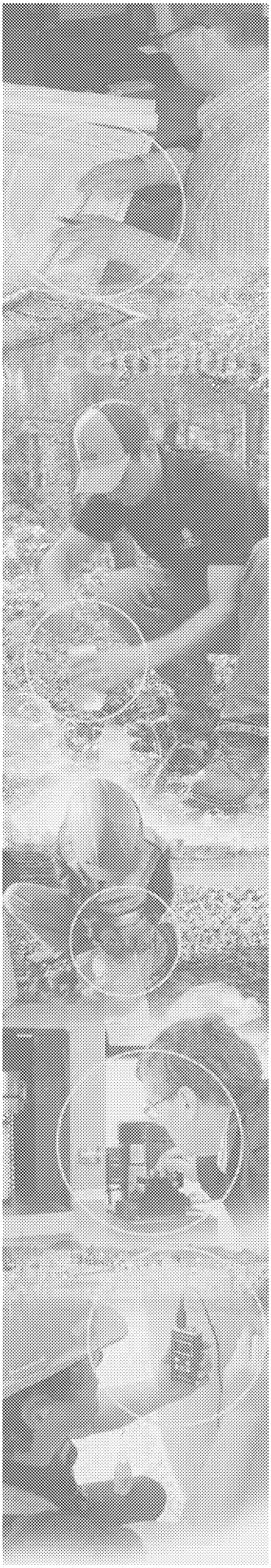

Geotechnical Investigation Report 380 Lockhart Road, Barrie, Ontario

Cambium Reference No.: 9121-003

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1.0 INTRODUCTION

Cambium Inc. (Cambium) was retained by Kingslea Developments (Client) to complete a preliminary geotechnical investigation in support of the design and construction of a single storey industrial building and associated parking and driving areas at 380 Lockhart Road in Barrie, Ontario (Site).

The property is irregularly shaped, approximately 1.4 hectares in size and appears to be a historically planted treed lot. Rows of mature trees were noted throughout the property with a clearing near the centre consisting of deadfall and shrubs. The general topography of the site is higher than the adjacent Lockhart Road and Huronia Road with a downstream slope towards Lovers Creek which is situated east of the site boundary. Based on discussions with the Client, it is understood that any proposed development will be outside of the Lake Simcoe Region Conservation Authority (LSRCA) development constraints.

The geotechnical investigation was required to confirm the subsurface conditions at the Site to provide geotechnical design parameters as input into the design and construction of the proposed industrial development and associated infrastructure. A Site Plan, including borehole locations, is included as Figure 1 of this report.

2.0 METHODOLOGY

2.1 BOREHOLE INVESTIGATION

A borehole investigation was completed on November 8th, 2019 to assess subsurface conditions at the Site. Due to the site access constraints, the scope of work had to be modified following approval by the Client. A total of two (2) boreholes were advanced within the property limits, designated as BH101-19 and BH102-19. The boreholes were terminated at a depth of 6.7 m below ground surface (mbgs). Each of the boreholes were equipped with monitoring wells to determine the static groundwater level at the site.

The borehole locations and elevations were surveyed by the Client. The borehole UTMs and elevations are provided on the borehole logs in Appendix A. Borehole locations are shown on Figure 1.

Drilling and sampling was completed using a track-mounted drill rig, under the supervision of a Cambium Geotechnical Analyst. The boreholes were advanced to the pre-determined depths by means of continuous flight hollow stem augers with 50 mm O.D. split spoon samplers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon (SS) sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. Soil samples were collected at 0.75 m intervals from 0 to 3 m and at 1.5 m intervals after 3 m. The encountered soil units were logged in the field using visual and tactile methods, and samples were placed in labelled plastic bags for transport, future reference, laboratory testing, and storage. Open boreholes were checked for groundwater and general stability prior to backfilling.

Borehole logs are provided in Appendix A. Site soil and groundwater conditions are described and geotechnical recommendations are discussed in the following sections of this report.

2.2 PHYSICAL LABORATORY TESTING

Physical laboratory testing, including three (3) sieve and hydrometer analyses (LS-702, 705), was completed on selected soil samples to confirm textural classification and to assess geotechnical parameters. Natural moisture content testing (LS-701) was completed on all retrieved soil samples. Results are presented in Appendix B and are discussed in Section 3.0.

2.3 SOIL CHEMICAL TESTING

Samples of soil were collected from boreholes BH101-19 and BH102-19 to be assessed for potential contamination from historical pesticide and land uses. Samples were sent to Caduceon Laboratories in Barrie, ON for analysis of select parameters including: Petroleum Hydrocarbons (PHCs), Volatile Organic Compounds (VOCs), Metals and Inorganics, and Organochlorine (OC) Pesticides. The results of the soil testing are presented in Appendix D and discussed in Section 4.11.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions at the site consist of topsoil overlying sand and silty clay to clayey silt deposits. These soils were encountered throughout the boreholes to the termination depths of 6.7 mbgs. Per available mapping from the Ontario Geological Survey (OGS) the primary on site soils consist of glaciofluvial ice contact deposits, predominantly gravel and sand and minor till. (OGS, Accessed 2019)

The borehole locations are shown on Figure 1 and the individual soil units are described in detail below with the borehole logs provided in Appendix A.

3.1 TOPSOIL AND ORGANICS

A layer of dark brown to black sandy topsoil was encountered at the surface of each of the borehole locations. The topsoil was approximately 150 mm in thickness where encountered.

The topsoil was generally loose in relative density and moist at the time of the investigation. Analysis of the organic or nutrient content of the topsoil was not part of the scope of work for this investigation. Delineation of topsoil thickness would require shallow test pits spaced in a grid pattern.

3.2 NATIVE SOILS

Beneath the topsoil discussed above, the native soils predominately consisted of sand overlying silty clay to clayey silt soils in each of the borehole locations.

3.2.1 SAND

Native sand soils were encountered beneath surficial topsoil in each of the boreholes advanced at the site and extended to depths of 2.4 mbgs to 3.7 mbgs. The sand was brown in colour and contained traces of silt and gravel. The sand was generally moist at the time of the investigation with natural moisture content varying from 3% to 12% based on laboratory testing. The SPT N values in the sand soils ranged from 4 to 11 blows, indicating a loose to compact relative density.

A laboratory particle size distribution analysis was completed for one (1) sample of the sand soils, taken from the borehole and depth provided in Table 1 in order to identify the varying textures encountered throughout the overburden material. The testing results are provided in Appendix B and are summarized in Table 1 based on the Unified Soil Classification System (USCS).

Table 1 Particle Size Distribution – Sand Soils

Borehole ID	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
BH101-19	1.5 - 2.0	Sand some Silt trace Clay	0	83	15	2

3.2.2 SILTY CLAY AND CLAYEY SILT

Silty clay and clayey silt soils were encountered in each of the boreholes beneath sand deposits, extending to the borehole termination depths of 6.7 mbgs. The silty clay and clayey silt soils were generally brown in colour and contained varying amounts of sand and gravel. The silty clay and clayey silt soils had a firm to very stiff consistency based on SPT N values between 4 and 19 blows. The natural moisture content of the silty clay and clayey silt soils was between 9% and 28% based on laboratory testing.

Laboratory particle size distribution analyses were completed for two (2) samples of the silty clay and clayey silt soils, taken from the boreholes and depths provided in Table 2 in order to identify the varying textures encountered throughout the overburden material. The testing results are provided in Appendix B and are summarized in Table 2 based on the USCS.

Table 2 Particle Size Distribution – Silty Clay and Clayey Silt Soils

Borehole ID	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
BH101-19	3.0 – 3.5	Silty Clay some Sand trace Gravel	1	11	32	56
BH102-19	4.6 – 5.0	Clayey Silt trace Sand	0	10	65	25

3.3 BEDROCK

Bedrock was not encountered within the investigation depths. Each of the boreholes were terminated at a depth of 6.7 mbgs in native soils. The termination depth and elevation of each borehole is summarized in Table 3.

Table 3 Borehole Termination Depth and Elevation

Borehole ID	Borehole Elevation (mASL)	Borehole Termination Depth (mbgs)	Borehole Termination Elevation (mASL)
BH101-19	252.68	6.7	245.98
BH102-19	253.51	6.7	246.81

3.4 GROUNDWATER

The presence of groundwater (free water) and caving (sloughing) was not observed in either of the boreholes advanced at the Site on completion of drilling. The moisture content of the soils generally ranged from 3% to 28%.

A Cambium technician recorded groundwater level measurements from each of the monitoring wells installed at the site on November 15th, 2019; the measurements are summarized in Table 4.

It should be noted that soil moisture and groundwater levels at the Site may fluctuate seasonally and in response to climatic events.

Table 4 Monitoring Well Groundwater Measurements

Date	Monitoring Well ID	Borehole Elevation (mASL)	Top of Standpipe (TOS) Elevation (mASL)	Groundwater Depth (mbTOS)	Groundwater Elevation (mASL)
November 15th, 2019	BH101-19	252.68	253.74	6.69	247.57
	BH102-19	253.51	254.56	6.17	247.87

4.0 GEOTECHNICAL CONSIDERATIONS

The following recommendations are based on borehole information and are intended to assist designers. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the borehole locations may vary from those observed. In addition, due to the soil sampling procedures and the limited size of samples, the depth/elevation demarcations on the borehole logs must be viewed as "transitional" zones, and cannot be construed as exact geologic boundaries between layers. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings.

4.1 SITE PREPARATION

It is understood that significant regrading of the site will likely occur to accommodate the proposed development. The existing topsoil and any organic materials encountered should be excavated and removed from beneath the proposed parking and driving areas, and building footprints; additionally this material should be excavated and removed to a minimum distance of 3 m around the building footprints. Any topsoil and materials with significant quantities of organics are not appropriate for use as fill below buildings or grading and parking areas.

On completion of regrading, the exposed subgrade should be proof-rolled and inspected by a qualified Geotechnical Engineer prior to placement of granular fill or foundations. Any loose/soft soils identified at the time of proof-rolling that are unable to uniformly be compacted should be sub-excavated and removed. The excavations created through the removal of these materials should be backfilled with approved engineered fill consistent with the recommendations provided below.

The near surface sand soils can become unstable if they are wet or saturated. Such conditions are common in the spring and late fall. Under these conditions, temporary use of granular fill, and possible reinforcing geotextiles, may be required to prevent severe rutting on construction access routes.

4.2 FROST PENETRATION

Based on climate data and design charts, the maximum frost penetration depth below the surface at the site is estimated at 1.5 mbgs.

Exterior footings for the proposed structures should be situated at or below this depth for frost penetration or should be appropriately protected.

Any services should be located below the frost penetration depth or be appropriately insulated.

4.3 EXCAVATIONS AND BACKFILL

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally loose to compact sand soils and soft to stiff silty clay soils encountered to approximately 3.5 m depth may be classified as Type 3 soils above the groundwater table in accordance with OHSA. Type 3 soils may be excavated with side slopes no steeper than 1H:1V. Beneath the groundwater table the soils may be classified as Type 4 soils and may be excavated with side slopes no steeper than 3H:1V.

4.4 DEWATERING

Groundwater was measured in each of the two (2) monitoring wells at elevations of 247.57 metres above sea level (mASL) to 247.87 mASL. Based on these observations, groundwater seepage is not anticipated within the proposed excavation depths. If groundwater seepage is encountered it should be manageable with filtered sumps and pumps depending on size of excavation. It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events. In order to minimize predictable water issues and costs, it is recommended that excavation and in-ground construction be performed in drier seasons. Consideration can be given to measuring the water levels in the wells during seasonally wetter times to identify any change in groundwater levels, as it is noted that groundwater levels fluctuate with seasonal conditions and rainfall events.

4.5 BACKFILL AND COMPACTION

Excavated topsoil from the Site is not appropriate for use as fill below grading and parking areas. Excavated native sand may be appropriate for use as fill below grading and parking areas, provided that the actual or adjusted moisture content at the time of construction is within a range that permits compaction to required densities. Some moisture content adjustments may be required depending upon seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Any engineered fill below foundations should be placed in lifts appropriate to the type of compaction equipment used, and be compacted to a minimum of 100% of standard Proctor maximum dry density (SPMDD), as confirmed by nuclear densometer testing. If native soils from the site are not used as engineered fill, imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction. Consideration could be given to using a material meeting the specifications of OPSS 1010 Granular B or an approved equivalent. Foundation wall and any buried utility backfill material should consist of free-draining imported granular material.

The backfill material, if any, in the upper 300 mm below the pavement subgrade elevation should be compacted to 100 percent of SPMDD in all areas.

4.6 FOUNDATION DESIGN

We understand that some regrading of the Site will occur prior to construction of the proposed development.

Overall, assuming the site is prepared as outlined above, the native subsoils are competent to support the industrial building on conventional strip and spread footings. Any new exterior footings must be placed a minimum of 1.5 m below final adjacent grade for frost protection.

If the footings are to be found on compact native sand silt or sand and firm to very stiff silty clay, they may be designed for an allowable bearing capacity of 75 kPa at serviceability limit state (SLS) and 110 kPa at ultimate limit state (ULS).

Any required grade raises can be accomplished with engineered fill placed in accordance with the recommendations in Section 4.5. If footings are to be found entirely on engineered fill overlying approved native soils, they may be designed for an allowable bearing capacity of 75 kPa at (SLS) and 110 kPa at ULS. It is noted that in some areas the near surface sand soils are relatively loose, provisions should be made by the Contractor to excavate to the compact or stiff native soils stipulated above. A minimum thickness of 1.2 m of engineered fill is recommended where it is placed on loose soils. If engineered fill is to be constructed above cohesive soils (i.e., soils with significant clay deposits), Cambium would recommend waiting at least six months following completion of fill placement prior to construction of major structures in order to allow initial settlement to occur within the cohesive soils.

If footings are found on differing surfaces (i.e., engineered fill and/or native soils) the footings and foundation walls should be appropriately reinforced as determined by the structural engineer.

The quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm bearing capacity estimates and suitability of any engineered fill. Settlement potential at the above-noted SLS loadings is less than 25 mm and differential settlement should be less than 10 mm.

4.7 LATERAL EARTH PRESSURE

Lateral earth pressure coefficients (K) are shown in Table 5. It is assumed that potential lateral loads will result from cohesionless, frictional materials, such as granular backfill.

Table 5 Lateral Earth Pressure Coefficients

K	Unfactored
Ko (at rest)	0.42
Ka (active)	0.27
Kp (passive)	3.70

The coefficients provided in Table 5 assume that the surface of the granular backfill is horizontal against any proposed retaining wall, and the wall is vertical and smooth. Cambium should be contacted to provide updated

lateral earth pressure coefficients should the assumptions differ to those noted and if the soil slopes at an angle against the retaining wall.

A unit weight of 22 kN/m^3 should be assumed for compacted granular backfill loadings.

4.8 FLOOR SLABS

To create a stable working surface, to distribute loadings, and for drainage purposes, an allowance should be made to provide at least 200 mm of OPSS 1010 Granular A compacted to 98% of SPMDD beneath all floor slabs.

4.9 SUBDRAINAGE

Given the site grading information is unknown, but will likely involve the removal of soil. Geotextile wrapped perforated pipe subdrains set in a trench of clear stone and connected to a sump or other frost-free positive outlet are recommended below floor slabs and around the perimeter of building foundations. This recommendation may be revisited depending on the regrading plans.

4.10 BURIED UTILITIES

Trench excavations above the groundwater table and in the loose to compact sandy silt soils and firm to stiff silty clay or clayey silt soils should generally consider Type 3 which require side slopes no steeper than 1H:1V. Beneath the groundwater table the soils may be classified as Type 4 soils and may be excavated with side slopes no steeper than 3H:1V.

Bedding and cover material for any services should consist of OPSS 1010-3 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.013). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98 percent of SPMDD. The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 98 percent of SPMDD, taking care not to damage the utility pipes during compaction.

4.11 SOIL CHEMICAL TESTING RESULTS

The Ministry of the Environment (MOE) document *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act* (Ministry of the Environment, 2011), herein referred to as the *Standard*, was referenced in determining the applicable criteria for the Site. The soil samples collected from BH101-19 and BH102-19 were analyzed per the requirements in Table 1 Standards - Full Depth Background Site Condition Standards - Agricultural or Other Property Use is applicable for comparison of the analytical results.

From the results of the testing, no exceedances were discovered. It should be noted that due to access limitations, the samples gathered were from the western edge of the site and conditions throughout other portions of the site may differ.

Based on the test results, the following handling options are available for soils sampled and analyzed under this program:

- Remain on-site to be appropriately reused as backfill or for re-grading, under the guidance of a Qualified Person (QP) as defined by the MOECC and as approved by a geotechnical engineer;

- Accepted by a Receiving Site with specifications for receipt of soil based on the above test results under the guidance of the receiving site's QP and Fill Management Plan, and subject to the municipality's fill bylaw;

- Disposed of at a waste disposal landfill appropriately certified by the MOECC. Additional testing may be required for O. Reg. 347 waste characterization analysis as directed by the Receiver.

It is noted that the chemical parameters tested and the number of samples likely do not meet the requirements of a Record of Site Condition nor meet the requirements of the intended receiving site. This report should not be construed as an Environmental Site Assessment. Handling options provided herein are based solely on the chemical analysis of soil located at site, and does not represent acceptance or suitability of this material on behalf of the intended receiving site. Should conditions encountered or the proposed work scopes vary from those described in this report, Cambium should be notified to evaluate the need for further work.

Test results and associated samples detailed within this report do not represent any areas or soil depths beyond the aforementioned sampling event.

Handling options provided herein are based solely on the chemical analysis of the sampled soil located at Site, specifically soil from all of the boreholes advanced on the Site, and does not represent acceptance or suitability of this material on behalf of an intended receiving site. Should conditions encountered or the proposed work scopes vary from those described in this report, Cambium should be notified to evaluate the need for further work.

4.12 SEISMIC SITE CLASSIFICATION

The Ontario Building Code (OBC) specifies that the structures should be designed to withstand forces due to earthquakes. For the purpose of earthquake design, geotechnical information shall be used to determine the "Site Class". Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the OBC (2006), it is recommended that Site Class "E" (soft soil) be applied for structural design at the Site. This recommendation may be revisited depending on the regrading plans.

Peak ground acceleration and spectral acceleration (period of 0.2 seconds) for the site are calculated to be 0.065g and 0.109g respectively using the 2015 National Building Code Seismic Hazard Calculation. A detailed report of the calculation and its results can be found in Appendix D.