Report On

Preliminary Geotechnical Investigation
Proposed Residential Development
2170 Ghent Avenue
Burlington, Ontario

Prepared For:

Northern Cardinal Homes Ltd.

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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Northern Cardinal Homes Ltd. to provide geotechnical engineering design recommendations for the proposed residential development located at 2170 Ghent Avenue, Burlington, Ontario.

It is understood that the geotechnical investigation is required to support a future development, which will consist of residential townhouse buildings with no basements. The proposed site grades and ground floor finished elevations for the proposed structures were not available to us at the time of writing this report.

DS has previously carried out a Phase One Environmental Site Assessment (ESA) for the property, the findings of which are issued under separate cover.

Additionally, a previous geotechnical investigation which included the advancement of nine boreholes extending to depths ranging from 1.5 to 5.0 m was conducted on the site by Peto MacCallum Ltd. (PML) in 2013. The borehole location plan and borehole logs from the previous investigation by PML are attached in **Appendix A** of this report.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions at the borehole locations and provide recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and groundwater control
4. Earth pressures
5. Earthquake considerations
6. Pavements
7. Underground Utilities

This report is provided on the basis of the terms of reference presented above and, on the assumption, that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and

economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Northern Cardinal Homes Ltd. and its architect and designers. Third party use of this report without DS consent is prohibited.

2. BACKGROUND INFORMATION

In 2013, Peto MacCallum Ltd. (PML) completed a geotechnical investigation on the subject site to support a development consisting of a four (4) storey retirement home without a basement. The findings of PML's investigation are documented in the report is entitled "Geotechnical Investigation, Retirement Home Development, 2170 Ghent Avenue, Burlington, Ontario" PML Ref.: 13HF024, dated August 8, 2013. A total of nine (9) boreholes (Boreholes 1 to 9) were advanced at the site to depths ranging from 1.5 to 5.0 m below existing ground surface. The borehole location plan and borehole logs are included as **Appendix A** in this report.

Five (5) boreholes (Boreholes 1 to 5) were advanced to a depth of 5.0 m below existing ground surface and contacted the surface of the shale bedrock. These boreholes indicated that below surficial layers of topsoil and fill, the site was generally underlain by a thin layer of cohesionless sand followed by glacial tills consisting of silt and sandy silt matrix. However, there were no gradation analyses conducted on any soil samples recovered by PML. The till was underlain by silt till/shale complex transition zone to the bedrock followed by the weathered shale bedrock. The bedrock was not cored. PML indicated that free water was observed at depths ranging from 1.5 to 2.4 m (Elev. 90.4 to 91.2 m) upon completion of drilling.

3. FIELD AND LABORATORY WORK

The field work for this investigation by DS was carried out between August 30 and September 3, 2024. A total of four (4) boreholes (BH24-1 to BH24-4, see **Drawing 1**) were drilled to depths ranging from 3.2 to 4.7 m below existing ground surface. The boreholes were drilled with solid stem continuous flight augers equipment by a drilling sub-contractor under the direction and supervision of DS Consultants Ltd. personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the DS Consultants Ltd. laboratory for detailed examination by the project engineer and for laboratory testing.

In addition to visual examination in the laboratory, all the recovered soil samples were tested for moisture contents and results are presented on the respective borehole logs. Five (5) selected

soil samples (BH24-1/SS5, BH24-2/SS3, BH24-4/SS3T, BH24-4/SS3B and BH24-4/SS4) were subjected to grain size analyses and the gradation curves for the grain size analyses are presented on **Drawing 7.** Three (3) selected samples (BH24-1/SS5, BH24-2/SS3 and BH24-4/SS4) were tested for Atterberg Limits and lab results are presented on **Drawing 8.**

Water level observations were made during drilling and in the open boreholes (BH24-1 to BH24-4) at the completion of the drilling operations. Monitoring wells were installed in boreholes BH24-1 and BH24-3 for the long-term stabilized groundwater level monitoring.

The ground surface elevations at the borehole locations were undertaken by DS personnel, using the differential GPS unit. It should be noted that the elevations at the as-drilled borehole locations were not provided by a professional surveyor and should be considered to be approximate. Contractors performing any work referenced to the borehole elevations should confirm the borehole elevations for their work.

4. SITE AND SUBSURFACE CONDITIONS

The subject site is rectangular shaped with a footprint of approximately 1240 m^2 including the proposed building development and parking lot construction area. There are visible remnant concrete structures present at the ground surface on portions of the site which may be attributable to previous construction or start of construction on the site. The site is located in a predominantly residential neighbourhood in the City of Burlington, Ontario.

The borehole location plan is shown on **Drawing 1**. General notes on sample description are provided on **Drawing 1A**. The subsurface conditions in the boreholes (BH24-1 to BH24-4) are presented in the individual borehole logs presented on **Drawings 2 to 5**. A generalized sub-surface profile for the subject site is presented on **Drawing 6**. Location Plan and borehole logs (Boreholes 1 to 9) drilled by PML are attached in **Appendix A.**

4.1 SOIL AND BEDROCK CONDITIONS

The glacial tills encountered in DS' boreholes consisted predominantly of silty clay matrix with occasional sandy silt till zones/layers. The soil and bedrock conditions encountered in DS' boreholes are summarized as follows:

Topsoil:

A surficial topsoil layer with an approximate thickness of 100 mm was encountered at Borehole, BH24-1. It should be noted that the thickness of the topsoil explored at the borehole location may not be representative for the site and should not be relied on to calculate the amount of topsoil

at the site. Shallow hand-dug test-pits should be carried out to further explore the topsoil conditions, if required.

Fill Materials:

Fill materials were encountered below the surficial topsoil in BH245-1 and at the surface of the BH24-2 to 24-4. The fill materials extended to depths ranging from 1.1 to 1.7 m below existing ground surface. The fill materials consisted of cohesionless sandy silt to silty sand, sand, sand and gravel with trace inclusions of organics/organic staining, asphalt and concrete pieces, angular rock fragments, cobbles, gravel and silty clay.

The SPT 'N' values in the fill materials ranged from 5 to 27 blows per 300 mm of penetration, indicating a loose to compact relative density. The moisture content in the fill material ranged from 7 to 19%.

Cohesionless Deposit of Sandy Silt:

A native deposit of sandy silt was encountered below the fill in BH24-4 and extended to a depth of 1.6 m below existing ground surface. The cohesionless sandy silt layer was gravelly and had inclusions of trace clay and occasional cobbles. The SPT 'N' value in the sandy silt was 20 blows per 300 mm of penetration, indicating a compact relative density. The moisture content in the sandy silt layer was from 12%.

Grain size analysis of one (1) cohesionless sandy silt sample (BH24-4/SS3T) was conducted and the results are presented on **Drawing 7**, with the following fractions:

Clay: 5 %
Silt: 35 %
Sand: 33 %
Gravel: 27 %

Silty Clay Till:

A silty clay (glacial) till deposit was encountered below the fill, sand/sandy silt or sandy silt till deposits in all boreholes (BH24-1 to BH24-4) and extended to a depth ranging from 3.1 to 4.6 m below existing ground surface. The brown to reddish brown silty clay till contained inclusions of trace amounts of gravel, trace sand to sandy with occasional cobbles/boulders.

The SPT 'N' values in the silty clay till ranged from 25 to over 50 blows per 300 mm of penetration, indicating a very stiff to hard consistency. The moisture content of the cohesive silty clay glacial deposit ranged from 9 to 13%.

Grain size analyses of three (3) silty clay till samples (BH24-1/SS5, BH24-2/SS3 and BH24-4/SS4) were conducted and the results are presented on **Drawing 7**, with the following fractions:

Clay: 19 to 20 %
Silt: 46 to 55 %
Sand: 19 to 27%
Gravel: 7 to 8%

Atterberg limits test of the same silty clay till samples (BH24-1/SS5, BH24-2/SS3 and BH24-4/SS4) were also conducted. The results are shown on the respective borehole logs, on **Drawing 8** and are summarized as follows:

Liquid limit (WL): 24 to 25%
Plastic limit (WP): 13%
Plasticity index (PI): 11 to 12

Sandy Silt to Silty Sand Till:

Cohesionless glacial deposits of sandy silt to silty sand till were encountered below the silty clay till in BH24-3 and below the sandy silt layer in BH24-4 and extended to depths of 3.5 and 2.3 m below existing ground surface, respectively. The sandy silt to silty sand till deposits contained trace amounts of clay to clayey and gravel.

The SPT 'N' values ranged from 20 (BH24-4) to over 100 (BH24-3) blows per 300 mm of penetration, indicating a compact to very dense relative density. The moisture content in this sandy silt to silty sand till deposit ranged from 13 to 14%.

Grain size analysis of one (1) cohesionless sandy silt till glacial till sample (BH24-4/SS3B) was conducted and the results are presented on **Drawing 7,** with the following fractions:

Clay: 20 %
Silt: 51 %
Sand: 23 %
Gravel: 6 %

Till/Shale Complex:

Till/shale complex was encountered below the silty clay till in boreholes, BH24-1 and BH24-4 at a depth of 4.6 and 3.1 m below existing ground surface, respectively. The till/shale complex extended to a depth of 4.7 and 3.4 m below existing ground surface, respectively. This deposit

was found to have a hard consistency, with measured SPT 'N' values of over 100 blows per 300 mm of penetration. This deposit consisted of silty clay till mixed with highly weathered shale.

Shale Bedrock:

Shale bedrock of Queenston Formation was encountered in boreholes BH24-2 to BH24-4 at depths ranging from approximately 3.1 to 3.5 m below existing ground surface, corresponding to Elev. 89.0 to 89.3 m. The reddish-brown bedrock had grey seams and inclusions of limestone.

The bedrock was not proven by rock coring and was penetrated by auger for minimal depths. The bedrock depths shown on the borehole logs are approximate. Commonly the till overlaying shale contains slabs of limestone which would give a false indication of the bedrock level. Similarly, the depth of weathering cannot be determined accurately due to the presence of limestone layers.

Methane gas is anticipated in the bedrock. Appropriate care and monitoring are essential in all confined bedrock excavations, particularly for trenches and tunnels. **Appendix B** presents more details and general comments about the shale bedrock.

4.2 GROUNDWATER CONDITIONS

Stabilized groundwater levels in the monitoring well installed in BH24-1 and BH24-3 were recorded at depths ranging from 1.4 to 1.8 m below the existing grade, corresponding to Elevations 90.6 to 91.1 m. The groundwater levels measured in the monitoring wells are summarized in **Table 1**.

Table 1: Summary of Groundwater Level Measurements in DS Monitoring Wells

Borehole No.	Ground Surface Elev. (m)	Date of Observation	Depth of Groundwater (m)	Elevation of Groundwater (m)
BH24-1	92.4	September 17, 2024	1.8	90.6
BH24-3	92.5	September 17, 2024	1.4	91.1

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events. Further groundwater level readings in the monitoring wells are recommended.

5. DISCUSSION AND RECOMMENDATIONS

Based on the borehole information, preliminary geotechnical discussion and recommendations for the proposed development are presented as follows.

5.1 SITE GRADING AND ENGINEERED FILL

The site will be developed to include residential townhouse buildings with no basement and will include new internal road with associated site service infrastructure. Given the presence of existing heterogeneous fill on the site, it is recommended that all fill to be placed for grading purposes be constructed as engineered fill to provide competent subgrade below house foundations/slab-on-grade, roads, boulevards, etc.

In the boreholes, fill materials extended to depths ranging from 1.1 to 1.7 m below the existing grade. The fill materials are considered unsuitable to support the proposed structures and/or engineered fill. These unsuitable soils must be removed prior to the construction of engineered fill.

Dewatering will be required for excavation in sandy soils below the groundwater table.

The existing onsite soils are susceptible to disturbance when exposed to weather and construction traffic. Water (e.g., surface water runoff) should not be permitted to enter and/or pond within the construction area. This is especially important to the success of the planned construction (i.e., proof rolling or engineered fill placement).

Before the construction of engineered fill, all the existing topsoil, fill material, and any other unsuitable soils should be removed. Groundwater must be lowered to at least 1.0 m below the lowest level of the excavation. The (native) base of the excavation should be compacted, and proof rolled with heavy compactors (minimum 10,000 kg). The entire area should be inspected and approved by geotechnical engineer. During proof rolling, spongy, wet, or soft/loose spots should be sub-excavated to stable subgrade and replaced with approved soil, compatible with subgrade conditions, as directed by the geotechnical engineer. After approval of the exposed subgrade, the grade can be restored to design grades with compacted engineered fill. Depth of fill materials, and loose native soils to be removed before engineered fill construction is given below in **Table 2**.

Table 2: Depth of Existing Fill to be removed

Borehole No.	Depth of Overburden to be Removed (m)	Elevation of Native Subgrade (m)
BH24-1	1.5	90.9
BH24-2	1.1	91.1
BH24-3	1.7	90.8
BH23-4	1.5	91.2

Subsequent to any stripping and/or sub-excavation, it is recommended that all new fill, where required, be placed as engineered fill to provide competent subgrade for the proposed structures and roads. The material for backfilling the excavation and raising the grades should consist of inorganic material. Recommendations regarding engineered fill placement are provided in **Appendix C**. Based on the boreholes, some of the fill are likely not suitable to be re-used for engineered fill as it contains organics and debris including trace asphalt pieces and concrete pieces. Some of the fill which is relatively free of organics and free of debris and environmentally acceptable, may be selectively re-used as engineered fill, subject to approval of the geotechnical engineer. We recommend that the nature/extent and quality of the fill on the site be explored further through test pits.

The engineered fill must be compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) throughout. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential.

5.2 ROADS

The investigation has shown that the predominant subgrade soil, after engineered fill placement will generally consist of engineered fill and compacted fill.

Based on the above and assuming that traffic usage will be residential local road, the following minimum pavement thickness is recommended for road to be constructed within the development:

40 mm HL3 Asphaltic Concrete

80 mm HL8 Asphaltic Concrete

150 mm of Granular ‘A’ (20 mm Crusher run Limestone)

350mm of Granular ‘B’ (50 mm Crusher run Limestone)

Roads and driveway pavements/aprons should be constructed as per the City of Burlington standards. The site subgrade and weather conditions (i.e., if wet) at the time of construction may necessitate the placement of thicker granular sub-base layer in order to facilitate the construction. The need for filter fabric/geo-grid can be evaluated during construction stage. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

5.2.1 STRIPPING, SUB-EXCAVATION AND GRADING

The site should be stripped of all topsoil, fill materials and any organic, weathered or otherwise unsuitable soils to the full depth of the roads, both in cut and fill areas. Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proof rolled, in the presence of the Geotechnical Engineer, by at least several passes of a heavy compactor having a rated capacity of at least 8 tonnes. Any soft spots thus exposed should be removed and replaced by select fill material, similar to the existing subgrade soil and approved by the Geotechnical Engineer. The subgrade should then be re-compacted from the surface to at least 98% of its Standard Proctor Maximum Dry Density (SPMDD). The final subgrade should be cambered or otherwise shaped properly to facilitate rapid drainage and to prevent the formation of local depressions in which water could accumulate.

Proper cambering of the subgrade is required to allow the surface water to escape towards the sides, where it can be removed by means of subdrains. Otherwise, any water collected in the granular sub-base materials could be trapped thus causing problems due to softened subgrade, differential frost heave, etc. For the same reason damaging the subgrade during and after placement of the granular materials by heavy construction traffic should be avoided. If the moisture content of the local material cannot be maintained at ±2% of the optimum moisture content, imported granular material may need to be used.

Any fill required for re-grading the site or backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. The fill should be placed in thin layers and compacted to at least 98% of its SPMDD. The compaction of the new fill should be checked by frequent field density tests.

5.2.2 ROAD CONSTRUCTION

Once the subgrade has been inspected and approved, the granular base and sub-base course materials should be placed in layers not exceeding 200 mm (uncompacted thickness) and should be compacted to 100% of their respective SPMDD. The grading of the material should conform to current OPS Specifications.

The placing, spreading, and rolling of the asphalt should be in accordance with OPS Specifications or as required by the local authorities.

Frequent field density tests should be carried out on both the asphalt and granular base and sub-base materials to ensure that the required degree of compaction is achieved.

5.2.3 DRAINAGE

The City of Burlington requires the installation of full-length subdrains on all roads. The subdrains should be properly filtered to prevent the loss of (and clogging by) soil fines.

All paved surfaces should be sloped to provide satisfactory drainage towards catch-basins. As discussed in Section 5.2.1, by means of good planning any water trapped in the granular sub-base materials should be drained rapidly towards subdrains or other interceptors.

5.3 UNDERGROUND UTILITIES

As a part of the site development, new watermains, storm and sanitary sewers will be constructed. It is assumed that the trenches will generally be within 4 to 5 m below the existing grade.

5.3.1 TRENCHING

The boreholes show that below the existing topsoil and fill, the trenches will be predominantly dug through the sand/sandy silt, silty clay till, sandy silt to silty sand till, silty clay till/complex deposits and shale bedrock. Excavations can be carried out with heavy hydraulic backhoe, however, obstructions and boulder should be expected. Excavation of the shale can be carried out using heaviest available single tooth ripper equipment. The limestone beds where present may be frequent and may overlay the shale bedrock surface at some locations. It will be necessary to utilize jackhammer type equipment to “open” the limestone layers for the ripper.

Stabilized groundwater levels in the monitoring wells (installed by DS) were recorded at depths ranging from 1.4 to 1.8 m below the existing grade, corresponding to Elevations 90.6 to 91.1 m. Dewatering will be required prior to any excavation in cohesionless sandy soils below the groundwater table. Otherwise, it will result in an unstable base and flowing sides. Groundwater table must be lowered to 1.0 m below the lowest excavation level.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, fill, engineered fill, sand/sandy silt, and sandy silt to silty sand till can be classified as Type 3 Soil above the groundwater table and Type 4 Soil below the groundwater table or in perched water condition. Very stiff to hard silty clay till can be classified as Type 2 Soil above the groundwater table and Type 3 soil below the groundwater table.

It should be noted that the till is a non-sorted sediment and therefore contain cobbles and boulders. Possible large obstructions such as buried concrete pieces may be present in the fill

material. Provisions must be made in the excavation contract for the removal of possible boulders in the till and obstructions in the fill materials.

5.3.2 BEDDING

Subject to design grades, it is expected that the sewer/watermain pipes will predominantly be laid within the native soils, engineered fill or shale bedrock which will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The bedding should conform to the current Ontario Provincial Standard specifications (OPSS 401/OPSD 802) and/or standards set by the local municipality.

The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, have to be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions or fill materials are encountered at the trench base level. The bedding material should consist of well graded granular material such as Granular 'A' or equivalent.

After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local Authority, should be placed.

To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless, below the granular bedding material, a suitable, approved filter fabric (geotextile) is placed. The geotextile should extend along the sides of the trench and should be wrapped all around the poorly graded bedding material.

For deep sewers to be installed in shale bedrock, i.e., more than 2.0 m below the shale surface, a minimum 50 mm thick polystyrene layer will be required at both sides of the pipe to avoid potential rock squeezing. The polystyrene layer should extend vertically to at least 0.3 m above the pipe. The rock trench should be wide enough so that at each side, the horizontal distance between the side of the pipe and the cut rock face is at least 0.3 m.

5.3.3 BACKFILLING OF TRENCHES

Based on visual and tactile examination, the fill materials, and native soils free from topsoil/organics and debris can be reused as backfill material provided its moisture content is within 2 percent of optimum moisture content, and it is environmentally suitable.

The backfill should be placed in maximum 200 mm thick layers at or near (±2%) their optimum moisture content and each layer should be compacted to at least 95% SPMDD. In the upper 1.5m of the subgrade, underneath the road base, the compaction should be increased to 98% SPMDD.

Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc. should not be used for backfilling.

Granular B material should be used as backfill for trenches located under slab on grade or paved areas. Compaction of the granular soils should be carried out with vibratory compactors and loose lifts not exceeding about 200 mm.

Imported granular fill, which can be compacted with handheld equipment, should be used in confined areas.

The clayey soils will have to be compacted using heavy equipment suitable for these soils which may be difficult to operate in the narrow confines of the trenches. Unless the clayey materials are properly pulverized and compacted in sufficiently thin lifts, post-construction settlements could occur. Their use in narrow trenches such as laterals (where heavy compaction equipment cannot be operated) may not be feasible.

The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

5.4 FOUNDATION CONDITIONS

It is understood the proposed residential development will include the construction of townhouse buildings with no basements. The proposed site grades and lowest finished floor elevations for the proposed structures were not available to us at the time of writing this report.

5.4.1 Footings Founded on Native Soils

In the boreholes, fill materials extended to depths ranging from 1.1 to 1.7 m below the existing grade. The fill and possible fill materials are considered unsuitable to support the proposed structure. These unsuitable soils must be removed prior to the construction of engineered fill, prior to the construction of proposed structures, as discussed in Section 5.1 of this report.

The proposed house structures can be supported by conventional footings founded on engineered fill, designed for bearing capacity values of 150 kPa at SLS and 225 kPa at ULS.

The engineered fill supporting footings should be constructed in accordance with the guidelines presented in Section 5.1 and **Appendix C**.

The design grades and lowest finished floor elevation was not available to us at the time of writing this report. Therefore, our recommendations should be considered preliminary and will be revised if and as required when the proposed Site/Foundation plan becomes available.

Based on the information from the above-mentioned boreholes, the following soil bearing capacities, as presented in **Table 3**, are available for proposed building with no basement supported on conventional footings on undisturbed native soils.

Table 3: Bearing Values and Founding Levels of conventional Footings in Native Soils

BH No.	Ground Surface Elevation At Borehole (m)	Bearing Capacity at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth below Existing Ground (m)	Founding Level At or Below Elevation (m)
BH24-1 (DS)	92.4	300	450	1.8	90.6
BH24-2 (DS)	92.2	300	450	1.4	90.8
BH24-3 (DS)	92.5	250	375	2.0	90.5
BH24-4 (DS)	92.7	200	300	1.8	90.9
BH 1 (PML)	92.8	300	450	2.0	90.8
BH 2 (PML)	93.1	300	450	2.1	91.0
BH 3 (PML)	92.7	300	450	1.8	90.9
BH 4 (PML)	92.6	300	450	1.2	91.4
BH 5 (PML)	92.7	300	450	1.4	91.3

Higher bearing capacity values can be provided for footings on dense/hard native soils and bedrock, if required.

5.4.2 General Foundation Notes

Variations in the soil conditions are expected in between the borehole locations, and during construction, the soil bearing pressures should be confirmed by the Geotechnical Engineer.

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing.

The lower footing must be installed first to help minimize the risk of undermining the upper footing.

It should be noted that the recommended bearing capacities have been calculated by DS from the borehole information for the preliminary design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by DS to validate the information for use during the construction stage.

5.5 FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade provided all topsoil, unsuitable fill materials and surficially softened / disturbed soils are removed and the site is regraded with engineered fill.

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

A subgrade reaction coefficient of kt = 15 MPa/m can be used for the design of the concrete slab on engineered fill, if required.

If the floor slab is more than 300 mm higher than the exterior grade, then perimeter drainage is not considered to be necessary. If the floor is lower, then the perimeter drainage system shown on **Drawing 9** is recommended**.**

5.6 FROST PROTECTION

All foundations exposed to seasonal freezing conditions must have at least 1.2 m soil cover for frost protection.

5.7 EARTH PRESSURES

The lateral earth pressures acting on retaining walls, if any, may be calculated from the following expression:

$$p = K(\gamma h + q)$$

where p = Lateral earth pressure in kPa acting at depth h

K = Earth pressure coefficient equal to 0.40 for vertical walls and horizontal backfill used for permanent construction. Water pressure must be considered if continuous wall drains are not used.

γ = Unit weight of backfill, a value of 21.0 kN/m^3 may be assumed

h = Depth to point of interest in metres

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the wall.

5.8 EXCAVATION AND GROUNDWATER CONTROL

Excavations can be carried out with heavy hydraulic backhoe. Cobbles and boulders are present at the site as evidence of auger grinding. Provisions should be provided in the contractor documents to deal with the boulders and cobbles encountered at the site.

Groundwater levels were recorded were recorded at depths ranging from 1.4 to 1.8 m below the existing grade, corresponding to Elevations 90.6 to 91.1 m. Groundwater seepage within the silty clay (till) is expected to be slow. It is expected that any seepage which occurs from perched water in the fill materials, and native cohesive till should be manageable by gravity drainage and pumping from filtered sumps. More significant groundwater seepage/inflow would be expected from the cohesionless sand/sandy silt or sandy silt (till) and zones of sandy soils within the silty clay (till), if present, below groundwater table. Dewatering will be required for excavation into the cohesionless sandy deposits below groundwater table. The groundwater must be lowered to at least 1.0 m below the excavation bases.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, fill, engineered fill, sand/sandy silt, and sandy silt to silty sand till can be classified as Type 3 Soil above the groundwater table and Type 4 Soil below the groundwater table or in perched water condition. Very stiff to hard silty clay till can be classified as Type 2 Soil above the groundwater table and Type 3 soil below the groundwater table.

5.9 EARTHQUAKE CONSIDERATIONS

Based on the existing borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed building with no basement can be classified as “Class D” for seismic site response. It may be possible to classify the site as Class “C” for buildings when the design information is available to DS to review.

6. GENERAL COMMENTS AND LIMITATIONS OF REPORT

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

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to DS at the time of preparation. Unless otherwise agreed in writing by DS, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the

subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

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. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

DS CONSULTANTS LTD



Osbert (Ozzie) Benjamin, P.Eng.
Senior Geotechnical Engineer



Fanyu Zhu, Ph.D., P.Eng.
Principal Engineer



Alka Sangar, M.Eng., P.Eng.

Drawings

J:\2024 Projects\24-063-101 Geo - 2170 Ghent Avenue, Burlington, Ontario\Geotechnical\QGIS\1-QGIS\Drawing 1 Borehole Location Plan.qgs Sep-19 10:06



Legend

- Approx Site Boundary
- Borehole
- Monitoring Well

DS CONSULTANTS LTD.
6221 Highway 7, UNIT 16
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Telephone: (905) 264-9393
www.dsconsultants.ca

Project: GEOTECHNICAL INVESTIGATION
2170 Ghent Avenue, Burlington, ON

Title: **BOREHOLE LOCATION PLAN**

N

Client: NORTHERN CARDINAL HOMES LTD.

Size:	Approved By:	Drawn By:	Date:
8.5 x 11	O.B	K.T	September 2024
Rev: 0	Scale: As Shown	Project No.: 24-063-101	Drawing No.: 1

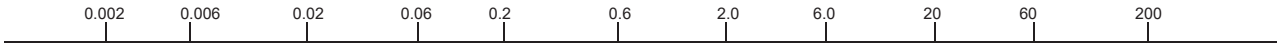
Image/Map Source: *Google Satellite Image*

Drawing 1A: Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by DS also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH24-1

PROJECT: Geotechnical Investigation
CLIENT: Northern Cardinal Homes Ltd.
PROJECT LOCATION: 2170 Ghent Avenue, Burlington, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4798915.7 E 597089.5

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Aug/30/2024 to Aug/30/2024

REF. NO.: 24-063-101
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
92.4							
92.0 / 0.1	**TOPSOIL:** 100mm						
	FILL: sandy silt to silty sand, trace organics, trace gravel, brown, moist, loose		1	SS	6		92
91.2 / 1.2	**FILL:** sand, trace gravel, brown, moist, loose		2	SS	5		
90.9 / 1.5	**SILTY CLAY TILL:** some sand, trace gravel, reddish brown, moist, hard		3	SS	50	▽	91
	reddish grey at 2.3m		4	SS	50		90
			5	SS	46		89
87.8							88
87.7 / 4.7	**SILTY CLAY TILL / SHALE COMPLEX:** reddish brown, moist, very dense		6	SS	50/ 70 mm		
	END OF BOREHOLE						

W. L. 90.6 m
Sep 17, 2024

Notes:
1) 50mm dia. monitoring well (MW) was installed upon completion.
2) Water level Readings:

Date:	W.L. Depth (mbgs):
September 17, 2024	1.8

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
7	19	55	20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

DS SOIL LOG-2021-FINAL 24-063-101 GEO.GPJ DS.GDT 9/27/24

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LOG OF BOREHOLE BH24-2

PROJECT: Geotechnical Investigation
CLIENT: Northern Cardinal Homes Ltd.
PROJECT LOCATION: 2170 Ghent Avenue, Burlington, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4798932.1 E 597106.1

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Aug/30/2024 to Aug/30/2024

REF. NO.: 24-063-101
ENCL NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS / 0.3 m "N"	ELEVATION
92.2					
0.0	**FILL:** silty sand, trace organics, trace gravel, brown to dark brown, moist, compact	1	SS	11	92
	angular rock fragments below 0.5m				
	silty clay inclusions below 0.8m	2	SS	27	
91.1					
1.1	**SILTY CLAY TILL:** occasional cobble / boulder, sandy, trace gravel, reddish brown, moist, very stiff to hard	3	SS	39	91
		4	SS	38	90
89.1					
89.0	**SHALE BEDROCK:** Queenston	5	SS	50/	89
3.2	Formation, limestone fragments, reddish brown with grey seams, weathered			51 mm	
	END OF BOREHOLE:				
	Notes:				
	1) Borehole dry upon completion.				

GROUND WATER CONDITIONS

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
7	22	50	20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

DS SOIL LOG-2021-FINAL 24-063-101 GEO.GPJ DS.GDT 9/27/24

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH24-3

PROJECT: Geotechnical Investigation
CLIENT: Northern Cardinal Homes Ltd.
PROJECT LOCATION: 2170 Ghent Avenue, Burlington, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4798958.8 E 597074.8

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Aug/30/2024 to Sep/03/2024

REF. NO.: 24-063-101
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.5												
0.0	**FILL:** sandy silt to silty sand, trace organics / organic staining, trace gravel, brown, moist, compact		1	SS	15		92					
1 91.5												
1.0	**FILL:** sand and gravel with cobble fragments, brown, wet, compact		2	SS	14	▽						
90.8												
1.7	**SILTY CLAY TILL:** trace sand, trace gravel, brown, moist, very stiff to hard		3	SS	25		W. L. 91.1 m Sep 17, 2024					
2	occasional cobble / boulder at 2.3m		4	SS	66		90					
3 89.4												
3.1	**SANDY SILT TO SILTY SAND TILL:** trace clay, trace gravel, brown, moist, very dense		5	SS	50/ 100 mm		89					
89.0												
3.5	**SHALE BEDROCK:** Queenston Formation, reddish brown with grey seams, weathered											
4												
87.8			6	SS	50/ 51 mm		88					
4.7	**END OF BOREHOLE**											

Notes:
1) 50mm dia. monitoring well was installed upon completion.
2) Water level readings:

Date:	W.L. Depth (mbgs):
September 17, 2024	1.4

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH24-4

PROJECT: Geotechnical Investigation
CLIENT: Northern Cardinal Homes Ltd.
PROJECT LOCATION: 2170 Ghent Avenue, Burlington, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4798973.3 E 597060.8

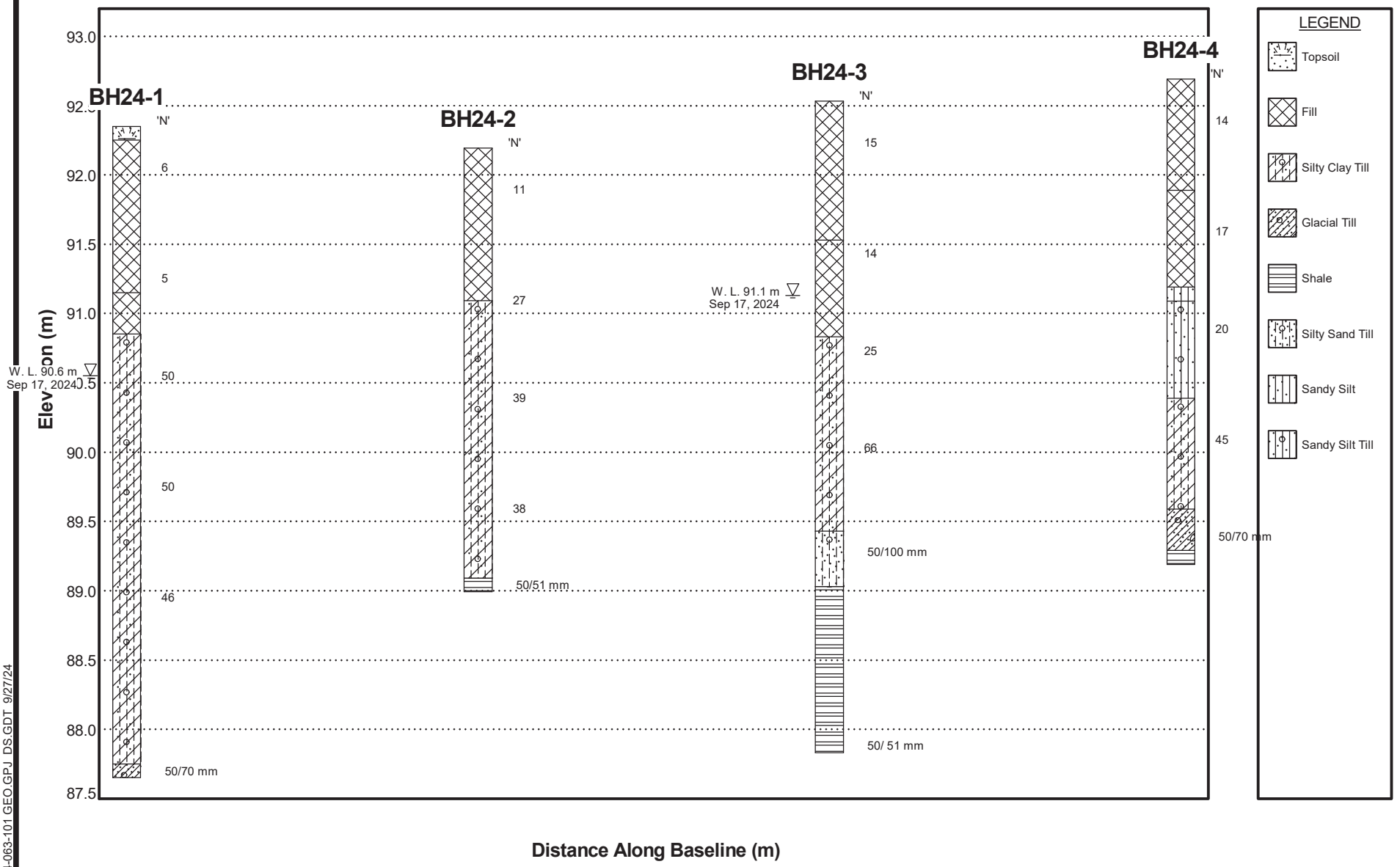
DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Aug/30/2024 to Aug/30/2024

REF. NO.: 24-063-101
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.7												
0.0 / 91.9	**FILL:** silty sand, trace asphalt pieces, trace concrete pieces, trace gravel, brown, moist, compact		1	SS	14		92	○ at 14	○ at 10			
0.8 / 91.2	**FILL:** sand, trace organics, trace gravel, brown, moist, compact		2	SS	17			○ at 17	○ at 20			
91.5 / 1.6 / 90.4	**SANDY SILT:** occasional cobbles, gravelly, trace clay, brown, moist, compact **SANDY SILT TILL:** clayey, trace gravel, brown, moist, compact		3	SS	20		91	○ at 20	○ at 20			27 33 35 5 6 23 51 20
2.3 / 89.6	**SILTY CLAY TILL:** occasional cobble/boulder, sandy, trace gravel, reddish brown, moist, hard		4	SS	45		90	○ at 45	○ at 25			8 27 46 19
3.1 / 89.3	**SILTY CLAY TILL / SHALE COMPLEX:** reddish brown, moist, hard		5	SS	50/ 70 mm			○ at 50/70 mm	○ at 15			
89.2												
3.5	**SHALE BEDROCK:** Queenston Formation, reddish brown with grey seams, weathered **END OF BOREHOLE:** Notes: 1) Borehole dry upon completion.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure



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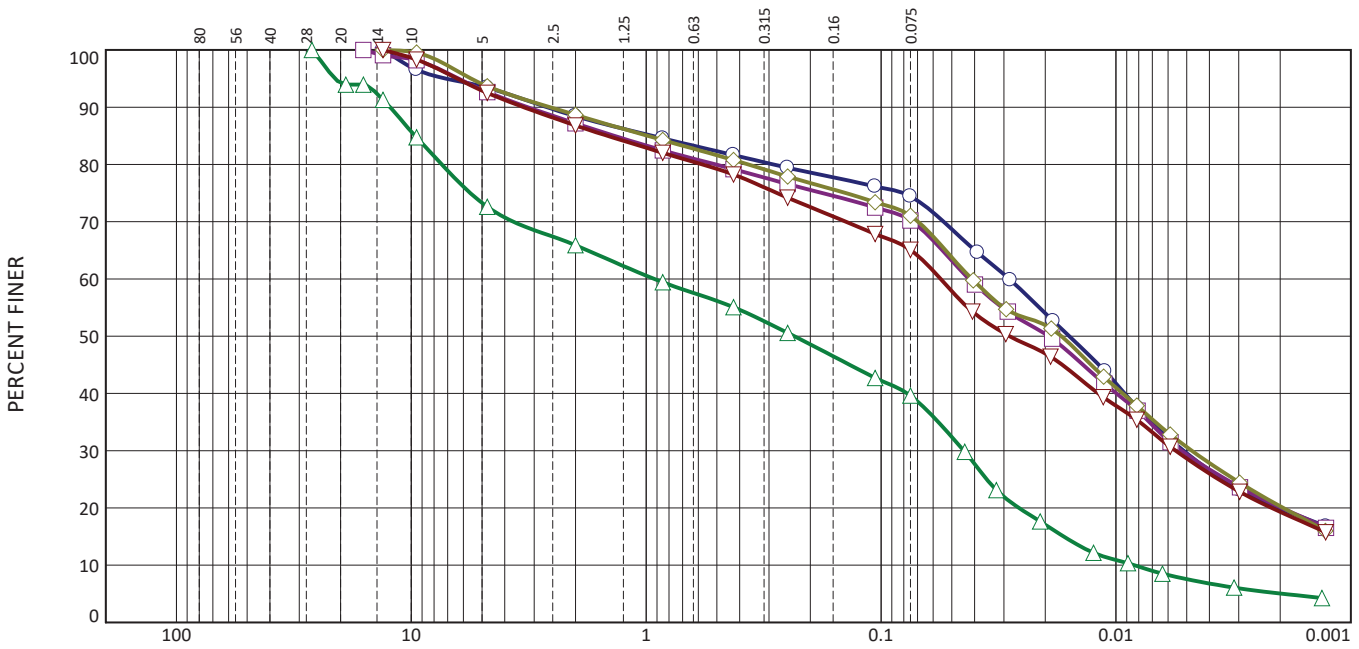
Generalized Sub-surface Profile (NTS)

DRAWING NO.	6
JOB NO.	24-063-101
DATE	September, 2024

DS FENCE (M) 24-063-101 GEO.GPJ DS.GDT 9/27/24

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.6	5.0	6.8	7.2	54.6	19.8
□	0.0	0.0	7.4	5.4	8.0	9.0	50.1	20.1
△	0.0	6.1	21.3	6.7	10.8	15.5	34.5	5.1
◇	0.0	0.0	6.4	4.9	7.9	9.8	50.7	20.3
▽	0.0	0.0	7.5	5.7	8.6	13.1	45.8	19.3

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	24	13	0.9408	0.0285	0.0158	0.0052				
□	25	13	1.3679	0.0422	0.0193	0.0053				
△			9.6374	0.9228	0.2343	0.0445	0.0167	0.0084	0.26	110.39
◇			0.9840	0.0411	0.0171	0.0048				
▽	25	13	1.4627	0.0558	0.0284	0.0056				

	Material Description	USCS	AASHTO
○	Silty clay till, some sand, trace gravel	CL	A-6(5)
□	Silty clay till, sandy, trace gravel	CL	A-6(5)
△	Sandy silt, trace clay, gravelly		
◇	Sandy silt till, clayey, trace gravel		
▽	Silty clay till, sandy, trace gravel	CL	A-6(5)

Project No. 24-063-101 **Client:** Northern Cardinal Homes Ltd

Project: 2170 Ghent Avenue, Burlington, ON

○ **Location:** BH24-1 SS5 **Sample Number:** VM-5889

□ **Location:** BH24-2 SS3 **Sample Number:** VM-5889

△ **Location:** BH24-4 SS3T **Sample Number:** VM-5889

◇ **Location:** BH24-4 SS3B **Sample Number:** VM-5889

▽ **Location:** BH24-4 SS4 **Sample Number:** VM-5889

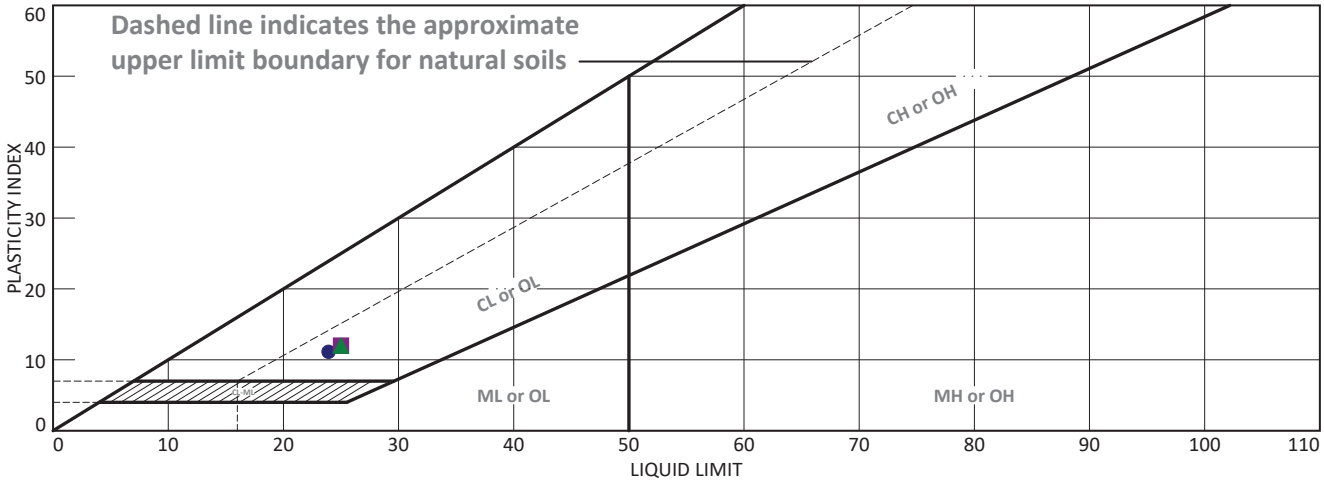
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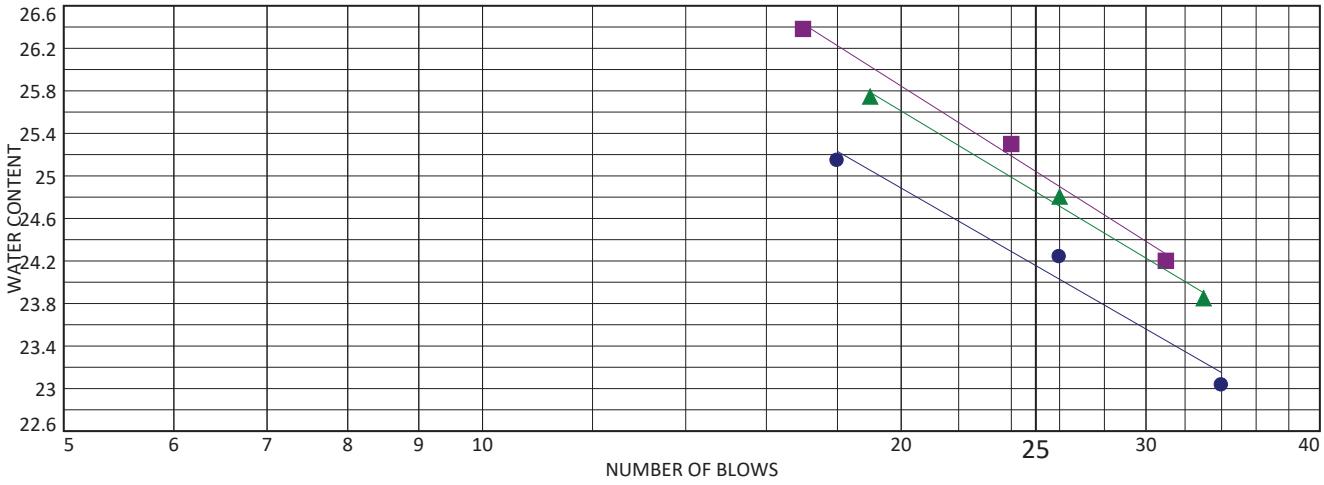
Remarks:

Figure 7

Tested By: Helen/Nisha **Checked By:** Kirupa

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty clay till, some sand, trace gravel	24	13	11	81.6	74.4	CL
■	Silty clay till, sandy, trace gravel	25	13	12	79.2	70.2	CL
▲	Silty clay till, sandy, trace gravel	25	13	12	78.2	65.1	CL

Project No. 24-063-101 **Client:** Northern Cardinal Homes Ltd

Project: 2170 Ghent Avenue, Burlington, ON

●**Location:** BH24-1 SS5 **Sample Number:** VM-5889

■**Location:** BH24-2 SS3 **Sample Number:** VM-5889

▲**Location:** BH24-4 SS4 **Sample Number:** VM-5889

Remarks:

●Sampled on August 30, 2024

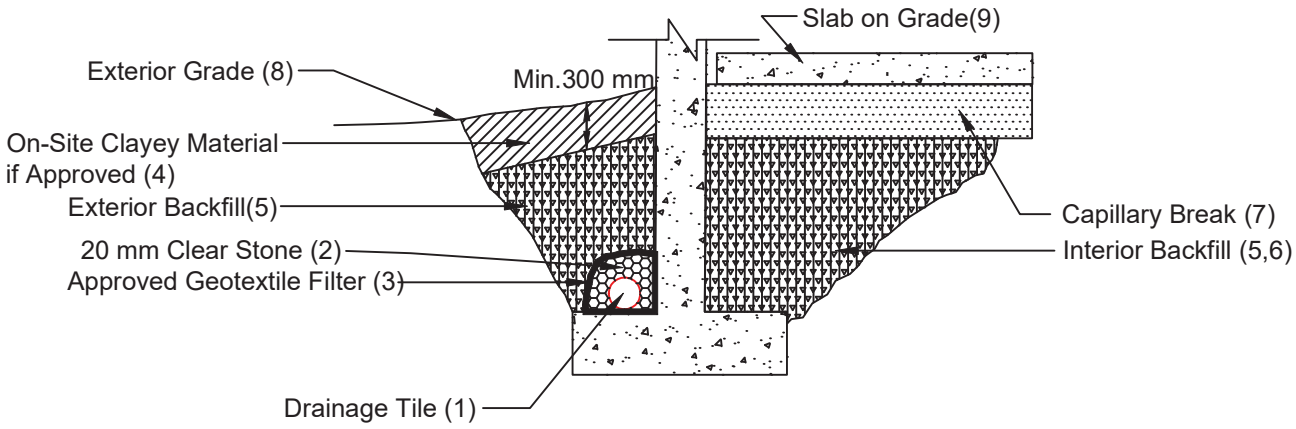
■Sampled on August 30, 2024

▲Sampled on August 30, 2024

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Figure 8

Tested By: Nisha **Checked By:** Kirupa



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved geotextile filter (Terrafix 270R or equivalent).
4. The on-site clayey material, if approved, can be used as backfill in the upper 300 mm.
5. The interior and exterior fill adjacent to foundation walls should be OPSS Granular 'B' Type I. Compact to at least 98% SPMDD.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall. Place fill on both sides simultaneously.
7. Capillary break to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors (consult with architect).
8. Exterior grade to slope away from building at min. 2%.
9. Slab on grade should not be structurally connected to the wall or footing.
10. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Slab on Grade Construction Without Underfloor Drainage

(not to scale)

Appendix A

Borehole Location Plan and Borehole Logs
PML Investigation 2013

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

Standard Penetration Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

CONSISTENCY	N (blows/0.3 m)	c (kPa)	DENSENESS	N (blows/0.3 m)
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		

WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample		
	PH Sample Advanced Hydraulically		
	PM Sample Advanced Manually		

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 1

METRIC

17T 0597032E
4798955N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.8	Ground Surface						
92.3 / 0.5	TOPSOIL: Very loose, black sandy silt topsoil, low organic, damp		1A	SS	2		
	SAND: Very loose, brown fine to medium silty sand, trace gravel, damp		1B	SS			
1.0			2	SS	1	92	
91.1 / 1.7	becoming compact, gravelly, saturated; with occasional shale fragments and iron staining		3A	SS			
90.7 / 2.1			3B	SS	29	91	
	SILT TILL: Very dense, grey sandy silt till, trace sand and clay, damp; occasional shale fragments		4	SS	84		
89.9 / 2.9						90	
	SILT TILL/SHALE COMPLEX: Very dense, red silt till/shale complex, trace sand and gravel, moist		5	SS	50/100mm		
88.8 / 4.0	SHALE: Highly weathered to weathered red shale					89	
			6	SS	50/100mm	88	
87.8 / 5.0	BOREHOLE TERMINATED AT 5.0 m						Upon completion of augering, free water and cave to 2.4 m

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kN/m³

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KP.GPJ ON_MOT.GDT 7/26/2013 1:34:23 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

METRIC

17T 0597043E
4798973N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES
93.1	Ground Surface				
0.3	PAVEMENT STRUCTURE: 100 mm asphalt over 150 mm brown sand and gravel granular base; occasional slag fragments		1A 1B 1C	SS SS SS	11
91.7 1.4	FILL: Loose, brown silty sand fill, trace gravel, damp; occasional coal fragments		2	SS	9
91.0 2.1	SAND: Loose, brown fine to medium silty sand, trace gravel, damp; with iron/oxidized stains		3	SS	21
	becoming compact, grey, some gravel, saturated		4	SS	48
89.8 3.3	SILT TILL: Dense, grey sandy silt till, trace sand and clay, damp; occasional shale fragments		5A 5B	SS SS	73/225mm
89.1 4.0	SILT TILL/SHALE COMPLEX: Very dense, red silt till/shale complex, trace sand and gravel, moist				
	SHALE: Highly weathered to weathered red shale		6	SS	50/100mm
88.1 5.0	BOREHOLE TERMINATED AT 5.0 m				

ELEVATION SCALE: 93, 92, 91, 90, 89

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION
STANDARD PENETRATION TEST ×
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Upon completion of augering, free water at 2.1 m, cave to 4.3 m

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KF.GPJ ON_MOT.GDT 7/26/2013 1:34:25 PM

+7, ×5: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

17T 0597058E
4798945N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
92.7	Ground Surface					
0.3	FILL: Compact, brown sand fill, trace silt and gravel, damp		1A	SS		
			1B	SS	15	
0.5	layer of asphalt fragments		1C	SS		
0.7	SAND: Compact, brown fine to medium silty sand, trace gravel, damp; with iron/oxidized stains		2	SS	12	92
91.3						
1.4	becoming dense, gravelly, saturated; with occasional shale fragments and iron staining		3A	SS	26	
90.9			3B	SS		91
1.8	SILT TILL: Very dense, grey sandy silt till, trace sand and clay, damp; occasional shale fragments		4	SS	68	
89.8						90
2.9	SAND TILL: Very dense, brown, fine to medium silty sand till, trace gravel, damp; occasional shale fragments		5	SS	88/225mm	
88.4						89
4.3	SHALE: Highly weathered to weathered red shale		6	SS	50/100mm	88
87.7						
5.0	BOREHOLE TERMINATED AT 5.0 m					

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION
STANDARD PENETRATION TEST
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Upon completion of augering, free water at 1.5 m, cave to 2.7 m

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KF.GPJ ON_MOT.GDT 7/26/2013 1:34:27 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 4

METRIC

17T 0597075E
4798922N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION ×, STANDARD PENETRATION TEST ●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.
92.6	Ground Surface									
92.1 / 0.5	TOPSOIL: Loose, black sandy silt topsoil, low organic, damp		1A	SS	6					
0.7	SAND: Loose, brown fine to medium silty sand, trace gravel, damp; with iron/oxidized stains		1B	SS		92				
1.0			2	SS	19					
91.2	becoming compact, moist									
1.4	SILT TILL: Hard, reddish brown clayey silt till, some sand, trace gravel, DTPL; occasional shale fragments		3	SS	40	91				
2.0 / 90.5										
2.1	becoming very dense, grey sandy silt till, trace sand and clay, damp; occasional shale fragments		4	SS	50/100mm	90				
3.0										
89.3			5A	SS						
3.3	SAND TILL: Very dense, brown, fine to medium silty sand till, trace gravel, damp; occasional shale fragments		5B	SS	68/300mm	89				
4.0 / 88.3										
4.3	SHALE: Highly weathered to weathered red shale		6	SS	50/100mm	88				
87.6										
5.0	BOREHOLE TERMINATED AT 5.0 m									Upon completion of augering, no free water, no cave

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 5

METRIC

17T 0597085E
4798940N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
92.7	Ground Surface					
92.2 / 0.5	TOPSOIL: Very loose, black sandy silt topsoil, low organic, damp		1A	SS	3	
			1B	SS		
0.7	SAND: Compact, brown fine to medium silty sand, trace gravel, damp; with iron/oxidized stains		2	SS	25	92
91.3	becoming wet					
1.4	SILT TILL: Hard, reddish brown clayey silt till, some sand, trace gravel, DTPL; occasional shale fragments		3	SS	55	91
90.6	becoming dense to very dense, grey sandy silt till, trace sand and clay, damp; occasional shale fragments		4	SS	60	90
			5	SS	45	89
88.6						
4.1	SAND TILL: Very dense, reddish brown, fine to medium silty sand till, trace gravel, wet; occasional shale fragments		6	SS	50/75mm	88
87.7 / 5.0	BOREHOLE TERMINATED AT 5.0 m					

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲/Δ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT W_P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Upon completion of augering, no free water, no cave

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KF.GPJ ON_MOT.GDT 7/26/2013 1:34:31 PM

+ , × : Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 6

METRIC

17T 0597052E
4798981N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
93.2	Ground Surface					
92.6 / 0.6	TOPSOIL: Very loose, black sandy silt topsoil, low organic, damp		1	SS	1	93
	SAND: Compact, brown fine to medium silty sand, trace gravel, damp; with iron/oxidized stains		2	SS	3	92
91.4 / 1.8	becoming compact, grey, saturated		3A	SS		
			3B	SS	10	
2.1	BOREHOLE TERMINATED AT 2.1 m					

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT W_P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Upon completion of augering, no free water, no cave

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 7

METRIC

17T 0597072E
4798965N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ▲/△ POCKET PENETROMETER/TORVANE; 50 100 150 200; DYNAMIC CONE PENETRATION ×, STANDARD PENETRATION TEST ●; 20 40 60 80)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.1	Ground Surface									
	FILL: Brown sand and gravel fill, trace silt, damp; occasional coal and slag fragments		1A	SS		93				
0.3			1B	SS	5					
92.3										
0.8	SAND: Loose, brown fine to medium silty sand, trace gravel, damp									
1.0	becoming moist, iron stained		2	SS	8	92				
91.6										
1.5	BOREHOLE TERMINATED AT 1.5 m									Upon completion of augering, no free water, no cave

2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KF.GPJ ON_MOT.GDT 7/26/2013 1:34:34 PM

+⁷, ×⁵ Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

METRIC

17T 0597083E
4798951N

1 of 1

PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ▲/△ POCKET PENETROMETER/TORVANE, DYNAMIC CONE PENETRATION ×, STANDARD PENETRATION TEST ●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.0	Ground Surface									
92.5 / 0.5	TOPSOIL: Very loose, black sandy silt topsoil, low organic, damp		1A	SS	2					
0.8	SAND: Loose, brown fine to medium silty sand, trace gravel, damp		1B	SS						
1.0	with some gravel; iron stained		2	SS	9	92				
91.5 / 1.5	BOREHOLE TERMINATED AT 1.5 m									Upon completion of augering, no free water, no cave

2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 9

METRIC

17T 0597100E
4798936N

1 of 1

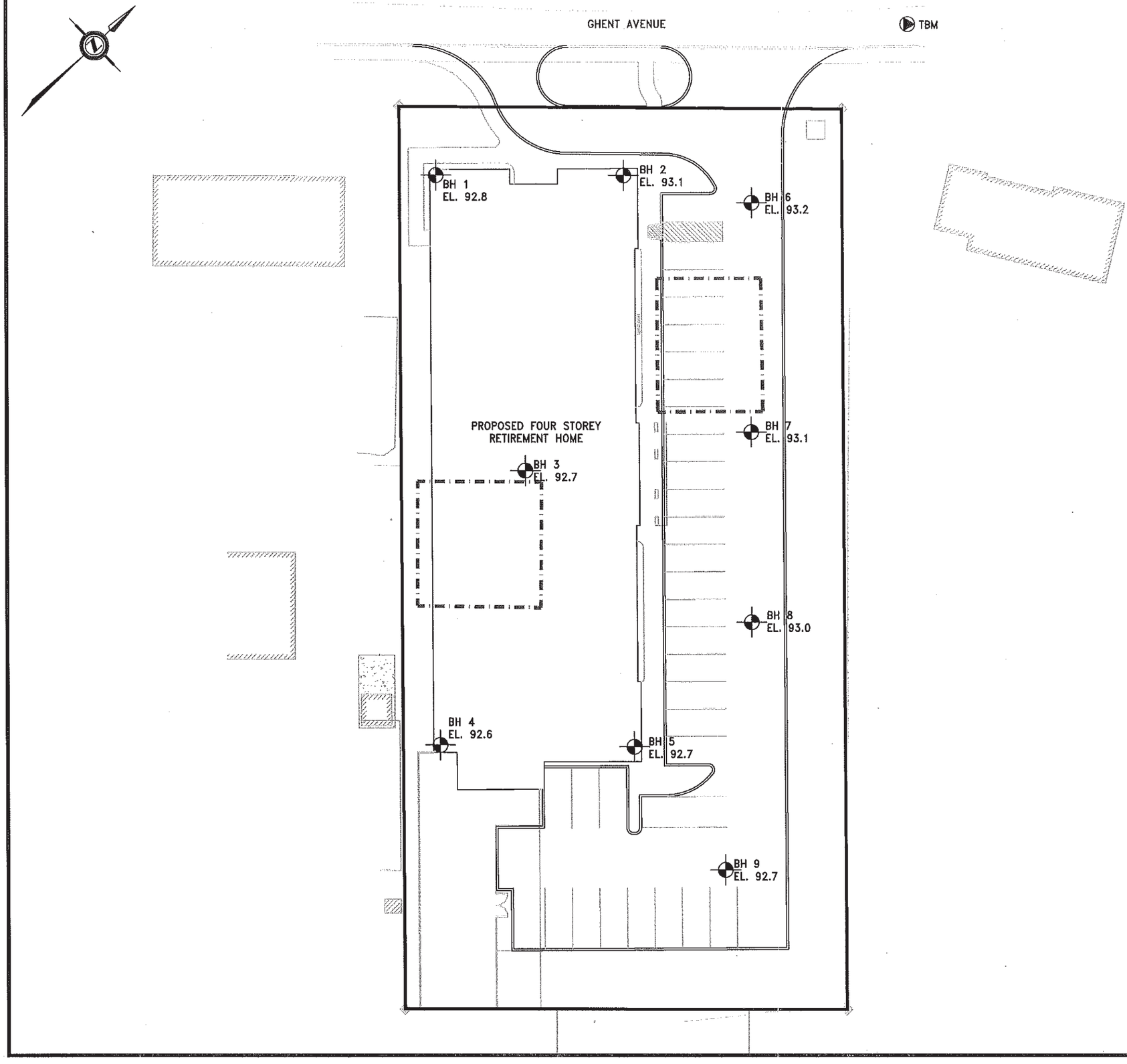
PROJECT Retirement Home Development
LOCATION 2170 Ghent Avenue, Burlington, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE July 12, 2013
OUR PROJECT NO. 13HF024
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

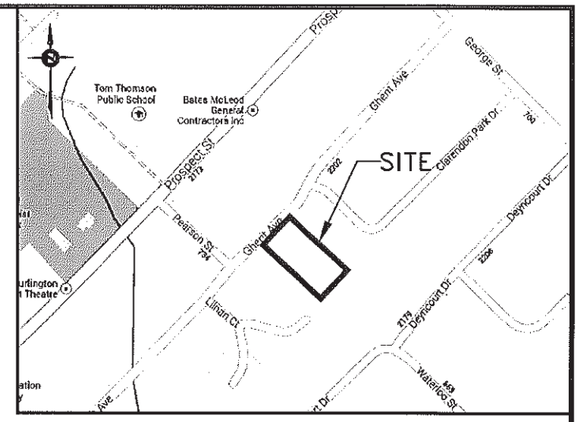
ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION, STANDARD PENETRATION TEST)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.7	Ground Surface									
92.2 / 0.5	TOPSOIL: Very loose, black sandy silt topsoil, low organic, damp		1A	SS	3	92				
0.8 / 91.5 / 1.2	SAND: Compact, brown fine to medium silty sand, trace gravel, damp; with occasional cobbles, iron/oxidized stains		1B	SS						
			2A	SS						
1.5	SILT TILL: Very stiff, reddish brown clayey silt till, some sand, trace gravel, DTPL; occasional shale fragments		2B	SS	15					Upon completion of augering, no free water, no cave
	becoming compact, grey sandy silt till, trace sand and clay, damp; occasional shale fragments									
	BOREHOLE TERMINATED AT 1.5 m									

PML- BH LOG GEO 13HF024 BH LOGS 1 TO 9 2013-07-23 KF.GPJ ON_MOT.GDT 7/26/2013 1:34:38 PM

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE





KEY PLAN
BURLINGTON, ONTARIO

LEGEND:

- SITE LIMITS
- APPROXIMATE LOCATION OF FORMER BUILDING STRUCTURE
- BH 1 EL. 999.0 — PML BOREHOLE (BH) LOCATION
- TEMPORARY BENCHMARK (TBM)

TEMPORARY BENCHMARK:

TOP OF SANITARY MANHOLE COVER LOCATED IN THE EAST BOUND LANE OF GHENT AVENUE, APPROXIMATELY 8 m NORTH AND 6 m EAST OF NORTHEAST CORNER OF PROPERTY LINE. ELEVATION: 93.20 m (GEODETIC)

REFERENCE:

PLAN PRODUCED FROM DRAWING NO. 07-227 BY MACKAY, MACKAY & PETERS LIMITED DATED JANUARY 22, 2008 AND FROM AN UNTITLED SITE PLAN DATED JULY 3, 2013

NOTE:

THE INFERRED STRATIGRAPHY REFERRED TO IN THE REPORT IS BASED ON THE DATA FROM THESE BOREHOLES SUPPLEMENTED BY GEOLOGICAL EVIDENCE. THE ACTUAL STRATIGRAPHY BETWEEN THE BOREHOLES MAY VARY.

5 0m 5 10 15 20 30

SCALE

MEMORYCARE INVESTMENTS

GEOTECHNICAL INVESTIGATION
RETIREMENT HOME DEVELOPMENT
2170 GHENT AVENUE, BURLINGTON

BOREHOLE LOCATION PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS

DRAWN	KF	DATE	SCALE	PML REF.	DRAWING NO.
CHECKED	MDS	JULY 2013	AS SHOWN	13HF024	1
APPROVED	MDS				

Appendix B

General Comments – Bedrock in Greater Toronto Area

General Comments – Bedrock in Greater Toronto Area

The bedrock that makes spread footings or caissons a popular choice for high-rise foundation support is a shale or shale limestone composition. The highest member, the Queenston Formation, is generally found west of Toronto, while the Georgian Bay Formation underlies most of Metro Toronto, with the Collingwood Formation east of Toronto. The Queenston is, relatively speaking, the weaker of the three formations that are likely to support caissons or footings.

The Georgian Bay as well as the Queenston and Collingwood Formation are of Middle Ordovician Age. It is defined as the rock unit that overlies the bluish grey shales of the Collingwood Formation and is in turn overlain by the red shale of the Queenston Formation. The Georgian Bay Formation consists of bluish and grey shale with interbeds of sandstone, limestone and dolostone. Towards the west where the Georgian Bay formation underlies the Queenston Formation, the limestone content increases significantly and limestone and/or sandstone may comprise as much as 70 to 90 percent of the bedrock. The hard layers are usually less than about 100 to 150 mm thick but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at some sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

The upper portion of the bedrock is commonly weathered for a depth of 600 to 1000 mm and within this weathered zone hard limestone layers or lenses are common. These hard limestone layers can result in contractual problems for augers, and can provide misleading bedrock elevations. Where the weathering is more extensive a shale till layer may be found above the bedrock. In the sound bedrock, the limestone, sandstone, dolostone is hard to very hard.

Stress relief features such as folds and faults are common in the bedrock. In these features, the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Weathering is much deeper than the surrounding rock in these features and often there is a lateral migration of the stress relief features resulting in sound unweathered bedrock overlying fractured and weather bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m. These features occur randomly.

The bedrock contains significant high locked in horizontal stresses. These stresses can impose significant loads on tunnel walls but the slower rate of construction for basements allows for a relaxation of these stresses and they are not normally a problem for basement construction.

Groundwater seepage below the top 1000 mm is generally small, however, at several locations in Toronto and Mississauga large quantities have been encountered.

Bedding joints in the bedrock are very close-to-close, smooth planar in the shale and rough planar in the limestone. Significant vertical jointing is common.

Where the bedrock was cored, a detailed description of the rock core is appended to the borehole log.

Design features related to the bedrock are discussed in other sections of this report, and these general comments must be considered with these comments.

Methane gas exists in the bedrock, normally below the top 1000 mm and more concentrated with depth. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly caissons and tunnels.

Appendix C

Requirements for Engineered Fill

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows; however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and DS Consultants Ltd (DSCL). Without this confirmation no responsibility for the performance of the structure can be accepted by DSCL. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a DSCL engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by DSCL during placement of engineered fill is required. Work cannot commence or continue without the presence of the DSCL representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

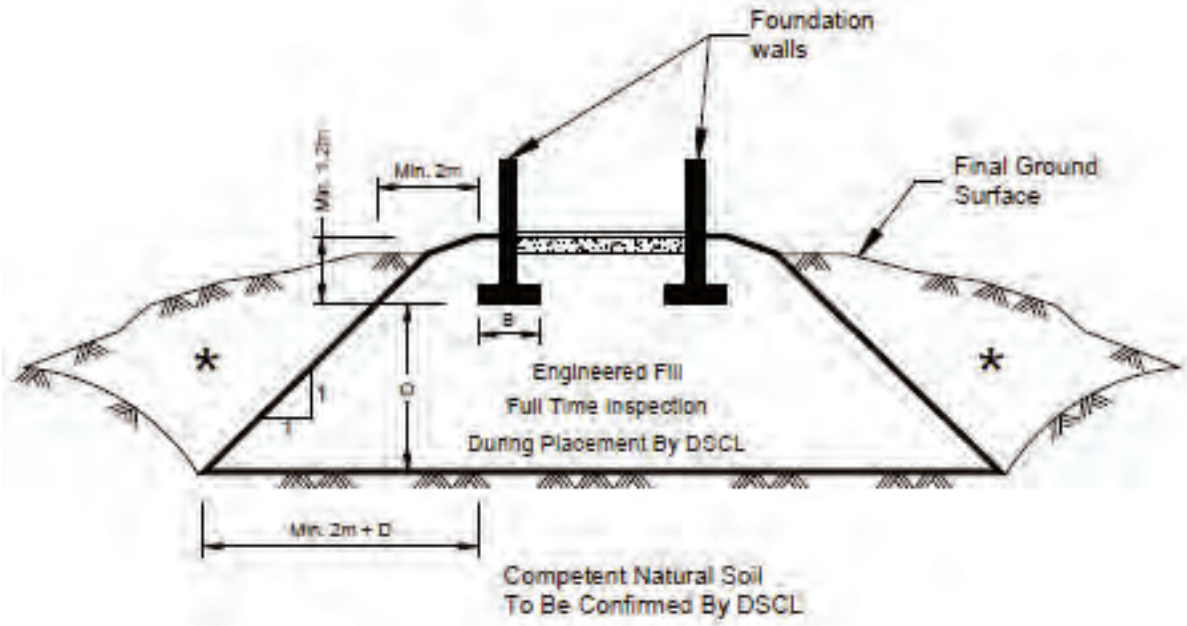
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from DSCL prior to footing concrete placements. All excavations must be backfilled under full time supervision by DSCL to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of DSCL.

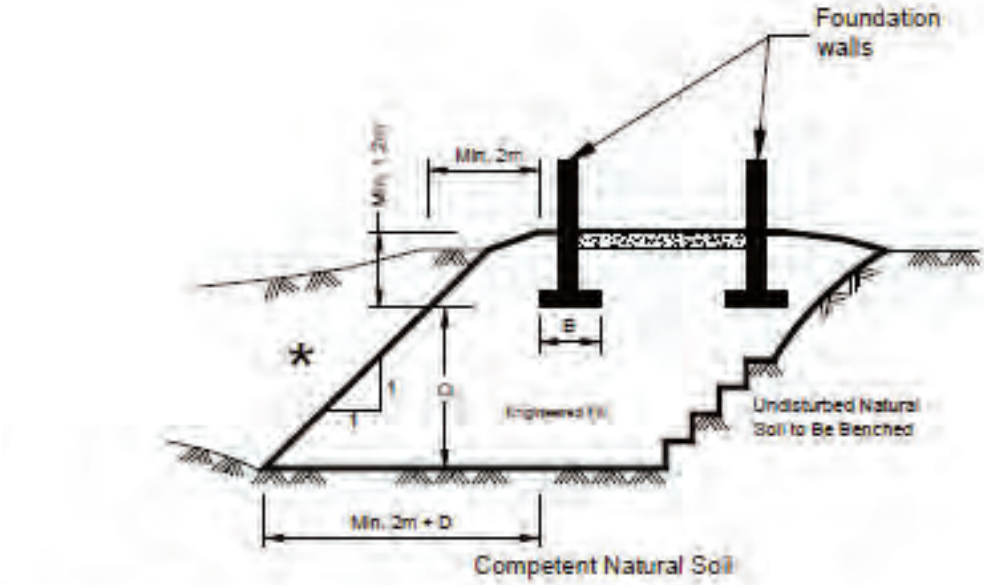
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.

14. These guidelines are to be read in conjunction with DS Consultants Ltd report attached.





* Backfill in this area to be as per the DSCL report.