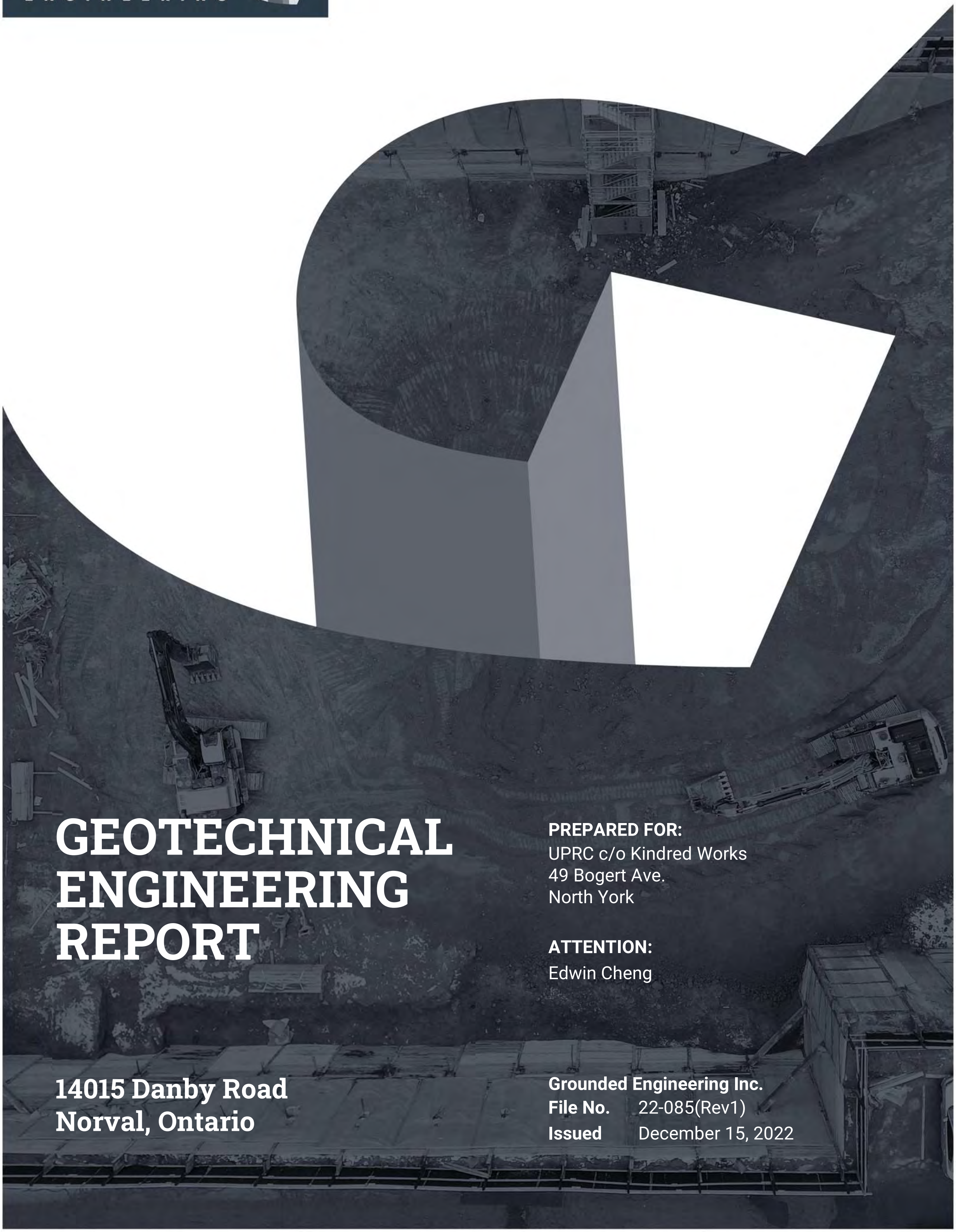

GEOTECHNICAL ENGINEERING REPORT

14015 Danby Road
Norval, Ontario

PREPARED FOR:
UPRC c/o Kindred Works
49 Bogert Ave.
North York

ATTENTION:
Edwin Cheng

Grounded Engineering Inc.
File No. 22-085(Rev1)
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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 14015 Danby Road, in Norval, Ontario.

Present development of the site consists of an existing church building and asphalt pavements surrounded by landscaping and grass areas. The proposed project includes constructing low rise affordable housing around the existing church. Based on the limited information provided to Grounded, it is assumed that new development will consist of a 6-storey building on the north side of the site with one underground parking level (P1). Design details including Finished Floor Elevations (FFE) were not provided at the time of this investigation.

This report has been revised (Rev 1) to include the updated site plan drawings received December 13th, 2022.

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

- Site Servicing Plan Phase 1, prepared by Urbantech (Feb 5, 2020).
- Norval United Presentation (concept plans), prepared by UPRC (April, 2021)
- UCC Norval United Site Plans, prepared by KPMB Architects (Nov 11, 2022), received December 13, 2022

Grounded's subsurface investigation of the site to date includes five (5) boreholes (Boreholes 1 to 5) which were advanced from May 24th to 25th, 2022.

Based on the borehole findings, preliminary 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.

This preliminary geotechnical engineering report is appropriate for due diligence and planning purposes only. Additional boreholes, wells, and a detailed geotechnical engineering report will be required for detailed design.

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 based on a benchmark shown on the provided drawings. The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM) geographic coordinate system.

2.1 Soil Stratigraphy

The following soil 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

The boreholes encountered 50 to 75 mm of topsoil at the existing ground surface.

Underlying the topsoil, the boreholes observed a layer of earth fill that extends to depths of 0.8 to 3.8 metres below grade (Elev. 239.9 to 243.8 metres). The earth fill varies in composition but generally consists of sandy silt to silty sand with trace gravel and trace clay. It contains construction debris, asphalt, and rootlets, and occasional plastic pieces. The earth fill is typically light to dark brown, and moist. Due to inconsistent placement and the inherent heterogeneity of earth fill materials, the relative density of the earth fill varies but is on average compact.

Some of the earth fill soils may be native soil that has been disturbed or reworked in place by site grading or agricultural activities previously conducted at this site. Reworked soils are grouped within the earth fill unit based on their engineering properties and their suitability for foundations and pavements.

2.1.2 Glacial Till (Sandy Silt)

Underlying the fill materials, all the boreholes encountered an undisturbed native glacial till deposit consisting of sandy silt with occasional seams and layers of silt and clay at depths of 0.8 to 3.8 metres below grade (Elev. 239.9 to 243.8 m), extending to depths beyond our investigation of 8.2 m below grade (Elev. 233.4 to 236.9 m). The till is generally brown, and moist to wet. Standard Penetration Test (SPT) results (N-Values) measured in the sandy silt till range from 20 to 98 blows per 300 mm of penetration ("bpf"), generally increasing with depth. The N-values indicate a relative density ranging from compact to very dense (on average, dense).

2.2 Groundwater

Monitoring wells were installed in each of the boreholes, and stabilized groundwater levels were measured in each of the monitoring wells approximately 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.	Borehole depth (m)	Upon completion of drilling		Strata Screened	Water Level in Well on June 2, 2022 (m)	
		Depth to cave (m)	Unstabilized water level (m)		Depth	Elevation
1	8.2	n/a	6.4	Sandy silt till (Elev. 240.5 - 237.5± m)	1.7	243.4
2	8.2	n/a	Not measured	Sandy silt till (Elev. 238.3 - 235.2± m)	2.8	240.1
3	8.2	n/a	Dry	Sandy silt till (Elev. 237.0 - 234.0± m)	4.2	237.4
4	8.2	n/a	Dry	Sandy silt till (Elev. 239.7 - 236.7± m)	3.7	240.6
5	8.2	n/a	Not measured	Sandy silt till (Elev. 240.0 - 236.9± m)	2.2	242.4

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 groundwater table appears to follow the general topography of the site, sloping downwards towards the east. The groundwater table varies from 1.7 to 4.2 metres below grade (Elev. 237.4 to 243.4 m). The groundwater table for engineering purposes is assumed to be 1.7 meters below existing grade. The soils at this site have a moderate permeability and will yield some seepage in the short-term and long-term. Grounded has prepared a separate hydrogeological report for this site (File No. 22-085).

2.3 Corrosivity and Sulphate Attack

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

The analytical results only provide an indication of the potential for corrosion. All three samples scored less than 10 points and corrosion protective measures are therefore not required 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 three samples had resistivity measurements exceeding 2000 ohm.cm.

3 Geotechnical Engineering Recommendations

Based on the factual data summarized above, preliminary geotechnical engineering recommendations are provided. These preliminary recommendations are for due diligence purposes only. They must be supplemented and confirmed by additional boreholes, wells, and a detailed geotechnical engineering report at the detailed design stage.

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

3.1 Site Grading

A site grading plan was not available at the time of this investigation, however it is assumed that some modest level of site grading (i.e. cutting and/or filling) will be required for new development. For pavement areas, grade raises may comprise compacted fill or engineered fill. For building areas where fill is required to provide structural support for foundations, engineered fill is required.

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

1. Compacted fill does not need full-time inspection and testing, although it does need periodic geotechnical engineering testing and inspections for quality control. The frequency of periodic inspections can vary from once a day to once every 3 days and is to be confirmed after the construction schedule is available for review. Engineered fill requires full-time inspection and testing.
2. Compacted fill can be made on an existing earth fill subgrade if it is proof rolled under our inspection and approved by us prior to fill placement. Engineered fill requires an approved subgrade of native soils.

Both compacted fill and engineered fill shall comprise earth fill that is inorganic, clean, and geotechnically suitable soil sourced from the site or imported.

Across the entire fill area, the topsoil and other deleterious materials must be removed. The proposed subgrade must be cut neat and must be inspected by Grounded to identify any voids, organics, or soft, wet, or weak zones. Any identified areas must be sub-excavated to a competent subgrade. Compacted fill may be made on inspector-approved existing clean non-organic earth fill, or native soil. Engineered fill must be made to bear on inspector-approved undisturbed native soil.

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

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

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

The existing topsoil is not geotechnically suitable and must be removed from settlement sensitive areas (structures, pavements, etc.). Topsoil may be re-used in landscaped areas that are not sensitive to settlement, or wasted off-site. A portion of the existing earth fill may be suitable for immediate re-use as common earth fill or engineered fill if it is sorted or blended to remove any excess organics, moisture, or other deleterious materials. The amount of fill to be removed and replaced with engineered fill varies by borehole locations, but ranges from 0.8 to 3.8 m.

We estimate that most of the undisturbed native soil at the site is likely suitable for immediate re-use on site.

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

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

Frost susceptible soils within 1.4 m of finished grades in unheated areas (e.g. pavements) could potentially cause pavements to heave or crack next to other structures (e.g. curbs, catchbasins, etc.). The degree of heaving is unknown. If frost susceptibility is to be considered in design (to be determined by the Owner based on their own pavement performance criteria), all soil placed within 1.2 m of finished grades must be classified to have a low susceptibility to frost heaving.

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

For the expected heights of engineered fill to be placed, post-construction settlements of the engineered fill itself (i.e. due to self-weight) can be expected to be around 1% of the height of soil placed, depending on the composition of the engineered fill. If the engineered fill is composed of sand or aggregate materials, then post-construction settlements of the engineered fill will be around 0.5% or less and will occur within a week or two. If the engineered fill is sourced from the existing earth fill or glacial till from the site or similar fine grained soils, it will take several weeks for the majority of post-construction settlement due to self-weight to occur.

3.2 Foundation Design Parameters

The topsoil and earth fill soils are considered unsuitable for the support of the proposed building foundations. There are several foundation options for the site, depending on final design grades and site development details. Consideration has been given to supporting new buildings at the site on conventional spread footings bearing on undisturbed soils, engineered fill, or ground improved soils. It is also feasible to support the new structure at the site on helical piles.

When exposed to ambient environmental temperatures in the Georgetown (Norval) area, the design earth cover for frost protection of foundations and grade beams is 1.4 metres.

3.2.1 Spread Footings

Conventional spread footings made to bear on these undisturbed native soils at 0.8 to 3.8 m below grade (as shown on the borehole logs) may be designed using the following maximum factored geotechnical resistances at ULS, and net geotechnical reactions at SLS for an estimated total settlement of 25 mm at or below the following elevations.

Summary of Bearing Capacities for Conventional Spread Footings on Native Soil at Site

Borehole	Top of Competent Native Soil Elevations (m)	Basement Approach	Native Founding Subgrade	Design Bearing Capacity	
				ULS Capacity	SLS Capacity
1	242.5± m	Conventional Drained	Sandy silt till	500 kPa	350 kPa
2	239.5± m	Conventional Drained	Sandy silt till	500 kPa	350 kPa
3	240.0± m	Conventional Drained	Sandy silt till	500 kPa	350 kPa
4	240.0± m	Conventional Drained	Sandy silt till	500 kPa	350 kPa
5	243.5± m	Conventional Drained	Sandy silt till	500 kPa	350 kPa

Individual spread footing foundations must be at least 1000 mm wide and must be embedded a minimum of 1000 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. At this site, the SLS bearing pressures provided above also limit the maximum footing sizes for spread footings to 3000 mm.

Prior to excavation, it will be necessary to positively dewater for any foundation excavations extending below the groundwater table. These excavations must be dewatered to a minimum 1.2 m below proposed excavation elevation prior to excavation, to preserve the in-situ integrity of the native soils. If the subsurface is not dewatered prior to excavation, the native soils will become disturbed by the ingress of groundwater and the above recommendations for bearing capacity will not be valid.

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

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.

3.2.2 Conventional Spread Footings on Engineered Fill

Alternatively, the proposed structure may be supported on conventional spread footing foundations resting on engineered fill. An engineered fill specification is provided in Appendix D and discussed in Section 3.1.

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

For footings supported on engineered fill, the minimum width for conventional strip footings must be 600 mm, and the minimum size of individual spread footings must be 1000 mm x 1000 mm. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to a settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

Any single grid line should be supported fully on either engineered fill or on native soils.

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

- Sand or gravel soil – several days
- Silt soil – several weeks

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

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

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

3.2.3 Helical Piles

Helical piles may be designed to carry new structural load. Since helical pile installations require little to no excavation, they are a suitable option where excavation and replacement of existing fill is not desired. Helical piles can be installed using small equipment or by hand, with minimal ground disturbance and minimal excess soil cuttings.

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

At this site, helical piles can be installed to bear into the dense glacial till in order to obtain adequate resistance to support the new loads. Following helical pile installation, a pile cap or grade beam is constructed to transfer the building loads onto the underlying competent soils through the helical piles. The design earth cover (or equivalent insulation) for frost protection of grade beams exposed to ambient environmental temperatures is 1.4 metres for this location.

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

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

3.2.4 Spread Footings Supported by Ground Improvement

The proposed buildings can be supported by strip and spread footings resting on existing soil reinforced by stone column or rammed aggregate elements. These are constructed by using displacement methods depending on soil conditions and project requirements. The aggregate is compacted in thin lifts using crowd pressure and a high energy vibratory hammer with a specialized tamper to densify the aggregate vertically and increase lateral stress in the soil matrix. The construction process results in a reinforced soil profile, providing positive settlement control and a resulting high bearing capacity that can support spread and strip footings. Design of ground improvement is performed as a design-build process by a specialty foundation contractor.

3.3 Earthquake Design Parameters

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

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2012). The classification is based on the determination of the average shear wave velocity in the 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 136-130± metres, the boreholes observe stiff to very still cohesive till. Based on this information, the site designation for seismic analysis is **Class C**, per Table 4.1.8.4.A of the Ontario Building Code (2012). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration- and velocity-based site coefficients.

3.4 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 (Sandy Silt)	21	34	0.28	0.44	3.54

γ = soil bulk unit weight (kN/m^3)
φ = internal friction angle (degrees)
K_a = active earth pressure coefficient (Rankine, dimensionless)

K_o	=	at-rest earth pressure coefficient (Rankine, dimensionless)
K_p	=	passive earth pressure coefficient (Rankine, dimensionless)

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

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

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

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

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

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

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

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

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

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

3.5 Slab on Grade Design Parameters

The undisturbed native soils will provide adequate subgrade for the support of a conventional slab on grade. The modulus of subgrade reaction (MSR) for slab-on-grade design supported by undisturbed native soils is 30,000 kPa/m. Alternatively, the MSR for a slab-on-grade supported by engineered fill is 22,000 kPa/m.

If this basement structure is made as a conventional drained structure, a permanent drainage system including subfloor drains is required (see Section 3.5). In this case, 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 200 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) (HL8 coarse aggregate (OPSS.MUNI 1150) 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 HL8 coarse aggregate (OPSS.MUNI 1150) or HPB, vibrated to a dense state. Any solid collection pipes must be sloped so that they positively discharge to the sumps.

Prior to placement of the capillary moisture break and construction of the slab, the cut subgrade be cut and inspected by Grounded for obvious exposed loose or disturbed areas, or for areas containing excessive deleterious materials or moisture. These areas shall be recompacted in place and retested, or else replaced with Granular B placed as engineered fill (in lifts 150 mm thick or less and compacted to a minimum of 98 percent SPMDD). The slab on grade should not be placed on frozen subgrade, to prevent settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

Without proper filtering there may be entry of fines from the surrounding subgrade soils into the bedding. This loss of ground could result in a loss of support of the slab and clogging of the subfloor drainage system. The use of a non-woven geotextile can be used to prevent fines from the subgrade soils from entering the drainage layer beneath the slab on grade.

3.6 Long-Term Groundwater and Seepage Control

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

For 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. The exterior faces of foundation walls should be provided with a layer of waterproofing to protect interior finishes.

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.

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.

In an open cut excavation, basement wall drainage is installed directly against the basement wall from the open cut side. Perimeter foundation drains made in this application comprise perforated pipe (minimum 100 mm diameter) surrounded by a granular filter of OPSS.MUNI HL-8 Coarse Aggregate providing a minimum 300 mm of cover over the drain pipe.

Typical basement drainage details are appended.

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. 22-085).

4 Considerations for Construction

4.1 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 4 soil, or Type 3 soil if dewatered
- The glacial till is a Type 3 soil, or Type 2 soil if dewatered

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

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.

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.

4.2 Short-Term Groundwater Control

Considerations pertaining to groundwater discharge quantities and quality are discussed in Grounded's hydrogeological report for the site (File No. 22-085), under separate cover.

The groundwater table is approximately 1.7 m below grade which will likely coincide with the bulk excavation elevation for spread footings on undisturbed glacial till. Positive dewatering to lower the groundwater table will be required to facilitate construction as well as to maintain the integrity of the subgrade for foundation and slab-on-grade support. Dewatering will take some time to accomplish prior to the start of excavation. The water level must be kept at least 1.2 m below the lowest excavation elevation during construction. Failure to dewater prior to excavation will result in unrecoverable disturbance of the subgrade, which will render advice provided for undisturbed subgrade conditions inapplicable.

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.

Should the excavation be supported using permeable soldier pile and lagging shoring, positive dewatering will be required on a continuous ongoing basis during excavation and throughout construction.

4.3 Site Work

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

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

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

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

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

4.4 Engineering Review

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

All foundation installations must be reviewed in the field by Grounded, the Geotechnical Engineer of Record, as they are constructed. The on-site review of 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.

House foundations designed under Part 9 of the Building Code are approved by local building inspectors. Prior to placing concrete for foundations of dwellings, the foundation areas must be cleaned of all deleterious materials such as topsoil, fill, and softened, disturbed, or caved materials, as well as any standing water.

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

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

5 Limitations and Restrictions

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

This preliminary geotechnical engineering study is intended for due diligence purposes only. At detailed design, additional site-specific boreholes, groundwater monitoring wells, and updated detailed geotechnical engineering advice are required. Once completed, the future detailed geotechnical engineering report by Grounded Engineering would then supersede this preliminary report.

5.1 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 and mud rotary drilling equipment. 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.

5.2 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.

This report provides preliminary geotechnical engineering advice intended for use by the owner and their retained design team for due diligence only. These preliminary interpretations, design parameters, advice, and discussion on construction considerations are not complete. A detailed site-specific geotechnical investigation must be conducted by Grounded during detailed design to confirm and update the preliminary recommendations provided here.

5.3 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 also make use of and rely upon this report, subject to the limitations as stated.

6 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

Nico Piers, BASc, EIT
Project Coordinator

LICENSED PROFESSIONAL ENGINEER
K. J. BYCKALO
100199873
2022-12-15
PROVINCE OF ONTARIO

Kyle Byckalo, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
J. J. CROWDER
100077148
2022-12-15
PROVINCE OF ONTARIO

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

FIGURES

GROUNDED ENGINEERING

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

LEGEND

APPROXIMATE PROPERTY BOUNDARY

Note

Reference

ArcGis 2021

Project

14015 DANBY ROAD, GEORGETOWN, ONTARIO

Figure Title

SITE LOCATION PLAN

North

TRUE

PROJECT

Date

JUNE 2022

Scale

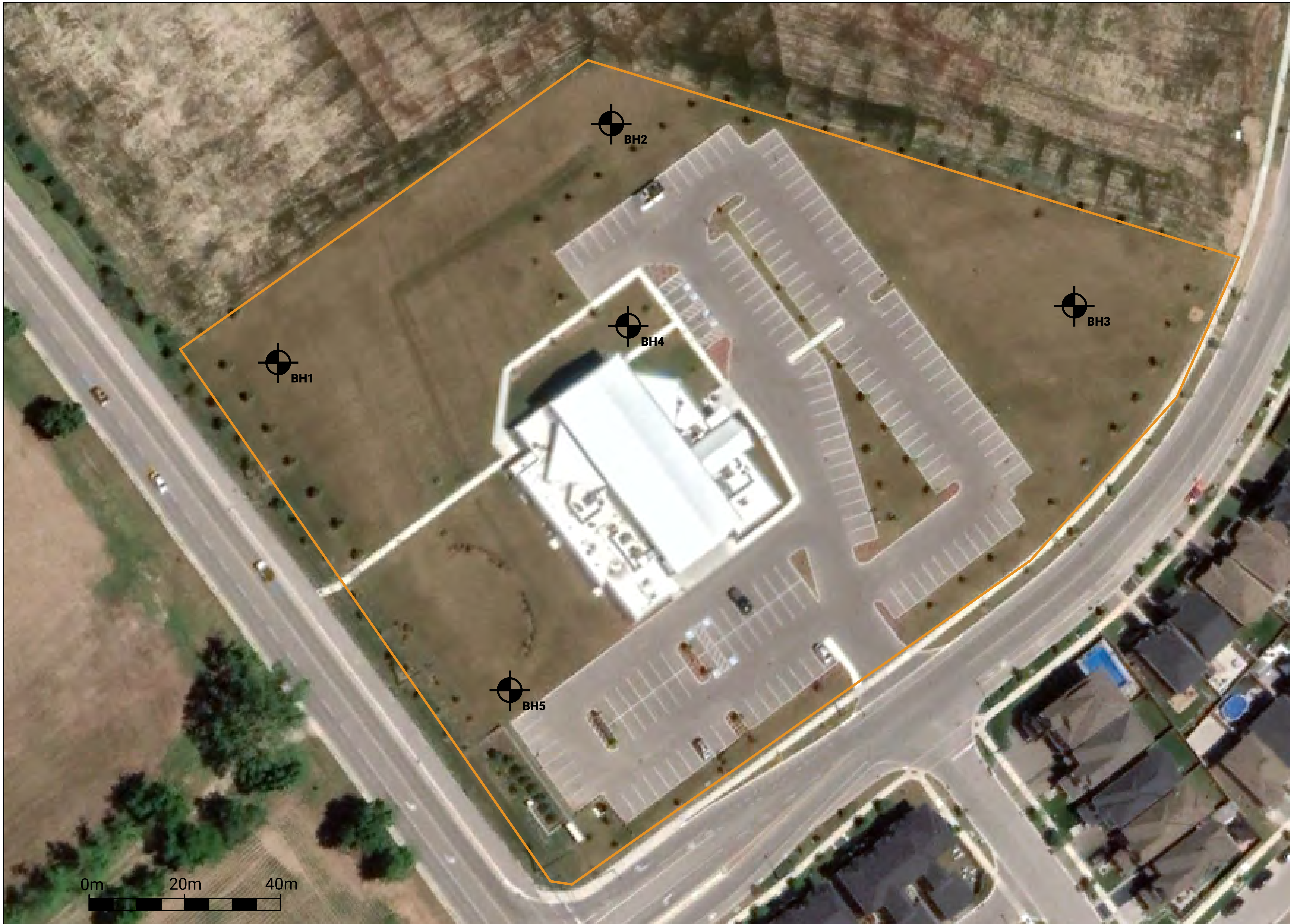
AS INDICATED

Job No

22-085

Figure No

FIGURE 1



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

LEGEND

APPROXIMATE PROPERTY BOUNDARY

MONITORING WELL/BOREHOLE BY GROUNDED

GUELPH PERMEAMETER BY GROUNDED

Note

Reference

Google Earth 2021

Project

14015 DANBY ROAD, NORVAL, ONTARIO, L0P 1K0

Figure Title

BOREHOLE LOCATION PLAN

North

TRUE

PROJECT

Date

JUNE 2022

Scale

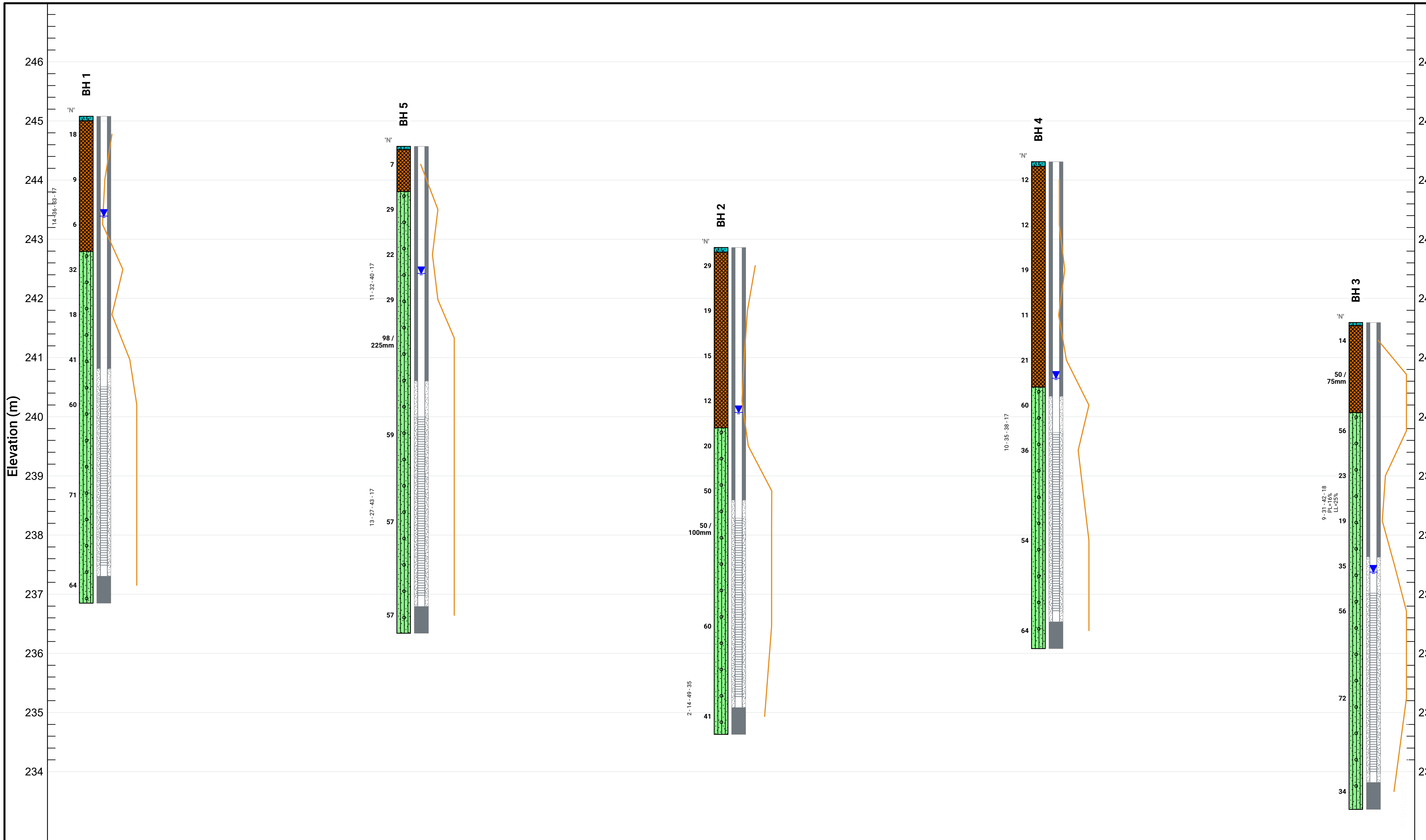
AS INDICATED

Job No

22-082

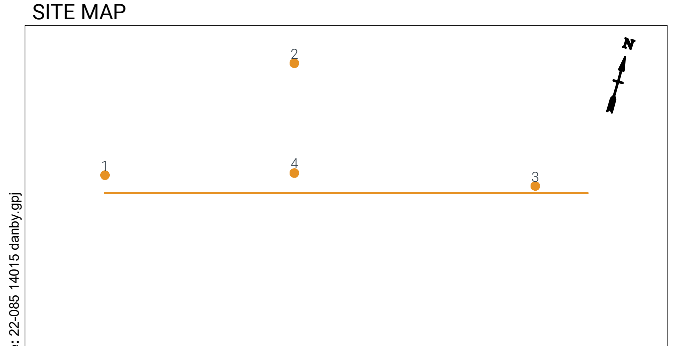
Figure No

FIGURE 2



Boreholes Equally Spaced

SITE MAP



LITHOLOGY GRAPHIC LEGEND

- Topsoil
- Fill
- Sandy Silt Till

GROUNDED ENGINEERING

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www.groundedeng.ca

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

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

Project
UPRC NORVAL
14015 DANBY ROAD

Figure Title
SUBSURFACE PROFILE

Date
JUNE 2022

Scale
AS INDICATED

Job No
22-085

Figure No
FIGURE 3

APPENDIX A

BOREHOLE LOG TERMINOLOGY

GROUNDED ENGINEERING

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

PI: plasticity index

γ: soil unit weight (bulk)

G_s: specific gravity

S_u: undrained shear strength

▽ unstabilized water level

▼ 1st water level measurement

▼ 2nd water level measurement most recent

▼ water level measurement

ENVIRONMENTAL SAMPLES

M&I: metals and inorganic parameters

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

VOC: volatile organic compound

PHC: petroleum hydrocarbon

BTEX: benzene, toluene, ethylbenzene and xylene

PPM: parts per million

FIELD MOISTURE (based on tactile inspection)

DRY: no observable pore water

MOIST: inferred pore water, not observable (i.e. grey, cool, etc.)

WET: visible pore water

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

COMPOSITION

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

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.

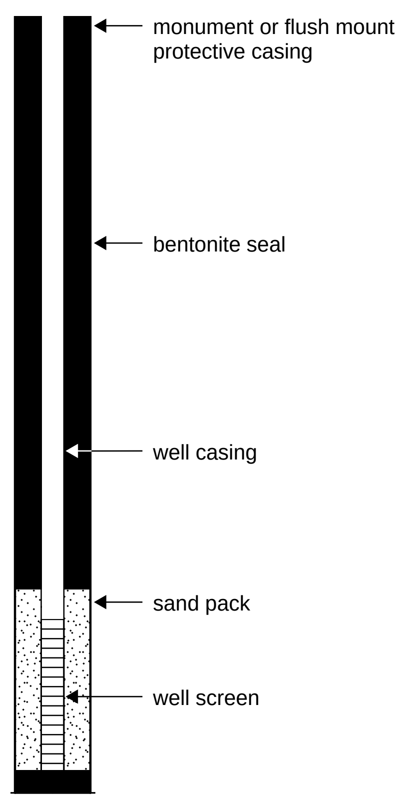
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



GROUNDED ENGINEERING

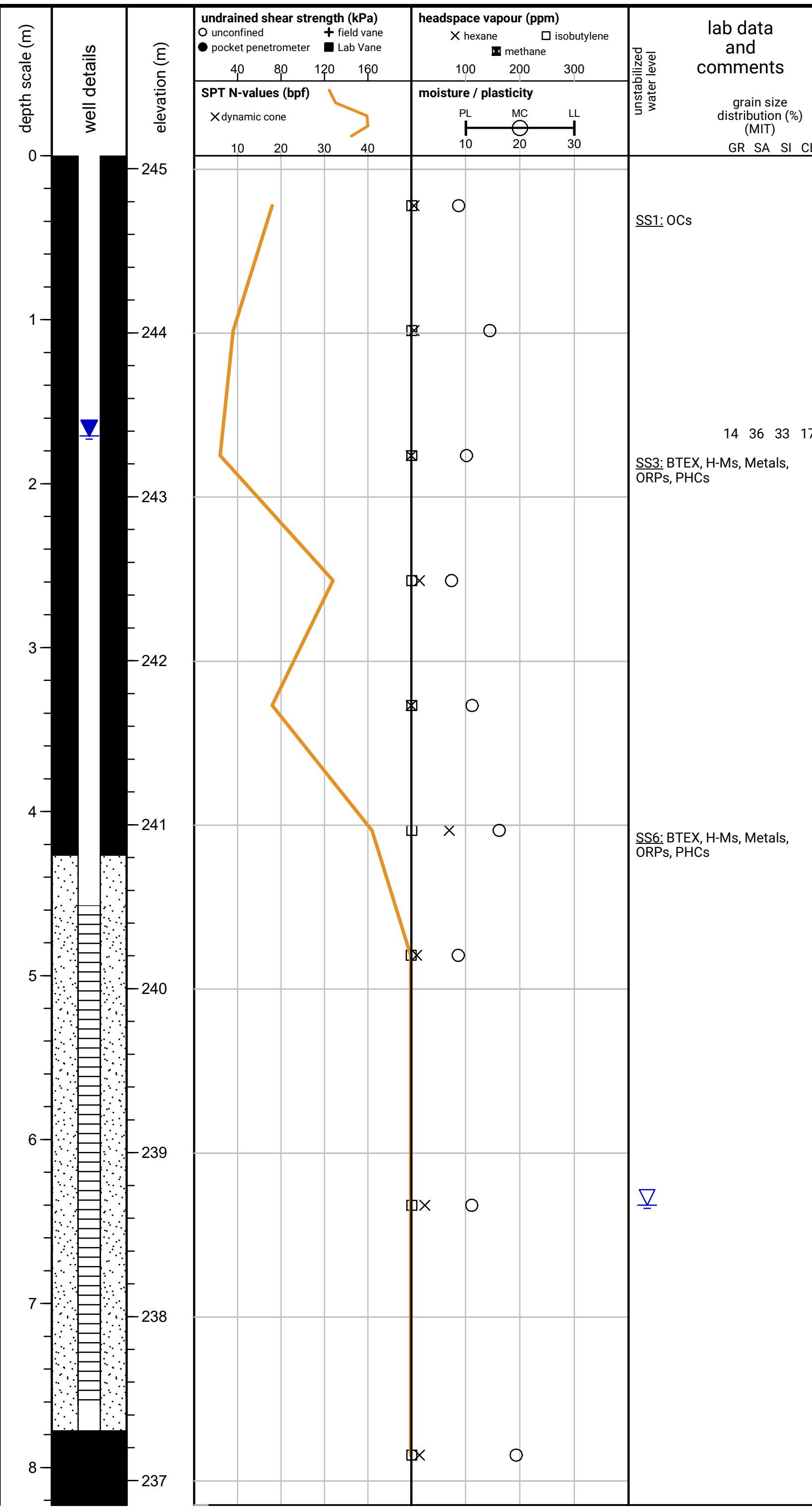
Date Started : May 24, 2022
Position : E: 589787, N: 4830358 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 1

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	stratigraphy: description	graphic log	samples: number	type	SPT N-value
245.1	**GROUND SURFACE**				
	75mm **TOPSOIL**				
	FILL, silty sand, trace gravel, trace construction debris, compact, brown to light brown, moist		1	SS	18
	...at 0.8 m, loose		2	SS	9
			3	SS	6
242.8 2.3	**SANDY SILT**, some clay, some gravel, occasional seams and layers of silt and clay, dense, brown, moist (GLACIAL TILL)		4	SS	32
	...at 3.0 m, compact		5	SS	18
	...at 3.8 m, sand seam, dense		6	SS	41
	...at 4.6 m, grey, very dense		7	SS	60
	...at 6.1 m, wet		8	SS	71
			9	SS	64
236.9 8.2					



lab data and comments

grain size distribution (%) (MIT): GR SA SI CL — 14 36 33 17

SS1: OCs

SS3: BTEX, H-Ms, Metals, ORPs, PHCs

SS6: BTEX, H-Ms, Metals, ORPs, PHCs

END OF BOREHOLE

Unstabilized water level measured at 6.4 m below ground surface upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	1.7	243.4

file: 22-085 14015 danby.gpj

Tech : CSH | **PM** : NP | **Rev** : KB

BOREHOLE LOG 2

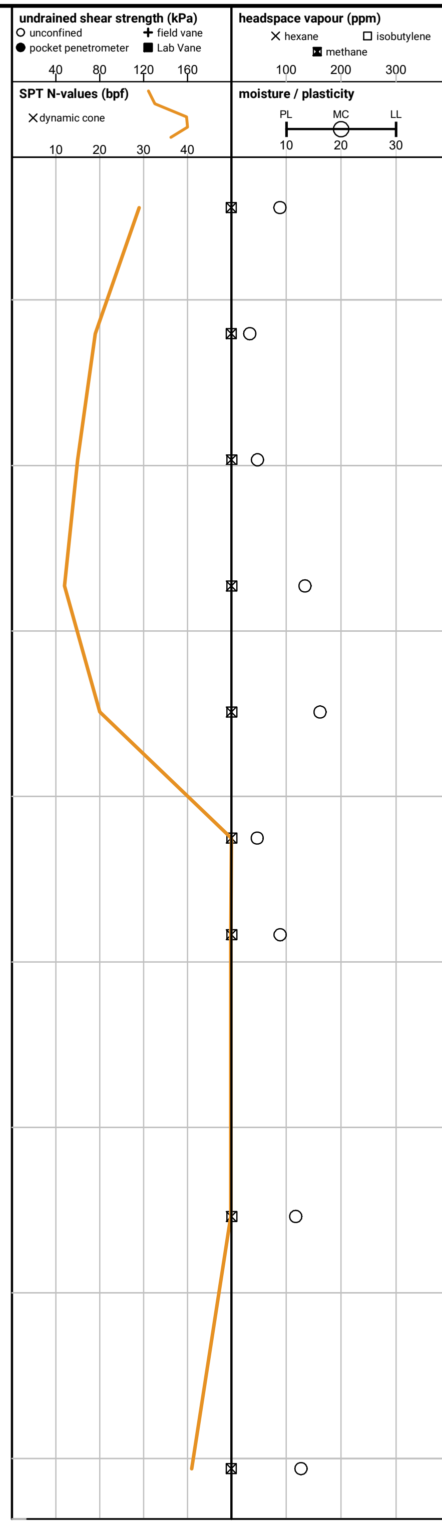
GROUNDED ENGINEERING

Date Started : May 24, 2022
Position : E: 589844, N: 4830418 (UTM 17T)
Elev. Datum : Geodetic

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	description	sample number	type	SPT N-value	elevation (m)	lab data and comments
242.9	**GROUND SURFACE**					
	75mm **TOPSOIL**					
	FILL, sandy silt, trace gravel, trace clay, trace construction debris, compact, light brown, moist	1	SS	29		SS1: OCs
		2	SS	19	242	SS2: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 1.5 m, rock fragments, inferred cobble	3	SS	15	241	
	...at 2.3 m, trace plastic, trace rootlets	4	SS	12	240	
239.9 / 3.0	**SANDY SILT**, some clay, trace gravel, occasional seams and layers of silt and clay, compact, brown, moist (GLACIAL TILL)	5	SS	20		
	...at 3.8 m, sand seam, very dense	6	SS	50	239	SS6: BTEX, H-Ms, Metals, ORPs, PHCs
		7	SS	50 / 100mm	238	
	...at 6.1 m, grey	8	SS	60	237, 236	
	...at 7.6 m, silt and clay, some sand, trace gravel, dense	9	SS	41	235	grain size distribution (%) (MIT): GR 2, SA 14, SI 49, CL 35
234.7 / 8.2						



END OF BOREHOLE

Water level and cave not measured upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	2.8	240.1

file: 22-085 14015 danby.gpj

Tech : CSH | **PM** : NP | **Rev** : KB

BOREHOLE LOG 3

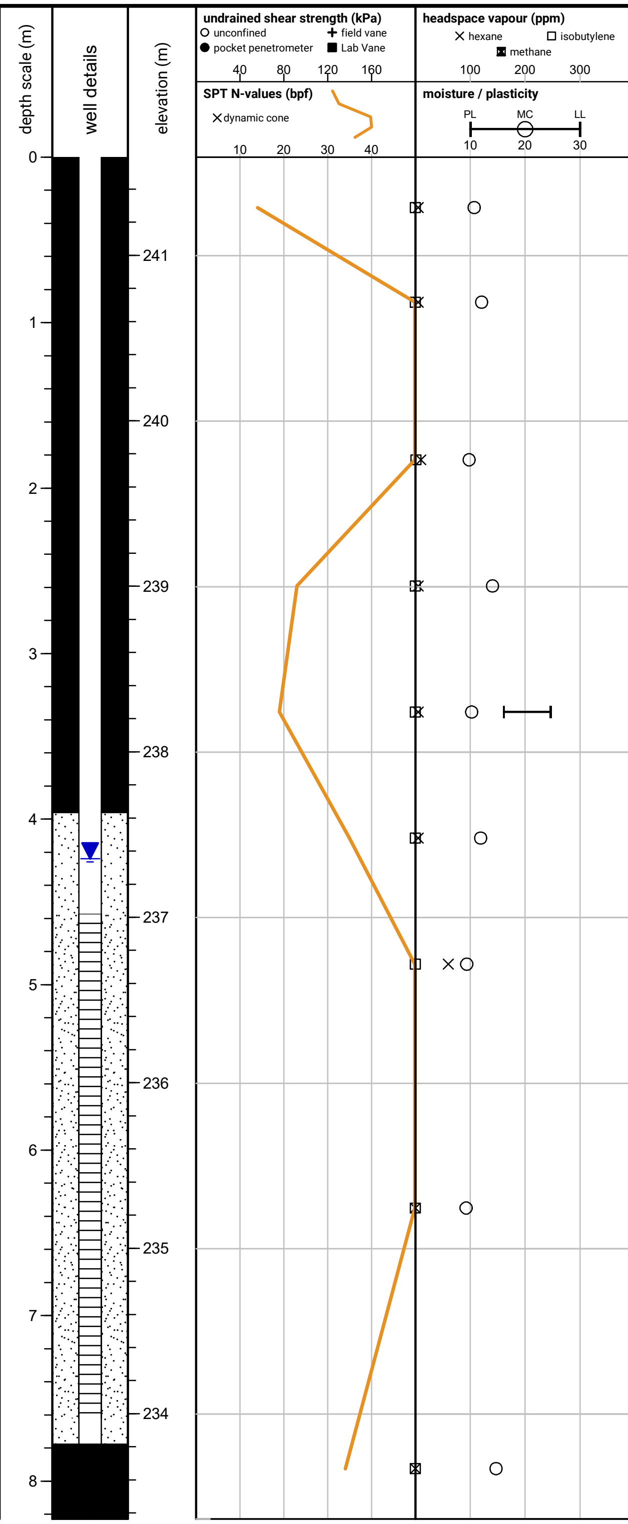
GROUNDED ENGINEERING

Date Started : May 25, 2022
Position : E: 589943, N: 4830398 (UTM 17T)
Elev. Datum : Geodetic

File No. : 22-085
Project : UPRC Norval, 14015 Danby Road
Client : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev / depth (m)	stratigraphy description	sample number	type	SPT N-value	lab data and comments	grain size distribution (%) (MIT) GR SA SI CL
241.6	**GROUND SURFACE**					
	50mm **TOPSOIL**					
	FILL, silty sand, trace gravel, trace construction debris, trace rootlets, trace rock fragments, trace clay, compact, light to dark brown, moist	1	SS	14	SS1: OCs	
		2	SS	50 / 75mm		
240.1 / 1.5	**SANDY SILT**, some clay, trace gravel, occasional seams and layers of silt and clay, very dense, brown, moist (GLACIAL TILL)	3	SS	56	SS3: BTEX, H-Ms, Metals, ORPs, PHCs	
	...at 2.3 m, compact	4	SS	23		
		5	SS	19		9 31 42 18
	...at 3.8 m, rock fragments, inferred cobble, dense	6	SS	35		
	...at 4.6 m, brown to grey, very dense	7	SS	56	SS7: BTEX, H-Ms, Metals, ORPs, PHCs	
	...at 6.1 m, grey	8	SS	72		
	...at 7.6 m, dense, wet	9	SS	34		
233.4 / 8.2	**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 2, 2022	4.2	237.4

file: 22-085 14015 danby.gpj

Tech : FR | **PM** : NP | **Rev** : KB

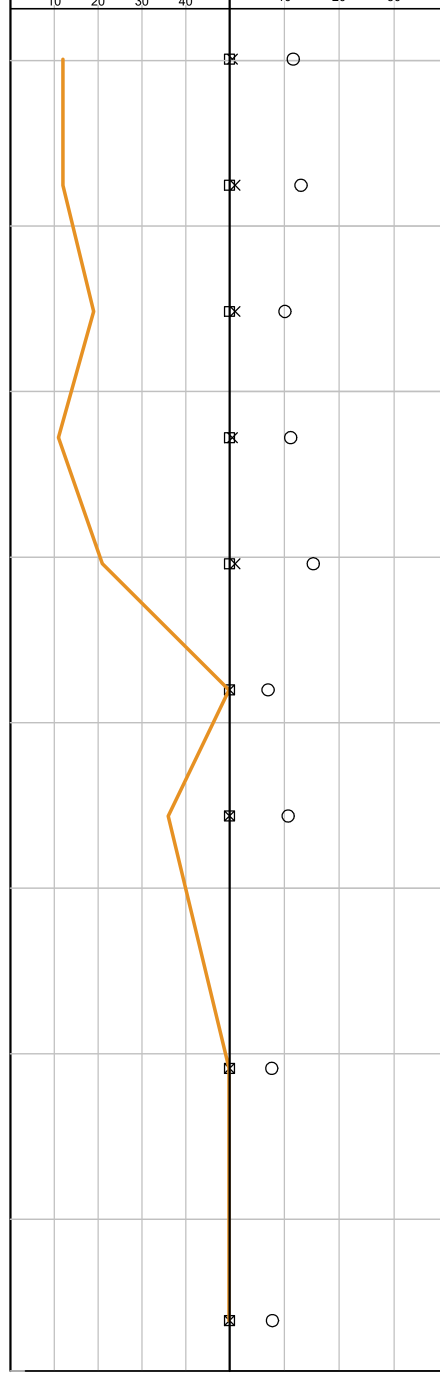
Date Started : May 25, 2022
Position : E: 589855, N: 4830378 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 4

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	description	number	type	SPT N-value	lab data and comments
244.3	**GROUND SURFACE**				
	75mm **TOPSOIL**				
	FILL, sandy silt, trace gravel, trace silt, trace asphalt, trace rootlets, compact, light to dark brown, moist	1	SS	12	SS1: OCs
	...at 0.8 m, trace rock fragments, inferred cobble, brown to grey	2	SS	12	
	...at 1.5 m, trace brick fragments, trace construction debris	3	SS	19	
	...at 2.3 m, trace plastic	4	SS	11	SS4: BTEX, H-Ms, Metals, ORPs, PHCs
		5	SS	21	
240.5 / 3.8	...at 3.8 m, trace rock fragments, inferred cobble				
	SANDY SILT, trace gravel, some clay, occasional seams and layers of silt and clay, very dense, brown, moist (GLACIAL TILL)	6	SS	60	
	...at 4.6 m, dense	7	SS	36	grain size distribution (%) (MIT): GR 10, SA 35, SI 38, CL 17; SS7: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 6.1 m, grey, very dense	8	SS	54	
		9	SS	64	
236.1 / 8.2					



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 2, 2022	3.7	240.6

file: 22-085 14015 danby.gpj

Tech : FR | **PM** : NP | **Rev** : KB

GROUNDED ENGINEERING

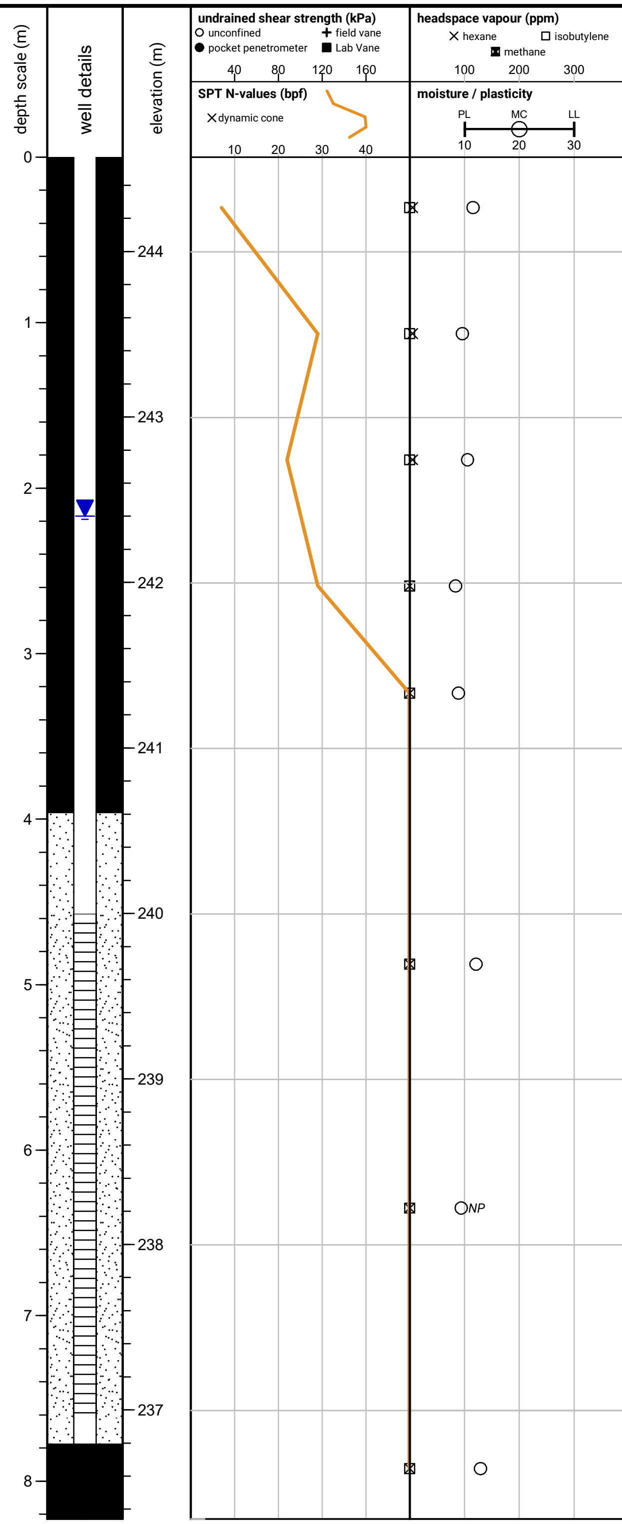
Date Started : May 25, 2022
Position : E: 589843, N: 4830299 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 5

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value	lab data and comments	grain size distribution (%) (MIT) GR SA SI CL
244.6	**GROUND SURFACE**					
	50mm **TOPSOIL**					
	FILL, sandy silt, some clay, trace gravel, loose, brown, moist	1	SS	7	SS1: OCs	
243.8 0.8	**SANDY SILT**, some gravel, some clay, occasional seams and layers of silt and clay, compact, brown, moist (GLACIAL TILL)	2	SS	29	SS2: BTEX, H-Ms, Metals, ORPs, PHCs	
		3	SS	22		
		4	SS	29		11 32 40 17
	...at 3.0 m, very dense, trace rock fragments, inferred cobble	5	SS	98 / 225mm		
	...at 4.6 m, grey	6	SS	59	SS6: BTEX, H-Ms, Metals, ORPs, PHCs	
	...at 6.1 m, wet	7	SS	57		13 27 43 17
		8	SS	57		
236.4 8.2						



END OF BOREHOLE

Water level and cave not measured upon completion of drilling.

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

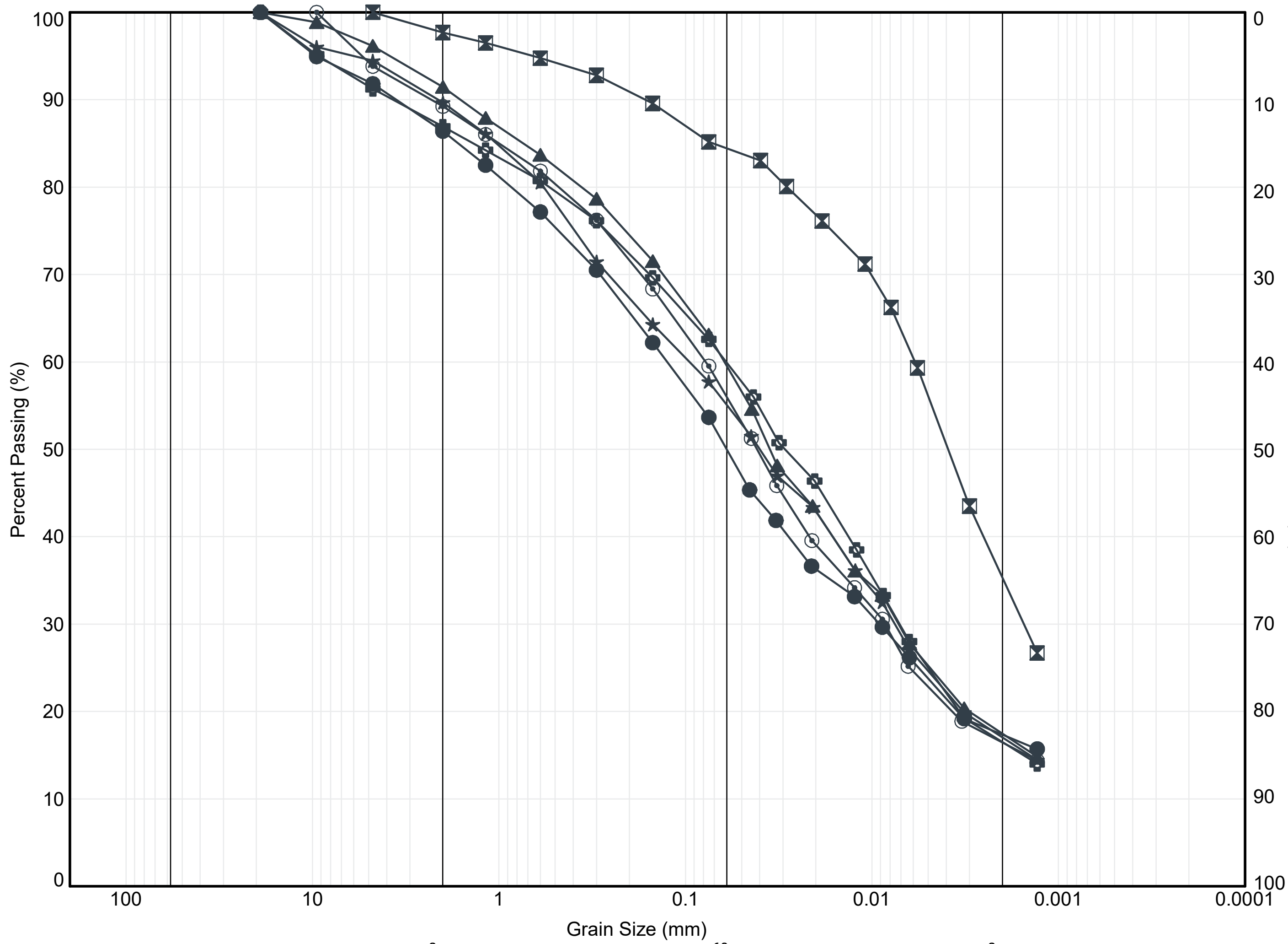
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	2.2	242.4

file: 22-085 14015 danby.gpj

Tech : FR | **PM** : NP | **Rev** : KB

APPENDIX B



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

MIT SYSTEM

	Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
●	1	SS3	1.8	243.3	14	36	33	17
⊠	2	SS9	7.9	234.9	2	14	49	35
▲	3	SS5	3.4	238.2	9	31	42	18
★	4	SS7	4.9	239.4	10	35	38	17
⊙	5	SS4	2.6	242.0	11	32	40	17
✪	5	SS7	6.4	238.2	13	27	43	17

GROUNDED ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION**

File No.: **22-085**

file: 22-085 14015 danby.gpj

APPENDIX C

CORROSIVITY (ALS)

Results Summary L2711222

Job Reference	22-085
Report To	Nicholas Piers, Grounded Engineering Inc
Date Received	1-Jun-2022 11:00
Report Date	14-Jun-2022 7:14
Report Version	1

Client Sample ID			BH1-SS5	BH5-SS4	BH5-SS8
Date Sampled			30-May-2022	30-May-2022	30-May-2022
Time Sampled			12:00	12:00	12:00
ALS Sample ID			L2711222-1	L2711222-2	L2711222-3
Parameter	Lowest Detection Limit	Units	Soil	Soil	Soil
Physical Tests (Soil)					
Conductivity	0.0040	mS/cm	0.217	0.189	0.303
% Moisture	0.25	%	9.15	9.40	11.0
pH	0.10	pH units	7.88	8.00	8.17
Redox Potential	-1000	mV	314	240	257
Resistivity	1.0	ohm*cm	4610	5280	3300
Leachable Anions & Nutrients (Soil)					
Chloride	5.0	ug/g	77.8	63.8	22.3
Anions and Nutrients (Soil)					
Sulphate	20	ug/g	20	<20	142
Inorganic Parameters (Soil)					
Acid Volatile Sulphides	0.20	mg/kg	0.49	0.40	0.79

INTERPRETATION

AWWA C-105 Standard		**Points**	**Points**	**Points**
% Moisture	%	1	1	1
pH	pH units	0	0	0
Redox Potential	mV	0	0	0
Resistivity	ohm*cm	0	0	0
Acid Volatile Sulphides	mg/kg	3.5	2	3.5
TOTAL SCORE (AWWA C-105)		**4.5**	**3**	**4.5**
Sample		**BH1-SS5**	**BH5-SS4**	**BH5-SS8**
Corrosion Protection Recommended?		**No**	**No**	**No**
Resistivity less than 2000 ohm.cm?		**No**	**No**	**No**
Anions and Nutrients (Soil)				
Sulphate	%	<0.002	<0.002	0.0142
CLASS OF EXPOSURE		**Negligible**	**Negligible**	**Negligible**

Grounded Engineering Inc
ATTN: Nicholas Piers
1 Banigan Drive
TORONTO ON M4H 1G3

Date Received: 01-JUN-22
Report Date: 14-JUN-22 07:14 (MT)
Version: FINAL

Client Phone: 647-264-7932

Certificate of Analysis

Lab Work Order #: L2711222

Project P.O. #: NOT SUBMITTED
Job Reference: 22-085
C of C Numbers: 20-1003801
Legal Site Desc: 14015 DANBY ROAD

Amanda Overholster
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2711222-1 BH1-SS5 Sampled By: CLIENT on 30-MAY-22 @ 12:00 Matrix: SOIL							
Physical Tests							
Conductivity	0.217		0.0040	mS/cm		13-JUN-22	R5798359
% Moisture	9.15		0.25	%	02-JUN-22	03-JUN-22	R5793144
pH	7.88		0.10	pH units		03-JUN-22	R5794059
Redox Potential	314		-1000	mV		06-JUN-22	R5794795
Resistivity	4610		1.0	ohm*cm		13-JUN-22	
Leachable Anions & Nutrients							
Chloride	77.8		5.0	ug/g	10-JUN-22	10-JUN-22	R5797695
Anions and Nutrients							
Sulphate	<20		20	ug/g	10-JUN-22	10-JUN-22	R5797695
Inorganic Parameters							
Acid Volatile Sulphides	0.49		0.20	mg/kg	02-JUN-22	02-JUN-22	R5792977
L2711222-2 BH5-SS4 Sampled By: CLIENT on 30-MAY-22 @ 12:00 Matrix: SOIL							
Physical Tests							
Conductivity	0.189		0.0040	mS/cm		13-JUN-22	R5798359
% Moisture	9.40		0.25	%	02-JUN-22	03-JUN-22	R5793144
pH	8.00		0.10	pH units		03-JUN-22	R5794059
Redox Potential	240		-1000	mV		06-JUN-22	R5794795
Resistivity	5280		1.0	ohm*cm		13-JUN-22	
Leachable Anions & Nutrients							
Chloride	63.8		5.0	ug/g	10-JUN-22	10-JUN-22	R5797695
Anions and Nutrients							
Sulphate	<20		20	ug/g	10-JUN-22	10-JUN-22	R5797695
Inorganic Parameters							
Acid Volatile Sulphides	0.40		0.20	mg/kg	02-JUN-22	02-JUN-22	R5792977
L2711222-3 BH5-SS8 Sampled By: CLIENT on 30-MAY-22 @ 12:00 Matrix: SOIL							
Physical Tests							
Conductivity	0.303		0.0040	mS/cm		13-JUN-22	R5798359
% Moisture	11.0		0.25	%	07-JUN-22	08-JUN-22	R5795110
pH	8.17		0.10	pH units		03-JUN-22	R5794059
Redox Potential	257		-1000	mV		06-JUN-22	R5794795
Resistivity	3300		1.0	ohm*cm		13-JUN-22	
Leachable Anions & Nutrients							
Chloride	22.3		5.0	ug/g	10-JUN-22	10-JUN-22	R5797695
Anions and Nutrients							
Sulphate	142		20	ug/g	10-JUN-22	10-JUN-22	R5797695
Inorganic Parameters							
Acid Volatile Sulphides	0.79		0.20	mg/kg	02-JUN-22	02-JUN-22	R5792977

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

"Soil Resistivity (calculated)" is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H_2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

20-1003801

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid weight of sample

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

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

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Quality Control Report

Workorder: L2711222   Report Date: 14-JUN-22

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Nicholas Piers

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT		**Soil**							
Batch	**R5797695**								
WG3738123-3	**CRM**		**AN-CRM-WT**						
Chloride				95.4		%		70-130	10-JUN-22
WG3738123-4	**DUP**		**L2711222-1**						
Chloride			77.8	78.4		ug/g	0.8	30	10-JUN-22
WG3738123-2	**LCS**								
Chloride				99.1		%		80-120	10-JUN-22
WG3738123-1	**MB**								
Chloride				<5.0		ug/g		5	10-JUN-22
EC-WT		**Soil**							
Batch	**R5798359**								
WG3738121-3	**DUP**		**L2711232-2**						
Conductivity			0.177	0.181		mS/cm	2.0	20	13-JUN-22
WG3738121-2	**IRM**		**WT SAR4**						
Conductivity				106.3		%		70-130	13-JUN-22
WG3739021-1	**LCS**								
Conductivity				102.9		%		90-110	13-JUN-22
WG3738121-1	**MB**								
Conductivity				<0.0040		mS/cm		0.004	13-JUN-22
MOISTURE-WT		**Soil**							
Batch	**R5793144**								
WG3734713-3	**DUP**		**L2710662-6**						
% Moisture			31.3	31.3		%	0.2	20	03-JUN-22
WG3734713-2	**LCS**								
% Moisture				100.3		%		90-110	03-JUN-22
WG3734713-1	**MB**								
% Moisture				<0.25		%		0.25	03-JUN-22
Batch	**R5795110**								
WG3736238-10	**DUP**		**L2711575-1**						
% Moisture			5.42	5.23		%	3.6	20	08-JUN-22
WG3736238-7	**LCS**								
% Moisture				99.5		%		90-110	08-JUN-22
WG3736238-6	**MB**								
% Moisture				<0.25		%		0.25	08-JUN-22
PH-WT		**Soil**							

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Nicholas Piers

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WT	**Soil**							
Batch R5794059								
WG3734502-1 DUP		**L2711222-1**						
pH		7.88	7.94	J	pH units	0.06	0.3	03-JUN-22
WG3735082-1 LCS								
pH			7.07		pH units		6.9-7.1	03-JUN-22
REDOX-POTENTIAL-WT	**Soil**							
Batch R5794795								
WG3735971-1 CRM		**WT-REDOX**						
Redox Potential			100.0		%		90-110	06-JUN-22
WG3734416-1 DUP		**L2710188-6**						
Redox Potential		291	264		mV	9.7	25	06-JUN-22
SO4-WT	**Soil**							
Batch R5797695								
WG3738123-3 CRM		**AN-CRM-WT**						
Sulphate			96.1		%		60-140	10-JUN-22
WG3738123-4 DUP		**L2711222-1**						
Sulphate		<20	<20	RPD-NA	ug/g	N/A	25	10-JUN-22
WG3738123-2 LCS								
Sulphate			99.3		%		70-130	10-JUN-22
WG3738123-1 MB								
Sulphate			<20		ug/g		20	10-JUN-22
SULPHIDE-WT	**Soil**							
Batch R5792977								
WG3734744-3 DUP		**L2711224-3**						
Acid Volatile Sulphides		0.54	0.61		mg/kg	12	45	02-JUN-22
WG3734744-2 LCS								
Acid Volatile Sulphides			89.8		%		70-130	02-JUN-22
WG3734744-1 MB								
Acid Volatile Sulphides			<0.20		mg/kg		0.2	02-JUN-22

Quality Control Report

Workorder: L2711222 Report Date: 14-JUN-22

Client:	Grounded Engineering Inc 1 Banigan Drive TORONTO ON M4H 1G3
Contact:	Nicholas Piers

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Cust... L2711222-COFC

www.alsglobal.com

COC Number: 20 - 1003801

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Grounded Engineering
Contact:	Nico Piers
Phone:	416 984 5234
	Company address below will appear on the final report
Street:	1 Banigan Dr
City/Province:	Toronto, ON
Postal Code:	M4H 1G3
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Merge QC/QCI Reports with COA ☑ YES ☐ NO ☐ N/A
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: npiers@groundedeng.ca
Email 2
Email 3

Invoice Recipients
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax
Email 2

Turnaround Time (TAT) Requested
- ☑ Routine [R] if received by 3pm M-F - no surcharges apply
- ☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
- ☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
- ☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
- ☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
- ☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information
ALS Account # / Quote #:
Job #: 22-085
PO / AFE:
LSD: 1405 Dundas Road

Oil and Gas Required Fields (client use)
AFE/Cost Center: | PO#
Major/Minor Code: | Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (ALS use only): L2711222
ALS Contact:
Sampler:

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Corrosivity	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	BH1-555	03-10-22	12:00	S	2				
	BH5-554	↓	↓	↓	2				
	BH5-558	↓	↓	↓	2				

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human consumption/ use? ☐ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Corrosivity suite

SAMPLE RECEIPT DETAILS (ALS use only)
Cooling Method: ☐ NONE ☐ ICE ☑ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED
Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO
Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A
INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C: 0.3

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by: JK	Date: 06/01/22	Time: 11:05

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

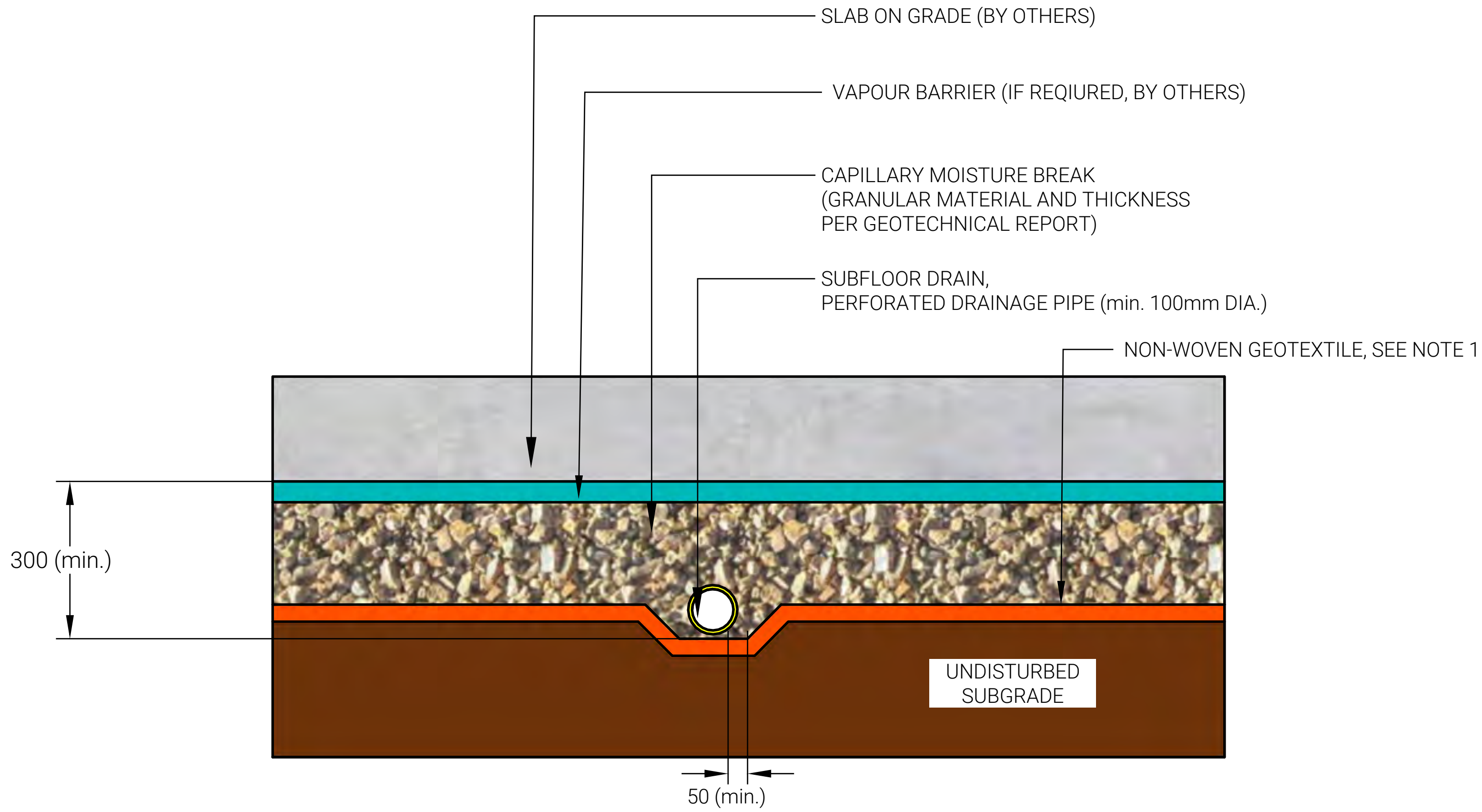
WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

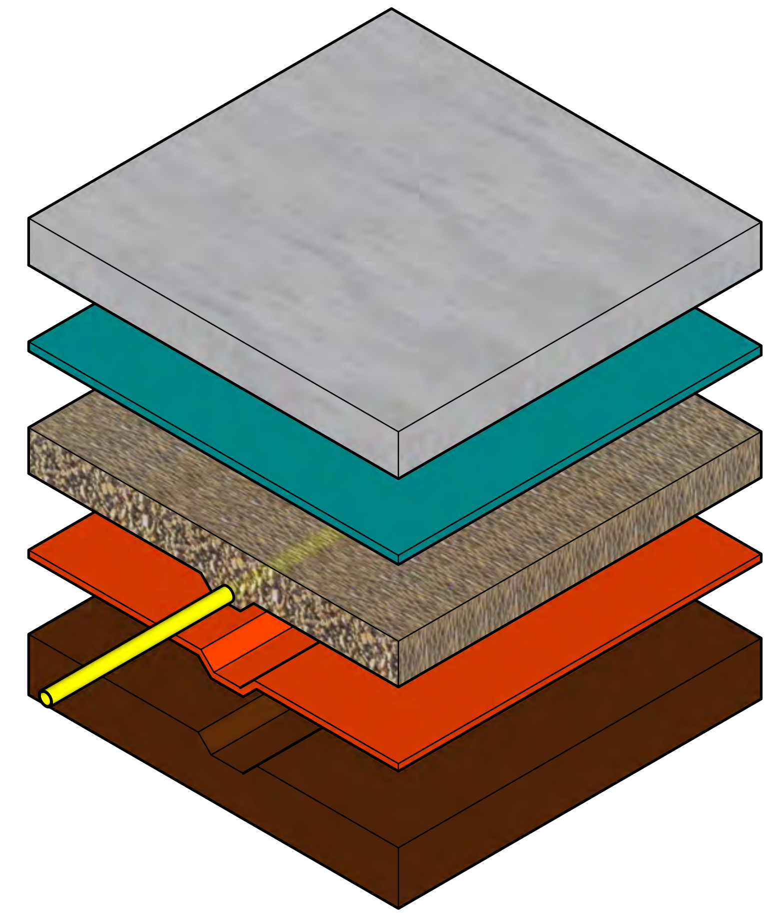
1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX D

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

1 GENERAL

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

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

1.1 Description

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

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

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

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

1. Topsoil stripping from the ground surface below all Engineered Fill areas,

2. Test pit excavating into the subgrade to a) investigate subgrade suitability for the support of Engineered Fill and b) observe and document any prior existing fill materials,

3. Proof-rolling of the subgrade below all Engineered Fill areas, to detect the presence and extent of unstable ground conditions,

4. Excavating and removing unstable/unacceptable subgrade materials, or the implementation of other approved subgrade stabilization measures (as required) prior to the placement of Engineered Fill,

5. Surveying of ground elevations prior to placing Engineered Fill,

6. Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,

7. Surveying of ground elevations on completion of Engineered Fill placement,

8. Providing and maintaining survey layout of the Engineered Fill areas, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.2 The Project Parties

1. The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of Engineered Fill.

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

3. The term Geotechnical Engineer shall refer to Grounded Engineering.

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

2 MATERIALS

2.1 Definitions

1. Topsoil is the layer of naturally organic soil typically found at the ground surface and commonly in the range of about 100 to 300 mm thick.

2. Earth Fill is soil material which has been placed by humans and has not been deposited by nature over a long period of time.

3. Subgrade Soil is the “in situ” (in place) native soil beneath any earth fill and/or topsoil layer(s).

4. Disturbed Soil is soil material which was originally deposited naturally but has since been disturbed or reworked in place, usually by agriculture activities. Disturbed Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.

5. Weathered Soil is soil material which is naturally deposited but weathered in place due to its exposure to the elements. Weathered Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.

6. Engineered Fill soils must consist of clean earth materials, not excessively wet, free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials. It is placed in thin lifts of no more than 150 mm in thickness. Cohesionless soils such as sand or gravel are the easiest to place and compact.

7. All values stated in metric units shall be considered as accurate.

3 ENGINEERED FILL DESIGN

3.1 Design Foundation Pressure

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

   a) sand or gravel soil; several days
   b) silt soil; several weeks
   c) clay or clayey soil; several months.

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

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

2. Unless otherwise stated, the Engineered Fill is to be placed over the entire lot area or site area.

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

4. An allowable design foundation pressure (net geotechnical reaction at SLS for 25 mm of settlement) of 150 kPa is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.8 m for continuous strip footings, and minimum dimensions of 1 m for column footings.

5. At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.

6. Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for stiffening of basement foundation walls and for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.

7. At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,

   a) placement of footing concrete, and
   b) placement of foundation wall concrete.

4 CONSTRUCTION

4.1 Survey Layout

1. The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.

2. At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed. Benchmark positions may need to be reviewed by Grounded if consolidation settlement is expected to influence their elevations.

3. The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Testing Engineer.

4. The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.

5. On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.2 Topsoil Stripping

1. The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.

2. Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have been suitably stripped.

4.3 Test Holes Into Subgrade

1. After topsoil has been stripped, the exposed subgrade must be investigated for the presence of old buried fill or deleterious material, which may be unsuitable (as determined by the Testing Engineer or the Geotechnical Engineer) for the support of Engineered Fill.

2. Exploratory test pits must be dug using a small backhoe, on a suitable pattern, to observe an appropriate representation of the entire site area.

3. The Testing Engineer or Geotechnical Engineer must observe the digging and backfilling of the test pits; must log the test pit stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test pit.

4. If the test pits discover any old buried fill or deleterious materials, it must be excavated and removed from the Engineering Fill area down to undisturbed, stable native soil.

5. All test pits must be properly backfilled and compacted in thin lifts (max. 150mm thickness) to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Testing Engineer or Geotechnical Engineer must observe the backfilling and compaction of the test pits.

4.4 Subgrade Proof-rolling

1. Prior to placing any Engineered Fill, the exposed subgrade must be proofrolled under the observation of the Testing Engineer.

2. If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.5 Engineered Fill Placement

1. Engineered fill must not be placed without the approval of the Testing Engineer. Prior to placing any Engineered Fill, the topsoil must be stripped, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.

2. Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability both geotechnically and environmentally. Samples of the proposed fill material must be obtained and tested by the Testing Engineer. The samples must be tested in a geotechnical laboratory for Standard Proctor Maximum Dry Density. Samples must also be tested per the requirements of Ontario Regulation 406/19, prior to approval of the material for use as Engineered Fill. The results of the lab testing must be approved by the Geotechnical Engineer and the results of the environmental testing must be approved by the site Qualified Person, prior to import.

3. The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.

4. Field density tests must be taken by the Testing Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.

5. Engineered fill must not be placed during the period of the year when cold weather occurs, i.e. when there are freezing ambient temperatures during the daytime and overnight.

4.6 Certification

1. The Testing Engineer shall provide written summaries of the compaction and lab testing to the Geotechnical Engineer on a frequency of not less than every two weeks.

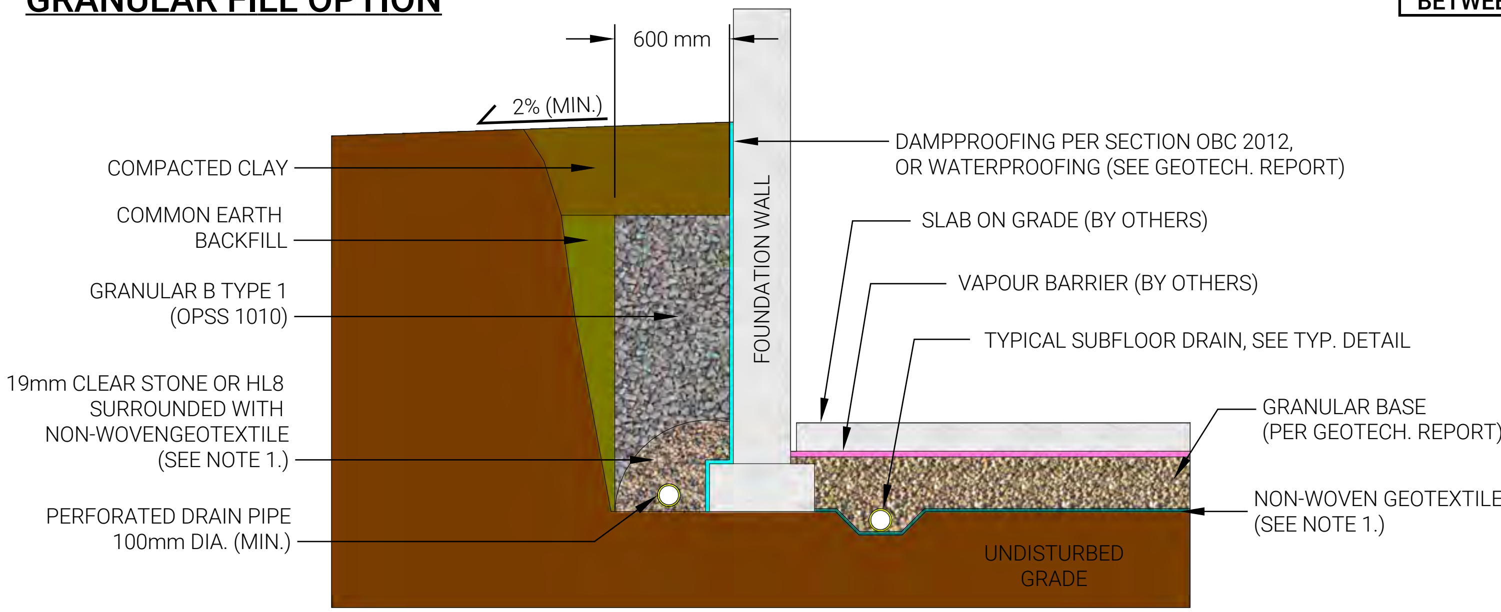
2. Upon Completion of the Engineered Fill placement the Testing Engineer will provide certification to the Geotechnical Engineer of General Compliance with this specification.

3. Upon receipt of the certification from the Testing Engineer, the Geotechnical Engineer will provide the owner with a Certificate of Engineered Fill

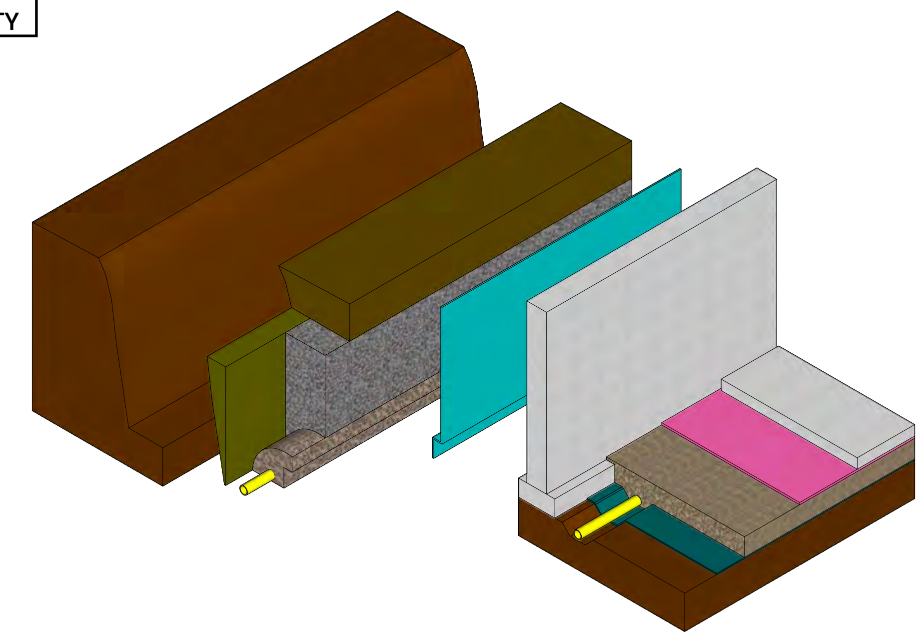
APPENDIX E

GRANULAR FILL OPTION

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY

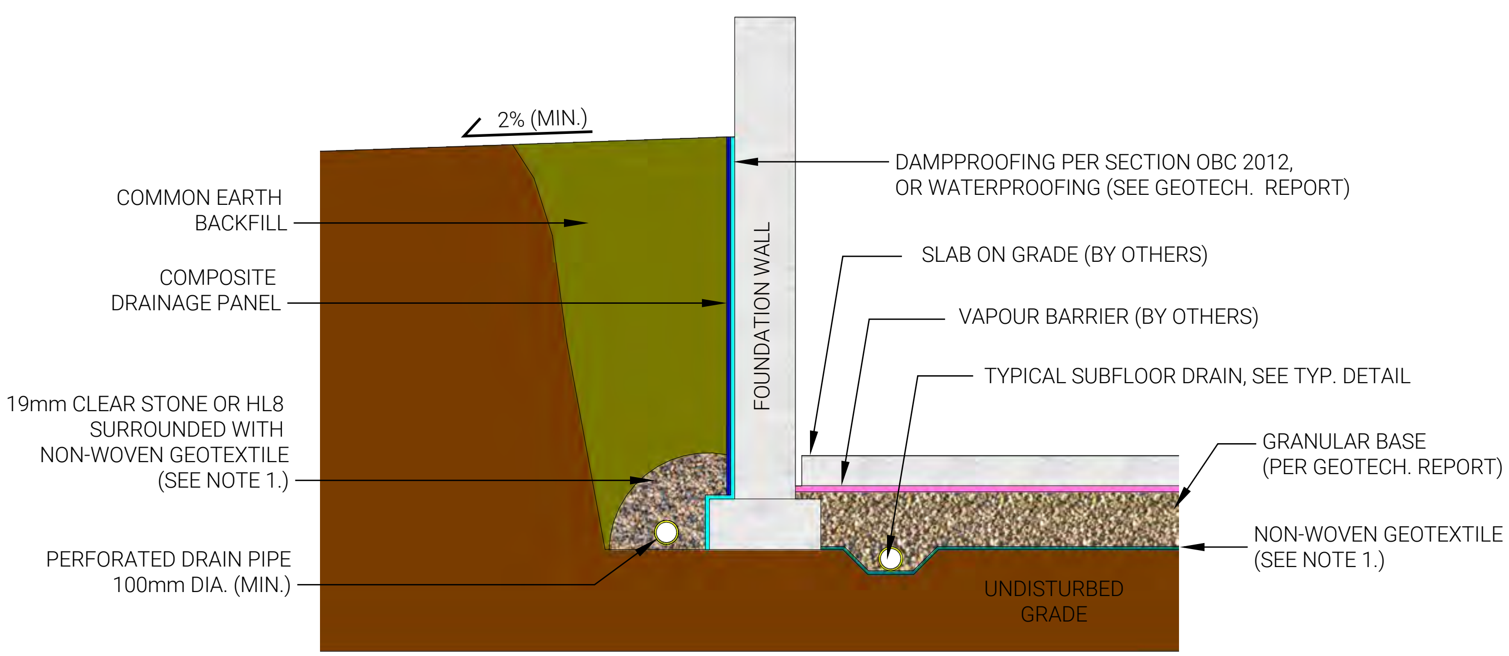


SECTIONAL VIEW

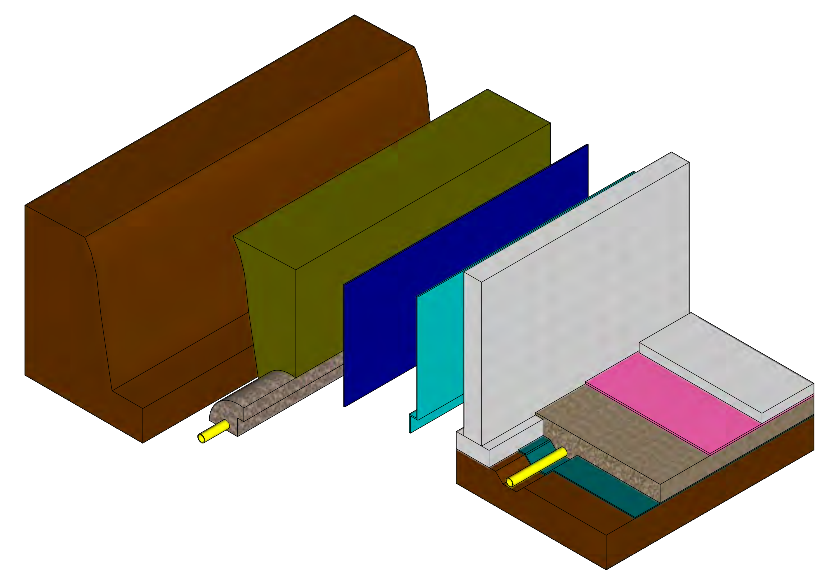


ISOMETRIC VIEW

GEO-COMPOSITE DRAINAGE PANEL OPTION



SECTIONAL VIEW



ISOMETRIC VIEW

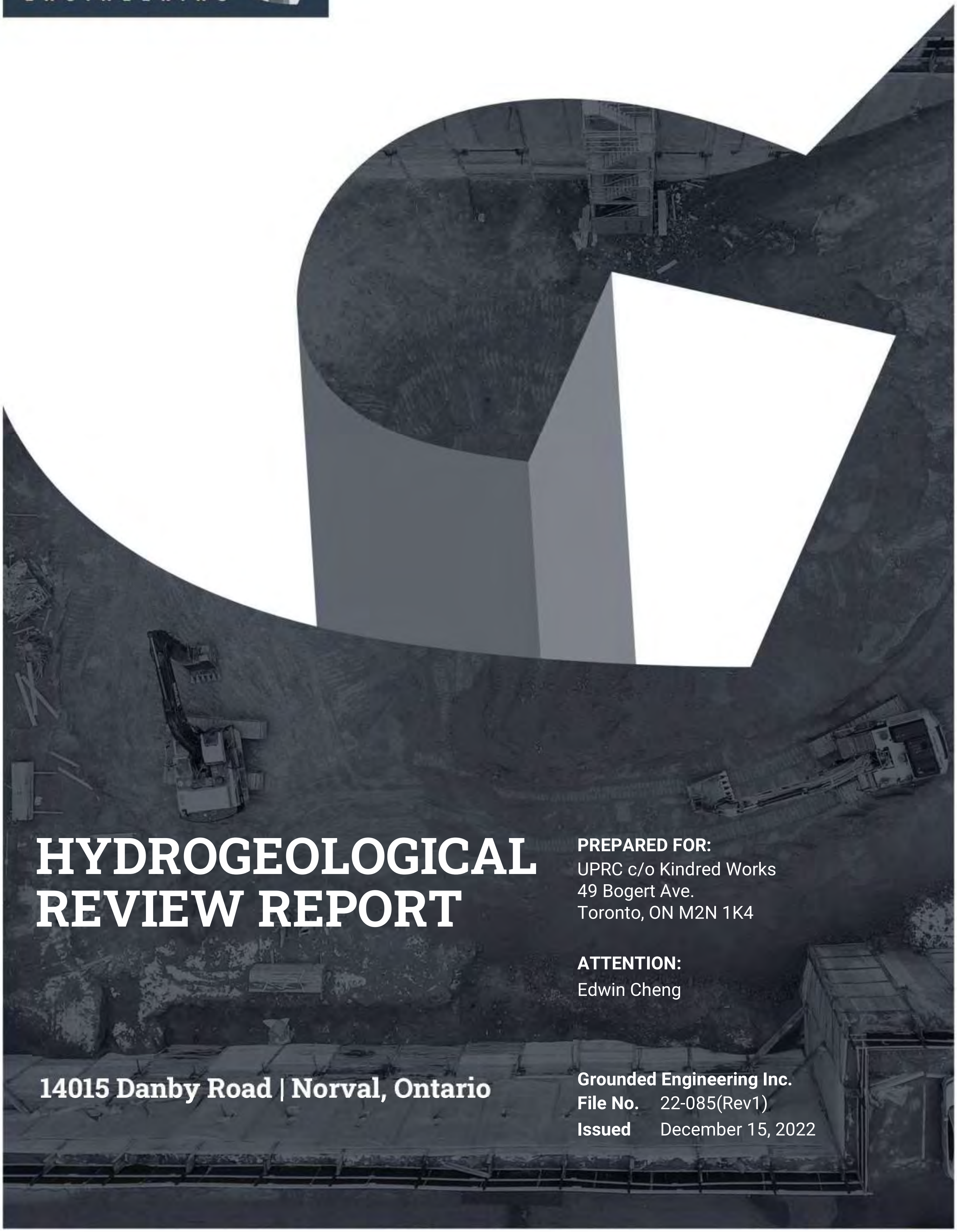
NOTES

1. A NON-WOVEN GEOTEXTILE WITH AN APPARENT OPENING SIZE OF < 0.250mm AND A TEAR RESISTANCE OF > 200 N.

GROUNDED ENGINEERING

Title

BASEMENT DRAINAGE TYPICAL DETAIL



HYDROGEOLOGICAL REVIEW REPORT

PREPARED FOR:
UPRC c/o Kindred Works
49 Bogert Ave.
Toronto, ON M2N 1K4

ATTENTION:
Edwin Cheng

14015 Danby Road | Norval, Ontario

Grounded Engineering Inc.
File No. 22-085(Rev1)
Issued December 15, 2022

Executive Summary

Grounded Engineering Inc. (Grounded) was retained by UPRC c/o Kindred Works to conduct a Hydrogeological Review for the proposed redevelopment of 14015 Danby Road in Norval, Ontario. The conclusions of the investigation are summarized as follows:

Site Information

Existing Development					
Site	Above Grade Levels	Below Grade Levels			
		Level #	Lowest Finished Floor		Approximate Base of Foundations (masl)
			Depth (m)	Elevation (masl)	
14015 Danby Road	1	0	n/a	n/a	Unknown

Proposed Development					
Site	Above Grade Levels	Below Grade Levels			
		Level #	Lowest Finished Floor		Approximate Base of Foundations (masl)
			Depth (m)	Elevation (masl)	
6 Storey Building	6	1	Approx. 4.0	Approx. 241.0	Approx. 239.5

Proposed development assumptions are based on preliminary architectural plans provided to Grounded by UPRC (UCC Norval United Site Plans, prepared by KPMB Architects, Nov 11, 2022, received December 13, 2022). These plans are not finalized and are subject to change.

Site Conditions

Site Stratigraphy					
Stratum/Formation	Aquifer or Aquitard	Depth Range (mbgs)	Elevation Range (masl)	Hydraulic Conductivity (m/s)	Method
Fill	Aquifer	0.1 to 3.8	245.0 to 239.9	1.0×10^{-5}	Literature
Glacial Till (Sandy Silt)	Aquifer	0.8 to 8.2	243.8 to 233.4	1.1×10^{-6}	Slug test

Groundwater Elevation	
Design Groundwater Elevation (masl)	243.5

Groundwater Quality				
Sample ID	**Sample Date**	**Sample Expiry Date**	**Halton Storm Sewer Limits**	**Halton Sanitary and Combined Sewer Limits**
SEW-UF-BH1	June 2, 2022	March 2, 2023	Meets	Meets

Groundwater Control

Stored Groundwater (pre-excavation/dewatering)					
Volume of Excavation (m³)	**Volume of Excavation Below Water Table (m³)**	**Estimated Volume of Stored Groundwater**		**Estimated Volume of Available Groundwater**	
		m³	**L**	**m³**	**L**
9,720	6,480	3,300	3,300,000	2,300	2,300,000

Short Term (Construction) Steady State Groundwater Quantity – Safety Factor of 2.0 Used					
Estimated Groundwater Seepage		**Design Rainfall Event (25mm)**		**Estimated Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
120,000	83.3	54,000	37.5	174,000	120.8

Long Term (Permanent) Steady State Groundwater Quantity – Safety Factor of 2.0 Used					
Estimated Groundwater Seepage		**Estimated Infiltrated Stormwater – Design Rainfall Event (25mm)**		**Estimated Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
75,000	52.1	19,000	13.2	94,000	65.3

Land Stability	**Short Term (Construction)**	**Long Term (Permanent)**
Maximum Zone of Influence (m)	21	14
Maximum Potential Settlement (mm)	6	3

Regulatory Requirements	
Environmental Activity and Sector Registry (EASR) Posting	Required
Short Term Permit to Take Water (PTTW)	Not Required
Long Term Permit to Take Water (PTTW)	Required
Short Term Discharge Agreement Town of Halton Hills	Required
Long Term Discharge Agreement Town of Halton Hills	Required

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FIGURES

APPENDICES

1 Introduction

UPRC c/o Kindred Works has retained Grounded Engineering Inc. ("Grounded") to provide hydrogeological engineering design advice for their proposed development at 14015 Danby Road, in Norval, Ontario.

Property Information	
Location of Site	14015 Danby Road, Norval, Ontario, L0P 1K0
Ownership of Site	UPRC c/o Turner Townsend
Site Dimensions (m)	145 x 145 (irregular shaped)
Site Area (m^2)	20,039

Existing Development	
Number of Building Structures	1
Number of Above Grade Levels	1
Number of Underground Levels	0
Sub-Grade Depth of Development (m)	n/a
Sub-Grade Area (m^2)	n/a
Land Use Classification	Institutional

Proposed Development	
Number of Building Structures	1
Number of Above Grade Levels	6
Number of Underground Levels	1
Sub-Grade Depth of Development (m)	Approx. 4
Sub-Grade Area (m^2)	Approx. 2,120
Land Use Classification	Residential

Qualified Person and Hydrogeological Review Information	
Qualified Person	Matthew Bielaski, P.Eng., $QP_{RA\text{-}ESA}$
Consulting Firm	Grounded Engineering Inc.
Date of Hydrogeological Review	December 15, 2022
Scope of Work	▪ Review of MECP Water Well Records for the area ▪ Review of geological information for the area ▪ Review of topographic information for the area ▪ Advancement of 5 boreholes to a maximum depth of 8.2 m, which were instrumented with 5 monitoring wells ▪ Completion of a 24 hour pump test (if feasible) ▪ Completion of slug tests in all available monitoring wells ▪ Groundwater elevation monitoring ▪ Groundwater sampling and analysis to the Halton Sewer Use Limits ▪ Assessment of groundwater controls and potential impacts ▪ Report preparation in accordance with Ontario Water Resources Act, Ontario Regulation 387/04.

General Hydrogeological Characterization	
Site Topography	The site has an approximate ground surface elevation of 242 to 245 masl sloping down to the northeast.
Local Physiographic Features	The site is composed of sandy silt glacial till deposits and consists of drumlinized till plains.
Regional Physiographic Features	The site is located in southern portion of the South Slope. The South Slope contains a variety of soils developed upon tills which are sandier in the east and clayey in the west. The South Slope is bounded in the north by the Oak Ridges and in the south by the Iroquois Plain.
Watershed	The site is located within the East Branch Watershed. Locally, groundwater is anticipated to flow northeast towards a Credit River West Branch.
Surface Drainage	Surface water is expected to flow towards municipal catch basins located on the parking lot and along Danby Road to the northeast.

2 Study Area Map

A map has been enclosed which shows the following information:

- All monitoring wells identified on site
- All monitoring wells identified off site within the study area
- All boreholes identified on site
- All buildings identified on site and within the study area
- The Site boundaries
- Any watercourses and drainage features within the study area.

3 Geology and Physical Hydrogeology

The site stratigraphy, including soil materials, composition and texture are presented in detail on the borehole logs in Appendix A. A summary of stratigraphic units that were encountered at the site are as follows:

Site Stratigraphy					
Stratum/Formation	**Aquifer or Aquitard**	**Depth Range (mbgs)**	**Elevation Range (masl)**	**Hydraulic Conductivity (m/s)**	**Method of Determination**
Fill	Aquifer	0.1 to 3.8	245.0 to 239.9	1.0×10^{-5}	Literature[1]
Glacial Till (Sandy Silt)	Aquifer	0.8 to 8.2	243.8 to 233.4	1.1×10^{-6}	Slug test

Surface Water			
Surface Water Body	**Distance from site (m)**	**Direction from site**	**Hydraulically Connected to Site (yes/no)**
Credit River	3,500	Northeast	No

[1] Freeze and Cherry (1979)

4 Monitoring Well Information

Well ID	Well Diameter (mm)	Ground Surface (masl)	Top of Screen (masl)	Bottom of Screen (masl)	Screened Geological Unit
BH1	50	245.1	240.5	237.5	Sandy silt till
BH2	50	242.9	238.3	235.2	Sandy silt till
BH3	50	241.6	237.0	234.0	Sandy silt till
BH4	50	244.3	239.7	236.7	Sandy silt till
BH5	50	244.6	240.0	237.0	Sandy silt till

5 Groundwater Elevations

Well ID	Groundwater Elevation (masl)
	June 2, 2022
BH1	243.4
BH2	240.1
BH3	237.4
BH4	240.6
BH5	242.4

For design purposes, the groundwater table is at Elev. 243.5 m in the fill and the cohesionless till.

6 Aquifer Testing

6.1 Pump Test

A pumping test was not completed at the site. Due to the nature of the soil materials present and slow ground recharge of the aquifer it was not feasible to complete a 24 hour pumping test. Please note however that in-situ single well response tests were completed on each of the monitoring wells installed at the site.

6.2 Single Well Response Test (Slug Test)

The hydraulic conductivities from the monitoring wells were determined based on slug tests (single-well response tests). These tests involve rapid removal of water or addition of a "slug" which displaces a known volume of water from a single well, and then monitoring the water level in the well until it recovers. The results of the slug tests were analyzed using the Bouwer and Rice method (1976).

The hydraulic properties of the strata applicable to the site are as follows:

Well ID	Well Screen Elevation (masl)	Screened Geological Unit	Hydraulic Conductivity (m/s)
BH1	240.5 - 237.5	Sandy silt till	1.1×10^{-6}
BH2	238.3 - 235.2	Sandy silt till	8.1×10^{-9}
BH3	237.0 - 234.0	Sandy silt till	5.3×10^{-8}
BH4	239.7 - 236.7	Sandy silt till	3.0×10^{-7}
BH5	240.0 - 236.9	Sandy silt till	6.5×10^{-6}

6.3 Soil Grain Size Distribution

The hydraulic conductivities of various soil types can also be estimated from grain size analyses. An assessment of the grain sizes was conducted using the excel-based tool, HydrogeoSieve XL (*HydrogeoSieve XL ver.2.2, J.F. Devlin, University of Kansas, 2015*). HydrogeoSieve XL compares the results of the grain size analyses against fifteen (15) different analytical methods.

Given our experience in the area as well as published literature, some of the geometric means provided for the soil were biased low by one or more methods. In these instances, the values determined by these methods were excluded from the mean. The table below illustrates the hydraulic conductivity values estimated from the mean of the analytical methods where the soil met the applicable analysis criteria.

Sample ID	Soil Description	Applicable Analysis Methods	Hydraulic Conductivity (m/s)
BH1SS3	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	2.2×10^{-8}
BH2SS9	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	1.0×10^{-9}
BH3SS5	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	1.5×10^{-8}
BH4SS7	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	1.8×10^{-8}
BH5SS4	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	2.0×10^{-8}

The results of the analyses are presented in Appendix D.

6.4 Literature

According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated at the site are:

Stratum/Formation	Hydraulic Conductivity (m/s)
Earth Fill	10^{-2} to 10^{-6}
Sands	10^{-2} to 10^{-7}
Silts	10^{-5} to 10^{-9}
Glacial Tills	10^{-6} to 10^{-12}

6.5 Infiltration Testing

On June 2, 2022, a representative of Grounded conducted six (6) in-situ infiltration tests, in three (3) locations to support a water balance, using a Guelph Permeameter. The infiltration tests were completed in unsaturated soils and carried out in accordance with the methodology recommended by the Toronto Region Conservation Authority (TRCA). The location of the infiltration test is presented on Figures 2 & 3.

The results of the infiltration tests are provided in Appendix H and are summarized below:

Test Location	Ground Surface Elev. (masl)	Approx. Test Depth (mbgs)	Approx. Test Elev. (masl)	Soil Description	Field Saturated Hydraulic Conductivity (m/s)	Average Hydraulic Conductivity (m/s)	Infiltration Rate (mm/hr)	Factored Infiltration Rate* (mm/hr)
GP1	243.8	0.3	243.5	Sandy Silt	2.4×10^{-7}	2.6×10^{-7}	32	9
					2.9×10^{-7}			
GP2	242.9	0.3	242.6	Silty Sand	2.6×10^{-7}	2.6×10^{-7}	32	9
					2.7×10^{-7}			
GP3	244.4	0.3	244.1	Sandy Silt	1.3×10^{-6}	1.2×10^{-6}	48	14
					1.1×10^{-6}			

*A Factor of Safety of 8.5 has been applied to the measured rates, as determined by TRCA guidelines.

7 Water Quality

One (1) unfiltered groundwater sample was collected and analyzed by a Canadian laboratory accredited and licensed by Standards Council of Canada and or Canadian Association for Laboratory Accreditation.

The sample was collected directly from monitoring well BH1 on June 2, 2022. The sample was analyzed for the following parameters:

- Ontario Halton Sanitary Sewer By-law No. 02-03– Limits for Sanitary and Combined Sewers Discharge
- Ontario Halton Sanitary Sewer By-law No. 02-03– Limits for Storm Sewer Discharge

The groundwater sample **met** the **Limits for Storm Sewer Discharge** for all parameters:

The groundwater sample **met** the **Limits for Sanitary and Combined Sewer Discharge** for all parameters analyzed.

A true copy of the analysis report, Certificate of Analysis and a chain of custody record for the sample are enclosed.

8 Proposed Construction Method

The proposed shoring methodology at the site is currently undetermined. For the purposes of this report, numerical analyses were conducted employing conventional soldier piling and lagging in order to determine a “worst-case scenario” with respect to dewatering volumes and groundwater seepage at the site.

For design purposes, the stabilized groundwater table is at about Elev. 243.5± m. The groundwater table is in fill and glacial till. These deposits have a moderate permeability and will yield seepage in the long term. The lowest FFE is not confirmed at the time of this report, but a P1 Level with an FFE at about Elev. 241.0 m has been assumed. Therefore,

- Bulk excavation will extend below the elevation of the design groundwater table.
- Foundation excavations will extend below the design groundwater table.

Prior to excavation, positive dewatering to lower the groundwater table will be required to facilitate construction as well as to maintain the integrity of the subgrade for foundation and slab-on-grade support. The water level must be kept at least 1.2 m below the lowest excavation elevation during construction. Failure to dewater prior to excavation will result in unrecoverable disturbance of the subgrade, which will render advice provided for undisturbed subgrade conditions inapplicable.

Dewatering will take some time to accomplish prior to the start of excavation. Stored water within the excavation will need to be considered prior to excavation/dewatering.

A professional dewatering contractor must 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 proposed structures will consist of drained foundations.

9 Private Water Drainage System (PWDS)

If the proposed development consists of drained foundations, then a private water drainage system will be required. The total sub floor drain area will be approximately 2,120 m^2 based on the drawings which have been provided.

If the development is designed with a private water drainage system, the drainage system is a critical structural element since it keeps water pressure from acting on the basement walls and floor slab. As such, the sump that ensures the performance of this system must have a duplexed pump arrangement for 100% pumping redundancy and these pumps must be on emergency power. The size of the sump should be adequate to accommodate the estimated groundwater seepage. It is anticipated that the groundwater seepage can be controlled with typical, widely available, commercial/residential sump pumps.

If the proposed development is designed as a watertight structure, then a private water drainage system will not be required. However, the structure must then be designed to resist hydrostatic pressure and uplift forces.

10 Groundwater Extraction and Discharge

Numerical analyses were conducted for both short term and long term dewatering scenarios. The modeling was conducted using computer software, which deploys the finite element modelling method. The Finite Element Model (FEM) for groundwater seepage indicates the short term (construction) and long term (permanent) dewatering requirements as provided below. The finite element model results are presented in Appendix F.

The groundwater seepage estimates, which have been provided, represent the steady state groundwater seepage. There will be an initial drawdown of the groundwater before a steady state condition is reached. The rate of the initial drawdown, and therefore discharge, is dependent on the dewatering contractor and how the groundwater is being dealt with at the site. An estimated initial volume of stored groundwater which will require removal before steady state is reached has been provided below.

Please note that if excavation is exposed to the elements, stormwater will have to be managed. The short term control of groundwater should consider stormwater management from rainfall events. A dewatering system should be designed to consider the removal of rainfall from excavation. A design storm of 25 mm has been used in the quantity estimates.

As required by Ontario Regulation 63/16, a plan for discharge must consider the conveyance of stormwater from a 100-year storm. The additional volume that will be generated in the occurrence of a 100-year storm event is approximately 204,000 L.

The following design considerations and values have been incorporated into the numerical modelling / dewatering estimates:

- A Factor of Safety of 2.0 was used for all groundwater seepage volume calculations.
- The design hydraulic conductivities for the site are:

Design Hydraulic Conductivity	
Stratum/Formation	**K (m/s)**
Earth Fill	1.0×10^{-5}
Glacial Till (Sandy Silt)	1.1×10^{-6}

Stored Groundwater (pre-excavation/dewatering)					
Volume of Excavation (m^3)	**Volume of Excavation Below Water Table (m^3)**	**Estimated Volume of Stored Groundwater**		**Estimated Volume of Available Groundwater**	
		m^3	**L**	**m^3**	**L**
9,720	6,480	3,300	3,300,000	2,300	2,300,000

Short Term (Construction) Steady State Groundwater Quantity – Safety Factor of 2.0 Used					
Estimated Groundwater Seepage		**Design Rainfall Event (25mm)**		**Estimated Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
120,000	83.3	54,000	37.5	174,000	120.8

Long Term (Permanent) Steady State Groundwater Quantity – Safety Factor of 2.0 Used					
Estimated Groundwater Seepage		**Estimated Infiltrated Stormwater – Design Rainfall Event (25mm)**		**Estimated Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
75,000	52.1	19,000	13.2	94,000	65.3

Regulatory Requirements	
Environmental Activity and Sector Registry (EASR) Posting	Required
Short Term Permit to Take Water (PTTW)	Not Required
Long Term Permit to Take Water (PTTW)	Required
Short Term Discharge Agreement Town of Halton Hills	Required
Long Term Discharge Agreement Town of Halton Hills	Required

Please note:

- The native soils must be dewatered a minimum of 1.2 m below the footing elevation prior to excavation to preserve the in-situ integrity of the native soils during construction dewatering activities. It is anticipated that the groundwater table will rise to the elevation of the subfloor drainage in the event of a drained structure or the waterproofing in the event of a watertight structure.

- The proposed pump schedule for short term construction dewatering has not been completed. As such, the actual peak short term discharge rate is not available at the time of writing this report. The pump schedule must be specified by either the dewatering contractor retained or the mechanical consultant.
- The proposed pump schedule for long term permanent drainage has not been completed. As such the actual peak long term discharge rate is not available at the time writing of this report. The pump schedule must be specified by the mechanical consultant.
- A watertight structure (structure that has not included a private water drainage system) has not been considered as part of the proposed development at this time.

11 Evaluation of Impact

11.1 Zone of Influence (ZOI)

The Zone of Influence (ZOI) with respect to groundwater was calculated based on the estimated groundwater taking rate and the hydraulic conductivity of the unit which water will be taken at the Site.

The ZOI was calculated using the Sichardt equation below.

Equation:

$$R_0 = 3000(\Delta H)\sqrt{K}$$

ΔH	=	dewatering thickness (m)
K	=	hydraulic conductivity (m/s)
R_0	=	radius of influence (m)

The ZOI with respect to groundwater seepage at the site is summarized as follows.

Zone of Influence (ZOI)		
	Short Term (Construction)	**Long Term (Permanent)**
Maximum Zone of Influence (m)	21	14

11.2 Land Stability

The impacts to land stability on adjacent structures due to the proposed short and long term dewatering at the site are summarized as follows:

Land Stability		
	Short Term (Construction)	**Long Term (Permanent)**
Dewatering Thickness (m)	5.2	3.0

Increase in Effective Stress (kPa)	51	29
Maximum Theoretical Settlement due to Dewatering (mm)	6	3
Public Realm Theoretical Settlement due to Dewatering (mm)	1	0

The maximum induced settlement occurs directly adjacent to the proposed excavation and decreases in a nonlinear fashion with distance away from the excavation.

On this basis, the impact of the proposed dewatering on the existing adjacent structures is considered by Grounded to be within acceptable limits.

11.3 City's Sewage Works

Negative impacts to City's sewage works may occur in terms of the quantity or quality of the groundwater discharged. This report provided the estimated quantity of the water discharge. However, this report does not speak to the sewer capacities. The sewer capacity analysis is provided under a separate cover by the civil consultant.

The quality of the proposed groundwater discharge is provided in Section 7. As noted in that section, the groundwater sample met the Limits for Storm Sewer Discharge and for Sanitary and Combined Sewer Discharge.

As such additional treatment will not be required before the water can be discharged to the Storm Sewer or to the Sanitary and Combined Sewer, to avoid impacts to the City's sewage works caused by groundwater quality.

11.4 Natural Environment

There are no natural waterbodies within the ZOI that will be affected by the proposed construction dewatering or permanent drainage. Any groundwater which will be taken from the site will be discharged (if required) into the City's sewer systems and not into any natural waterbody. As such, there will be no impact to the natural environment caused by the water takings at the site.

11.5 Local Drinking Water Wells

The Town of Norval obtains its potable water from a groundwater source. Potable groundwater wells were suspected in the area, but none were observed during the site visit. We do not believe construction and long term dewatering will impact any local drinking water wells.

11.6 Contamination Source

The site and immediately surrounding area currently consist mostly of residential areas. These land uses are not anticipated to be a source of potential contamination and are not expected to provide an Area of Potential Environmental Concern for the site. As such, the pumping of groundwater at the site is not anticipated to facilitate the movement of potential contaminants onto the site. Evaluation of the environmental condition of the site will be completed under a separate cover.

11.7 Water Balance Analysis

A water balance model was prepared for the Property to assess the distribution of rainfall run-off and infiltration for existing (pre- and post-development) conditions (Appendix I). The model is based on the CVSPA Water Balance Tool and the Credit River Water Management Strategy Update Report dated August 15, 2007. The water balance for pre-and post-development conditions is summarized below:

Pre-Development Water Balance

	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building	1,490	1,329	-	-	1,329
Hard Surface Paving	6,249	5,574	-	-	5,574
Landscape Area	12,300	10,972	6,519	2,672	1,781
Total	**20,039**	**17,875**	**6,519**	**2,672**	**8,684**

The post-development water balance accounts for hard surfaced areas created by buildings and pavements and was estimated from the preliminary site plan drawings (UCC Norval United Site Plans, prepared by KPMB Architects, Nov 11, 2022) and site statistics (UCC Norval United Site statistics, prepared by KPMB Architects, Dec 9, 2022) provided by UPRC.

Post-Development Water Balance

	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building	3,610	3,220	-	-	3,220
Hard Surface Paving	8,888	7,928	-	-	7,928
Landscape Area	7,541	6,727	3,997	1,638	1,092

Total	**20,039**	**17,875**	**3,997**	**1,638**	**12,240**

The volume of surface water run-off available from roof tops was calculated to be 3,220 m^3, as noted in the above table. It is estimated that 90 percent of this volume of water will be available as a resource, to maintain groundwater recharge and function. The volume of roof run-off available is compared to the difference in infiltration volume between pre-development and post-development, as noted below:

Potential Post-Development Infiltration Deficit (m^3)	Volume of Roof Run-off (m^3)	Volume of Usable Roof Run-off (m^3)
1,034	3,220	2,898

Therefore the percentage of available runoff required to match pre-development infiltration is 36 percent.

12 Proposed Mitigation Measures and Monitoring Plan

The extent of the negative impact identified in previous sections will be limited to the ZOI caused by the groundwater taking at the site.

As a result of dewatering and draining the soil, changes in groundwater level have the potential to cause settlement based on the change in the effective stresses within the ZOI.

If adjacent buildings or municipal infrastructure are within the ZOI and will undergo settlement that may be considered unacceptable as identified the Land Stability Section, consideration should be given to implement a monitoring and mitigation program during dewatering activities.

Both the temporary construction dewatering system and the permanent building drainage system must be properly installed and screened to ensure sediments and fines will not be removed, which is typically a primary cause of dewatering related settlement.

13 Limitations

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 must be considered with attention and care as they relate this potential site alteration.

The hydrogeological 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.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Grounded accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report, including consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

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14 Closure

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

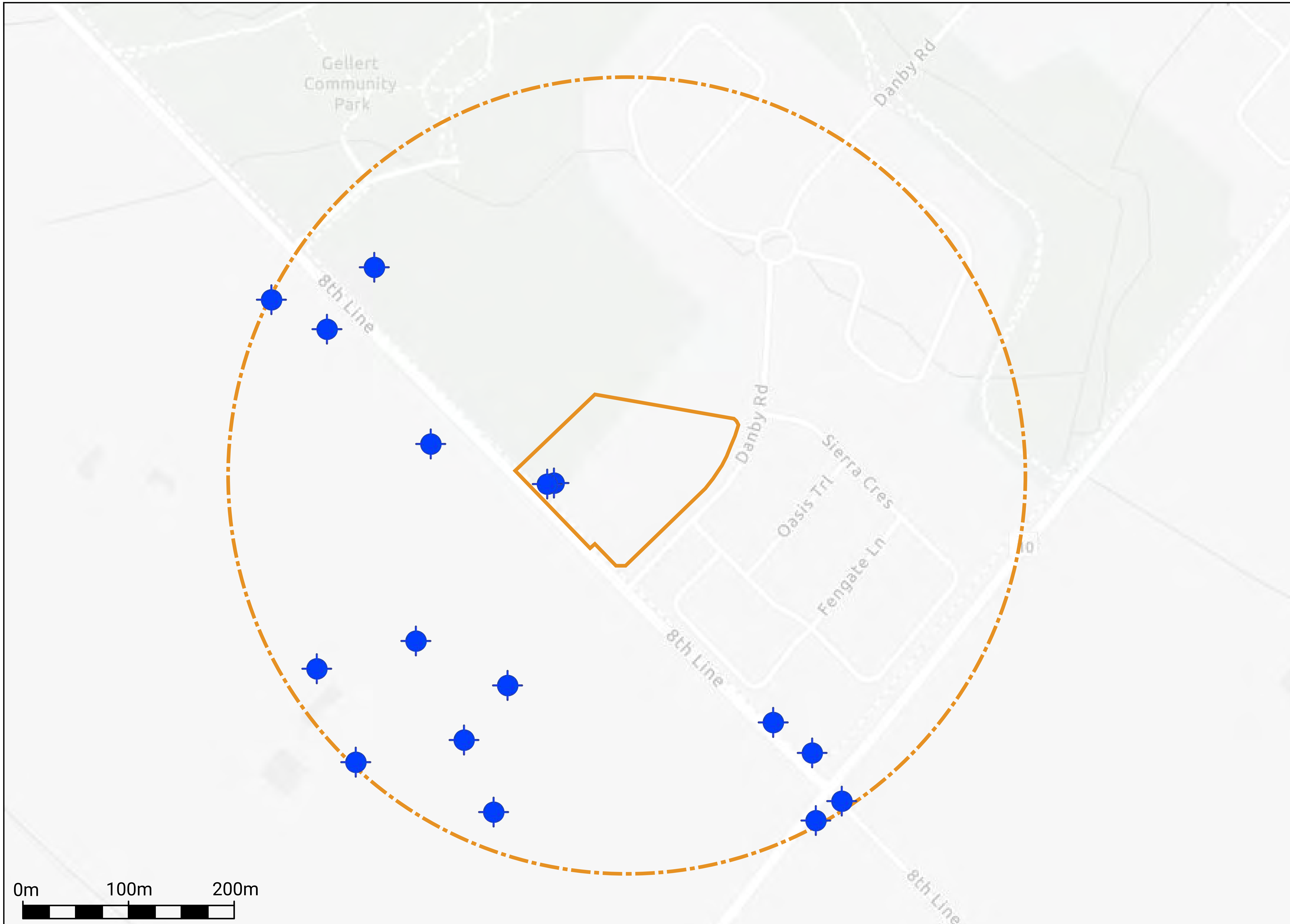
For and on behalf of our team,

GROUNDED ENGINEERING

Nico Piers, EIT
Project Coordinator

Matthew Bielaski, P.Eng., $QP_{RA\text{-}ESA}$
Principal

FIGURES



GROUNDED
ENGINEERING

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

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- STUDY AREA (250 m RADIUS)
- MECP MONITORING WELL LOCATION

Note

Reference

ArcGIS MyMaps 2021.

Project

14015 DANBY ROAD, GEORGETOWN, ONTARIO

Figure Title

SITE LOCATION PLAN

North

TRUE

PROJECT

Date

JULY 2022

Scale

AS INDICATED

Job No

22-085

Figure No

FIGURE 1

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

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- MONITORING WELL/BOREHOLE BY GROUNDED
- GUELPH PERMEAMETER BY GROUNDED

Note

Reference

Google Earth 2021

Project

14015 DANBY ROAD,
NORVAL, ONTARIO,
L0P 1K0

Figure Title

BOREHOLE LOCATION PLAN

North

TRUE
PROJECT

Date

JULY 2022

Scale

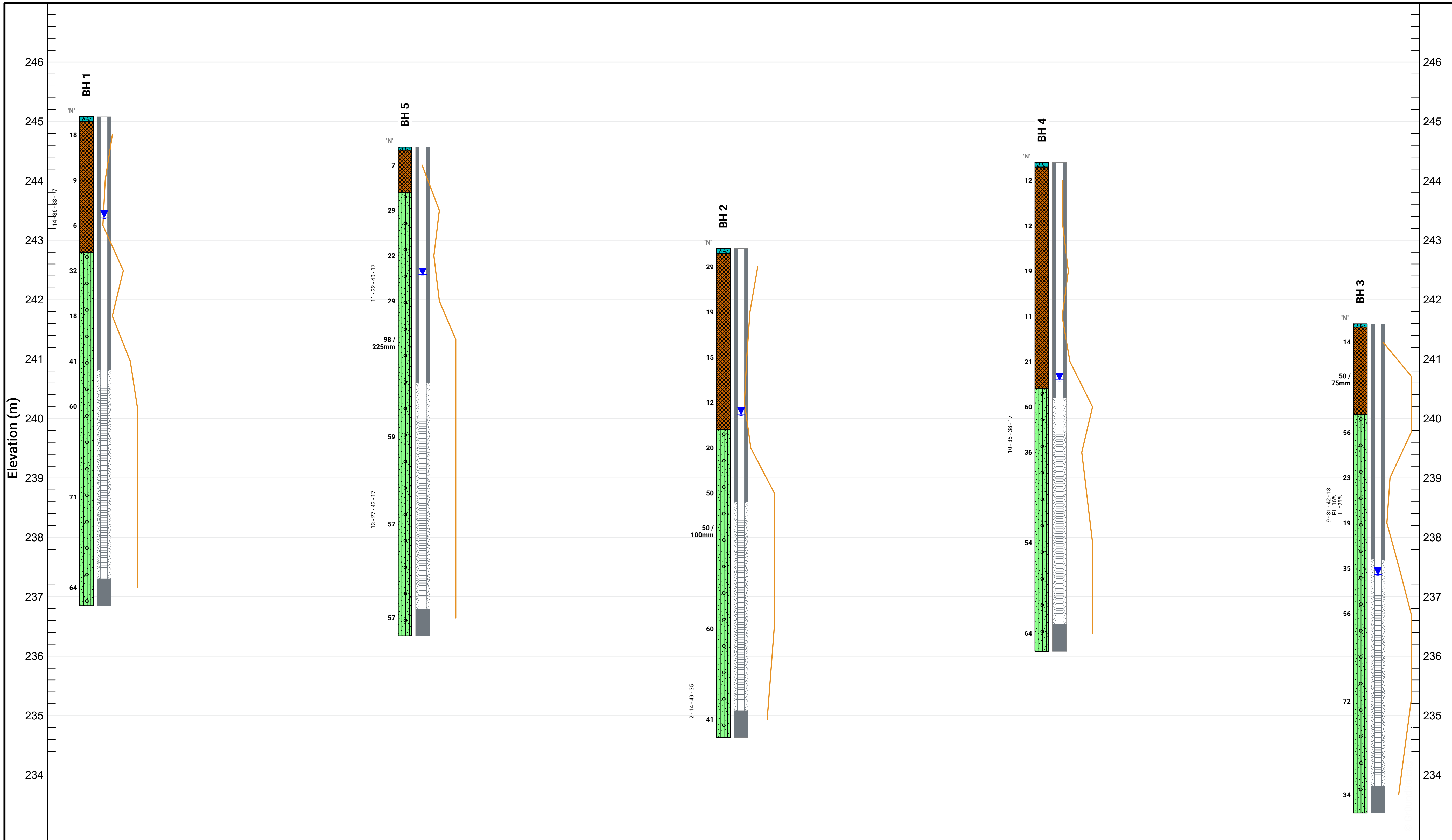
AS INDICATED

Job No

22-082

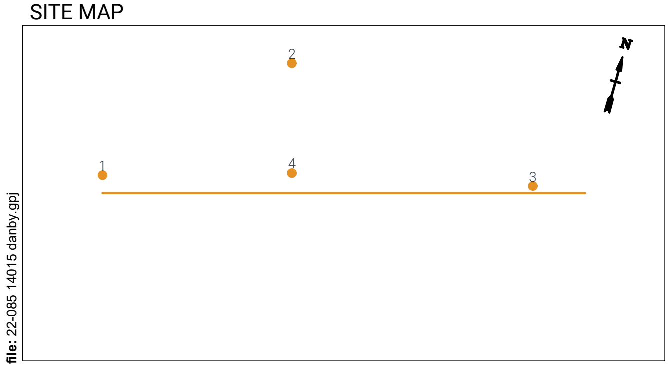
Figure No

FIGURE 2



Boreholes Equally Spaced

SITE MAP



LITHOLOGY GRAPHIC LEGEND

- Topsoil
- Fill
- Sandy Silt Till

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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

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

Project
UPRC NORVAL
14015 DANBY ROAD

Figure Title
SUBSURFACE PROFILE

Date
JULY 2022

Scale
AS INDICATED

Job No
22-085

Figure No
FIGURE 3

APPENDIX A

BOREHOLE LOG TERMINOLOGY

GROUNDED ENGINEERING

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

PI: plasticity index

γ: soil unit weight (bulk)

G_s: specific gravity

S_u: undrained shear strength

▽ unstabilized water level

▼ 1st water level measurement

▼ 2nd water level measurement most recent

▼ water level measurement

ENVIRONMENTAL SAMPLES

M&I: metals and inorganic parameters

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

VOC: volatile organic compound

PHC: petroleum hydrocarbon

BTEX: benzene, toluene, ethylbenzene and xylene

PPM: parts per million

FIELD MOISTURE (based on tactile inspection)

DRY: no observable pore water

MOIST: inferred pore water, not observable (i.e. grey, cool, etc.)

WET: visible pore water

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

COMPOSITION

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

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.

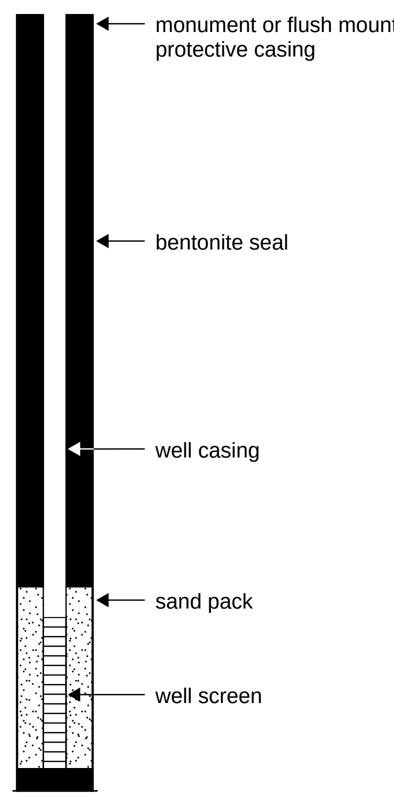
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



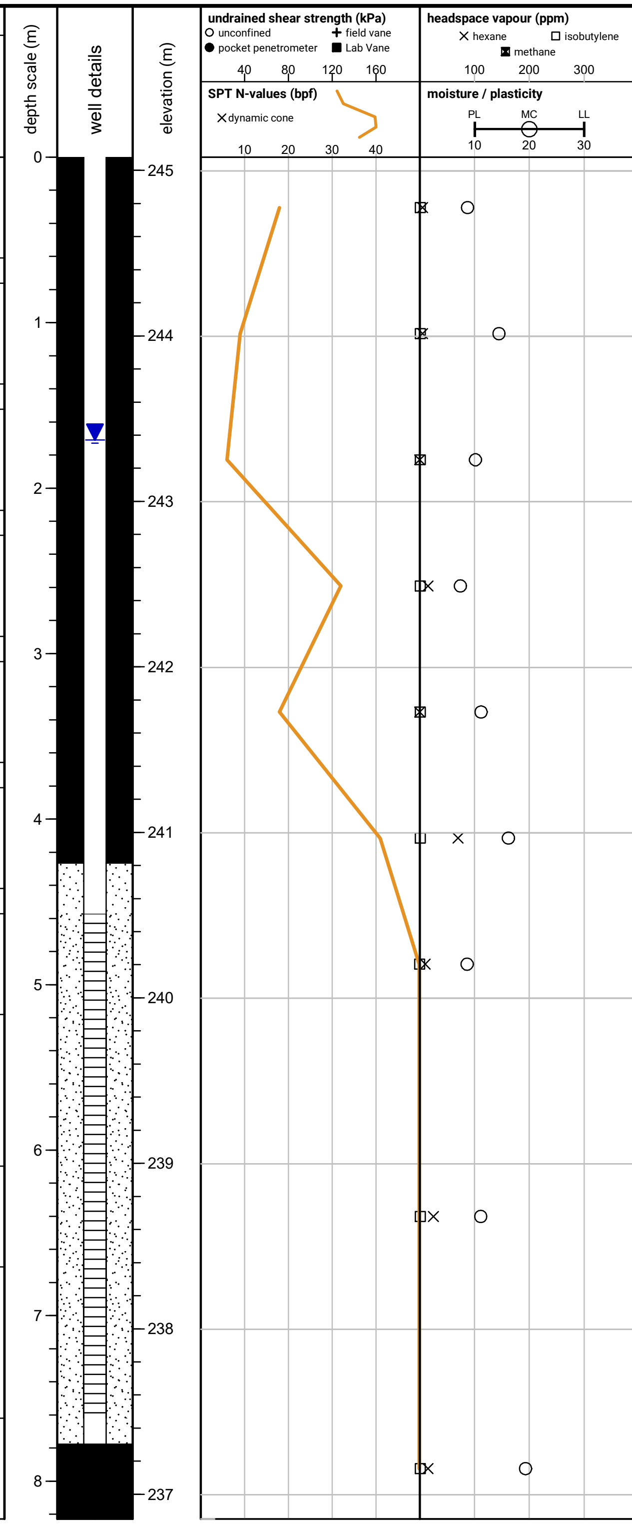
Date Started : May 24, 2022
Position : E: 589787, N: 4830358 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 1

File No. : 22-085 | **Project** : UPRC Norval, 14015 Danby Road | **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	description	number	type	SPT N-value
245.1	**GROUND SURFACE**			
	75mm **TOPSOIL**			
	FILL, silty sand, trace gravel, trace construction debris, compact, brown to light brown, moist	1	SS	18
	...at 0.8 m, loose	2	SS	9
		3	SS	6
242.8 2.3	**SANDY SILT**, some clay, some gravel, occasional seams and layers of silt and clay, dense, brown, moist (GLACIAL TILL)	4	SS	32
	...at 3.0 m, compact	5	SS	18
	...at 3.8 m, sand seam, dense	6	SS	41
	...at 4.6 m, grey, very dense	7	SS	60
	...at 6.1 m, wet	8	SS	71
		9	SS	64
236.9 8.2				



unstabilized water level

lab data and comments

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

14 36 33 17

SS1: OCs

SS3: BTEX, H-Ms, Metals, ORPs, PHCs

SS6: BTEX, H-Ms, Metals, ORPs, PHCs

END OF BOREHOLE

Unstabilized water level measured at 6.4 m below ground surface upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	1.7	243.4

file: 22-085 14015 danby.gpj

Tech : CSH | **PM** : NP | **Rev** : KB

GROUNDED ENGINEERING

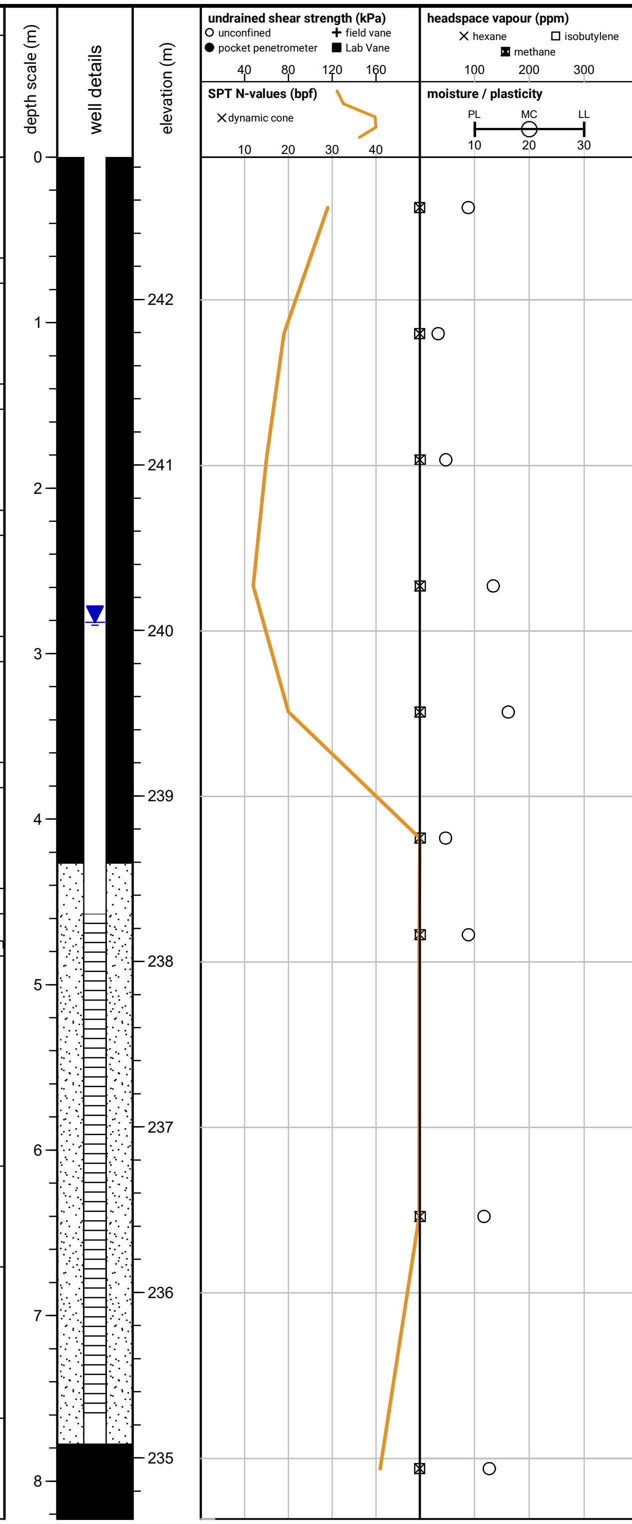
Date Started : May 24, 2022
Position : E: 589844, N: 4830418 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 2

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value	depth (m)	lab data and comments
242.9	**GROUND SURFACE**				0	
	75mm **TOPSOIL**					
	FILL, sandy silt, trace gravel, trace clay, trace construction debris, compact, light brown, moist	1	SS	29		SS1: OCs
		2	SS	19	1	SS2: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 1.5 m, rock fragments, inferred cobble	3	SS	15	2	
	...at 2.3 m, trace plastic, trace rootlets	4	SS	12		
239.9 / 3.0	**SANDY SILT**, some clay, trace gravel, occasional seams and layers of silt and clay, compact, brown, moist (GLACIAL TILL)	5	SS	20	3	
	...at 3.8 m, sand seam, very dense	6	SS	50	4	SS6: BTEX, H-Ms, Metals, ORPs, PHCs
		7	SS	50 / 100mm		
	...at 6.1 m, grey	8	SS	60	6	
	...at 7.6 m, silt and clay, some sand, trace gravel, dense	9	SS	41	8	grain size distribution (%) (MIT): GR 2, SA 14, SI 49, CL 35
234.7 / 8.2	**END OF BOREHOLE**					



Water level and cave not measured upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	2.8	240.1

file: 22-085 14015 danby.gpj

Tech : CSH | **PM** : NP | **Rev** : KB

GROUNDED ENGINEERING

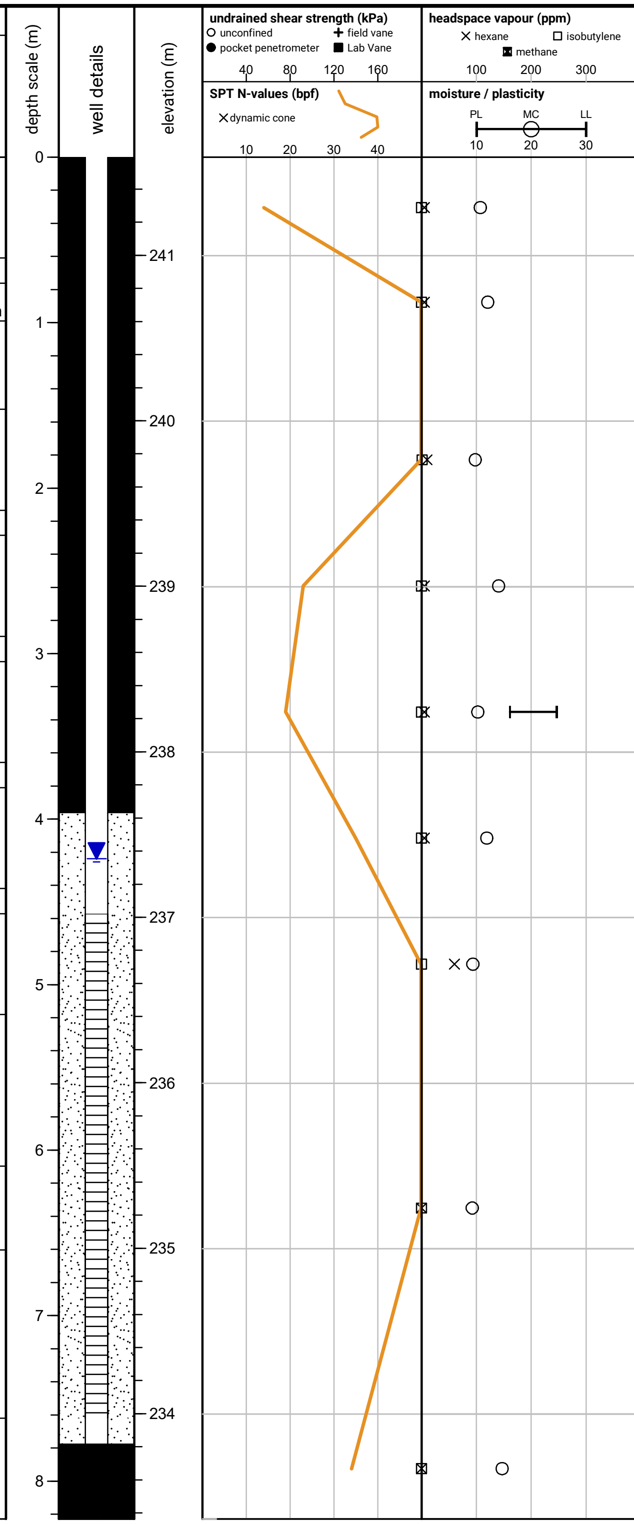
Date Started : May 25, 2022
Position : E: 589943, N: 4830398 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 3

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

Drill method: CME 55, hollow stem augers (med) OD=175 mm

elev / depth (m)	description (stratigraphy)	sample number	type	SPT N-value	lab data and comments
241.6	**GROUND SURFACE**				
	50mm **TOPSOIL**				
	FILL, silty sand, trace gravel, trace construction debris, trace rootlets, trace rock fragments, trace clay, compact, light to dark brown, moist	1	SS	14	SS1: OCs
		2	SS	50 / 75mm	
240.1 / 1.5	**SANDY SILT**, some clay, trace gravel, occasional seams and layers of silt and clay, very dense, brown, moist (GLACIAL TILL)	3	SS	56	SS3: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 2.3 m, compact	4	SS	23	
		5	SS	19	grain size distribution (%) (MIT): GR 9, SA 31, SI 42, CL 18
	...at 3.8 m, rock fragments, inferred cobble, dense	6	SS	35	
	...at 4.6 m, brown to grey, very dense	7	SS	56	SS7: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 6.1 m, grey	8	SS	72	
	...at 7.6 m, dense, wet	9	SS	34	
233.4 / 8.2	**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 2, 2022	4.2	237.4

file: 22-085 14015 danby.gpj

 Tech : FR | **PM** : NP | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 25, 2022
Position : E: 589855, N: 4830378 (UTM 17T)
Elev. Datum : Geodetic

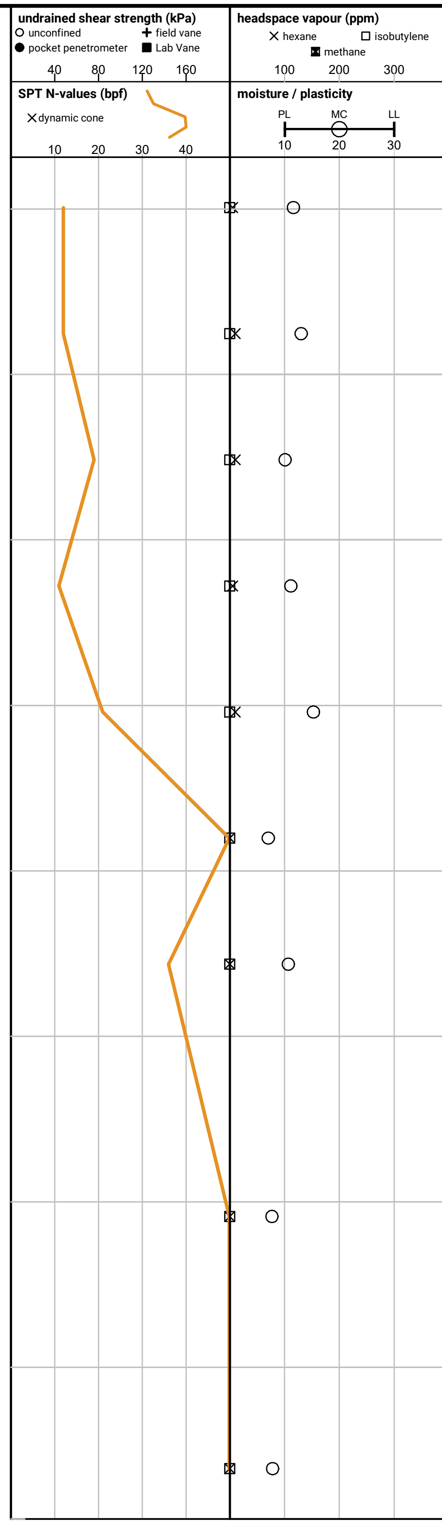
BOREHOLE LOG 4

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value
244.3	**GROUND SURFACE**			
	75mm **TOPSOIL**			
	FILL, sandy silt, trace gravel, trace silt, trace asphalt, trace rootlets, compact, light to dark brown, moist	1	SS	12
	...at 0.8 m, trace rock fragments, inferred cobble, brown to grey	2	SS	12
	...at 1.5 m, trace brick fragments, trace construction debris	3	SS	19
	...at 2.3 m, trace plastic	4	SS	11
		5	SS	21
240.5 3.8	...at 3.8 m, trace rock fragments, inferred cobble			
	SANDY SILT, trace gravel, some clay, occasional seams and layers of silt and clay, very dense, brown, moist (GLACIAL TILL)	6	SS	60
	...at 4.6 m, dense	7	SS	36
	...at 6.1 m, grey, very dense	8	SS	54
236.1 8.2		9	SS	64

depth scale (m): 0–8; well details; elevation (m): 244–237



unstabilized water level

lab data and comments — grain size distribution (%) (MIT): GR SA SI CL

- SS1: OCs
- SS4: BTEX, H-Ms, Metals, ORPs, PHCs
- 10 35 38 17
- SS7: BTEX, H-Ms, Metals, ORPs, PHCs

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 2, 2022	3.7	240.6

file: 22-085 14015 danby.gpj

 Tech : FR | **PM** : NP | **Rev** : KB

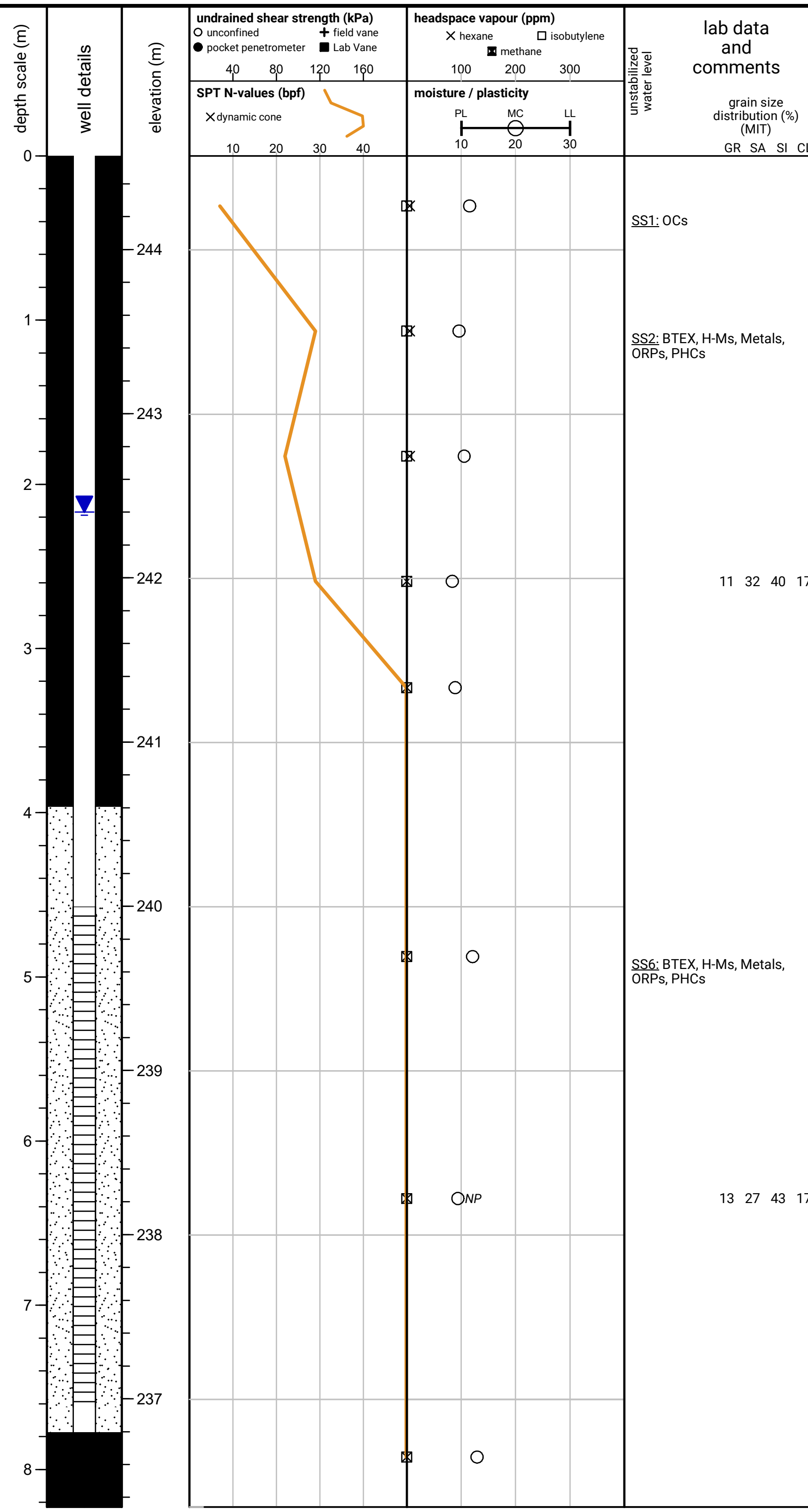
BOREHOLE LOG 5

Date Started : May 25, 2022
Position : E: 589843, N: 4830299 (UTM 17T)
Elev. Datum : Geodetic

File No. : 22-085 **Project** : UPRC Norval, 14015 Danby Road **Client** : UPRC c/o Turner Townsend

drill method : CME 55 — hollow stem augers (med) OD=175 mm

elev depth (m)	description	sample number	type	SPT N-value	lab data and comments
244.6	GROUND SURFACE				
	50mm **TOPSOIL**				
	FILL, sandy silt, some clay, trace gravel, loose, brown, moist	1	SS	7	SS1: OCs
243.8 / 0.8	**SANDY SILT**, some gravel, some clay, occasional seams and layers of silt and clay, compact, brown, moist (GLACIAL TILL)	2	SS	29	SS2: BTEX, H-Ms, Metals, ORPs, PHCs
		3	SS	22	
		4	SS	29	GR 11, SA 32, SI 40, CL 17
	...at 3.0 m, very dense, trace rock fragments, inferred cobble	5	SS	98 / 225mm	
	...at 4.6 m, grey	6	SS	59	SS6: BTEX, H-Ms, Metals, ORPs, PHCs
	...at 6.1 m, wet	7	SS	57	GR 13, SA 27, SI 43, CL 17
		8	SS	57	
236.4 / 8.2	**END OF BOREHOLE**				



Water level and cave not measured upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 2, 2022	2.2	242.4

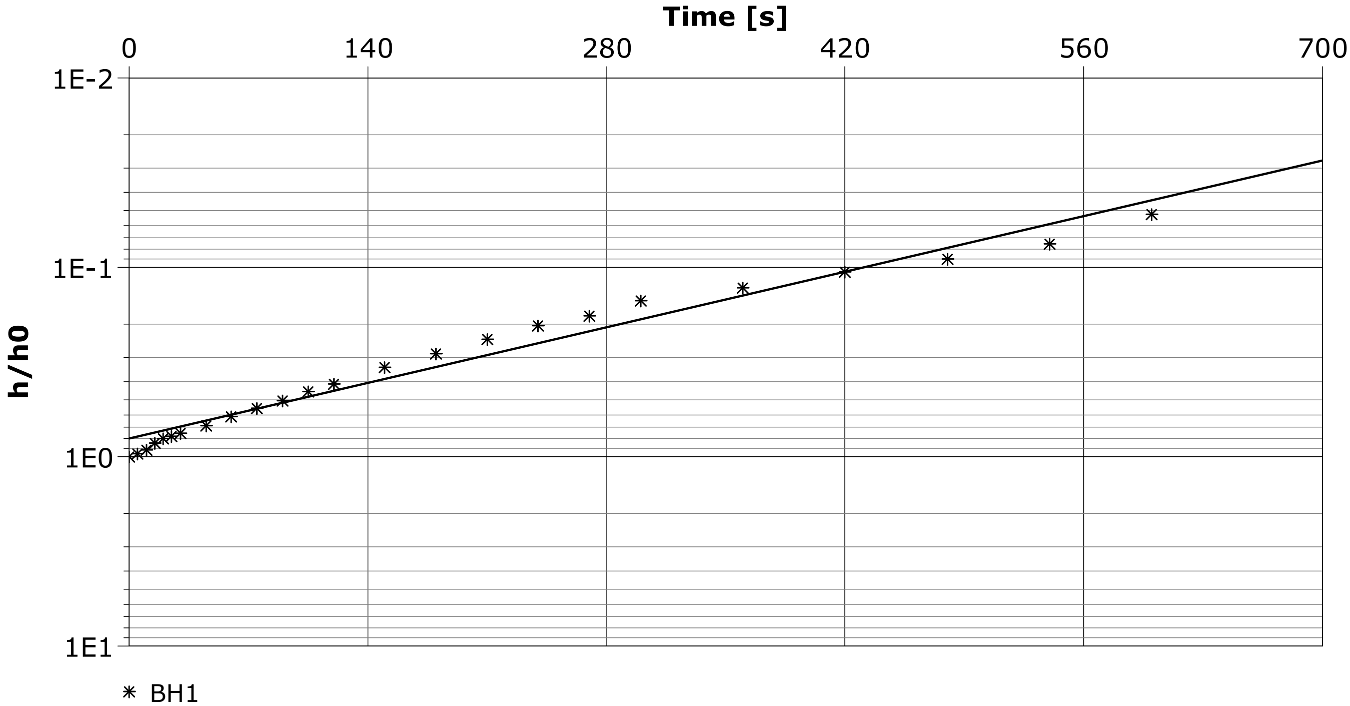
file: 22-085 14015 danby.gpj

Tech : FR | **PM** : NP | **Rev** : KB

APPENDIX B

Slug Test Analysis Report	
Project:	UPRC - Norval
Number:	22-085
Client:	UPRC c/o Turner Townsend

Location: 14015 Danby road	Slug Test: BH1 RHT	Test Well: BH1
Test Conducted by: FR		Test Date: 2022-06-02
Analysis Performed by: NP	BH1 RHT	Analysis Date: 2022-06-07
Aquifer Thickness: 8.00 m		

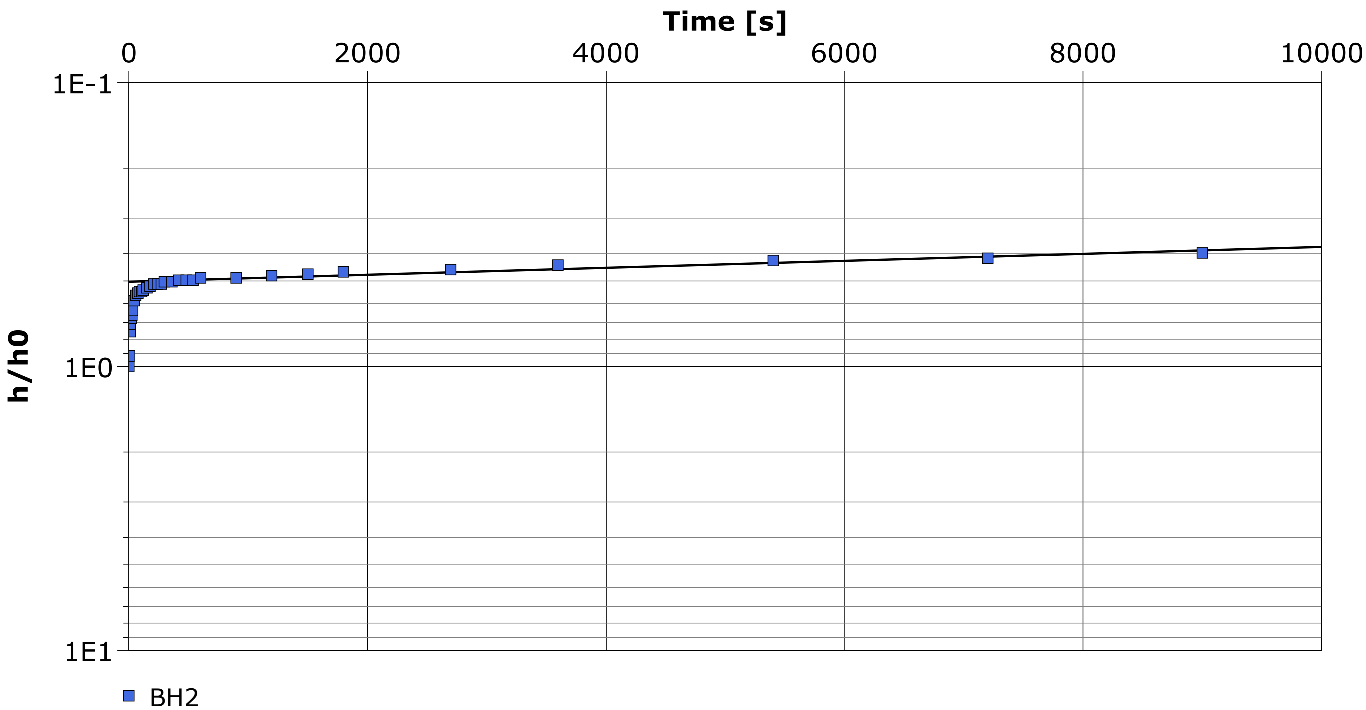


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH1	1.08×10^{-6}	

	Slug Test Analysis Report
	Project: UPRC - Norval
	Number: 22-085
	Client: UPRC c/o Turner Townsend

Location: 14015 Danby road	Slug Test: BH2 RHT	Test Well: BH2
Test Conducted by: FR		Test Date: 2022-06-02
Analysis Performed by: NP	BH2 RHT	Analysis Date: 2022-06-07
Aquifer Thickness: 8.00 m		

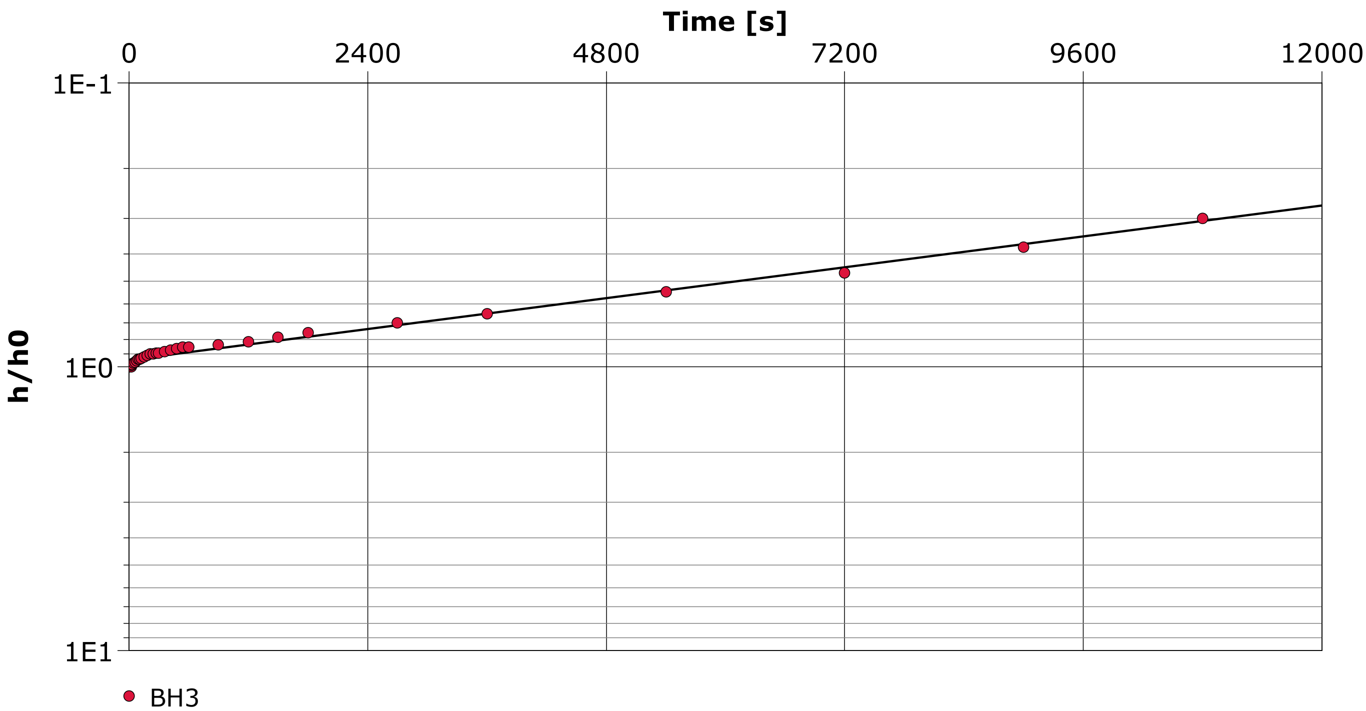


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH2	8.11×10^{-9}	

Slug Test Analysis Report	
	Project: UPRC - Norval
	Number: 22-085
	Client: UPRC c/o Turner Townsend

Location: 14015 Danby road	Slug Test: BH3 RHT	Test Well: BH3
Test Conducted by: KS		Test Date: 2022-06-06
Analysis Performed by: NP	BH3 RHT	Analysis Date: 2022-06-07
Aquifer Thickness: 7.00 m		

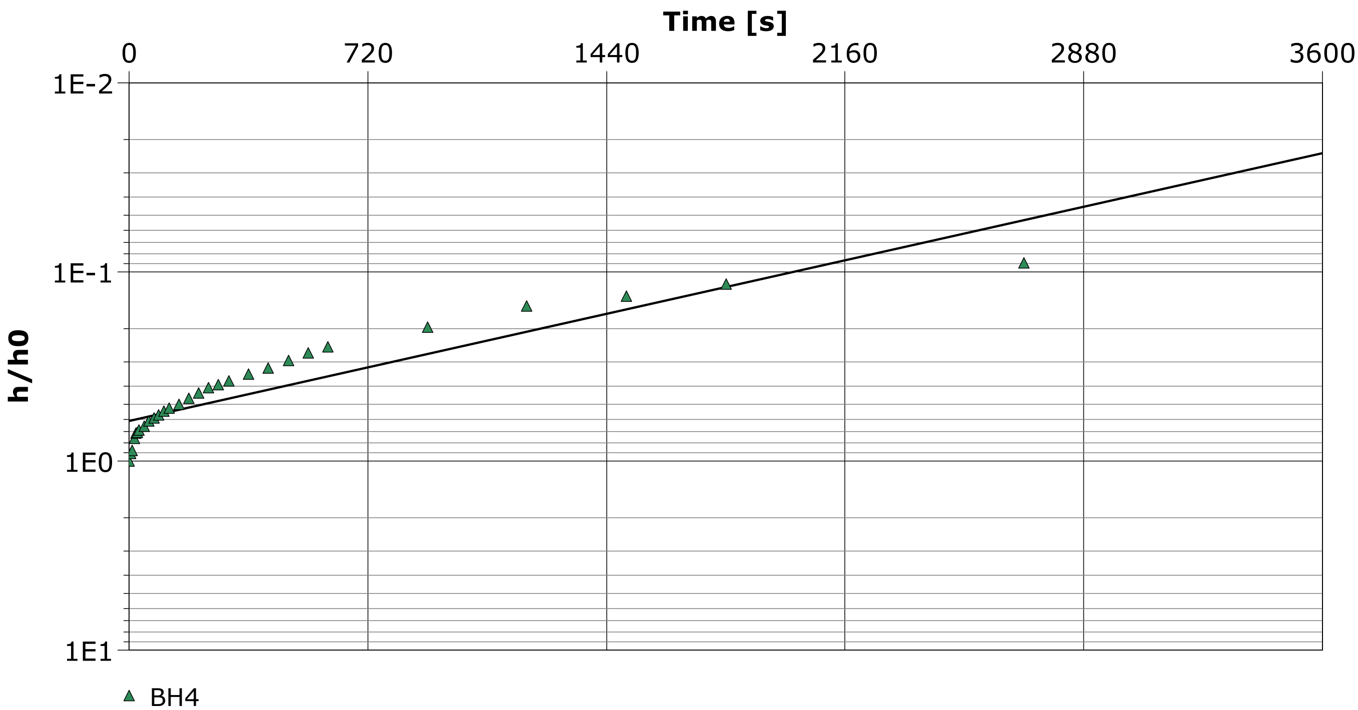


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH3	5.31×10^{-8}	

Slug Test Analysis Report	
Project:	UPRC - Norval
Number:	22-085
Client:	UPRC c/o Turner Townsend

Location: 14015 Danby road	Slug Test: BH4 RHT	Test Well: BH4
Test Conducted by: FR		Test Date: 2022-06-02
Analysis Performed by: NP	BH4 RHT	Analysis Date: 2022-06-07
Aquifer Thickness: 8.00 m		

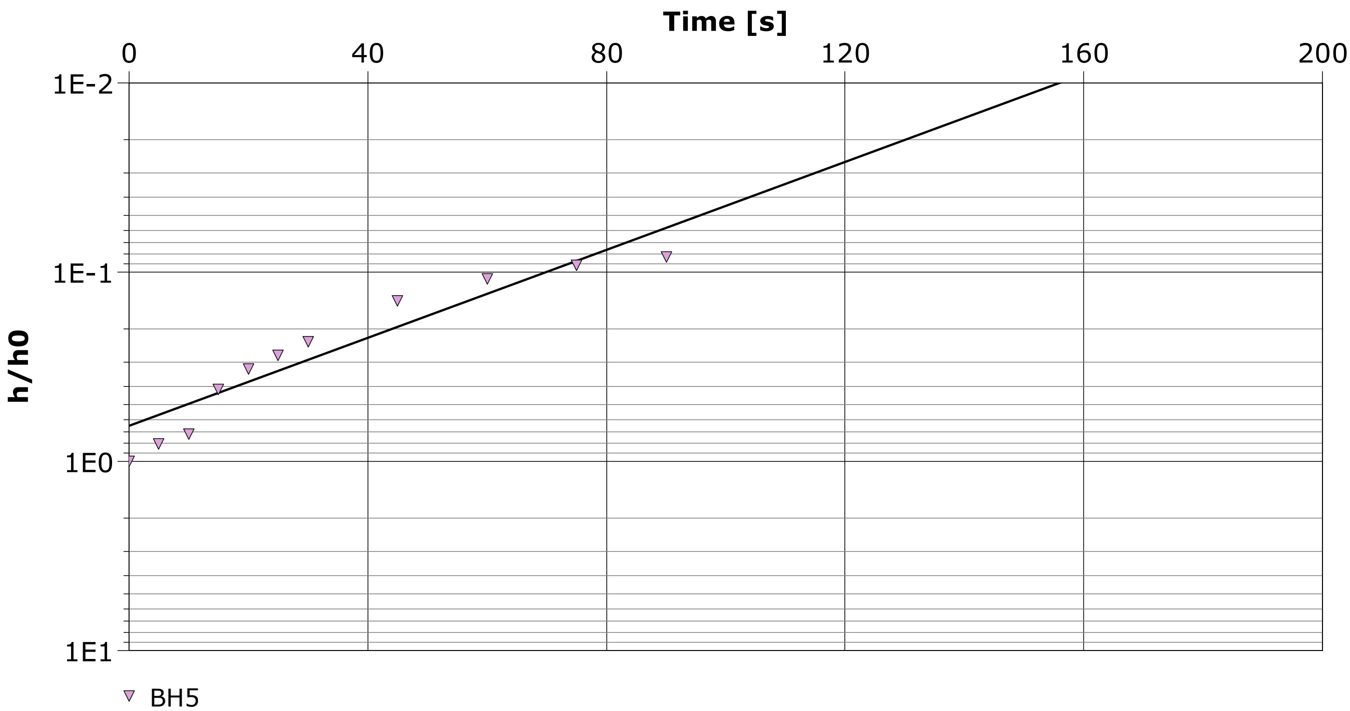


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH4	3.04×10^{-7}	

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: UPRC - Norval
	Number: 22-085
	Client: UPRC c/o Turner Townsend

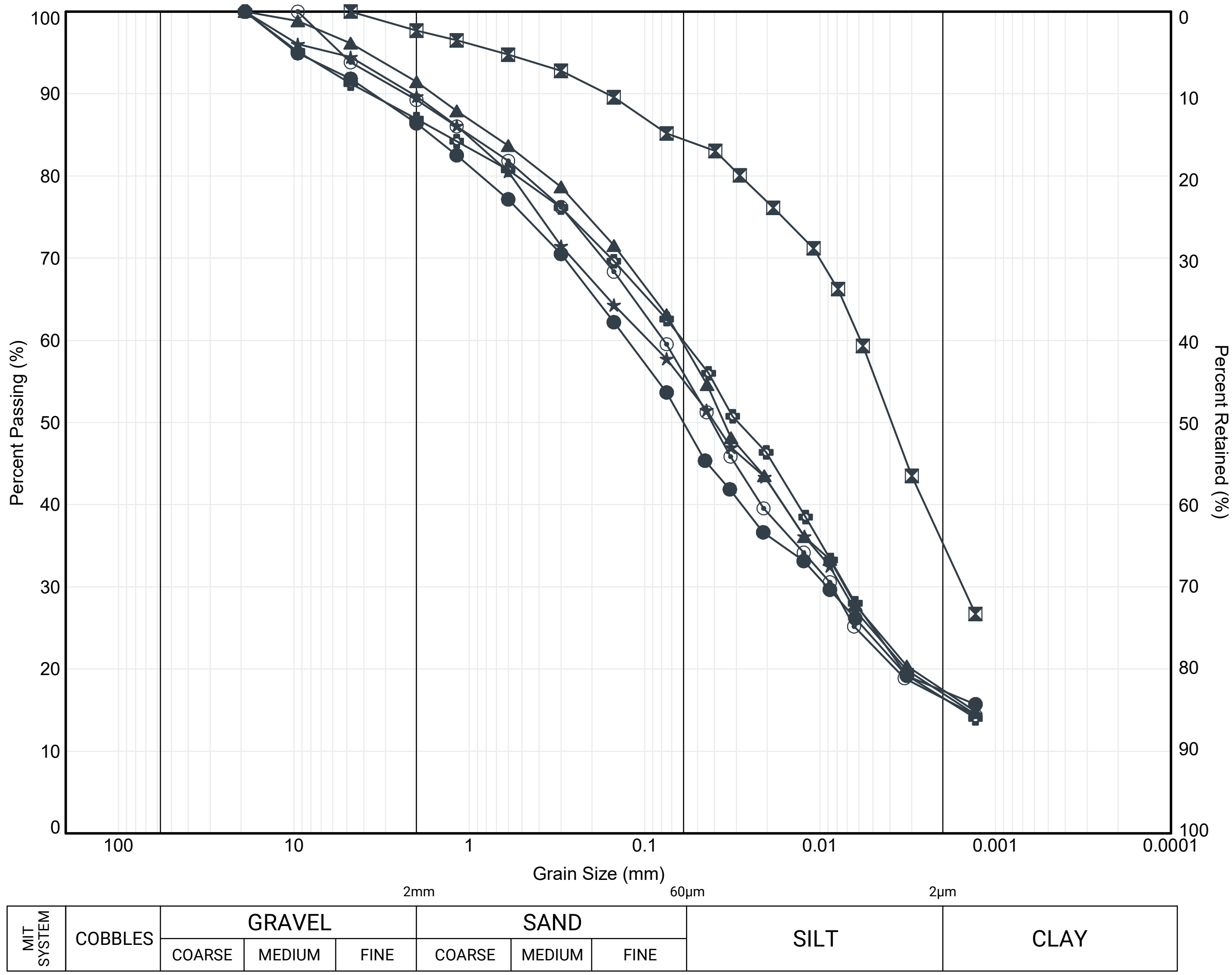
Location: 14015 Danby road	Slug Test: BH5 RHT	Test Well: BH5
Test Conducted by: FR		Test Date: 2022-06-02
Analysis Performed by: NP	BH5 RHT	Analysis Date: 2022-06-07
Aquifer Thickness: 8.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH5	6.49×10^{-6}	

APPENDIX C



MIT SYSTEM

	Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
●	**1**	SS3	1.8	243.3	14	36	33	17
⊠	**2**	SS9	7.9	234.9	2	14	49	35
▲	**3**	SS5	3.4	238.2	9	31	42	18
★	**4**	SS7	4.9	239.4	10	35	38	17
⊙	**5**	SS4	2.6	242.0	11	32	40	17
✪	**5**	SS7	6.4	238.2	13	27	43	17

GROUNDED ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION**

File No.: **22-085**

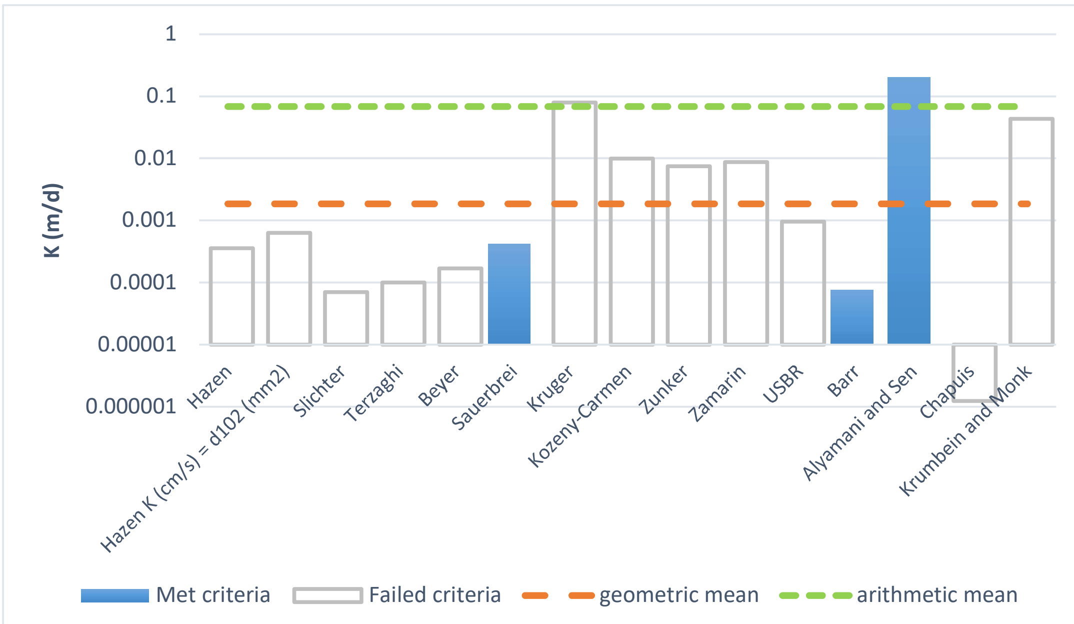
APPENDIX D

K from Grain Size Analysis Report | Date: 31-May-21

Sample Name: BH1 SS3

Mass Sample (g): 97.5 | T (oC) 20

Poorly sorted sandy gravelly silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	4.1E-07	4.1E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	7.3E-07	7.3E-09	0.00	
Slichter	8.1E-08	8.1E-10	0.00	
Terzaghi	1.2E-07	1.2E-09	0.00	
Beyer	1.9E-07	1.9E-09	0.00	
Sauerbrei	4.9E-07	4.9E-09	0.00	
Kruger	9.2E-05	9.2E-07	0.08	
Kozeny-Carmen	1.2E-05	1.2E-07	0.01	
Zunker	8.7E-06	8.7E-08	0.01	
Zamarin	1.0E-05	1.0E-07	0.01	
USBR	1.1E-06	1.1E-08	0.00	
Barr	8.7E-08	8.7E-10	0.00	
Alyamani and Sen	2.4E-04	2.4E-06	0.21	
Chapuis	1.4E-09	1.4E-11	0.00	
Krumbein and Monk	5.0E-05	5.0E-07	0.04	
geometric mean	2.2E-06	2.2E-08	0.00	
arithmetic mean	8.0E-05	8.0E-07	0.07	

K from Grain Size Analysis Report

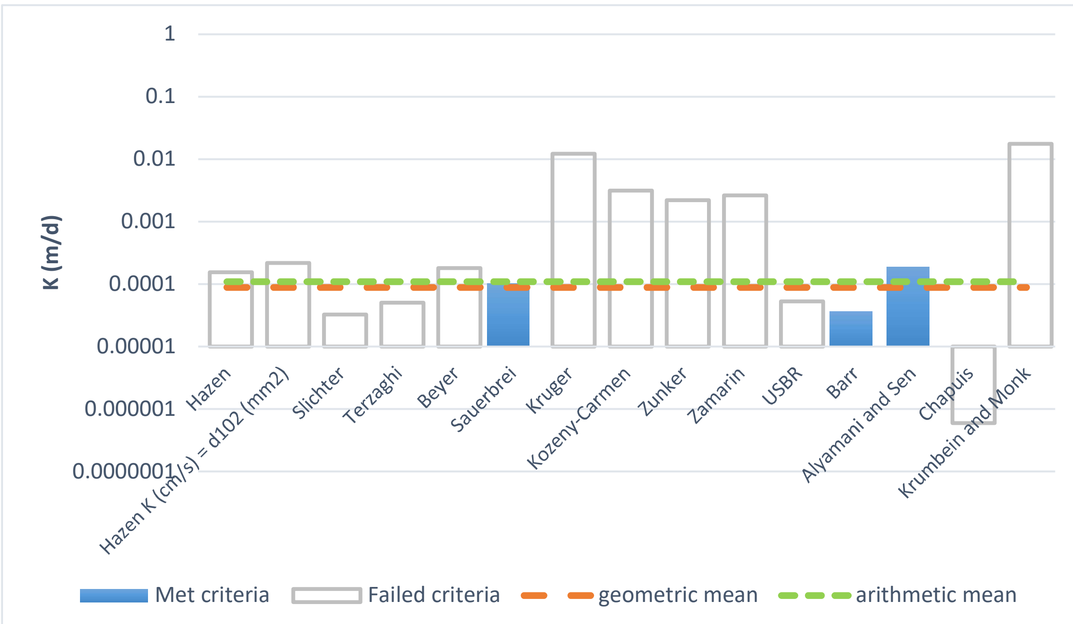
Date: 31-May-21

Sample Name: BH2 SS9

Mass Sample (g): 142.9

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	1.8E-07	1.8E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	2.5E-07	2.5E-09	0.00	
Slichter	3.8E-08	3.8E-10	0.00	
Terzaghi	5.8E-08	5.8E-10	0.00	
Beyer	2.1E-07	2.1E-09	0.00	
Sauerbrei	1.2E-07	1.2E-09	0.00	
Kruger	1.4E-05	1.4E-07	0.01	
Kozeny-Carmen	3.6E-06	3.6E-08	0.00	
Zunker	2.5E-06	2.5E-08	0.00	
Zamarin	3.0E-06	3.0E-08	0.00	
USBR	6.1E-08	6.1E-10	0.00	
Barr	4.2E-08	4.2E-10	0.00	
Alyamani and Sen	2.2E-07	2.2E-09	0.00	
Chapuis	6.8E-10	6.8E-12	0.00	
Krumbein and Monk	2.0E-05	2.0E-07	0.02	
geometric mean	1.0E-07	1.0E-09	0.00	
arithmetic mean	1.3E-07	1.3E-09	0.00	

K from Grain Size Analysis Report

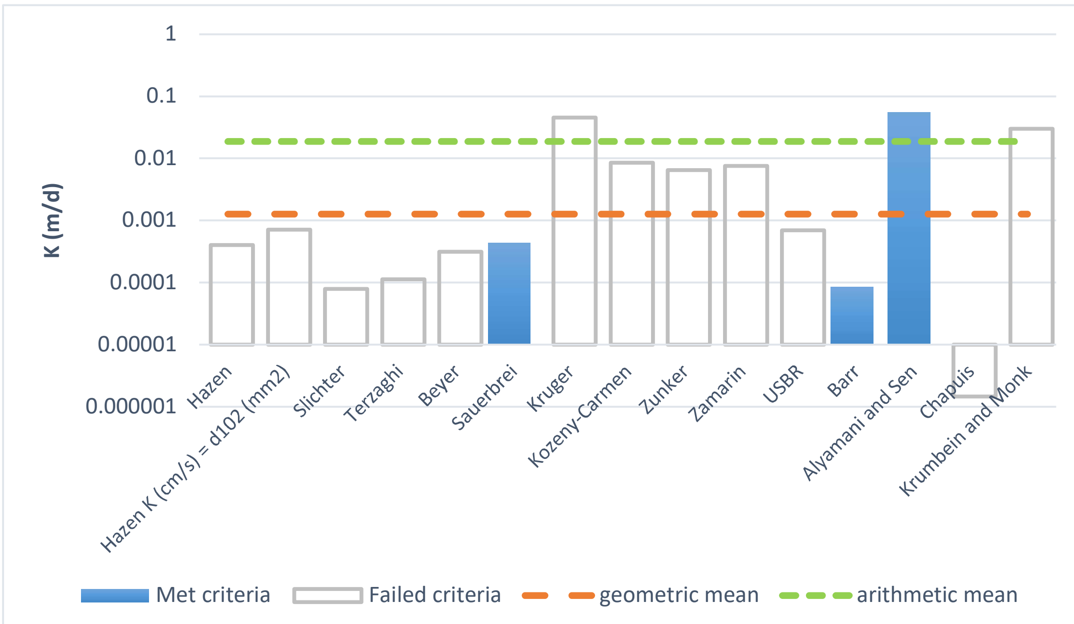
Date: 31-May-21

Sample Name: BH3 SS5

Mass Sample (g): 298.7

T (oC) 20

Poorly sorted sandy silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	4.6E-07	4.6E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	8.2E-07	8.2E-09	0.00	
Slichter	9.1E-08	9.1E-10	0.00	
Terzaghi	1.3E-07	1.3E-09	0.00	
Beyer	3.6E-07	3.6E-09	0.00	
Sauerbrei	5.1E-07	5.1E-09	0.00	
Kruger	5.3E-05	5.3E-07	0.05	
Kozeny-Carmen	9.9E-06	9.9E-08	0.01	
Zunker	7.5E-06	7.5E-08	0.01	
Zamarin	8.8E-06	8.8E-08	0.01	
USBR	8.0E-07	8.0E-09	0.00	
Barr	9.8E-08	9.8E-10	0.00	
Alyamani and Sen	6.5E-05	6.5E-07	0.06	
Chapuis	1.7E-09	1.7E-11	0.00	
Krumbein and Monk	3.5E-05	3.5E-07	0.03	
geometric mean	1.5E-06	1.5E-08	0.00	
arithmetic mean	2.2E-05	2.2E-07	0.02	

K from Grain Size Analysis Report

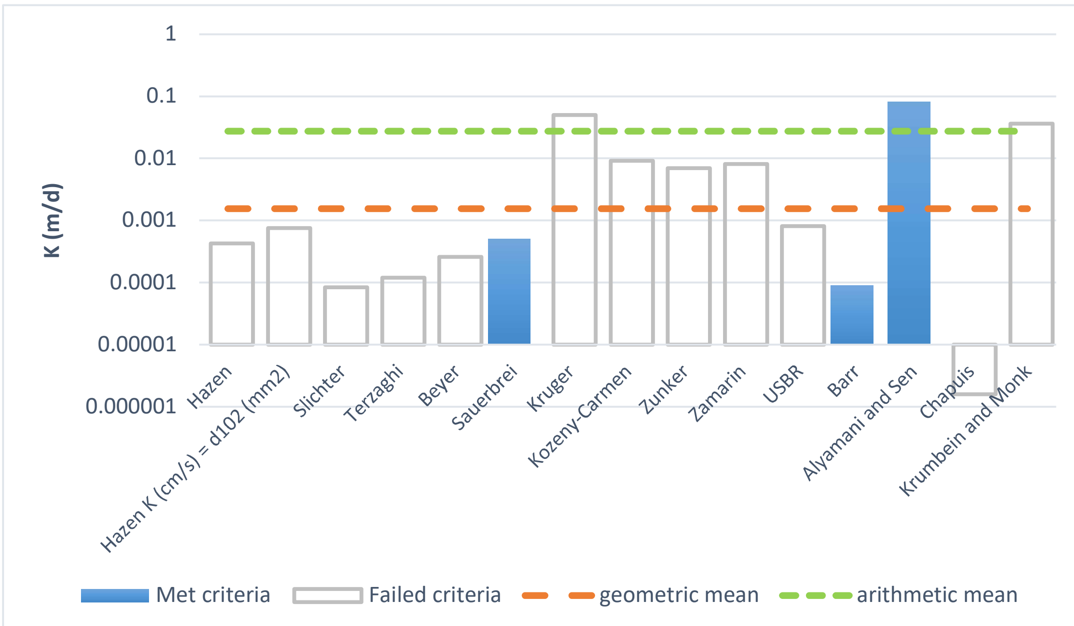
Date: 31-May-21

Sample Name: BH4 SS7

Mass Sample (g): 181.2

T (oC) 20

Poorly sorted sandy gravelly silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	4.9E-07	4.9E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	8.7E-07	8.7E-09	0.00	
Slichter	9.7E-08	9.7E-10	0.00	
Terzaghi	1.4E-07	1.4E-09	0.00	
Beyer	3.0E-07	3.0E-09	0.00	
Sauerbrei	5.9E-07	5.9E-09	0.00	
Kruger	5.8E-05	5.8E-07	0.05	
Kozeny-Carmen	1.1E-05	1.1E-07	0.01	
Zunker	8.0E-06	8.0E-08	0.01	
Zamarin	9.4E-06	9.4E-08	0.01	
USBR	9.4E-07	9.4E-09	0.00	
Barr	1.0E-07	1.0E-09	0.00	
Alyamani and Sen	9.5E-05	9.5E-07	0.08	
Chapuis	1.8E-09	1.8E-11	0.00	
Krumbein and Monk	4.2E-05	4.2E-07	0.04	
geometric mean	1.8E-06	1.8E-08	0.00	
arithmetic mean	3.2E-05	3.2E-07	0.03	

K from Grain Size Analysis Report

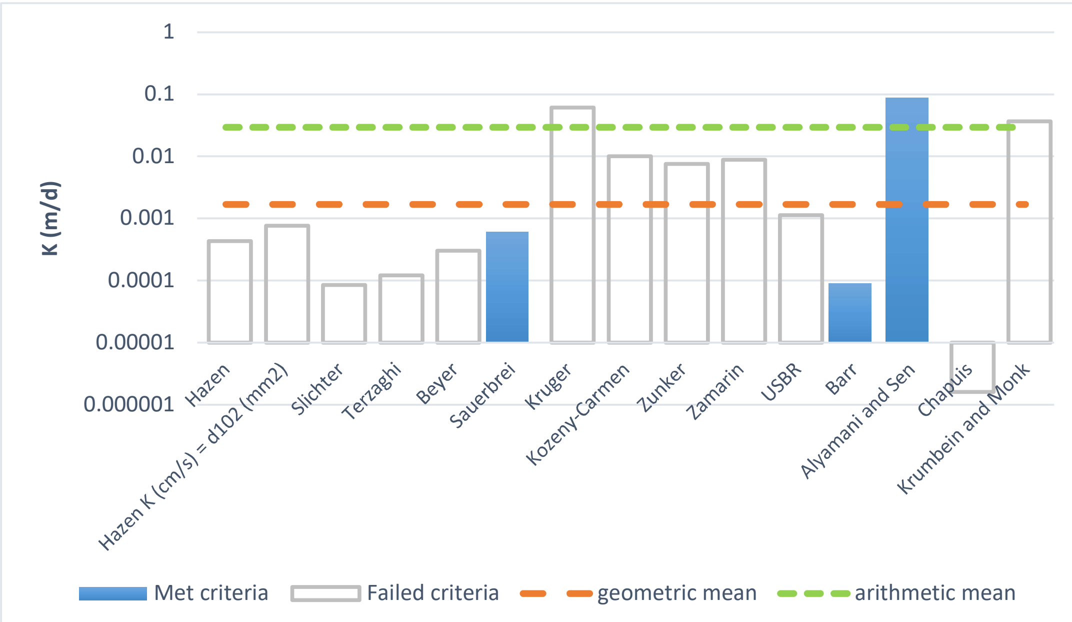
Date: 31-May-21

Sample Name: BH5 SS4

Mass Sample (g): 123

T (oC) 20

Poorly sorted sandy gravelly silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.0E-07	5.0E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	8.8E-07	8.8E-09	0.00	
Slichter	9.8E-08	9.8E-10	0.00	
Terzaghi	1.4E-07	1.4E-09	0.00	
Beyer	3.5E-07	3.5E-09	0.00	
Sauerbrei	7.1E-07	7.1E-09	0.00	
Kruger	7.1E-05	7.1E-07	0.06	
Kozeny-Carmen	1.2E-05	1.2E-07	0.01	
Zunker	8.8E-06	8.8E-08	0.01	
Zamarin	1.0E-05	1.0E-07	0.01	
USBR	1.3E-06	1.3E-08	0.00	
Barr	1.0E-07	1.0E-09	0.00	
Alyamani and Sen	1.0E-04	1.0E-06	0.09	
Chapuis	1.8E-09	1.8E-11	0.00	
Krumbein and Monk	4.2E-05	4.2E-07	0.04	
geometric mean	2.0E-06	2.0E-08	0.00	
arithmetic mean	3.4E-05	3.4E-07	0.03	

K from Grain Size Analysis Report

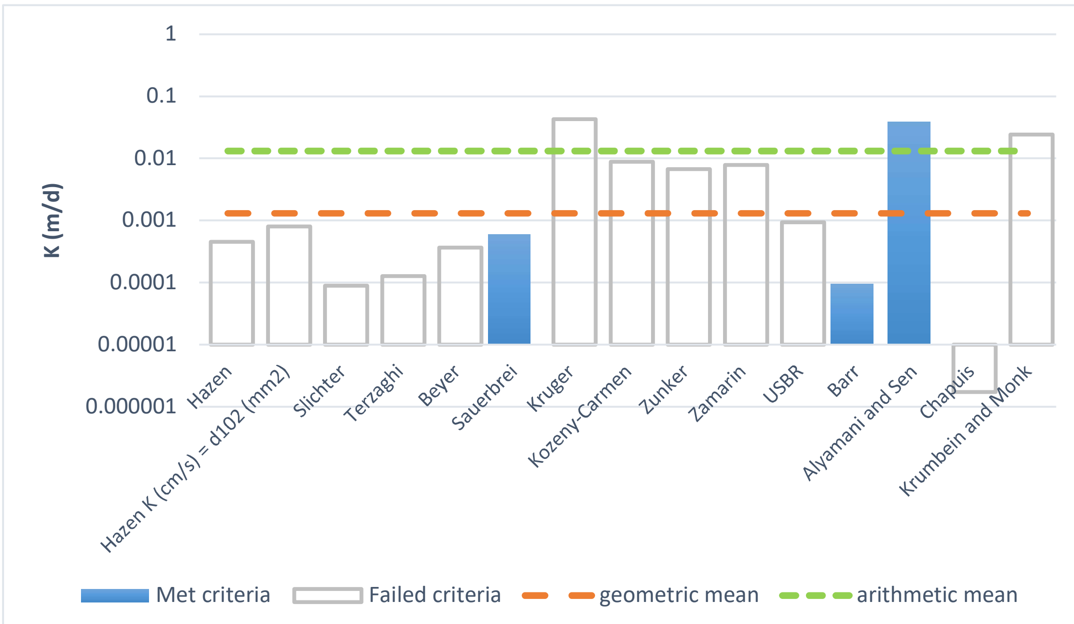
Date: 31-May-21

Sample Name: BH5 SS7

Mass Sample (g): 246.6

T (oC) 20

Poorly sorted sandy gravelly silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.3E-07	5.3E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	9.3E-07	9.3E-09	0.00	
Slichter	1.0E-07	1.0E-09	0.00	
Terzaghi	1.5E-07	1.5E-09	0.00	
Beyer	4.2E-07	4.2E-09	0.00	
Sauerbrei	6.9E-07	6.9E-09	0.00	
Kruger	4.9E-05	4.9E-07	0.04	
Kozeny-Carmen	1.0E-05	1.0E-07	0.01	
Zunker	7.8E-06	7.8E-08	0.01	
Zamarin	9.1E-06	9.1E-08	0.01	
USBR	1.1E-06	1.1E-08	0.00	
Barr	1.1E-07	1.1E-09	0.00	
Alyamani and Sen	4.5E-05	4.5E-07	0.04	
Chapuis	2.0E-09	2.0E-11	0.00	
Krumbein and Monk	2.8E-05	2.8E-07	0.02	
geometric mean	1.5E-06	1.5E-08	0.00	
arithmetic mean	1.5E-05	1.5E-07	0.01	

APPENDIX E

Grounded Engineering Inc
ATTN: Lindsy Levesque
1 Banigan Drive
TORONTO ON M4H 1G3

Date Received: 02-JUN-22
Report Date: 10-JUN-22 12:57 (MT)
Version: FINAL

Client Phone: 647-264-7932

Certificate of Analysis

Lab Work Order #: L2711921

Project P.O. #: Lindsy Levesque
Job Reference: 22-085
C of C Numbers: 20-1000611
Legal Site Desc: 14015 DANBY RD, NORVAL, ON

Amanda Overholster
Account Manager

Sample Details / Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2
L2711921-1 SEW-UF-BH1							
Sampled By: FR on 02-JUN-22 @ 10:00							
Matrix: WATER							
Physical Tests							
pH	7.61		0.10	pH units	03-JUN-22	6.00-10.0	6.5-8.5
Total Suspended Solids	208		3.0	mg/L	08-JUN-22	350	
Anions and Nutrients							
Fluoride (F)	<0.10	DLDS	0.10	mg/L	07-JUN-22	10	
Total Kjeldahl Nitrogen	0.375		0.050	mg/L	07-JUN-22	100	
Phosphorus, Total	0.0437		0.0030	mg/L	08-JUN-22	10.0	
Sulfate (SO4)	147	DLDS	1.5	mg/L	07-JUN-22	1500	
Cyanides							
Cyanide, Total	<0.0020		0.0020	mg/L	07-JUN-22	2	
Bacteriological Tests							
E. Coli	0		0	CFU/100mL	03-JUN-22		200
Total Metals							
Aluminum (Al)-Total	1.35	DLHC	0.050	mg/L	06-JUN-22	50	
Antimony (Sb)-Total	<0.0010	DLHC	0.0010	mg/L	06-JUN-22	5	
Arsenic (As)-Total	0.0016	DLHC	0.0010	mg/L	06-JUN-22	1	
Beryllium (Be)-Total	<0.0010	DLHC	0.0010	mg/L	06-JUN-22	5	
Cadmium (Cd)-Total	<0.000050	DLHC	0.000050	mg/L	06-JUN-22	1	
Chromium (Cr)-Total	<0.0050	DLHC	0.0050	mg/L	06-JUN-22	3	
Cobalt (Co)-Total	0.0018	DLHC	0.0010	mg/L	06-JUN-22	5	
Copper (Cu)-Total	<0.0050	DLHC	0.0050	mg/L	06-JUN-22	3	
Iron (Fe)-Total	2.40	DLHC	0.10	mg/L	06-JUN-22	50	
Lead (Pb)-Total	0.00092	DLHC	0.00050	mg/L	06-JUN-22	3	
Manganese (Mn)-Total	0.132	DLHC	0.0050	mg/L	06-JUN-22	5	
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L	06-JUN-22	0.05	
Molybdenum (Mo)-Total	0.00565	DLHC	0.00050	mg/L	06-JUN-22	5	
Nickel (Ni)-Total	<0.0050	DLHC	0.0050	mg/L	06-JUN-22	3	
Selenium (Se)-Total	<0.00050	DLHC	0.00050	mg/L	06-JUN-22	5	
Silver (Ag)-Total	<0.00050	DLHC	0.00050	mg/L	06-JUN-22	5	
Tin (Sn)-Total	0.0011	DLHC	0.0010	mg/L	06-JUN-22	5	
Titanium (Ti)-Total	0.0341	DLHC	0.0030	mg/L	06-JUN-22	5	
Zinc (Zn)-Total	<0.030	DLHC	0.030	mg/L	06-JUN-22	3	
Aggregate Organics							
BOD Carbonaceous	<3.0	BODL	3.0	mg/L	03-JUN-22	300	
Oil and Grease, Total	<5.0		5.0	mg/L	03-JUN-22		
Animal/Veg Oil & Grease	<5.0		5.0	mg/L	08-JUN-22	150	
Mineral Oil and Grease	<2.5		2.5	mg/L	03-JUN-22	15	
Phenols (4AAP)	0.0011		0.0010	mg/L	07-JUN-22	1.0	
Volatile Organic Compounds							
Benzene	<0.50		0.50	ug/L	10-JUN-22	10	
Chloroform	<1.0		1.0	ug/L	10-JUN-22	40	
1,4-Dichlorobenzene	<0.50		0.50	ug/L	10-JUN-22	80	
Dichloromethane	<2.0		2.0	ug/L	10-JUN-22	2000	
Ethylbenzene	<0.50		0.50	ug/L	10-JUN-22	160	

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Halton Santitary Sewer By-law No. 02-03 (MAR, 2003) = [Suite] - ON-SAN+STORM-HALTON

#1: Halton Sanitary Sewer By-Law No. 02-03

#2: Halton Storm Sewer By-Law No, 02-03

ANALYTICAL GUIDELINE REPORT

22-085 - 14015 DANBY RD, NORVAL, ON

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2
L2711921-1	SEW-UF-BH1							
Sampled By:	FR on 02-JUN-22 @ 10:00							
Matrix:	WATER							
Volatile Organic Compounds								
	Tetrachloroethylene	<0.50		0.50	ug/L	10-JUN-22	1000	
	Toluene	<0.50		0.50	ug/L	10-JUN-22	16	
	Trichloroethylene	<0.50		0.50	ug/L	10-JUN-22	400	
	Surrogate: 4-Bromofluorobenzene	82.9		70-130	%	10-JUN-22		
	Surrogate: 1,4-Difluorobenzene	99.3		70-130	%	10-JUN-22		
Polycyclic Aromatic Hydrocarbons								
	Naphthalene	<0.020		0.020	ug/L	07-JUN-22	140	
	Surrogate: d8-Naphthalene	106.3		60-140	%	07-JUN-22		

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Halton Santitary Sewer By-law No. 02-03 (MAR, 2003) = [Suite] - ON-SAN+STORM-HALTON

#1: Halton Sanitary Sewer By-Law No. 02-03 **#2: Halton Storm Sewer By-Law No, 02-03**

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
BODL	Limit of Reporting for BOD was increased to account for the largest volume of sample tested.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
BOD-C-WT	Water	BOD Carbonaceous	APHA 5210 B (CBOD)

This analysis is carried out using procedures adapted from APHA Method 5210B - "Biochemical Oxygen Demand (BOD)". All forms of biochemical oxygen demand (BOD) are determined by diluting and incubating a sample for a specified time period, and measuring the oxygen depletion using a dissolved oxygen meter. Dissolved BOD (SOLUBLE) is determined by filtering the sample through a glass fibre filter prior to dilution. Carbonaceous BOD (CBOD) is determined by adding a nitrification inhibitor to the diluted sample prior to incubation.

ALS Test Code	Matrix	Test Description	Method Reference***
CN-TOT-WT	Water	Cyanide, Total	ISO 14403-2

Total cyanide is determined by the combination of UV digestion and distillation. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

When using this method, high levels of thiocyanate in samples can cause false positives at ~1-2% of the thiocyanate concentration. For samples with detectable cyanide analyzed by this method, ALS recommends analysis for thiocyanate to check for this potential interference

ALS Test Code	Matrix	Test Description	Method Reference***
EC-SCREEN-WT	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference***
EC-WW-MF-WT	Water	E. Coli	SM 9222D

A 100 mL volume of sample is filtered through a membrane, the membrane is placed on mFC-BCIG agar and incubated at 44.5 –0 .2 °C for 24 – 2 h.
Method ID: WT-TM-1200

ALS Test Code	Matrix	Test Description	Method Reference***
F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference***
HG-T-CVAA-WT	Water	Total Mercury in Water by CVAAS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference***
MET-T-CCMS-WT	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

ALS Test Code	Matrix	Test Description	Method Reference***
OGG-SPEC-CALC-WT	Water	Speciated Oil and Grease A/V Calc	CALCULATION

Sample is extracted with hexane, sample speciation into mineral and animal/vegetable fractions is achieved via silica gel separation and is then determined gravimetrically.

ALS Test Code	Matrix	Test Description	Method Reference***
OGG-SPEC-WT	Water	Speciated Oil and Grease-Gravimetric	APHA 5520 B

The procedure involves an extraction of the entire water sample with hexane. Sample speciation into mineral and animal/vegetable fractions is achieved via silica gel separation and is then determined gravimetrically.

ALS Test Code	Matrix	Test Description	Method Reference***
P-T-COL-WT	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is deteremined colourimetrically after persulphate digestion of the sample.

ALS Test Code	Matrix	Test Description	Method Reference***
PAH-NAPHTHALENE-WT	Water	Polyaromatic Hydrocarbons (PAHs)	SW846 8270

Sample is extracted at neutral pH using separate aliquots of dichloromethane with a modified separatory funnel technique, extracts are then concentrated and analyzed by GC/MSD.

ALS Test Code	Matrix	Test Description	Method Reference***
PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011). Holdtime for samples under this regulation is 28 days

ALS Test Code	Matrix	Test Description	Method Reference***
PHENOLS-4AAP-WT	Water	Phenol (4AAP)	EPA 9066

An automated method is used to distill the sample. The distillate is then buffered to pH 9.4 which reacts with 4AAP and potassium ferricyanide to form a red complex which is measured colorimetrically.

Reference Information

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TSS-WT	Water	Suspended solids	APHA 2540 D-Gravimetric

A well-mixed sample is filtered through a weighed standard glass fibre filter and the residue retained is dried in an oven at 104–1°C for a minimum of four hours or until a constant weight is achieved.

TKN-F-WT	Water	TKN in Water by Fluorescence	J. ENVIRON. MONIT., 2005,7,37-42,RSC

Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection

VOC-ROU-HS-WT	Water	Volatile Organic Compounds	SW846 8260

Aqueous samples are analyzed by headspace-GC/MS.

*** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody numbers:

20-1000611

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA		

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guideline limits are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

ALS Environmental

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BOD-C-WT	**Water**							
Batch R5795762								
WG3735298-2 DUP		**L2711921-1**						
BOD Carbonaceous		<3.0	<3.0	RPD-NA	mg/L	N/A	30	03-JUN-22
WG3735298-3 LCS								
BOD Carbonaceous			95.5		%		85-115	03-JUN-22
WG3735298-1 MB								
BOD Carbonaceous			<2.0		mg/L		2	03-JUN-22
CN-TOT-WT	**Water**							
Batch R5795609								
WG3736539-20 DUP		**WG3736539-18**						
Cyanide, Total		0.0090	0.0091		mg/L	1.4	20	07-JUN-22
WG3736539-17 LCS								
Cyanide, Total			103.1		%		80-120	07-JUN-22
WG3736539-16 MB								
Cyanide, Total			<0.0020		mg/L		0.002	07-JUN-22
WG3736539-19 MS		**WG3736539-18**						
Cyanide, Total			103.0		%		70-130	07-JUN-22
EC-WW-MF-WT	**Water**							
Batch R5794405								
WG3735441-1 MB								
E. Coli			0		CFU/100mL		1	03-JUN-22
F-IC-N-WT	**Water**							
Batch R5795518								
WG3736689-4 DUP		**WG3736689-3**						
Fluoride (F)		0.664	0.664		mg/L	0.0	20	07-JUN-22
WG3736689-2 LCS								
Fluoride (F)			100.6		%		90-110	07-JUN-22
WG3736689-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	07-JUN-22
WG3736689-5 MS		**WG3736689-3**						
Fluoride (F)			97.4		%		75-125	07-JUN-22
HG-T-CVAA-WT	**Water**							
Batch R5794586								
WG3735791-3 DUP		**WG3735791-5**						
Mercury (Hg)-Total		<0.0000050	<0.000005C	RPD-NA	mg/L	N/A	20	06-JUN-22
WG3735791-2 LCS								
Mercury (Hg)-Total			97.7		%		80-120	06-JUN-22

ALS Environmental

Quality Control Report

Workorder: L2711921 Report Date: 10-JUN-22

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-T-CVAA-WT	**Water**							
Batch R5794586								
WG3735791-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	06-JUN-22
WG3735791-4 MS		**WG3735791-6**						
Mercury (Hg)-Total			92.8		%		70-130	06-JUN-22
MET-T-CCMS-WT	**Water**							
Batch R5795106								
WG3735719-4 DUP		**WG3735719-3**						
Aluminum (Al)-Total		19.1	19.4		mg/L	1.3	20	06-JUN-22
Antimony (Sb)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-JUN-22
Arsenic (As)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-JUN-22
Beryllium (Be)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-JUN-22
Cadmium (Cd)-Total		0.548	0.556		mg/L	1.5	20	06-JUN-22
Chromium (Cr)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	06-JUN-22
Cobalt (Co)-Total		0.132	0.137		mg/L	3.7	20	06-JUN-22
Copper (Cu)-Total		26.1	26.1		mg/L	0.2	20	06-JUN-22
Iron (Fe)-Total		7.9	7.9		mg/L	1.0	20	06-JUN-22
Lead (Pb)-Total		0.126	0.130		mg/L	3.0	20	06-JUN-22
Manganese (Mn)-Total		5.96	6.05		mg/L	1.5	20	06-JUN-22
Molybdenum (Mo)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-JUN-22
Nickel (Ni)-Total		0.109	0.107		mg/L	1.7	20	06-JUN-22
Selenium (Se)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-JUN-22
Silver (Ag)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-JUN-22
Tin (Sn)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-JUN-22
Titanium (Ti)-Total		<0.030	<0.030	RPD-NA	mg/L	N/A	20	06-JUN-22
Zinc (Zn)-Total		212	213		mg/L	0.3	20	06-JUN-22
WG3735719-2 LCS								
Aluminum (Al)-Total			101.4		%		80-120	06-JUN-22
Antimony (Sb)-Total			104.6		%		80-120	06-JUN-22
Arsenic (As)-Total			99.2		%		80-120	06-JUN-22
Beryllium (Be)-Total			98.5		%		80-120	06-JUN-22
Cadmium (Cd)-Total			100.6		%		80-120	06-JUN-22
Chromium (Cr)-Total			99.97		%		80-120	06-JUN-22
Cobalt (Co)-Total			98.5		%		80-120	06-JUN-22
Copper (Cu)-Total			96.4		%		80-120	06-JUN-22
Iron (Fe)-Total			100.8				80-120	

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R5795106								
WG3735719-2 LCS								
Iron (Fe)-Total			100.8		%		80-120	06-JUN-22
Lead (Pb)-Total			97.9		%		80-120	06-JUN-22
Manganese (Mn)-Total			99.7		%		80-120	06-JUN-22
Molybdenum (Mo)-Total			104.5		%		80-120	06-JUN-22
Nickel (Ni)-Total			97.9		%		80-120	06-JUN-22
Selenium (Se)-Total			101.0		%		80-120	06-JUN-22
Silver (Ag)-Total			97.3		%		80-120	06-JUN-22
Tin (Sn)-Total			97.8		%		80-120	06-JUN-22
Titanium (Ti)-Total			96.9		%		80-120	06-JUN-22
Zinc (Zn)-Total			98.7		%		80-120	06-JUN-22
WG3735719-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	06-JUN-22
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	06-JUN-22
Arsenic (As)-Total			<0.00010		mg/L		0.0001	06-JUN-22
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	06-JUN-22
Cadmium (Cd)-Total			<0.000005C		mg/L		0.000005	06-JUN-22
Chromium (Cr)-Total			<0.00050		mg/L		0.0005	06-JUN-22
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	06-JUN-22
Copper (Cu)-Total			<0.00050		mg/L		0.0005	06-JUN-22
Iron (Fe)-Total			<0.010		mg/L		0.01	06-JUN-22
Lead (Pb)-Total			<0.000050		mg/L		0.00005	06-JUN-22
Manganese (Mn)-Total			<0.00050		mg/L		0.0005	06-JUN-22
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	06-JUN-22
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	06-JUN-22
Selenium (Se)-Total			<0.000050		mg/L		0.00005	06-JUN-22
Silver (Ag)-Total			<0.000050		mg/L		0.00005	06-JUN-22
Tin (Sn)-Total			<0.00010		mg/L		0.0001	06-JUN-22
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	06-JUN-22
Zinc (Zn)-Total			<0.0030		mg/L		0.003	06-JUN-22
WG3735719-5 MS		**WG3735719-6**						
Aluminum (Al)-Total			N/A	MS-B	%		-	06-JUN-22
Antimony (Sb)-Total			97.0		%		70-130	06-JUN-22
Arsenic (As)-Total			94.8		%		70-130	06-JUN-22
Beryllium (Be)-Total			95.4		%		70-130	06-JUN-22

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R5795106								
WG3735719-5 MS		**WG3735719-6**						
Cadmium (Cd)-Total			N/A	MS-B	%		-	06-JUN-22
Chromium (Cr)-Total			90.6		%		70-130	06-JUN-22
Cobalt (Co)-Total			N/A	MS-B	%		-	06-JUN-22
Copper (Cu)-Total			N/A	MS-B	%		-	06-JUN-22
Iron (Fe)-Total			N/A	MS-B	%		-	06-JUN-22
Lead (Pb)-Total			N/A	MS-B	%		-	06-JUN-22
Manganese (Mn)-Total			N/A	MS-B	%		-	06-JUN-22
Molybdenum (Mo)-Total			108.3		%		70-130	06-JUN-22
Nickel (Ni)-Total			N/A	MS-B	%		-	06-JUN-22
Selenium (Se)-Total			88.7		%		70-130	06-JUN-22
Silver (Ag)-Total			92.0		%		70-130	06-JUN-22
Tin (Sn)-Total			91.5		%		70-130	06-JUN-22
Titanium (Ti)-Total			71.1		%		70-130	06-JUN-22
Zinc (Zn)-Total			N/A	MS-B	%		-	06-JUN-22
OGG-SPEC-WT	**Water**							
Batch R5795824								
WG3735040-2 LCS								
Oil and Grease, Total			88.6		%		70-130	03-JUN-22
Mineral Oil and Grease			85.2		%		70-130	03-JUN-22
WG3735040-1 MB								
Oil and Grease, Total			<5.0		mg/L		5	03-JUN-22
Mineral Oil and Grease			<2.5		mg/L		2.5	03-JUN-22
P-T-COL-WT	**Water**							
Batch R5795719								
WG3735798-3 DUP		**L2711917-7**						
Phosphorus, Total		0.0047	0.0057		mg/L	19	20	08-JUN-22
WG3735798-2 LCS								
Phosphorus, Total			103.0		%		80-120	08-JUN-22
WG3735798-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	08-JUN-22
WG3735798-4 MS		**L2711917-7**						
Phosphorus, Total			72.4		%		70-130	08-JUN-22
PAH-NAPHTHALENE-WT	**Water**							

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-NAPHTHALENE-WT	**Water**							
Batch R5795154								
WG3735112-2 LCS								
Naphthalene			98.5		%		50-130	07-JUN-22
WG3735112-1 MB								
Naphthalene			<0.020		ug/L		0.02	07-JUN-22
Surrogate: d8-Naphthalene			104.7		%		60-140	07-JUN-22
PH-WT	**Water**							
Batch R5794327								
WG3735416-4 DUP		**WG3735416-3**						
pH		7.61	7.58	J	pH units	0.03	0.2	03-JUN-22
WG3735416-2 LCS								
pH			7.05		pH units		6.9-7.1	03-JUN-22
PHENOLS-4AAP-WT	**Water**							
Batch R5795632								
WG3735065-3 DUP		**WG3735065-5**						
Phenols (4AAP)		0.0036	0.0034		mg/L	5.8	20	08-JUN-22
WG3735065-1 MB								
Phenols (4AAP)			<0.0010		mg/L		0.001	07-JUN-22
WG3735065-4 MS		**WG3735065-5**						
Phenols (4AAP)			101.8		%		75-125	08-JUN-22
SO4-IC-N-WT	**Water**							
Batch R5795518								
WG3736689-4 DUP		**WG3736689-3**						
Sulfate (SO4)		17.6	17.4		mg/L	0.8	20	07-JUN-22
WG3736689-2 LCS								
Sulfate (SO4)			101.1		%		90-110	07-JUN-22
WG3736689-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	07-JUN-22
WG3736689-5 MS		**WG3736689-3**						
Sulfate (SO4)			97.9		%		75-125	07-JUN-22
SOLIDS-TSS-WT	**Water**							
Batch R5795430								
WG3736402-3 DUP		**L2710218-1**						
Total Suspended Solids		104	118		mg/L	13	20	08-JUN-22
WG3736402-2 LCS								
Total Suspended Solids			86.0		%		85-115	08-JUN-22
WG3736402-1 MB								
Total Suspended Solids			<3.0		mg/L		3	08-JUN-22

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-F-WT	**Water**							
Batch R5795559								
WG3735795-3 DUP		**L2712084-1**						
Total Kjeldahl Nitrogen		6.83	6.93		mg/L	1.4	20	08-JUN-22
WG3735795-2 LCS								
Total Kjeldahl Nitrogen			113.3		%		75-125	07-JUN-22
WG3735795-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	07-JUN-22
WG3735795-4 MS		**L2712084-1**						
Total Kjeldahl Nitrogen			N/A	MS-B	%		-	08-JUN-22
VOC-ROU-HS-WT	**Water**							
Batch R5796107								
WG3737596-4 DUP		**WG3737596-3**						
1,4-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	10-JUN-22
Benzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	10-JUN-22
Chloroform		<1.0	<1.0	RPD-NA	ug/L	N/A	30	10-JUN-22
Dichloromethane		<2.0	<2.0	RPD-NA	ug/L	N/A	30	10-JUN-22
Ethylbenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	10-JUN-22
Tetrachloroethylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	10-JUN-22
Toluene		<0.40	<0.40	RPD-NA	ug/L	N/A	30	10-JUN-22
Trichloroethylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	10-JUN-22
WG3737596-1 LCS								
1,4-Dichlorobenzene			93.0		%		70-130	09-JUN-22
Benzene			97.1		%		70-130	09-JUN-22
Chloroform			99.3		%		70-130	09-JUN-22
Dichloromethane			103.9		%		70-130	09-JUN-22
Ethylbenzene			93.4		%		70-130	09-JUN-22
Tetrachloroethylene			95.2		%		70-130	09-JUN-22
Toluene			96.6		%		70-130	09-JUN-22
Trichloroethylene			95.6		%		70-130	09-JUN-22
WG3737596-2 MB								
1,4-Dichlorobenzene			<0.50		ug/L		0.5	09-JUN-22
Benzene			<0.50		ug/L		0.5	09-JUN-22
Chloroform			<1.0		ug/L		1	09-JUN-22
Dichloromethane			<2.0		ug/L		2	09-JUN-22
Ethylbenzene			<0.50		ug/L		0.5	09-JUN-22
Tetrachloroethylene			<0.50		ug/L		0.5	09-JUN-22
							0.4	

Quality Control Report

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Lindsy Levesque

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R5796107								
WG3737596-2 MB								
Toluene			<0.40		ug/L		0.4	09-JUN-22
Trichloroethylene			<0.50		ug/L		0.5	09-JUN-22
Surrogate: 1,4-Difluorobenzene			100.1		%		70-130	09-JUN-22
Surrogate: 4-Bromofluorobenzene			85.9		%		70-130	09-JUN-22
WG3737596-5 MS		**WG3737596-3**						
1,4-Dichlorobenzene			94.9		%		50-150	10-JUN-22
Benzene			97.0		%		50-150	10-JUN-22
Chloroform			99.5		%		50-150	10-JUN-22
Dichloromethane			104.2		%		50-150	10-JUN-22
Ethylbenzene			94.3		%		50-150	10-JUN-22
Tetrachloroethylene			97.5		%		50-150	10-JUN-22
Toluene			97.1		%		50-150	10-JUN-22
Trichloroethylene			96.1		%		50-150	10-JUN-22

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS www.alsglobal.com

Canada Toll Free: 1 800 668 9878

COC Number: 20 - 1000611 JD

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	GROUNDED ENG
Contact:	LINDSY LEVESQUE
Phone:	
	Company address below will appear on the final report
Street:	1 BANIGAN DR
City/Province:	TORONTO, ON
Postal Code:	
Invoice To	Same as Report To ☒ YES ☐ NO
	Copy of Invoice with Report ☒ YES ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)

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

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

Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax LLEVESQUE@GROUNDEDENG.CA

Email 2 NPIERS@GROUNDEDENG.CA

Email 3

Invoice Recipients

Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax SAME AS ABOVE

Email 2

Turnaround Time (TAT) Requested

- ☒ Routine [R] if received by 3pm M-F - no surcharges apply
- ☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
- ☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
- ☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
- ☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
- ☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information

ALS Account # / Quote #:	
Job #:	22-085
PO / AFE:	LINDSY LEVESQUE
LSD:	14015 DANBY RD, NORVAL, ON
ALS Lab Work Order # (ALS use only):	L2711921 JD

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	Sampler: FR

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	HALTON SANITARY/STORM COMBINED	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	SEW-UF-BH1	02-06-22	10:00	GW	13	X			

L2711921-COFC

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☒ NO

Are samples for human consumption/ use? ☐ YES ☒ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

HALTON STORM SANITARY COMBINED

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C: 0

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by: [signature]	Date: 02/06/22	Time:	Received by: JD	Date: June 2/22	Time: 1130	Received by: HD	Date: June 2	Time: 7:30

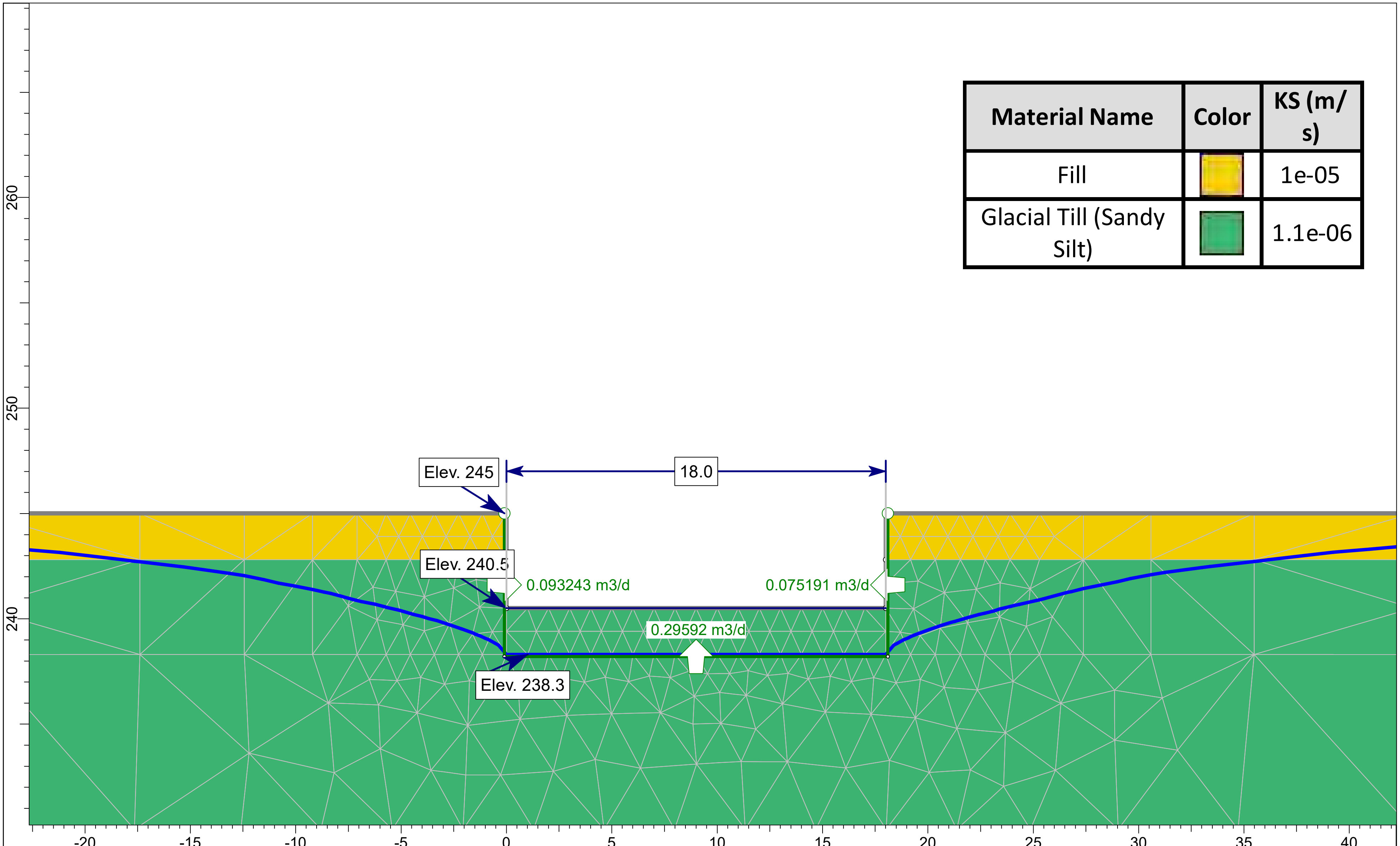
REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX F

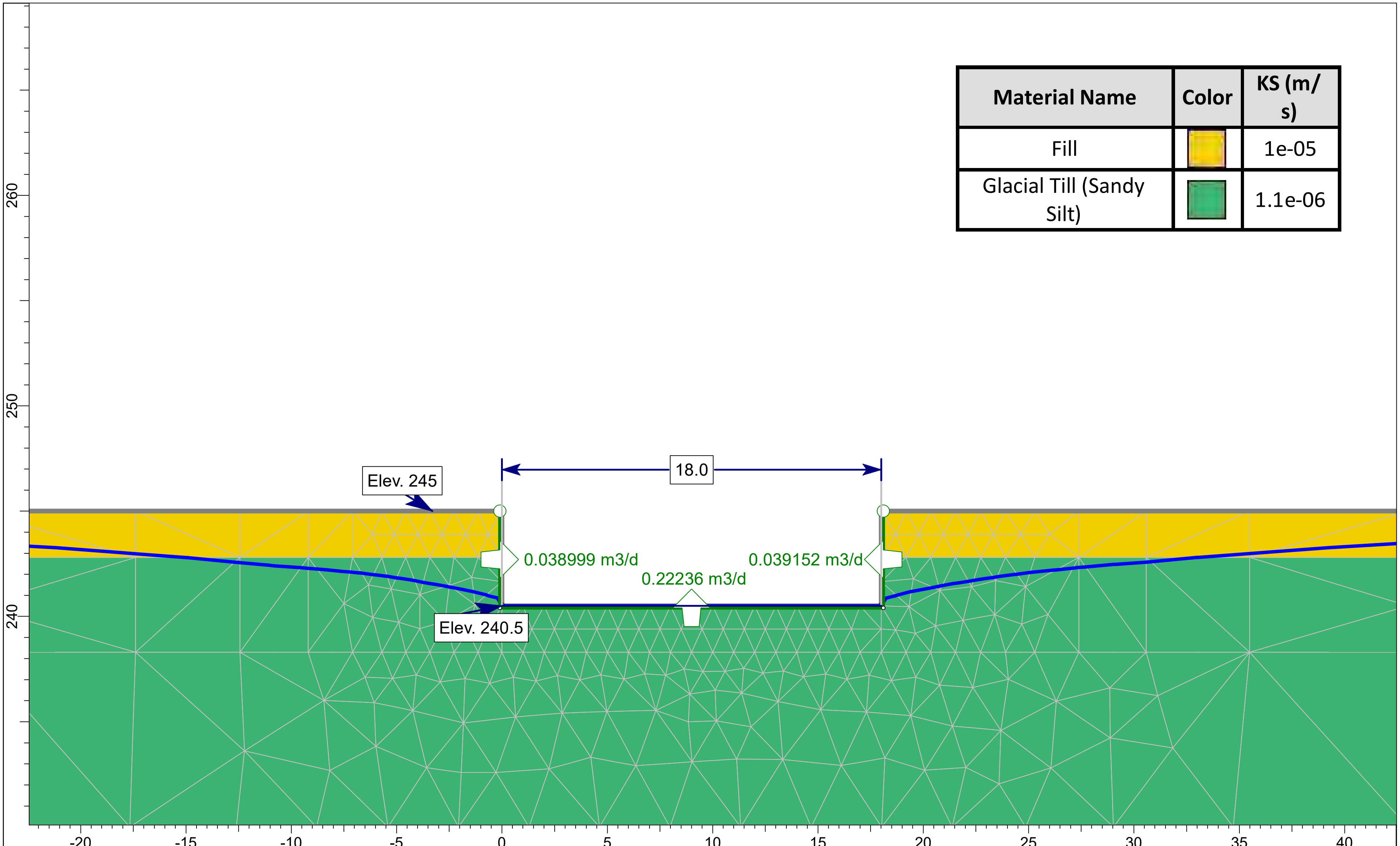


Material Name	Color	KS (m/s)
Fill	(yellow)	1e-05
Glacial Till (Sandy Silt)	(green)	1.1e-06

GROUNDED ENGINEERING

SLIDEINTERPRET 9.018

File	**22-085 | 14015 Danby Road, Norval**
Analysis	FEM Seepage Model: 6 Storey P1
Ref.	
RS2 File	22-085 fem.slmd
Scale	1:255
Eng	NP



Material Name	Color	KS (m/s)
Fill		1e-05
Glacial Till (Sandy Silt)		1.1e-06

GROUNDED ENGINEERING	File	22-085 | 14015 Danby Road, Norval			
	Analysis	FEM Seepage Model: 6 Storey P1			
	Ref.				
SLIDEINTERPRET 9.018	RS2 File	22-085 fem.slmd	Scale 1:255	Eng	NP

APPENDIX G

SHORT TERM - DEWATERING

Excavation Dimensions [m]	
N-S	18
E-W	120
Area (m2)	2160
Perimeter (m)	276

Rainfall Data		
Year	2	100
Hour	3	12
Depth (mm)	25	94
Depth (m)	0.025	0.094

Section		Flow [m3/day]	Length [m]	Volume [L/day]
Base		0.29	120	34,800
Sides		0.09	276	24,840
Total				59,640
Factor of Safety	2.0			119,280

Storm Events	
2 Year [L/day]	**100 Year [L/day]**
54,000	204,000

Summary	L/day	L/min
Groundwater	120,000	83.3
Rainfall	54,000	37.5
Total	174,000	120.8

LONG TERM - DEWATERING

Excavation Dimensions [m]	
N-S	18
E-W	120
Area (m2)	2160
Perimeter (m)	276

Rainfall Data		
Year	2	100
Hour	3	12
Depth (mm)	25	94
Depth (m)	0.025	0.094

Section		Flow [m3/day]	Length [m]	Volume [L/day]
Base		0.22	120	26,400
Sides		0.039	276	10,764
Total				37,164
Factor of Safety	2.0			74,328

Infiltration [L/day]
18630

Summary	L/day	L/min
Groundwater	75,000	52.1
Infiltration	19,000	13.2
Total	94,000	65.3

APPENDIX H

GP1

Guelph Permeameter

(green)	Input
(yellow)	Result

Single Head Method (1)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**
Enter water Head Height ("H" in cm): **5**
Enter the Borehole Radius ("a" in cm): **3.5**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): **0.0250**

Res Type	35.22
H	5
a	3.5
H/a	1.429
a*	0.12
C0.01	0.736
C0.04	0.763
C0.12	0.72
C0.36	0.72
C	0.72
R	0.025
Q	0.015
pi	3.142

α^* = **0.12** cm^{-1}

C = 0.72043
Q = 0.01468

K_{fs} = **2.37E-05** cm/sec
1.42E-03 cm/min
2.37E-07 m/sec
5.59E-04 inch/min
9.32E-06 inch/sec

Φ_m = **1.97E-04** cm^2/min

Single Head Method (2)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**
Enter water Head Height ("H" in cm): **10**
Enter the Borehole Radius ("a" in cm): **3.5**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.0500**

Res Type	35.22
H	10
a	3.5
H/a	2.85714
a*	0.12
C0.01	1.11597
C0.04	1.17651
C0.12	1.16258
C0.36	1.16258
C	1.16258
R	0.050
Q	0.02935
pi	3.1415

α^* = **0.12** cm^{-1}

C = 1.16258
Q = 0.02935

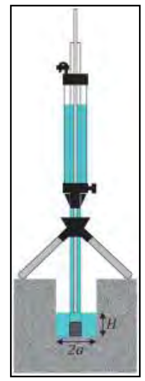
K_{fs} = **2.85E-05** cm/sec
1.71E-03 cm/min
2.85E-07 m/ses
6.74E-04 inch/min
1.12E-05 inch/sec

Φ_m = **2.38E-04** cm^2/min

Average

K_{fs} = **2.61E-05** cm/sec
1.57E-03 cm/min
2.61E-07 m/s
6.16E-04 inch/min
1.03E-05 inch/sec

Φ_m = **2.17E-04** cm^2/min



Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1=\left(\frac{H_1/a}{2.081+0.121(H_1/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1=\left(\frac{H_1/a}{1.992+0.091(H_1/a)}\right)^{0.683}$ $C_2=\left(\frac{H_2/a}{1.992+0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1=\left(\frac{H_1/a}{2.074+0.093(H_1/a)}\right)^{0.754}$ $C_2=\left(\frac{H_2/a}{2.074+0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1=\left(\frac{H_1/a}{2.074+0.093(H_1/a)}\right)^{0.754}$ $C_2=\left(\frac{H_2/a}{2.074+0.093(H_2/a)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where $\bar{R}$ is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1=\bar{R}_1\times 35.22$	$K_{fs}=\frac{C_1\times Q_1}{2\pi H_1^2+\pi a^2C_1+2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m=\frac{C_1\times Q_1}{(2\pi H_1^2+\pi a^2C_1)\alpha^*+2\pi H_1}$
One Head, Inner Reservoir	$Q_1=\bar{R}_1\times 2.16$	
Two Head, Combined Reservoir	$Q_1=\bar{R}_1\times 35.22$ $Q_2=\bar{R}_2\times 35.22$	$G_1=\frac{H_2C_1}{\pi(2H_1H_2(H_2-H_1)+a^2(H_1C_2-H_2C_1))}$ $G_2=\frac{H_1C_2}{\pi(2H_1H_2(H_2-H_1)+a^2(H_1C_2-H_2C_1))}$ $K_{fs}=G_2Q_2-G_1Q_1$ $G_3=\frac{(2H_2^2+a^2C_2)C_1}{2\pi(2H_1H_2(H_2-H_1)+a^2(H_1C_2-H_2C_1))}$ $G_4=\frac{(2H_1^2+a^2C_1)C_2}{2\pi(2H_1H_2(H_2-H_1)+a^2(H_1C_2-H_2C_1))}$ $\Phi_m=G_3Q_1-G_4Q_2$
Two Head, Inner Reservoir	$Q_1=\bar{R}_1\times 2.16$ $Q_2=\bar{R}_2\times 2.16$	

GP2

Guelph Permeameter

Input

Result

Single Head Method (1)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir):	35.22
Enter water Head Height ("H" in cm):	10
Enter the Borehole Radius ("a" in cm):	4

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 0.0500

Res Type	35.22
H	10
a	4
H/a	2.5
a*	0.12
C0.01	1.033
C0.04	1.085
C0.12	1.063
C0.36	1.063
C	1.063
R	0.050
Q	0.029
pi	3.142

α^* = 0.12 cm^{-1}

C = 1.06262

Q = 0.02935

K_{fs} = 2.59E-05 cm/sec; 1.55E-03 cm/min; 2.59E-07 m/sec; 6.11E-04 inch/min; 1.02E-05 inch/sec

Φ_m = 2.16E-04 cm^2/min

Single Head Method (2)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir):	35.22
Enter water Head Height ("H" in cm):	20
Enter the Borehole Radius ("a" in cm):	4

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 0.1000

Res Type	35.22
H	20
a	4
H/a	5
a*	0.12
C0.01	1.51827
C0.04	1.62914
C0.12	1.66689
C0.36	1.66689
C	1.66689
R	0.100
Q	0.0587
pi	3.1415

α^* = 0.12 cm^{-1}

C = 1.66689

Q = 0.0587

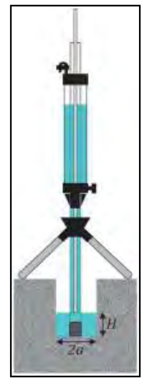
K_{fs} = 2.69E-05 cm/sec; 1.61E-03 cm/min; 2.69E-07 m/ses; 6.34E-04 inch/min; 1.06E-05 inch/sec

Φ_m = 2.24E-04 cm^2/min

Average

K_{fs} = 2.64E-05 cm/sec; 1.58E-03 cm/min; 2.64E-07 m/s; 6.23E-04 inch/min; 1.04E-05 inch/sec

Φ_m = 2.20E-04 cm^2/min



Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where $\bar{R}$ is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm²/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

GP3

Guelph Permeameter

Input

Result

Single Head Method (1)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir):	35.22
Enter water Head Height ("H" in cm):	10
Enter the Borehole Radius ("a" in cm):	4
Enter the soil texture-structure category (enter one of the below numbers):	3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 0.2500

Res Type	35.22
H	10
a	4
H/a	2.5
a*	0.12
C0.01	1.033
C0.04	1.085
C0.12	1.063
C0.36	1.063
C	1.063
R	0.250
Q	0.147
pi	3.142

α^* = 0.12 cm^{-1}

C = 1.062625

Q = 0.14675

K_{fs} =	1.29E-04	cm/sec
	7.76E-03	cm/min
	1.29E-06	m/sec
	3.06E-03	inch/min
	5.09E-05	inch/sec
Φ_m =	1.08E-03	cm^2/min

Single Head Method (2)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir):	35.22
Enter water Head Height ("H" in cm):	20
Enter the Borehole Radius ("a" in cm):	4
Enter the soil texture-structure category (enter one of the below numbers):	3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 0.4000

Res Type	35.22
H	20
a	4
H/a	5
a*	0.12
C0.01	1.51827
C0.04	1.62914
C0.12	1.66689
C0.36	1.66689
C	1.66689
R	0.400
Q	0.2348
pi	3.1415

α^* = 0.12 cm^{-1}

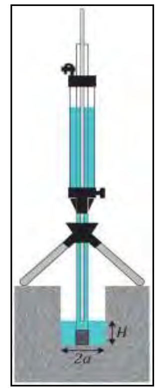
C = 1.666893

Q = 0.2348

K_{fs} =	1.07E-04	cm/sec
	6.44E-03	cm/min
	1.07E-06	m/ses
	2.54E-03	inch/min
	4.23E-05	inch/sec
Φ_m =	8.95E-04	cm^2/min

Average

K_{fs} =	1.18E-04	cm/sec
	7.10E-03	cm/min
	1.18E-06	m/s
	2.80E-03	inch/min
	4.66E-05	inch/sec
Φ_m =	9.87E-04	cm^2/min



Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where $\bar{R}$ is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

APPENDIX I

Water Balance - 14015 Danby Road

1. Climate Information

Precipitation	892	mm/a	0.89	m/a *
Evapotranspiration	530	mm/a	0.53	m/a *
Water Surplus	362	mm/a	0.36	m/a

2. Infiltration Rates

Selected Approach **Table 2**

Table 2 Approach - Infiltration Factors

Topography - (Flat land, rolling land, hilly land)	0.1	*
Soil - (Tight impervious clay, etc...)	0.4	*
Cover - (Cultivated lands, woodland)	0.1	*
TOTAL:	0.6	

Infiltration (Infiltration Factor x Water Surplus)	217.2	mm/a	0.2172	m/a
Run-off (Water Surplus - Infiltration)	145	mm/a	0.1448	m/a

Table 3 Approach - Typical Recharge Rates

coarse sand and gravel	250+	mm/a *
fine to medium sand	200 - 250	mm/a *
silty sand to sandy silt	150 - 200	mm/a *
silt	125 - 150	mm/a *
clayey silt	100 - 125	mm/a *
clay	< 100	mm/a *

3. Property Statistics - Pre-development

Area Covered by Existing Building	1,490	m^2	0.15	ha
Area Covered by Existing Hard Surface Paving	6,249	m^2	0.62	ha
Area Covered by Existing Landscaped area	12,300	m^2	1.23	ha
TOTAL	20,039	m^2	2.00	ha

4. Property Statistics - Post-development

Area Covered by Building with Additions	3,610	m^2	0.36	ha
Area Covered by Hard Surface Paving	8,888	m^2	0.89	ha
Area Covered by Landscaped Area	7,541	m^2	0.75	ha
TOTAL:	20,039	m^2	2.00	ha

*Based on published information

Water Balance - 14015 Danby Road

5. Annual Water Balance Before Building Additions

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building (entire site)	1,490	1,329	-	-	-	1,329
Hard Surface Paving	6,249	5,574	-	-	-	5,574
Landscape Area (entire site)	12,300	10,972	6,519	-	2,672	1,781
TOTAL	**20,039**	**17,875**	**6,519**	**0**	**2,672**	**8,684**

6. Annual Water Balance After Building Additions

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building (entire site)	3,610	3,220	-	-	-	3,220
Hard Surface Paving	8,888	7,928	-	-	-	7,928
Landscape Area (entire site)	7,541	6,727	3,997	-	1,638	1,092
TOTAL	**20,039**	**17,875**	**3,997**	**0**	**1,638**	**12,240**

7. Comparison of Pre-Development (before buidling additions) and Post-Development (after building additions)

	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	17,875	6,519	-	2,672	8,684
Post-Development	17,875	3,997	-	1,638	12,240

8. Requirement for Infiltration of Roof Runoff

Volume of roof (building additions) run-off captured (90%)	2,898	m^3
Volume of post-development infiltration without roof run-off	1,638	m^3
Volume of roof run-off required to match pre-development infiltration rates	1,034	m^3

Percentage of roof run-off (building additions roof) required to match pre-development infiltration 36%