	SS3	1.8	136.3	9	5	53	33	*(0)*
✚	**BH 207**	SS4	2.4	134.3	16	12	53	19	*(0)*

GROUNDED
ENGINEERING

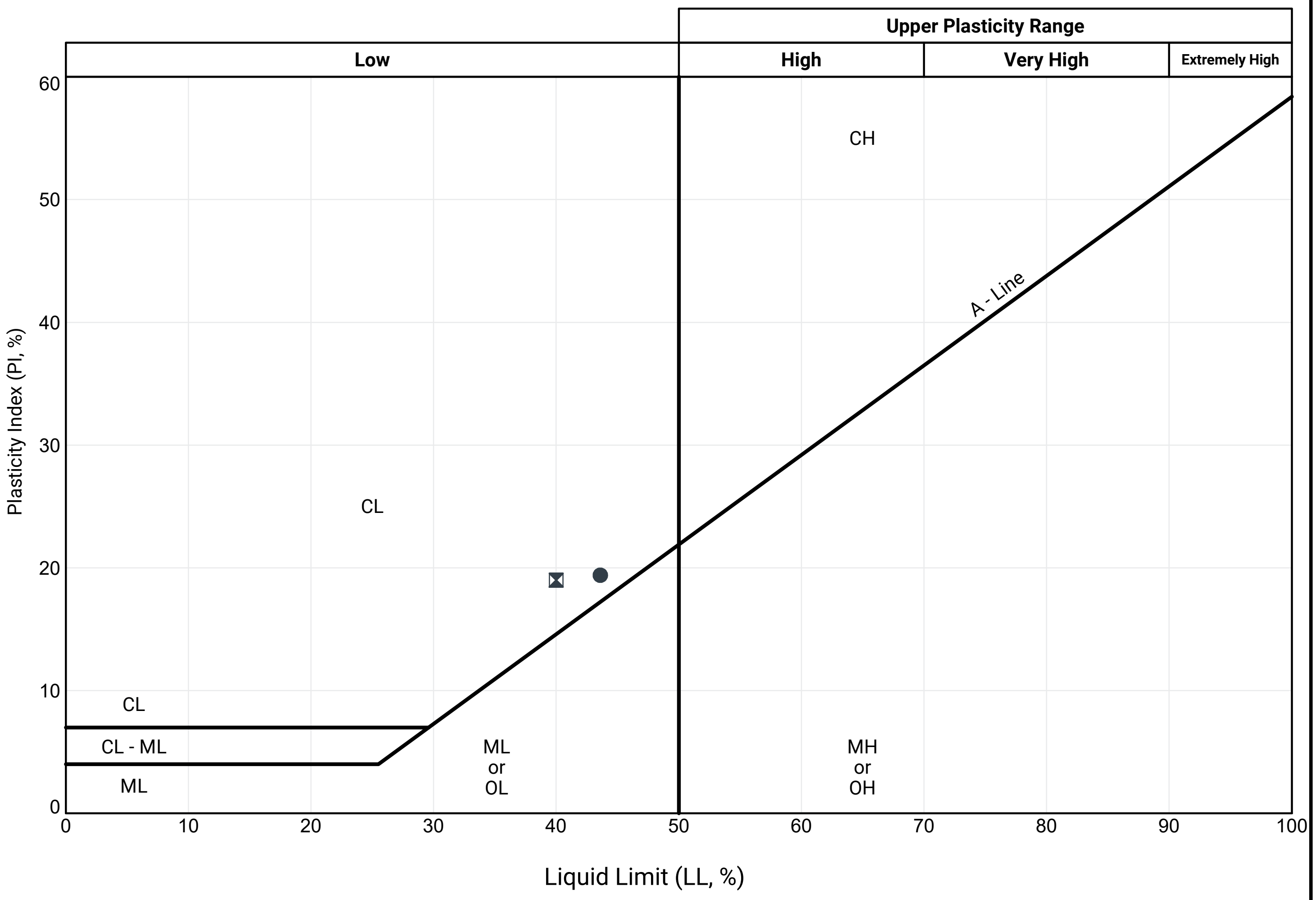
Title:

GRAIN SIZE DISTRIBUTION

File No.:

22-087

file: 22-087 gint.gpj



	Location	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
●	**BH 1**	SS3	1.8	136.1	44	24	20
☒	**BH 201**	SS4	2.6	135.6	40	21	19

GROUNDED
ENGINEERING

Title:

ATTERBERG LIMITS CHART

File No.: **22-087**

file: 22-087 gint.gpj

APPENDIX C

Borehole 1

Run #	Depth	Elevation
1	4.3 – 5.5 m	133.6 – 132.4 m
2	5.5 – 7.0 m	132.4 – 130.9 m
3	7.0 – 8.5 m	130.9 – 129.4 m
4	8.5 – 10.1 m	129.4 – 127.8 m

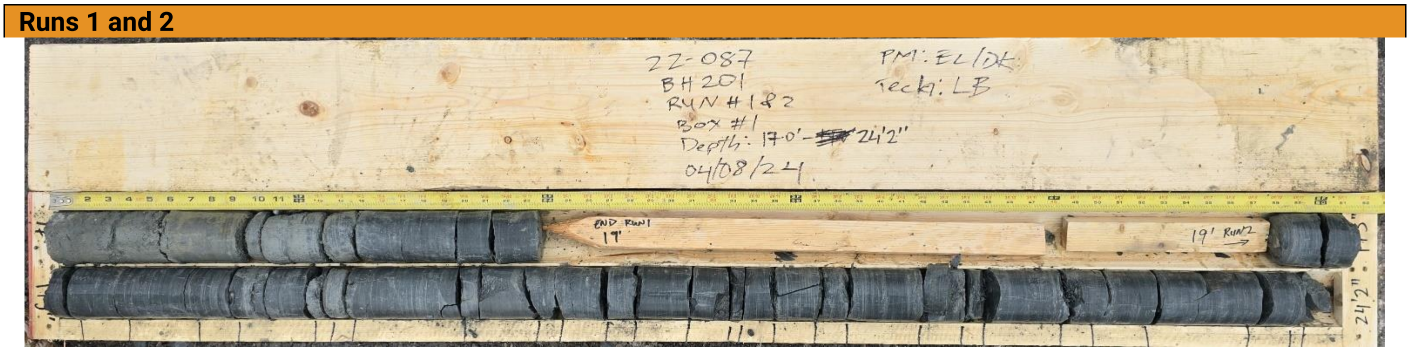
Runs 1 and 2

Runs 3 and 4

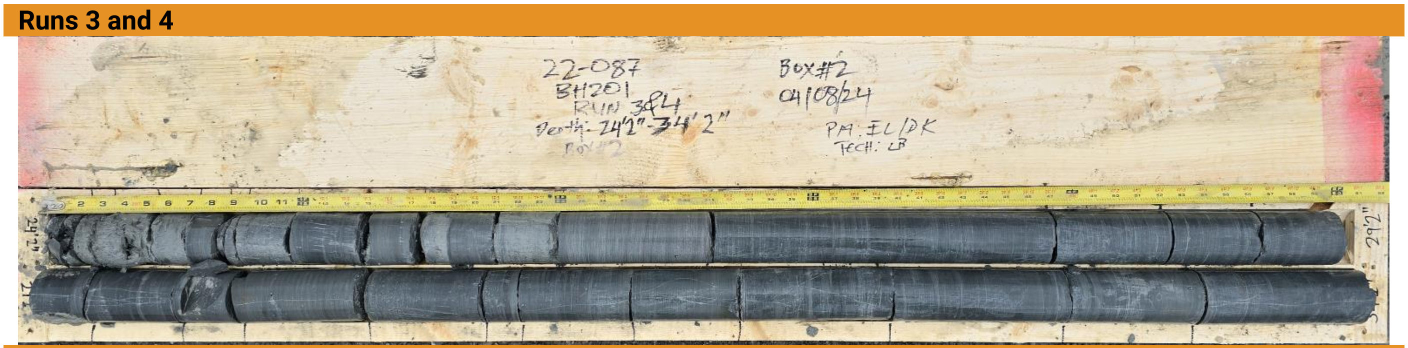
Borehole 201

Run #	Depth	Elevation
1	5.2 - 5.8 m	133.0 - 132.4 m
2	5.8 - 7.4 m	132.4 - 130.8 m
3	7.4 - 8.9 m	130.8 - 129.3 m
4	8.9 - 10.4 m	129.3 - 127.8 m
5	10.4 - 11.9 m	127.8 - 126.3 m
6	11.9 - 13.4 m	126.3 - 124.8 m

Runs 1 and 2



Runs 3 and 4

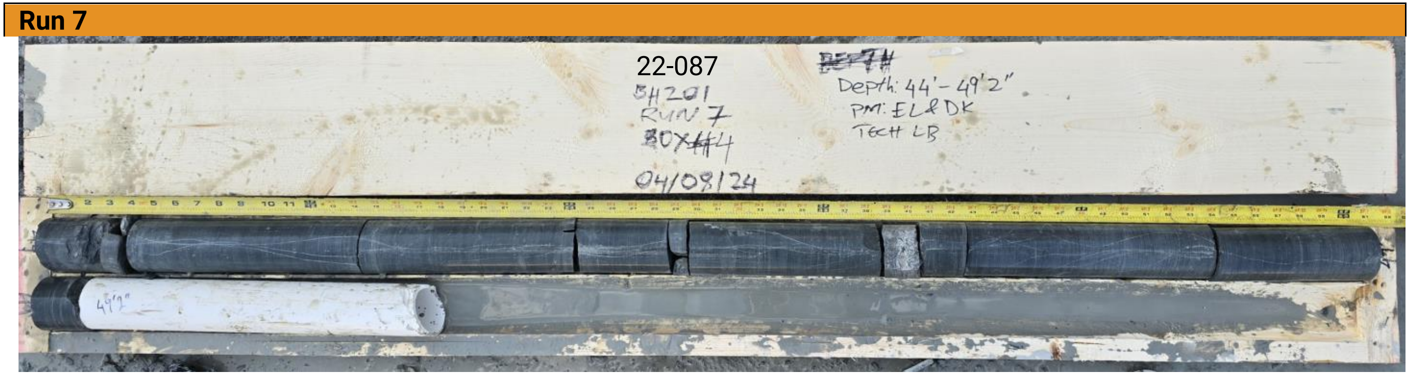


Runs 5 and 6

Borehole 201

Run #	Depth	Elevation
7	13.4 - 15.0 m	124.8 - 123.2 m
8	15.0 - 16.5 m	123.2 - 121.7 m

Run 7

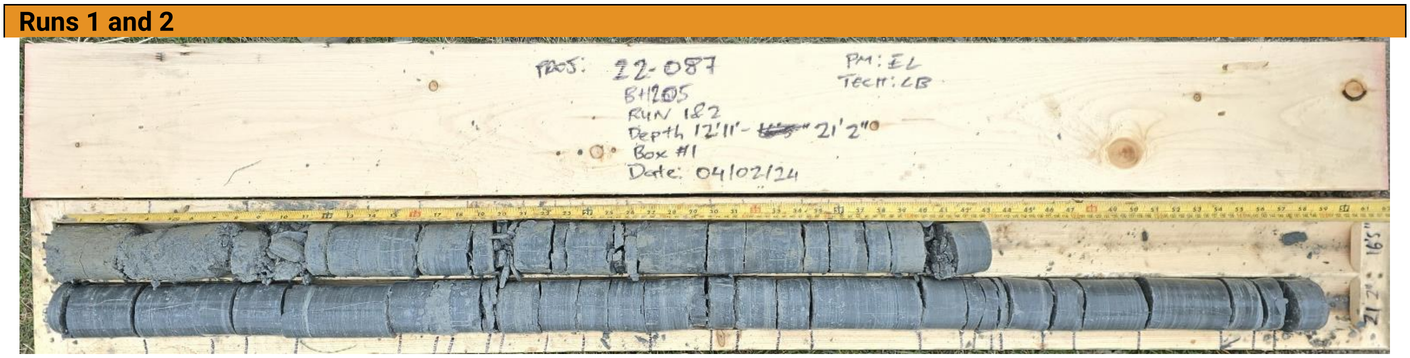


Run 8

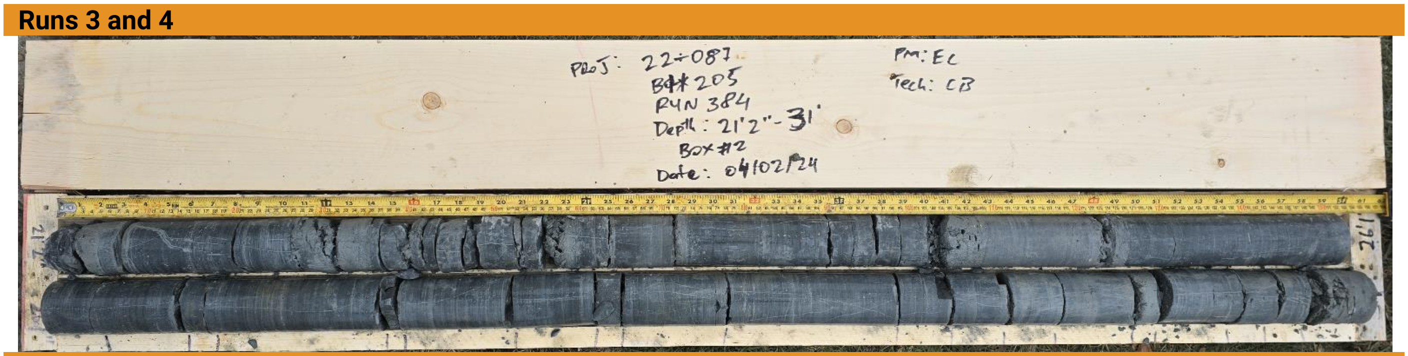
Borehole 205

Run #	Depth	Elevation
1	3.9 - 5.0 m	134.2 - 133.1 m
2	5.0 - 6.5 m	133.1 - 131.7 m
3	6.5 - 7.9 m	131.7 - 130.2 m
4	7.9 - 9.4 m	130.2 - 128.7 m
5	9.4 - 11.0 m	128.7 - 127.2 m
6	11.0 - 12.5 m	127.2 - 125.6 m

Runs 1 and 2



Runs 3 and 4

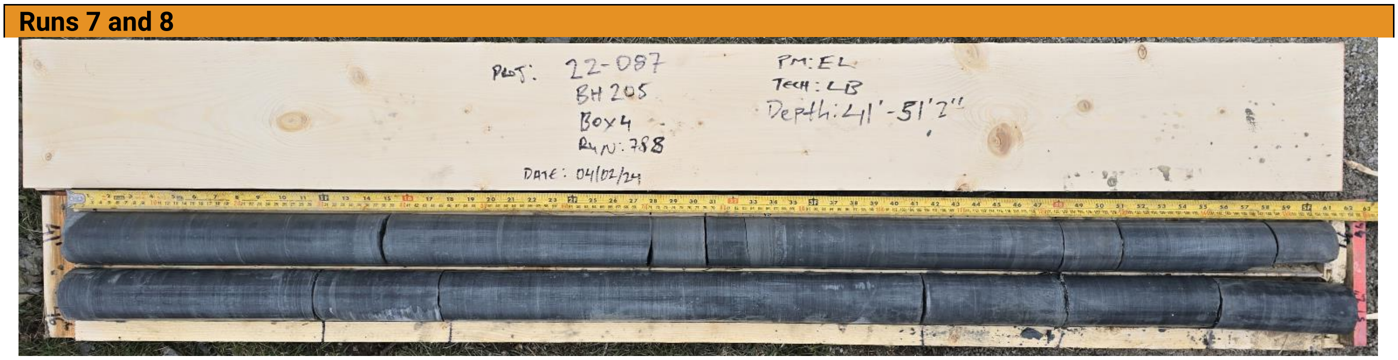


Runs 5 and 6

Borehole 205

Run #	Depth	Elevation
7	12.5 - 14.0 m	125.6 - 124.1 m
8	14.0 - 15.6 m	124.1 - 122.5 m

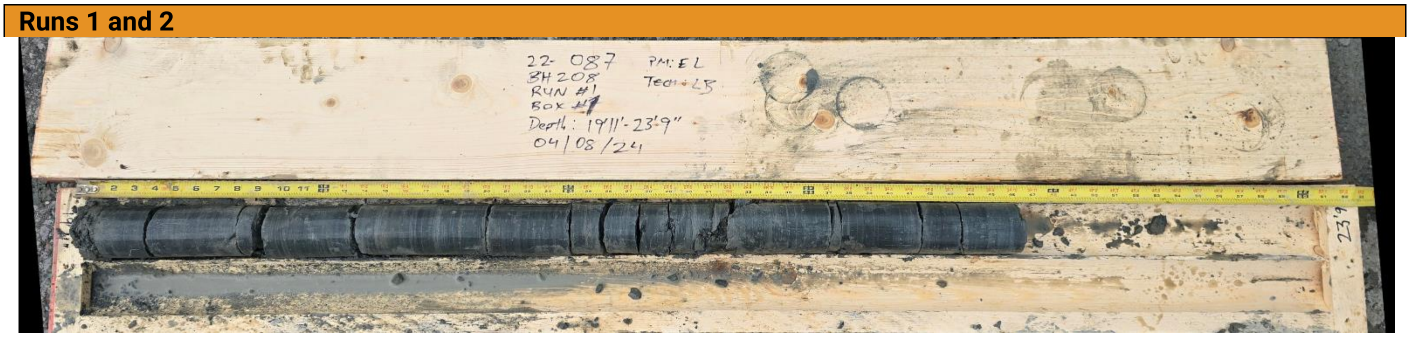
Runs 7 and 8



Borehole 208

Run #	Depth	Elevation
1	6.1 - 7.2 m	132.7 - 131.6 m

Runs 1 and 2



Rock Laboratory Testing Results

A report submitted to:

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Prepared by:

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April 24, 2024
Project number: 22-087

Abstract

This document summarizes the results of rock laboratory testing, including 2 Uniaxial Compressive Strength (UCS) tests. The UCS and tangent Young's modulus values along with photographs of specimens before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing. The testing was performed in Geomechanica Inc.'s rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.150 mm/min (Figure 1). The preparation and testing procedure for each specimen included the following:

1. Unwrapping the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture during subsequent specimen preparation.
2. Diamond cutting the core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within ±0.025 mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimen to rupture while continuously recording axial force to determine the peak strength (UCS) and the axial deformation to determine the tangent Young's modulus.

Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens included the measurement of the UCS and elastic modulus, but not the Poisson's ratio. This represents a hybrid between Methods C and D of ASTM D7012-14.

1.2 Results

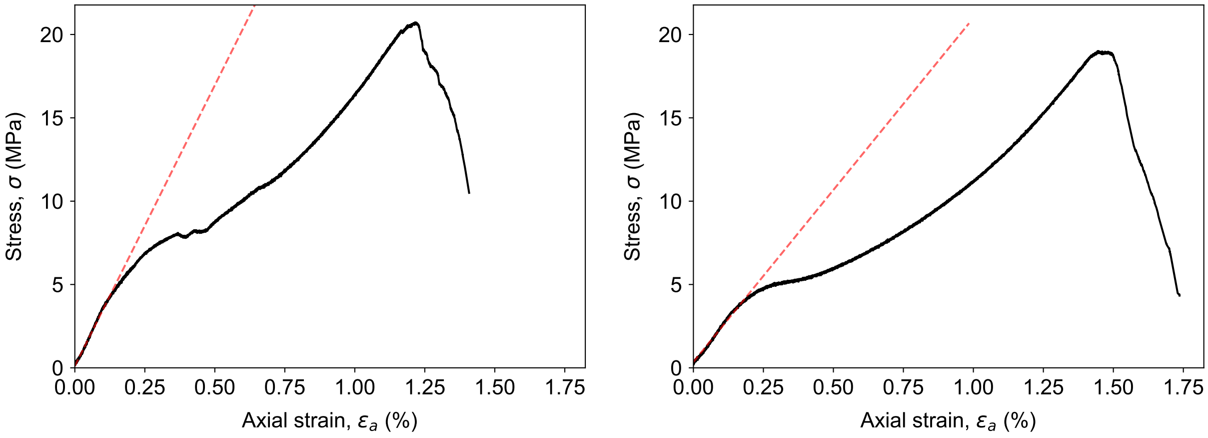
The results of UCS testing are summarized in Table 1. The corresponding stress-strain curves are presented in Figure 2. The Young's modulus is the tangent modulus calculated as the slope of the best-fit line through a selection of data points defining the stress-strain curve. Typically the modulus is defined at 50% of the UCS strength. However, due to non-linear pre-peak stress-strain behaviour of the specimens, a custom stress range (where the specimen deformed linearly) was selected for modulus determination. This stress range along with additional specimen details and measurements are provided in the summary spreadsheet that accompanies this report.

Table 1: Summary of UCS test results.

Sample	Depth (ft' in")	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's modulus E (GPa)	Lithology	Failure description
BH205 CS1	41'0" - 41'8.5"	2.634	20.7	3.4	Shale	1, 2
BH201 CS2	38'3.5" - 39'0"	2.605	19.0	2.1	Shale	1, 2

[1] Partial hourglass failure

[2] Specimen emitted pore water upon loading



(a) BH205-CS1

(b) BH201-CS2

Figure 2: Measured stress-strain curves.

1.3 Specimen photographs

Photographs of the specimens before and after testing are presented in the Appendix of this report.

Appendices

Specimen sheets

- BH205 CS1
- BH201 CS2

Uniaxial Compression Test

Client	Grounded Engineering Inc.	**Project**	22-087
Sample	BH205 CS1	**Depth**	41’0” - 41’8.5”

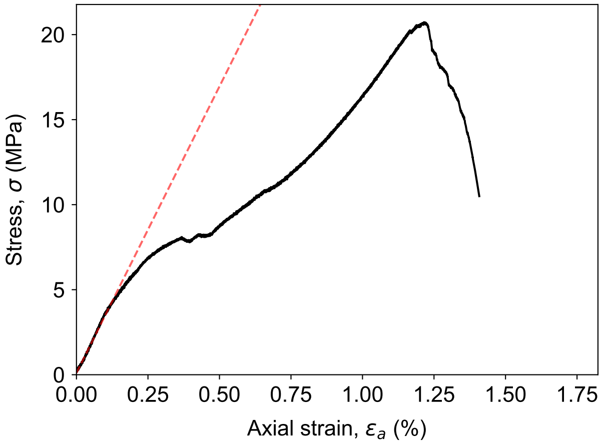
Specimen parameters

Diameter (mm) [a]	62.99
Length (mm) [a]	128.92
Bulk density ρ (g/cm^3)	2.634
UCS (MPa)	20.7
Young’s modulus E (GPa) [b]	3.4
Lithology	Shale
Failure description [c]	1, 2

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 15.0% of the peak strength.
[c] Failure description: [1] Partial hourglass failure; [2] Specimen emitted pore water upon loading;

Prior to testing

After testing



Remarks: Loading Rate: 0.15 mm/min.

Performed by	AB	**Date**	2024-04-16

Uniaxial Compression Test

Client	Grounded Engineering Inc.	**Project**	22-087
Sample	BH201 CS2	**Depth**	38’3.5” - 39’0”

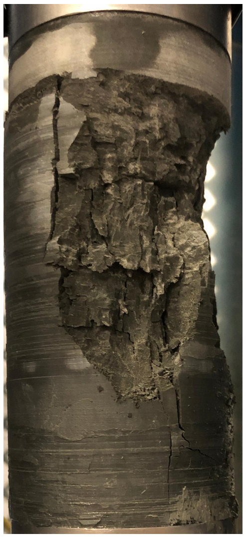
Specimen parameters

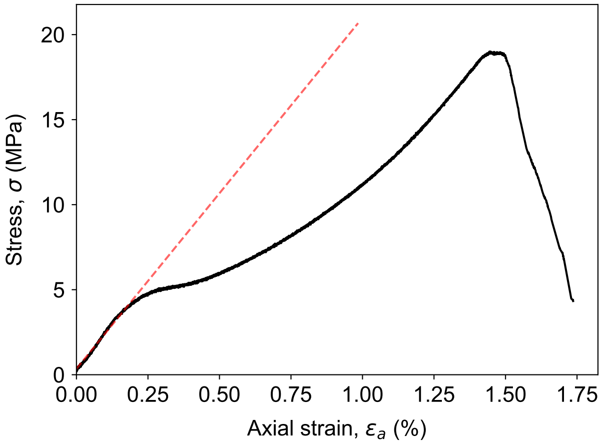
Diameter (mm) [a]	63.13
Length (mm) [a]	127.94
Bulk density ρ (g/cm^3)	2.605
UCS (MPa)	19.0
Young’s modulus E (GPa) [b]	2.1
Lithology	Shale
Failure description [c]	1, 2

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 15.0% of the peak strength.
[c] Failure description: [1] Partial hourglass failure; [2] Specimen emitted pore water upon loading;

Prior to testing

After testing





Remarks: Loading Rate: 0.15 mm/min.

Performed by	AB	**Date**	2024-04-16

APPENDIX D

CORROSIVITY (SGS)

Report No.	**CA40021-AUG22**
Customer	**Grounded Engineering Inc.**
Attention	**Nicholas Piers**
Reference	**22-087, Nicholas Piers**
Works#	
Title	**Final Report**

Sample ID		Analysis Start Date	Analysis Start Time	Analysis Completed Date	Analysis Completed Time	BH 3 SS3 5'-7'	BH 2 SS4 7'6"-8'3"	BH 3 SS2 2'6"-4'6"
Sample Date / Time						03-Aug-22 09:00	03-Aug-22 09:00	03-Aug-22 09:00
Analysis	**Units**							
Corrosivity Index	none	05-Aug-22	14:33	05-Aug-22	14:36	8	4	---
Soil Redox Potential	mV	04-Aug-22	08:50	04-Aug-22	12:03	346	455	412
Sulphide (Na2CO3)	%	04-Aug-22	20:52	05-Aug-22	09:38	< 0.04	< 0.04	---
Moisture Content	%	03-Aug-22	21:40	04-Aug-22	09:35	8.3	5.5	11.8
pH	pH Units	04-Aug-22	11:51	05-Aug-22	14:33	8.78	8.98	8.40
Chloride	µg/g	04-Aug-22	11:51	04-Aug-22	16:27	270	1.7	---
Sulphate	µg/g	04-Aug-22	11:51	04-Aug-22	16:27	140	8.4	---
Conductivity	uS/cm	04-Aug-22	11:51	05-Aug-22	14:33	139	108	295
Resistivity (calculated)	ohms.cm	04-Aug-22	14:43	05-Aug-22	14:33	7190	9260	3390

INTERPRETATION

AWWA C-105 Standard	**Points**	**Points**	**Points**
% Moisture	**2**	**2**	**2**
pH			
Is pH bet 6.5-7.5 ?	NO	NO	NO
Is Redox Potential < 100 mv?	NO	NO	NO
Are Sulphides present ?	NO	NO	NO
If above three conditions are met, pH is assigned 3 points			
pH - Score	**3**	**3**	**0**
Redox Potential	**0**	**0**	**0**
Resistivity	**0**	**0**	**0**
Acid Volatile Sulphides	**0**	**0**	**0**
TOTAL SCORE (AWWA C-105)	**5**	**5**	**2**

Sample	**BH 3 SS3 5'-7'**	**BH 2 SS4 7'6"-8'3"**	**BH 3 SS2 2'6"-4'6"**
Corrosion Protection Recommended?	**No**	**No**	**No**
Resistivity less than 2000 ohm.cm?	**No**	**No**	**No**

Anions and Nutrients (Soil)				
Sulphate	%	0.014	0.00084	---
CLASS OF EXPOSURE		**Negligible**	**Negligible**	**Negligible**

FINAL REPORT

CA40021-AUG22 R1

22-087, 4094 Tomken Rd., Mississauga

Prepared for

Grounded Engineering Inc.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Grounded Engineering Inc.	Project Specialist	Brad Moore Hon. B.Sc
		Laboratory	SGS Canada Inc.
Address	1 Banigan Drive Toronto, Ontario M4H1G3, Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Nicholas Piers	Telephone	705-652-2143
Telephone	647-264-7931	Facsimile	705-652-6365
Facsimile		Email	brad.moore@sgs.com
Email	npiers@groundedeng.ca	SGS Reference	CA40021-AUG22
Project	22-087, 4094 Tomken Rd., Mississauga	Received	08/03/2022
Order Number		Approved	08/05/2022
Samples	Soil (3)	Report Number	CA40021-AUG22 R1
		Date Reported	08/05/2022

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C

Cooling Agent Present: Yes

Custody Seal Present: Yes

Chain of Custody Number: 032864

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

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

FINAL REPORT

CA40021-AUG22 R1

Client: Grounded Engineering Inc.
Project: 22-087, 4094 Tomken Rd., Mississauga
Project Manager: Nicholas Piers
Samplers: Sam Bastan

MATRIX: SOIL

Sample Number	5	6	7
Sample Name	BH 3 SS3 5'-7'	BH 2 SS4 7'6"-8'3"	BH 3 SS2 2'6"-4'6"
Sample Matrix	Soil	Soil	Soil
Sample Date	03/08/2022	03/08/2022	03/08/2022

Parameter	Units	RL		Result	Result	Result
Corrosivity Index						
Corrosivity Index	none	1		8	4	---
Soil Redox Potential	mV	no		346	455	412
Sulphide (Na2CO3)	%	0.04		< 0.04	< 0.04	---
pH	pH Units	0.05		8.78	8.98	8.40
Resistivity (calculated)	ohms.cm	-9999		7190	9260	3390
General Chemistry						
Conductivity	uS/cm	2		139	108	295
Metals and Inorganics						
Moisture Content	%	0.1		8.3	5.5	11.8
Sulphate	µg/g	0.4		140	8.4	---
Other (ORP)						
Chloride	µg/g	0.4		270	1.7	---

QC SUMMARY

Anions by IC

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0057-AUG22	µg/g	0.4	<0.4	2	35	98	80	120	nv	75	125
Sulphate	DIO0057-AUG22	µg/g	0.4	<0.4	1	35	94	80	120	99	75	125

Carbon/Sulphur

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0016-AUG22	%	0.04	< 0.04	ND	20	113	80	120			

QC SUMMARY

Conductivity

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0068-AUG22	uS/cm	2	< 2	0	20	97	90	110	NA		
Conductivity	EWL0103-AUG22	uS/cm	2	< 2	12	20	99	90	110	NA		

pH

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0068-AUG22	pH Units	0.05	NA	0		101			NA		
pH	EWL0103-AUG22	pH Units	0.05	NA	1		100			NA		

QC SUMMARY

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

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

Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.

"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

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

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY

Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 032864

Page ______ of ______

Laboratory Information Section - Lab use only

Received By: Najeed Ahmadlakwi/
Received Date: AUG 0 3 2022 AUG 0 3 2022 (mm/dd/yy)
Received Time: 10 : 10 (hr : min)
Received By (signature): Majeed Ahmadlakwi
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C) 5, 6, 6C
LAB LIMS #: CA-40021-Aug22

REPORT INFORMATION

Company: Grounded Engineering
Contact: Nico Piers
Address: 1 Benigo Dr.
Toronto, ON M4H 1G3
Phone: 6472647931
Fax:
Email: npiers@groundedeng.ca

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

Quotation #:
P.O. #:
Project #: 22-087
Site Location/ID: 4094 Tomken Rd, Mississauga

TURNAROUND TIME (TAT) REQUIRED

☐ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☑ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium/Fine
☐ Table ______ Appx. ______
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M & I: Metals & Inorganics incl CrVI, CN,Hg pH,(B(HWS),EC,SAR-soil) (Cl, Na-water)	M & I: Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	M & I: ICP Metals only Sb,As,Ba,Be,B,Cd, Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs Total ☐ Aroclor ☐	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other (please specify): Corrosivity	Other	Other	Other	Sewer Use: Specify pkg:	Water Characterization Pkg General ☐ Extended ☐	SPLP Specify tests ☐Metals ☐VOC ☐1,4-Dioxane ☐OCP ☐ABN	TCLP Specify tests ☐M&I ☐VOC ☐PCB ☐B(a)P ☐ABN ☐Ignit.	COMMENTS:
1	BH3 SS3 5'-7'	Aug. 3/22	9:00	2	Soil													✓								
2	BH2 SS4 7'6"-8'3"	"	"	2	Soil													✓								
3	BH3 SS2 2'6"-4'6"	"	"	1	Soil													✓								
4																										
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

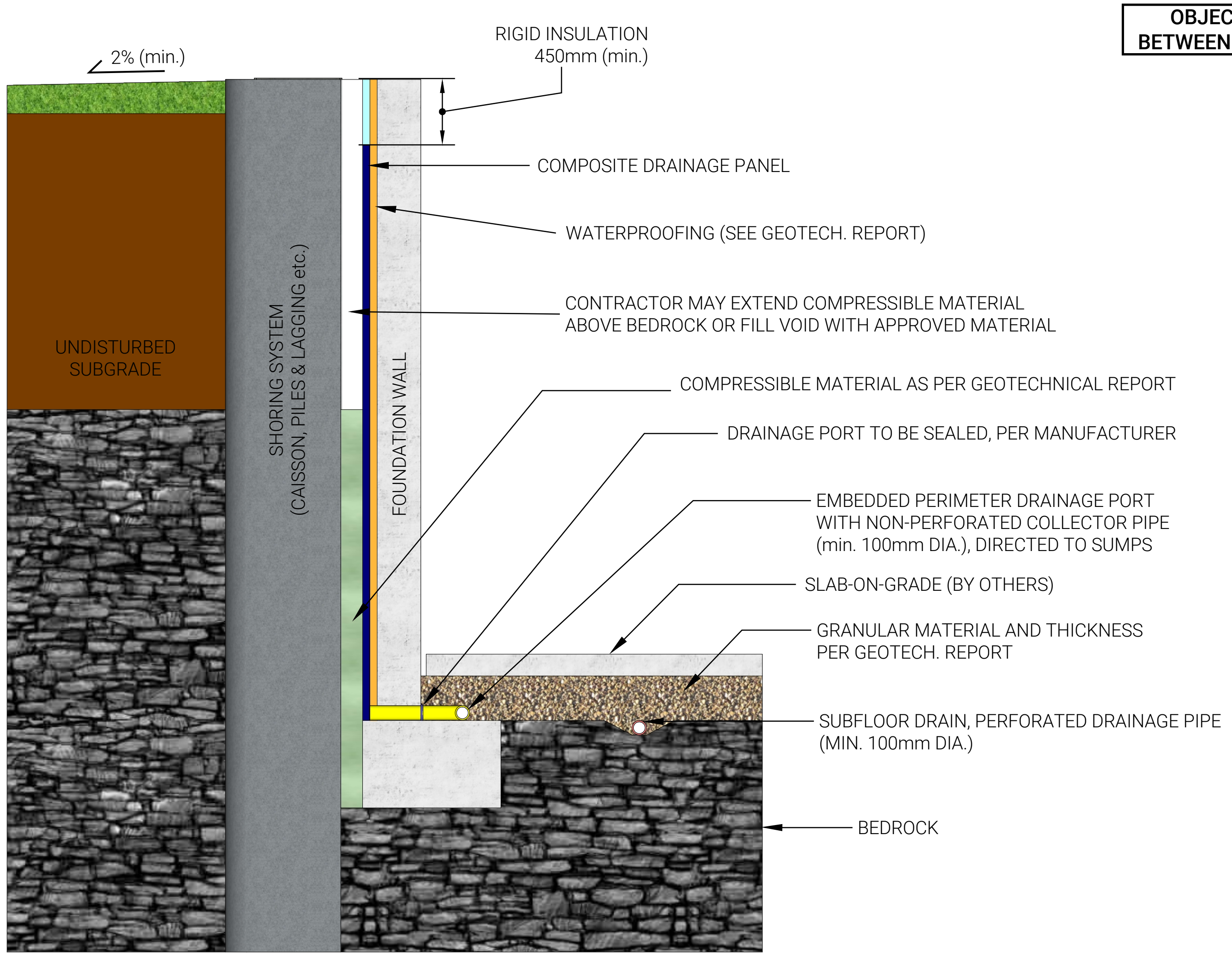
Observations/Comments/Special Instructions
Minimal soil available

Sampled By (NAME): ~~Sam~~ / Sam Bostan Signature: Date: Aug / 03 / 22 (mm/dd/yy) Pink Copy - Client
Relinquished by (NAME): Signature: Date: ____/____/____ (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.6
Date of Issue: 02 May 2022

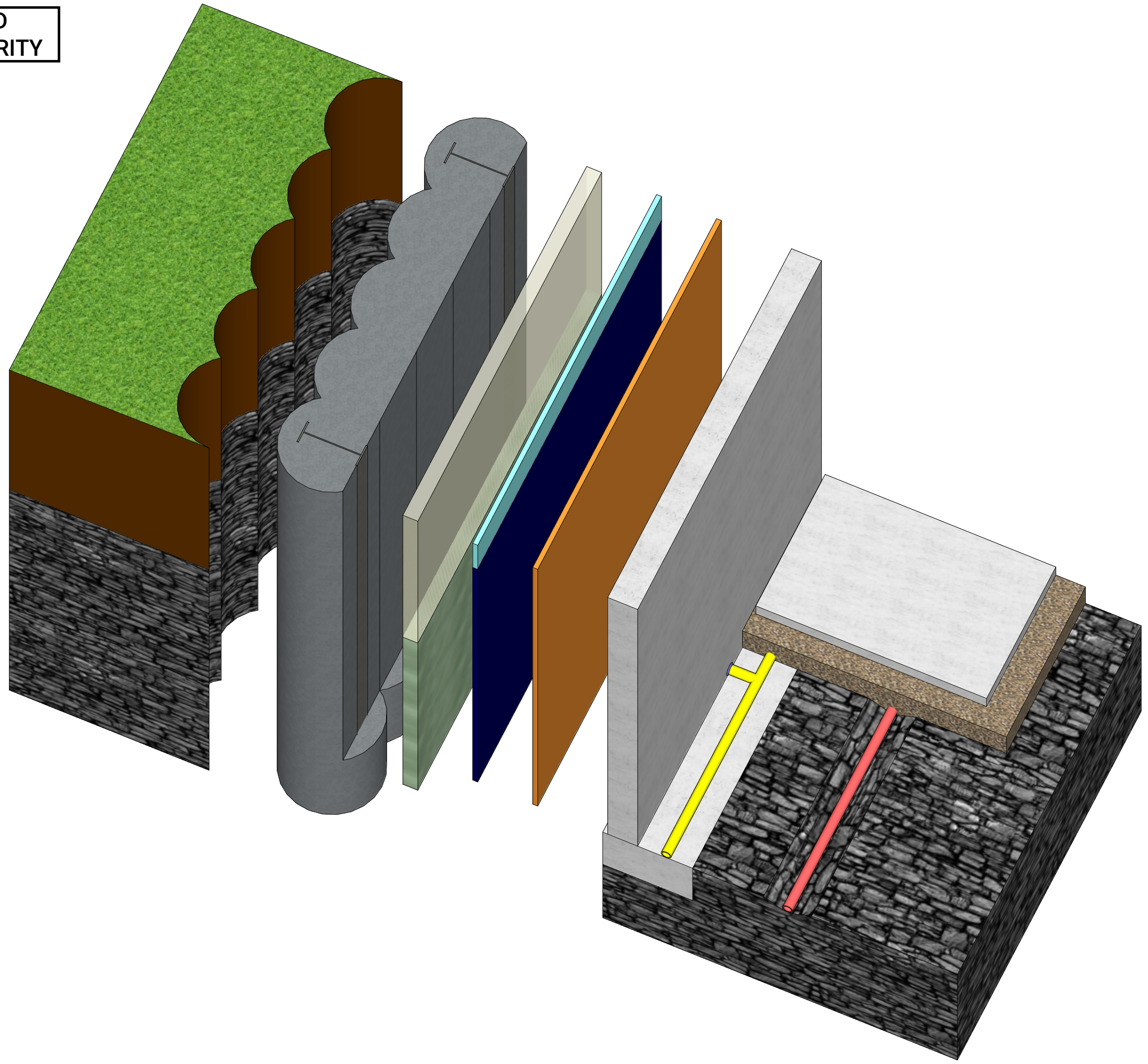
Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. {2} Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). {3} Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

APPENDIX E



SECTIONAL VIEW

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



ISOMETERIC VIEW

SUBFLOOR DRAINAGE SYSTEM

1. THE SUBFLOOR DRAINS SHOULD BE SET IN PARALLEL ROWS, IN ONE DIRECTION, AND SPACED AS PER THE GEOTECHNICAL REPORT.
2. THE INVERT OF THE PIPES SHOULD BE A MINIMUM OF 300mm BELOW THE UNDERSIDE OF THE SLAB-ON-GRADE.
3. A CAPILLARY MOISTURE BARRIER (I.E. DRAINAGE LAYER) CONSISTING OF A MINIMUM 200 mm LAYER OF CLEAR STONE (OPSS MUNI 1004) COMPACTED TO A DENSE STATE (OR AS PER THE GEOTECHNICAL REPORT). WHERE VEHICULAR TRAFFIC IS REQUIRED, THE UPPER 50 mm OF THE CAPILLARY MOISTURE BARRIER MAY BE REPLACED WITH GRANULAR A (OPSS MUNI 1010) COMPACTED TO A MINIMUM 98% SPMDD.

PERIMETER DRAINAGE SYSTEM

1. FOR A DISTANCE OF 1.2m FROM THE BUILDING, THE GROUND SURFACE SHOULD HAVE A MINIMUM 2% GRADE.
2. PREFABRICATED COMPOSITE DRAINAGE PANEL (CONTINUOUS COVER, AS PER MANUFACTURER'S REQUIREMENTS) IS RECOMMENDED BETWEEN THE BASEMENT WALL AND RIGID SHORING WALL. THE DRAINAGE PANEL MAY CONSIST OF MIRADRAIN 6000 OR AN APPROVED EQUIVALENT.
3. PERIMETER DRAINAGE IS TO BE COLLECTED IN NON-PERFORATED PIPES AND CONVEYED DIRECTLY TO THE BUILDING SUMPS.
4. PERIMETER DRAINAGE PORTS SHOULD BE SPACED A MAXIMUM 3m ON-CENTRE. EACH PORT SHOULD HAVE A MINIMUM CROSS-SECTIONAL AREA OF 1500 mm2.

GENERAL NOTES

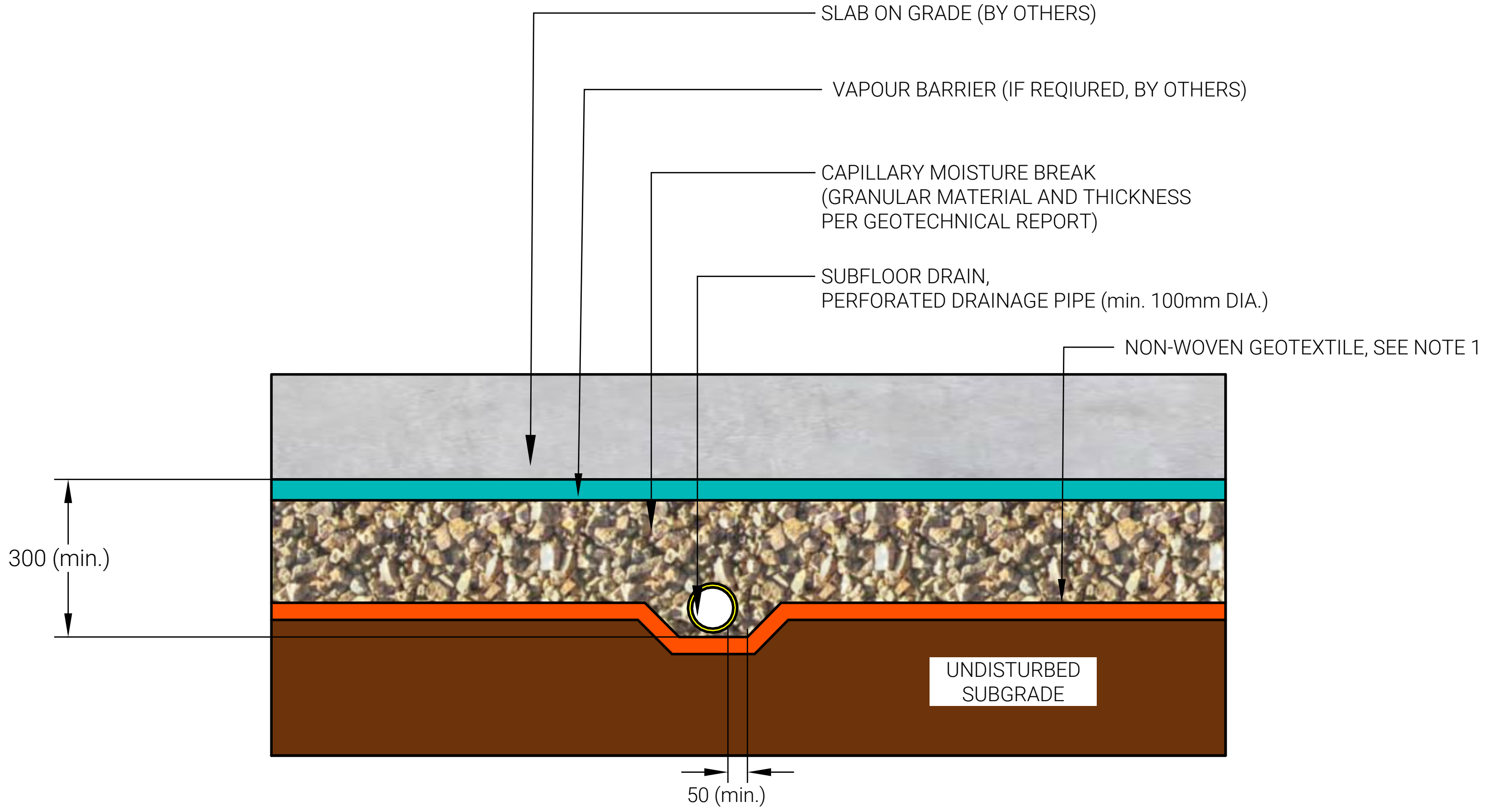
1. THERE SHOULD BE NO STRUCTURAL CONNECTION BETWEEN THE SLAB-ON-GRADE AND THE FOUNDATION WALL OR FOOTING.
2. THERE SHOULD BE NO CONNECTION BETWEEN THE SUBFLOOR AND PERIMETER DRAINAGE SYSTEMS.
3. THIS IS ONLY A TYPICAL BASEMENT DRAINAGE DETAIL. THE GEOTECHNICAL REPORT SHOULD BE CONSULTED FOR SITE SPECIFIC RECOMMENDATIONS.
4. THE FINAL BASEMENT DRAINAGE DESIGN SHOULD BE REVIEWED BY THE GEOTECHNICAL ENGINEER TO CONFIRM THE DESIGN IS ACCEPTABLE.

GROUNDED
ENGINEERING

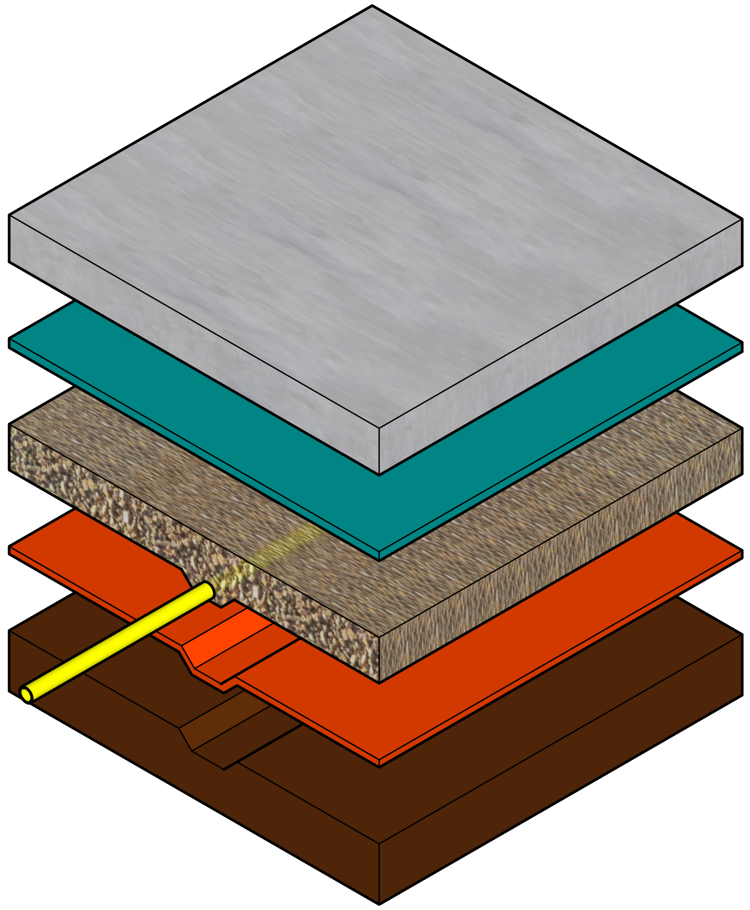
Title

FOUNDATION WALL BLINDSIDE DRAINAGE SYSTEM (IN DEEP ROCK) DETAIL

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 < 0.250mm AND A TEAR RESISTANCE OF > 200 N).

2. TYPICAL SCHEMATIC ONLY. MUST BE READ IN CONJUNCTION WITH GEOTECHNICAL REPORT.

GROUNDED
ENGINEERING

Title

BASEMENT SUBDRAIN TYPICAL DETAIL