Geotechnical Engineering Report

Proposed Development
10367 County Road 10, Clearview, Ontario

Region of Huronia Environmental Services Ltd.
Final Report

April 10, 2024
02210643.000

ENGLOBE

Region of Huronia Environmental Services Ltd.

Prepared by:

Reza Mahmoudipour, M.Sc., P.Eng.
Senior Project Manager, Geotechnical

Reviewed by:

Seth Zhang, M. Eng, M.Sc., P.Eng.
Team Lead, Geotechnical

Production team

Kevlar Developments Inc.

Owner	Clarence McGillivary

Englobe Corp.

Senior Project Manager, Geotechnical	Reza Mahmoudipour
Team Lead, Geotechnical	Seth Zhang

Revisions and publications log

REVISION No.	DATE	DESCRIPTION
00	July 17, 2023	Draft Report Issued
0A	April 10, 2024	Final Report Issued

Property and Confidentiality

“This report can only be used for the purposes stated therein. Any use of the report must take into consideration the object and scope of the mandate by virtue of which the report was prepared, as well as the limitations and conditions specified therein and the state of scientific knowledge at the time the report was prepared. Englobe Corp. provides no warranty and makes no representations other than those expressly contained in the report.

This document is the work product of Englobe Corp. Any reproduction, distribution or adaptation, partial or total, is strictly forbidden without the prior written authorization of Englobe Corp. and its Client. For greater certainty, use of any and all extracts from the report is strictly forbidden without the written authorization of Englobe Corp. and its Client, given that the report must be read and considered in its entirety.

No information contained in this report can be used by any third party without the prior written authorization of Englobe Corp. and its Client. Englobe Corp. disclaims any responsibility or liability for any unauthorized reproduction, distribution, adaptation or use of the report.

If tests have been carried out, the results of these tests are valid only for the sample described in this report.

Englobe Corp.’s subcontractors who have carried out on-site or laboratory work are duly assessed according to the purchase procedure of our quality system. For further information, please contact your project manager.”

Table of Contents

TABLES

APPENDICES

1 Introduction

Englobe Corp. (Englobe) was retained by Region of Huronia Environmental Services Ltd. to conduct a geotechnical investigation for the new sewage lagoon storage cells to be installed at the project site located at 10367 County Road 10, in the Township of Clearview, Ontario. The site is located in the southeast quadrant of the Concession Road 5 and County Road 10 intersection and bounded by parcels of agricultural land. The general location of the site is presented on Figure 1.

Th site currently includes nine (9) sewage lagoon storage cells (Cells 1 to 9). Based on the final Conceptual Site Plan prepared by Innovative Planning Solution dated March 12, 2024, and email communication, it is understood that the proposed new development would include a total of ten (10) new sewage lagoon storage cells, a hauled sewage receiving station, and a new gravel access road. Four (4) new cells will be installed north of the existing cells while another six (6) cells will be installed west of the existing cells.

It was understood that the lagoons are being used for storage of liquid waste materials and therefore a liner should be provided to prevent infiltration of contaminants into the underlying soil and groundwater.

This report encompasses the results of the geotechnical investigation conducted for the proposed cell areas to determine the prevailing subsurface soil and groundwater conditions, and based on this information, provides geotechnical engineering design recommendations relevant to the design and construction of the project including liners, earth pressure design, parameters, excavation, backfill, short term dewatering, pavement design and other constructability recommendations.

On-going liaison with Englobe during the construction phase of the project is recommended to ensure that the recommendations in this report are applicable and/or correctly interpreted and implemented.

The recommendations and opinions provided in this report apply only to the proposed development as described above and the limitations of the Investigation found in Section 5 are an integral part of this report.

It is important to mention that a hydrogeological assessment was conducted by Englobe and provided separately. This assessment should be read in conjunction with this report.

It should also be noted that the original investigation for this project was conducted by Terraprobe, which was subsequently acquired by Englobe.

2 Investigation Procedure

Englobe (formerly known as Terraprobe) conducted a prior geotechnical investigation, and a geotechnical report was issued on February 14, 2013. During this investigation, four (4) monitoring wells were installed at the site and subsequently converted into monitoring wells. The results of the previous investigation were utilized toward the section 32 of the Ministry of the Environment's *"Amended environmental Compliance Approval, Number A740051"*. The available date from the previous investigation was used to refine the current geotechnical and hydrogeological investigations.

The new field investigation was conducted on June 1, 2023, and consisted of drilling and sampling a total of three (3) boreholes, extending to about 5.0 m to 6.6 meters below ground surface (mbgs). The general layout of the existing and new boreholes is shown in Figure 2.

The boreholes were drilled by a specialist drilling contractor using track-mounted drill rig power auger. The borings were advanced using non-continuous flight solid and hollow stem augers and were sampled at 0.75 m (up to 3.0 m depth) and 1.5 m (below 3.0 m depth) intervals with a conventional 50 mm diameter split barrel samplers, when the Standard Penetration Test (SPT) was carried out (ASTM D1586). The field work (drilling, sampling and testing) was observed and recorded by a member of our field engineering staff, who logged the borings and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into clean plastic jars and transported to our geotechnical testing laboratory for detailed inspection and testing. All borehole samples were examined (tactile) in detail by a geotechnical engineer and classified according to visual and index properties. Laboratory tests consisted of water content determination on all samples. The measured natural water contents of individual samples are plotted on the enclosed Borehole Logs at respective sampling depths.

Water levels were measured in open boreholes upon completion of drilling. Monitoring well comprising 50 mm diameter PVC pipes were installed in one (1) selected borehole (Borehole 6) to facilitate ground water monitoring. The PVC tubing was fitted with a sand filter and bentonite clay seal as shown on the accompanying Borehole Logs. Water levels in the monitoring wells were measured on June 6, 2023. The results of groundwater monitoring are presented in Section 3.2 of this report.

The borehole ground surface elevations were surveyed by Englobe using a Trimble R10 GNSS System. The Trimble R10 system uses the Global Navigation Satellite System and the Can-Net reference system to determine target location and elevation. The Trimble R10 system is reported to have an accuracy of up to 10 mm horizontally and up to 30 mm vertically. It should be noted that the elevations provided on the Borehole Logs are approximate only, for the purpose of relating soil stratigraphy and should not be used or relied on for other purposes.

3 Subsurface Conditions

The specific soil conditions encountered at each borehole location are described in greater detail on the Borehole Logs, with a summary of the general subsurface soil conditions outlined below. This summary is intended to correlate this data to assist in interpretation the subsurface conditions at the site.

It should be noted that the subsurface conditions are confirmed at the borehole locations only and may vary between and beyond the borehole locations. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

3.1 Stratigraphy

The following stratigraphy is based on the borehole findings. The summary provided below is for general guidance only. Detailed depths and elevations are given in the following subsections and appended borehole logs.
In general, the soil stratigraphy at the site comprised fill underlain by silt and silty sand to the maximum termination depth of approximately 6.6 mbgs.

3.1.1 Topsoil

Topsoil was encountered at ground surface in all boreholes and observed to have a thickness between 130 and 180 mm.

3.1.2 Fill Materials

Fill material was encountered in all boreholes beneath the topsoil and extended to depths varied from 0.8 to 4.6 mbgs. The fill material encountered in Borehole 5 extended to 4.6 mbgs and consisted of sand to clayey silt, whereas the fill material in other boreholes comprised sandy silt to silty sand and extended to 0.8 and 1.5 mbgs.

Standard Penetration Test results (N-values) obtained from the fill zone ranged from 4 to 19 blows per 300 mm of penetration, indicating a loose to compact relative density in cohesionless fill zone and 10 blows per 300 mm of penetration, indicating a stiff consistency in cohesive fill zone. The in-situ moisture contents of the earth fill samples ranged from 9 to 28 percent by mass, indicating a moist to wet condition.

3.1.3 Silt

Silt with trace to some clay and sand was encountered beneath the fill zone in Boreholes 5 and 7 and extended to the borehole termination depths of 5.0 and 6.6 mbgs.

The Standard Penetration Test results (N-Values) obtained from the silty sand deposit ranged from 1 to 17 blows per 300 mm penetration, indicating a very loose to compact relative density. The measured moisture contents of the silt samples ranged from 19 to 28 percent by mass, indicating a wet condition. Based on the result of Atterberg Limits test, the moisture content of the tested silt sample was greater than the liquid limit.

3.1.4 Silty Sand

Silty sand with trace amounts of clay was encountered beneath the fill zone in Borehole 6 and extended to the borehole termination depth of 6.6 mbgs.

The Standard Penetration Test results (N-Values) obtained from the silty sand deposit ranged from 4 to 9 blows per 300 mm penetration, indicating a very loose to loose relative density. The measured moisture contents of the silty sand samples ranged from 12 to 25 percent by mass, indicating a moist to wet condition.

3.2 Groundwater

Observations pertaining to the depth of groundwater level and caving were made in the open boreholes upon completion of drilling and are noted on the enclosed borehole logs. A monitoring well was installed in Borehole 6 to facilitate groundwater level monitoring. The groundwater level measurement in the monitoring well was taken on June 22, 2023, and is noted on the enclosed Borehole Log. The groundwater level was also measured in the old monitoring wells, i.e., Borehole 1 to 4. A summary of these observations is provided as follows:

Table 1 Boreholes information

Borehole No.	Depth of Boring below Grade (m)	Depth to Cave below Grade (m)	Water Level Depth/Elevation (m) at the Time of Drilling	Water Level Depth/Elevation (m) in Monitoring Well on June 6, 2023
Borehole 6	6.6	Open	Dry	2.0/186.2
Borehole 1	5.0	-	-	1.4/189.0
Borehole 2	5.0	-	-	1.3/187.9
Borehole 3	5.0	-	-	1.0/187.8
Borehole 4	5.0	-	-	1.3/188.2

The design groundwater table at this site may be taken at Elev. 189 m±. Perched water may be present in the earth fill zone. The water levels noted above may fluctuate seasonally depending upon the precipitation and surface runoff.

Additional information pertaining to groundwater at the Site is discussed in the hydrogeological report by Englobe provided under a separate cover.

4 Discussions and Recommendations

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use of the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards and guidelines of practice. The Ontario Building Code may require additional considerations beyond the recommendations provided in this report and must be followed. If there are any changes to the site development features or is any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Englobe should be retained to review the implications of these changes with respect to the contents of this report.

4.1 Liner System Recommendations

It was understood that the proposed sewage lagoon storage cells will be a retention structure and will be constructed with a liner.

It was understood that the depth of each pond will be 3.6 m (12 ft) and therefore the required excavation should be carried out under the elevation of groundwater. For details about dewatering and excavation requirements please refer to section 4.5. and the hydrogeological investigation report.

The liner system is an important component of the retention pond, as it prevents the infiltration of contaminations into the underlying soil and groundwater. In general, three (3) common liner options for

retention ponds are clay liners, geosynthetic clay liners (GCLs) and geomembranes. Based on the information provided by ROHES via an email dated June 20, 2023, it was understood that the existing lagoons were installed with a 24 mm layer of geomembrane.

Note the cell bottom is about 3 m depth below the design ground water level (Elev. 189.0 m). Therefore, all above-noted options must be designed to resist hydrostatic pressure.

4.1.1 Clay Liner

4.1.1.1 Compaction

The clay liner material should be properly compacted to achieve at least 95% of Standard Proctor Maximum Dry Density (SPMDD, as determined by laboratory testing) as per ASTM D698, to minimize permeability and settlement. Compaction tests should be conducted during construction to ensure compliance with the specified compaction requirements.

4.1.1.2 Permeability

The clay liner should have a permeability coefficient of not more than 10^{-7} cm/s. This can be achieved by selecting a suitable clay material with low permeability characteristics and by maintaining proper compaction during construction.

4.1.1.3 Thickness

The clay liner thickness should be determined based on the anticipated hydraulic loading, soil properties, and the required level of containment. A minimum thickness of 1.0 m is recommended to provide an adequate barrier against seepage.

4.1.1.4 Compatibility

Ensure that the clay liner material is compatible with the sewage water being stored. Certain chemicals or constituents in the sewage water may adversely affect the performance of the clay liner. A compatibility test may need to be carried out to assess the chemical compatibility and determine any necessary protective measures.

4.1.2 Geosynthetic Clay Liner (GCL)

If a GCL is selected as the liner system, the following recommendations should be considered:

4.1.2.1 Manufacturer's Specifications

The manufacturer's specifications and recommendations for installation, seam integrity, and overlap requirements should be followed. The selected GCLs should comply with relevant industry standards and have a proven track record for similar applications. Englobe should be consulted to approve the selected GCL.

4.1.2.2 Compatibility

The compatibility of the GCL material should be verified with the sewage water to ensure that the GCL is resistant to chemical degradation and can effectively retain the contaminants present in the sewage water.

4.1.2.3 Protection

An additional protective layer above the GCL should be provided to minimize the potential for damage during installation and subsequent operations. This protective layer can consist of a geotextile or geomembrane to provide puncture resistance and enhance the longevity of the liner system.

4.1.3 Geomembrane

The third option is a 24 mm thick geomembrane, which provides a durable and impermeable barrier against seepage. This geomembrane can be expertly installed and tested by a qualified company to ensure a secure seal and long-term performance. Please note that if hazardous liquids are intended to be stored in these lagoons, it is recommended to incorporate a layer of clay beneath the geomembrane. This additional layer serves to minimize the risk of soil and groundwater contamination. The geomembrane should be installed in accordance with manufacturer's installation instruction, but generally, it is envisaged that the installation will consist of the following steps,

- Prior to installation, thoroughly inspect the subgrade to ensure it is free from sharp objects, rocks, or any debris that could potentially puncture or damage the geomembrane.
- Prepare a smooth and even subgrade surface to minimize the risk of wrinkles, voids, or stress points in the geomembrane.
- The subgrade should be compacted to at least 95% of the maximum dry density (SPMDD as determined by laboratory testing) as per ASTM D698.

Quality Assurance:

- Engage a qualified installation company, that specializes in geomembrane installation.
- Conduct regular inspections during the installation process to ensure proper handling, placement, and seam integrity of the geomembrane.

Seaming:

- Follow the manufacturer's specifications for seam preparation, overlap requirements, and welding techniques. Utilize qualified technicians to perform the seaming process.
- Perform rigorous testing, such as peel and shear tests, to verify the strength and integrity of the welded seams.
- Conduct quality control checks on the seaming process, including visual inspections and non-destructive testing methods, to identify any potential defects or deficiencies.

Protection:

- Implement measures to protect the installed geomembrane from potential damage during construction activities or subsequent operations. This can include using geotextiles or protective layers above the geomembrane to provide puncture resistance and distribute loads.
- Avoid heavy machinery or equipment traffic directly on the geomembrane to prevent excessive stress or punctures.

Documentation and As-Built Drawings:

- Maintain comprehensive records of the geomembrane installation, including seam testing results, inspection reports, and any deviations from the original design or specifications.
- Develop accurate as-built drawings that clearly indicate the location and details of the installed geomembrane, including seam locations and any additional protective measures.

Ongoing Maintenance and Monitoring:

- Establish a regular maintenance program to inspect the geomembrane periodically for signs of damage, deterioration, or potential issues.
- Monitor the performance of the geomembrane over time, including the detection of any leaks or seepage, and promptly address any identified issues.

4.1.4 Drainage Recommendations

Proper drainage design is important to manage the water levels within the cells and prevent overtopping or failure. The following recommendations are provided:

- Surface drainage: design and construct a well-defined surface drainage system to efficiently collect and channel runoff from the surrounding area. The system should include appropriate slopes, swales, and surface ditches to direct water away from the retention pond.
- Subsurface drainage: install a subsurface drainage system, such as perforated pipes or a french drain, within the pond to manage groundwater levels. This will help control the pore pressure and prevent seepage-related issues. Ensure that the drainage system is adequately sized and properly maintained.
- Emergency overflow: incorporate an emergency overflow system to handle extreme rainfall events and prevent the retention pond from overflowing. The overflow system should be designed to safely discharge excess water while minimizing erosion and downstream impacts.

4.2 Earth Pressure Design Parameters

In case that the designer requires to calculate the earth pressures it can be calculated based on the following equation:

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

Where:

- **P** = the horizontal pressure at depth h (kPa)
- **K** = the earth pressure coefficient
- h_w = the depth below the ground water level (m)
- γ = the bulk unit weight of soil (kN/m^3)
- γ_w = the bulk unit weight of water (9.8 kN/m^3)
- γ' = the submerged unit weight of the exterior soil, (γ_{sat} - γ_w)
- **q** = the complete surcharge loading (kPa)

The average values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follow:

Table 2 Coefficient of Lateral Earth Pressure

Stratum/Parameter	γ (kN/m³)	Φ (degree)	K_a	K_o	K_p
Earth Fill	18.0	28	0.36	0.53	2.77
Undisturbed silt to silty sand	20.0	28	0.36	0.53	2.77

The values of the earth pressure coefficients are for the horizontal backfill grade. The earth pressure coefficients for inclined grade will vary based on the inclination of the retained ground surface.

4.3 Pavement

The paved areas at the project site would include sewage receiving station and the new gravel access road.

4.3.1 Pavement Design

The pavement design for the project site is provided in the following table,

Table 3 Pavement Structure

Pavement Structural Layers	Gravel Pavement
Granular Surface Course OPSS.MUNI 1010 Granular A	150 mm
Granular Base Course OPSS.MUNI 1010 Granular B Type II	500 mm
Total Pavement Thickness	650 mm

By utilizing a layer of geogrid (for instance, Tensar TX 5 or equivalent) the volume of the required granular material can be minimized, and the pavement can be designed as follows:

Table 4 Pavement Structure with Geogrid

Pavement Structural Layers	Gravel Pavement
Surface Granular Course OPSS.MUNI 1010 Granular A	400 mm
Geogrid (TX 5 or equivalent)	-
Total Pavement Thickness	400 mm

Granular A and B materials should meet the requirements of OPSS.MUNI 1010 and relevant standards. Granular materials should be compacted to 100 percent SPMDD at ±2 percent of the optimum moisture content.

4.3.2 Drainage

Control of water is an important factor in achieving a good pavement life. We recommended that the gravel pavement structure be sloped at a grade of 3 percent to drain surface water to the side ditches. The subgrade must be free of depressions and sloped at a grade of 3 percent to provide positive drainages.

4.3.3 Subgrade Preparation

The exposed subgrade is expected to generally consist of earth fill materials and these soils will be weakened by construction traffic when wet; especially if site work is carried out during periods of wet weather. In these weather conditions, an adequate granular working surface would be required in order to minimize subgrade disturbance and protect its integrity.

Immediately prior to placing the granular subbase, the exposed subgrade should be proof-rolled with a heavy rubber tired vehicle (such as a loaded gravel truck). The subgrade should be inspected for signs of rutting or displacement. Areas displaying signs of rutting or displacement should be compacted and tested or the material should be excavated and replaced with Granular A material. Backfill material should be placed and compacted to at least 100 percent of SPMDD. The final subgrade surface should be sloped at a grade of 3 percent to provide positive subgrade drainage.

4.3.4 Routine Maintenance

The gravel surfaced route and parking lot should be maintained at a grade of about 3 percent to drain surface water to the side ditches. Distresses, for instance rutting, potholes, washboard may appear due to the truck traffic loadings. Routine maintenance of the granular surfaced pavement will be sustained comprising placement of additional Granular A material, regrading and compaction.

4.4 Excavations and Groundwater Control

The boreholes data indicate that the earth fill materials and silt and silty sand deposits would be encountered in the excavations. Excavations must be carried out in accordance with the *Occupational Health and Safety Act and Regulations for Construction Projects*. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

a. is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b. has a low natural moisture content and a high degree of internal strength;
c. has no signs of water seepage; and
d. can be excavated only by mechanical equipment.

TYPE 2 SOIL

a. is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b. has a low to medium natural moisture content and a medium degree of internal strength; and
c. has a damp appearance after it is excavated.

TYPE 3 SOIL

a. is stiff to firm and compact to loose in consistency or is previously-excavated soil;
b. exhibits signs of surface cracking;
c. exhibits signs of water seepage;
d. if it is dry, may run easily into a well-defined conical pile; and
e. has a low degree of internal strength

TYPE 4 SOIL

a. is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b. runs easily or flows, unless it is completely supported before excavating procedures;
c. has almost no internal strength;
d. is wet or muddy; and
e. exerts substantial fluid pressure on its supporting system.

The earth fill materials and native soils encountered in the boreholes would be classified as Type 4 Soil.

Where workmen must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates the steepest slopes of excavation by soil type as follows:

Table 5 The Regulation for Safe Excavation Slopes

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

It should be noted that the earth fill material and native deposits may contain larger particles (cobbles and boulders) that are not specifically identified in the Borehole Logs. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples of the particles of this size. Provision should be made in excavation contracts to allocate risks associated with time spent and equipment utilized to remove or penetrate such obstructions when encountered.

The design groundwater table at this site may be taken at Elev. 189 m±. Perched water may be present in the earth fill zone. The water levels noted above may fluctuate seasonally depending upon the precipitation and surface runoff.

Based on the subsurface conditions and the proposed design information, groundwater seepage would be expected during excavation period and active dewatering (by well points etc.) would be required. For more details about dewatering requirements please refer to the Hydrogeological report.

4.5 Quality Control

The on-site review of the condition of the subgrade soil as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code 2012. If Englobe is not retained to carry out subgrade evaluations during construction, then Englobe accepts no responsibility for the performance or non-performance of the design, even if they are ostensibly constructed in accordance with the conceptual design advice provided in this report.

Concrete for this structure will be specified in accordance with the requirements of CAN3 - CSA A23.1. Englobe maintains a CSA certified concrete laboratory and can provide concrete sampling and testing services for the project as necessary.

The requirements for fill placement on this project should be stipulated relative to SPMDD, as determined by ASTM D698. In-situ determinations of density during fill placement by Procedure Method B of ASTM D2922 are recommended to demonstrate that the contractor is achieving the specified soil density. Englobe is a CNSC licensed operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary.

Englobe can provide thorough in-house resources, quality control services for Building Envelope, Roofing and Structural Steel in accordance with CSA W178, as necessary, for the Structural and Architectural quality control requirements of the project. Englobe is certified by the Canadian Welding Bureau under W178.1-1996.

5 Limitations and Risk

5.1 Procedures

This subsurface investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Englobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained by Englobe.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Englobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Englobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

5.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Ground water levels are particularly susceptible to seasonal fluctuations.

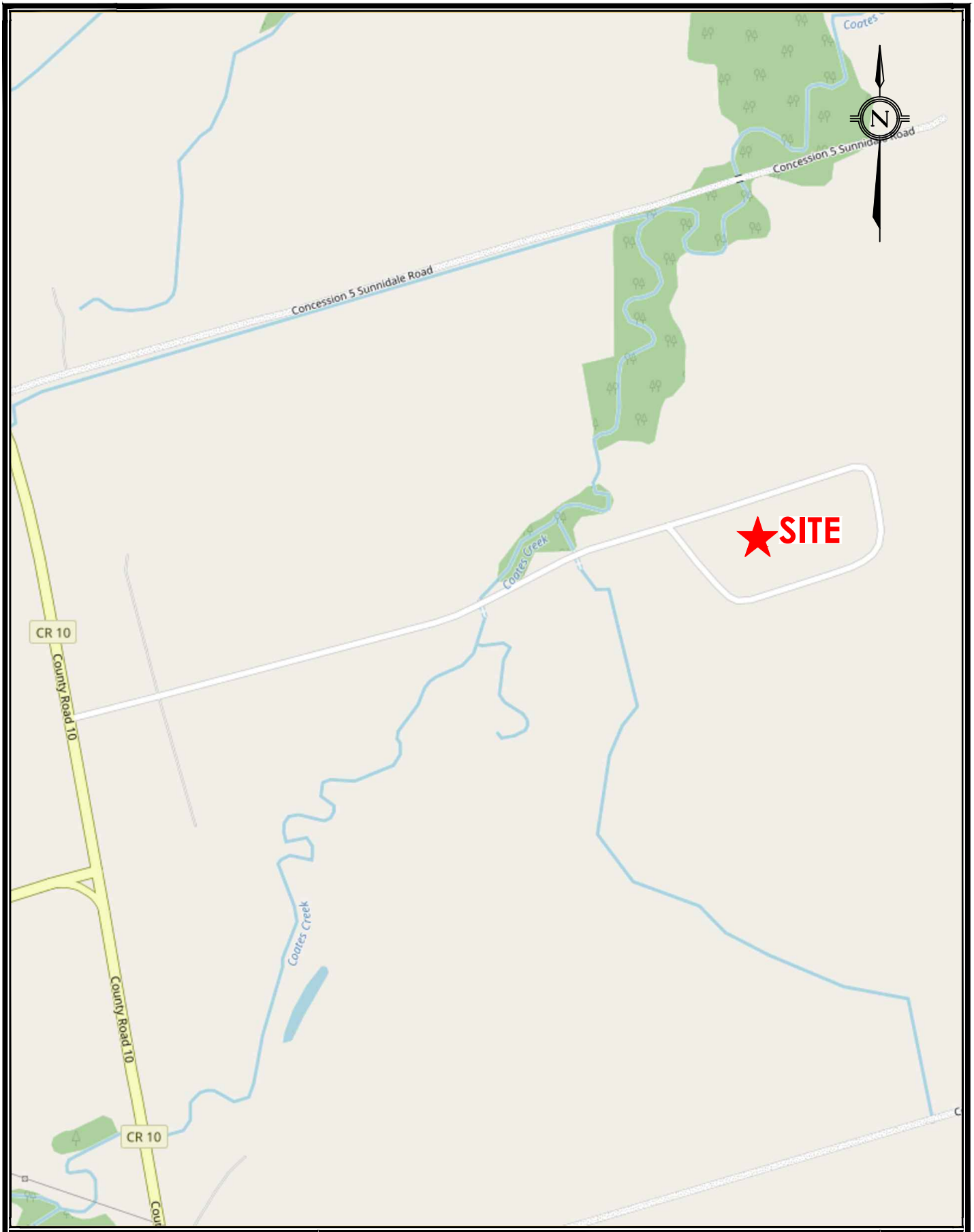
The discussion and recommendations are based on the factual data obtained from this investigation made at the site by Englobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Englobe should be retained to review the implications of such changes with respect to the contents of this report.

It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

ENCLOSURES

FIGURES

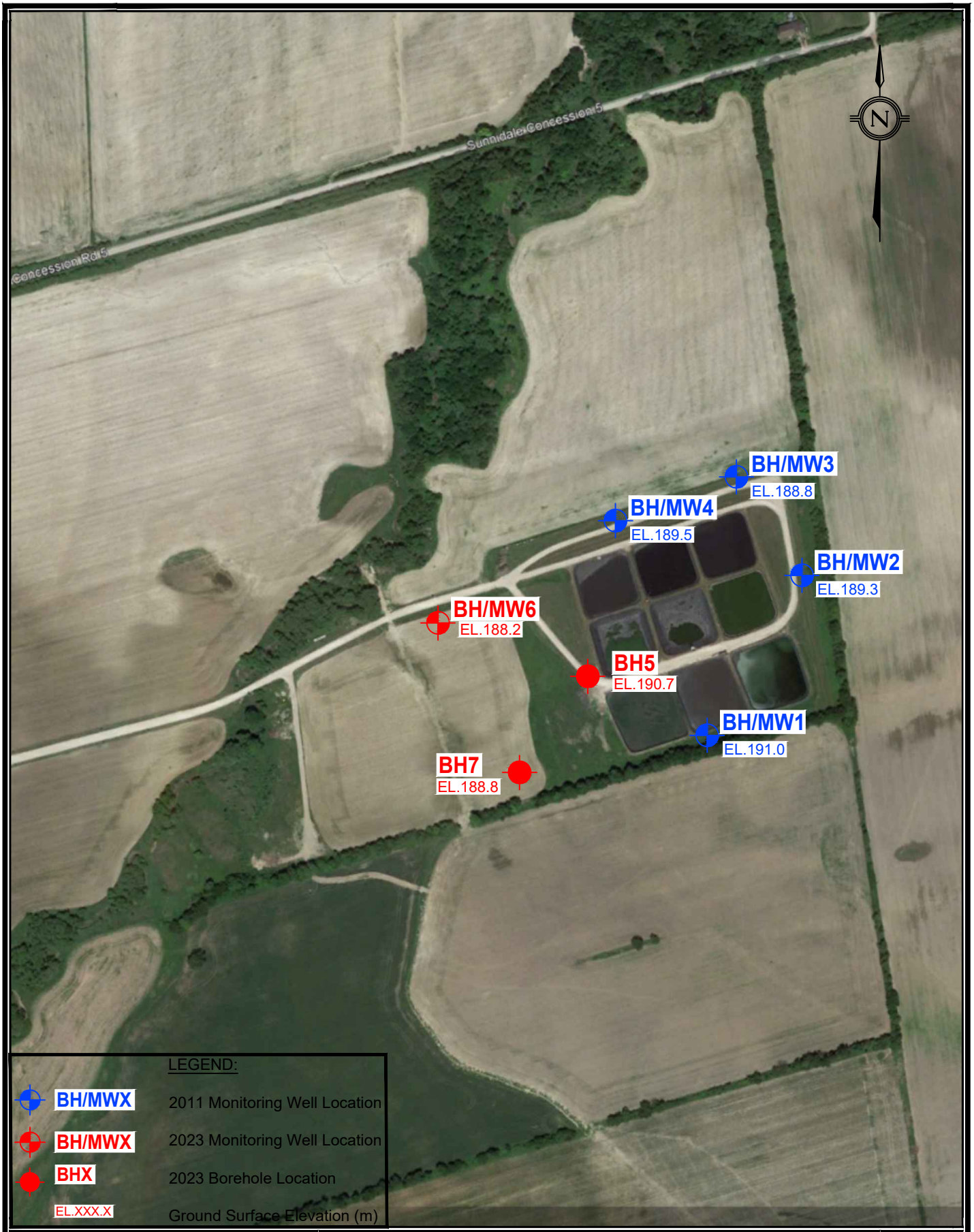


ENGLOBE
903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: SITE LOCATION PLAN

File No. 02210643.000

FIGURE : 1



eNGLOBe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: BOREHOLE LOCATION PLAN

File No. 02210643.000

FIGURE : 2

APPENDIX A

SAMPLING METHODS

AS	auger sample
CORE	cored sample
DP	direct push
FV	field vane
GS	grab sample
SS	split spoon
ST	shelby tube
WS	wash sample

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.)."

COHESIONLESS SOILS

Compactness	'N' value
very loose	< 4
loose	4 – 10
compact	10 – 30
dense	30 – 50
very dense	> 50

COHESIVE SOILS

Consistency	'N' value	Undrained Shear Strength (kPa)
very soft	< 2	< 12
soft	2 – 4	12 – 25
firm	4 – 8	25 – 50
stiff	8 – 15	50 – 100
very stiff	15 – 30	100 – 200
hard	> 30	> 200

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
silt*y*	20 – 35
sand *and* silt	> 35

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
G_s	specific gravity
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index
c_v	coefficient of consolidation
m_v	coefficient of compressibility
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Damp	refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.
Moist	refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at or close to plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

LOG OF BOREHOLE 5

Project No.	: 02210643.000	Client	: Region of Huronia Environmental Services (ROHES)	Originated by	: OH
Date started	: June 1, 2023	Project	: 10367 County Road 10	Compiled by	: RM
Sheet No.	: 1 of 1	Location	: Clearview, Ontario	Checked by	: SZ

Position : E: 585170, N: 4913331 (UTM 17T) Elevation Datum : Geodetic

Rig type : Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	**190.7**	**GROUND SURFACE**				
	190.5	180mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace gravel, trace rootlets, loose, brown, moist		1	SS	7
	189.9					
1	0.8	**FILL**, sand, some silt, trace rock fragments, very loose to compact, brown, wet		2	SS	19
				3	SS	9
2				4	SS	4
3	187.7					
	3.0	**FILL**, clayey silt, trace gravel, trace sand, trace organics, trace wood pieces, stiff, dark grey, wet		5	SS	10
4	186.1					
	4.6	**SILT**, trace sand, trace clay, compact, brown, wet		6	SS	17
5	185.7					
	5.0	**END OF BOREHOLE**				

Elevation Scale (m): 190, 189, 188, 187, 186

Penetration Test Values (Blows / 0.3m): Dynamic Cone; 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane; 40 80 120 160

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit; PL MC LL; 10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

Borehole was dry and open upon completion of drilling.

file: 02210643.000 bh logs.gpj

LOG OF BOREHOLE 6

Project No.	: 02210643.000	Client	: Region of Huronia Environmental Services (ROHES)	Originated by	: OH
Date started	: June 1, 2023	Project	: 10367 County Road 10	Compiled by	: RM
Sheet No.	: 1 of 1	Location	: Clearview, Ontario	Checked by	: SZ

Position : E: 585013, N: 4913384 (UTM 17T) Elevation Datum : Geodetic

Rig type : Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	188.2	**GROUND SURFACE**				
		130mm **TOPSOIL**				
		FILL, sandy silt, trace clay, trace gravel, trace rootlets, loose, brown, moist		1	SS	9
	187.4					
1	0.8	**SILTY SAND**, loose, brown, moist to wet		2	SS	6
		...sand		3	SS	9
2				4	SS	9
3		...grey		5	SS	4
4						
5				6	SS	4
6		...grey		7	SS	6
	181.6					
	6.6	**END OF BOREHOLE**				

Elevation Scale (m): 188, 187, 186, 185, 184, 183, 182

Penetration Test Values (Blows / 0.3m): Dynamic Cone; 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane; 40 80 120 160

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit; PL MC LL; 10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

	GR	SA	SI	CL
6	0	74	21	5

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Jun 6, 2023	2.0	186.2

file: 02210643.000 bh logs.gpj

LOG OF BOREHOLE 7

Project No.	: 02210643.000	Client	: Region of Huronia Environmental Services (ROHES)	Originated by	: OH
Date started	: June 1, 2023	Project	: 10367 County Road 10	Compiled by	: RM
Sheet No.	: 1 of 1	Location	: Clearview, Ontario	Checked by	: SZ

Position : E: 585100, N: 4913233 (UTM 17T) Elevation Datum : Geodetic

Rig type : Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	188.8	**GROUND SURFACE**				
	188.6	180mm **TOPSOIL**				
	0.2	**FILL**, sandy silt, trace rootlets, loose, brown, moist		1	SS	7
	188.0					
1	0.8	**FILL**, silty sand, trace rootlets, very loose to loose, greyish brown, wet		2	SS	15
	187.3					
	1.5	**SILT**, trace to some clay, trace to some sand, trace oxidation, very loose to loose, brown, wet		3	SS	10
2				4	SS	6
3				5	SS	2
4				6	SS	1
5				7	SS	3
6	182.2					
	6.6	**END OF BOREHOLE**				

Elevation Scale (m): 188, 187, 186, 185, 184, 183

Penetration Test Values (Blows / 0.3m): Dynamic Cone; 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane; 40 80 120 160

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit; PL MC LL; 10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

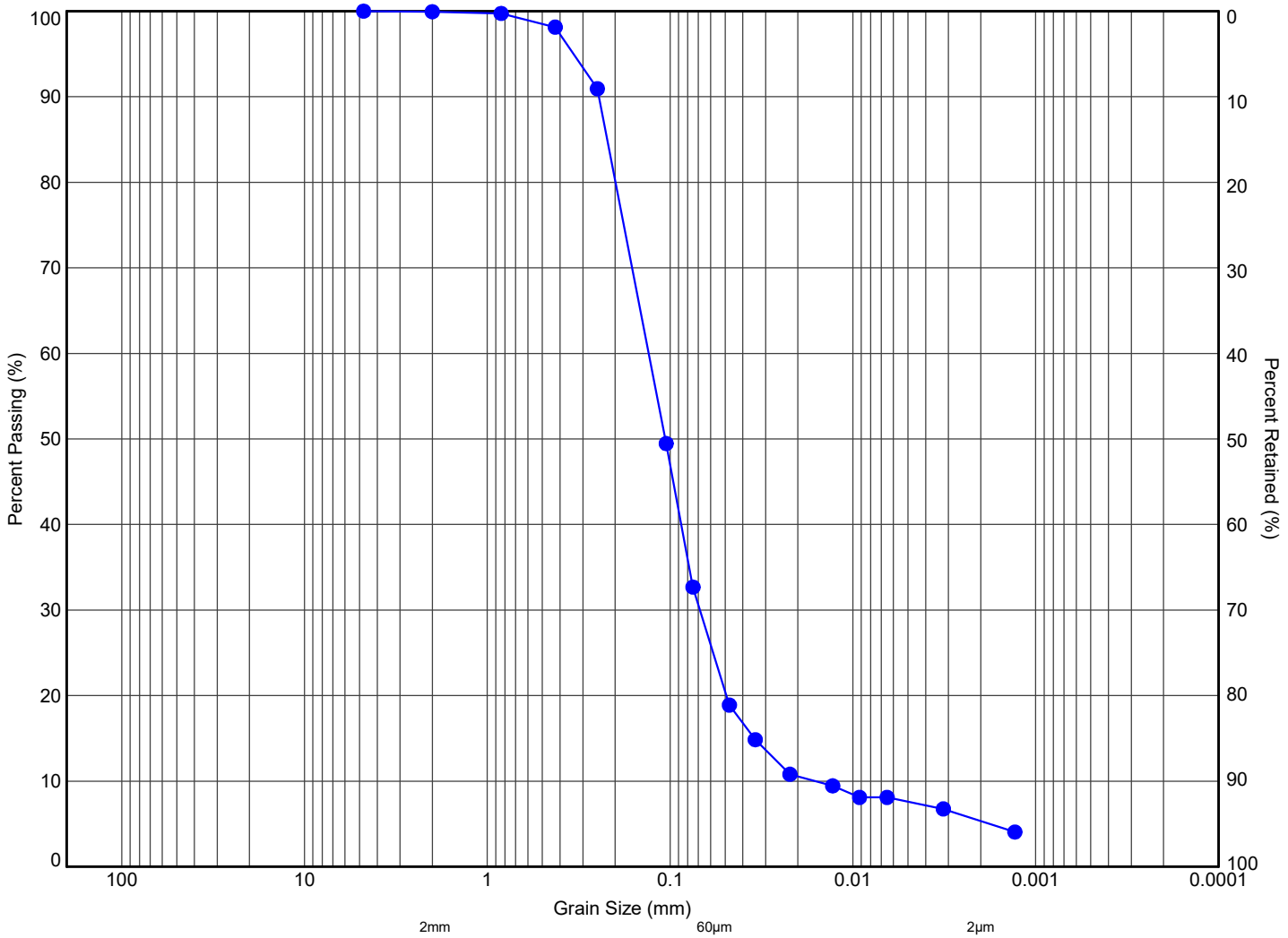
GR SA SI CL

0 15 68 17

Borehole was dry and open upon completion of drilling.

file: 02210643.000 bh logs.gpj

APPENDIX B



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

MIT SYSTEM

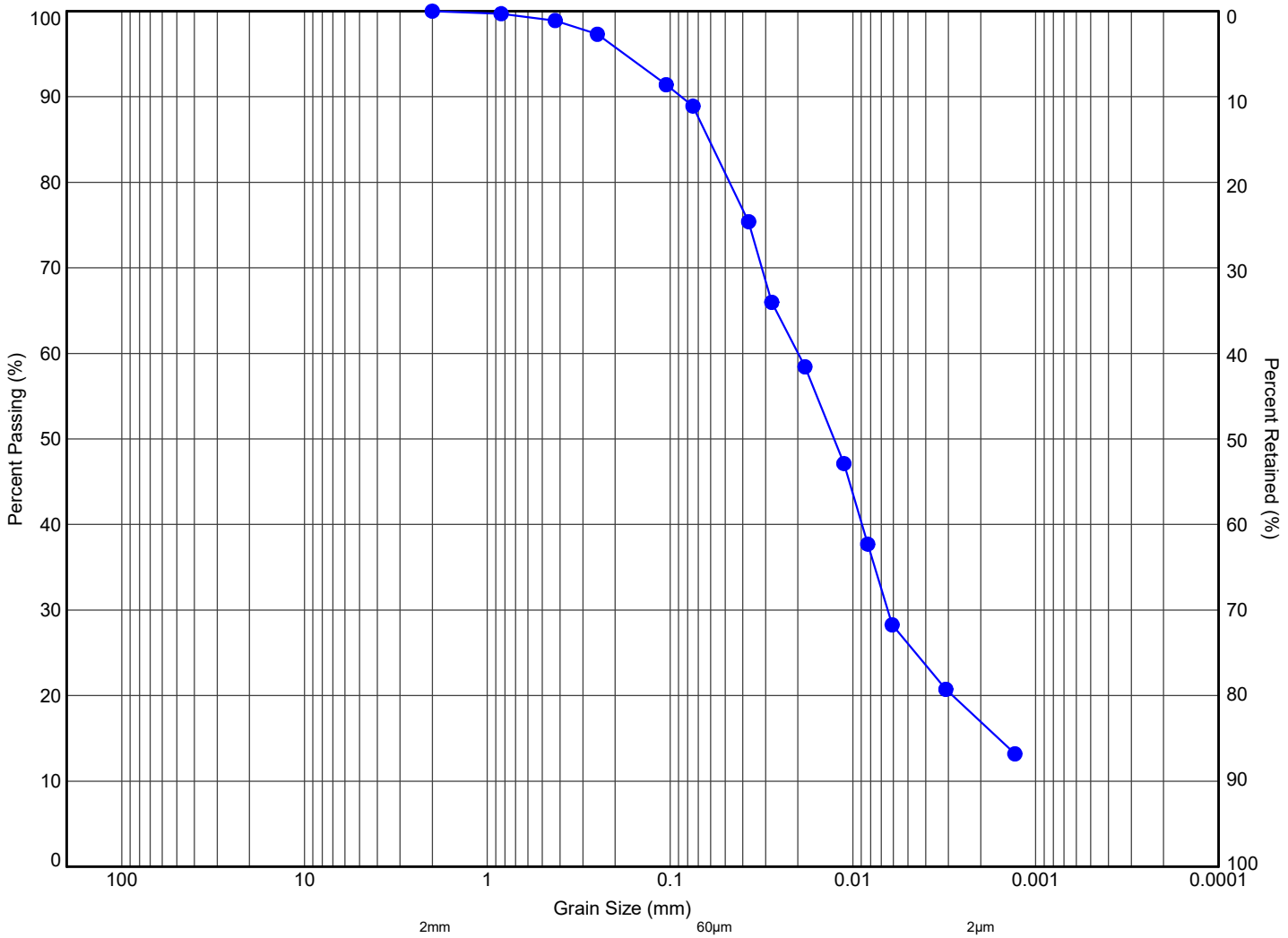
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**6**	SS6	4.8	183.4	0	74	21	5	

ENGLOBE

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title: **GRAIN SIZE DISTRIBUTION**
SILTY SAND, TRACE CLAY

File No.: **02210643.000**



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

MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**7**	SS4	2.5	186.3	0	15	68	17	

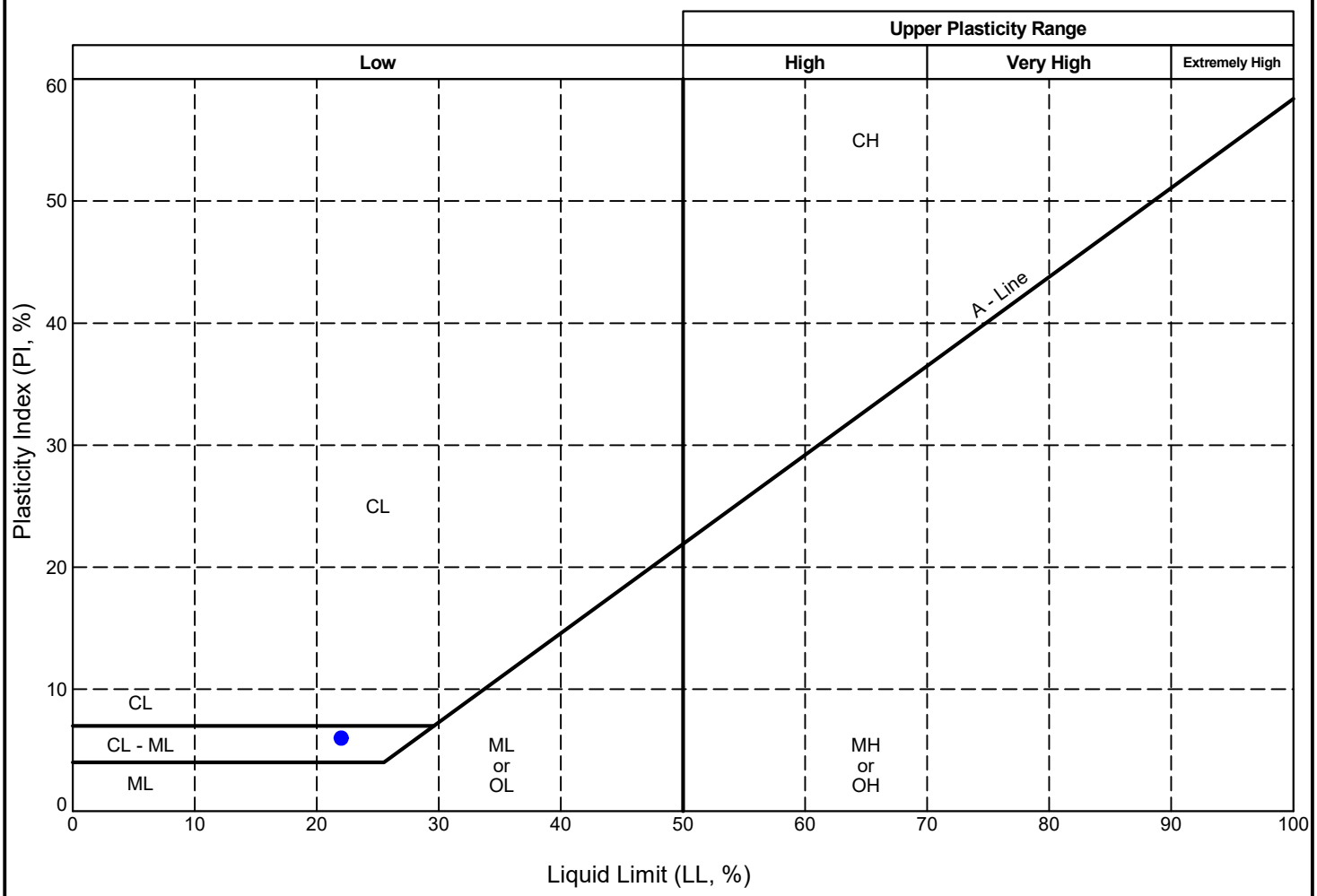
ENGLOBE

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SILT, SOME CLAY, SOME SAND

File No.: **02210643.000**



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)	Description
●	7	SS4	2.5	186.3	22	16	6	SLIGHTLY PLASTIC

ENGLOBE

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title: **ATTERBERG LIMITS CHART**

File No.: **02210643.000**