REPORT

Preliminary Geotechnical Investigation, Coscorp HL Developments Inc.

Proposed Residential Development, Snell's Hollow Secondary Plan, Caledon, Ontario

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Coscorp HL Developments Inc. (Coscorp) to provide preliminary geotechnical consulting services to support a draft plan approval for a future residential subdivision development located north east of Heart Lake Road and Mayfield Road in Caledon, Ontario (the Site), as shown in the Site and Borehole Location Plan, ***Figure 1***.

The terms of reference for the geotechnical consulting services are included in Golder's proposal No. P19115264 Rev 1, dated March 8, 2019.

The purpose of the investigation is to obtain information on the general subsurface soil and shallow groundwater conditions at the site by means of a limited number of boreholes and geotechnical laboratory tests. Based on our interpretation of the factual information collected as part of the preliminary geotechnical investigation carried out at this site, a general description of the subsurface conditions across the site is presented herein. The interpreted subsurface conditions and available project details were used to develop preliminary engineering parameters and recommendations on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

This report provides the results of the preliminary geotechnical investigation and should be read in conjunction with the *"Important Information and Limitations of This Report"* ***Appendix D***. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report. The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within twelve months of the date of the report, Golder should be given an opportunity to confirm that the recommendations in this report are still valid.

2.0 SITE DESCRIPTION AND BACKGROUND

The subject property is located north east of Heart Lake Road and Mayfield Road and is part of the Snell's Hollow Secondary Plan, which is a proposed residential development to be located in the southern part of the Town of Caledon. The site is bounded by Heart Lake Road to the west, Mayfield Road to the south and Highway 410 to the north and east as shown in ***Figure 1.***

The site has a total area of approximately 6.3 hectares (15.6 acres) of predominantly flat land which slightly slopes at the property limit next to Highway 410. The site consists of agricultural land as noted by the presence of previous farming activities (crops). There is one residential dwelling located to the north of the site which has a municipal address of 12109 Heart Lake Road Caledon, Ontario.

Based on our understanding, the Site is to be developed into a residential development, with associated underground services and supporting roads. For the purposes of this report, we have assumed that the future residential houses will be constructed utilizing shallow strip/spread footings, with an interior slab-on-grade, and one-level of underground basement. We have also assumed cuts and/or fills required for site grading purposes will not exceed 2.0 m and that the invert of the site servicing will be no greater than 3.0 m below existing site grades.

3.0 ADJACENT GEOTECHNICAL SITE INFORMATION

An additional geotechnical investigation consisting of sixteen boreholes was also carried out as part of the Snell's Hollow Secondary Plan on the properties adjacent too and west side of Heart Lake Road. The following is a summary of subsurface conditions obtained from boreholes located adjacent to the site (BH/MW19-05, BH/MW19-06, and BH19-17) as shown on the Site and Borehole Location Plan, ***Figure 1***.

In general, the subsurface conditions encountered in Boreholes BH/MW19-05, BH/MW19-06, BH19-17 typically consist of a surficial topsoil ranging in thickness from about 280 mm to over 400 mm overlying a disturbed/reworked dark to light brown silty clay layer, which contains various amounts organics, underlain by glacial till composed of stiff to very stiff brown silty clay to a depth ranging from 0.3 m to 4.86 m below ground surface. A very stiff to hard grey clayey silt till was generally found below the brown silty clay till layer. These subsurface conditions were found to be similar to the subsurface conditions encountered in the boreholes located on Coscorp HL Developments Inc. site (discussed in detail in subsequent sections).

The record of borehole logs from these reports are enclosed in ***Appendix C***. The approximate locations of the boreholes drilled at these sites are shown on the Site and Borehole Location Plan, ***Figure 1.***

Groundwater was encountered in BH/MW19-06 and BH19-17 upon the completion of drilling and ranged from 2.5 m to 3.4 m below existing ground surface, whereas Borehole BH/MW19-05 was found to be dry upon the completion of drilling. Two 50 mm diameter monitoring wells were installed at Boreholes BH/MW19-05 and BH/MW19-06 to permit further monitoring of the groundwater levels. Shallow groundwater levels measured in the 50 mm diameter monitoring wells on April 17, 2019 ranged from 0.34 m (BH/MW19-06) to 8.32 m (BH/MW19-05) below existing ground surface.

4.0 REGIONAL GEOLOGY

The surficial geology aspects of the general site area were reviewed from the following publication:

- Chapman, L.J., and Putnam, D.F., 2007, *"The Physiography of Southern Ontario"*; 4th Edition, Ontario Geological Survey.

Physiographic mapping in the area according to the above noted reference indicates that the site lies within the physiographic region of southern Ontario known as the South Slope. The South Slope region slopes gradually downward towards Lake Ontario. The overburden immediately below ground surface within the South Slope generally consists of clayey silt till and silty clay till and at depth consists of alternating deposits of dense lacustrine sands and silts and overconsolidated lacustrine clays and clay tills overlying the bedrock.

The subsurface conditions encountered during the investigation are generally consistent with the physiographic mapping.

5.0 INVESTIGATION PROCEDURE

The field work for the preliminary geotechnical investigation was carried out between March 26 and March 27, 2019, during which time three boreholes (designated as Boreholes BH19-18, BH19-19 and BH/MW19-07) were advanced at the site to depths between about 6.7 m and 14.4 m below existing ground surface at the approximate locations shown on the Site and Borehole Location Plan, ***Figure 1***, attached. One additional borehole was advanced to about 7.0 m below existing ground surface adjacent to BH/MW19-07 for the purpose of installing a shallow monitoring well, adjacent to the deep monitoring well which was installed in the BH/MW19-07 borehole.

The boreholes were advanced using a track-mounted drill rig supplied and operated by a specialist drilling contractor, subcontracted to Golder. Standard Penetration Testing (SPT) and sampling was carried out at regular intervals of depth in the boreholes using conventional 35 mm internal diameter split spoon sampling equipment advanced using an automatic hammer, in accordance with ASTM D1586 (99). Two, 50 mm diameter monitoring wells were installed at BH/MW19-07 to permit further monitoring of the groundwater levels. Groundwater level measurements were recorded immediately following drilling procedures for all boreholes and on the monitoring wells on April 17, 2019. The well installation and water level readings are presented on the Record of Borehole sheets in **Appendix A**.

The field work for this investigation was directed by members of our engineering staff who located the boreholes in the field, directed the sampling and in-situ testing operation, logged the boreholes and cared for the samples obtained. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory for further examination and laboratory testing. Index and classification tests, consisting of water content determinations, Atterberg limits and grain size distribution, were carried out on selected soil samples. The results of the geotechnical laboratory tests are included in **Appendix B** and on the Record of Borehole sheets in **Appendix A**.

6.0 SUBSURFACE CONDITIONS

The subsurface soil and shallow groundwater conditions encountered in the boreholes and the results of the field and laboratory testing, are shown on the Record of Boreholes sheets, in **Appendix A**. Method of Soil Classification and Symbols and Terms Used on Records of Boreholes are provided to assist in the interpretation of the borehole logs. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Further, conditions will vary between and beyond the boreholes. The following is a summary of the subsurface conditions of the boreholes advanced during this investigation followed by a more detailed description of the major soil strata and groundwater conditions.

In general, the subsurface conditions encountered at the boreholes advanced at the site typically consist of a surficial topsoil/silty clay layer underlain by native soil deposits of glacial till composed of silty clay to clayey silt containing varying amounts of sand and gravel, underlain by sandy silt to silty sand deposits.

Details of the observations of the groundwater conditions during and upon completion of drilling are included on the Record of Borehole sheets. Shallow ground water was encountered at depths ranging from 2.7 m to 12.8 m below existing ground surface upon the completion of drilling activities. Shallow groundwater levels measured in the 50 mm diameter monitoring wells installed at the site are also presented below.

6.1 Topsoil and (CL) sandy Silty Clay (possibly re-worked)

Topsoil materials were encountered in all the boreholes and extended to depths ranging from 0.20 m to 0.61 m. A summary of topsoil thickness in each of the boreholes is outlined in the table below.

Table 1: Approximate Topsoil Thickness

Borehole No.	Approximate Topsoil Thickness (m)
BH/MW19-07	0.23
BH19-18	0.20
BH19-19	0.61

Materials identified as topsoil in this report were classified based on visual and textural evidence as no other testing for organic content or other nutrients was carried out. As such, the ability for these materials to support vegetation has not been assessed.

Reworked/disturbed sandy silty clay material was encountered in borehole BH/MW19-07 below the surficial topsoil. Reworked material thickness was observed from 0.23 m to 0.61 m below existing ground surface. The reworked material consisted of sandy silty clay with trace amounts of gravel. SPT ‘N’ values within cohesive the reworked material was found to be 19 blows per 0.3 m penetration indicating a very stiff consistency.

The natural water content of the reworked material was measured at 20 percent.

6.2 (CL) Silty Clay to sandy Silty Clay (Upper Glacial Till)

A glacial till deposit consisting of cohesive silty clay to sandy silty clay was generally encountered directly underneath the topsoil/reworked till deposits to depths about 6.10 m below existing ground surface. The till deposit is light brown to brown mottled with oxidation staining, about 4.5 m to 6.7 m in thickness, with various amounts of sand and gravel. The silty clay till increases in sand content in borehole BH/MW19-07 at a depth of 3 m below ground surface and in borehole BH19-19 at a depth of 4.6 m below ground surface. The till is believed to contain cobbles and/or possible boulders which have been inferred as a result of auger grinding observed in boreholes BH19-18 and BH19-19.

The SPT ‘N’ values measured in these till materials range from 11 blows per 0.3 m of penetration to 86 blows per 0.3 m of penetration, but typically greater than 22 blows per 0.3 m of penetration, indicating that the silty clay till is generally stiff to hard in consistency.

The results of grain size distribution tests carried out on selected samples from this deposit are presented in **Figure B1.** Atterberg limits tests that were carried out on the same samples from this deposit measured liquid limit values ranging from about 20 to 24 and plastic limit values ranging from about 13 to 15; yielding corresponding plasticity index values ranging from about 7 to 10. These results are plotted on the plasticity chart as shown in **Figure B2**.

The water content of selected samples ranged from about 9 percent to 17 percent.

6.3 (ML/SM to SM) sandy Silt to Silty Sand

A non-cohesive sandy silt to silty sand deposit was encountered underneath the cohesive silty clay till, in BH/MW19-07 and BH19-19. The sandy silt to silty sand deposit, is light brown, contains various amount of gravel, with cobbles/boulders being inferred from auger grinding. Both boreholes were terminated in the silty sand deposit.

The SPT ‘N’ values measured in this deposit ranged from 36 blows per 0.3 m to 131 blows per 0.3 m of penetration. These SPT ‘N’ values indicated a dense to very dense compactness.

The water content of selected samples ranged from about 3 percent and 20 percent.

6.4 (CL/ML) Clayey Silt (Lower Glacial Till)

A clayey silt till deposit was encountered directly underneath the sandy silty clay till in borehole BH19-18 from a depth of 6.10 m below existing ground surface. The borehole was terminated in this layer at a depth of 6.7 m below existing ground surface. The cohesive till deposit contains various amounts of sand and gravel and is grey in colour.

The SPT ‘N’ values of this till deposit was 33 blows per 0.3 m of penetration indicating hard consistency.

6.5 Groundwater Conditions

Groundwater level measurements were recorded immediately following drilling procedures. Monitoring wells were installed (one deep and one shallow) in borehole BH/MW19-07 to permit monitoring of the groundwater level at the site. Details of the monitoring well installation and the measured groundwater levels are shown on the Records of Borehole in ***Appendix A***. The groundwater level measurements in the drilled boreholes and in the monitoring wells are summarized in Table 2, below.

Table 2: Groundwater Level Measurements

Borehole No.	Measurements Upon Completion of Drilling		Measurements in Monitoring Wells	
	Approximate Groundwater Depth (begs)*	Date	Approximate Groundwater Depth (begs)*	Date
BH/MW19-07 (Shallow Well)	N/A	March 27, 2019	6.9 m	April 17, 2019
BH/MW19-07 (Deep Well)	12.8 m		12.8 m	
BH19-18	2.7 m	March 27, 2019	No monitoring well installed	
BH19-19	Dry	March 26, 2019	No monitoring well installed	

*begs- below existing ground surface.

It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

7.0 GEOTECHNICAL ENGINEERING DISCUSSION

This section of the report provides preliminary geotechnical engineering recommendations on the geotechnical aspects of the proposed development based on our interpretation of the limited borehole information and on our understanding of the project scope and requirements. The information in this portion of the report is provided for the guidance of the design engineers and professionals.

Based on the results of this investigation, the subsurface soil conditions encountered at the site are considered to be generally suitable for the proposed residential development.

As noted above, at the time of this report, proposed design grades (i.e., finished floor slab elevation, pavement subgrade and utility invert levels) were not available for the proposed development. The following engineering recommendations regarding the geotechnical design aspects of the project including underground services, pavements and building foundations should be considered as preliminary only, and should be reviewed when the final design grades and utility invert levels have been finalized.

Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

This report addresses only the geotechnical (physical) aspects of the subsurface conditions at this site. The geo-environmental (chemical) aspects, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are outside of the terms of reference for this report.

7.1 Site Preparation

7.1.1 Subgrade Preparation

The existing site vegetation, surficial topsoil/organics and other near-surface soils containing significant amounts of organic matter are not considered to be suitable for the subgrade support of engineered fill, building foundations, floor slabs, or other settlement sensitive structures. These materials should be completely stripped prior to placing any engineered fill or construction of foundations or interior or exterior slab-on-grade(s).

Disturbed/reworked materials containing excessive amounts of construction debris or organic material should be disposed of following appropriate environmental procedures. Furthermore; excessively-wet soils should be suitably dried before reuse as engineered fill.

Following the stripping of the surficial topsoil and soils containing significant amounts of organics and/or soft/disturbed surficial soils, the exposed subgrade should be heavily proof-rolled with suitable equipment, in conjunction with inspection by qualified geotechnical personnel to confirm that the exposed soils are competent and have been adequately stripped of ponded water and all disturbed, loosened, softened, organic and other deleterious material. Remedial work (i.e., further subexcavation and replacement) should be carried out on poorly-performing areas identified during the proof-rolling activities, as directed by Golder.

Any filling carried out at the site in conjunction with regrading should be carried out as under engineered fill procedures. Recommendations for the placement of engineered fill are outlined in Section 7.1.2 of this report.

7.1.2 Engineered Fill Requirements

As described above, the anticipated site grading activities may include both cutting and raising (filling) the original grade to meet the final design site grades. At the time of this report, the design cut and fill depths were not available for review. As such, for the purposes of this report, it has been assumed that cuts will not exceed 2 m and grade raises will not exceed more than 2 m.

In general, the existing native material is considered to be acceptable for reuse as engineered fill. Based on the laboratory test results, the water content of soils present at the site are considered to be generally near or above their optimum water contents for compaction, and therefore may require minor drying prior to placement, in general.

It should be noted that the native materials at the site are silty in nature, and as such are susceptible to over-wetting and subsequent freezing during inclement weather. Therefore, it is recommended that site grading activities not be carried out during late fall, winter, early spring seasons or any periods of inclement weather conditions. All oversized cobbles (i.e., greater than 150 mm in size) and boulders, if present, should be removed from excavated material that will be used as engineered fill material.

If imported material is required for the engineered fill process, the material that is proposed for use as engineered fill should be approved by the geotechnical engineer at its source, prior to importing the material to the site. Suitable soils, free of topsoil, organic matter or other deleterious materials can be used as engineered fill provided that the water content of the soil at the time of placement does not vary by more than 2 percent above or below its optimum water content for compaction. Otherwise, the soils may require treatment (i.e., drying or wetting) prior to placement.

Following the inspection and approval of the subgrade as described previously in this report, engineered fill materials should be placed in maximum 300 mm-thick loose lifts and uniformly compacted to 98 percent of the Standard Proctor maximum dry density (SPMDD). Filling should continue until the design elevations are achieved.

Full-time monitoring and in-situ density testing should be carried out by Golder during placement of engineered fill.

The final surface of the engineered fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water during the construction period. If the engineered fill materials will be left exposed (i.e. uncovered) during periods of freezing weather, additional soil cover should be placed above final subgrade to provide some level of frost protection. Prior to placing the granular subbase and/or base courses within pavement areas, the surface of the engineered fill/subgrade should be inspected by Golder.

7.2 Installation of Underground Services

7.2.1 Temporary Excavations

Details of the underground servicing for the proposed development are unknown at the time of this investigation; as such, for the purpose of this report, the maximum depth of the underground services was assumed to be about 3 m below the existing ground surface. Once detailed design is completed, review of the underground services should be completed by this office for compliance with the recommendations contained herein.

The founding soils are anticipated to generally consist of the native sandy silty clay or engineered fill. These materials are considered to be suitable for supporting the underground services provided that the integrity of the base of the trench excavations is maintained during construction. Where softened or disturbed native soils or other deleterious materials are encountered at the base of excavations for settlement-sensitive services, these materials should be subexcavated and replaced with compacted fills approved by the geotechnical engineer.

Care should be taken to direct surface water away from any open excavations and all temporary excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects.

In general, the groundwater level in the open boreholes, upon completion of drilling, was measured to be at depths ranging from 2.7 m to 12.8 m below existing ground surface. Whereas, the groundwater level in the monitoring wells, one month after drilling, was measured to be at depths ranging from 6.9 m to 12.8 m below existing ground surface. In general, groundwater in the excavations within the native deposits, are likely to be handled by collection via properly constructed and filtered sumps, located within the excavations, and then pumping and discharging the water to a suitable discharge point. However, should excavations deeper than 3 m below existing ground surface be required, some form of active dewatering, such as well points, may have to be implemented.

Excavations for the site servicing would generally extend through the native sandy silty clay deposit. Conventional excavation equipment should be suitable to excavate through these materials.

The hard stiff to very stiff native clayey till soils are classified as a “Type 2” soils under the OH&S Act. As such, all conventional temporary trench excavations should consist of open cuts with side slopes not steeper than 1 horizontal to 1 vertical in the overburden soils to within 1.2 m of the base of the excavation and then may be made vertical to the base. Where engineered fill is used or the native sandy silt/silty clay exhibits signs of water seepage, the soil is classified as a “Type 3”, as such all conventional temporary trench excavations should consist of gradient of 1 horizontal to 1 vertical. Where the side slopes of excavations are required to be steepened to limit the extent of the excavation, then some form of trench support may be required. Some trench excavations could be carried out using a vertically-excavated, unsupported excavation (using a properly-engineered trench liner box for protection, certified by an experienced engineer); or by a supported (sheeted) excavation if conditions warrant so; such as in wet areas and/or in close proximity to adjacent underground services

7.2.2 Pipe Bedding and Cover

The bedding for the sewers and watermains should be compatible with the size, type and class of pipe and the surrounding subsoil and the requirements of the City of Oshawa. If granular bedding is deemed to be acceptable, then Ontario Provincial Standard Specifications (OPSS) Granular A should be used from at least 150 mm below invert to springline. Clear stone should not be used as bedding material. From springline to 300 mm above the obvert of the pipe, sand cover could be used. All bedding and cover material should be placed in 150 mm loose lifts and uniformly compacted to at least 100 percent of SPMDD. Where variable fill materials, softened or disturbed native soils or other deleterious materials are encountered at the base of excavations for settlement-sensitive services, these materials should be subexcavated and replaced with compacted fills approved by the geotechnical engineer.

7.2.3 Trench Backfill

The excavated materials from the site will consist predominantly of silty clay till materials. Based on the measured water contents, in general, the native materials encountered at the site are estimated to be near or above their optimum water contents for compaction, and therefore, will probably require only minor drying prior to placement.

Care should be taken to maintain the water content of the soils close to/at the optimum water content for compaction during the construction operations, as difficulties with compaction and/or backfill performance would be anticipated with fine-grained soils where the water content is significantly above the optimum for compaction purposes. Soils that contain significant quantities of organics or debris are also not suitable for use as trench backfill within settlement-sensitive areas. In addition, all boulders and cobbles greater than 150 mm in size should be removed from the trench backfill materials. If there is a shortage of suitable in-situ material, an approved imported material such as Ontario Provincial Standard Specifications Select Subgrade Material should be used for trench backfill. Again, as noted above, the trench backfill materials are silty in nature and are very susceptible to wetting/freezing temperatures. Backfilling trenches during cold or wet weather is not recommended.

Trench backfill should be placed in maximum 300 mm loose lift thickness and uniformly compacted to at least 98 percent of the SPMDD of the material. Soil that is frozen should not be used as backfill.

Normal post-construction settlement of the compacted trench backfill should be anticipated with the majority of such settlement taking place within about 12 months following the completion of trench backfilling operations. If the trench backfill operations are completed during the winter months, post-construction settlements may increase beyond typical anticipated values. These settlements will be reflected at the ground surface. If the asphalt binder course is laid shortly following the completion of the trench backfilling operations, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding. If possible, the surface course asphalt should not be placed over the binder course asphalt for about 12 months. Where scheduling requires that the surface course be placed over the binder course asphalt before this period, trench backfill settlement would be reflected by subsidence and possible cracking of the finished pavement surface in these areas which, depending upon the extent and magnitude, may require local repairs.

7.3 Building Foundations

As previously indicated, the existing site vegetation, surficial topsoil/organics and other near-surface soils containing significant amounts of organic matter are not considered to be suitable for the subgrade support of engineered fill, building foundations, floor slabs, or other settlement sensitive structures. These materials should be completely stripped prior to placing any engineered fill or construction of foundations or interior or exterior slab-on-grades.

Based on the subsurface conditions encountered in the boreholes, strip and spread footings that may be used, provided that the footings are founded on the native sandy silty clay deposit or on engineered fill (based on existing site soils) placed in accordance with the recommendation outlined in section 7.1, and maintained a minimum depth of soil embedment below finished adjacent ground surface and top of slab of 1.2 m.

For such strip and spread footings, a factored geotechnical resistance at Ultimate Limit States (ULS) of 225 kPa and a geotechnical reaction at Serviceability Limit States (SLS) of 150 kPa may be assumed for design purposes, provided that the strip footings dimensions of 0.45 m in width and 10 m in length or spread footings have a minimum width of 0.60 m and a maximum width of 1.2 m.

Where spread footings are constructed at different elevations, the difference in elevation between the individual footings should not be greater than one half the clear distance 650 mm between the footings. In addition, the lower footings should be constructed first so that if it is necessary to construct the lower footings at a greater depth than anticipated, the elevation of the upper footings can be adjusted accordingly. Stepped strip footings should be constructed in accordance with the Ontario Building Code (2012), Section 9.15.3.9.

The maximum total and differential settlements are expected to be less than 25 mm and 20 mm; respectively, for footings designed, constructed and inspected as outlined above.

All exterior footings, and interior footings in unheated areas, should be founded at a minimum depth of 1.2 m below finished grade level in order to provide adequate protection against frost penetration.

The native soils are susceptible to disturbance from construction activity, especially during wet or freezing weather. Care should be taken to preserve the integrity of the materials as bearing strata. It is essential that the founding surface for the footings be inspected by qualified geotechnical personnel prior to placing concrete. If the concrete for the footings cannot be placed immediately after excavation and inspection of the subgrade, it is recommended that a working mat of lean concrete be placed in the excavation to protect the integrity of the bearing stratum.

Resistance to lateral forces/sliding resistance between the concrete footings and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The unfactored coefficient of friction, tan δ, for the interface between the cast-in-place concrete footing and the properly-prepared subgrade can be assumed to be 0.35.

7.3.1 Below Grade Walls

The exterior perimeter of all housing basement walls should be backfilled with an imported free draining, non-frost susceptible granular material approved by a geotechnical engineer, carefully placed and compacted in 200 mm thick loose lifts. The design of the foundation walls for the below-grade walls should take into account the horizontal soil loads as well as surcharge loads that may occur during or after construction and should be designed using a lateral (at-rest) earth pressure coefficient of 0.5 and a unit weight of backfill of 21 kN/m^3.

The wall backfill layers should be compacted to at least 95 per cent of the materials' standard Proctor maximum dry density. Light compaction equipment should be used immediately adjacent to the foundation wall, otherwise compaction stresses on the wall may be greater than that imposed by the backfill material. With the exception of the driveway area, the upper 0.3 m of backfill should consist of clayey material to provide a low permeability cap and the exterior grade should also be shaped to slope away from the building.

Provided that the excavations adjacent to foundation/basement walls are backfilled with free-draining granular materials and a drainage collection system is provided around the perimeter of the building, the design of below-grade walls does not need to take into account hydrostatic forces acting on the walls. However, it is recommended that the exterior of the below-grade walls be damp-proofed.

7.4 Pavement Design within the Proposed Development

Following site grading operations, as noted previously, the proposed pavement subgrade will generally consist of either re-compacted engineered fill or native silty clay till. These materials are considered to be frost susceptible, and as such, the pavement design provided in **Table 3** below has taken this condition into consideration.

Based on the proposed pavement usage, (i.e. residential development type traffic and loads/frequencies) frost susceptibility and strength of the subgrade soils, the following pavement component given are recommended for the proposed development of access roads and streets, however the Town of Caledon and Region of Peel design standards should be followed:

Table 3: Pavement Design

Material		Minimum Thickness of Pavement Components (mm)	
		Local Road (7.9m Road Pavement Width)	9.5 m Neighbourhood Collector (8.9 m Road Pavement Width)
Asphaltic Concrete (OPSS 1150)	HL 3 Surface Course	40	40
	HL 8 Binder Course	65	90
Granular Materials (OPSS.MUNI 1010)	Granular A Base	150	150
	Granular B Type II Subbase	350	500
Total Pavement Thickness (mm)		605	780
		Prepared and Approved Subgrade	

As part of the subgrade preparation, proposed access roads should be stripped of topsoil and other obviously unsuitable fill or organic materials. Fill required to raise the grades to design elevations should conform to the engineered fill requirements outlined previously in the report. Soft or spongy trench backfill areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98 percent SPMDD. Prior to placing pavement subbase and/or base materials, the exposed soil subgrade should be heavily proof-rolled in conjunction with an inspection by Golder. The granular subbase and base materials should be placed in loose layers no thicker than 200 mm and uniformly compacted to 100 percent of their SPMDD. The binder course and surface course asphalt materials should be compacted to minimum at 92.0 of their Marshall Maximum Relative Density according to OPSS 310, as measured in the field using a nuclear density gauge.

Where new pavement abuts existing pavement (e.g. at the development limits), proper longitudinal lap joints should be constructed to key the new asphalt into the existing asphalt surface. The existing asphalt edges should be provided with a proper sawcut edge prior to keying-in the new asphalt. It should be ensured that any undermining or broken edges resulting from the construction activities are removed by the sawcut.

It should be noted that in some cases, even though the compaction requirements have been met, the subgrade strength may not be adequate to support heavy construction loading especially during wet weather or where backfill materials wet of optimum have been placed. In this regard, the design subbase thickness may not be sufficient for a construction haul road and additional subbase (in the order of 450 mm) may be required. In any event, the subgrade should be proofrolled and inspected by Golder prior to placing the subbase and any additional material, as required, consistent with the prevailing weather conditions and anticipated use by construction traffic.

7.4.1 Subgrade Drainage

In order to preserve the integrity of the pavement, continuous subdrains should be placed at the concrete curb lines along both sides of the proposed streets. The invert of the subdrains should be at least 300 mm below the bottom of the Granular “B” subbase and should be sloped to drain to catchbasins. The subdrains should consist of perforated pipe wrapped in a suitable geotextile and surrounded on all sides with a minimum thickness of 150 mm of OPSS.PROV 1002 Concrete Fine Aggregate (i.e. concrete sand).

8.0 SEISMIC SITE CLASSIFICATION

Seismic hazard is defined in the 2012 Ontario Building Code (OBC) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 second, 0.5 second, 1.0 second and 2.0 seconds and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g. shear wave velocity, Standard Penetration Test (SPT) resistance, undrained soil shear strength, etc.) in the 30 m below the foundation level. There are six site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g. sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain acceleration and velocity-based site coefficients F_a and F_v; respectively, used to modify the UHS to account for the effects of site-specific soil conditions in design.

Based on the results of the preliminary geotechnical investigation and assuming soils below the maximum depth investigated exhibit similar properties / strengths, a **Site Class D** is estimated for planning purposes. The Site Class will need to be verified, and adjusted as necessary, during detail design.

9.0 INSPECTION AND TESTING

During construction, full-time observation should be carried out during engineered fill and site servicing backfill placement, and sufficient foundation inspections, subgrade inspections and in-situ materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications.

10.0 CLOSING

We trust that this preliminary report provides enough preliminary geotechnical engineering information to proceed with the detailed design of the proposed development. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Signature Page

Golder Associates Ltd.

Erti

Erti Mansaku, P.Eng.
Geotechnical Engineer

Jeff Tolton, C.E.T.
Associate, Senior Geotechnical Technologist

JD/EM/JET/sm

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https://golderassociates.sharepoint.com/sites/102461/technical work/phase 6000 - coscorp hl developments inc/19115264 (6000) final georeport coscorp hl developments inc. (jet).docx

LEGEND

- ⊕ Approximate Borehole Location
- ⊕ Approximate Borehole and Monitoring Well Location
- ⊕ Approximate Geotechnical Borehole from Adjacent Properties (Golder 2018, Clearbrook)
- — Watercourse
- ▨ Wetland
- ▭ Site Boundary
- ▭ Coscorp HL Developments Inc. Site Boundary

0 75 150

1:2,500 METRES

REFERENCE(S)

1. IMAGERY: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
© 2019 MICROSOFT CORPORATION © 2019 DIGITALGLOBE ©CNES (2019) DISTRIBUTION AIRBUS DS
2. BASE DATA: LIO MNRF 2019
3. PROJECTION: TRANSVERSE MERCATOR NAD 1983 UTM ZONE 17N

CLIENT
COSCORP HL DEVELOPMENTS INC.

PROJECT
PRELIMINARY GEOTECHNICAL INVESTIGATION, PROPOSED RESIDENTIAL DEVELOPMENT, COSCORP HL DEVELOPMENTS INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-04-16
DESIGNED	MM
PREPARED	MM
REVIEWED	EM
APPROVED	-

TITLE
SITE AND BOREHOLE LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
19115264	6000	-	1

APPENDIX A

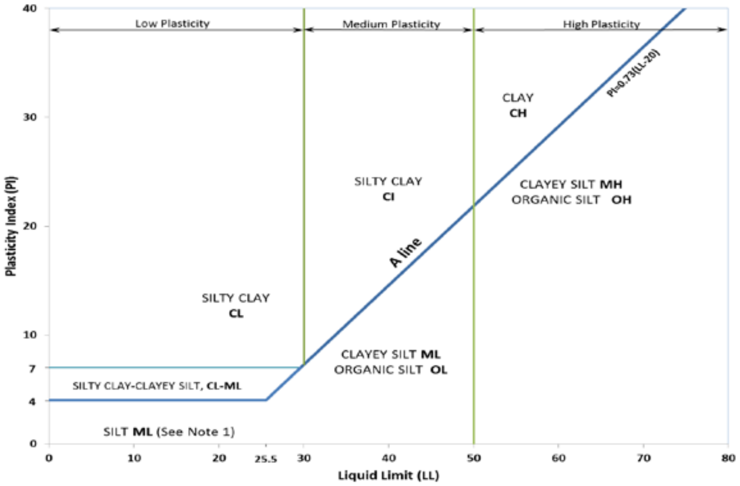
Method of Soil Classification
Abbreviations and Terms used on Record of Borehole
List of Symbols
Record of Boreholes

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\ \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

PROJECT: 19115264-6000
LOCATION: Lat. 43.755372 Long. -79.802724
(See Figure 1)

RECORD OF BOREHOLE: BH/MW19-07

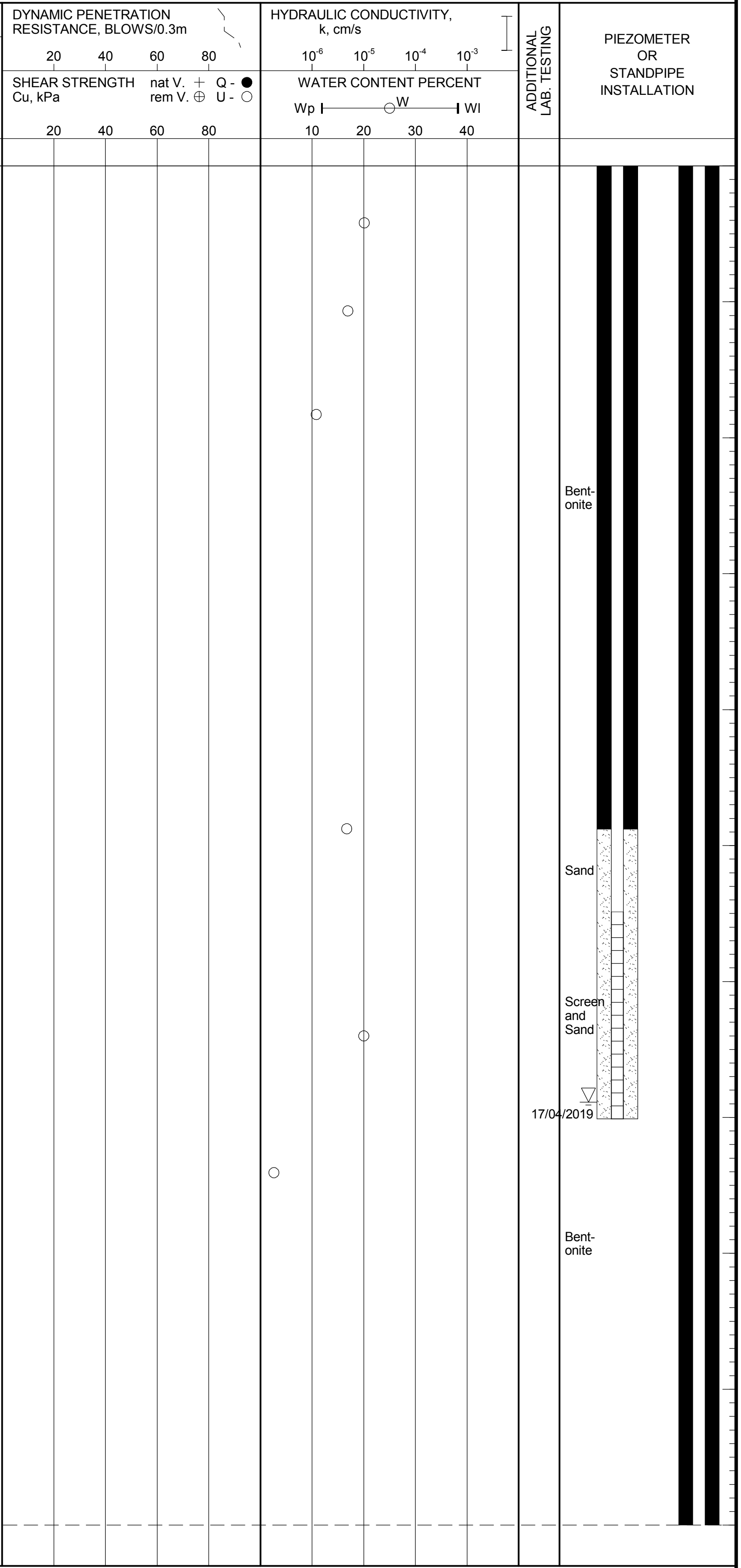
BORING DATE: March 27, 2019

SHEET 1 OF 2

DATUM: Existing Ground Surface

BORING METHOD: CME 75 Track Mount Power Auger
100 mm Solid Stem

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE				
0	TOPSOIL (230 mm)	0.00	1A	SS	19
	(CL) sandy CLAY, trace gravel, trace organics; dark brown; cohesive, w<PL, very stiff	0.23	1B	SS	
	(CL) SILTY CLAY, some sand to sandy, trace gravel; light brown with oxidation staining, (TILL); cohesive, w<PL, very stiff to hard	0.61			
1			2	SS	11
2			3	SS	11
			4	SS	24
3	- Becoming sandy at a depth of 3 m				
			5	SS	45
4					
5			6	SS	44
6	(SM/ML) sandy SILT to SILT, trace to some clay, slight plasticity; light brown; non-cohesive,wet, dense to very dense	5.90			
			7	SS	36
7	- Cobble/boulder inferred from auger grinding at a depth of 7.3 m		8	SS	100/ 2"
	(SM) SILTY SAND, fine to medium grained, some to trace gravel; light brown; non-cohesive, moist, dense to very dense	7.62			
8					
9			9	SS	131
10	*CONTINUED NEXT PAGE*				



DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

PROJECT: 19115264-6000

RECORD OF BOREHOLE: BH/MW19-07

SHEET 2 OF 2

LOCATION: Lat. 43.755372 Long. -79.802724
(See Figure 1)

BORING DATE: March 27, 2019

DATUM: Existing Ground Surface

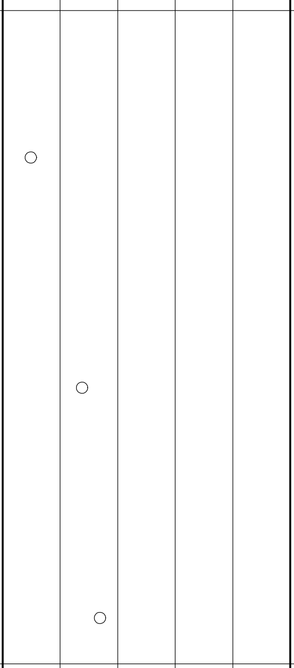
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---						
10	CME 75 Track Mount Power Auger 100 mm Solid Stem	(SM) SILTY SAND, fine to medium grained, some to trace gravel; light brown; non-cohesive, moist, dense to very dense						
11				10	SS	94		
12		- Contains wet sandy silt layer at a depth of 12.2 m		11	SS	40		Sand Screen and Sand 17/04/2019
14				12	SS	38		Bentonite
		END OF BOREHOLE.	14.33					

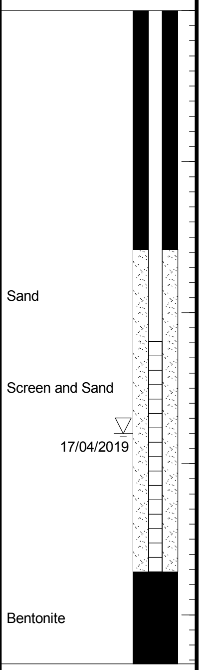
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40





Notes:
1. Water level measured at 12.8 mbgs upon completion of drilling.

2. Water level measured in monitoring well as follows:

Deep Well

Date	Depth	Elev. (m)
April 17, 2019	12.8 mbgs	N/A

Shallow Well

Date	Depth	Elev. (m)
April 17, 2019	6.9 mbgs	N/A

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

PROJECT: 19115264-6000

RECORD OF BOREHOLE: BH19-18

SHEET 1 OF 1

LOCATION: Lat. 43.753587 Long. -79.803241
(See Figure 1)

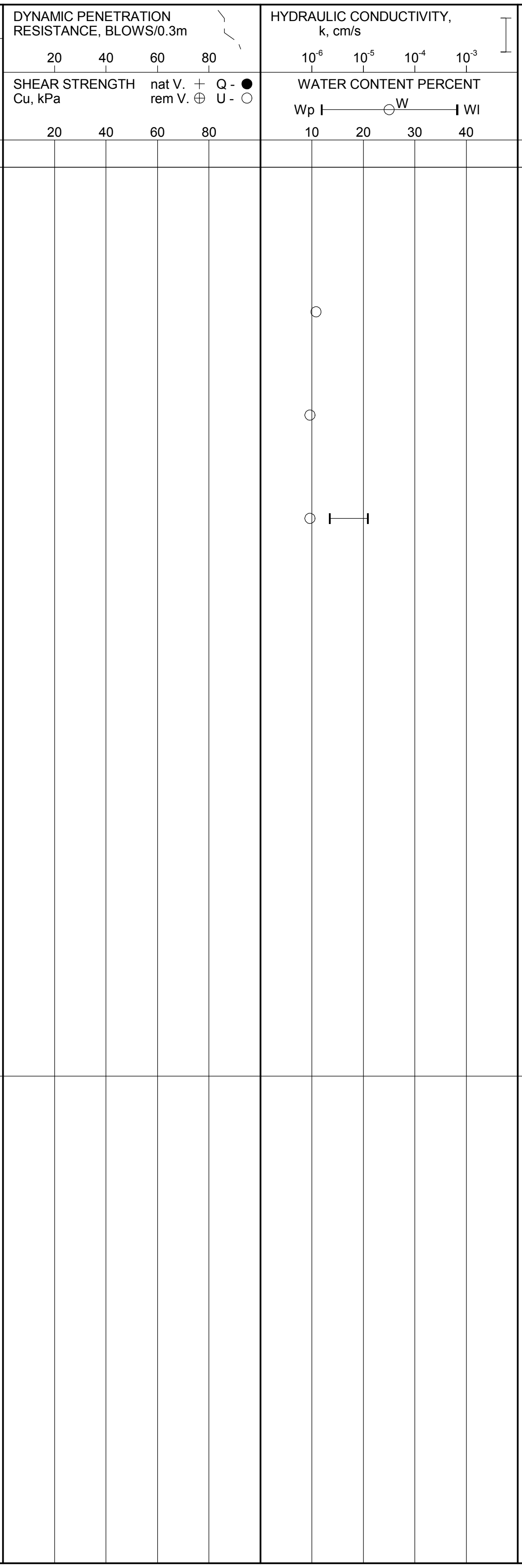
BORING DATE: March 27, 2019

DATUM: Existing Ground Surface

BORING METHOD: CME 75 Track Mount Power Auger
100 mm Solid Stem

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE						
0	TOPSOIL (200 mm)	0.00	1A	SS			
	(CL) sandy SILTY CLAY, trace to some gravel with cobbles/boulders inferred from auger grinding; brown to light brown with oxidation staining, (TILL); cohesive, w<PL, stiff to hard	0.20	1B	SS	11		
1			2	SS	22		
2			3	SS	38		
			4	SS	35	MH	▽ 27/03/2019
3			5	SS	35		
5			6	SS	52		
6	(CL/ML) CLAYEY SILT, trace sand; grey, (TILL); cohesive, w>PL, hard	6.10	7	SS	33		
	END OF BOREHOLE	6.71					

Notes:
1. Water level measured at 2.7 mbgs upon completion of drilling.



DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

GTA-BHS 001 G:_CLIENTS\CLEARBROOKDEVELOPMENTS\CALEDON\12_GINT\19115264-SNELLSHOLLOW BH LOGS.GPJ GAL-MIS.GDT 17/6/19 JMC

PROJECT: 19115264-6000

LOCATION: Lat. 43.754896 Long. -79.804943

(See Figure 1)

RECORD OF BOREHOLE: BH19-19

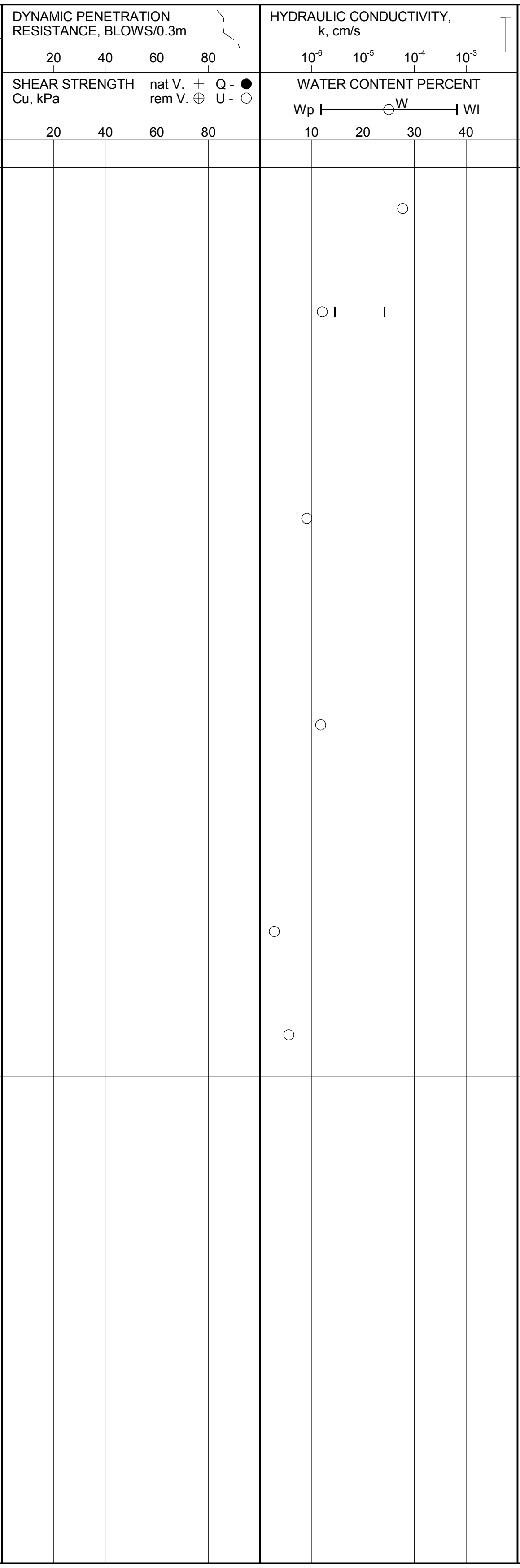
BORING DATE: March 26, 2019

SHEET 1 OF 1

DATUM: Existing Ground Surface

BORING METHOD: CME 75 Track Mount Power Auger
100 mm Solid Stem

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE						
TOPSOIL (610 mm)	0.00	1	SS	4		
(CL) sandy SILTY CLAY, some sand, trace gravel with cobbles/boulders inferred from auger grinding; brown with oxidation staining, (TILL); w<PL, very stiff to hard	0.61	2	SS	26	MH	
		3	SS	40		
		4	SS	49		
		5	SS	54		
		6	SS	55		
- Increased sand content at a depth of 4.6 m		7	SS	86		
(SM) SILTY SAND, fine grained, inferred cobbles/boulders; light brown; non-cohesive, moist, very dense	5.18	8	SS	95		
		9	SS	100		
END OF BOREHOLE. Notes: 1. Borehole dry upon completion of drilling.	6.71					



DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: EM

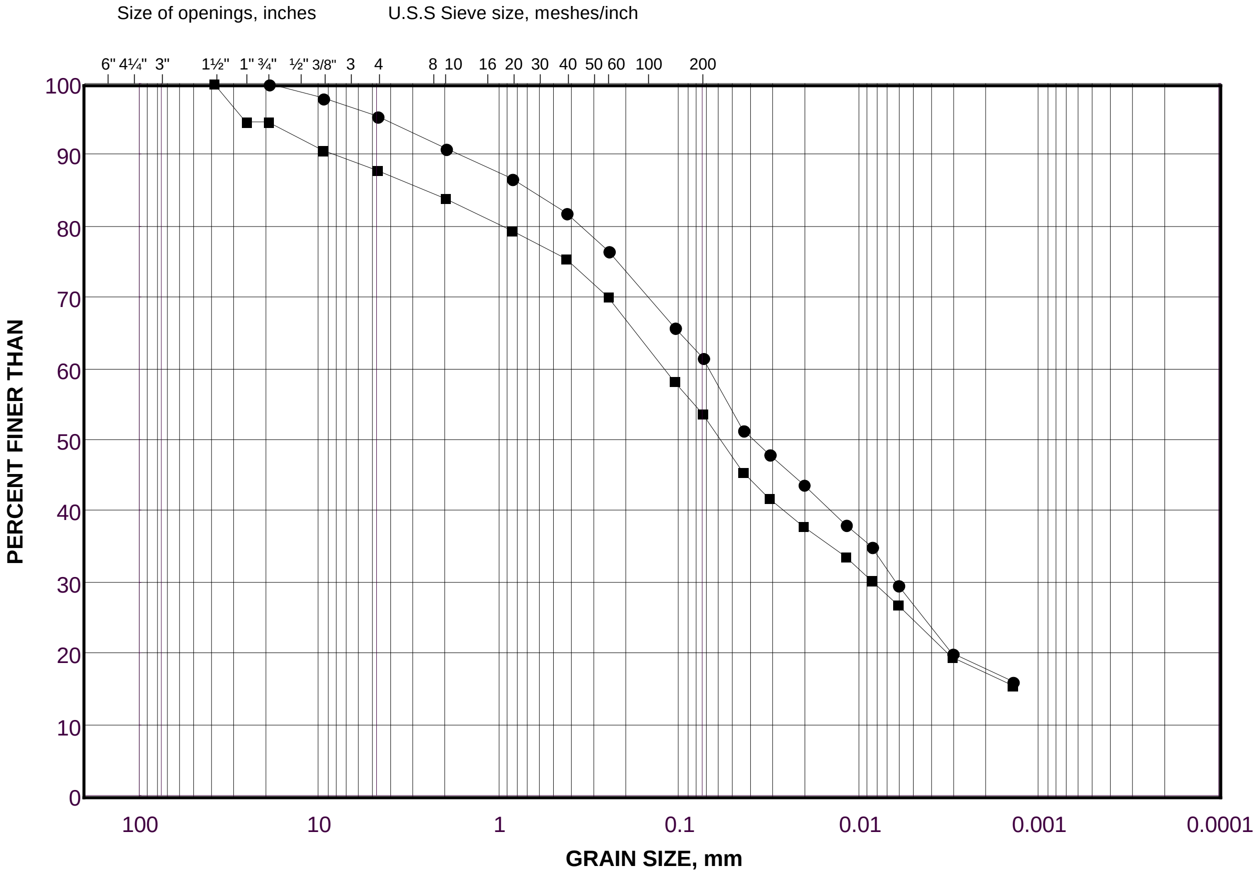
APPENDIX B

Geotechnical Laboratory Figures

GRAIN SIZE DISTRIBUTION

sandy SILTY CLAY to SILTY CLAY (CL) - TILL

FIGURE B1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

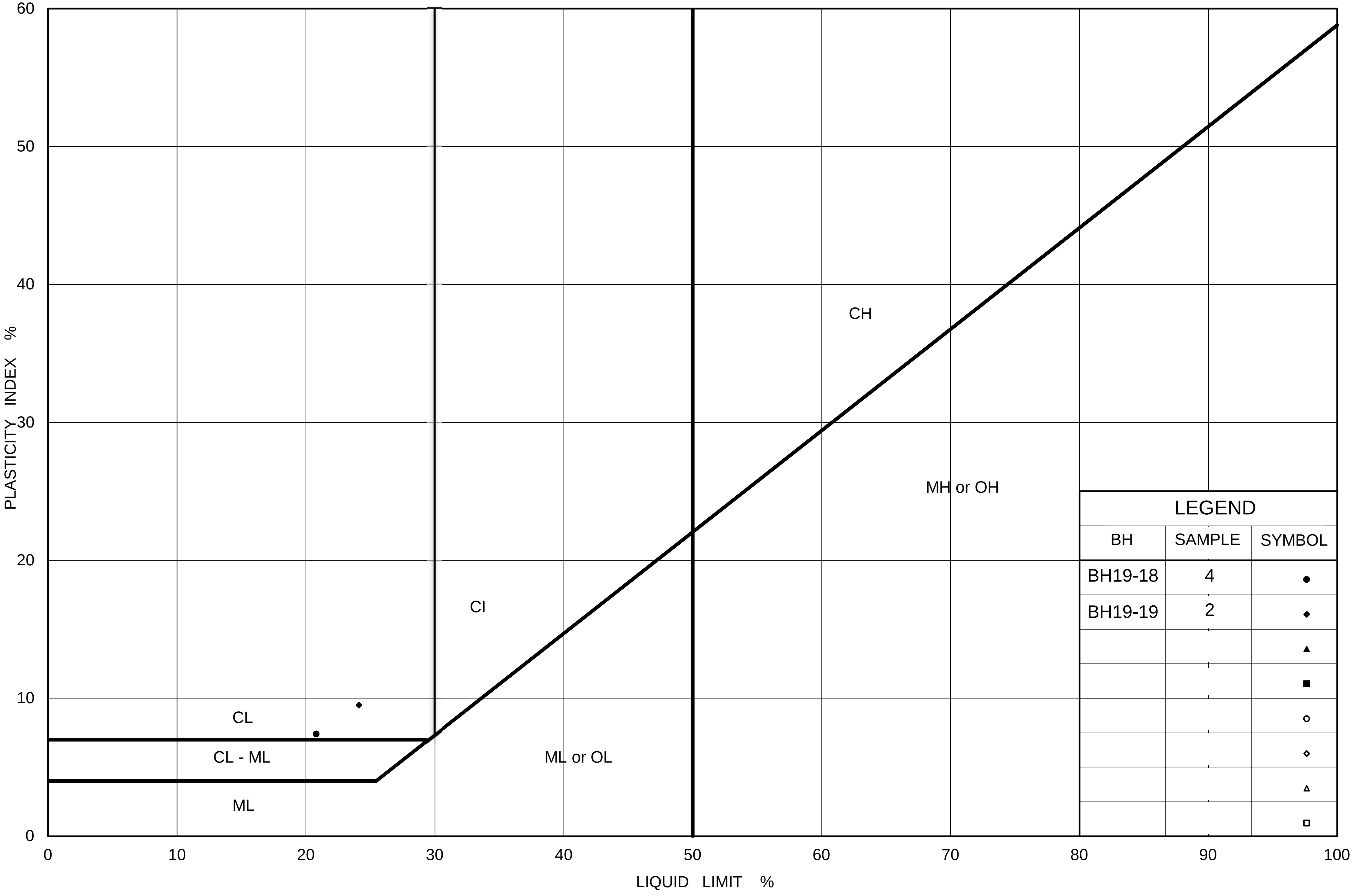
SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	BH 19-19	2	0.76 - 1.37
■	BH 19-18	4	2.29 - 2.90

Project Number: 19115264

Checked By: EM

Golder Associates

Date: 30-May-19



GOLDER

PLASTICITY CHART

sandy SILTY CLAY to SILTY CLAY (CL) - TILL

Figure No. B2

Project No. 19115264 (6000)

Checked By: EM

APPENDIX C

Adjacent Properties Borehole Logs

PROJECT: 19115264-1000/5000
LOCATION: Lat. 43.75409 Long. -79.807715
(See Figure 1)

RECORD OF BOREHOLE: BH/MW19-05

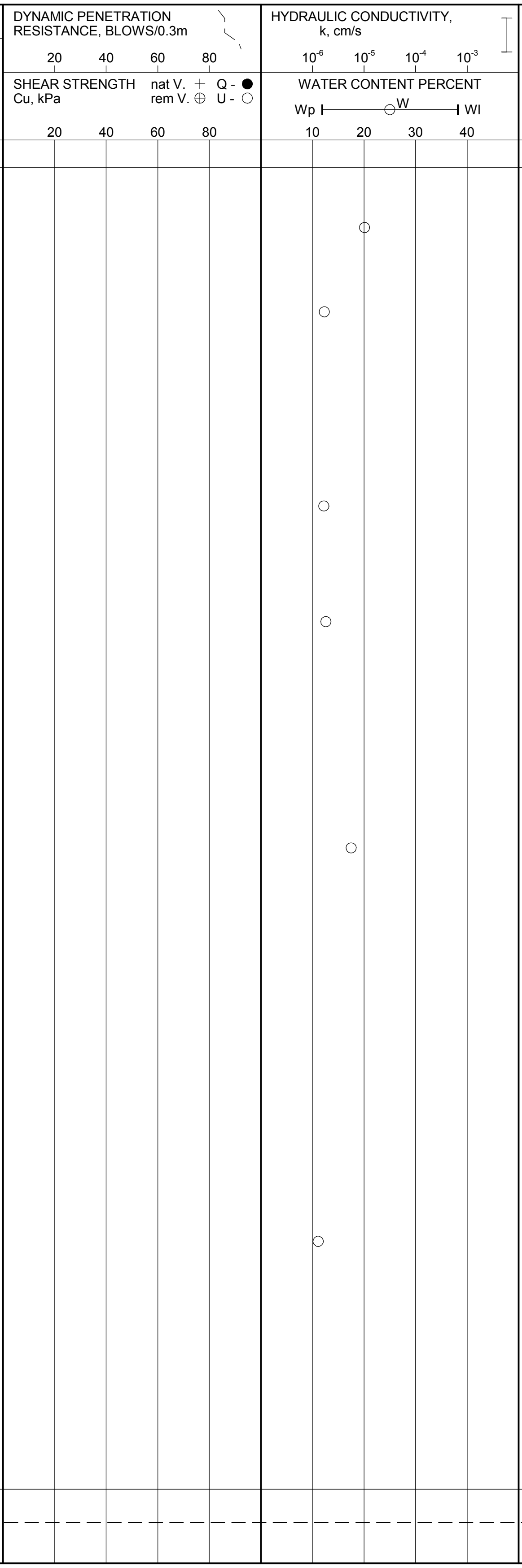
BORING DATE: March 28, 2019

SHEET 1 OF 2

DATUM: Geodetic

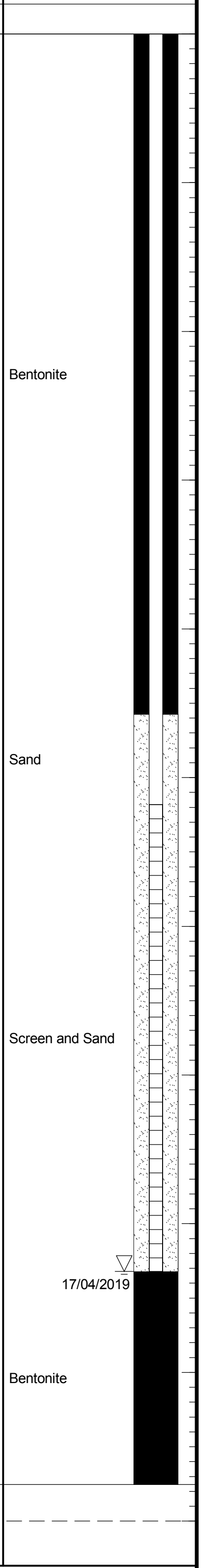
BORING METHOD: CME 75 Track Mount Power Auger
100 mm Solid Stem

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	270.50			
TOPSOIL (280 mm)	0.00	1A	SS	12
(CL) SILTY CLAY, trace gravel, trace organics; dark to light brown; cohesive, w~PL, stiff	270.22 0.28	1B	SS	
(CL) SILTY CLAY, some sand, trace gravel; light brown with oxidation staining, (TILL); w<PL, very stiff	269.74 0.76	2	SS	24
		3	SS	26
		4	SS	23
		5	SS	26
		6A	SS	44
(CL-ML) CLAYEY SILT, trace sand to sandy, trace gravel; grey, (TILL); cohesive, w<PL, hard	265.64 4.86	6B	SS	
- Becoming sandy, with sand seams below a depth of 6.1 m		7	SS	77
- Silty sand layer/stratum encountered at a depth of 7.6 m		8	SS	94
		9	SS	100
END OF BOREHOLE.	260.75 9.75			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: JD
CHECKED: EM

PROJECT: 19115264-1000/5000

LOCATION: Lat. 43.75409 Long. -79.807715
(See Figure 1)

RECORD OF BOREHOLE: BH/MW19-05

BORING DATE: March 28, 2019

SHEET 2 OF 2

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10		Notes: 1. Borehole dry upon completion of drilling. 2. Water level measured in monitoring well as follows:									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Date	Depth	Elev. (m)
March 28, 2019	Dry	Dry
April 17, 2019	8.32 mbgs	262.18 m

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

PROJECT: 19115264-1000/5000

LOCATION: Lat. 43.752469 Long. -79.804999
(See Figure 1)

RECORD OF BOREHOLE: BH/MW19-06

BORING DATE: March 2, 2019

SHEET 1 OF 1

DATUM: Geodetic

BORING METHOD: CME 75 Track Mount Power Auger, 100 mm Solid Stem

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE		262.00			
TOPSOIL (410 mm)		0.00	1A	SS	9
(CL) SILTY CLAY, trace organics, some to trace sand, trace gravel; dark brown; cohesive, w>PL, firm		261.59 0.41	1B	SS	
			2	SS	5
(CL) SILTY CLAY, some sand to sandy, trace gravel; light brown, (TILL); cohesive, w>PL, stiff to very stiff		260.55 1.45	3	SS	14
			4	SS	28
			5A	SS	
(CL-ML) CLAYEY SILT, trace sand and gravel; grey, (TILL); cohesive, w>PL, very stiff to hard		258.88 3.12	5B	SS	39
			6	SS	15
			7	SS	27
			8	SS	36
END OF BOREHOLE.		253.68 8.32			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

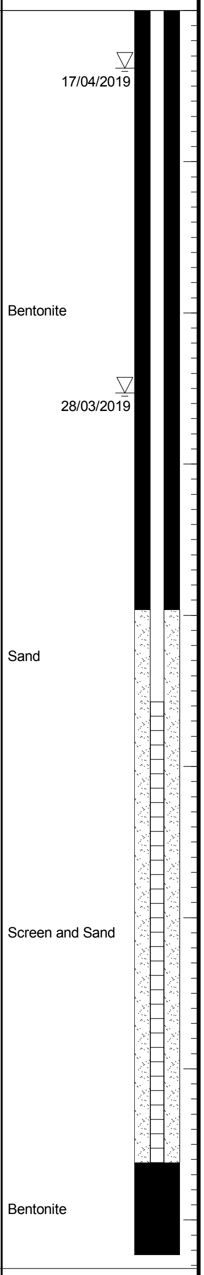
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl ; 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

Notes:
1. Water level measured in monitoring well as follows:

Date	Depth	Elev. (m)
March 28, 2019	2.54 mbgs	259.46 m
April 17, 2019	0.38 mbgs	261.62 m

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

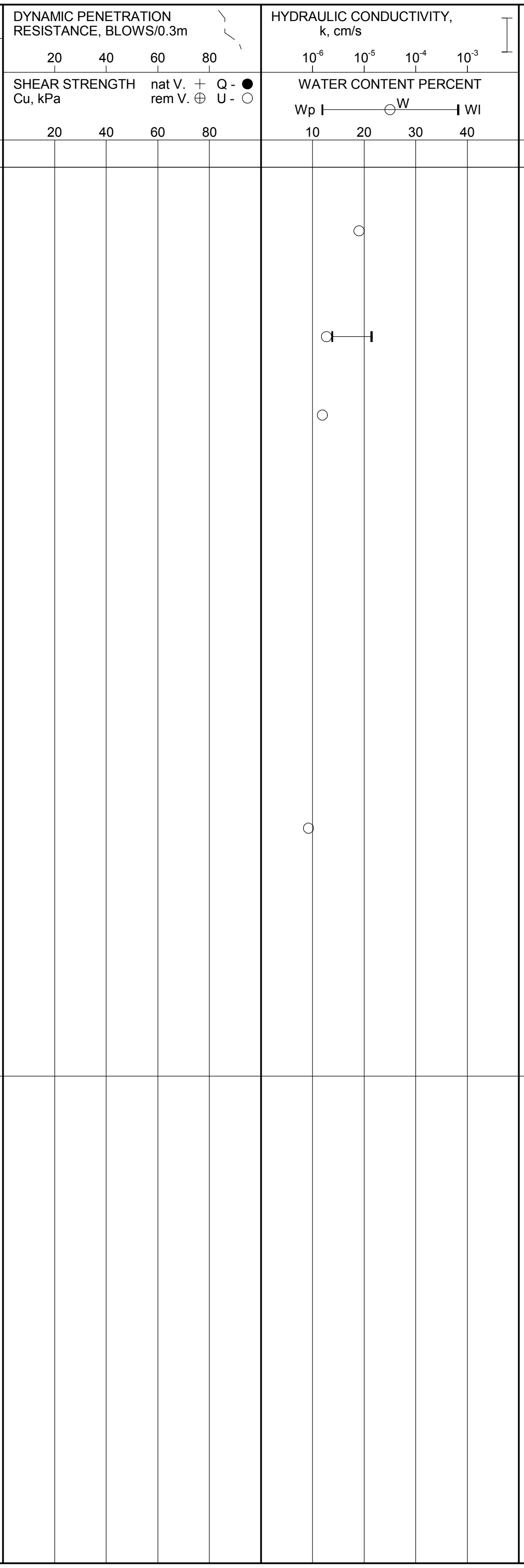
PROJECT: 19115264-1000/5000
LOCATION: Lat. 43.753061 Long. -79.806846
(See Figure 1)

RECORD OF BOREHOLE: BH19-17

BORING DATE: March 28, 2019

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	269.50					
0	CME 75 Track Mount Power Auger 100 mm Solid Stem	TOPSOIL (330 mm)	0.00 269.17	1A	SS	12		
		(CL) SILTY CLAY and SAND to sandy SILTY CLAY, trace gravel; light brown with oxidation staining, (TILL); cohesive, w<PL, stiff to very stiff	0.33	1B	SS			
1				2A	SS	18		
				2B	SS		MH	
2				3	SS	29		
				4	SS	14		
3				5	SS	29		▽ 28/03/2019
4			264.93					
		(CL-ML) CLAYEY SILT, some sand, trace gravel; grey, (TILL); cohesive, w<PL, hard	4.57					
5				6	SS	34		
6				7	SS	46		
			262.79					
7		END OF BOREHOLE. Notes: 1. Water level measured at 3.4 mbgs upon completion of drilling.	6.71					
8								
9								
10								



DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: EM

APPENDIX D

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder’s report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder’s report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder’s report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder’s report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder’s responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

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