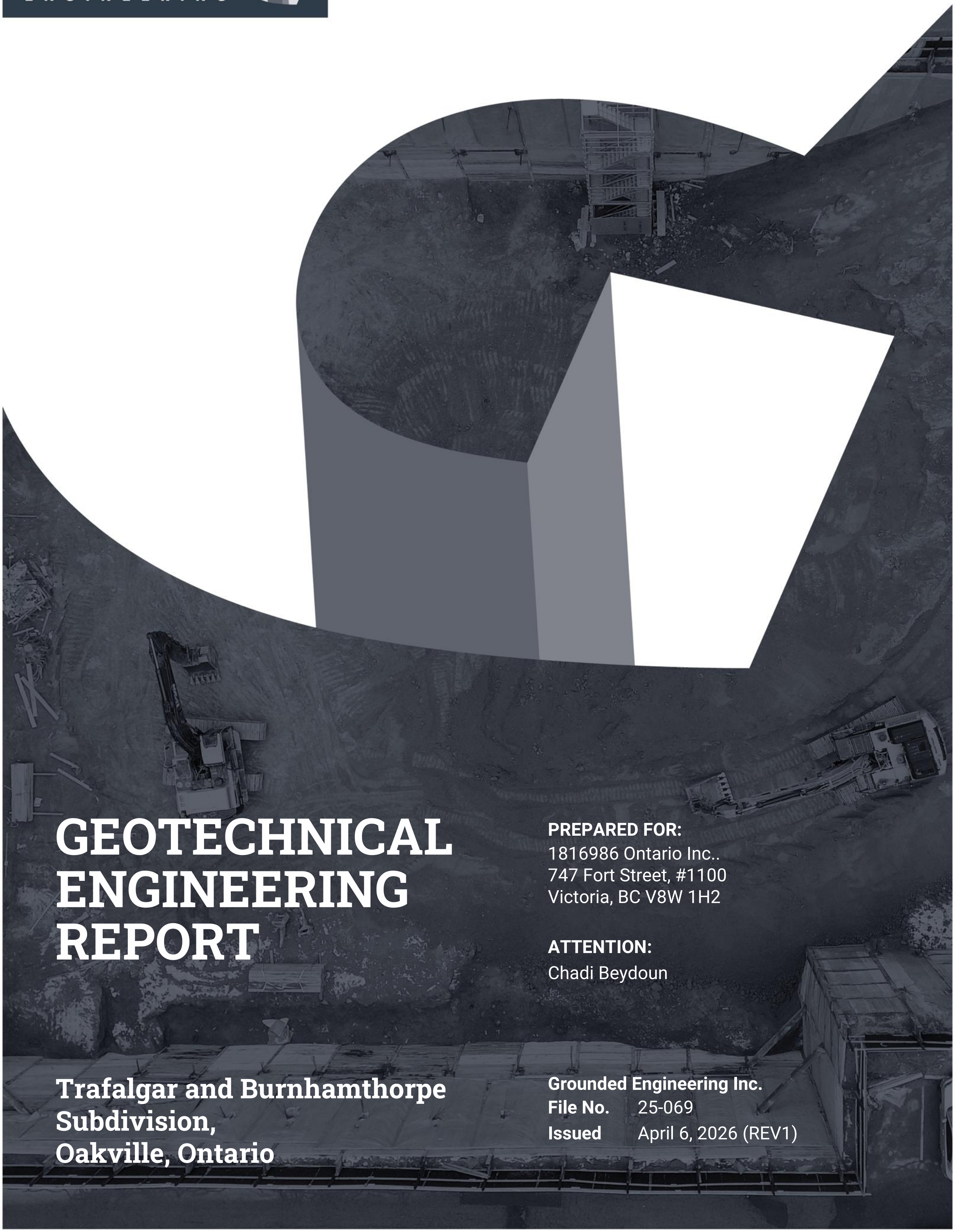

GEOTECHNICAL ENGINEERING REPORT

PREPARED FOR:
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ATTENTION:
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Trafalgar and Burnhamthorpe Subdivision, Oakville, Ontario

Grounded Engineering Inc.
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Executive Summary

This executive summary is intended to provide a general overview of the following geotechnical report. It cannot be relied upon on its own, as the entire geotechnical engineering report must be reviewed for the geotechnical engineering recommendations relevant for the proposed development. This executive summary is subject to limitations included in Section 6 of this report.

The proposed development includes constructing a new mixed-use subdivision separated into various building blocks (1 to 15), comprised of mid-rise to high-rise residential and/or commercial buildings ranging in height from 4 to 30-storeys, with podium heights ranging from 1 to 8-storeys. Each block will have underground parking levels ranging from 4 to 10 m depth (P1 to P3) as well as some on-grade structures. The proposed development also includes two public parks (Blocks 14 and 15) and is designed to provide appropriate connections to a planned school site (Block 13).

Grounded's subsurface investigation of the site to date includes twelve (12) boreholes and seven (7) monitoring wells. The level of investigation conducted at the site for geotechnical engineering is considered preliminary. For detailed design of any block or individual buildings, additional subsurface investigation and updated geotechnical engineering recommendations will be required.

The subsurface conditions generally consist of surficial materials (topsoil, pavements, etc.) and existing earth fills overlying native, undisturbed Halton Till and/or sands and silts, which are underlain by shale bedrock (Queenston Formation). The groundwater table varies across the site but is generally observed at depths of 0.6 to 2.5± m below existing site grades.

Site grading, including cutting and/or filling, will be necessary to achieve the desired site grades prior to construction. Given the extent of grade raises required, it is recommended that all up-fill for grade raises be placed as engineered fill and allow time to self-settle upon completion.

Given the variability in building sizes and depths proposed at the site, and the preliminary nature of this investigation and geotechnical engineering assessment, a variety of preliminary foundation options are provided in this report. Consideration is given for conventional spread footings bearing on native soils, weathered bedrock, and on engineered fill, as well as consideration for end-bearing caissons in bedrock, and helical piles.

The seismic site designation is $\mathbf{X_D}$, with further testing (MASW testing) recommended for detailed structural design. Excavations can be completed as open cut or with shoring, depending on the space available for sloped excavation sides of any particular block or building. Groundwater during construction can be managed using sump and pumps. Below grade structures may be designed as either drained structures, or alternatively watertight, however hydrostatic uplift pressures would need to be considered in that case.

1 Introduction

1816986 Ontario Inc.. has retained Grounded Engineering Inc. to provide preliminary geotechnical engineering design advice for the proposed development at Trafalgar and Burnhamthorpe Subdivision located on the known municipally as 340 Burnhamthorpe Road East and 3437 Trafalgar Road, in Oakville, Ontario. The level of study presented in this report is consistent with the requirements for a Zoning Bylaw Amendment and Plan of Subdivision. Additional boreholes, in-situ testing, and a detailed geotechnical engineering report will be required for detailed design and building permit purposes.

This report has been revised (Revision 1), as follows:

- Updated architectural drawings were provided to Grounded, which are reflected in this report.
- Updated client information. The report is now addressed to 1816986 Ontario Inc.
- The executive summary has been revised.

The subject site, which is comprised of 2 properties, has a total area of approximately 19.9 hectares (49.2 acres), with approximately 537 metres of frontage along Burnhamthorpe Road East and 374 metres along Trafalgar Road.

The majority of the Site is currently underutilized farmland. There is a two-storey abandoned farmhouse in the southwest portion of the Site, which is a listed property in the Oakville Heritage Property Register. The Vic Hadfield Golf & Learning Centre, which is a small golf facility, is located at the northwest corner of the Site.

The proposed development is a mixed-use community over 12 development blocks (Blocks 1 to 12) including 0.5 hectares of public parks (Blocks 14 and 15), urban square, walking trails, a new public street network. The various building blocks are comprised of mid-rise to high-rise residential and/or commercial buildings ranging in height from 4 to 30-storeys with podium heights ranging from 1 to 8-storeys. Below Blocks 1, 3, 4 and 5 there will be three (P3) levels of underground parking with a lowest P3 FFE set at a depth of 10 m. Below Blocks 2, 6, 8 and 9 there will be two (P2) levels of underground parking with a lowest P2 FFE set at a depth of 7 m. Below blocks 7 and 10 to 12 there will be a single (P1) level of underground parking with a lowest P1 FFE set at a depth of 4 m. The proposed development is designed to provide appropriate connections to a planned school site (Block 13).

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

- Site survey, prepared by JD Barnes (Feb. 11, 2025).
- Architectural Drawings, "Draft Trafalgar & Burnhamthorpe"; Project No. 24064, dated 2026-04-06, prepared by BDP. Quadrangle.
- Functional Servicing Report, OPA/ZBA Draft Plan of Subdivision; Project No. 1767, dated April 6, 2026, prepared by Trafalgar Engineering.

- Draft Plan of Subdivision, dated February 9, 2026, prepared by JD. Barnes.

Grounded's subsurface investigation of the site to date includes twelve (12) boreholes (Boreholes 101 to 112) which were advanced from June 2nd to 9th, 2025.

Based on the borehole findings, preliminary geotechnical engineering advice for the proposed development is provided for foundations, seismic site designation, 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.

This geotechnical engineering report is considered preliminary and should be used for planning purposes only. Additional site-specific boreholes, monitoring wells, in situ and laboratory testing, and a detailed geotechnical engineering report are 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 (Site Survey by J.D. Barnes). The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM) geographic coordinate system.

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

2.1 Stratigraphy

The following stratigraphic summary is based on the results of the boreholes and the geotechnical laboratory testing. A subsurface profile showing stratigraphy and engineering units is appended.

2.1.1 Surficial and Earth Fill

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

Borehole 101 encountered a 100 mm thick aggregate layer at the existing ground surface. Borehole 112 encountered 50 mm of asphalt at the existing ground surface. A layer of topsoil, approximately 25 to 300 mm thick, was encountered at the existing ground surface of Boreholes 102 to 104, and 106 to 111, and underlying the above-noted surficial materials in Boreholes 101 and 112.

2.1.1.1 Earth Fill

Underlying the surficial materials, Boreholes 101 to 107 and 109 observed a layer of earth fill that extends to depths of about 0.8 to 3.0 metres below grade (Elev. 182.7 to 178.8 metres). The earth fill varies in composition but generally consists of sandy silt to clayey silt with trace gravel and trace rootlets. The earth fill is typically dark brown to brown, and moist.

Standard Penetration Test (SPT) results (N-Values) measured in the existing earth fill range from 3 to 46 blows per 300 mm of penetration ("bpf"). Due to inconsistent placement and the inherent heterogeneity of earth fill materials, the relative density of the earth fill is variable.

2.1.1.2 Reworked Soils

Underlying the surficial materials in Boreholes 108 and 110 to 112 and underlying the earth fill in Boreholes 101, 105 and 109, the boreholes observed a layer of reworked soils that extends to depths of 0.8 to 2.3 metres below grade (Elev. 183.2 to 178.1 metres). The reworked soils appear to be similar to the underlying Halton Till, and are likely disturbed or re-worked due to farm-tilling and/or previous site grading activities.The reworked soils generally consist of sandy silt with some clay, trace gravel, trace rootlets and trace rock fragments. The reworked sandy silt is typically brown to reddish brown, and moist.

SPT N-Values measured in the reworked soils range from 9 to 60 bpf, indicating a highly variable relative density. Higher N-values are likely indicative of the presence of cobbles and/or rock fragments within the soil matrix, as well as the variability due to regrading or reworking.

For the purposes of providing geotechnical engineering recommendations, the reworked soils are grouped together with the earth fill unit based on their engineering properties and their suitability for foundations and pavements.

2.1.2 Halton Till

Underlying the fill materials in Boreholes 101 to 104, 106 to 110 and 112 and underlying the sands and silts described below in Borehole 105, the boreholes encountered an undisturbed native glacial till deposit with a matrix of cohesionless and cohesive sandy silt to clayey silt, and cohesionless silty sand, more commonly known in this region as "**Halton Till**". This unit was encountered at depths of 0.8 to 7.6 metres below grade (Elev. 183.2 to 175.7 m) and extends down to depths of 3.2 to 9.4 m below grade (Elev. 177.9 to 172.9 m). Boreholes 103, 104, 105, 107 and 112 were terminated within this stratum at their target investigation depths. The Halton till is generally brown to grey, and moist. This unit contains a varying amount of clay (trace to clayey), trace to some gravel, trace shale fragments, inferred cobbles and trace rock fragments.

SPT N-values measured in this unit range from 17 to greater than 50 bpf (compact to very dense in the cohesionless till, and hard in the cohesive till).

2.1.3 Sands and Silts

Underlying the fill materials in Boreholes 105 and 111 and below the Halton till in Boreholes 106 and 109, an undisturbed native cohesionless sand to silt unit was encountered at depths of 0.8 to 4.6 metres below grade (Elev. 180.9 to 177.7 m), and extends down to a depth of about 7.6 m below grade (Elev. 174.8 to 173.9 m). This unit is generally brown to grey, and moist to wet, and contains varying amounts of clay (trace to clayey), trace rock fragments, trace shale fragments and trace gravel. SPT N-values measured in the sands and silts unit range from 20 to greater than 50 bpf, indicating a compact to very dense relative density.

2.1.4 Inferred Bedrock

Inferred bedrock was encountered in Boreholes 101, 102, 106, and 108 to 111 underlying either the Halton till or sands and silts at depths of 3.0 to 9.4 m below grade (Elev. 176.6 to 172.5 m). Rock coring was not included in our scope. The bedrock was inferred from observations of auger and split spoon resistance and limited sample recovery in the split spoons to depths of 4.6 to 9.5 metres below grade (Elev. 175.0 to 170.9 m), at which depth Boreholes 101, 102, 106, 108 to 111 were terminated. The bedrock beneath the site is known to consist of reddish brown shale of the Queenston Formation, which typically has a weathered zone at and near the surface of the bedrock which eventually transitions to unweathered (sound) bedrock. Sound bedrock elevations were not determined in the boreholes, as this was not part of this scope of work. It is recommended that rock coring to determine the elevation of sound bedrock is conducted as part of a future scope of work.

2.2 Groundwater

The depth to (unstabilized) groundwater and caved soils was measured in each of the boreholes immediately following the completion of drilling, prior to installing the monitoring wells and/or backfilling the boreholes.

Monitoring wells (7 total) were installed at six (6) select borehole locations (including a nested well in BH 108), and stabilized groundwater levels were measured in each of the installed monitoring wells. The monitoring well installation information and the groundwater measurements and observations are shown on the Borehole Logs and are summarized in Table 1 appended.

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 elevation changes across the site, generally following the existing grades which fluctuate across the site. For engineering purposes, the groundwater table ranges from a depth of 0.6± to 2.5± metres below the existing site grades.

The groundwater table is in all the native soil units and the weathered zone of the underlying (inferred) bedrock. The Halton till has a relatively low permeability and will yield minor seepage in the long term. The sands and silts unit has a relatively high permeability and will yield free-flowing water when penetrated below the groundwater table. It can be expected that fractures in the weathered and sound bedrock will also produce groundwater seepage. There is also infiltrated stormwater perched in the earth fill which is flowing down towards the groundwater table.

Grounded has prepared a hydrogeological report for this site (File No. 25-069) under separate cover.

2.3 Corrosivity and Sulphate Attack

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

The soil samples were analysed for soluble sulphate concentration and compared to the Canadian Standard CAN3/CSA A23.1-M94 Table 3, *Additional Requirements for Concrete Subjected to Sulphate Attack*. Corrosivity parameters are also used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C-105-18 standard[1].

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

- All of the samples have negligible sulphate concentrations.
- All of the samples scored less than 10 points in the AWWA C-105 evaluation. Corrosion protective measures are therefore not necessary for cast iron alloys.

2.4 Frost Heave Susceptibility of Soils

A soil's susceptibility to frost heave is related to the percentage of silt and very fine sand in the soil, as frost heave impacts fine-grained soils with low cohesion and high capillarity. The site soils are classified for susceptibility to frost heave according to their grain size distributions on this basis. Geotechnical laboratory results for this site are appended. Per the Second Edition of the

[1] ANSI/AWWA C105/A21.5-18, Appendix A

Pavement Design and Rehabilitation Manual by the Ministry of Transportation in Ontario, the following table summarizes the relationship between grain size and frost heave susceptibility:

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

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

Stratum	Grain Size Percentage between 5 and 75 µm	Susceptibility to Frost Heaving
Earth Fill	Est. 25 to 50%	Low to Moderate
Halton Till	Approx. 34 to 61%	Low to High (Avg. Moderate)
Silt	Approx. 45%	Moderate
Sand	Est. 10%	Low

3 Preliminary Geotechnical Engineering Recommendations

Based on the factual data summarized above, preliminary geotechnical engineering recommendations are provided. They must be supplemented and confirmed by additional boreholes, wells, and detailed geotechnical engineering reports (likely for each block) 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

Site grading, including cutting and/or filling, will be necessary to achieve the desired site grades prior to construction. Based on the provided site grading plan (Trafalgar Core Grading, 2025-08-27), it is expected that up-fill will be necessary to raise grades by up to about 4.0± m (existing versus proposed final grade) in the areas of the proposed roadways.

Between the roadways are various blocks which will consist primarily of building structures with 1 to 3 levels of underground parking. It is understood that the roadways will be built up first as part of the site grading activities.

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

3.1.1 Compacted Fill / Engineered Fill

For pavement areas, grade raises may comprise compacted fill or engineered fill. Compacted fill is suitable for raising grades to support new pavements, landscaping, and services. Engineered fill is required wherever the fill material must provide structural support for foundations. Given the extent of grade raises required for the pavements, it is recommended that all up-fill for grade raises be placed as engineered fill.

When building up the pavement subgrades, the engineered fill must be constructed to reach the desired grade with a consistent slope of 2:1 (horizontal to vertical) or shallower to ensure proper stability and support. This slope ratio helps in maintaining structural integrity by effectively distributing loads and preventing erosion or slippage of the underlying materials. A 2:1 slope also facilitates better drainage, reducing the risk of water accumulation that can compromise the subgrade's durability. Adhering to this gradient during construction is essential for ultimately achieving long-term performance and safety of the pavement structure post-construction.

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

1. **Inspection and Testing:** Compacted fill does not need full-time inspection and testing, although it does need periodic geotechnical engineering testing and inspections for quality control. The frequency of periodic inspections can vary from once a day to once every 3 days and is to be confirmed after the construction schedule is available for review. Engineered fill requires full-time inspection and testing.
2. **Acceptable Subgrade:** Compacted fill can be made on an existing earth fill subgrade if it is proof rolled under the inspection of a qualified geotechnical technician and approved by a geotechnical engineer prior to fill placement. Engineered fill requires an approved subgrade of undisturbed (dewatered) native soils, which implies that the existing earth fill must be subexcavated down to the top of native soil across the site.
3. **Dewatering**: Engineered fill construction requires an undisturbed native subgrade for construction. If the top of native soil elevation is below the groundwater table, positive dewatering may be required to lower the groundwater table to 1.2 m below the top of native, to preserve the native soils in their undisturbed state. Compacted fill does not require that the existing fill materials be excavated (so long as they are proof rolled and approved as described below), which can reduce the need for dewatering during construction. Note that compacted fill may still require occasional sub-excavation below the groundwater table, to remediate any obvious loose/weak areas exposed during proof rolling.
4. **Slab on Grade Design:** Compacted fill typically has a lower modulus of subgrade reaction than engineered fill (see section below). Slabs made on compacted fill may need to be thicker or have more reinforcement.

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

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

3.1.2 Subgrade Approval

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

3.1.3 Construction

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

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

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

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 (e.g. berms or landscaping), or wasted off-site. Moisture content measurements made on earth fill soil samples from the boreholes range from 9 to 23% (on average, 15.2%). They occasionally contain trace organics. We estimate that potentially half of the existing fill may be suitable for immediate re-use as compacted or engineered fill, if it is sorted or blended to remove any excess organics, moisture, or other deleterious materials.

Moisture content measurements made on Halton Till soil samples from the boreholes within 2 m of existing grade range from 7 to 13% (on average, 10.6%). 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.

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

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

3.1.4 Frost Susceptibility

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

3.1.5 Post-Construction Settlement

Engineered/compacted fill can be expected to experience self-weight post-construction settlement on the order of about 1% of the depth of the compacted/engineered fill. If the engineered fill is composed of sand or aggregate materials, then self-weight post-construction settlements of the engineered fill will be around 0.5% or less. The time period over which this settlement occurs depends on the composition of the engineered fill as follows (after initial placement):

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

If compacted fill is constructed over an approved existing earth fill subgrade, the fill subgrade will also be prone to settlement due to the increase in effective vertical stress. Organics in the existing earth fill may also be subject to secondary consolidation (creep). For grade raises of over 0.5 m immediately above existing fill, Grounded should be consulted to assess the potential for post-construction settlement, and provide recommendations for mitigation measures.

3.2 Preliminary Foundation Design Parameters

The proposed development includes constructing a new mixed-use subdivision separated into various building blocks (1 to 15) and comprised mid-rise to high-rise residential and/or commercial buildings ranging in height from 4 to 30-storeys with podium heights ranging from 1 to 8-storeys. Below Blocks 1, 3, 4 and 5 there will be three (P3) levels of underground parking with a lowest P3 FFE set at a depth of 10 m. Below Blocks 2, 6, 8 and 9 there will be two (P2) levels of underground parking with a lowest P2 FFE set at a depth of 7 m. Below blocks 7 and 10 to 12 there will be a single (P1) level of underground parking with a lowest P1 FFE set at a depth of 4 m. The proposed development also includes two public parks (Blocks 14 and 15) and is designed to provide appropriate connections to a planned school site (Block 13).

The topsoil and earth fill soils (in their current state) are considered unsuitable for the support of the proposed building foundations.

Given the variable depth to / elevation of bedrock at the site, and in consideration that the lowest FFE of the underground structures within each block is not presently known, and will be variable from block to block, the foundation design recommendations provided in this report are considered preliminary.

The following foundation options have been considered in our preliminary analysis.

- Conventional spread footings bearing on native soil.
- Conventional spread footings bearing on engineered fill.
- Caissons on end-bearing on sound bedrock
- Helical piles

Alternative foundation options such as micropiles, or the use of ground improvement in conjunction with conventional spread footings or a raft foundation under the towers with tie down anchors may also be considered as feasible foundation options to support the proposed building structures. These options (as well as the caisson option) will likely only be necessary or feasible if/where the base of a given underground structure is situated within compacted or engineered fill (i.e. above the elevation of the top of native soils), so that the building loads are transferred down to competent native bearing strata, where needed. If these options are considered/required at the detailed design level, Grounded can provide recommendations in an updated geotechnical report.

Regardless, additional boreholes, including in-situ pressuremeter testing, and/or rock coring, as well as additional monitoring wells, and an updated geotechnical report will be required for detailed design.

3.2.1 General Foundation Recommendations

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

Footings stepped from one elevation to another should be offset at a slope not steeper than 7 vertical to 10 horizontal. This requirement exists to avoid undermining adjacent footings at the higher elevation.

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

The 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 Spread Footings Bearing on Native Soils / Weathered Bedrock

Conventional foundations made for the proposed buildings may bear on undisturbed native dense to very dense cohesionless soils or weathered bedrock. The depth and elevation of competent bearing strata varies across the site. Conventional spread footings made to bear on these soils may be designed using the following maximum factored geotechnical resistances at ULS, and maximum geotechnical reactions at SLS for an estimated maximum total settlement of 25 mm at the following elevations as determined at each borehole location within the proposed areas of development. For present purposes, a maximum 3 x 3 m spread footing was used for our preliminary analyses.

Borehole No.	Approximate Foundation Bearing Elevation (m) for a Maximum 3 x 3 m Conventional Spread Footing	
	Bearing in Dense to Very Dense Glacial Till or Sands and Silts (750 kPa SLS / 1,500 kPa ULS)	Bearing on Weathered Bedrock (3,000 kPa SLS / 4,000 kPa ULS)
101	178.5 ±	172.5 ±
102	179.5 ±	173.0 ±
103	181.0 ±	173.5 ±
104	181.0 ±	*n/a**
105	179.0 ±	*n/a**
106	179.0 ±	174.5 ±
107	178.5 ±	*n/a**

Borehole No.	Approximate Foundation Bearing Elevation (m) for a Maximum 3 x 3 m Conventional Spread Footing	
	Bearing in Dense to Very Dense Glacial Till or Sands and Silts (750 kPa SLS / 1,500 kPa ULS)	Bearing on Weathered Bedrock (3,000 kPa SLS / 4,000 kPa ULS)
108	178.5 ±	176.0 ±
109	180.0 ±	174.5 ±
110	178.0 ±	176.5 ±
111	179.0 ±	174.0 ±
112	182.0 ±	*n/a**

**Bedrock was not encountered/inferred at these borehole locations*

The capacities provided above are based on individual spread footing foundations that are 1 to 3 m wide, spaced one footing width apart, and embedded a minimum of 0.6 m 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 an estimated settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

3.2.3 Spread Footings Bearing on Engineered Fill

It may be feasible to support smaller structures on spread footing foundations resting on engineered fill. An engineered fill specification is appended and discussed in Section 3.1.

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

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

The timing of foundation construction must consider the post-construction settlement of the engineered fill (see Section 3.1).

3.2.4 Preliminary Caissons Bearing on Sound Bedrock

End-bearing caissons, extending into unweathered (sound) bedrock may be used to support building structures at the site. This foundation method may be beneficial when large structural loads are required to be supported and competent bearing soil is not immediately beneath the lowest FFE. This may be the case if/when the lowest FFE of any given building is within earth fill soils (placed or existing), and the depth to competent bearing strata is not conducive for conventional foundation construction.

Coring of the bedrock was not part of the current scope of work. A summary of bedrock elevations observed/reported in site-specific boreholes is provided in a table in Section 2.1.4. If caissons extending into sound bedrock are to be considered, additional boreholes including rock coring will be required for detailed design. For present, preliminary design purposes, it can be assumed that caissons must be socketed a minimum of 3 m into bedrock (i.e. from the top of weathered bedrock) in order to bear on sound bedrock.

Preliminary caissons end-bearing in sound bedrock may be designed using a maximum factored geotechnical resistance at ULS of 10 MPa. The geotechnical reaction at SLS is 8 MPa, for 20 mm of estimated settlement at pile tip elevation, for individual caissons no larger than 2 m diameter and not subject to group effects.

In addition to the displacement of the rock, there will be compression of the concrete caisson shaft under loading which will increase the apparent settlement at the structure level. Caisson shaft compression must be assessed by the structural engineer.

Caissons end bearing on bedrock should be separated from each other by at least 2 times the largest caisson diameter (measured on centres) to avoid inducing additional settlement from group effect. Caissons placed closer than this will induce group effects, and a reduced bearing capacity will apply, which is dependent on caisson sizing, bearing stratum, founding elevation, and separation distance. If this situation is unavoidable from a structural engineering perspective, we can review the structural drawings and estimate the expected settlement of the caisson group, on request.

Augered boreholes for caissons will need to be protected against loss of ground, upheave, and basal disturbance due to the ingress of groundwater. Augered boreholes for caissons may require temporary liners, polymer mud drilling techniques, tremie pour concrete, pre-advancing casing, or other means and methods as deemed necessary by the contractor to prevent groundwater inflow or loss of soil into the drill holes, disturbance to placed concrete, or similar issues. Concrete for caissons must be placed by tremie method where there is more than 300 mm of water or fluid at the base of the hole.

The following construction methodology must be utilized for all structural caisson installations:

- All caisson excavations are to be inspected on a full-time basis by Grounded per the Ontario Building Code (2024).

- Caissons designed to bear on sound rock are to be initially advanced to the top of weathered bedrock as identified in Section 2.1.4, and as confirmed by Grounded through observation of the drilling and auger cuttings at each location.
- Once the top of weathered bedrock elevation is established for a given caisson by Grounded, the caisson must then be advanced a minimum of 1 m into sound bedrock as identified in the nearest borehole (see table in Section 2.1.4.), to be sure that the caisson is seated in the sound bedrock.
- Auger, cleanout bucket, or one-eyed bucket cleaning of the hole base is to then take place in each caisson hole, and visually inspected by Grounded to ensure that base cleaning has been carried out as thoroughly as practically possible.
- Place 30 MPa (min.) concrete to a minimum depth of 600 mm in the base of the hole (volume to be determined based on caisson diameter) to be stirred with the auger without advancing the auger any further for about 5 minutes.
- The auger spun concrete is then removed and wasted, leaving no more than 100 mm depth of concrete at the base of the caisson.
- Tremie placement of concrete is required wherever the drill holes have more than 300 mm of water in the base or are full of drilling fluid.
- Complete construction of the caisson to cut off elevation.

Any recommendations must also satisfy the structural engineering requirements regardless of any interpretation provided herein.

3.2.5 Helical Piles

Helical piles may be designed to carry new structural load. Helical piles may be beneficial where the lowest FFE of a given building structure is situated within fill (existing, engineered, etc.) and the structural loads must be carried deeper in order to provide the necessary resistance. It may be possible to support low to mid-rise sized buildings on helical piles at this site.

Contractors specializing in helical pile design and installation can provide detailed information on installation methodology, detailed design, product quality, and certification. Local specialist contractors that provide these design-build services can be provided on request.

At this site, helical piles can be installed to bear into the dense to very dense native strata at the site 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.

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

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

The presence of debris/obstructions within fill materials or larger sized cobbles or boulders in native soil (although not specifically encountered in the boreholes) 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.

Within the design frost depth, uplift due to frost (also known as ‘adfreezing’) on the shaft of helical piles must also be considered in the design. Based on the Canadian Foundation Engineering Manual (5th Ed.), design adfreeze bonds vary from 65 kPa (fine grained soils frozen to wood/concrete) to 100 kPa (fine grained soils frozen to steel), to 150 kPa (gravel frozen to steel). These loads act in the upward direction on the portion of shaft that is above the design frost depth. Alternatively, bond breakers can be designed and applied to the shaft of the helical pile.

3.3 Seismic Site Designation

The Ontario Building Code (2024) stipulates the methodology for earthquake load and effects analysis and design, as set out in Subsection 4.1.8. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

The site designation, X, is determined using the average shear wave velocity, V_{s30}, calculated from in situ measurements of shear wave velocity, in accordance with ground profiles provided in Table 4.1.8.4.-A. For all other ground profiles, the site designation is X_V, where V is the value of V_{s30}. At sites where V_{s30} is not available, the site designation is X_S, where S is the Site Class as determined from rational analysis of average undrained shear strength (s_u) or energy-corrected average standard penetration resistance (SPT N-values) in accordance with Table 4.1.8.4.-B.

The structural commentaries to the NBC 2020, on which the OBC 2024 are based, have been recently released. Based on the structural commentaries, site designation must be evaluated in the top 30 m of site stratigraphy.

At this site, the boreholes generally observe compact to very dense cohesionless soils. These soils are classified as “Stiff Soil”. Based on this information, the site designation for seismic analysis is $\mathbf{X_D}$, per Table 4.1.8.4.-B of the Ontario Building Code (2024).

We have determined the site designation based on rational analysis of energy-corrected average standard penetration resistance (SPT N-values) with assumed N-values for the stratigraphy beyond the investigation depth. The National Building Code 2020 (and the OBC 2024) provides the option of calculating the seismic hazard (i.e. spectral acceleration) directly from average Vs_{30} measurement. Consideration should be given to conducting site-specific shear wave testing (Multichannel Analysis of Surface Waves (MASW) testing or downhole shear wave testing) as part of a future scope of work, to determine the average shear wave velocity in the 30 meters of stratigraphy (Vs_{30}). Shear wave testing may result in an improved seismic site designation.

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
Halton Till (Cohesionless)	21	37	0.25	0.40	4.02
Halton Till (Cohesive)	21	32	0.31	0.47	3.25
Silts and Sands	21	37	0.25	0.40	4.02
Weathered Bedrock	26	28	n/a		

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

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

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

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

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

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

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

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

Foundation resistance to sliding is proportional to the friction between the 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 CFEM 5th Ed. (0.8 for cohesionless soils or rock; 0.6 for cohesive soils)
N	=	normal load at base of footing (kN)
φ	=	internal friction angle (see table above)

3.5 Slab on Grade Design Parameters

For watertight underground structures, the lowest slab on grade must be designed to be watertight and to withstand uplift and hydrostatic pressures, with no permanent drainage. This is generally achieved via raft slabs or pressurized structural slabs spanning between columns and walls.

For underground structures situated above the groundwater table (i.e. the base of the subfloor drainage layer is above the water table), and for on-grade structures, a conventional (drained) slab on grade approach can be implemented. The following recommendations apply only to a conventionally drained slab on grade.

Conventional slabs on grade constructed at the site may rest on native undisturbed sands and silts or the Halton till, existing fill, or on engineered fill. The undisturbed native soils or engineered fill will provide adequate subgrade for the support of a conventional slab on grade. In its present state the earth fill/disturbed soils are not competent for the support of a slab on grade. If slabs on grade are to rest on existing fill / disturbed soils, the subgrade should be compacted in place, proof-rolled, and inspected under the supervision of Grounded for obvious exposed loose/soft or disturbed areas, or for areas containing excessive deleterious materials or moisture. Unacceptable material (as determined by Grounded) must be sub-excavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The modulus of subgrade reaction appropriate for design of a slab on grade resting on the above noted subgrade types is summarized in the following table.

Subgrade Type	Modulus of Subgrade Reaction (kPa/m)
Native cohesionless soils, undisturbed	30,000
Engineered Fill	22,000
Compacted Earth Fill (Existing Fill or Placed Fill)	10,000

For conventional drained structures, a permanent drainage system including subfloor drains is required (see section below). In this case, the slabs on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slabs on a minimum 200 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state.

Wherever a slab-on-grade is made on native sands and silts, the drainage layer must be separated from the underlying soils using a non-woven geotextile (with an apparent opening size of less than 0.250 mm and a tear resistance of more than 200 N) with a minimum 600 mm overlap. The stone drainage layer is then placed over the geotextile. Without this filtering layer, fines from the underlying subgrade will enter the drainage layer potentially resulting in loss of ground, loss of slab support, and clogging of the subfloor drainage system.

The subgrade should be cut neat and inspected by Grounded prior to placement of the capillary moisture break and construction of the slab. Disturbed or otherwise unacceptable material (as determined by Grounded) must be sub-excavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The slabs on grade should not be placed on frozen subgrade, to prevent excessive settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

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.

The requirement for a permanent basement drainage system depends on whether a fully watertight approach is adopted for any particular underground structure constructed at the site. Grounded’s Hydrogeological Report (File No. 25-069) provides further discussion on this.

A watertight basement implies that the basement structure is designed to withstand hydrostatic pressures, with no permanent drainage system. The full height of the basement walls should be watertight (no drainage) and designed to withstand hydrostatic pressure (horizontal and uplift) using a static groundwater table ranging from a depth of 0.6± to 2.5± metres below the existing site grades. A connection to the Town’s sewer for emergency repair services is recommended.

For conventional slab-on-grade structures with no basement, perimeter drainage is not needed where the finished floor is higher than exterior grade. To prevent impaired door function during winter months, subgrade adjacent to doors should be either drained or protected against potential frost heave. These details are provided by the building science engineer. If drained, perimeter drains should be connected directly to a sump, or positively discharged to grade if possible.

Regardless of any requirements for watertight basements/underground structures from a development application perspective, a drained basement approach is considered feasible from an engineering perspective.

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. Perimeter drainage must be collected and conveyed directly to the building sumps, and not discharged into the subfloor drainage system, the granular layer, or beneath the floor slab.

Subfloor drainage pipes are to be spaced at a maximum 9 m (measured on-centres).

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 drainpipe.

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 drainage system should be connected directly to the municipal storm system if possible, or else discharge at grade.

The permanent dewatering requirements are provided in Grounded's Hydrogeological Report (File No. 25-069) under separate cover.

3.7 Site Servicing

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

Where site services extend beyond the building footprint, the following recommendations apply.

3.7.1 Bedding

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

Based on the preliminary site servicing report outlined in the FSR (dated April 6, 2026), service trenches will be made above and below the groundwater table across the site.

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

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

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

3.7.2 Backfill

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

- Any deleterious material in the earth fill is removed prior to reuse as backfill.
- Backfill materials are not frozen.
- The moisture content is within 2% of optimum, or moisture conditioned to within 2% of optimum.
- The backfill must be compacted to a minimum 98% SPMDD.

3.7.3 Trench Plugs

Trench plugs are installed when the invert of the trench is below the groundwater table, to prevent the groundwater from preferentially flowing through the granular bedding and backfill material, creating a local drawdown of the groundwater table. Where local drawdown is not tolerated or contaminant transport is a risk, trench plugs can be installed in the granular bedding and backfill material.

Trench plugs may be constructed as clay plugs or cut off collars around the pipe. Clay plugs should be installed no further than 50 m apart along the full length of the trench. Clay plugs must be a minimum of 1 m thick along the length of the trench and will completely replace any bedding or backfill material around the pipe. Soil used for clay plugs must have greater than 50% fines content, 15% of the particles finer than 2 microns, and a hydraulic conductivity of less than 10^{-8} m/s. The clay plug must be compacted to minimum 95% SPMDD. A representative sample of the clay plug material must be submitted prior to construction and during construction for hydraulic conductivity and particle size testing to confirm the material is adequate and in compliance with the above material specifications.

If cutoff collars are used instead of clay plugs, the cutoff collar must not be placed within 1 m of a pipe joint to ensure adequate compaction of the backfill. The soils around the cutoff collar must be compacted to 95% SPMDD. Cutoff collars are designed by the civil engineer.

The region and/or municipality may have its own minimum design requirements for trench plugs. If this is the case, the relevant specifications should be reviewed and incorporated by the civil engineer, and the more stringent of the two specifications should be used.

4 Pavement Engineering Recommendations

4.1 Pavements Above Underground Parking Structures

Some of the pavements will be placed on top of the underground parking structures. In these cases, standard pavement design does not apply since the parking structure incorporates waterproofing and drainage elements, and the pavement should be specified by the architect. All drainage and pavement design considerations for these areas must be designed separately and in conjunction with the civil and mechanical engineering design of the underground parking structure. The design presented below is only for areas in which the pavements will rest on a soil subgrade.

4.2 Asphalt Pavements on Soil Subgrade

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

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

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

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

The Municipality may eventually assume the roads. The municipality has its own minimum pavement design requirements which will have to be followed for the making of any of the pavement surfaces that will eventually become a municipal responsibility. If this is the case, the relevant specifications should be reviewed in detail, and the more stringent of the two specifications should be used.

4.2.1 Pavement Subgrade Preparation

The subgrade must be adequately prepared prior to pavement construction. A discussion on site grading and subgrade preparation is provided in Section 3.1. As discussed in that section, the internal roadways for this development are to be constructed first, which will require the placement of engineered to raise grades for the pavements. If just the roadways are to be built up (and not the building pad areas, or not the entire site at once), the engineered fill must be tapered at a maximum slope of 2H:1V, as discussed in Section 3.1.

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

Existing earth fill (free of organic-rich or wet soils) and native subgrade will provide adequate subgrade for the support of the pavement. The subgrade must be proof-rolled and inspected under the supervision of Grounded for obvious loose or disturbed soils or where there is deleterious materials or moisture. These areas can either be recompacted in place and retested, or replaced with Granular B (OPSS.MUNI 1010) in 150 mm thick lifts, compacted to a minimum of 98% SPMDD.

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

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

4.2.2 Asphalt Pavement Design – Parking Lots and Driveways

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

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

Basic Pavement Structure	Compaction Requirement	Car Parking Minimum Component Thickness	Bus/Truck Traffic Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	65 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	N/A	50 mm

Basic **Pavement Structure**	**Compaction Requirement**	**Car Parking Minimum Component Thickness**	**Bus/Truck Traffic Minimum Component Thickness**
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	400 mm
Total Thickness		**515 mm**	**640 mm**

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

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

The existing subgrade soils have a relatively low to moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly. To reduce frost heave, soil subgrade that is susceptible to frost (as defined in Section 2.4) should be replaced to a depth of 70 percent of the frost penetration depth (i.e. 0.85± m below proposed top of pavement) with non-frost susceptible soils or with granular materials. The most effective ways of dealing with potential frost heave are to construct a good subsurface drainage system, and to stay above the groundwater table.

Pavements for roadways should be constructed to reach the desired grade with a consistent slope of 2:1 (horizontal to vertical) to ensure proper stability and support. This slope ratio helps in maintaining structural integrity by effectively distributing loads and preventing erosion or slippage of the underlying materials. A 2:1 slope also facilitates better drainage, reducing the risk of water accumulation that can compromise the pavement's durability. Adhering to this gradient during construction is essential for achieving long-term performance and safety of the pavement structure.

4.2.3 Asphalt Pavement Design – Internal Roadways

The Town of Oakville's Development Engineering Procedures and Guidelines (Section 7.7.2 – Private Residential Roadways) provides the minimum road pavement design for internal private roadways. The following table summarizes the Town's minimum requirements as well as Grounded's recommended pavement component thicknesses.

Basic Pavement Structure	Compaction Requirement	Private Residential Roadways Minimum Component Thickness	
		Town of Oakville Minimum Requirements	Grounded's Recommended Minimum Requirements
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	50 mm	50 mm
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	400 mm
Total Thickness		**540 mm**	**640 mm**

The existing subgrade soils have a relatively low to moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly. To reduce frost heave, soil subgrade that is susceptible to frost (as defined in Section 2.4) should be replaced to a depth of 70 percent of the frost penetration depth (i.e. 0.85± m below proposed top of pavement) with non-frost susceptible soils or with granular materials. The most effective ways of dealing with potential frost heave are to construct a good subsurface drainage system, and to stay above the groundwater table.

Pavements for roadways should be constructed to reach the desired grade with a consistent slope of 2:1 (horizontal to vertical) to ensure proper stability and support. This slope ratio helps in maintaining structural integrity by effectively distributing loads and preventing erosion or slippage of the underlying materials. A 2:1 slope also facilitates better drainage, reducing the risk of water accumulation that can compromise the pavement's durability. Adhering to this gradient during construction is essential for achieving long-term performance and safety of the pavement structure.

4.2.4 Pavement Drainage

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

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

5 Considerations for Construction

5.1 Excavations

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

- The earth fill is a Type 3 soil
- The Halton Till is considered a Type 2 soil
- The wet sands and silts are Type 4 soils, or can be considered Type 3 soils if dewatered or above the groundwater table

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

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

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

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

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

5.2 Short-Term Groundwater Control

Considerations pertaining to groundwater discharge quantities and quality are discussed in Grounded's hydrogeological report for the site (File No. 25-069), under separate cover.

The groundwater table is relatively shallow and varies across the site, ranging from 0.6 to 2.5 ±m below existing site grade. Depending on final site grading, basement excavations for new dwellings may extend below the groundwater table. Seepage may be allowed to drain into the excavations and then pumped out. In open excavations, it is anticipated that seepage volumes will be limited to the extent that temporary pumping will sufficiently control any groundwater seepage. Excavation delays will occur as seepage (however limited) is controlled. These delays should be anticipated in the construction schedule.

5.3 Site Work

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

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

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

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

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

5.4 Engineering Review

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

All foundation installations must be reviewed in the field by Grounded, the Geotechnical Engineer of Record, as they are constructed. The on-site review of foundation installations and the condition of the founding subgrade as the foundations are constructed is as much a part of the geotechnical engineering design function as the design itself; it is also required by Section 4.2.2.3. of the 2024 Ontario Building Code. If Grounded is not retained to carry out foundation engineering field review during construction, then Grounded accepts no responsibility for the performance or non-performance of the foundations, even if they are constructed in general conformance with the engineering design advice contained in this report.

Strict procedures must be maintained during construction to maintain the integrity of the subgrade to the extent possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade should be monitored by Grounded at the time of construction to confirm material quality, and thickness.

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

Fill placement is typically measured relative to Standard Proctor Maximum Dry Density (SPMDD). A third-party testing agency can be retained to provide in situ density measurements on site to confirm that the specified density is achieved during fill or asphalt placement. Grounded can provide oversight and review services for this testing as needed.

6 Limitations and Restrictions

This preliminary geotechnical engineering report is intended for planning purposes only. At detailed design, additional boreholes, possibly including in-situ pressuremeter testing and/or rock coring, groundwater monitoring wells, and updated detailed geotechnical engineering advice are required. Shear wave velocity (MASW) testing is recommended for detailed seismic site designation for each block. Once completed, the future detailed geotechnical engineering reports by Grounded Engineering would then supersede this preliminary report. Note that preliminary findings can vary significantly from the findings of a detailed comprehensive study.

6.1 Investigation Procedures

The geotechnical engineering analysis and advice provided are based on the factual borehole information observed and recorded by Grounded. The investigation methodology and engineering analysis methods used to carry out this scope of work are consistent with Grounded's standard of practice as well as other reasonable and prudent 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 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.

6.2 Site and Scope Changes

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

This report provides preliminary geotechnical engineering advice intended for use by the owner and their retained design team for planning 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.

6.3 Report Use

The authorized users of this report are 1816986 Ontario Inc.. 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.

7 Closure

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

For and on behalf of our team,

GROUNDED ENGINEERING

LICENSED PROFESSIONAL ENGINEER
SB
S. BASTAN
100532430
2026-04-06
PROVINCE OF ONTARIO

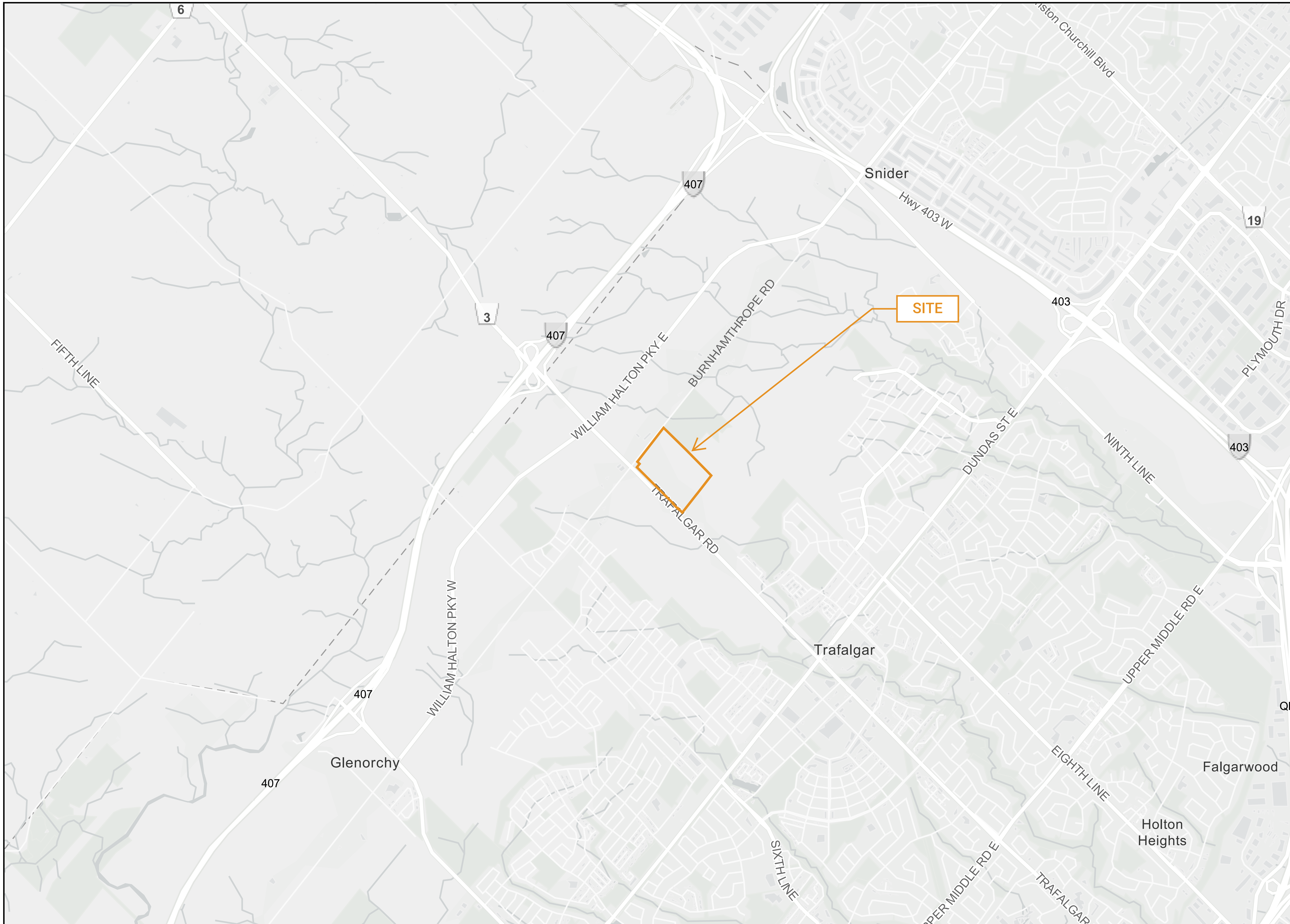
LICENSED PROFESSIONAL ENGINEER
KB
K. J. BYCKALO
100199873
2026-04-06
PROVINCE OF ONTARIO

Sam Bastan, P.Eng.
Intermediate Project Engineer

Kyle Byckalo, P.Eng.
Associate

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

FIGURES



GROUNDED
ENGINEERING

49 MOBILE DRIVE., NORTH YORK, ON M4A 1H5
www.groundedeng.ca

LEGEND

APPROXIMATE PROPERTY BOUNDARY

Note

Reference

ArcGIS Online 2025

Project

TRAFALGAR & BURNHAMTHORPE SUBDIVISION OAKVILLE, ONTARIO

Figure Title

KEY PLAN

North

TRUE

PROJECT

Date

APRIL 2026

Scale

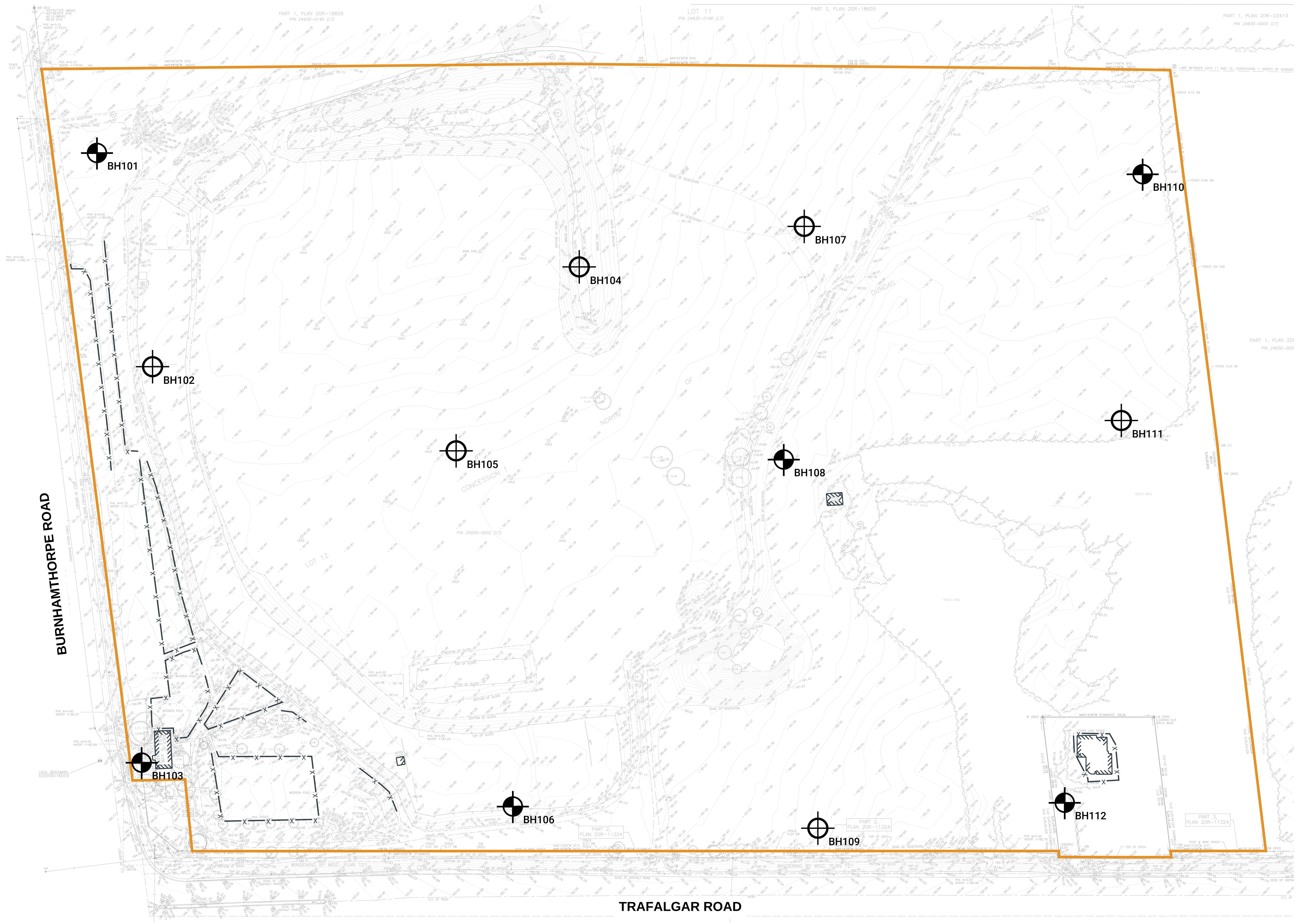
0m 500m 1000m

Job No

25-069

Figure No

FIGURE 1



GROUNDED ENGINEERING

49 MOBILE DRIVE., NORTH YORK, ON M4A 1H5
www.groundedeng.ca

LEGEND

- APPROX PROPERTY BOUNDARY
- EXISTING BUILDING STRUCTURE
- FENCE LINE
- MONITORING WELL/BOREHOLE BY GROUNDED

Note

Reference

Survey Drawing 24-30-276-00.
Dated February 11, 2025.
Prepared by J.D. Barnes Limited.
Received on May 7, 2025.

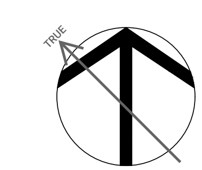
Project

TRAFALGAR & BURNHAMTHORPE SUBDIVISION OAKVILLE, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - EXISTING SITE CONDITIONS

North



Date

APRIL 2026

Scale

0m 25m 50m

Job No

25-069

Figure No

FIGURE 2

GROUNDED ENGINEERING

49 MOBILE DRIVE, NORTH YORK, ON M4A 1H5
www.groundedeng.ca

LEGEND

APPROX PROPERTY BOUNDARY

MONITORING WELL/BOREHOLE BY GROUNDED

Note

Reference

Site Plan A-105S.
Dated 2026-04-06
Prepared by BDP. Quadrangle.

Project

TRAFALGAR & BURNHAMTHORPE SUBDIVISION OAKVILLE, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - PROPOSED SITE CONDITIONS

North

TRUE

PROJECT

Date

APRIL 2026

Scale

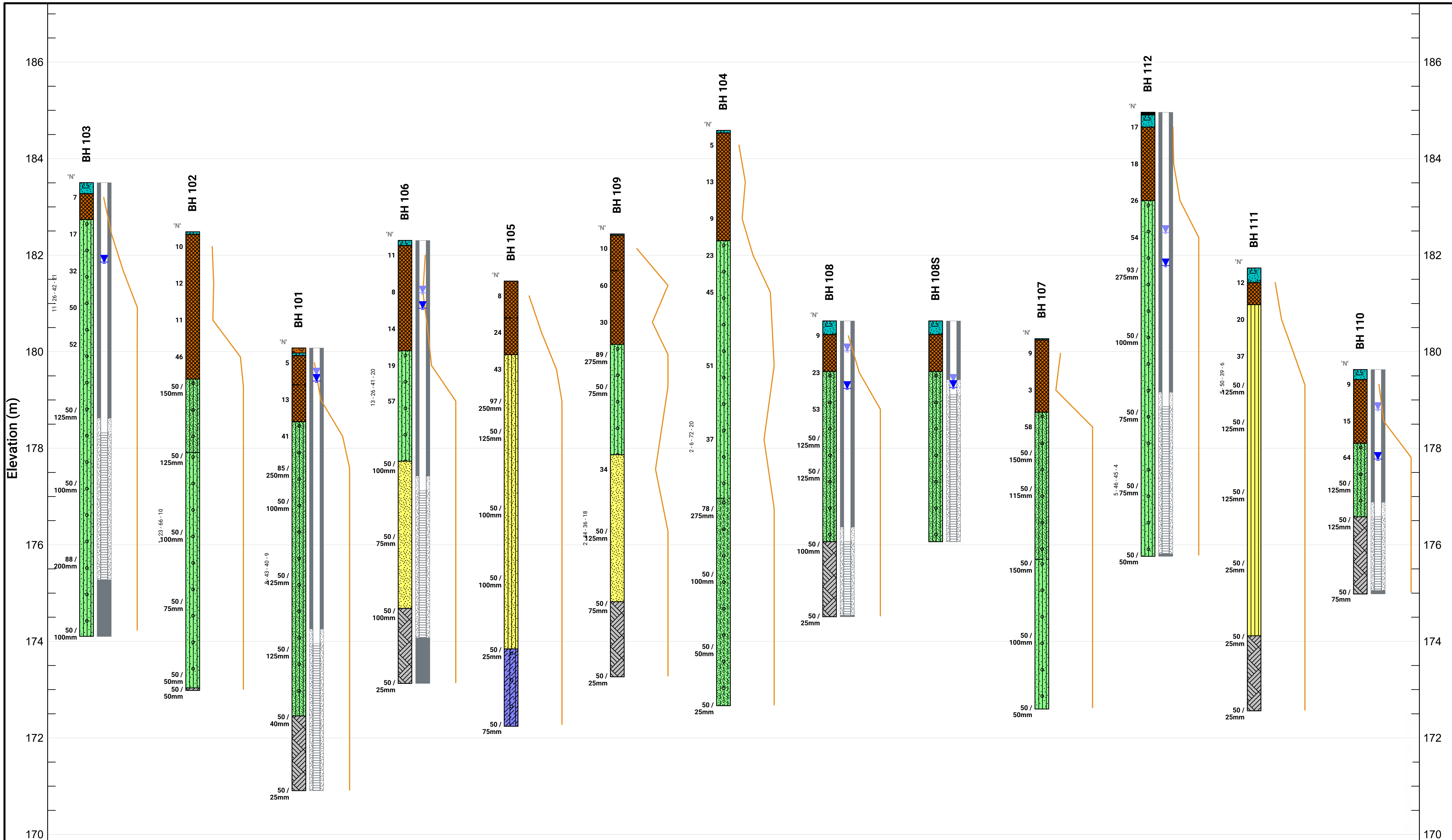
0m 25m 50m

Job No

25-069

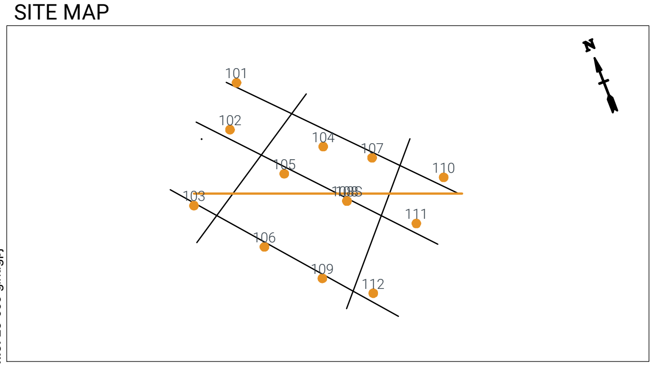
Figure No

FIGURE 3



Boreholes Equally Spaced

SITE MAP



file: 25-069 gint.gpj

BOREHOLE STRATIGRAPHY LEGEND

Aggregate | Bedrock (inferred) | Clayey Silt Till | Asphalt
Topsoil | Sandy Silt Till | Sand
Fill | Silty Sand Till | Silt and Sand Till
Sand and Silt Till | Sand and Silt | Silt

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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

BH 101 BOREHOLES BY GROUNDED

T-BH7 BOREHOLES BY OTHERS

water level, unstabilized

water level, stabilized (latest)

water level, stabilized (highest)

Project

TRAFALGAR AND BURNHAMTHORPE SUBDIVISION OAKVILLE

Figure Title

SUBSURFACE PROFILE

Date

APRIL 2026

Scale

AS INDICATED

Job No

25-069

Figure No

FIGURE 4

TABLES

TABLE 1:
GROUNDWATER LEVEL MONITORING SUMMARY
340 BURNHAMTHORPE RD. E., 3437 TRAFALGAR RD., Oakville

Well ID	Ground Surface Elev. (masl)	Well Screen Interval		Soil Strata	Grounded Engineering										Minimum Elev. (Lowest)		Maximum Elev. (Highest)	
					June 12, 2025		July 18, 2025		August 8, 2025		September 5, 2025		October 3, 2025					
		(mbgs)	(masl)		(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)
BH101	180.1	6.1 - 9.2	174.0 - 170.9	SN+SL-TL	0.58	179.52	0.71	179.39	0.97	179.13	0.67	179.43	0.57	179.53	0.97	179.13	0.57	179.53
BH103	183.5	5.2 - 8.2	178.3 - 175.3	SN-SL-TL	1.86	181.64	1.67	181.83	1.82	181.68	1.89	181.61	1.89	181.61	1.89	181.61	1.67	181.83
BH106	182.3	5.2 - 8.2	177.1 - 174.1	SN	1.11	181.19	1.43	180.87	1.76	180.54	1.90	180.40	2.09	180.22	2.09	180.22	1.11	181.19
BH108S	180.6	3.0 - 4.6	177.6 - 176.1	SN+SL-TL	NA	-	1.40	179.20	2.00	178.60	2.50	178.11	2.43	178.17	2.50	178.11	1.40	179.20
BH108	180.6	4.6 - 6.1	176.1 - 174.5	BEDROCK	0.64	179.96	1.42	179.18	2.03	178.57	2.49	178.12	2.63	177.98	2.63	177.98	0.64	179.96
BH110	179.6	3.0 - 4.6	176.6 - 175.1	BEDROCK	0.85	178.75	1.88	177.72	2.52	177.08	3.07	176.53	3.30	176.31	3.30	176.31	0.85	178.75
BH112	185.0	6.1 - 9.1	178.9 - 175.8	SN-SL-TL	2.51	182.49	3.20	181.80	3.63	181.37	4.07	180.93	4.43	180.57	4.43	180.57	2.51	182.49

mbgs = metres below existing ground surface
masl = metres above sea level
* = unstabilized groundwater level
NA = not available, unable to access monitoring well

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.

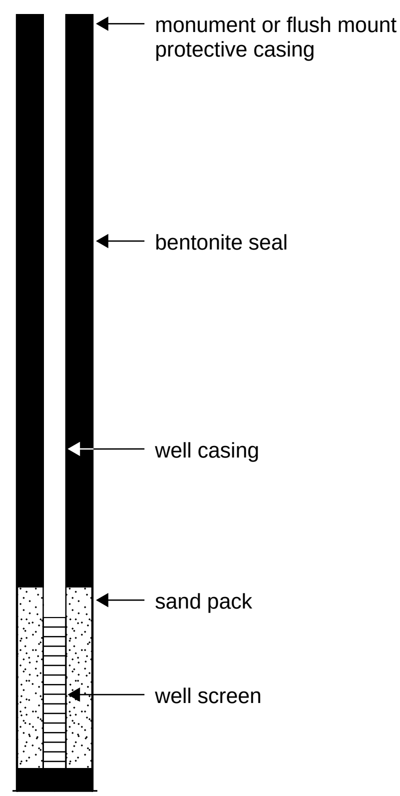
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



BOREHOLE LOG 101

GROUNDED ENGINEERING

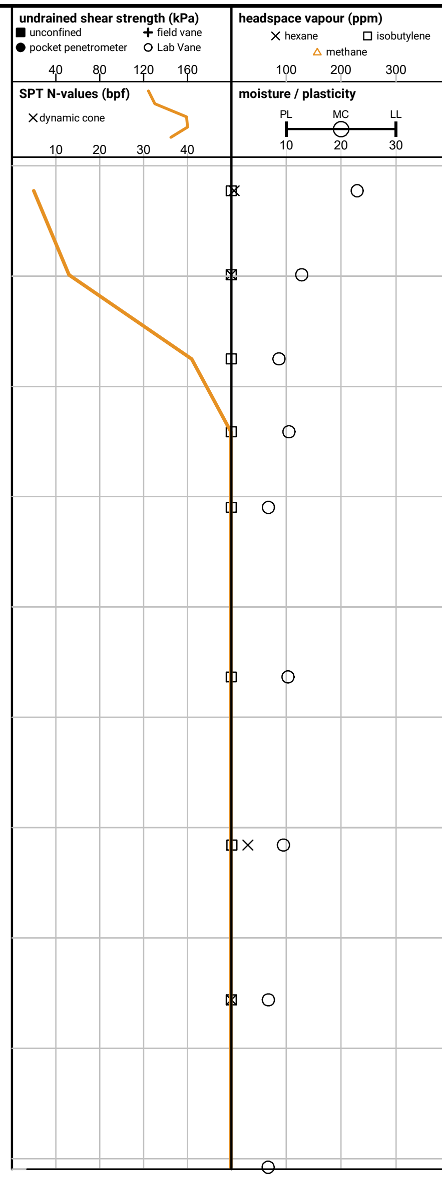
Date Started : Jun 2, 2025
Position : E: 602245, N: 4817567 (UTM 17T)
Elev. Datum : Geodetic

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK — solid stem augers OD=150 mm

elev / depth (m)	stratigraphy description	sample number	type	SPT N-value	lab data and comments
180.1	GROUND SURFACE				
179.9 / 0.2	100mm **AGGREGATE**				
	50mm **TOPSOIL**	1	SS	5	SS1: H-Ms, Metals, ORPs, OCs
179.3 / 0.8	**FILL**, clayey silt, some sand, trace gravel, trace rootlets, firm, dark brown, moist				
178.6 / 1.5	**SANDY SILT**, some clay, trace gravel, trace rootlets, compact, reddish brown, moist (REWORKED)	2	SS	13	SS2: BTEX, PAHs, PHCs, VOCs
	SAND AND SILT, trace clay, trace gravel, trace rock fragments, dense, reddish brown, moist (HALTON TILL)	3	SS	41	SS3: H-Ms, Metals, ORPs, OCs
	...at 2.3 m, some clay, very dense	4	SS	85 / 250mm	SS4: PAHs
	...at 3.0 m, trace clay, grey	5	SS	50 / 100mm	
	...at 4.6 m, wet	6	SS	50 / 125mm	grain size distribution (%) (MIT) GR 8 SA 43 SI 40 CL 9; SS6: BTEX, PHCs
172.5 / 7.6	...at 6.1 m, trace rock fragments, reddish brown, moist	7	SS	50 / 125mm	SS7: VOCs
170.9 / 9.2	**INFERRED BEDROCK**, shale fragments (WEATHERED)	8	SS	50 / 40mm	**7.6m:** spoon bouncing
		9	SS	50 / 25mm	**9.1m:** spoon bouncing

depth scale (m): 0–9; elevation (m): 180–171; well details; unstabilized water level



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 12, 2025	0.6	179.5
Jul 18, 2025	0.7	179.4
Aug 8, 2025	1.0	179.1
Sep 5, 2025	0.7	179.4
Oct 3, 2025	0.6	179.5

file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

Date Started : Jun 2, 2025
Position : E: 602194, N: 4817474 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 102

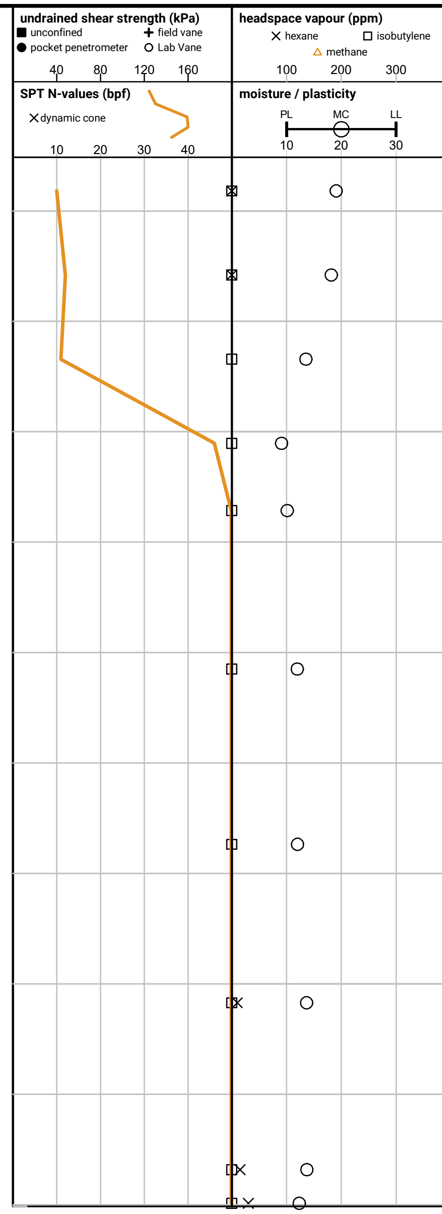
File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

Drill method: CME TRACK — solid stem augers, OD=150 mm

elev / depth (m)	description	number	type	SPT N-value	lab data and comments
182.5	**GROUND SURFACE**				
	50mm **TOPSOIL**				
	FILL, sandy silt, some clay, trace gravel, trace rootlets, organic odour, compact, dark brown, moist	1	SS	10	SS1: OCs
	...at 0.8 m, clayey silt, sandy, stiff, reddish brown, moist	2	SS	12	SS2: H-Ms, Metals, ORPs
	...at 1.5 m, silty sand, trace clay, trace gravel, trace shale fragments, compact	3	SS	11	SS3: PAHs, VOCs
	...at 2.3 m, sand and gravel, trace silt, dense, brown, wet	4	SS	46	SS4: BTEX, PHCs
179.5 / 3.0	**SAND AND SILT**, trace clay, trace gravel, very dense, brown, moist (HALTON TILL)	5	SS	50 / 150mm	SS5: H-Ms, Metals, PAHs, OCs
177.9 / 4.6	**SANDY SILT**, some clay, trace gravel, very dense, grey, moist (HALTON TILL)	6	SS	50 / 125mm	SS6: BTEX, PHCs, VOCs
		7	SS	50 / 100mm	grain size distribution (%) (MIT): GR 1, SA 23, SI 66, CL 10
		8	SS	50 / 75mm	
173.1	...at 9.1 m, some shale fragments, wet	9	SS	50 / 50mm	**9.1m:** switch to hollow stem augers
173.0 / 9.5	**INFERRED BEDROCK**, shale fragments (WEATHERED)	10	SS	50 / 50mm	**9.4m:** auger grinding, spoon bouncing

END OF BOREHOLE

Water level and cave not measured upon completion of drilling.



file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Jun 9, 2025
Position : E: 602058, N: 4817345 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 103

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

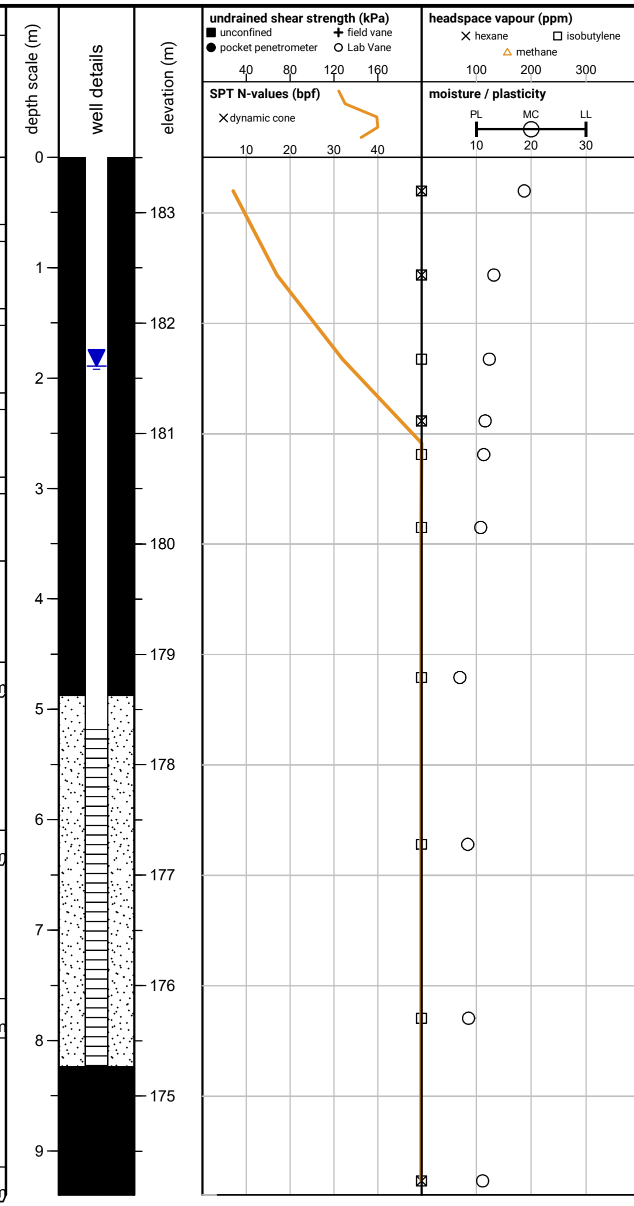
drill method : CME TRACK — hollow stem augers OD=215 mm

Stratigraphy

elev / depth (m)	description
183.5	GROUND SURFACE
183.3 / 0.2	225mm **TOPSOIL**
	FILL, sandy silt, trace gravel, trace clay, trace rootlets, loose, dark brown, moist
182.7 / 0.8	**SANDY SILT**, clayey, some shale fragments, trace gravel, trace rock fragments, compact, brown, moist (HALTON TILL)
	...at 1.5 m, dense
	...at 2.3 m, some gravel, very dense
	...at 2.5 m, some clay
	...at 4.6 m, sand, some silt, grey
	...at 6.1 m, silty
174.1 / 9.4	END OF BOREHOLE

Samples

number	type	SPT N-value	lab data and comments
1	SS	7	SS1: H-Ms, Metals, ORPs, OCs
2	SS	17	SS2: BTEX, PAHs, PHCs
3	SS	32	SS3: VOCs
4A	SS	50	grain size distribution (%) (MIT): GR 11, SA 26, SI 42, CL 21
4B			4B: H-Ms, Metals, ORPs
5	SS	52	SS5: PAHs, OCs
6	SS	50 / 125mm	
7	SS	50 / 100mm	SS7: BTEX, PHCs
8	SS	88 / 200mm	SS8: VOCs; 7.9m: auger grinding
9	SS	50 / 100mm	8.8m: auger grinding



END OF BOREHOLE

Unstabilized water level measured at 7.0 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 12, 2025	1.9	181.6
Jun 17, 2025	2.0	181.5
Jul 18, 2025	1.7	181.8
Aug 8, 2025	1.8	181.7
Sep 5, 2025	1.9	181.6
Oct 3, 2025	1.9	181.6

file: 25-069 gint.gpj

 Tech : EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

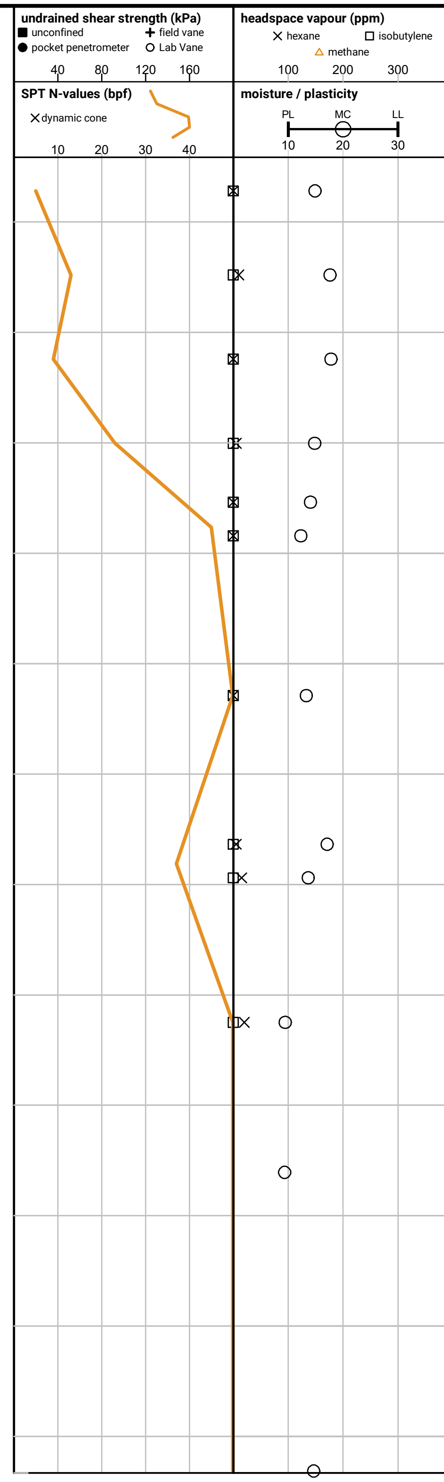
Date Started : Jun 3, 2025
Position : E: 602375, N: 4817364 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 104

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

Drill method : CME TRACK — hollow stem augers OD=215 mm

elev / depth (m)	stratigraphy description	sample number	type	SPT N-value	depth scale (m)	elevation (m)	unstabilized water level	lab data and comments / grain size distribution (%) (MIT) GR SA SI CL
184.6	GROUND SURFACE				0			
	50mm **TOPSOIL**							
	FILL, sandy silt, trace clay, trace gravel, trace rootlets, organic odour, loose to compact, brown, moist	1	SS	5		184		SS1: OCs
	...at 0.8 m, trace rock fragments	2	SS	13	1			SS2: BTEX, PHCs, VOCs
	...at 1.5 m, trace shale fragments	3	SS	9	2	183		SS3: H-Ms, Metals, ORPs, PAHs
182.3 / 2.3	**SANDY SILT**, some clay, trace gravel, compact, brown, moist (HALTON TILL)	4	SS	23		182		
	...at 3.0 m, dense	5A	SS	45	3			
	...at 3.2 m, very dense	5B				181		
	...at 4.6 m, brown with orange	6	SS	51	4, 5	180		
						179	∇ (5.5 m)	
		7A	SS	37	6			
	...at 6.3 m, clayey silt, trace sand, hard, grey	7B				178		2 6 72 20
177.0 / 7.6	**SILTY SAND**, trace gravel, trace clay, trace rock fragments, very dense, grey, moist (HALTON TILL)	8	SS	78 / 275mm	7, 8	177		
		9	SS	50 / 100mm	9	176, 175		
		10	SS	50 / 50mm	10, 11	174		**10.7m:** no recovery, auger grinding
172.7 / 11.9	...at 11.9 m, clayey, some shale fragments, wet	11	SS	50 / 25mm		173		**11.9m:** spoon bouncing, auger refusal



END OF BOREHOLE

Unstabilized water level measured at 5.5 m below ground surface; caved to 8.5 m below ground surface upon completion of drilling.

file: 25-069 gint.gpj

Tech : KS/EB | **PM** : KrS | **Rev** : KB

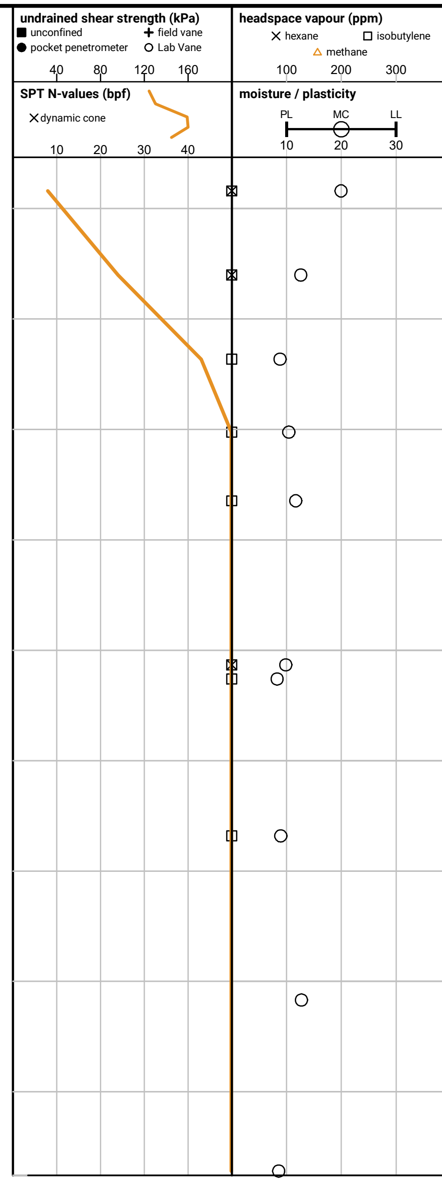
BOREHOLE LOG 105

Date Started : Jun 4, 2025
Position : E: 602272, N: 4817338 (UTM 17T)
Elev. Datum : Geodetic

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK — solid stem augers OD=150 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value	unstabilized water level	lab data and comments
181.5	GROUND SURFACE					
	FILL, sandy silt, some clay, trace gravel, trace rootlets, organic odour, loose, brown, moist	1	SS	8		
180.7 / 0.8	**SANDY SILT**, some clay, trace gravel, trace rock fragments, compact, brown, moist (REWORKED)	2	SS	24		SS2: OCs
180.0 / 1.5	**SAND AND SILT**, trace clay, trace gravel, trace rock fragments, very dense, brown, moist	3	SS	43		SS3: H-Ms, Metals, ORPs
		4	SS	97 / 250mm		
	...at 3.0 m, wet	5	SS	50 / 125mm		
	...at 4.6 m, sandy silt, clayey, grey ...at 4.6 m, some clay, trace shale fragments, reddish brown	6A/6B	SS	50 / 100mm		
		7	SS	50 / 100mm	∇	
173.9 / 7.6	**CLAYEY SILT**, some sand, trace gravel, trace shale fragments, hard (HALTON TILL)	8	SS	50 / 25mm		
172.3 / 9.2	...at 9.1 m, some shale fragments	9	SS	50 / 75mm		



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

END OF BOREHOLE

Unstabilized water level measured at 6.4 m below ground surface; caved to 7.0 m below ground surface upon completion of drilling.

file: 25-069 gint.gpj

Tech : KS/EB | **PM** : KrS | **Rev** : KB

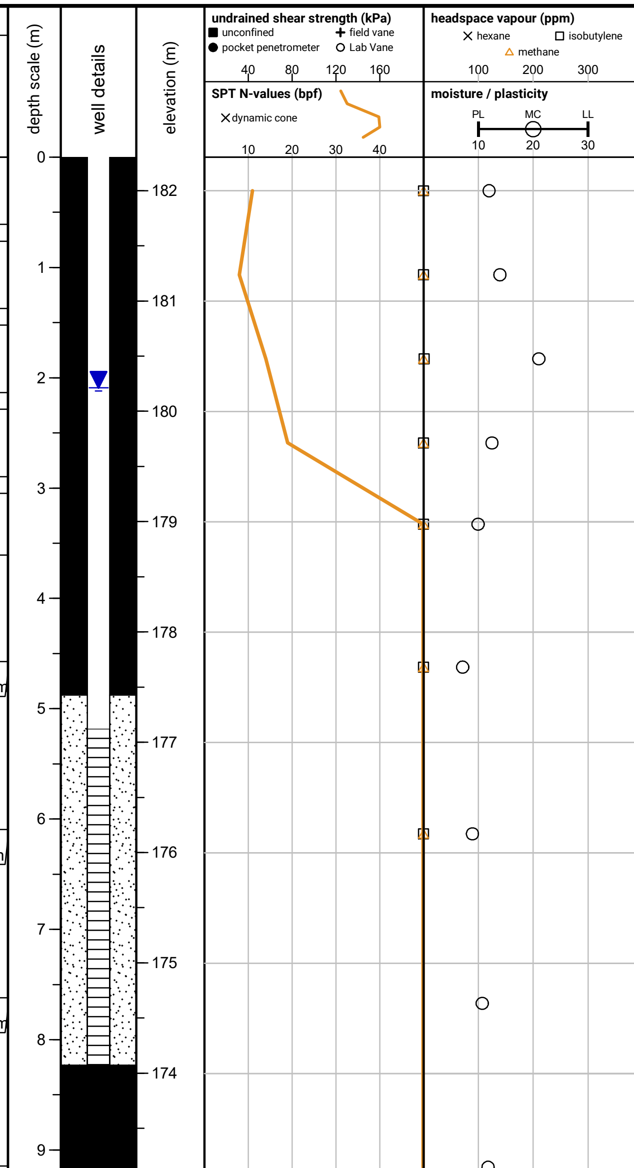
Date Started : Jun 4, 2025
Position : E: 602172, N: 4817202 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 106

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

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

elev depth (m)	description	graphic log	number	type	SPT N-value	lab data and comments
182.3	**GROUND SURFACE**					
	100mm **TOPSOIL**					
	FILL, sandy silt, trace gravel, trace rootlets, organic odour, compact to loose, dark brown, moist		1	SS	11	SS1: OCs
	...at 0.8 m, silty sand		2	SS	8	SS2: H-Ms, Metals, ORPs
	...at 1.5 m, sandy silt, some clay, dark grey		3	SS	14	SS3: BTEX, PAHs, PHCs, VOCs
180.0 2.3	**SANDY SILT**, some clay, some gravel, trace rock fragments, trace rootlets, compact, brown, moist (HALTON TILL)		4	SS	19	
	...at 3.0 m, very dense		5	SS	57	grain size distribution (%) (MIT): GR 13, SA 26, SI 41, CL 20
177.7 4.6	**SAND**, some silt, very dense, grey, moist		6	SS	50 / 100mm	**4.9m:** auger grinding
	...at 6.1 m, silty, some clay, trace shale fragments		7	SS	50 / 75mm	**6.1m:** spoon bouncing
174.7 7.6	**INFERRED BEDROCK**, shale fragments, wet (WEATHERED)		8	SS	50 / 100mm	
173.1 9.2			9	SS	50 / 25mm	



END OF BOREHOLE

Unstabilized water level measured at 6.1 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 12, 2025	1.1	181.2
Jul 9, 2025	1.2	181.1
Jul 18, 2025	1.4	180.9
Aug 8, 2025	1.8	180.5
Sep 5, 2025	1.9	180.4
Oct 3, 2025	2.1	180.2

file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Jun 3, 2025
Position : E: 602468, N: 4817301 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 107

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK; solid stem augers OD=150 mm

elev depth (m)	description	sample number	type	SPT N-value	depth (m)	elevation (m)	lab data and comments
180.3	GROUND SURFACE				0		
	25mm **TOPSOIL**						
	FILL, clayey silt, some sand, trace gravel, trace rootlets, firm, dark brown, moist	1	SS	9		180	
	...at 0.8 m, sandy, soft, wet	2	SS	3	1	179	SS2: OCs
178.8 / 1.5	**SAND AND SILT**, trace gravel, trace clay, very dense, brown, moist (HALTON TILL)	3	SS	58	2		SS3: H-Ms, Metals, ORPs
		4	SS	50 / 150mm		178	
		5	SS	50 / 115mm	3	177	
175.7 / 4.6	**SANDY SILT**, some clay, some gravel, trace shale fragments, very dense, reddish brown, moist (HALTON TILL)	6	SS	50 / 150mm	4–5	176–175	5.5m: auger grinding to 6.1m
	...at 6.1 m, some shale fragments, wet	7	SS	50 / 100mm	6	174	7.0m: auger grinding to 7.6m
172.6 / 7.7		8	SS	50 / 50mm	7	173	

END OF BOREHOLE

Water level and cave not measured upon completion of drilling.

Chart columns: undrained shear strength (kPa) — ■ unconfined, ✚ field vane, ● pocket penetrometer, ○ Lab Vane (40, 80, 120, 160); SPT N-values (bpf) — ✕ dynamic cone (10, 20, 30, 40); headspace vapour (ppm) — ✕ hexane, □ isobutylene, △ methane (100, 200, 300); moisture / plasticity — PL, MC, LL (10, 20, 30); unstabilized water level; grain size distribution (%) (MIT) GR SA SI CL

file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

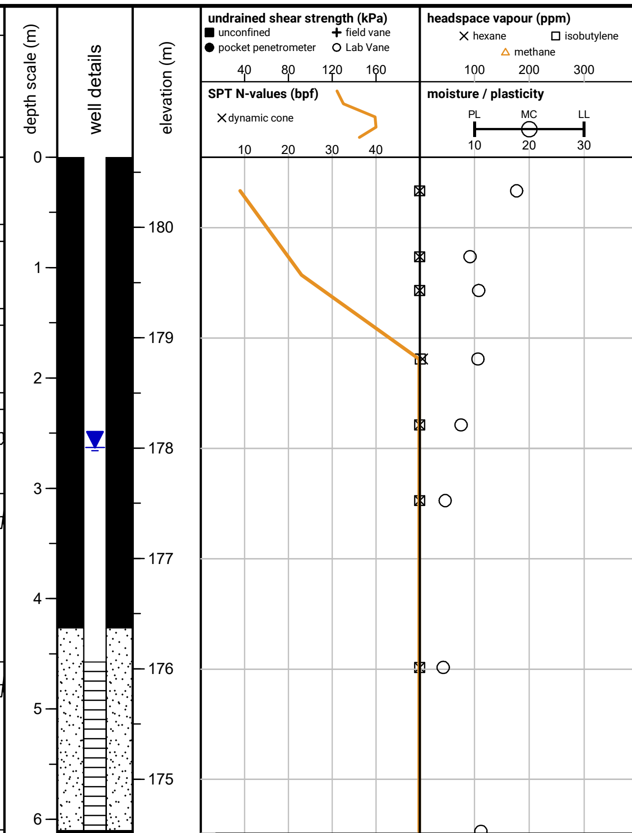
Date Started : Jun 6, 2025
Position : E: 602381, N: 4817231 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 108

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

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

elev depth (m)	description	number	type	SPT N-value
180.6	**GROUND SURFACE**			
180.3 / 0.3	275mm **TOPSOIL**			
	SANDY SILT, some clay, trace gravel, trace rootlets, loose, greyish brown, moist (REWORKED)	1	SS	9
	...at 0.8 m, trace rock fragments, compact	2A	SS	23
179.6 / 1.0	**SAND AND SILT**, trace gravel, trace clay, trace rock fragments, compact, brown, moist (HALTON TILL)	2B		
	...at 1.5 m, very dense	3	SS	53
		4	SS	50 / 125mm
	...at 3.0 m, grey	5	SS	50 / 125mm
176.0 / 4.6	**INFERRED BEDROCK**, shale fragments (WEATHERED)	6	SS	50 / 100mm
174.5 / 6.1	...at 6.1 m, wet	7	SS	50 / 25mm



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

2B: H-Ms, Metals, ORPs

SS3: OCs

5.5m: auger grinding

END OF BOREHOLE

Unstabilized water level measured at 5.5 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 12, 2025	0.6	180.0
Jul 18, 2025	1.4	179.2
Aug 8, 2025	2.0	178.6
Sep 5, 2025	2.5	178.1
Oct 3, 2025	2.6	178.0

file: 25-069 gint.gpj

Tech : KS/EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Jun 27, 2025
Position : E: 602381, N: 4817231 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 108S

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK

hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value
180.6	GROUND SURFACE			
180.3 / 0.3	Straight drilled Refer to borehole 108 for stratigraphy			
179.6 / 1.0				
176.0 / 4.6				

END OF BOREHOLE

Dry and open upon completion of drilling.

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jul 9, 2025	1.3	179.3
Jul 18, 2025	1.4	179.2
Aug 8, 2025	2.0	178.6
Sep 5, 2025	2.5	178.1
Oct 3, 2025	2.4	178.2

Tech : KS/EB | **PM** : KrS | **Rev** : KB

BOREHOLE LOG 109

GROUNDED ENGINEERING

Date Started : Jun 9, 2025
Position : E: 602268, N: 4817089 (UTM 17T)
Elev. Datum : Geodetic

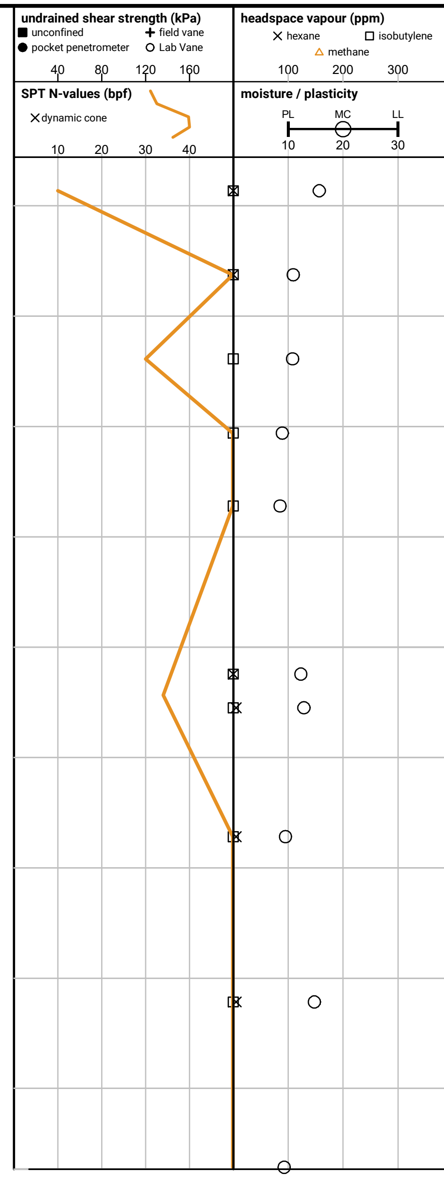
File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK — solid stem augers OD=150 mm

elev / depth (m)	description (stratigraphy)
182.4	**GROUND SURFACE**
	25mm **TOPSOIL**
	FILL, sandy silt, some clay, trace gravel, trace rootlets, compact, brown, moist
181.6 / 0.8	**SANDY SILT**, some clay, trace gravel, trace rock fragments, cobbles (inferred), dense, brown, moist (REWORKED)
180.1 / 2.3	**SANDY SILT**, trace clay, trace gravel, trace rock fragments, cobbles (inferred), dense, brown, moist (HALTON TILL) ...at 3.0 m, some clay, very dense
177.8 / 4.6	**SAND**, some silt, trace gravel, dense, grey, wet ...at 4.8 m, some gravel, cobbles (inferred) ...at 6.1 m, sand and silt, some shale fragments, some clay, trace gravel, very dense
174.8 / 7.6	**INFERRED BEDROCK**, shale fragments, wet (WEATHERED)
173.2 / 9.2	...at 9.1 m, moist
	END OF BOREHOLE

Unstabilized water level measured at 2.1 m below ground surface; caved to 4.3 m below ground surface upon completion of drilling.

samples: number	type	SPT N-value	lab data and comments	grain size distribution (%) (MIT) GR SA SI CL
1	SS	10		
2	SS	60	SS2: OCs	
3	SS	30		
4	SS	89 / 275mm	SS4: H-Ms, Metals, ORPs	
5	SS	50 / 75mm	**3.4m:** auger grinding	
6A / 6B	SS	34		
7	SS	50 / 125mm		2 44 36 18
8	SS	50 / 75mm		
9	SS	50 / 25mm		



depth scale (m): 0–9; elevation (m): 182–174; well details; unstabilized water level

file: 25-069 gint.gpj

 Tech : EB | **PM** : KrS | **Rev** : KB

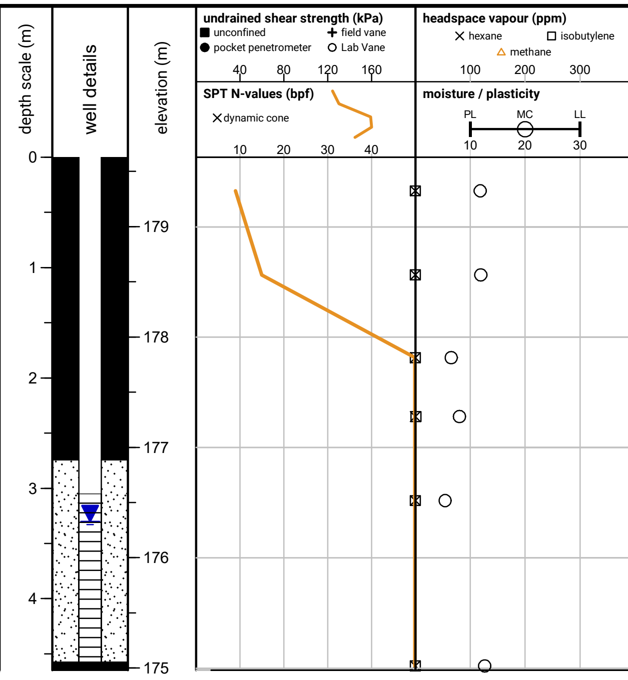
Date Started : Jun 5, 2025
Position : E: 602602, N: 4817203 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 110

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

Drill method: CME TRACK; hollow stem augers OD=215 mm

elev / depth (m)	description	number	type	SPT N-value
179.6	GROUND SURFACE			
179.4 / 0.2	200mm **TOPSOIL**			
	SANDY SILT, some clay, trace gravel, trace rootlets, loose to compact, brown, moist (REWORKED)	1	SS	9
		2	SS	15
178.1 / 1.5	**SILT AND SAND**, trace gravel, trace clay, very dense, brown with orange, moist (HALTON TILL)	3	SS	64
	...at 2.3 m, trace rock fragments, cobbles (inferred)	4	SS	50 / 125mm
176.6 / 3.0	**INFERRED BEDROCK**, shale fragments (WEATHERED)	5	SS	50 / 125mm
175.0 / 4.6	...at 4.6 m, wet	6	SS	50 / 75mm



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

- SS1: OCs
- SS2: H-Ms, Metals, ORPs
- **3.7m:** auger grinding
- **4.6m:** spoon bouncing

END OF BOREHOLE

Unstabilized water level measured at 2.4 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 12, 2025	0.9	178.7
Jul 18, 2025	1.9	177.7
Aug 8, 2025	2.6	177.0
Sep 5, 2025	3.1	176.5
Oct 3, 2025	3.3	176.3

file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

BOREHOLE LOG 111

GROUNDED ENGINEERING

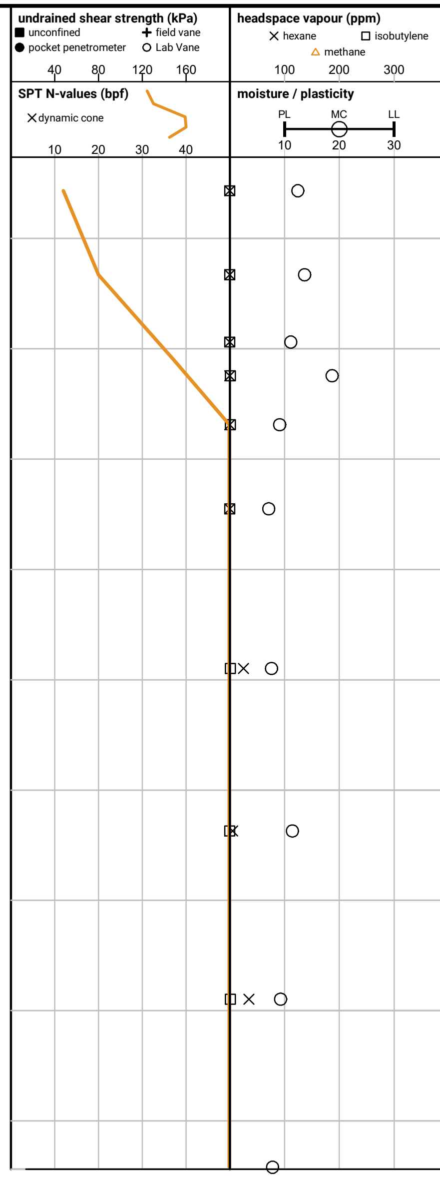
Date Started : Jun 5, 2025
Position : E: 602508, N: 4817128 (UTM 17T)
Elev. Datum : Geodetic

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

drill method : CME TRACK — solid stem augers OD=150 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value	lab data and comments
181.7	**GROUND SURFACE**				
181.4 / 0.3	300mm **TOPSOIL**				
180.9 / 0.8	**SANDY SILT**, some clay, trace gravel, trace rootlets, compact, brown, moist (REWORKED)	1	SS	12	
	SILT, some sand, trace clay, trace gravel, compact, greyish brown, moist	2	SS	20	SS2: OCs
	...at 1.5 m, trace rock fragments, dense	3A	SS	37	
	...at 1.8 m, sandy silt, brown, grey	3B			
	...at 2.3 m, sand and silt, very dense, moist	4	SS	50 / 125mm	GR 5, SA 50, SI 39, CL 6; SS4: H-Ms, Metals, ORPs
	...at 3.0 m, grey	5	SS	50 / 125mm	
		6	SS	50 / 125mm	
	...at 6.1 m, clayey with shale fragments, reddish brown, wet	7	SS	50 / 25mm	5.8m: auger grinding
174.1 / 7.6	**INFERRED BEDROCK**, shale fragments (WEATHERED)	8	SS	50 / 25mm	
172.5 / 9.2		9	SS	50 / 25mm	

Unstabilized water level at approx. 2.4 m depth (elev. approx. 179.3).



END OF BOREHOLE

Unstabilized water level measured at 2.4 m below ground surface; caved to 4.9 m below ground surface upon completion of drilling.

file: 25-069 gint.gpj

Tech : KS/EB | **PM** : KrS | **Rev** : KB

GROUNDED ENGINEERING

Date Started : Jun 6, 2025
Position : E: 602362, N: 4817017 (UTM 17T)
Elev. Datum : Geodetic

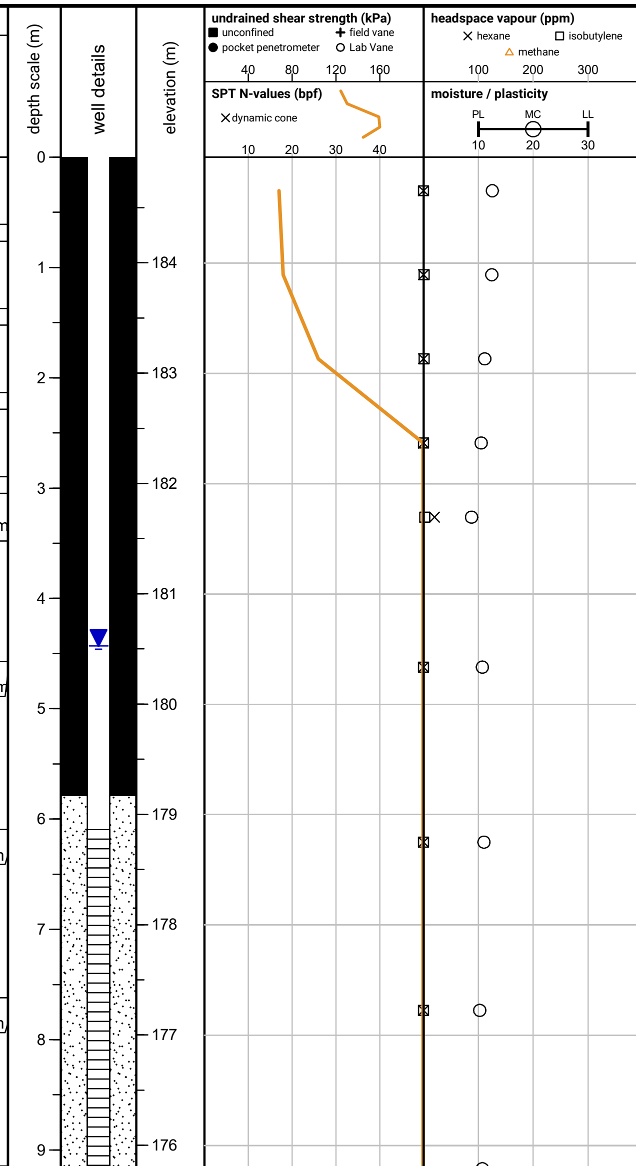
BOREHOLE LOG 112

File No. : 25-069 **Project** : Trafalgar and Burnhamthorpe Subdivision, Oakville **Client** : Westerkirk Trafalgar Inc.

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

elev / depth (m)	stratigraphy description
185.0	GROUND SURFACE
	50mm **ASPHALT**
184.7 / 0.3	250mm **TOPSOIL**
	SANDY SILT, some clay, trace gravel, trace rootlets until 0.9m, compact, brown, moist (REWORKED)
183.2 / 1.8	**SANDY SILT**, some clay, trace gravel, very dense, brown, moist (HALTON TILL) ...at 2.3 m, trace rock fragments, cobbles (inferred) ...at 3.0 m, silt and sand ...at 4.6 m, sand and silt, brown with orange, wet ...at 6.1 m, grey
175.8 / 9.2	...at 9.1 m, clayey with shale fragments
	END OF BOREHOLE

samples number	type	SPT N-value
1	SS	17
2	SS	18
3	SS	26
4	SS	54
5	SS	93 / 275mm
6	SS	50 / 100mm
7	SS	50 / 75mm
8	SS	50 / 75mm
9	SS	50 / 50mm



lab data and comments

SS2:	H-Ms, Metals, ORPs, PAHs
SS3:	BTEX, PHCs
SS4:	PAHs
3.0m:	auger grinding, added water
SS5:	BTEX, H-Ms, Metals, ORPs, PHCs
5.2m:	auger grinding

grain size distribution (%) (MIT)

GR	SA	SI	CL
5	46	45	4

Water level and cave not measured upon completion of drilling.

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

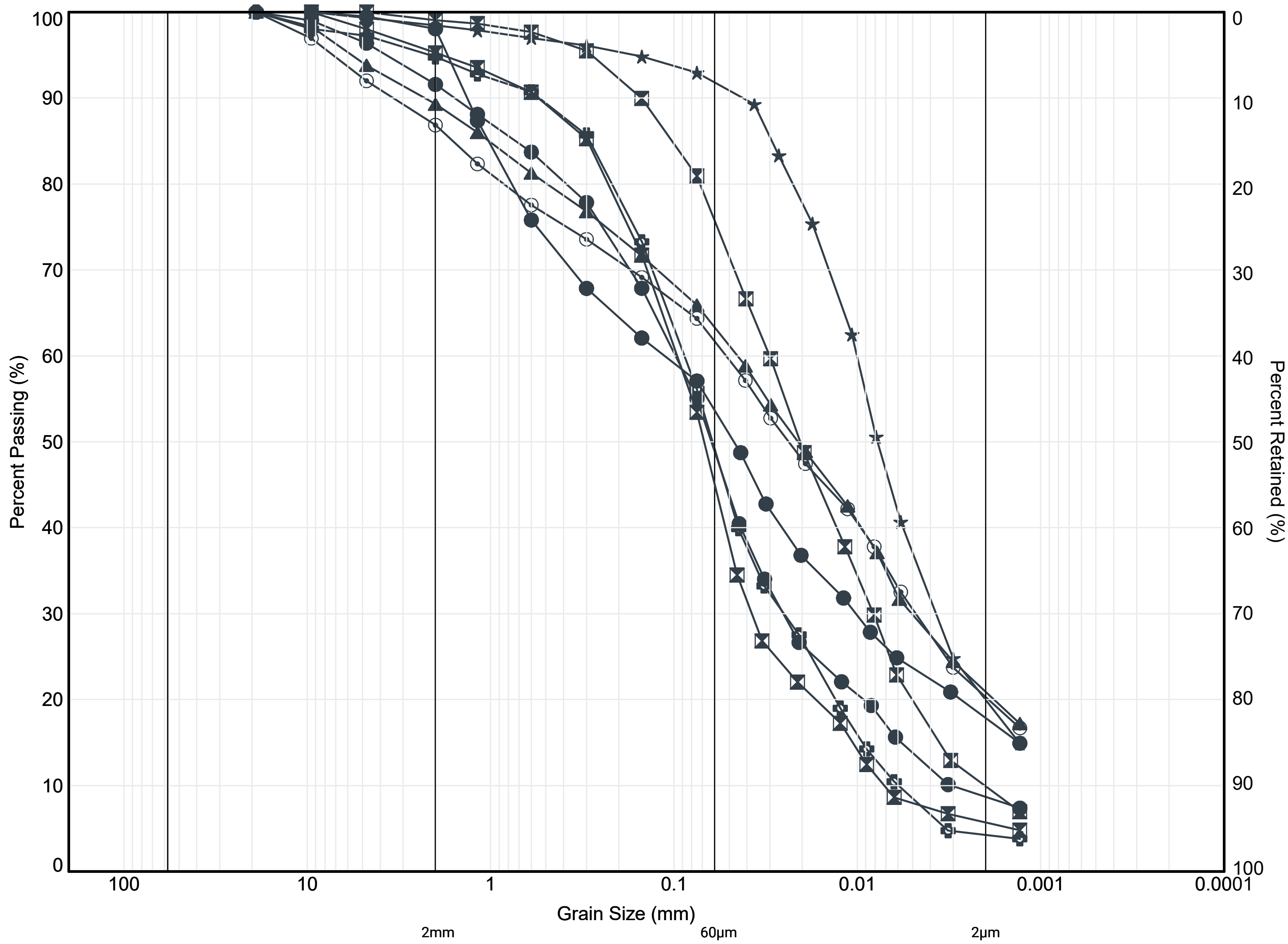
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jun 12, 2025	2.5	182.5
Jun 17, 2025	3.3	181.7
Jul 18, 2025	3.2	181.8
Aug 8, 2025	3.6	181.4
Sep 5, 2025	4.1	180.9
Oct 3, 2025	4.4	180.6

file: 25-069 gint.gpj

 Tech : KS/EB | **PM** : KrS | **Rev** : KB

APPENDIX B



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

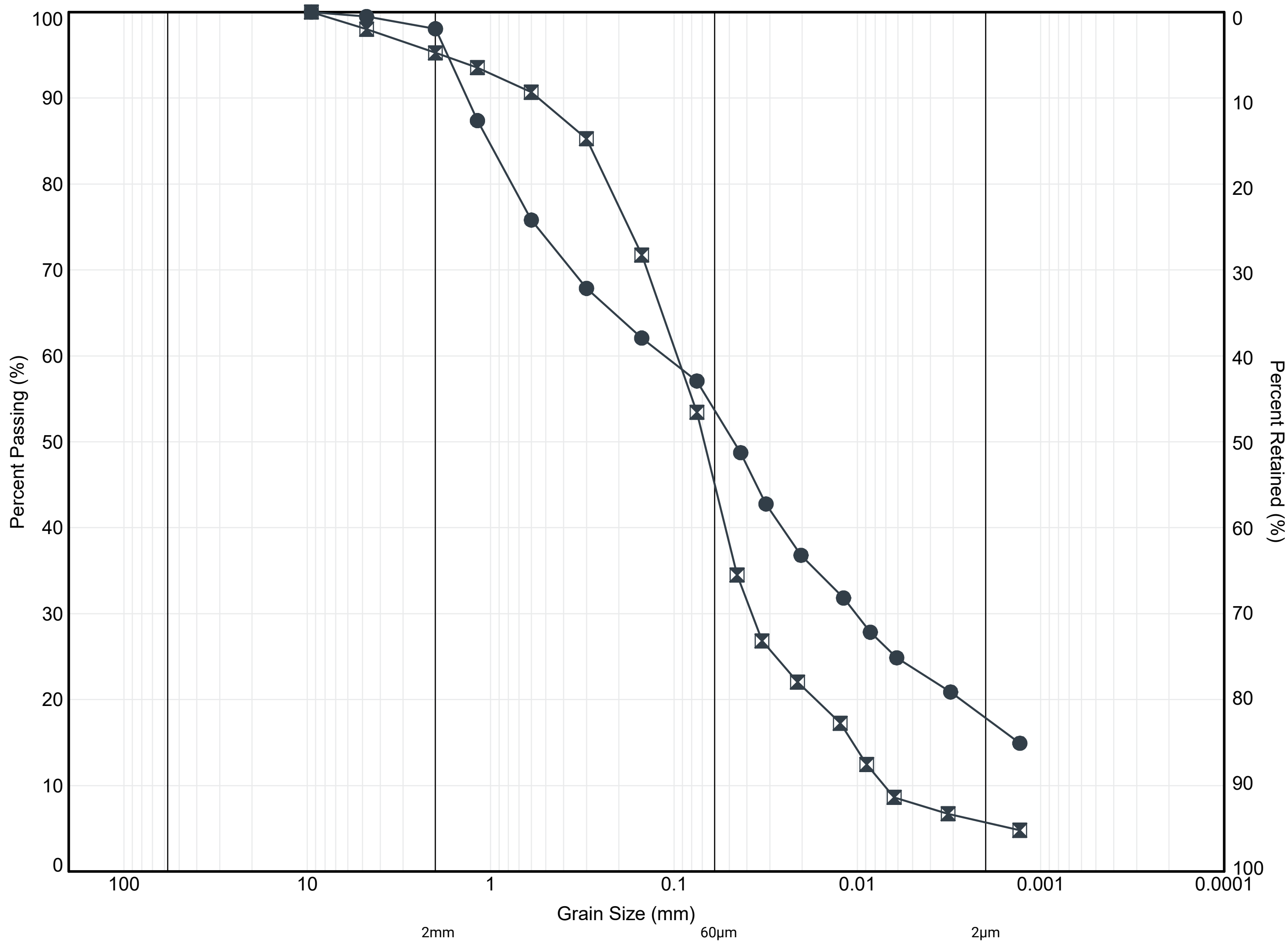
					MIT SYSTEM			
	Location	**Sample**	**Depth (m)**	**Elev. (m)**	**Gravel (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**
●	**BH 101**	SS6	4.7	175.4	8	43	40	9
⊠	**BH 102**	SS7	6.2	176.3	1	23	66	10
▲	**BH 103**	4A	2.4	181.1	11	26	42	21
★	**BH 104**	7B	6.5	178.1	2	6	72	20
⊙	**BH 106**	SS5	3.3	179.0	13	26	41	20
✪	**BH 112**	SS8	7.7	177.2	5	46	45	4

GROUNDED ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION HALTON TILL**

File No.: **25-069**

file: 25-069 gint.gpj



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

	Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
					MIT SYSTEM			
●	**BH 109**	SS7	6.2	176.3	2	44	36	18
⊠	**BH 111**	SS4	2.4	179.3	5	50	39	6

GROUNDED ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION SANDS AND SILTS**

File No.: **25-069**

file: 25-069 gint.gpj

APPENDIX C

CORROSIVITY (SGS)

Report No.	**CA40092-JUN25**
Customer	**Grounded Engineering Inc.**
Attention	**Kristen Shaver**
Reference	**25-069, Kristen Shaver**
Works#	
Title	**Final Report**

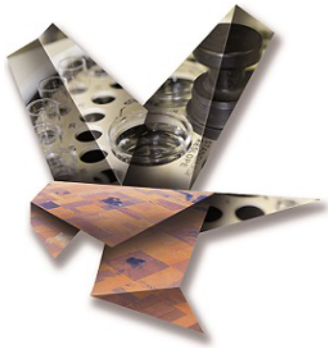
Sample ID		Analysis Start Date	Analysis Start Time	Analysis Completed Date	Analysis Completed Time	BH101 SS3	BH106 SS3	BH111 SS5
Sample Date / Time						02-Jun-25 18:00	04-Jun-25 12:30	05-Jun-25 15:00
Analysis	**Units**							
Sample Date & Time						June 2, 2025	June 4, 2025	June 5, 2025
Corrosivity Index	none	12-Jun-25	13:54	12-Jun-25	13:54	4	4	4
pH	pH Units	10-Jun-25	08:24	11-Jun-25	08:46	8.75	8.52	8.74
Soil Redox Potential	mV	10-Jun-25	15:30	11-Jun-25	08:47	308.0	303.0	298.0
Sulphide (Na2CO3)	%	11-Jun-25	13:18	11-Jun-25	13:51	0.01	< 0.01	0.01
Moisture Index	N/A	10-Jun-25	15:30	11-Jun-25	08:47	1	1.0	1
Chloride	µg/g	12-Jun-25	11:06	13-Jun-25	14:02	17	48.0	2.2
Sulphate	µg/g	12-Jun-25	11:06	13-Jun-25	14:02	23	79	24
Conductivity	uS/cm	10-Jun-25	08:24	11-Jun-25	08:46	139	237	108
Resistivity (calculated)	ohms.cm	45818	45821.4	45819	45821.3653	7190	4220	9260

INTERPRETATION

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

Sample	**BH101 SS3**	**BH106 SS3**	**BH111 SS5**
Corrosion Protection Recommended?	**No**	**No**	**No**

Sulphate	**%**	0.002%	0.005%	0.000%
CLASS OF EXPOSURE		**Negligible**	**Negligible**	**Negligible**



FINAL REPORT

CA40092-JUN25 R1

25-069, 340 Bumhamthorpe Rd. E. Oakville

Prepared for

Grounded Engineering Inc.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Grounded Engineering Inc.	Project Specialist	Maarit Wolfe, Hon.B.Sc
		Laboratory	SGS Canada Inc.
Address	49 Mobile Drive Toronto, Ontario M4A 1H5, Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Kristen Shaver	Telephone	705-652-2000
Telephone		Facsimile	705-652-6365
Facsimile		Email	Maarit.Wolfe@sgs.com
Email	kshaver@groundedeng.ca	SGS Reference	CA40092-JUN25
Project	25-069, 340 Bumhamthorpe Rd. E. Oakville	Received	06/09/2025
Order Number		Approved	06/13/2025
Samples	Soil (3)	Report Number	CA40092-JUN25 R1
		Date Reported	06/13/2025

COMMENTS

Temperature of Sample upon Receipt: 4 degrees C

Cooling Agent Present: yes

Custody Seal Present: yes

Chain of Custody Number: 042794

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

SIGNATORIES

Maarit Wolfe, Hon.B.Sc

TABLE OF CONTENTS

FINAL REPORT

CA40092-JUN25 R1

Client: Grounded Engineering Inc.

Project: 25-069, 340 Bumhamthorpe Rd. E. Oakville

Project Manager: Kristen Shaver

Samplers: Elizabeth Beard

MATRIX: SOIL

Parameter	Units	RL		Result	Result	Result
			Sample Number	5	6	7
			Sample Name	BH101 SS3	BH106 SS3	BH111 SS5
			Sample Matrix	Soil	Soil	Soil
			Sample Date	02/06/2025	04/06/2025	05/06/2025
Corrosivity Index						
Corrosivity Index	none	1		4	4	4
pH	pH Units	0.05		8.75	8.52	8.74
Soil Redox Potential	mV	no		308	303	298
Sulphide (Na2CO3)	%	0.01		0.01	< 0.01	0.01
Resistivity (calculated)	ohms.cm	-9999		7190	4220	9260
General Chemistry						
Conductivity	uS/cm	2		139	237	108
Metals and Inorganics						
Sulphate	µg/g	0.4		23	79	24
Other (ORP)						
Chloride	µg/g	0.4		17	48	2.2

HOLDING TIME SUMMARY

Method: Calculation |

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3		5	06/02/2025	06/09/2025	06/12/2025	06/12/2025		06/12/2025
BH106 SS3		6	06/04/2025	06/09/2025	06/12/2025	06/12/2025		06/12/2025
BH111 SS5	EWL0242-JUN25	7	06/05/2025	06/09/2025	06/10/2025	06/10/2025 †	06/09/2025	06/11/2025

Anions by IC

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

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3	DIO0285-JUN25	5	06/02/2025	06/09/2025	06/12/2025	06/12/2025	07/02/2025	06/13/2025
BH106 SS3	DIO0285-JUN25	6	06/04/2025	06/09/2025	06/12/2025	06/12/2025	07/02/2025	06/13/2025
BH111 SS5	DIO0285-JUN25	7	06/05/2025	06/09/2025	06/12/2025	06/12/2025	07/05/2025	06/13/2025

Carbon/Sulphur

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

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3	ECS0032-JUN25	5	06/02/2025	06/09/2025	06/11/2025	06/11/2025	06/16/2025	06/11/2025
BH106 SS3	ECS0032-JUN25	6	06/04/2025	06/09/2025	06/11/2025	06/11/2025	06/18/2025	06/11/2025
BH111 SS5	ECS0032-JUN25	7	06/05/2025	06/09/2025	06/11/2025	06/11/2025	06/19/2025	06/11/2025

Conductivity

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

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3	EWL0222-JUN25	5	06/02/2025	06/09/2025	06/10/2025	06/10/2025	07/02/2025	06/11/2025
BH106 SS3	EWL0222-JUN25	6	06/04/2025	06/09/2025	06/10/2025	06/10/2025	07/04/2025	06/11/2025
BH111 SS5	EWL0222-JUN25	7	06/05/2025	06/09/2025	06/10/2025	06/10/2025	07/05/2025	06/11/2025

Inorganics-General

Method: N/A - Calculation | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-30

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3	EWL0242-JUN25	5	06/02/2025	06/09/2025	06/10/2025	06/10/2025		06/11/2025
BH106 SS3	EWL0242-JUN25	6	06/04/2025	06/09/2025	06/10/2025	06/10/2025		06/11/2025
BH111 SS5	EWL0242-JUN25	7	06/05/2025	06/09/2025	06/10/2025	06/10/2025		06/11/2025

pH

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

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
BH101 SS3	EWL0222-JUN25	5	06/02/2025	06/09/2025	06/10/2025	06/10/2025 †	06/09/2025	06/11/2025
BH106 SS3	EWL0222-JUN25	6	06/04/2025	06/09/2025	06/10/2025	06/10/2025	06/11/2025	06/11/2025
BH111 SS5	EWL0222-JUN25	7	06/05/2025	06/09/2025	06/10/2025	06/10/2025	06/12/2025	06/11/2025

QC SUMMARY

Anions by IC

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0285-JUN25	µg/g	0.4	<0.4	12	35	96	80	120	101	75	125
Sulphate	DIO0285-JUN25	µg/g	0.4	<0.4	35	35	99	80	120	104	75	125

Carbon/Sulphur

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0032-JUN25	%	0.01	< 0.01								

Conductivity

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0222-JUN25	uS/cm	2	< 2	0	20	98	90	110	NA		

QC SUMMARY

pH

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0222-JUN25	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

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

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

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

This report supersedes all previous versions.

-- End of Analytical Report --

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

Request for Laboratory Services and CHAIN OF CUSTODY

No: 042794

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: Scott Ren

Received Date: 06/09/2025 (mm/dd/yy)

Received Time: 07:30 (hr : min)

Received By (signature): S

Custody Seal Present: Yes ☑ No ☐

Custody Seal Intact: Yes ☐ No ☐

Cooling Agent Present: Yes ☑ No ☐ Type: ice

Temperature Upon Receipt (°C) 4x3

LAB LIMS #: CA40092 Jun 25

REPORT INFORMATION

Company: Grounded Engineering

Contact: Kristen Shaver

Address: 49 Mobile Dr., Toronto ON, M4A 1H5

Phone:

Fax:

Email: kshaver@groundedeng.ca

INVOICE INFORMATION

☒ (same as Report Information)

Company:

Contact:

Address:

Phone:

Email:

Quotation #:

P.O. #:

Project #: 25-069

Site Location/ID: 340 Burnhamthorpe Rd. E. Oakville

TURNAROUND TIME (TAT) REQUIRED

☐ Client Regular TAT ☒ Regular TAT (5-7days)

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

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

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

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

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19

☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse

☐ Table 2 ☐ Ind/Com ☐ Medium/Fine

☐ Table 3 ☐ Agri/Other

☐ Table ____ Appx. ____

Soil Volume ☐ <350m3 ☐ >350m3

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

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☒ YES ☐ NO

ANALYSIS REQUESTED

M & I: Field Filtered (Y/N); Metals & Inorganics (incl CrVI, CN, Hg pH, (B(HWS), EC, SAR-soil) (Cl, Na-water)); Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI); ICP Metals only (Sb,As,Ba,Be,B,Cd, Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn)

SVOC: PAHs only; SVOCs (all incl PAHs, ABNs, CPs)

PCB: PCBs ☐ Total ☐ Aroclor

PHC: F1-F4 + BTEX; F1-F4 only (no BTEX)

VOC: VOCs (all incl BTEX); BTEX only

Pest: Pesticides (Organochlorine or specify other)

Other (please specify): Corrosivity; ~~OCPs~~; Sewer Use: (Specify pkg:); Water Characterization Pkg ☐ General ☐ Extended

SPLP (Specify tests): ☐ Metals ☐ VOC ☐ 1,4-Dioxane ☐ OCP ☐ ABN

TCLP (Specify tests): ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Corrosivity	~~OCPs~~	COMMENTS
1	BH101 SS3	06/02/25	18:00	1	soil	X		
2	BH106 SS3	06/04/25	12:30	1	↓	X		
3	BH111 SS5	06/05/25	15:00	1		X		
4	~~BH108 SS3~~	~~06/06/25~~	~~17:30~~	~~1~~			~~X~~	
5	~~BH112~~							
6								
7								
8								
9								
10								
11								
12								

EB

Observations/Comments/Special Instructions

Sampled By (NAME): Elizabeth Beard Signature: E. Beard Date: 06/06/25 (mm/dd/yy)

Relinquished by (NAME): Signature: Date: __/__/__ (mm/dd/yy)

Pink Copy - Client

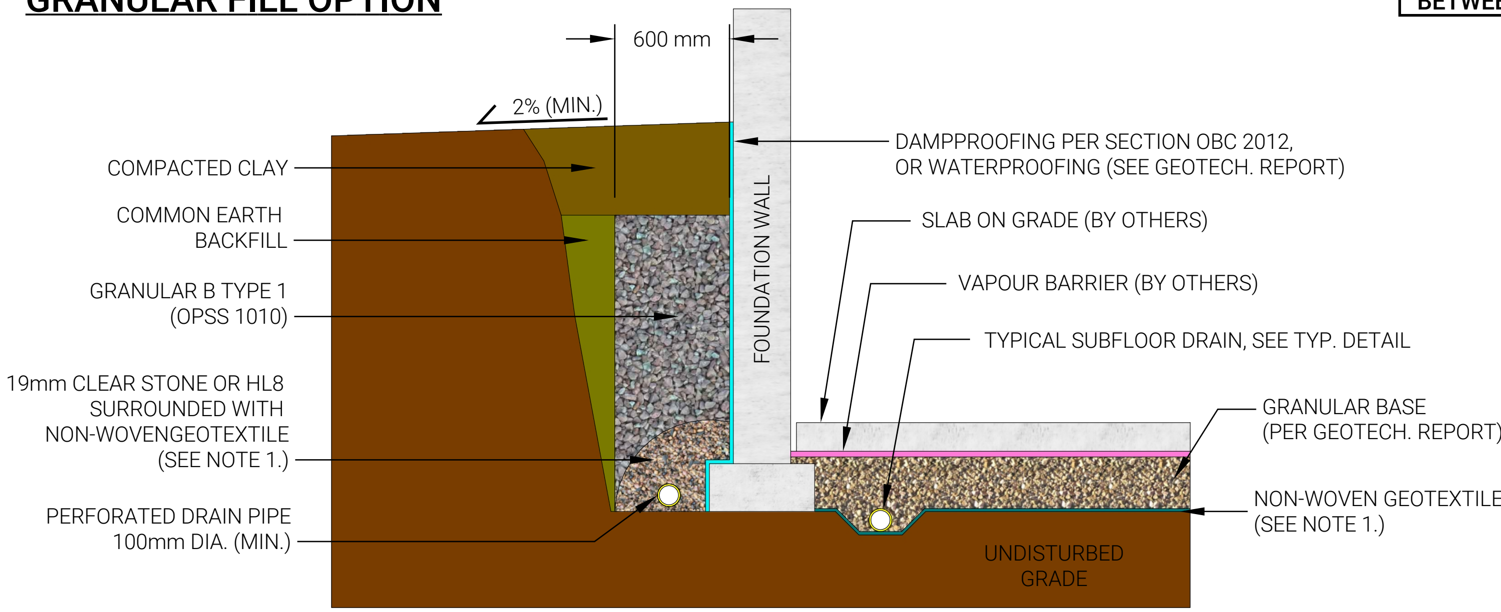
Yellow & White Copy - SGS

Revision #: 1.8 Date of Issue: 06 SEP 2024

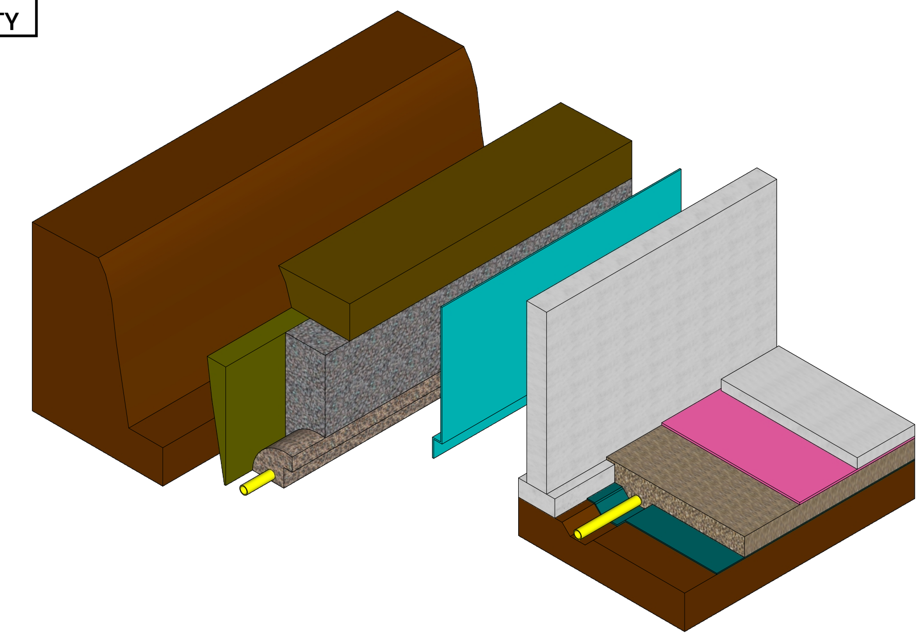
APPENDIX D

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY

GRANULAR FILL OPTION

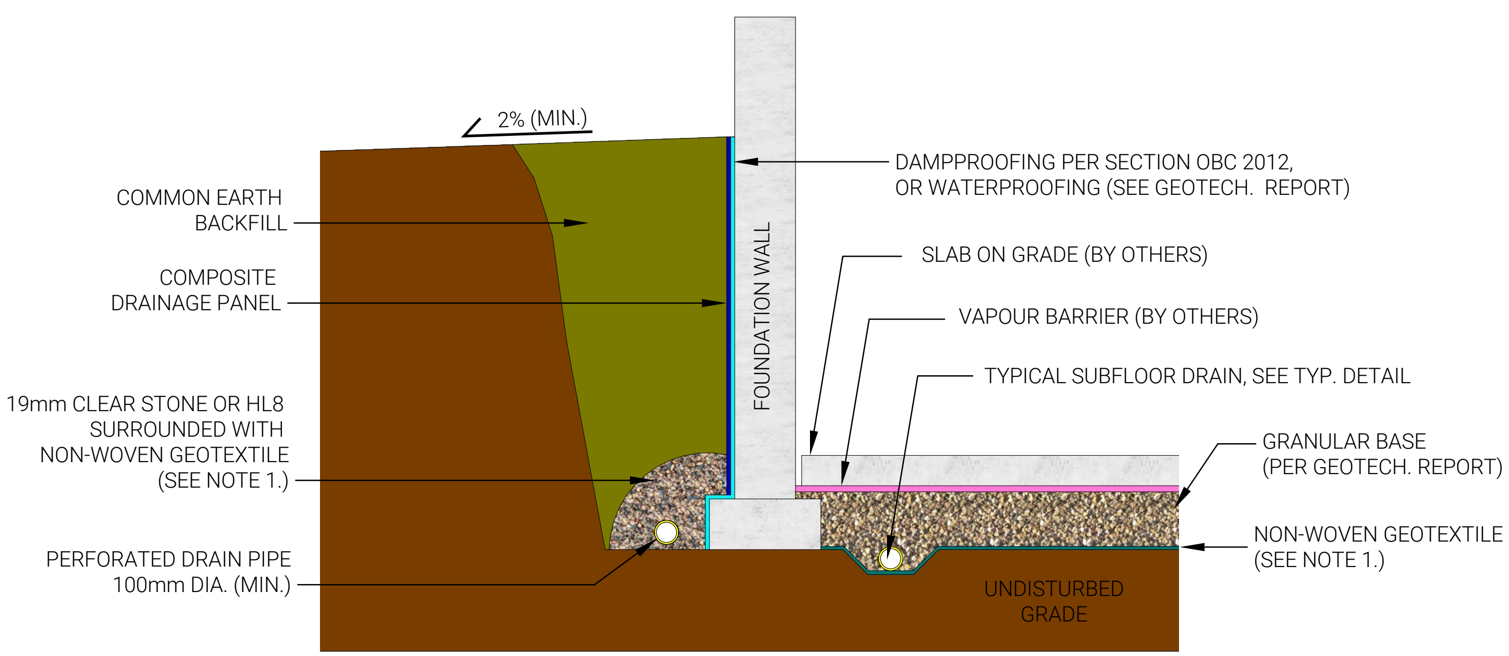


SECTIONAL VIEW

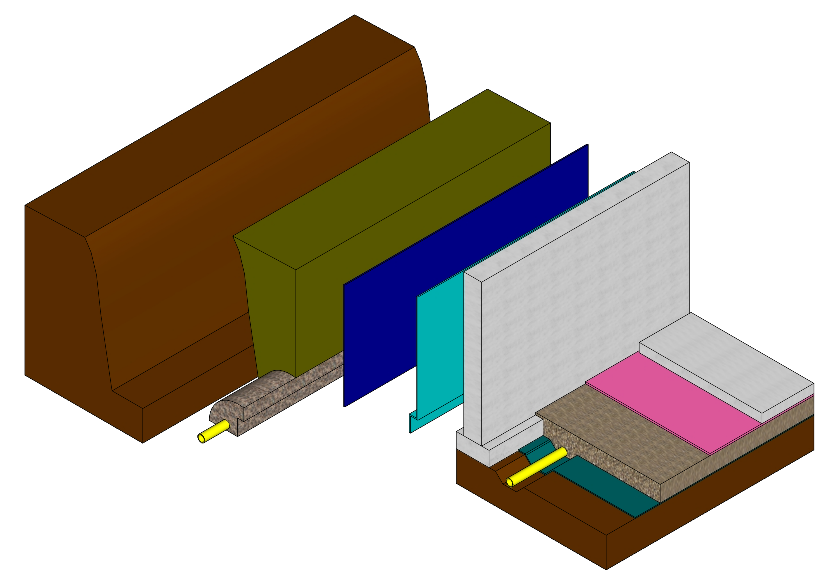


ISOMETRIC VIEW

GEO-COMPOSITE DRAINAGE PANEL OPTION



SECTIONAL VIEW



ISOMETRIC VIEW

NOTES

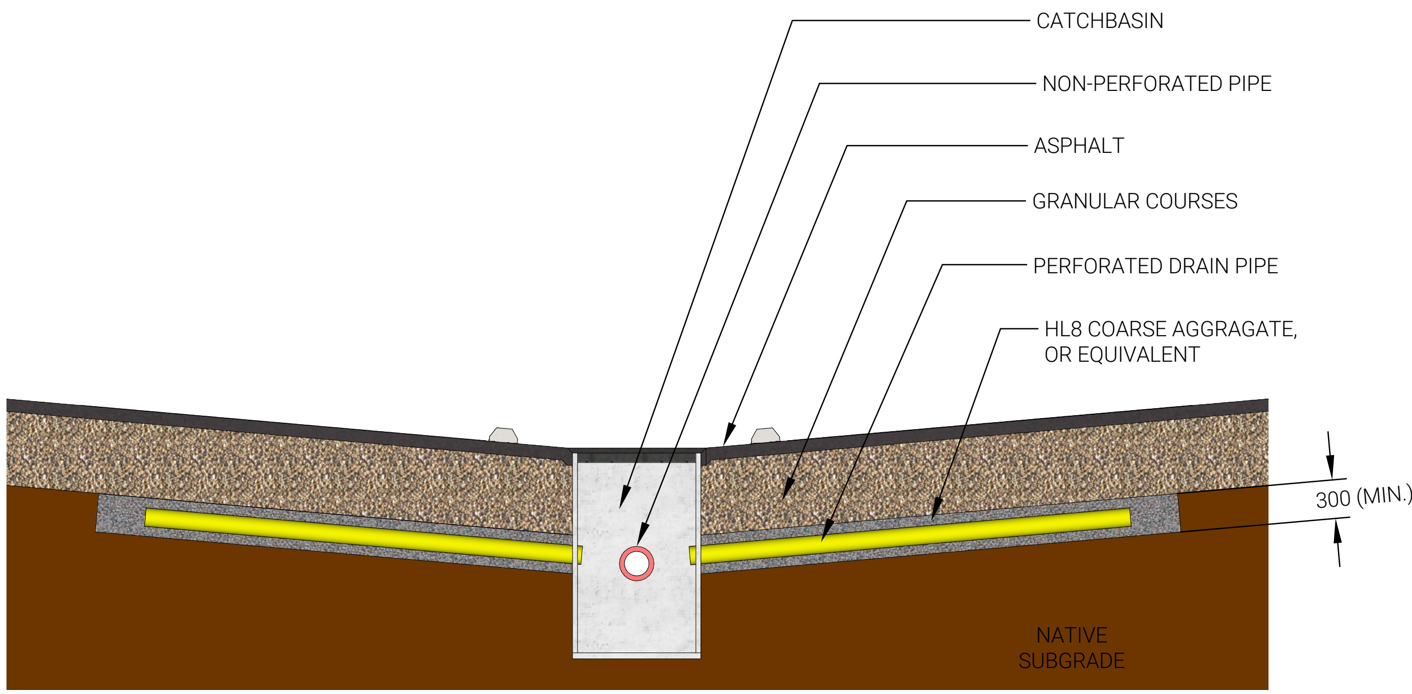
1. A NON-WOVEN GEOTEXTILE WITH AN APPARENT OPENING SIZE OF < 0.250mm AND A TEAR RESISTANCE OF > 200 N.

GROUNDED ENGINEERING

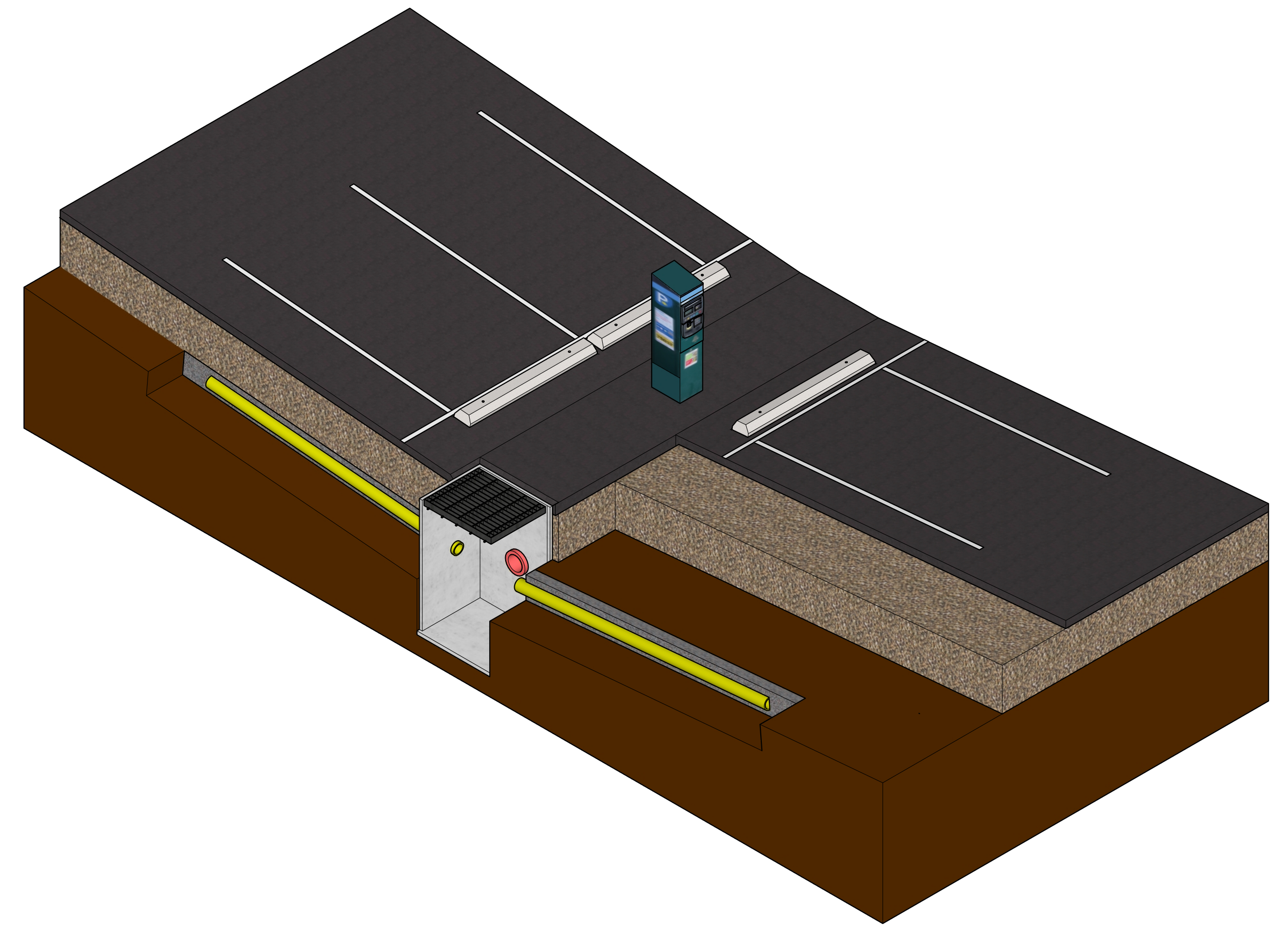
Title

BASEMENT DRAINAGE TYPICAL DETAIL

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



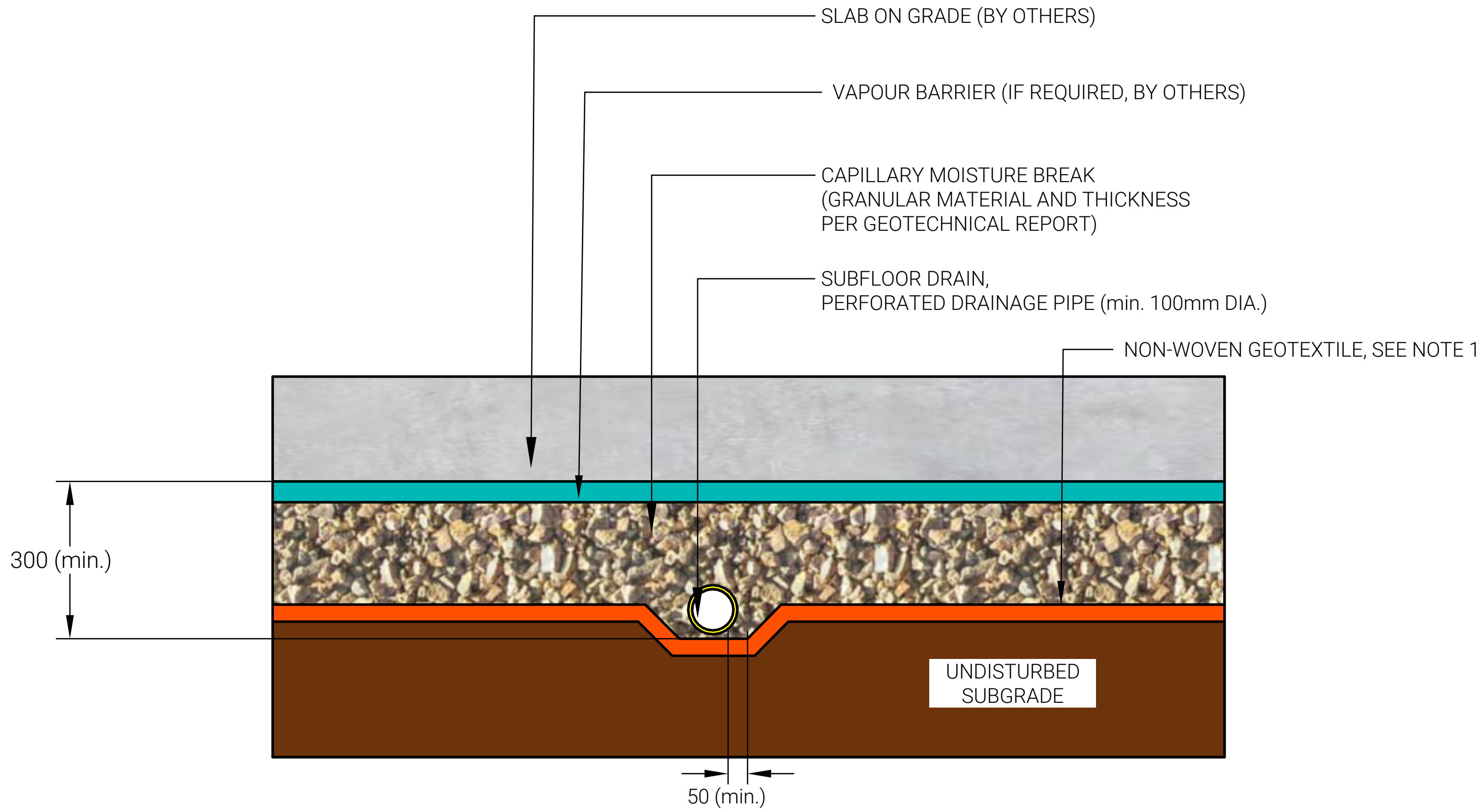
ISOMETRIC

GROUNDED
ENGINEERING

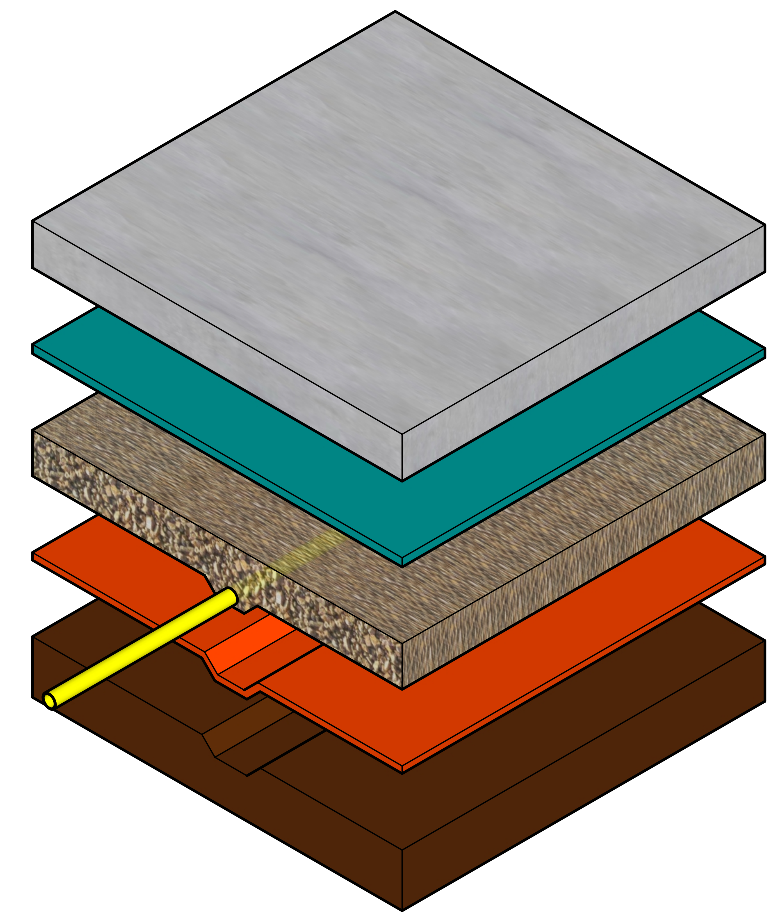
Title

LONGITUDINAL SUBDRAIN CONNECTION TO CATCHBASIN

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

APPENDIX E

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