Geotechnical Investigation Report 189 – 197 Duckworth Street, Barrie, Ontario

Cambium Reference No.: 10273-001

October 31, 2023

Prepared for: Cygnus Developments

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1.0 INTRODUCTION

Cambium Inc. (Cambium) was retained by Cygnus Developments (Client) to complete a geotechnical investigation in support of the re-development (re-zoning application) of the property located at 189, 191, 195 & 197 Duckworth Street in Barrie, Ontario (Site).

The Site currently consists of four developed residential properties with residential house units, existing service utilities (municipal water and wastewater, gas) and associated landscaping (mature tree coverage and existing property line fencing). An updated development plan was provided by the Client in September 2023 which consists of demolishing the residential properties and constructing a single block townhouse development with one basement level. The anticipated depth of the basement is approximately 3.3 metres below the proposed finished floor elevation (FFE) which is 275.80 metres above sea level (mASL). It is noted that the scope of work detailed herein was initially developed to support a development consisting of slab on grade structures.

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

It is noted that a hydrogeological assessment was also carried out by Cambium concurrently with the geotechnical investigation, the results of which are provided under a separate cover.

2.0 METHODOLOGY

2.1 BOREHOLE INVESTIGATION

A borehole investigation was completed on October 2, 2020, to assess subsurface conditions at the Site. A total of three boreholes, designated as BH101-20 through BH103-20, were advanced throughout the Site. All the boreholes were terminated at depths ranging from 3.1 m to 4.7 m below ground surface (mbgs). It is noted that the scope of work was initially developed to support a development consisting of slab on grade structures.

The borehole locations and elevations were surveyed using a Sokkia RTK GPS system. The elevations were adjusted based on the closest Control Survey Information Exchange benchmark to site (Station 03120080028) which has an Elevation 269.474 mASL. The borehole UTMs and elevations are provided on the borehole logs in Appendix A. Borehole locations are shown on Figure 1.

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

Three boreholes, BH101-20, BH102-20, and BH103-20 were outfitted as monitoring wells in order to determine the static groundwater elevation at the Site.

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

3.0 SUBSURFACE CONDITIONS

The subsurface conditions at the site consist of glacial till deposits predominantly sand with gravel to silty sand. These soils were encountered throughout the boreholes to the termination depths ranging from 3.1 mbgs to 4.7 mbgs. The boreholes were terminated in native soils and bedrock was not encountered within the investigation depths.

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

Conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole locations. The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. 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 (drilling speed, shaking/grinding of the augers, etc.).

3.1 TOPSOIL / ORGANIC FILL

The surface topsoil and organic fill ranged in thickness from 600 to 900 mm, with an average thickness of 750 mm. The black sandy topsoil was found to have a loose to compact relative density. The natural moisture content of the topsoil ranged from 13.7% to 23.6%.

Analysis of the organic content or nutrients in the topsoil was not part of the scope of work for this investigation. Based on the variability in the thickness of the topsoil, full delineation of the volume of topsoil at the site would require additional test pits excavated in a grid pattern.

3.2 INORGANIC SOILS

Beneath the Topsoil discussed, the inorganic soils consisted primarily of sand to silty sand with gravelly sand observed throughout the boreholes, to the termination depths ranging from 3.1 mbgs to 4.7 mbgs. Given the local topography, historical nature of the existing development and recorded blow counts the inorganic soils are assumed to be that of a native deposit, it is noted that some fill soils or reworked native soils may be observed during construction which may be deemed unsuitable and as such, contractors should make an allowance for this.

3.2.1 SILTY SAND

The texture of the native soils encountered was predominantly brown silty sand with trace gravel and clay. The silty sand SPT “N” values varied between 30 and greater than 50 indicating a dense to very dense relative density.

Based on laboratory testing, the natural moisture content ranged between 4.6% and 13.3%. Boreholes BH101-20 and BH102-20 were terminated within the silty sand material at depths of 4.6 mbgs and 4.7 mbgs, respectively. It is noted that early refusal was encountered within this soil in BH102-20 and BH103-20, in addition some of the samples gathered during the SPT testing recovered a low amount of soil which indicates possible obstructions (i.e., boulders, cobbles, etc.).

Laboratory particle size distribution analysis was completed for two samples of the silty sand soils, taken from the borehole and depth provided in Table 1 in order to identify the soil texture. The testing results are provided in Appendix B and are summarized in Table 1 based on the Unified Soil Classification System (USCS).

Table 1 Particle Size Distribution – Silty Sand Soils

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay	%Moisture content
BH101-20	1.5 – 1.8	Silty Sand trace Gravel and Clay	5	43	41	11	9.9
BH102-20	3 – 3.5	Silty Sand trace Gravel and Clay	7	44	36	13	9.7

3.2.2 GRAVELLY SAND

Gravelly sand soils were encountered in boreholes BH101-20 and BH102-20 at depth of 3.04 mbgs and 0.76 mbgs and extended to a depth of 4.6 mbgs (termination depth) and 2.3 mbgs, respectively. This sand was generally brown in colour with gravel, some silt and trace clay. Based on SPT “N” values of greater than 50 blows, this material is very dense in relative density. Laboratory moisture content testing determined the natural moisture content of these soils was between 3% and 4.5%.

Laboratory particle size distribution analysis was completed for one sample of the gravelly sand. The testing results are provided in Appendix B and are summarized in Table 2 based on the USCS.

Table 2 Particle Size Distribution – Gravelly Sand Soils

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay	%Moisture content
BH102-20	0.9 – 1.1	Gravelly Sand trace Silt and Clay	25	65	8	2	4.9

3.3 BEDROCK

Bedrock was not confirmed within the investigation depths, each of the boreholes were terminated due to auger refusal on material that was greater than 50 blows per 50 mm of penetration, presumed to be cemented till soils based on geological mapping available for the area. Boreholes were terminated at depths ranging from 3.1 mbgs to 4.7 mbgs or from an elevation of 269.27 mASL to 272.13 mASL in native soils. The elevation of each boreholes and their respective termination depths are identified in Table 3 below.

Table 3 Borehole Termination Depth – Elevations

Borehole ID	Borehole Elevation (mASL)	Borehole Termination Depth (mbgs)	Borehole Termination Elevation (mASL)
BH101-19	273.97	4.7	269.27
BH102-19	274.96	4.6	270.36
BH103-19	275.23	3.1	272.13

3.4 GROUNDWATER

Groundwater (free water) and caving were not noted in any of the boreholes advanced at the site during the investigation. Monitoring wells were installed in boreholes, BH101-20 to BH103-20. The groundwater levels in monitoring wells were recorded on October 15, 2020, and it was observed that all of the monitoring wells were dry.

The groundwater levels were measured again on October 19, 2023, in which only BH101-20 and BH103-20 were reported as being dry. BH102-20 had a static water level of 4.33 mbgs which corresponds to an elevation of 270.63 mASL. Cambium recommends that water levels be measured monthly during high spring groundwater season (March to June) to confirm dry conditions.

4.0 GEOTECHNICAL CONSIDERATIONS

The following recommendations are based on borehole information and are intended to assist designers. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the borehole locations may vary from those observed. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings, if necessary.

4.1 SITE PREPARATION

The existing topsoil and any organic materials encountered should be excavated and removed from beneath the proposed addition footprints; additionally this material should be excavated and removed to a minimum distance of 3 m around the building(s) footprint. Any topsoil and materials with significant quantities of organics and deleterious materials (i.e., construction debris, asphalt etc.) are not appropriate for use as fill below parking and driving areas.

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

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

4.2 FROST PENETRATION

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

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

It is assumed that the pavement structure thickness will be less than 1.5 m, so grading and drainage are important for good pavement performance and life expectancy. Any services should be located below this depth or be appropriately insulated.

4.3 EXCAVATIONS AND BACKFILL

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally dense to very dense fill, silty sand and native sand soils may be classified as Type 2 soils above the groundwater table in accordance with OHSA. Type 2 soils may be excavated with vertical sides no taller

than 1.2 m, after which side slopes no steeper than 1H:1V are required. Below the groundwater table the soils may be classified as Type 3 soils and may be excavated with unsupported side slopes no steeper than 1H:1V.

4.4 DEWATERING

The groundwater table was not encountered across the site during the borehole drilling nor when the monitoring wells were measured on October 15, 2020, and in two of the monitoring wells (BH101-20 and BH103-20) on October 19, 2023. The monitoring well in BH102-20 had a groundwater measurement of 4.33 mbgs (270.63 mASL). Seepage may occur across the Site if high groundwater conditions are present during construction due to seasonal fluctuations. If groundwater seepage is encountered it should be manageable with filtered sumps and pumps and a Permit to Take Water (PTTW) or registration in the Environmental Activity and Sector Registry (EASR) will likely not be required. It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events. To minimize predictable water issues and costs, it is recommended that excavation and in-ground construction be performed in drier seasons.

4.5 BACKFILL AND COMPACTION

Excavated topsoil or organic soil from the Site is not appropriate for use as fill below grading and parking areas. Excavated sand soils not containing organics or significant deposits of clay 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, and that the material is only used below frost penetration depth of 1.5 m below proposed grade. Some moisture content adjustments may be required depending upon seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Any engineered fill below foundations should be placed in lifts appropriate to the type of compaction equipment used, and be compacted to a minimum of 100% of standard Proctor maximum dry density (SPMDD), as confirmed by nuclear densometer testing. If native soils from the site are not used as engineered fill, imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction. Consideration could be given to using a material meeting the specifications of OPSS 1010 Granular B or an approved equivalent. Foundation wall and any buried utility backfill material should consist of free-draining imported granular material. Most of the native site soils are too fine-grained to provide proper drainage, and as such this should be accomplished using well graded Granular B Type 1 material complying with OPSS 1010.

Foundation wall backfill consisting of free draining material such as Granular B Type I should be compacted to 98% of SPMDD within the foundation walls, and 95% on the exterior of the foundation.

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

4.6 FOUNDATION DESIGN

Based on the updated site development plan, we understand that basements are now proposed as part of the proposed additions. Assuming that the site is prepared as outlined above, the native sub-soils are competent to support the structure on conventional strip and spread footings. Assuming any new exterior footings will be placed a minimum of 1.5 m below final adjacent grade for frost protection, these footings can be founded on dense to very dense sand or silty sand soils at depth. Any required grade raises to the footing elevations can be accomplished with engineered fill, using an OPSS 1010 SSM or Granular 'B' Type I granular material in 200 mm lifts and compacted to a minimum of 100% of Standard Proctor Maximum Dry Density (SPMDD) as specified above.

New footings situated at a minimum depth of 1.5 m below the final adjacent grade, founded in undisturbed dense to very dense native soil may be designed for an allowable bearing capacity of 225 kPa at serviceability limit state (SLS) and 275 kPa at ultimate limit state (ULS). If the footings are to be founded on approved engineered fill, the foundations may be designed for an allowable bearing capacity of 150 kPa SLS and 200 kPa ULS.

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

4.7 LATERAL EARTH PRESSURE

Lateral earth pressure coefficients (K) are shown in Table 4. It is assumed that potential lateral loads will result from cohesionless, frictional materials, such as granular backfill.

Table 4 Lateral Earth Pressure Coefficients

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

The coefficients provided in Table 4 assume that the surface of the granular backfill is horizontal against any proposed retaining wall, and the wall is vertical and smooth. Cambium should be contacted to provide updated lateral earth pressure coefficients should the assumptions differ to those noted and if the soil slopes at an angle against the retaining wall.

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

4.8 SLABS ON GRADE

To create a stable working surface, to distribute loadings, and for drainage purposes, an allowance should be made to provide at least 200 mm of OPSS 1010 Granular A compacted to 100% of SPMDD beneath all floor slabs.

4.9 SUBDRAINAGE

Geotextile wrapped perforated pipe subdrains set in a trench of clear stone and connected to a sump or other frost-free positive outlet are recommended around all basement footings. Given that groundwater was generally not observed throughout the investigation depths, subdrains are not required for slab on grade structures. However, depending on regrading plans and if shallow water is observed during excavations and at seasonal wetter times, geotextile wrapped subdrains set in a trench of clear stone and connected to a sump or other frost-free positive outlet will be recommended below the floor slab and around the perimeter of building foundations.

4.10 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 site classification is based on the average shear wave velocity in the top 30 m of the soil stratigraphy. If the average shear wave velocity is not known, the site class can be estimated from the energy corrected Standard Penetration Resistance (N_{60}) and/or the average undrained shear strength of the soil in the top 30 m. Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the OBC (2006), it is recommended that Site Class “C” (very dense soil) be applied for structural design at the Site.

Peak ground acceleration and spectral acceleration (period of 0.2 seconds) for the site are calculated to be 0.063g and 0.108g respectively using the 2015 National Building Code Seismic Hazard Calculation. A detailed report of the calculation and its results can be found in Appendix C.

4.11 BURIED UTILITIES

Trench excavations above the groundwater table should generally consider Type 2 soil conditions, Type 2 soils may be excavated with vertical sides no taller than 1.2 m, after which side slopes no steeper than 1H:1V are required. Any excavations below the water table should generally consider Type 3 soil conditions which require side slopes of 1H:1V or flatter. Bedding and cover material for any services should consist of OPSS 1010-3 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.013). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98% of SPMDD. The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 98% of SPMDD, taking care not to damage the utility pipes during compaction.

4.12 PAVEMENT DESIGN

The performance of the pavement is dependent upon proper subgrade preparation. All topsoil and organic materials should be removed down to native material and backfilled with approved engineered fill or native material, compacted to 100% of SPMDD. The subgrade should be proof rolled and inspected by a Geotechnical Engineer. Any areas where boulders, rutting, or appreciable deflection is noted should be subexcavated and replaced with suitable fill. The fill should be compacted to at least 100% of SPMDD.

The recommended minimum pavement structure design has been developed for two traffic loading scenarios; light duty and heavy duty. The light duty design is appropriate for areas where no truck traffic is anticipated. The heavy duty design should meet the City of Barrie Transportation Design Manual (2020) requirements and as a minimum, consist of the pavement layers identified in Table 5. The heavy-duty pavement structure recommended below assumes that the annual average daily traffic (AADT) is less than 2,500 and is appropriate for areas where heavy traffic or heavy loads are anticipated. If the predicted AADT is higher than that assumed, Cambium should be contacted to reassess this recommendation.

Table 5 Recommended Minimum Pavement Structure

Pavement Layer	Light Duty	Heavy Duty (City of Barrie Designated Routes or Fire Truck Routes)
Surface Course Asphalt	40 mm HL3 or HL4	40 mm HL3 or SP 12.5
Binder Course Asphalt	50 mm HL8	70 mm HL8 or SP 19
Granular Base	150 mm OPSS 1010 Granular A	150 mm OPSS 1010 Granular A
Granular Subbase	300 mm OPSS 1010 Granular B	450 mm OPSS 1010 Granular B

Material and thickness substitutions must be approved by the Design Engineer. The thickness of the subbase layer could be increased at the discretion of the Engineer, to accommodate site conditions at the time of construction, including soft or weak subgrade soil replacement.

Compaction of the subgrade should be verified by the Engineer prior to placing the granular fill. Granular layers should be placed in 200 mm thick maximum loose lifts and compacted to at least 100% of SPMDD. The granular materials specified should conform to OPSS standards, as confirmed by appropriate materials testing.

Subdrains are recommended beneath the pavement structure, connecting to the storm sewer or an alternate frost-free outlet as outlined above, to extend the lifespan of the structure.

The final asphalt surface should be sloped at a minimum of 2% to shed runoff. Abutting pavements should be saw cut to provide clean vertical joints with new pavement areas.

4.13 DESIGN REVIEW AND INSPECTIONS

Cambium should be retained to complete testing and inspections during construction operations to examine and approve subgrade conditions, placement and compaction of fill materials, granular base courses, and asphaltic concrete.

We 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.

5.0 CLOSING

We trust that the information contained in this report meets your current requirements. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (705)719-0700.

Respectfully submitted,

CAMBIUM INC.

Rob Gethin, P.Eng.
Group Manager – Geotechnical Services

SEB/RLG/fj

Appended Figures

GEOTECHNICAL INVESTIGATION

CYGNUS DEVELOPMENTS
189 - 197 Duckworth Street,
Barrie, Ontario

LEGEND

- Monitoring Well
- Site (approximate)

Notes:
- Overlay was created by Caricari Lee Architects, Project no. 23010, drawing no. A 1.31, titled Site Pla (Roof View), dated September 2023.
- Base mapping features are © King's Printer of Ontario, 2022 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- 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.

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BOREHOLE LOCATION PLAN

Project No.:	18989-001	Date:	November 2020
		Rev.:	October 2023
Scale:	1:400	Projection:	NAD 1983 UTM Zone 17N
Created by:	MAT	Checked by:	CM
Figure:	1		

O:\GIS\MXDs\18900-18999\18989-001 Cygnus Developments Report Updates - 189 Duckworth St. Barrie\2023-10-24 Geotech FIG 1 - Borehole Location Plan.mxd

Appendix A
Borehole Logs

Peterborough
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Kingston
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Log of Borehole: BH101-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 189 Duckworth Street, Barrie
UTM: 17T, 605493 m E, 49176988 m N
Elevation: 273.97 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 0		Topsoil: Black sandy topsoil,compact, moist	1	SS	40	12			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
									Bentonite Plug	
									PVC Standpipe	
			2A							
-1 / 1		Sand and silt: Brown sand and silt, some clay, trace gravel, dense, moist	2B	SS	75	30				
		-very dense	3	SS	50	50/ 175 mm				GSA SS3: 5% Gravel 43% Sand 41% Silt 11% Clay
-2 / 2			4	SS	40	50/ 100 mm			Sand Pack	
-3 / 3		Sand: Brown sand, some silt, trace gravel, very dense, dry	5	SS	25	50/ 125 mm			PVC Screen	

Logged By: JD
Input By: JD

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Log of Borehole: BH101-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 189 Duckworth Street, Barrie
UTM: 17T, 605493 m E, 49176988 m N
Elevation: 273.97 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
-4 / 4		Silty Sand: Brown silty sand, some gravel, very dense, dry	6	SS	25	50/ 100 mm			Sand Pack; PVC Screen; Cap	
		Borehole terminated at 4.7 mbgs.								

Logged By: JD
Input By: JD

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Log of Borehole: BH102-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 197 Duckworth Street, Barrie
UTM: 17T, 605469 m E, 4917043 m N
Elevation: 274.96 mASL

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 0		Topsoil: Black sandy topsoil, loose, moist	1	SS	10	5			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
									Bentonite Plug	
		Gravelly Sand: Brown gravelly sand, trace silt, trace clay, dense, moist	2	SS	50	50/ 225 mm			PVC Standpipe	GSA SS2: 25% Gravel 65% Sand 8% Silt 2% Clay
-1 / 1										
		-less gravel	3	SS	70	50/ 250 mm				
-2 / 2										
		Sand and Silt: Brown sand and silt, some clay, trace gravel, dense, moist	4	SS	75	49			Sand Pack	
-3 / 3		-very dense	5	SS	75	50/ 280 mm			PVC Screen	GSA SS5: 7% Gravel 44% Sand 36% Silt 13% Clay

Logged By: JD
Input By: JD

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Log of Borehole: BH102-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 197 Duckworth Street, Barrie
UTM: 17T, 605469 m E, 4917043 m N
Elevation: 274.96 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
-4 — 4		-more clay	6	SS	13	50/ 75 mm			Sand Pack; PVC Screen; Cap	
		Borehole terminated at 4.6 mbgs.								

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Log of Borehole: BH103-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 195 Duckworth Street, Barrie
UTM: 17T, 605509 m E, 4917022 mN
Elevation: 275.23 mASL

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 0		Topsoil: Black sandy topsoil, compact, moist	1	SS	25	12			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
		Silty Sand: Brown silty sand, trace clay, trace gravel, very dense, moist							Bentonite Plug	
			2	SS	0	50/ 50 mm			PVC Standpipe	
-1 / 1										
			3	SS	50	50/ 100 mm				
-2 / 2									Sand Pack	
			4	SS	0	50/ 50 mm			PVC Screen	
		Gravelly Sand: Grey gravelley sand, some silt, very dense, moist								
-3 / 3				GS					Cap	
		Borehole terminated at 3.1 mbgs upon auger refusal.								

Logged By: JD
Input By: JD

Appendix B
Physical Laboratory Testing Results

Grain Size Distribution Chart

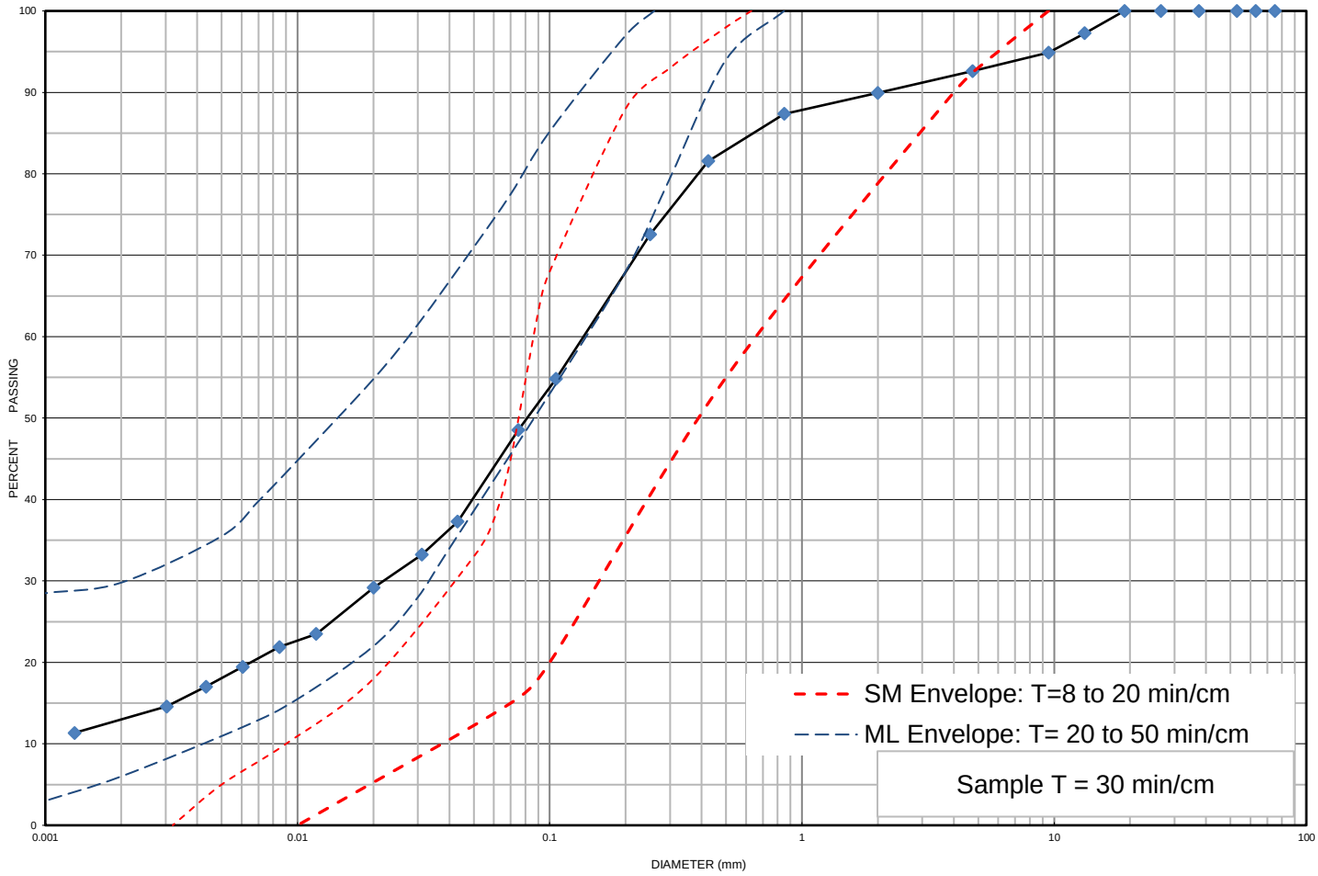
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 5* **Depth:** *3 m to 3.5 m* **Lab Sample No:** *S-20-0821*

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 102-20	SS 5	3 m to 3.5 m	7	44	36	13	9.7

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	SM	0.145	0.022	0.000	-	-

Additional information availabe upon request

Issued By: _____ *Date Issued:* *November 24, 2020*

(Senior Project Manager)

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Grain Size Distribution Chart

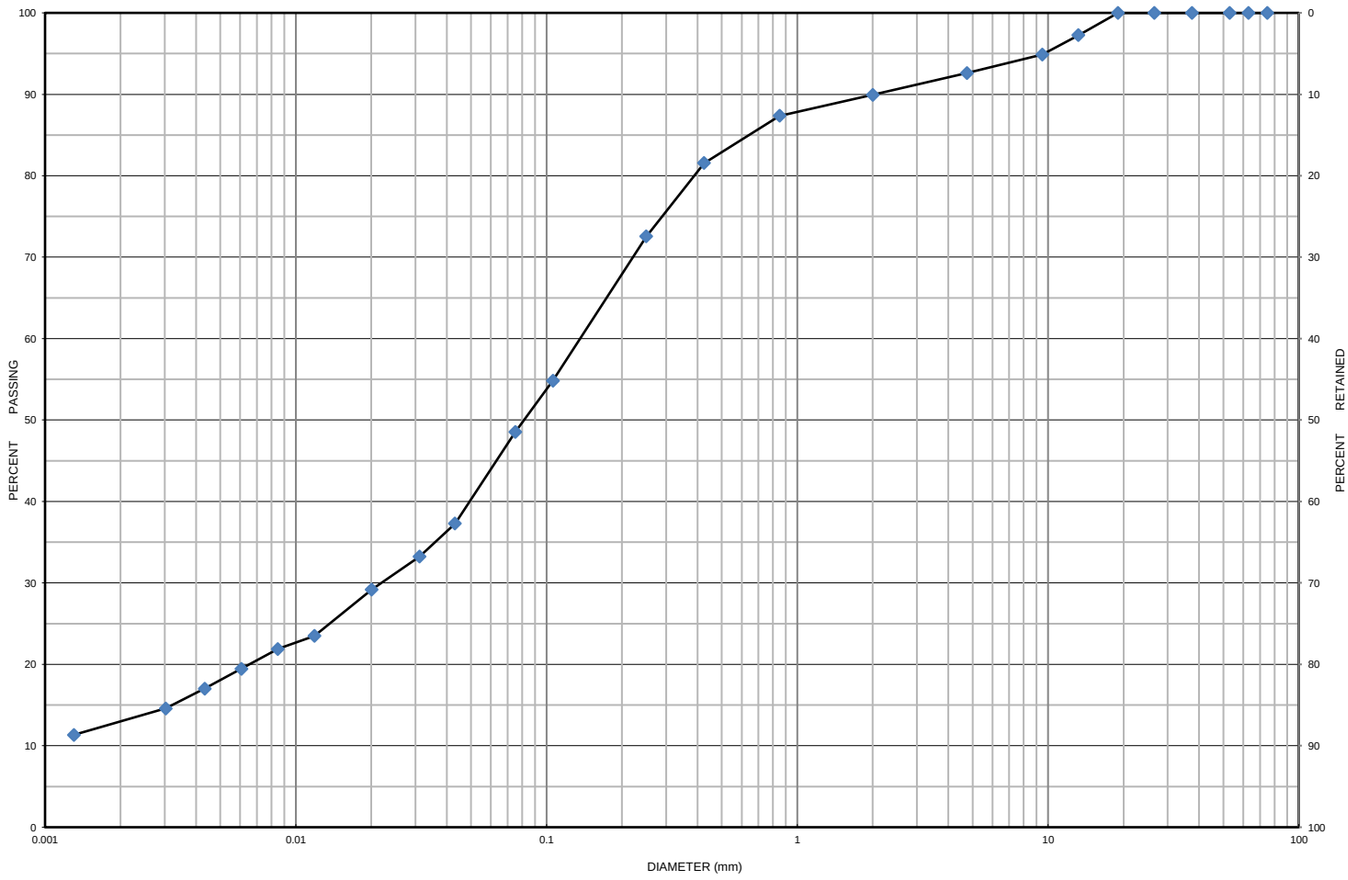
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 5* **Depth:** *3 m to 3.5 m* **Lab Sample No:** *S-20-0821*

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 102-20	SS 5	3 m to 3.5 m	7	44	36	13	9.7

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	SM	0.145	0.022	0.000	-	-

Additional information available upon request

Issued By: _____ *Date Issued:* *October 16, 2020*

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Grain Size Distribution Chart

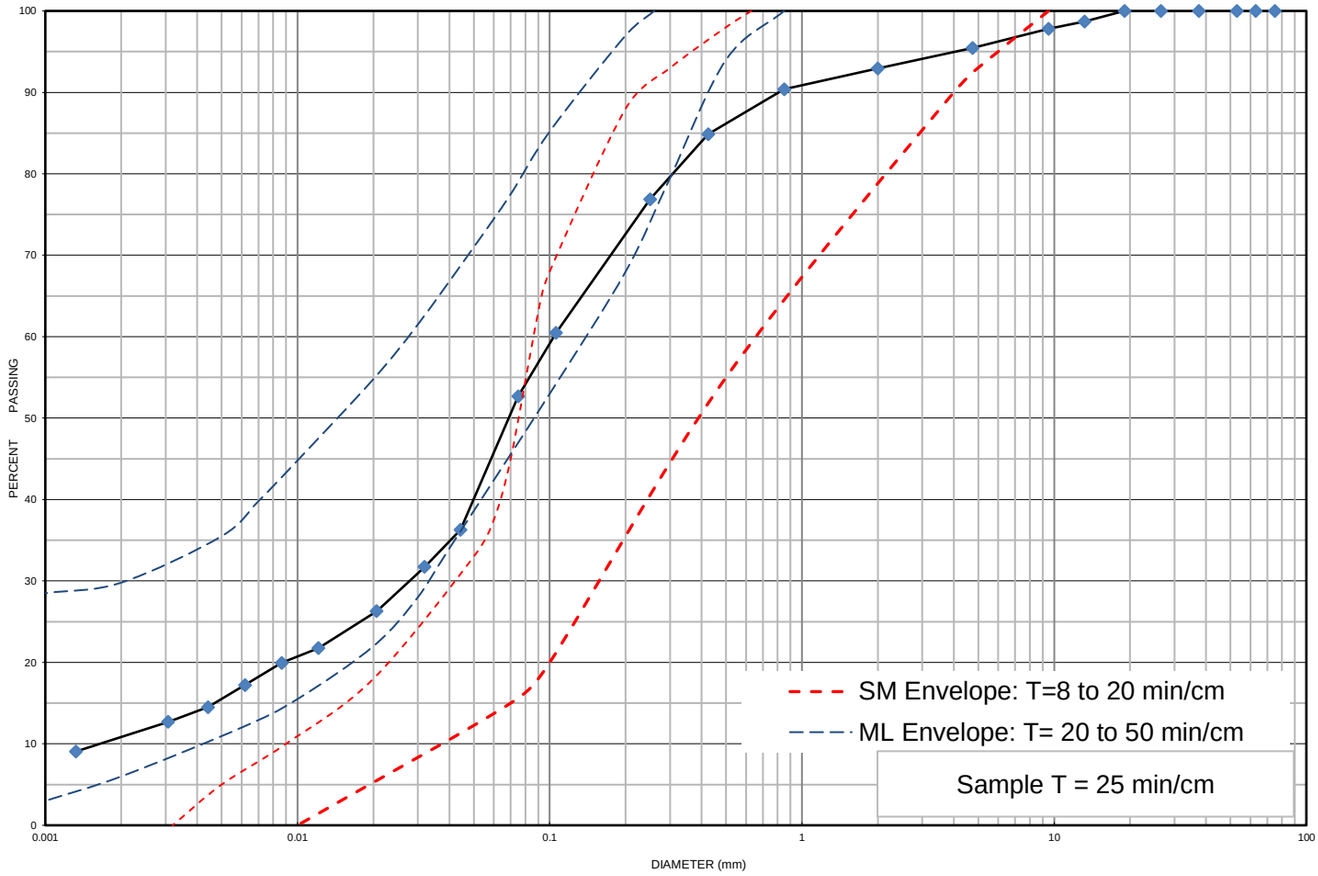
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 3* **Depth:** *1.5 m to 1.8 m* **Lab Sample No:** *S-20-0822*

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 101-20	SS 3	1.5 m to 1.8 m	5	43	41	11	9.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	ML	0.1100	0.0180	0.0016	68.75	1.84

Additional information availabe upon request

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Grain Size Distribution Chart

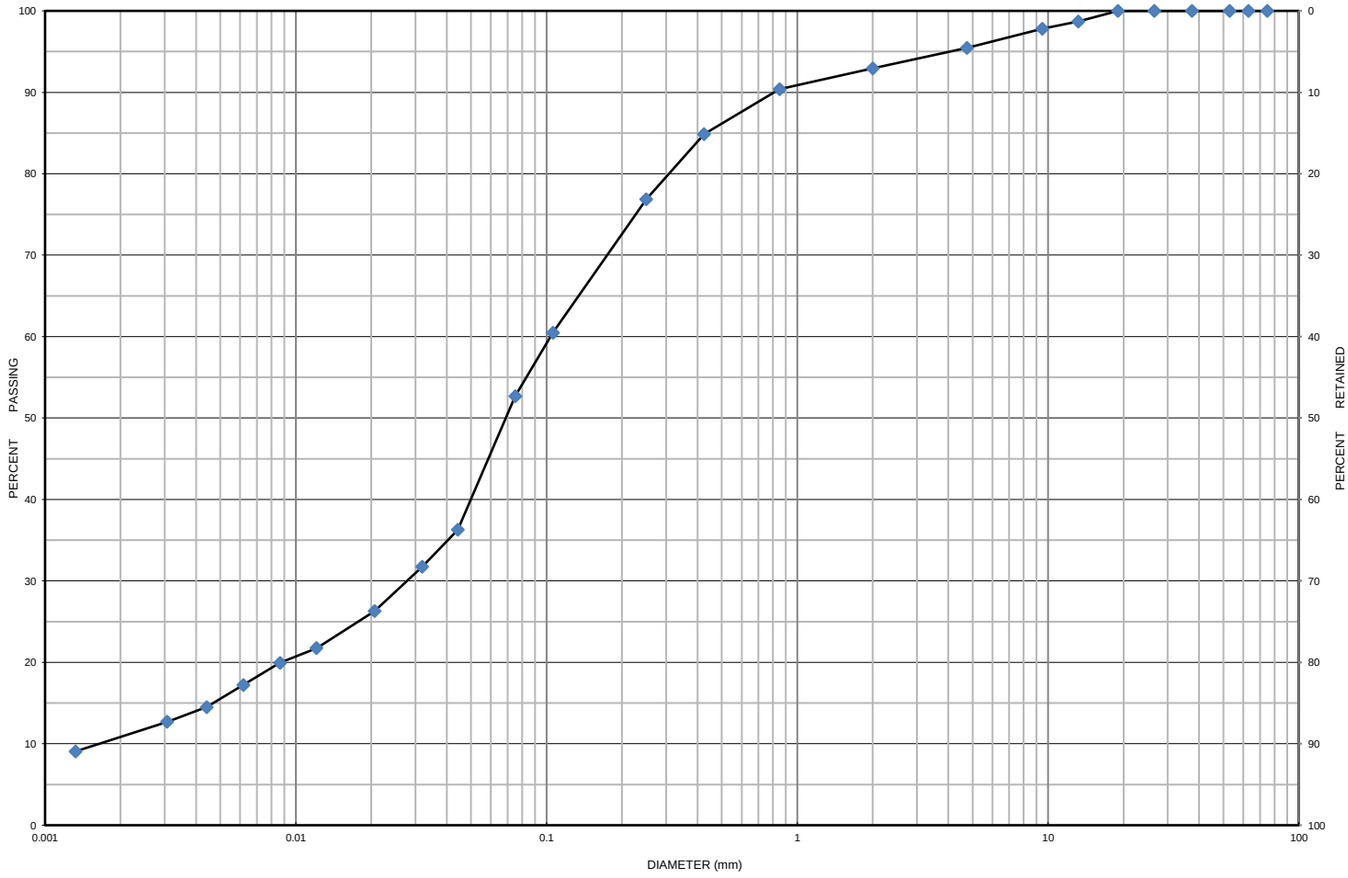
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 3* **Depth:** *1.5 m to 1.8 m* **Lab Sample No:** *S-20-0822*

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 101-20	SS 3	1.5 m to 1.8 m	5	43	41	11	9.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	ML	0.1100	0.0180	0.0016	68.75	1.84

Additional information available upon request

Issued By: _____ *Date Issued:* *October 16, 2020*

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Grain Size Distribution Chart

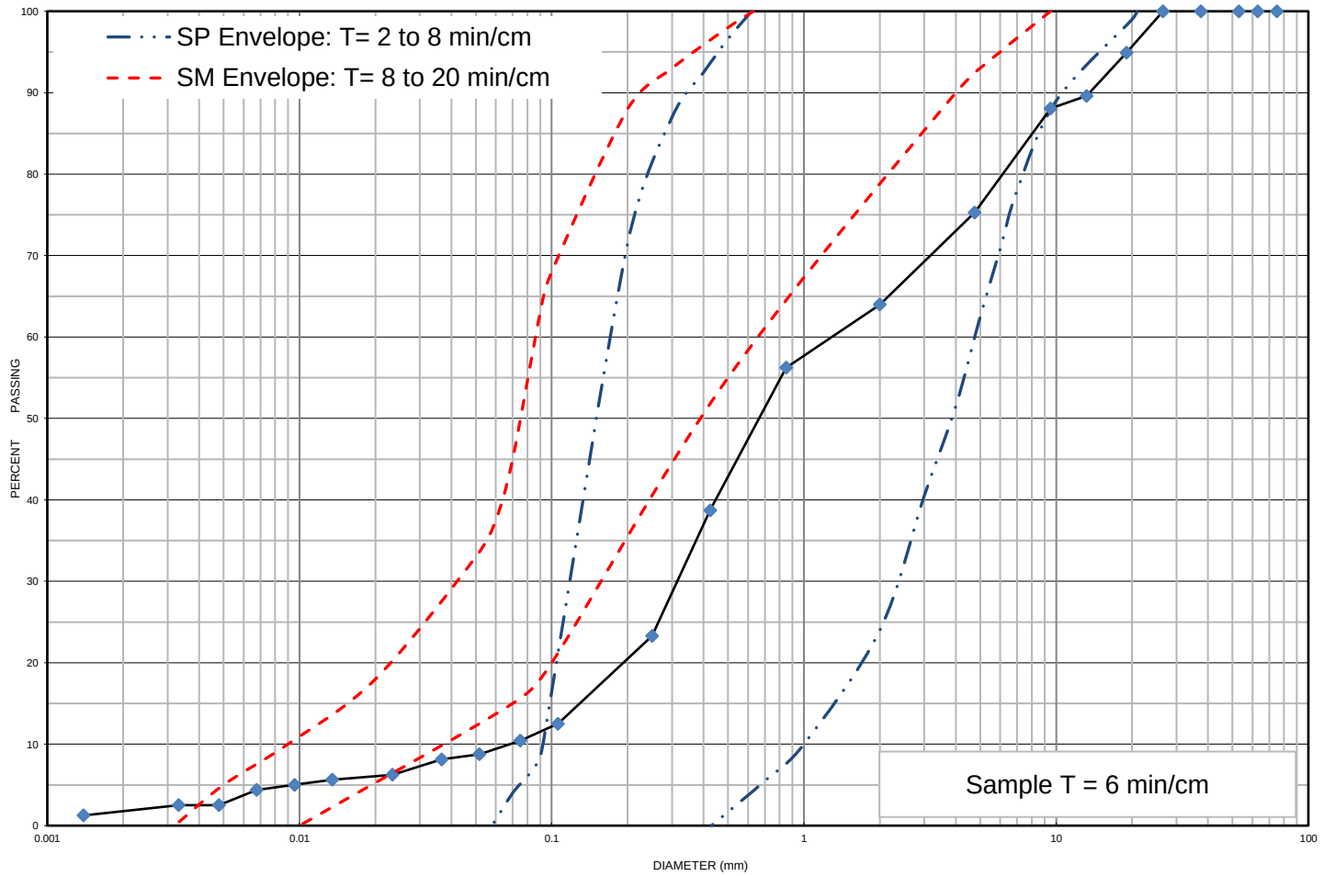
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 2* **Depth:** *0.8 m to 1.2 m* **Lab Sample No:** *S-20-0880*

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 102-20	SS 2	0.8 m to 1.2 m	25	65	8	2	4.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Sand trace Silt trace Clay	SW	1.400	0.310	0.070	20.00	0.98

Additional information available upon request

Issued By: _____ *Date Issued:* *November 24, 2020*

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Grain Size Distribution Chart

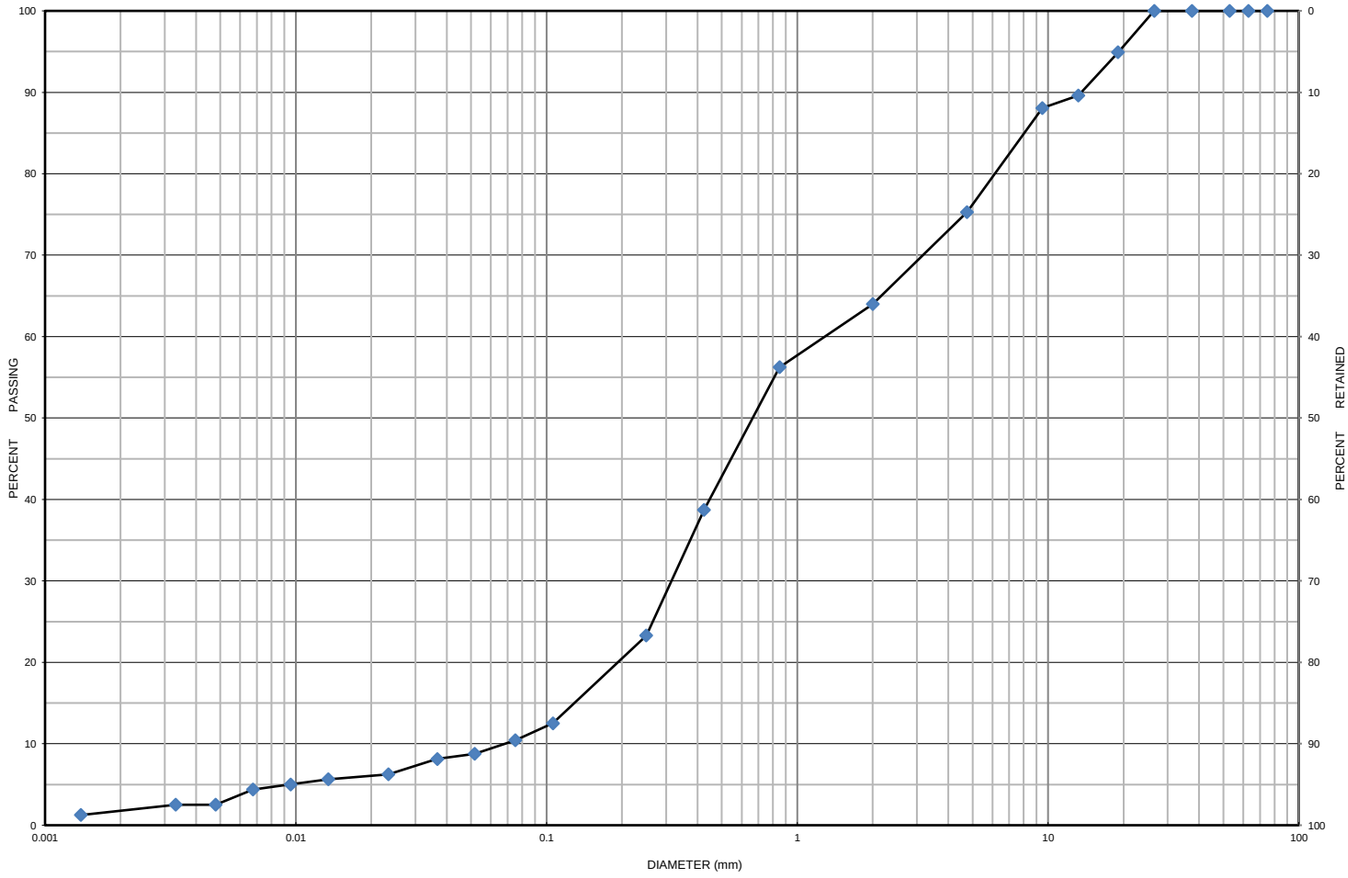
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 2* **Depth:** *0.8 m to 1.2 m* **Lab Sample No:** *S-20-0880*

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 102-20	SS 2	0.8 m to 1.2 m	25	65	8	2	4.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Sand trace Silt trace Clay	SW	1.400	0.310	0.070	20.00	0.98

Additional information available upon request

Issued By: _____ *Date Issued:* *October 27, 2020*

(Senior Project Manager)

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Grain Size Distribution Chart

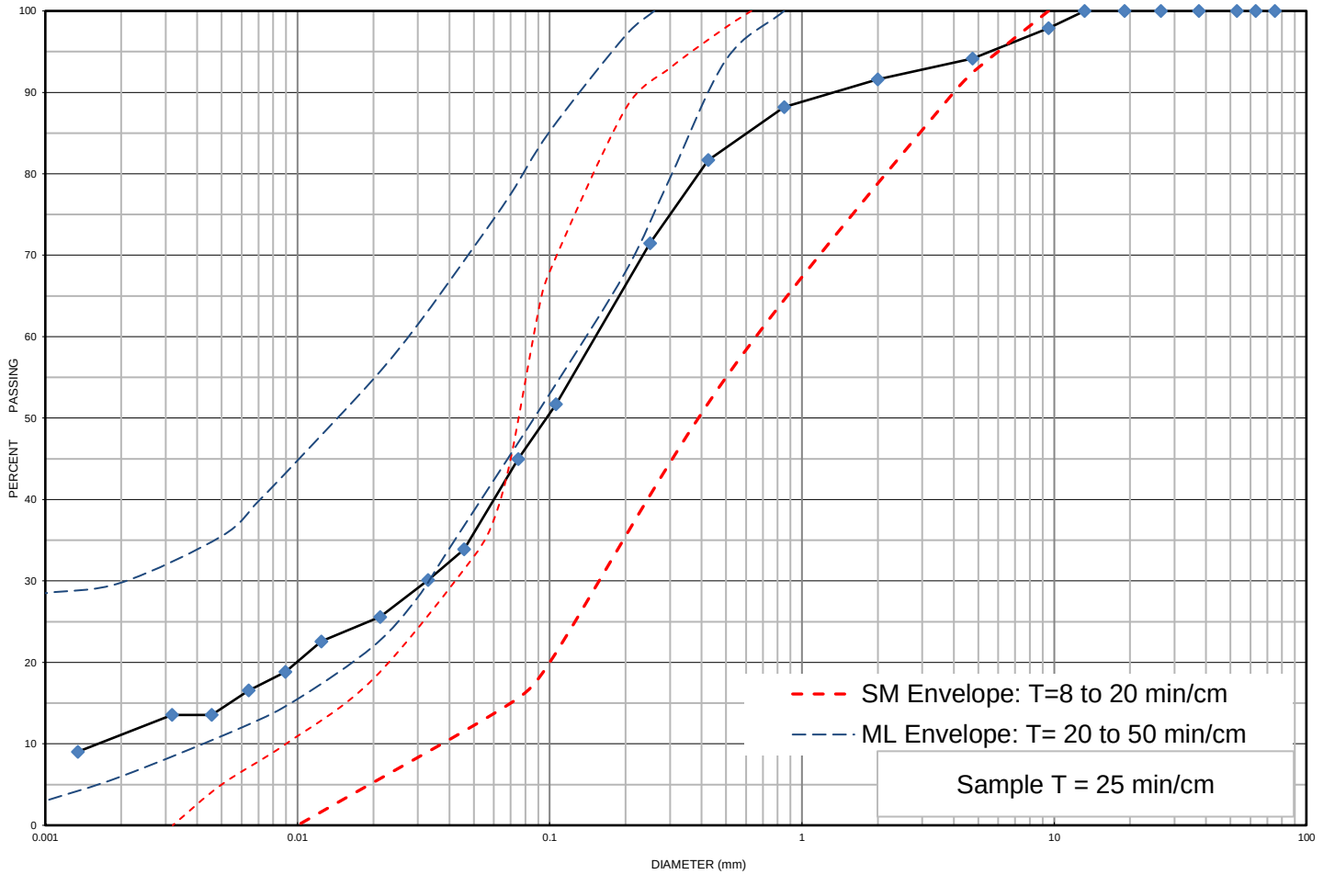
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 2B* **Depth:** *0.9 m to 1.2 m* **Lab Sample No:** *S-20-1094*

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 101-20	SS 2B	0.9 m to 1.2 m	6	49	33	12	9.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand some Clay trace Gravel	SM	0.1550	0.0320	0.0016	96.88	4.13

Additional information availabe upon request

Issued By: _____ *Date Issued:* *November 26, 2020*

(Senior Project Manager)

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Grain Size Distribution Chart

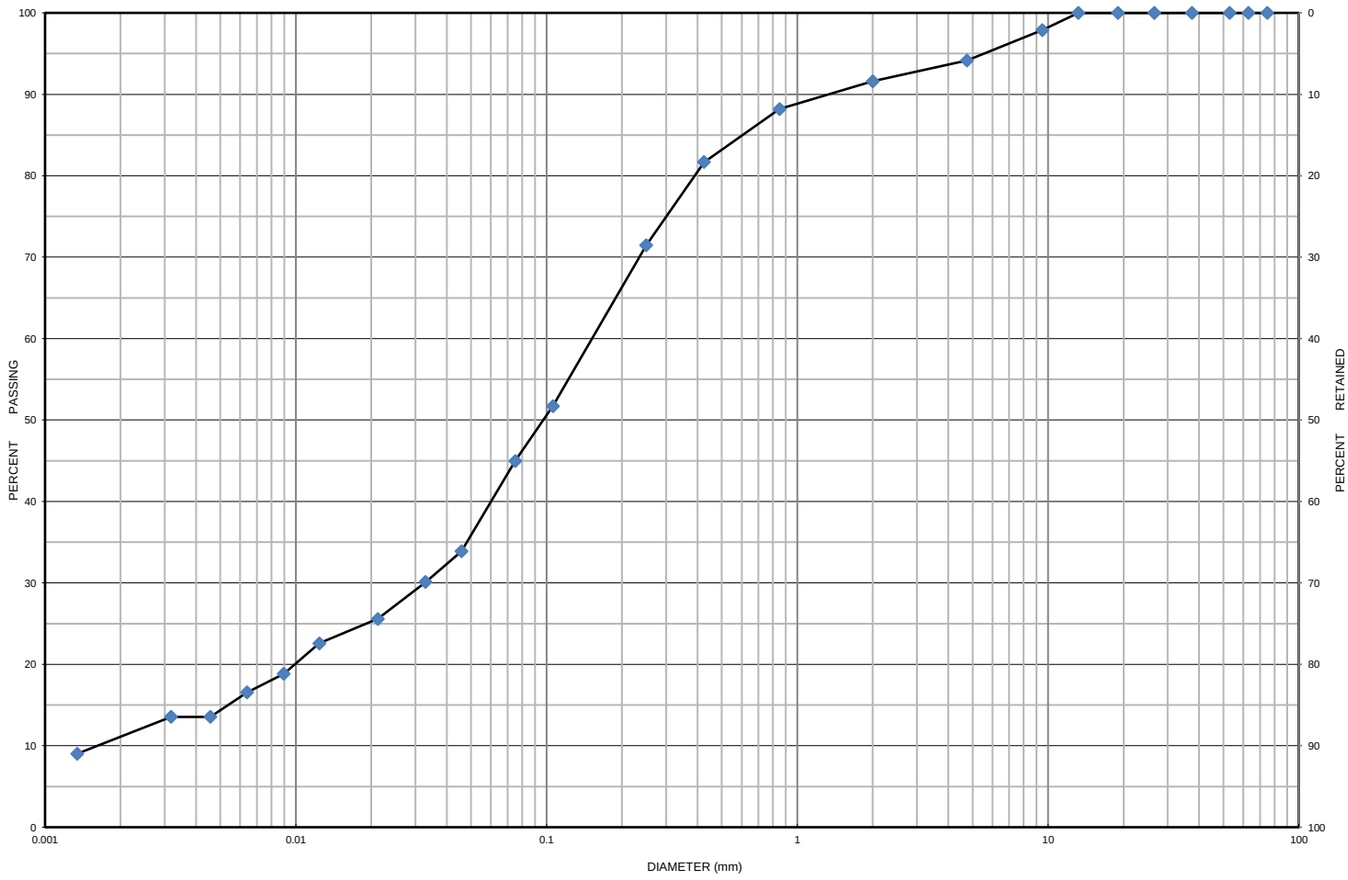
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 2B* **Depth:** *0.9 m to 1.2 m* **Lab Sample No:** *S-20-1094*

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 101-20	SS 2B	0.9 m to 1.2 m	6	49	33	12	9.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand some Clay trace Gravel	SM	0.1550	0.0320	0.0016	96.88	4.13

Additional information available upon request

Issued By: _____ *Date Issued:* *November 26, 2020*

(Senior Project Manager)

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Moisture Content

Project Number: 10273-001
Project Name: 189-197 Duckworth St.
Client: Cygnus Developments
Date Taken: 2020-10-02

Lab Number: S-20-0820
Date Tested: 2020-10-08
Tested By: AM

Borehole Number	Sample Number	Sample Depth (m)	Water Weight (g)	Water Content (%)	Additional Observations
101	1	0.000-0.610	30.5	20.1	1
101	2A	0.762-0.914	32.0	18.4	N/R,1
101	2B	0.914-1.219	30.9	13.3	
101	3	1.524-1.829	55.8	9.9	N/R
101	4	2.286-2.591	26.9	8.0	N/R
101	5	3.048-3.200	7.3	3.0	N/R
101	6	4.572-4.724	9.3	4.6	
102	1	0.000-0.610	16.2	23.6	1,N/R
102	2	0.762-1.219	10.8	4.5	
102	3	1.524-1.981	14.5	4.2	
102	4	2.286-2.743	31.5	9.9	
102	5	3.048-3.505	92.7	9.6	N/R
102	6	4.572-4.724	13.4	9.6	
103	1	0.000-0.610	26.3	13.7	1
103	2	1.524-1.981	12.9	5.7	
103	3GS	3.048-3.048	17.1	6.4	

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

Appendix C

2015 National Building Code Seismic Hazard Values

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 44.399N 79.673W **User File Reference:** 189 Duckworth St., Barrie, Ontario 2020-10-19 18:16 UT

Requested by: Cambium Inc.

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.080	0.049	0.032	0.011
Sa (0.1)	0.110	0.071	0.047	0.017
Sa (0.2)	0.108	0.071	0.049	0.019
Sa (0.3)	0.092	0.062	0.043	0.017
Sa (0.5)	0.077	0.052	0.036	0.013
Sa (1.0)	0.047	0.031	0.021	0.006
Sa (2.0)	0.025	0.016	0.010	0.003
Sa (5.0)	0.006	0.004	0.002	0.001
Sa (10.0)	0.003	0.002	0.001	0.000
PGA (g)	0.063	0.040	0.027	0.009
PGV (m/s)	0.064	0.040	0.026	0.008

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information