



Geotechnical Investigation

Proposed Nature Centre Building

Scanlon Creek Conservation Area, 2450 9th Line, Bradford,
Ontario

Submitted to:

Lake Simcoe Region Conservation Authority

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1. Introduction

GEI Consultants (GEI) was retained by the Lake Simcoe Region Conservation Authority (LSRCA, the Client) to complete a geotechnical investigation and report for the proposed development of the Scanlon Creek Nature Centre at 2450 9th Line, in Bradford, Ontario. A site location plan is enclosed as Figure 1. Revision 1 of this report was prepared to include analysis and recommendations for the proposed slope cut for site grading in the southeastern part of the proposed new southern parking lot.

The study area measures approximately 1.94 ha in size. Existing developments in or near the study area include roadways, a parking lot, and septic beds, an existing Operations Centre in the western part of the site, and an existing Education Centre to the northeast of the site. Parts of the site are currently wooded and covered with vegetation, while the roadways and the parking lot area are surfaced with gravel. An aerial image of the site is provided on Figure 2.

The following drawings were provided to GEI for review:

- Drawing set: “*Scanlon Creek Nature Centre*,” dated November 10, 2023, by Gow Hastings Architects, showing site plans and elevation views of the proposed Nature Centre.
- “*Preliminary Grading Plan*,” Figure No. 5.1, Project No. 2238, dated February 2024, by SCS Consulting Group.

It is proposed to construct an approximately 595 m² (6400 ft²) Nature Centre with an approximately 227.5 m² (2449 ft²) outdoor terrace space. It is understood that part of the building will have a basement level set 3.25 m below Level 1 of the building. Finished Floor Elevations (FFE) were not available, but in discussion with Gow Hastings Architects it is understood the basement level may be set near Elev. 268.5 m. Due to the existing gradual sloping grades in the proposed building area, the basement could be about 0.5 to 1 m below grade at the west side of the building and about 3.5 m below grade at the east side. The proposed building location is shown on Figure 2B. A new parking lot is proposed just southeast of the existing Operations Centre, as shown on Figure 2B. The preliminary grading plan shows that the southern parking lot could range from near Elev. 267.6 to 269.47 m, but other site grades are unknown. It is noted that existing septic beds are currently located beneath the proposed parking location, but will be decommissioned as part of the development. Other features include proposed accessible parking spaces, a bus drop-off, and bike parking.

The purpose of the geotechnical investigation was to assess the subsurface soil conditions at the site, and based on this information, provide geotechnical engineering recommendations in support of the proposed development. This report summarizes the subsurface conditions, provides geotechnical engineering recommendations for foundations, slabs-on-grade, earth



pressures, basement drainage, site servicing installation, and pavement design. Considerations for constructability such as soil excavation, compaction, on-site backfill suitability and temporary groundwater control are also provided.

GEI has also been retained to complete a hydrogeological study, a Phase One ESA, a soil characterization report, a potable water assessment, and detailed design for a new large subsurface sewage disposal system under separate covers.



2. Procedures and Methodology

It is noted that all elevations in this report are metric/geodetic and expressed in metres (m). All measurements are also in metric and expressed in millimetres (mm), metres (m) or kilometers (km).

Prior to the commencement of drilling activities, the borehole locations were staked in the field by GEI. It is noted that the borehole locations were established prior to drilling using a previous site plan provided from Gow Hastings Architects. The proposed building footprint on the latest site plan has shifted slightly compared to the previous plan, however the borehole coverage is still considered sufficient.

Underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies. LSRCA Operations Staff also assisted with locating private buried utilities.

The fieldwork for the drilling program was carried out between October 25 to 27, 2023. Boreholes 1 to 7 were advanced to 8.2 m depth below existing grade (Elev. 263.9 to 260.8 m). Boreholes 8 to 10 were advanced to 3.5 to 3.7 m depth below existing grade (Elev. 265.3 to 263.2 m). Boreholes 11 and 12 were advanced to 2.1 m depth below existing grade (Elev. 271.8 to 269.9 m). Borehole logs are provided in Appendix A and the borehole locations are shown on Figures 2A and 2B.

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a track-mounted drill rig, hollow stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) “N” Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Ground surface elevations of the boreholes (referencing NAD 83 geodetic datum) and coordinates were surveyed by GEI with a Topcon FC – 5000 GPS Survey unit.

Monitoring wells were installed in Boreholes 2, 4, 7 and 12 by GEI to facilitate long-term groundwater monitoring, each consisting of 50 mm diameter PVC pipe with a 1.5 m long screen and protective casing. Monitoring well construction is shown on the borehole logs in Appendix A. Boreholes without wells were backfilled in accordance with O.Reg. 903.

The GEI field staff examined, and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, groundwater observations during and upon



completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI's laboratory for more detailed examination and classification.

In GEI's laboratory, the samples were classified as to their visual and textural characteristics. Four (4) representative samples of the major soil units were selected and submitted to our laboratory for grain size analysis. Grain size results are provided in Appendix B.



3. Subsurface Conditions

3.1 General Overview

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix A, and the geotechnical laboratory results are included in Appendix B. The borehole locations are shown on Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including: visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

3.2 Stratigraphy

The site is predominantly underlain by loose to very dense glacial till deposits. The subsurface soil conditions encountered in the boreholes are summarized below.

3.2.1 *Topsoil*

A surficial topsoil layer was at the ground surface in Boreholes 3 to 12 ranging in thickness from 100 to 405 mm.

3.2.2 *Granular Material*

Boreholes 1 and 2 were advanced through the granular material at the existing parking lot and encountered 125 to 180 mm of granular material.

3.2.3 *Earth Fill / Reworked Native Soil*

A layer of earth fill (which appears to consist of reworked native soil) was revealed beneath the topsoil in Boreholes 4 to 12 and extended to depths of 0.8 to 1.5 m (Elev. 273.2 to 266.1 m). The earth fill typically comprised silty sand / sandy silt / clayey silt, with trace to some organics, trace to some rootlets, and trace to some gravel. Some zones of the earth fill contained

trace amounts of wood fragments. The material was loose to compact, with SPT “N” values of 4 to 11, was typically moist with moisture contents of 5 to 19%, and was brown to dark brown.

3.2.4 Glacial Till Deposits

Glacial till deposits were encountered at depths of 0.1 to 1.5 m below grade (Elev. 273.2 to 266.1 m) underlying the granular or topsoil in Boreholes 1 to 3, and underlying the earth fill in Boreholes 4 to 12.

In the proposed Nature Centre building location, Boreholes 1 to 4 encountered an upper unit of glacial till with a cohesionless matrix consisting of sand and silt, with some clay and trace gravel that extended to depths of 2.3 to 3.0 m below grade (Elev. 267.7 to 266.4 m). Trace to some organics and trace to some rootlets were encountered in the upper zone of this glacial till unit. The sand and silt glacial till was typically brown and moist, with moisture contents of 9 to 25%. The SPT “N” values ranged from 5 to 27 indicating a loose to compact relative density. Two soil samples were submitted for grain size analysis which measured 3 to 9% gravel, 39 to 40% sand, 39 to 42% silt, and 12 to 16% clay as shown in Appendix B.

In the proposed building location, Boreholes 5 to 7 encountered an upper unit of glacial till with a cohesive matrix that consisted of sandy and clayey silt, with trace gravel. The unit extended to 3.0 to 4.6 m below grade (Elev. 268.9 to 267.5 m) and was brown and moist. The SPT “N” values ranged from 6 to 55, indicating a firm to hard (but typically stiff) consistency. Two soil samples were submitted for grain size analysis which measured 1 to 2% gravel, 21 to 22% sand, 51 to 52% silt, and 25 to 26% clay as shown in Appendix B. A local wet zone (potentially perched water) was encountered in the glacial till at 1.5 m below grade in Borehole 6.

Underlying the upper glacial till units, Boreholes 1 to 7 encountered a deeper unit of glacial till with a cohesionless matrix comprising sandy silt to sand and silt, with trace clay and trace gravel. This unit extended beyond the depth of investigation at 8.2 m below grade (Elev. 263.9 to 260.8 m) and was brown and moist. The deposit was noted as wet at 7.5 m below grade in Boreholes 2 and 3. The measured SPT “N” values ranged from 20 to more than 100, indicating compact to very dense (but typically dense to very dense) conditions.

Boreholes 8 to 10 were advanced in the proposed new parking area. Underlying the earth fill, the boreholes encountered glacial till consisting of silty sand to sandy silt, trace clay to clayey, and trace to some gravel. The deposit was brown and moist, extended to 3.0 m (Elev. 263.8 m) in Borehole 10 and extended beyond the depth of drilling in Boreholes 8 and 9 at 3.5 to 3.7 m (Elev. 265.3 to 265.2 m). The SPT “N” values ranged from 9 to 87, indicating loose to very dense conditions.



The glacial till encountered in Boreholes 11 and 12 consisted of silty sand to sandy silt, with trace clay and trace gravel. The till was brown and moist, and the SPT “N” values were 11 to 17 indicating a compact relative density.

It is noted that cobbles and boulders are inferred to be embedded within all glacial till deposits encountered on site.

3.2.5 *Fine Sand*

Beneath the glacial till deposit in Borehole 10, a deposit of fine sand with some silt and trace gravel was encountered. The sand was encountered at 3.0 m below grade (Elev. 263.8 m) and extended beyond the 3.7 m depth of the exploration (Elev. 263.2 m). The SPT “N” Value measured in the sand was 47, indicating a dense relative density. The sand was greyish brown and moist with a moisture content of 4%.

3.2.6 *Sand and Gravel*

Beneath the glacial till unit in Borehole 12, a deposit of sand and gravel with trace silt was encountered. The sand and gravel was encountered at 1.5 m below grade (Elev. 272.4 m) and extended beyond the 2.1 m depth of the exploration (Elev. 271.8 m). The soil was very dense with a measured SPT “N” value of 64. The soil was brown and damp, with a moisture content of 2%.

3.3 Groundwater

Unstabilized groundwater level measurements and cave measurements were taken upon the completion of drilling of each borehole as shown on the borehole logs in Appendix A. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. Unstabilized groundwater was encountered in Borehole 3 at 7.6 m below grade. All other boreholes remained open and dry upon completion.

Four (4) boreholes were outfitted with a monitoring well with 50 mm diameter PVC standpipes and typically 1.5 m long screens. Monitoring well configuration and groundwater observations are noted on the borehole logs in Appendix A, and a summary is below.

Monitoring Wells	Well Screen Location		Strata Screened	Groundwater Level Depth / Elev. (m)	
	Depth (m)	Elev. (m)		Nov. 7, 2023	Nov. 25, 2023
BH/MW 2	4.6 to 7.6	264.8 to 261.8	Silty Sand Glacial Till	Dry	Dry
BH/MW 4	4.6 to 7.6	266.1 to 263.1	Silty Sand Glacial Till	Dry	Dry
BH/MW 7	4.6 to 7.6	267.5 to 264.5	Silty Sand to Sand and Silt Glacial Till	Dry	Dry



Monitoring Wells	Well Screen Location		Strata Screened	Groundwater Level Depth / Elev. (m)	
	Depth (m)	Elev. (m)		Nov. 7, 2023	Nov. 25, 2023
BH/MW 12	0.6 to 2.1	273.4 to 271.9	Sandy Silt to Silty Sand Glacial Till; Sand and Gravel	Dry	Dry

The monitoring wells remained dry on both observation dates. The prevailing groundwater table is therefore deeper than 7.5 m below grade in the proposed Nature Centre building location.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. Additional groundwater details are provided in GEI's hydrogeological report under a separate cover.

3.4 Soil Chemistry Analysis

3.4.1 Topsoil Testing

Chemical sampling was conducted to provide a general characterization of the topsoil on site. Each chemical sample was taken from a cleaned split spoon (to mitigate the potential for cross-contamination), with a dedicated pair of nitrile gloves and placed into a sterile jar or vial which was then subsequently placed in an insulated cooler on ice to keep the temperature between 0° to 10° C.

Topsoil samples were collected from Boreholes 3, 4, 7, 8 and 9 and were submitted to CALA-accredited SGS Canada Inc. for analysis. Please refer to Appendix C for the topsoil testing results and assessments provided by SGS.

3.4.2 Soil Corrosivity and Sulphate Attack of Concrete

The following three (3) soil samples were collected from the site and submitted to CALA-accredited AGAT Laboratories for testing to determine the potential for soil corrosivity and sulphate attack on concrete:

- BH1 / SS3.
- BH6 / SS4.
- BH7 / SS2.

The American Water Works Association (AWWA) has developed a scoring system in their C-105 Standard to determine the potential for soil to corrode cast iron alloys. The scoring system assigns points based on several soil parameters, including resistivity, pH, redox potential, sulfides, and moisture content. A rank of 10 or more indicates a potential for corrosion and



suggests that corrosion protection measures should be considered. The results from the testing at this site is summarized below and the laboratory Certificate of Analysis is included as Appendix C.

Soil Parameter	AWWA Score		
	BH1 / SS3	BH6 / SS4	BH7 / SS2
Resistivity	1	0	0
pH	0	3	0
Redox Potential*	5*	5*	5*
Sulfides	0	0	2
Moisture	1	1	1
TOTAL SCORE	7*	9*	8*

*Redox potential testing was not completed by the chemical laboratory. The maximum score of 5 for redox potential was assigned in this case, but the total score still remains below 10 for all samples tested.

Based on the AWWA scoring system, the samples from Boreholes 1, 6, and 7 scored less than 10 points which indicates a low potential for the soil corrosivity to affect cast iron alloys and corrosion protection measures are therefore not recommended in the south half of the site.

It should be noted that this ranking system provides a general indication of soil corrosivity potential only. Other external factors may increase corrosivity potential, such as stray electrical currents or the application of de-icing salts in the winter that can leach into the ground.

The samples were also tested for water-soluble sulphate content and compared to *Table 3: Additional Requirements for Concrete Subjected to Sulphate Attack* as found in CSA A23.1 *Concrete Materials and Methods of Construction*. Table 3 is used to determine the cementing materials required in concrete based on degree of exposure to sulphate attack. The testing shows the samples have less than 0.02% water-soluble sulphate, and therefore there will be negligible exposure to sulphate attack. The cementing materials listed in CSA A23.1 Table 3 are not required at this site based on sulphate attack potential.



4. Engineering Design Parameters & Analysis

It is proposed to construct an approximately 595 m² (6400 ft²) Nature Centre with an approximately 227.5 m² (2449 ft²) outdoor terrace space. It is understood that part of the building will have a basement level set 3.25 m below Level 1 of the building. Finished Floor Elevations (FFE) were not available, but in discussion with Gow Hastings Architects it is understood the basement level may be set near Elev. 268.5 m. Due to the existing gradual sloping grades in the proposed building area, the basement could be about 0.5 to 1 m below grade at the west side of the building and about 3.5 m below grade at the east side. The proposed building location is shown on Figure 2B. A new parking lot is proposed just southeast of the existing Operations Centre, as shown on Figure 2B. The preliminary grading plan shows that the southern parking lot could range from near Elev. 267.6 to 269.47 m, but other site grades are unknown. It is noted that existing septic beds are currently located beneath the proposed parking location, but will be decommissioned as part of the development. Other features include proposed accessible parking spaces, a bus drop-off, and bike parking.

Final site servicing or grading plans were not available at the time of writing this report. GEI should be provided with any drawings when available to review and confirm the geotechnical recommendations below remain valid.

4.1 Site Grading

“Preliminary Grading Plan,” (Figure No. 5.1, Project No. 2238, dated February 2024, by SCS Consulting Group) shows that the southern parking lot could range from near Elev. 267.6 to 269.47 m. No other proposed site grades are shown, but it is speculated that only minor grading will be required for the building and other parking areas to establish proposed grades, as the site already contains buildings and parking spaces with surrounding infrastructure. When grading is established, GEI should review the drawings for geotechnical requirements. Please refer to Section 4.9 for details on the slope stability analysis and review of the proposed slope adjacent to the southern parking lot.

4.1.1 General Site Grading and Septic Bed Backfill

Some general site grading will be required for the proposed parking areas. Furthermore, the existing septic beds just southeast of the Operations Centre are beneath the proposed parking lot, and will be decommissioned and removed during construction. Once the septic beds are removed, the excavation will be backfilled up to the granular pavement structure subgrade.

The existing topsoil, gravel pavement structures, organic rich soils, deleterious soils, septic bed material, and vegetation must be stripped from any location where grades will be raised, prior to placing any new fill. A subgrade consisting of the existing earth fill / reworked native



soil or glacial till deposits as encountered in Boreholes 8 to 10 are suitable to accommodate grade raises beneath new pavement structures and landscaped areas. The exposed soil subgrade must be proof-rolled and inspected by the geotechnical engineer in advance of placing fill. Any soil subgrade areas observed containing excessive organics, soft or weak areas, or deleterious material should be further sub-excavated to a competent subgrade under the direction of the geotechnical engineer.

Once the subgrade is approved, all new material placed to raise the grades shall be inorganic soil sourced from the site or suitable imported fill compacted to a minimum of 98% SPMDD, within 2% of optimum moisture content. The purpose of this compaction specification is to provide uniform support and to mitigate the potential of significant differential settlements. Additional soil compaction recommendations are provided in Section 5.2 of this report.

4.1.2 Engineered Fill

GEI defines “engineered fill” as material that will support foundations, and which is placed and compacted in a specified and controlled manner under full-time supervision of geotechnical engineering staff.

In any location where engineered fill will be placed to raise grades or replace poor / weak soil, the topsoil, vegetation, granular pavement, and existing earth fill (if encountered) must be fully removed down to competent soil. The exposed subgrade soil must be proof-rolled and inspected by the geotechnical engineer to ensure all unsuitable material (e.g. organics, weak or soft soil, weathered / disturbed soil, deleterious materials, existing fill) was removed from the engineered fill footprint. Any unsuitable areas must be further sub-excavated to a competent subgrade.

Once the subgrade is approved, engineered fill can be placed. Engineered fill is compacted to targeted 100% Standard Proctor Maximum Dry Density (SPMDD), minimum 98% SPMDD in building areas. Engineered fill must be placed under the full-time supervision of a geotechnical engineer as required in the Ontario Building Code. The engineered fill may consist of excavated on-site native cohesionless soils provided they have been moisture conditioned to a moisture content within 2% of optimum moisture content and do not contain organics, topsoil or deleterious material. It is recommended that any imported soil to be used as engineered fill consist of Granular B (OPSS.MUNI 1010). Engineered fill must be placed in loose lifts of 200 mm or less and compacted as noted above.

The engineered fill must extend a minimum of 1 m out from all sides of the foundations and extend at a 1 horizontal to 1 vertical slope (1H:1V) down to the exposed subgrade. A typical detail for engineered fill pad dimensioning is included in Appendix D.



4.2 Foundation Design

4.2.1 Foundations on Native Soil

The proposed Nature Centre building can be constructed on conventional spread and strip footings. Topsoil, pavements, existing earth fill, and disturbed native soils are not suitable for the support of foundations. The undisturbed glacial till encountered in Boreholes 1 to 7 is suitable for the support of foundations.

Spread footings or strip footings made on the undisturbed, loose to compact / firm to stiff glacial till encountered at 1.5 m below ground surface (Elev. 270.6 to 267.5 m) can be designed using a geotechnical reaction of 100 kPa at SLS, for 25 mm or less of total settlement. The maximum factored geotechnical resistance is 150 kPa at ULS.

If footings are made on the undisturbed native soils encountered on site at 3.0 m below ground surface (Elev. 269.1 to 266.0 m), the footings can be designed using a geotechnical reaction of 250 kPa at SLS, for 25 mm or less of total settlement. The maximum factored geotechnical resistance is 350 kPa at ULS.

Final footing elevations must be reviewed by geotechnical personnel from GEI to confirm bearing capacity values. The final site configuration must also be reviewed by GEI to assess the potential for footings to be founded on different soil subgrades, and to assess the potential for differential settlement. It is recommended that all foundations for each individual building / structure be set on the same soil subgrade wherever possible, to reduce the potential for differential settlement.

4.2.2 Foundations on Engineered Fill

Alternatively, the foundations can be support on engineered fill used to raise grades beneath the building footprint. As the building is currently designed it is considered unlikely that this will be the case but is being provided in the case that the building design elevations or building footprint is revised. If the foundations are set on an engineered fill pad, constructed as discussed in Section 4.1.2, the spread or strip footings can be designed using a geotechnical reaction of 100 kPa at SLS, for 25 mm or less of total settlement, and a maximum factored geotechnical resistance of 150 kPa at ULS.

It is recommended that nominal reinforcing steel for stiffening of the foundation walls made on engineered fill be provided to help mitigate minor cracking due to minor differential settlement. The reinforcing steel in the poured concrete foundation walls may 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. Typically, these bars are placed 100 to 200 mm from the top or bottom of the foundation wall, respectively. The reinforcing steel should extend a minimum of 3 m past any transition zones between engineered fill and native soil. A typical reinforcing



steel detail for foundation walls placed on engineered fill is provided within Appendix D. The recommended nominal reinforcing steel should not be considered a structural design. The need for different or additional reinforcement should be reviewed by a structural engineer to ensure the original structural design intent of the structure is maintained.

4.2.3 Exterior Light Pole Foundations

It is expected that the new light poles will generally be made in the locations of the new proposed parking lot and building. Boreholes 1 to 10 were advanced in these areas and encountered up to 1.5 m of earth fill / reworked native soil underlain by loose to compact glacial till (becoming dense to very dense with depth). Light fixtures are typically supported on shallower pile foundations.

Design elements such as the type of pile, diameter, and length of pile are unknown. The structural engineer can calculate the factored lateral resistance in the soils at ULS using passive earth pressure theory and the equation below. To account for the upper earth fill and frost penetration depth of 1.5 m, the upper 1.5 m must be neglected for lateral capacity of the piles. All other surficial weak soils such as earth fill should also be neglected when determining lateral resistance.

$$P = \Phi 1.5 K_p \gamma D H^2$$

- where, **P** = factored passive lateral resistance at ULS (kN)
K_p = passive earth pressure coefficient (dimensionless) = 3.25 for the glacial till soils on site.
H = length of the pile (m)
γ = the bulk unit weight of soil, (kN/m³) = 20 kN/m³ for the glacial till soils.
D = diameter of the pile (m)
Φ = resistance factor = 0.5 for horizontal passive resistance.

The manufacturer of the light poles may have specific design standards and considerations regarding installation, depth, and passive resistance. In this context, GEI advises opting for the more conservative approach between the manufacturer's design methodology and the recommendations and design considerations outlined above.

4.2.4 General Foundation Considerations

All footings exposed to ambient air temperature throughout the year must be provided with a minimum of 1.5 m of earth cover or equivalent insulation for frost protection (25 mm of polystyrene insulation is equivalent to 300 mm of soil cover). The minimum strip and spread footing widths to be used shall be dictated as per the Ontario Building Code, regardless of loading considerations. Footings stepped from one level to another must be at a slope not exceeding 7V:10H. If foundations for the building are set on two different types of soil (i.e. a



portion of the building is on engineered fill while another portion is on native soil), it is recommended to uniformly use the more conservative bearing capacity across the entire building.

The foundation design parameters provided above are predicated on the assumption that the foundation subgrade surface is undisturbed, and that all deleterious, softened, disturbed, organic, and caved material is removed. The foundation excavation must be done in such a way that groundwater is controlled to prevent any disturbance to the foundation base.

The foundation subgrade must be reviewed by the geotechnical engineer prior to concrete placement to ensure the foundation design parameters provided are applicable, and to provide remedial recommendations if necessary. If the foundation excavation will be open for a prolonged period of time, the foundation subgrade should be protected with a skim coat of lean mix concrete (applied immediately after inspection by the geotechnical engineer), to ensure that no deterioration will occur due to weather effects.

4.3 Seismic Site Classification

Section 4.1.8.4 of the Ontario Building Code provides values of the acceleration and velocity-based site coefficients (F_a and F_v) for various time periods, associated with specific Site Classes. These Site Classes are based on the energy-corrected Average Standard Penetration Resistance values and undrained shear strength within the 30 metres of soil directly underlying the foundations of the proposed structure. As the boreholes were advanced less than this depth at the site, the site classification recommendation provided below assumes that the soil conditions are similar below the drilled depth.

The foundations for the proposed Nature Centre building will be set on loose to compact or dense glacial till, or on engineered fill constructed from an undisturbed glacial till subgrade. The glacial till is typically very dense below 3 to 5 m below grade. Based on the soil profile revealed in the boreholes and SPT “N” Values, the applicable Site Classification for Seismic Site Response is Class “C” for this site.

4.4 Basement Wall Earth Pressure Design Parameters

Basement walls must be designed to resist unbalanced lateral earth pressures imparted from the weight of adjacent soils. Lateral earth pressures are calculated using the following equation:

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

- where, P = the horizontal pressure at depth, h (m)
 K = the earth pressure coefficient (dimensionless)
 h = depth below surface in metres
 γ = the bulk unit weight of soil, (kN/m^3)



q = surcharge loading (kPa)

The above equation assumes that a drainage system is present which prevents the build up of any hydrostatic pressure behind the structure subjected to the unbalanced lateral earth pressures. If this is not the case, the equation must be revised to also incorporate the submerged unit weight of the soil multiplied by the earth pressure coefficient, in addition to the water pressure itself.

The values for use in the design of basements subjected to unbalanced lateral earth pressures typically in the upper 2 to 5 m of the site are as follows:

Soil Type	γ – Bulk Unit Weight (kN/m ³)	ϕ – Friction Angle (degrees)	Earth Pressure Coefficient (dimensionless)		
			K_a – Active	K_o – At-Rest	K_p – Passive
Imported Granular 'B' (OPSS.MUNI 1010)	21.0	32	0.31	0.47	3.25
Existing Earth Fill	19.0	30	0.33	0.50	3.00
Loose to Compact Glacial Till	20.0	32	0.31	0.47	3.25

The calculation of the earth pressure coefficients is based on Rankine theory, which provides a conservative estimate as no friction between the soil and the structure is accounted for. The earth pressure coefficients provided above are only applicable for flat ground surfaces beyond the structure and will change for sloping ground surfaces.

The earth pressure coefficients referenced within the above table are a function of the friction angle of the adjacent soil, and both the degree and direction of movement of the structure subjected to unbalanced lateral earth pressures. For structures that are restrained at the top (such as basement walls), the at-rest earth pressure coefficient will apply. For structures that allow for 0.1 to 1% of movement away from the soil, the full active earth pressure coefficient will apply. For structures that allow for 1 to 10% of movement into the soil, the full passive earth pressure coefficient will apply. The percentage movement is based on the height of the structure.

Other types of structures such as shoring walls with multiple rows of tiebacks and soil nail walls are subject to different loading conditions and must be analyzed separately.



4.5 Floor Slabs-on-Grade

Topsoil, vegetation, organics, pavement, in-situ earth fill and other soil containing organics, excessive moisture, or deleterious materials are not suitable to support floor slabs and must be removed. The undisturbed glacial till or engineered fill are suitable for the support of a lightly loaded and unreinforced concrete slab on grade.

The exposed subgrade must be proof-rolled and inspected by the geotechnical engineer. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of deleterious / organic material, they must be locally sub-excavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 98% SPMDD within 2% optimum moisture content.

All building floor slabs must be provided with a capillary moisture barrier and drainage layer. This is made by placing the concrete slab on a minimum 200 mm layer of 19 mm clear stone (OPSS.MUNI 1004) compacted by vibration to a dense state. The upper 50 mm of clear stone can be replaced with 19 mm crusher run limestone for a working surface. The clear stone and a cohesionless subgrade must be separated by a geotextile such as Terrafix 270R (or approved equivalent) to prevent the migration of fines into the clear stone layer which could result in loss of support for the slab. Alternatively, Granular 'A' Type I (OPSS.MUNI 1010) compacted to 100% SPMDD can be utilized for the drainage layer.

The modulus of subgrade reaction for design of a slab-on-grade set on the 200 mm drainage layer with a subgrade consisting of engineered fill or undisturbed glacial till is 25,000 kPa/m.

4.6 Basement Drainage

Where a basement is constructed, the basement foundation walls must be provided with damp-proofing provisions in conformance to the Ontario Building Code. Backfill along the foundation wall must consist of Granular 'B' Type 1 (OPSS 1010) for a minimum lateral distance of 600 mm out from the foundation wall. Alternatively, if a filtered cellular drainage media is provided adjacent to the foundation wall, the backfill may consist of common earth fill. To minimize infiltration of surface water, the upper 150 mm of backfill should consist of relatively impervious compacted soil material.

For the basement areas, a perimeter drainage system must be installed that will remove any water that infiltrates into the building backfill, to ensure that any water does not infiltrate into the basement. The perimeter drains must consist of minimum 100 mm diameter perforated pipes wrapped in filter socks, sufficiently covered on all sides by 19 mm clear stone. Perimeter drains should be directed to the sump underneath the basement floor in solid pipes so as not to surcharge the underfloor drainage layer with water. The clear stone must be surrounded with filter fabric to prevent the migration of fines (Terrafix 270R or approved equivalent). All sump

pumps should be on emergency power for redundancy in case of a power outage. A typical basement drainage detail is included in Appendix D.

The monitoring wells installed on site were dry on two measurement dates, and the groundwater table is expected to be deeper than 7.5 m below grade. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. It is common practice to set the basement level a minimum of 0.5 m above the seasonally high groundwater level. A seasonal groundwater monitoring program is being completed by GEI in the hydrogeological study under a separate cover, but a basement level set at Elev. 268.5 m as indicated by the architect is expected to be more than 0.5 m above the seasonal groundwater level.

4.7 Site Servicing

The proposed building will be serviced with private water and septic systems. Inverts for pipe connections are assumed to extend as deep as 3 m below existing grade for purposes of this report.

4.7.1 Bedding

The type of material and depth of granular bedding below the pipe will, to some extent, depend on the method of construction used by the contractor. Pipe bedding for flexible pipes should follow the requirements in Ontario Provincial Standard Drawing 802.010 or applicable municipal standards. Pipe bedding for rigid pipes should follow the requirements in Ontario Provincial Standard Drawings 802.030 to 802.032 or applicable municipal standards.

A subgrade consisting of the native soils or earth fill at the site will provide adequate support for pipes with the bedding requirements as laid out in the above referenced OPS drawings. Where disturbance of the trench base has occurred from groundwater seepage, construction traffic, etc., or if in-situ fill is present at the invert level, the material should be sub-excavated and replaced with suitably compacted granular fill. If weak zones are encountered, they should be sub-excavated and replaced with approved earth fill from the site or imported granular material compacted to 95% SPMDD. Details on temporary groundwater control are provided in Section 5.2.

Regardless of whether flexible or rigid pipes are implemented, granular bedding and cover material should consist of a well graded, free draining material, such as Granular “A” (OPSS.MUNI 1010). All granular bedding must be compacted to a minimum of 95% SPMDD.



4.7.2 Backfill

Excavated native cohesionless soils may be re-used as backfill in trenches, provided they are moisture conditioned so that the moisture content is within 2% of optimum. Additional soil compaction details are provided in Section 5.2. The backfill should be compacted to a minimum of 95% SPMDD in landscaped areas, and 98% SPMDD below any roadways or parking areas. In confined areas the layer thickness will have to be reduced to utilize smaller compaction equipment efficiently or by using granular material instead of locally sourced fill. Any backfill that is frozen, contains a high percentage of organic material (topsoil, peat, etc.) or moisture, or has otherwise unsuitable deleterious inclusion should not be used as backfill. The maximum cobble or boulder size should not exceed half of the loose lift thickness (i.e., all particles with a diameter greater than 100 mm should be removed).

Where trenches are within the traveled portions of a roadway / parking area, backfill within the frost penetration depth of 1.5 m should consist of native, non-organic, excavated material consistent with the soils surrounding the trench. If this technique is not undertaken, then frequently problems arise with yearly differential frost heave movements between the trench backfill and the adjacent native soil. This would occur, for example, if imported granular material is used to backfill trenches which is less susceptible to frost effects compared to the native soils on site with a variable silt content. Alternatively, if different soil is used as the backfill due to issues with achieving compaction, a frost taper of 10H:1V can be implemented to help mitigate the potential for differential settlement and frost heave.

4.8 Pavement Design

A new parking area is planned as part of the development and will consist of a granular pavement structure.

4.8.1 Subgrade Preparation

Topsoil is not a suitable subgrade and must be removed. It is expected that subgrade soils below the pavement structure will consist of silty sand to clayey silt earth fill / reworked native soil, or loose to compact silty sand to sandy silt glacial till. These soils will be an adequate subgrade for the support of a pavement structure, provided the subgrade is proof-rolled, compacted to a minimum of 98% SPMDD, and inspected by a geotechnical engineer at the time of construction and does not contain excessive amounts of organics or deleterious materials. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of moisture or deleterious / organic material, they must be locally sub-excavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 98% SPMDD.



Any fill placed to raise the grades of the pavement subgrade must be compacted to a minimum of 98% SPMDD. Section 4.1 provides additional details for site grading and backfilling the existing septic beds that will be decommissioned and removed from the site.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible where fill is placed, and the subgrade is not disturbed or weakened after it is exposed/prepared.

4.8.2 Drainage

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade of 3 percent) to provide effective drainage toward subdrains or ditches/swales adjacent to the pavement. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement.

Typical pavement drainage details are provided in Appendix D. It is expected that a rural cross-section will be used for drainage where the granular pavement structure is sloped to drain into adjacent ditches or swales.

4.8.3 Granular Pavement Structures

It is understood that granular pavement structures are proposed for the site. In addition to car traffic, there will also be buses and likely a fire route that may access parts of the new pavement.

Traffic volumes are unknown but expected to be relatively low. The pavement thickness design below is based soil conditions encountered on site.

Pavement Layer	Compaction Requirements	Component Thickness	
		Light Duty (Car Traffic)	Heavy Duty (Bus Traffic, Fire Routes)
<u>Surface Course:</u> Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	200 mm	200 mm
<u>Base Course:</u> Granular B Type I or II (OPSS.MUNI 1010)		400 mm	550 mm

The granular materials should be placed in lifts 200 mm thick or less and must be compacted to a minimum of 100% SPMDD. The granular pavement materials and their placement should conform to OPSS.MUNI 206, 314, 501, and 1010 as required.

If the pavement construction occurs in wet, winter or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular courses. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials.

It should be noted that in addition to adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

4.9 Slope Stability Analysis for Parking Lot Grading Cut

4.9.1 Overview

GEI was requested to review and provide geotechnical recommendations for the proposed slope cut shown on the preliminary grading plan for the southern parking lot. The following drawing was provided for review:

- “*Preliminary Grading Plan,*” Figure No. 5.1, Project No. 2238, dated February 2024, by SCS Consulting Group.

To accommodate the proposed southern parking lot grades, a 3H:1V cut is currently shown along the eastern side of the proposed parking lot. The grading plan shows the cut could be up to 1.9 m in height in the worst-case location, with an existing grade at Elev. 269.08 m and the proposed grade at Elev. 267.22 m.

Borehole 9 was advanced near this location, and encountered 150 mm of topsoil, then firm clayey silt earth fill extending to 0.8 m below grade (Elev. 268.2 m), then silty sand to sandy silt glacial till that extended beyond the depth of drilling at 3.7 m below grade (Elev. 265.3 m). The upper zone of the glacial till was clayey and stiff, and the lower zone of glacial till contained some clay with compact to dense conditions. The groundwater table in the area is expected to be deeper than 4 m below grade near Borehole 9.



4.9.2 Soil Strength Design Parameters

Soil strength parameters for the soil stratum encountered on site were estimated based on published information, empirical correlations for cohesionless soils relating SPT “N” values, soil type, unit weight and effective friction angle, and our experience on other slope evaluation projects. The values for use in the slope stability model at this site are as follows:

Strata from Borehole 9	γ - Bulk Unit Weight (kN/m ³)	ϕ - Friction Angle (degrees)	c' – Effective Cohesion (kPa)
Earth Fill	19.0	30	0
Glacial Till	20.0	32	2

The estimated soil strength parameters are also indicated on the results of the slope stability analysis within Appendix E. The soil strength parameters are based on effective stress analysis for long-term slope stability. It is considered that these soil properties are conservative, and the site soils are stronger. Furthermore, other effects which can increase the stability of the slope, such as negative pore water pressures within unsaturated soils (matric suction), and root mat reinforcement, have not been modelled.

4.9.3 Slope Stability Results and Recommendations

It is noted MNRF guidelines allow a factor of safety between 1.20 to 1.30 for light land use (e.g. for a parking lot) when determining the stable slope inclination. The MNRF table is below:

Land Uses	Design Minimum Factor of Safety
Passive: no buildings near slope; farm field, bush, forest, timberland, woods, wasteland, badlands, tundra.	1.10
Light: no habitable structures near slope; recreational parks, golf courses, buried small utilities, tile beds, barns, garages, swimming pools, sheds, satellite dishes, dog houses.	1.20 to 1.30
Active: habitable or occupied structures near slope; residential, commercial, and industrial buildings, retaining walls, storage/warehousing of non-hazardous substances.	1.30 to 1.50
Infrastructure and Public Use: public use structures or buildings (i.e. hospitals, schools, stadiums), cemeteries, bridges, high voltage power transmission lines, towers, storage/warehousing of hazardous materials, waste management areas.	1.40 to 1.50

Based on these policy guidelines and standard engineering practice, a minimum factor of safety of 1.3 is recommended to determine the stable slope inclination for the proposed parking lot grading cut. No occupied structures are near the slope cut.

Stability analysis was carried out using the commercially available computer program *Slide2* (Version 9.029) provided by RocScience Inc. The slope stability analysis was based on a force and moment limit equilibrium analysis using the Spencer method. This method of analysis calculates the minimum factor of safety (resisting versus driving forces) for numerous circular surfaces. The circular surfaces are centered on points on a grid with a set number of radius distances to be calculated for each centre. A factor of safety of 1.0 indicates the slope is at a point of pending failure since the resisting forces are equal to the driving forces.

The results of the *Slide2* slope stability analysis are included in Appendix E and are summarized below:

- An inclination of 2 horizontal to 1 vertical (or flatter) is recommended for the proposed slope cut for the southern parking lot.
- This achieves a factor of safety of greater than 1.3.
- The inclination should not be steeper than 2H:1V to reduce the potential for surficial erosion.

The following recommendations should also be followed during / after construction, to help reduce the potential for surficial erosion:

- Construction and restoration activities should be conducted in a manner which does not result in surface erosion of the slope.
- Site grading and drainage should be designed to prevent direct concentrated or channelized surface runoff from flowing directly over the slope.
- Water drainage from down-spouts or road drainage should not be permitted to flow over the slope, but be directed away from the slope or to the bottom of the slope in non-perforated pipes.
- A healthy vegetative cover should be maintained on the slope. Any slope areas disturbed by construction should be restored with suitable native vegetation as soon as possible. Erosion control blankets are recommended to help vegetation establish following construction.
- The slope should not be further steepened and fill materials (including landscape debris, soil, building materials, etc.) should not be placed on the slope or within 3 m of the slope crest.
- A sedimentation control fence (silt fence) should be erected around work areas prior to the commencement of site works.



5. Constructability Considerations

5.1 Excavations and Temporary Groundwater Control

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III - Excavations, Section 222 through 242.

Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the OHSA. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. The regulation stipulates safe slopes of excavation as follows based on the soils encountered at this site:

- Type 3 Soils – Earth Fill/Reworked Native Soil, and Upper Glacial Till Deposits:
Trench sidewalls to be constructed no steeper than 1 horizontal to 1 vertical from the base of the excavation.

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the OHSA and include provisions for timbering, shoring and moveable trench boxes. In order to reduce the potential for instability of the trench excavations, materials excavated from the service trenches and/or other fill materials or heavy equipment should not be placed near the crest of the trench excavations.

Cobbles and boulders are embedded within the glacial till deposits and may be encountered in excavations on site during construction.

Groundwater was not encountered in the monitoring wells installed on site. Excavations for foundations or site services are therefore not expected to extend into the groundwater table. Any minor seepage from perched groundwater that enters the excavation can be controlled using sump pumps.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in the boreholes advanced on site. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that GEI be contacted immediately to evaluate the conditions encountered.



5.2 Compaction Specifications

Standard Proctor maximum dry density (SPMDD) is the specification to indicate the degree to which soil or aggregate is compacted. To achieve the specified SPMDD as indicated in this report, all soils or aggregates must be placed in lift thicknesses no greater than 200 mm. If this is not the case, only the upper portion of the lift will be adequately compacted, and the lower portion of the lift has a high probability of not meeting compaction specifications. In addition, industry standard equipment used to determine the degree of compaction consists of nuclear densometers. These devices have an inherent limitation in that they cannot test beyond 300 mm in depth, and so the degree of compaction beyond this depth cannot be quantitatively determined.

Along with lift thickness, ensuring that the soil or aggregate is within 2% of its optimum moisture content ensures that the specified compaction can be reached. If the soil or aggregate is too dry/wet, it is either very difficult or impossible to reach the specified compaction. This is especially true for when higher compaction specifications such as 98% and 100% SPMDD are required.

Based on our review of the soil types encountered in the boreholes with associated moisture contents, the soils at this site are expected to be near or wet of optimum moisture content. Moisture can be reduced by tilling or spreading out the soil to dry or blending it with drier material. In-situ moisture contents can change based on the season and local groundwater levels and can also change for stockpiled material due to precipitation.

If needed, moisture can be increased by adding water and mixing the soil prior to re-use, blending the soil with wetter material, or by importing soil to the site that is at optimum and can be readily compacted.

In addition to the above compaction specifications, in any areas where compacted fill will be placed over the exposed native soil subgrade, any loose, soft, wet, organic or unstable areas should be sub-excavated, and backfilled with site material or Granular 'B' (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. This recommendation applies to site servicing and pavement subgrades. Where structures/buildings require upfilling beneath the structure the engineered fill must be compacted to 100% SPMDD.

5.3 Quality Verification Services

On-site quality verification services are an integral part of the geotechnical design function, and for foundations and engineered fill, are required under the Ontario Building Code. Quality verification services are used to confirm that construction is being conducted in general conformance with the requirements as outlined in the drawings, reports and specifications prepared for the proposed development.



GEI Consultants can provide all the on-site quality verification services outlined below:

- The subgrade for foundations must be field reviewed by the geotechnical engineer per the OBC.
- Installation of retaining structures over 1.0 m high and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required in the OBC.
- Full-time monitoring, testing and inspection of engineered fill placement is required by the geotechnical engineer per the OBC.
- Part-time monitoring of the subgrade support capabilities, material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for the following areas to ensure the recommendations within this report are followed and they perform adequately in the long-term;
 - Slab-on-grades;
 - Pavement structure; and
 - Bedding/backfilling of site servicing.
- Testing of the concrete (compressive strength, slump, air content, etc.) is recommended to ensure that the quality of the materials being brought to site meet the requirements of the project.

5.4 Site Work

The soils found at this site may become disturbed/weakened when subjected to traffic, particularly when wet. If there is site work carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of granular fill material for site restoration or underfloor fill that is not intrinsic to the project requirements.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during paving and other work may be required, especially if construction is carried out during unfavourable weather.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade and concrete must be provided. The soil at this site is susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project development.



6. Limitations and Conclusions

6.1 Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of Lake Simcoe Region Conservation Authority. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.



6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statutes, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

GEI Consultants

Prepared By:



Frankie Huang, E.I.T.
Geotechnical Engineer in Training

Reviewed By:



Russell Wiginton, P.Eng.
Senior Geotechnical Engineer



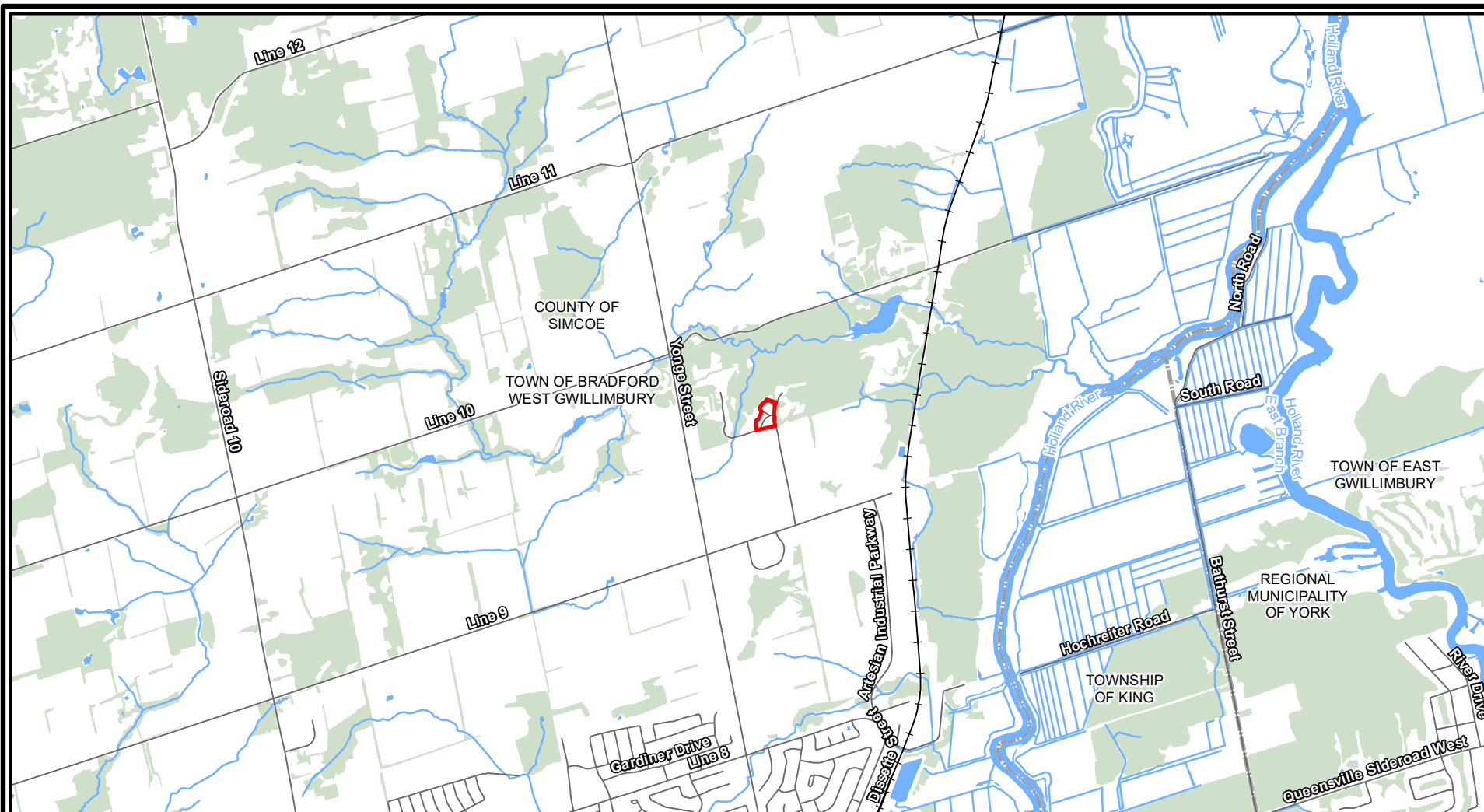
Figures

Site Location Plan

Borehole Location Plans

Subsurface Cross-Sections





Legend

- Approx. Site Boundary
- Road
- Wooded Area
- Railway
- Watercourse
- Highway
- Waterbody

NOTES:
 1. Coordinate System: NAD 1983 UTM Zone 17N.
 2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.

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Hydrogeological Investigation
 Scanlon Creek Conservation Authority
 Lake Simcoe Region Conservation
 Authority

GEI Consultants
 Project 2304770

Project Area Location Plan

December 2023

Fig. 1



Legend

- Approx. Site Boundary
- Borehole
- Borehole and Monitoring Well
- Road
- Watercourse
- Development Cross Section

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Orthoimagery © First Base Solutions, 2023. Imagery taken in 2022.

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Hydrogeological Investigation
Scanlon Creek Conservation Area

Lake Simcoe Region Conservation
Authority



Borehole Location Plan
(Aerial Image)

Project 2304770

December 2023

Fig.2a



Legend

- Approx. Site Boundary
- Road
- Watercourse
- Borehole
- Borehole and Monitoring Well
- Development Cross Section

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Orthoimagery © First Base Solutions, 2023. Imagery taken in 2022.

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Hydrogeological Investigation
Scanlon Creek Conservation Area

Lake Simcoe Region Conservation
Authority

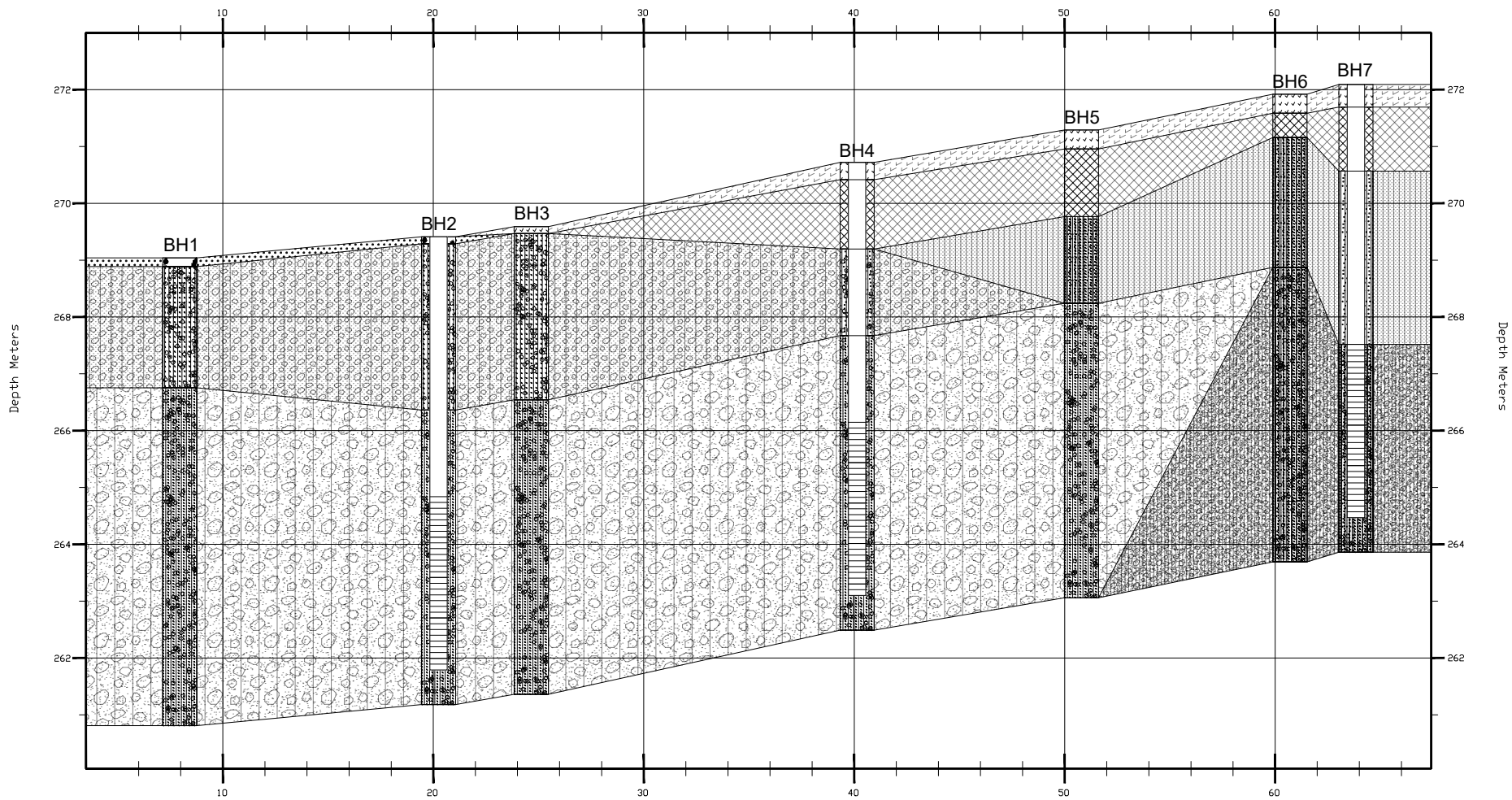


Project 2304770

Borehole Location Plan
(Proposed Site Plan)

December 2023

Fig.2b



LEGEND

	Topsoil		Sand and Silt Glacial Till
	Granular		Silty Sand Glacial Till
	Fill		Sandy Silt Glacial Till
	Silty Sand to Sand and Silt Glacial Till		

Proposed New Nature Centre
Scanlon Creek Conservation Area
Braftord, Ontario

Lake Simcoe Region Conservation Authority
Newmarket, Ontario

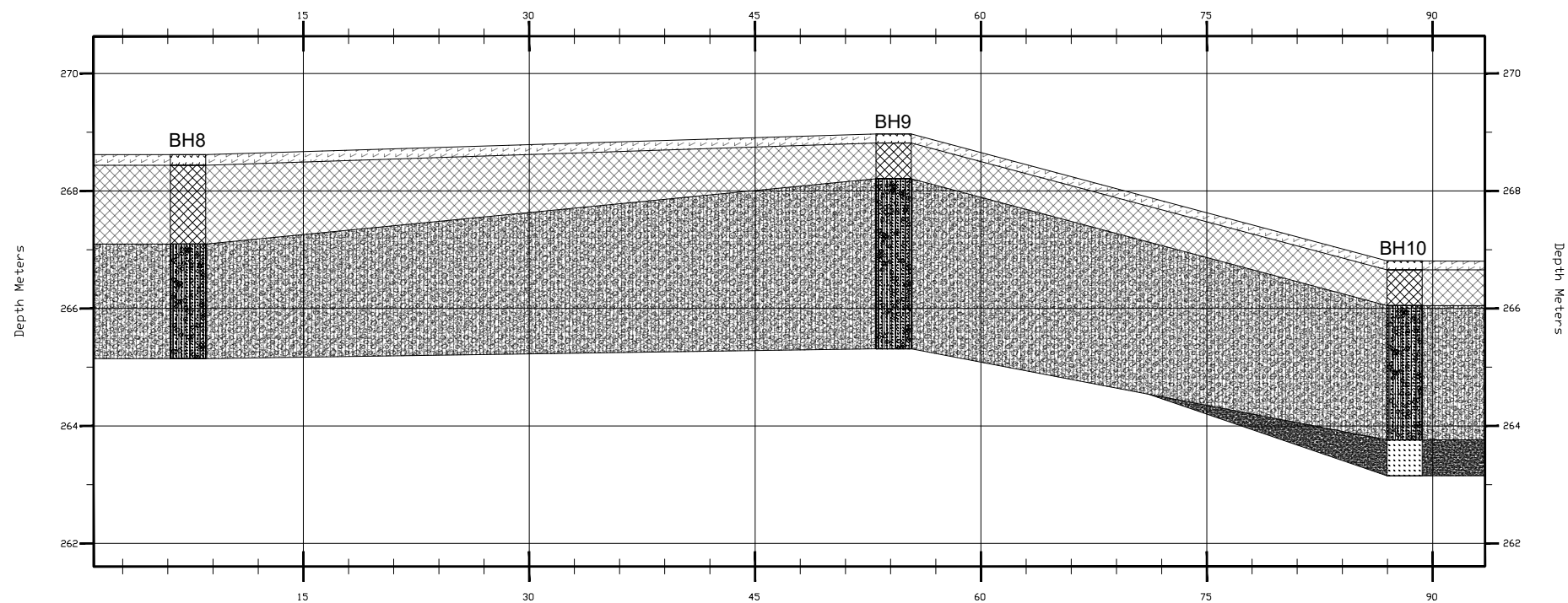


Project 2304770





CROSS SECTION A-A'

November 2023

Fig. 3A



LEGEND

-  Topsoil
-  Fill
-  Silty Sand to Sandy Silt Glacial Till
-  Fine Sand

Proposed New Nature Centre
Scanlon Creek Conservation Area
Bradford, Ontario

Lake Simcoe Region Conservation Authority
Newmarket, Ontario



Project 2304770

CROSS SECTION B-B'

November 2023

Fig. 3B

Appendix A

Borehole Logs

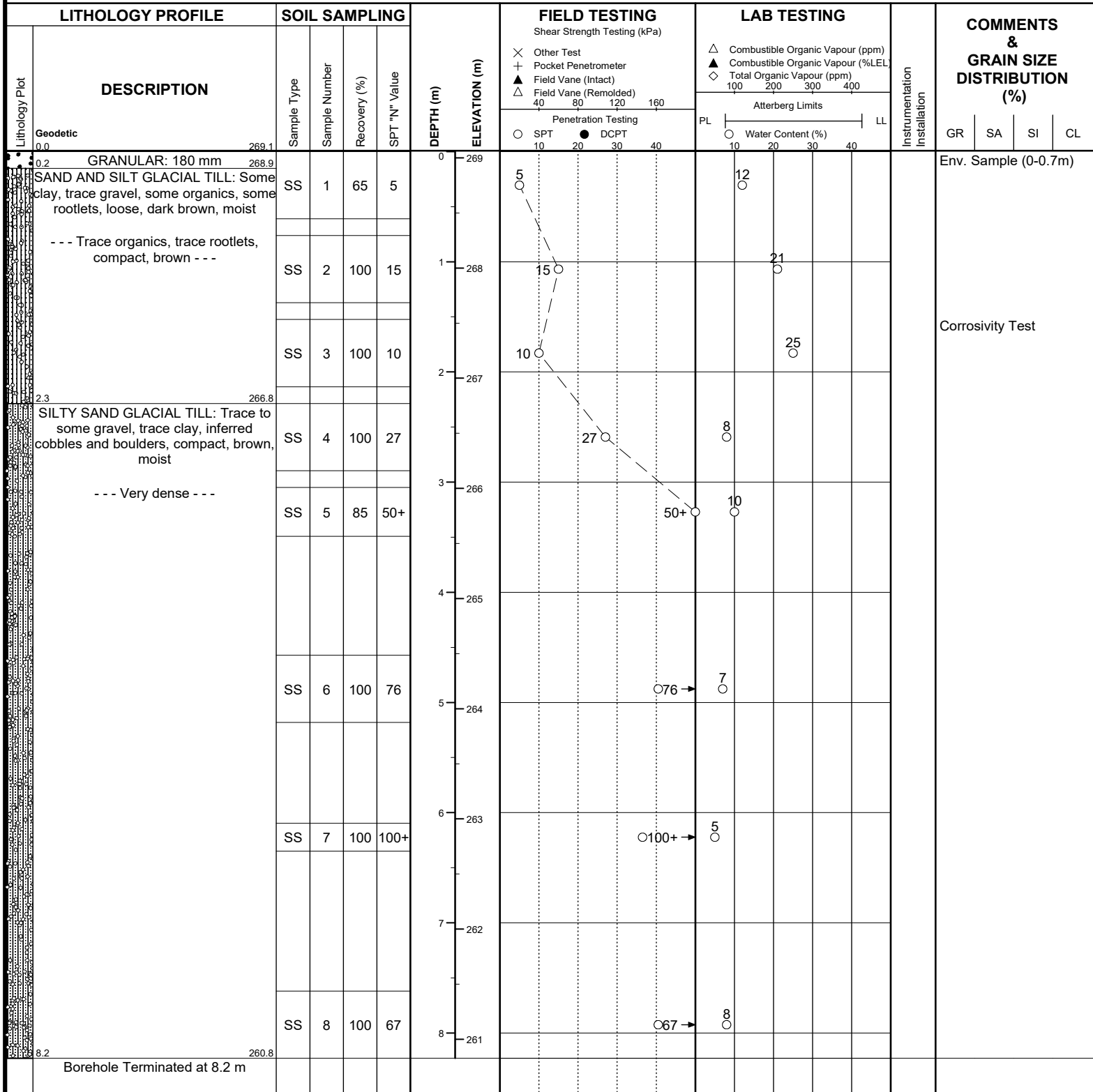


RECORD OF BOREHOLE No. 1

Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**






Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889330** Date Started: **Oct 27/23**
 Reviewed By: **RW** Easting: **614708.1** Date Completed: **Oct 27/23**



GEI Consultants

Drilling Method:	<u>Hollow Stem Augers</u>	Drilling Machine:	<u>Track Mount</u>		
Logged By:	<u>SLove</u>	Northing:	<u>4889310</u>	Date Started:	<u>Oct 27/23</u>
Reviewed By:	<u>RW</u>	Easting:	<u>614710.1</u>	Date Completed:	<u>Oct 27/23</u>

GEI CONSULTANTS 647 Welham Road, Unit 14 Barrie, Ontario L4N 0B7 T : (705) 719-7994 www.geiconsultants.com	 Groundwater depth encountered on completion of drilling: Dry	 Cave depth after auger removal: Open
	 Groundwater depth observed on: Nov. 25, 2023 at depth of: Dry	Groundwater Elevation:

RECORD OF BOREHOLE No. 3

Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**



Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889314** Date Started: **Oct 27/23**
 Reviewed By: **RW** Easting: **614717.8** Date Completed: **Oct 27/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)	Penetration Testing	Atterberg Limits	Water Content (%)		GR	SA	SI	CL
Geodetic 0.0 269.6								X Other Test + Pocket Penetrometer ▲ Field Vane (Intact) △ Field Vane (Remolded)	○ SPT ● DCPT	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ◇ Total Organic Vapour (ppm)	PL ○ Water Content (%) LL					
0.1 TOPSOIL: 100 mm 269.5						0										
SAND AND SILT GLACIAL TILL: Some clay, trace gravel, some organics, some rootlets, loose, dark brown, moist		SS	1	80	6											
--- Brown ---																
		SS	2	100	8											
--- Compact ---																
		SS	3	100	13											
--- Some rock fragments ---																
		SS	4	100	27											
3.0 266.6						3										
SILTY SAND GLACIAL TILL: Some gravel, trace clay, inferred cobbles and boulders, dense to very dense, brown, moist		SS	5	100	35											
		SS	6	100	88											
		SS	7	100	67											
--- Wet ---																
		SS	8	100	57											
8.2 261.4						8										
Borehole Terminated at 8.2 m																

GEI CONSULTANTS
 647 Welham Road, Unit 14
 Barrie, Ontario L4N 0B7
 T : (705) 719-7994
 www.geiconsultants.com

Groundwater depth encountered on completion of drilling: 7.6 m. Cave depth after auger removal: Open
 Groundwater depth observed on: Groundwater Elevation:




Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 : 50**

Page: **1 of 1**

GEI Consultants

Drilling Method:	<u>Hollow Stem Augers</u>	Drilling Machine:	<u>Track Mount</u>		
Logged By:	<u>SLove</u>	Northing:	<u>4889316</u>	Date Started:	<u>Oct 25/23</u>
Reviewed By:	<u>RW</u>	Easting:	<u>614737.3</u>	Date Completed:	<u>Oct 25/23</u>

GEI CONSULTANTS 647 Welham Road, Unit 14 Barrie, Ontario L4N 0B7 T : (705) 719-7994 www.geiconsultants.com	 Groundwater depth encountered on completion of drilling: Dry	 Cave depth after auger removal: Open
	 Groundwater depth observed on: Nov. 25, 2023 at depth of: Dry	Groundwater Elevation:

RECORD OF BOREHOLE No. 5

Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**



Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889309** Date Started: **Oct 25/23**
 Reviewed By: **RW** Easting: **614745.5** Date Completed: **Oct 25/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)	Penetration Testing	Atterberg Limits	Water Content (%)		GR	SA	SI	CL
Geodetic 0.0 271.3						0	271.3									
TOPSOIL: 355 mm						0.2	271.1									
FILL / REWORKED NATIVE SOIL: Silty sand, some organics, trace wood fragments, trace to some gravel, loose to compact, brown, moist		SS	1	75	6											
SANDY SILT GLACIAL TILL: Clayey, trace gravel, stiff, brown, moist		SS	2	80	11											
		SS	3	75	10											
		SS	4	100	11											
SILTY SAND GLACIAL TILL: Trace clay, trace gravel, dense to very dense, brown, moist		SS	5	100	41											
		SS	6	100	41											
		SS	7	100	52											
		SS	8	100	100+											
Borehole Terminated at 8.2 m						8.2	263.1									

RECORD OF BOREHOLE No. 6



Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889310** Date Started: **Oct 25/23**
 Reviewed By: **RW** Easting: **614757.8** Date Completed: **Oct 25/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)				
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits			GR		SA	SI	CL		
								X Other Test	+ Pocket Penetrometer	▲ Field Vane (Intact)	△ Field Vane (Remolded)	△ Combustible Organic Vapour (ppm)						▲ Combustible Organic Vapour (%LEL)	◇ Total Organic Vapour (ppm)
Geodetic 0.0 271.9		SPT 10 20 30 40		DCPT 10 20 30 40		PL 10 20 30 40		LL 10 20 30 40											
TOPSOIL: 355 mm						0		8		10				Env. Sample (0.8-1.4m)					
0.3 271.6		SS	1	75	8														
FILL / REWORKED NATIVE SOIL: Silty sand, some organics, some rootlets, trace gravel, loose, dark brown, moist																			
SANDY SILT GLACIAL TILL: Clayey, trace gravel, very stiff, brown, moist		SS	2	100	17	1	271	17		18				Env. Sample (2.3-2.9m) Corrosivity Test					
--- Wet (perched water), firm to stiff ---																			
		SS	3	100	6	2	270	6		13									
--- Moist ---																			
		SS	4	75	9			9		10									
3.0 268.9		SS	5	100	44	3	269			8									
SILTY SAND TO SAND AND SILT GLACIAL TILL: Trace clay, trace gravel, dense to very dense, brown, moist								44											
		SS	6	100	49	5	267			9									
		SS	7	100	62	6	266			8									
								62											
		SS	8	100	83	7	265												
								83		11									
8.2 263.7						8	264												
Borehole Terminated at 8.2 m																			

GEI CONSULTANTS
 647 Welham Road, Unit 14
 Barrie, Ontario L4N 0B7
 T : (705) 719-7994
 www.geiconsultants.com

Groundwater depth encountered on completion of drilling: Dry Cave depth after auger removal: Open
 Groundwater depth observed on: Groundwater Elevation:

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 : 50**

Page: **1 of 1**

RECORD OF BOREHOLE No. 7



Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889298** Date Started: **Oct 25/23**
 Reviewed By: **RW** Easting: **614754** Date Completed: **Oct 25/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits			GR SA SI CL					
	Geodetic 0.0	272.1						Penetration Testing		PL	Water Content (%)			LL				
	TOPSOIL: 405 mm	SS	1	65	5	0	272	5			13							
	0.4	271.7																
	FILL / REWORKED NATIVE SOIL: Silty sand, some organics, trace rootlets, trace gravel, loose to compact, brown, moist	SS	2	0	10	1	271	10			5							
	1.5	270.6																
	SANDY SILT GLACIAL TILL: Clayey, trace gravel, stiff, brown, moist	SS	3	100	10	2	270	10			16							
		SS	4	100	14			14			9							
	--- Hard ---																	
		SS	5	100	55	3	269		55		8							
	4.6	267.5																
	SILTY SAND TO SAND AND SILT GLACIAL TILL: Trace clay, trace gravel, dense to very dense, brown, moist	SS	6	100	56	5	267		56		5							
		SS	7	100	37	6	266		37		7							
		SS	8	100	39	8	264		39		8							
	8.2	263.9																
	Borehole Terminated at 8.2 m																	

RECORD OF BOREHOLE No. 8



Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889252** Date Started: **Oct 26/23**
 Reviewed By: **RW** Easting: **614681.5** Date Completed: **Oct 26/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits					GR	SA	SI	CL
								Other Test	Penetration Testing	PL	LL	Water Content (%)						
	Geodetic 0.0 268.6							○ SPT 10 20 30 40	● DCPT 10 20 30 40	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ◇ Total Organic Vapour (ppm) 100 200 300 400								
	0.2 TOPSOIL: 205 mm 268.4					0												
	FILL / REWORKED NATIVE SOIL: Silty sand, some rootlets, trace organics, trace gravel, compact to loose, dark brown to brown, moist	SS	1	75	11			○ 11			○ 16						Env. Sample (0-0.7m)	
						268												
		SS	2	100	6	1		○ 6			○ 10							
	1.5 267.1					267		○ 9			○ 11							
	SILTY SAND TO SANDY SILT GLACIAL TILL: Trace gravel, trace clay, inferred cobbles and boulders, loose to compact, brown, moist	SS	3	100	9	2												
		SS	4	100	26		266	○ 26			○ 6							
	--- Very dense ---					3												
	3.5 265.2	SS	5	100	87			○ 87 →			○ 7							
	Borehole Terminated at 3.5 m																	

RECORD OF BOREHOLE No. 9



Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889193** Date Started: **Oct 26/23**
 Reviewed By: **RW** Easting: **614679.9** Date Completed: **Oct 26/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits			GR	SA	SI	CL
Geodetic 0.0 269.0								X Other Test + Pocket Penetrometer ▲ Field Vane (Intact) △ Field Vane (Remolded)		△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ◇ Total Organic Vapour (ppm)						
0.2 TOPSOIL: 150 mm 268.8						0		Penetration Testing ○ SPT 10 20 30 40 ● DCPT 20 30 40		PL Water Content (%) 10 20 30 40 LL						
FILL / REWORKED NATIVE SOIL: Clayey silt, some sand, some organics, trace rootlets, trace gravel, firm, brown, moist 268.2		SS	1	65	6			6		30						
0.8 SILTY SAND TO SANDY SILT GLACIAL TILL: Clayey, trace gravel, inferred cobbles and boulders, trace rootlets, stiff, brown, moist 268.2		SS	2	75	12	1	268	12		11						
--- Some clay, compact ---		SS	3	100	11	2	267	11		20						
--- Dense to very dense ---		SS	4	100	49			49		19						
		SS	5	100	51	3	266	51		8						
3.7 Borehole Terminated at 3.7 m 265.3																

Env. Sample (1.5-2.1m)

RECORD OF BOREHOLE No. 10

Project Number: **2304770**
 Project Client: **LSRCA**
 Project Name: **Proposed New Nature Centre**
 Project Location: **Scanlon Creek Conservation Area,**
 Drilling Location: **See Borehole Location Plan**
 Local Benchmark: **NAD 83 Geodetic Datum**



Drilling Method: **Hollow Stem Augers** Drilling Machine: **Track Mount**
 Logged By: **SLove** Northing: **4889184** Date Started: **Oct 26/23**
 Reviewed By: **RW** Easting: **614637.1** Date Completed: **Oct 26/23**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m) ELEVATION (m)		FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)										
								✕ Other Test + Pocket Penetrometer ▲ Field Vane (Intact) △ Field Vane (Remolded) 40 80 120 160	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ◇ Total Organic Vapour (ppm) 100 200 300 400									
						Penetration Testing ○ SPT ● DCPT 10 20 30 40		Atterberg Limits PL LL ○ Water Content (%) 10 20 30 40										
Geodetic 0.0																		

RECORD OF BOREHOLE No. 11



Project Number: 2304770
Project Client: LSRCA
Project Name: Proposed New Nature Centre
Project Location: Scanlon Creek Conservation Area,
Drilling Location: See Borehole Location Plan
Local Benchmark: NAD 83 Geodetic Datum

Drilling Method: Hollow Stem Augers Drilling Machine: Track Mount
Logged By: SLove Northing: 4889220 Date Started: Oct 26/23
Reviewed By: RW Easting: 614736.1 Date Completed: Oct 26/23

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits								
								Penetration Testing		Water Content (%)								
	Geodetic 0.0 272.0							○ SPT 10 20 30 40	● DCPT 10 20 30 40	PL	○ 10 20 30 40	LL		GR	SA	SI	CL	
	0.2 TOPSOIL: 175 mm 271.9	SS	1	65	4	0 272	1 271	4	11	11	6	9	10					
	FILL / REWORKED NATIVE SOIL: Sandy silt, trace organics, trace clay, trace rootlets, trace gravel, loose, brown, moist 271.3																	
	SILTY SAND TO SANDY SILT GLACIAL TILL: Trace clay, trace gravel, inferred cobbles and boulders, compact, brown, moist 269.9	SS	2	100	11													
		SS	3	100	11													
	2.1 Borehole Terminated at 2.1 m 269.9																	

RECORD OF BOREHOLE No. 12

Project Number: 2304770
Project Client: LSRCA
Project Name: Proposed New Nature Centre
Project Location: Scanlon Creek Conservation Area,
Drilling Location: See Borehole Location Plan
Local Benchmark: NAD 83 Geodetic Datum



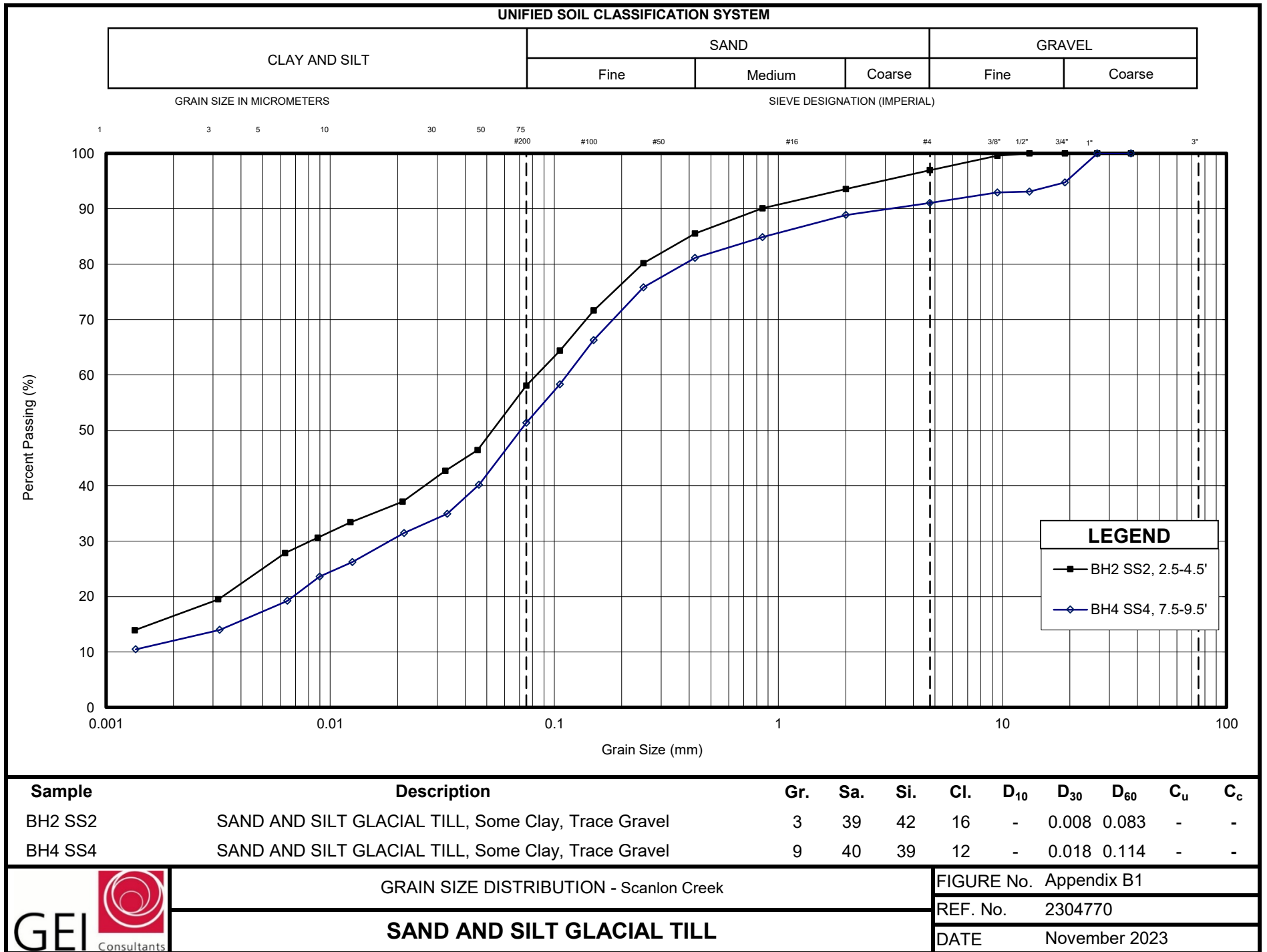
Drilling Method: Hollow Stem Augers Drilling Machine: Track Mount
Logged By: SLove Northing: Date Started: Oct 26/23
Reviewed By: RW Easting: 614752 Date Completed: Oct 26/23

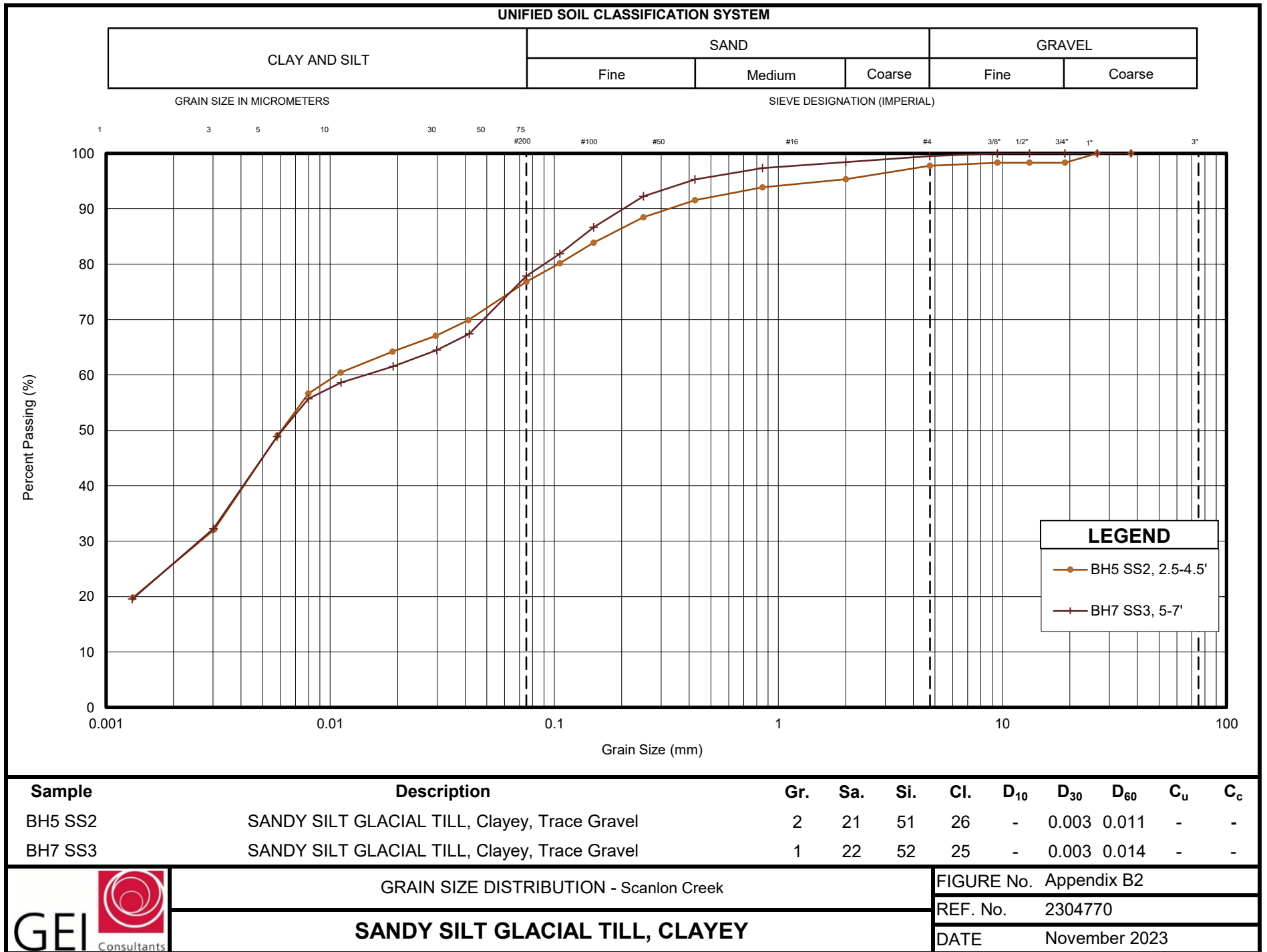
LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)				
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits			Water Content (%)		GR	SA	SI
						Other Test	Pocket Penetrometer	Field Vane (Intact)	Field Vane (Remolded)	PL	LL	Water Content (%)	Water Content (%)				
	Geodetic 0.0 274.0							Penetration Testing		Atterberg Limits							
	0.2 TOPSOIL: 355 mm 273.8					0		10		10							
	FILL / REWORKED NATIVE SOIL: Sandy silt, trace clay, trace gravel, trace organics, trace rootlets, trace wood fragments, loose, dark brown, moist	SS	1	75	10												
	0.8 SANDY SILT TO SILTY SAND GLACIAL TILL: Trace clay, trace gravel, compact, brown, moist	SS	2	100	17	1	273	17		7							
	1.5 SAND AND GRAVEL: Trace silt, very dense, brown, damp	SS	3	100	64	2	272	64	2								
	2.1 Borehole Terminated at 2.1 m																

Appendix B

Geotechnical Laboratory Testing







Appendix C

Soil Chemistry Certificates of Analysis



Certificate of Analysis

Client: GEI Consultants Inc.
647 Welham Rd Unit 14
Barrie, ON
L4N 0B7
Attention: Ms. Shannon Love
PO#:
Invoice to: GEI Consultants Inc.

Report Number: 3002710
Date Submitted: 2023-10-30
Date Reported: 2023-11-06
Project: 2304770
COC #: 223316

Page 1 of 3

Dear Shannon Love:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL:

Raheleh Zafari, Environmental Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <https://directory.cala.ca/>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

Client: GEI Consultants Inc.
647 Welham Rd Unit 14
Barrie, ON
L4N 0B7
Attention: Ms. Shannon Love
PO#:
Invoice to: GEI Consultants Inc.

Report Number: 3002710
Date Submitted: 2023-10-30
Date Reported: 2023-11-06
Project: 2304770
COC #: 223316

					Lab I.D.	Sample Matrix	Sample Type	Sampling Date	Sample I.D.
Group	Analyte	MRL	Units	Guideline	1708853	1708854	1708855		
Anions	SO4	0.01	%		Soil	Soil	Soil		
Cl in Concrete	Cl	0.002	%		2023-10-27	2023-10-25	2023-10-25		
General Chemistry	Electrical Conductivity	0.05	mS/cm		BH1-SS3	BH6-SS4	BH7-SS2		
	pH	2.00							
	Resistivity	1	ohm-cm						
					<0.01	<0.01	0.02		
					0.018	0.005	<0.002		
					0.37	0.17	0.12		
					8.09	8.56	8.26		
					2703	5882	8333		

Guideline = * = Guideline Exceedence

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Client: GEI Consultants Inc.
647 Welham Rd Unit 14
Barrie, ON
L4N 0B7
Attention: Ms. Shannon Love
PO#:
Invoice to: GEI Consultants Inc.

Report Number: 3002710
Date Submitted: 2023-10-30
Date Reported: 2023-11-06
Project: 2304770
COC #: 223316

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 451552 Analysis/Extraction Date 2023-11-02 Analyst IP Method Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	100	90-110
pH	6.64	99	90-110
Resistivity			
Run No 451604 Analysis/Extraction Date 2023-11-03 Analyst AsA Method C ASTM C114			
Chloride	<0.002 %	96	80-120
Run No 451683 Analysis/Extraction Date 2023-11-06 Analyst MW Method AG SOIL			
SO4	<0.01 %	98	70-130

Guideline = * = **Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range



Analysis Report

GS23-04917.001

GEI CONSULTANTS INC
647 WELHAM ROAD, UNIT 14
BARRIE ON L4N 0B7
CANADA

Received: 02-Nov-2023
Sample ID: 2304770 [BH8]
Order Reference: Aamna - Shannon Love - PO# 2304770

Completed: 16-Nov-2023

Page 1 of 5

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)	
pH	7.6	5.5 - 7.5	N	The ranges in the Typical Guidelines are for comparative purposes and are characteristic of a Sandy Loam to Loam textured topsoil. These are considered to be optimal ranges for these soil types, and test results are compared to these ranges in the Within Range column with Yes/No designation. However, an N does not necessarily suggest a soil will not support growth, and some project specifications may differ from these Typical Guidelines. Soil modification recommendations are provided where possible or necessary to amend soil test values that fall beyond these optimal ranges.
Buffer pH	-			
Organic Matter (%)	4.6	4 - 15	Y	
Total Salts (mmhos/cm)	0.21	< 1.5	Y	
Phosphorus (ppm)	5	10 - 60	N	
Potassium (ppm)	70	80 - 250	N	
Calcium (ppm)	4090	1000 - 4000	N	
Magnesium (ppm)	88	100 - 300	N	
Sodium (ppm)	33	< 200	Y	
Sodium Adsorption Ratio	0.09	< 15	Y	
CEC (meq/100g)	22.6			Most adapted species will establish at this pH, which is common for calcareous Ontario soil and not detrimental.
Base Sat. K (%)	0.8			
Base Sat. Mg (%)	3.3			
Base Sat. Ca (%)	90.6			Potassium and magnesium levels will be raised by following the fertility guidelines below. High levels of calcium are typical of Ontario topsoil and pose no threat to plant growth.
Chloride (ppm)	28.0	< 100	Y	
Texture	Sandy Loam	Loam/Sandy Loam		
Sand (%)	57	20 - 75	Y	General Fertility Guidelines for Turf Grass: Before seeding or sodding, apply 6-12-12 at 15 lbs and KMag (0-0-22) at 1 lb per 1000 sq feet and incorporate into the rootzone.
Silt (%)	36	5 - 50	Y	
Clay (%)	7	5 - 30	Y	

Recommendations	N	P205	K2O	Mg	Lime (te/ha)
turf grass					
(lb/ac)	27	80	92		
(lb/1000 sq.ft)	0.63	1.87	2.14		
(kg/100 sq.m)	0.30	0.90	1.03		

Signed and dated in Guelph, ON
On 16-Nov-2023

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

Report File Reference Number: 0000292123

The analysis report above refers to the time and place of testing, and strictly to the supplied sample(s) only, without reference to any other matter. This report does not evidence or refer to any consignment or shipment or/and SGS sampling and inspection. This document is issued by the Company under its General Conditions of Service accessible at <http://www.sgs.com/en/terms-and-conditions.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.



Analysis Report

GS23-04917.002

GEI CONSULTANTS INC
647 WELHAM ROAD, UNIT 14
BARRIE ON L4N 0B7
CANADA

Received: 02-Nov-2023
Sample ID: BH3
Order Reference: Aamna - Shannon Love - PO# 2304770

Completed: 16-Nov-2023

Page 2 of 5

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)	
pH	7.8	5.5 - 7.5	N	<p>The ranges in the Typical Guidelines are for comparative purposes and are characteristic of a Sandy Loam to Loam textured topsoil. These are considered to be optimal ranges for these soil types, and test results are compared to these ranges in the Within Range column with Yes/No designation. However, an N does not necessarily suggest a soil will not support growth, and some project specifications may differ from these Typical Guidelines. Soil modification recommendations are provided where possible or necessary to amend soil test values that fall beyond these optimal ranges.</p> <p>Most adapted species will establish at this pH, which is common for calcareous Ontario soil and not detrimental. The addition of 9 lbs of elemental sulphur per 1000 sq feet, thoroughly incorporated into the root zone, may help to lower pH and enhance root growth.</p>
Buffer pH	-			
Organic Matter (%)	3.4	4 - 15	N	
Total Salts (mmhos/cm)	0.18	< 1.5	Y	
Phosphorus (ppm)	5	10 - 60	N	
Potassium (ppm)	68	80 - 250	N	
Calcium (ppm)	4040	1000 - 4000	N	
Magnesium (ppm)	66	100 - 300	N	
Sodium (ppm)	87	< 200	Y	
Sodium Adsorption Ratio	0.39	< 15	Y	
CEC (meq/100g)	22.1			<p>Soil organic matter content can be increased to 4% with sphagnum peat moss at 8 kg per cubic meter of topsoil. Up to 30% of this rate can be substituted with compost. Higher inclusion rates of compost may be used if the mineral content is known and adjustments are made to reflect that content in the fertility guidelines. Testing the compost as topsoil will provide the pertinent information.</p> <p>Potassium and magnesium levels will be raised by following the fertility guidelines below. .</p> <p>General Fertility Guidelines for Turf Grass: Before seeding or sodding, apply 6-12-12 at 15 lbs and KMag (0-0-22) at 2 lbs per 1000 sq feet and incorporate into the rootzone.</p>
Base Sat. K (%)	0.8			
Base Sat. Mg (%)	2.5			
Base Sat. Ca (%)	91.3			
Chloride (ppm)	16.0	< 100	Y	
Texture	Sandy Loam	Loam/Sandy Loam		
Sand (%)	57	20 - 75	Y	
Silt (%)	31	5 - 50	Y	
Clay (%)	12	5 - 30	Y	

Recommendations	N	P205	K2O	Mg	Lime (te/ha)
turf grass					
(lb/ac)	30	80	93		
(lb/1000 sq.ft)	0.70	1.87	2.17		
(kg/100 sq.m)	0.34	0.90	1.04		

Signed and dated in Guelph, ON
On 16-Nov-2023

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

Report File Reference Number: 0000292123

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Analysis Report

GS23-04917.003

GEI CONSULTANTS INC
647 WELHAM ROAD, UNIT 14
BARRIE ON L4N 0B7
CANADA

Received: 02-Nov-2023
Sample ID: BH4
Order Reference: Aamna - Shannon Love - PO# 2304770

Completed: 16-Nov-2023

Page 3 of 5

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)	
pH	7.0	5.5 - 7.5	Y	<p>The ranges in the Typical Guidelines are for comparative purposes and are characteristic of a Sandy Loam to Loam textured topsoil. These are considered to be optimal ranges for these soil types, and test results are compared to these ranges in the Within Range column with Yes/No designation. However, an N does not necessarily suggest a soil will not support growth, and some project specifications may differ from these Typical Guidelines. Soil modification recommendations are provided where possible or necessary to amend soil test values that fall beyond these optimal ranges.</p> <p>Potassium and magnesium levels will be raised by following the fertility guidelines below.</p> <p>General Fertility Guidelines for Turf Grass: Before seeding or sodding, apply 6-12-12 at 15 lbs and KMag (0-0-22) at 2 lbs per 1000 sq feet and incorporate into the rootzone.</p>
Buffer pH	-			
Organic Matter (%)	4.5	4 - 15	Y	
Total Salts (mmhos/cm)	0.10	< 1.5	Y	
Phosphorus (ppm)	6	10 - 60	N	
Potassium (ppm)	36	80 - 250	N	
Calcium (ppm)	2070	1000 - 4000	Y	
Magnesium (ppm)	59	100 - 300	N	
Sodium (ppm)	26	< 200	Y	
Sodium Adsorption Ratio	0.06	< 15	Y	
CEC (meq/100g)	12.1			
Base Sat. K (%)	0.8			
Base Sat. Mg (%)	4.1			
Base Sat. Ca (%)	85.3			
Chloride (ppm)	10.0	< 100	Y	
Texture	Sandy Loam	Loam/Sandy Loam		
Sand (%)	51	20 - 75	Y	
Silt (%)	47	5 - 50	Y	
Clay (%)	2	5 - 30	N	

Recommendations	N	P205	K2O	Mg	Lime (te/ha)
turf grass					
(lb/ac)	24	80	101		
(lb/1000 sq.ft)	0.56	1.87	2.35		
(kg/100 sq.m)	0.27	0.90	1.13		

Signed and dated in Guelph, ON
On 16-Nov-2023

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

Report File Reference Number: 0000292123

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Analysis Report

GS23-04917.004

GEI CONSULTANTS INC
647 WELHAM ROAD, UNIT 14
BARRIE ON L4N 0B7
CANADA

Received: 02-Nov-2023
Sample ID: BH7
Order Reference: Aamna - Shannon Love - PO# 2304770

Completed: 16-Nov-2023

Page 4 of 5

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)	
pH	7.6	5.5 - 7.5	N	The ranges in the Typical Guidelines are for comparative purposes and are characteristic of a Sandy Loam to Loam textured topsoil. These are considered to be optimal ranges for these soil types, and test results are compared to these ranges in the Within Range column with Yes/No designation. However, an N does not necessarily suggest a soil will not support growth, and some project specifications may differ from these Typical Guidelines. Soil modification recommendations are provided where possible or necessary to amend soil test values that fall beyond these optimal ranges.
Buffer pH	-			
Organic Matter (%)	4.8	4 - 15	Y	
Total Salts (mmhos/cm)	0.15	< 1.5	Y	
Phosphorus (ppm)	8	10 - 60	N	
Potassium (ppm)	74	80 - 250	N	
Calcium (ppm)	3740	1000 - 4000	Y	
Magnesium (ppm)	78	100 - 300	N	
Sodium (ppm)	23	< 200	Y	
Sodium Adsorption Ratio	0.05	< 15	Y	
CEC (meq/100g)	20.7			Most adapted species will establish at this pH, which is common for calcareous Ontario soil and not detrimental.
Base Sat. K (%)	0.9			
Base Sat. Mg (%)	3.1			Potassium and magnesium levels will be raised by following the fertility guidelines below.
Base Sat. Ca (%)	90.2			
Chloride (ppm)	18.0	< 100	Y	
Texture	Sandy Loam	Loam/Sandy Loam		
Sand (%)	48	20 - 75	Y	
Silt (%)	47	5 - 50	Y	
Clay (%)	5	5 - 30	Y	General Fertility Guidelines for Turf Grass: Before seeding or sodding, apply 6-12-12 at 14 lbs and KMag (0-0-22) at 1.5 lbs per 1000 sq feet and incorporate into the rootzone.

Recommendations	N	P205	K2O	Mg	Lime (te/ha)
turf grass					
(lb/ac)	27	67	82		
(lb/1000 sq.ft)	0.63	1.56	1.91		
(kg/100 sq.m)	0.30	0.75	0.92		

Signed and dated in Guelph, ON
On 16-Nov-2023

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

Report File Reference Number: 0000292123

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Analysis Report

GS23-04917.005

GEI CONSULTANTS INC
647 WELHAM ROAD, UNIT 14
BARRIE ON L4N 0B7
CANADA

Received: 02-Nov-2023
Sample ID: BH9
Order Reference: Aamna - Shannon Love - PO# 2304770

Completed: 16-Nov-2023

Page 5 of 5

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)	
pH	7.5	5.5 - 7.5	Y	<p>The ranges in the Typical Guidelines are for comparative purposes and are characteristic of a Sandy Loam to Loam textured topsoil. These are considered to be optimal ranges for these soil types, and test results are compared to these ranges in the Within Range column with Yes/No designation. However, an N does not necessarily suggest a soil will not support growth, and some project specifications may differ from these Typical Guidelines. Soil modification recommendations are provided where possible or necessary to amend soil test values that fall beyond these optimal ranges.</p> <p>Magnesium levels will be raised by following the fertility guidelines below.</p> <p>High levels of calcium are typical of Ontario topsoil and pose no threat to plant growth.</p> <p>General Fertility Guidelines for Turf Grass: Before seeding or sodding, apply 10-20-5 at 7 lbs and KMag (0-0-22) at 1.5 lbs per 1000 sq feet and incorporate into the rootzone.</p>
Buffer pH	-			
Organic Matter (%)	5.9	4 - 15	Y	
Total Salts (mmhos/cm)	0.20	< 1.5	Y	
Phosphorus (ppm)	14	10 - 60	Y	
Potassium (ppm)	155	80 - 250	Y	
Calcium (ppm)	4990	1000 - 4000	N	
Magnesium (ppm)	83	100 - 300	N	
Sodium (ppm)	25	< 200	Y	
Sodium Adsorption Ratio	0.02	< 15	Y	
CEC (meq/100g)	27.2			
Base Sat. K (%)	1.5			
Base Sat. Mg (%)	2.5			
Base Sat. Ca (%)	91.6			
Chloride (ppm)	8.0	< 100	Y	
Texture	Loam	Loam/Sandy Loam		
Sand (%)	39	20 - 75	Y	
Silt (%)	49	5 - 50	Y	
Clay (%)	12	5 - 30	Y	

Recommendations	N	P205	K2O	Mg	Lime (te/ha)
turf grass					
(lb/ac)	27	58			
(lb/1000 sq.ft)	0.63	1.35			
(kg/100 sq.m)	0.30	0.65			

Signed and dated in Guelph, ON
On 16-Nov-2023

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

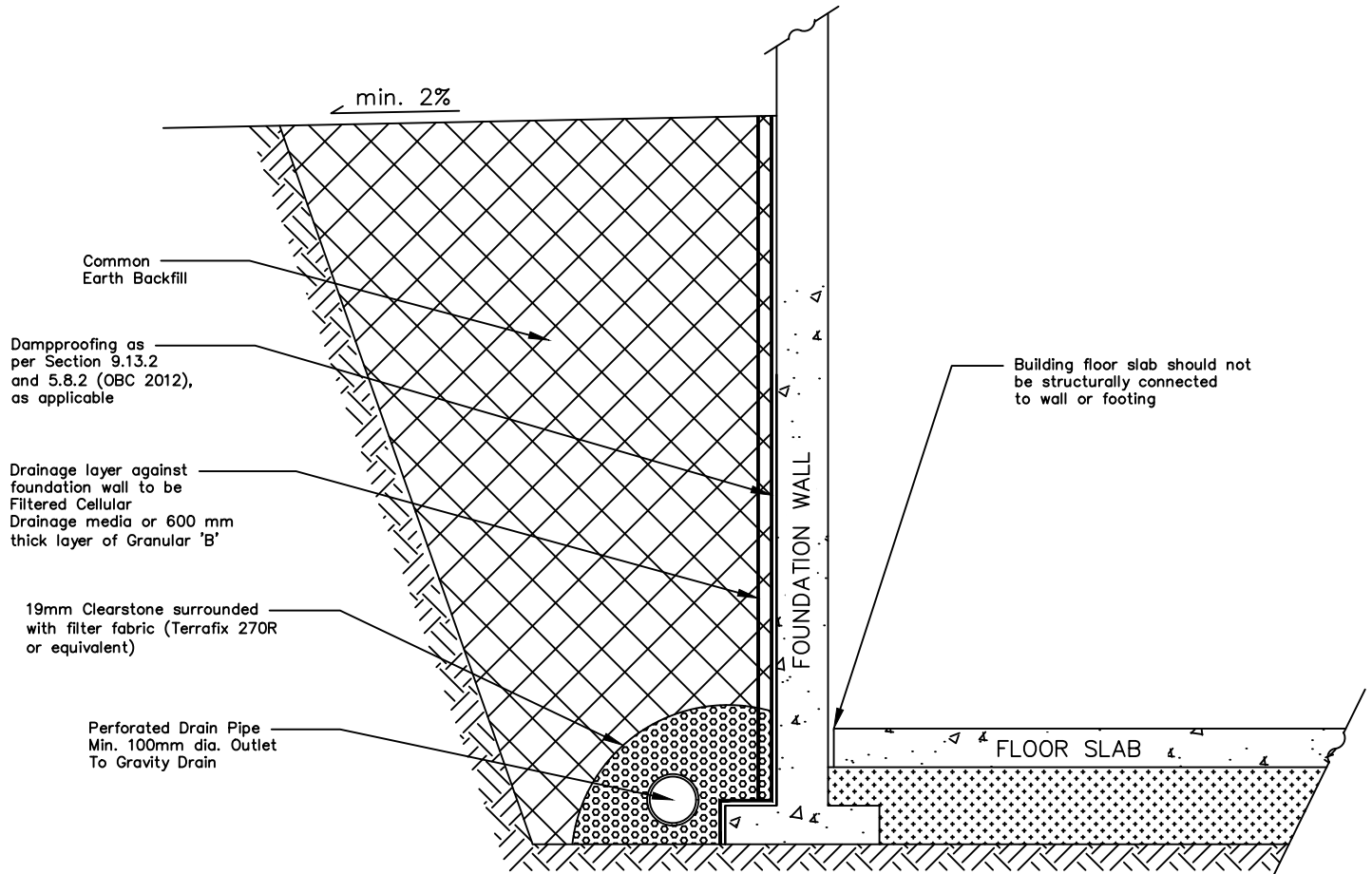
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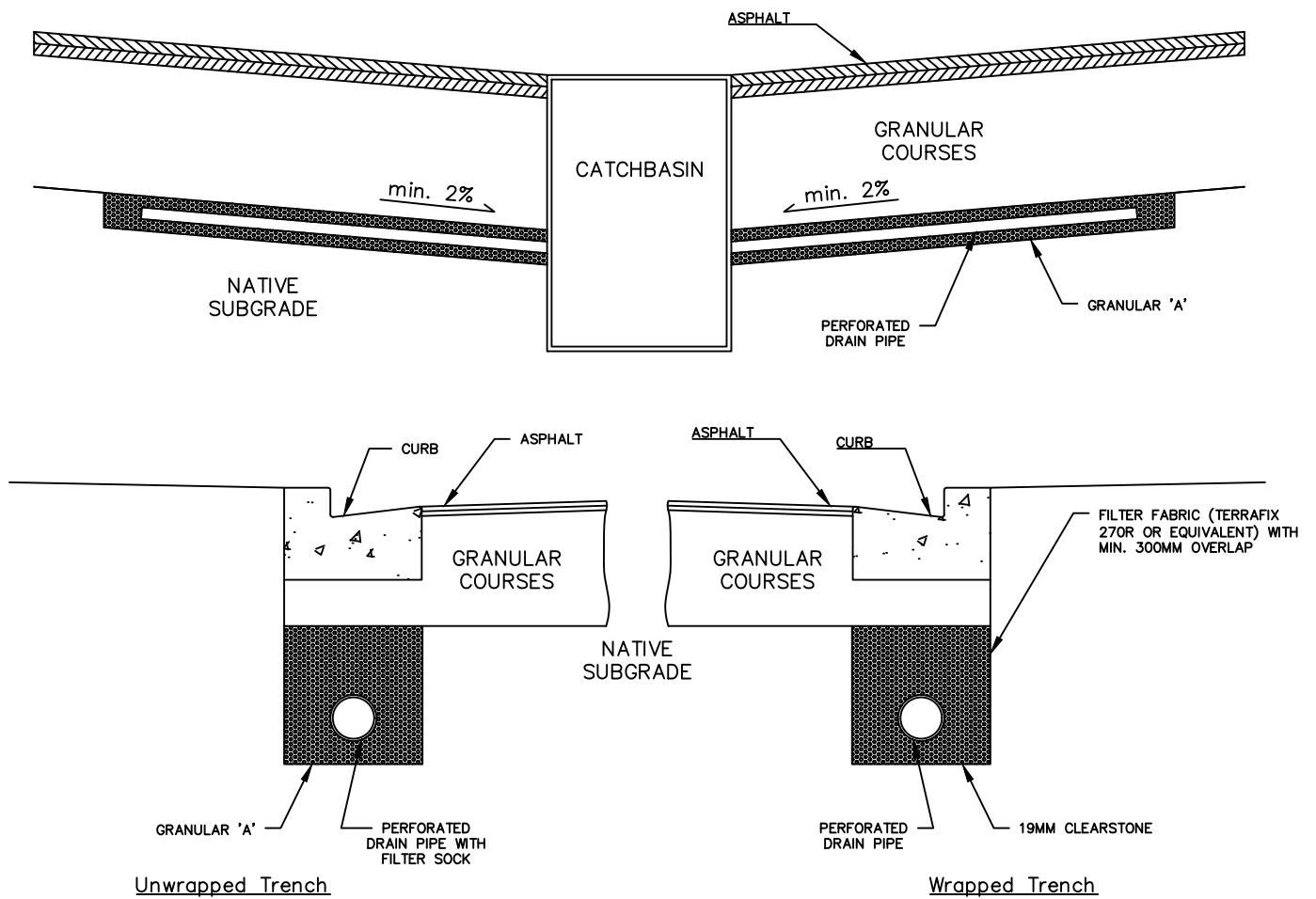
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Appendix D

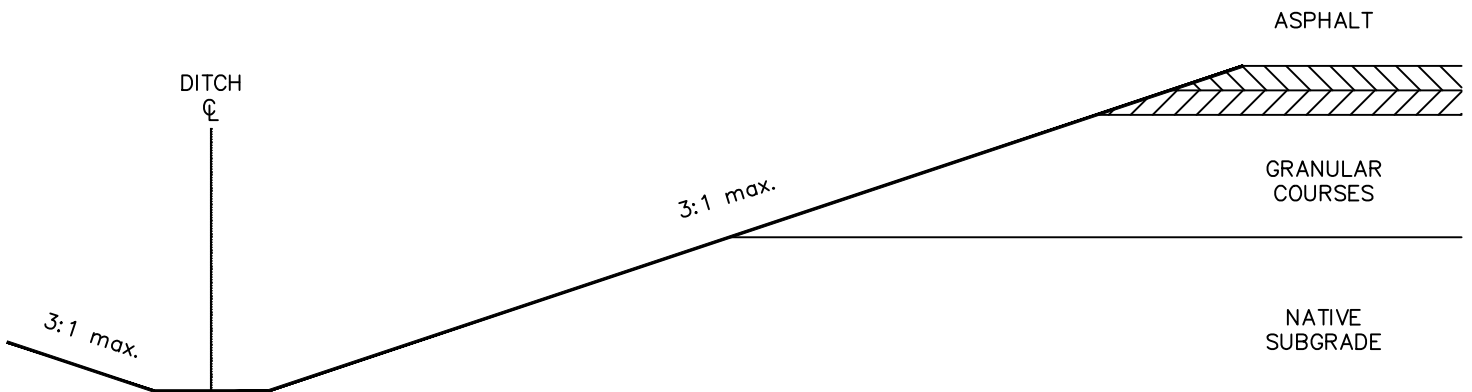
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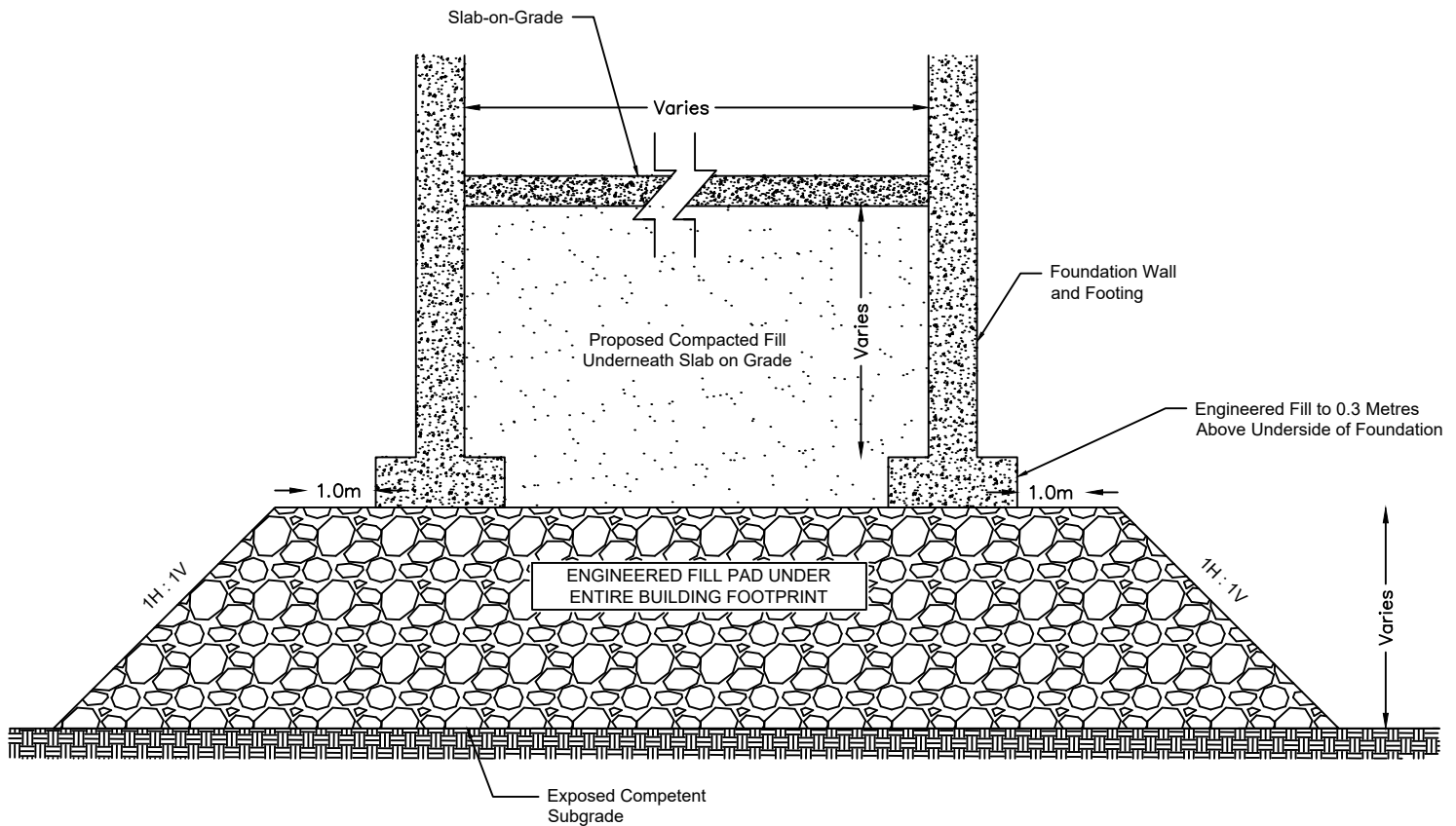
Urban Cross Sections

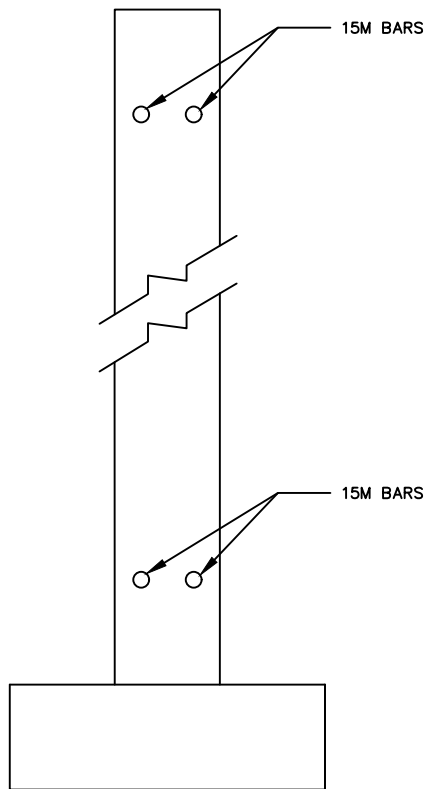


Rural Cross Section

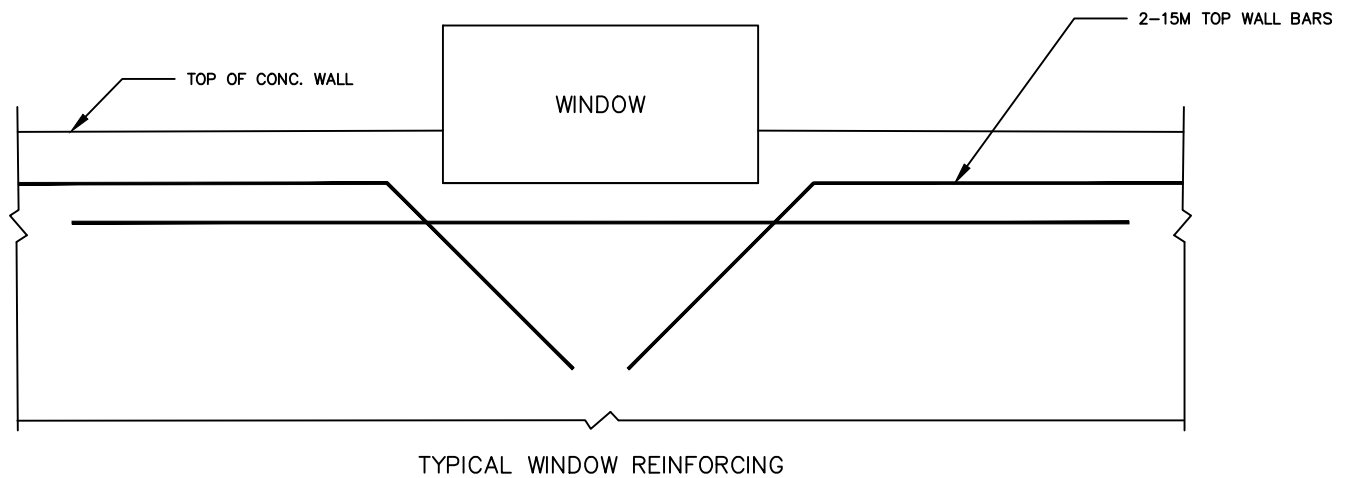
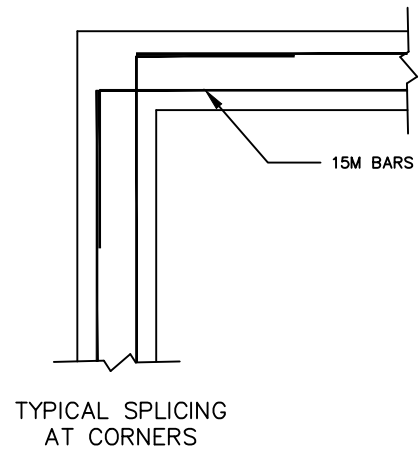
Notes:

1. Engineered Fill compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) and inspected under the full time supervision of GEI.
2. Engineered fill must be placed in loose lifts of 200 mm or less and then compacted as noted above.
3. Interior non-structural compacted fill compacted to 98% SPMDD with recommended part-time inspection.





TYPICAL REINFORCED
WALL



Appendix E

Slope Stability Analysis for Parking Lot Grading Cut



