Subsurface Investigation Report

6787 Hiram Drive, Ottawa, ON, K4P 1A2

Abstract

This report presents the Findings of a subsurface investigation completed at the 6787 Hiram Drive parcel, in the City of Ottawa, ON, K4P 1A2, and issue recommendations for a proposed Light Industrial Warehouse. It consists on a qualified interpretation of the subsurface conditions at 3 boreholes from information compiled from field sampling and testing and a subsequent laboratory testing program of soils. The borehole locations are shown in figure 1 in page 6. The information reviewed also includes a site reconnaissance, readily available geologic information from the Geological Survey of Canada (GSC), and local climate data from Environment Canada.

Yuri Mendez M. Eng., P. Eng.

Report number: 33-VPS-R1[1]
January 03, 2019
Re: City of Ottawa file D07-12-18-0090 referred to as "Site Plan Control Approval Application - 6787 Hiram Drive"

Yuri Mendez Engineering

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[1]For the account of Venom Powersports Ltd. (VPS) as per proposal dated email dated March 07, 2018 and subject to the user agreement in page 13

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Contents

1 Report Organization

The body of this report and its appendices constitute the entire report. To facilitate expedite and efficient use of its contents, the most relevant aspects in connection with the findings of this investigation are described in the body under section headings. The discussion presented under sections in the body may refer to further information and/or background and/or details which may be required contextually for each topic in the appendices. The reader is responsible of reviewing the information in the appendices as applicable for each case. Other references may be presented as footnotes.

2 Sampling and Testing

The field and laboratory program set out in our proposal dated email dated March 07, 2018, is guided by the following standards:

- ASTM D 420-98 Standard Guide to Site Characterization for Engineering Design and Construction Purposes,
- ASTM D5434 - 12 Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock,
- ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils,

The program also included an elevation survey referenced to an elevation of 100 m assigned arbitrarily to the pavement at the intersection of the center lines of Hiram Drive and Mckeowm Drive (TBM) shown in the Test Hole Locations Plan in fig. 1 in page 6. The program included in addition a laboratory review of samples recovered from the field and one sample submitted to a local laboratory to investigate soluble ions concentration, PH and resistivity.

The test hole locations are shown in the test-hole location plan in figure 1 in page 6. The laboratory testing, soil sampling and field testing at each location are shown in the soil profile testing and sampling logs (BH) in the appendices.

Note that all references to elevations in this report are with respect to the TBM.

3 Physical Settings, Strata and Topography

The site and surrounding streets and properties are relatively flat. It consists on the 6787 Hiram Drive parcel in the City of Ottawa, ON. Figure 1 in page 6 shows a plan view of the site displaying the approximate test hole locations, elevations and depth. Figure 2 in page 6 presents a schematic site cross section including some borehole data.

The geology data base by Belanger J. R. 1998 suggests 10 to 15 m of overburden soils underlain by dolomite bedrock at this site.

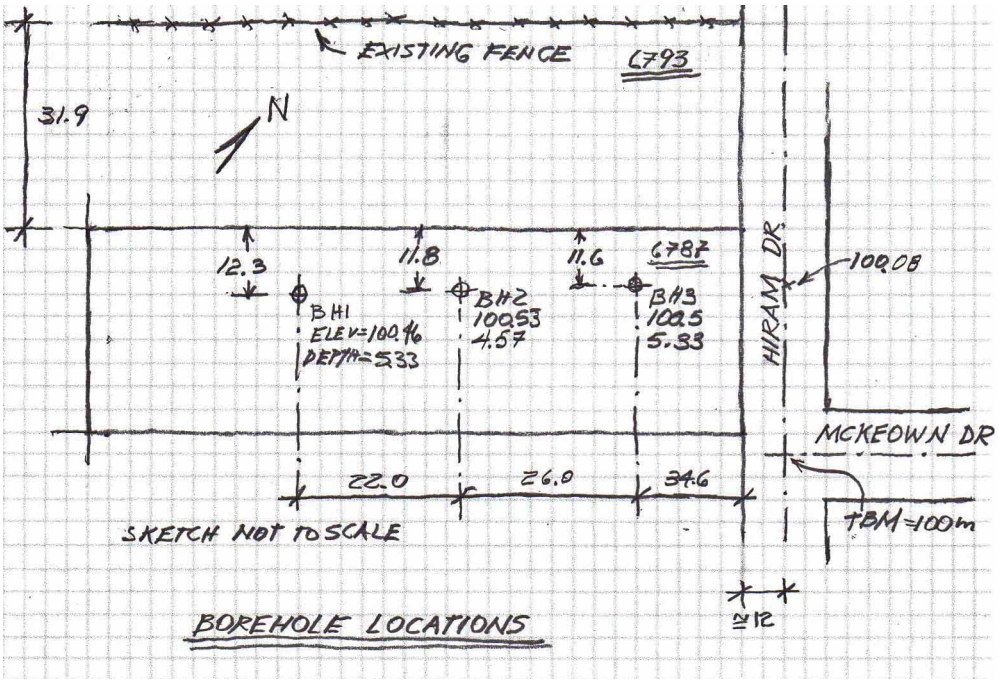

Figure 1: Test hole Locations Plan

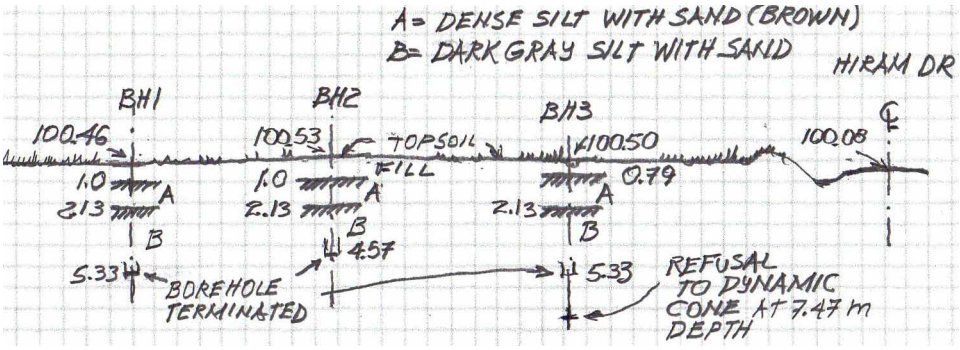

Figure 2: Schematic cross section A-A

3.1 Surface and Subsurface Materials

The site surface is grass and topsoil covered. The arrangement of strata found in our investigation is shown in the borehole logs in appendix A. The schematic cross section shown in Fig. 2 in page 6 presents rough details regarding the geometry, depth and strata found during this investigation at the borehole locations. Generally,the site is underlain by dense silt with sand and trace clay. At surface, the dense silt with sand and trace clay is overlain by 0.79 to 1 m of fill at the borehole locations. The DCPT test suggests bedrock or very dense materials depth of approximately 7.47 m at BH3. Refer to the borehole logs in appendix A for specific and accurate details at each location.

3.2 Groundwater and Moisture

The water level was measured on March 26, 2018 in monitoring wells installed in BH3 at 0.25 m depth respectively and shown in the borehole logs. Ground water measurements in stand pipe installations often require numerous assessments in combination with borehole data.

The above noted measurement was completed during the spring thaw with water ponding seen at several locations and is interpreted as water perched within the surface materials. From borehole data it is seen that the transition of brown coloration to gray occurs at about 2.1 m which strongly suggest that the permanent ground water table is approximately at this depth.

4 Recommendations

The following set of the recommendations result from sampling and testing outlined in section 2 and from geotechnical engineering evaluation and assessments.

It is understood that the proposed Light Industrial Warehouse may be of slab on grade construction.

4.1 Foundations General

Generally speaking, code compliant Part 9 and Part 4 buildings founded on shallow spread footings can be considered for the proposed Light Industrial Warehouse.

4.1.1 Load and Resistance Factors

For the purpose of computations related to the service (SLS) and strength limits (ULS) note:

- A resistance factor of 0.5 is applied to the computed or estimated (nominal) bearing resistance to obtain the strength limit for factored loads (ULS).

- An average load factor of 1.5 is assumed to compute the service limit (SLS).

4.2 Bearing Capacity of Strip and/or Pad Footings

Shallow strip or pad footings below frost depth can be given consideration for the proposed Light Industrial Warehouse.

Based on the findings of this investigation and geotechnical assessments, the following bearing capacity can be used *for strip footings up to 1.0 m wide and pad footings up to 2 m wide placed on undisturbed dense silt with sand and trace clay or engineered backfill placed on undisturbed soils*:

- 150 kPa at service limit (SLS).
- 225 kPa for factored loads (ULS).

4.3 Settlements

For the footing loads provided in section 4.2 building settlements for foundations on undisturbed soils are not to exceed limiting values of 25 mm and 20 mm total and differential settlements respectively at this site.

4.4 Frost Protection for Foundations

Shallow foundations in section 4.2 are considered to be frost protected when placed at sufficient depth to prevent supporting soils from freezing. Foundations in the perimeter of heated buildings where snow is not cleared are considered frost protected at 1.5 m depth (as having a soil cover of 1.5 m). Foundations away from heated buildings or in areas where snow is cleared, need to be at about 1.8 m depth to be frost protected. On the alternative frost protection can be provided by using foundation insulation for shallower foundations.

4.4.1 Foundation Insulation

For foundation placement not having the minimum soil cover protection indicated in section 4.4 and in unheated areas in otherwise heated buildings foundation insulation is required. Frost protection of unheated buildings can also be considered at shallow depths by insulation placement beneath the entire perimeter and extending out via insulation "skirts".

Generally speaking, 75 mm of extruded polystyrene insulation (XPS) type V, VI or VII meet foundation insulation requirements for the freezing index in the Ottawa area. However, foundation insulation requirements include vertical placement and are highly dependent on geometry and foundation loads. It is hence advised to have a geotechnical review or design with view of the proposed geometry.

4.5 Site Class for Seismic Design

At this site, the geotechnical testing completed along with the estimated 7.47 m depth of bedrock (or hard strata) via Dynamic Cone Penetration (DCPT) conducted in BH3 are indicative of a Vs(30) between 360 to 760 m/s. As such, site class C is assigned under the provisions in section 4.1.8.4 of the Ontario Building Code 2012 (OBC 2012) for seismic design. It is hence recommended to refer to the following information in appendix B.1:

1. The 2010 National Building Code Seismic Hazard Calculation for the *reference site* in page 22.

2. Figure 3 in page 21 showing the design spectral accelerations.

4.6 Roadbed Soils and Pavement Structure

Generally, for low volume roads, the pavement structure to be placed on native soils or engineered roadbed at this site may consist of 400 mm of OPSS granular B, 150 mm of OPSS Granular A and up to 75 mm of asphalt.

For parking lots, pavement structure to be placed on native soils or engineered roadbed at this site may consist of 300 mm of OPSS granular B, 150 mm of OPSS Granular A and 50 mm of asphalt. This thicknesses will vary depending on expected traffic at different locations.

4.7 Excavations, Open Cuts, Trenches and Safety

Typically, the main concern when excavating soils or rock is the stability of the sides of excavations. The stability of the sides is achieved by either cutting the sides to safe slopes or by providing shoring. It is also an issue of safety because of imminent hazards to the safety of workers and to property. As such, excavations are governed by the provisions in the Occupational Health and Safety Act of Ontario (O. Reg. 213/91). The application of O. Reg. 213/91 requires a classification of soils in one or several of four types (type I to type IV). At this site for soils can be considered type II under O. Reg. 213/91. As such, the following key aspects of O. Reg. 213/91 are applicable to excavations:

- Safe open cut is 1 vertical to 1 horizontal.

- Within 1.2 m of the bottom of open cut areas or trenches, the soil can be cut vertical.

Where the safe open cut is not provided, either the shoring systems described in O. Reg. 213/91 or engineered shoring systems need be used.

Note also that since excavation and safety are usually in control of the contractor, *shoring design and construction is done by the contractor.*

4.8 Underground Corrosion

For the resistivity, PH and soluble ions concentrations found at this site and shown in the Paracel Laboratories certificate of analysis in appendix C.1, the soils are mildly corrosive. Resistivity, PH and soluble ions testing was completed in a representative sample at a 1.8 m depth in BH1. After Romanoff (1957)[2], the following corrosion rates can be used:

1. For carbon steel:
    - 16 μm/year for the first 2 years,
    - 12 μm/year, thereafter.
2. For galvanized metal:
    - 4.6 μm/year for the first 2 years,
    - 3.2 μm/year until depletion of zinc,
    - 12 μm/year for carbon steel.

4.9 Potential of Sulphate Attack to Concrete

For the sulphate content less than 0.1% in soil encountered at this site, there are no restrictions to the cement type which can be used for underground structures. This refers to restrictions associated with sulphate attack only.

4.10 Special Issues or Concerns

Our investigation did not reveal special concerns for the proposed development, such as slope stability, liquefaction, organic materials, etc.

4.11 Construction Recommendations for Stripping, Excavation to Undisturbed Soils, Fill Placement and Compaction

Appendix D presents recommended geotechnical guidelines for stripping, excavation to undisturbed soils, fill placement, compacted lifts thicknesses for equipment type and compaction for different placements.

[2]Romanoff's work for the U. S. National Bureau of Standards is authoritative in underground corrosion

5 Responses to Requests from the City of Ottawa

5.1 Requests Dated December 21, 2018 under File D07-12-18-0090

This section provides information to amend this report in response to items 33 to 41 in the December 21, 2018 City of Ottawa request made under C of O file D07-12-18-0090 referred to as "Site Plan Control Approval Application - 6787 Hiram Drive".

Note that the above noted request includes items that are unrelated to the findings of this investigation.

5.1.1 Response to Item 33

Item 33 reads "All elevations must be geodetic. Please ensure that all elevations are a referenced to the geodetic benchmark."

This request have never been made in 9 years of reports in the C of O. Geodetic elevations are at times provided when

- there is a geodetic benchmarrk available at the time of the investigation and an elevation survey is part of the services agreed upon or
- when the client hires a surveyor to pick borehole elevations.

Although, these geodetic elevations at borehole locations under the conditions noted above are occasionally available it is not always the case neither they have been rendered as a must (in boreholes in geotechnical reports) in the past by the C of O. In any event, the request would need to be fulfilled by a surveyor.

5.1.2 Response to Item 34

Item 34 reads "Please provide the groundwater elevation referenced to a geodetic benchmark".

The response to item 33 applies.

5.1.3 Response to Item 35

Item 35 reads "The City also requests data for both the undisturbed and remoulded vane shear test. Please provide these results in a table in the appendix."

There was no vane testing at this site, however, remoulded vane testing are always done (when they apply) for geotechnical assessments but have never been explicitly reported in 9 years of reports.

5.1.4 Response to Item 36

Item 36 reads "While your reporl does clearly state that liquefaction is not likely to occur at this site, please also address the possibility of liquefaction-like behaviour."

Because this report states that liquefaction is not a concern, there are no comments regarding the probability of liquefaction to be made that are relevant to the development.

5.1.5 Response to Item 37

Item 37 reads "Moisture depletion of the silty clay soil caused by water demand of trees is a known cause of foundation distress in the Ottawa area. Please identify if the soils on this site will experience moisture depletion issues."

There are no moisture depletion issues that are relevant to the development. There is no silty clay identified in the report at this site.

5.1.6 Response to Item 38

Item 38 reads "Sensitive marine clays are widely found across the Ottawa area. Please discuss if they are present on this site. lf marine clay soils have been identified on site, please discuss what measures would be implemented."

There were no marine clays found at this site. There are no comments in this regard that are relevant to the development.

5.1.7 Response to Item 39

Item 39 reads "Please include a Summary or Conclusions section for quick reference."

There are no conclusions to geotechnical reports neither there have been conclusions in 9 years. It is believed that there is no reasonable justification to a conclusion in them.

5.1.8 Response to Item 40

Item 40 reads "Please indicate in the report what the pavement design for the fire route is and if the low volume design is adequate for fire trucks."

There are only 2 pavement structures indicated in the report, one for parking lots and the other one elsewhere. The flexible pavement structures supplied in this report follow the guidelines set out in AASHTO 1993 Guide for Design of Pavement Structures (AASHTO) for climatic Region III. Under AASHTO pavements are designed to withstand 20 year accumulated design Equivalent Single Axle 80 kN (18,000 pounds) load applications (ESALs). And of course this includes fire trucks.

5.1.9 Response to Item 41

Item 41 reads "Please provide more information on the pervious pavement used on this site. lf this is to be a specialized type of pavement, we will need detailed information in the Geotechnical Repoft ".

YME is unaware of any proposal for pervious pavement at this site at the time of writing and at the time of investigation.

User Agreement

Acknowledgment of Duties

In this 33-VPS-R1 report, Yuri Mendez Engineering (YME) has pursued to fulfill every aspect of the obligations of professional engineers. As a part of those duties, from field work, operations, testing, analyses, application of knowledge and report, YME has ensured that it meats a high standard of Geotechnical engineering practice and care in the province of Ontario. Obligations under R.R.O. 1990, Reg. 941: Professional Engineers Act, R.S.O. 1990, c. P.28, further referred to as Reg. 941 which are of immediate interest to this service are:

"77. 7. A practitioner shall,

i. act towards other practitioners with courtesy and good faith,

ii. not accept an engagement to review the work of another practitioner for the same employer except with the knowledge of the other practitioner or except where the connection of the other practitioner with the work has been terminated,

iii. not maliciously injure the reputation or business of another practitioner,

8. A practitioner shall maintain the honour and integrity of the practitioners profession and without fear or favour expose before the proper tribunals unprofessional, dishonest or unethical conduct by any other practitioner."

Communications

33-VPS-R1 is to be used solely in connection with the Light Industrial Warehouse by Venom Powersports Ltd. (VPS) and thus subject of communications amongst other professionals (OP), government bodies and authorities, and VPS for that purpose. YME demands great care in precluding damage to the integrity of this professional work which may arise from careless communications from engineers of Canada. OP and VPS acknowledge understanding that where any such communication occur in connection with this report, they are bound by this agreement as an extension to the standard of care embodied in R.R.O. 1990, Reg. 941 and thus accept that any correspondence from OP or the public seen to add any bad connotations to the breadth, depth, typesetting, typography, formal semantics and scope of this report or otherwise diminish the breadth of services and knowledge delivered in this report which in any way raise concerns or insecurities to the qualities and/or the *reasonable completeness* delivered to VPS in this report will be forwarded to YME.

Reasonable Completeness

OP and Venom Powersports Ltd. acknowledge understanding that said care and said standard has been applied equality to the reasonable completeness of this report relative to the information available from the field program and acknowledge understanding that is neither feasible nor possible to convey geotechnical information in this report that would cover for every possible consideration by OP and/or VPS and that upon issuance it will be subject to reviews which may trigger the need to add information which at the discretion of YME will be added when considered within the practice obligations under Reg. 941. The geotechnical information here provided is thus envisioned as to cover for the scope and breadth of design figures and assessments generally foreseeable as needed by other designers at the time of issuance and which could be amended as needed within the context of services provided by

other designers. YME agrees to issue revised versions of this 33-VPS-R1 report by adding R# to each revision where # is the number of the revision. OP covenant to conduct all communications in connection with these reviews following great care to preclude the suggestion of a breach to the reasonable completeness acknowledged herein. Written communications which may trigger reviews under this agreement will be acknowledged as requests for "review under the 33-VPS-R1 report user agreement". This reasonable completeness is also relative to the scope of services generally accepted in geotechnical engineering work in Ontario

Errors

Where errors are found during reviews under the 33-VPS-R1 report user agreement, OP covenant great care in communications to preclude the suggestion of a breach to the duties acknowledge herein which could induce damages to YME. Communications triggered by errors or any such communication which would render the person doing the request in a position of technical authority above the author implies an unauthorized review and constitute a serious breach of the code of ethics under Reg. 941 and damages to YME and so subject to disciplinary measures and/or liability for damages to YME. VPS is thus acquainted that correction of errors will be made and acknowledged by YME as they may arise in any professional work but in no way OP will purport or render such corrections as omissions departing away from the correction of errors set forth in this agreement. Where communications in connection with the correction of errors process set forth in this agreement raise concerns or insecurities to the qualities and/or the reasonable completeness delivered to VPS in this report occur, VPS covenants to inform YME. VPS is acquainted that such corrections are part of the natural processes associated with the applied sciences nature of this report and so typified explicitly in this agreement to protect YME from inappropriate manipulation of those processes by OP and others.

Disclaimer

VPS and OP understand that soils and groundwater information in this report has been collected in boreholes guided by standards and practice guidelines generally accepted for engineering characterization of ground conditions in Ontario and in no case borehole data and their interpretation warrant understanding of conditions away from the borehole locations. VPS accepts that as development will have spread away from the boreholes other designers will need the best opinion from the geotechnical consultant based on the findings of the investigation so that any statements which could be implicitly or explicitly depart from the conditions at borehole may be given to fulfill this need in good faith as best available opinion with the information available at the time without any warranties.

Appendices

A Borehole Logs

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Project:	**Proposed warehouse**	YME Yuri Mendez Engineering.
Location: **6787 Hiram Dr**	Client: **Venom Powersports Inc.**	**Test Hole No.: BH1 of 3**
Job No.: **33-VMS**	Test Hole Type: **Rotary 8"dia.**	Date: **March 22, 2018**
8" Hollow stem augers (4.25" ID).	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 100.46	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.46	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	100.2		Fill: Dark gray silty sand with clay wood and trace gravel	2		100.2	0.25				
0.5							0.5				
0.75	99.7					99.7	0.75				
1			Brownish dense silt with fine sand and trace clay	3			1				
1.25	99.2					99.2	1.25				
1.5							1.5				
1.75	98.7			23		98.7	1.75				
2							2				
2.25	98.2		Dark gray dense silt with fine sand and trace clay			98.2	2.25				
2.5				13			2.5				
2.75	97.7					97.7	2.75				
3							3				
3.25	97.2			17		97.2	3.25				
3.5							3.5				
3.75	96.7					96.7	3.75				
4				6			4				
4.25	96.2					96.2	4.25				
4.5							4.5				
4.75	95.7			5		95.7	4.75				
5							5				
			Borehole terminated at 5.33								

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Measured water level

Project:	**Proposed warehouse**	YME Yuri Mendez Engineering.
Location: **6787 Hiram Dr**	Client: **Venom Powersports Inc.**	**Test Hole No.: BH2 of 3**
Job No.: **33-VMS**	Test Hole Type: **Rotary 8"dia.**	Date: **March 22, 2018**
8" Hollow stem augers (4.25" ID).	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 100.53	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.53	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil		▼		0				
0.25			Fill: Dark gray silty sand with clay wood and trace gravel				0.25				
0.5	100.1					100.1	0.5				
0.75							0.75				
1	99.6		Brownish dense silt with fine sand and trace clay	2		99.6	1				
1.25							1.25				
1.5	99.1					99.1	1.5				
1.75				23			1.75				
2	98.6					98.6	2				
2.25			Dark gray dense silt with fine sand and trace clay				2.25				
2.5	98.1			23		98.1	2.5				
2.75							2.75				
3	97.6					97.6	3				
3.25				21			3.25				
3.5	97.1					97.1	3.5				
3.75							3.75				
4	96.6			21		96.6	4				
4.25							4.25				
4.5	96.1		Borehole terminated			96.1	4.5				

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Measured water level

Project:	**Proposed warehouse**	YME Yuri Mendez Engineering.
Location: **6787 Hiram Dr**	Client: **Venom Powersports Inc.**	**Test Hole No.: BH3 of 3**
Job No.: **33-VMS**	Test Hole Type: **Rotary 8"dia.**	Date: **March 22, 2018**
8" Hollow stem augers (4.25" ID).	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 100.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	100.3		Fill: Dark gray silty sand with clay wood and trace gravel	3		100.3	0.25				
0.5							0.5				
0.75	99.8					99.8	0.75				
1			Brownish dense silt with fine sand and trace clay	4			1				
1.25	99.3					99.3	1.25				
1.5							1.5				
1.75	98.8			28		98.8	1.75				
2							2				
2.25	98.3		Dark gray dense silt with fine sand and trace clay			98.3	2.25				
2.5				28			2.5				
2.75	97.8					97.8	2.75				
3							3				
3.25	97.3			18		97.3	3.25				
3.5							3.5				
3.75	96.8					96.8	3.75				
4				17			4				
4.25	96.3					96.3	4.25				
4.5							4.5				
4.75	95.8			32		95.8	4.75				
5							5				
5.25	95.3					95.3	5.25				
5.5			Borehole terminated at 5.33 m depth	17			5.5				
5.75	94.8		Dynamic cone test (soils not sampled below)	36		94.8	5.75				
6				46			6				
6.25	94.3					94.3	6.25				
6.5				23			6.5				
6.75	93.8			39		93.8	6.75				
7				108			7				
7.25	93.3			133		93.3	7.25				
			Dynamic cone penetration refusal at 7.47 m depth								

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Measured water level

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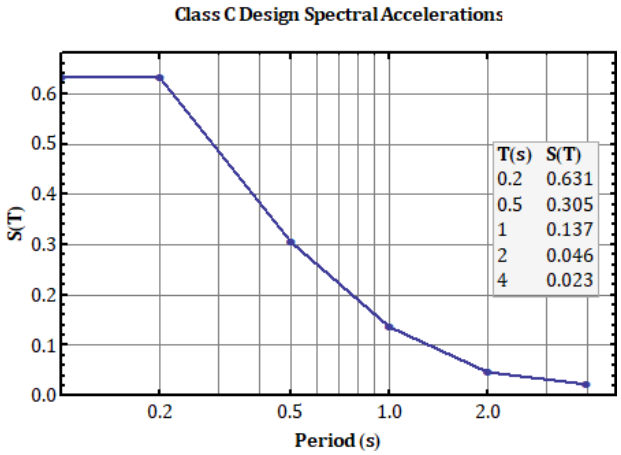


Figure 3:

Appendix

B Geotechnical Site Class Assignment

The ground motion transfered from earthquakes to buildings depend largely on ground conditions. Current seismic provisions in building codes recognize seismic waves as oscillations and buildings as oscillators having natural periods and damping. The role of soils engineering is to assign a site class which defines the interpolations prescribed under the code to obtain a spectrum of period versus damped accelerations using a base *reference site* for design of buildings at a given site. The soils information required to do this site class assignment is the velocity at which a seismic shear wave travels upward 30 meters (or downward) in a given site (Vs(30)). The Vs(30) is estimated based on standard geotechnical testing along with experience and available local data bases. Seismic tests can also be completed to determine the Vs(30) with greater accuracy.

B.1 Reference Site and Design Spectral Accelerations

Details of the *reference site* spectral and peak seismic hazard values applicable to this site are presented in the 2010 National Building Code Seismic Hazard Calculation in page 22 of this appendix. Figure 3 in page 21 presents the design spectral accelerations computed under section 4.1.8.4 of the Ontario Building Code 2012 (OBC 2012) for the site class C assigned to this site.

2010 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

Requested by: , March 29, 2018

Site Coordinates: 45.2558 North 75.5784 West

User File Reference: 6787 Hiram Drive

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.631	0.305	0.137	0.046	0.321

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. 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 calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.088	0.245	0.382
Sa(0.5)	0.043	0.121	0.185
Sa(1.0)	0.017	0.055	0.087
Sa(2.0)	0.0061	0.018	0.028
PGA	0.037	0.121	0.198

References

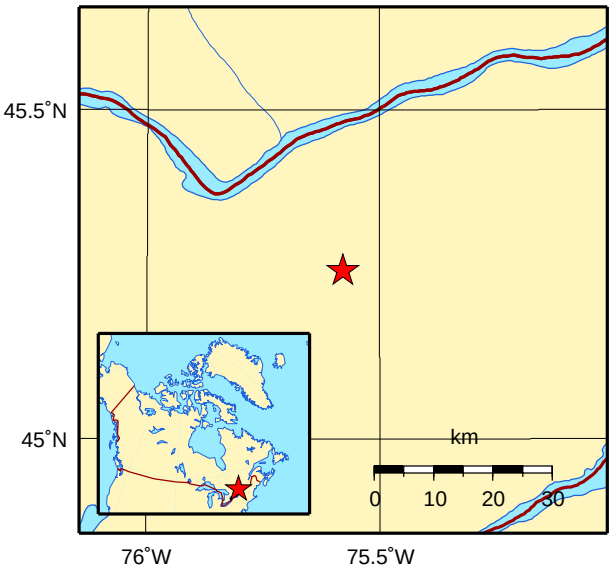
National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

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

Aussi disponible en français



Appendix

C Resistivity, PH and Soluble Salts Test

Certificate of Analysis

Client: Yuri Mendez

Client PO:

Report Date: 28-Mar-2018

Order Date: 22-Mar-2018

Project Description: 6787 Hiram Dr.

	Client ID:	BH1 SS3	-	-	-
	Sample Date:	03/22/2018 09:00	-	-	-
	Sample ID:	1812532-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	86.4	-	-	-
General Inorganics					
pH	0.05 pH Units	7.78	-	-	-
Resistivity	0.10 Ohm.m	51.0	-	-	-
Anions					
Chloride	5 ug/g dry	10	-	-	-
Sulphate	5 ug/g dry	65	-	-	-

Appendix

D Construction Recommendations for Stripping, Excavation to Undisturbed Soils, Fill Placement and Compaction

In the event that any of the following recommendations conflict with municipal and or provincial specifications, the most restrictive applies. For the case when products involving ground conditions are used, the manufacturers specifications take precedence.

D.1 Striping

Topsoil and existing fill must be removed from the perimeter of all proposed structures, including retaining wall, buildings, pavement, parking areas and earth or fill banks for grading.

D.2 Excavation to Undisturbed Soil Surface

All soil surfaces in which to commence construction for all structures are to be preserved in undisturbed condition (Undisturbed Soil Surface (USS)). Where rainy weather and/or equipment operation and/or labours make impractical or difficult the preservation of USS a working-leveling granular pad may be used. Use the compaction requirements and materials for trench foundation (stabilization).

Except as otherwise indicated for select borrow materials at this site, reinstatement of excavated soil is not allowed. When excavation exceeds the depth of the proposed USS, a granular pad using the material and compaction requirements for trench foundation will be used.

It can be assumed that it is impractical to conduct excavations to an even USS. In such case a granular pad not less than 150mm thick must be used to remedy for irregularities caused by the operation of equipment.

D.3 Fill Placement

D.3.1 Compacted Lifts Thicknesses Equipment and Passes

Compacted lifts for non cohesive soils or specified granular will not exceed 200 mm and 150 mm for cohesive soils. For specified granulars, subject to test trials a maximum compacted lift of 300 mm may be accepted provided vibratory compaction equipment rated at 60,000 lb-f (27,300 kg-f) of dynamic force is used.

For road construction passes are to overlap by 300 mm for full coverage.

Where non vibratory pneumatic compactors with ballast an tire pressure of 100 psi (7 kg/cm2) are used (9 or 13 ply) the compacted lift thicknesses will not exceed 150 mm for granular and 120 mm for cohesive soils.

For services and culvert trenches, when using rammers and light vibratory plates weighing less than 115 kg (250 lbs) the compacted lift thicknesses will not exceed 100 and 125 mm respectively. For heavier trench equipment the compacted lifts for non cohesive soils or specified granular will not exceed 200 mm and 150 mm for cohesive soils.

No heavy equipment will be operated above the crown of pipes or culverts unless 1.2 m of fill has been placed or the subgrade elevation has been reached.

For all trenches below the water table, trench foundation not less than 200 mm will be provided as per materials and specification in Table 1 in page 27.

Materials lift placement beneath foundations, slabs or any placement not specified above must abide to the above specifications as they relate to the equipment being used.

D.3.2 Compaction Guide for Passes and Level of Compaction

The contents of this section are provided as guidelines for construction. The resulting compaction densities and compacted lift thicknesses can only be verified by actual testing and field trials respectively.

For equipment passes the contractor may consider not less than 6, 7 or 8 passes for 90, 95 or 100 % Proctor Standard compaction.

For granular materials loose lifts may be approximately 150, 175 and 235 mm for compacted lift thicknesses 125, 150 and 200 mm respectively.

For cohesive materials loose lifts may be approximately 125 and 190 mm for compacted lift thicknesses 100 and 150 mm respectively.

D.4 Compaction General

Table 1 in page 27 presents Proctor Standard (PS) compaction requirements for specified placement and materials.

D.5 Compaction Specific

D.5.1 Compaction Along Basement Walls and Retaining Walls

The consolidation zone is defined as the zone within 0.9 m of the exterior edge of basements or the interior edge of retaining walls. Compaction along the consolidation zone is to be conducted in 125 mm compacted lifts using 2 passes of light vibratory equipment.

D.5.2 Compaction Quality Control

Provide moisture density relationships for Standard Proctor compaction for the proposed materials and source. Conduct one in situ test at randomly selected

Material Placement	Material Description	% PS
Base	OPSS 1010 Granular A	100
Subbase	OPSS 1010 Granular B Type II	100
Subgrade	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve	95
	Cohesive	95
Backfill for trenches under pavement	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve.	95
	Cohesive	95
Under sidewalks top 200 mm	Any OPSS 1010 Granular specification for which 100% passes the 26.5 mm sieve the 26.5 mm sieve	95
	Cohesive	95
Under foundations	Any OPSS 1010 Granular specification for which 100% passes the 106 mm sieve except Granular B Type I	95
Backfill under slabs on grade	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve.	100
	Cohesive	95
Top 100 mm under slabs	Crushed stone 9.5 to 19 mm (use one or several sizes).	90
Pipe bedding and cover (150 mm for bedding to 150 mm above the crown)	Any OPSS 1010 Granular specification for which 100% passes the 26.5 mm sieve	95
Trench foundation (stabilization minimum 200 mm)	Any OPSS 1010 Granular specification for which 100% passes the 106 mm sieve except Granular B Type I	95
Backfill for non building, non traffic and/or non parking areas	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve	90
	Cohesive	90
Placement not specified above	Cohesionless (with 12% or less fines) and 100% passing 106 mm sieve	95
	Cohesive	95

Table 1: Proctor Standard (PS) compaction requirements for specified placement and materials.

locations per 60 m3 of fill. This is approximately one test, each 300 m2 of lift in place. Nuclear or non-nuclear density probes testing can be used.