



Geotechnical Investigation Report – 240 County Road 4, Millhaven, Ontario

July 15, 2024

Prepared for:
The Corporation of Loyalist Township

Cambium Reference: 19697-001

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1.0 Introduction

Cambium Inc. (Cambium) was retained by The Corporation of Loyalist Township (Client) to complete a geotechnical investigation in support of the proposed development to be located at 240 County Road 4, Millhaven, Ontario (Site). The approximate Site location is shown on the attached Figure 1.

The geotechnical investigation was required to confirm the existing subsurface conditions, groundwater conditions, and soil parameters as input into the design and construction of the proposed development. Analysis from the geotechnical investigation, recommendations for the proposed developments, and relevant supporting documents are provided in the following sections and/or appended to this report.

1.1 Reviewed Documents

The following project documents were provided by the Client for Cambium to review during the preparation of this report:

[1] Bell + Associates Architecture – 3108 Carp Road, Ottawa, ON (K0A 1L0)

SITE PLAN – Project Name: 240 County Road 4, Bath, Ontario, Project #: 223-05c,
Drawing #: A.1, Revision Date: November 6, 2023.

1.2 Standards and Guidelines

Applicable standards, guidelines and other normative documents utilized in preparing geotechnical engineering recommendations for this report are provided below.

[2] Canadian Foundation Engineering Manual – 4th and 5th Edition; Canadian Geotechnical Society; 2006, 2023.



2.0 Site & Project Description

2.1 Site Description

The Site is bounded to the north and south by vacant undeveloped land, to the east by County Road 4, and to the west by Millhaven Creek and forested areas. The Site is currently occupied by an existing building, asphalt surfaced driving/parking areas, greenspace, and occasional vegetation (trees, bush along the south and east portion of the Site). It is Cambium's understanding that the Site is currently serviced by a private water well and septic system. The immediate investigation area limits were slightly variable between borehole locations but in general appeared to be relatively flat with a slight decrease in elevation towards the south.

2.2 Project Description

It is Cambium's understanding that the proposed development includes a building addition to the south elevation of the existing building on Site and a new single-storey administration building to be located east of the existing parking area. At the time of report preparation, additional information and detailed drawings related to the proposed building developments were not available; however, it is understood that the proposed buildings will not contain a basement level and it is assumed that the finished floor elevation of the building addition will match the finished floor elevation of the existing building.

The proposed development will also include expanded asphalt surfaced parking and driving areas, landscaped areas, and a new septic system and private water well.

In addition to the geotechnical investigation, hydrogeological and wastewater investigations were requested by the Client and will be completed by Cambium. Results and analysis from the hydrogeological and wastewater investigation are to be presented to the Client under a separate cover. Cambium recommends that, when available, the hydrogeological and wastewater reports be read in conjunction with the geotechnical investigation report to obtain a comprehensive understanding of the existing Site conditions and associated recommendations for the proposed development.



3.0 Methodology

3.1 Geotechnical Field Investigation

The geotechnical investigation was conducted at the Site by Cambium on April 12, 2024. A total of four sampled boreholes, designated as boreholes BH101-24 through BH104-24 were strategically placed and advanced within or nearby the proposed building footprints. The boreholes were advanced to depths ranging between approximately 4.3 and 5.2 mbgs where they were terminated within the natural subgrade soils. The approximate locations of the boreholes advanced are shown on the attached Figure 2.

Advancement and sampling of the boreholes was completed using a track-mounted drill rig operating under the direct supervision of an experienced Cambium technician. The boreholes were advanced to the sampling depths by means of continuous flight solid 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 sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. The SPT N values are used in this report to assess the in-situ relative density of the non-cohesive soil and to estimate the consistency of the cohesive soil. The encountered soil units were logged in the field using visual and tactile methods, and the obtained samples were placed in labelled plastic bags for transport, future reference, laboratory testing and storage.

Upon completion of drilling, the open boreholes were checked for groundwater and general stability prior to backfilling. All boreholes were backfilled with the soil cuttings and efforts were made to reinstate the property to pre-existing conditions.

The spatial location of each borehole was referenced locally by a Cambium technician using a Trimble Catalyst surveying unit. UTM coordinates and relative elevations are included on the borehole logs provided in Appendix A. The top of a private culvert was used as a temporary benchmark for the survey. The temporary benchmark was assigned an elevation of 200.00 m.REL and is shown as benchmark 'BM' on Figure 2.



Physical laboratory testing, consisting of three sieve analyses (LS-702) and two sieve and hydrometer analyses (LS-702, LS-705) was completed on selected soil samples to confirm textural classification and to assess geotechnical parameters. Moisture content testing was completed on all soil samples. Laboratory results are presented in Appendix B and are also discussed in Section 4.0.



4.0 Subsurface Conditions

The stratigraphy encountered in the boreholes is summarized on the attached borehole logs in Appendix A. It is noted that the conditions indicated on the borehole logs are for specific locations only and the soil conditions can vary between and beyond the borehole locations.

The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations made during the drilling process. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. In addition, the descriptions provided on the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself.

The subsurface conditions at the Site generally consisted of either surficial asphalt or surficial topsoil material generally underlain by mixtures of sand and silt that extended to the maximum borehole termination depth of approximately 5.2 mbgs.

4.1 Surface Soils

Topsoil was encountered at the surface of boreholes BH101-24 to BH103-24 and was measured to range in thickness from approximately 400 to 750 mm. Analysis of the organic content within the topsoil material was beyond the scope of this investigation.

Surficial asphalt was encountered within Borehole BH104-24 and was measured to be approximately 75 mm thick.

4.2 Granular Fill Materials

Underlying the surficial asphalt in borehole BH104-24, a granular fill material was encountered which consisted of a gravelly silty sand material that extended to approximately 0.4 mbgs. The granular fill material was brown in colour and moist at the time of sampling. The granular fill material had a compact relative density based on an SPT (N) value of 10 blows per 300 mm of penetration. Particle size distribution analysis was completed on one sample of the granular fill material and the results are summarized below in Table 1.



Table 1 Particle Size Distribution Analysis – Granular Fill Materials

Sample	Depth (mbgs)	Soil	Gravel (%)	Sand (%)	Silt (%) Clay (%)	Moisture (%)
BH104-24, SS1A	0.2 – 0.4	Gravelly Silty Sand	28	50	22	5.9

4.3 Subsurface Soils

Gravelly silty sand, gravelly silt and sand, sandy silty clay, and sand and silt soils were encountered underlying the granular fill materials or surficial topsoil in all boreholes and extended to the borehole termination depths.

The sandy silty clay was encountered in borehole BH103-24 underlying the surficial topsoil and extended to a depth of approximately 2.3 mbgs. The sandy silty clay typically contained some gravel, was brown in colour and was generally about the plastic limit ($w \approx PL$) at the time of sampling. The sandy silty clay soils had a soft to very stiff consistency based on SPT (N) values of 3 to 16 blows per 300 mm of penetration.

In the remaining boreholes, gravelly silty sand to gravelly silt and sand soils were encountered beneath the topsoil or granular fill and extended to depths ranging between approximately 3.1 and 4.3 mbgs. A sand and silt deposit containing some clay and some gravel was encountered within Boreholes BH101-24, BH103-24 and BH104-24 at depths ranging from approximately 2.3 to 4.0 mbgs. The gravelly silty sand, gravelly silt and sand, and sand and silt soils were generally brown to grey in colour with moisture contents ranging from 7.6 to 21.1%, indicating the material was moist at the time of sampling. The soils had a loose to very dense relative density based on SPT (N) values of 8 to greater than 50 blows per 300 mm of penetration.

Particle size distribution analyses were completed on four samples of the subsurface soils and the results are summarized below in Table 2.



Table 2 Particle Size Distribution Analysis – Silty Gravel and Sand Soils

Sample	Depth (mbgs)	Soil	Gravel (%)	Sand (%)	Silt (%) Clay (%)		Moisture (%)
BH101-24, SS3	1.5 – 2.1	Gravelly Silty Sand	22	56	22		10.4
BH102-24, SS2	0.8 – 1.4	Gravelly Silty Sand	30	51	19		13.0
BH103-24, SS2	0.8 – 1.4	Sandy Silty Clay some Gravel	6	20	26	48	26.2
BH103-24, SS6	4.0 – 4.6	Sand and Silt some Clay some Gravel	6	46	38	10	16.8

4.4 Groundwater

At drilling completion, standing water was observed within the open boreholes at depths ranging from approximately 0.2 to 2.6 mbgs. Cambium notes that a significant rainfall event was occurring during the geotechnical investigation; as such, it is noted that groundwater measurements may have been impacted by natural weather conditions and it is recommended that the hydrogeological report be consulted to verify stable groundwater levels throughout the Site.

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



5.0 Geotechnical Design Considerations

This section of the report provides engineering information on, and recommendations for, the geotechnical design aspects of the project based on our interpretation of the borehole information, laboratory test data, and our understanding of the project requirements. The information in this portion of the report is provided for planning and design purposes for the guidance of the design engineers and architects. Where comments are made on construction, they are provided only 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 independent interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing, and the like. Cambium will not assume any responsibility for construction-related decisions made by contractors based on this report.

In the Millhaven, Ontario area exterior foundations for buildings require a minimum of 1.5 m of soil cover for frost protection. As such, Cambium recommends that foundations for the proposed buildings be extended to the frost depth where they will be founded on undisturbed natural soil. Based on the results of the field investigation, potential bearing materials for the proposed buildings include silty sand soils (proposed administration building, borehole BH101-24, dense relative density between approximately 199.1 – 197.6 mREL) and sandy silty clay soils (proposed building addition, borehole BH103-24, very stiff consistency, between approximately 198.6 – 197.8 mREL). These soils are considered suitable to support the proposed building foundations.

5.1 Excavations

Excavations for the proposed development are expected to extend to approximately 1.5 mbgs for the proposed building foundations, and upwards of 2.5 mbgs for any proposed Site service trenches. All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA) and Ontario Regulation 213/91 (as amended).



Based on the OHSA, subsurface soils above the groundwater table can be considered Type 3 soils and excavation side slopes should be no steeper than 1 Horizontal (H) to 1 Vertical (V). Subsurface soils below the groundwater table may be considered Type 4 soils and excavation side slopes should be no steeper than 3 Horizontal (H) to 1 Vertical (V).

Excavation slopes should be protected during construction from precipitation, runoff, or snow/ice melt and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions or the excavation sidewalls must be fully supported (shored).

Stockpiles of excavated materials should be kept at least at the same distance as the excavation depth from the top edge of the excavation to prevent slope instability. Care should also be taken to avoid overloading of any existing underground services/structures by stockpiles and to ensure that foundations for the existing building are not undermined or damaged during excavation operations. In addition to compliance with the OHSA, the excavation procedures must also comply to any potential other regulatory authorities, such as federal and municipal safety standards.

5.1.1 Excavations Against Existing Foundations

Where the proposed addition is to be constructed against the existing building, Cambium recommends exposing sections of the existing footings to confirm the bearing material and structural capacity of the footings prior to finalizing the proposed designs. This can be completed during the excavation for the proposed addition foundations.

5.2 Dewatering

Based on the results of the geotechnical investigation, groundwater may be encountered during construction operations. Any patterns of groundwater flow were not recognized based on the borehole observations and the hydrogeological report should be consulted to better understand specific dewatering requirements throughout the Site.



Prior to commencing earthwork for the proposed development, it is critical that all existing surface water is controlled and diverted away from the Site. At no time should excavations be left open for a period of time that will expose them to precipitation and cause excavation sidewall softening. The groundwater inflow into the excavations should be relatively small and controlled by pumping from filtered sumps within the excavations. All collected water is to discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures, such as a silt fence should be installed at the discharge point of the dewatering system. The utmost care should be taken to avoid any potential impacts on the environment.

The Ministry of the Environment, Conservation and Parks (MECP) stipulate the requirements for Permit to Take Water (PTTW) approvals for construction related activities. Under the requirements, specific construction related water taking activities are eligible for Environmental Activity and Sector Registry (EASR). The trigger volume for EASR is water taking more than 50,000 litres/day. Volumes beyond 400,000 litres/day will require the application of a PTTW. This includes water that is collected from open excavations as well as precipitation and/or surface runoff that enters the excavation. It is the responsibility of the contractor to make this application if required.

5.3 Buried Utilities

5.3.1 Pipe Bedding and Cover Materials

Bedding and cover material for any services should conform to Ontario Provincial Standard Drawings (OPSD) 802.010 and 802.013 (flexible pipes) and OPSD 802.031 to 802.033 (rigid pipes). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98% SPMDD. The cover material shall extend a minimum of 300 mm above the top of the pipe and be compacted to a minimum of 98% of SPMDD, taking care not to damage the utility pipes during compaction. If bedding is being placed in wet conditions consideration should be given to using 19 mm crushed clear stone underlain by a geotextile (Terrafix 270R or similar).



5.3.2 Pipe Backfill

Above the pipe cover material, the pipe can be backfilled by re-using the excavated organic free natural soil matching the materials exposed on the sides of the trenches to provide soil compatibility and help minimize potential differential frost heave from the surrounding materials. The soil should be placed in maximum 300 mm thick lifts compacted to 98% SPMDD.

All stockpiled material should be protected from deleterious materials, additional moisture and be kept from freezing. Quality control will be the utmost importance when selecting the material. The selection of the material should be done as early in the contract as possible to allow sufficient time for gradation and proctor testing on representative samples to ensure it meets the projects specifications.

5.3.3 Frost Protection

The frost penetration depth in Millhaven, Ontario is estimated to extend to approximately 1.5 mbgs in open roadways cleared of snow. As such, it is recommended to place water services at a minimum depth of 300 mm below this elevation with the top of the pipe located at 1.8 mbgs or lower as dictated by municipal service requirements. If a minimum of 1.8 m of soil cover cannot be provided, then the pipe should be insulated with a rigid polystyrene insulation (DOW Styrofoam HI40, or equivalent) or a pre-insulated pipe be utilized.

The insulation design configuration may either consist of placing horizontal insulation to a specified design distance beyond the outside edge of the pipe or an inverted “U” surrounding the top and sides of the pipe. Any method chosen requires suitable design and installation in accordance with the manufacture’s recommendations. To accommodate the placement of horizontal insulation a wider excavation trench may be required.

5.4 Foundation Design

Conventional shallow strip and spread footings founded on either the natural silty sand or sandy silty clay soils encountered approximately 1.5 mbgs may be sized using a bearing resistance for 25 mm of settlement at Serviceability Limit States (SLS) of 150 kPa and a



factored geotechnical resistance at ULS of 225 kPa. Cambium should be contacted to review site grading and foundation drawings to confirm the bearing resistances and/or revise if necessary.

Under no circumstances will the foundations be placed directly on organic materials, loose, frozen subgrade, construction debris, or within ponded water.

It is noted that there is a potential for weaker subgrade soil to be encountered between the investigation locations, specifically within the vicinity of Boreholes BH103-24 and BH104-24. As such, the quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm the recommended bearing resistances. Cambium assumes that any potential areas of weaker subgrade soil will consist of small pockets of soft/loose natural soil which can be compacted to match the density of the remainder of the Site. As such, prior to placing foundation formwork the subgrade material must be compacted to a minimum of 100% Standard Proctor Maximum Dry Density (SPMDD). Any soft/loose areas which are not able to achieve the recommended 100% SPMDD are to be sub excavated and replaced with approved engineered fill compacted to a minimum of 100% SPMDD.

5.5 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”. The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the OBC (2012). The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (V_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (S_u) or penetration resistances (N_{60} values).

Based on the explored soil properties and in accordance with Table 4.1.8.4.A, it is recommended that Site Class “D” be used for the proposed building design. A Site Class D has an average shear wave velocity of between 180 and 360 m/s.



5.6 Foundation Frost Penetration and Foundation Backfill

Based on climate data and design charts, the maximum frost penetration depth for the Millhaven, Ontario area is estimated at 1.5 mbgs. As such, exterior footings for the proposed buildings should be provided with a minimum of 1.5 m of soil cover for frost protection or should be appropriately protected with a combination of rigid insulation and soil cover.

Foundation wall backfill should consist of free-draining imported granular material such as OPSS 1010 Granular B, or approved equivalent. Backfill should be placed in lifts not exceeding 200 mm in thickness and compacted to 100% of the SPMDD. Placement of engineered fill should be verified by onsite compaction testing during construction. The natural subgrade soil encountered within the boreholes is generally not considered suitable as foundation wall backfill, however, additional testing of stockpiled materials is recommended to confirm suitability prior to any re-use, if desired.

5.7 Building Drainage

The exterior grades around the proposed building should be sloped from the walls to direct surface runoff away from the buildings at a minimum 2% grade. Roof drains should discharge a minimum of 1.5 m away from the building to appropriate drainage areas.

5.8 Slab on Grade Design

Based on the results of the geotechnical investigation, the floor slabs should be supported on compacted engineered fill such as material meeting OPSS 1010 Granular A or B Type II.

The deflections and the resulting forces and bending moments in the slab to be used in its structural design could be determined by structural analysis using a modulus of subgrade reaction, K_v , for the subgrade. However, the modulus of subgrade reaction is not a fundamental soil property, and its value depends, in part, on the size and shape of the slab. For the analysis of the contact stress distribution beneath a slab, its value would depend on the size of the areas over which increased/concentrated contact stresses are anticipated; the size of these areas is in turn related to the value the modulus of subgrade reaction. Accordingly, the analysis of the slab should involve an iterative analysis between the



determination of the contact stress distribution by the structural engineer and the geotechnical determination of the modulus of subgrade reaction value, until these two are consistent with each other. For initial analyses, the moduli of subgrade reaction appropriate for slab on grade design on the soils at the site are as follows:

- Engineered Fill: 75,000 kPa/m
- Native Silty/Sandy Soil: 25,000 kPa/m
- Native Silty/Clayey Soil: 15,000 kPa/m

All organic material and disturbed materials must be removed prior to constructing the slab on grade. These materials do not constitute an adequate subgrade for support of a slab on grade. The subgrade for the slab must be cut-neat, proof rolled, and inspected by Cambium, prior to the placement of an aggregate base. The subgrade should be proof rolled using a static smooth drum roller. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of deleterious/organic material or moisture, they must be locally sub-excavated and backfilled with approved clean earth fill or engineered fill such as OPSS Granular B (Type I or II) and compacted to a minimum 98% of SPMDD.

Any interior areas that may be exposed to freezing conditions for extended periods of time, such as by garage doors that may be left open during the winter. The floor slab may be susceptible to frost heaving, depending on the thickness of the granular supporting structure. The subgrade underlying these areas should be adequately insulated to prevent frost penetration. Frost protection can be provided using approved polystyrene insulation.

It is necessary that the slab be provided with a capillary moisture barrier and drainage layer. This is made by placing the slab on a minimum 200 mm layer of 19 mm diameter crushed clear stone and nominally compacted by vibration to a dense state. A geotextile separator (Terrafix 270R or equivalent) is recommended between the granular material/clear stone and the native subgrade soils.



5.9 Pavement Design for Driveway and Parking Areas

The performance of the pavement is dependent upon proper subgrade preparation. All topsoil and organic materials should be removed down to the native subgrade material. The subgrade should be proof rolled and inspected by a Geotechnical Engineer and any areas where rutting or appreciable deflection is noted should be sub-excavated and replaced with suitable fill in accordance with the recommendations in this report. The recommended pavement structure should meet the municipal standards for parking and driving areas and should, as a minimum, consist of the pavement layers identified in Table 3. For the proposed parking lot and driveway expansion, the Light Duty options would be considered suitable.

Table 3 Recommended Pavement Structure

Pavement Layer	Light Duty	Heavy Duty
Surface Course Asphalt	40 mm HL3	40 mm HL3
Binder Course Asphalt	50 mm HL8	50 mm HL8
Granular Base	150 mm OPSS 1010 Granular A	150 mm OPSS 1010 Granular A
Granular Subbase	300 mm OPSS 1010 Granular B Type I or II	450 mm of OPSS Granular B Type I or II

Material and thickness substitutions must be approved by the Design Engineer. Compaction of the subgrade should be verified by an engineering consultant prior to placing the granular fill. Granular layers should be placed in maximum 150 mm thick lifts and compacted to at least 100% of the SPMDD. The final asphalt surface should be sloped at a minimum of 2% to shed water runoff away from the building. Abutting pavements should be sawcut to provide clean vertical joints with new pavement areas.



6.0 Design Review and Inspections

Testing and inspections should be carried out during construction operations to examine and approve subgrade conditions, fill material, compaction of pipe bedding, trench backfill, granular base courses, and asphaltic concrete.

Cambium should be contacted to review and approve design drawings, prior to tendering or commencing construction, to ensure that all pertinent geotechnical-related factors have been addressed. It is important that onsite geotechnical supervision be provided at this site for excavation and backfill procedures, deleterious soil removal, subgrade inspections and compaction testing.



7.0 Closing

Please note that this work program and report are governed by the attached Qualifications and Limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (613) 389-2323.

Respectfully submitted,

Cambium Inc.

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8.0 Standard Limitations

Limited Warranty

In performing work on behalf of a client, Cambium relies on its client to provide instructions on the scope of its retainer, and, on that basis, Cambium determines the precise nature of the work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards. Unless required under local laws, other than as expressly stated herein, no other warranties or conditions, either expressed or implied, are made regarding the services, work or reports provided.

Reliance on Materials and Information

The findings and results presented in reports prepared by Cambium are based on the materials and information provided by the client to Cambium and on the facts, conditions and circumstances encountered by Cambium during the performance of the work requested by the client. In formulating its findings and results into a report, Cambium assumes that the information and materials provided by the client or obtained by Cambium from the client or otherwise are factual, accurate and represent a true depiction of the circumstances that exist. Cambium relies on its client to inform Cambium if there are changes to any such information and materials. Cambium does not review, analyze, or attempt to verify the accuracy or completeness of the information or materials provided, or circumstances encountered, other than in accordance with applicable accepted industry practice. Cambium will not be responsible for matters arising from incomplete, incorrect, or misleading information or from facts or circumstances that are not fully disclosed to or that are concealed from Cambium during the provision of services, work, or reports.

Facts, conditions, information, and circumstances may vary with time and locations and Cambium's work is based on a review of such matters as they existed at the particular time and location indicated in its reports. No assurance is made by Cambium that the facts, conditions, information, circumstances, or any underlying assumptions made by Cambium in connection with the work performed will not change after the work is completed and a report is submitted. If any such changes occur or additional information is obtained, Cambium should be advised and requested to consider if the changes or additional information affect its findings or results.

When preparing reports, Cambium considers applicable legislation, regulations, governmental guidelines, and policies to the extent they are within its knowledge, but Cambium is not qualified to advise with respect to legal matters. The presentation of information regarding applicable legislation, regulations, governmental guidelines, and policies is for information only and is not intended to and should not be interpreted as constituting a legal opinion concerning the work completed or conditions outlined in a report. All legal matters should be reviewed and considered by an appropriately qualified legal practitioner.

Site Assessments

A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work or report considers any locations or times other than those from which information, sample results and data was specifically received, the work or report is based on a reasonable extrapolation from such information, sample results and data but the actual conditions encountered may vary from those extrapolations.

Only conditions at the site and locations chosen for study by the client are evaluated; no adjacent or other properties are evaluated unless specifically requested by the client. Any physical or other aspects of the site chosen for study by the client, or any other matter not specifically addressed in a report prepared by Cambium, are beyond the scope of the work performed by Cambium and such matters have not been investigated or addressed.

Reliance

Cambium's services, work and reports may be relied on by the client and its corporate directors and officers, employees, and professional advisors. Cambium is not responsible for the use of its work or reports by any other party, or for the reliance on, or for any decision which is made by any party using the services or work performed by or a report prepared by Cambium without Cambium's express written consent. Any party that relies on services or work performed by Cambium or a report prepared by Cambium without Cambium's express written consent, does so at its own risk. No report of Cambium may be disclosed or referred to in any public document without Cambium's express prior written consent. Cambium specifically disclaims any liability or responsibility to any such party for any loss, damage, expense, fine, penalty or other such thing which may arise or result from the use of any information, recommendation or other matter arising from the services, work or reports provided by Cambium.

Limitation of Liability

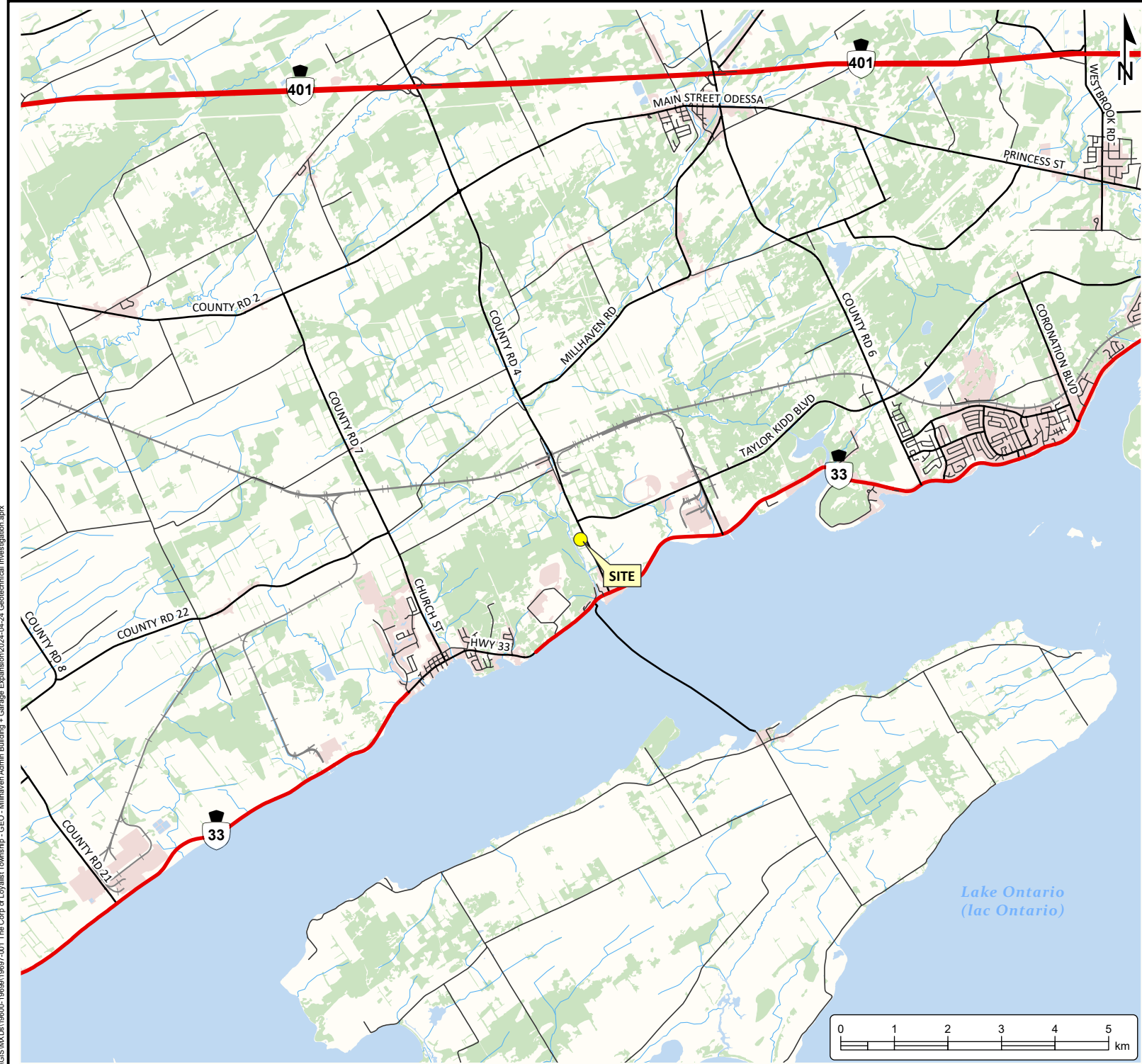
Potential liability to the client arising out of the report is limited to the amount of Cambium's professional liability insurance coverage. Cambium shall only be liable for direct damages to the extent caused by Cambium's negligence and/or breach of contract. Cambium shall not be liable for consequential damages.

Personal Liability

The client expressly agrees that Cambium employees shall have no personal liability to the client with respect to a claim, whether in contract, tort and/or other cause of action in law. Furthermore, the client agrees that it will bring no proceedings nor take any action in any court of law against Cambium employees in their personal capacity.



Appended Figures



**GEOTECHNICAL
INVESTIGATION**
THE CORPORATION OF
LOYALIST TOWNSHIP
240 County Road 4
Millhaven, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Water Area
- Wooded Area
- Built Up Area

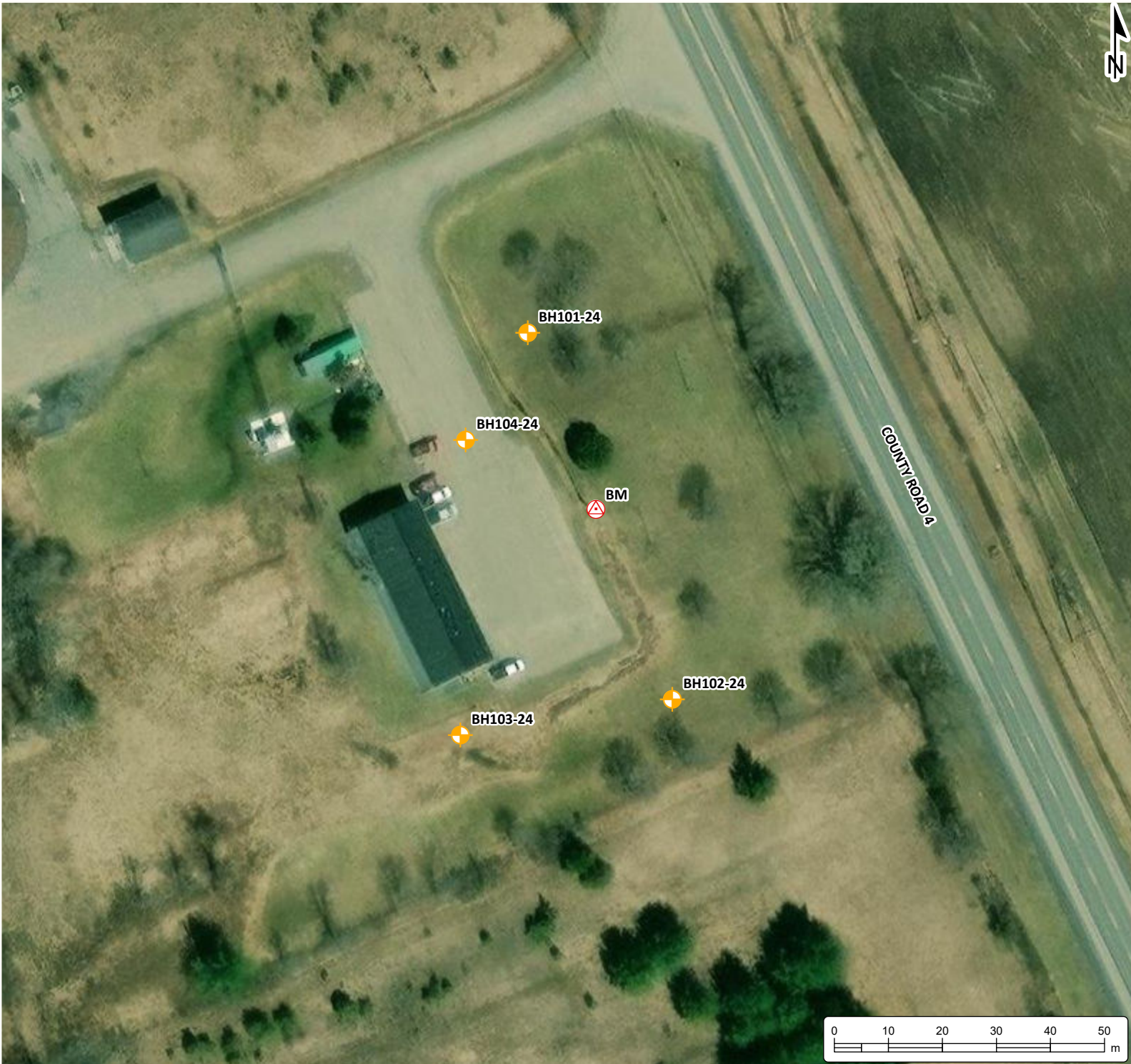
Notes:
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- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.



194 Sophia Street
Peterborough, Ontario, K9H 1E5
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www.cambium-inc.com

SITE LOCATION PLAN

Project No.: 19697-001	Date: July 2024
Scale: 1:100,000	Rev.: Rev.
Created by: TLC	Checked by: WT
Figure: 1	



**GEOTECHNICAL
INVESTIGATION**
THE CORPORATION OF
LOYALIST TOWNSHIP
240 County Road 4
Millhaven, Ontario

LEGEND

-  Benchmark
-  Borehole

Notes:
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BOREHOLE LOCATION PLAN

Project No.: 19697-001		Date: July 2024	
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 18N	
Created by: TLC	Checked by: WT	Figure: 2	



Appendix A
Borehole Logs

Project Name: Geotechnical Investigation

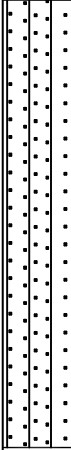
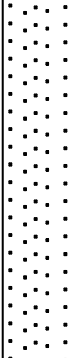
Log of Borehole: BH101-24

Page: 1 of 1

Elevation: 200.64 mREL

Date Completed: April 12, 2024

Location: 240 County Rd 4, Millhaven, ON **UTM:** 18T **N:** 4896083 **E:** 360592

SUBSURFACE PROFILE				SAMPLE																
Elevation (m)	Depth	Lithology	Description	Elevation Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)			Shear Strength Cu, kPa				Well Installation	Log Notes			
									LL	PL	PI	nat V. rem V.	20	40	60			80		
																			25	50
									% Moisture			SPT (N)								
									25	50	75	20	40	60	80					
200.6	0		TOPSOIL: 400 mm	200.23	1A	SS	85	6	29.6%					6						
200.1	0.5		(SM) gravelly SILTY SAND: brown, moist, loose	0.41	1B	SS			16.8%											
			becomes dense		2A	SS			17%											
199.6	1		increase in gravel content		2B	SS	75	46	7.6%						46					
199.1	1.5		decrease in gravel content		3	SS	75	43	10.4%						43					
198.6	2																			
198.1	2.5				4	SS	100	38	13.1%						38					
197.6	3		(SP) SAND and SILT: grey, moist, very dense, some clay, some gravel	197.59	5	SS	100	59	11.3%						59					
197.1	3.5																			
196.6	4																			
196.1	4.5																			
195.6	5				6	SS	100	88	9.2%						88					
				195.46																
195.1	5.5		Borehole terminated @ 5.2 mbgs within sand and silt.	5.18																
194.6	6																			
194.1	6.5																			
193.6	7																			
193.1																				
									GRAINSIZE DISTRIBUTION		SAMPLE		GRAVEL		SAND		SILT		CLAY	
											SS3		22		56		22			

Peterborough, Barrie, Whitby, Kingston, Ottawa



The Corporation of
Client: Loyalist Township

Project Name: Geotechnical Investigation

Contractor: Canadian Environmental Drilling

Method: Track Mounted Solid Stem Auger

Project No.: 19697-001

Elevation: 200.26 mREL

Location: 240 County Rd 4, Millhaven, ON

UTM: 18T **N:** 4896015 **E:** 360619

Log of Borehole: BH102-24

Page: 1 of 1

Date Completed: April 12, 2024

SUBSURFACE PROFILE					SAMPLE														
Elevation (m)	Depth	Lithology	Description	Elevation Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)			Shear Strength Cu, kPa			Well Installation	Log Notes			
									LL	PL	PI	nat V. rem V.	20	40			60	80	
									25	50	75	% Moisture	20	40			60	80	
200.3	0		TOPSOIL: 750 mm		1	SS	100	2											
199.8	0.5																		
199.3	1		(SM) gravelly SILTY SAND: brown, moist, compact		2	SS	85	13											
198.8	1.5																		
198.3	2																		
197.8	2.5		becomes dense, increase in silt content		4	SS	100	35											
197.3	3																		
196.8	3.5		increase in gravel content		5	SS	90	31											
196.3	4																		
195.8	4.5		becomes very dense		6	SS	100	50											
195.3	5	Borehole terminated @ 4.3 mbgs within gravelly silty sand.																	
194.8	5.5																		
194.3	6																		
193.8	6.5																		
193.3	7																		
192.8																			
															GRAINSIZE DISTRIBUTION				
															SAMPLE	GRAVEL	SAND	SILT	CLAY
															SS2	30	51	19	

Project Name: Geotechnical Investigation

Contractor: Canadian Environmental Drilling **Method:** Track Mounted Solid Stem Auger

Page: 1 of 1

Project No.: 19697-001

Elevation: 200.08 mREL

Date Completed: April 12, 2024

Location: 240 County Rd 4, Millhaven, ON **UTM:** 18T **N:** 4896009 **E:** 360580

SUBSURFACE PROFILE				SAMPLE																														
Elevation (m)	Depth	Lithology	Description	Elevation Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)			Shear Strength Cu, kPa				Well Installation	Log Notes																	
									LL	PL	PI	20	40	60	80																			
									25	50	75	nat V. rem V.	6																					
									% Moisture			SPT (N)																						
									25	50	75	20	40	60	80																			
200.1	0		TOPSOIL: 750 mm		1	SS	25	1	27.1%			1																						
199.6	0.5			199.32																														
199.1	1		(CI) sandy SILTY CLAY: brown, w~PL, soft, some gravel	0.76	2	SS	100	3	26.2%			3																						
198.6	1.5		becomes very stiff																															
198.1	2				3	SS	75	16	33%			16																						
197.6	2.5		(SP) SAND and SILT: brown, moist, compact, some clay, some gravel	2.29	4	SS	80	11	12.2%			11																						
197.1	3																																	
196.6	3.5				5	SS	100	17	16.6%			17																						
196.1	4		becomes grey, very dense, increase in silt content																															
195.6	4.5		Borehole terminated @ 4.6 mbgs within sand and silt.	4.57	6	SS	100	58	16.8%			58																						
195.1	5																																	
194.6	5.5																																	
194.1	6																																	
193.6	6.5																																	
193.1	7																																	
192.6																																		
										GRAINSIZE DISTRIBUTION					<table><tr><td>SAMPLE</td><td>GRAVEL</td><td>SAND</td><td>SILT</td><td>CLAY</td></tr><tr><td>SS2</td><td>6</td><td>20</td><td>26</td><td>48</td></tr><tr><td>SS6</td><td>6</td><td>46</td><td>38</td><td>10</td></tr></table>					SAMPLE	GRAVEL	SAND	SILT	CLAY	SS2	6	20	26	48	SS6	6	46	38	10
SAMPLE	GRAVEL	SAND	SILT	CLAY																														
SS2	6	20	26	48																														
SS6	6	46	38	10																														

Peterborough, Barrie, Whitby, Kingston, Ottawa



The Corporation of
Client: Loyalist Township
Contractor: Canadian Environmental Drilling
Project No.: 19697-001
Location: 240 County Rd 4, Millhaven, ON

Project Name: Geotechnical Investigation
Method: Track Mounted Solid Stem Auger
Elevation: 200.58 mREL
UTM: 18T **N:** 4896063 **E:** 360581

Log of Borehole: BH104-24
Page: 1 of 1
Date Completed: April 12, 2024

SUBSURFACE PROFILE					SAMPLE												
Elevation (m)	Depth	Lithology	Description	Elevation Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)			Shear Strength Cu, kPa			Well Installation	Log Notes	
									LL	PL	PI	20	40	60			80
												% Moisture					SPT (N)
									25 50 75			20 40 60 80					
200.6	0		ASPHALT: 75 mm	200.50													
			(SM) gravelly SILTY SAND: brown, moist, compact [FILL]	200.22	1A	SS				5.9%					10		
200.1	0.5		(ML) gravelly SILT and SAND: brown, moist, compact	200.22	1B	SS	60	10		15.6%							
				0.36													
199.6	1																
						2	SS	75	11		20%				11		
199.1	1.5																
198.6	2		(SM) gravelly SILTY SAND: brown, moist, loose	198.90	3	SS	65	8		18.4%					8		
				1.68													
198.1	2.5																
			becomes compact		4	SS	100	13		21.1%				13			
197.6	3																
197.1	3.5		increase in gravel content		5	SS	100	27		13.2%				27			
196.6	4		(SP) SAND and SILT: brown-grey, moist, very dense, some clay, some gravel	196.62	6	SS	100	80		12.8%				80			
				3.96													
196.1	4.5		Borehole terminated @ 4.6 mbgs within sand and silt.	196.01													
				4.57													
195.6	5																
195.1	5.5																
194.6	6																
194.1	6.5																
193.6	7																
193.1																	

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
1A	28	50	22	

Borehole casing
observed at 3.5 mbgs.
Standing water
observed at 2.1 mbgs.



Geotechnical Investigation Report – 240 County Road 4, Millhaven, Ontario
The Corporation of Loyalist Township
Cambium Reference: 19697-001
July 15, 2024

Appendix B

Physical Laboratory Results



Grain Size Distribution Chart

Project Number: 19697-001

Client: The Corporation of Loyalist Township

Project Name: Millhaven Admin Building + Garage Expansion

Sample Date: April 12, 2024

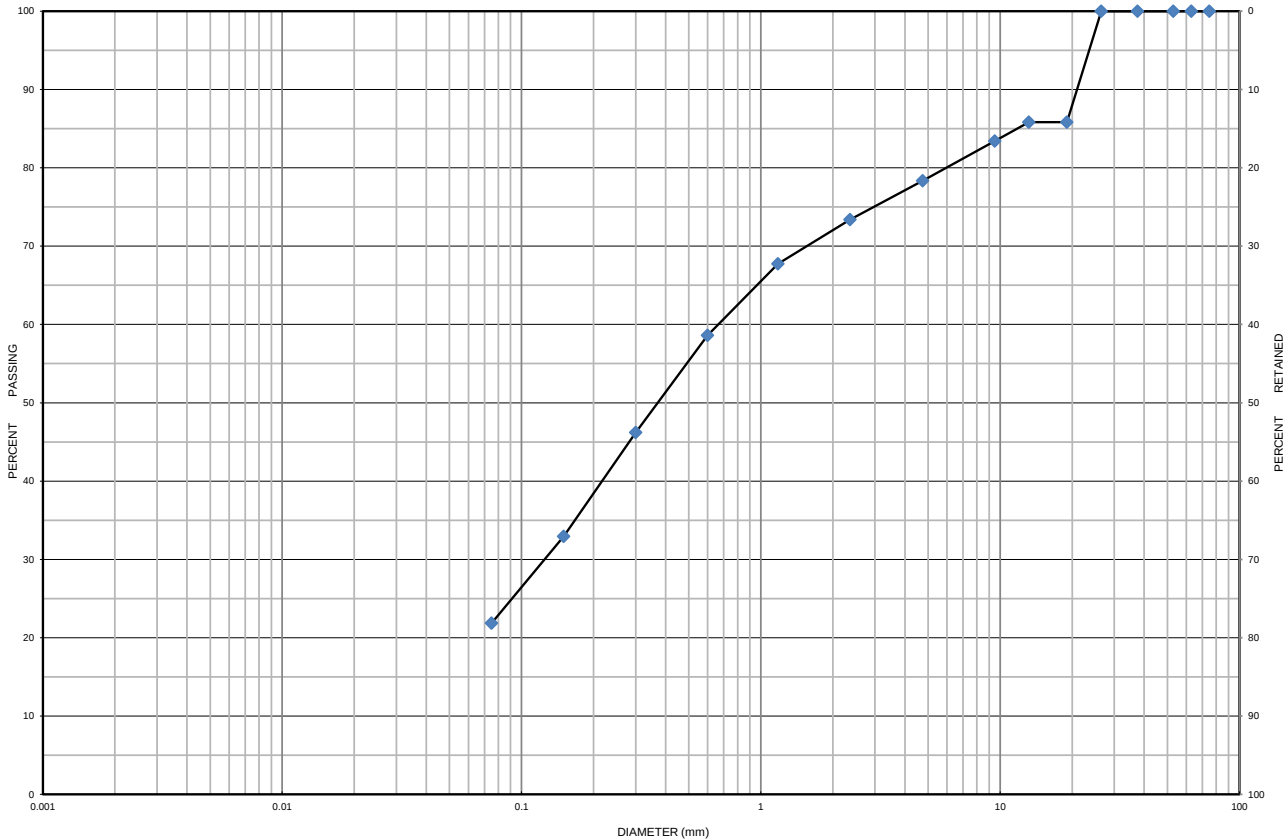
Sampled By: Samuel Makinde - Cambium Inc.

Location: BH 101-24 SS 3

Depth: 1.5 m to 2.1 m

Lab Sample No: S-24-0751

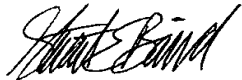
UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-24	SS 3	1.5 m to 2.1 m	22	56	22		10.4
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Silty Sand		SM	0.660	0.135	-	-	-

Additional information available upon request

Issued By: 
(Senior Project Manager)

Date Issued: April 29, 2024



Grain Size Distribution Chart

Project Number:

19697-001

Client:

The Corporation of Loyalist Township

Project Name:

Millhaven Admin Building + Garage Expansion

Sample Date:

April 12, 2024

Sampled By:

Samuel Makinde - Cambium Inc.

Location:

BH 102-24 SS 2

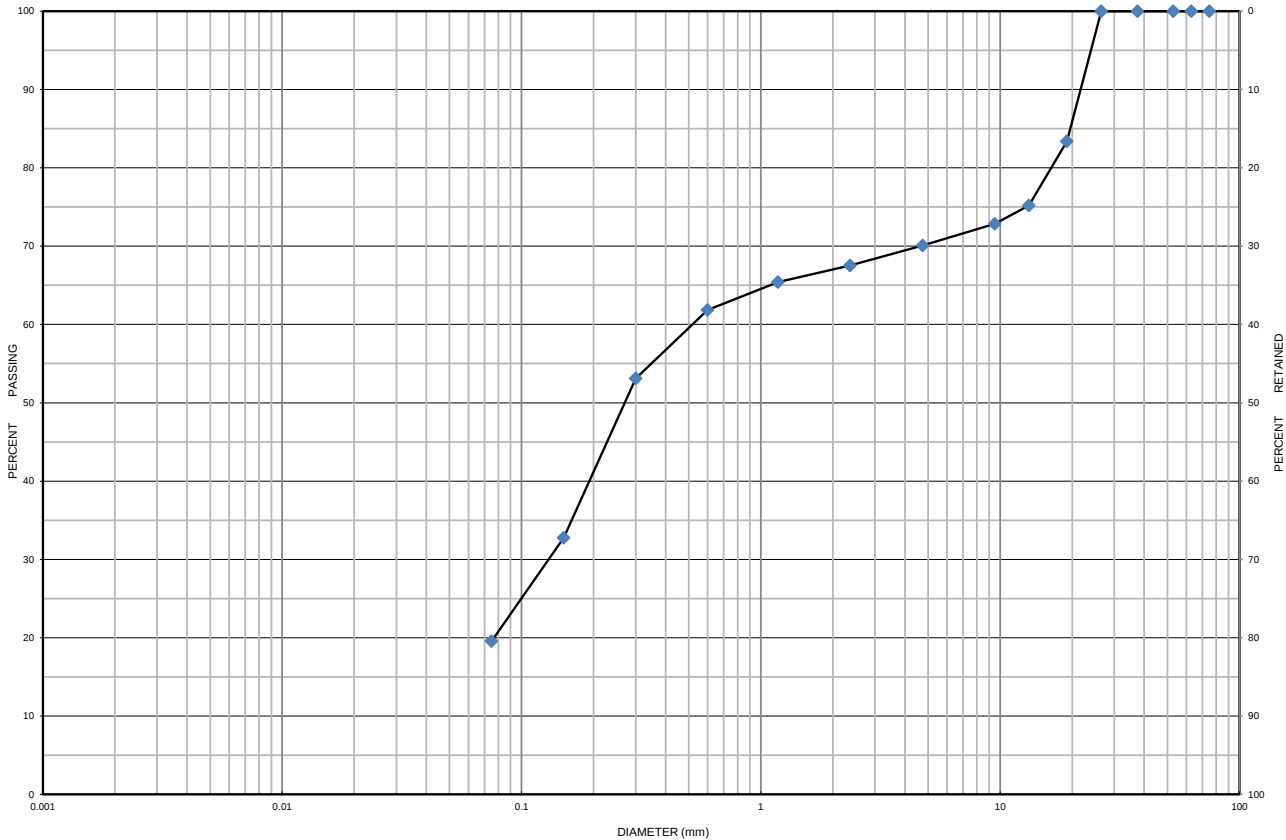
Depth:

0.8 m to 1.4 m

Lab Sample No:

S-24-0752

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-24	SS 2	0.8 m to 1.4 m	30	51	19		13.0
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Sand some Silt		SM	0.510	0.140	-	-	-

Additional information available upon request

Issued By:

(Senior Project Manager)

Date Issued:

April 29, 2024



Grain Size Distribution Chart

Project Number: 19697-001

Client: The Corporation of Loyalist Township

Project Name: Millhaven Admin Building + Garage Expansion

Sample Date: April 12, 2024

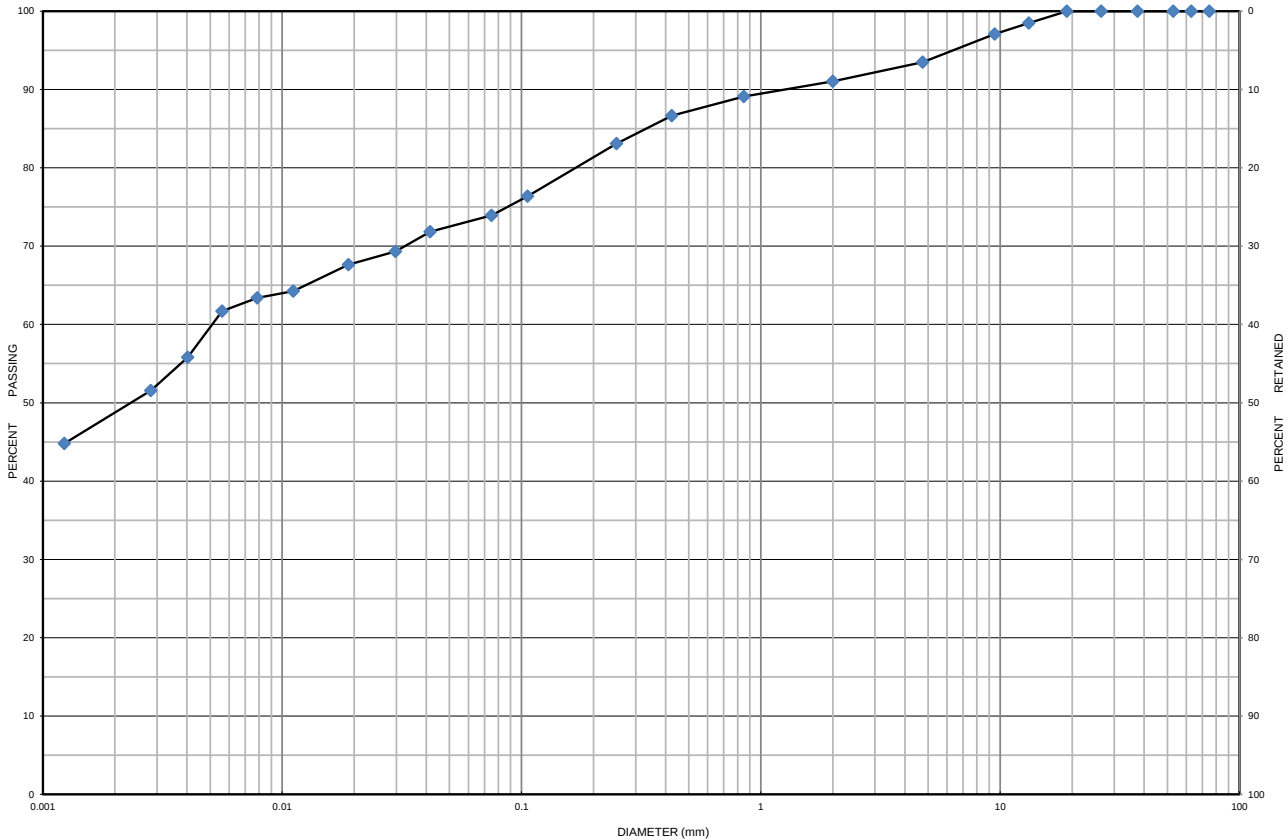
Sampled By: Samuel Makinde - Cambium Inc.

Location: BH 103-24 SS 2

Depth: 0.8 m to 1.4 m

Lab Sample No: S-24-0755

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-24	SS 2	0.8 m to 1.4 m	6	20	26	48	26.2
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sandy Clay trace Gravel		CL	0.0052	-	-	-	-

Additional information available upon request

Issued By: 
(Senior Project Manager)

Date Issued: April 29, 2024



Grain Size Distribution Chart

Project Number:

19697-001

Client:

The Corporation of Loyalist Township

Project Name:

Millhaven Admin Building + Garage Expansion

Sample Date:

April 12, 2024

Sampled By:

Samuel Makinde - Cambium Inc.

Location:

BH 103-24 SS 6

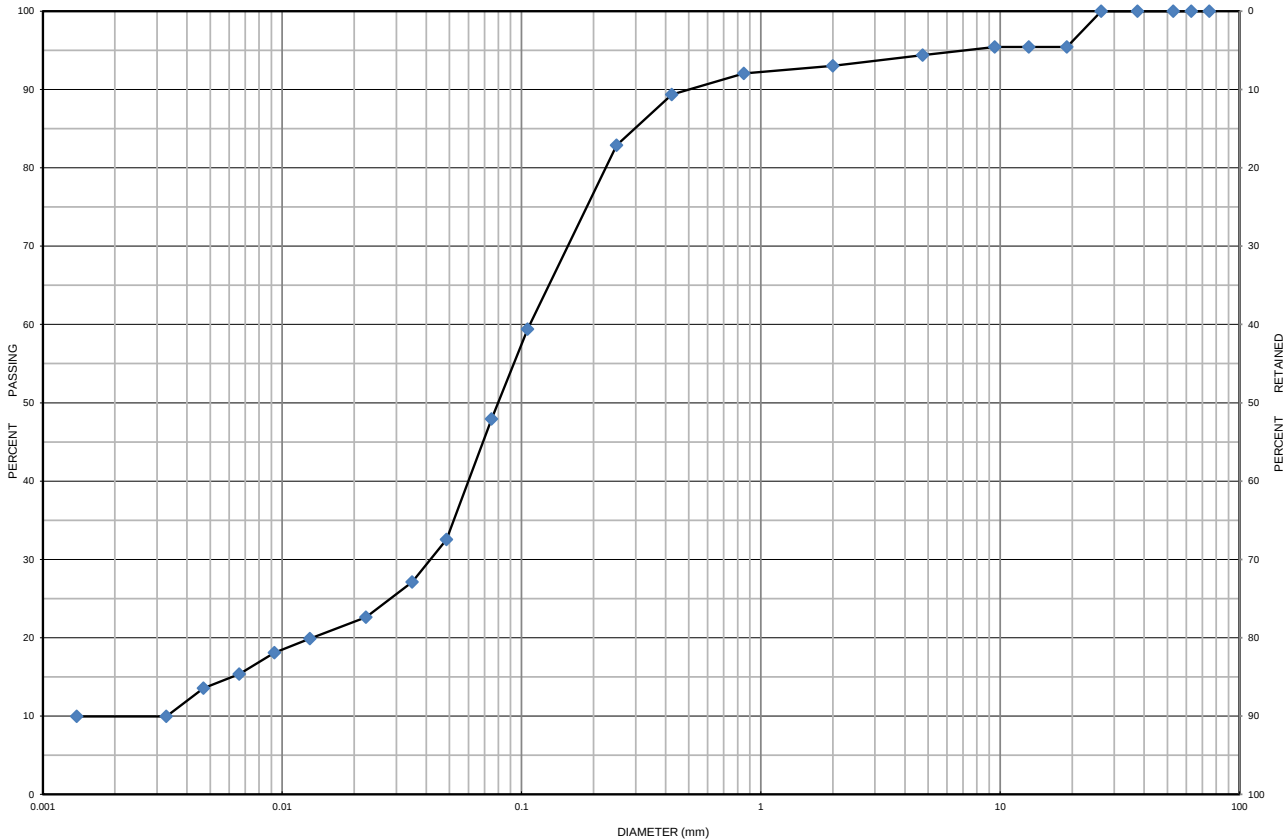
Depth:

4 m to 4.6 m

Lab Sample No:

S-24-0753

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-24	SS 6	4 m to 4.6 m	6	46	38	10	16.8
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand and Silt some Clay trace Gravel		SM	0.1150	0.0120	0.0015	76.67	0.83

Additional information available upon request

Issued By: 
(Senior Project Manager)

Date Issued: April 29, 2024



Grain Size Distribution Chart

Project Number:

19697-001

Client:

The Corporation of Loyalist Township

Project Name:

Millhaven Admin Building + Garage Expansion

Sample Date:

April 12, 2024

Sampled By:

Samuel Makinde - Cambium Inc.

Location:

BH 104-24 SS 1A

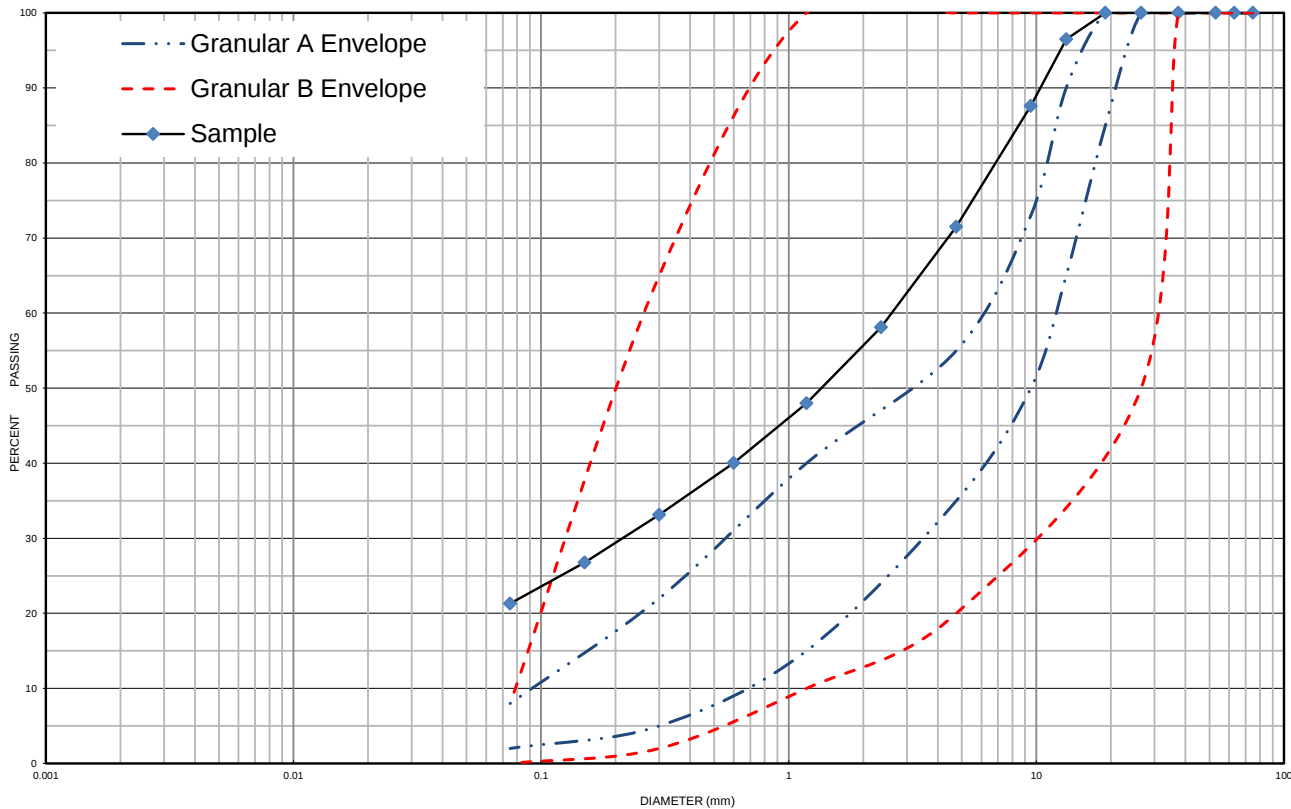
Depth:

0.2 m to 0.4 m

Lab Sample No:

S-24-0754

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 104-24	SS 1A	0.2 m to 0.4 m	28	50	22		5.9
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Silty Sand		SM	2.600	0.220	-	-	-

Additional information available upon request

Issued By:


(Senior Project Manager)

Date Issued:

April 29, 2024



Moisture Content



Project Number:

19697-001

Lab Number:

S-24-0750

Project Name:

Millhaven Admin Building + Garage Expansion

Date Tested:

2024-04-23

Client:

The Corporation of Loyalist Township

Tested By:

R. McCabe

Date Taken:

2024-04-12

Borehole Number	Sample Number	Sample Depth (m)	Water Weight (g)	Water Content (%)	Additional Observations
101	1A	0.00-0.41	74.0	29.6	
101	1B	0.41-0.61	37.6	16.8	
101	2A	0.76-0.97	42.9	17.0	
101	2B	0.97-1.37	19.2	7.6	
101	3	1.52-2.13	66.3	10.4	NR
101	4	2.29-2.90	42.9	13.1	
101	5	3.05-3.66	41.2	11.3	
101	6	4.57-5.18	28.9	9.2	
102	1	0.00-0.61	63.3	28.7	
102	2	0.76-1.37	77.6	13.0	NR
102	3	1.52-2.13	38.1	11.4	
102	4	2.29-2.90	51.1	13.4	
102	5	3.05-3.66	40.1	11.3	
102	6	3.96-4.27	37.5	13.2	
103	1	0.00-0.61	40.2	27.1	
103	2	0.76-1.37	171.8	26.2	NR
103	3	1.52-2.13	85.4	33.0	
103	4	2.29-2.90	33.1	12.2	
103	5	3.05-3.66	48.8	16.6	
103	6	3.96-4.57	127.9	16.8	NR
104	1A	0.15-0.36	13.4	5.9	NR
104	1B	0.36-0.76	25.6	15.6	
104	2	0.91-1.52	41.3	20.0	
104	3	1.68-2.29	49.3	18.4	
104	4	2.44-3.05	68.2	21.1	
104	5	3.20-3.81	32.3	13.2	
104	6	3.96-4.57	27.8	12.8	

- 1 – Contains organics

2 – Contains rubble

3 – Hydrocarbon Odour

4 – Unknown Chemical Odour

5 – Saturated – free water visible
- 6 – Very moist – near optimum moisture content

7 – Moist – below optimum moisture

8 – Dry – dry texture – powdery

9 – Very small – caution may not be representative

10 – Hold sample for gradation analysis