Geotechnical Investigation Report - Proposed Retaining Wall Replacement, Minden Hills Library, Minden, Ontario

April 23, 2026

Prepared for:
Township of Minden Hills

Cambium Reference: 02602062.000

CAMBIUM INC.

866.217.7900

cambium-inc.com

Table of Contents

List of Embedded Tables

List of Appended Figures

List of Appendices

1.0 Introduction

Cambium Inc. (Cambium) was retained by Township of Minden Hills (Client) to complete a geotechnical investigation in support of the proposed retaining wall replacement at the Haliburton County Public Library, Minden Hills Branch located at 176 Bobcaygeon Road, Minden, ON (Site). A site location plan is appended as Figure 1 of this report.

The site is currently developed with a one-storey local library and an access driveway and parking lot immediately south of the building. Along the south edge of the entrance deck, an existing timber retaining wall extends east–west for approximately 35 m, separating the building from the parking area. The retaining wall appears to support loads from the building roof that are transferred through structural columns bearing near the wall alignment.

At the time of the investigation, the timber retaining wall exhibited signs of outward lean and was supported by a temporary bracing system consisting of timber soldier piles and lagging with angled rakers to limit further movement. It is understood that the retaining wall is currently proposed to be replaced with a new SienaStone 500 retaining wall, and that the structural columns will be supported on helical piles as part of the proposed works.

It’s assumed that the proposed grades will remain relatively consistent with the existing grades. At the time of preparing this report, the preliminary design drawings of the retaining wall, or structural drawings, are not available.

The purpose of the geotechnical investigation was to obtain information about the subsurface conditions by means of boreholes and based on the findings provide geotechnical recommendations for the proposed redevelopment.

2.0 Methodology

2.1 Borehole Investigation

A borehole investigation was conducted on March 30, 2026, to assess subsurface conditions at the Site. A total of three boreholes, denoted as BH101-26 to BH103-26, were advanced into the subsurface at predetermined locations throughout the Site. All boreholes were advanced within the parking lot adjacent to the existing timber retaining wall.

Borehole BH103-26 was advanced to a termination depth of 5.2 m below ground surface (mbgs). Boreholes BH101-26 and BH102-26 were drilled to depth of 5.2 mbgs and 8.2 mbgs respectively using solid stem augers, prior to switching to dynamic cone penetration testing (DCPT) method, in order to assess soil density to final termination depths of approximately 13.1 mbgs and 13.7 mbgs respectively. A borehole location map is appended as Figure 2 of this report.

The boreholes were surveyed by a Real-time kinematic positioning (RTK) device, and the elevations were measured based on information derived from the TopNET Live real-time GNSS correction service with a vertical geodetic accuracy of 3 cm. Elevations are presented in the CGVD28:78 datum. Elevations were measured relative to the center of a manhole cover, located on Bobcaygeon Road, on the southbound lane across the Site, which was given as assumed elevation of 100 m. This benchmark is denoted as BM1 in Figure 2 of this report. All borehole elevations are measured in meters relative to this benchmark (mREL). It should be noted that the ground surface elevations at the boreholes are referenced for describing the soil stratigraphy only and should not be used or relied upon for any other purpose.

Drilling and sampling were completed using a track-mounted drill rig operating under the supervision of a Cambium technician. The borehole was 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 consistency of cohesive soils and relative density of non-cohesive soils. Soil

samples were collected at approximately 0.75 m intervals in the upper 3.0 m and in 1.5 m intervals thereafter. The encountered soil units were logged in the field using visual and tactile methods, and samples were placed in labelled plastic bags for transport, future reference, possible laboratory testing, and storage.

In the DCPT, a 51 mm diameter, 60-degree Apex cone point, screw-attached to the tip of A-size rods, is driven into the ground using the same driving energy as in the SPT method. By recording the number of blows to drive the cone/rod assembly into the soil every 305 mm, a qualitative record of relative density/consistency is obtained. Although the interpretation of the test results may be difficult because no soil samples are obtained through this method, and the penetration resistances are not necessarily equivalent to N values or undrained shear strengths, useful information is gained by the continuity of the results and by the elimination of unbalanced hydrostatic effects which may affect SPT N values. In some deposits, soil adhesion to the drill rod assembly may affect DCPT results and therefore should be taken into account in the geotechnical assessments.

Open boreholes were checked for groundwater and general stability prior to backfilling. All other boreholes were backfilled and sealed in accordance with Ontario Regulation (O.Reg.) 903, as amended, and the property was reinstated to pre-existing conditions.

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

2.2 Physical Laboratory Testing

Physical laboratory testing, including one particle size distribution analysis (LS-702,705), was completed on a selected soil sample to confirm textural classification and to assess geotechnical parameters. Moisture content testing (LS-701) was completed on all retrieved soil samples. Results are presented in Appendix B and are discussed in subsequent sections of this report.

3.0 Subsurface Conditions

The detailed soil profiles encountered in the borehole are indicated on the attached borehole log in Appendix A. It should be noted that the conditions indicated on the borehole log is for specific locations only and can vary beyond the borehole location.

Based on the borehole investigation, subsurface conditions generally consist of a surficial pavement structure underlain by loose to compact silty sand to sand and silt, interbedded with a very loose organic silt layer ranging in thickness of approximately 1.4 m to 3.1 m. The organic silt was first encountered at depths between about 1.5 mbgs and 2.7 mbgs.

3.1 Pavement Structure

A layer of asphalt concrete was encountered in each borehole, with a thickness ranging from 25 mm to 75 mm. A layer of granular fill material, varying from sand and gravel to gravelly sand with various amounts of silt, was encountered beneath the asphalt layer in each borehole, approximately 0.68 m to 1.5 m in thickness. The fill formed the granular base/subbase material. The material was generally moist to wet at the time of the investigation, likely due to the thawing and snowmelt infiltration conditions at the Site at the time of the investigation. Natural moisture content values ranged from 9% to 11%.

3.2 Silty Sand

A layer of grey silty sand with trace to some gravel was encountered in all borehole locations beneath the pavement structure and extended to depths ranging approximately between 1.5 mbgs and 2.7 mbgs. The silty sand contained trace organics in boreholes BH101-26 and BH106-26. SPT N values measured within the fill ranged from 4 to 12, indicating loose to compact relative density. The silty sand soils were generally found to be wet at the time of the investigation, with the moisture contents ranging from 15% to 27% based on laboratory testing.

Laboratory particle size distribution analysis was completed for one sample of the silty sand material. The analysis results are summarized in Table 1 with details provided in Appendix B.

Table 1 Particle Size Distribution Analysis – Silty Sand

Borehole	Depth (mbgs)	Description	% Gravel	% Sand	% Silt & Clay	% Moisture Content
BH101-26 SS2	0.8 – 1.4	Silty Sand trace Gravel	5	75	20	22.3

3.3 Organic Silt

Beneath the silty sand material in each borehole, a layer of an organic-rich silt soil with trace to some amounts of sand and clay was encountered. The grey to dark brown organic silt contained visible wood fibres and rootlets, indicating a compressible deposit of organic / peat soils. The organic silt ranged in thickness of approximately 1.4 m to 3.1 m and was first encountered at depths between about 1.5 mbgs and 2.7 mbgs. SPT N values ranged from 0 (weight of hammer) to 5, indicating a very loose to loose relative density. The organic silt was generally moist to wet at the time of the investigation, with natural moisture content values ranging from 83% to 100% based on laboratory testing, with the extreme high values being attributed to the high organic content. Table 2 below summarizes the depth and elevation of the encountered organic silt material.

Table 2 Summary of Encountered Organic Material

Borehole	Depth of Encountered Organic Silt (mbgs)	Elevation of Encountered Organic Silt (mREL)
BH101-25	1.52 – 4.57	99.19 – 95.14
BH102-25	2.06 – 4.57	97.57 – 95.06
BH103-25	2.74 – 4.11	96.93 – 95.56

3.4 Sand and Silt

In all boreholes, a grey to brown sand and silt with various amounts of clay was encountered beneath the organic silt and extended to the sampling termination depths of 5.2 mbgs to 8.2 mbgs. The sand and silt material contained trace organics in borehole BH102-26 down to the sampling termination depth of 8.2 mbgs. Based on SPT N values ranging from 6 to 14, the

sand and silt material had a loose to compact relative density down to a depth of 8.2 mbgs. Due to the wet conditions and generally loose state of the sand materials, DCPT was completed in boreholes BH101-26 and BH102-26 from 5.5 mbgs to 13.1 mbgs and 8.2 mbgs to 13.7 mbgs, respectively, to identify the depth of dense material. Based on DCPT results, dense material was consistently encountered in these two boreholes from a depth of 12.2 mbgs. Since no samples are obtained from DCPT, the dense material can be inferred as sand and silt or a glacial till. Glacial till is a heterogenous mixture of all grain sizes and will vary across the site slightly. The natural moisture content of the sampled sand and silt ranged from 22% to 32% based on laboratory testing.

3.5 Bedrock

Bedrock was not encountered during the drilling investigation depths. All boreholes, including DCPT, extended to depths ranging between 5.2 mbgs to 13.7 mbgs (94.49 mREL to 86.03 mREL).

3.6 Groundwater

Groundwater seepage was encountered in all three boreholes upon drilling completion prior to backfilling, between depths 0.1 mbgs and 0.6 mbgs. Boreholes caved (sloughing) up to a depth of 0.6 mbgs to 1.2 mbgs upon completion, prior to backfilling.

The high groundwater table encountered at the time of the investigation, prior to backfilling, likely reflects a perched groundwater elevation. The seasonal Site conditions at the time of drilling (freeze/thaw cycles) and ongoing snowmelt indicates that the seepage encountered at the shallow depths is likely a result of perched seasonal water from the surface and could be trapped above the organic silt layer. It is also noted that a large puddle was present in the parking lot at the time of the investigation, immediately adjacent to the existing retaining wall in the vicinity of the boreholes.

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

4.0 Geotechnical Considerations

The following subsections provide preliminary geotechnical engineering guidelines for site development planning. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the borehole location may vary from those observed. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings, if necessary. A more detailed geotechnical investigation, including additional boreholes for adequate site coverage, should be conducted to confirm geotechnical parameters for final design and construction of the proposed development.

4.1 General Site Preparation

Given the compressibility of the 1.3 m to 3.1 m thick organic silt layer immediately beneath the thin silty sand subgrade, the retaining wall and structural columns are not suitable for support on the shallow silty sand. The preferred foundation options for both the retaining wall and columns include helical piles extending into the dense native material, encountered at approximately 12.2 mbgs (elevation 87.50 mREL to 87.40 mREL). Depending on final structural design, existing asphalt, fill, and any near-surface organic material identified or found shall be excavated and removed from beneath any areas of the Site to be developed. The loose sand and very loose organic silt soils observed to significant depth are the key concern for construction of the proposed retaining wall and structural columns.

4.2 Frost Penetration

Based on Ontario Provincial Standard Drawings (OPSD) 3090.101, the typical frost penetration depth is approximately 1.7 m. Footings for the proposed structures should be placed below this depth for frost protection.

4.3 Excavations

Any excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally loose to compact sand soils may be classified as

Type 3 soils above the groundwater table in accordance with OHSA and may be excavated with unsupported side slopes no steeper than 1H:1V. Excavations should not extend down to the organic silt soils. Soils below the groundwater table, should be considered Type 4 soils and may be excavated with unsupported side slopes no steeper than 3H:1V, or be fully supported (shored). Test excavations should be carried out at the time of construction to assess the soil integrity and water levels.

Excavation side slopes should be protected from exposure to precipitation and associated ground surface runoff 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 shored.

4.4 Dewatering

Groundwater levels were observed between depths of 0.1 mbgs and 0.6 mbgs at the time of the investigation within the borehole prior to backfilling. However, as noted in Section 3.6, this high water is likely a seasonal perched water table.

It is recommended that construction be scheduled during a drier period, such as the summer months. If groundwater is encountered during the shallow excavations required to create a working bench/platform for the helical piles, it is expected that it can be controlled using filtered sumps and pumps. However, it is recommended that excavations do not sit open for a long period of time, and test excavations should be made immediately prior to construction to observe groundwater conditions.

It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events.

4.5 Foundation Design

4.5.1 General

Based on borehole information, the subsurface conditions below the surficial material and fill at the Site generally consist of loose to compact sand soils and organic silt. A deep foundation system, such as helical piles, is recommended given the proposed redevelopment and the poor soil conditions to depth. Under no circumstances will the foundations be placed directly on organic materials, loose, frozen subgrade, construction debris, or within ponded water.

4.5.2 Helical Piles

Based on the current structural design, a segmental retaining wall was proposed for the replacement and helical piles are recommended to support the proposed structural columns that support the existing building roof. Based on borehole information, the soil won't be able to provide adequate bearing capacity for the segmental retaining wall as shown, therefore it is suggested that the retaining wall should be supported by deep foundations such as helical piles as well. It is anticipated that a grade beam or pile cap will be required. The structural engineer should be consulted to determine the type of retaining wall.

If both retaining wall and columns are supported by helical pile, the helical piles should extend to a minimum depth of 12.2 mbgs (elevation 87.50 mREL to 87.40 mREL), or to the required depth identified by the helical pile contractor based on their installation equipment and size of piles. The final depth of the helical piles will be well below frost penetration, extending past the organic silt layer, and anchored into the dense sand and silt or glacial till material. Individual helical piles can generally carry loads of up to 100 kN in compression. Final grade beam or prefabricated steel bracket system should be completed once a specified helical pile contractor has been retained. A test pile can be completed before the installation of the piles to ensure the material becomes dense at the final depth (12.2 mbgs or otherwise specified by the contractor), and the minimum desired torque is achieved.

Based on preliminary observations, it is Cambium's opinion that the observed leaning of the existing retaining wall is a result of the thick organic silt layer encountered at a minimum depth of approximately 1.5 mbgs.

4.5.3 Subdrainage & Waterproofing

Provisions should be made for draining the retaining wall backfill to prevent buildup of hydrostatic pressures; this could also consist of geotextile-wrapped perforated plastic sub-drain appropriately slope and drained to the stormwater management system or other suitable frost-free outlet, or geotextile-wrapped perforated plastic sub-drains draining through the wall itself would be considered suitable provided they could be kept frost-free.

4.6 Seismic Site Classification

To determine a seismic site classification, it was assumed that soils as encountered in the borehole would remain continuous minimum depth of 30 m below the bottom of any foundations. In addition, average 'N60' values for soils were assumed for the site. Based on these assumptions, in combination with the known local geological conditions, the site class is "E" as per Table 4.1.8.4.A, Site Classification for Seismic Site Response (OBC 2024). These seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required.

Consideration could be given to carrying out shear wave velocity testing (Multichannel Analysis of Surface Waves, "MASW") to evaluate whether an improved seismic site class and/or seismic hazard value can be obtained. Further details regarding shear wave velocity testing could be provided upon request. The Ontario Building Code (OBC) specifies that the structures should be designed to withstand.

4.7 Backfill and Compaction

All existing pavement, vegetation, topsoil, and any surficial organic soils shall be removed down to a competent base prior to installing the helical piles.

Excavated asphalt, topsoil, organic fill, organic or excessively wet or otherwise deleterious material should not be used for backfilling purposes. Any engineered fill below foundations should be placed in maximum 200 thick lifts and be compacted to a minimum of 100% of Standard Proctor Maximum Dry Density (SPMDD), as confirmed by nuclear densometer testing. Excavated non-organic, non-debris and non-cohesive soils from the site may be appropriate for use as fill below grading and parking areas, provided that the actual or adjusted moisture content at the time of construction is within a range that permits compaction to required densities. Some moisture content adjustments may be required depending on seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction. Consideration could be given to using a material meeting the specifications of OPSS 1010 Granular B Type I or an approved equivalent.

Any retaining wall backfill material should consist of free-draining imported granular material meeting the specifications of OPSS 1010 Granular A or Granular B Type I material or an approved equivalent. The fill should be placed in maximum 200 mm thick lifts and compacted to a minimum of 100% Proctor maximum dry density (SPMDD) as confirmed by densometer testing. If engineered fill is being placed for general site backfill and grading, then compaction to 98% of SPMDD is applicable.

4.8 Lateral Earth Pressures

The design of the retaining wall should consider the horizontal soil loads, as well as surcharge loads that may occur during construction. The backfill materials should consist of imported free-draining soils (e.g. OPSS Granular B, Type I or Granular A and Granular B Type II) as approved by the Engineer.

Based on the results of the geotechnical investigation, Cambium has developed parameters for soil properties for lateral earth pressures to be used in the design of retaining walls and

temporary shoring structures; These recommended parameters are provided in Table 3, below. It is assumed that potential lateral loads will result from cohesionless, frictional materials.

It should be noted that these parameters are provided for gravity retaining wall design only, it is anticipated that different retaining wall system may be proposed, in that case these parameters should be revisited.

Table 3 Soil Parameters for Retaining Wall Design

Soil	Bulk Unit Weight γ (kN/m³)	Internal Friction Angle Φ' (º)	Active earth pressure coefficient Ka (Rankine)	Passive earth pressure coefficient Kp (Rankine)	At-rest earth pressure coefficient Ko (Rankine)
Compacted Granular Fill	22	35	0.27	3.69	0.42
Loose to Compact Silty Sand	19	30	0.33	3.00	0.50

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained or some movement can occur such that the active state of earth pressure can develop. The use of vibratory compaction equipment immediately behind the retaining walls should be restricted in size.

The coefficients provide in Table 3 assume that the surface of the granular backfill or native material is horizontal against any proposed retaining wall, and the wall is vertical and smooth.

The following formula may be used to calculate lateral thrust (Pa) on yielding retaining structures;

$$P_a = (\mathrm{H}/2)(\mathrm{K_a})(\gamma\mathrm{H}+2\mathrm{q})$$

where,

H = Height of retaining structure (m)

γ = unit weight of retained soil (kN/m³)

q = surcharge (kPa)

Unit weights found in Table 3 should be used for compacted loadings of the appropriate material.

No traffic loads are expected for the retaining walls, however if the excavation requires temporary shoring, a vehicle surcharge pressure should be applied; the actual surcharge pressure should depend on type of traffic. The above pressures should be assumed to act over the entire width of the retaining wall.

4.8.1.1 Earthquake-Induced Pressures

Earthquakes will induce additional pressures on retaining structures. For active earth pressure loads:

$$P_{ae} = \frac{1}{2}\gamma H^2(1 - k_v)K_{ae}$$

where,

P_{ae} = resultant active lateral earth load inducing static and dynamic loads;

γ = unit weight of the soil behind the wall;

k_v = vertical component of the earthquake acceleration (as a decimal fraction of the acceleration due to gravity);

k_h = horizontal component of the earthquake acceleration (as a decimal fraction of the acceleration due to gravity); and

K_{ae} = horizontal component of active earth pressure coefficient including effects of earthquake loading;

And

$$K_{ae} = \frac{\cos(\delta + \alpha cos^2(\phi' - \varphi - i))}{cos^2 i \ \cos\delta \cos(\delta + i + \varphi)(1 + X_a^{1/2})^2}$$

$$X_a = \frac{\sin(\delta + \varphi')\sin(\phi' - \varphi - \beta)}{\cos(\delta + i + \varphi)\cos(\beta - i)}$$

$$\varphi = \tan^{-1}[k_h/(1 - k_v)]$$

$$i = 90 - \alpha$$

For the site, γ is as provided in Table 3, α=90° and i=0. Using Coulomb's theory, the angle of wall friction (δ) is related to both the internal angle of friction of the soil (Φ') as provided in Table 3 and the roughness of the wall. For smooth vertical walls δ=0, and the recommended maximum value for rough walls δ = 14.

4.9 Design Review and Inspections

Cambium should be provided the opportunity to review the design drawings, prior to next stage tendering and construction, to ensure that all pertinent geotechnical-related factors have been addressed.

Cambium should also be retained to complete testing and inspections during construction operations to examine and approve subgrade conditions, placement, and compaction of fill materials.

5.0 Closing

Please note that this report is governed by the attached qualifications and limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned.

Cambium Inc.

Juan Monroy, P.Eng.
Coordinator – Geotechnical

Stuart Baird, M.Eng., P.Eng.
Director of Technical Operations, Services

Zhaochang Luo, M.Eng., P.Eng.
Group Manager - Geotechnical

JDM/seb/zl

\\cambiumincstorage.file.core.windows.net\projects\02602000 - 02603000\02602062.000 GEO - Minden Hills Library Retaining Wall\09-Deliverables\REPORT - GEO\Draft\2026-04-23 RPT – GEO – Minden Hills Library Retaining Wall.docx

6.0 Statement of Qualifications & Limitations

Limited Warranty

Cambium relies on its client to provide instructions on the scope of work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards, and with the degree of care and skill ordinarily exercised by professionals performing similar services for similar projects in the same region. Unless required under applicable 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, results, information and data prepared by Cambium are based on the materials, documents and information provided by the client to Cambium and on the facts, conditions and circumstances encountered by Cambium during the performance of the work. In formulating its findings, results, information and data, Cambium assumes that the information, documents and materials provided by the client to Cambium are factual, accurate and represent a true depiction of the circumstances that exist at the Project. Cambium relies on its client to inform Cambium if there are changes to any such information, documents and materials. Cambium does not review, analyze or attempt to verify the accuracy or completeness of the information, documents or materials provided by the client, 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 Cambium, are unknown by Cambium, or are otherwise concealed from Cambium during the provision of its services.

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 the findings, results, information and data prepared by Cambium. 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 Cambium has completed its work. 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 work.

When preparing reports, Cambium considers applicable legislation, regulations, governmental guidelines and policies. 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 purposes 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 considers any locations or times other than those from which information, sample results and data was specifically received, the work shall be 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 and paid for 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 findings, results, information and data prepared by Cambium, are beyond the scopes of the work performed by Cambium and such matters have not been investigated or addressed.

Intellectual Property Rights

Upon full payment of all fees properly owing to Cambium, the client shall have a perpetual, non-exclusive, non-transferable license (without sub-licensing rights) to use the work and reports prepared by Cambium solely for their intended purpose. For greater certainty, Cambium retains all right, title, and interest in and to the work and reports, and they may not be modified, used for other purposes, or relied upon for additional work without Cambium's prior written consent.

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.

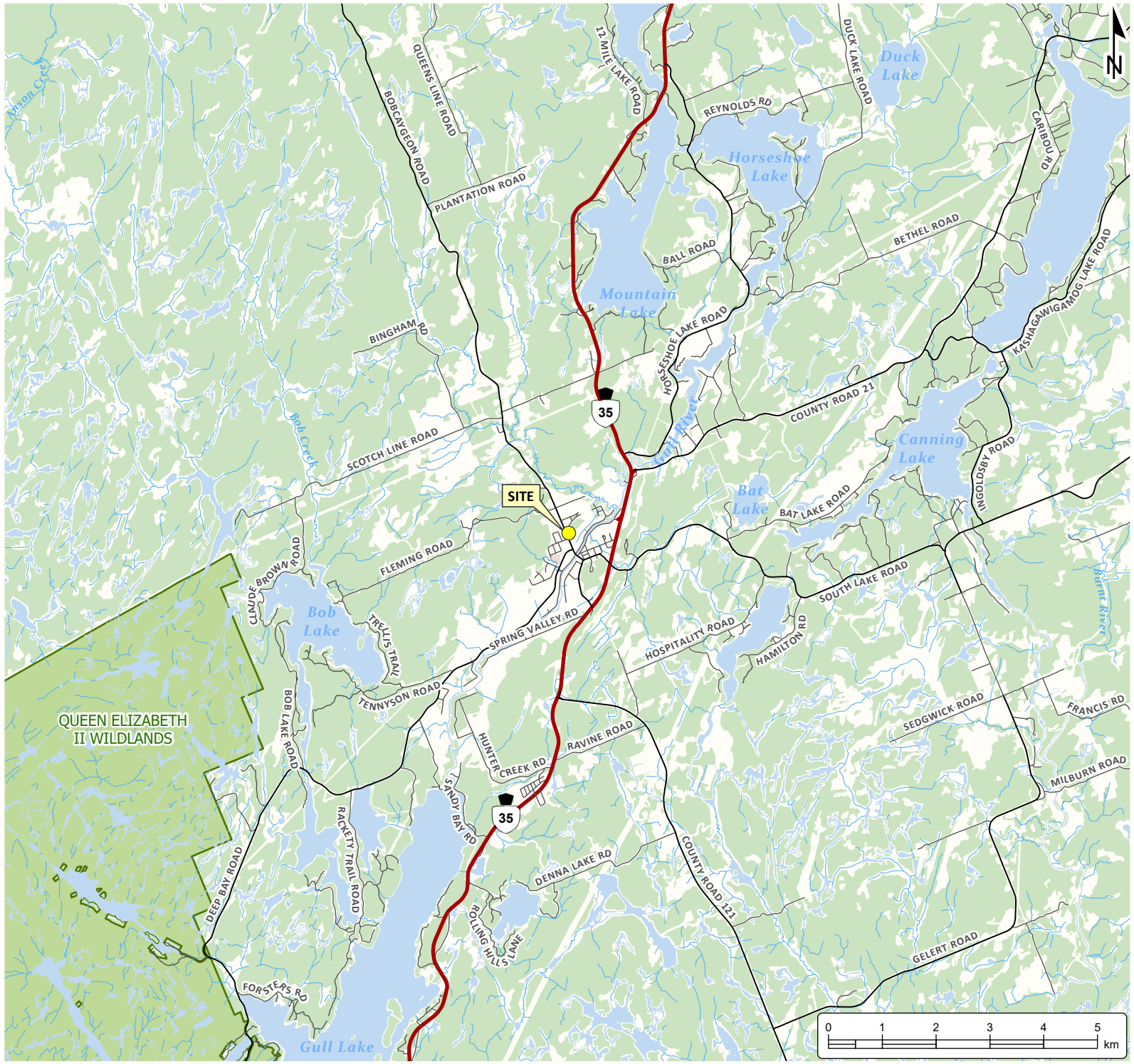
Limitation of Liability

Potential liability to the client arising out of the report is limited to an amount equal to the fees paid to Cambium for the preparation of the report. 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 indirect, consequential, aggravated or punitive damages and the client expressly waives the right to claim for such 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

TOWNSHIP OF MINDEN HILLS
176 Bobcaygeon Road
Minden, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Watercourse
- Provincial Park
- Water Area
- Wooded Area

Notes:
- This document contains information licensed under the Open Government License - Ontario.
- 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.

CAMBIUM
194 Sophia Street
Peterborough, Ontario, K9H 1E5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

SITE LOCATION PLAN

Project No.:	Date:
02602062.000	April 2026
Scale:	**Projection:**
1:100,000	NAD 1983 UTM Zone 17N

Created by:	Checked by:	Figure:
LD	JM	1

O:\GIS\Projects\02602000-02603000\02602062.000 GEO - Minden Hills Library Retaining Wall\2026-04-06 Geotechnical Investigation.aprx

GEOTECHNICAL INVESTIGATION

TOWNSHIP OF MINDEN HILLS
176 Bobcaygeon Road
Minden, Ontario

LEGEND

- Benchmark
- Borehole
- Existing Retaining Wall
- Site (approximate)

Notes:
- Aerial imagery obtained from the South Central Ontario Orthophotography Project (SCOOP) 2023. Source: Ontario Ministry of Natural Resources and Forestry. © Copyright: 2023 King's Printer of Ontario. All Rights Reserved.
- This document contains information licensed under the Open Government License - Ontario.
- 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.

CAMBIUM
194 Sophia Street
Peterborough, Ontario, K9H 1E5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

BOREHOLE LOCATION PLAN

Project No.:	Date:
02602062.000	April 2026
Scale: 1:750	Projection: NAD 1983 UTM Zone 17N
Created by: LD	Checked by: JM
Figure: 2	

O:\GIS\Projects\02602000-02603000\02602062.000 GEO - Minden Hills Library Retaining Wall\2026-04-06 Geotechnical Investigation.aprx

Appendix A

Borehole Logs

Client:	Township of Minden Hills	**Project Name:**	Minden Hills Library Retaining Wall	**Log of Borehole:**	BH101-26
Contractor:	Strong Soil Search	**Method:**	Truck Mounted Solid Stem Auger	Page:	1 of 2
Project No.:	02602062.000	**Elevation:**	99.71 mREL	**Date Completed:**	March 30, 2026
Location:	Minden, ON	**UTM:**	17T **N:** 4977617.22 **E:** 679349.82		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
99.7 / 0		**ASPHALT:** ~ 75 mm thick	99.63 / 0.08	1A	SS	100	50 /100 mm	9.2%	50		
99.2 / 0.5		**FILL:** SAND & GRAVEL: some silt; grey; moist to wet, very dense	99.38 / 0.33	1B	GB			10.1%			
		FILL: gravelly SAND: some silt; grey, wet, compact	98.95 / 0.76								
98.7 / 1		**(SM) SILTY SAND:** trace gravel; grey; wet, compact	98.19	2	SS	50	12	22.3%	12		
98.2 / 1.5		**(OL) ORGANIC SILT:** some sand, trace clay, some organics (wood fibres); grey to dark brown; wet to moist, loose	1.52	3	SS	65	5		>100 15%		
97.7 / 2											
97.2 / 2.5		- some clay; very loose - (rootlets)		4	SS	100	0		>100 0%		
96.7 / 3											
96.2 / 3.5				5	SS	100	0		83.3% 0		
95.7 / 4											
95.2 / 4.5		**(SP) SAND and SILT:** trace clay; grey; wet, loose	4.57 / 95.14	6	SS	100	6	21.6%	6		Borehole augering and split spoon sampling terminated at 5.2 mbgs in sand and silt. Borehole caving observed at 1.2 mbgs. Wet soils first encountered at 0.3 mbgs. Standing water observed at 0.6 mbgs.
94.7 / 5											
			5.18								
94.2 / 5.5				7	DCPT		12		12		Dynamic Cone Penetration Testing commenced at 5.5 mbgs and terminated at 13.1 mbgs.
93.7 / 6				8	DCPT		8		8		
				9	DCPT		10		10		
93.2 / 6.5				10	DCPT		16		16		
				11	DCPT		16		16		
92.7 / 7				12	DCPT		12		12		
92.2											

GRAINSIZE DISTRIBUTION	SAMPLE	GRAVEL	SAND	SILT	CLAY
	SS2	5	75	20	

Logged By: AM **Input By:** AM

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Township of Minden Hills	**Project Name:**	Minden Hills Library Retaining Wall	**Log of Borehole:**	BH101-26
Contractor:	Strong Soil Search	**Method:**	Truck Mounted Solid Stem Auger	Page:	2 of 2
Project No.:	02602062.000	**Elevation:**	99.71 mREL	**Date Completed:**	March 30, 2026
Location:	Minden, ON	**UTM:**	17T **N:** 4977617.22 **E:** 679349.82		

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI — 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
92.2 / 7.5			13	DCPT		22		22		
			14	DCPT		15		15		
91.7 / 8			15	DCPT		20		20		
			16	DCPT		22		22		
91.2 / 8.5			17	DCPT		25		25		
			18	DCPT		21		21		
90.7 / 9			19	DCPT		31		31		
			20	DCPT		48		48		
90.2 / 9.5			21	DCPT		39		39		
			22	DCPT		50		50		
89.7 / 10			23	DCPT		34		34		
			24	DCPT		18		18		
89.2 / 10.5			25	DCPT		20		20		
			26	DCPT		20		20		
88.7 / 11			27	DCPT		27		27		
			28	DCPT		45		45		
88.2 / 11.5			29	DCPT		30		30		
			30	DCPT		49		49		
87.7 / 12			31	DCPT		53		53		
87.2 / 12.5										
86.7 / 13										
86.2 / 13.5										
85.7 / 14										
85.2 / 14.5										
84.7										

GRAINSIZE DISTRIBUTION	SAMPLE	GRAVEL	SAND	SILT	CLAY
	SS2	5	75	20	

Logged By: AM **Input By:** AM

Client:	Township of Minden Hills	**Project Name:**	Minden Hills Library Retaining Wall	**Log of Borehole:**	BH102-26
Contractor:	Strong Soil Search	**Method:**	Truck Mounted Solid Stem Auger	Page:	1 of 2
Project No.:	02602062.000	**Elevation:**	99.63 mREL	**Date Completed:**	March 30, 2026
Location:	Minden, ON	**UTM:**	17T **N:** 4977622.14 **E:** 679360.83		

Elevation (m)	Depth	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI / % Moisture	Shear Strength Cu, kPa (nat V., rem V.) / SPT (N)	Well Installation	Log Notes
								25 50 75	20 40 60 80		
99.6	0	**ASPHALT:** ~ 75 mm thick	99.55 / 0.08	1A	SS	100	78	9.7%	78		
		FILL: SAND & GRAVEL: trace silt; grey; wet, very dense	99.33 / 0.30	1B	SS			9%			
99.1	0.5	**FILL:** gravelly SAND: trace silt; grey; wet, very dense	98.87 / 0.76								
98.6	1	**(SM) SILTY SAND:** trace gravel, trace organics; grey; wet, loose		2	SS	35	12	26.6%	12		
98.1	1.5	- loose									
				3A	SS	100	5	19.6%	5		
97.6	2		97.57 / 2.06	3B	SS				>100%		
97.1	2.5	**(OL) ORGANIC SILT:** some sand, trace clay, some organics (rootlets and wood fibres); dark brown; moist to wet, loose		4	SS	50	0		>100%		
		- very loose									
96.6	3										
96.1	3.5	- some clay; grey		5	SS	100	0		>100%		
95.6	4										
95.1	4.5		95.06 / 4.57								
		(SP) SAND and SILT: trace clay, trace organics; grey; wet, loose		6	SS	100	7	22.6%	7		
94.6	5										
94.1	5.5										
93.6	6										
		- trace wood fibres		7	SS	100	6	27.3%	6		
93.1	6.5										
92.6	7										
92.1			92.13 / 7.50								

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: AM **Input By:** AM

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Township of Minden Hills	**Project Name:**	Minden Hills Library Retaining Wall	**Log of Borehole:**	BH102-26
Contractor:	Strong Soil Search	**Method:**	Truck Mounted Solid Stem Auger	Page:	2 of 2
Project No.:	02602062.000	**Elevation:**	99.63 mREL	**Date Completed:**	March 30, 2026
Location:	Minden, ON	**UTM:**	17T **N:** 4977622.14 **E:** 679360.83		

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI — 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
92.1 / 7.5		**(SP) SAND and SILT:** trace clay, trace organics; grey; wet, loose — 91.40 / 8.23								Borehole augering and split spoon sampling terminated at 8.2 mbgs in sand and silt. Borehole caving observed at 1.0 mbgs. Wet soils first encountered at 0.1 mbgs. Standing water observed at 0.4 mbgs.
91.6 / 8			8	SS	100	12	23.7%	12		
91.1 / 8.5			9	DCPT		14		14		
90.6 / 9			10	DCPT		15		15		
			11	DCPT		15		15		
			12	DCPT		17		17		
90.1 / 9.5			13	DCPT		48		48		
89.6 / 10			14	DCPT		26		26		
			15	DCPT		32		32		
89.1 / 10.5			16	DCPT		28		28		
			17	DCPT		19		19		
88.6 / 11			18	DCPT		16		16		
			19	DCPT		16		16		
88.1 / 11.5			20	DCPT		19		19		
87.6 / 12			21	DCPT		26		26		
			22	DCPT		30		30		
87.1 / 12.5			23	DCPT		38		38		
86.6 / 13			24	DCPT		43		43		
			25	DCPT		45		45		
86.1 / 13.5			26	DCPT		49		49		
85.6 / 14										
85.1 / 14.5										
84.6										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: AM **Input By:** AM

Client:	Township of Minden Hills	**Project Name:**	Minden Hills Library Retaining Wall	**Log of Borehole:**	BH103-26
Contractor:	Strong Soil Search	**Method:**	Truck Mounted Solid Stem Auger	Page:	1 of 1
Project No.:	02602062.000	**Elevation:**	99.67 mREL	**Date Completed:**	March 30, 2026
Location:	Minden, ON	**UTM:**	17T **N:** 4977630.36 **E:** 679370.62		

Elevation (m)	Depth	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI / % Moisture	Shear Strength Cu, kPa (nat V., rem V.) / SPT (N)	Well Installation	Log Notes
								25 50 75	20 40 60 80		
99.7	0	**ASPHALT:** ~ 25 mm thick	99.64 / 0.03	1A	SS	50	8	10.7%	8		
		FILL: SAND & GRAVEL: trace silt; grey; wet, loose	99.42 / 0.25	1B	SS			11.4%			
99.2	0.5	**FILL:** gravelly SAND: some silt; grey; wet, loose	98.91 / 0.76								
98.7	1	**FILL:** gravelly SILTY SAND: grey; wet, loose		2	SS	35	6	11.2%	6		
98.2	1.5	**(SM) SILTY SAND:** some gravel; grey; wet, loose	98.15 / 1.52	3	SS	50	7	21.9%	7		
97.7	2	- trace organics		4A	SS	100	4	14.7%	4		
97.2	2.5		96.93 / 2.74	4B	SS				>100%		
96.7	3	**(OL) ORGANIC SILT:** some sand, trace organics; dark brown; moist, loose		5	SS	60	2		90% 2		
96.2	3.5										
95.7	4		95.56 / 4.11								
		(ML) SILT and SAND: some clay; light brown/grey; moist to wet, compact									
95.2	4.5	- some clay; light brown/grey		6	SS	100	14	32.3%	14		
94.7	5		94.49 / 5.18								
		Borehole terminated @ 5.2 mbgs due to target depth achieved.									
94.2	5.5										
93.7	6										
93.2	6.5										
92.7	7										
92.2											

Borehole terminated in silt and sand. Borehole caving observed at 0.6 mbgs. Wet soils first encountered at surface. Standing water observed at 0.1 mbgs.

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: AM **Input By:** AM

Appendix B

Physical Laboratory Results

Grain Size Distribution Chart

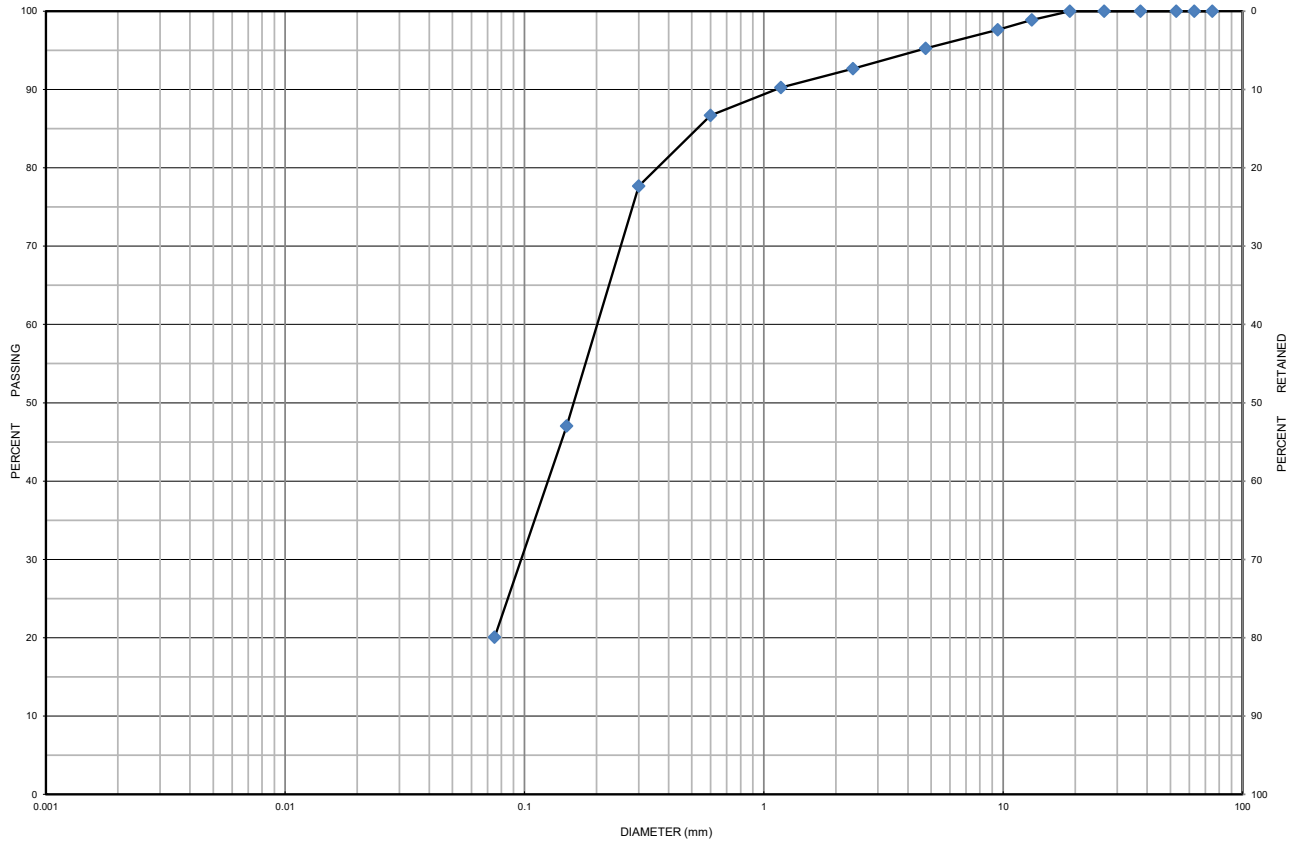
Project Number: *02602062-000* **Client:** *Township of Minden Hills*

Project Name: *Minden Hills Library Retaining Wall*

Sample Date: *March 30, 2026* **Sampled By:** *Abigail Mackle - Cambium Inc.*

Location: *BH 101-26 SS 2* **Depth:** *0.8 m to 1.4 m* **Lab Sample No:** *S-26-0332*

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 101-26	SS 2	0.8 m to 1.4 m	5	75	20		22.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand trace Gravel	SM	0.200	0.098	-	-	-

Additional information available upon request

Issued By: _____ *Date Issued:* *April 13, 2026*

(Senior Project Manager)

Cambium Inc. (Laboratory)
866.217.7900 | cambium-inc.com
194 Sophia St. | Peterborough | ON | K9H 1E5

Moisture Content

Project Number: 02602062.000
Project Name: Minden Hills Library Retaining Wall
Client: Township of Minden Hills
Date Taken: 2026-03-30

Lab Number: S-26-0331
Date Tested: 2026-04-09
Tested By: R. McCabe

Borehole Number	Sample Number	Sample Depth (m)	Water Weight (g)	Water Content (%)	Additional Observations
101	1A	0.00-0.30	29.9	9.2	
101	1B	0.30-0.61	35.8	10.1	
101	2	0.76-1.37	111.9	22.3	NR
101	3	1.52-2.13	122.0	137.5	
101	4	2.29-2.90	147.4	174.0	
101	5	3.05-3.66	119.3	83.3	
101	6	4.57-5.18	73.3	21.6	
102	1A	0.00-0.30	36.1	9.7	
102	1B	0.30-0.61	26.3	9.0	
102	2	0.76-1.37	45.2	26.6	NR
102	3A	1.52-2.06	63.0	19.6	
102	3B	2.06-2.13	46.0	142.4	NR
102	4	2.29-2.90	68.1	122.9	NR
102	5	3.05-3.66	118.2	137.1	
102	6	4.57-5.18	58.2	22.6	
102	7	5.18-6.10	77.2	27.3	
102	8	7.62-8.23	71.4	23.7	
103	1A	0.02-0.25	41.0	10.7	
103	1B	0.25-0.61	41.2	11.4	NR
103	2	0.76-1.22	37.5	11.2	
103	3	1.52-2.13	70.9	21.9	
103	4A	2.29-2.74	61.2	14.7	
103	4B	2.74-2.90	65.1	148.6	NR
103	5	3.05-3.66	120.5	90.0	
103	6	4.57-5.18	83.9	32.3	

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